APPENDIX 5 – LANDSCAPE AND VEGETATION PLAN

Landscape & Vegetation Plan

Dandy Premix Quarries - Grantville Spring 2013



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Introduction

Bass Coast Planning Permit No 120388 was issued to Dandy Premix Quarries on the 7th of August 2013, for the development and use of a sand extraction quarry at 1295-1381 Bass Highway, Grantville. As a condition of permit, Dandy Premix Quarries is required to submit a Landscape and Vegetation Plan (this document), detailing the location of plantings with height at maturity, botanical and common names of plants to be used, as well as ongoing management. The Landscape and Vegetation Plan will form part of the Site Environment Management Plan (SEMP).

A Work Authority No. 1488 for the sand quarry was endorsed by the Department of State Development, Business and Innovation (DSDBI), Energy and Resources, Earth Resources Division on the 3rd of August 2012.

Site

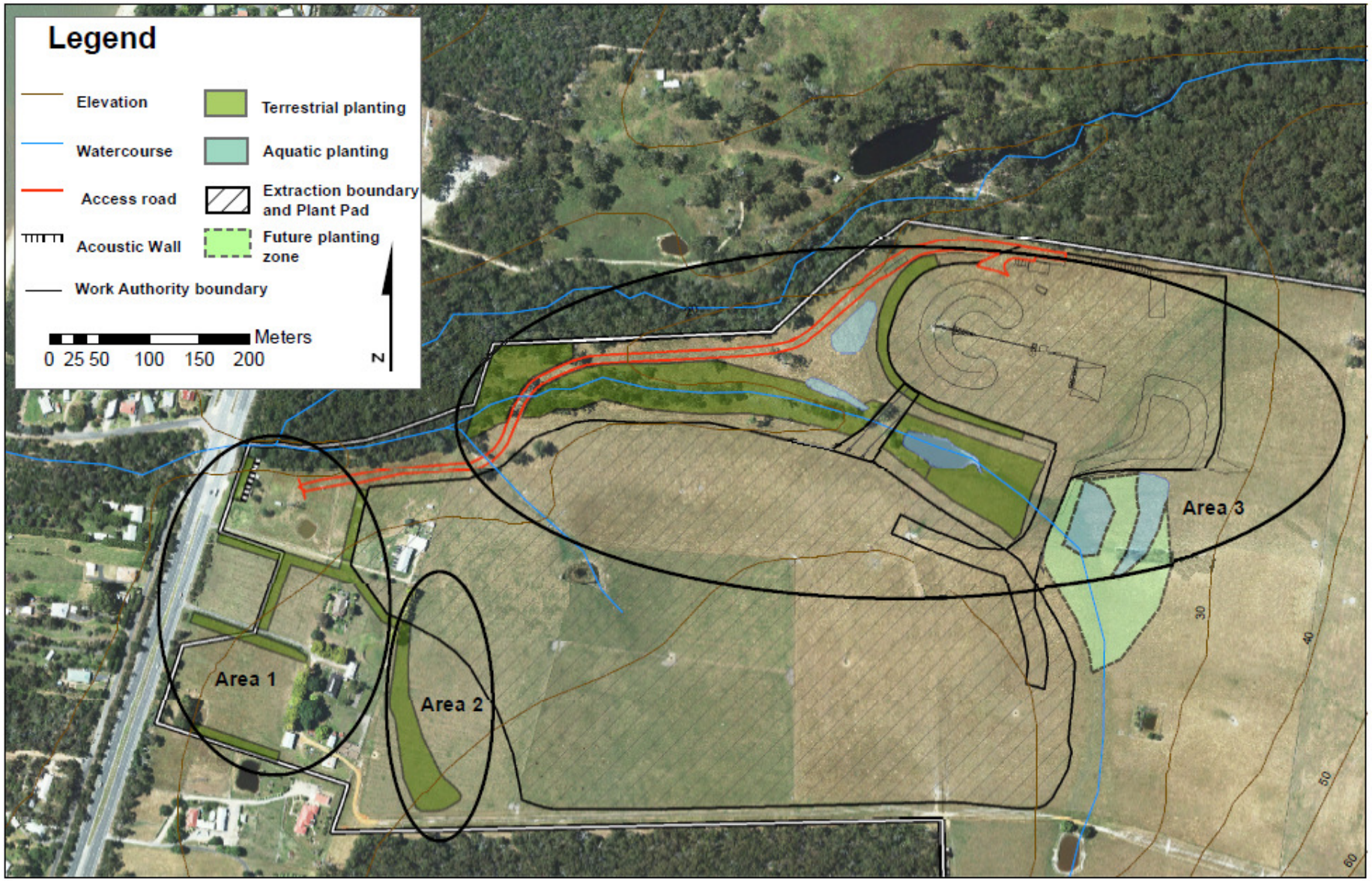
This Landscape and Vegetation plan relates to the area of Work Authority 1488 (WA1488) shown in the following map. There is little of ecological value in this area, having been cleared and converted to exotic pasture for grazing over 50 years ago.

Historically, the type of indigenous vegetation that dominated this area prior to clearing is classified as Lowland Forest (DEPI, 2013). Examples of this type of vegetation can be seen in the nearby Gurdies reserve to the east of the Bass Highway. Scattered large old trees along a small tributary (Melbourne Waterway 3840) of Deep creek now make up the only indigenous vegetation in this WA1488 area.

The development of the site for sand extraction (subject to PP120388) will have minimal impact on existing indigenous vegetation. The location of the quarry, access road and hardstand area (including plant pad) will also minimise the impact on the aesthetic values of the area. As a further precaution a number of plantings have been designed across the area to mitigate any negative impacts on ecology, visual landscape, water quality, noise levels, and air quality. These plantings will also greatly improve the biodiversity values of the WA1488 area - from grazing land with deteriorating scattered large trees, to a densely vegetated and protected waterway with a series of naturally functioning wetlands connecting with Deep Creek and the surrounding vegetation. “These works will contribute significantly to protecting the values of the receiving waters of Deep Creek and Western Port” (Pat Condina, Appendix A).

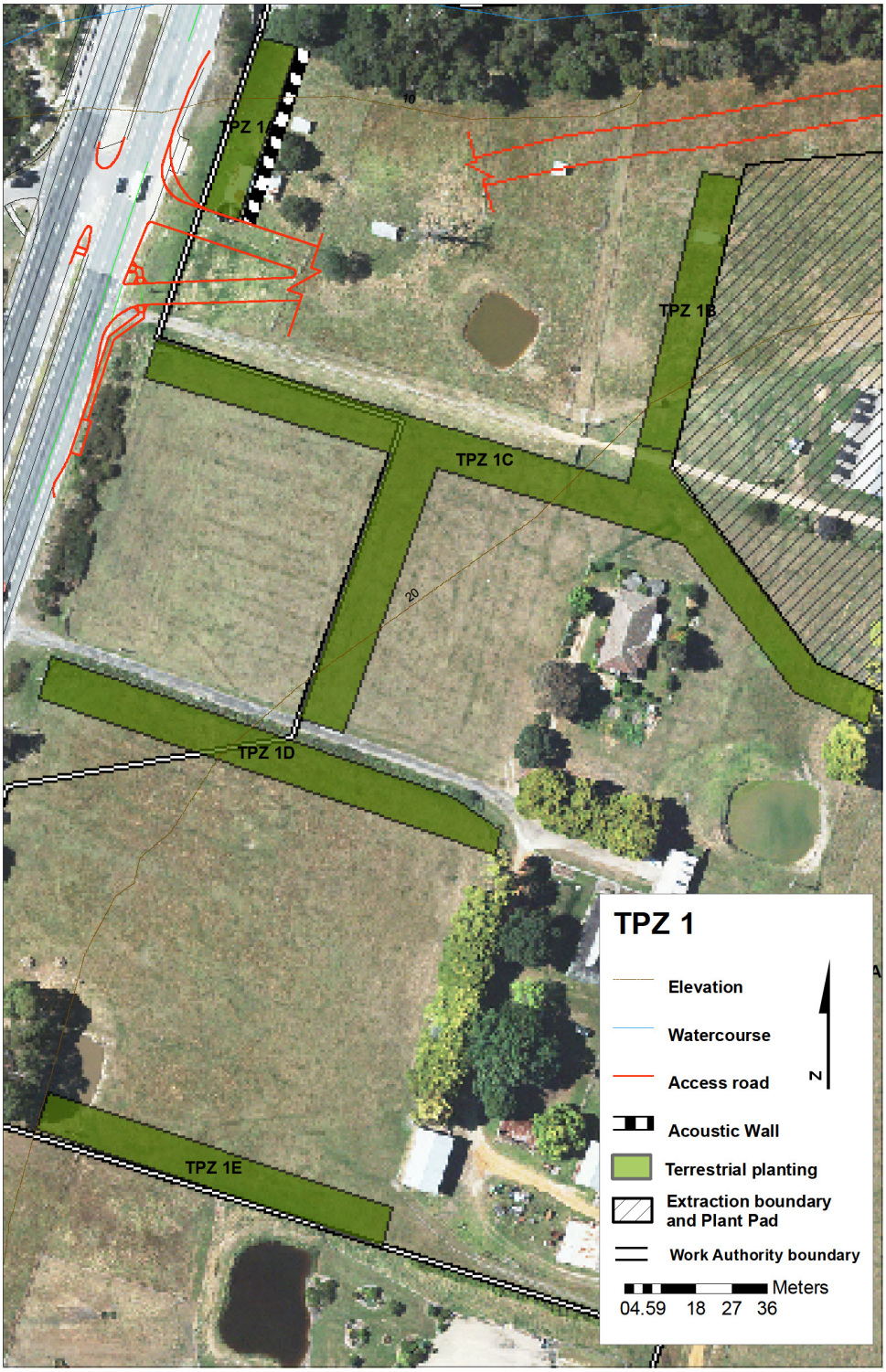
Existing stock fences to the north, east and south-east of the site will be left intact, excluding stock from the landscape and revegetation works.

The area of Work Authority 1488 covered by the Landscape and Vegetation plan



Area 1 – TPZ 1

Terrestrial Planting zones 1A, B, C, D, and E



Overview of TPZ 1 plantings adjacent to the Bass highway

TPZ 1 Description

TPZ 1 is located at the western end of the WA1488 site and has frontage of the Bass Highway. TPZ 1 has a westerly aspect and slopes gently towards the Bass Highway and Western Port. Prior to clearing this site would have been covered by Lowland Forest (DEPI, 2013a).

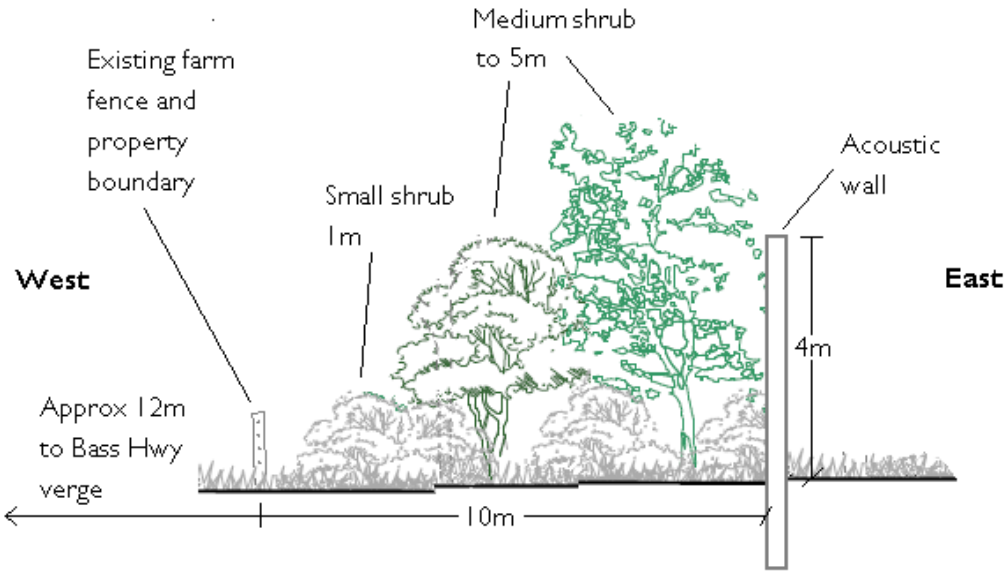
TPZ 1 Purpose

A four metre high acoustic wall is being installed to the north-west frontage of the site to the Bass Highway. Plantings in TPZ 1A will be used to screen the wall from the highway. The other TPZ1 plantings will screen off the access road (mitigating noise and dust) from the surrounding houses. The location of the plantings has been designed to maintain the 'farm feel' of the landscape.



Looking south along TPZ 1A; this house will be demolished to make way for the acoustic wall, and the planting will be between the acoustic wall and farm fence.

TPZ 1A cross section



Cross section of TPZ 1A planting showing structure of mature vegetation (5-7 years after planting)

As shown in the previous planting cross section, TPZ 1A planting will be restricted to shrubby species that will reach a height at maturity of 5m. This will effectively screen the 4 m high acoustic wall as well as preventing large tree debris from falling towards the Bass Highway.

TPZ 1B, C, D and E cross section



Cross section of TPZ 1B, C, D & E planting showing structure of mature vegetation (10-15 years after planting)

TPZ 1B, C, D, & E do not run alongside the Bass Highway, so trees have been included consistent with standard Lowland Forest planting recommendations.

TPZ 1 Site preparation

The 2013 planting season is coming to an end and local indigenous nurseries are running low on stock. In order to supply the required species and numbers these nurseries require plant orders nine months in advance. Therefore the earliest that TPZ 1 plantings can take place is after the autumn break (May – June) 2014.

High threat invasive weeds will be controlled prior to planting. High threat weeds observed during a site visit on 28/8/2013 included agapanthus, kikuyu, angled onion, snow drops, and arum lily.

Once high moisture levels are achieved in late Autumn 2014, spots of approximately 400mm in diameter will be sprayed at the required density within TPZ 1 planting zones. When the sprayed grass has yellowed off seedlings will be planted using Hamilton tree planter punches. Species will be laid out to achieve the vegetation structure outlined in the TPZ 1 cross sections. If browsing animals are present (rabbits and wallabies) appropriate tree guards will be installed over the plants.

For more detail refer to the TPZ 1 site management table.

TPZ 1 Species list and numbers

Species	Common Name	1A (m2)	1B (m2)	1C (m2)	1D (m2)	1E (m2)	Sub Total	Description
		425	725	3116	1224	910		
Eucalyptus obliqua	Messmate Stringybark		5	20	10	5	40	Tree - overstorey 20m
Eucalyptus ovata var. ovata	Swamp Gum							Tree - overstorey 20m
Eucalyptus radiata s.l.	Narrow-leaf Peppermint		5	20	10	5	40	Tree - overstorey 20m
Eucalyptus viminalis	Manna gum			15			15	Tree - overstorey 20m
Acacia dealbata	Silver wattle							Understorey tree 15m
Acacia mearnsii	Black wattle						0	Understorey tree 15m
Acacia melanoxylon	Blackwood		10	45	15	10	80	Understorey tree 15m
Bursaria spinosa subsp. spinosa	Sweet Bursaria	10	5	20	10	5	50	Tall Shrub 5-7m tall
Melaleuca ericifolia	Swamp paperbark							Tall Shrub 5-7m tall
Melaleuca squarrosa	Scented paperbark							Tall Shrub 5-7m tall
Mersin howittiana	Mutton-wood							Tall Shrub 5-7m tall
Pomaderris aspera	Hazel Pomaderris							Tall Shrub 5-7m tall
Acacia mucronata subsp. longifolia	Narrow-leaf Wattle		10	45	15	10	80	Medium Shrub 1-5m tall
Acacia paradoxa	Hedge wattle	10	5	20	10	5	50	Medium Shrub 1-5m tall
Acacia stricta	Hop Wattle	10	10	45	15	10	90	Medium Shrub 1-5m tall
Acacia suaveolens	Sweet Wattle		10	45	15	10	80	Medium Shrub 1-5m tall
Acacia verticillata	Prickly Moses	10	5	20	10	5	50	Medium Shrub 1-5m tall
Cassinia aculeata	Common Cassinia			10	10	5	25	Medium Shrub 1-5m tall
Coprosma quadrifida	Prickly currant bush		10	45	15	10	80	Medium Shrub 1-5m tall
Indigofera australis	Austral Indigo	10	5	20	10	5	50	Medium Shrub 1-5m tall
Leptospermum continentale	Prickly Tea-tree	10	10	45	15	10	90	Medium Shrub 1-5m tall
Olearia lirata	Snowy Daisy-bush							Medium Shrub 1-5m tall
Ozothamnus ferrugineus	Tree Everlasting		5	20	10	5	40	Medium Shrub 1-5m tall
Polyscias sambucifolia	Elderberry Panax							Medium Shrub 1-5m tall
Solanum aviculare	Kangaroo Apple		10	45	15	10	80	Medium Shrub 1-5m tall
Viminaria juncea	Golden Spray	5	5	30	10	5	55	Medium Shrub 1-5m tall
Goodenia ovata	Hop Goodenia	20	20	90	15	25	170	Small Shrub 1m tall
Pultenaea daphnoides	Large leaf bush pea		10	45	15	10	80	Small Shrub 1m tall
Tetrarrhena juncea	Forest Wire-grass							Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Carex appressa	Tall sedge							Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Dianella tasmanica	Tasman Flax-lily	20	40	70	60	50	240	Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Gahnia sieberiana	Red fruit saw sedge							Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Juncus australis	Austral rush							Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Dianella revoluta	Black anther flax lily			70	20	20	110	Medium Tufted Graminoid (grasses & grass-like < 1m tall)
Lomandra longifolia	Spiny-headed Mat-rush	25	40	70	60	50	245	Medium Tufted Graminoid (grasses & grass-like < 1m tall)
Poa labillardieri	Common Tussock-grass			80			80	Medium Tufted Graminoid (grasses & grass-like < 1m tall)
Clematis aristata	Mountain clematis							Scrambler / climber
Pandorea pandorana subsp. Pandorana	Wonga vine							Scrambler / climber
	Total	**130**	**220**	**935**	**365**	**270**		

Note: final species list will be determined by the availability of species from nurseries. If, for example, certain medium shrub species are not available, numbers of available medium shrubs will be increased accordingly.

TPZ 1 Management

Ongoing management of TPZ1 plantings is essential if the plantings are to achieve the desired structure and purpose. High threat weeds and browsing animals are the biggest threats. A certain amount of replacement planting will be required to ensure vegetation structure is achieved and maintained.

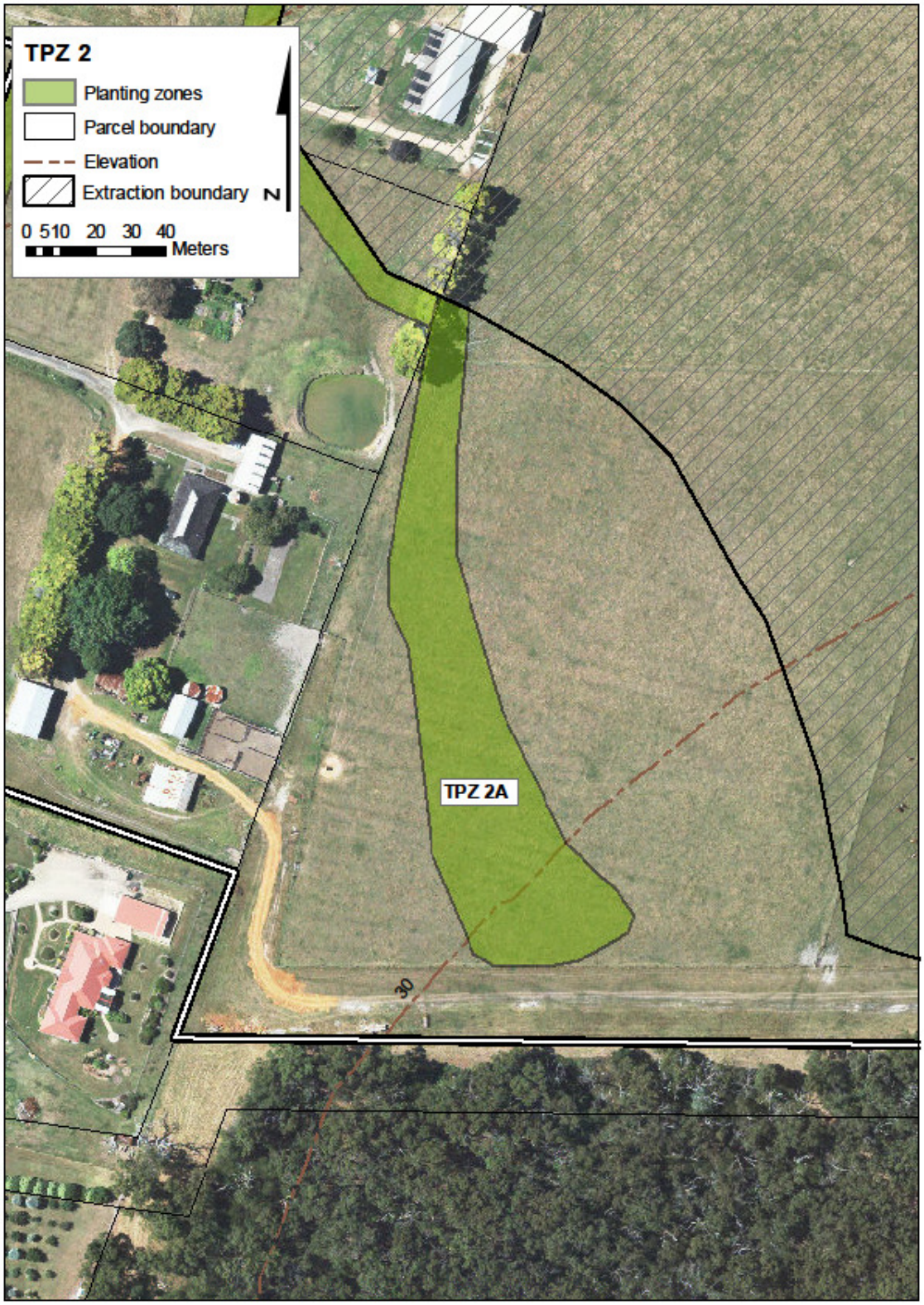
Year one – 2013				
Season	*Activity*	*Species*	*Sites*	*Method*
Spring	Spray weeds before seed set at known locations	Kikuyu, angled onion, snow drops, and arum lily Agapanthus,	TPZ 1A TPZ 1D	Spot spray with Esteem™. Use at the rate appropriate to weed and use relevant PPE (see label)
	Order plants	See species list	All zones	

Year two – 2014				
Season	*Activity*	*Species*	*Sites*	*Method*
Summer/ Autumn	Pest animal monitoring	Rabbits and wallabies	All zones	Spotlight count over 3 successive nights
Autumn/ Winter	Site preparation		All zones	Spray 400mm diameter spots at the required density with Roundup Biactive™. Use at the rate appropriate and use relevant PPE (see label)
	Plant tubes and guard if required		All zones	Distribute seedlings at locations to achieve the desired vegetation structure, punch holes and plant.
Spring	Spray weed regrowth before seed set at known locations and any new infestations discovered	Kikuyu, angled onion, snow drops, and arum lily Agapanthus,	All zones	Spot spray very carefully to avoid seedling damage with Esteem™. Use at the rate appropriate to weed and use relevant PPE (see label)
Spring / Summer	Monitoring – refer to pg 25		All zones	3-4 months following planting monitor sites for plant loss and high threat weed cover
	Order plants	See species list	All zones	Order plants for replacement planting if required

Ongoing – 2015 onwards				
Season	*Activity*	*Species*	*Sites*	*Method*
Summer/ Autumn	Pest animal monitoring	Rabbits and wallabies	All zones	Spotlight count over 3 successive nights
Autumn/ Winter	Site preparation for replacement planting if required		All zones	Spray 400mm diameter spots at the required density with Roundup Biactive™. Use at the rate appropriate and use relevant PPE (see label)
	Plant tubes and guard if required		All zones	Distribute seedlings at locations to achieve the desired vegetation structure, punch holes and plant.
Ongoing	Spray new and emerging weeds before seed set	All high threat weeds	All zones	Spot spray very carefully to avoid seedling damage with appropriate herbicide. Use at the rate appropriate to weed and use relevant PPE (see label).
Spring / Summer	Monitoring – refer to pg 25		All zones	3-4 months following planting monitor sites for plant loss and high threat weed cover
	Order plants	See species list	All zones	Order plants for replacement planting if required

Area 2 – TPZ 2

Terrestrial planting zone 2A

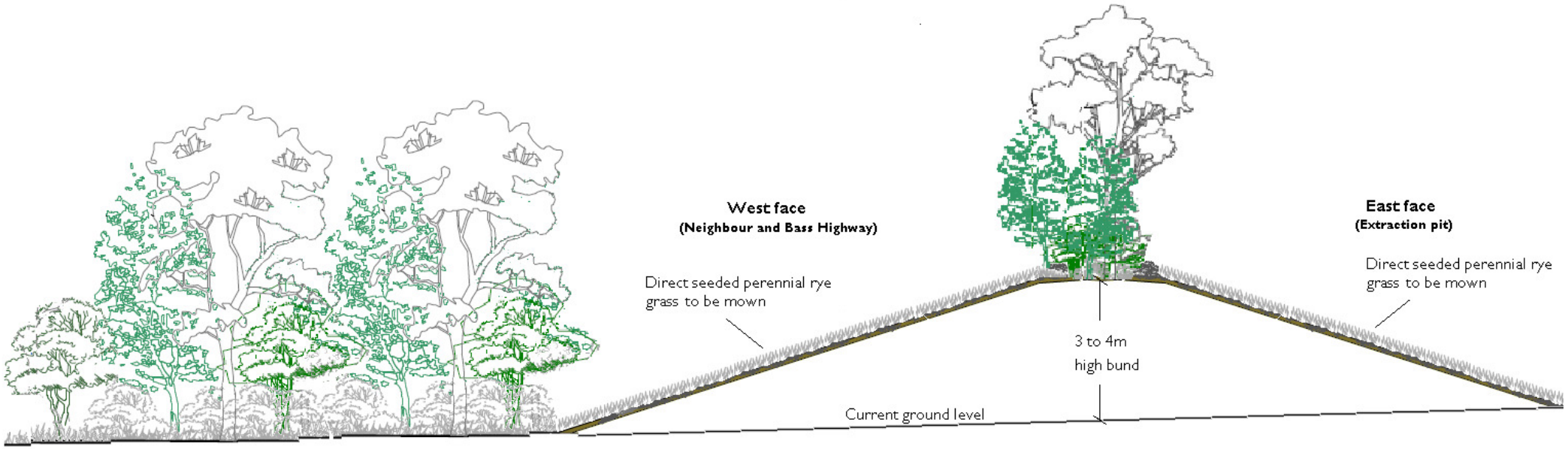


Overview of area 2 planting and bund providing screening for the neighbouring house to the SW.

TPZ 2 Description
TPZ 2 is a small area of agricultural grazing land in the south west corner of WA1488. Being adjacent to TPZ 1 it has the same aspect and would have originally been covered by Lowland Forest (DEPI, 2013a)

TPZ 2 Purpose
The primary purpose of this planting is to provide visual, noise and dust screening for the neighbouring house and property to the south west. It will also provide bund stability.

TPZ 2A cross section



Cross section of TPZ 2A planting and bund showing structure of mature vegetation (10-15 years after planting)

The majority of the TPZ 2A planting will be on the west side of the bund. A smaller strip will be planted along the top of the bund to increase the screening height. Large trees will be included in this planting which is very similar in structure to TPZ 1B, C, D & E, and will reach a height of approximately 15m when mature. The slopes of the bund will be sown with perennial rye seed, and will be maintained by slashing.

TPZ 2 Site preparation

It will be several years before the quarry extraction operations reaches the south - west corner of the extraction pit. The landholder, for whom the screening is being constructed, has indicated their preference for the construction of the bund and planting of TPZ 2A to be delayed until they begin to see quarrying activity from their residence / property (approximately 3 years).

There were no high threat invasive weeds observed to be present during the site visit on 28/8/2013. However, the area should still be maintained (through current land management of grazing and weed control) prior to planting to ensure none establish.

Once the bund has been constructed perennial rye grass seed will be sown over the earthworks. The bund should be established so that at least one winter occurs before the tube stock planting. This will ensure soil moisture levels will be suitable for planting. Once high moisture levels are achieved in Autumn of the year the planting is to take place, spots of approximately 400mm in diameter will be sprayed at the required density west and at the top of the bund. When the spot sprayed grass has 'yellowed off' seedlings will be planted using Hamilton tree planter punches. Species will be laid out to achieve the vegetation structure outlined in the TPZ 2 cross section. If browsing animals are present (rabbits and wallabies) appropriate tree guards will be installed over the plants.

For more detail refer to the TPZ 2 site management table.

TPZ 2 Species list

Species	Common Name	2A (m2) 4660	Description
Eucalyptus obliqua	Messmate Stringybark	15	Tree - overstorey 20m
Eucalyptus ovata var. ovata	Swamp Gum		Tree - overstorey 20m
Eucalyptus radiata s.l.	Narrow-leaf Peppermint	20	Tree - overstorey 20m
Eucalyptus viminalis	Manna gum	10	Tree - overstorey 20m
Acacia dealbata	Silver wattle		Understorey tree 15m
Acacia mearnsii	Black wattle	15	Understorey tree 15m
Acacia melanoxylon	Blackwood	15	Understorey tree 15m
Bursaria spinosa subsp. spinosa	Sweet Bursaria	15	Tall Shrub 5-7m tall
Melaleuca ericifolia	Swamp paperbark		Tall Shrub 5-7m tall
Melaleuca squarrosa	Scented paperbark		Tall Shrub 5-7m tall
Mersin howittiana	Mutton-wood		Tall Shrub 5-7m tall
Pomaderris aspera	Hazel Pomaderris		Tall Shrub 5-7m tall
Acacia mucronata subsp. longifolia	Narrow-leaf Wattle	30	Medium Shrub 1-5m tall
Acacia paradoxa	Hedge wattle	20	Medium Shrub 1-5m tall
Acacia stricta	Hop Wattle	30	Medium Shrub 1-5m tall
Acacia suaveolens	Sweet Wattle	30	Medium Shrub 1-5m tall
Acacia verticillata	Prickly Moses	15	Medium Shrub 1-5m tall
Cassinia aculeata	Common Cassinia	5	Medium Shrub 1-5m tall
Coprosma quadrifida	Prickly currant bush	30	Medium Shrub 1-5m tall
Indigofera australis	Austral Indigo	20	Medium Shrub 1-5m tall
Leptospermum continentale	Prickly Tea-tree	30	Medium Shrub 1-5m tall
Olearia lirata	Snowy Daisy-bush		Medium Shrub 1-5m tall
Ozothamnus ferrugineus	Tree Everlasting	20	Medium Shrub 1-5m tall
Polyscias sambucifolia	Elderberry Panax		Medium Shrub 1-5m tall
Solanum aviculare	Kangaroo Apple	30	Medium Shrub 1-5m tall
Viminaria juncea	Golden Spray	20	Medium Shrub 1-5m tall
Goodenia ovata	Hop Goodenia	60	Small Shrub 1m tall
Pultenaea daphnoides	Large leaf bush pea	30	Small Shrub 1m tall
Tetrarrhena juncea	Forest Wire-grass		Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Carex appressa	Tall sedge		Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Dianella tasmanica	Tasman Flax-lily	60	Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Gahnia sieberiana	Red fruit saw sedge		Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Juncus australis	Austral rush		Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Dianella revoluta	Black anther flax lily	60	Medium Tufted Graminoid (grasses & grass-like < 1m tall)
Lomandra longifolia	Spiny-headed Mat-rush	60	Medium Tufted Graminoid (grasses & grass-like < 1m tall)
Poa labillardieri	Common Tussock-grass	60	Medium Tufted Graminoid (grasses & grass-like < 1m tall)
Clematis aristata	Mountain clematis		Scrambler / climber
Pandorea pandorana subsp. Pandora	Wonga vine		Scrambler / climber
		700	

Note: final species list will be determined by the availability of species from nurseries. If, for example, certain medium shrub species are not available, numbers of available medium shrubs will be increased accordingly.

TPZ 2 Management

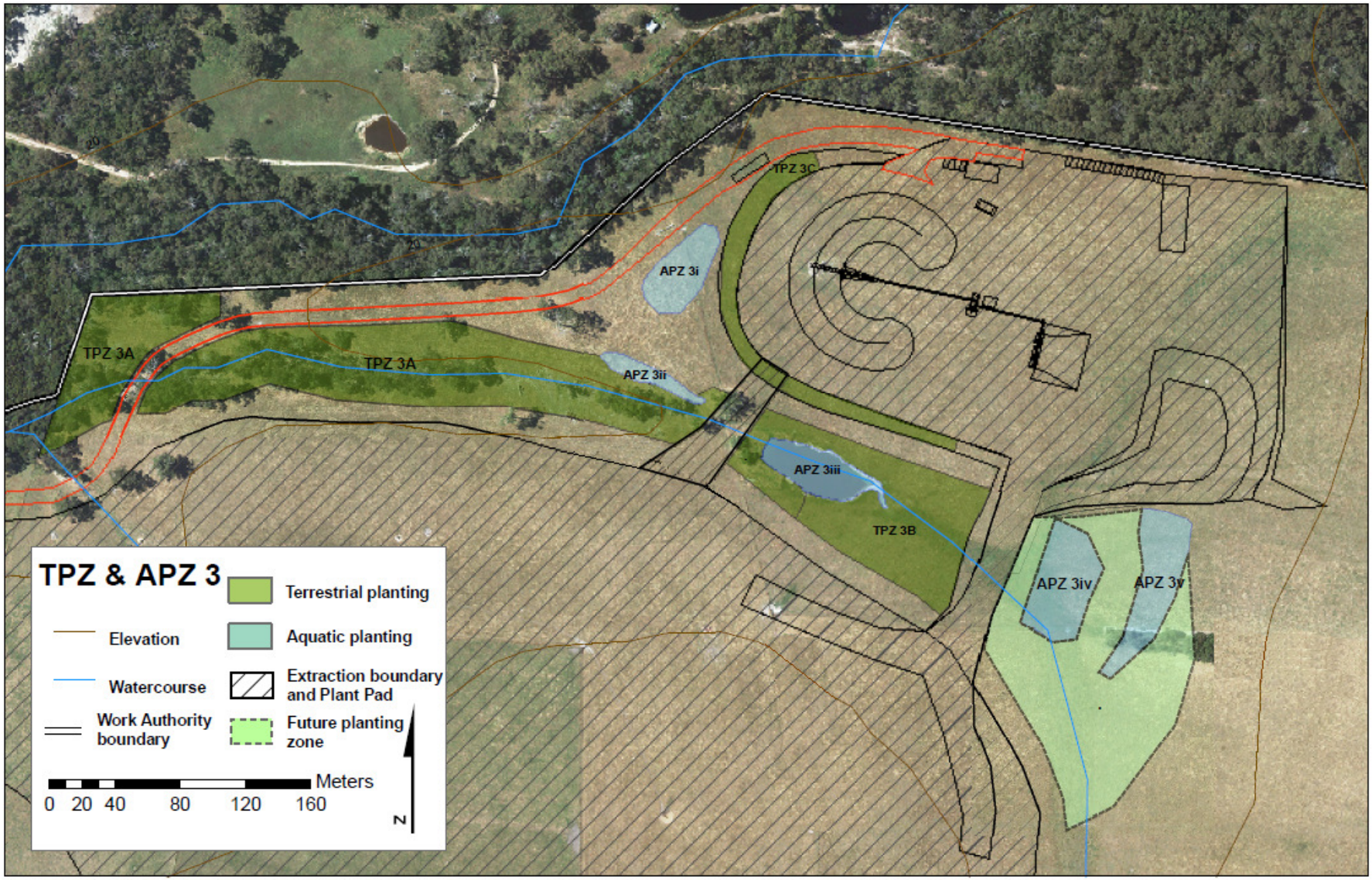
Ongoing management of TPZ 2 plantings is essential if the plantings are to achieve the desired structure and purpose. High threat weeds and browsing animals are the biggest threats.

Years prior to planting				
Season	*Activity*	*Species*	*Sites*	*Method*
Ongoing	Spray new and emerging high threat weeds before seed set	New and emerging	TPZ 2A	Spot spray with appropriate herbicide (eg. Esteem™ if thistle or broad leaf, Roundup™ if grass). Use at the rate appropriate to weed and use relevant PPE (see label).
	Order plants and seed if planting in the following year	See species list	TPZ 2A	

Planting year				
Season	*Activity*	*Species*	*Sites*	*Method*
Summer/ Autumn	Pest animal monitoring	Rabbits and wallabies	TPZ 2A	Spotlight count over 3 successive nights
Autumn/ Winter Autumn/ Winter cont.	Site preparation		TPZ 2A	Spray 400mm diameter spots in the planting areas at the required density with Roundup Biactive™. Use at the rate appropriate and use relevant PPE (see label)
	Plant tubes and guard if required		TPZ 2A	Distribute seedlings at locations to achieve the desired vegetation structure, punch holes and plant.
Post bund construc-tion	Sow grass seed	Perennial rye *Lolium perenne*	TPZ 2A	Broadcast grass seed to ensure even coverage and rake soil over seed.
Ongoing	Spray new and emerging weeds before seed set	All high threat weeds	TPZ 2A	Spot spray very carefully to avoid seedling damage with appropriate herbicide (eg. Esteem™ if thistle or broad leaf, Roundup™ if grass). Use at the rate appropriate to weed and use relevant PPE (see label).
Spring / Summer	Monitoring – refer to pg 25		TPZ 2A	3-4 months following planting monitor sites for plant loss and high threat weed cover
	Order plants	See species list	TPZ 2A	Order plants for replacement planting if required

Ongoing				
Season	*Activity*	*Species*	*Sites*	*Method*
Summer/ Autumn	Pest animal monitoring	Rabbits and wallabies	TPZ 2A	Spotlight count over 3 successive nights
Autumn/ Winter	Slash slopes		TPZ 2A	Slash grass on slopes
	Site preparation for replacement planting if required		TPZ 2A	Spray 400mm diameter spots at the required density with Roundup Biactive™. Use at the rate appropriate and use relevant PPE (see label)
	Plant tubes and guard if required		TPZ 2A	Distribute seedlings at locations to achieve the desired vegetation structure, punch holes and plant.
Ongoing	Spray new and emerging weeds before seed set	All high threat weeds	TPZ 2A	Spot spray very carefully to avoid seedling and native grass damage with appropriate herbicide (eg. Esteem™ if thistle or broad leaf, Roundup™ if grass). Use at the rate appropriate to weed and use relevant PPE (see label).
Spring / Summer	Slash slopes		TPZ 2A	Slash grass on slopes
	Monitoring – refer to pg 25		TPZ 2A	3-4 months following planting monitor sites for plant loss and high threat weed cover
	Order plants	See species list	TPZ 2A	Order plants for replacement planting if required

Area 3 – TPZ 3
Terrestrial planting Zones 3A, B, and C



Overview of area 3 including plantings in and around drainage line, dams, and screening around hardstand area (including plant pad).

TPZ 3 Description

This planting zone encompasses a first order (Melbourne Water, 2013) eroding drainage line (Melbourne Water Waterway 3840), an existing farm dam, and proposed sediment ponds and bio-retention basin to manage water run off from the hardstand area (including plant pad), the acoustic wall and bund around the hard stand, and a large majority of the scattered mature trees within the drainage line.

Waterway 3840 is deeply incised where it leaves the WA1488 boundary. Above the existing farm dam the waterway is defined only by a slight waterlogged depression in the grazing paddock. During a site visit on the 10th of October 2013, Pat Condina noted the greatest environmental impact is unrestricted cattle access to waterway 3840, which has resulted in extensive bare bank areas. This has caused minor slumping and erosion which is continuing, but can be halted and reversed through the proposed restoration works (additional comments can be found in Appedix A).

Although the area is mapped as once supporting lowland forest (DEPI, 2013a), as it follows a waterway it would have elements of a Riparian Forest / Damp Forest species mix in the steeper sections (TPZ3A), and Swamp Scrub / Riparian Scrub elements in the flatter boggy sections (TPZ3B). This is supported by the plant species found in the adjacent Deep and Colbert creeks (Kelly, 2013).

TPZ 3 Purpose

TPZ 3A and B are designed to encourage natural regeneration, protect and enhance the waterway and scattered large old trees, and to stabilise the access road crossings. These plantings will also have the added benefit of improving water quality and reducing noise from the access road. The revegetation will be no less than 10m from the top of bank, with an average total width of 20-30 metres being achieved along the length of the site. The revegetation will be protected by a farm fence erected on the southern and northern boundaries of TPZ 3A & B, which can be upgraded to exclude wallabies if they are deemed a threat to plant establishment. TPZ 3C is designed to screen the 4m high acoustic wall around the hard stand, as well as stabilise the bund slope.



Deeply incised lower section of drainage line in TPZ 3A



100m upstream the banks begin to flatten out

TPZ 3A Planting cross section including in stream

The section of drainage line in TPZ 3A has been eroding for some time. The planting density on the banks and drainage line crossings will be 50% greater than a standard TPZ planting, consisting of grasses, sedges and rushes with fibrous root systems. This will assist with stabilising the banks and earth works, and improving water quality. Melbourne Water's *'Waterway Corridors, Guidelines for greenfield development areas within the Port Phillip and Westernport Region'* has been used in the design of planting zones in TPZ 3; the average planting setback from the bank (in excess of 20m) is greater than the minimum setback guidelines required by Melbourne Water (20m), and the planting zones encompass the vast majority of site specific values (scattered large old trees) (Melbourne Water, 2013).

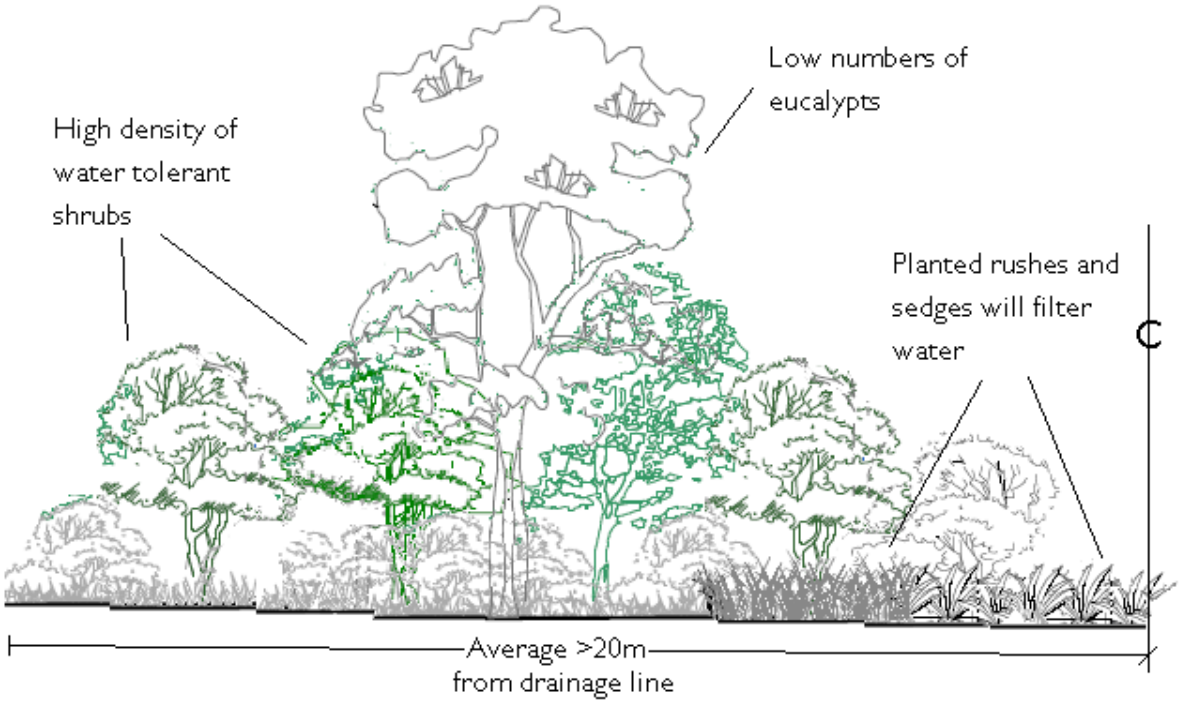
The understorey planting will be more diverse than TPZ 1 and 2, but the structure and overall height will be similar.



Cross section from drainage line centre of TPZ 3A planting showing structure of mature vegetation (10-15 years after planting).

TPZ 3B cross section

The species to be planted in TPZ 3B will be consistent with a Swamp Scrub / Riparian Scrub vegetation community as this area is much flatter and wetter area than TPZ3A,. The planting will be dominated by water tolerant shrubs with a small number of *Eucalyptus ovata* (Swamp Gum). *Melaleuca ericifolia* (Swamp Paperbark) numbers have been kept low as they sucker and can dominate and exclude grasses that will filter the water. A dense strip of grasses, sedges and rushes will be planted either side of the drainage line to assist in removing sediment from the water.

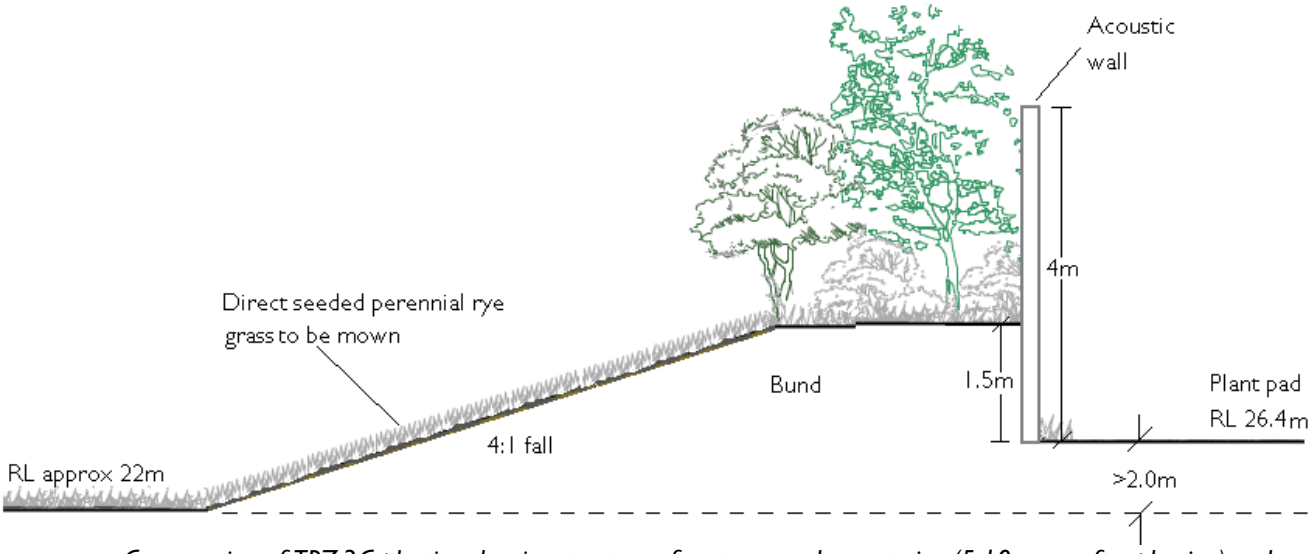


Cross section of TPZ 3B planting showing structure of mature vegetation (10-15 years after planting) dominated by water tolerant shrubs (5-7m at maturity).



TPZ 3B is much flatter and waterlogged, and leads in to Aquatic Planting Zone 3iii (see TPZ 3 map). TPZ 3B will be approximately 60m wide at the upstream end of the site.

TPZ 3C Cross section



Cross section of TPZ 3C planting showing structure of mature woody vegetation (5-10 years after planting) and grass (one year after planting)

Planting TPZ 3C will be restricted to shrubby species that will reach a height at maturity of 5m. This will effectively screen the 4 m high acoustic wall and not compromise the structure of the bund. Perennial rye grass seed will be sown over the bund as soon as it is constructed.

TPZ 3 Site preparation

Planting will commence (approximately winter / spring 2014) once the earthworks for the hardstand (including plant pad), access roads and water treatment works have been completed. This will allow enough time for nurseries to propagate the required variety and number of plants.

Several high threat weeds were noted during the site visit on 28/8/2013, but they were individual plants and not infestations. These will be controlled prior to planting, and include blackberry, briar rose, sweet pittosporum, willow, and spear thistle.

When the bund in TPZ 3C has been constructed perennial rye grass seed will be sown over the earthworks. The bund should be established so that at least one winter occurs before the tube stock planting. This will ensure soil moisture levels will be suitable for planting.

Once high moisture levels are achieved in late Autumn 2014, spots of approximately 400mm in diameter will be sprayed at the required density within the TPZ 3 zones. When the spot sprayed grass has 'yellowed off' seedlings will be planted using Hamilton tree planter punches. Species will be laid out to achieve the vegetation structure outlined in the TPZ 3 cross sections. If browsing animals are present (rabbits and wallabies) appropriate tree guards will be installed over the plants.

For more detail refer to the TPZ 3 site management table

TPZ 3 Species list and numbers

Species	Common Name	3A TOB (m2) 12131.25	3A bank (m2) 4043.75	3B TOB (m2) 6345	3B bank (m2) 2115	3C screen area 3250	Sub Total	Description
Eucalyptus obliqua	Messmate Stringybark	100					100	Tree - overstorey 20m
Eucalyptus ovata var. ovata	Swamp Gum	40		50			90	Tree - overstorey 20m
Eucalyptus radiata s.l.	Narrow-leaf Peppermint	100					100	Tree - overstorey 20m
Eucalyptus viminalis	Manna gum	100					100	Tree - overstorey 20m
Acacia dealbata	Silver wattle						0	Understorey tree 15m
Acacia mearnsii	Black wattle						0	Understorey tree 15m
Acacia melanoxylon	Blackwood	250					250	Understorey tree 15m
Bursaria spinosa subsp. spinosa	Sweet Bursaria	50				25	75	Tall Shrub 5-7m tall
Melaleuca ericifolia	Swamp paperbark	100	200	300			600	Tall Shrub 5-7m tall
Melaleuca squarrosa	Scented paperbark		50	200	200		450	Tall Shrub 5-7m tall
Mersin howittiana	Mutton-wood	80					80	Tall Shrub 5-7m tall
Pomaderris aspera	Hazel Pomaderris	80					80	Tall Shrub 5-7m tall
Acacia mucronata subsp. longifolia	Narrow-leaf Wattle	100					100	Medium Shrub 1-5m tall
Acacia paradoxa	Hedge wattle					25	25	Medium Shrub 1-5m tall
Acacia stricta	Hop Wattle	100				25	125	Medium Shrub 1-5m tall
Acacia suaveolens	Sweet Wattle	100					100	Medium Shrub 1-5m tall
Acacia verticillata	Prickly Moses	100				25	125	Medium Shrub 1-5m tall
Cassinia aculeata	Common Cassinia	100		100			200	Medium Shrub 1-5m tall
Coprosma quadrifida	Prickly currant bush	80					80	Medium Shrub 1-5m tall
Indigofera australis	Austral Indigo	80		100		25	205	Medium Shrub 1-5m tall
Leptospermum continentale	Prickly Tea-tree	150		100		25	275	Medium Shrub 1-5m tall
Olearia lirata	Snowy Daisy-bush	150		200			350	Medium Shrub 1-5m tall
Ozothamnus ferrugineus	Tree Everlasting	150		100			250	Medium Shrub 1-5m tall
Polyscias sambucifolia	Elderberry Panax	50					50	Medium Shrub 1-5m tall
Solanum aviculare	Kangaroo Apple	100					100	Medium Shrub 1-5m tall
Viminaria juncea	Golden Spray	50		50		15	115	Medium Shrub 1-5m tall
Goodenia ovata	Hop Goodenia	200		100		55	355	Small Shrub 1m tall
Pultenaea daphnoides	Large leaf bush pea	80					80	Small Shrub 1m tall
Tetrarrhena juncea	Forest Wire-grass	50					50	Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Carex appressa	Tall sedge	150	220	200	50		620	Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Dianella tasmanica	Tasman Flax-lily	150	200	50	50	55	505	Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Gahnia sieberiana	Red fruit saw sedge	150	200	50	50		450	Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Juncus australis	Austral rush		200	100	50		350	Large non Tufted Graminoid (grasses & grass-like > 1m tall)
Dianella revoluta	Black anther flax lily	150	200	50	50		450	Medium Tufted Graminoid (grasses & grass-like < 1m tall)
Lomandra longifolia	Spiny-headed Mat-rush	150	250	50	80	65	595	Medium Tufted Graminoid (grasses & grass-like < 1m tall)
Poa labillardieri	Common Tussock-grass	150	300	100	100		650	Medium Tufted Graminoid (grasses & grass-like < 1m tall)
Clematis aristata	Mountain clematis	100					100	Scrambler / climber
Pandorea pandorana subsp. Pandora	Wonga vine	100					100	Scrambler / climber
		3640	**1820**	**1900**	**630**	**340**		

Note: final species list will be determined by the availability of species from nurseries. If, for example, certain medium shrub species are not available, numbers of available medium shrubs will be increased accordingly.

TPZ 3 Management

Ongoing management of TPZ 3 plantings is essential if the plantings are to achieve the desired structure and purpose. High threat weeds and browsing animals are the biggest threats.

Year one - 2013				
Season	*Activity*	*Species*	*Sites*	*Method*
Spring/ summer	Spray weeds before seed set at known locations	Blackberry, briar rose, spear thistle Sweet pittosporum Willow	3A 3 B	Spot spray with Esteem™. Use at the rate appropriate to weed and use relevant PPE (see label) Cut off just above ground level and immediately paint stump with 50% Roundup Biactive™ 50% water mix. Drill and fill around base of tree with 50% Roundup Biactive™ 50% water mix
	Order plants	See species list	All zones	

Year two - 2014				
Season	*Activity*	*Species*	*Sites*	*Method*
Summer/ Autumn	Pest animal monitoring	Rabbits and wallabies	3A	Spotlight count over 3 successive nights
	Weed control	Willow	3B	Once head of tree has died, cut off at bass and paint stump with 50% Roundup Biactive™ 50% water mix. Pile up and burn head.
	Fencing		3A and B	Erect farm fencing on the N and S frontages of waterway 3840 when the ground is soft enough
Autumn/ Winter	Site preparation		All zones	Spray 400mm diameter spots in the planting areas at the required density with Roundup Biactive™. Use at the rate appropriate and use relevant PPE (see label)
	Plant tubes and guard if required		All zones	Distribute seedlings at locations to achieve the desired vegetation structure, punch holes and plant.
Post bund construc-tion	Sow grass seed	Perennial rye *Lolium perenne*	3C	Broadcast grass seed to ensure even coverage and rake soil over seed.
Ongoing	Spray new and emerging weeds before seed set	All high threat weeds	All zones	Spot spray very carefully to avoid seedling damage with appropriate herbicide. Use at the rate appropriate to weed and use relevant PPE (see label).
Spring / Summer	Monitoring – refer to pg 25		All zones	3-4 months following planting monitor sites for plant loss and high threat weed cover
	Order plants	See species list	All zones	Order plants for replacement planting if required

Year three – 2015 onwards				
Season	*Activity*	*Species*	*Sites*	*Method*
Summer/ Autumn	Pest animal monitoring	Rabbits and wallabies	All zones	Spotlight count over 3 successive nights
Autumn/ Winter	Slash slopes		3C	Slash grass on slopes
	Site preparation for replacement planting if required		All zones	Spray 400mm diameter spots at the required density with Roundup Biactive™. Use at the rate appropriate and use relevant PPE (see label)
	Plant tubes and guard if required		All zones	Distribute seedlings at locations to achieve the desired vegetation structure, punch holes and plant.
Ongoing	Spray new and emerging weeds before seed set	All high threat weeds	All zones	Spot spray very carefully to avoid seedling and native grass damage with appropriate herbicide. Use at the rate appropriate to weed and use relevant PPE (see label).
Spring / Summer	Slash slopes		3C	Slash grass on slopes
	Monitoring – refer to pg 25		All zones	3-4 months following planting monitor sites for plant loss and high threat weed cover
	Order plants	See species list	All zones	Order plants for replacement planting if required

General TPZ considerations

TPZ densities

High density revegetation reduces need for supplementary planting as well as weed cover, and therefore the amount of weed control required. As such the density of plantings is 50% greater than the minimum recommended by DEPI revegetation standards (DSE, 2006)

Seed and tube stock providence and supply

There are a variety of nurseries in the region that specialise in growing indigenous plants from locally sourced seed. Tube stock for all plantings will be sourced from these nurseries, and grown from seed collected locally.

Monitoring

The first round of planting zone monitoring will be undertaken 3-4 months after the initial planting. Once the vegetation is established monitoring will then take place on an annual basis.

Monitoring of plant density and high threat weed cover will be through randomly sampling 5% of each TPZ using 5x5m quadrats (with a minimum of at least three per TPZ). Within each quadrat the number of healthy indigenous plants will be counted, and the cover of high threat weeds will be estimated. The sampling results will be extrapolated over the zone area.

If plant densities drop below 85% then replacement planting will take place. If high threat weed cover increases above 5%, annual weed control measures will be revised by the land manager and action taken to ensure high threat weeds remain below 5% cover.

A qualitative survey will also be undertaken on an annual basis. This is to ensure that the structure of the planting is consistent throughout the planting zone. If overall plant density is acceptable, but localised areas of high plant losses are present, replacement planting will occur. Infestations of high threat weeds will be recorded and locations captured using a GPS to aid targeted control works.

Reporting

Results and recommendations from the monitoring will be summarised in a standard reporting template to allow site condition comparisons over time. Dandy Pre Mix Quarries will keep records of all the monitoring results.

Aquatic planting zones 3i, ii, iii, iv, and v

APZ 3 Description

APZ 3i and 3v are to be developed as sediment ponds for the treatment of water from the vehicle wash down area and the sand stockpile area. APZ 3i will be constructed first so as to trap any sediment from water run off during the development of the hardstand area. APZ 3iv will be a storage dam above the existing farm dam APZ 3iii. The overflow all of from these water bodies will flow through the bio-retention pond APZ 3ii, and finally into the drainage line.

Wetland Treatment Site	Approximate Wetland Area m2*
3i North Sediment pond	1000
3ii Bio-retention Basin	200
3iii Existing online farm dam	1540
3iv North Storage dam	3000
3v North East sediment pond	4000

* final size will be determined once wetlands are constructed

APZ 3 Purpose

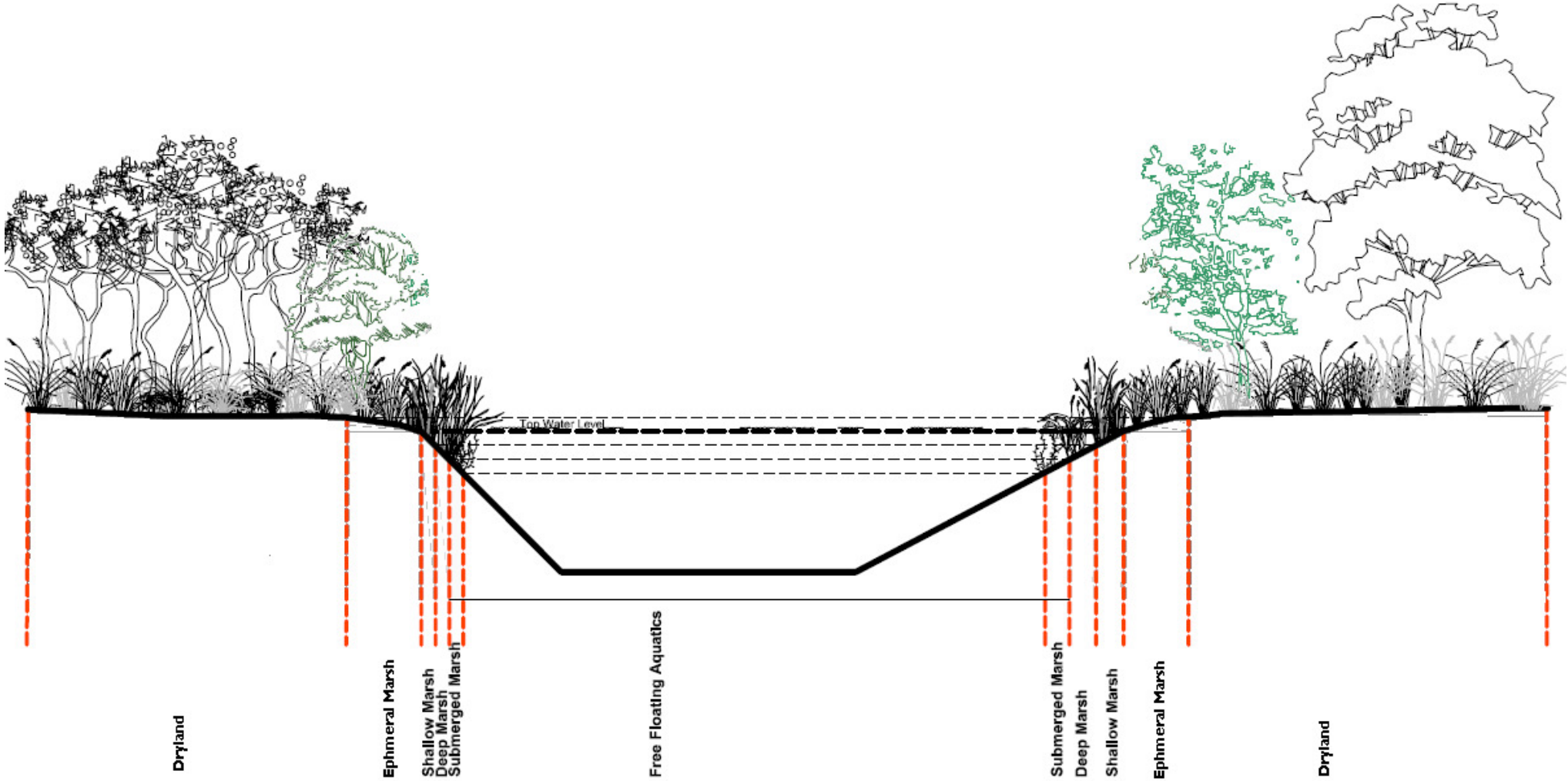
The primary purpose of the aquatic plantings is to filter sediment and nutrients from stormwater before it flows into the drainage line. The plantings will also protect the edges of the water body from eroding, and provide habitat for wading birds, frogs, invertebrates and possibly fish. Please refer to Appendix B for more detail on the benefit of aquatic plantings.



Looking west over the existing dam and APZ 3iii.

APZ 3 Cross Section

Example of a steep sided wetland, with the location of aquatic planting zones illustrated.



APZ 3 Site preparation and planting

In 2006 Bass Coast Landcare Network commissioned a report titled 'Guidelines for Dam Restoration in the Bass Coast' (Osler, 2006). Site preparation, planting, and maintenance will be undertaken following the guidelines outlined in the report and summarised below;

In order to sustainably establish and manage indigenous aquatic vegetation it is crucial to eradicate and suppress certain key weeds through the timely application of appropriate herbicides, monitoring and follow up maintenance. Weed control will be performed by contractors with a sound knowledge of aquatic plant identification, which allows them to target weeds before they get out of control and to retain any natural regeneration of indigenous species. Weed control will be achieved through a combination of hand weeding in sensitive areas or in water, and the careful use of specific herbicides on the wetland fringe to treat particular groups of weeds such as grasses or broad-leaved herbs.

The correct timing of planting of aquatic and semi-aquatic species is crucial to maximise successful establishment. The optimal time for planting is just before a species enters its optimal growing season. The growing season of wetland plants varies considerably. In southern Australia plants which grow on the fringe of wetlands often grow in cool, moist seasons when there is plenty of moisture available in this zone, while many truly aquatic species that occur in deeper water grow most actively in warmer seasons. For a range of reasons deep water is a hostile environment for establishing young plants. Large rhizomatous sedge species such as Jointed twig rush *(Baumea articulata)* and Tall spike sedge *(Eleocharis sphacelata)* should be planted at the shallow edge of their preferred habitat, i.e. in 200-300 mm of water. Once well established in the shallows these plants will grow out into deeper water.

A common cause of failure of establishment of some wetland species is that they are destroyed while still small by grazing waterbirds. If plants can be protected through the first growing season even the most palatable species can become established enough to survive the destructive feeding habits of birds such Purple Swamp Hens or Black Swans. Protection of young plants is particularly crucial in constructed wetlands close to areas where there are established populations of waterbirds. For these highly palatable species protection is achieved by suspending enclosures around young plants made of netting. This netting is arranged so that plants have space to grow for a full growing season. Netted areas are regularly inspected for entangled or trapped wildlife.

APZ 3 Species list and densities

The following table has been supplied by Pat Condina along with information given in Appendix B.

Table 2 Grantville Quarry Treatment Wetland Ponds Schedule of recommended wetland plants subject to availability, advice of suppliers, and inclusion of locally occurring native aquatics			
Zone Code	**Zone Description**	**Recommended Plants**	**Plants/ Square Metre**
A. Dryland	+0.3m above NTWL to 1 year ARI flood level. Riparian zone native vegetation subject to infrequent ephemeral inundation **SHADE ESTABLISHMENT IS A CRITICAL CONSIDERATION FOR SELECTION AND DENSITY OF PLANTINGS ESPECIALLY AROUND WATER EDGES.**	The following could form basis of Dryland plantings of Lowland Forest and Herb Rich Foothill Forest species with preferential selection of locally indigenous species if available: Eucalyptus obliqua Eucalyptus ovata **Acacia melanoxylon** **Leptospermum lanigerum** **Melaleuca ericifolia** Melaleuca squarrosa Dianella revoluta (b) **Goodenia ovate (b)** **Lomandra longifolia** Lomandra filformis Microlaena stipoides Poa labillardieri Poa poiformis	0.2 for upper and middle storey species, 0.5 for shrubs and 6 for grasses, or as recommended by landscape architects.
1	Normal Top Water Level to +0.3 m above NTWL **Ephemeral Marsh** Grasses of moist soils and aquatic native vegetation subject to occasional inundation during high flows or capillary rise from edges of water body. Swamp Scrub species predominate. Some of these species (b) are also suitable for planting in the Bio retention Swale	**Melaleuca ericifolia** Poa labillardierei Poa poiformis Carex gaudichudiana **Carex appressa (b)** **Carex fascicularis** Gahnia radula Gahnia sieberiana **Juncus procerus** **Juncus kraussi** Juncus subsecundus Isolepsis inundata Lomandra longifolia (b) Lepidosperma laterale Marsilea drummondii Triglochin striatum	0.5 for M. ericifolia and 6 for remainder. Species in bold forming 80% of zone total

Table 2 Grantville Quarry Treatment Wetland Ponds Schedule of recommended wetland plants subject to availability, advice of suppliers, and inclusion of locally occurring native aquatics			
Zone Code	**Zone Description**	**Recommended Plants**	**Plants/ Square Metre**
2	Depth from 0 to -0.2m. **Shallow Marsh**. Experiences frequent drying 1V:1:10 to 1V:8H Width ~ 2 m Some of these species (b) are also suitable for planting in the Bio retention Swale	Alisma plantago aquatic **Bulboschoenus caldwellii** Bulboschoenus medianus **Baumea articulata** Baumea arthrophylla **Carex fascicularis** Carex appressa Cyperus lucidus **Crassula helmsii** **Eleocharis acuta** Eleocharis pusilla Isolepsis fluitans Juncus amabilis (b) Juncus holoschoenus Juncus flavidus (b) Myriophyllum crispatum Neopaxia australasica Restio tetraphyllus Schoenus lepidosperma Villarsia reniformis	6 Species in bold forming 80% of zone total. Subject to inclusion of any locally occurring species
3	Depth from -0.2 to –0.4.m **Marsh/Deep Marsh (emergent).** Shrinks in extended dry period but does not dry up completely 1V:3H	**Eleocharis sphacelata** **Schoenoplectus tabernaemontani** Schoenoplectus pungens **Triglochin procerum** **Vallisneria americana**	4 Species in bold forming 80% of zone total
4	Depth from 0.4 m to 0.6 m. **Deep Marsh (submerged)**	**Chara sp** **Nitella sp**. **Potamogeton ochreatus** **Triglochin procerum**	2 Equal numbers of each
5	Depth from 0.6 to 1.1m **Submerged macrophyte zone**	**Potamogeton ochreatus**	1
6	Depth >1.0m **Open Water**	No plantings recommended. The submerged marsh species will colonise these zones	0

Actual species numbers per APZ will be calculated using the densities outlined above once final APZ areas are known.

APZ 3 Management

Year one - 2013				
Season	*Activity*	*Species*	*Sites*	*Method*
Spring / summer	Order aquatic plants and collect and grow plants not supplied by nurseries	See species list above	All APZ's	Once all wetlands have been constructed, measure the area of APZ's and calculate species numbers.

Year two - 2014				
Season	*Activity*	*Species*	*Sites*	*Method*
Summer	Spray weeds before seed set within the planting zones, as well as a 1m buffer above the Dryland zone	All exotic species	All APZ's	Spot spray with Roundup Biactive™. Take care to avoid any indigenous species. Use at the rate appropriate to weed and use relevant PPE (see label)
Early Spring	Spray weed regrowth before seed set within the planting zones, as well as a 1m buffer above the Dryland zone	All exotic species	All APZ's	Spot spray with Roundup Biactive™. Take care to avoid any indigenous species. Use at the rate appropriate to weed and use relevant PPE (see label)
	Plant aquatic species	As per species list	All APZ's	Distribute seedlings at locations to achieve the desired vegetation structure, punch holes where required and plant.
	Net seedlings	Net species vulnerable to bird grazing	All APZ's	Arrange suspending netting over plants, allowing room for growth and ensuring there are no bird access points.
Ongoing	Check netting for wildlife entanglement		All APZ's	Designate staff working on site to check all netting during regular working duties and remove entangled wildlife on a daily basis.

Ongoing – 2015 onwards				
Season	*Activity*	*Species*	*Sites*	*Method*
Ongoing on a regular basis	Spray weeds before seed set within the planting zones, as well as a 1m buffer above the Dryland zone	All high threat weeds	All APZ's	Spot spray with Roundup Biactive™ on a monthly basis. Use at the rate appropriate to weed and use relevant PPE (see label). Take care to avoid any indigenous species – hand weed where weeds are entangled with indigenous plants.
	Check netting for wildlife entanglement		All APZ's	Designate staff working on site to check all netting during regular working duties and remove entangled wildlife on a daily basis.
Spring / Summer	Remove netting		All APZ's	If netted plants are well established remove the netting.
	Harvest biomass	Any vigorous indigenous species that is reducing diversity	All APZ's	Slash and remove plant material where appropriate, or manually remove.

APZ 3 Plant stock providence and supply

There are a variety of nurseries in the region that specialise in growing indigenous plants from locally sourced seed. Some grow a limited range of aquatic plants, how ever many species can be sourced locally and propagated. There are two farm dams, one within the WA1488 and another north of the WA1488 on land owned by Dandy Pre Mix, that have a range of well established indigenous aquatic plants. These local dams would be ideal sources of a variety of species.

Summary

Dandy Pre Mix has taken care to develop a landscape and revegetation plan that enhances the biodiversity and aesthetic values of the site, and which can be considered best practice for developing a quarry. Once the revegetation takes place the plantings will greatly reduce sediment and nutrient load flowing into Deep Creek Western Port, enhance and stabilise the banks of the tributary of Deep Creek which runs through the WA1488 area, enhance wildlife habitat, as well as mitigate any dust and noise from the site. The ongoing monitoring and maintenance of the planting zones will ensure the revegetation establishes and continues to perform the functions for which it was designed.

References

Bradley, Joan (1997). Bringing back the bush: The Bradley method of bush regeneration. Lansdowne Publishing Pty. Ltd. 18 Argyle Street , The Rocks, New South Wales, Australia

DEPI (2013) *Biodiversity Interactive Map 2.0* [online], Victorian Government, Department of Sustainability and Environment. www.dse.vic.gov.au

DPI 2013, Invasive plant classification – Regionally controlled weeds [online], Victorian Government, Department of Primary Industry. http://www.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds/weeds/invasive-plants .

DSE 2006 *Native Vegetation Revegetation planting standards – Guidelines for establishing native vegetation for net gain accounting*, Victorian Government, Department of Sustainability and Environment, 8 Nicholson St, East Melbourne 3002

Kelly, Paul (2013) *The Biodiversity and Ecology of Deep and Colbert Creeks, Grantville*, Paul Kelly and Associates, Melbourne.

Melbourne Water (2013*) Waterway Corridors, Guidelines for greenfield development areas within the Port Phillip and Westernport Region*, Melbourne Water Corporation, 990 La Trobe Street, Docklands, Vic 3008

Osler, Dylan (2006) *Guidelines for Dam Restoration in the Bass Coast*, Australian Ecosystems, Patterson Lakes.

Appendix A

PAT CONDINA & ASSOCIATES

Consultants in waterway, wetland and lake management
Water quality monitoring and assessment
Community consultation and education

Mr Garry Cranny
Dandy Premix Quarries PL

11 October 2013

By Email
Cc Neil Craigie

Garry

Re: **Current Stability of Tributary 3840 and Future Rehabilitation**

Further to yesterday's inspection at the quarry development site at Grantville I take this opportunity to record the current stability of the 3840 Tributary to Deep Creek and comment of proposed rehabilitation measures.

Having inspected the tributary in periods with flow and no flow it is apparent that the greatest environmental impact is the unrestricted cattle access to date. The cattle cause both direct and indirect damage through access all along the tributary. They lead to many bare bank areas and prevent any regeneration of native vegetation. As a result the banks are subject to minor slumping and erosion by water – by direct rainfall, surface flow and channel flow.

While the bed has deepened considerably in the past, bed erosion is still active, and this is shown by a number of small drops of about 0.5 along the length of the tributary up to the farm dam. This deepening further de-stabilizes the banks and is the main cause of continuing minor bank slumping and the continuing loss of the isolated remnant eucalypts on the banks.

The degree of erosion of the sandy clay banks is reflected in the sand deposited in some parts of the bed and overall the tributary exports large amounts of sediment to Deep Creek.

Fortunately this degradation can be reversed through the works anticipated in conjunction with quarry development, and the waterway returned to a very good environmental condition with the creation of considerable native habitat. Specifically the following steps are required:

1. Exclusion of cattle from the stream zone by erection of standard rural farm fence (6strand plain wire, pine posts 5 m apart). The fence will be erected on both sides, from 10 to 25metres from the edge of the waterway depending on physical constraints.

2. The fenced area is to be extensively planted in accordance with the comprehensive revegetation plan prepared by Bass Coast Landcare Network.

3. The need to create a new lower tributary crossing for the main access road site and to upgrade an existing crossing some 60 metres downstream of the existing farm dam presents an opportunity to design crossings which will create ponding upstream of these crossings and so stabilize the bed. Neil Craigie will advise as to crossing design optimization for such an outcome.

The following photos clearly illustrate the above assessment. This is an exciting opportunity for tributary rehabilitation. Along with the proposed water quality protection measures separately considered, these works will contribute significantly to protecting the values of the receiving waters of Deep Creek and Westernport Bay

Yours Sincerely

Pat Condina

Photo 1. 3/10/13 Upstream from the proposed lower crossing site. Note drop in bed at the log jam. Bed control/ stabilization is required



Photo 2. 3/10/13 Bare banks and minor slumping due to unrestricted cattle access



Photo 3 10/10/13. Sand deposits in bed of tributary illustrate magnitude of sediment transport



Photo 4. 10/10/12 Wombat hole in bank of tributary



Photo 5. 10/10/12 Current cattle access to waterway

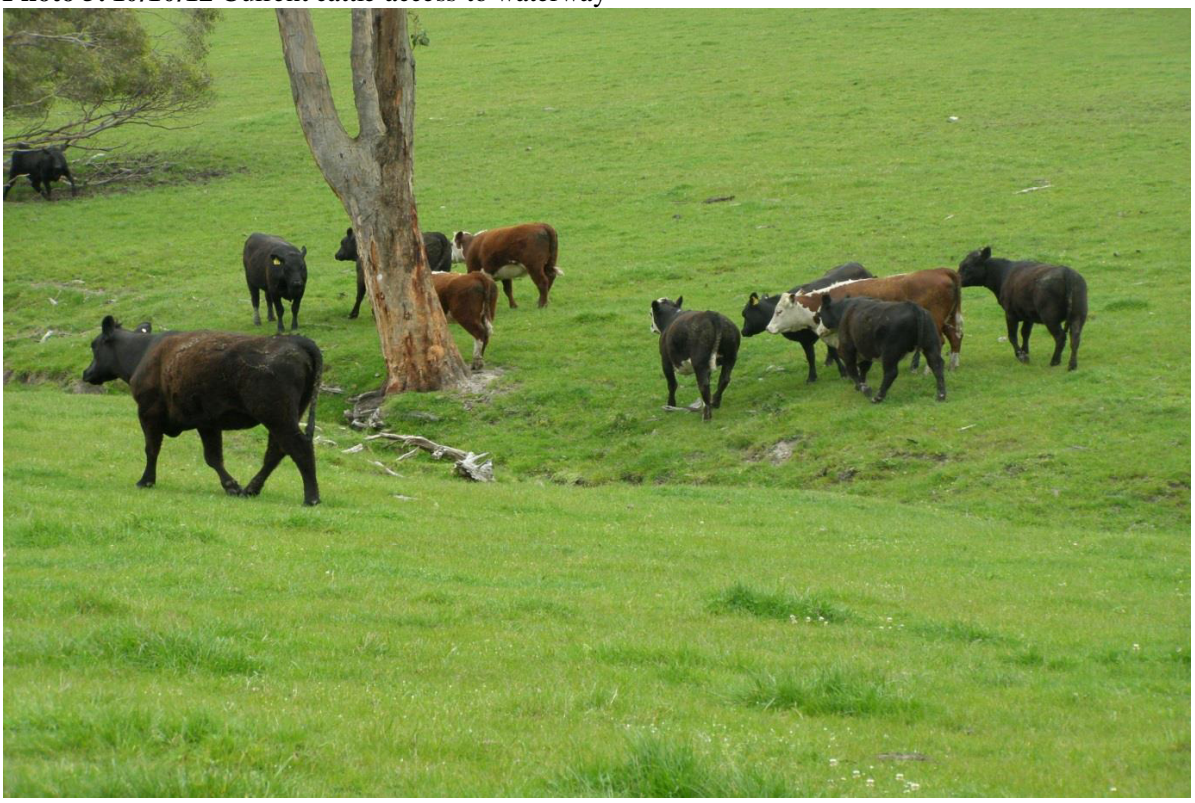


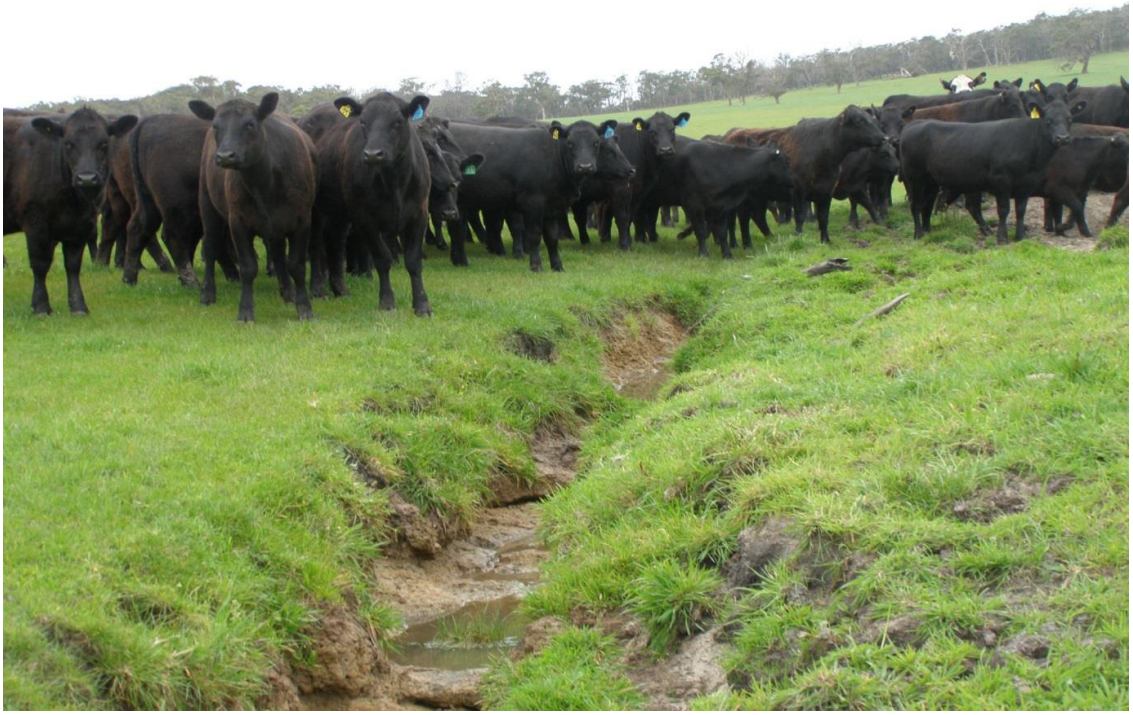
Photo 6. 10/10/12 Continuing loss of isolated remnant eucalypts



Photo 7. 10/10/12 Existing upper crossing about 60 m downstream of farm dam. To be upgraded and used for internal sand transport.



Photo 8. 10/10/12 Tributary upstream of existing crossing and leading into farm dam, minor bed erosion



Appendix B

PAT CONDINA & ASSOCIATES

Consultants in waterway, wetland and lake management
Water quality monitoring and assessment

Mr Robbie Gray
By Email 24 September 2013

Dear Robbie

Re: **Interim Treatment Wetlands Planting Schedule, Grantville Quarry**

Further to our recent discussions I have prepared a schedule incorporating a range of aquatic plants which I consider are suitable for use in the treatment wetland pondages proposed for this site.

Healthy populations of water plants are essential for effective stormwater treatment. Apart from their value as aquatic habitat they:

- Take up nutrients from stormwater that would otherwise be available for algal productivity;
- Can be a visually attractive and interesting part of the aquatic system;
- Give the system a more natural, less artificial appearance;
- Protect the edges from erosion, and make level fluctuations less obvious;
- Provide food, shade and shelter to invertebrates and fish.

There is always the possibility that one or more species could grow in nuisance proportions (in particular some species of Myriophyllum, Typha, Cyperus, Persicaria and Paspalum so I have omitted these) but attention to monitoring and maintenance, and early control will prevent such conditions from arising. Depending on the rates of growth of aquatic species some harvesting may be required in future.

Wetland plantings are selected primarily for water treatment purposes, but other species should also be included for the purpose of increasing ecosystem diversity and landscape interest. Table 2 shows the preferred depth zones of a range of water plant we should include and gives an indication of planting density. In preparing the list reference has been made to Melbourne Water's Constructed Wetland Guidelines (2010), however other aquatic species suitable for wetland treatment, and adding to the overall habitat diversity of the site, have also been included.

You will note that I have not yet calculated the actual numbers required as the wetland areas are still not finalized. Table 1 shows current area estimates made both by yourself and Neil Craigie and even these are still subject to change. Over 20,000 plants could be required overall, allowing for future natural spread.

Table 1 Estimated Wetland Treatment Areas

Wetland Treatment Site	Total Wetland Area m2
3i North Sediment pond	1460 RG 1000 NC
3ii Bio-retention Basin	1615 RG 200 NC
3iii Existing online farm dam	1540 RG
3iv North Storage dam	2350 RG 3000 NC
3v North East sediment pond	2800 RG 4000 NC

The main purpose of the plants is their ability to provide treatment to incoming stormwater runoff from the site therefore perhaps 4 - 6 structural species are planted in large numbers while a further 10 or so species are planted to increase species, habitat and visual diversity. Preference is given to plants naturally occurring locally. The densities suggested form an initial minimum. It is expected that over the first two years, there will be natural spread to achieve an optimum density. Some further in-fill planting may then be required along with attention to the control of any weed invasion. Protection against damage by waterfowl may be necessary during the plant establishment phase.

It is suggest that the species marked in bold form about 80% of the total number of species for that zone, with approximately equal numbers of each; with a selection of about 10 or so other species comprising about 20% of the zone total, and again each species being about equally represented. An experienced aquatic plant contractor will mix the overall plants in each zone to obtain a pleasing landscape effect and furthermore will, even within a zone, be aware of plant depth preference and plant accordingly.

I will provide an updated list giving suggested species numbers once treatment zone areas are fixed for each wetland.

Yours Sincerely

Pat Condina

APPENDIX 6 – EXTRACTIVE INDUSTRY INTEREST AREAS PLAN

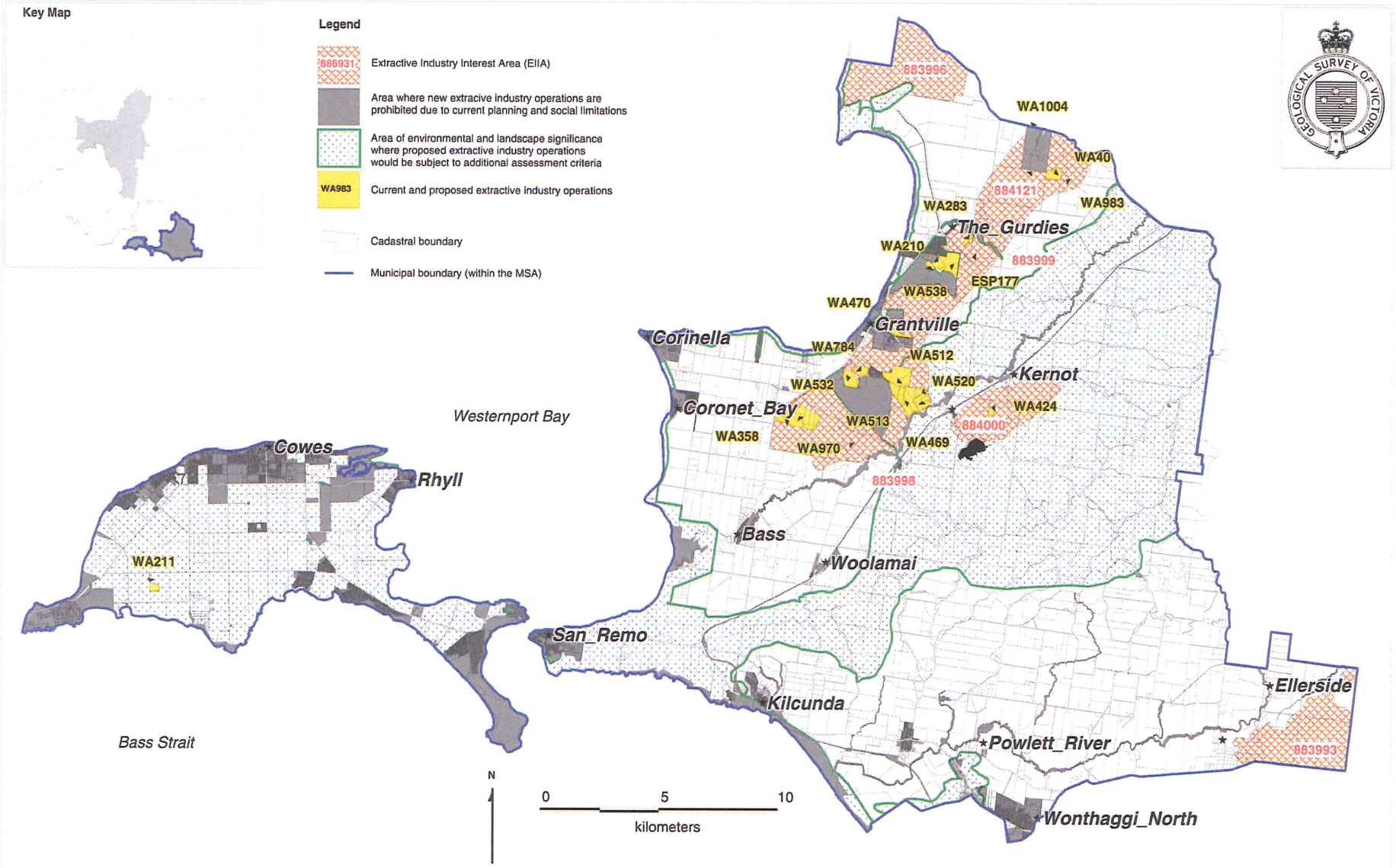
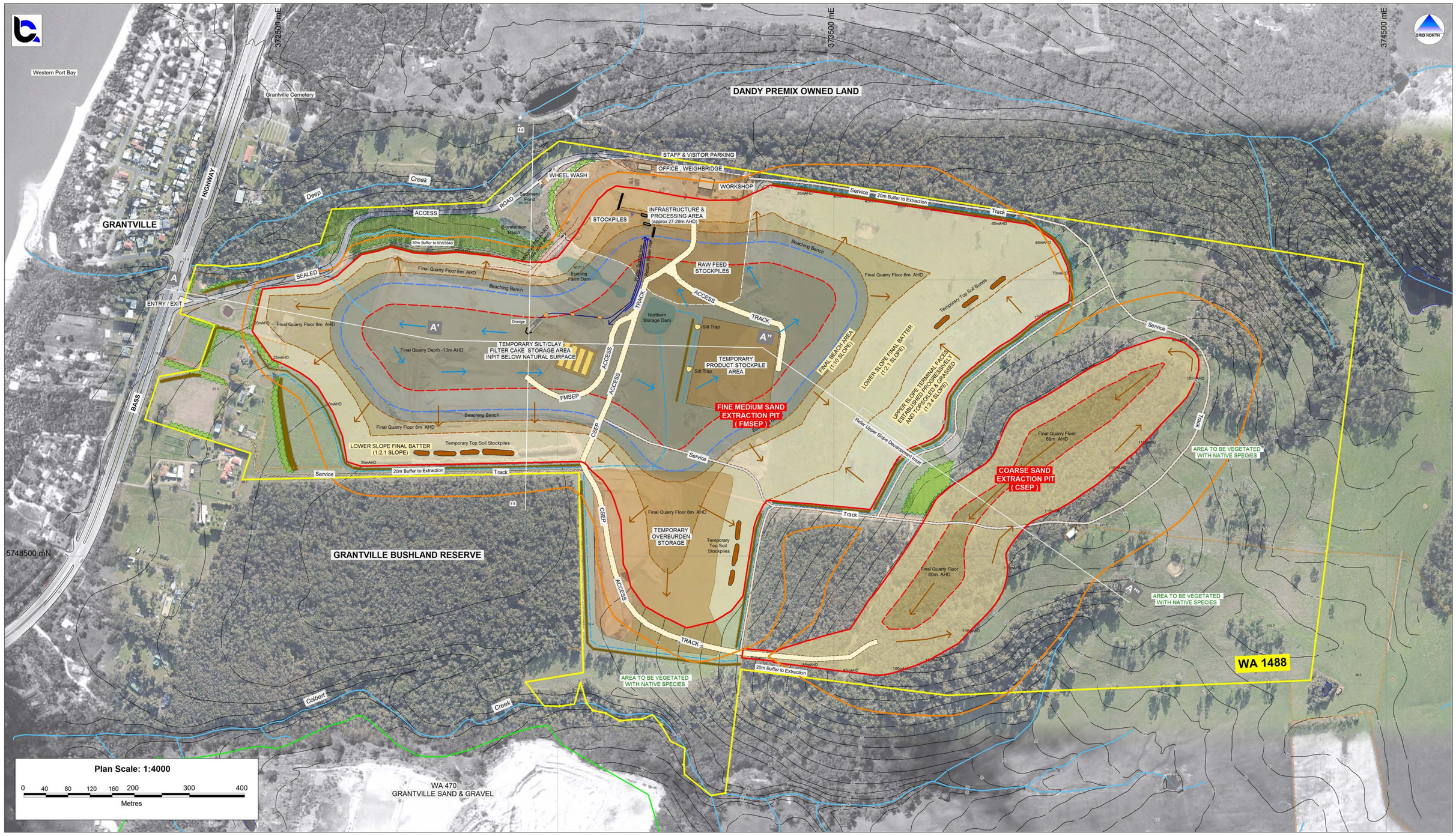
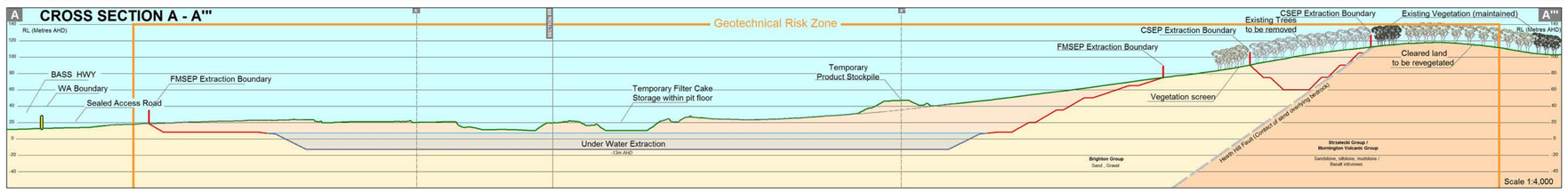
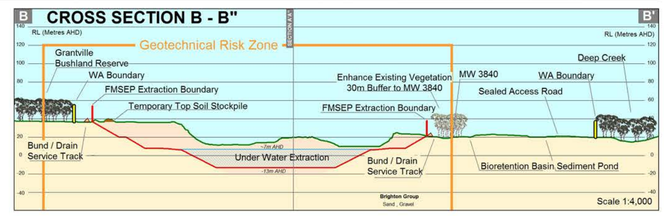


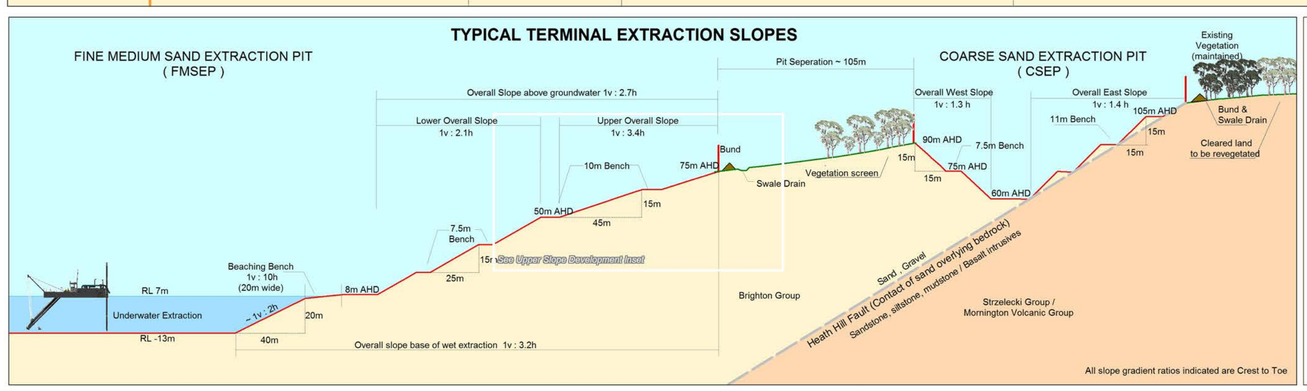
Figure 4 *Planning constraints, cadastral boundaries and EIIAs for Bass Coast Shire within the MSA.*

APPENDIX 9 – FIGURE 3 – SITE LAYOUT PLAN & FIGURE 4 – REHABILITATION PLAN





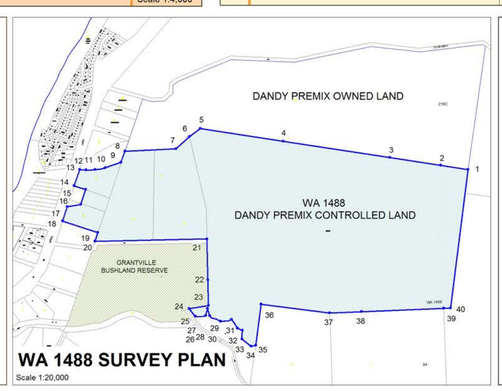




WA 1488 BOUNDARY COORDINATES

GDA 94, MGA Zone 55

Number	Easting	Northing	Number	Easting	Northing
1	374458	5749027	21	373039	5748651
2	374308	5749051	22	373044	5748429
3	374032	5749094	23	373047	5748289
4	373453	5749181	24	372942	5748272
5	373003	5749251	25	372976	5748229
6	372944	5749207	26	373031	5748232
7	372870	5749140	27	373042	5748272
8	372592	5749128	28	373053	5748234
9	372571	5749066	29	373113	5748202
10	372486	5749037	30	373172	5748213
11	372430	5749027	31	373205	5748165
12	372382	5749026	32	373231	5748153
13	372347	5749028	33	373230	5748105
14	372318	5748939	34	373278	5748067
15	372380	5748918	35	373304	5748072
16	372352	5748838	36	373332	5748295
17	372280	5748825	37	373706	5748248
18	372254	5748747	38	373878	5748256
19	372446	5748686	39	374325	5748274
20	372430	5748639	40	374363	5748276



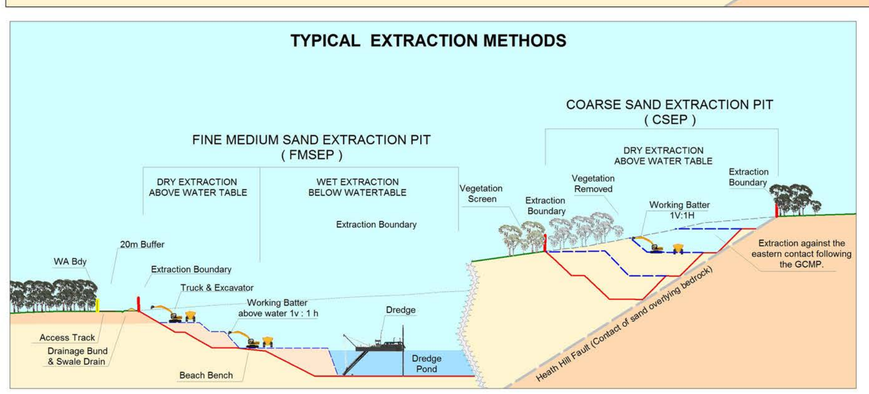
LEGEND

- WA 1488 BOUNDARY
- WORK AUTHORITIES
- EXTRACTION BOUNDARY
- TERMINAL FACE TOE
- MAXIMUM GRZ (Terminal Extraction Face Toe)
- ACCESS TRACK (Operations HV & Light Vehicles)
- SERVICE TRACK (Light Vehicles & Occasional HV)
- GENERAL DIRECTION (of Working Dry Extraction)
- GENERAL DIRECTION (of Working Wet Extraction)
- WATER WAYS
- DRAINS
- BUND & SWALE DRAIN
- FENCE
- INDEX CONTOUR
- SPOT HEIGHT
- GRID COORDINATES (GDA 94, MGA ZONE 55)
- CROSS SECTION LINES
- EXISTING VEGETATION TO BE REMOVED
- ESTABLISHING REVEGETATION
- EXISTING VEGETATION & ESTABLISHED REVEGETATION
- VISUAL SCREENING PLANTING
- RETAINED VEGETATION AND ENHANCED

BATTER AREAS

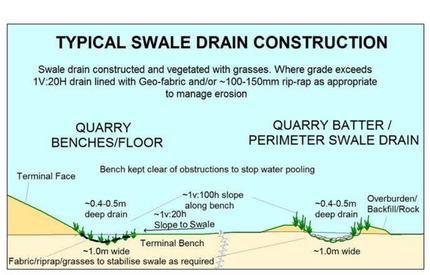
- CSEP
- FMSEP - UPPER SLOPE
- FMSEP - LOWER SLOPE
- FMSEP - BEACHING
- FMSEP - BELOW WATER

WA (Work Authority) · CSEP (Coarse Sand Extraction Pit) · FMSEP (Fine Medium Sand Extraction Pit) · GRZ (Geotechnical Risk Zone) · mAHD (Metres above Australian Height Datum) · RL (Reduced Level) which on this plan is AHD · HV (Heavy Vehicles)



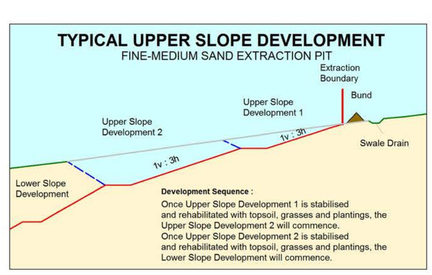
TYPICAL SWALE DRAIN CONSTRUCTION

Swale drain constructed and vegetated with grasses. Where grade exceeds 1V:20H drain lined with Geo-fabric and/or ~100-150mm rip-rap as appropriate to manage erosion



TYPICAL UPPER SLOPE DEVELOPMENT

FINE-MEDIUM SAND EXTRACTION PIT



Development Sequence :

Once Upper Slope Development 1 is stabilised and rehabilitated with topsoil, grasses and plantings, the Upper Slope Development 2 will commence.
Once Upper Slope Development 2 is stabilised and rehabilitated with topsoil, grasses and plantings, the Lower Slope Development will commence.

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Ph 9703 8222
info@dandypremix.com

Extractive Industry Work Authority No: 1488

Grantville Sand Quarry, GRANTVILLE

SITE LAYOUT PLAN

Author: AJM Date:6/01/2020	Drawing: NS - 1903 : Rev 0
Survey Source: Landair Surveys	
Orthophoto Date 30/6/19, Google, undated	**Project No: D10_003**
Projection: MGA Zone 55 (GDA 94)	**Figure: 3**
Fig3_SiteLayoutPlan_120.WOR	

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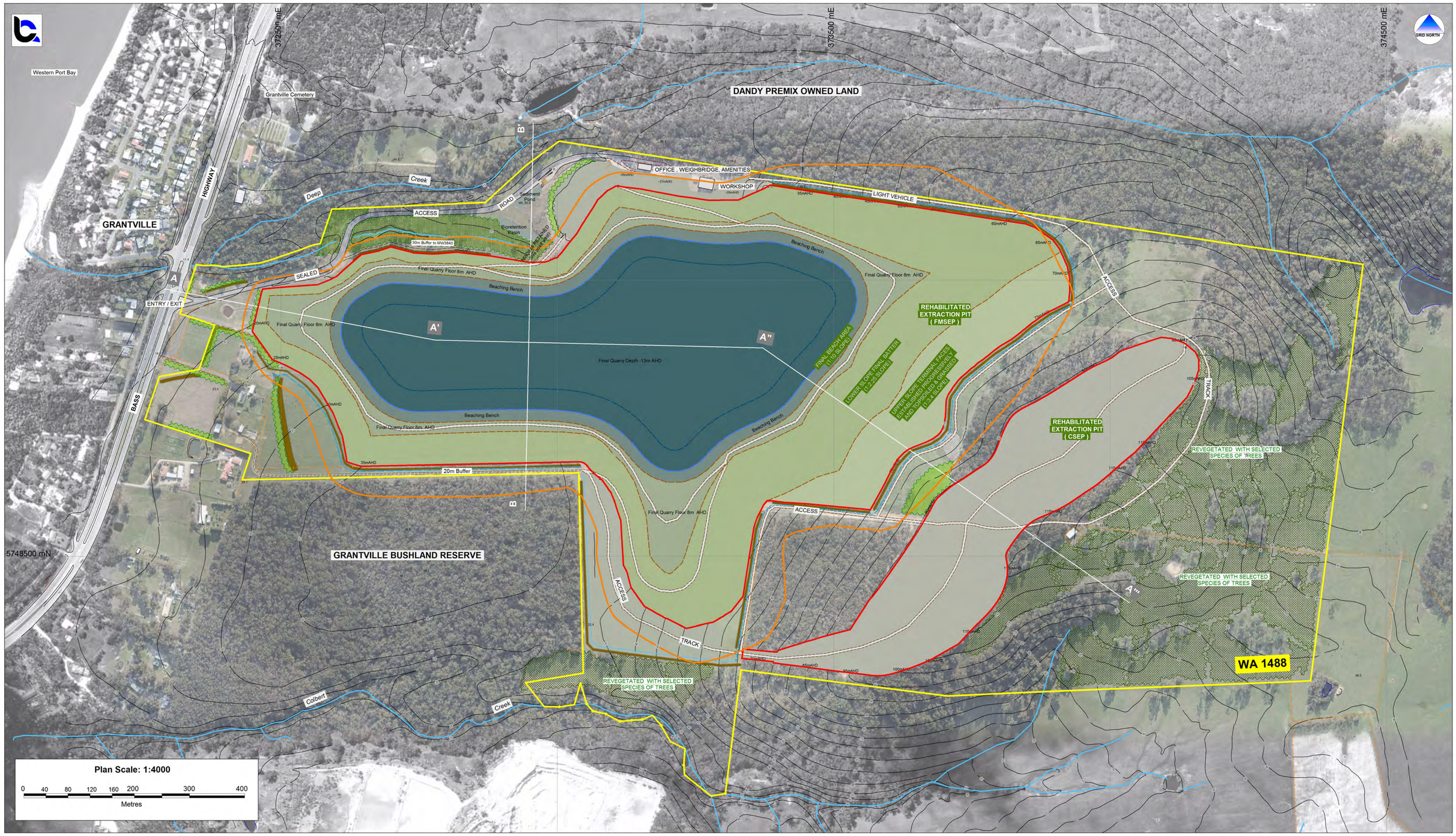
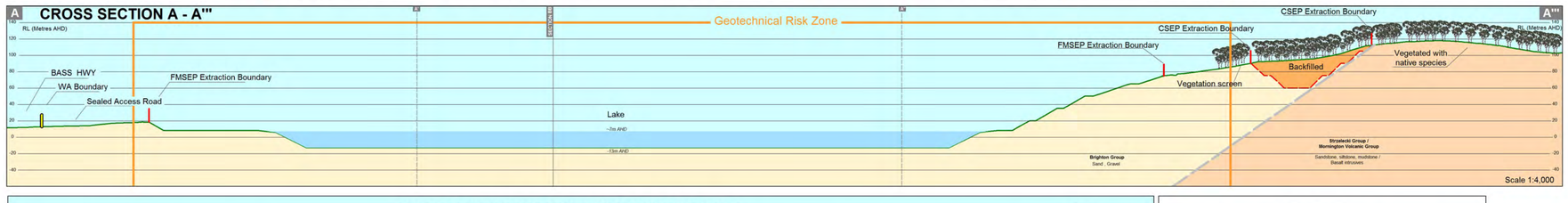
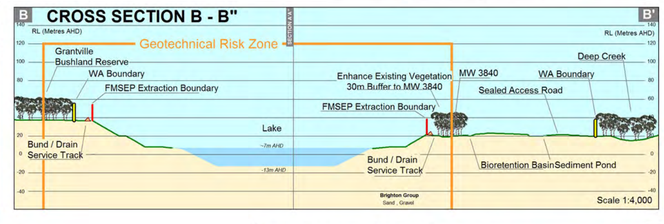
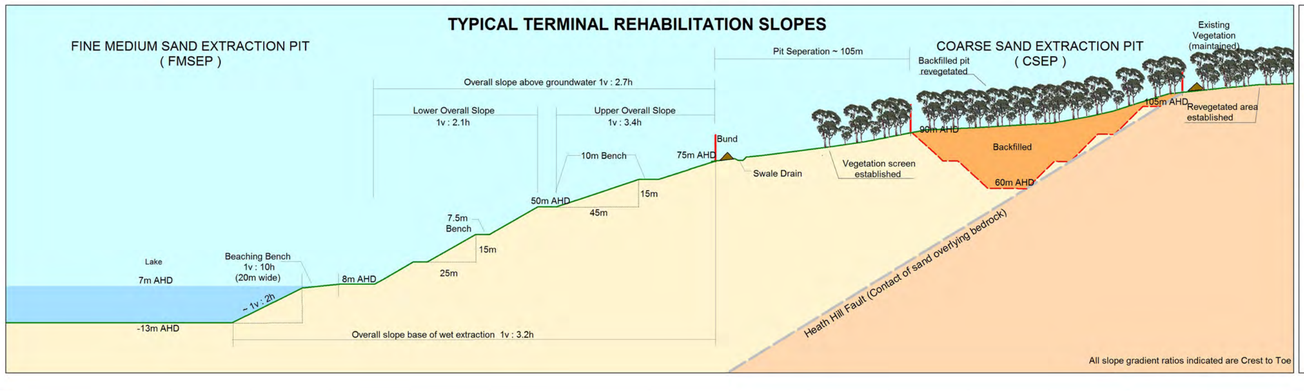
Ph: 03 9873 5123 | email: admin@bcaconsulting.com.au | www.bcaconsulting.com.au









LEGEND

- WA 1488 BOUNDARY
- WORK AUTHORITIES
- TERMINAL FACE TOE
- MAXIMUM GRZ (Terminal Extraction Face Toe)
- SERVICE TRACK
- WATER WAYS
- DRAINS
- BUND & SWALE DRAIN
- FENCE
- INDEX CONTOUR
- SPOT HEIGHT
- GRID COORDINATES (GDA 94, MGA ZONE55)
- CROSS SECTION LINES

WA (Work Authority)
CSEP (Coarse Sand Extraction Pit)
FMSEP (Fine Medium Sand Extraction Pit)
GRZ (Geotechnical Risk Zone)
mAHD (Meters above Australian Height Datum)
RL (Reduced Level) which on this plan is AHD
HV (Heavy Vehicles)

- EXISTING VEGETATION & ESTABLISHED REVEGETATION
- VISUAL SCREENING PLANTING
- RETAINED VEGETATION AND ENHANCED
- VEGETATION OF CLEARED LAND

REHABILITATION TREATMENT

- LAKE
- NATIVE AQUATIC PLANTS
- SHRUBS & TREES
- CLUMPS OF SHRUBS & TREES & GRASSES
- CLUMPS OF SHRUBS & GRASSES
- SCATTERED SHADE TREES & CLUMPS OF SHRUBS
- SCATTERED SHADE TREES & GRASSES

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Extractive Industry Work Authority No: 1488

Grantville Sand Quarry, GRANTVILLE

SITE REHABILITATION PLAN

Author: AJM Date:10/01/2020	Drawing: NS - 1904 : Rev 0
Survey Source: Landair Surveys	
Orthophoto Date 30/6/19, Google, undated	**Project No: D10_003**
Projection: MGA Zone 55 (GDA 94)	**Figure: 4**
WA1488_Fig4_RehabPlanR0.WOR	

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APPENDIX 10 – REHABILITATION AND SITE CLOSURE PLAN

REHABILITATION

&

SITE CLOSURE PLAN

Extractive Industry Work Authority WA1488

RRAM Designation:- PLN-001354

Grantville Sand Quarry



Site Address: 1381 Bass Highway, Grantville, VIC 3984
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Ph 9703 8222 (Reception & Accounts)
info@dandypremix.com

Project No. D10-003
8th Jan 2020

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Revision History.

Document Date	Description
18 Dec 2019	1st draft of rehabilitation plan
27 Dec 2019	V4
8 Jan 2020	V5

1. Rehabilitation and Site Closure Plan

This Rehabilitation and Closure Plan has been developed to address the requirements of Schedule 1 of the Mineral Resources (Sustainable Development) (Extractive Industries) Regulations 2010, and Section 5.5 of the Preparation of Work Plans and Work Plan Variation guidelines, December 2018.

1.1. Rehabilitation Objective and Site End Use.

Rehabilitation Objective

The primary objective of the Rehabilitation Plan for the site is to leave it in a safe, stable and sustainable condition. The rehabilitated landform will include some backfilled excavation areas and a water filled pit.

This rehabilitation concept is illustrated **Figure 4 Rehabilitation Plan**.

To achieve this objective, the following principles will be applied:

- undertake progressive rehabilitation at the earliest possible opportunity, including the backfilling and/or vegetating of any terminal batters and topdressing worked out areas,
- initially revegetate the final surfaces with pasture grass species to stabilise the surfaces and manage erosion,
- actively encourage natural regeneration,
- identify and plant out suitable areas with trees / shrubs or pasture grasses, and
- continually monitor and evaluate the effectiveness of rehabilitation and revegetation and modify as necessary to continue to achieve the stated objectives.

Site End Use/Regeneration

The proposed 156 hectare (ha) site end use and regeneration is significantly influenced by the following factors:

- Approximately 65 ha on the upper elevations, eastern outlook and including a small area on the southern site boundary to Colbert Creek are committed to revegetation and conservation in perpetuity under a registered s173 Agreement with DELWP, Council and DJPR/ERR;
- A further 53 ha of the 70 ha of Dandy Premix freehold land adjoining the WA1488 site to the north is also committed to revegetation and conservation in perpetuity under the same s173 Agreement;
- The revegetation and conservation areas of the s173 Agreement will form a sustainable Biolink between The Gurdies Nature Conservation Reserve and the Grantville Bushland Reserve, consistent with the 'Bass Coast Biodiversity Biolinks Plan, 2018';
- The proposed further development of the Fine Medium Sand Extraction Pit (FMSEP) will result in a finished lake estimated to have a surface area of approximately 24 ha by John Leonard Consulting Services in his Hydrogeological Assessment, December 2019;

However, as a first order of rehabilitation, it is proposed to return the site to a safe and stable condition with limited agricultural use. This end use is consistent with the past and current land use and the activities conducted immediately prior to extractive industry use. No additional planning consent is required, and the initial end use

concept is representative of current thinking but retains the potential to be influenced by future trends, technology and both the natural assets and tourism strategies of the Bass Coast Shire Council.

Given the significant reserves within the site this concept may change over time in line with the prevailing situation.

Other influencing factors include the potential for integration with adjoining public land or use as public space.

The detail of the final rehabilitation and regeneration design and any additional monitoring criteria will be agreed with Earth Resources Regulation (DJPR/ERR) approximately 5 years prior to site closure, which is not anticipated under the Work Plan Variation development proposal, for an estimated 30-40 years.

1.2. Progressive Rehabilitation

The key driver for the site to undertake progressive rehabilitation is the reduction of risk to the environment (amenity, visual, flora and fauna habitat).

Areas of the site not required for quarrying or as vegetation off-sets, being primarily the smaller, “house paddocks” on the western Work Authority boundary, will continue to be used for limited agricultural purposes.

The quantity of overburden and dewatering plant generated filter cake material, the cost of stockpiling and rehandling material on the site, community expectations and regulatory requirements are all factors influencing progressive rehabilitation. Commencing progressive rehabilitation of terminal faces and worked out areas as soon as physically possible is the most economical solution and has been designed into the progressive development of the site.

Strategy

Progressive rehabilitation will be integrated into daily operations and wherever possible will occur as soon as practicable after extraction, however this will not always be possible. Factors effecting the timing of progressive rehabilitation include (but are not limited to):

- the availability of suitable rehabilitation areas across the site, i.e. terminal faces and/or finished batters;
- the availability of suitable material to undertake rehabilitation,
- seasonal weather conditions

The progressive rehabilitation principles applying to this site are:

- to store topsoil on site in bunds for use in site rehabilitation;
- to store overburden in nominated stockpiles for future use;
- where possible, directly place overburden in compacted layers in worked out areas;
- to progressively batter and vegetate all terminal faces as soon as practical;

The success (or otherwise) of progressive rehabilitation will be regularly reviewed and any changes in the progressive rehabilitation strategy required will be implemented as appropriate. The criteria and monitoring frequency presented in the table below are adopted for all progressive rehabilitation undertaken on the site.

Timing

A commitment to having a nominated area rehabilitated at a specific point time is not practical. The maximum disturbed area (ie un rehabilitated area) will be 40 ha.

There are two key milestones in achieving satisfactory progressive rehabilitation: firstly, the completion of earthworks and establishment of ground cover (to minimise the risk to the environment) and secondly the establishment of more substantial/trees/shrubs in those areas where this is proposed.

The timing for the first milestone is:

- ***As soon as practical***: complete all earth works for the final land forming including the spreading of topsoil

- ***Within 3 months of completing earthworks***: Initially stabilise slopes through brush matting and / or seeding, including undertaking any remediation works and spreading of additional soil followed by seeding/fertilising to pasture grasses as appropriate. The revegetation of rehabilitated areas and batters will occur within 12 months of the completed earth works

- ***Each Spring and Autumn*** (ie 6 monthly intervals): review and report vegetation status, undertake any remediation earthworks necessary and supplement pasture as appropriate.

This first milestone will be achieved when the rehabilitated area has a consistent ground cover (as determined by no bare patches greater than $10m^2$).

The timing for the second milestone is dependent on areas being available and seasonal considerations. Rehabilitated areas with an established groundcover will be maintained until such time as suitable continuous areas can be planted out with larger vegetation.

2. General Closure Design

A conceptual, site wide Rehabilitation Plan is attached as Figure 4

2.1. Assets to be retained.

The land and the Work Authority are owned and operated by Dandy Premix Quarries. The office, weighbridge, workshop and any associated infrastructure and services, some hardstand areas, any fuel / hydrocarbon stores and the site access road will be retained post closure. Additionally, some site access tracks and water dams as presented on the Rehabilitation Plan attached will be retained.

It is estimated that approximately:

- 2.5 ha of hardstand area (including office, amenities, weighbridge etc.) and
- a total of approximately 4.0 ha of internal sealed access road and other tracks

will be retained post closure.

All excavating and processing plant, both fixed and mobile will be removed from the site.

All visual screening bunds and plantings constructed or established over the course of operation will be retained, other than those temporary screenings identified in the development plan.

Any remaining stockpiles and waste dumps will be shaped, graded and incorporated into the rehabilitation surface as presented in the rehabilitation plan.

2.2. Timing and Maximum disturbed area

As noted above, progressive rehabilitation will be integrated into daily operations as much as possible. Whilst it is anticipated that all earthworks involved in rehabilitation will be achieved within 12 months of the completion of extraction, revegetation will be dependent upon environmental and practical factors.

The total disturbed area, including all roads, hardstands, visual screening mounds, other earthworks and extraction areas is estimated to be 84.21 ha, whilst the maximum disturbed area open and unrehabilitated (including rehabilitated areas that have not met the primary objective) at any given time is estimated to be approximately 40 ha.

2.3. Terminal Face Treatment

Terminal faces in the Fine Medium Sand Extraction Pit (FMSEP) will be excavated at the designed terminal batter angle and rehabilitated as soon as possible by contour ripping, and the placing and spreading of topsoil before establishing vegetation. The dredge pond will remain as an open water body, containing groundwater and retaining run-off from the previous extraction area. Water edge vegetation and the construction of a 20m wide beaching bench (at 1V:10H) will stabilise the terminal face/groundwater interface and provide safe access/egress at the water's edge.

Terminal faces in the Coarse Sand Extraction Pit (CSEP) will be rehabilitated as soon as possible by placing and compacting suitable material (primarily overburden with some co-disposal of dried filter cake) to achieve complete backfilling of the pit void to a free draining surface. The final surface be lightly ripped, covered with topsoil and revegetated with grasses within 3 months of completing the earthwork to aid in managing erosion and dust. Fill material will be delivered by haul truck, and spread, compacted and battered by a dozer and/or wheel loader. This method of placing material has previously been shown to achieve a compaction of at least 95% standard compaction (AS1289.5.1.1).

Subsequent vegetation, or revegetation, will match existing vegetation type or EVC (Lowland Forest and Heathy Woodland), with further detail below.

As part of the operational phase, a safety bund will be established around the crest of operating faces. Where an existing fence coincides with a terminal boundary providing potential accessibility to the general public, the fence will be retained. The vegetated screening bund to the Bass Highway site aspect will assist in deterring out-of-hours public access to the site.

Timing of the rehabilitation of terminal faces and benches, including the placement of overburden, topsoiling and revegetation, occurs after extraction limits have been achieved, potentially requiring the temporary stockpiling of some overburden material.

2.4. Dams and constructed works

There are no slimes dams or constructed dams proposed for the site. There are several existing, shallow farm dams on the site, as well as the existing Sedimentation Pond and Bio-retention Basin and proposed sedimentation traps as part of the Surface Water Management Plan. The two farm dams located within the extraction footprint of the FMSEP will be removed as part of extraction activities, while all other farm dams located outside of the two extraction areas will be retained.

All visual screening bunds and plantings constructed or established over the course of operation will be retained, other than any temporary screenings that might be identified as being required.

Roads, tracks and other hardstand areas that were constructed as part of the quarry establishment works, and which are deemed unnecessary for the post quarry operations land use, will be removed/ripped and rehabilitated in keeping with other site areas and vegetation.

2.5. Overburden Requirements

The geological model for the site suggests:

- 150-200 mm of soil in open paddocks to under 100mm poor sand soil where sand outcrops;
- 5-10m of overburden; and
- Over 60 metres of sand sequence generally consisting of fine-medium, medium-coarse, coarse, very coarse and very fine sand

Resource calculations based on the geological model and proposed terminal pit designs show approximately 3.73 million cubic metres of material is available for rehabilitation, comprising:

Topsoil	130,000 cubic metres
Clay/overburden:	3.6 million cubic meters

The volume of material required to create the proposed rehabilitated land form (i.e. back fill the CSEP) is estimated to be approximately 3.5 million cubic metres. The terminal faces of the FMSEP will be excavated at the terminal design and no overburden will be required for face battering or backfilling.

2.6. Surface water management

Through the operational extraction phase surface water is managed to ensure run-off from disturbed areas (including roads, stockpiles and the temporary overburden stockpile) is intercepted and directed to sediment traps or basins, or into the extraction areas of the FMSEP, thereby minimising the potential for turbid (dirty) water run-off and erosion. The site Surface Water Management Plan, which is updated as required by extractive operations, details the most current surface water management strategies employed on the site.

Post closure, much of the surface water management infrastructure will remain in place. The lower bench of the FMSEP will be below the standing groundwater level, while surface water run-off from the rehabilitated terminal batters of the FMSEP will drain to the exposed water body (lake).

The existing protection measures related to the western end of the Deep Creek tributary (Melbourne Water asset MW3840) will remain in place.

2.7. Imported Material

Sufficient overburden material is available on site to undertake the proposed rehabilitation land forming, and there are currently no plans to import material.

Prior to importing any material, an Imported Fill Management Plan in accordance with ERR guidelines (and any other guidelines issued by the Environment Protection Authority) will be prepared and approved by the relevant authority.

2.8. Site security

The rehabilitation plan does not leave any vertical / steep faces, or high and exposed faces. The former dredge pond will remain as an open water body (lake). Emergency egress from the water will be assisted by the wide beaching bench and water edge vegetation.

No additional security fencing to the site's perimeter is anticipated. The existing site access point infrastructure, stock proof fencing, surface water diversion structures, and any retained screening vegetation will be retained post closure to assist in barring unauthorised vehicle and pedestrian access to the site.

Throughout the operation, site security will be periodic reviewed with any additional security protocols (surveillance, fencing, bunding, vegetation, etc.) implemented to meet the requirements of prevailing conditions. Post closure a detailed review of the established (in-place and operative) security infrastructure will be undertaken; a decision(s) will be made as to whether it is required in the longer term, and if so, it will be retained, or amended to best suit the site's post closure needs.

2.9. Pest Animals and Noxious Weeds

All pest animals will be controlled to the satisfaction of the DELWP, the Bass Coast Shire and ERR using approved methods. Spraying using approved treatments will be used to control declared noxious weeds. The presence of pest plants and animals on site will be monitored and managed on an ongoing basis and in accordance with Paul Kelly & Associates, Native Vegetation Removal and Offset Management Plan, December 2019.

2.10. Revegetation requirements

The primary objective is to return the site to a safe and stable condition with limited agricultural use, although significant areas of the Work Authority site have been committed to and are currently undergoing active establishment as a native revegetation and conservation corridor (Biolink). Throughout the life of the site, it will also be necessary to monitor the need and where required, establish more screening vegetation / perimeter planting.

The rehabilitated quarry faces, quarry floor and other disturbed areas will be fertilised and seeded as appropriate to initially establish pasture grasses before planting out with native species of local EVC and provenance. Detailed planting and species requirements for off-set areas are detailed in the Native Vegetation Offset Management Plan (attached to the WPV). Similar detailed requirements for buffer, landscape and riparian areas are contained within the Landscape and Vegetation Plan, Spring 2013, prepared and being implemented by Bass Coast Landcare Network by engagement from the Work Authority holder, Dandy Premix (copy also attached to the WPV).

A variety of re-vegetation methods may be required to establish a viable vegetative cover. Experience at this site has shown that natural revegetation has not proved to be successful in one area of the s173 Conservation and Revegetation plan, necessitating direct seeding and the increased planting of tube-stock.

Where appropriate a short-term cover of grasses may be established to stabilise disturbed areas prone to wind or surface water erosion. Fencing (both temporary and permanent) will be used to protect specific or vulnerable areas of revegetation from access, both during and after establishment.

The conceptual rehabilitation plan is presented in Figure 4 Rehabilitation Plan.

3. Closure Criteria and Monitoring

The Table below outlines the key criteria and monitoring to evaluate the success of the rehabilitation program, including operational works, progressive rehabilitation and any final rehabilitation completed during the site's operational phases as well as after site closure.

3.1. Criteria

In line with rehabilitation objectives, closure criteria will initially concentrate on measuring the success of the prevention of erosion within the extraction areas and turbid (dirty) water run-off from the disturbance footprint. These risks will be mitigated through cut off drains, vegetation establishment, strategic location of batter swale drains and any other surface water management strategies as required and outlined in the Surface Water Management Plan. Subsequent criteria will focus on the re-establishment and maintenance of agricultural land.

In addition to the criteria outlined below it is understood that ERR, from time to time, may require specific rehabilitation and/or site closure requirements, including any monitoring and reporting requirements. If additional requirements are imposed, they shall be documented appropriately (i.e. TARP etc.) and available for review by the relevant authority on request.

3.2. Monitoring

Monitoring of rehabilitation, including any progressive rehabilitation is an integral part of the operational phase of the site and will continue post closure. Post closure monitoring records will adopt any operational monitoring worksheets/pro-forma reports. The post closure monitoring program is designed to demonstrate that the closure criteria has been met and that the site is not causing any hazardous, or environmental, off-site impacts, nor is it adversely impacting local amenity.

Post closure monitoring will continue for at least three years, or for a period conditioned by ERR, after the site has ceased operating, or until the relevant authority is satisfied closure criteria has been met.

3.3. Remedial Works

If any of the closure criterial is not being met or is not satisfactorily progressing based on the site monitoring, any corrective and/or immediate maintenance and remediation activities will be undertaken to ensure the earliest compliance with the criteria. Example situations would include, but not be limited to:

- Damage to fencing – repair fencing, investigate the cause, initiate additional measures as necessary;
- Poor vegetation development – investigate cause, engage agronomist for advice on pasture species, soil properties, fertiliser, remedial works as required;
- Excessive weed presence –initiate one off weed eradication program, review weed management schedule and pasture development; and
- Excessive erosion– repair the erosion area(s), review surface water management operations, consider more appropriate location of drains and/or culverts. Investigate alternative erosion control devices (e.g. rock armour, hay bales, other vegetation).

4. Management

4.1. Roles & Responsibilities

The Quarry Manager (or their nominated representative) is responsible for managing the implementation of the Rehabilitation and Site Closure Plan, including:

- Delegating tasks associated with this Rehabilitation and Site Closure Plan where necessary;
- Providing adequate resources to implement this Rehabilitation and Site Closure Plan; and
- Providing adequate training to employees and contractors regarding their requirements under this Rehabilitation and Site Closure Plan.

4.2. Documentation

All monitoring outcomes, including any visual inspection worksheets/reports, any testing or analysis, any specialist reports etc, will be recorded and retained at the Dandy Premix Quarries site office for periodic review. Where appropriate, or as required, this information will be available to ERR or other relevant authorities.

4.3. Review

This Rehabilitation and Site Closure Plan will be reviewed every five years for ongoing appropriateness, with a comprehensive review approximately five years prior to the anticipated quarry closure to ensure it adequately addresses local community, Council and ERR objectives.

These reviews will take into consideration any changes that may have occurred on site, the results of any monitoring, advice from any specialist, the effectiveness or otherwise of any progressive rehabilitation and any directives by ERR.

Depending on the nature of any changes to the plan, discussions will be undertaken with ERR to determine if there is any significant increase in the risk profile of the site to determine if a variation or a notification is required. Any such decision will be thoroughly assessed at the time of the review and the most appropriate pathway undertaken in consultation with ERR, including initiation of a work plan notification or variation.

5. Post Closure Monitoring

Given the projected site closure is several decades in the future it is unrealistic to describe a detailed post closure monitoring program at this current point-in-time. A detailed post closure monitoring schedule will be developed at the time of the final review (some 5 years before the anticipated site closure), addressing all relevant activities to the satisfaction of all the relevant authorities at that time.

It can be expected that post closure monitoring will reflect closure criteria by:

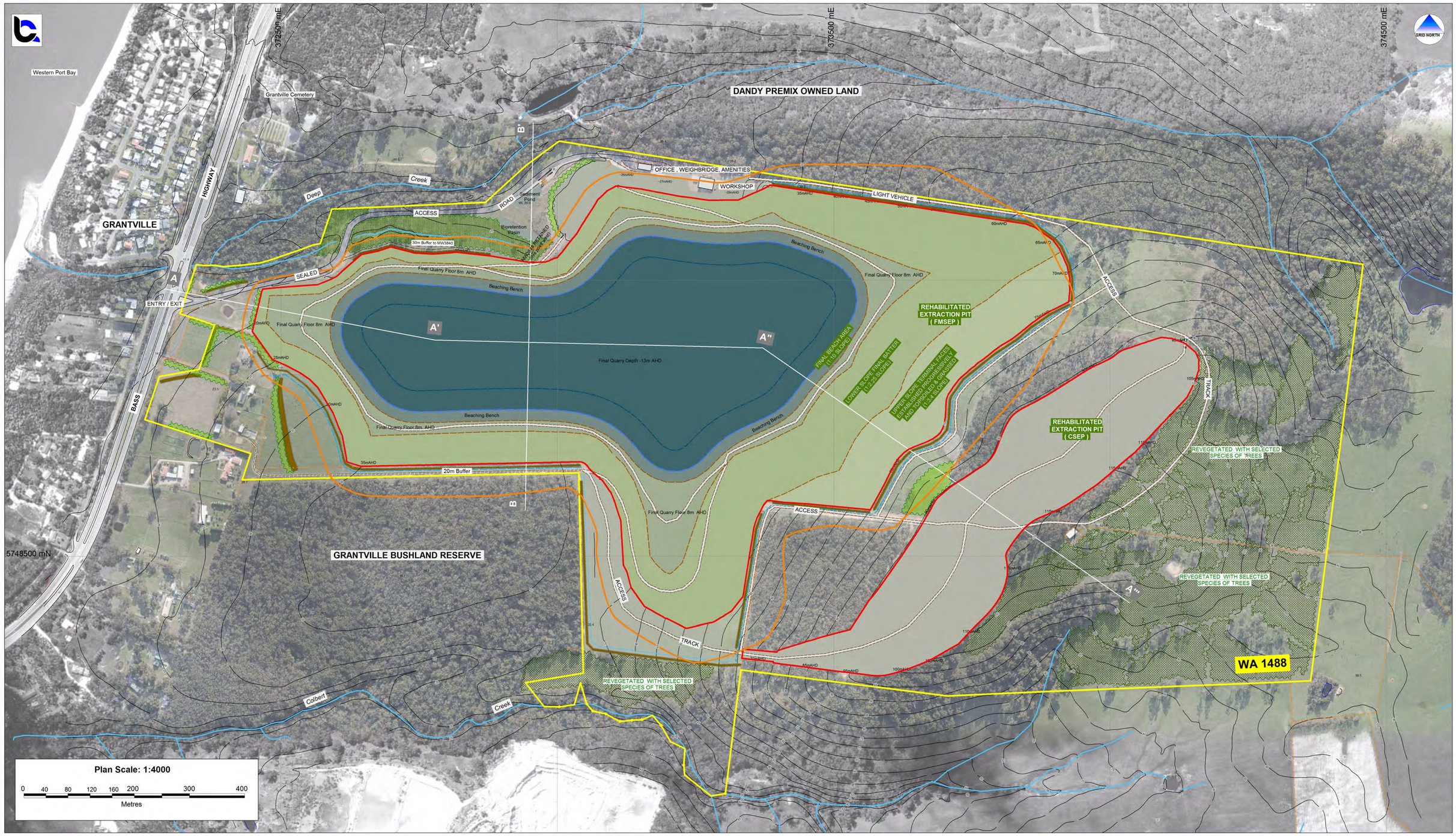
- Auditing the site for remaining plant, machinery, scrap, rubbish etc.;
- Measuring suspended solids content of surface water run-off from the MW3840 tributary; and
- Pasture establishment, native vegetation growth rates and the agricultural viability of the site.

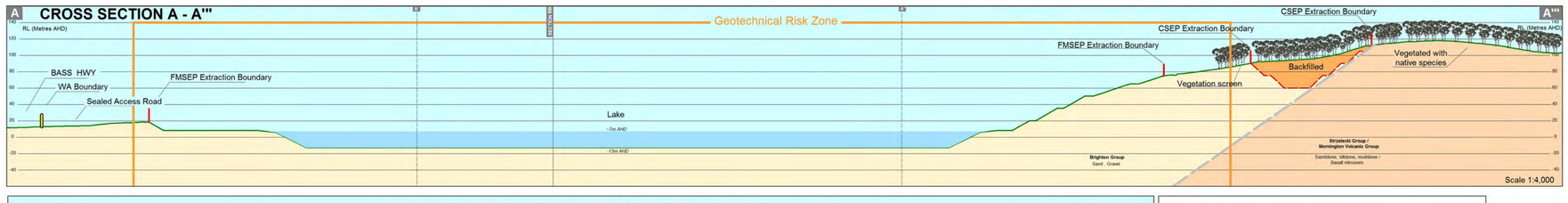
Item	Rehabilitation / Closure Criteria	Elements to be Monitored	Frequency
Fine/Medium Sand Excavation Pit (FMSEP)	Terminal batters as per design Surface water treatments in place Sediment traps, sediment dams in place and functioning Viable vegetation established Groundwater level established Acceptable level of erosion	Final landform criteria constructed in accordance with the plan Visual assessment of batters, looking for presence/absence of landform slumping, cracks or movement Pasture / vegetation establishment (see below) Effectiveness of fencing to control stock and feral animals impacting terminal batter Erosion (see below)	**Operationally** 3 Monthly Additional inspections after significant rainfall events. **Post Closure** Y1 - 3 Monthly Y2 - 6 Monthly Y3 -12 Monthly Additional inspections after significant rainfall events.
Coarse Sand Extraction Pit (CSEP)	Terminal batters as per design Backfilled to previous landform Minimum compaction of backfilled batter 95% Standard Compaction (AS1289.5.1.1) Viable vegetation established Batter Swale drains functioning Acceptable level of erosion	Final landform criteria constructed in accordance with the plan Visual assessment of batters, looking for presence/absence of landform slumping, cracks or movement Native vegetation establishment (see below) Erosion (see below)	**Operationally** 3 Monthly Additional inspections after significant rainfall events. **Post Closure** Y1 - 3 Monthly Y2 - 6 Monthly Y3 -12 Monthly Additional inspections after significant rainfall events.
Geotechnical Integrity – General Operation	Safe and stable final landform	Site Inspection of all working faces, terminal faces and rehabilitated faces in accordance with Ground Control Management Plan (GCMP). Periodic review of faces by suitably experience geotechnical engineer	**Operationally** Site inspection Monthly Geotechnical Review as required by the GCMP **Post Closure** Site inspection Y1 - 3 Monthly Y2 - 6 Monthly Y3 --6 Monthly Y4 – 6 Monthly Geotechnical Review every 1 years for 3 years.

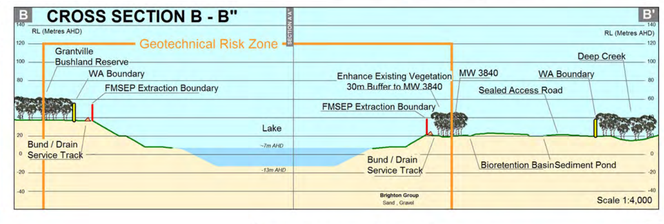
Item	Rehabilitation / Closure Criteria	Elements to be Monitored	Frequency
Screening Vegetation where established	Min 90% vegetation establishment No bare patches greater than $10m^2$	Visual estimate of vegetation establishment (tree establishment) General description of vegetation vitality / die back (see BCLN Landscape and Vegetation Plan) Record / photograph any bare patches	**Operationally** 3 Monthly Additional inspections after significant rainfall events. **Post Closure** Y1 - 3 Monthly Y2 - 6 Monthly Y3 -12 Monthly Additional inspections after significant rainfall events.
Erosion	No erosion channels greater than 1m deep and/or wide No more than 5 erosion channels greater than 0.5m deep and/or wide within a 20m wide area.	Erosion channels greater than 0.25m deep or wide recorded & photographed Note /photograph any erosion channels less than 0.25m deep or wide for potential follow-up	**Operationally** 6 Monthly Additional inspections after significant rainfall events. **Post Closure** Y1 - 3 Monthly Y2 - 6 Monthly Y3 -12 Monthly Additional inspections after significant rainfall events.
Pasture / Vegetation (batters and extraction areas)	Min 90% vegetation establishment No bare patches greater than $10m^2$	Visual estimate of vegetation establishment (canopy cover) General description of vegetation vitality / species survival (see Off-set Management Plan etc) Record / photograph any bare patches	**Operationally** 6 Monthly Additional inspections after significant rainfall events. **Post Closure** Y1 - 3 Monthly Y2 - 6 Monthly Y3 -12 Monthly Additional inspections after significant rainfall events.
Fixed / Mobile Plant	All fixed and mobile processing plant removed from site	Record / photograph presence of any fixed / mobile processing plant	**Operationally** Annually for derelict / redundant plant **Post Closure** One off
Infrastructure (retained post closure)	Infrastructure maintained to neat/tidy appearance	Photograph all retained infrastructure Weighbridge/Office/Amenities building Workshop/Storage Shed	**Operationally** Annually for derelict / redundant plant **Post Closure** Annually

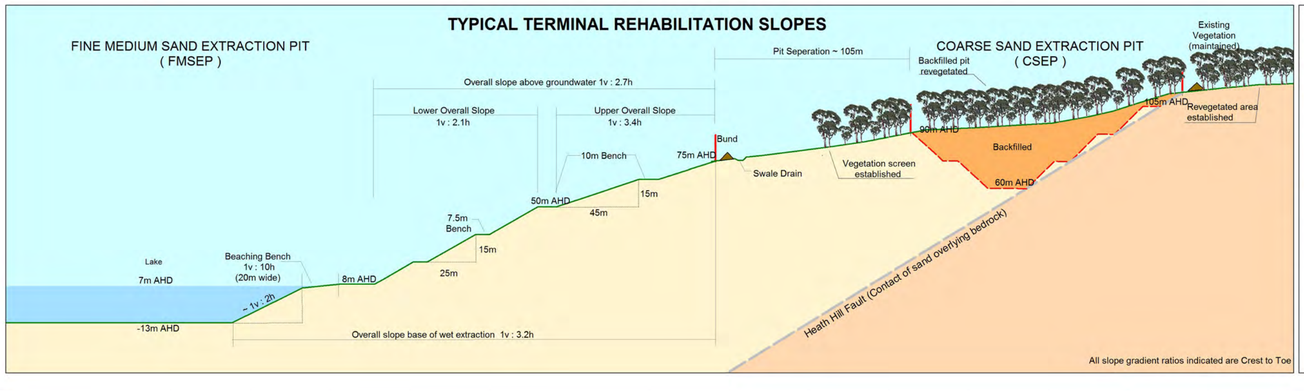
Item	Rehabilitation / Closure Criteria	Elements to be Monitored	Frequency
Surface Water Drains	Surface water drains in place and free flowing Erosion satisfactorily controlled	Specific monitoring as per Water Management Plan, otherwise visual inspection drains, silt traps and sediment control devices for suitability and ensure that no adverse level of sediment is leaving the site, note / photograph	**Operationally** 3 Monthly Additional inspections after significant rainfall events. **Post Closure** Y1 - 3 Monthly Y2 - 6 Monthly Y3 -12 Monthly Additional inspections after significant rainfall events.
Surface Water Quality (for water leaving the site)	No turbid water leaving site Clean water (Salinity, turbidity & TDS levels of any water leaving the site in accordance with sites EPA guidelines)	Visual inspection for water quality, specific monitoring as per the Surface Water Management Plan Periodic sampling and analysis when flow allows, e.g. after significant rainfall event(s)	**Operationally** Inspections and monitoring in accordance with the Surface Water Management Plan Additional inspections after significant rainfall events. **Post Closure** Y1 - 3 Monthly Y2 - 6 Monthly Y3 -12 Monthly Additional inspections after significant rainfall events.
Roads / Tracks (removed post closure)	Tracks/Roads for removal clearly identified and agreed with ERR and with CFA input All identified roads and tracks, not required as 'Fire Access Track' returned to pasture / vegetation	Visual estimate of pasture establishment (ground cover) General description of pasture vitality Record / photograph any bare patches	**Operationally** Annually for redundant tracks. **Post Closure** Y1 - 3 Monthly Y2 - 6 Monthly Y3 -12 Monthly
Hardstand Areas (removed post closure)	Hardstand areas for rehabilitation clearly identified and agreed with ERR Area returned to pasture / vegetation	Visual estimate of pasture establishment (ground cover) General description of pasture vitality Record / photograph any bare patches	**Operationally** Annually for redundant areas. **Post Closure** Y1 - 3 Monthly Y2 - 6 Monthly Y3 -12 Monthly
Hardstand Areas (retained post closure)	Hardstand area remaining post closure clearly identified and agreed with ERR Hardstand area maintained to acceptable standard	General description of road surface & drainage system, inclusive of Sediment Pond and Bio-retention Basin Record / photograph typical section erosion	**Operationally** Annually for redundant areas. **Post Closure** At site closure then annually

Item	Rehabilitation / Closure Criteria	Elements to be Monitored	Frequency
Roads / Tracks (retained post closure)	Tracks/Roads remaining post closure clearly identified and agreed with ERR Roads/ tracks surfaces maintained to acceptable standard Edge drains maintained and effective	General description of road surface & drains Record / photograph typical section	**Operationally** Annually for redundant areas. **Post Closure** At site closure then annually
Sediment Pond and Bio-retention Basin (retained post closure)	Structure wall integrity maintained No erosion on downstream embankment Upstream wall integrity not compromised by excessive flow action	Record / photograph typical section Erosion (see above) Aquatic Vegetation establishment and health (see BCLN Landscape and Vegetation Plan)	**Operationally** Monthly visual inspection **Post Closure** Y1 - 3 Monthly Y2 - 6 Monthly Y3 -12 Monthly Additional inspections after significant rainfall events.
Site Security	Integrity / suitability for purpose of WA boundary and property fencing maintained	Boundary Fencing Vegetation quality/viability Bund and / drain integrity	**Operationally** Annually **Post Closure** Annually
Noxious Weeds	Noxious weeds less than 2.5% total ground cover	Weed cover – Woody and Herbaceous Weeds – Scheduled weed spaying program maintained and recorded	**Operationally** 6 monthly. **Post Closure** 6 monthly
Pest Animals	Local guidelines re pest animals No visible impact on rehabilitation	Evidence of pest animals (photo) Assessment of numbers (if possible)	**Operationally** 6 monthly. **Post Closure** 6 monthly









LEGEND

- WA 1488 BOUNDARY
- WORK AUTHORITIES
- TERMINAL FACE TOE
- MAXIMUM GRZ (Terminal Extraction Face Toe)
- SERVICE TRACK
- WATER WAYS
- DRAINS
- BUND & SWALE DRAIN
- FENCE
- INDEX CONTOUR
- SPOT HEIGHT
- GRID COORDINATES (GDA 94, MGA ZONE55)
- CROSS SECTION LINES

WA (Work Authority)
CSEP (Coarse Sand Extraction Pit)
FMSEP (Fine Medium Sand Extraction Pit)
GRZ (Geotechnical Risk Zone)
mAHD (Meters above Australian Height Datum)
RL (Reduced Level) which on this plan is AHD
HV (Heavy Vehicles)

- EXISTING VEGETATION & ESTABLISHED REVEGETATION
- VISUAL SCREENING PLANTING
- RETAINED VEGETATION AND ENHANCED
- VEGETATION OF CLEARED LAND

REHABILITATION TREATMENT

- LAKE
- NATIVE AQUATIC PLANTS
- SHRUBS & TREES
- CLUMPS OF SHRUBS & TREES & GRASSES
- CLUMPS OF SHRUBS & GRASSES
- SCATTERED SHADE TREES & CLUMPS OF SHRUBS
- SCATTERED SHADE TREES & GRASSES

DANDY PREMIX QUARRIES PTY LTD
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Ph 9703 8222
info@dandypremix.com

Extractive Industry Work Authority No: 1488

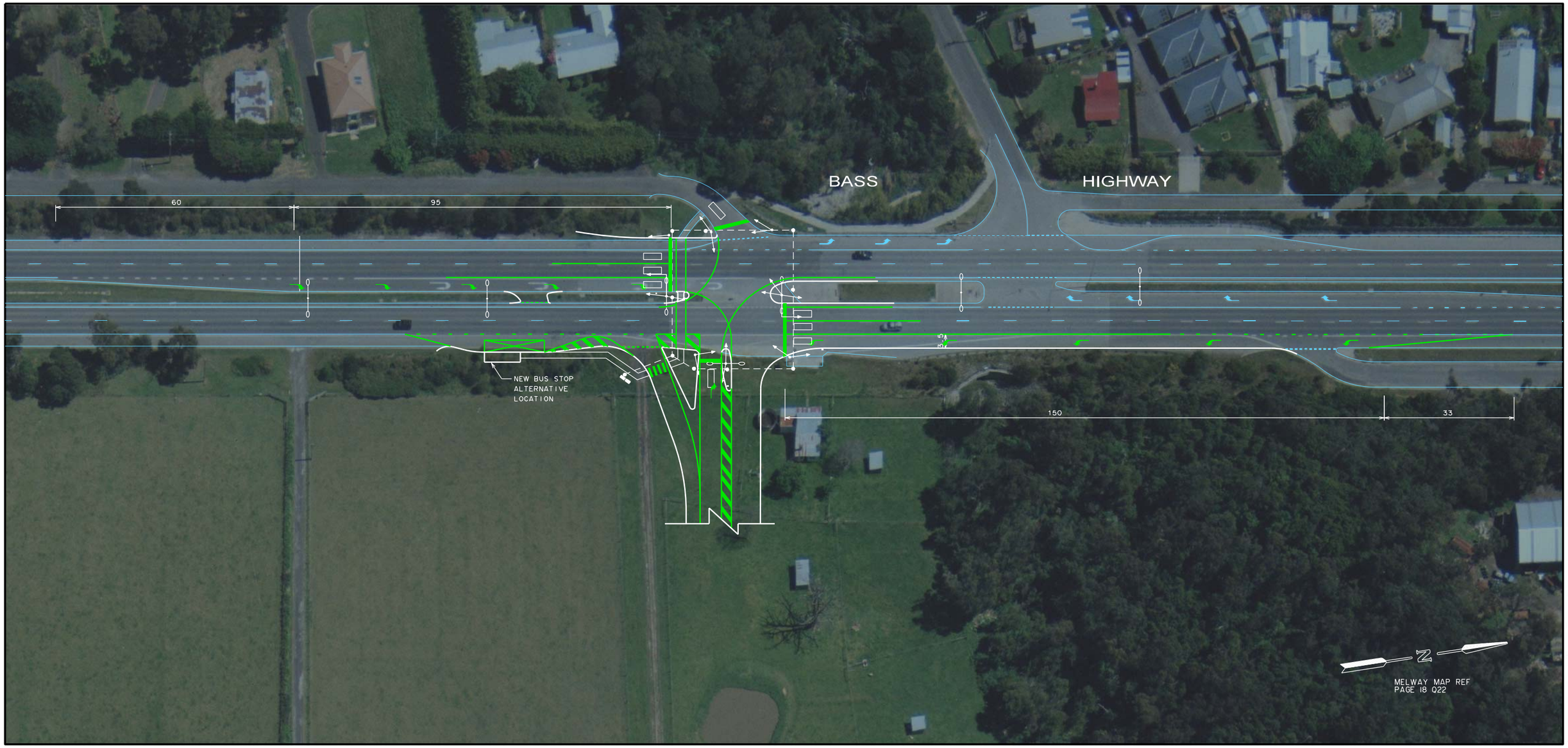
Grantville Sand Quarry, GRANTVILLE

SITE REHABILITATION PLAN

Author: AJM Date:10/01/2020	Drawing: NS - 1904 : Rev 0
Survey Source: Landair Surveys	
Orthophoto Date 30/6/19, Google, undated	**Project No: D10_003**
Projection: MGA Zone 55 (GDA 94)	**Figure: 4**
WA1488_Fig4_RehabPlanR0.WOR	

BCA CONSULTING - Earth Resources | 29/41 Norcal Road Nunawading 3131
Ph: 03 9873 5123 | email: admin@bcaconsulting.com.au | www.bcaconsulting.com.au

APPENDIX 11 – FUNCTIONAL LAYOUT OF INTERSECTION



PRELIMINARY PLAN
FOR DISCUSSION
PURPOSES ONLY

WARNING
BEWARE OF UNDERGROUND SERVICES
The locations of underground services shown are approximate only and their exact position should be proven on site.

REVISION	REVISION NOTES	REVISION DATE

GENERAL NOTES
1. BASE INFORMATION FROM AERIAL PHOTOGRAPHY AND SITE INSPECTION.
2. MAIN ROAD - BASS HIGHWAY (SPEED ZONE 100km/h).

DESIGNED G.RAKITA 26 SEPTEMBER 2012
CHECKED/APPROVED H.TURNBULL 26 SEPTEMBER 2012
FILE NAME G13716.dgn
ISSUE A

TraffixDesign
Traffic Engineering Design and Survey
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www.traffixgroup.com.au

1393-1395 BASS HIGHWAY
GRANTVILLE
BASS COAST SHIRE COUNCIL
FUNCTIONAL LAYOUT PLAN - OPTION 3

SCALE 0 5 10 15 20
SHEET No.
DWG No. G13716A-03

APPENDIX 12 – DUST MANAGEMENT PLAN

ATTACHMENT 3. DUST MANAGEMENT PLAN

DPQ GRANTVILLE SAND QUARRY
DRAFT DUST CONTROL MANAGEMENT PLAN – Updated 12 December 2019

1. Air Quality (Dust Control) Objectives and Performance Indicators

The Dandy Premix Quarries Grantville Sand Quarry site objectives applicable to air quality and dust control are:

- ***To ensure that no visible dust emissions generated by the quarry operations are detected beyond the site boundaries; and***

- ***To ensure that dust emissions comply with relevant guidelines in the Mining and Extractive Industries PEM.***

Corresponding performance indicators to be used to monitor the achievement of these objectives are:

- Visual observations of dust beyond the quarry site boundary; and
- Measured dust deposition rates as recorded through the site monitoring program in accordance with the operational control requirements of the PEM.

2. Dust Control Program

Dust will be controlled by implementation of the actions below:

Trafficable Areas:

- Water will be applied to trafficable areas around the processing plant, raw sand and finished product stockpiles on the Hard Stand Area through the use of a water tanker truck fitted with spray bars and a cannon, fixed sprays and sprinkler systems;

- Water will be applied to designated Haul Roads by fixed sprinklers where road moisture content is low and dust would otherwise be generated from Haul Truck passage;

- Water will be applied proactively as a dust control measure before the onset of potentially dusty weather conditions (based on Bureau of Meteorology weather predictions);

- Approved chemical dust suppressants may also be applied where appropriate to enhance dust control and to reduce the volume of water required for effective dust control;

- All Haul Truck movements will be kept to designated Haul Roads to minimise the extent of trafficked areas; and

- Ancillary and administrative vehicle speeds on-site will be limited to 25 kilometres per hour (kph).

Truck Movements – Entry & Exit to Site:

- The DPQ Grantville site entry and exit to the Bass Highway is sealed (paved) and swept as required to control any accumulation of dust;

- Loads will be covered or be wet-down when required to prevent the emission of dust from materials being transported;

- The tailgates of all trucks leaving the site will be securely closed to prevent any loss of materials;

- Trucks will be required to drive through the wheel wash when wet conditions on the hardstand result in significant material attached to their tyres; and

- Where sediment or mud is deposited on a public road, by trucks departing DPQ Grantville, this will be cleaned-up immediately by DPQ.

Plant and Processing Hard Stand Area:

- Surfaces on which front-end wheel loaders operate will be treated with water (inclusive of approved chemical dust suppressants where appropriate) to ensure minimal dust generation;

- Loader operators are trained and will operate in accordance with their training to fill bins, hoppers, stockpiles and delivery trucks in a manner that minimises dust generation;

- Approved chemical dust suppressants may be applied to the most trafficked sections of the sales (loading) and sand processing Hard Stand Area;

- Periodic watering of the remainder of the Plant and Processing Hard Stand Area is to be undertaken with a water tanker truck as required;

- Water sprays will be installed, fully maintained and used whenever the screening and blending plant , including the raw feed bins and the radial conveyor (transfer) stacker are operating; and

- All sections of the Hard Stand Area including the sales loading, weighbridge and the sand processing and dewatering plant shall be kept in a clean and tidy condition at all times.

Stockpiles:

- Sprinklers will be maintained and operated to apply water to the surfaces of the raw sand and finished product stockpiles as required to minimise dust generation;

- Approved chemical dust suppressants may be used to seal surfaces and minimise dust emissions where appropriate;

- Sprinklers shall have the ability to operate out of working hours if required; and

- The DPQ Grantville Site Quarry Manager/Supervisor will monitor the condition of the stockpiles.

Site Supervision:

- The DPQ Grantville Quarry Manager/Supervisor will monitor those areas and operations of the site that have the potential to generate dust to ensure dust control actions are being satisfactorily undertaken as required to mitigate and/or minimise dust generation. All staff will be required to immediately advise the Quarry Manager/Supervisor if they observe significant dust generation.

Contingencies:

- During those times of the year with higher evaporation rates (September – April) the DPQ Grantville Quarry Manager/Supervisor will download 10-day Bureau of Meteorology climate model predictions (available in the form of meteorograms to "Weatherzone" subscribers) which provide advance warning of likely strong winds and very hot weather conditions. This will assist with the daily and proactive management of dust suppressant measures. These measures may include the suspension of overburden, or sand extraction and sand washing, screening and blending operations for the duration of the adverse weather conditions.

- Where strong winds are forecast which will place operations upwind from nearby sensitive uses, the DPQ Grantville Quarry Manager/Supervisor shall implement proactive dust suppression measures such as undertaking additional dust suppression measures on stockpiles and haul routes; and

- If off-site dust emissions are observed or indicated by elevated dust deposition monitoring data, additional/proactive dust suppression measures will be implemented. These may include:

    - Increased use of water and approved chemical dust suppressants;
    - A reduction of all vehicle speeds on site; and
    - The suspension of works in the area generating the dust;

    Until such time as effective dust control is achieved or conditions abate.

Scheduling Potentially Dusty Operations:

- Potentially dusty operations, such as overburden removal and placement, and installation of screening bunds will, whenever practicable, be conducted between the Autumn break and the end of November (this is particularly the case for overburden removal and other potentially dust generating works predominately towards both the western end of the FMSEP and the site).

3. Dust Monitoring Actions

The DPQ Grantville Sand Quarry dust monitoring program is designed to facilitate an adaptive management approach to the control of dust. The monitoring of dust generation and dust emissions will be undertaken as follows:

- The DPQ Grantville Quarry Manager/Supervisor will undertake daily visual site inspections for dust generation including an assessment of the dust suppression measures in operation at the time of inspection;

- Three dust deposition gauges are located on the DPQ Grantville Sand Quarry site boundaries at locations determined in consultation with DPI. The results of monthly sampling are used to assess compliance with the PEM dust deposition guidelines. This monitoring is ongoing, subject to compliance with the PEM guidelines and is reported every four months to the Grantville Environmental Review Committee (ERC).

Prepared for: Dandy Premix Quarries Pty Ltd

Prepared by: FOCUS Creative Development Solutions
9-10 Garden Court, Narre Warren, Victoria AUSTRALIA 3805

Submission in support of application to amend
Planning Permit No. 120388

Sand Extraction

1381 - 1395 Bass Highway, Grantville

Volume 2 - Specialist Reports

July 2020
(2586R02)

FocusCDS Consultants

VOLUME 2 – SPECIALIST REPORTS

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REPORT 5 – TRAFFIC ENGINEERING ASSESSMENT

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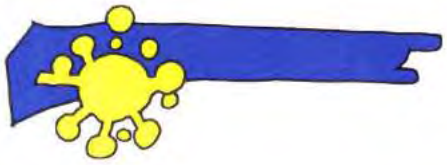
REPORT 7 – DUST ASSESSMENT

REPORT 8 – ECONOMIC AND SOCIAL IMPACT STUDY

REPORT 9 – GEOTECHNICAL ASSESSMENTS

REPORT 1 – NATIVE VEGETATION REMOVAL REPORT, DETAILED PATHWAY



Paul Kelly & Associates
Ecological Services

12029

Proposed Quarry Extension
Native Vegetation Removal Report
Detailed Pathway

Dandy Premix Quarry Extension, Grantville

15 December 2019

Prepared by PKA (For Dandy Premix)
PO Box 2022, Indented Head VIC 3186;
m – 0438 030 841

Issue Date	Revision No	Author	Checked	Approved
23 July 2019	Draft	PCK		
7 August 2019	Draft (with OMP)	PCK	GC	
3 November 2019	Draft	PCK	MB (DELWaP)	
15 December 2019	Final	PCK	GC	

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Appendix 1 – Location & Biological Features Map

Appendix 2 – Native Vegetation Removal Report

Appendix 3 – Large & Scattered tree removal

Appendix 4 – Topographic & Land Information Map

Appendix 5 – Offset Management Zones

Appendix 6 – Offset Site Report

Appendix 7 – Offset Management Plan

1 Introduction

1.1 Project Background

PKA was commissioned by Dandy Premix to prepare a Native Vegetation Removal Report of the proposed Work Plan Variation (WPV) for further development of the current extraction area within WA1488 (1381 –1395 Bass Highway Grantville).

WA1488 is the subject of Bass Coast Shire Council Planning Permit No 120388, issued 7 August 2013, which included a S173 agreement (Equipe Lawyers 2014). This agreement contains an endorsed Conservation & Revegetation plan for the currently approved WA1488 site.

1.2 Site location

Dandy Premix hold freehold title to a total of 227ha across seven (7) titles which comprises the currently approved sand quarry and associated surrounding agricultural land. The freehold titles include a significant portion of Deep Creek upstream from the Bass Highway and a smaller section to mid-stream of Colbert Creek. (Appendix 1).

WA1488 occupies 156 Hectares in total and is located on a sandy ridge framed by Deep Creek to the north and Colbert Creek to the south. The WA1488 site has a history of agricultural use and is variously cleared of indigenous vegetation. No indigenous vegetation was required to be removed as part of establishing the WA1488 sand quarry in 2013.

The adjoining Dandy Premix property to the north of WA1488, known as Lot 2, Dunbabbin Road, Grantville includes the greater majority of Deep Creek and its associated vegetation. This 70 Hectare parcel of freehold land abuts the southern Crown Land boundary of the Gurdies Nature Conservation Reserve.

The site is located within the Gippsland Plain Bioregion and is within the Bass Coast Shire Council Local Government Area (LGA).

1.3 Site Assessment

The biological features of the site have been assessed several times over the last few years. An initial assessment of the site was made in May 2012 with follow up assessments in 2013, 2017, 2018 and 2019. Baseline assessment was reported in May 2012 (Norris & Schoeffel 2012)[1] and March 2013 (PKA 2013)[2].

[1] A copy of Norris & Schoeffel 2012 – **Proposed Grantville Sandpit, Dandy Premix Pty Ltd. Ecological Assessment. May 24 2012**. Norris & Schoeffel, Bairnsdale is included in the Work Authority application (2013).

[2] A copy of PKA 2013 **The Biodiversity and Ecology of Deep and Colbert Creeks, Grantville - Biodiversity Assessment & Management Guidelines. Paul Kelly & Associates, Melbourne** is included in the Work Plan Variation application.

These reports provide a comprehensive assessment of the flora and fauna of the entire site and includes chapters on:

- Ecological condition of Deep & Colbert Creeks;
- Native vegetation remnants;
- A review of the potential presence of notable species;
- Results of targeted Fauna Surveys;
- Results of flora survey (Plant List).

Subsequent vegetation quality assessments (VQA) were carried out in accordance with vegetation quality assessment methodologies current at the time (DSE 2014a). The latter VQA and flora survey assessments provided the quarry design team with detailed vegetation quality data to assist in avoiding and minimising the amount and quality of native vegetation required for removal and offsetting. The most recent assessments of vegetation were carried out in June and December 2019.

1.3.1 Native Vegetation Assessment

Six (6) patches of native vegetation were identified on the site (Appendix 1) and assessed (DSE 2004a). (Table 1-1)

Habitat Zone 1

HZ 1 is the largest of the patches identified. It is all EVC 16 Lowland Forest (DSE 2004b) of similar quality. This patch appears not to have been logged or grazed for some time. It is fenced for most of its boundary. It includes the majority of Deep Creek which is deeply trenched along most of its length. It should be noted that several species of Warm Temperate rainforest shrubs occur close to and within the gully of Deep Creek but not in a discernible patch. These species include Blackwood *Acacia melanoxylon*, Muttonwood *Myrsine howittiana* and Sweet Pittosporum *Pittosporum undulatum*.

HZ 1 has an overstorey dominated by large Messmate *Eucalyptus obliqua* with occasional Narrow-leaf Peppermint *Eucalyptus radiata*. The understorey has a diversity of shrubs and grasses including Prickly Tea-tree *Leptospermum continentale*, Burgan *Kunzea ericoides*, Thatch Saw-sedge *Gahnia radula*, Spiny-headed Mat-rush *Lomandra longifolia* and Tussock Grass *Poa labillardierei*. Floristic elements of EVC 48 Heathy Woodland (DSE 2004c) occur at scattered locations in the patch but generally along the margins of this Lowland Forest patch.

The weed cover is low in all Habitat Zones particularly HZ 1, HZ 2, HZ 4 and HZ 5. Scattered plants of Blackberry, Gorse and Ragwort were recorded in the gully of HZ1 (PKA 2013).



Figure 1 – Habitat Zone 1 - Deep Creek Gully (08/01/2019



Figure 2 – Habitat Zone 1 – Gully vegetation (24/05/2019)



Figure 3 – Habitat Zone 1 – Large Messmate (08/01/2019)

Habitat Zone 2

HZ 2 is EVC 16 - Lowland Forest. The vegetation quality in this patch is of similar quality to HZ 1. It is unfenced and contains the upper reaches of Deep Creek which has protected it from the impact of grazing.

Habitat Zone 3

HZ 3 is EVC16 – Lowland Forest. This patch has had a history of bush grazing and timber collection. It contains part of the proposed CSEP.
There is considerable ground disturbance by cattle, feral pigs and wombats. The overstorey is dominated by Messmate with the occasional Narrow-leaf Peppermint. The understorey is sparse but contains dispersed shrubs of Prickly *Acacia verticillata*, Broom Spurge, Prickly Tea-tree, River Sheoak *Allocasuarina littoralis*, Burgan, Silver Banksia and Sweet Bursaria. Bracken is also present. Several weeds are present including Inkweed Blackberry, Brown top Bent grass and Sweet Vernal Grass.



Figure 4 – Habitat Zone 3 – Lowland Forest (14/05/2019)

Habitat Zone 4

HZ 4 is a patch of EVC 16 - Lowland Forest and is associated with Colbert Creek It is of similar quality to HZ 1 and HZ 2.

Habitat Zone 5

HZ 5 is a a clearly discernible patch of EVC 48 Heathy Woodland (DSE 2004c) surrounded by HZ 1. It is dominated by an overstorey of Narrow-leaf Peppermint. The understorey is dominated by Common Beard-heath *Leucopogon virgatus*, Prickly Tea-tree, Heath Tea-tree *Leptospermum myrsinoides*, Burgan, Silver Banksia *Banksia marginata*, and Pink Heath *Epacris impressa* with the occasional Broom Spurge *Amperea xiphoclada*, Small Grass-tree *Xanthorrhoea minor* and Bracken *Pteridium esculentum*.



Figure 5 – Habitat Zone 5 – Heathy Woodland (08/01/2019)

Habitat Zone 6

HZ 6 is a patch of EVC 48 Heathy Woodland (DSE 2004c) that has been subjected to similar management to HZ 3. HZ 6 contains the balance of the proposed CSEP with HZ 3. The understorey has been extensively modified by

grazing and timber removal. There is considerable ground disturbance by wombats and feral pigs. Despite this the weed cover is low. It is dominated by an overstorey of Narrow-leaf Peppermint with scattered Messmate. The understorey is dominated by Prickly Tea-tree, Burgan, Silver Banksia *Banksia marginata*, and Pink Heath with the occasional Broom Spurge *Amperea xiphoclada*, Small Grass-tree *Xanthorrhoea minor* and Bracken *Pteridium esculentum*



Figure 6 – Habitat Zone 6 (14/05/2019)

1.3.2 Large Trees

Large tree numbers in each Habitat Zone are recorded in Table 1-1 (Appendix 1)

All large trees within habitat zones HZ 3 and HZ 6 were measured and GPS plotted. These habitat zones contain the proposed coarse sand extraction pit (CSEP) area.

A sample number of large trees within offset areas HZ 1, HZ 2, HZ 4 and HZ 5. were measured and GPS plotted.

176 Large Trees with a DBH equal to or greater than the (EVC 16–Lowland Forest) benchmark i.e.70cm DBH were recorded in HZ 1, HZ 2 and HZ 4. 27 large trees with a DBH equal to or greater than the (EVC 48–Heathy Woodland) benchmark i.e. 50cm DBH were recorded in HZ 5. The number of large trees recorded greatly exceeds the offset requirement (Appendix 2), as such it was considered that plotting all large trees in these offset sites was unnecessary particularly given the apparent density of large trees in the offset sites.

1.3.3 Scattered trees

The currently approved fine medium sand extraction pit (FMSEP) is proposed to be further developed in a north easterly direction. (Appendices 1 & 4). The FMSEP development area is cleared farmland which was until recently, used for grazing of livestock.

All the scattered large trees in this area were plotted and measured. Twelve (12) of those large scattered trees are required to be removed (Appendix 3).

Table 1-1 - Quantification and significance of freehold patches of Native Vegetation

Habitat Zone			HZ1	HZ 2	HZ 3	HZ 4	HZ 5	HZ 6
Bioregion			GP	GP	GP	GP	GP	GP
EVC #: Name			**16 LF**	**16 LF**	**16 LF**	**16 LF**	**48 HW**	**48 HW**
EVC Bioregional Conservation Status			V	V	V	V	LC	LC
		Max Score	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**
Site Condition	Large Old Trees	10	8	8	2	8	8	5
	Canopy Cover	5	5	5	2	5	5	4
	Understorey	25	15	15	10	15	15	15
	Lack of Weeds	15	11	11	7	11	11	7
	Recruitment	10	0	0	0	0	3	5
	Organic Matter	5	5	5	3	5	5	3
	Logs	5	5	5	2	5	5	2
	Total Site Score	75	49	49	26	49	52	41
	EVC standardiser (e.g. 75/65)		1.00	1.00	1.00	1.0	1.0	1.0
	Adjusted Site Score		49	49	26	49	52	41
Landscape value	Patch Size	10	8	8	6	8	2	6
	Neighbourhood	10	5	5	5	5	7	5
	Distance to Core	5	4	4	4	4	3	3
Habitat Score		**100**	**66**	**66**	**41**	**66**	**64**	**55**
Habitat points = #/100		**1**	**0.66**	**0.66**	**0.49**	**0.66**	**0.74**	**0.55**
Large trees			**109 Sample**	**66 Sample**	**49 plotted**	**8 Sample**	**27 Sample**	**29 plotted**
Area (Ha)			**46.16**	**6.16**	**16.44**	**3.21**	**4.93**	**10.31**

2 Proposed Work Plan Variation (WPV)

Appendices 1 and 4 outline the extent of further sand extraction development (FMSEP and CSEP) within WA1488.

The vegetation of the WPV development has been comprehensively sampled to refine the location of the quarry extension to maximise resource extraction efficiency, minimise extraction costs, limit the impact of the quarry on the landscape and importantly to avoid and minimise the removal of native vegetation. The sampling included several VQA assessments throughout the proposed quarry extension site and mapping all the large trees and scattered trees on the proposed quarry extension site.

No other native vegetation has been removed from the site other than that which is exempt from requiring a planning permit i.e. minimal amount of firewood by the previous landowner. A Property Vegetation Plan (DELWaP 2017) does not apply to the site. The proposed removal of native vegetation is not associated with providing Defendable Space. A Native Vegetation Precinct Plan does not apply to the site.

2.1 Native Vegetation Removal Report

A Detailed Assessment Pathway Native Vegetation Report (Appendix 2) was prepared to determine the offsets required to compensate for the removal of 12.988ha of native vegetation (including 47 large trees) to provide for the proposed quarry extension (Appendix 3). The native vegetation will be removed from part of patches HZ 3 and HZ 6 which includes 35 large trees (Table 2-1). Twelve (12) scattered trees will be removed (Table 2-2) from the paddock north west of HZ 3 and HZ 6 (Appendix 2). The required offsets are tabled (Table 2-3).

Table 2-1 – Large tree removal within patch (Appendix

Tree Number	Species	DBH (cm)	EVC	Large Tree BM (cm)
1	Messmate	113	EVC 48 - Heathy Woodland	≥50
2	NLP	73	EVC 48 - Heathy Woodland	≥50
3	NLP	60	EVC 48 - Heathy Woodland	≥50
4	Messmate	70	EVC 48 - Heathy Woodland	≥50
5	Messmate	77	EVC 48 - Heathy Woodland	≥50
6	Messmate	94	EVC 48 - Heathy Woodland	≥50
7	Dead	102	EVC 48 - Heathy Woodland	≥50
8	Messmate	76	EVC 48 - Heathy Woodland	≥50
9	Messmate	83	EVC 48 - Heathy Woodland	≥50
10	NLP	55	EVC 48 - Heathy Woodland	≥50
11	Messmate	66	EVC 48 - Heathy Woodland	≥50
12	NLP	72	EVC 48 - Heathy Woodland	≥50
13	NLP	55	EVC 48 - Heathy Woodland	≥50
14	NLP	55	EVC 48 - Heathy Woodland	≥50

Tree Number	Species	DBH (cm)	EVC	Large Tree BM (cm)
15	NLP	72	EVC 48 - Heathy Woodland	≥50
16	Messmate	62	EVC 48 - Heathy Woodland	≥50
17	Dead	75	EVC 48 - Heathy Woodland	≥50
18	Messmate	106	EVC 48 - Heathy Woodland	≥50
19	Messmate	102	EVC 16 -Lowland Forest	≥70
20	Messmate	71	EVC 16 -Lowland Forest	≥70
21	NLP	72	EVC 16 -Lowland Forest	≥70
22	NLP	86	EVC 16 -Lowland Forest	≥70
23	NLP	70	EVC 16 -Lowland Forest	≥70
24	Messmate	74	EVC 16 -Lowland Forest	≥70
25	Messmate	84	EVC 16 -Lowland Forest	≥70
26	NLP	82	EVC 16 -Lowland Forest	≥70
27	NLP	71	EVC 16 -Lowland Forest	≥70
28	Messmate	94	EVC 16 -Lowland Forest	≥70
29	Messmate	70	EVC 16 -Lowland Forest	≥70
30	Dead	97	EVC 16 -Lowland Forest	≥70
31	Messmate	89	EVC 16 -Lowland Forest	≥70
32	Messmate	90	EVC 16 -Lowland Forest	≥70
33	Messmate	107	EVC 16 -Lowland Forest	≥70
34	Messmate	110	EVC 16 -Lowland Forest	≥70
35	Messmate	89	EVC 16 -Lowland Forest	≥70

Table 2-2 – Scattered trees to be removed (EVC 16 Lowland Forest – Gippsland Plain)
(Large tree - ≥ 70cm DBH)

Tree Number	Species	DBH (cm)
1	Messmate	120
2	Messmate	165
3	Messmate	108
4	Swamp Gum	70
5	Swamp Gum	78
6	Swamp Gum	98
7	Dead	141
8	Messmate	144
9	Messmate	103
10	Messmate	126
11	Dead	137
12	Dead	124

This report includes an extensive review of the potential presence of the habitat of rare or threatened species and the potential impact of the removal of the native vegetation on those species as required for a Detailed Assessment pathway (PKA 2013). The two species highlighted as being impacted by the native vegetation removal report (Appendix 2), Strzelecki Gum and Orange-tip Finger-orchid, were not recorded during the site assessments. Further flora and fauna survey of the site is not considered warranted.

Table 2-3 - Offset Requirement (if planning permit is granted)

General Offset amount	0.043 general habitat units
Vicinity	Port Phillip & Westernport CMA or Bass Coast Shire Council
Minimum Strategic Biodiversity Value Score	0.288
Large Trees *	3 Large trees
Species Offset Amount	11.160 species units of habitat for Orange-tip Finger-orchid. *Caladenia aurantiaca* 11.042 species units of habitat for Strzelecki Gum *Eucalyptus strzeleckii.*
Large Trees	44 Large trees
* **The total number of large trees that the offset must protect**	47 large trees to be protected in either the general, species or combination across all habitat units

2.2 Topographic & Land Information

Appendix 4 shows the relevant topographic characteristics and proposed WPV sand extraction areas of the approved WA 1488 quarry site.

The soils within the quarry extraction areas have been extensively sampled to comprehensively describe the sub-surface resource. The soils are best described as deep sands of varying quality from coarse, to medium, to fine and very fine sands to variable depths to greater than 100m, at the upper site elevations ranging between RL60m to RL115m (CSEP). Areas of bare ground are present in the proposed extraction areas (FSEMP & CSEP) to be further developed (Figure 6) but no soil erosion is evident.

2.3 Avoid & Minimise Statement

2.3.1 Strategic Level Planning

A Regional Sand Extraction Strategy–Lang Lang to Grantville was prepared in1996 (DOL 1996). This strategy identified the location of the sand resources in the vicinity of the WA1488 and provided guidance on extraction planning and environmentally sensitive methods.

A review of the Melbourne Extractive Industry was carried out in 2003. (Olshina & Burn 2003). This review identified areas that contain significant sand and stone resources in Victoria to ensure that the identified areas are not encumbered in the

future by inappropriate land use planning. The review recognised Grantville (VicMine site ID 883998) as an Extractive Industry Interest Area (EIIA) (Melbourne Supply Areas). The Grantville EIIA included 1381 –1395 Bass Highway Grantville (the Dandy Premix freehold), now WA1488 and includes the subject site of this report.

Planning Policy Framework (14.03-1S) of the Bass Coast Planning Scheme addresses Natural Resource Exploration and extraction. This Planning Policy encourages the exploration and extraction of natural resources in accordance with acceptable environmental standards.

Bass Coast Shire Council has prepared a Bass Coast Biodiversity Biolinks Plan (Bass Coast 2018). This plan gives strategic direction to provide connectivity in the Bass Coast landscape by linking remnant patches of indigenous vegetation. The long-term management planning for the Dandy Premix freehold is consistent with this plan by ultimately providing a secure and sustainable linkage of improved vegetation quality across the site. The majority of the Dandy Premix freehold will be managed in perpetuity for biodiversity conservation purposes and directed by an approved Offset Management Plan (Appendix 7) in accordance with the Planning Permit and the S 173 agreement. When the proposed quarry is exhausted it will be rehabilitated to mimic the vegetation quality prior to removal. The proposed management of the site is consistent with the objectives of the Biolinks Plan (Bass Coast 2018).

2.3.2 Site Level Planning

The limits of the proposed extraction site have been guided by several factors but significantly by the requirement to avoid and minimise the removal of native vegetation.

Several iterations of the pit design have been prepared. The limits of the clearing have been adjusted after considering the Vegetation Quality Assessments of the site. Suitable vegetation removed from the site during the initial clearing will be placed in the revegetation areas and other locations where logs are lacking. The heads of the trees removed will be placed in sites where bare ground is present. Seed will be collected from the removed native vegetation and retained native vegetation patches. This seed will be used for seedling propagation and direct seeding revegetation works.

It is proposed to offset the removal on-site as part of the extensive conservation management of the entire site. It will be provided as First Party Offsets on Dandy Premix freehold adjoining WA 1488.

The design of the CSEP is such that it will be hidden from highway view by retaining native vegetation on its fringe and ridgeline. The FMSEP will be similarly shielded from Bass Highway by planted native vegetation in accordance with the Landscape and Vegetation Plan – Spring 2013. (Endorsed in Bass Coast Planning Permit No 120388 for the site)

2.3.3 Feasible Alternatives

No feasible alternative to further avoid and minimise the removal of native vegetation to provide for the proposed quarry is considered practical. The sand resource has been extensively sampled and is located in a discrete band beneath the vegetation.

2.4 Offset Statement

First Party Offsets for the removal of the native vegetation will be met on-site consistent with the current Bass Coast Planning Permit (No. 120388) and the associated S 173 agreement for the site.

The required offsets (Table 2-3) will be met by establishing and managing secure patches of native vegetation and revegetation on the Dandy Premix freehold (Appendix 5) in accordance with an approved Offset Management Plan.

2.4.1 Offset Site Management

A Native Vegetation Offset Site report has been prepared (Appendix 6). The total general and species habitat units provided by the proposed offset site are tabled (Table 2-4) when managed in accordance with an agreed (Bass Coast Council & DELWaP) Offset Management Plan (Appendix 7). Table 2-5 provides an offset statement balance demonstrating that the offset site will exceed the offset requirements for the removal of the native vegetation as proposed.

Table 2-4 - Total large trees and General and Species habitat units of the Offset Site

Number of large trees	(Estimated) 247 Large trees are protected on the offset sites (See 1.3.2 above)
General Habitat Units	14.457 general habitat units; Port Phillip & Westernport CMA or Bass Coast Shire Council; 0.571 Strategic Biodiversity Value
Species Habitat Units	13.205 species habitat units for Grey Goshawk, *Accipiter novaehollandiae novaehollandiae*; 13.826 species habitat units for Swamp Skink, *Lissolepis coventryi* 13.488 species habitat units for Southern Toadlet, *Pseudophryne semimarmorata* 13.051 species habitat units for Orange-tip Finger-orchid, *Caladenia aurantiaca* 13.021 species habitat units for Spurred Helmet-orchid, *Corybas aconitiflorus* 13.021 species habitat units for Cobra Greenhood, *Pterostylis grandiflora* 13.030 species habitat units for Mauve-tuft Sun-orchid, *Thelymitra malvina* 9.857 species habitat units for Wavy Swamp Wallaby-grass, *Amphibromus sinuatus* 12.232 species habitat units for Strzelecki Gum, *Eucalyptus strzeleckii*

	12.998 species habitat units for Green-striped Greenhood, *Pterostylis chlorogramma.*

Table 2-5 – Offset Balance Sheet

	Offsets Required	Offsets provided by First Party Offset Management Plan	Balance
Number of large trees	47 Large trees	247 Large trees counted	Excess of 200 Large trees
General Habitat Units	0.043 general habitat units; Port Phillip and Westernport CMA, Bass Coast Shire; 0.288(minimum)Strategic Biodiversity Value	14.457 general habitat units; Port Phillip and Westernport CMA, Bass Coast Shire; 0.571 Strategic Biodiversity Value	14.414 general habitat units Exceeds minimum Strategic Biodiversity Value
Species Habitat Units	11.160 species habitat units for Orange-tip Finger-orchid *Caladenia aurantiaca*	13.051 species habitat units for Orange-tip Finger-orchid *Caladenia aurantiaca*	Exceeds Orange-tip Finger-orchid requirement by 1.891 species habitat units
	11.042 species habitat units for Strzelecki Gum *Eucalyptus strzeleckii*.	12.998 species habitat units for Strzelecki Gum *Eucalyptus strzeleckii*.	Exceeds Strzelecki Gum requirements by 1.956 species habitat units

3 References

Bass Coast Shire Council 2018 **Biodiversity Biolinks Plan 2018**. Bass Coast shire Council, Wonthaggi

DELWaP 2018 Nature Kit
http://maps.biodiversity.vic.gov.au/viewer/?viewer=NatureKit
Department of Environment, Land, Water & Planning – website

DELWaP 2017 Guidelines for the removal, destruction or lopping of native. Vegetation. Department of Environment Land, Water & Planning – website.https://www.environment.vic.gov.au/__data/assets/pdf_file/0021/91146/Guidelines-for-the-removal,-destruction-or-lopping-of-native-vegetation,-2017.pdf

DEPI 2013 **Permitted Clearing of Native Vegetation – Biodiversity Assessment Guidelines**. Department of Environment & Primary Industries, Melbourne

DoI 1996 **Regional Sand Extraction Strategy – Lang Lang to Grantville** Department of Infrastructure, Melbourne

DSE 2004a **Vegetation Quality Assessment Manual–Guidelines for applying the habitat hectares scoring method–Version 1.3** Department of Sustainability and Environment, Melbourne

DSE 2004b **EVC 16 – Lowland Forest benchmark – Gippsland Plain Bioregion**. Department of Sustainability & Environment, Melbourne

DSE 2004c **EVC 48 – Heathy Woodland benchmark – Gippsland Plain Bioregion**. Department of Sustainability & Environment, Melbourne

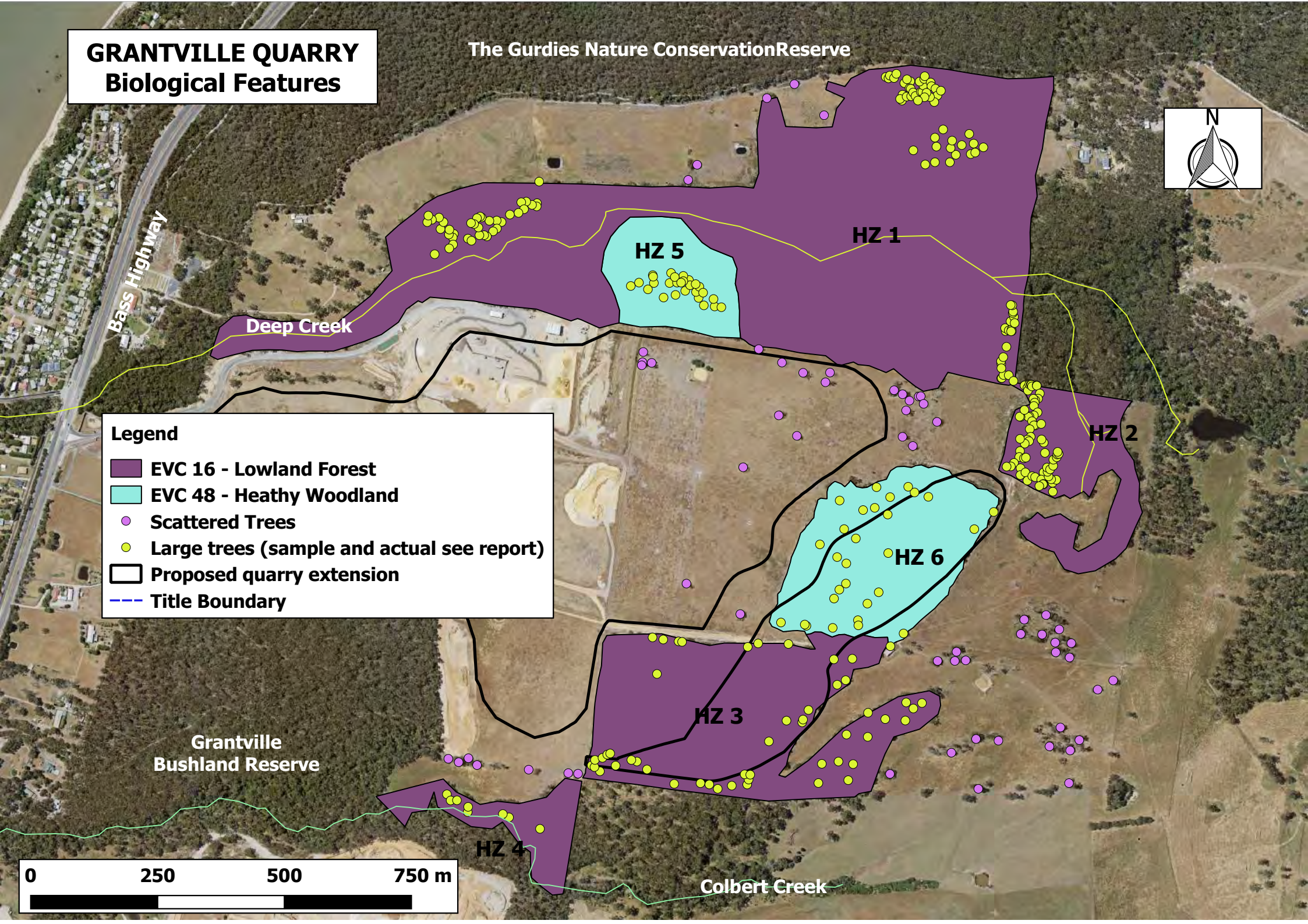
Equipe Lawyers 2014 – **Section 173 Agreement – 1381 – 1395 Bass Highway, Grantville. (Doc ID 214100943/v2) (Signed 19 December 2014)** Equipe Lawyers, Kew.

Norris & Schoeffel 2012 – **Proposed Grantville Sandpit, Dandy Premix Pty Ltd. Ecological Assessment. May 24 2012**. Norris & Schoeffel, Bairnsdale.

Olshina, A. & Burn, P., 2003 **Melbourne Supply Area–Extractive Industry Areas Review.** Geological Survey of Victoria Technical Record 2003/2 Department of Primary Industries, Melbourne

PKA 2013 **The Biodiversity and Ecology of Deep and Colbert Creeks, Grantville - Biodiversity Assessment & Management Guidelines.** Paul Kelly & Associates, Melbourne.

Appendix 1 – Location & Biological Features Map


GRANTVILLE QUARRY
Biological Features
The Gurdies Nature ConservationReserve
N
Bass Highway
Deep Creek
HZ 1
HZ 5
HZ 2
HZ 6
HZ 3
HZ 4
Grantville
Bushland Reserve
Colbert Creek
Legend
EVC 16 - Lowland Forest
EVC 48 - Heathy Woodland
Scattered Trees
Large trees (sample and actual see report)
Proposed quarry extension
Title Boundary
0
250
500
750 m

Appendix 2 – Native Vegetation Removal Report

Native vegetation removal report

This report provides information to support an application to remove, destroy or lop native vegetation in accordance with the *Guidelines for the removal, destruction or lopping of native vegetation*. The report **is not an assessment by DELWP** of the proposed native vegetation removal. Native vegetation information and offset requirements have been determined using spatial data provided by the applicant or their consultant.

Date of issue: **29/10/2019**
Time of issue: **10:23 am**

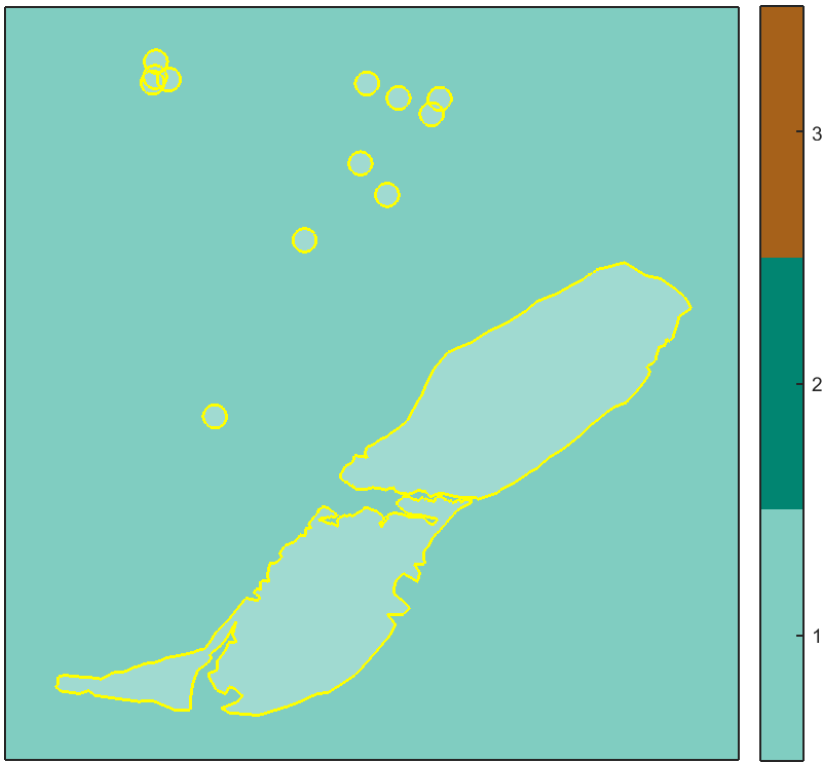
Report ID: PKA_2019_016

Project ID	Vegetation Removal Pit

Assessment pathway

Assessment pathway	**Detailed Assessment Pathway**
Extent including past and proposed	12.988 ha
Extent of past removal	0.000 ha
Extent of proposed removal	12.988 ha
No. Large trees proposed to be removed	47
Location category of proposed removal	Location 1 The native vegetation is not in an area mapped as an endangered Ecological Vegetation Class (as per the statewide EVC map), sensitive wetland or coastal area. Removal of less than 0.5 hectares in this location will not have a significant impact on any habitat for a rare or threatened species

1. Location map



Offset requirements if a permit is granted

Any approval granted will include a condition to obtain an offset that meets the following requirements:

General offset amount[1]	0.043 general habitat units
Vicinity	Port Phillip and Westernport Catchment Management Authority (CMA) or Bass Coast Shire Council
Minimum strategic biodiversity value score[2]	0.288
Large trees*	3 large trees
Species offset amount[3]	11.160 species units of habitat for Orange-tip Finger-orchid, *Caladenia aurantiaca* 11.042 species units of habitat for Strzelecki Gum, *Eucalyptus strzeleckii*
Large trees*	44 trees
*** The total number of large trees that the offset must protect**	47 large trees to be protected in either the general, species or combination across all habitat units protected

NB: values within tables in this document may not add to the totals shown above due to rounding

Appendix 1 includes information about the native vegetation to be removed

Appendix 2 includes information about the rare or threatened species mapped at the site.

Appendix 3 includes maps showing native vegetation to be removed and extracts of relevant species habitat importance maps

1 The general offset amount required is the sum of all general habitat units in Appendix 1.

2 Minimum strategic biodiversity score is 80 per cent of the weighted average score across habitat zones where a general offset is required

3 The species offset amount(s) required is the sum of all species habitat units in Appendix 1.

Next steps

Any proposal to remove native vegetation must meet the application requirements of the Detailed Assessment Pathway and it will be assessed under the Detailed Assessment Pathway.

If you wish to remove the mapped native vegetation you are required to apply for a permit from your local council. Council will refer your application to DELWP for assessment, as required. **This report is not a referral assessment by DELWP.**

This *Native vegetation removal report* must be submitted with your application for a permit to remove, destroy or lop native vegetation.

Refer to the *Guidelines for the removal, destruction or lopping of native* vegetation (the Guidelines) for a full list of application requirements This report provides information that meets the following application requirements:

- The assessment pathway and reason for the assessment pathway
- A description of the native vegetation to be removed (partly met)
- Maps showing the native vegetation and property (partly met)
- Information about the impacts on rare or threatened species.
- The offset requirements determined in accordance with section 5 of the Guidelines that apply if approval is granted to remove native vegetation.

Additional application requirements must be met including:

- Topographical and land information
- Recent dated photographs
- Details of past native vegetation removal
- An avoid and minimise statement
- A copy of any Property Vegetation Plan that applies
- A defendable space statement as applicable
- A statement about the Native Vegetation Precinct Plan as applicable
- A site assessment report including a habitat hectare assessment of any patches of native vegetation and details of trees
- An offset statement that explains that an offset has been identified and how it will be secured.

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Obtaining this publication does not guarantee that an application will meet the requirements of Clauses 52.16 or 52.17 of the Victoria Planning Provisions and Victorian planning schemes or that a permit to remove native vegetation will be granted.

Notwithstanding anything else contained in this publication, you must ensure that you comply with all relevant laws, legislation, awards or orders and that you obtain and comply with all permits, approvals and the like that affect, are applicable or are necessary to undertake any action to remove, lop or destroy or otherwise deal with any native vegetation or that apply to matters within the scope of Clauses 52.16 or 52.17 of the Victoria Planning Provisions and Victorian planning schemes.

Appendix 1: Description of native vegetation to be removed

The species-general offset test was applied to your proposal. This test determines if the proposed removal of native vegetation has a proportional impact on any rare or threatened species habitats above the species offset threshold. The threshold is set at 0.005 per cent of the mapped habitat value for a species. When the proportional impact is above the species offset threshold a species offset is required. This test is done for all species mapped at the site. Multiple species offsets will be required if the species offset threshold is exceeded for multiple species.

Where a zone requires species offset(s), the species habitat units for each species in that zone is calculated by the following equation in accordance with the Guidelines:

Species habitat units = extent x condition x species landscape factor x 2, where the species landscape factor = 0.5 + (habitat importance score/2)

The species offset amount(s) required is the sum of all species habitat units per zone

Where a zone does not require a species offset, the general habitat units in that zone is calculated by the following equation in accordance with the Guidelines:

General habitat units = extent x condition x general landscape factor x 1.5, where the general landscape factor = 0.5 + (strategic biodiversity value score/2)

The general offset amount required is the sum of all general habitat units per zone.

Native vegetation to be removed

Information provided by or on behalf of the applicant in a GIS file							Information calculated by EnSym					
Zone	**Type**	**BioEVC**	**BioEVC conservation status**	**Large tree(s)**	**Partial removal**	**Condition score**	**Polygon Extent**	**Extent without overlap**	**SBV score**	**HI score**	**Habitat units**	**Offset type**
1-A	Patch	gipp0048	Least Concern	18	no	0.550	6.707	6.707	0.602	0.687	6.225	500523 Orange-tip Finger-orchid *Caladenia aurantiaca*
										0.617	6.225	504558 Strzelecki Gum *Eucalyptus strzeleckii*
2-B	Patch	gipp0016	Vulnerable	17	no	0.490	5.527	5.527	0.598	0.771	4.795	500523 Orange-tip Finger-orchid *Caladenia aurantiaca*
										0.603	4.817	504558 Strzelecki Gum *Eucalyptus strzeleckii*
3-C	Scattered Tree	gipp0016	Vulnerable	1	no	0.200	0.071	0.063	0.690	0.271	0.016	500523 Orange-tip Finger-orchid *Caladenia aurantiaca*
4-D	Scattered Tree	gipp0016	Vulnerable	1	no	0.200	0.071	0.060	0.608	0.340	0.016	500523 Orange-tip Finger-orchid *Caladenia aurantiaca*
5-E	Scattered Tree	gipp0016	Vulnerable	1	no	0.200	0.071	0.031	0.690	0.259	0.008	500523 Orange-tip Finger-orchid *Caladenia aurantiaca*
6-F	Scattered Tree	gipp0016	Vulnerable	1	no	0.200	0.071	0.046	0.496	0.243	0.011	500523 Orange-tip Finger-orchid *Caladenia aurantiaca*

Information provided by or on behalf of the applicant in a GIS file							Information calculated by EnSym					
Zone	**Type**	**BioEVC**	**BioEVC conservation status**	**Large tree(s)**	**Partial removal**	**Condition score**	**Polygon Extent**	**Extent without overlap**	**SBV score**	**HI score**	**Habitat units**	**Offset type**
7-G	Scattered Tree	gipp0016	Vulnerable	1	no	0.200	0.071	0.071	0.535	0.560	0.022	500523 Orange-tip Finger-orchid *Caladenia aurantiaca*
8-H	Scattered Tree	gipp0016	Vulnerable	1	no	0.200	0.071	0.071	0.395	0.240	0.018	500523 Orange-tip Finger-orchid *Caladenia aurantiaca*
9-I	Scattered Tree	gipp0016	Vulnerable	1	no	0.200	0.071	0.066	0.400	0.248	0.016	500523 Orange-tip Finger-orchid *Caladenia aurantiaca*
10-J	Scattered Tree	gipp0016	Vulnerable	1	no	0.200	0.071	0.066	0.400	0.240	0.016	500523 Orange-tip Finger-orchid *Caladenia aurantiaca*
11-K	Scattered Tree	gipp0016	Vulnerable	1	no	0.200	0.071	0.071	0.360		0.014	General
12-L	Scattered Tree	gipp0016	Vulnerable	1	no	0.200	0.071	0.071	0.371	0.234	0.017	500523 Orange-tip Finger-orchid *Caladenia aurantiaca*
13-M	Scattered Tree	gipp0016	Vulnerable	1	no	0.200	0.071	0.071	0.360		0.014	General
15-O	Scattered Tree	gipp0016	Vulnerable	1	no	0.200	0.071	0.071	0.360		0.014	General

Appendix 2: Information about impacts to rare or threatened species' habitats on site

This table lists all rare or threatened species' habitats mapped at the site.

Species common name	Species scientific name	Species number	Conservation status	Group	Habitat impacted	% habitat value affected
Strzelecki Gum	*Eucalyptus strzeleckii*	504558	Vulnerable	Dispersed	Habitat importance map	0.0062
Orange-tip Finger-orchid	*Caladenia aurantiaca*	500523	Rare	Dispersed	Habitat importance map	0.0054
Spurred Helmet-orchid	*Corybas aconitiflorus*	500835	Rare	Dispersed	Habitat importance map	0.0021
Swamp Skink	*Lissolepis coventryi*	12407	Vulnerable	Dispersed	Habitat importance map	0.0019
Mauve-tuft Sun-orchid	*Thelymitra malvina*	503374	Vulnerable	Dispersed	Habitat importance map	0.0019
Green-striped Greenhood	*Pterostylis chlorogramma*	504728	Vulnerable	Dispersed	Habitat importance map	0.0018
Southern Toadlet	*Pseudophryne semimarmorata*	13125	Vulnerable	Dispersed	Habitat importance map	0.0014
Cobra Greenhood	*Pterostylis grandiflora*	502798	Rare	Dispersed	Habitat importance map	0.0010
Grey Goshawk	*Accipiter novaehollandiae novaehollandiae*	10220	Vulnerable	Dispersed	Habitat importance map	0.0005
Lace Monitor	*Varanus varius*	12283	Endangered	Dispersed	Habitat importance map	0.0001
Powerful Owl	*Ninox strenua*	10248	Vulnerable	Dispersed	Habitat importance map	0.0001
Wavy Swamp Wallaby-grass	*Amphibromus sinuatus*	503625	Vulnerable	Dispersed	Habitat importance map	0.0000

Habitat group

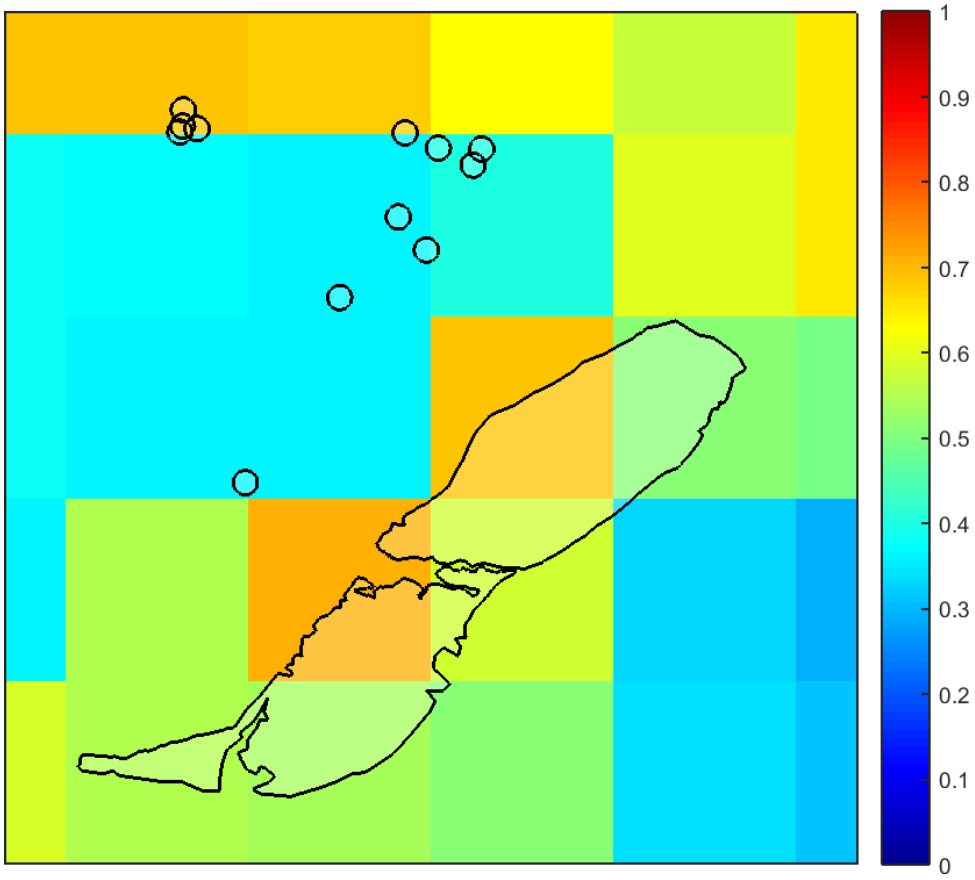
- Highly localised habitat means there is 2000 hectares or less mapped habitat for the species
- Dispersed habitat means there is more than 2000 hectares of mapped habitat for the species

Habitat impacted

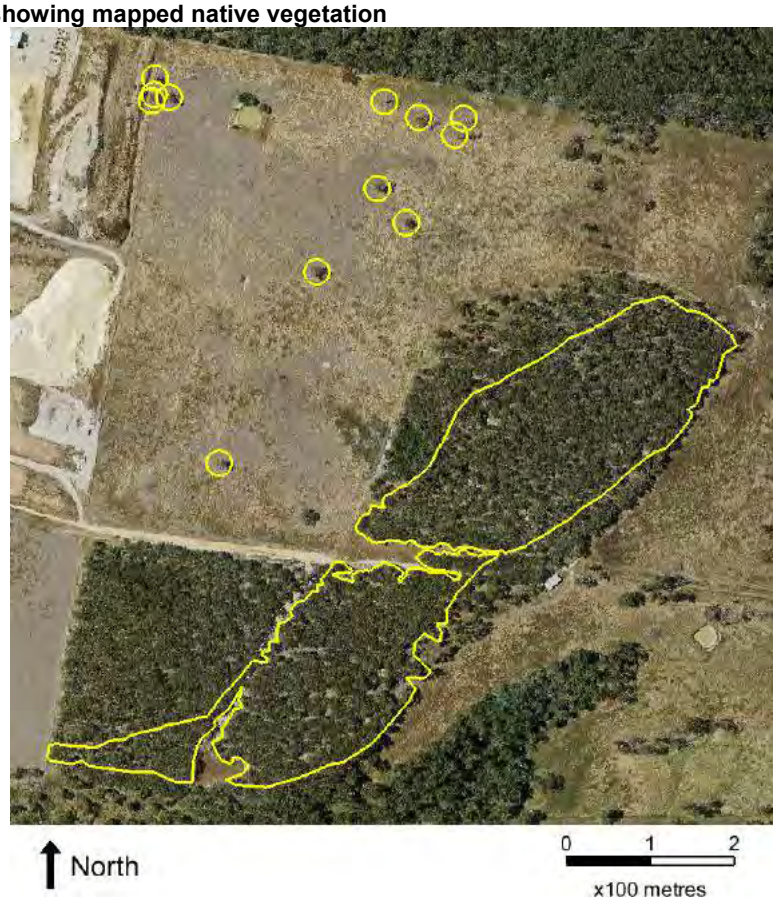
- Habitat importance maps are the maps defined in the Guidelines that include all the mapped habitat for a rare or threatened species
- Top ranking maps are the maps defined in the Guidelines that depict the important areas of a dispersed species habitat, developed from the highest habitat importance scores in dispersed species habitat maps and selected VBA records
- Selected VBA record is an area in Victoria that represents a large population, roosting or breeding site etc.

Appendix 3 – Images of mapped native vegetation

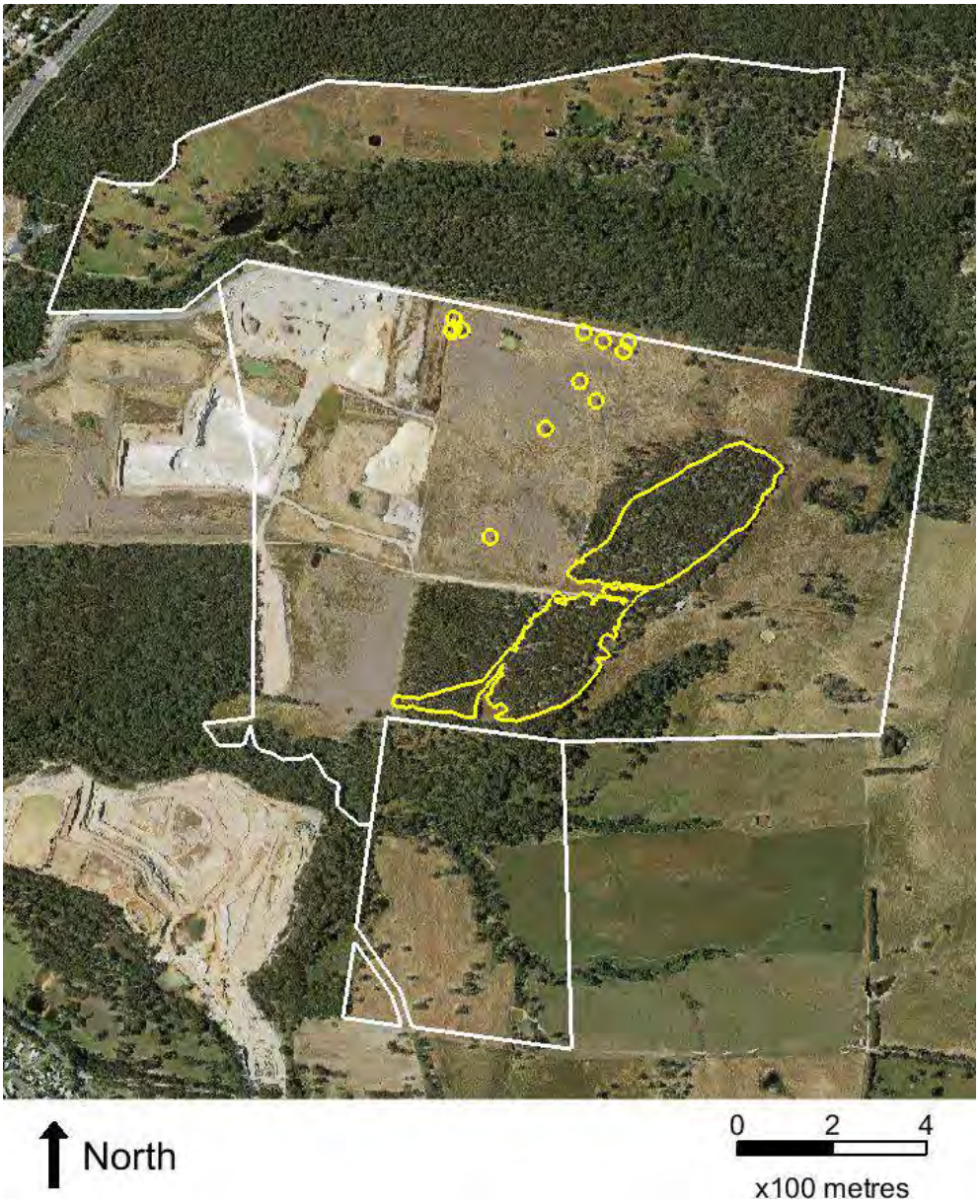
2. Strategic biodiversity values map



3. Aerial photograph showing mapped native vegetation



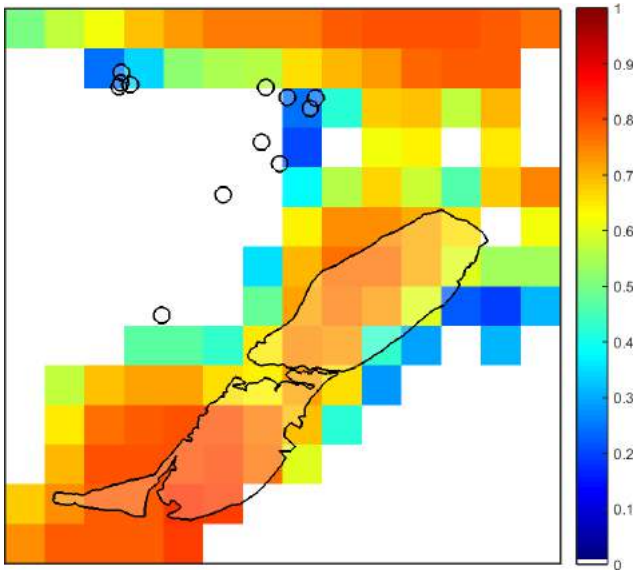
4. Map of the property in context



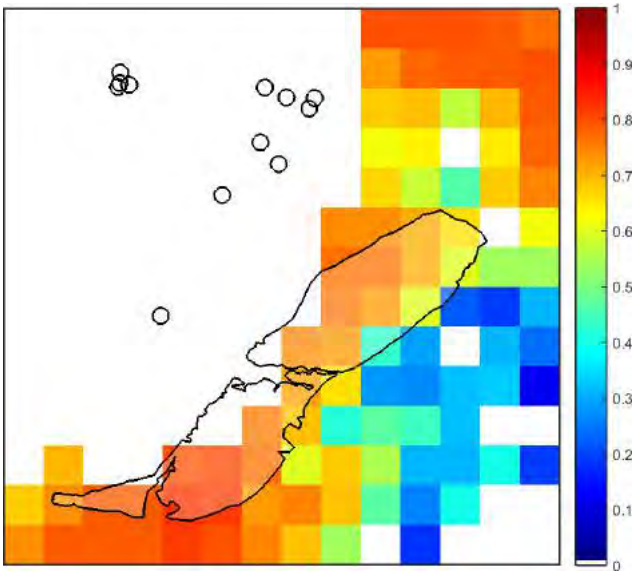
Yellow boundaries denote areas of proposed native vegetation removal.

4. Habitat importance maps

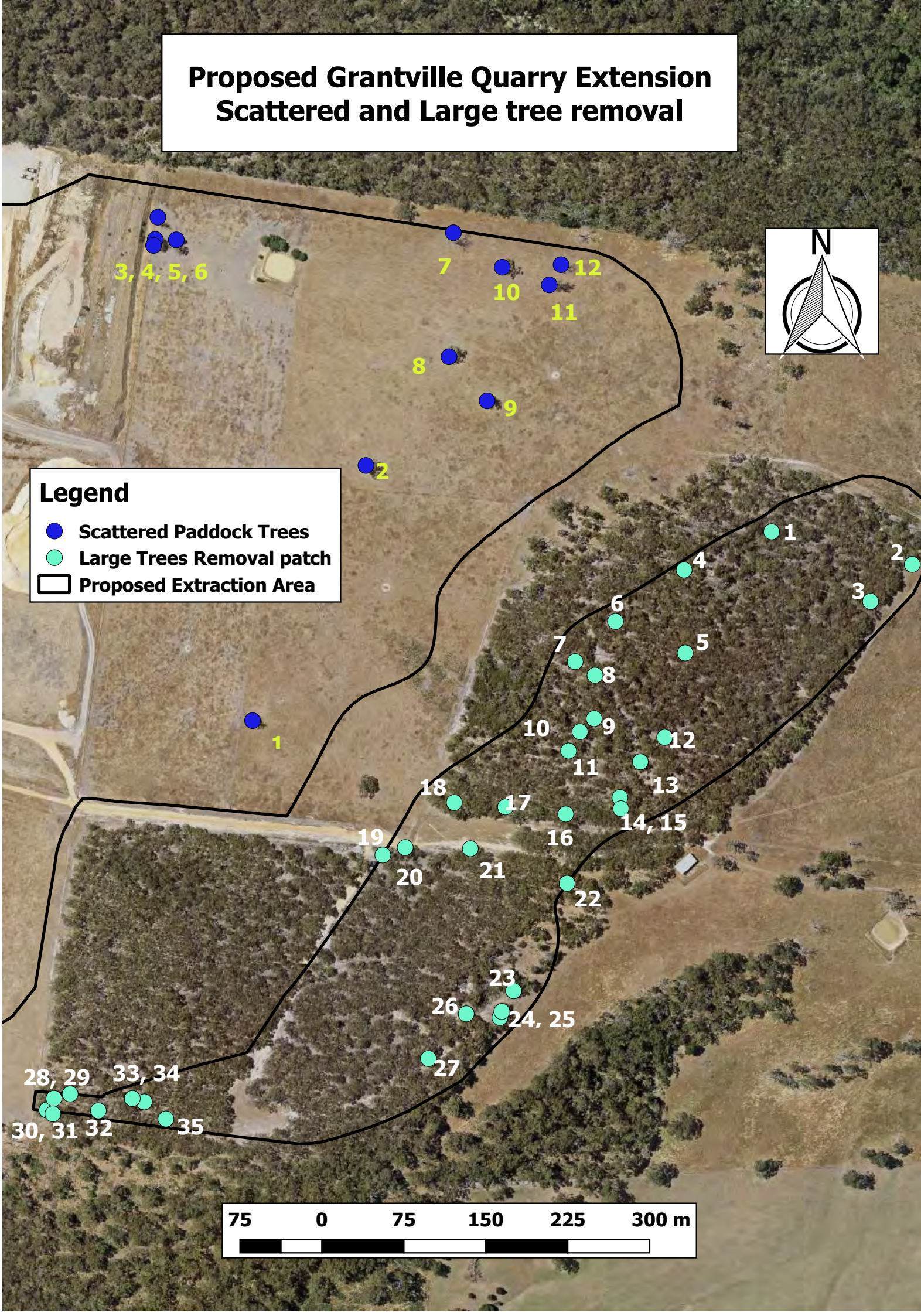
Orange-tip Finger-orchid
Caladenia aurantiaca
500523



Strzelecki Gum
Eucalyptus strzeleckii
504558



Appendix 3 – Large & Scattered tree removal


Proposed Grantville Quarry Extension
Scattered and Large tree removal
N
Legend
Scattered Paddock Trees
Large Trees Removal patch
Proposed Extraction Area
3, 4, 5, 6
7
10
12
11
8
9
2
1
1
2
4
3
6
7
5
8
10
9
12
11
13
18
17
14, 15
16
19
20
21
22
23
26
24, 25
27
28, 29
33, 34
30, 31
32
35
75
0
75
150
225
300 m

Appendix 4 – Topographic & Land Information map



Scale: 1:6000

0 40 80 120 160 200 300

metres

For

DANDY PREMIX QUARRIES P/ L

Drawing: A3 - 1890 : Rev 0 Author: PK	Project No: D10-003
App3_Topo&LandMan Plan_1119.WOR	Appendix 3
Date: 14/11/2019	

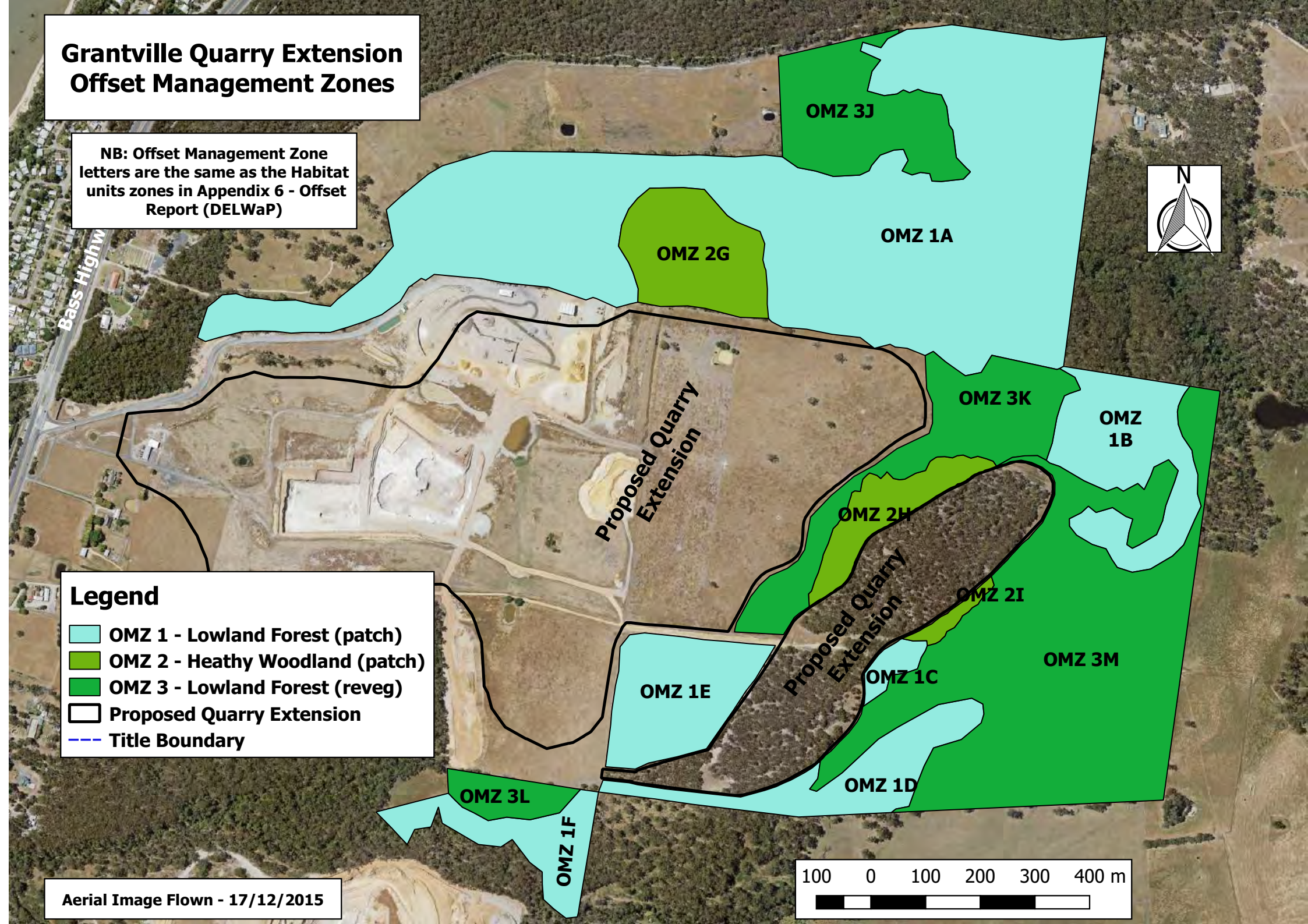
Extractive Industry Work Authority No: 1488

Grantville Sand Pit, GRANTVILLE

2019 SITE PHOTO PLAN

TOPOGRAPHIC & LAND INFORMATION

Appendix 5 – Offset Management Zones


Grantville Quarry Extension
Offset Management Zones
NB: Offset Management Zone letters are the same as the Habitat units zones in Appendix 6 - Offset Report (DELWaP)
Bass Highw
OMZ 3J
OMZ 1A
OMZ 2G
N
OMZ 3K
OMZ 1B
Proposed Quarry Extension
OMZ 2H
Proposed Quarry Extension
OMZ 2I
OMZ 3M
OMZ 1C
OMZ 1E
OMZ 1D
OMZ 3L
OMZ 1F
Legend
OMZ 1 - Lowland Forest (patch)
OMZ 2 - Heathy Woodland (patch)
OMZ 3 - Lowland Forest (reveg)
Proposed Quarry Extension
Title Boundary
100 0 100 200 300 400 m
Aerial Image Flown - 17/12/2015

Appendix 6 – Offset Site Report

Native vegetation offset report

Information included in this report is based on spatial data provided to DELWP. The proposal has not been assessed to confirm eligibility or gain

This report provides information about a potential native vegetation offset site in accordance with the *Guidelines for the removal, destruction or lopping of native vegetation*. The information in this report is based on spatial information and the gain score provided by the landholder (or their representative). Any changes to this input information will change the habitat units of gain reflected in this report and it must be reissued.

Date of issue: **29/10/2019**
Time of issue: **10:34 am**

DELWP ref: PKA_2019_017

Project ID	Total Offset

Extent of proposed offset site

Total extent	107.481 ha
Patches	68.866 ha
Revegetation	38.615 ha
Scattered tree(s)	0.000 ha

Habitat units of gain for the proposed offset site

The offset site has the following total general and species habitat units. These units can be used to satisfy a **single permit condition** or if the offset site is established as a **first party offset site**.

Total habitat units and attributes used for a single permit (once off use)	
Number of large tree(s)	247 large trees are protected at the offset site
General habitat units	14.457 general habitat units Port Phillip And Westernport CMA, Bass Coast Shire Council 0.571 Strategic biodiversity value
Species habitat units	13.205 species habitat units for Grey Goshawk, *Accipiter novaehollandiae novaehollandiae* 13.826 species habitat units for Swamp Skink, *Lissolepis coventryi* 13.488 species habitat units for Southern Toadlet, *Pseudophryne semimarmorata* 13.051 species habitat units for Orange-tip Finger-orchid, *Caladenia aurantiaca* 13.021 species habitat units for Spurred Helmet-orchid, *Corybas aconitiflorus* 13.021 species habitat units for Cobra Greenhood, *Pterostylis grandiflora* 13.030 species habitat units for Mauve-tuft Sun-orchid, *Thelymitra malvina*

	9.857 species habitat units for Wavy Swamp Wallaby-grass, *Amphibromus sinuatus* 12.232 species habitat units for Strzelecki Gum, *Eucalyptus strzeleckii* 12.998 species habitat units for Green-striped Greenhood, *Pterostylis chlorogramma*

Habitat units of gain per zone of the proposed offset site

This table provides the habitat units of gain per zone of the offset site. Trading and allocation of units within the **Native Vegetation Credit Register** takes place at the zone.

The species-general offset test is done to determine which species the proposed offset site provides habitat for. The threshold is set at 0.0025 per cent of the mapped habitat value for a species. When the threshold is met or exceeded, species habitat units are generated. If required species habitat units can be generated for all other species mapped at the site. Multiple species units will be generated if the threshold is exceeded for multiple species.

The species habitat units for each species in a zone is calculated by the following equation in accordance with the Guidelines:

Species habitat units = extent x gain score x species landscape factor, where the species landscape factor = 0.5 + (habitat importance score/2)

The general habitat units in a zone is calculated by the following equation in accordance with the Guidelines:

General habitat units = extent x gain score x general landscape factor, where the general landscape factor = 0.5 + (strategic biodiversity value score/2)

Species and general habitat units are alternates and the use or sale of one type of unit will affect the number of other types of units remaining.

Information provided by or on behalf of the applicant				**Information calculated by EnSym**					
Zone	Type	Gain score	Large tree	Polygon extent	Extent without overlap	SBV	HIS	Habitat units	Attributes
1-A	Patch	0.230	109	41.923	41.923	0.654		7.958 general habitat units	Port Phillip And Westernport ; Bass Coast Shire
							0.763	8.484 species habitat units	10220 Grey Goshawk, *Accipiter novaehollandiae novaehollandiae*
							0.862	8.958 species habitat units	12407 Swamp Skink, *Lissolepis coventryi*
							0.821	8.760 species habitat units	13125 Southern Toadlet, *Pseudophryne semimarmorata*
							0.755	8.441 species habitat units	500523 Orange-tip Finger-orchid, *Caladenia aurantiaca*
							0.755	8.441 species habitat units	500835 Spurred Helmet-orchid, *Corybas aconitiflorus*

							0.755	8.441 species habitat units	502798 Cobra Greenhood, *Pterostylis grandiflora*
							0.755	8.441 species habitat units	503374 Mauve-tuft Sun-orchid, *Thelymitra malvina*
							0.719	8.272 species habitat units	503625 Wavy Swamp Wallaby-grass, *Amphibromus sinuatus*
							0.788	8.602 species habitat units	504558 Strzelecki Gum, *Eucalyptus strzeleckii*
							0.755	8.441 species habitat units	504728 Green-striped Greenhood, *Pterostylis chlorogramma*
2-B	Patch	0.230	66	6.164	6.164	0.579		1.117 general habitat units	Port Phillip And Westernport ; Bass Coast Shire
							0.756	1.242 species habitat units	10220 Grey Goshawk, *Accipiter novaehollandiae novaehollandiae*
							0.779	1.258 species habitat units	12407 Swamp Skink, *Lissolepis coventryi*
							0.752	1.239 species habitat units	13125 Southern Toadlet, *Pseudophryne semimarmorata*
							0.635	1.156 species habitat units	500523 Orange-tip Finger-orchid, *Caladenia aurantiaca*
							0.655	1.171 species habitat units	500835 Spurred Helmet-orchid, *Corybas aconitiflorus*
							0.655	1.171 species habitat units	502798 Cobra Greenhood, *Pterostylis grandiflora*
							0.632	1.154 species habitat units	503374 Mauve-tuft Sun-orchid, *Thelymitra malvina*
							0.655	1.171 species habitat units	504558 Strzelecki Gum, *Eucalyptus strzeleckii*
							0.620	1.146 species habitat units	504728 Green-striped Greenhood, *Pterostylis chlorogramma*
3-C	Patch	0.165	3	0.554	0.554	0.580		0.072 general habitat units	Port Phillip And Westernport ; Bass Coast Shire

							0.753	0.080 species habitat units	10220 Grey Goshawk, *Accipiter novaehollandiae novaehollandiae*
							0.785	0.081 species habitat units	12407 Swamp Skink, *Lissolepis coventryi*
							0.725	0.079 species habitat units	13125 Southern Toadlet, *Pseudophryne semimarmorata*
							0.604	0.073 species habitat units	500523 Orange-tip Finger-orchid, *Caladenia aurantiaca*
							0.604	0.073 species habitat units	500835 Spurred Helmet-orchid, *Corybas aconitiflorus*
							0.604	0.073 species habitat units	502798 Cobra Greenhood, *Pterostylis grandiflora*
							0.604	0.073 species habitat units	503374 Mauve-tuft Sun-orchid, *Thelymitra malvina*
							0.604	0.073 species habitat units	504558 Strzelecki Gum, *Eucalyptus strzeleckii*
							0.604	0.073 species habitat units	504728 Green-striped Greenhood, *Pterostylis chlorogramma*
4-D	Patch	0.165	14	4.267	4.267	0.515		0.533 general habitat units	Port Phillip And Westernport ; Bass Coast Shire
							0.744	0.613 species habitat units	10220 Grey Goshawk, *Accipiter novaehollandiae novaehollandiae*
							0.755	0.617 species habitat units	12407 Swamp Skink, *Lissolepis coventryi*
							0.700	0.598 species habitat units	13125 Southern Toadlet, *Pseudophryne semimarmorata*
							0.784	0.627 species habitat units	500523 Orange-tip Finger-orchid, *Caladenia aurantiaca*
							0.683	0.592 species habitat units	500835 Spurred Helmet-orchid, *Corybas aconitiflorus*
							0.683	0.592 species habitat units	502798 Cobra Greenhood, *Pterostylis grandiflora*

							0.756	0.618 species habitat units	503374 Mauve-tuft Sun-orchid, *Thelymitra malvina*
							0.683	0.592 species habitat units	504558 Strzelecki Gum, *Eucalyptus strzeleckii*
							0.683	0.592 species habitat units	504728 Green-striped Greenhood, *Pterostylis chlorogramma*
5-E	Patch	0.165	6	5.168	5.168	0.580		0.673 general habitat units	Port Phillip And Westernport ; Bass Coast Shire
							0.741	0.742 species habitat units	10220 Grey Goshawk, *Accipiter novaehollandiae novaehollandiae*
							0.805	0.769 species habitat units	12407 Swamp Skink, *Lissolepis coventryi*
							0.735	0.739 species habitat units	13125 Southern Toadlet, *Pseudophryne semimarmorata*
							0.743	0.742 species habitat units	500523 Orange-tip Finger-orchid, *Caladenia aurantiaca*
							0.743	0.742 species habitat units	500835 Spurred Helmet-orchid, *Corybas aconitiflorus*
							0.743	0.742 species habitat units	502798 Cobra Greenhood, *Pterostylis grandiflora*
							0.743	0.742 species habitat units	503374 Mauve-tuft Sun-orchid, *Thelymitra malvina*
							0.724	0.734 species habitat units	504558 Strzelecki Gum, *Eucalyptus strzeleckii*
							0.743	0.742 species habitat units	504728 Green-striped Greenhood, *Pterostylis chlorogramma*
6-F	Patch	0.230	8	3.244	3.244	0.567		0.583 general habitat units	Port Phillip And Westernport ; Bass Coast Shire
							0.732	0.645 species habitat units	10220 Grey Goshawk, *Accipiter novaehollandiae novaehollandiae*
							0.794	0.668 species habitat units	12407 Swamp Skink, *Lissolepis coventryi*

							0.718	0.640 species habitat units	13125 Southern Toadlet, *Pseudophryne semimarmorata*
							0.734	0.646 species habitat units	500523 Orange-tip Finger-orchid, *Caladenia aurantiaca*
							0.709	0.636 species habitat units	500835 Spurred Helmet-orchid, *Corybas aconitiflorus*
							0.709	0.636 species habitat units	502798 Cobra Greenhood, *Pterostylis grandiflora*
							0.709	0.636 species habitat units	503374 Mauve-tuft Sun-orchid, *Thelymitra malvina*
							0.693	0.630 species habitat units	503625 Wavy Swamp Wallaby-grass, *Amphibromus sinuatus*
							0.709	0.636 species habitat units	504558 Strzelecki Gum, *Eucalyptus strzeleckii*
							0.716	0.639 species habitat units	504728 Green-striped Greenhood, *Pterostylis chlorogramma*
7-G	Patch	0.229	27	4.815	4.815	0.695		0.933 general habitat units	Port Phillip And Westernport ; Bass Coast Shire
							0.745	0.960 species habitat units	10220 Grey Goshawk, *Accipiter novaehollandiae novaehollandiae*
							0.855	1.021 species habitat units	12407 Swamp Skink, *Lissolepis coventryi*
							0.809	0.995 species habitat units	13125 Southern Toadlet, *Pseudophryne semimarmorata*
							0.731	0.952 species habitat units	500523 Orange-tip Finger-orchid, *Caladenia aurantiaca*
							0.731	0.952 species habitat units	500835 Spurred Helmet-orchid, *Corybas aconitiflorus*
							0.731	0.952 species habitat units	502798 Cobra Greenhood, *Pterostylis grandiflora*
							0.731	0.952 species habitat units	503374 Mauve-tuft Sun-orchid, *Thelymitra malvina*

							0.737	0.956 species habitat units	503625 Wavy Swamp Wallaby-grass, *Amphibromus sinuatus*
							0.731	0.952 species habitat units	504728 Green-striped Greenhood, *Pterostylis chlorogramma*
8-H	Patch	0.185	7	2.356	2.356	0.633		0.357 general habitat units	Port Phillip And Westernport ; Bass Coast Shire
							0.744	0.381 species habitat units	10220 Grey Goshawk, *Accipiter novaehollandiae novaehollandiae*
							0.806	0.394 species habitat units	12407 Swamp Skink, *Lissolepis coventryi*
							0.746	0.381 species habitat units	13125 Southern Toadlet, *Pseudophryne semimarmorata*
							0.680	0.367 species habitat units	500523 Orange-tip Finger-orchid, *Caladenia aurantiaca*
							0.680	0.367 species habitat units	500835 Spurred Helmet-orchid, *Corybas aconitiflorus*
							0.680	0.367 species habitat units	502798 Cobra Greenhood, *Pterostylis grandiflora*
							0.680	0.367 species habitat units	503374 Mauve-tuft Sun-orchid, *Thelymitra malvina*
							0.723	0.376 species habitat units	504558 Strzelecki Gum, *Eucalyptus strzeleckii*
							0.680	0.367 species habitat units	504728 Green-striped Greenhood, *Pterostylis chlorogramma*
9-I	Patch	0.185	7	0.374	0.374	0.497		0.052 general habitat units	Port Phillip And Westernport ; Bass Coast Shire
							0.710	0.059 species habitat units	10220 Grey Goshawk, *Accipiter novaehollandiae novaehollandiae*
							0.729	0.060 species habitat units	12407 Swamp Skink, *Lissolepis coventryi*
							0.669	0.058 species habitat units	13125 Southern Toadlet, *Pseudophryne semimarmorata*

							0.367	0.047 species habitat units	500523 Orange-tip Finger-orchid, *Caladenia aurantiaca*
							0.367	0.047 species habitat units	500835 Spurred Helmet-orchid, *Corybas aconitiflorus*
							0.367	0.047 species habitat units	502798 Cobra Greenhood, *Pterostylis grandiflora*
							0.367	0.047 species habitat units	503374 Mauve-tuft Sun-orchid, *Thelymitra malvina*
							0.367	0.047 species habitat units	504558 Strzelecki Gum, *Eucalyptus strzeleckii*
							0.367	0.047 species habitat units	504728 Green-striped Greenhood, *Pterostylis chlorogramma*
10-J	Revegetation	0.077	0	5.926	5.926	0.635		0.373 general habitat units	Port Phillip And Westernport ; Bass Coast Shire
11-K	Revegetation	0.077	0	6.586	6.586	0.550		0.393 general habitat units	Port Phillip And Westernport ; Bass Coast Shire
12-L	Revegetation	0.077	0	1.483	1.483	0.588		0.091 general habitat units	Port Phillip And Westernport ; Bass Coast Shire
13-M	Revegetation	0.077	0	24.619	24.619	0.397		1.324 general habitat units	Port Phillip And Westernport ; Bass Coast Shire

Next steps

Offset sites must meet eligibility criteria as outlined in the *Guidelines for the removal, destruction or lopping of native vegetation* and the *Native vegetation gain scoring manual, version 2* available on the DELWP website, and any other relevant requirements. Eligible offset sites that are intended to be banked or sold as credits must be registered on the Native Vegetation Credit Register (NVCR). A gain scoring assessment must be done before any offset can be registered on the NVCR. All proposed offset sites must be secured by a relevant security agreement that includes an offset management plan.

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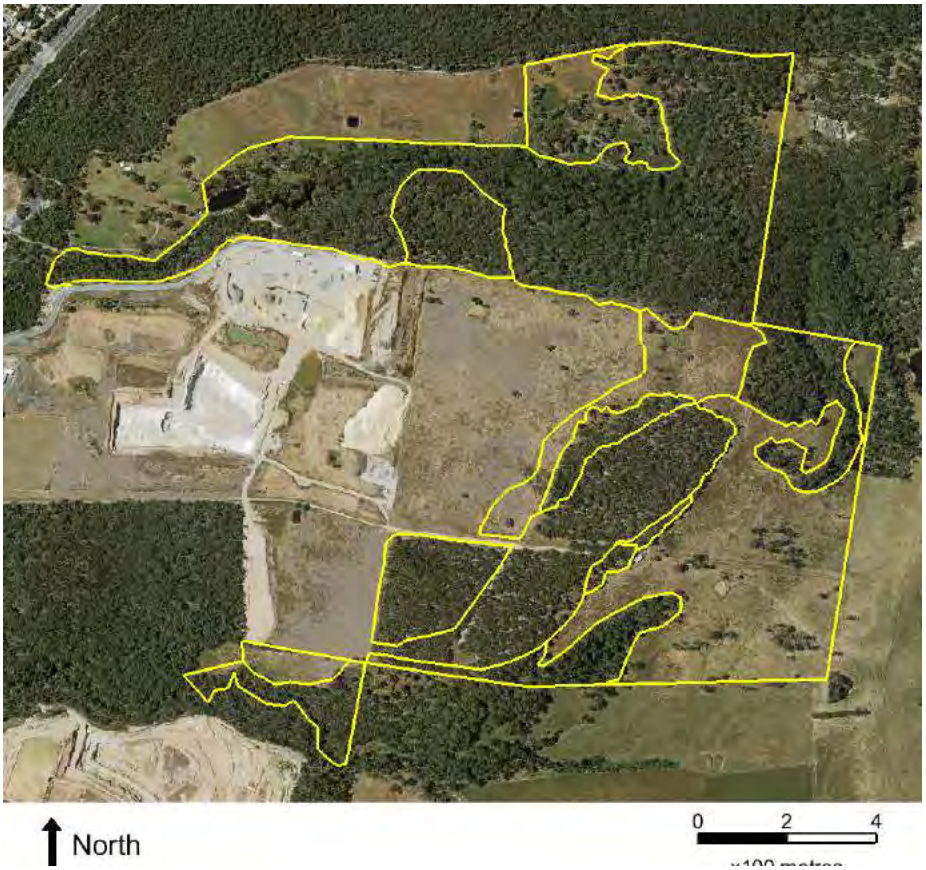
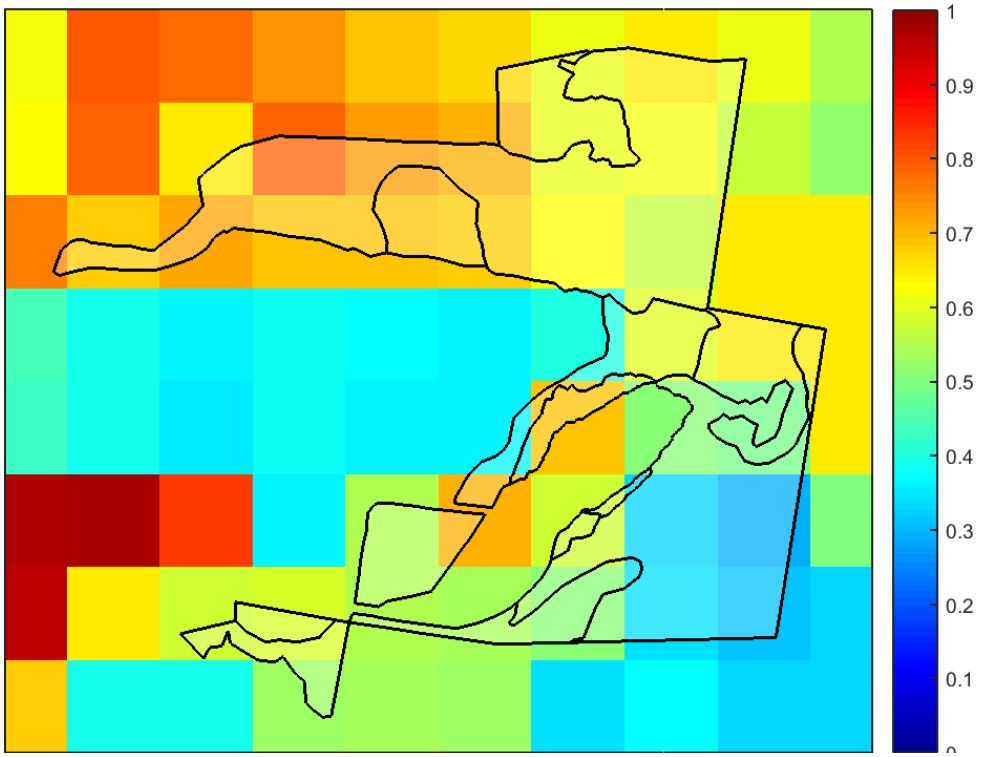
Appendix 1 – Images of marked native vegetation

1. Aerial photograph showing marked native vegetation

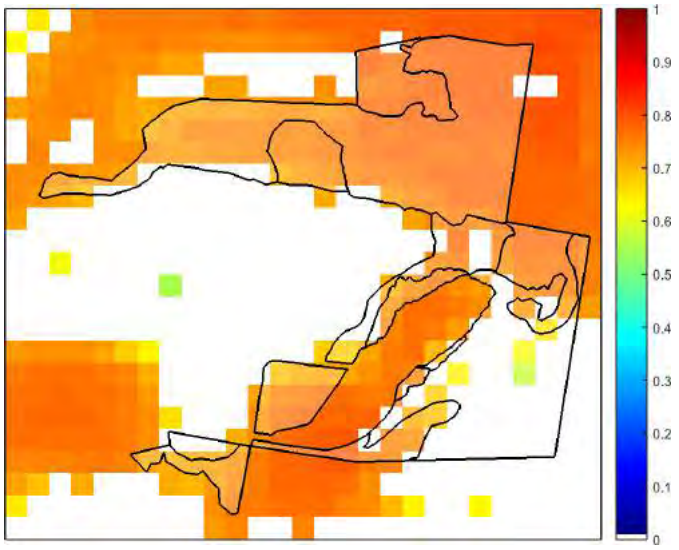


2. Strategic biodiversity value map

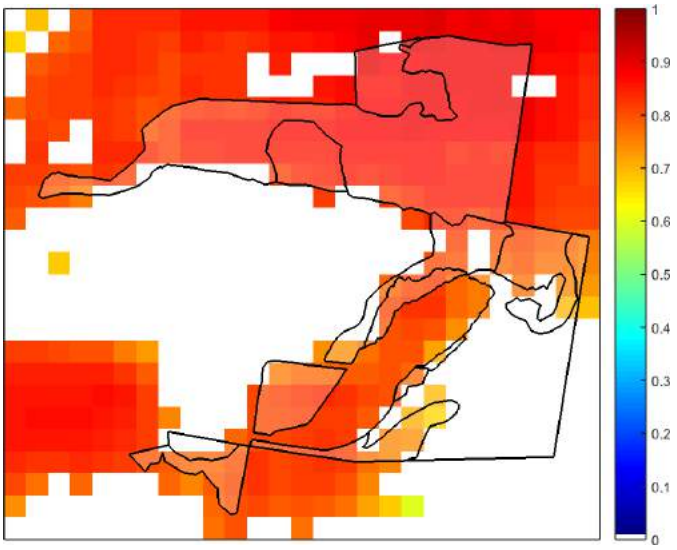


3. Habitat importance maps

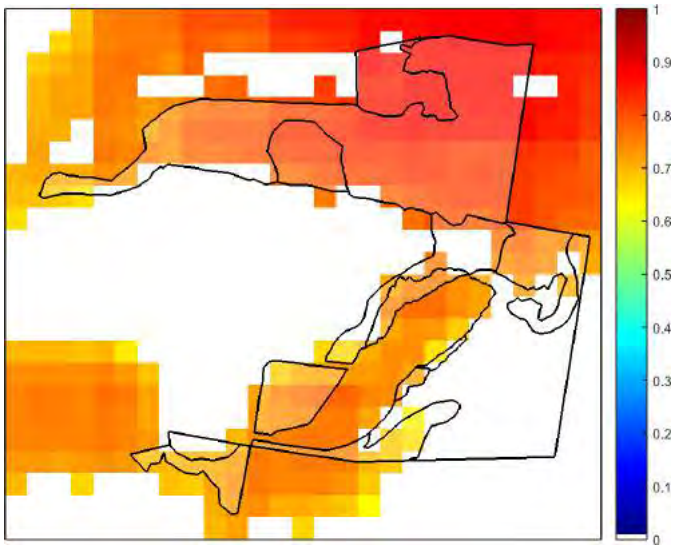
Grey Goshawk
Accipiter novaehollandiae novaehollandiae
10220



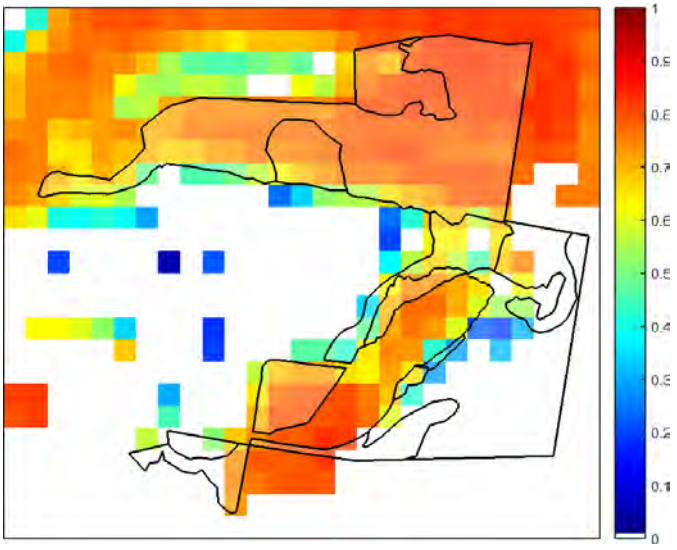
Swamp Skink
Lissolepis coventryi
12407



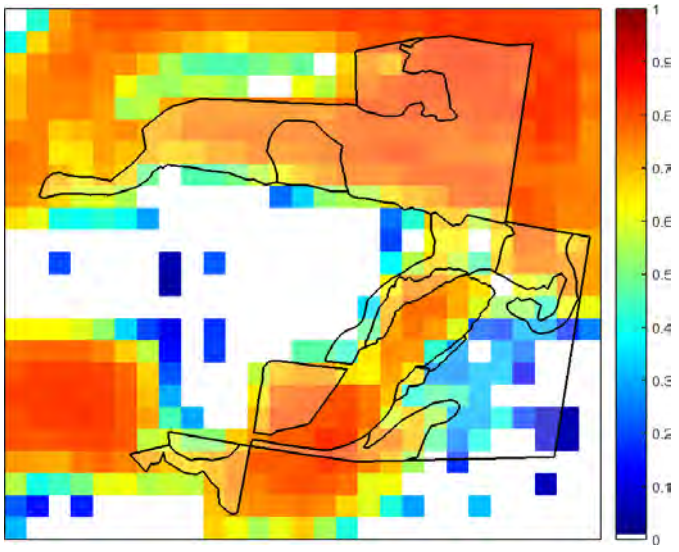
Southern Toadlet
Pseudophryne semimarmorata
13125



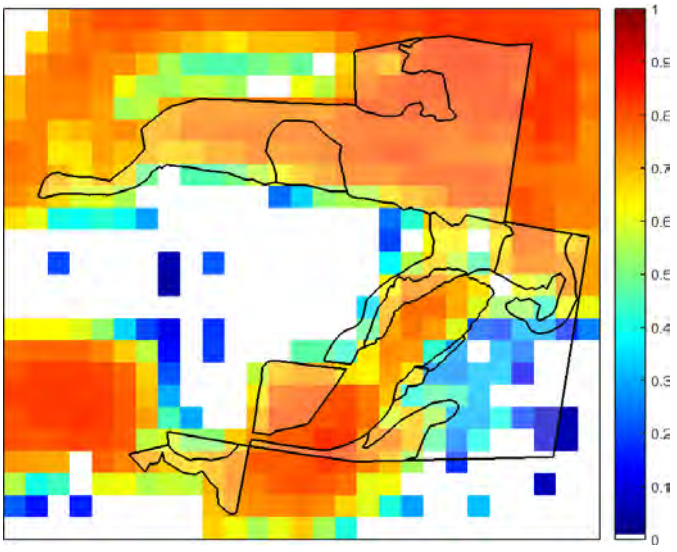
Orange-tip Finger-orchid
Caladenia aurantiaca
500523



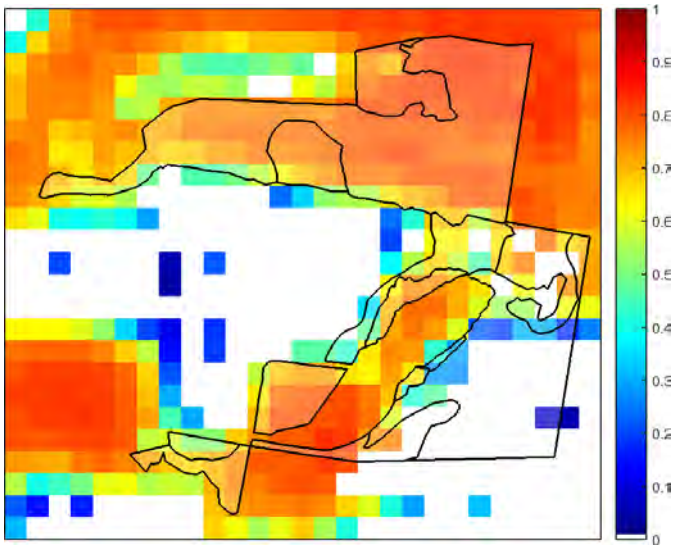
Spurred Helmet-orchid
Corybas aconitiflorus
500835



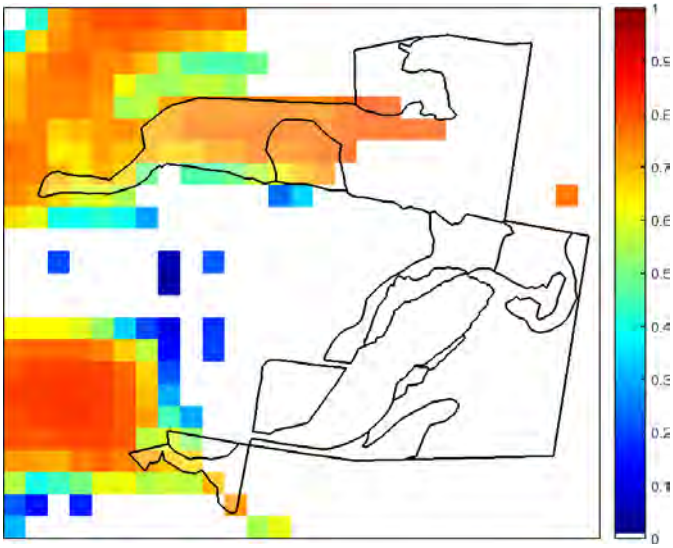
Cobra Greenhood
Pterostylis grandiflora
502798



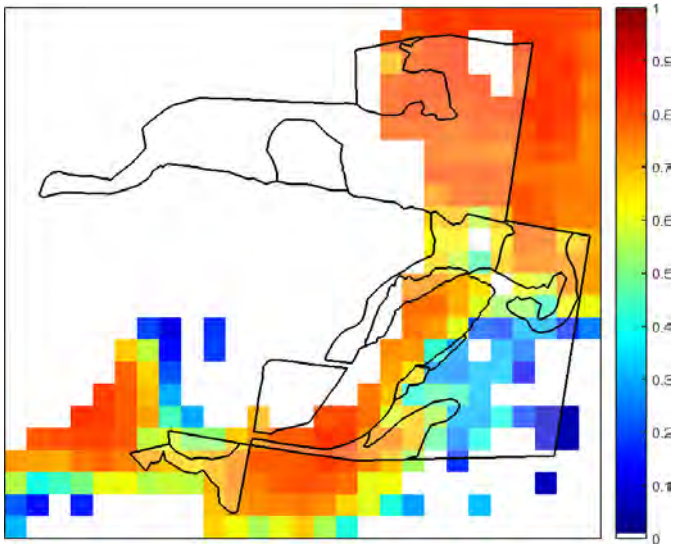
Mauve-tuft Sun-orchid
Thelymitra malvina
503374



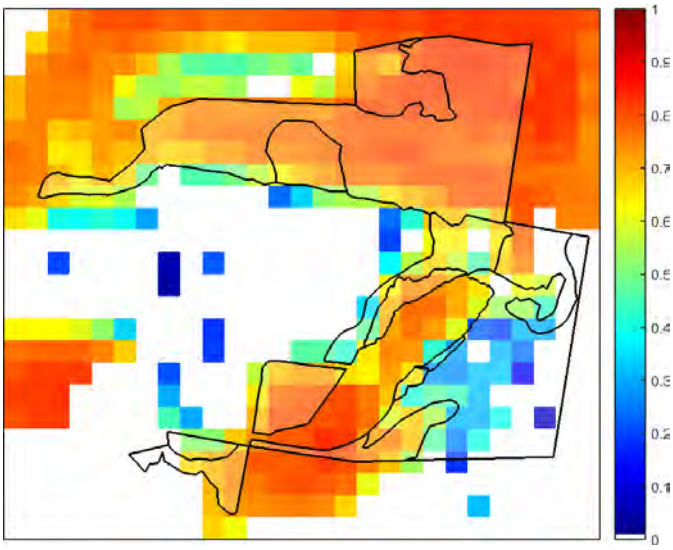
Wavy Swamp Wallaby-grass
Amphibromus sinuatus
503625



Strzelecki Gum
Eucalyptus strzeleckii
504558



Green-striped Greenhood
Pterostylis chlorogramma
504728



GLOSSARY

Alternate offset types

Offset types within a zone are alternates. The use of one offset type will result in the proportional reduction of all other offset types within the zone. Refer to *Native vegetation offset sites* fact sheet available on the DELWP website for more information.

Gain score

This is the site-assessed gain score for the native vegetation based on the agreed management and security commitments. Each zone in the proposed offset site is assigned a gain score according to the gain scoring assessment. The score is divided by 100 to give a number between 0 and 1.

General habitat units of gain

The general habitat units quantify the overall contribution that the protection and management of native vegetation at the offset site makes to Victoria's biodiversity. The general habitat units are calculated as follows:

$$\textit{General habitat units} = \textit{extent} \times \textit{gain score} \times \textit{general landscape factor}$$

General landscape factor

The general landscape factor is the adjusted strategic biodiversity value (SBV) score. The SBV score is adjusted so that site-based biodiversity information has more influence on the number of units.

General offset attributes

The attributes of a general offset includes the location (Catchment Management Authority and Municipal District), strategic biodiversity value score and the number of large trees protected.

Offset type

There are two types of offsets, general offsets and species offsets. All offset sites include general offsets. Sites that are mapped as habitat for rare or threatened species can also include species offsets for the mapped species.

Species offset attributes

The attributes of a species offset is the mapped habitat for the species and the number of large trees protected.

Species habitat units of gain

The species habitat units quantify the overall contribution that the protection and management of native vegetation at an offset site makes to the habitat of the relevant rare or threatened species. Species habitat units are calculated for each species in the zone where the result of the threshold test is greater than 0.0025 per cent. Species units are calcualted as follows:

$$\textit{Species habitat units}_{\textit{species x}} = \textit{extent} \times \textit{gain score} \times \textit{species landscape factor}_{\textit{species x}}$$

Appendix 7 – Offset Management Plan

Appendix 7

VEGETATION OFFSET MANAGEMENT PLAN FOR GRANTVILLE OFFSET SITE

MANAGEMENT PLAN

Offset Site Details

Address of Offset site	1381 -1395 Bass Highway, Grantville
Land tenure	Freehold
Assessor details	
Site assessor	Paul Kelly
Assessment date	Various – December 2012, 2017, 2018 & 2019
Offset details	
Offset identifier	DELWaP ref – PKA_2019_009
Number of sites(s)	1
Number of zone(s)	3
Total area of sites (ha)	101.79ha
Asset type	Protection of native vegetation patch

Offset Management Plan – Zone Details

Asset Type	Offset Zone Number	Offset Zone Area (Ha)
Patch	OMZ 1A	41.923
Patch	OMZ 1B	6.164
Patch	OMZ 1C	0.554
Patch	OMZ 1D	4.267
Patch	OMZ 1E	5.168
Patch	OMZ 1F	3.244
Patch	OMZ 2G	4.815
Patch	OMZ 2H	2.356
Patch	OMZ 2I	0.374
Reveg	OMZ 3J	5.926
Reveg	OMZ 3K	6.586
Reveg	OMZ 3L	1.483
Reveg	OMZ 3M	24.619

Appendix 5 is a map of the offset sites detailing the Offset Management Zones.

Statement of Landowner's management commitments to be achieved at the site

10-year management commitments

This management plan will be implemented by Dandy Premix with Bass Coast Landcare Network and other suppliers as considered necessary. It was developed in accordance with DELWaP 2018.

From the commencement of the Agreement, the landowner agrees to undertake the following management commitments to improve the quality and condition of native vegetation in the site for a period of 10 years from the commencement of the Agreement:

10-year management commitments	
Zone(s)	Commitment
All	• eliminate all woody weeds >1% cover with no mature plants present; • ensure that weed cover does not increase beyond the current level; • monitor for any new and emerging high threat weeds; • control rabbits, foxes and feral pigs in conjunction with adjoining neighbours; • monitor all high threat herbaceous and grassy weeds. Control if >1% cover. (see Table 2); • retain all standing trees (dead or alive); • retain all logs, fallen timber and leaf litter; and • exclude stock unless approved as part of annual weed and fuel reduction management.
OMZ 3J – 3M,	• revegetation of nominated areas in accordance with *Native Vegetation Revegetation Planting Standards (DSE 2006)*

The landowner is required to achieve the native vegetation condition and targets at the end of the 10-year management period, as outlined above.

Ongoing management commitments

The landowner agrees to undertake the following management commitments to maintain in perpetuity, the quality and condition of native vegetation achieved by the end of the 10-year management period at the site:

Ongoing management commitments	
Zone(s)	Commitment
All	• ensure that weed cover does not increase beyond the current level; • monitor for any new and emerging high threat weeds and eliminate to < 1% cover; • control rabbits, foxes & feral pigs; • retain all standing trees (dead or alive); • retain all logs, fallen timber and leaf litter; • exclude stock unless as part of approved annual weed and fuel management.

Summary of threats and actions required to be completed to achieve the management commitments

Fencing

Stock must be excluded from the site(s) at all times during the 10 year management period. The intention of fencing is to protect the site(s) from threats such as grazing. This is especially important for those zones containing revegetation areas. The location of fencing is not important as long as the site(s) are protected from all threats in perpetuity.

Grazing by livestock will not be carried out within the entire quarry pit and offset site as such, stock proof fencing is only required adjoining the freehold boundary of the offset site.

Stock-proof fencing is present on the entire boundary of OMZ 1A, OMZ 2G and OMZ 3J. This fencing will be inspected and repaired if necessary. It will be regularly monitored to ensure integrity.

Stock proof fencing is present adjoining the freehold boundary of OMZ 1B, OMZ 1D and OMZ 3M. It is not intended to erect additional stock-proof fencing to enclose all other offset areas. Stock proof fencing to enclose these OMZ may be required in the future if grazing is reintroduced to manage weeds.

All fencing around the freehold boundary of the site will be maintained in good stock proof condition according to the standards detailed in *BushBroker Information Sheet 12 - Standards for Management – Fencing (DEPI 2013a),* for the term of the contract.

Table 1: Fencing method and timing

Site(s)	**Method**	**Location for fencing and length**	**Timing**
OMZ 1	Inspect existing fence and repair if necessary, according to the standards detailed in (DEPI 2013a) around the perimeter of the site.	Entire boundary – approx. 4340m	Within 3 months of commencement of the Agreement
All Sites	Maintain fencing around boundary of all sites in good stock proof condition according to the standards detailed in (DEPI 2013a). Conduct bi-yearly monitoring to ensure all fencing meets the required standard.	Entire boundary around all sites where fencing exists or is required	Ongoing

Woody weeds

Elimination of all woody weeds
The total cover of all woody weeds on the site at present is <1%.
The location of all significant areas of woody weeds on the site will be mapped. All woody weeds (listed in Table 2) on site will be eliminated by the end of the second year of management using the methods outlined in Table 2. In addition, it is intended that there will be no mature plants present on site by the end of the third year. Indigenous plants should not be impacted during treatment. Monitor for any re-sprouting or seedlings and eradicate (either spot spray or hand pull).

Refer to *BushBroker Information Sheet 8 - Standards for Management – Weeds (DEPI 2013b)*

New and emerging woody weeds

Monitoring for new and emerging woody weeds will be conducted throughout the year for the term of the Agreement, and any new and emerging woody weeds eliminated. The location of any new and emerging woody weeds will be mapped and monitored.

Refer to *Information Sheet 8 - Standards for Management – Weeds (DEPI 2013b)*

Table 2: Woody weeds to be eliminated – method and timing

Common name	Scientific name	Zone(s)	Method	Timing
Blackberry	Rubus fruticosus	All	Spot spray with suitable herbicide	Late Spring/Early summer
Gorse	Ulex europaeus	OMZ 1A	Spot spray with suitable herbicide	Late Spring/Early summer
Ragwort	Senecio jacobaea	OMZ 1A	Hand pull and spot spray with suitable herbicide where necessary	Late Spring/Early summer

Herbaceous weeds

Control of all herbaceous weeds:

The total cover of manageable herbaceous weeds on the site at present is <1%.

Management will ensure that herbaceous weed cover does not increase beyond current levels. Weeds listed in Table 3 were found on site. These weeds will be monitored each year to ensure their cover is not increasing. Increasing cover of these weeds will be controlled using the methods outlined in Table 2 using the least toxic herbicide. Herbaceous weeds will be controlled before the plant has flowered and set seed. Indigenous plants will not be impacted during treatment.

Refer to *BushBroker Information Sheet 8 - Standards for Management – Weeds (DEPI 2013 b).*

New and emerging high threat herbaceous and grassy weeds
Monitoring for new and emerging high threat herbaceous and grassy weeds will be conducted throughout the year for the term of the Agreement, and any new and emerging high threat weeds controlled.

Table 3: Herbaceous weeds to be controlled – method and timing

Common name	Scientific name	Threat Status	Zone(s)	Method	Timing	Cover
Agapanthus	Agapanthus praecox		OMZ 1A	Monitor and respond accordingly. Spot spray with appropriate herbicide.	Monitor bi-annually	< 1%
Angled Onion	Allium triquetrum		OMZ 1A	Monitor and respond accordingly. Spot spray with appropriate herbicide.	Monitor bi-annually	< 1%
Arum Lily	Zantedeschia aethiopica		OMZ 1A	Monitor and respond accordingly. Spot spray with appropriate herbicide.	Monitor bi-annually	< 1%
Bridle Creeper	Asparagus asparagoides	High	OMZ 1A	Monitor and respond accordingly. Spot spray with appropriate herbicide.	Monitor bi-annually	< 1%
Cape Ivy	Delairea odorata	High	OMZ 1A	Monitor and respond accordingly. Spot spray with appropriate herbicide.	Monitor bi-annually	< 1%
Kikuyu	Pennisetum clandestinum	High	All	Monitor and respond accordingly. Spot spray with appropriate herbicide.	Monitor bi-annually	< 1%
Panic Veldt Grass	Ehrharta erecta		All	Monitor and respond accordingly. Spot spray with appropriate herbicide.	Monitor bi-annually	< 1%
Spear Thistle	Cirsium vulgare		All	Monitor and respond accordingly. Spot spray with appropriate herbicide.	Monitor bi-annually	< 1%
Sweet Vernal Grass	Anthoxanthum odoratum		All	Monitor and respond accordingly. Spot spray with appropriate herbicide.	Monitor bi-annually	< 1%

Pest animals

The *Catchment and Land Protection Act 1994* lists rabbits and foxes as established pest animals and requires that all landowners take reasonable steps to prevent the spread of, and as far as possible eradicate, established pest animals on their land.

Rabbits should be monitored and controlled throughout the year. If rabbit activity is detected on the site use an integrated approach in accordance with *BushBroker Information Sheet 7 - Standards of Management – Rabbits (DEPI 2013c)*, which would involve fumigation, hand collapsing of burrows and baiting. Remove any carcasses to prevent poisoning of native predators.

Feral pigs have been recorded on the property. An integrated control program should be implemented in conjunction with adjoining property owners. (*Integrated Feral Pig Control - Agriculture Victoria 2019*)

Foxes are a threat to native fauna and should be controlled where practical. Fox dens where present are required to be destroyed through fumigation and hand collapse.

Continue to monitor and control rabbits, foxes and feral pigs all year round as well as any new and emerging pest animals.

Table 4: Pest animals to be controlled – species, method and timing

Zone(s)	Common name	Method	Timing
All	Rabbits & Foxes	Fumigation and hand collapse of rabbit burrows and fox dens. Monitor & control.	Ongoing
All	Rabbits	Baiting. Participate as part of community control program. When baiting, carcasses will be collected and disposed of to prevent poisoning of native predators.	
All	New & Emerging pest animals	Monitor and control	Ongoing
All	Feral Pigs	Poison, Trap and kill as part of an integrated community program.	Ongoing

Revegetation

Natural regeneration will be encouraged by excluding grazing from all Offset Management Zones for the 10-year management period combined with targeted pest plant and animal management where required. Active revegetation will be carried out by Dandy Premix with Bass Coast Landcare Network and other suppliers as considered necessary.

Seed for propagation of tubestock and direct seeding will be collected from the native vegetation on the clearing site and the retained patches or from appropriate locally sourced seed to replicate the vegetation quality of the site.

No active revegetation or supplementary planting will be carried out in the retained patches of native vegetation i.e. OMZ 1A – 1F and OMZ 2G – 2I (Appendix 5). Natural regeneration will be encouraged passively due to the absence of livestock grazing and pest animal control.

Active revegetation will be carried out in OMZ 3J – 3M (Appendix 5)

The need for a revegetation program for OMZ 3J will be reviewed in the first six months of the commencement of this management plan. The majority of the vegetation on this site is an area of regenerating Burgan and Bracken. Active vegetation management and revegetation may be necessary. The use of direct seeding in this area may not be practical but will be considered as part of the review. Revegetation with tubestock may also be required.

The vegetation OMZ 3K prior to historic clearing is considered to have affinities with the adjoining Lowland Forest of OMZ 1A. It is dominated by derelict pasture of weedy grasses and herbs. It contains several large scattered Messmates *Eucalyptus obliqua*. This derelict pasture areas of this zone will be revegetated using tubestock.

The vegetation of OMZ 3L prior to historic clearing is considered to have affinities with the adjoining Lowland Forest of OMZ 1F. This zone is also dominated by derelict pasture of weedy grasses and herbs. The derelict pasture areas of this zone will be revegetated using tubestock.

The vegetation of OMZ 3M prior to historic clearing is considered to have affinities with the adjoining Lowland Forest of OMZ 1B, OMZ 1D and part of the proposed clearing area. This zone is also dominated by derelict pasture of weedy grasses and herbs. It also contains several native senescent and mature scattered native trees. This zone will be revegetated primarily by using direct seeding (see Table 5 - Direct Seeding Prescription below). Direct seeding trials have commenced in this site consistent with the revegetation requirement of the S173 agreement (Equipe Lawyers 2014). Success of the direct seeding will be monitored bi-annually depending on seasonal conditions but most likely in August/September and April/May. Further seeding will take place the following year if germination targets are not met. The use of tubestock will be considered if the revegetation targets using direct seeding are not met within 7 years of the commencement of this agreement.

The minimum survival targets and minimal species diversity targets for all life forms are set out in Table 6 and have been derived from DSE 2006.

Table 5 - Direct seeding prescription (from BCLN):

Commencement Year	Proposed activity (assuming optimal seasonal conditions)
1	• Develop species list based on local plants suitable for direct seeding • November - collect / order seed • Throughout year - undertake weed control, especially woody and rhizomatous weeds • Monitor trial direct seeding sites.
2	• Prior to ploughing in September - undertake weed control, especially woody and rhizomatous weeds. • August - Spray out area with non-specific herbicide. • September - Plough site with mouldboard / ripper seeder so top 200mm of soil is fully and neatly inverted to bury weed seed bank. Mix seed with bulking agent, divide up and allocate evenly across the site to ensure equal spread, then broadcast seed.
3	• Throughout year - undertake woody weed control only through hand weeding
4	• Throughout year - undertake woody weed control only through hand weeding • November - assess the site for successful germination. Determine the areas that need infill planting, develop species list and order plants
5	• Throughout year - undertake weed control on high threat woody and herbaceous weeds; • July - spot spray and plant seedlings; • November - assess the site for successful establishment. Determine the areas that need infill planting, develop species list and order plants.
6	• Throughout - undertake weed control on high threat woody and herbaceous weeds; • July - spot spray and plant seedlings
7	• Throughout - undertake weed control on high threat woody and herbaceous weeds
8	• Throughout - undertake weed control on high threat woody and herbaceous weeds; • November - assess the site for successful establishment. Determine the areas that need infill planting, develop species list and order plants.
9	• Throughout - undertake weed control on high threat woody and herbaceous weeds • July - spot spray and plant seedlings
10	• Throughout - undertake weed control on high threat woody and herbaceous weeds

Table 6: Revegetation targets – species survival targets

EVC # and name		EVC 16 Lowland Forest					
Bioregion		Gippsland Plain					
							Survival Targets [1]
Life form		**Common name**	**Species name**	**Density/Ha**	**Area (Ha)**		**Approx Number of plants/zone**
Overstorey **Canopy species**		Messmate Stringybark Narrow-leaf Peppermint	Eucalyptus obliqua Eucalyptus radiata	150	OMZ 3J	5.926	800
					OMZ 3K	6.586	900
					OMZ 3L	1.483	200
					OMZ 3M	24.619	3500
Understorey	**Understorey Trees and Large Shrubs** (> 5 m tall)	Blackwood Late Black Wattle	Acacia melanoxylon Acacia mearnsii	50	OMZ 3J	5.926	300
					OMZ 3K	6.586	300
					OMZ 3L	1.483	100
					OMZ 3M	24.619	1200
	Medium Shrubs (1-5 m tall)	Silver Banksia Hedge Wattle Sweet Bursaria Burgan Prickly Teatree	Banksia marginata Acacia verticillata Bursaria spinosa Kunzea ericoides Leptospermum continentale	200	OMZ 3J	5.926	1100
					OMZ 3K	6.586	1300
					OMZ 3L	1.483	300
					OMZ 3M	24.619	5000
	Large Tufted Graminoids (>1 m tall)	Spiny-headed Mat Rush Thatch Saw-sedge	Lomandra longifolia Gahnia radula	500	OMZ 3J	5.926	3000
					OMZ 3K	6.586	3200
					OMZ 3L	1.483	700
					OMZ 3M	24.619	12000
Total Survival Targets				900/ha	OMZ 3J	5.926	5300
					OMZ 3K	6.586	5900
					OMZ 3L	1.483	1300
					OMZ 3M	24.619	22,000

[1] The minimum number of plants specified under survival targets for each category are the numbers aimed to be established by Year 10 of the management plan.

Fire Protection:

Fire access tracks will be established and maintained around the freehold boundary of each Offset Management Zones on the recommendation of the CFA. Existing internal access tracks will be maintained and able to be used by fire appliances.

Annual Reporting – 10 Year Active Management Agreement

This Landowner Agreement requires the landowner to submit a report annually for each year of the ten years of this management plan and thereafter at the reasonable request of the Secretary. Reports are to be submitted at least 2 months prior to the anniversary date of the execution of the Agreement to allow time for compliance to be assessed before the anniversary date.

The Annual Report addresses progress against the commitments set out in this Agreement. Annual Reports should provide enough detail in the form of written comments and supporting evidence that an assessor can easily determine the completion of/progress against the commitments for each zone.

Maintaining native vegetation quality and condition in perpetuity

This Landowner Agreement outlines management commitments and targets required to be achieved at the site to improve the quality and condition of native vegetation.

At the completion of the 10-year active management period, the landowner is required to continue to undertake management to maintain native vegetation quality and condition at the site.

This includes maintaining native vegetation condition and targets required to be achieved at the end of the 10-year management period and all ongoing management commitments in perpetuity.

References:

Agriculture Victoria 2019 **Integrated Feral Pig Control.** http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/pest-animals/invasive-animal-management/established-invasive-animals/integrated-feral-pig-control

DSE 2006 **Native Vegetation Revegetation Planting Standards**. DSE, Melbourne

DEPI 2013a, BushBroker information sheet 12 – Standards for management – fencing. Department of Environment and Primary Industries, East Melbourne.

DEPI 2013b, BushBroker information sheet 8 – Standards for management – weeds. Department of Environment and Primary Industries, East Melbourne.

DEPI 2013c, BushBroker information sheet 7 – Standards for management – rabbits. Department of Environment and Primary Industries, East Melbourne.

DEPI 2013d, BushBroker information sheet 9 – Standards for management – supplementary planting. Department of Environment and Primary Industries, East Melbourne.

DELWaP 2018 **First Party Offset Guide – How to establish a First Party Offset Site**. Department of Environment, Land, Water & Environment, Melbourne https://www.environment.vic.gov.au/__data/assets/pdf_file/0029/329456/First-party-offset-guide.pdf

Ten-year management action plan with targets

Table 7: 10-Year Management Actions Plan with Targets

Year from Commencement: Year 1

Zone(s)	Management Action Description	Reference Table for action	Timing	Target to be achieved
Fencing				
OMZ 1A, 1B, 1F, 2G, 3J & 3M	Inspect existing freehold boundary fence and repair if necessary. No fencing is required on the western boundary of the offset sites unless prescribed grazing of the area is proposed after the 10-year grazing moratorium.	Table 1	Within 3 months of commencement of the Agreement	Upgrade existing fencing to DEPI fencing standards in BushBroker Information Sheet 12 - Standards for Management – Fencing (DEPI 2013a)
All Sites	Maintain fencing in serviceable condition around entire boundary of all offset sites where fencing exists. Conduct yearly monitoring to ensure all fencing meets the required standard.	Table 1	Ongoing	Maintain fencing to DEPI fencing standards in BushBroker Information Sheet 12 - Standards for Management – Fencing.
Woody Weeds				
All	Monitor for and eliminate all woody weeds. Refer to Table 2 for list of woody weeds, their control method and timing of actions Monitor for any re-sprouting or seedlings and eradicate (either spot spray or hand pull)	Table 2	As indicated in Table 2 above. Generally, in Late Spring/Early summer	Eliminate all listed woody weeds, with no mature plants present by end of Year 3 <1% cover of all listed woody weeds, with no mature plants present at the end of Year 10 Minimise off-target damage (avoid all native plants)
All	Eliminate all new & emerging woody weeds	n/a	Ongoing	<1% cover of all woody weeds, with no mature plants present at the end of Year 10

Year from Commencement: Year 1

Zone(s)	Management Action Description	Reference Table for action	Timing	Target to be achieved
Herbaceous Weeds				
All	Monitor for and eliminate all high threat herbaceous and grassy weeds with emphasis on the boundaries of each offset site.	Table 3	As indicated in Table 3 above	Aim to eliminate all listed high threat herbaceous and weeds by end of Year 5 <1% cover of all high threat herbaceous and weeds at the end of Year 10 Minimise off-target damage (avoid all native plants)
All	Monitor for and control all herbaceous weeds. Refer to Table 3 for list of herbaceous weeds, their control method and timing of actions	Table 3	Refer to Table 3	No increase in cover beyond the cover listed in Table Y for each Zone for all herbaceous weeds Minimise off-target damage (avoid all native plants)
All	Monitor for and Eliminate all new & emerging herbaceous weeds	n/a	Ongoing	<1% cover of all new and emerging herbaceous weeds at the end of Year 10
Pest Animals				
All	Monitor for and control rabbits, feral pigs and foxes. Refer to Table 4 for a list of control methods and timing of actions	Table 4	Refer to Table 4	No surface disturbance within the Offset site No active rabbit warrens to be present No active fox dens to be present No rubbish Minimal artificial piles of logs and rocks
All	Monitor for and control rabbits, feral pigs and foxes	n/a	Ongoing	Control numbers of rabbits and foxes
All	Monitor for and control all new and emerging pest animals	n/a	Ongoing	Control numbers of any new & emerging pest animals including Common Wombat

Year from Commencement: Year 1

Zone(s)	Management Action Description	Reference Table for action	Timing	Target to be achieved
Revegetation				
OMZ 3J	Review revegetation strategy and method for Burgan and Bracken area		Commencement of agreement	Decide on revegetation strategy with BCLN
Clearing Site and all Offset Sites	Collect indigenous seed on site and place order for propagation with local indigenous nursery. Refer to Table 6 for species list and minimum survival targets and minimum species diversity targets	Revegetation Table 6 Survival and diversity targets Table 5	If collecting on site - after seed has set for target species. Summer.	Collect seed / propagate tubestock (seedlings) for species listed in Table 6 from seed sourced on site or as locally as possible and from the same soil type Provenance principles should be followed. Seek advice from a local indigenous nursery & BCLN The minimum survival targets and minimum species diversity targets for understory life forms as set out in Table 6 must be achieved
OMZ 3M	Carry out further trial direct seeding sites. Prepare other direct seeding areas as required. Cultivation and weed control		Winter dependent on soil moisture	As per prescription, Table 5 (BCLN) • August; Spray out area with non-specific herbicide • September; Plough site with mouldboard / ripper seeder so top 200mm of soil is fully and neatly inverted to bury weed seed bank. Mix native seed with bulking agent, divide up and allocate evenly across the site to ensure equal spread, then broadcast seed.
OMZ 3K, 3L	Spot spray planting sites in preparation for seedling planting. Undertake pest animal control over planting area (avoiding any native plants).	n/a	Ongoing	Minimise off-target damage (avoid all native plants)
All revegetation sites (OMZ 3J, 3K, 3L & 3M)	Monitor for browsing of plantings	n/a	Late Spring/early summer	Develop browser management regime if required.
Fire Access				
All	Undertake fire access and management track maintenance		Late Spring	

Year from Commencement: Year 1

Zone(s)	Management Action Description	Reference Table for action	Timing	Target to be achieved
Annual reporting				
All	Prepare and submit an annual report	n/a	Submit at least 2 months prior to Agreement anniversary date	Annual report is signed, dated and submitted by the landowner at least 2 months prior to the anniversary date of the Agreement Report provides enough detail in the form of written comments and supporting evidence that an assessor can easily determine the completion of / progress against the commitments for each zone Obligations of the landowner (compliance with section 6 of the Landowner Agreement) have been met and the obligations form is read, signed, dated and submitted with the annual report

Year from Commencement: Year 2

Zone(s)	Management Action Description	Reference Table for action	Timing	Target to be achieved
Fencing				
All Sites	Maintain fencing in good condition around entire boundary of all sites where fencing exists or is required. Conduct yearly monitoring to ensure all fencing meets the required standard.	Table 1	Ongoing	Maintain fencing to DEPI fencing standards
Woody Weeds				
All	Monitor for and eliminate all woody weeds. Refer to Table 2 for list of woody weeds, their control method and timing of actions Monitor for any re-sprouting or seedlings and eradicate (either spot spray or hand pull)	Table 2	Refer to Table 2	Eliminate all listed woody weeds, with no mature plants present by end of Year 3 <1% cover of all listed woody weeds, with no mature plants present at the end of Year 10 Minimise off-target damage (avoid all native plants)
All	Monitor for and eliminate all new & emerging woody weeds	n/a	Ongoing	<1% cover of all woody weeds, with no mature plants present at the end of Year 10
Herbaceous Weeds				
All	Control all herbaceous weeds. Refer to Table 3 for list of herbaceous weeds, their control method and timing of actions	Table 3	Refer to Table 3	No increase in cover beyond the cover listed in Table 4 for each Zone for all herbaceous weeds Minimise off-target damage (avoid all native plants)
All	Monitor for and eliminate all new & emerging herbaceous weeds	n/a	Ongoing	<1% cover of all new and emerging herbaceous weeds at the end of Year 10
Pest Animals				
All	Monitor for and control rabbits, feral pigs and foxes. Refer to Table 4 for a list of control methods and timing of actions	Table 4	Refer to Table 4	No surface disturbance within the Offset site No active rabbit warrens to be present No active fox dens to be present No rubbish Minimal artificial piles of logs and rocks
All	Monitor for and control rabbits, feral pigs and foxes	n/a	Ongoing	Control numbers of rabbits and foxes
All	Monitor for and control all new and emerging pest animals	n/a	Ongoing	Control numbers of any new & emerging pest animals.
All	Monitor for impact of wombat burrowing.		Ongoing	

Year from Commencement: Year 2

Zone(s)	Management Action Description	Reference Table for action	Timing	Target to be achieved
Revegetation				
OMZ 3J, 3K & 3L	Plant tubestock or seedlings and guard if required	Revegetation Table 5	Late Winter if adequate soil moisture	Survival and diversity targets Table 5 By the end of Year 4 ensure that 100% of the Survival Target is met for the Zone as specified in Table 5 By the end of Year 4 ensure that 100% of the Target Diversity of understorey life forms for the Zone is met as specified in Table 5
OMZ 3M	Direct seeding into previously prepared sites inc established trial sites			August; Spray out area with non-specific herbicide September; Plough site with mouldboard / ripper seeder so top 200mm of soil is fully and neatly inverted to bury weed seed bank. Mix seed with bulking agent, divide up and allocate evenly across the site to ensure equal spread, then broadcast seed.
All	Undertake selective weed control of planted tubestock.			Minimise off-target damage (avoid all native plants)
All	Undertake pest animal control as required		Ongoing	
Fire Access				
All	Undertake fire access track maintenance		Late Spring	
Annual reporting				
All	Prepare and submit an annual report	n/a	Submit at least 2 months prior to Agreement anniversary date	Annual report is signed, dated and submitted by the landowner at least 2 months prior to the anniversary date of the Agreement Report provides enough detail in the form of written comments and supporting evidence that an assessor can easily determine the completion of / progress against the commitments for each zone Obligations of the landowner (compliance with section 6 of the Landowner Agreement) have been met and the obligations form is read, signed, dated and submitted with the annual report

Year from Commencement: Year 3

Zone(s)	Management Action Description	Reference Table for action	Timing	Target to be achieved
Fencing				
All Sites	Maintain fencing in good condition around entire boundary of all sites where fencing exists or is required. Conduct yearly monitoring to ensure all fencing meets the required standard.	Table 1	Ongoing	Maintain fencing to DEPI fencing standards
Woody Weeds				
All	Monitor for any re-sprouting or seedlings and eradicate (either spot spray or hand pull)	Table 2	Refer to Table 2	<1% cover of all listed woody weeds, with no mature plants present at the end of Year 10 Minimise off-target damage (avoid all native plants)
All	Monitor for and eliminate all new & emerging woody weeds	n/a	Ongoing	<1% cover of all woody weeds, with no mature plants present at the end of Year 10
Herbaceous Weeds				
All	Monitor for and control all herbaceous weeds. Refer to Table 4 for list of herbaceous weeds, their control method and timing of actions	Table 3	Refer to Table 3	No increase in cover beyond the cover listed in Table 3 for each Zone for all herbaceous weeds Minimise off-target damage (avoid all native plants)
All	Monitor for and eliminate all new & emerging herbaceous weeds	n/a	Ongoing	<1% cover of all new and emerging herbaceous weeds at the end of Year 10
Pest Animals				
All	Monitor for and control rabbits and foxes. Refer to Table 6 for a list of control methods and timing of actions	Table 6	Refer to Table 6	No surface disturbance within the Offset site No active rabbit warrens to be present No active fox dens to be present No rubbish Minimal artificial piles of logs and rocks
All	Monitor for and control rabbits and foxes	n/a	Ongoing	Control numbers of rabbits and foxes
All	Monitor for and control all new and emerging pest animals	n/a	Ongoing	Control numbers of any new & emerging pest animals

Year from Commencement: Year 3

Zone(s)	Management Action Description	Reference Table for action	Timing	Target to be achieved
Revegetation				
All sites	Monitor survival rates and adjust planting schedule accordingly.		Late Summer early autumn	
OMZ 3J, 3K & 3L	Plant tubestock or seedlings and guard if required	Revegetation Table 5	Late Winter if adequate soil moisture	Survival and diversity targets Table 6 By the end of Year 4 ensure that 100% of the Survival Target is met for the Zone as specified in Table 5 By the end of Year 4 ensure that 100% of the Target Diversity of understorey life forms for the Zone is met as specified in Table 5
OMZ 3M	Direct seeding into Year 2 & 3 prepared sites			Throughout year - undertake woody weed control only through hand weeding, August; Spray out area with non-specific herbicide September; Plough site with mouldboard / ripper seeder so top 200mm of soil is fully and neatly inverted to bury weed seed bank. Mix seed with bulking agent, divide up and allocate evenly across the site to ensure equal spread, then broadcast seed.
All	Undertake selective weed control of planted tubestock and direct seeding sites.			Minimise off-target damage (avoid all native plants)
All	Undertake pest animal control as required		Ongoing	
Fire Access				
All	Undertake fire access track maintenance		Late Spring	
Annual reporting				
All	Prepare and submit an annual report	n/a	Submit at least 2 months prior to Agreement anniversary date	Annual report is signed, dated and submitted by the landowner at least 2 months prior to the anniversary date of the Agreement Report provides enough detail in the form of written comments and supporting evidence that an assessor can easily determine the completion of / progress against the commitments for each zone Obligations of the landowner (compliance with section 6 of the Landowner Agreement) have been met and the obligations form is read, signed, dated and submitted with the annual report

Year from Commencement: 4 – 10

Zone(s)	Management Action Description	Reference Table for action	Timing	Target to be achieved
Fencing				
All Sites	Maintain fencing in good condition around entire boundary of all sites where fencing exists or is required. Conduct yearly monitoring to ensure all fencing meets the required standard.	Table 1	Ongoing	Maintain fencing to DEPI fencing standards in BushBroker Information Sheet 12 - Standards for Management – Fencing
Woody Weeds				
All	Monitor for any re-sprouting or seedlings and eradicate (either spot spray or hand pull)	Table 2 & 3	Refer to Table 2	<1% cover of all listed woody weeds, with no mature plants present at the end of Year 10 Minimise off-target damage (avoid all native plants)
All	Monitor for and eliminate all new & emerging woody weeds	n/a	Ongoing	<1% cover of all woody weeds, with no mature plants present at the end of Year 10
Herbaceous Weeds				
All	Monitor for and control all herbaceous weeds. Refer to Table 4 for list of herbaceous weeds, their control method and timing of actions	Tables 4	Refer to Table 4	No increase in cover beyond the cover listed in Table 4 for each Zone for all herbaceous weeds Minimise off-target damage (avoid all native plants)
All	Monitor for and eliminate all new & emerging herbaceous weeds	n/a	Ongoing	<1% cover of all new and emerging herbaceous weeds at the end of Year 10
Pest Animals				
All	Monitor for and control rabbits, foxes and feral pigs. Refer to Table 6 for a list of control methods and timing of actions	Table 6	Refer to Table 6	No surface disturbance within the Offset site No active rabbit warrens to be present No active fox dens to be present No rubbish Minimal artificial piles of logs and rocks
All	Monitor for and control rabbits, foxes and feral pigs	n/a	Ongoing	Control numbers of rabbits, foxes and feral pigs
All	Monitor for and control all new and emerging pest animals	n/a	Ongoing	Control numbers of any new & emerging pest animals

Year from Commencement: 4 – 10

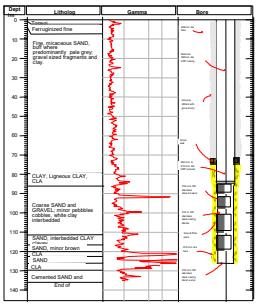
Zone(s)	Management Action Description	Reference Table for action	Timing	Target to be achieved
Revegetation				
All sites	Monitor seedling survival rates and adjust planting schedule accordingly. Assess soil moisture.		Late Summer / early autumn	
OMZ 3J, 3K & 3L	Plant tubestock or seedlings and guard if required. Repeat direct seeding if recommended. If not recommended prepare for tubestock planting.	Revegetation Table 6	Late Winter if adequate soil moisture	Survival and diversity targets Table 6 By the end of Year 4 ensure that 100% of the Survival Target is met for the Zone as specified in Table 6 By the end of Year 4 ensure that 100% of the Target Diversity of understorey life forms for the Zone is met as specified in Table 6
OMZ 3M	Direct seeding into prepared sites if recommended. Review revegetation program to assess need for planting of tubestock to supplement direct seeding program.			As per BCLN prescription (Above) Throughout year - undertake woody weed control only through hand weeding November - assess the site for successful germination. Determine the areas that need infill planting, develop species list and order plants Year 8 - November - assess the site for successful establishment. Determine the areas that need infill planting, develop species list and order plants.
All	Undertake selective weed control of planted tubestock and direct seeding sites.			Minimise off-target damage (avoid all native plants)
All	Undertake pest animal control as required		Ongoing	
Fire Access				
All	Undertake fire access and management track maintenance		Late Spring	
Annual reporting				
All	Prepare and submit an annual report	n/a	Submit at least 2 months prior to Agreement anniversary date	Annual report is signed, dated and submitted by the landowner at least 2 months prior to the anniversary date of the Agreement Report provides enough detail in the form of written comments and supporting evidence that an assessor can easily determine the completion of / progress against the commitments for each zone Obligations of the landowner (compliance with section 6 of the Landowner Agreement) have been met and the obligations form is read, signed, dated and submitted with the annual report

REPORT 2 – HYDROGEOLOGICAL ASSESSMENT

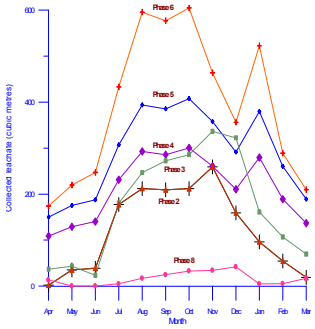
DANDY PREMIX QUARRIES PTY LTD

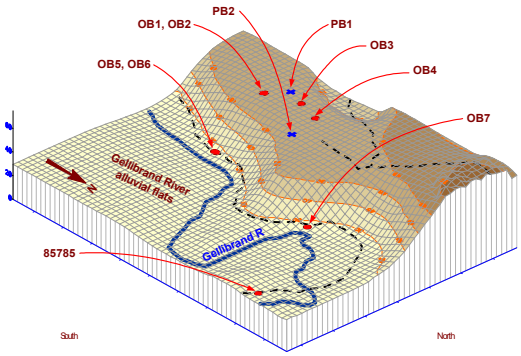




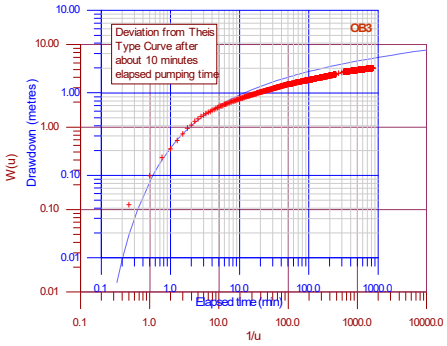


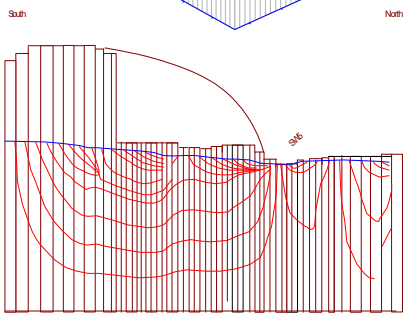


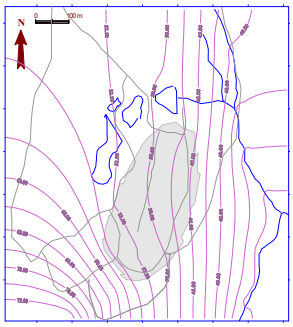












WA1488, 1381-1395 BASS HIGHWAY, GRANTVILLE
WORK PLAN VARIATION
PHASE 2 DEVELOPMENT
HYDROGEOLOGICAL ASSESSMENT

December 2019

Ref. No.:GW-19/012



JOHN LEONARD CONSULTING SERVICES

Groundwater and Environmental Consultants



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1.0 INTRODUCTION

JOHN LEONARD CONSULTING SERVICES Pty Ltd (JLCS) was engaged by Dandy Premix Quarries Pty Ltd (DPQ) to prepare a Hydrogeological Assessment for a Work Plan Variation (WPV) – Phase 2 Development of Work Authority Number 1488 (WA1488), 1381-1395 Bass Highway, Grantville, Victoria.

1.1 BACKGROUND

WA1488 covers an area of about 155.65 ha[1] and is located about 85 km SSE of the Melbourne Central Business District and about one km NNE of the small township of Grantville (Figure 1.1) in the parish of Corinella, Bass Coast Shire. The site is within the Koo Wee Rup Water Supply Protection Area. The site is bordered by Deep Creek to the north and Colbert Creek along part of its southern boundary, with rural land to the east and Bass Highway frontage to the west. Western Port Bay is about 300 metres from the western boundary of WA1488. The site elevation ranges from less than 10 m AHD near the northwestern corner of WA1488 up to more than 120 m AHD on the hill in the eastern portion of the site

The 2013 approved Work Plan for WA1488 authorized quarrying sand from a pit above the water table in the western portion of the site and onsite dry blending of *in situ* and imported coarse washed sand. DPQ are seeking a variation to the approved work authority to further develop sand quarrying operations including 1) enlarging the existing fine-medium extraction sand pit (FMSEP) and extracting sand from below the water table using a dredge cutter, and 2) establishing a new coarse sand extraction pit (CSEP) more than 40 m above the water table in the eastern portion of the site (Figure 1.2).

The dry screening and blending sand plant at WA1488 will be significantly enhanced enlarged to process both wet sand slurry from the proposed FMSEP dredge pond as well as "dry" sand from the FMSEP areas above the water table and "dry" coarse sand from the CSEP. The processing plant will include a sand wash plant, thickener and water clarifier, mud buffer tank, dewatering belt press, fresh water storage tank and recycled water storage tank (recycled water will be returned to the dredge pond). The processed concrete sand along with other construction sand products will be stockpiled on-site for sales distribution.

The final dredge pond within the FMSEP will cover about 24.1 ha and contain about 3,500 ML of water. Groundwater will be removed from the pond in the slurry (25% sand and 75% water) dredged from the pond and pumped to the sand washing plant for processing. Groundwater will also be pumped directly from the pond for sand processing make-up water and for dust suppression. DPQ have negotiated an 80.5 megalitres per year (ML/yr) groundwater allocation on a temporary transfer basis. [An application for a "Take and Use" license is being considered by Southern Rural Water (SRW); SRW will set license conditions to ensure that the groundwater extracting at WA1488 will not adversely impact existing groundwater users, hydraulically interconnected surface waters and/or groundwater dependent ecosystems.]

[1] Determined from georeferenced Earth Resources – GeoVic – Explore Victoria Online Current Extractive Industry Work Authorities Map http://er-info.dpi.vic.gov.au/sd_weave/anonymous.html.

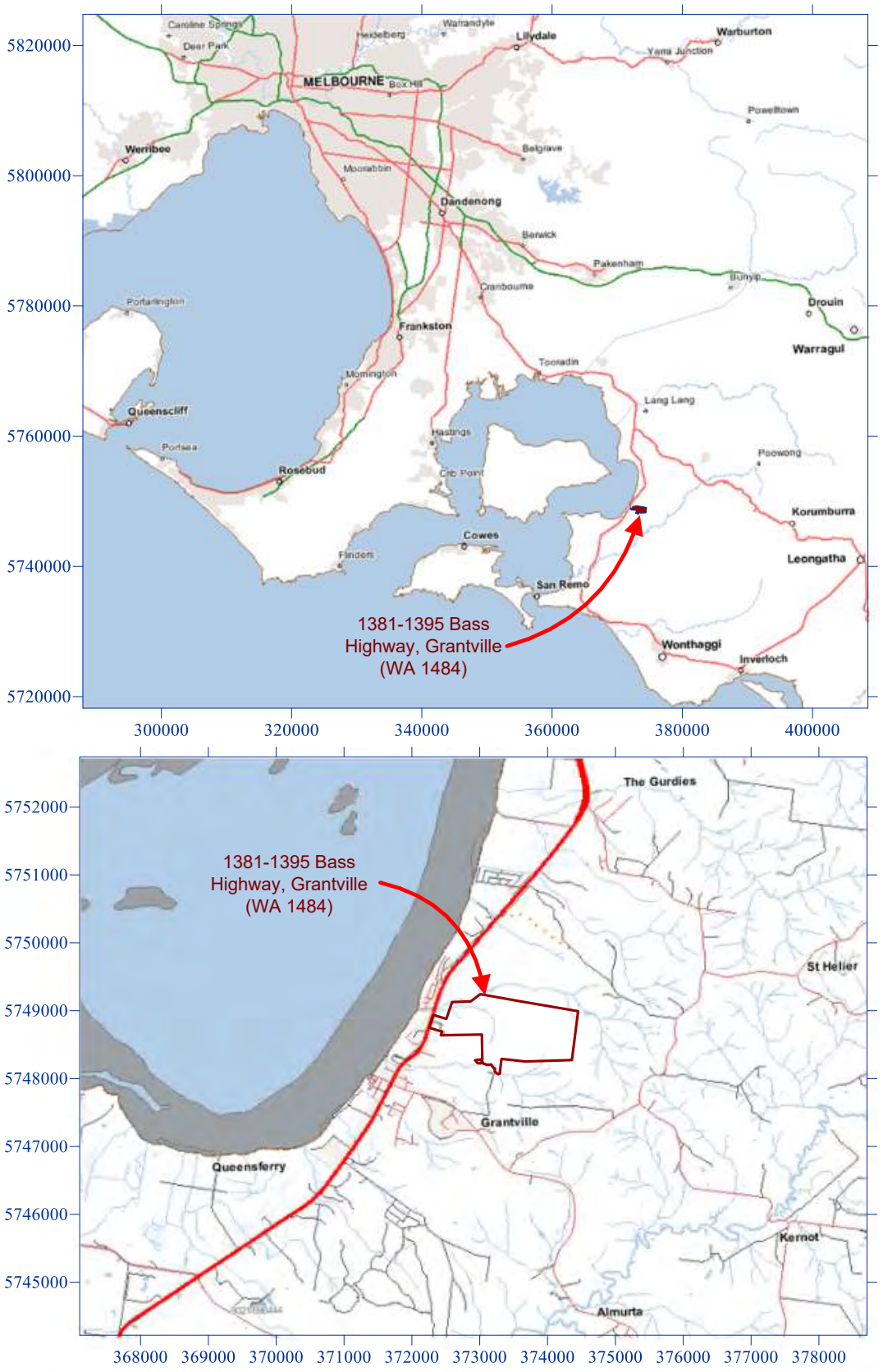


FIGURE 1.1: WA1488, 1381-1395 Bass Highway Grantville Site Location

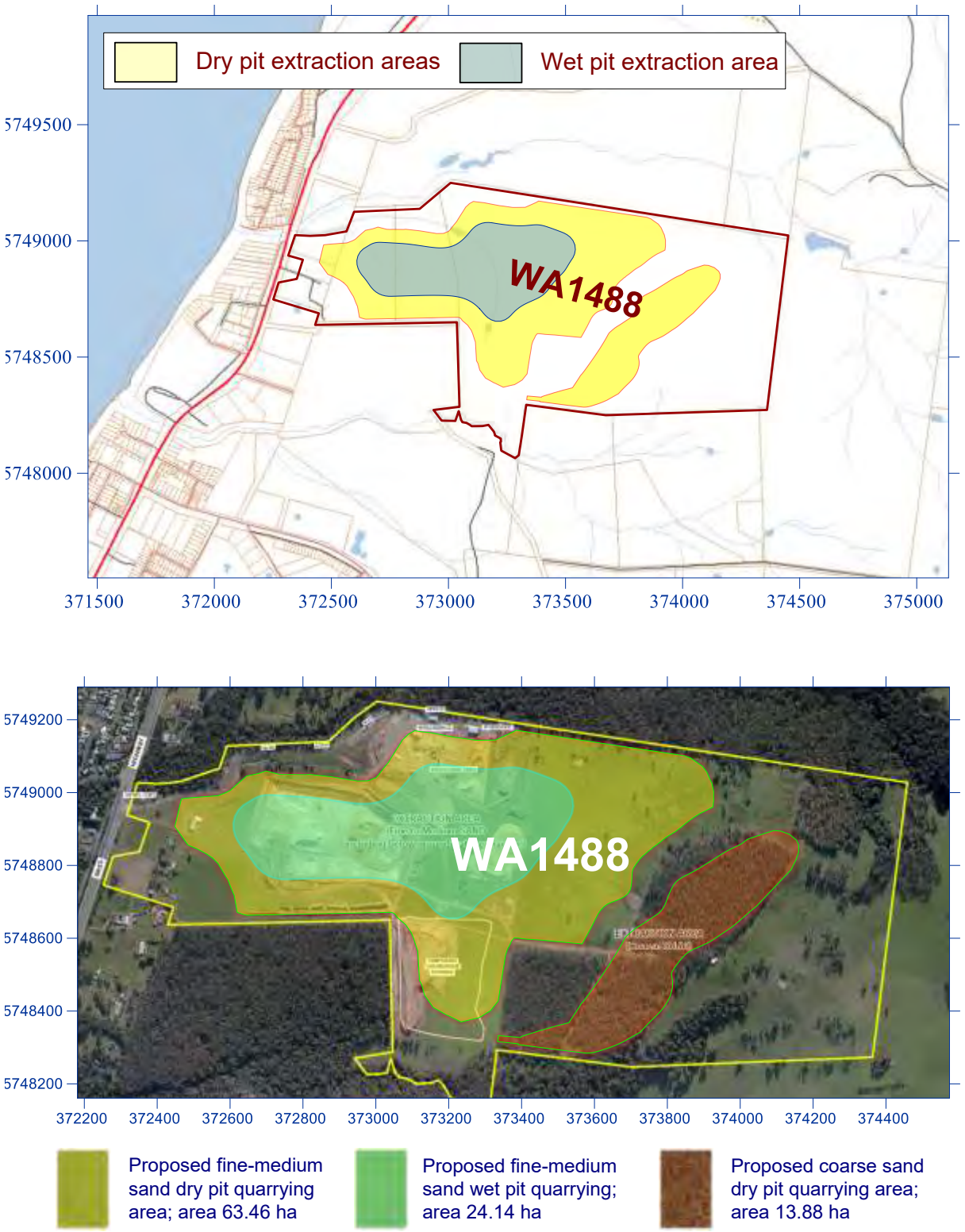


FIGURE 1.2 WA1488 Proposed FMSEP and CSEP Areas



The "Preparation of Work Plans and Work Plan — Variations Guidelines for Mining Projects" prepared by the Department of Jobs, Precincts and Regions (DJPR, V12, 2019) identifies descriptions that must be included in WA variation documents including (but not limited to) 1) the nature of any new auxiliary works, e.g., dewatering bores, and water treatment plant that could adversely impact local groundwater systems, 2) the location of sensitive hydraulically connected receptors such as water supply bores and Groundwater Dependent Ecosystems within two kilometres of the licence boundary relevant to the new or changing works, and 3) an assessment of the risk of harm arising from the proposed changed operations to local groundwater users and hydraulically connected sensitive environmental segments such as wetlands or Groundwater Dependent Ecosystems (GDEs).

A previous Hydrogeological Assessment (HA) was prepared by JLCS in 2013. However, substantial more hydrogeological information has been obtained during the five-plus years of quarrying at WA1488, including information from additional (sand) resource investigation drilling, installation of nine groundwater monitoring bores, target drilling to investigate geology and geological structures at the site, and more recent geological information from other quarries in the Grantville and surrounding area.

1.2 KEY CONCEPTUAL HYDROGEOLOGICAL MODEL COMPONENT

A robust, technically defensible conceptual hydrogeological model (CHM) is fundamental to all hydrogeological assessments. CHMs describe the geological setting and hydrogeological regime including the aquifer rock type and degree of groundwater confinement, movement of groundwater and contaminants, and the interactions between groundwater and the surface, and identifies potential receptors (groundwater users or environmental segments where groundwater discharges or can be accessed). CHMs provide a foundation for understanding potential uncertainties of the physical characteristics of groundwater systems which can be useful for identifying data gaps necessary to further refine the understanding of the hydrogeology. CHMs should be developed and periodically updated as part of an iterative process as data gaps are addressed and new information becomes available.

Key considerations in developing a CHM include climate, topography, surface and subsurface geology, aquifer type and form, aquifer spatial distribution, and aquifer hydraulic parameters.

Climate, especially rainfall and evaporation, control the amount of water available to recharge aquifer systems. The amount of recharge together with other stresses on groundwater systems and aquifer hydraulic parameters in turn control the depth to groundwater.

Topography is not only one of the main controls on surface water runoff but also has a significant influence on water table position; the water table configuration is a subdued reflection of the surface topography. The influence of topography is more pronounced in hilly and mountainous terrain with high relief. Direct groundwater discharge occurs where the water table intersect the ground surface or indirectly via evapotranspiration where the water table is close to the ground surface.

The geological history of an area controls the number and type of aquifers, their lateral and vertical extent, and configuration (depth, outcrop pattern), hydraulic properties and degree of



interconnection. Surface/outcrop geology controls the recharge/discharge regime of aquifer systems whilst subsurface geology controls the distribution and flow of groundwater. Subsurface geology also controls possible development of perched water tables above the main regional water table.

1.3 INFORMATION SOURCES

Information used in preparing the WA1488 Hydrogeological Assessment was obtained from a number of sources including site-specific investigations. Key information sources included:

- Sand resource exploration bore logs and grain size analyses results provided by BCA Consulting (BCA).
- Pit design drawings prepared by BCA.
- Water Management Information System online database
- GEDIS geological data base.
- GeoScience Victoria geological maps (hardcopy and digital).
- Site rainfall measurements for 1985 to present collected by the former property owner (R Blackmore).
- Detailed pre-development land surface and July 2019 site contours provided by Landair.
- Regional 1.0 m Lidar topographic data obtained and provided by Dandy Premix.
- Grantville Quarry (WA1488) Geotechnical Assessment. Report for Dandy Premix Quarries Pty Ltd by GHD, October 2019.
- Grantville Sand Quarry Expansion – Surface Water Report. Report for Dandy Premix Quarries Pty Ltd by Water Technology (2019).
- Condition of Deep Creek by Pat Condina & Associates (Condina, 2012).
- Groundwater Management Plan. Koo Wee Rup Water Supply Protection Area. Southern Rural Water (SRW, 2010).
- Assessment of Pit Face Stability near Melbourne Water Creek MW 3840, 1381 - 1395 Bass Highway Grantville VIC 3984, Report prepared by ATC Williams, May 2016.
- Hydrogeological Assessment Sand Extraction Proposal, S 1381-1395 Bass Highway, Grantville. Report prepared by John Leonard Consulting Services, May 2012.
- BH8 lithologic log, core photographs and summary geological profile prepared by R Anderson.
- WA1488 Simplified Plant Water Balance Process Flow Diagrams prepared by S Young, 2019.
- Discussion with project team members (G Granny, Dandy Premix; B Natoli, A Marshall and C Thornton, BCA; B Tate, Water Technology; S Narendranathan, GHD; P Condina, Pat Condina & Associates; N Craigie, Neil M. Craigie; and S Young, S Young Pty Ltd).



JLCS compiled a project dataset from the various data sources. A number of regional, local and site two- and three-dimensional maps were prepared as background to developing a conceptual hydrogeological model of the proposed sand extraction areas within the approved WA1488 site boundary and surrounding area. Digital elevation models (DEMs) were prepared for 1) pre-quarry topography, 2) July 2019 topography of existing FMSEP, and 3) proposed quarries; enlarged western dry FMSEP and the proposed dredge pond, and eastern dry CSEP (Figures 1.3A, 1.3B and 1.3C, respectively).

The various maps produced for this report were georegistered to the UTM MGA94 Zone 55 coordinate system, and elevations referenced to the Australian Height Datum (AHD).

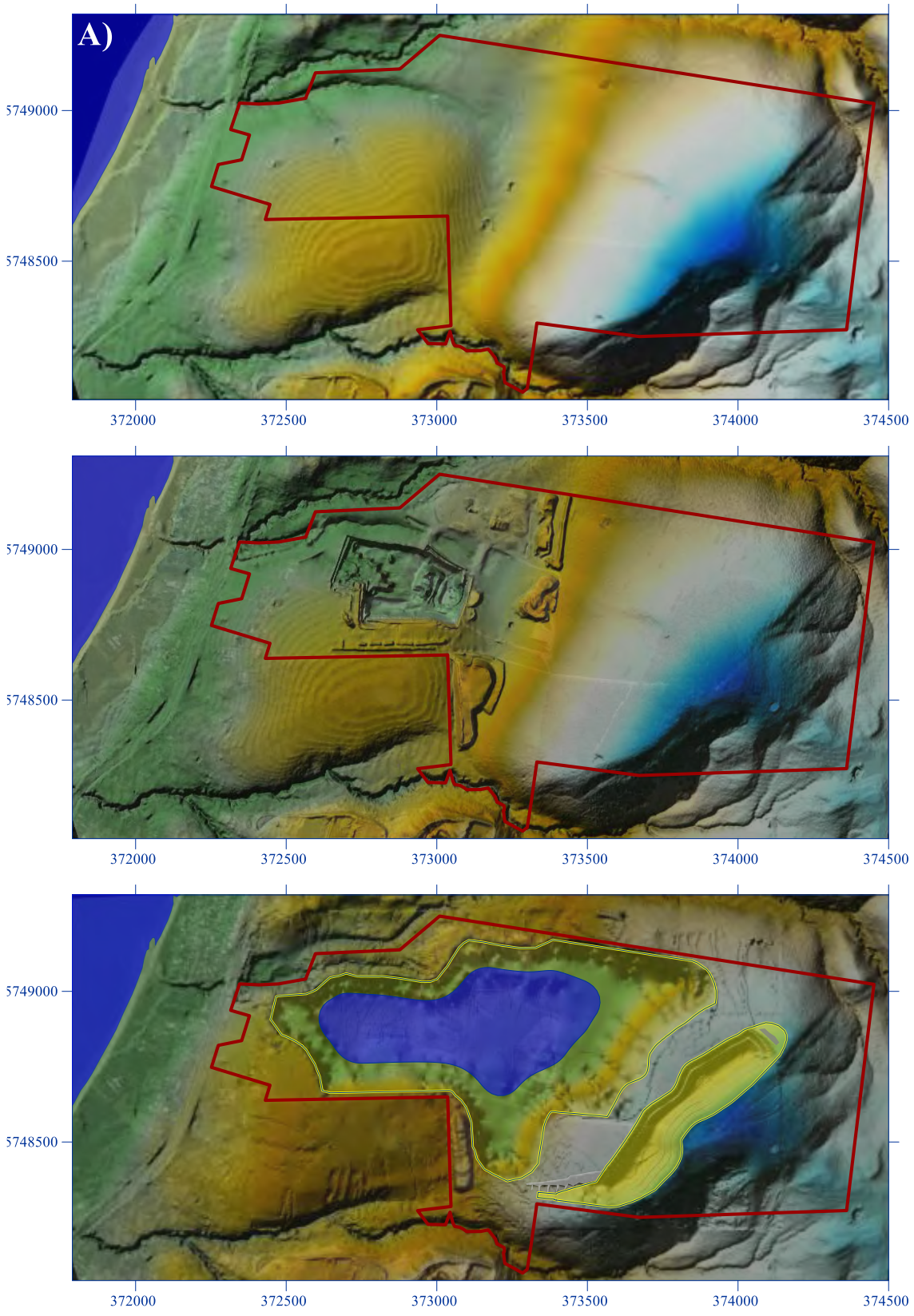


FIGURE 1.3 WA1488 Terrain Relief Models, A) Pre-Quarrying, B) July 2019, and WPV Proposed Final Sand Extraction Areas



2.0 GROUNDWATER MANAGEMENT AND PROTECTION

Sand extraction sites can alter the water table (depth and configuration) by 1) altering groundwater recharge characteristics, e.g., by removing low permeability overburden to access underlying "sands", 2) direct pumping of groundwater from a bore or pit sump, and/or 3) passively via evaporation loss from exposed water table. Additional some activities at quarry sites can result in groundwater contamination, e.g., leaking fuel storage tanks.

The main Victorian legislation and policies related to consumptive use of groundwater including dewatering and groundwater extraction impacts (Groundwater Resource Management) and potential contamination (Groundwater Quality Protection) are briefly discussed in the following Sections.

2.1 GROUNDWATER RESOURCE MANAGEMENT

Groundwater resources ("quantity") management is achieved under the provisions of the Water Act 1989, as amended. Southern Rural Water (SRW) has delegated responsibility for managing groundwater resources across southern Victoria.

The provisions of the Water Act 1989 require that potential groundwater users obtain 1) a license to construct a bore, and 2) a separate licence to take and use groundwater for commercial uses. [Extracting groundwater for stock watering and/or domestic use is a statutory right under the Water Act and does not require an extraction licence.] Licensing authorities are also required to ensure that allocation of a new groundwater licence does not undermine environmental water reserves or surface water allocations. In considering applications for a groundwater extraction licences the Rural Water Authorities including SRW have to take a number of matters into consideration including, 1) the existing and projected availability of water in the area, 2) any adverse effect that the allocation or use of water under the entitlement is likely to have on existing authorised uses of water, a waterway or an aquifer, 3) the need to protect the environment, including the riverine and riparian environment, and 4) government policies concerning the preferred allocation or use of water resources.

Areas of the State that have a high level of groundwater development or potential for development are designated as Groundwater Management Areas (GMAs). The Victorian legislation provides for the setting of an upper limit on the amount of groundwater that can be allocated or taken from a GMA. The limiting volume was initially referred to as Permissible Annual Volume but is now designated as Permissible Consumptive Volume (PCV). Where groundwater in a GMA is identified as being under threat of over use (usually where the volume of groundwater allocated within a GMA exceeds 70 percent of the PCV), the area is declared a Water (or in some cases a Groundwater) Supply Protection Area (WSPA) and extractions are managed in accordance with an approved management plan. Areas of the state not covered by a GMA or WSPA are known as "unincorporated areas".

No new licences can be issued in areas where groundwater is fully allocated. New licences can only be obtained by temporary or permanent trading of existing licences. Trades have to be approved by the water corporation. A traded licence may have its licence conditions altered

based on the properties of the local groundwater resource (DSE, 2009). Water trading in Victoria is governed by rules set by the Minister for Water.

Rural Water Authorities area required to consider the matters outlined in Section 40 & 53 of the Water Act 1989 when assessing groundwater licence applications including applications for trading licences (and by extensions activities that could impact on resource availability) and applications for licence trading whether the application is from an incorporated or unincorporated area including:

- the existing and projected availability of water in the area;
- any adverse effect that the allocation or use of water under the entitlement is likely to have on existing authorised uses of water; or a waterway or aquifer;
- the conservation policy of the government;
- the proper management of the aquifer;
- the purposes for which the water is to be used;
- the needs of other potential applicants.

2.1.1 Koo Wee Rup WSPA

The Koo Wee Rup Water Supply Protection Area (Koo Wee Rup WSPA) covers most of the Western Port (geological) Basin (Figure 2.1) The area covered by the WSPA was declared a groundwater conservation area, the "Koo Wee Rup Groundwater Conservation Area", in 1971 under the former Groundwater Act 1969 and subsequently declared a WSPA under the Water Act 1989. The WSPA area details were gazetted on 14 July 2011 (Table 2.1).

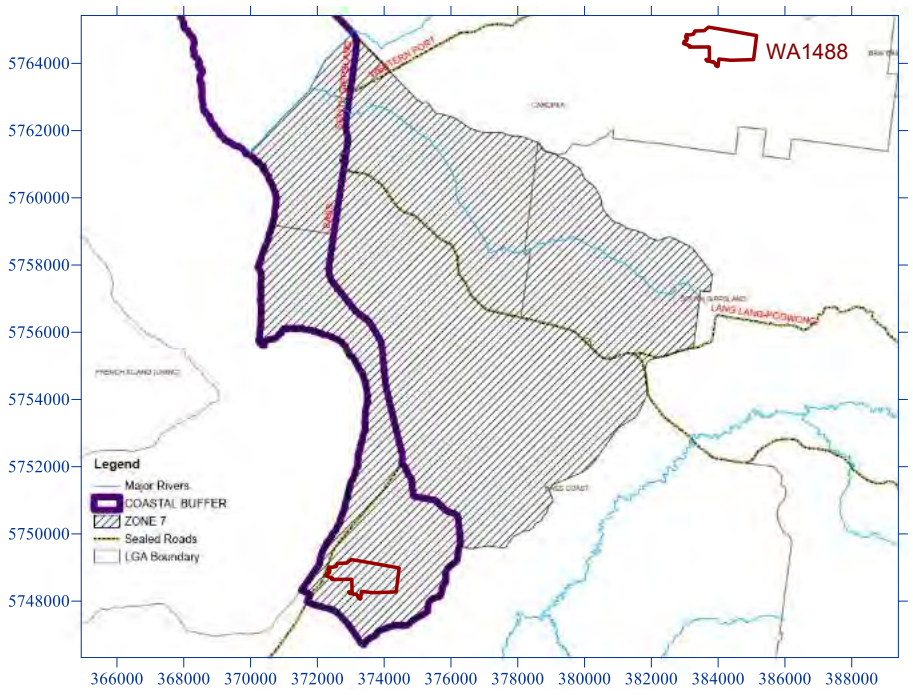


FIGURE 2.1 Koo Wee Rup WSPA Boundary and Zones

TABLE 2.1 Koo Wee Rup Water Supply Protection Area Gazette Details

Column A	Column B	Column C	Column D
Groundwater area name	**Plan number**	**Stratum, formation or zone**	**PCV**
Koo Wee Rup Water Supply	LEGL./04-230	All formations below the surface	12,915

Source: Victorian Government Gazette No. G 28 Thursday 14 July 2011. p 1642

The Koo Wee Rup WSPA has been divided into seven zones to facilitate groundwater management. WA1488 is with Zone 7 (Figure 2.2). Zone 7 was added to the WSPA zones following amalgamation of the Koo Wee Rup and Lang Lang areas into the one WSPA (Sinclair Knight Merz, 2000, 2002). This zone was intended to encompass the aquifer areas that are recharged from the Heath Hill area, but which are south of the main extraction areas. The main technical reason for this zone was to ensure that the full aquifer (sic) is included within the WSPA (SKM, 2003). A "Coastal Buffer" was incorporated into the Koo Wee Rup WSPA Groundwater Management Plan following recommendation in a 2003 technical assessment by Sinclair Knight Merz for the purposes of limiting water trading so that the total volume of groundwater extracted within the coastal sub-zone is not increased to further minimise the potential for sea water intrusion (SKM, 2003).

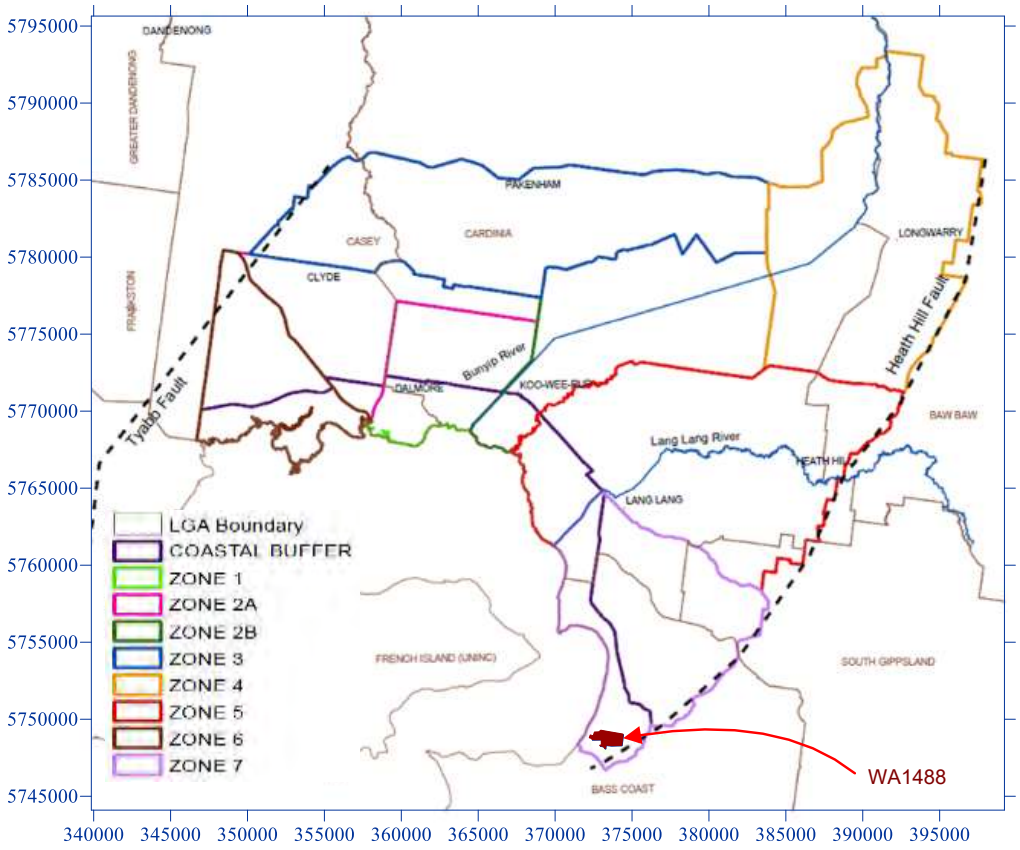


FIGURE 2.2 Koo Wee Rup WSPA Zones



The PCV for the Koo Wee Rup WSPA is currently (2018) 12,575 ML (Table 2.2; Figure 2.3). The PCV embraces "all formations from the ground surface". Although groundwater within the Koo Wee Rup WSPA is fully allocated the actual usage during 2017/18 was only 28% of the total licensed volume (Table 2.2). The percentage used during 2018 in Zone 7 was not reported however it was about 38% during 2009/10 (Table 2.3).

TABLE 2.2 Summary 2014-2018 Groundwater Use Details

At 30 June	2014	2015	2016	2017	2018
No. of licences	370	364	352	344	346
Total entitlement volume (ML)	12,611.8	12,597.5	12,579.6	12,577.2	12,575.0
No. of metered licences	204	197	193	173	162
Total entitlement volume metered (ML)	10,208.8	10,076.2	10,314.3	9,561.1	9,412.7
Metered volume used (ML)	3,277.2	3,698.8	4,347.8	3,503.3	3,451.1
Use % of allocation	26%	29%	35%	28%	28%
No. of licences with use greater than entitlement	3	6	2	1	2
Permissible Consumptive Volume (PCV)	12,915	12,915	12,915	12,915	12,915
Use as a % of PCV	25%	29%	34%	27%	27%
No. of D&S bores[1]	1,164	1,126	1,125	1,061	996
D & S bores estimated use[1]	1,746	1,689	1,688	2,402	1,494
Estimated D & S use from licensed bores[2]	555	534	528	516	519

Source: Koo Wee Rup Groundwater Management Plan Annual Report 2017-2018 (SRW, 2018)

TABLE 2.3 Koo Wee Rup WSPA Zone Groundwater Usage 2009/10

KWR WSPA Zone	Total Use for 09/10 (ML)	Total Licensed Volume (ML)	Percentage of Total Licensed Volume Used for 09/10
Zone 7	961.1	2545.5	37.8%

Source; Koo Wee Rup Regional Update, SRW October 2010
(http://www.srw.com.au/Files/Seasonal_updates/0041_ssnlup_oct_kwr_region.pdf)

2.1.2 Koo Wee Rup WSPA Groundwater Management Plan

A Groundwater Management Plan for the Koo Wee Rup WSPA was approved by Minister for Water in August 2010. The stated objective of the management plan is to ensure that the water resources of the area are managed in an equitable manner so as to ensure the long-term sustainability of those resources. "Long term sustainability" is the continued availability and

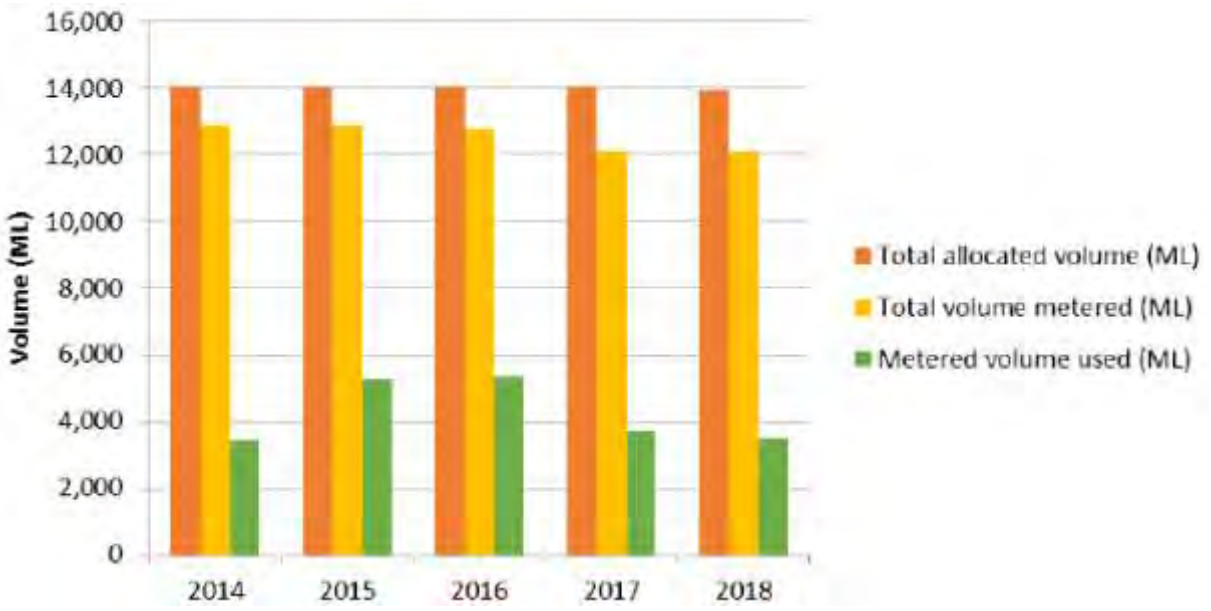


FIGURE 2.3 Koo Wee Rup WSPA Licence Entitlement and Metered Extracted Volumes (SRW, 2010)

security of supply of suitable quality water for all consumptive users (domestic, stock, irrigation, dairy and urban supply), and for the needs of the environment. A key objective of the Koo Wee Rup WSPA Management Plan is to preserve the environmental values and health of water ecosystems, including their biodiversity, ecosystem functioning, quality of water and other uses that depend on environmental condition (as required under the Water Act 1989). This objective will be achieved by: (SRW, 2010):

- Prohibiting the issue of new groundwater licences that would result in the current level of groundwater allocations increasing;
- Protecting groundwater discharges to Westernport Bay by ensuring that groundwater allocations remain stable or decrease in coastal zones;
- Establishing a program that monitors water levels in bores adjacent to surface water bodies to assess the level of interaction (if any); and
- Monitoring the salinity of groundwater across the protection area to identify potential degradation of the groundwater resource by intrusion of saline water from the ocean or saltier parts of the Westernport Basin.

In addition to the rules within the management plan, the Water Act 1989 requires SRW to consider the maintenance of the environmental objective when determining an extraction licence renewal or transfer. However, any changes to groundwater allocation across the WSPA would require amendments to the management plan through a consultative committee process.



2.2 GROUNDWATER QUALITY PROTECTION

Groundwater quality protection is achieved under the provisions of the Environment Protection Act 1970 administered by EPA. The principal policy for groundwater quality protection is the State Environment Protection Policy (SEPP) "Waters of Victoria" gazetted on 19 October 2018 and amended 23 October 2018 (Victoria Government Gazette No S 499 Tuesday 23 October 2018). The Waters SEPP consolidated surface water and groundwater policies with the intent of protecting and managing the quality of Victoria's surface waters, estuarine and marine waters, and groundwaters.

Segments of the groundwater environment and beneficial uses to be protected in each segment as defined in Schedule 2 of the SEPP Waters are in presented in Table 2.1. The SEPP requires that identified beneficial uses are protected and refers to various water quality guidelines for the assessment of water samples depending on the beneficial use category.

The objectives of this Policy are to (Victoria Government. Gazette No S 499, 2018):

(a) achieve the level of environmental quality required to protect the beneficial uses of waters; and

(b) ensure that pollution to waters from both diffuse and point sources is managed in an integrated way to deliver the best outcome for the community as a whole; and

(c) protect and improve environmental quality through consistent, equitable and proportionate regulatory decisions that focus on outcomes and use the best available information.

TABLE 2.4 Groundwater Environment Segments and Beneficial Uses

BENEFICIAL USE	SEGMENT (TDS mg/L)						
	A1 (0-600)	A2 (601-1,200)	B (1,201-3,100)	C (3,101-5,400)	D (5,401-7,100)	E (7,101-10,000)	F (>10,001)
Water dependent ecosystems and species	✓	✓	✓	✓	✓	✓	✓
Potable water supply (desirable)	✓						
Potable water supply (acceptable)		✓					
Potable mineral water supply	✓	✓	✓	✓			
Agriculture and irrigation (irrigation)	✓	✓	✓				
Agriculture and irrigation (stock watering)	✓	✓	✓	✓	✓	✓	
Industrial and commercial	✓	✓	✓	✓	✓		
Water-based recreation (primary contact recreation)	✓	✓	✓	✓	✓	✓	✓
Traditional Owner cultural values	✓	✓	✓	✓	✓	✓	✓
Cultural and spiritual values	✓	✓	✓	✓	✓	✓	✓
Buildings and structures	✓	✓	✓	✓	✓	✓	✓
Geothermal properties	✓	✓	✓	✓	✓	✓	✓

Source: Table 2. Schedule 2 Beneficial Uses SEPP (Waters) (Government Gazette s 499. 23 October 2018).



The SEPP Waters seeks to achieve these objectives by providing:

(a) the beneficial uses and environmental quality objectives for waters; and

(b) obligations to protect beneficial uses and improve water quality; and

(c) the rules for decision-making by protection agencies to protect beneficial uses and improve water quality.

The Authority may determine that a beneficial use specified in Table 2 of Schedule 2 does not apply to groundwater if any of the following apply:

(a) there is insufficient aquifer yield to sustain the beneficial use;
(b) the application of groundwater, such as for irrigation, may be a risk to beneficial uses of land or the broader environment due to the soil properties;

(c) the beneficial use specified in the definition of water dependent ecosystems and species relates to stygofauna and troglofauna;

(d) the background level of an environmental quality indicator would not provide for the protection of the beneficial use.

When making a determination under subclause (2)(a), the EPA:

(a) may take into account possible variations within the aquifer and reasonable bore development techniques to improve yield; and

(b) must be satisfied that:
  (i) the beneficial use for water dependent ecosystems and species is protected; and
  (ii) there will be no risk to beneficial uses; and
  (iii) preferential flow through fractures or naturally formed cavities is not the dominant mode of permeability.

The SEPP Waters of Victoria contains a number of provisions specific to groundwater beneficial uses including:

- Allow discharge waste to an aquifer by means of a bore, underground mine workings, infiltration basin, evaporation basin, excavations, or other similar structures, provided that the EPA or other relevant protection agencies approve that discharge.
- require that where non-aqueous phase liquids (e.g., petrol) are present as an uncontrolled source of groundwater contamination, they must be removed unless the party responsible can satisfy EPA that no unacceptable risk is posed to any beneficial use of groundwater.
- provide for the delineation of zones where groundwater is already polluted, as well as publication of these zones as a form of warning to potential users;
- allow for attenuation zones in strictly limited circumstances as recognition of the potential for some waste disposal authorities to impact on groundwater despite the application of best practice environmental management.

3.0 CLIMATE

The climate in the Grantville area is temperate and variable with moderate rainfall received in most months. The long- and short-term average annual rainfall for the Grantville area from SILO Datasets that were derived by interpolating BoM observational records from nearby climate stations. The resultant dataset is both spatially and temporally complete: (Queensland Government https://silo.longpaddock.qld.gov.au).

The annual rainfall for Grantville from the SILO database from 1900 to 2018, plotted by Water Technology (2019), is presented in Figures 3.1, and long-term average monthly rainfall and evaporation is plotted in Figure 3.2. The 10-year (2009-2018, inclusive) average monthly rainfall is present in Table 3.1 and shown as a histogram plot in Figure 3.3. The average rainfall over this 10-year period was 931.5 mm.

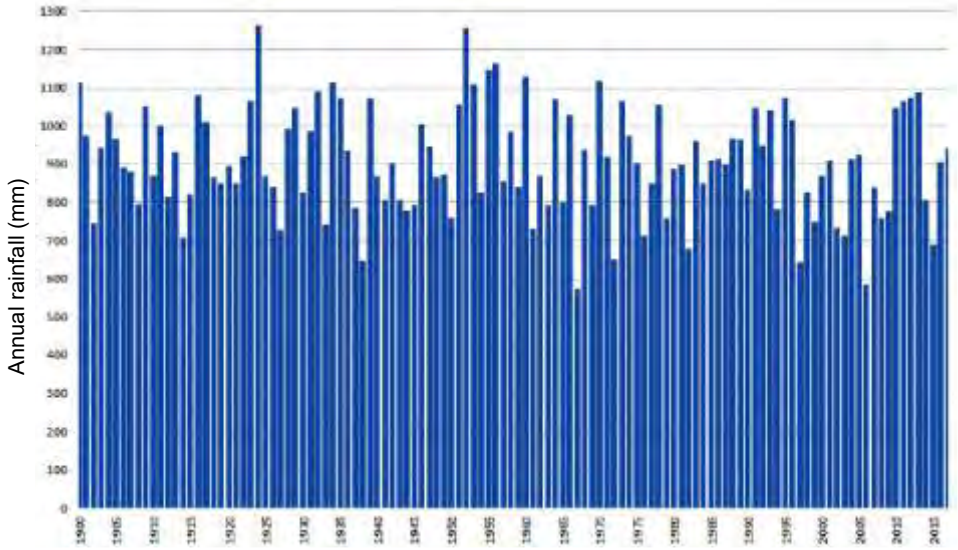


FIGURE 3.1 SILO Database Annual Rainfal1 (After Water Technology, 2019)

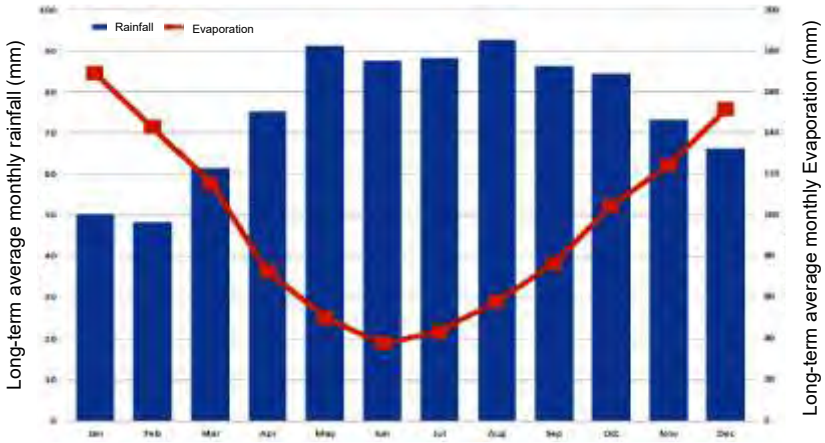


FIGURE 3.2 Long-term Average Monthly Rainfall and Evaporation

TABLE 3.1 Grantville Area Average Monthly Rainfall 2009-2018, Inclusive

Month	Rain	Month	Rain	Month	Rain	Month	Rain
Jan	43.38	Apr	73.70	Jul	92.99	Oct	74.65
Feb	53.06	May	98.01	Aug	99.34	Nov	86.19
Mar	54.93	Jun	91.18	Sep	92.79	Dec	71.27

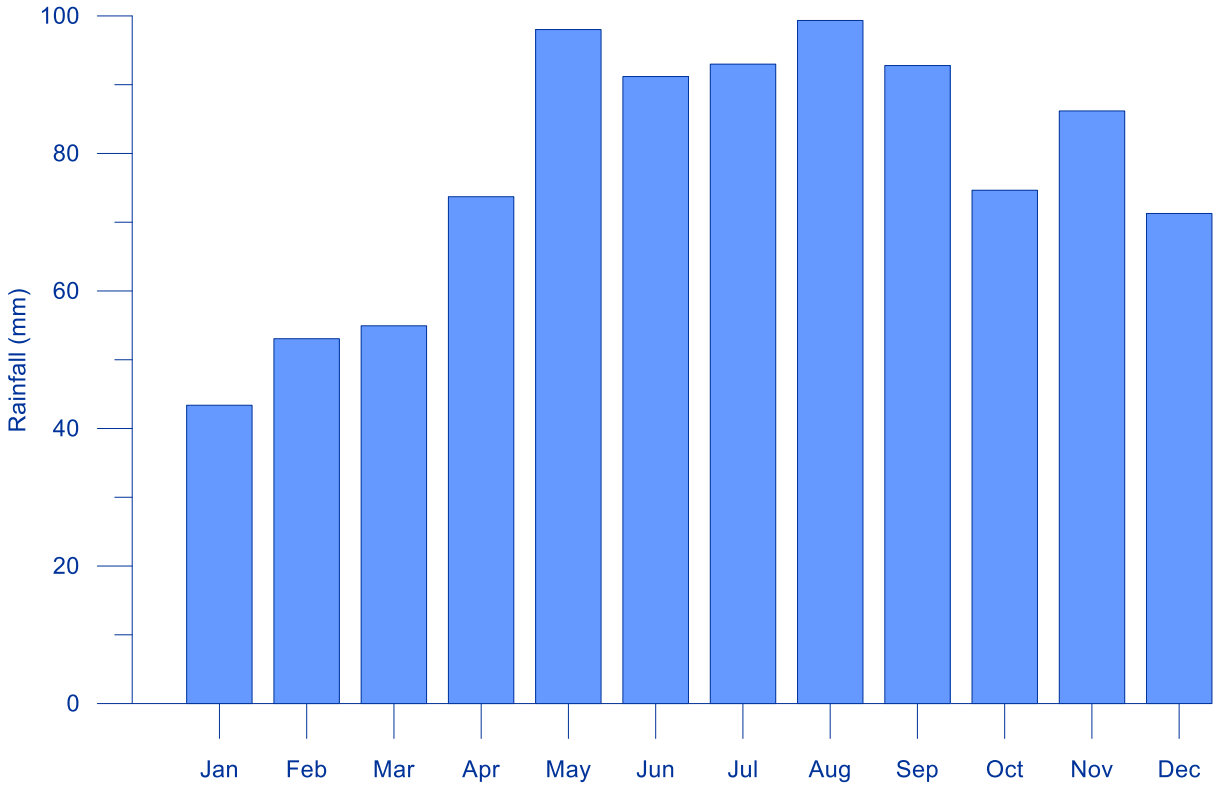


FIGURE 3.1 Average Monthly Rainfall 2009-2018, Inclusive

4.0 GEOMORPHOLOGY, TOPOGRAPHY AND DRAINAGE

4.1 REGIONAL

The Grantville area is located in on a coastal plain between Western Port Bay to the west and the foothills of the Strzelecki Ranges to the east. The inland margin of the coastal plain is marked by a relatively abrupt rise trending approximately northeast-southwest that extends from south of Grantville to west of Drouin and forms the western margin of the elevated block-faulted terrain of the Strzelecki Ranges (Figure 4.1).

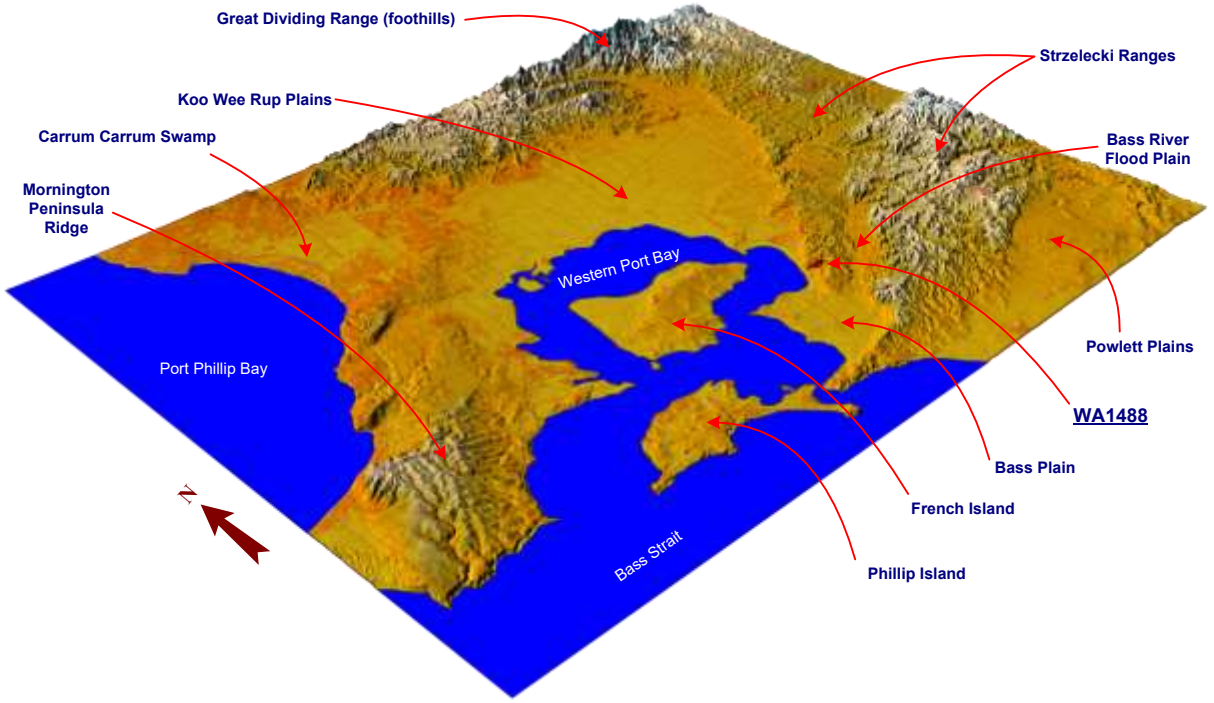


FIGURE 4.1 Regional Digital Elevation Model

The topography is the Grantville area is shown as Digital Elevation Model (DEM; derived from Lidar 1.0 m elevation data) and illustrated as a relief map in Figure 4.2. Local relief varies from near sea level along the coast to about 150 m Australian Height Datum (AHD) along the Strzelecki Ranges.

The coastal plain in the Grantville area is drained by a number of small general east-west aligned "streams" that discharge into Western Port Bay. These streams were dry except for short reaches (very) close) to Western Port Bay when inspected during field reconnaissance in 2012-3, 2017 and 2018 for JLCS project works at WA784 and adjoining Grantville Landfill as well as at WA1488. These observations indicated that flow in the streams draining off the Heath Block to Western Port Bay is only intermittent. Mapping the spatial relationship between stream bed elevations generated from the Lidar survey data and the local water table measured in boreholes at these sites and (zoomed-in) examination of the streams on aerial images displayed on high resolution 43-inch computer monitors supported the conclusion based on the field observations (Figure 4.3).

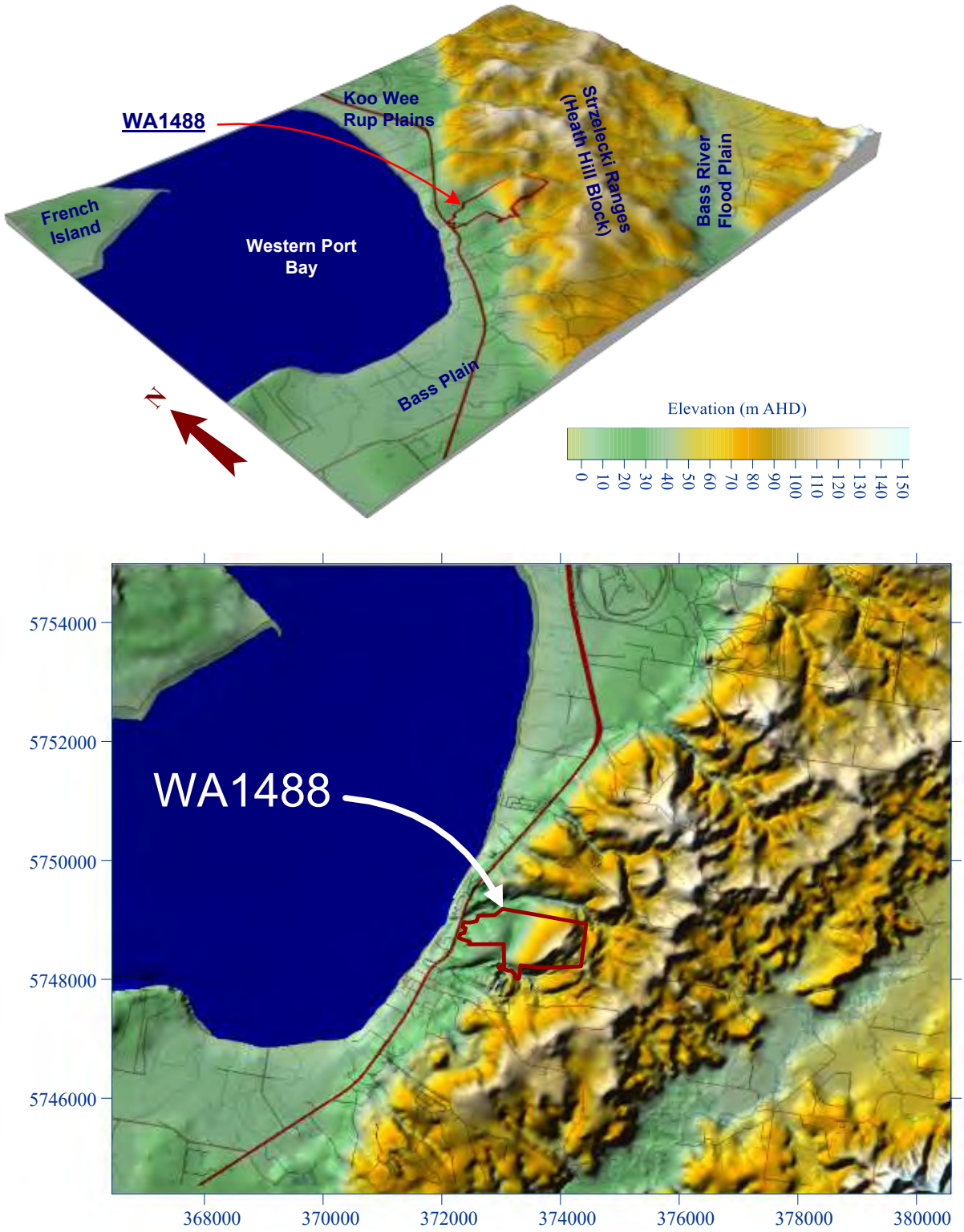


FIGURE 4.2 Grantville Area Digital Elevation Terrain Relief Models



FIGURE 4.3 Stream Flow Conditions Inspection Area Aerial Image

4.2 LOCAL

The pre-quarrying topography across WA1488 and immediately adjoining land, mapped using Lidar 1.0 m elevation data is illustrated by the "filled" contours in Figure 4.4 and the DEM of the quarry site presented in Figure 4.5. The site (pre-quarrying) elevation ranged from less than 10 m AHD along the base of the Deep Creek tributary near the northwestern corner of WA1488 up to more than 120 m AHD on the ridge in the eastern portion of the site.

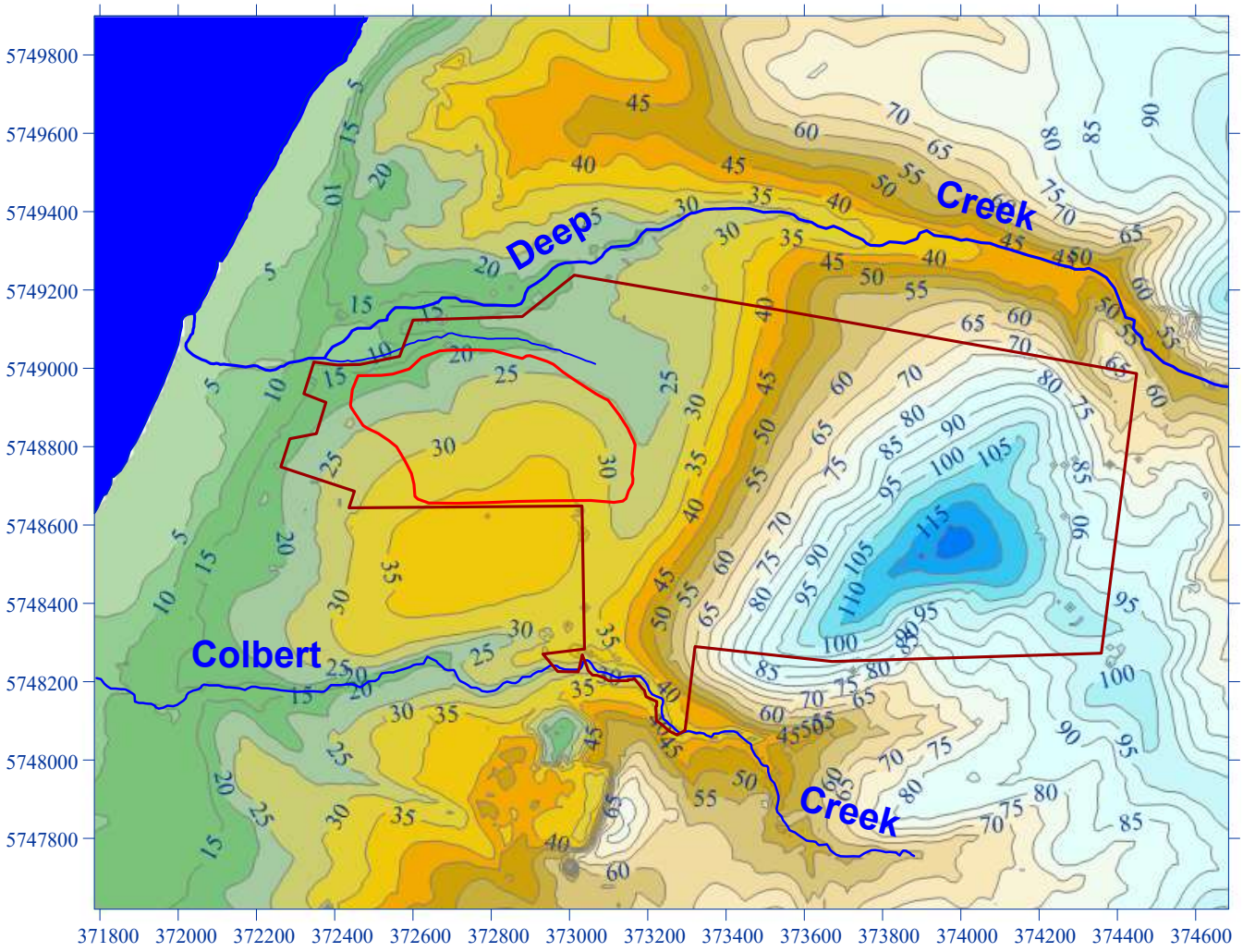


FIGURE 4.4 WA1488 and Surrounds Pre-Quarrying Filled Topographic Contours

The majority of WA1488 site drains to Deep Creek along the northern site boundary with a small area draining to Colbert Creek to the south (Figure 4.5). Both Deep Creek and Colbert Creek are intermittent streams except possibly for short stream tracts close to Western Port Bay. The channel of both these streams are incised and well defined with a number of shallow depressions in the streambed; small disconnected pools form in the depression after rainfall events (Plate 4.1).

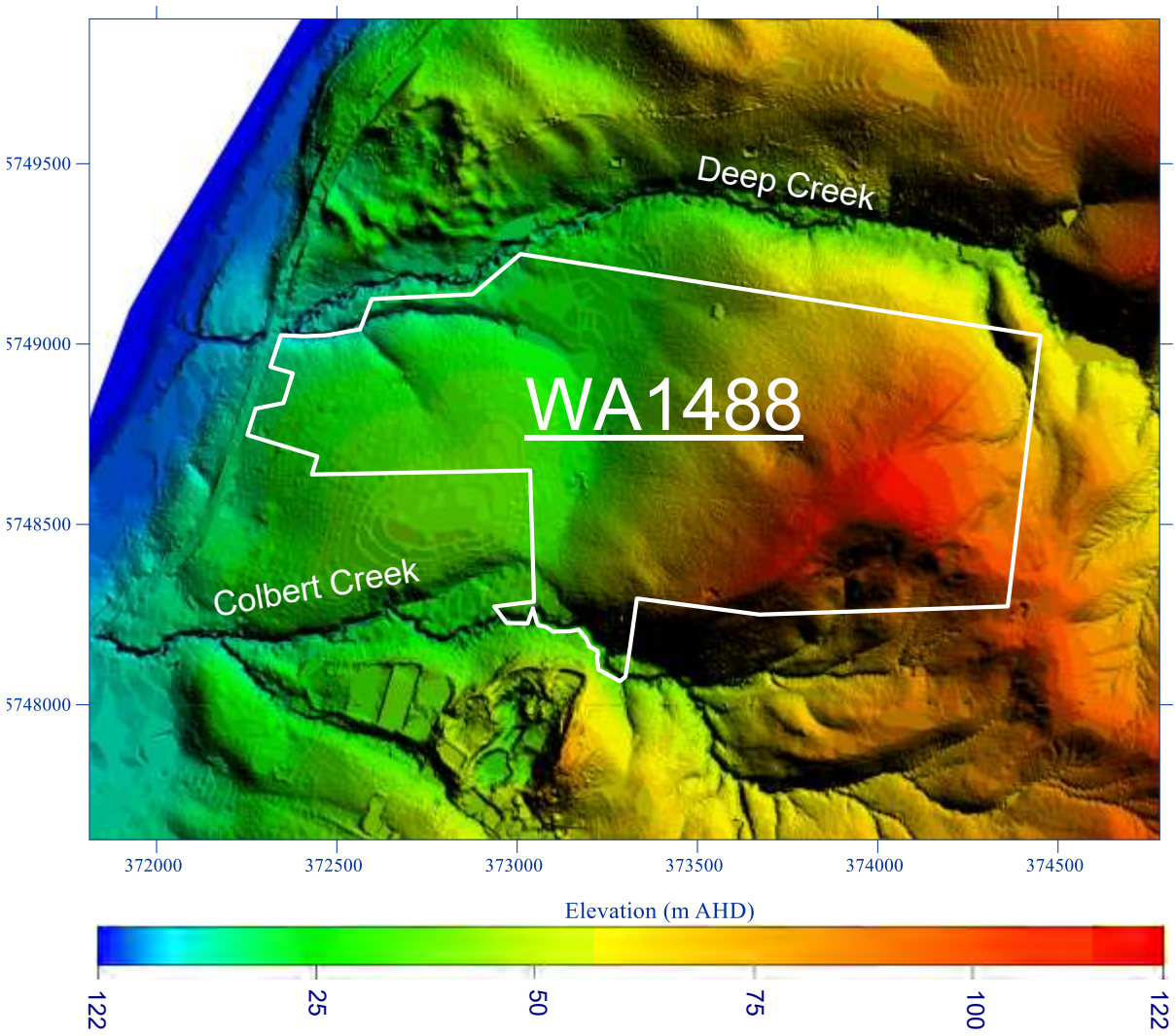


FIGURE 4.5 WA1488 and Surrounds Pre-Quarrying Terrain Relief Model

4.3 WESTERN PORT BAY

Local streams and groundwater ultimately discharge into Western Port Bay, a large, shallow bedrock-controlled semi-enclosed coastal embayment. The bay has an area of 680 km^2 with about 270 km^2 (~40 %) of intertidal mudflats (Figure 4.6). It is characterized by two main arms: north and east, which are separated by French Island in the centre and the tidal divide in the north-east corner of the bay.

The tidal mudflats in the Grantville area extend more than 2 km (up to 3.5 km in places) offshore to near the Eastern Arm Channel (Figure 4.6B). The mudflats are exposed during low tides (Plate 4.2). [The mudflats influence the coastal groundwater discharge hydraulics as discussed in Chapter 7.]





PLATE 4.1 Deep Creek Streambed: A) 60 m Upstream from Bass Highway (Photograph by P Condina), and B) Upstream of Confluence with Tributary Channel

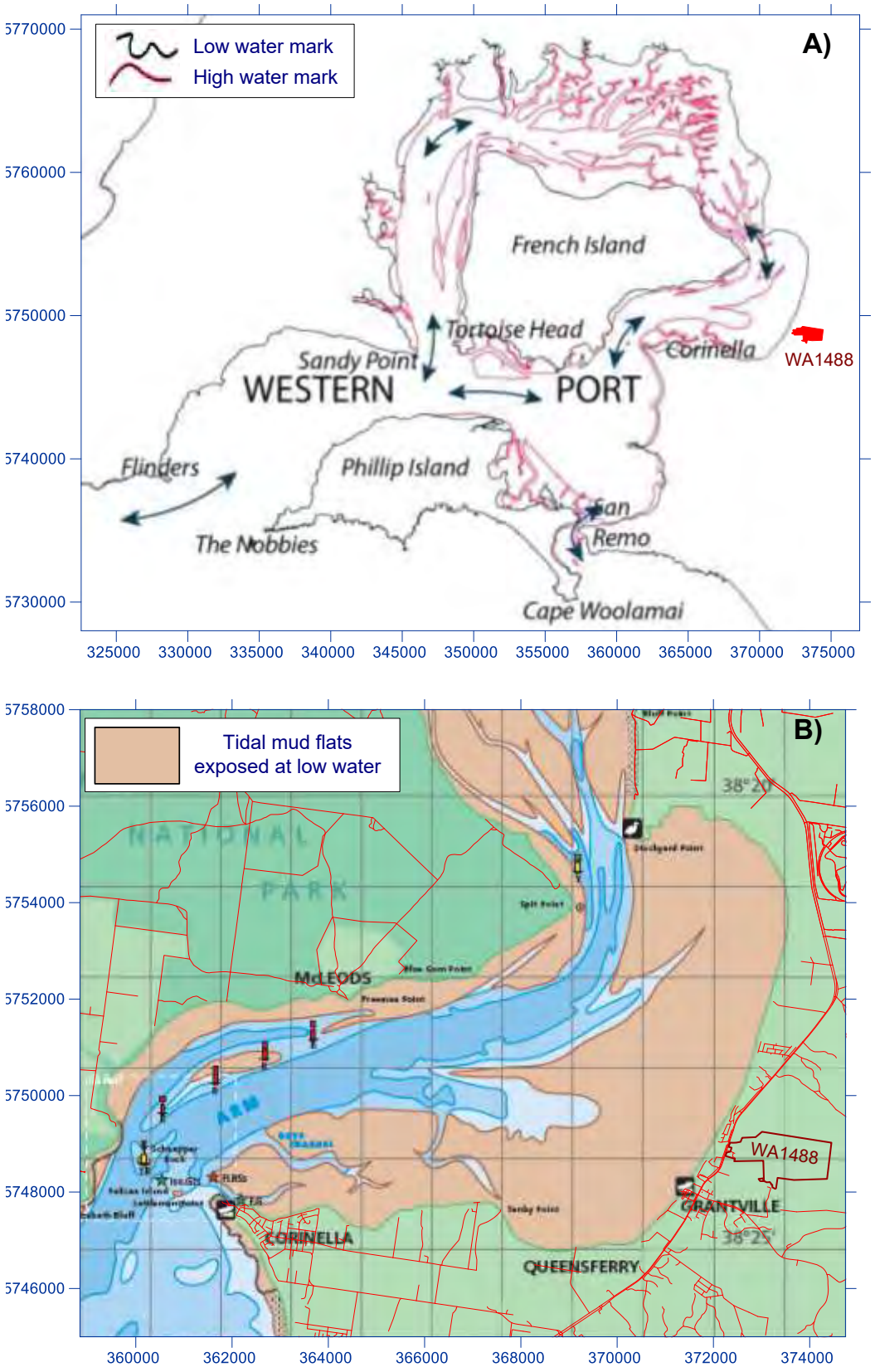


FIGURE 4.6 Western Port Bay A) Tidal Flow Directions and B) Grantville Mudflat Area



PLATE 4.2 Mud Flats Offshore from Deep Creek Mouth (Photo courtesy P Condina)

Most water enters and leaves Western Port Bay through the Western Entrance. The net movement of water in the bay is clockwise around French Island. The movement of water is dominated by semi-diurnal tides. The bay has a tidal range of between 2.3 and 3.1 metres (PP&WP CMA, 2018). However, there are large differences in tide heights on a sub-daily and daily timescale, as well as a strong spring-neap difference (Sternberg and Marsden, 1979).

Although generally well flushed by tides through the western entrance, wind forcing drives a prevailing clockwise circulation. The flow entrains catchment inflows and resuspended bay sediments, resulting in poorer water quality (and higher residence times) in the east.

General bay water salinity contours based on data from a detailed survey of 72 sites around the bay during wet conditions are shown in Figure 4.7. (Longmore, 1997). The salinity contours are general only as there are short term variation in salinity over tidal cycles, most likely from an interplay between the mudflats and incoming ocean waters (PP&WP CMA, 2018) and groundwater input.

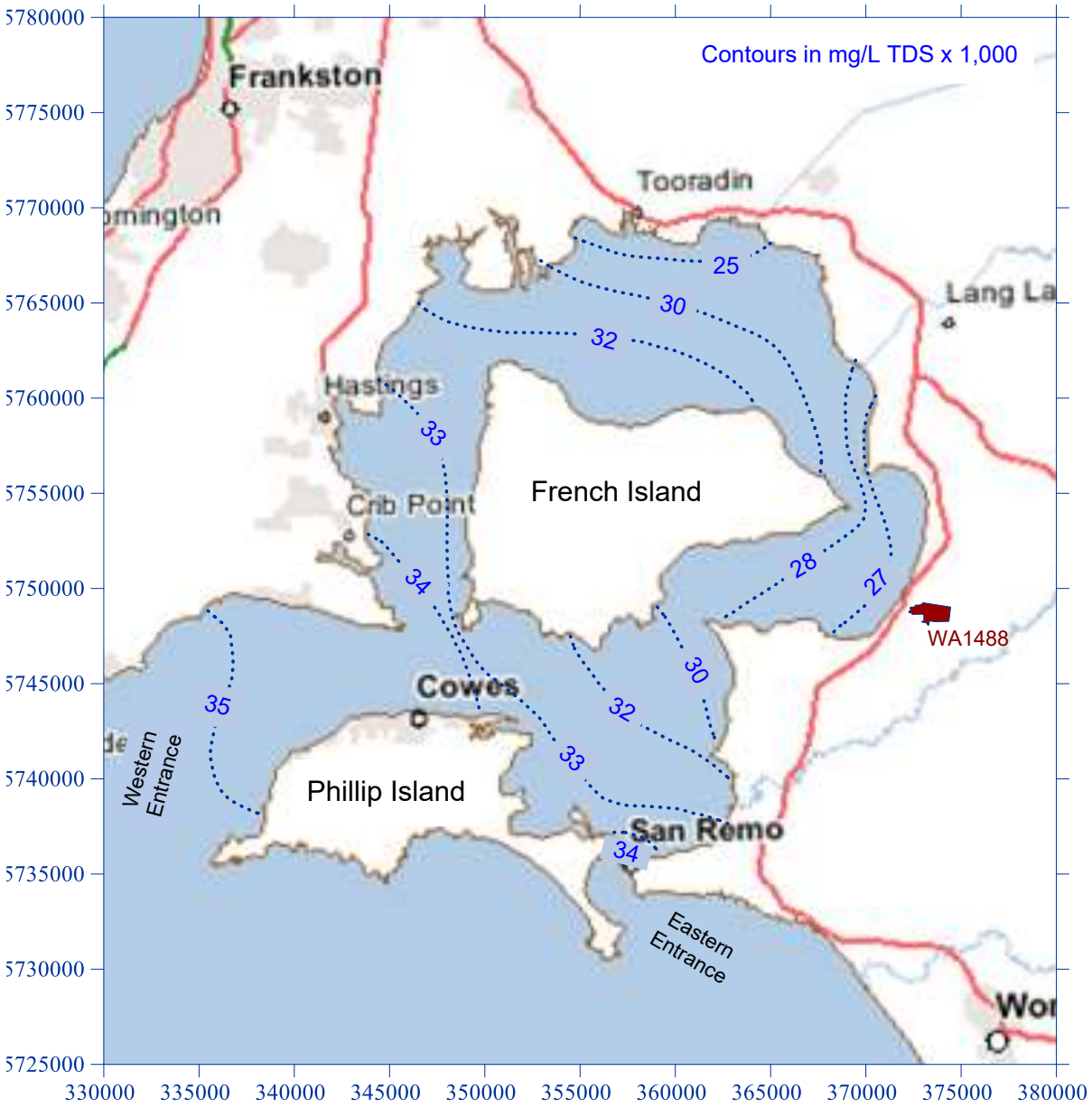


FIGURE 4.7 Western Port Bay General Water Salinity (contours from Longmore, 1997)

5.0 GEOLOGY

5.1 TECTONIC SETTING

WA1488 is located towards the western extent of the extensive (46,000 km^2) Gippsland Basin, an east-to-west to northwest-to-southeast trending rift basin that lies along Australia's southern margin. The Gippsland Basin unconformably overlies the Palaeozoic basement and extends more than 400 km west to east from the Mornington Peninsula (western boundary ill-defined) to Cape Howe. The basin was initiated during the Late-Jurassic in response to rifting of Australia and Antarctica. Rift and sag phases continued into the Early Cretaceous. Cretaceous to Recent phases of compression have resulted in inversion and wrenching of pre-existing rift structures (Holford et al, 2010). Miocene-Quaternary compression has also resulted in onshore deformation in the Gippsland Basin (King, et al., 2012). Post-rift sedimentary initiated during the early Oligocene infilled created the large Tertiary Gippsland Basin and smaller Western Port, Moe Swamp and Tarwin basins (Figures 5.1 and 5.2).

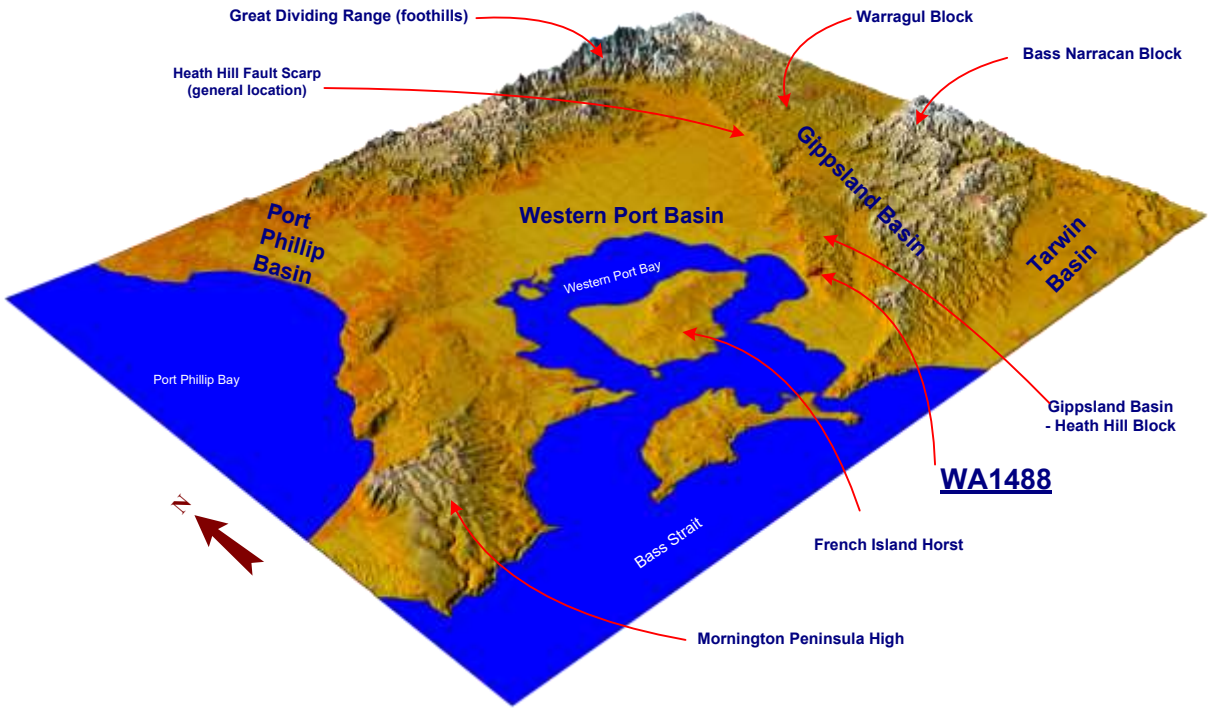


FIGURE 5.1 Tectonic Setting

The majority of WA1488 (western portion; ~124 ha) lies within a down-thrown Tertiary geological basin referred to as the Western Port Basin, a small (900 km^2) relatively shallow basin infilled by Cainozoic sedimentary and volcanic rocks developed at the western end of the older Gippsland Basin. The eastern small portion (~31.6 ha) of WA1488 is situated on a upthrown block of Cretaceous rocks (Strzelecki Group) that form the Strzelecki Ranges thought to have been uplifted since the late Miocene (Dickinson et al, 2001).

5.2 STRUCTURAL GEOLOGY

Numerous faults have been mapped within both the Tertiary Western Port and the Cretaceous Gippsland basins. Movement along faults formed the upthrown Strzelecki Ranges and the down-thrown Western Port Sunklands (Lowlands). Major faults in (greater) Grantville area are shown in Figure 5.2. Faulting was initially by northwest to southeast extension during the Miocene resulting in faults striking northeast to southwest which produced a series of horsts (upthrown blocks) and grabens (down thrown blocks) striking northeast to southwest (Figure 5.1). The area is still undergoing compression and uplift (Holdgate et al., 1998; Hillis, 2000; Tuitt et al., 2001; Brown et al., 2013).

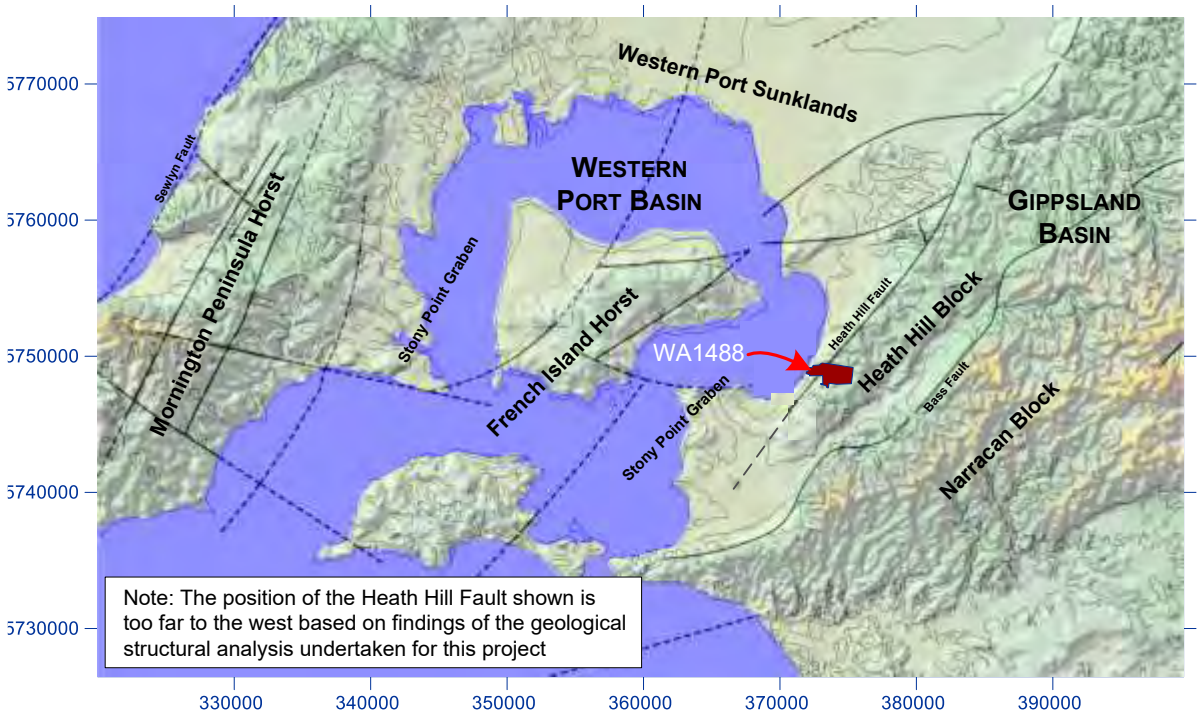


FIGURE 5.2 Grantville Area Major Faults

The eastern (small) portion of WA1488 is situated in the westernmost upthrown block of the Strzelecki Ranges referred to as the Heath Hill Block (Figure 5.2). The Heath Hill Block is bounded to the west by the Heath Hill Fault and to the east by the Bass Fault. These faults as with most of the major faults across the Gippsland Basin were initiated during the Late-Jurassic in response to rifting of Australia and Antarctica. Rift and sag phases continued into the Early Cretaceous. Cretaceous to Recent phases of compression have resulted in inversion and wrenching of the pre-existing rift structures (Holford et al, 2010).

The principal control of relief and geological outcrop pattern in the Grantville area is the Heath Hill Fault, a major regional fault of late Pliocene or early Pleistocene age (probably a reactivated older fault). The Heath Hill Fault has juxtapositioned Tertiary rocks of the Western Port Basin against the Cretaceous Strzelecki Group rocks of the Gippsland Basin. In the Heath Hill area, uplift of up to 150 metres to the east is indicated by the relative elevations



of Older Volcanics (Mornington Volcanic Group) on both sides of the fault. North of the Lang Lang River at Heath Hill the scarp is prominent, rising almost 100 metres above the flood plain. The fault location in the Grantville are is less obvious as the topographic relief is smaller.

The Heath Hill Fault is aligned northeast to southwest and extends from the foothills of the Great Dividing Range near Drouin to southeast of Grantville and possibly further southwest towards the Anderson area. The position of the trace of the Heath Hill Fault has been shown differently on at least three published maps, namely 1) Jenkin (1962); 2) Mines Department (1971) undated by NNRE (1997); and Thompson (1974). [The Heath Hill Fault is not shown in the DPI published map (Map 51 Western Port-Warragul; Welsh et al., 2011)]. The general position of the Heath Hill Fault has been remapped by BCA (A Marshall, pers com, 2019) based on more recent geological exposures at a number of sand quarries and more detailed topographic models (digital elevation and terrain relief models). The location of the fault at WA1488 has been further constrained by targeted drilling to intersect the fault (discussed in Section 5.5).

5.3 STRATIGRAPHY

The Strzelecki Group (Medwell, 1954) is the predominant outcropping stratigraphic unit east of the Heath Hill Fault. The group is covered in places by relatively minor occurrences of Brighton Group, Mornington Volcanic Group and/or alluvial deposits.

The stratigraphic sequence in the Western Port Basin ranges from less than 50 m to over 300 m in the Koo Wee Rup Dalmore area. The main stratigraphic units within the basin from oldest to youngest are:

- Strzelecki Group (siltstone, mudstone, sandstone, minor black coal and volcanics).
- Childers Formation (sand, clay, gravel, conglomerate, thin brown coal seams).
- Mornington Volcanic Group (Older Volcanics: basalt, basaltic clay).
- Yallock Formation (sand, gravel).
- Brighton Group formerly referred to as “Baxter Formation” (silt, sand, clay)
- Unnamed Quaternary deposits (clay, peat, silt, sand minor gravel).

The Brighton Group beneath WA1488 was not fully penetrated during sand resource investigative drilling undertaken by BCA between 2011, 2017 and 2018. However, based on review of bore logs in the (greater) Grantville area, the stratigraphic sequence beneath WA1488 is considered to consist of (from oldest to youngest): 1) Strzelecki Group, 2) possibly Childers Formation (thin brown coal was reported in a number of bores in the Grantville area), and Brighton Group.

5.3.1 Strzelecki Group

The Upper Strzelecki Group rocks are relatively uniform, consisting of a generally upwards-fining sequence of massive coarse- to fine-grained sandstone that interfinger with a range of minor rock types including siltstone, fine-grained sandstone, palaeosoils, coal seams and lacustrine shale. The sediments were originally deposited in fluvial environments dominated



by internally braided channels flowing through extensive floodplains with marginal alluvial fans. Rapid subsidence led to accumulation of multi-storied channel complexes, with numerous erosion surfaces. The sediments were mainly reworked tuffaceous material from rift-related explosive volcanism roughly contemporaneous with deposition, as well as some detritus from nearby outcropping Paleozoic rocks. The sequence exceeds 3 km in thickness and covers at least 30,000 km^2 (Duddy, 2003).

The Strzelecki Group outcrops extensively in the South Gippsland highlands and along coastal sections between San Remo and Inverloch in South Gippsland. Outcropping Strzelecki Group were mapped in the southeastern corner of WA 1488 to the east of the Heath Hill Fault in the southeastern corner of WA1488 (Welsh et al., 2011).

5.3.2 Older Volcanics

Tertiary aged volcanics rocks referred to as the Mornington Volcanic Group (MVG) are widespread within both the Western Port Basin and the eastern part of the Gippsland Basin. The volcanics consist of variably weathered to fresh basalt, agglomerate and tuff, interbedded with conglomerate, sandstone and carbonaceous claystone (Edwards, 1939). In some cases, the weathering has decomposed the basalts to variably coloured volcanic clays and other pedogenic soil profiles (Holdgate and Gallager, 2003). MVG rocks outcrop across most of Phillip Island, at San Remo, Corinella, and along the southern coast of French Island. These rocks also occur as extensive sheet-flows at depth over a large area extending from Cranbourne to Lang Lang where they are overlain by younger Cainozoic sedimentary rocks. Drillholes logs indicate that the Older Volcanics are mostly absent in the Grantville are except for a few outcrops on the upthrown Strzelecki Ranges inland from the Grantville Township.

Volcanic rocks (tuff and varyingly weathered basalt) were intersected in bore BH08 located near the top of the topographic high in the southeastern corner of WA1488. Volcanics were logged between 28.0 and 61.7 m depth beneath 12.6 m of unconsolidated silt-clayey-sandy sediments overlying 15.4 m of consolidated and indurated sedimentary rocks (siltstone and claystone) by Anderson (2018). Photographs of cores from BH8 provided by Anderson are presented in Figure 5.3.

The stratigraphic sequence intersected in BH8 is considered to be Brighton Group overlying Strzelecki Group above Older Volcanics (Figure 5.4). This interpreted stratigraphy is consistent with a volcanic plug associated with the Heath Hill Fault: Numerous basaltic plugs and dykes intrude the Strzelecki Croup on a generally NW-SE trend elsewhere within the onshore Gippsland Basin. Edwards (1934). Edwards referred these to the Tertiary Older Volcanics, but dating by K-Ar and fission track methods has shown that they were intruded over a broad time interval from about 100 to 75Ma. (Duddy and Green, 1992). [There has been no new mapping of the intrusions onshore since the Geological Survey's quarter-sheet mapping of the late 1800s and early 1900s (Duddy, 2003)]. Volcanic plugs have been mapped in the Strzelecki Group equivalent (Otway Group) rocks within the Otway Basin.

Geophysical electrical conductivity survey data contours together with findings of the targeted drilling investigation program indicate that the volcanics are limited to a relatively small areas immediately east of the Heath Hill Fault

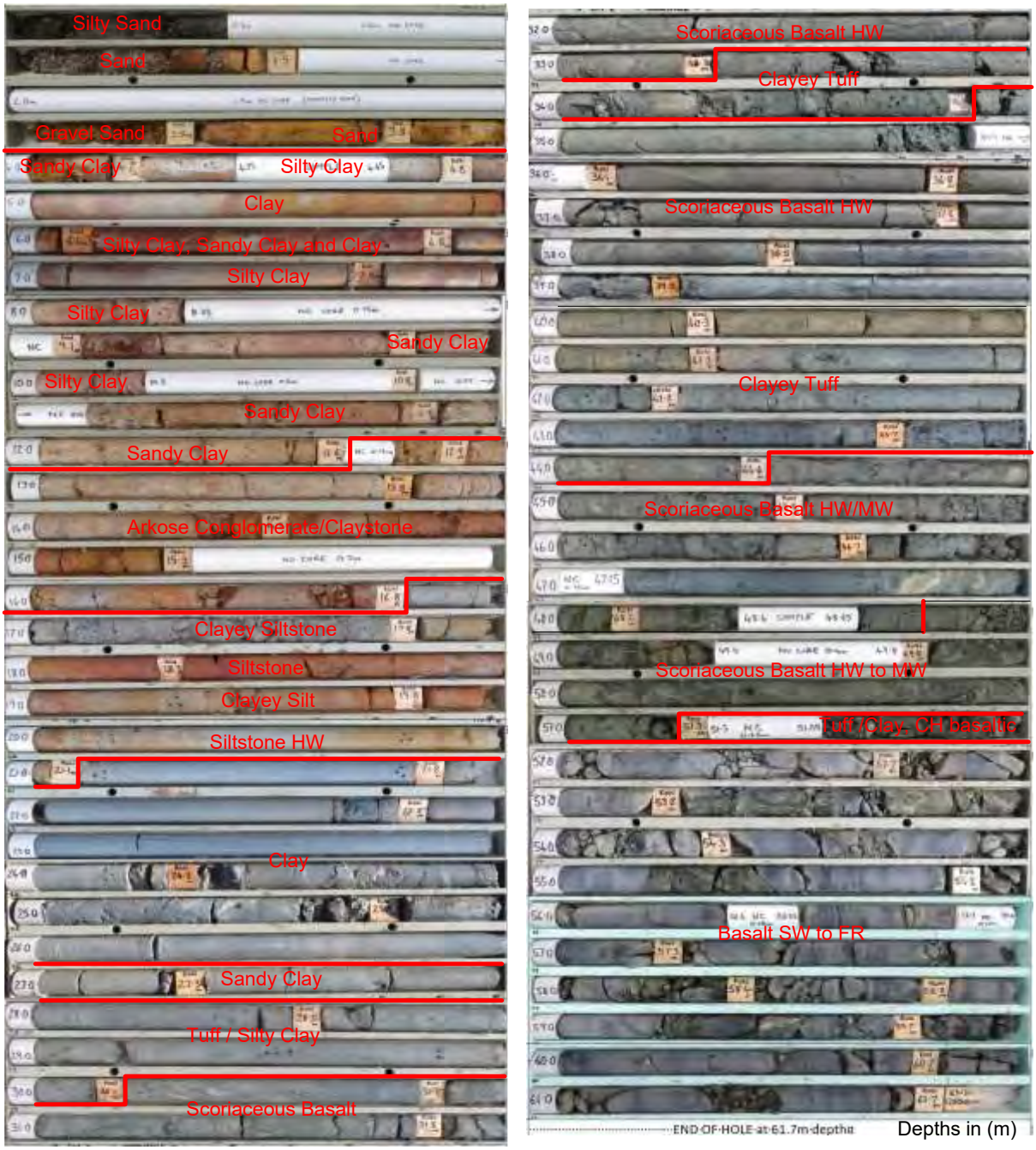


Figure 5.3 BH08 Core Photographs (modified from photographs provided by R Anderson, 2018)

4.3.3 Brighton Group

The outcropping sediments to the west of the Heath Hill Fault scarp (including at WA1488) were mapped by Jenkin (1962, 1974) as Grantville Gravels formed as alluvial fan materials developed from scarp erosion and retreat. Thompson (1974) and Spencer-Jones *et al*. (1975) regarded these as an upper unit of the Baxter Formation and not the result of the process described by Jenkin (1962, 1974). These sediments were mapped as Brighton Group in the

Geological Survey of Victoria (GSV) seamless geology mapping project (Welsh et al., 2011). Re-examination of the Brighton Group type sections in the adjoining Port Phillip Catchment by VandenBerg (2016) indicated that the unit is entirely of paralic origin, with no evidence for fluvial deposition. However, JLCS considers that it is likely that the depositional environment in the Grantville area was at least in part fluvial.

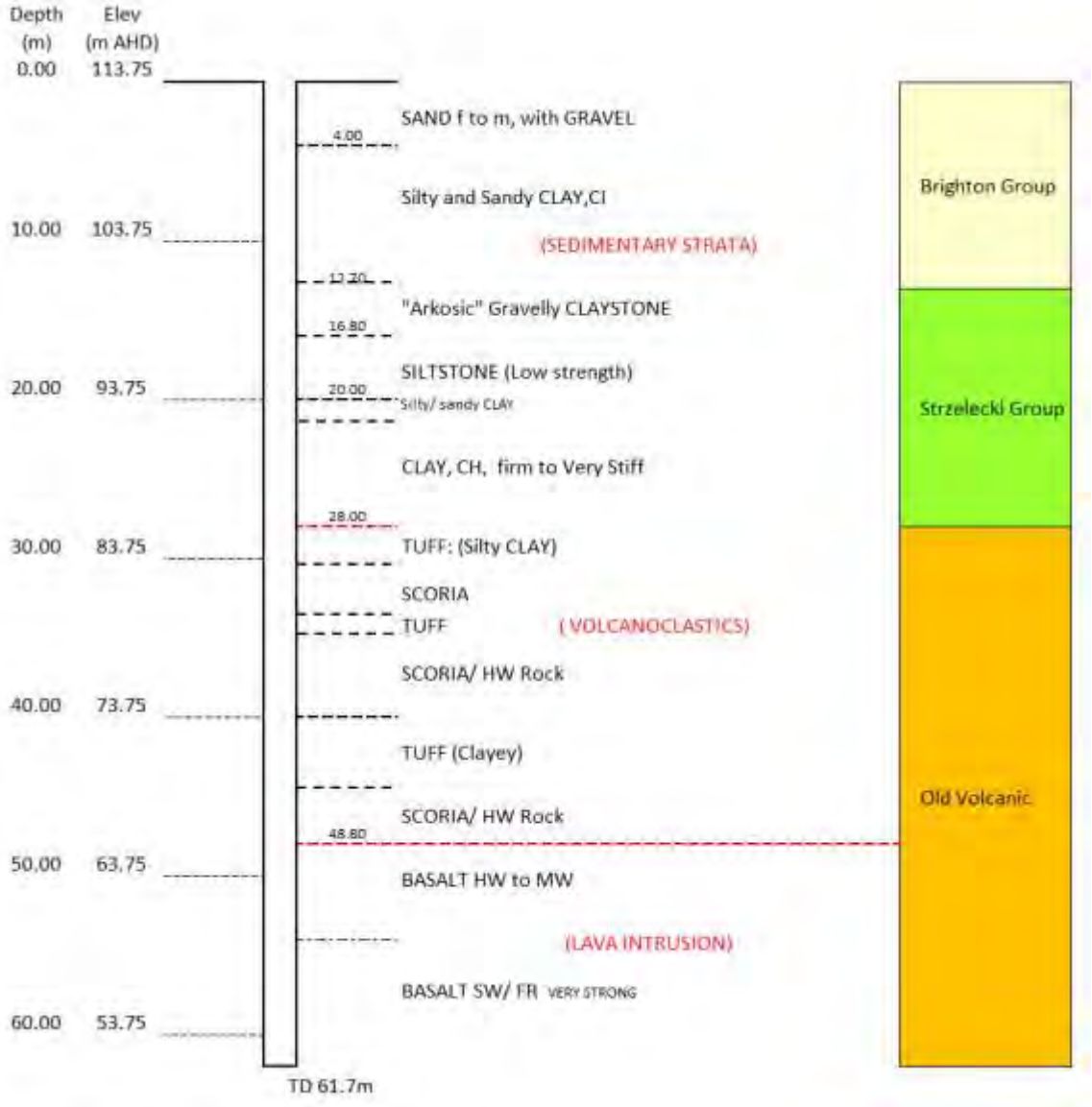


FIGURE 5.4 BH08 Interpreted Stratigraphic Log (modified after Anderson, 2018)

Movement along the Heath Hill Fault most likely dragged-up Brighton Group and other Tertiary stratigraphic units on the western side of the fault which would explain the reported steep dips in the Tertiary sediments and the greater than expected thickness of the Brighton Group close to the Tertiary-Cretaceous contact.

5.4 OUTCROP GEOLOGY

The outcropping geology in the Grantville area is shown in Figure 5.5. The upper (near surface) portion of the Brighton Group across WA1488 is predominantly clay or silt which in the context of sand extraction is referred to as "overburden". The thickness of the clay/silt overburden varies from absent to about 19 m and is mostly between 5 m and 10 m across the lower elevated, western portion of the site but is thinner to absent on the hill in the southeastern part of the site (Figure 5.6).

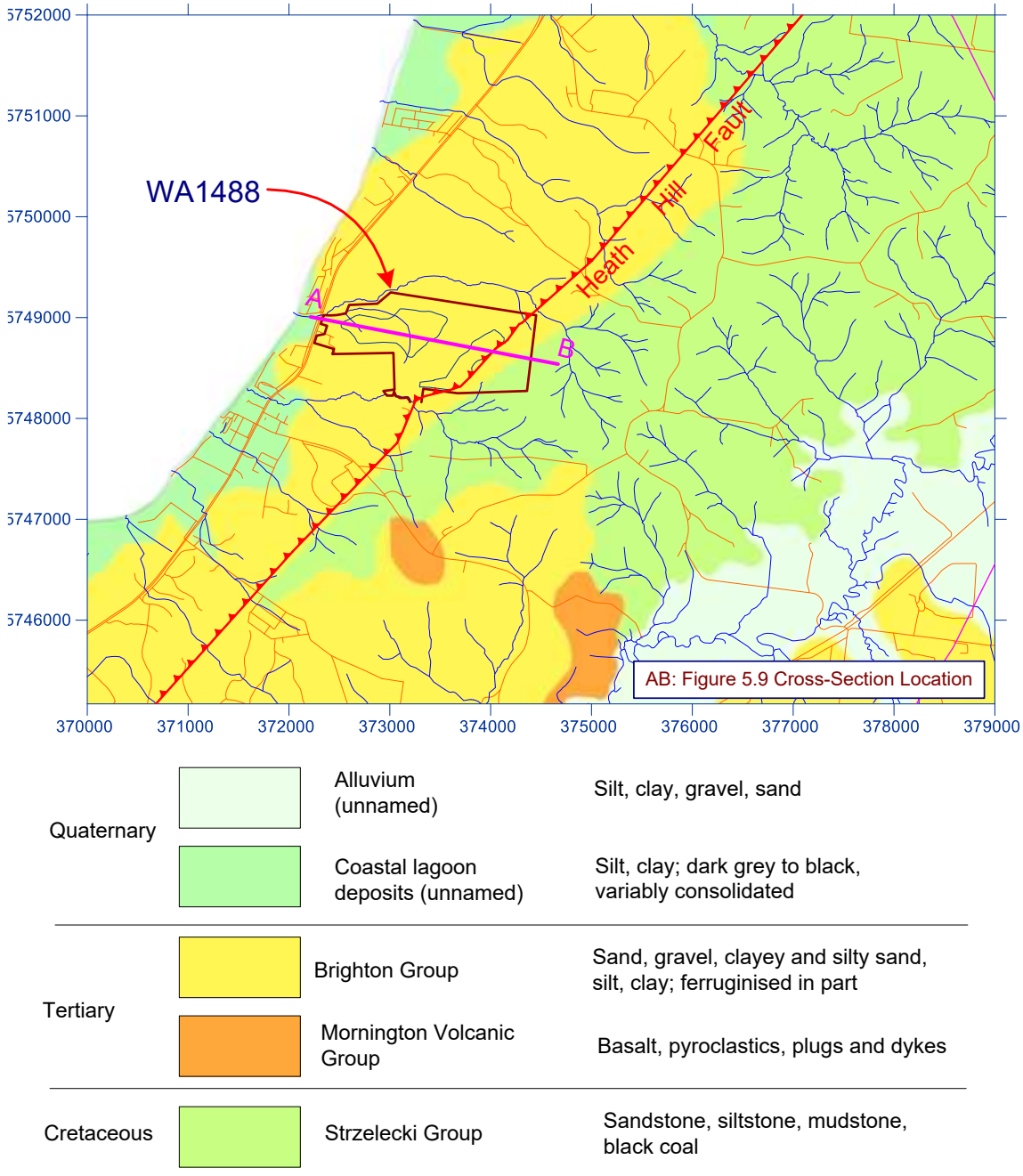


FIGURE 5.5 Mapped Outcrop Geology, Grantville Area (modified after DPI, 2011)



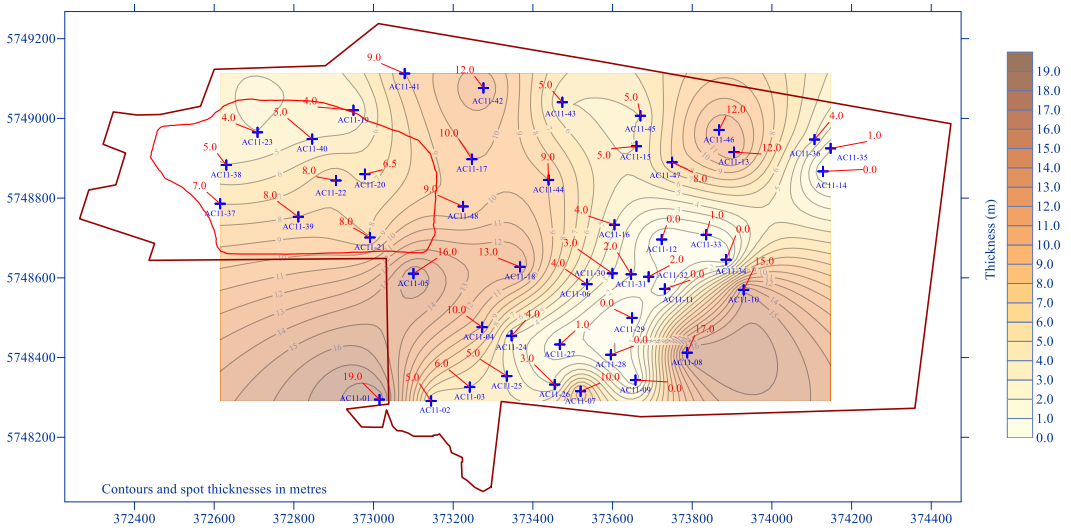


FIGURE 5.6 WA1488 Overburden Isopach

5.5 HEATH HILL FAULT

The location of the Heath Hill Fault across WA1488 has been mapped based on findings of on-site drilling targeted to intersect the fault, e.g., drillholes AC18-01, AC18-02 (Figure 5.7). The Strzelecki Group-Brighton Group faulted contact was intersected at 13 m depth in AC18-01 and at 21 m depth in AC18-02 (drillholes logged by S Young, 2018); the elevations of the fault surface were 101.0 and 92.6 m AHD, respectively. Trigonometric analysis indicated that the fault plane dipped at 30 degrees measured from the horizontal (Figure 5.8) to the NWbW, (i.e., fault strike bearing of 148 degrees (Figure 5.8). The faulted relationship between the Strzelecki Group and Brighton Group is shown in the approximated west-east geological cross-section presented in Figure 5.9).

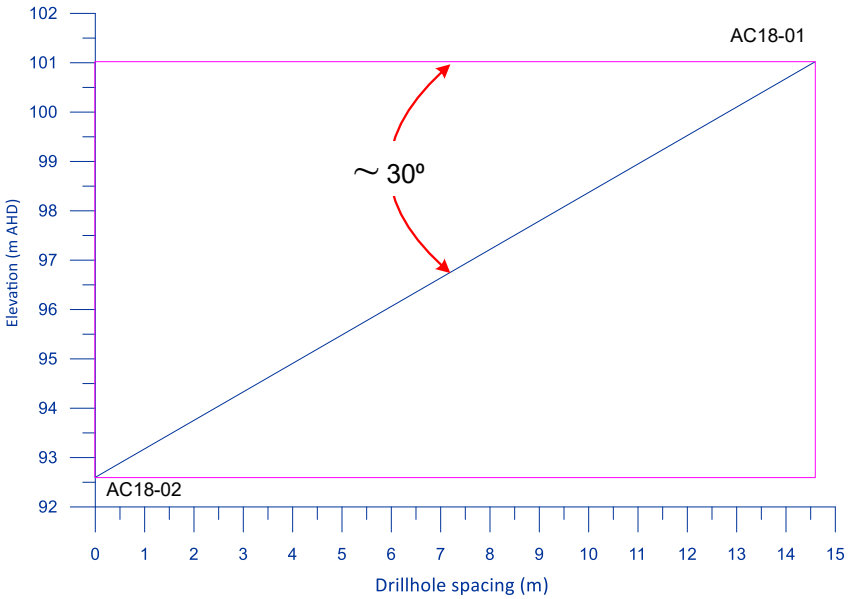


FIGURE 5.7 WA1488 Heath Hill Fault Dip Schematic



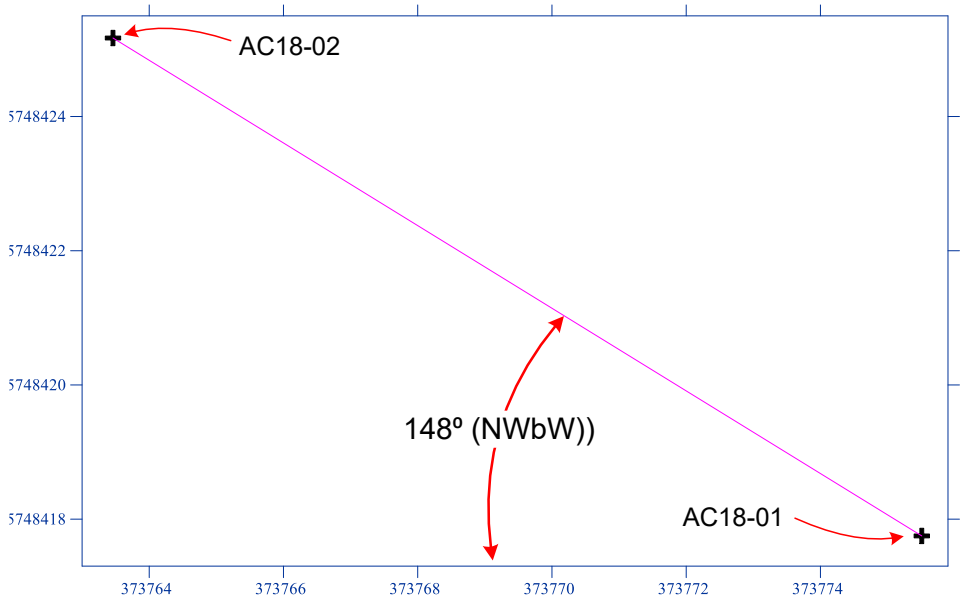


FIGURE 5.8 Heath Hill Fault Trace Bearing

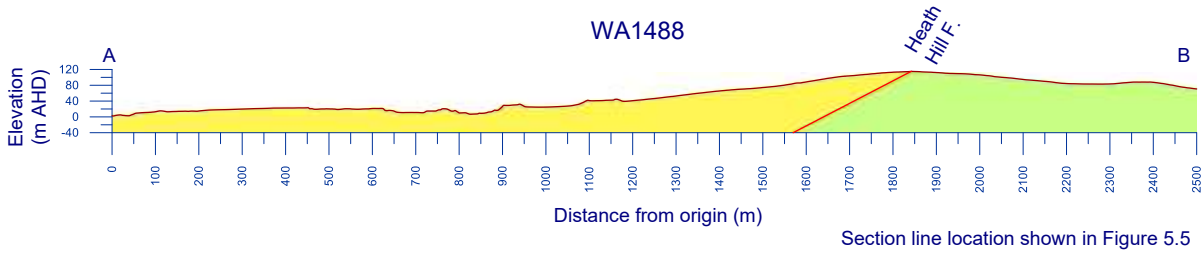


FIGURE 5.9 WA1488 Approximate West-East Cross-Section



6.0 WA1488 SITE INVESTIGATIONS

Sixty-nine holes have been drilled at the WA1488 site including sand resource drillholes (majority), groundwater monitoring bore drillholes, and holes to investigate the Heath Hill Fault. Bore locations are plotted on a two-dimensional terrain relief model and a three-dimensional visualization model in Figure 6.1A and 6.1B, respectively.

6.1 SAND RESOURCE INVESTIGATIONS

6.11 Drillholes

A total of 57 sand resource investigation holes have been drilled at WA1488; 48 holes drilled were drilled in 2011 and 9 in 2017. An additional three holes were drilled in 2018 to investigate the Heath Hill Fault. Drillhole details (locations, drilled depth, collar elevations, sand and overburden thickness) are presented in Table 6.1, and drillhole locations shown in Figure 6.2.

TABLE 6.1 BCA Sand Resource Exploration Drillhole Details

Hole ID	Fig 6.2 Plot No.	MGA coordinates		Depth (m bgl)	RLNS (m AHD)	O/B thickness (m)	Sand thickness (m)
		Easting	Northing				
AC11-01	1	373015.0	5748294.6	19.0	33.6	19.0	0
AC11-02	2	373144.6	5748291.1	39.0	40.0	5.0	34
AC11-03	3	373241.6	5748325.9	39.0	53.0	6.0	29
AC11-04	4	373272.6	5748476.3	54.0	48.2	10.0	44
AC11-05	5	373100.2	5748610.5	24.0	30.0	16.0	8
AC11-06	6	373535.9	5748584.1	30.0	71.5	4.0	26
AC11-07	7	373519.7	5748315.5	31.0	92.5	10.0	21
AC11-08	8	373787.5	5748412.2	15.0	112.2	17.0	-2
AC11-09	9	373657.5	5748343.6	24.0	108.2	0.0	24
AC11-10	10	373929.1	5748569.8	15.0	119.7	15.0	0
AC11-11	11	373731.2	5748572.3	21.0	100.0	0.0	21
AC11-12	12	373723.4	5748696.1	30.0	80.5	0.0	30
AC11-13	13	373904.9	5748915.4	21.0	78.4	12.0	9
AC11-14	14	374128.3	5748867.1	30.0	98.2	0.0	30
AC11-15	15	373660.0	5748930.1	21.0	60.2	5.0	16
AC11-16	16	373604.9	5748733.1	21.0	68.1	4.0	17
AC11-17	17	373247.1	5748897.6	24.0	25.2	10.0	14
AC11-18	18	373367.8	5748627.6	21.0	47.9	13.0	8
AC11-19	19	372949.6	5749020.6	21.0	22.2	4.0	17
AC11-20	20	372978.4	5748860.1	24.0	32.0	6.5	17.5
AC11-21	21	372991.1	5748701.3	21.0	35.3	8.0	13
AC11-22	22	372905.9	5748844.2	33.0	33.0	8.0	25
AC11-23	23	372708.8	5748965.1	24.0	24.5	4.0	20
AC11-24	24	373346.5	5748454.7	66.0	58.1	4.0	62
AC11-25	25	373334.7	5748353.4	30.0	65.8	5.0	25
AC11-26	26	373454.8	5748332.3	66.0	83.9	3.0	63
AC11-27	27	373467.7	5748432.8	71.0	76.0	1.0	70
AC11-28	28	373595.7	5748407.1	33.0	96.5	0.0	33
AC11-29	29	373649.0	5748499.5	30.0	95.0	0.0	30
AC11-30	30	373599.6	5748611.2	52.0	77.0	3.0	49
AC11-31	31	373646.5	5748608.8	64.0	85.0	2.0	62
AC11-32	32	373690.6	5748602.7	48.0	91.9	2.0	46
AC11-33	33	373835.0	5748708.0	33.0	96.8	1.0	32
AC11-34	34	373885.0	5748645.5	29.0	109.1	0.0	29
AC11-35	35	374147.4	5748924.8	39.0	90.8	1.0	38
AC11-36	36	374107.0	5748947.0	39.0	86.0	4.0	35
AC11-37	37	372615.0	5748786.0	45.0	30.0	7.0	38



TABLE 6.1 BCA Sand Resource Exploration Drillhole Details (continued)

Hole ID	Fig 6.2 Plot No.	MGA coordinates		Depth (m AHD)	RLNS (m)	O/B thickness (m)	Sand thickness
		Easting	(m bgl)				
AC11-38	38	372630.4	5748883.0	40.0	25.5	5.0	35
AC11-39	39	372811.3	5748753.1	39.0	33.8	8.0	31
AC11-39	39	372811.3	5748753.1	39.0	33.8	8.0	31
AC11-40	40	372846.1	5748948.2	33.0	27.8	5.0	28
AC11-41	41	373078.2	5749112.5	30.0	24.3	9.0	21
AC11-42	42	373275.8	5749076.3	42.0	25.9	12.0	30
AC11-43	43	373474.0	5749040.5	45.0	41.0	5.0	40
AC11-44	44	373439.5	5748845.6	51.0	44.2	9.0	42
AC11-45	45	373670.0	5749006.5	51.0	56.2	5.0	46
AC11-46	46	373867.4	5748971.1	36.0	71.1	12.0	24
AC11-47	47	373749.4	5748889.9	33.0	70.1	8.0	25
AC11-48	48	373224.8	5748779.1	36.0	26.5	9.0	27
AC17-01	49	372722.4	5748887.6	54.0	26.7	5	49
AC17-02	50	373018.0	5748827.9	42.0	10.9	0	42
AC17-03	51	373640.9	5748559.6	99.0	87.8	0	99
AC17-04	52	373931.3	5748921.3	80.0	79.4	15	65
AC17-05	53	373740.5	5748743.2	108.0	80.1	3	105
AC17-06	54	373540.5	5748581.4	102.0	71.8	4	98
AC17-07	55	373615.4	5748814.7	105.0	64.1	4	101
AC17-08	56	373769.4	5748569.7	42.0	104.1	0	42
AC17-09	57	373724.3	5748573.3	73.0	98.8	2	71
AC18-01	58	373775.5	5748417.8	16.0	114.0	0	16
AC18-02	59	373763.5	5748425.2	24.0	113.6	0	24
AC18-03	60	373605.2	5748511.5	44.0	87.1	1	33

Note: 1) O/B; Overburden

6.1.2 Grain Size Analysis

A total of 212 soil samples collected from 16 drillholes (including constructed monitoring bore BH05) and the sample grainsize distribution analysed (Table 6.2). The locations of the sampled holes are plotted in Figure 6.3. All but one of the sampled drillholes are located in the area of the western FMSEP with the tested soils predominant fine-medium sands. Example grain size analysis plots for the 19-21 m depth interval in drillhole AC11-19 and 21-24 m interval in AC11-20 are shown in Figure 6.4.

TABLE 6.2 Grain Size Analyses Details

Drillhole	MGA Coordinates		Hole Depth	No of Analyses	Drillhole	MGA Coordinates		Hole Depth	No of Analyses
	Easting	Northing				Easting	Northing		
AC11-17	373247.06	5748897.64	24.0	6	AC11-39	372811.29	5748753.06	39.0	13
AC11-19	372949.61	5749020.59	21.0	9	AC11-40	372846.06	5748948.16	33.0	11
AC11-20	372978.35	5748860.11	24.0	7	AC11-41	373078.22	5749112.53	30.0	9
AC11-21	372991.08	5748701.25	21.0	6	AC11-42	373275.84	5749076.28	42.0	14
AC11-22	372905.85	5748844.20	33.0	9	AC17-01	372722.36	5748887.64	54.0	37
AC11-23	372708.80	5748965.07	24.0	7	AC17-02	373017.97	5748827.88	42.0	36
AC11-37	372614.95	5748785.97	45.0	10	AC17-03	373640.91	5748559.64	99.0	17
AC11-38	372630.43	5748883.03	40.0	14	BH-05	373173.82	5748818.76	25.00	7

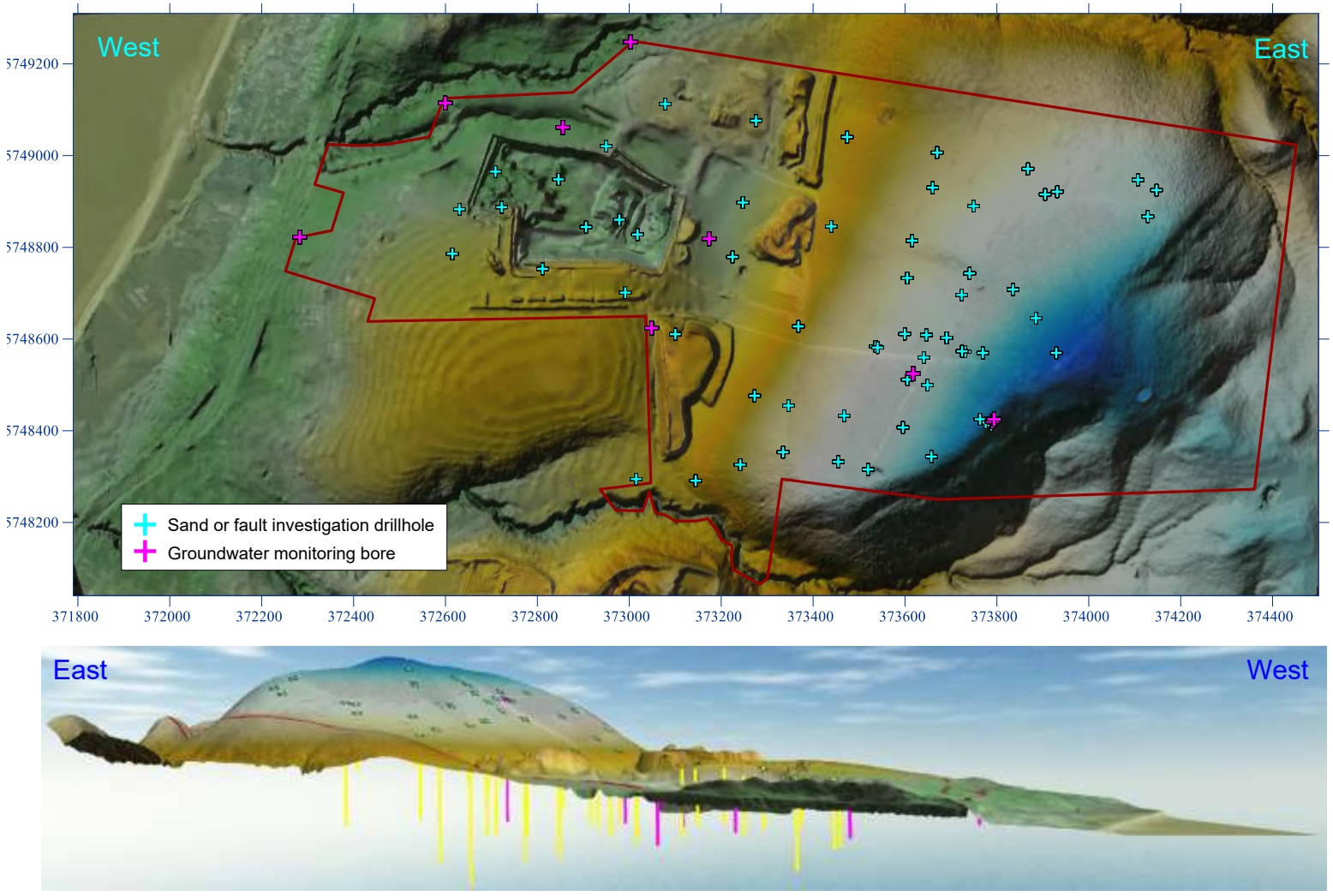


FIGURE 6.1 Drillhole and Monitoring Bore Location Visualizations

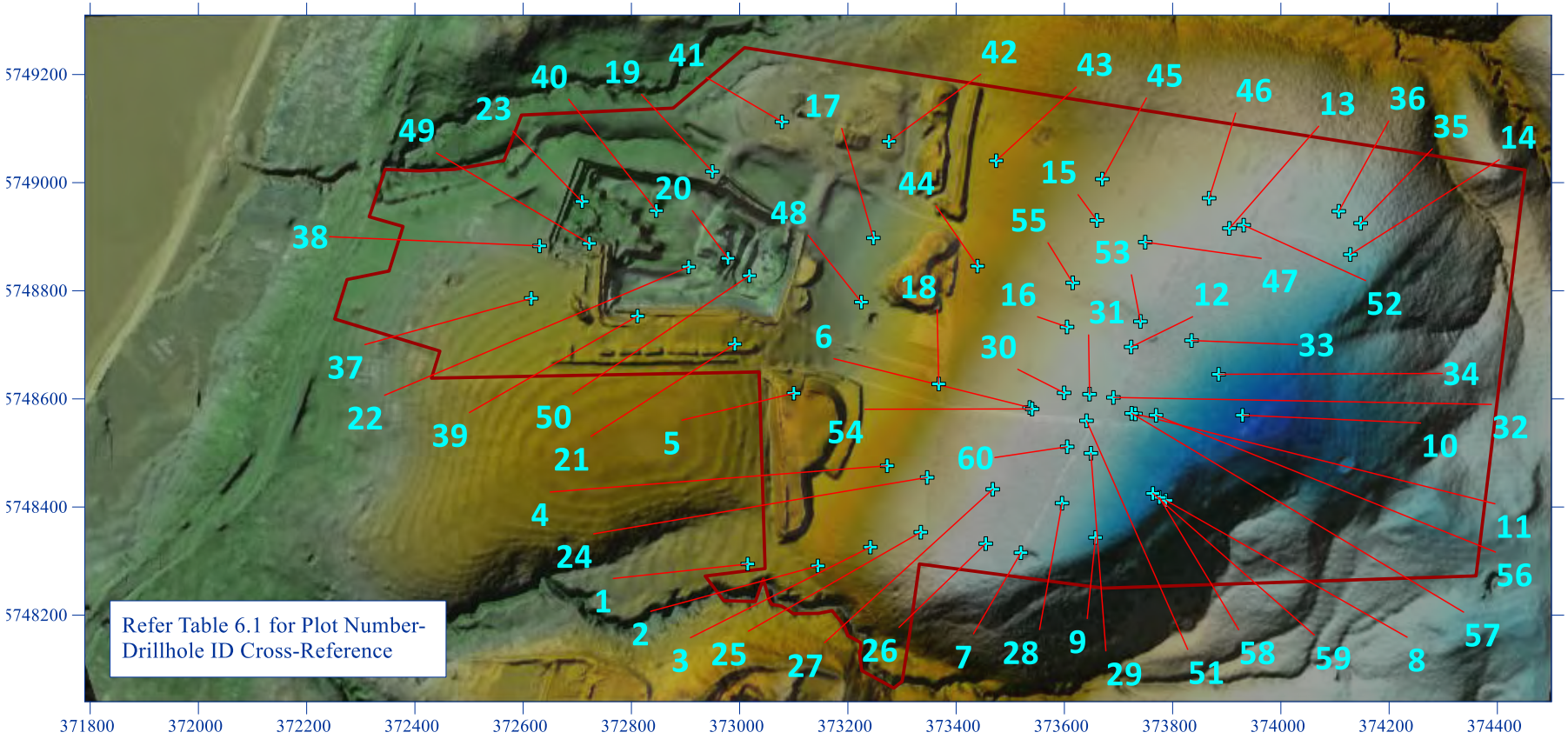


FIGURE 6.2 WA1488 Sand Resource Drillhole Locations

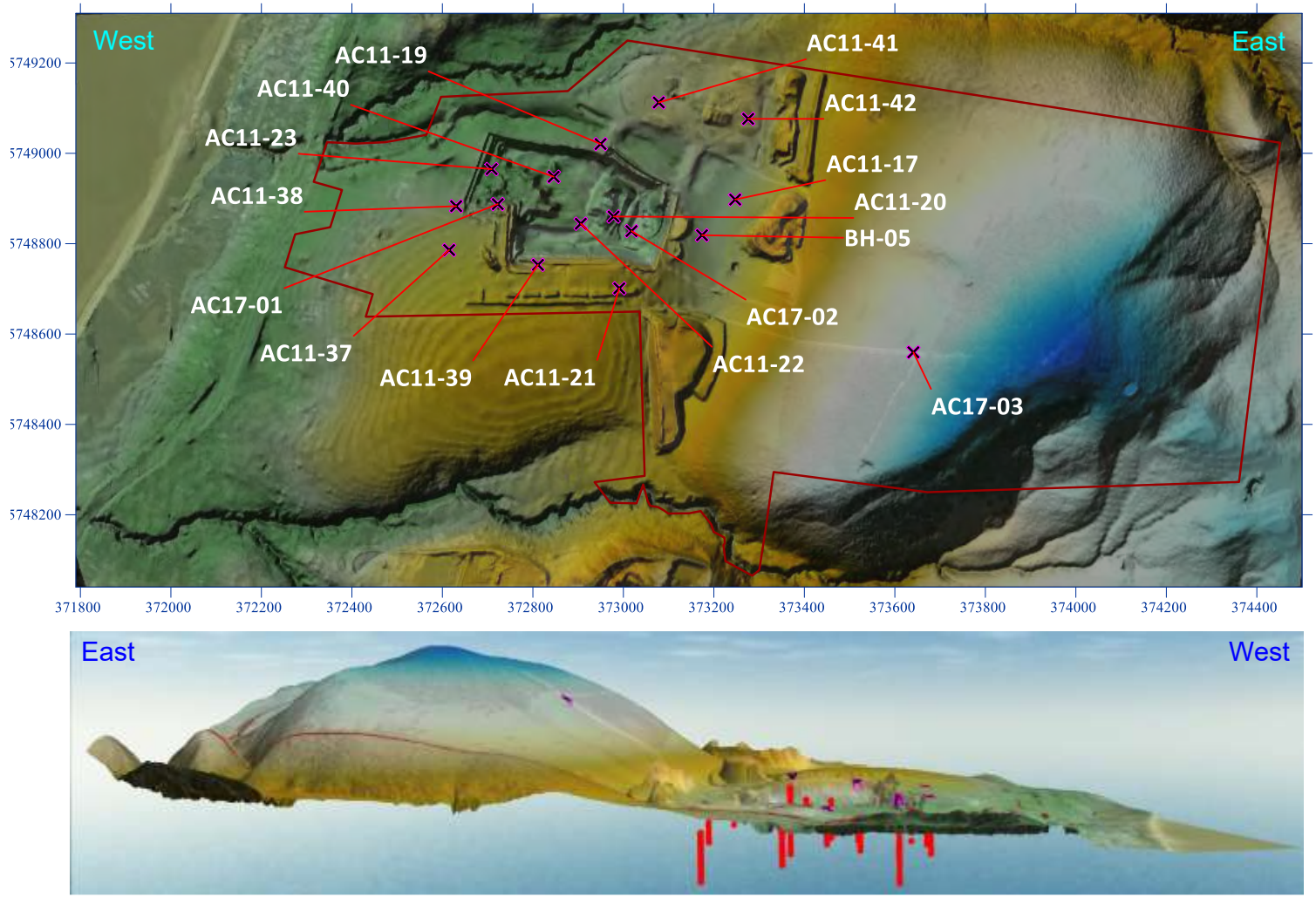


FIGURE 6.3 Grain Size Analysis Sampled Drillhole Locations

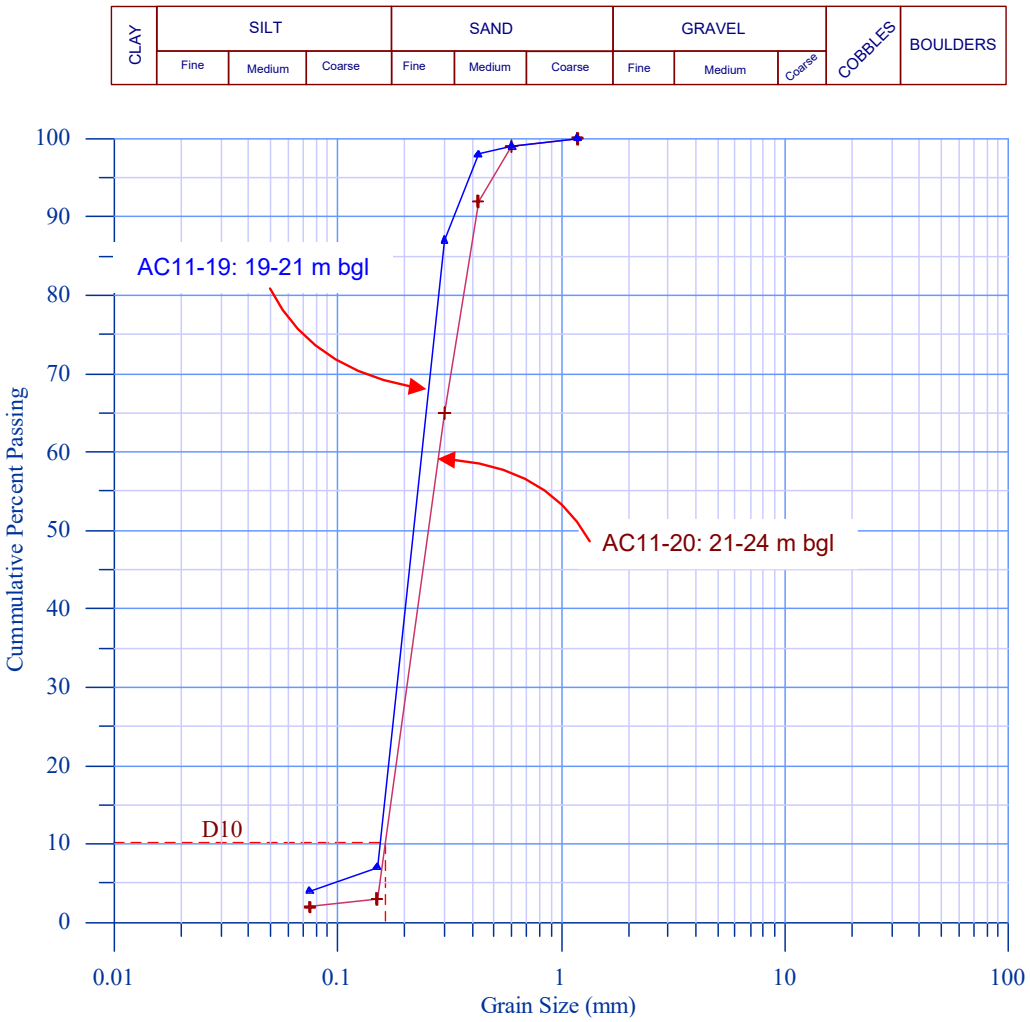


FIGURE 6.4 Example Grain Size Distribution Curves, WA1488 Sand Extraction Pit

7.1.3 Hydraulic Conductivity

The hydraulic conductivity of one soil sample from both drillholes AC11-19 and AC11-20 within the western FMSEP area determined using "SizePerm – Hydraulic Conductivity from Size Analysis" software program (program calculates hydraulic conductivity using 10 common analytical solutions) are presented in Figure 6.5. The calculated hydraulic conductivity values are presented in Table 6.3 The values in bold font are from applicable method based on sand grain size distribution criteria (effective diameter, D10 and uniformity coefficient). The applicable hydraulic conductivity values ranged from about 12 to 33 m/day with average and median values of 23.6 and 26.6 m/day, respectively.

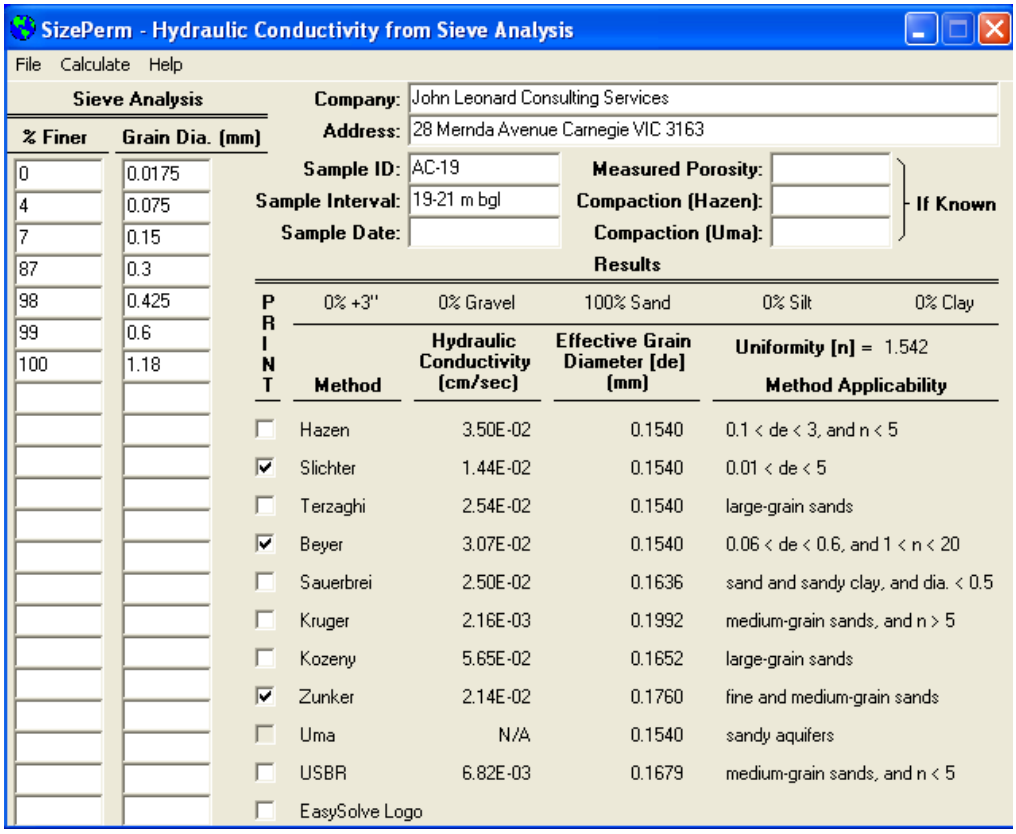


FIGURE 6.5 Brighton Group Fine Sand Hydraulic Conductivity from Grain Size Data

TABLE 6.3 Brighton Group Sand Hydraulic Conductivity

Sample	0 % finer	Method	D10	Uniformity	K (cm/sec)	K (m/day)	Method Applicability
AC11-19:	0.022	**Hazen**	**0.1540**	**1.542**	**0.0350**	**30.24**	**0.1 < de < 3, and n < 5**
19-21		**Slichter**	**0.1540**	**1.542**	**0.0144**	**12.44**	**0.01 < de < 5**
m bgl		Terzaghi	0.1540	1.542	0.0254	21.95	large-grain sands
		Beyer	**0.1540**	**1.542**	**0.0307**	**26.52**	**0.06 < de < 0.6, and 1 < n < 20**
		Sauerbrei	0.1636	1.542	0.0250	21.60	sand and sandy clay, and dia. < C
		Kruger	0.1992	1.542	0.0022	1.87	medium-grain sands, and n > 5
		Kozeny	0.1652	1.542	0.0565	48.82	large-grain sands
		Zunker	**0.1760**	**1.542**	**0.0214**	**18.49**	**fine and medium-grain sands**
		Uma	0.1540	1.542	N/A		sandy aquifers
		USBR	0.1679	1.542	0.0068	5.89	medium-grain sands, and n < 5
AC11-20:	0.018	**Hazen**	**0.1622**	**1.749**	**0.0379**	**32.75**	**0.1 < de < 3, and n < 5**
21-24		**Slichter**	**0.1622**	**1.749**	**0.0151**	**13.05**	**0.01 < de < 5**
m bgl		Terzaghi	0.1622	1.749	0.0267	23.07	large-grain sands
		Beyer	**0.1622**	**1.749**	**0.0334**	**28.86**	**0.06 < de < 0.6, and 1 < n < 20**
		Sauerbrei	0.1754	1.749	0.0267	23.07	sand and sandy clay, and dia. < 0.5
		Kruger	0.2398	1.749	0.0030	2.59	medium-grain sands, and n > 5
		Kozeny	0.2072	1.749	0.0825	71.28	large-grain sands
		Zunker	**0.2178**	**1.749**	**0.0309**	**26.72**	**fine and medium-grain sands**
		Uma	0.1622	1.749			sandy aquifers
		USBR	0.1814	1.749	0.0081	7.03	medium-grain sands, and n < 5



6.2 GROUNDWATER INVESTIGATIONS

6.2.1 Monitoring Bores

Nine groundwater investigation/ monitoring bores have been installed at WA1488. Bore construction details are summarised in Table 6.4. Water levels and field water quality parameters in the bores have been routinely monitored since 2012 in the initial three bores (BH01, BH02 and BH03) and the additional bores as they were installed. Groundwater samples from six of the bores were submitted for laboratory analysis for basic water chemistry quality parameters.

TABLE 6.4 Monitoring Bore Details

Bore	Year	MGA coordinates		Elevation (m AHD)		Depth (m bgl)	Screened interval (m bgl)	Bentonite plug (m bgl)
		Easting	Northing	NS	TOC			
BH01	2012	373002.8	5749247.9	20.14	20.66	26.0	20.0 to 26.0	18.0 to 19.0
BH02	2012	373048.5	5748624.0	33.00	33.39	38.0	32.0 to 38.0	30.0 to 31.0
BH03	2012	372599.4	5749114.6	16.69	17.05	21.3	15.3 to 21.3	14.0 to 15.0
BH04	2018	372282.84	5748822.30	17.00	17.57	18.0	13.0 to 18.0	11.8 to 12.8
BH05	2016	373173.82	5748818.76	25.05	25.60	25.0	19.0 to 25.0	18.0 to 19.0
BH06	2018	372855.45	5749061.60	19.43	20.11	21.50	15.5 to 21.5	14.0 to 15.0
BH08	2018	373790.16	5748420.35	113.75	114.44	61.50	55.0 to 61.5	53.8 to 54.8
BH08A	2018	373793.96	5748425.07	113.95	114.64	24.00	18.0 to 24.0	16.5 to 17.5
BH09	2018	373617.69	5748524.39	87.62	88.25	90.00	84.0 to 90.0	82.5 to 83.5

The monitoring bores installed at the WA1488 site were mostly screened within the Brighton Group (BH08A was screened in a thin veneer of Brighton Group on the eastern side of the Heath Hill Fault) except for BH08 located on the eastern side of the Heath Hill Fault and screened with the Older Volcanics.

6.2.3 Groundwater Levels

The depth to groundwater in monitoring Bores at WA1488 varies from around 12.5 metres below ground level (m bgl) in bore BH04 located near the western boundary of WA1488 close to the Bass Highway to about 77.5 m bgl in BH09 located about 1,370 m east of BH04.

Hydrographs (transient groundwater elevation plots) for the nine monitoring bores are shown in the hydrographs presented in Figure 6.6. The hydrographs show that 1) the water level in Brighton Group monitoring bores west of the Heath Hill Fault has been at consistent elevations over the 2013-2019 monitored period, and 2) the groundwater in the two bores east of the Heath Hill Fault (BH08 and BH08A) was more than 90 m higher than west of the fault. The large elevation difference indicates that the eastern bores monitor perched groundwater not the regional water table as monitored in the western bores (evidence for this interpretation is discussed in Chapter 7).

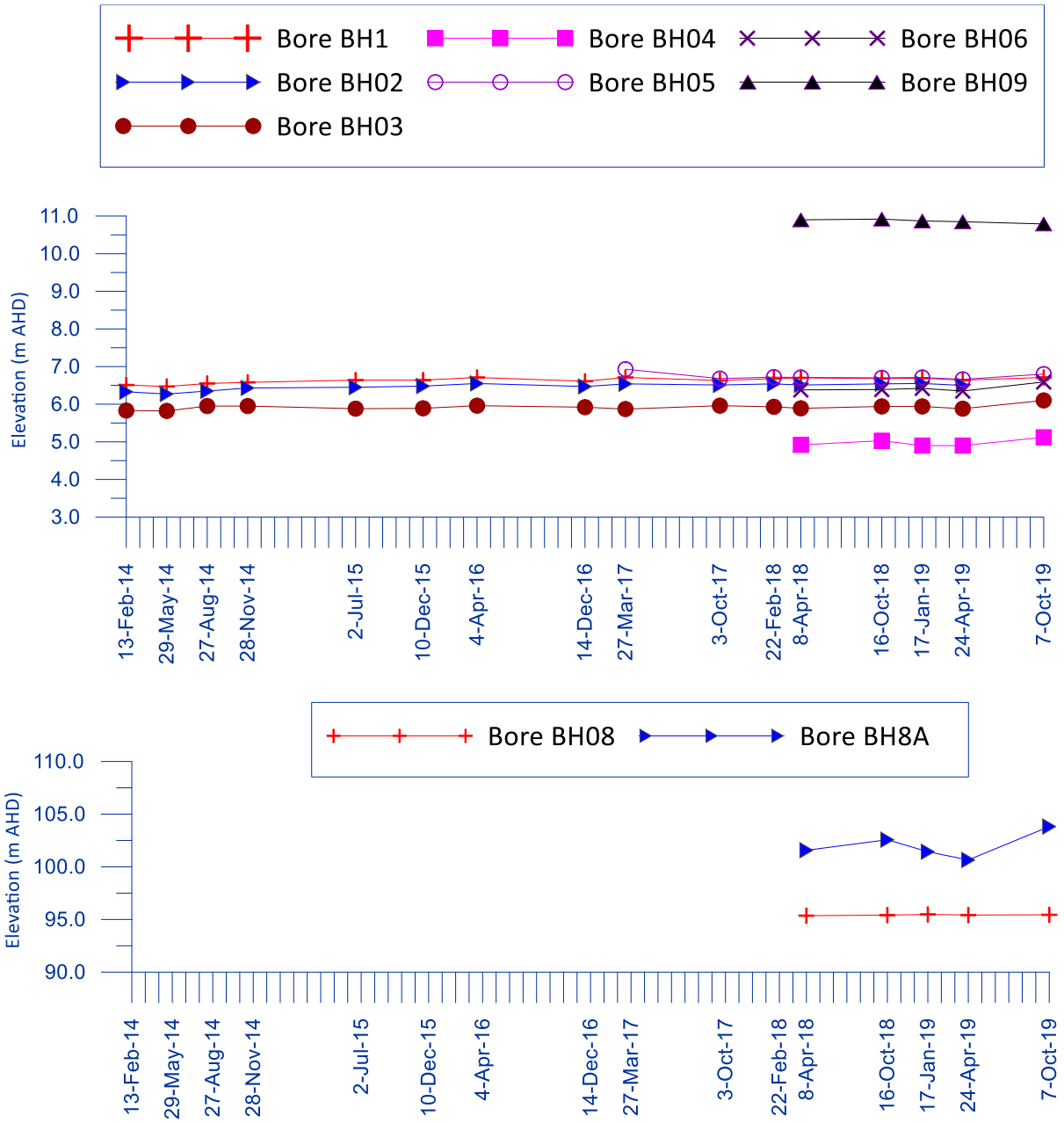


FIGURE 6.6 WA1488 Groundwater Hydrographs

6.2.2 Groundwater Quality

Groundwater samples from six of the WA1488 nine monitoring bores (BH01, BH02, BH03, BH08, BH08A and BH09) were analysed by Eurofins-MGT (formerly MGT-Labmark) for salinity, major ions and acidity. Analysis results are presented in Table 6.5. The tested samples were all Na-Cl type water.



TABLE 6.5 WA1488 Groundwater – Basic Chemistry

Date	March 2012			April 2018		
Bore Stratigraphic Unit	BH01 BG	BH02 BG	BH03 BG	BH08 OV	BH08A OV	BH09 BG
Total Dissolved Solids	540	560	480	2600	7200	420
Sodium	160	190	150	480	2100	110
Potassium	1.7	1.3	1.4	17	8.8	1.8
Calcium	8.9	10	7	110	83	4.3
Magnesium	17	17	13	120	170	4.4
Chloride	280	330	260	1200	2400	130
Bicarbonate	< 20	< 20	< 20	74	146	51
Carbonate	< 10	< 10	< 10	< 10	< 10	< 10
Sulphate (S)	11	9.4	5.3	48	280	29
pH	6.1	6.1	5.8	6.7	5.6	6.8

Notes: 1) Units mg/L except pH (pH units), 2) BG, Brighton Group; and 3) OV, Older Volcanics.

The salinity of the groundwater in the two tested bores east of the Heath Hill Fault (BH08, Older Volcanics; and BH08A, Brighton Group) was significantly higher than that of the groundwater in the Brighton Group west of the fault. Plots of the hydrochemistry analysis data demonstrated that the groundwater from bores on opposite sides of the Heath Hill Fault had different hydrochemical signatures (Figure 6.7).

The groundwater Beneficial Uses to be protected under the SEPP *Waters of Victoria (2018))* are indicate in Table 6.6.

TABLE 6.6 WA1488 Protected Groundwater Beneficial Uses

Beneficial Use	Segment (TDS mg/L)		
	A1 >600	B 1,201-3,100	E 7,101-10,000
	BH01-03 & 09	BH08	BH08A
Water dependent ecosystems and species	✓	✓	✓
Potable water supply (desirable)	✓		
Potable water supply (acceptable)			
Potable mineral water supply	✓	✓	
Agriculture and irrigation (irrigation)	✓	✓	
Agriculture and irrigation (stock watering)	✓	✓	✓
Industrial and commercial	✓	✓	
Water-based recreation (primary contact recreation)	✓	✓	✓
Traditional Owner cultural values	✓	✓	✓
Cultural and spiritual values	✓	✓	✓
Buildings and structures	✓	✓	✓
Geothermal properties	✓	✓	✓

Note: Potable Mineral Water Supply is not a protected beneficial use in the Grantville area as the groundwater is not classified as a mineral water in accordance with the definition in SEPP Groundwater of Victoria, is not effervescent (with respect to CO2) and the area is not a proclaimed Mineral Water Reserve under the Water Act 1989 or is a recognised mineral water province.

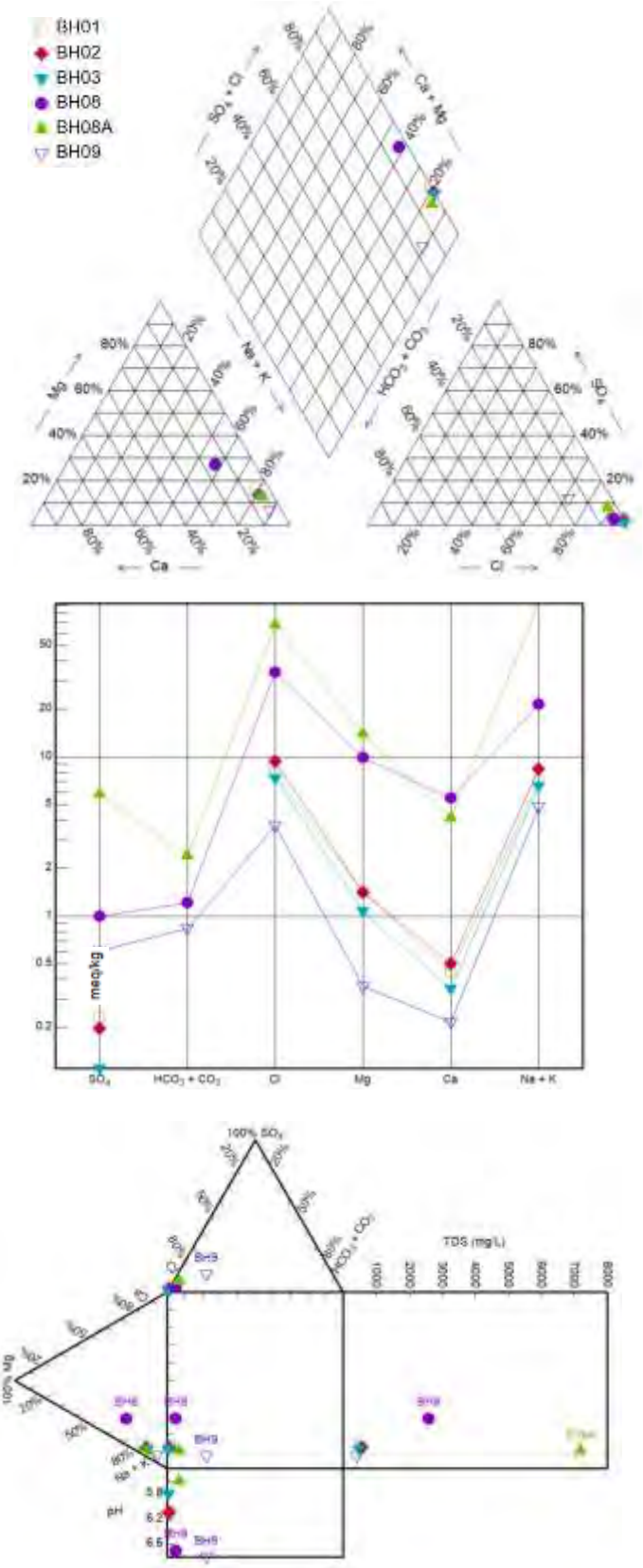


FIGURE 6.7 Groundwater Hydrochemistry Plots; A) Piper, B) Scholeller and C) Durov



7.0 HYDROGEOLOGY

A Conceptual Hydrogeological Model of the WA1488 site and surrounding area was developed based on interpretation of data from a range of sources including topographic analysis, geological maps, lithologic logs from sand resource and groundwater investigation drillholes, groundwater level and quality testing, field observations, and hydraulic theory (of groundwater flow in hilly terrains and in coastal aquifers).

7.1 HYDROSTRATIGRAPHY

Two main aquifers are present at WA1488, the Brighton Group and the Strzelecki Group aquifers. The hydraulic characteristics of the two main aquifers at WA1488 (Brighton Group and Strzelecki group) are very different; the Brighton Group is locally a permeable porous media type aquifer whereas the Strzelecki Group is predominantly a low productivity fractured rock type aquifer. The Older Volcanics in the southeastern portion of the site varies from porous media aquifer (tuff and deeply weathered basalt) to fractured rock aquifer (fresher basalt). The Brighton Group is in contact with the Strzelecki Group along the Heath Hill Fault. The hydraulic connectivity between groundwater on different sides of the fault is discussed in Chapter 7.3.

7.1.1 Strzelecki Group

The Strzelecki Group is predominantly a fractured rock type aquifer but where deeply weathered it can form a porous medium type aquifer or aquitard. The storage and transmitting capacity of the fresh rock is dependent on the frequency and degree of interconnection of joints and fractures. Groundwater in the outcropping Silurian bedrock varies from unconfined to semi-unconfined depending on the hydraulic characteristics of the material above the water table. The hydraulic conductivity of the unit is generally very low with the unit often considered as “groundwater basement” in regional groundwater resource assessment. The relatively high density of streams in the upthrown Strzelecki Group rock to the east of WA1488 is consistent with low hydraulic conductivity rocks. The water table hydraulic gradient in the Strzelecki Group would be (correspondingly) very steep.

7.1.2 Older Volcanics

The Older Volcanics at WA1488 are considered to represent a volcanic plug (as distinct from possibly more extensive volcanic lava flow). The description and core photographs (Anderson, 2018) indicate that the volcanics vary from clayey tuff and deeply weathered basalt to fresh basalt (Figure 5.3). The tuff and weathered basalt would behave hydraulically as an aquitard to (very) low productivity aquifer whereas the fresher basalt would form a fractured rock aquifer.

7.1.3 Brighton Group

The main aquifer beneath WA1488 is the Brighton Group west of the Heath Hill Fault. This unit consists predominantly of fine to coarse sand with minor silty and clay bands that appear to be lens-like and of limit (continuous) extent. The geology beneath the Brighton Group at WA1488 has not been investigated but it is possible based on lithologic logs of drillholes in



the Grantville area that the Brighton Group is underlain by Childers Formation which is composed of sand and gravel with interspersed lignite and clay beds. As the lithology of these two units are broadly similar, if the Childers Formation is present, the two stratigraphic units can be considered as a single hydrostratigraphic unit, here referred to as the Brighton Group Aquifer.

The Brighton Group Aquifer is porous media unconfined to semi-confined aquifer. Based on lithologic descriptions by BCA and others (S Young/G Granny), and hydraulic conductivity values determined using grain size analysis data (Chapter 7), the Brighton Group is considered to be a moderate to high productivity aquifer with hydraulic conductivity values greater than 20 m/day.

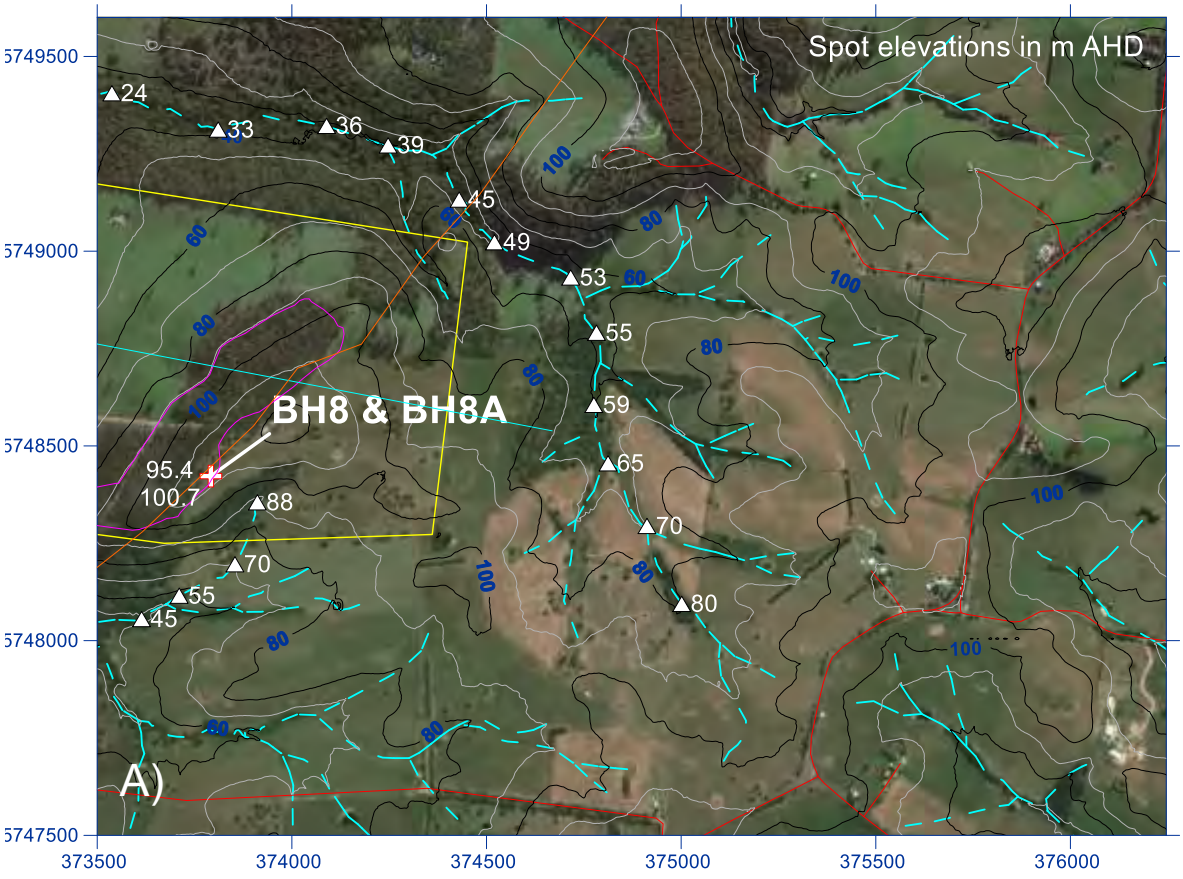
7.2 WATER TABLE POSITION AND TYPE

7.2.1 East of Heath Hill Fault

The water level elevation in bores BH08 (Older Volcanics) and BH08A (Brighton Group veneer) are about 102 and 92 m AHD, respectively. The elevation of the drainage lines that circumnavigate the ridge vary from about 80 to 90 m AHD along the headwaters of both Deep Creek and Colbert Creeks on the eastern side of the ridge (Figure 8.1A). The beds of these drainage lines are at lower elevations decreasing from about 40 m AHD down to 5 m AHD along the more incised streambeds tracts of theses creeks. If the observed water levels in bores represent the ("true") water table, then permanent flow along the surrounding drainage line should be evident. No flow was observed along headwaters of these drainage lines east of the WA1488 topographic high or along the more incised "downstream" beds of Deep Creek (north) and Colbert Creek (south) when inspected a number of times during the past five years by JLCS. In addition, no evidence of permanent flow is apparent in aerial images of the area as illustrated in the three-dimensional model of WA1488 in Figure 7.1B. These lines of evidence indicate that the groundwater intersected in BH08 and in BH08A represent groundwater perched within the Older Volcanic rocks (BH08) and the thin veneer of Brighton Group (BH08A), and that the regional water table is located at depth within the Strzelecki Group rocks.

7.2.1 West of Heath Hill Fault

The water table beneath WA1488 on the western side of the Heath Hill Fault is within the Brighton Group. Water table contours generated from April 2019 water level monitoring data are presented in Figure 7.2. The contours show that groundwater flows in a general westerly direction towards beneath the site. Western Port Bay. The (water table) hydraulic gradient varies from about 0.008 beneath the central portion of the site to 0.002 beneath the western part of the site. The gradient change indicates that finer grained sands are most likely present beneath the coarser sand immediately west of the Heath Hill Fault (based on the continuity equation and Darcy's law).



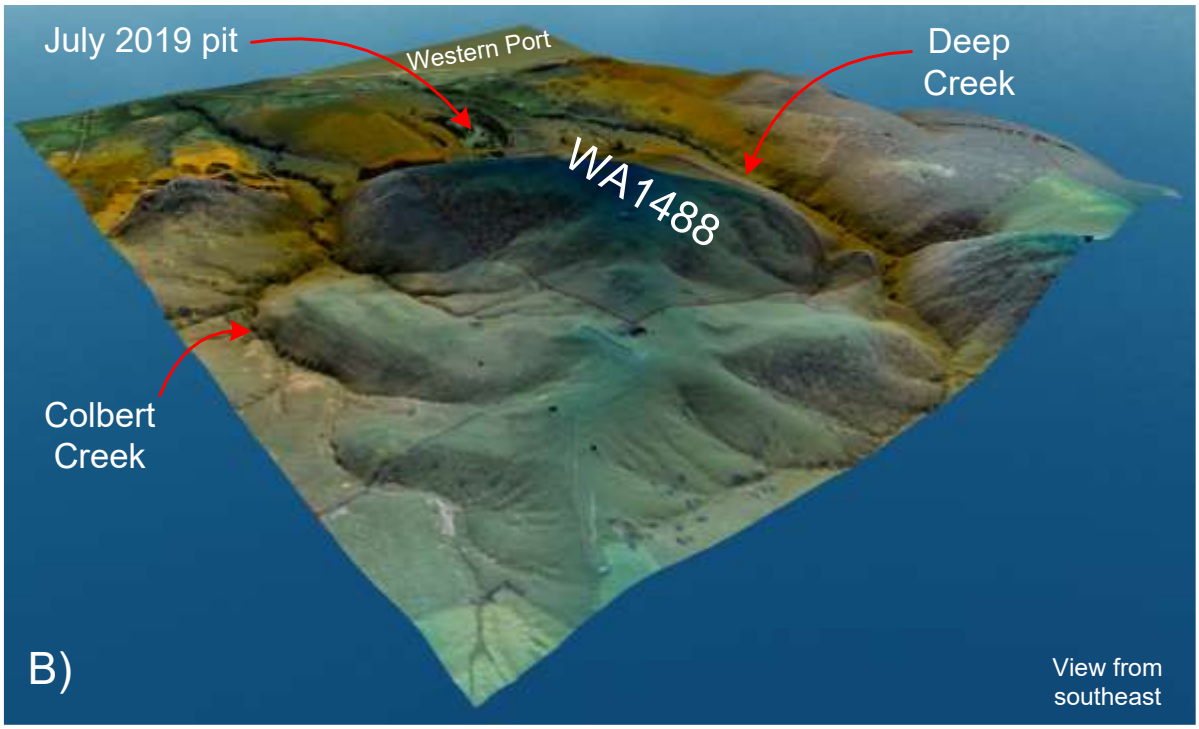


Figure 7.1 A) BH08/BH08A Water Level and Streambed Elevations, and B) Three-Dimensional View of WA1488

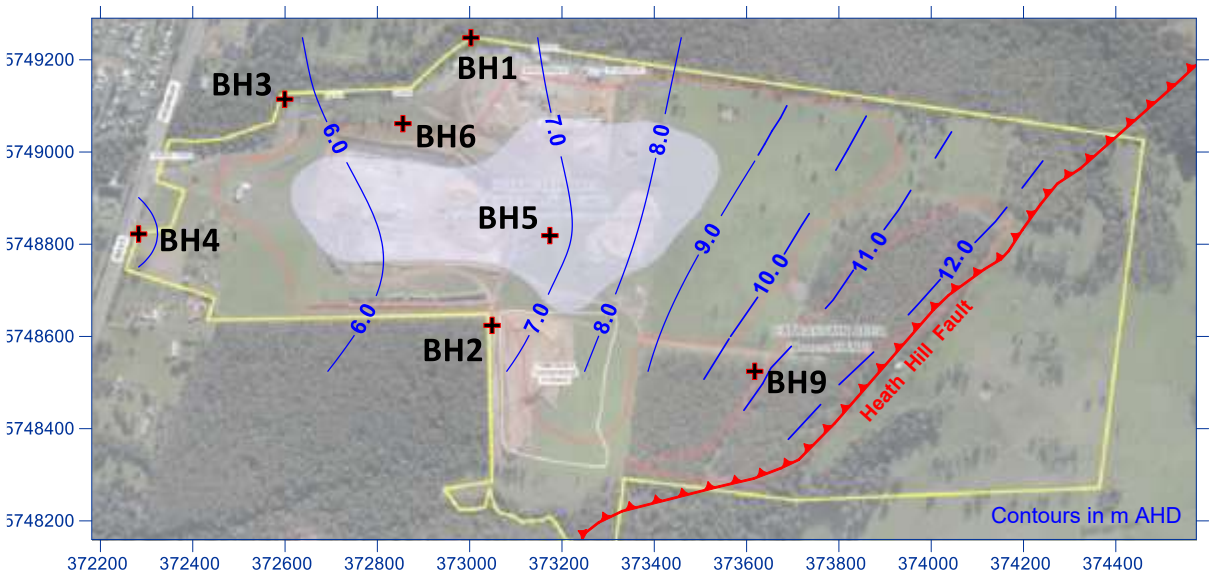


FIGURE 7.2 WA1488 April 2019 Brighton Group Water Table Contours

7.3 HYDRAULIC CONNECTIVITY ACROSS HEATH HILL FAULT

Brighton Group sediments are in contact with the Strzelecki Group rocks along the Heath Hill Fault. Consequently, an important consideration in the flow system analysis was to a develop conceptual model(s) of the hydraulic characteristics of the Heath Hill Fault and possible effects of the fault on groundwater flow beneath WA1488. The hydraulic connectivity between groundwater on different sides of the fault is discussed in Section 7.3.

Findings of numerous studies on groundwater flow in fault dominated hydrogeological setting have been reported in the scientific literature. The impact of faults ranges from minimal where the fault does not change hydraulic connectivity between aquifers on the opposite sides of the fault to situations where the fault forms a hydrogeological barrier boundary preventing flow across the fault resulting in groundwater flow compartmentalisation.

Typically, pre-faulting structure and fault displacement vary along major fault planes, resulting in spatially variable cross-fault hydraulic-conductivity connectivity (Allan, 1989; Haneberg. 1995; Came and Forster, 1999). These variations in hydraulic-conductivity distribution likely result in complex patterns of hydraulic gradient and flow along and across fault zones.

The groundwater elevation differential across the Heath Hill Fault from bores BH08/08A to BH09 is more than 80 m. This observation together with the significant water chemistry differences indicates that the “perched” groundwater east of the fault is not contiguous with the water levels in the Brighton Group west of the fault, and that the regional water table east of the faults lies within the Strzelecki Group rocks. Three different conceptualisations of the hydraulic connection of the regional water table across the fault are plausible namely, 1) uninhibited cross-fault flow model (Figure 7.3A), reduced cross-fault flow (Figure 7.3B), and no cross-fault flow (Figure 7.3C).

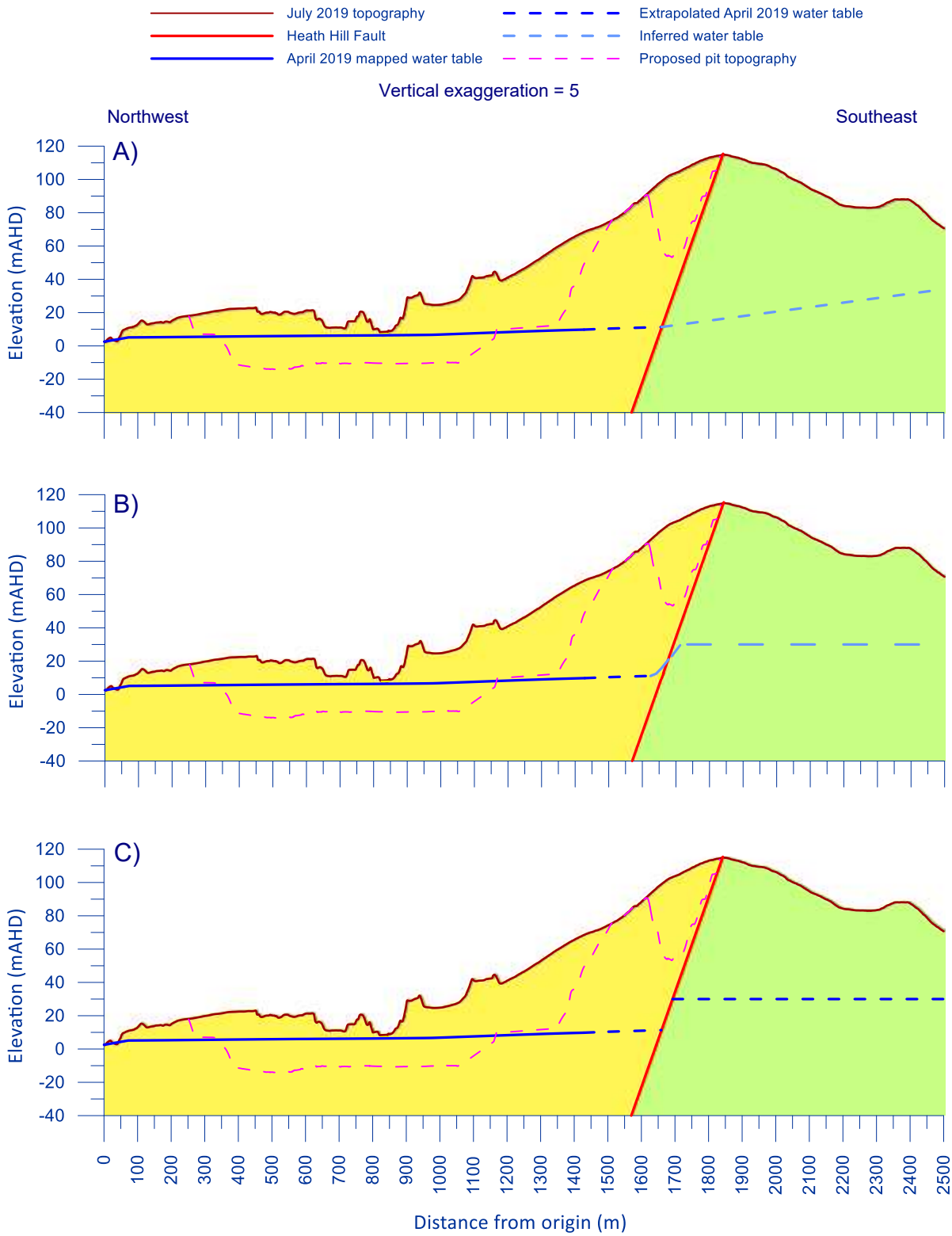


FIGURE 7.3 Conceptual Fault Groundwater Flow Models, A) Uninhibited Cross-Fault Flow, B) Reduced Cross-Fault Fault Flow, and C) No Cross-Fault Flow



If the movement associated with the Heath Hill Fault has not developed fault gouge or pug and/or caused significant clay smearing and realignment of mineral grains, flow across the fault would not be altered. Consequently, the regional water table would be contiguous from east to west. The hydraulic gradient within the Strzelecki Group (east of the fault) would be steeper than the gradient within the Brighton Group because of the lower hydraulic conductivity of the Strzelecki Group rocks (Figure 7.3A). However, it is possible some fault gouge was formed as Strzelecki Group rocks were dragged against Strzelecki Group depths before these rocks were exposed by further movement on the fault plane. It is also possible that clays within the Brighton Group where smeared by more recent movement along the fault. Clay smearing is a process which can strongly reduce the effective hydraulic conductivity of a fault zone. In sedimentary successions where clays are present, dragging or ductile flow of these layers along the fault plane between the up- and down-thrown beds can result in a clay smear along the fault plane (Smith 1980; Fulljames et al. 1997; Lindsay et al. 1993; Lehner and Pilaar 1997). Gibson (1998) considered that if sands contains more than ~10% clay, that deformation will probably always cause a reduction in hydraulic conductivity due to the a process referred to as 'deformation-induced mixing' This process involves the compaction and mixing of clay with sand grains, resulting in a more homogeneous distribution of clay than in the undeformed sediment and, therefore, lower bulk porosity (Bense et al. 2003). The presence of fault gouge/pug and/or clay smearing would reduce or prevent cross-fault flow as shown in Figures 7.3B and C. If Heath Hill Fault forms a (complete) hydrogeological barrier boundary, then the groundwater on opposite side of the fault would be hydraulically isolated resulting in compartmentalized groundwater flow systems.

The floor of the proposed eastern CSEP will be at 60 m AHD. The water table beneath the pit is at an elevation of between 11 and 12 m AHD (from the extrapolated regional water table contours shown in Figure 7.2). Consequently, regardless of the hydraulic connectivity across the Heath Hill Fault, interpretation of the available "hydrogeological" data indicates that the regional water table is most likely more than 45-50 m below the floor of the proposed eastern, CSEP.

7.4 GROUNDWATER RECHARGE

The ground surface across WA1488 is well above the regional water table and is a groundwater recharge area. Review of existing outcrop geology, drillhole logs and topography across WA1488 indicates that infiltration under pre-quarrying conditions would be variable with higher infiltration rates (15 to 25 per cent of rainfall) on the more elevated eastern portion of the site where coarse sands outcrops or subgroups beneath (very) thin layer of silt and clay, and lower (less than 10 per cent of rainfall) in the flatter-lying western portion of the site where the sand is overlaid by a thicker layer of silt and clay.

Recharge rates in areas that have been, or will be quarried, are much higher with most of the rainfall falling in quarry area infiltrating to recharge groundwater.

7.5 GROUNDWATER DISCHARGE

Most groundwater moving through the Brighton Group is discharged into the Western Port Bay with some "discharge" by evaporation in low lying area close to the bay where the water table is close to the ground surface. The findings of the flow system analysis indicated that the water table does nor intersect the streambeds of either Deep Creek or Colbert Creek except possibly close to the bay. Consequently, groundwater does not discharge into these creeks except close to the bay.

WA1488 is situated within a coastal aquifer regime where the groundwater flows towards and discharges into Western Port Bay. Because seawater is denser than the lower salinity groundwater, it forms a saltwater wedge under the fresher. On approaching the coast, groundwater flow lines converge, and curve upward, forcing discharge into the near onshore coastal zone (Figure 7.4).

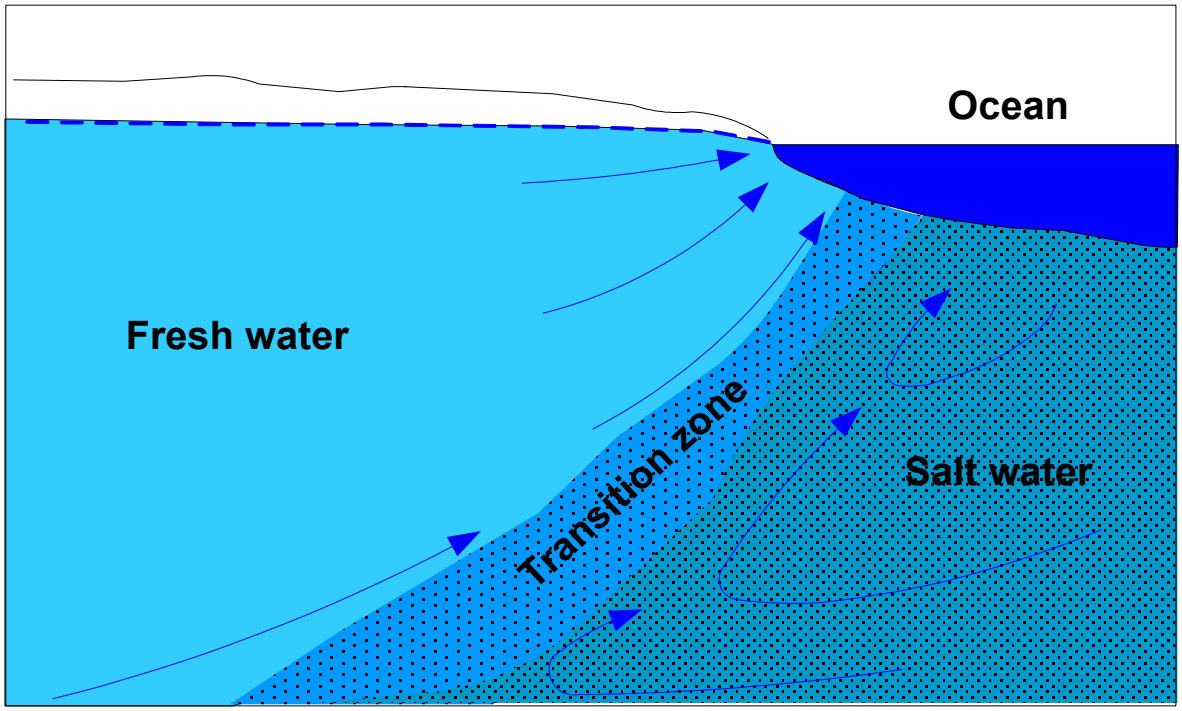


FIGURE 7.4 Coastal Aquifer Fresh Water-Salt Water Movement (After Cooper, 1959)

Under dynamic conditions the sea water is not static but flows perpetually in a cycle from the floor of the sea into a transition zone (zone of diffusion) in which there is a gradation of salt content from that of fresh water to that of salt water and back to the sea. There is a continuous discharge of salty water from the zone of diffusion into the sea (Cooper 1959).

As a first approximation, fresh water and salt water are treated as two immiscible fluids of different densities separated by a sharp, sloping interface. Under natural undisturbed conditions, a state of equilibrium is maintained, with a relatively stationary saline interface



and fresh water flow to the sea above it, subject to the dynamic effects of sea tides and the seasonal variations in regional groundwater recharge and flow. Ghyben, (1888-1889) and Herzberg (1901) analysed the position of the fresh water salt water interface in a homogeneous, unconfined coastal aquifer, under hydrostatic conditions assuming fresh and salt water to be immiscible fluids of different densities. Under these assumptions, a sharp, straight interface is formed. According to Ghyben-Herzberg relationship, the cross sections of coastal line, interface, ocean level, and water table meet at a point and the condition of hydrostatic balance is expressed as:

$$z = \left(\frac{\rho_f}{\rho_s - \rho_f}\right) h_f \qquad \text{Eq 1}$$

where p_f and p_s are the freshwater and saltwater density, respectively; g is the acceleration due to gravity; z is the depth below sea level to a point on the interface; and h_f is the difference between the elevation of the surface of the ocean and the elevation of the water table directly the point on the interface. This is referred to as the Ghyben-Herzberg relationship. If the density of fresh water and sea water are assumed to be 1.0 and 1.025 respectively, then z = 40 *hf.* This means that the depth below sea level to the interface is 40 times the height of the water table above sea level, and the slope of the interface is 40 times greater than the slope of the water table.

In the Ghyben-Herzberg model of coastal aquifers, the salt-water interface intercepts the water table at the coastline which does not allow vertical components of flow and discharge of the fresh water into the sea floor (effectively closes the system at its discharge point). In reality, fresh groundwater drains into the ocean over an area of the seabed rather than at a point (or along a linear contact), and vertical flow components occur in the aquifer as the fresh water moves up along the freshwater-saltwater interface. If static conditions existed, the water table would have zero slope and the interface would become horizontal with fresh water overlying salt water by mere density difference. In addition, the sea water is in a continuous state of motion and there is a dynamic rather than a hydrostatic equilibrium of the freshwater-saltwater interface.

Groundwater discharge generally occurs in the near offshore with the salt water-fresh water interface near to the coast. However, the interface in the Grantville area is most likely further offshore close to the tidal channel that is permanently under sea water rather than closer to shore as result of the very wide mud flat which is only covered by shallow seawater at high tides (Figure 7.5). A more distant offshore interface is consistent with observed dry stream beds along Deep and Colbert creeks close to the beach at Grantville.

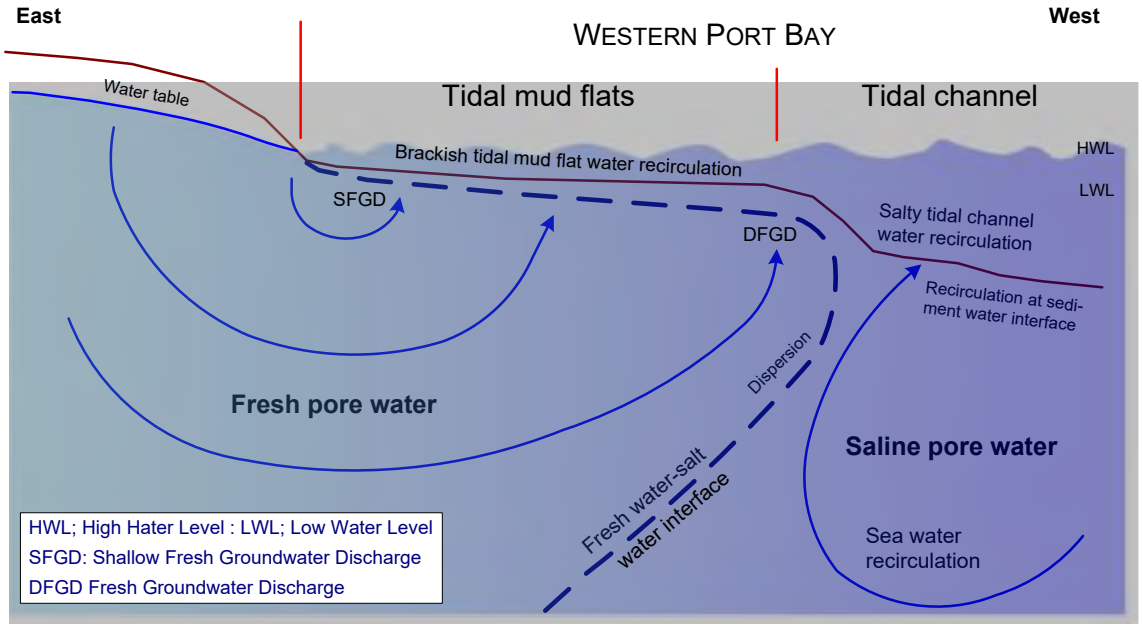


FIGURE 7.5 Seawater -Freshwater Interface Beneath Western Port Tidal Mud Flats



8.0 GROUNDWATER USE AND DEPENDENCE

Groundwater users and sensitive environmental assets that are dependent wholly or partially on groundwater within the area around WA1488 with emphasis on areas down hydraulic gradient from the proposed extraction pits were mapped as a necessary step in assessing potential adverse impacts associated with the further development of the WA1488 quarry site including assessing drawdown interference from extracting the sought 80.5 ML annual allocation (Take and Use Groundwater Extraction Licence).

8.1 GROUNDWATER USERS

Records of bores within a 2 km buffer zone around WA1488, as stipulated by DJPR (2019) were extracted from state government Water Measurement Information System (WMIS; database (accessed November 2019). The downloaded data subset was culled to only include groundwater supply bores by removing bores classified as observation (OB), non-groundwater (NG) or investigation bores (IV).

Sixty-four registered "supply" bores are located within the stipulated search area. Details of the bores in the culled project data subset are summarised in Table 8.1. Bore locations within the search area are posted on an aerial image base map in Figure 8.1 (plotting number cross-reference to registered bore ID in WMIS provided in Table 8.1). In detail:

- The recorded depths of the bores range from about 3.6 to 143 m with a median depth of 33.5 m with 75 per cent of the bores less than 50 m deep.
- Forty-five of the culled data subset bores are either domestic (DM) and/or stock (ST) bores. In detail, 17 of these bore are registered domestic bores (16 registered as "used" and one as "decommissioned"); 4 are registered as domestic and stock (3 are "used" and one has been "decommissioned"); 3 as stock only (all 'used") ; and 20 as stock and domestic (all "used").
- Six of the bores are registered for industrial (IN) use and one as industrial or commercial (CO); all seven bores are identified as "used". Three of the industrial use bores located at WA470 are more than 900 m south of the proposed WA1488 dredge pond, and three are more than 1,800 m northeast of the dredge pond at WA210; unfortunately, whether these bores are licensed or not is not recorded in the WMIS database because of privacy concerns.
- The use of 13 bores is recorded as not known (NKN); However, only two of these bores are used with one bore decommissioned and the other 10 as registered "not used".

The registered used groundwater bores are plotted on a georegistered satellite image base map in Figure 8.2.

8.2 HIGH VALUE ECOSYSTEMS

Extracting groundwater can potentially impact water storage and flow in hydraulically interconnected surface water systems. Reduced storage and/or flow can in turn have adverse impacts on ecosystem that are maintained at least in part by groundwater referred to as Groundwater dependent ecosystems (GDEs). GDEs require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to



maintain their communities of plants and animals, ecological processes and ecosystem services (NWC, 2011). GDEs include 1) aquatic ecosystems that rely on the surface expression of groundwater — including surface water ecosystems which may have a groundwater component, such as rivers, wetlands and springs, and 2) Terrestrial ecosystems that rely on the subsurface presence of groundwater—including vegetation ecosystems such as forests and riparian vegetation (BoM undated).

TABLE 8.1 Bore Records Summary

Bore ID	Fig. 9.1 Plot No.	MGA Z55 coordinates		Date Completed	RLNS (m AHD)	Depth (m)	Screens (m bgl)	Use	Status
		Easting	Northing						
56908	1	375516	5748691	31/12/19	89.75	140.81		ST DM	U
56925	2	375370	5747733	25/09/70	105.17	9.14		NKN	U
56926	3	376244	5749719	02/10/70	120.17	13.71		NKN	U
56933	4	372413	5747484	15/01/85	49.9	37.8		NKN	NU
56941	5	371249	5747334	01/01/70	5.31	42.6		ST	U
56964	6	371679	5747521	06/06/72	12.52	42.36	39.62 - 42.36	ST	U
56970	7	371445	5747988	24/06/74	4.46	21.33	15.24 - 21.33	ST DM	U
56972	8	372179	5748910	07/10/74	6.65	47.24	33.52 - 47.24	ST DM	U
56980	9	371937	5748537	21/04/76	3.38	9	6.4 - 7.92	ST DM	U
56986	10	372470	5748945	18/11/76	18.97	5	3.04 - 4.87	ST DM	U
56987	11	372265	5749371	16/12/76	3.64	4.26	3.04 - 4.26	ST DM	U
56989	12	372368	5749406	30/12/75	5.03	16.7		ST DM	U
56993	13	372232	5749230	20/05/77	5.76	6	4.5 - 5.48	DM	U
56998	14	371259	5747396	17/10/77	4.8	42	37 - 38.8	ST DM	U
57000	15	372455	5749415	28/10/77	19.33	20		DM	U
57003	16	372400	5749146	28/01/78	13.82	9.1	5.13 - 9.1	ST DM	U
57004	17	372419	5749719	13/08/78	2.91	7.61	7.31 - 7.61	DM	U
57008	18	372184	5748389	29/12/77	21.61	50		NKN	NU
57011	19	371830	5747927	08/12/78	10.9	57	15.54 - 17.37	ST DM	U
57020	20	372061	5748864	06/07/79	4.42	12	4.42 - 12.00	ST DM	U
57021	21	372358	5748497	04/08/79	24.57	17	13 - 16.3	DM	U
57022	22	372371	5748485	04/01/80	25.54	16	13 - 16	DM	U
57023	23	371870	5748843	13/12/79	0.03	16.4	13 - 16	DM	U
57024	24	371943	5748676	13/02/80	3.35	43	38.5 - 43	ST DM	U
57025	25	372193	5749104	08/01/80	7.71	16.7	13.7 - 16.7	DM	U
57031	26	372193	5749224	18/12/80	5.43	13.7	9.2 - 13.7	ST DM	U
57034	27	371413	5747834	03/12/80	4.04	14.4	10.4 - 14.4	ST DM	U
57038	28	372563	5749834	10/11/81	13.9	37	33 - 36.4	ST DM	U
57041	29	371863	5748084	07/01/82	11.07	15.4	9.8 - 15.4	DM	U
57042	30	371313	5747634	02/03/82	4.35	22.42	20 - 22.4	ST DM	U
57045	31	373092	5750824	07/09/82	3.35	47	41 - 45.2	ST DM	U
57047	32	371207	5747448	24/10/82	3.6	42.5	40 - 42.5	ST DM	U
57049	33	371663	5747584	14/11/82	11.56	51		NKN	NU
57050	34	371673	5747594	15/04/83	11.48	24		NKN	NU
57051	35	371913	5747684	08/04/82	12.85	16		NKN	NU
57052	36	373313	5750834	07/12/82	13.97	52	42 - 52	DM	U
57053	37	372213	5748684	26/10/82	17.38	15.69	0 - 15.69	DM	U
57058	38	372013	5748634	12/05/83	3.91	18	14.7 - 18	ST DM	U
57061	39	372213	5749234	25/03/83	5.27	30	18 - 20	DM	U
57063	40	372223	5749344	07/09/83	2.92	16.2	12 - 16.2	DM	U
57066	41	372263	5749084	22/12/83	8.77	12.2	9 - 12.2	ST DM	U
57075	42	372363	5749484	20/01/79	6.55	5.18	3.96 - 5.18	DM	U
57076	43	373097	5747716	15/01/85	60.47	62.4		NKN	D
57077	44	372413	5747484	18/01/85	49.9	13		NKN	NU
57078	45	372413	5747484	31/01/85	49.9	122	36 - 115	IN	U
57083	46	374588	5750784	04/10/85	81.58	25		NKN	NU

TABLE 8.1 Bore Records Summary (continued)

Bore ID	Fig. 9.1 Plot No.	MGA Z55 coordinates		Date Completed	RLNS (m AHD)	Depth (m)	Screens (m bgl)	Use	Status
		Easting	Northing						
57084	47	374588	5750794	30/10/85	81.56	37.6	36.5 - 37.6	IN	U
57106	48	373013	5747744	09/12/86	50.56	79		NKN	NU
134578	49	371653	5747464	31/03/98	12.73	42.6	38 - 42.5	ST	U
134579	50	372253	5749044	19/03/98	9.07	38.5	34.5 - 38	DM	U
140636	51	371473	5748104	17/05/00	3.84	24	21.5 - 24	DM	U
WRK038474	52	374583	5750394	07/07/88	69.34	62.4	39 - 57	IN	U
WRK041775	53	374353	5750664	28/09/93	57.09	76.2	40.5 - 76.2	IN	U
WRK041789	54	373013	5747704	27/02/85	51.32	62.5	45 - 62	IN	U
WRK046732	55	374515	5750801	27/05/04	75.46	76.2		IN	U
WRK046912	56	371759	5748227	12/02/07	7.82	142		DM ST	U
WRK073531	57	372981	5750474	02/05/13		46.5	41.5 - 44.5	DM ST	U
WRK100377	58	372899	5747759	14/07/17		85	43.5 - 65.5	IN CO	U
WRK965067	59	374515	5750801		75.46	76.2		NKN	NU
WRK978649	60	371982	5747769	01/03/07	12.61	143		DM ST	U
WRK979228	61	372950	5750494		3.57	30		NKN	NU
WRK985336	62	373177	5750874	06/08/08	4.89	46.5	41.5 - 46.5	DM ST	D
WRK985595	63	371515	5747976	18/06/08	5.43	57		DM	D
WRK989360	64	372266	5748733	14/05/09	19.36	73		DM	U

Notes: 1 RLNS; Reduced Level (elevation) Natural Surface, 2) m AHD; metres Australian Height Datum, 3) m bgl; metres below ground level, 4) Uses; DM Domestic; ST Stock, IN Industrial; CO Commercial, NKN Not Known, and 5) Status; U Used, NU Not Used, D Decommissioned.

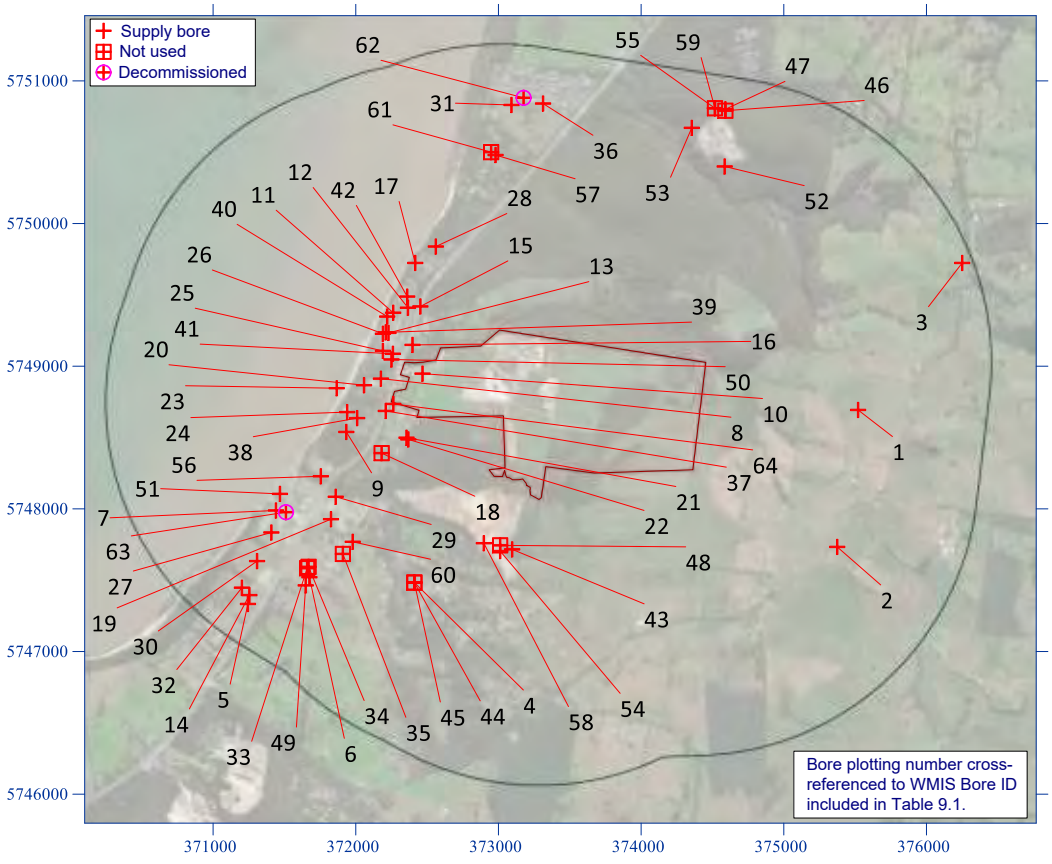


FIGURE 8.1 WMIS Registered Supply Bores, Two-km Buffer Area Around WA1488

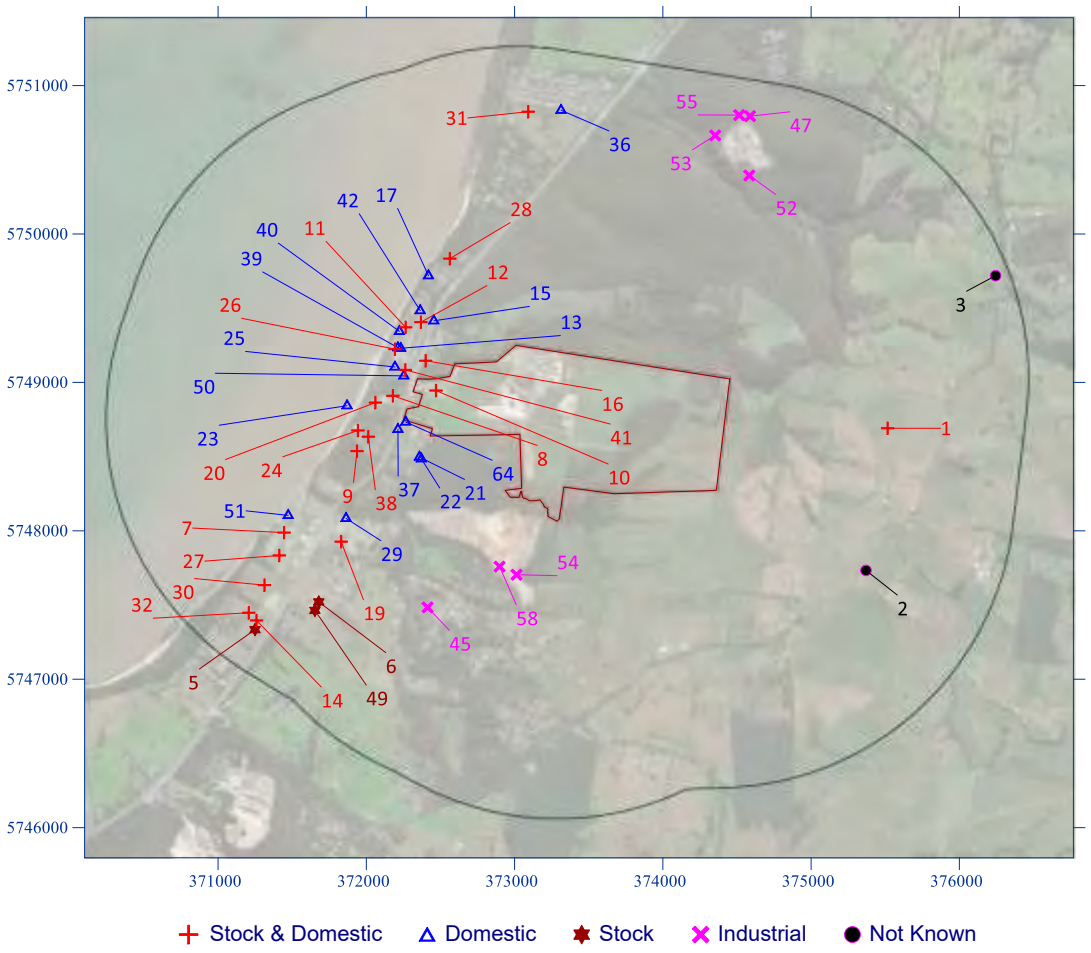


FIGURE 8.2 Locations of WMIS Registered Used Bores

According to the Environment Protection and Biodiversity Conservation (EPBC) Act 1999 significant impact on the ecological character of a Ramsar wetland is likely if there is, amongst other things:

- "a substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland; or
- the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected, or
- a substantial and measurable change in the water quality of the wetland - for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health"

A number of online web-based mapping applications were accessed to identify any groundwater dependent environmental segments within the stipulated 2 km buffer zone.

8.2.1 GDE Atlas Mapping

No terrestrial or aquatic ecosystems were identified in the Bureau of Meteorology GDE Atlas (Figure 8.3 and 8.4, respectively).

8.2.2 MapShareVic Wetlands

No local wetlands are mapped within the 2 km buffer zone on the Victorian Government MapShareVic Wetland interactive mapping tool (DELWP). However, Western Port Bay located about 300 m west of the western boundary of WA1488 and about 550 m from the western edge of the proposed FMSEP dredge pond is a listed Ramsar Site[2] (Figure 8.5).

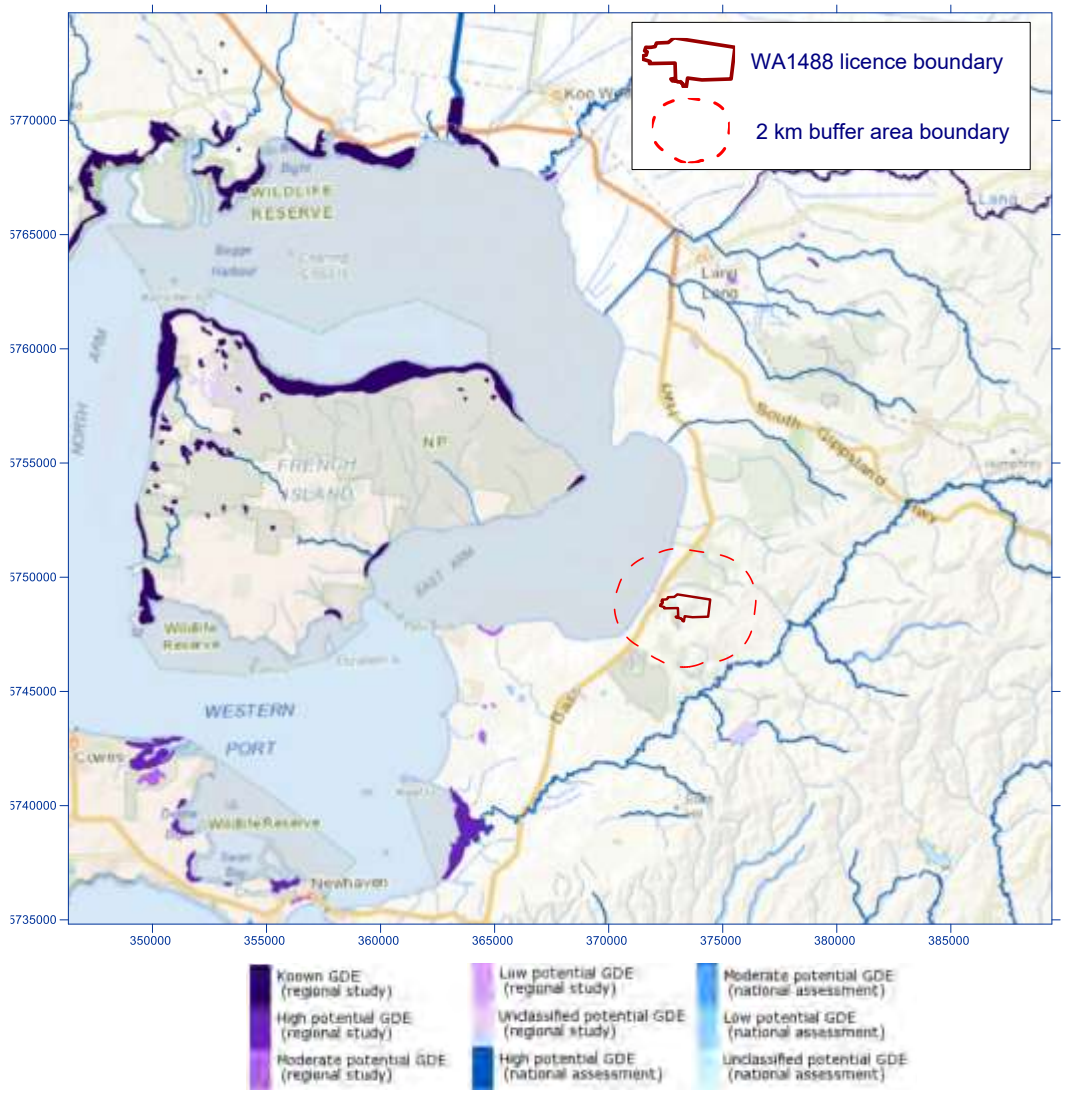


FIGURE 8.3 Aquatic GEDS (GDE Atlas; accessed October 2019)

[2] A Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention. The Convention on Wetlands, known as the Ramsar Convention, is an intergovernmental environmental treaty established in 1971 by UNESCO, which came into force in 1975.

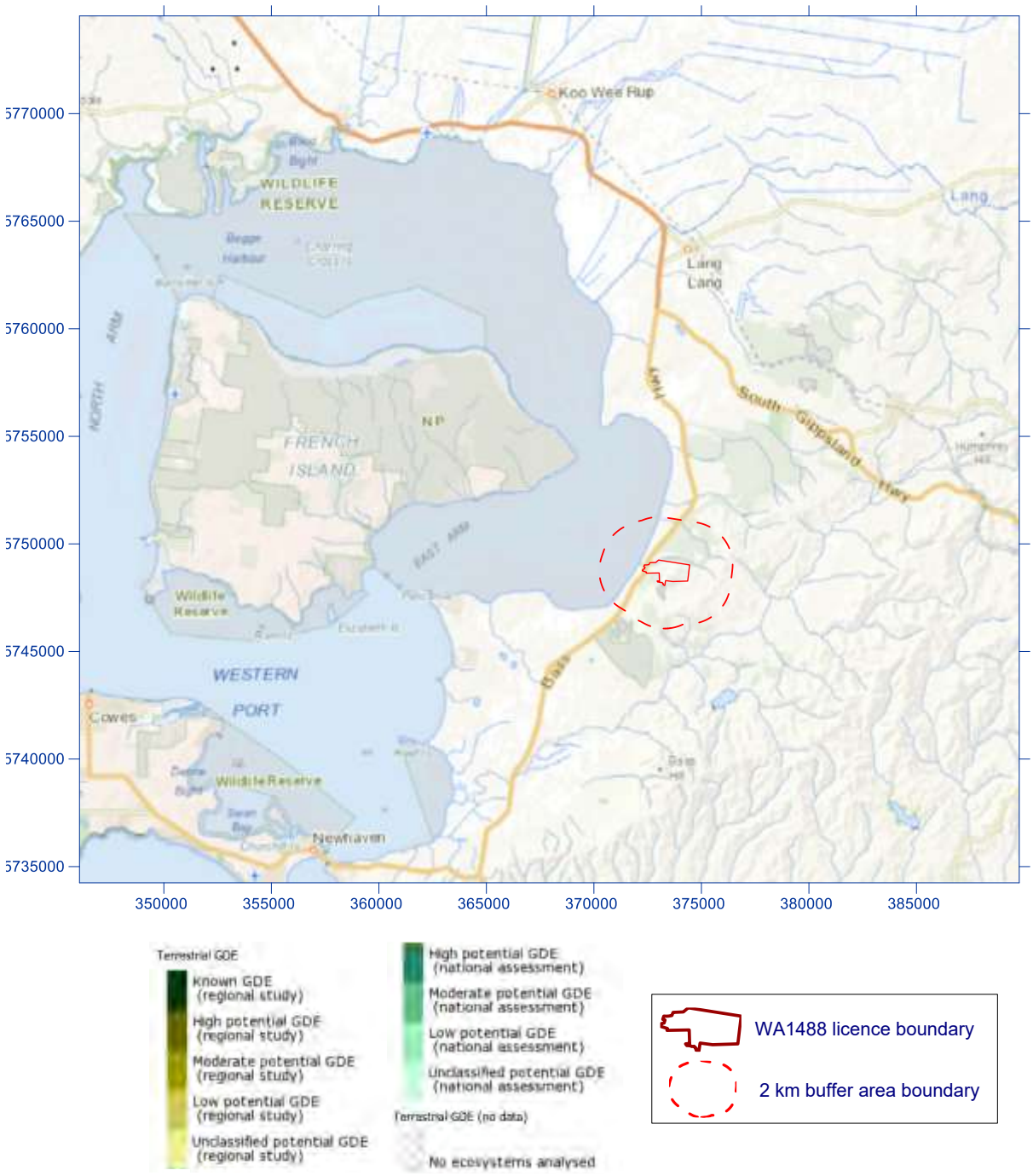


FIGURE 8.4 Terrestrial GEDS (GDE Atlas; accessed October 2019)

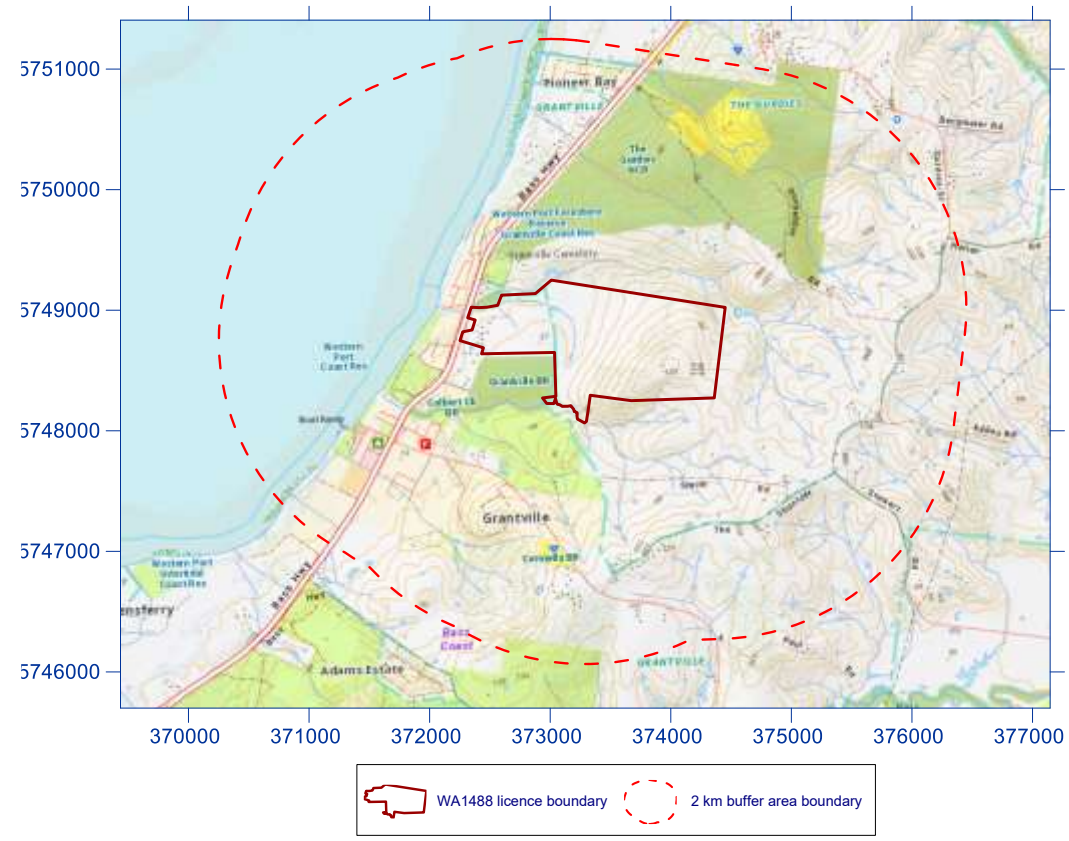




FIGURE 8.5 Wetlands and Ramsar Sites (MapShareVic; accessed October 2019)



9.0 SITE AND PROCESS WATER BALANCES

9.1 SITE WATER USE

The proposed variation to works at WA1488 will require water for sand washing and processing and for dust suppression.

The plant at WA1488 will be enlarged to process both slurry from the proposed FMSEP dredge pond. Dry sand will continue to be extracted above the water table from an expanded FMSEP and blended with sand from the proposed CSEP. The CSEP is designed with a pit floor of 60m AHD, enabling it to achieve a depth of 55m from 115m AHD. The CSEP floor level is estimated to be 45-55m above the regional water table in this eastern portion of the WA1488 site (as discussed in Section 7.3).

The enhanced sand washing and dewatering plant will incorporate the existing raw bulk feed bin system with the addition of constant density feed regulating sumps, cyclones, wet sizing and dewatering screens, water clarifier and thickening tank, mud buffer tanks, process water and make-up tanks, electrical MCC and PLC centre, a dewatering Belt Press and additional Sand transfer conveyors to coordinate continued use of the existing overland conveyor and radial stacking system for stockpiling the processed Sand product(s).

Sand processing water budgets for nominal 200 and 300 dry tonne per hour (dtph) capacity Sand Plants across a number of anticipated 'Resource (Sand) Blends' have been developed by S Young Pty Ltd, based on site resource investigations (drilling campaigns) and the associated sample laboratory test results, which also informed discussion and input from Sand Plant equipment manufacturers (OEMs) and other process related suppliers. The resource blends, take account of the resource sand variability across the site and the need to 'balance' resource use to achieve optimal and responsible utilization of the available resource. The blends include Dry Sand sourced from above the water table in each of the two proposed Extraction Pits ("dry pits") and Wet Sand extracted by Cutter Suction Dredge from below the water table in a pond established in the expanded FMSEP.

The highest water "losses" scenario analysed was for a combination of 220 dry tonnes per hour (dtph) of "wet" sand (25% sand and 75% water slurry) from the FMSEP dredge pond and 109 dtph of "dry" sand quarried from pit areas above the water table in both the FMSEP and the CSEP. A sand and water budget process flow diagram (PFD) for this scenario is presented in Figure 9.1. [It should be noted that this PFD although sufficiently detail for the purposes of this report is a simplification of more comprehensive flow diagrams developed by OEMs.]

The net water lost from the combined sand extraction and process system under the highest water loss operating scenario would be 34 m^3/hr. The corresponding annual water lost for 8-hour work day, 5-days per week for 48 weeks per year would be 65,280 m^3 (65.28 ML).

Dust suppression watering is likely be required mostly during the September-February period on an as needed basis. DPQ estimated that dust suppression is required on about 4 days per week during this period, with 4 tanker loads used per day. The current tanker has a 12,000 L

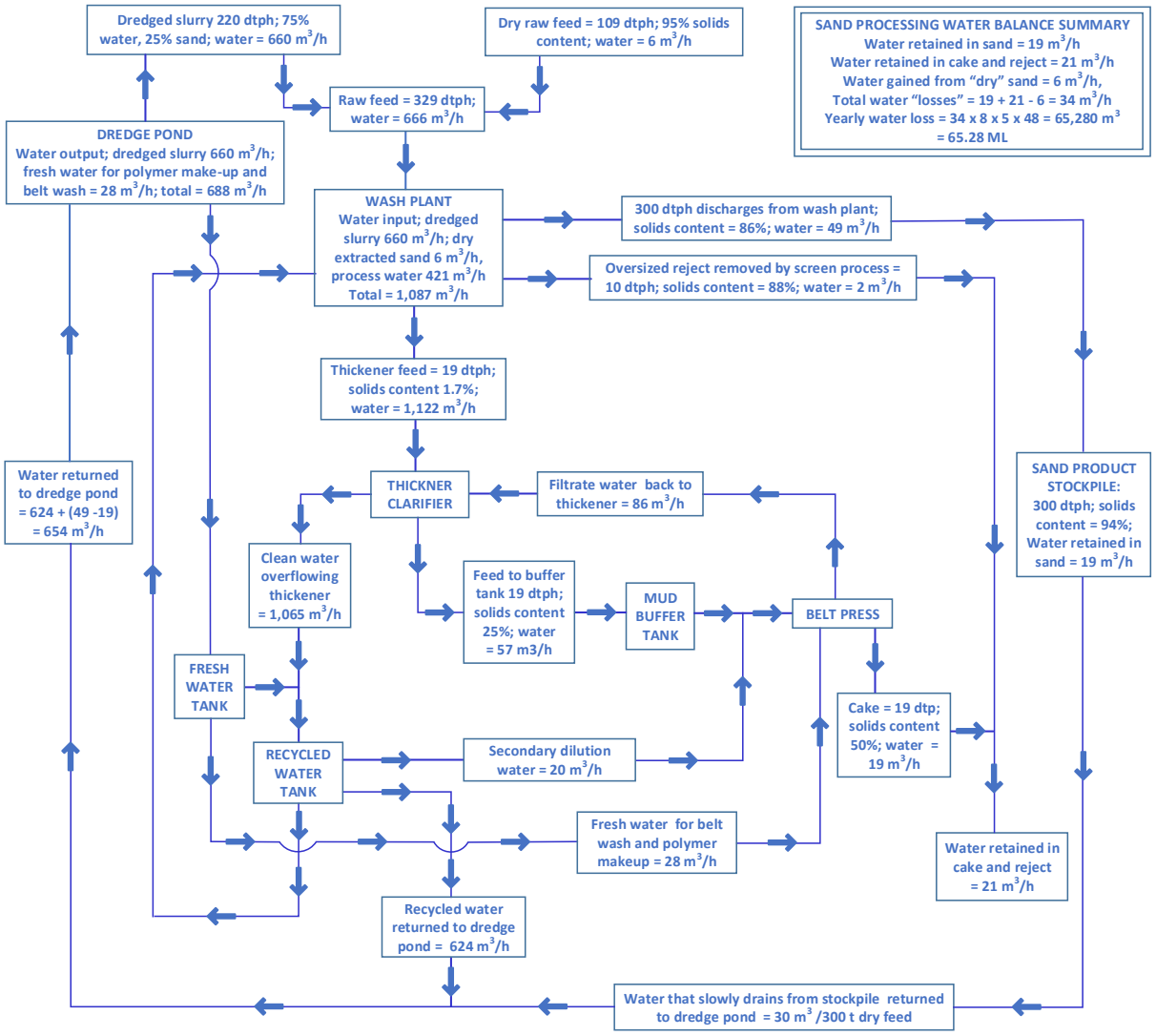


FIGURE 9.1 Sand Processing Mass and Water Budget, 200 dtph Slurry Plus 109 dtph Dry Sand Feed (redrawn after S Young Pty Ltd, 2019)

capacity. This works out to be approximately 7 ML/year, but to be conservative a volume of 10 ML/yr has been allowed. Dust suppression water is currently sourced from on-site dams which will be removed under the WPV as the proposed FMSEP is developed. Consequently, it was assumed that all dust suppression water will be sourced from the FMSEP dredge pond (i.e., groundwater). Water Technology (2019) considered this outcome in their report and recommended the existing Sediment Pond and associated Bio-retention Basin be retained to treat runoff from some of the heavily trafficked areas and the mandated, purpose-built truck wheel wash facility, etc.

The total water use would therefore be about (65 + 10 =) 75 ML/yr

9.2 DREDGE POND WATER STORAGE

The volume of water in the proposed FMSEP dredge pond (Figure 9.2) was determined from pit design drawings by BCA Consulting (in conjunction with DPQ and S Young Pty Ltd). As previously discussed, extraction of water (Groundwater) from the dredge pond will require approval, in the form of a Groundwater Extraction (Take and Use) Licence, from Southern Rural Water (SRW). SRW are the delegated Water Authority under the Water Act 1989, responsible for managing groundwater across southern Victoria. SRW licensed use of groundwater will form part of Earth Resources Regulation (DJPR/ERR) endorsement of the proposed WA1488 Work Plan Variation (WPV).



FIGURE 9.2 WA1488 Proposed FMSEP Dredge Pond Area

As a first approximation, the elevation of the proposed FMSEP dredge pond water surface elevation was assumed to be the mid-way between the elevations in bores up- and down hydraulic gradient of the proposed FMSEP.

Dredge pond surface area	= 241,000 m^2
Water surface elevation	≈ 6.9 m AHD
Dredge pond floor elevation	= -10 m AHD
Dredge pond depth	= (6.9 - (-10) ≈16.9 m
Dredge pond water volume	≈ 3,500 ML

9.3 NET GROUNDWATER STORAGE CHANGE

A simple annual water balance approach was used to estimate the change in groundwater storage from enhanced recharge over the areas of the proposed pits between pre-quarrying and proposed ultimate pits considering both plant processing and dust suppression water losses.



Analysis was undertaken for rainfall infiltration rates of 15%, 20%, 25% and 30% into the area of the pits under pre-quarry land use (JLCS considers that the lower infiltration rates are more likely based on the lithology of the near surface soils and results of grain size analyses on shallow soil samples by ATC Williams, 2016). For the purpose of the simplified water balance, the other water balance components (runoff, evaporation, evapotranspiration) are lumped as non-infiltrated rainfall. The infiltration rate for the ultimate pit conditions after the low permeability overburden is removed was considered to be 100%, i.e., all rain that falls over these area becomes groundwater via infiltration in pit areas above the water table, and rain that falls on the FMSEP dredge pond becomes groundwater storage (the exposed water in the dredge pond would be a "window" into the water table). Possible capture of additional water via runoff into the pits from surrounding areas was ignored.

The increase in groundwater recharge via rainfall infiltration between pre-quarry and ultimate quarry conditions is referred to as "enhanced recharge." The higher the assumed pre-quarrying infiltration rate, the lower the enhanced recharge.

Annual evaporation from the exposed water table in the dredge pond and the total water use volume (75 ML) were subtracted from the enhanced recharge to estimate the annual change in groundwater storage.

Areas and Assumptions:

FMSEP (western): 63.46 ha = 634,600 m^2
CSEP (eastern): 13.89 ha = 138,900 m^2
Total pit area = 77.35 ha = 773,500 m^2
FMSEP dredge pond: 24.1 ha = 241,000 m^2
Annual rainfall and evaporation; 0.9 and 1.145 m, respectively (back calculated from information in Water Technology, 2019)

Example Calculations - Annual:

Pre-quarrying recharge = 773,500 m^2 x 0.9 m x 0.15 = about 104,420 m^3 = 104.42 ML
Proposed pit recharge = 773,500 m^2 x 0.9 m x 1.0 = about 696,150 m^3 = 696 ML
Enhanced recharge = 696,150 – 104,420 = 591,730 m^3 = about 590 ML
Evaporation loss from dredge pit = 241,000 x 1.145 =275,945 m^3 = 275.95 ML
Enhanced recharge - evaporation = 591,730 – 275,945 = 315,785 m^3 = 315.79 ML
Groundwater storage change: 315.79 – 75 = + 240.79 ML

The net increase in groundwater storage for the four analysed infiltration rates are summarised in Table 9.1. The net increase in groundwater storage was derived considering changes in recharge over the ultimate pit areas and not the larger surface water catchment as modelled by Water Technology (2019). In addition, Water Technology (2019) used a different rainfall runoff loss approach, consequently the magnitudes of the water balance components are slightly different. Nevertheless, the annual change in groundwater storage from the simplistic groundwater balance under the 30% pre-quarrying infiltration rate of about 136 ML is in good agreement with volume of 146 ML determined from the Water Technology modelling. The agreement between the results of the two independent assessments increases the level of confidence in the change in groundwater storage estimates.



TABLE 9.1 Net Annual Groundwater Storage Changes, Proposed Pit Areas

Pre-quarrying Rainfall Infiltration Percentage	15%	20%	25%	30%
Coarse sand pit ultimate area	13.89	13.89	13.89	13.89
Fine-medium sand pit ultimate area	63.46	63.46	63.46	63.46
Dredge pond ultimate area	24.1	24.1	24.1	24.1
Annual rainfall	0.9	0.9	0.9	0.9
Annual Evaporation	1.145	1.145	1.145	1.145
Pre-quarrying annual recharge	104.42	139.23	174.04	208.85
Propose pits annual recharge	696.15	696.15	696.15	696.15
Enhanced annual recharge	591.73	556.92	522.11	487.31
Annual Evaporation loss	275.95	275.95	275.95	275.95
Enhanced recharge minus evaporation loss	315.78	280.98	246.17	211.36
Water Usage (processing plus dust suppression)	75	75	75	75
Net Annual Groundwater Storage Increase	**240.78**	**205.98**	**171.17**	**136.36**

Notes: 1) areas in ha, 2) depths in m, and 3) volumes in ML.

As the net groundwater storage increases, there will not be any adverse drawdown interference impacts. Significant mounding is not expected as the increased water going into the groundwater store will be spread throughout the year and any increased head would readily dissipate into the surrounding permeable Brighton Group aquifer.



10.0 GROUNDWATER DRAWDOWN ASSESSMENT

The proposed variation to the approved Work Plan for WA1488 will require additional water supplies. The additional water will be sourced from groundwater either directly via a pumped supply from the proposed dredge pond, or indirectly from water contained in the sand slurry dredged from the dredge pond.

The drawdown interference impact was assessed for a number of scenarios, namely, 1) drawdown based on the groundwater allocation being sought by DPQ, 2) volume of groundwater used based on water "lost" during sand processing plus water used for dust suppression ultimately sourced from the groundwater in the dredge pond, and 3) usage based on changed groundwater storage (as analysed in Chapter 9). A number of different methods were also used to provided "multiple-lines-of-evidence" to support impact assessment conclusions.

10.1 ALLOCATED GROUNDWATER EXTRACTION

DPQ have applied to SRW for the temporary transfer of a consumptive use allocation of 80.5 ML (80,500 m^3) per annum in accordance with provisions of the Water Act 1989 and supplementary rules adopted for the Koo Wee Rup WSPA.

The hourly pumping rate to extract 80,500 m^3 assuming that the quarry will be worked 8 hours per day, 5 days per week for 48 weeks per year would be (80,500 ÷ (48 x 5 x 8) = 80,500 ÷1,920 ≈) 41.927 m^3/hr (≈ 11.65 L/sec). The volume of groundwater pumped over an 8-hour work day would be (41.927 x 8 =) 335.42 m^3 (≈ 0.335 ML).

Drawdown Analytical Modelling

The drawdown induced assuming that the calculate daily volume of 335.4 m^3 was extracted from a bore located at the approximate centre of the proposed FMSEP dredge pond pumping at a rate of 11.65 L/sec for 8 hours was determined using the Theis nonequilibrium analytical modelling equation. This analysis assumed conservative saturated aquifer thickness and storativity of 80 m and 0.001 (dimensionless), respectively, and an aquifer hydraulic conductivity of 25 m/day as derived in Chapter 7. The modelled time-drawdown data and data plots for radii of 350, 700 and 1050 m from the theoretical pumping bore are presented in Table 10.1 and Figure 10.1, respectively. The drawdown at Western Port Bay about 1,050 m from the theoretical bore after pumping for 8-hours would be about 0.025 m.

It is stressed that the calculated drawdowns are significantly overstated as the hydraulics of groundwater flow towards a pumping bore are different than those of flow to a large pond or lake. Consequently the drawdown induced by pumping a single bore are much greater than that for extracting water from a dredge pond. In addition, the modelled storativity was for elastic response whereas the actual storativity (specific yield) could be significantly larger and the associated drawdown significantly lower.

TABLE 10.1 1 Daily Time-Drawdown Data, Discharge = 11.65 L/sec

Radius (m)	350	700	1050
Time (days)	Drawdown (m)	Drawdown (m)	Drawdown (m)
0.03	0.022	0.002	0.000
0.05	0.036	0.006	0.001
0.08	0.050	0.013	0.003
0.10	0.058	0.018	0.005
0.13	0.067	0.024	0.008
0.15	0.072	0.028	0.010
0.18	0.079	0.033	0.013
0.21	0.084	0.037	0.016
0.23	0.088	0.040	0.018
0.26	0.092	0.044	0.021
0.28	0.095	0.046	0.023
0.31	0.099	0.049	0.025
0.33	0.102	0.051	0.027

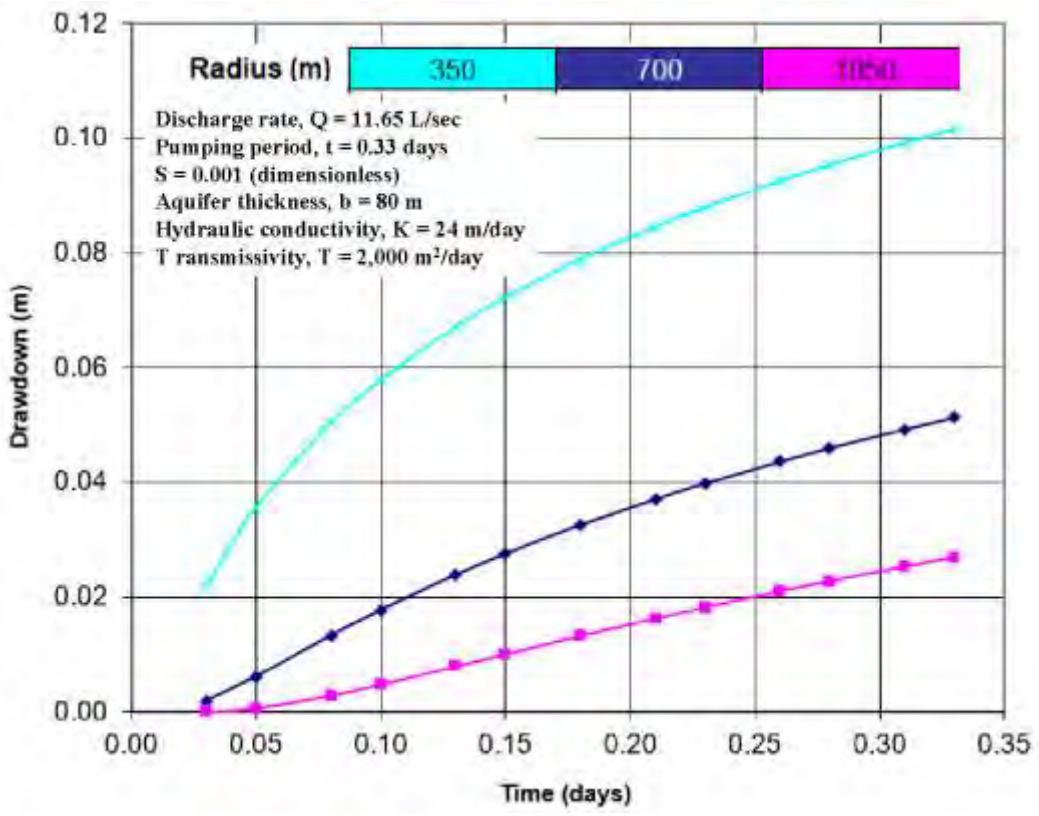


FIGURE 10.1 Daily Time-Drawdown Data Plots, Discharge = 11.65 L/sec



Instantaneous Dredge Pond Water Level Decline

The worst-case drawdown impact was assessed by assuming that the sought 80.5 ML (80,500 m^3) allocation was pumped instantaneously directly from the proposed FMSEP dredge pond.

The FMSEP dredge pond will have a surface area of about 24.1 ha, water depth of about 17 m and contains about 3,500 ML of water. A volume of 80.5 ML is about 2.3 per cent of the volume ow in the proposed dredge pond. The change in the water depth (Δd) in the dredge pond (surface area of 241,000 m^2) assuming that all the sought allocation of 80,500 m^3 is removed instantaneously directly from the pond (worst case scenario and physically not achievable) would be (241,000 x Δd = 80,500) would be about 0.33 m. Applying the same instantaneous extraction analysis for the volume of groundwater extracted during an 8-hour working day of (41,927 x 8 ≈) 335.42 m^3, the changed in water depth would be (241,000 x Δd = 335.42) 0.0014 m, or 1.4 mm (not measurable in the field).

Based on hydraulic theory, any water level depth change, i.e. "drawdown" induced by removing groundwater over an 8-hour working day would recovery during a following equal duration non-pumping period: The non-pumping periods at WA1488 would be significantly longer; 16 hours on Monday, Tuesday, Wednesday and Thursday, and 64 hours from Friday afternoon to Monday morning.

10. 2 ALL WATER FROM DREDGE POND, NO ENHANCED RECHARGE

The worst-case water "loss" from the proposed WA1488 variation would be for all water lost during sand processing and consumptive use (e.g., dust suppression) to be sourced from groundwater in the FMSEP dredge pond with no offset from the enhanced recharge that will occur under proposed quarrying conditions (as discussed in Section 9.3).

The highest water "loss" from sand processing would be for a sand feed blend from both the dredge pond slurry at an input rate of 220 dtph and dry sand quarried above the water table at 109 dtph. The net water loss from this combined feed input would be 34 m^3/hr (0.034 ML/hr) or 65.280 ML annually assuming that the quarry will operate 8-hours a day, 5-days a week for 48 weeks per year. Dust suppress watering will require a conservatively estimated 10 ML/yr. The total annual water deficit would therefore be about 75 ML.

The maximum extraction over an 8-hour day would result in the greatest drawdown interference as the water level would recover during the subsequent 16-hour non-pumping period. The highest daily water loss associated with sand production would therefore be (0.034 x 8 =) 0.272 ML. Assuming that dust suppression will only occur every working day during the 6-month period September to February (120 working days), the daily usage would be (10 ÷ 120 =) 0.08 ML. The highest total daily water deficit would therefore be (0.272 + 0.08 =) 0.352 ML (equivalent to 12.22 L/sec).

The drawdown after 8-hours continuous pumping at a rate of 12.22 L/sec 350 m, 700 m and 1,050 m from an imaginary pumping bore located at the approximated centre of the proposed dredge pond would be about 0.14, 0.06 and 0.03 m, respectively (Table 10.2; Figure 10.2).

TABLE 10.2 Daily Time-Drawdown Data, Deficit Rate = 12.22 L/sec

Radius (m)	350	700	1050
Time (days)	Drawdown (m)	Drawdown (m)	Drawdown (m)
0.03	0.020	0.001	0.000
0.05	0.038	0.003	0.000
0.08	0.060	0.010	0.001
0.10	0.071	0.015	0.002
0.13	0.085	0.023	0.005
0.15	0.094	0.027	0.007
0.18	0.104	0.034	0.010
0.21	0.113	0.040	0.014
0.23	0.119	0.044	0.016
0.26	0.126	0.050	0.019
0.28	0.131	0.053	0.021
0.31	0.137	0.058	0.025
0.33	0.141	0.061	0.027

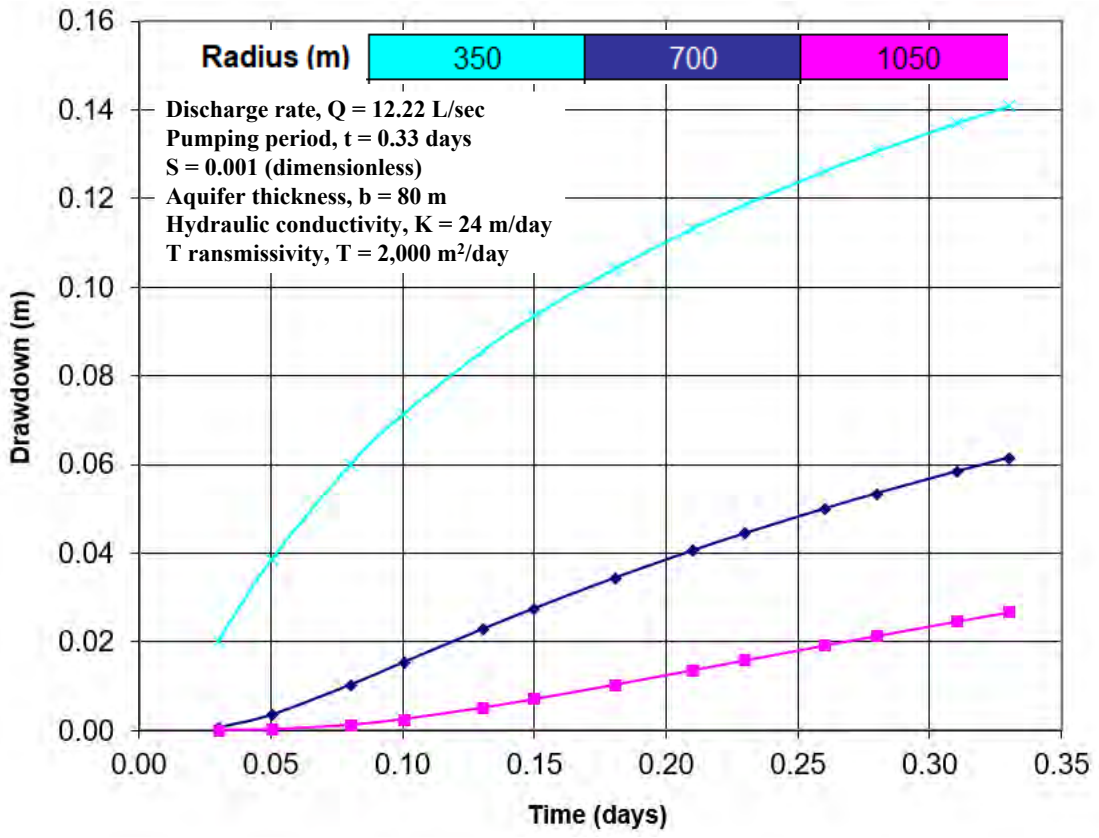


FIGURE 10.2 Daily Time-Drawdown Data Plots, Deficit Rate = 12.22 L/sec



The difference in modelled drawdown for groundwater deficit rates of 11.65 and 12.22 is greatest closer to the imaginary pumping bore (e.g., 350 m distant) than at greater distance with the modelled drawdowns at 1,050 m (distance to Western Port Bay) being the same for both pumping scenarios.

If the daily volume of about 352 m^3 (12.22 L/sec for 8 hours) was removed instantaneously from the proposed FMSEP dredge pond, the change in pond water depth would be (241,000 x $\Delta d = 352 \div 241{,}000 =$) 5 x 10^{-3} m which is miniscule and not measurable in the field.

10.3 NET GROUNDWATER STORAGE

In order to assess the realistic impact of the water deficit (processing loss plus dust suppression water) the increased groundwater storage has to be taken into account. The process and groundwater balances presented in Chapter 9 indicated that the total change in groundwater storage [(enhanced recharge; 487 ML/yr – evaporation loss (276 ML/yr)- water use deficit (75 ML/yr)] for worst case pre-quarrying infiltration (30% rainfall) would be a gain of:

487 – 276 -75 = 136 ML per year (refer Table 9.1).

As the change in groundwater storage is positive, the removal of groundwater in the FMSEP dredged sand slurry and by direct pumping of water from the dredge pond will not cause adverse drawdown interference around the pond. Consequently, the proposed variations to WA1488 Work Plan will not adversely impact local groundwater users or the environment.



11.0 RISK ASSESSMENT

A "groundwater" risk assessment was undertaken to identify and assess all potential risks that the proposed WA1488 variation poses to the groundwater environment including groundwater users, hydraulically interconnected surface water systems (streams, wetlands, springs, ocean) and associated Groundwater Dependent Ecosystems (GDEs). The risk assessment was conducted in accordance with ERR requirements as documented in "Preparation of Work Plans and Work Plan — Variations Guidelines for Mining Projects" (DJPR, 2019)

11.1 SAND EXTRACTION AND POTENTIAL IMPACTS

Sand extraction operations can have detrimental impacts on groundwater quantity if the water table is lowered and/or groundwater quality if extraction operations cause groundwater contamination. Lowering the water table can impact local groundwater users and/or hydraulically connected surface water systems (receiving waters) such as streams, wetland and Groundwater Dependent Ecosystems (GDEs).

Potential impacts on groundwater users, and surface water, wetland and GDE assets vary according to 1) the local hydrogeological setting (aquifer type, degree of groundwater confinement, etc.), 2) aquifer hydraulic parameters, 3) position of pit floor relative to the water table, 4) groundwater extraction (method, volume and extraction schedule) for pit dewatering and/or water supply, 5) method used to extract the sand (dry or wet extraction), 6) proximity of bores to groundwater extraction location(s), and 7) proximity of streams, wetlands and GDEs to pit or groundwater extraction location(s) and degree of hydraulic interconnection.

Groundwater at sand quarries can be contaminated indirectly via percolation from a source down to the water table or directly if runoff from a contaminated source area flows into a sump or pit (dredge pond) excavated below the water table. The potential for groundwater at sand quarries to be contaminated requires 1) a contamination source(s) (e.g., leaking fuel storage tank, accidental spills or leaks of potential contaminants, application of pesticides or herbicides, etc.), 2) complete hydrogeological pathway between the contamination sources and groundwater.

11.2 RISK ASSESSMENTS

Risk analysis involved considering the likelihood of an event occurring, and the severity of an event's consequence(s). The likelihood of an event (Table 11.1) and the consequence/severity of the event (Table 11.2) were combined to derive a risk matrix (Table 11.3). The risk matrix is then used to ascertain the risk of harm to the identified receptors. Once the risk rating has been established some risks will need to have controls in place to reduce them to an acceptable level. Higher risk levels should take priority. Guidance on whether the inherent risks are acceptable or if steps need to be taken to eliminate or reduce the risks is provided in Table 11.4.



TABLE 11.1 Likelihood Description

Likelihood	Description	Event probability
Almost Certain	The risk event is expected to occur in most circumstances.	90-100%
Likely	The risk event will probably occur in most circumstances.	70-90%
Possible	The risk event might occur at some time.	30-70%
Unlikely	The risk event could occur at some time.	5-30%
Rare	Highly unlikely, but the risk event may occur in exceptional circumstances.	0-5%

Source: DJPR, 2019.

TABLE 11.2 Consequences Description

Indicator	Human Impact	Environmental impact	Economic impact
Critical	Death, permanent health impact	Catastrophic on-site or off-site impacts	Immense financial loss
Major	Extensive injuries or illness	Substantial on-site or off-site impacts	Major financial loss
Moderate	Some health impacts	Some on-site or off-site impacts	Large financial loss
Minor	First aid treatment required	Minimal on-site or off-site impacts	Small financial loss
insignificant	No injuries or illness	No environmental impacts	Negligible financial loss

Modified after EPA Publication 1321.2, June 2011.

TABLE 11.3 Risk Matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Critical
Almost Certain	Medium	High	Very high	Very high	Very high
Likely	Medium	Medium	High	Very high	Very high
Possible	Low	Medium	Medium	High	Very high
Unlikely	Low	Low	Medium	High	High
Rare	Low	Low	Medium	Medium	High
None*	None	None	None	None	None

Notes: 1) Source: modified after DJPR, 2019, and 2) *The ERR Risk Matric does not have a category for events that have no likelihood of occurring but that may be of interest to referral agencies and/or the general community.

TABLE 11.4 Risk Rating Acceptability

Risk level	Description
Very High	Totally unacceptable level of risk. Controls must be put in place to reduce the risk to lower levels
High	Generally unacceptable level of risk. Controls must be put in place to reduce the risk to lower levels or seek specific guidance from ERR-
Medium	May be acceptable provided the risk has been minimised as far as reasonably practicable.
Low	Acceptable level of risk provided the risk cannot be eliminated

Source: DJPR, 2019.



The effect of applying the risk matrix is that a risk that is rare but would have an extreme consequence if it did occur is allocated a very high-risk rating. A risk that is almost certain and has only a moderate consequence is also allocated a very high-risk rating. This ensures that likely risks are given appropriate prominence in the impact assessment and that remote risks with major (or above) consequences are appropriately recognized and managed to ensure that they do not eventuate and cause environmental and or human health harm. It is therefore necessary to consider the impact both in terms of consequence and likelihood for the development of potential management and mitigation measures in response to significant risks. [Risk ratings should not be confused with the outcomes of the impact assessment, which consider the likely impacts and focus on current consequences.]

11.3 DRAWDOWN INTERFERENCE RISK ASSESSMENT

11.3.1 Risks

The likelihood, Consequence and Risk of harm from causing drawdown interference by directly or indirectly taking groundwater from the proposed dredge pond at WA1488 are summarised in Table 11.5.

TABLE 11. 5 Groundwater Use – Likelihood, Consequence and Risk of Harm

Risk event	Receptor(s)	Present	Likelihood	Consequence	Risk	Comments
Groundwater removal	Groundwater users	Yes	Unlikely	Minor	**Low**	Drawdown cone shallow and of limited extent
	Gaining streams	No	None[2]	Minor	**None**	Water table below stream beds expect possibly very close to WPB
	Wetlands, springs, GDEs	No	None[2]	Moderate	**None**	None identified with 2 km buffer zone
	WPB Ramsar Site	Yes	Rare	Moderate	**Low**	Drawdown highly unlikely to impact WPB

Notes: 1) GDEs; Groundwater Dependent Ecosystems, and WPB; Western Port Bay; 2) the DJPR (2019) Risk Matrix does not have a "no likelihood" ranking.; DJPR/ERR accepts that a "risk" is not present and does not need to be included in the WPV Risk Register.

11.3.2 Risk Mitigation

Groundwater extraction always causes drawdown dependent of the volume extracted, extraction duration (and schedule) as well as aquifer hydraulic parameters. The drawdown interference impact assessment presented in Chapter 10 indicated that the groundwater deficit associated with sand washing and dewatering, and using groundwater for dust suppression would not have any unacceptable impacts on the local groundwater system or hydraulically interconnected environment segments.

In addition, SRW will stipulated annual and maximum daily groundwater use volumes and other conditions, if any, to ensure that potential impacts and the risk of harm are acceptable. SRW have to consider the impact of using groundwater on local groundwater users and the environment (refer Chapter 2). In order to consider the temporary transfer of licence BEE025666, DPQ have to submit a comprehensive Hydrogeological Assessment (Drawdown

Interference Impact Assessment) report. SRW will then decide whether to grant the temporary licence transfer and what conditions to apply to ensure that all impacts are acceptable.

11.4 GROUNDWATER CONTAMINATION RISK ASSESSMENT

Groundwater contamination risk assessments (GCRAs) identify the risk of harm to groundwater users and/or the environment from potential contamination sources and involve determining the likelihood of a risk occurring and the consequence if it occurs. GCRAs require identification of source (hazard), pathways and receptors and are based on Source-Pathway-Receptor-Consequence (SPRC) models (Figure 11.1). If contamination is to cause harm, it must reach a receptor. A contaminant linkage occurs when a source, pathway and receptor are all present. If no pathways are present the linkage is incomplete. Consequently, there is no risk of the source adversely affecting a receptor.

11.4.1 WA1488 Contamination Sources, Pathways and Potential Receptors

Potential contamination sources at WA1488 are mainly associated with the storage and use of fuels, lubricants and other chemicals (e.g., coagulants and flocculants). Complete pathways for groundwater to be contaminated and for contaminated groundwater to reach potential receptors requires release of contaminants at the ground surface, vertical percolation of contaminated water through the unsaturated zone to the water table or direct entry into the FMSEP dredge pond, and horizontal flow under the prevailing hydraulic gradient to receptors. Potential receptors are local groundwater users, gaining stream reaches (limited to short stream tracts close to Western Port Bay), and saline ecosystems in the coastal groundwater discharge zone. (there are no hydraulically connected wetlands and/or springs, and/or Groundwater Dependent Ecosystems in the Grantville area).

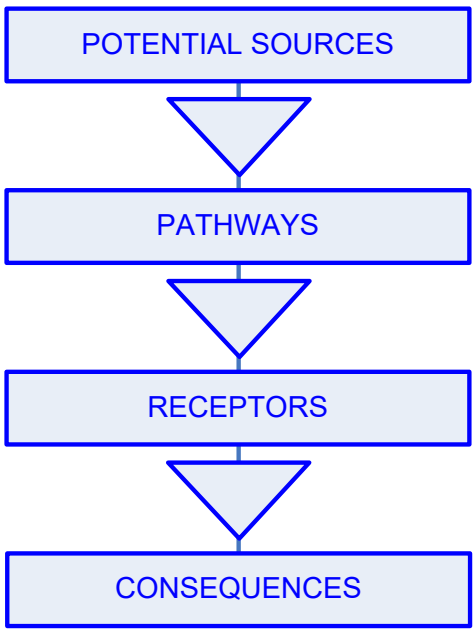


FIGURE 11.1 Groundwater Contamination S-P-R-C Model



11.3.1 Inherent Risks

Groundwater contamination event likelihood, event consequences and associated risk of harm are summarised in Table 11.6.

TABLE 11.6 Groundwater Contamination Inherent Risk Ratings

Risk Event	Receptor(s)	Present	Likelihood	Consequence	Risk	Comments
Leaking fuel storage tank and/or fuel spills	Groundwater users	Yes	Unlikely	Major	**High**	Closest down hydraulic gradient bore 375 m from dredge pond
	Gaining streams	No	None	Minor	**No risk**	Water table below stream beds expect possibly very close to WPB
	Wetlands, springs, GDEs	No	None	Major	**No risk**	None identified with 2 km buffer zone
	WPB Ramsar Site	Yes	Rare	Major	**Medium**	Contaminated groundwater could discharge into WPB
Leakage and/ or spills of stored processing chemicals: Chemicals in water returned to dredge pond	Groundwater users	Yes	Rare	Moderate	**Medium**	Closest bore ~900 m down hydraulic gradient from fuel storage area
	Gaining streams	No	None	Moderate	**No risk**	Water table below stream beds expect possibly very close to WPB
	Wetlands, springs, GDEs	No	None	Moderate	**No risk**	None identified with 2 km buffer zone
	WPB Ramsar Site	Yes	Rare	Minor	**Low**	Ramsar site~300m from WA1488 boundary.
Dredge incident	Groundwater users	Yes	Possible	Moderate	**Medium**	Closest down hydraulic gradient bore 375 m from dredge pond
	Gaining streams	No	None	Minor	**No risk**	Water table below stream beds expect possibly very close to WPB
	Wetlands, springs, GDEs	No	Rare	None	**No risk**	None identified with 2 km buffer zone
	WPB Ramsar Site	Yes	Rare	Moderate	**Medium**	Ramsar site~600m from dredge pond.

Notes: 1) GDEs; Groundwater Dependent Ecosystems, and 2) WPB; Western Port Bay.

The concentration of any contaminants that enter groundwater would be dilution and attenuation during migration from the source to receptors including Western Port Bay discharge area. Concentration levels in discharged groundwater would be further reduced by dilution with surface water.

11.4.2 Risk Mitigation and Residual Risks

Measure that will be used to mitigate risks of fuels and/or chemicals storage and use causing groundwater contamination will include:

- All fuels and other chemicals will be stored in compliance with 1) Hydrocarbon storage in accordance with AS 1940 (The Storage and Handling of Flammable and Combustible Liquids) and 2) the Dangerous Goods (Storage and Handling) Act.



- Underground fuel storage tanks will not be used.
- Vehicle refuelling will only be in bunded hardstand containment areas
- Contaminant spill kits will be kept onsite.
- All machinery and equipment including the cutter dredge will be regularly checked and maintained to minimize the potential for equipment failure.
- Drip trays will be used on the cutter dredge to contain accidental spills when refuelling or changing hydraulic fluids.

If any potential groundwater contaminating events occur, DPQ will initiate works to either remove or control the potential contamination source, install investigation/monitoring bores down hydraulic gradient from the source to determine water quality impacts, up-date the risk assessment to determine whether the risk of harm has become unacceptable, instigate clean-up measures appropriate to the source characteristics to rehabilitate any contaminated groundwater to the extent practicable or until the risks are acceptable.

Implementing the risk mitigation measures as outlined including undertaking action in the event of a potential groundwater contaminating event occurring, will reduce both the "Likelihood" of an event being potentially contaminating and the "Consequences' of any potential contaminating event to the "Rare" and "Minor" categories, respectively, and the risk ratings to "Low" (Table 11.7).

TABLE 11.7 Groundwater Contamination Residual Risk Ratings

Risk Event	Receptor(s)	Present	Likelihood	Consequence	Risk
Leaking fuel storage tank and/or fuel spills	Groundwater users	Yes	rare	Minor	**Low**
	Gaining streams	No	None	Minor	**No risk**
	Wetlands, springs, GDEs	No	None	Major	**No risk**
	WPB Ramsar Site	Yes	Rare	Minor	**Low**
Leakage and/ or spills of stored processing chemicals: Chemicals in water returned to dredge pond	Groundwater users	Yes	Rare	Minor	**Low**
	Gaining streams	No	None	Moderate	**No risk**
	Wetlands, springs, GDEs	No	None	Moderate	**No risk**
	WPB Ramsar Site	Yes	Rare	Minor	**Low**
Dredge incident	Groundwater users	Yes	rare	Minor	**Low**
	Gaining streams	No	None	Minor	**No risk**
	Wetlands, springs, GDEs	No	Rare	None	**No risk**
	WPB Ramsar Site	Yes	Rare	Minor	**Low**

Notes: 1) GDEs; Groundwater Dependent Ecosystems, and 2) WPB; Western Port Bay.



12.0 GROUNDWATER MONITORING AND MANAGEMENT

12.1 GROUNDWATER LEVEL

Groundwater levels at WA1488 are monitored in the nine purpose-installed and SRW licensed bores. The bores are considered to be suitably located to monitor groundwater around the proposed dredge pond. However, bore BH05 installed in January 2016, will be removed as it is located in the area of the proposed FMSEP dredge pond. JLCS recommends that two new bores are installed. The first bore should be sited to the west of the proposed pond to provide an addition down hydraulic gradient monitoring control point and the second sited to the south of the proposed FMSEP dredge pond to monitor hydraulic conditions to the Grantville Bushland Reserve, a sensitive Public Land receptor immediately adjoining part of the WA1488 southern boundary. Groundwater levels should continue to be measured quarterly for use in assessing the impact of sand extraction operations and groundwater extraction on local groundwater, groundwater users and the environment.

12.2 GROUNDWATER QUALITY

No specific measures are recommended to manage groundwater quality at this stage. However, if potentially groundwater contaminating events occur JLCS recommends:

- Installed targeted bores specifically located to monitor groundwater impacts around the of potentially contaminating source such as spill and or leak areas.
- Sample the contamination bores for Chemicals-of-Concern associated with the identified source.
- Review the water chemistry analytical results to identify any groundwater quality degeneration.
- Assess the impact of the groundwater contamination
- Update to the WA1488 Groundwater Risk Assessment to determine whether the risk of harm has become unacceptable
- If assessed impacts and/or risks are unacceptable develop and implement measure to remediate the contaminated groundwater.

12.3 GROUNDWATER SEEPS AND INFLOWS

Unexpected seeps or groundwater inflows associated with perched groundwater could occur as quarrying of the coarse sands in the proposed CSEP advances.

Depending on the nature of the seeps or inflow and the potential to cause batter slope instability or other safety impacts, groundwater control measures to drain working faces and lower pore pressure could be required such as:

- Construction of a sump to capture groundwater;
- installation of groundwater interception system, e.g., cut-off drains;



- installation of dewatering bores; and/or
- installation of horizontal or sub-horizontal drainage bores

A detailed Ground Control Management Plan (GCMP) has been prepared by GHD as stand-alone, iterative management document (tool) that will be updated to reflect changed conditions as the proposed extraction areas at WA1488 are developed. The GCMP includes the continued monitoring of groundwater at WA1488. The monitoring results from the investigation bores (BH08 and BH09) either side of the Heath Hill Fault will be of particular interest.

These groundwater monitoring results, in conjunction with the 'open ground' conditions encountered in the CSEP will provide information to guide measures that may be required to control groundwater and to monitor the effectiveness of any works undertaken to control groundwater seeps and/or inflows encountered in the CSEP. The GCMP will be updated to record the encountered 'open ground' conditions, any significant changes to the monitored groundwater and the effectiveness of any CSEP groundwater controls implemented.

Any impact on groundwater of the proposed below groundwater extraction of sands in the FMSEP will also be monitored. Should any groundwater, or ground stability risks be identified, they will be appropriately addressed in a recommended Groundwater Management Plan (GMP) in addition to the GCMP.

12.4 GROUNDWATER MONITOR AND IMPACT REVIEW

Information from the groundwater monitoring program should be reviewed annually and used to assess impacts, to update the risk assessments and, if required instigate measure to remove of mitigate any identified risks.

12.5 GROUNDWATER MANAGEMENT PLAN

A Groundwater Management Plans (GMP) for WA1488 will be prepared. The GMP will document measures and procedures to monitor the impact of quarrying activities on groundwater levels and quality, and impacts on local groundwater users and the environment. Similar to the GCMP, the GMP will be a stand-alone, iterative management document (tool) that will be updated to reflect changed conditions as the proposed pits at WA1488 are developed. The objectives of the GMP is to ensure that no unacceptable changes in the condition of local groundwater due to quarrying activities occur, and that groundwater does not affect the health and/or safety of site employees and other groundwater users.

Key considerations in the GMP for WA1488 will be:

- Changes to groundwater levels
- Changes to groundwater quality.
- Unexpected groundwater seeps and inflows



An important requirement of the GMP will be to ensure that the network of monitoring bores is adequate to detect change to groundwater levels and chemistry. The groundwater monitoring network and monitoring program for water level and ambient groundwater chemistry will be commensurate with the risk of quarrying activities causing unacceptable risks of drawdown that adversely effects the water level in local supply bores and/or hydraulically interconnected surface water systems including ecosystems that depend on groundwater (GDEs).



13.0 FINDINGS AND CONCLUSIONS

Dandy Premix Quarries Pty Ltd (DPQ) are seeking a Work Plan Variation (WPV) Phase 2 Development) of WA1488, 1381-1395 Bass Highway, Grantville, Victoria. The first element of the proposed WA1488 variation works include increasing the area of the western FMSEP above water table and dredging sand from the central area of the pit (dredge pond).

The second distinct element of the WPV is development of a new coarse sand extraction pit (CSEP) at higher elevation in the eastern portion of the approved site, well above the water table and immediately west of the Heath Hill Fault.

The WPV will also require additional water for sand washing and processing beyond the volume currently used for dust suppression only. The additional water would be sourced from groundwater either pumped directly from the dredge pond or recovered from the sand feed (mostly from dredged slurry). DPQ have negotiated a temporary groundwater licence transfer for 80.5 ML per annum. SRW as the delegated manager of groundwater across southern Victoria have to approve the transfer and will set licencing conditions to ensure that drawdown interference impacts, if any, are acceptable.

WA1488 is within Zone 7 Coastal Buffer of the Koo Wee Rup Water Supply Protection Area (KWRWSPA). The amount of groundwater that can be extracted annually from Zone 7 is 2,545.5 ML; this volume has been fully allocated. Actual groundwater usage in Zone 7 has historically been less than 40 per cent of the total allocated volume.

The topography and geology at WA1488 are controlled by movement along the general northeast-southwest aligned Heath Hill Fault in the eastern portion of the site and subsequent erosion. The larger western portion (~124.0 ha) is located within the Tertiary Western Port Basin and the eastern upthrown area (~31.6 ha) in the Cretaceous Gippsland Basin. Movement on the Heath Hill Fault has juxtapositioned younger, unconsolidated Tertiary Brighton Group against consolidated and indurated Cretaceous Strzelecki Group Rocks that form the Strzelecki Ranges.

The majority of WA1488 is located on outcropping Brighton Group sediments comprised of up to 4-10 m of silt and clay overburden overlaying fine-medium sand in the western portion of the site, with thinner to absent overburden above the coarse sand in the more elevated eastern portion of the site. A thin veneer of Brighton Group overlies older Cretaceous consolidated Strzelecki Group rocks. A volcanic plug intruding Strzelecki Group rocks was intersected in drillholes immediately east of the Heath Hill Fault.

WA1488 is in a coastal aquifer hydrogeological setting. The regional water table which slopes in a general westerly direction towards Western Port Bay occurs within the Brighton Group west of the Heath Hill Fault and in the Strzelecki Group east of the fault. Shallow groundwater intersected in bores immediately east of the Heath Hill Fault is consider to be perched above the deeper regional water table. The regional water table is below the base of both creeks that bound WA1488, Deep Creek near the northern boundary and Colbert Creek near the southern boundary. The salinity of the groundwater in the Brighton Group beneath WA1488 was less than 500 mg/L TDS.



The horizontal hydraulic conductivity of the fine to medium sand is in the general range 20 to 30 m/day. The hydraulic conductivity of the coarse sand facies in the eastern portion of WA1488 would be higher possibly up to 50 m/day.

Groundwater discharges mainly into the Western Port Bay over a relatively wide discharge/transition zone, into local creeks where the base of the creeks are below the water table, or via evapotranspiration near the bay where the water table is close to the ground surface. The water table is below the base of both creeks that bound WA1488 (Deep Creek along the northern boundary and Colbert Creek along the southern boundary). The water table only intersects the streambed of these creeks very close to Western Port Bay.

Rainfall recharge under per-quarrying conditions was variable with high infiltration rates (25 to 30%) on the more elevated eastern portion where Brighton Group sands outcrop or subgroup beneath a thin layer of silt and clay, and lower (less than 15-20) in the flatter-lying western portion of the site where sand is overlaid by a thicker layer of silt and clay.

Groundwater recharge at WA1488 has been increased by the development of the existing FMSEP as a result of the removed of the silt/clay overburden and exposure of the underlying more permeable sands. Recharge will be further increased (enhanced) as the proposed footprint of the existing FMSEP increases and with development of the proposed eastern CSEP. The resulting increased groundwater storage will be reduced by evaporation from the free water surface in the proposed FMSEP dredge pond and by water deficit associated with sand processing as well as by the future use of groundwater pumped from the FMSEP dredge pond for dust suppression (10 ML/yr).

Overall site and sand processing water budgets indicate that there will be a minimum net gain to the groundwater system of about 136 ML per annum resulting from increase rainfall infiltration into the exposed sands or the dredge pond. Consequently, local drawdown interference is not expected to occur.

The findings of groundwater quantity and quality risk assessments were that most potential risks are in the Low Risk category, and that Risk Mitigation measures would result in Low Residual Risks.

The current groundwater bore network is considered to be adequate to monitor the impact of the proposed WPV on the regional water table. However, it is recommended that a replacement bore for BH05 which will be removed as the FMSEP dredge pond is developed. The replacement BH05 should be sited down the hydraulic gradient to the west of the FMSEP dredge pond. An additional monitoring bore should be sited to the south of the FMSEP near the WA1488 site boundary with the Parks Victoria, Grantville Bushland Reserve.



14.0 REFERENCES

Anderson R (2018). BH8 lithologic log, core photographs and summary geological profile. Prepared by R Anderson, Consultant Engineering Geologist.

Bense V F, Van Den Berg E H and Van Balen R T (2003). Deformation mechanisms and hydraulic properties of fault zones in unconsolidated sediments; the Roer Valley Rift System, the Netherlands. Hydrogeol. Journal, 11,319-332.

Bense V F and Van Balen R T (2004). The effect of fault relay and clay smearing on groundwater flow patterns in the Lower Rhine Embayment. Basin Research(2004) 16, 397-411, doi: 10.1111/j.1365-2117.2004.00238.x

Brown, A, Allen, T, and Gibson, T (2013). Seismicity and Earthquake Hazard in Gippsland, Victoria. AEES Conference Paper November 2013.

Caine J S, Evans J P, and Forster C B (1996). Fault zone architecture and permeability structure: Geology, v. 24, p. 1025-1028.

Craigie, N M (2012). Drainage and water quality management report. Version 1 Draft Report. Neil M Craigie Pty Ltd. April, 2012.

Condina, P (2012). Condition of Deep Creek. Pat Condina & Associates. April 2012.

Dickinson J A, Wallace MW, Holdgate G R, Daniels J, Gallagher S. J. and Thomas L (2001). Neogene tectonics in SE Australia: implications for petroleum systems. Australian Petroleum Exploration Association Journal 41, 37-52.

Duddy I (2003) Mesozoic a time of change in tectonic regime. In: Birch WD (ed.) Geology of Victoria. Geological Society of Australia Special Publication 23. Geological Society of Australia (Victoria Division). Pp 239-286.

Duddy I R and Green P F (1992). Tectonic development of the Gippsland Basin and environs: identification of key episodes using apatite fission track analysis (AFTA). In: Barton C. ed. Energy; Economics and Environment; Gippsland Basin Symposium. Australasian Institute of Mining and Metallurgy Melbourne., 22-23 June 1992, pp. 111—120.

Edwards A B (1934). Tertiary dykes and volcanic necks of South Gippsland, Victoria. Proceedings of the Royal Society of Victoria 47 pp 112-132.

Edwards A B (1939). Petrology of the Tertiary Older Volcanic rocks of Victoria. Proceedings of the Royal Society of Victoria 51 pp 73-98.

Fulljames J R, Zijerveld J J and Franssen R C M W (1997). Fault seal processes: systematic analysis of fault seals over geological and production time scales. In: Hydrocarbon Importance for exploration and production (Ed. by N.R Society), NPF Special Publication 9, pp 51-59.

Gibson R G (1998). Physical character and fluid-flow properties of sandstone derived fault zones. Coward M P, Daltaban T S, Johnson H. Eds. Structural Geology in Reservoir Characterization. Geological Society, London, Special Publications 127 pp 83-97.

Holdgate G and Gallagher S J (2003). Tertiary: a period of transition to marine basin environments. Chapter 10. In: Birch WD (ed.) Geology of Victoria. Geological Society of Australia Special Publication 23. Geological Society of Australia (Victoria Division). pp 289-335.

Holdgate G and Gallagher S J (2003). Plio-Pleistocene tectonics and eustasy in the Gippsland Basin, southeast Australia: evidence from magnetic imagery and marine geological data.



Hillis R R and Reynolds S D (2000). The Australian Stress Map. Journal of the Geological Society of London, Vol 157, p 915-921.

Hocking, J. B. (1988). Gippsland Basin. In Geology of Victoria. 2nd Ed (eds. J G Douglas and J A Ferguson). Victorian Division Geological Society Australia. P322-347.

Jenkin J J (1962). The geology and hydrology of the Western Port area. Department of Mines, Victoria. Underground Water Investigation Report No. 5Jenkin J J (1962). The geology and hydrogeology of the Western Port area. Geological Survey Victoria Underground Water Report No. 5.

Jenkin, J J (1974). The geology of the Mornington Peninsula and Westernport. Geological Survey Victoria 1974/3.

JLCS (2012). Hydrogeological Assessment, Sand Extraction Proposal, 1381-1395 Bass Highway, Grantville. Consultants report prepared by John Leonard Consulting Services for Dandy Premix Quarries Pty Ltd, May 1012.

JLCS (2018). Hydrogeological Assessment Grantville Landfill. Consultants report prepared by John Leonard Consulting Services for Bass Coast Shire Council, September 1018King R S Holford S, Hillis R, Tuitt A, Swierczek E, Backe G, Tassone D and Tingay M (2012). Reassessing the in -situ stress regimes of Australia's Petroleum Basins. APPEA Journal 2012 p415-424.

Lakey, R and Tickell, S (1981). Explanatory Notes on the Western Port Groundwater Basin 1:100000 Hydrogeological Map. Geological Survey Victoria Report No.69.

Lehner F K and W F Pilaar (1997). On a mechanism of clay smear emplacement in synsedimentary normal faults, in Hydrocarbon Seals: Importance for Exploration and Production, NPF Spec. Publication vol. 7. edited by P. Moller-Pedersen and A. G. Koestler, pp. 39-50, Elsevier, New York.

Lindsay N G, Murphy F C, Walsh J J and Watterson J (1993). Outcrop studies of shale smears on fault surfaces. In: The Geological Modelling of Hydrocarbon Reservoirs and Outcrop Analogues. Ed. by S S Flint and I D Bryant. pp. 113—123. Blackwell Scientific Publications, Oxford.

Medwell L. M. 1954. A review and revision of the flora of the Victorian Lower Jurassic. Proceedings of the Royal Society of Victoria 65, 63—111.

SKM (2003). Koo Wee Rup Water Supply Protection Area Technical Assessment. Final Report. Sinclair Knight Merz. June 2003

Smith D A (1980). Sealing and non-sealing faults in Louisiana Gulf Coast Basins. American Association Petrology 64 pp145-172.

Spencer-Jones, D, Marsden, M A H, Barton, C M and Carrillo-Rivera, J J (1975). Geology of the Western Port sunkland. Proceedings Royal Society Victoria (87) 1&2, 43-68.

SRW (2010). Groundwater Management Plan. Koo Wee Rup Water Supply Protection Area. Southern Rural Water 2010.

SRW (2010). Koo Wee Rup Regional Update, Sothern Rural Water. October 2010

SRW (2018). Koo Wee Rup Groundwater Management Plan Annual Report 2017-2018. Southern Rural Water.

Thompson B R (1974). The Geology and Hydrogeology of the Western Port Sunklands. Geological Survey Victoria Report 1974/1.

Tuitt et al (2011). reverse-reactivation of deep syn-rift normal faults, resulting in deformation of Cenozoic post-rift sediments

VandenBurg F (1977). Warragul 1:250,000 Geological Map Sheet SJ55-10 Ed. No 2, May 1977. Geological Survey of Victoria.



VandenBurg F (2016). Depositional Facies and Extent of the Late Neogene Sandringham Sandstone in Southern Victoria, Australia. Royal Society of Victoria, 128 pp 7-24.

Victorian Government Gazette No. G 28 Thursday 14 July 2010.

Victoria Government Gazette (2018). State Environment Protection Policy (SEPP) "Waters of Victoria" gazetted on 19 October 2018 and amended 23 October 2018 (Victoria Government Gazette No S 499 Tuesday 23 October 2018.

Water Technology (2019). Grantville Sand Quarry Expansion - Surface Water Report. Prepared for Dandy Premix Quarries Pty Ltd. November 2019.

Welsh, S I, Higgins, D V and Callaway, G A (eds). (2011). Surface Geology of Victoria. Geological Survey of Victoria, Department of Primary Industries.

Young S (2019). WA1488 Simplified Plant Water Balance Process Flow Diagrams prepared by S Young, S Young Pty Ltd November 2019.

15.0 LIMITATIONS OF THIS REPORT

The advice provided in this report relates only to the project described herein and must be reviewed by a competent Engineer or Scientist before being used for any other purpose. JOHN LEONARD CONSULTING SERVICES Pty Ltd accepts no responsibility for other use of the data.

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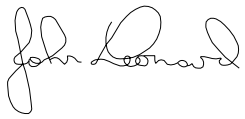

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December 2019

JOHN LEONARD CONSULTING SERVICES PTY LTD

REPORT 3 – SURFACE WATER MANAGEMENT



Report

WA1488 Grantville – Work Plan Variation Expansion of Sand Extraction Operations, Sand Washing & Dewatering Plant

Dandy Premix Quarries Pty Ltd

12 December 2019

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12 December 2019

Garry Cranny
Manager
Dandy Premix Quarries Pty Ltd
Via email GCranny@dandypremix.com

Dear Garry

WA1488 Grantville – Work Plan Variation Expansion of Sand Extraction Operations, Sand Washing & Dewatering Plant

Thank you for the opportunity to work with you and the assembled team of experts on this project. Water Technology has reviewed the previous work completed by Neil Craigie in May 2012 and has updated the surface water analysis completed at that time with information relevant to the proposed quarry expansion.

If you have any questions regarding this report, please do not hesitate to contact me on (03) 8526 0800.

Yours sincerely

Ben Tate
National Practice Lead - Flooding
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WATER TECHNOLOGY PTY LTD

5631-01_R01v03_Grantville_SurfaceWater

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1 INTRODUCTION

Dandy Premix Quarries Pty Ltd ('Dandy Premix') are seeking to expand their currently approved sand extraction operations at the WA1488 Grantville site. The current operation is approved to extract sands from above the Groundwater table to a maximum depth of 10m AHD. The proposed expansion of sand extraction operations includes extraction from a large portion of the MW3840 tributary catchment draining ephemerally to Deep Creek. The proposal also includes the extraction of sands to greater depth, including below the Groundwater table.

This report has reviewed the surface water catchment runoff and site drainage arrangements and summarises a surface water balance to demonstrate the impact of the proposed expansion of sand extraction operations to the water budget of the catchment on the WA1488 site.

Located on the Bass Highway approximately 1.2km north of Grantville, the subject property is approximately 156 hectares in size. The natural topographical fall of the site is from east to west with the ground surface elevation across the site ranging from 122m AHD in the east, to 12m AHD to its western boundary, which is approximately 300m from the foreshore of Western Port Bay. The subject site is situated to the south of Deep Creek and to the north of Colbert Creek, both draining east to west to Western Port Bay. The majority of the WA1488 site drains to the Melbourne Water asset, MW3840, a tributary to Deep Creek, with ephemeral tributary flows entering Deep Creek just upstream of the Bass Highway. Figure 1-1 shows the relevant surface water features of the WA1488 site, the surrounding areas and its proximity to Western Port Bay.

The south-eastern section of the MW3840 tributary upstream of the quarry operations area, is a poorly defined shallow depression through a previously stock grazed grass paddock. Two waterbodies are located along the MW3840 tributary within the site, including a shallow pondage (Northern Storage Dam) created upstream of a constructed haul road to the extraction pit and an augmented farm dam to the immediate west of the haul road which was present before quarry operations began.

The existing hardstand operations and sand processing area drains to a sediment basin which then overflows to a bioremediation pond before flowing to the MW3840 tributary. Downstream of the augmented farm dam the MW3840 tributary is a clearly defined waterway with a much larger capacity than upstream of the hardstand operations area. The downstream section of the MW3840 tributary was actively eroding prior to the commencement of quarry operations and is the subject of an approved slope stability monitoring plan and accompanying trigger action response plan (TARP).

Since the start of quarry site establishment and commercial operations, stock grazing of land surrounding the MW3840 tributary has ceased and the downstream section of the tributary has been progressively replanted with native riparian vegetation as part of the Bass Coast Landcare Network Landscape and Vegetation Plan (Spring 2013), endorsed by Bass Coast Shire Council under Planning Permit No.120388 for the WA1488 site. Figure 1-2 shows more detail of the MW3840 tributary draining the site and discharging to Deep Creek.

The currently approved WA1488 Work Plan extraction area is 22.6 ha, with approximately 14 ha currently under active extraction (topsoil and clay overburden removed). The approved Work Plan for the quarry has an approved overburden stockpile located near to the catchment divide between the MW3840 tributary catchment to Deep Creek and the catchment draining to Colbert Creek. The temporary overburden stockpile is approximately 3.1 ha in area and is approved to be further enlarged and to operate as an extended haul road to the proposed Coarse Sand Extraction Pit (CSEP).

Stormwater from the stockpile is presently captured at the base of the stockpile and directed via drains around the base of the overburden storage site to an onsite sedimentation basin north of the stockpile, before flowing via the shallow depression that forms the upper reach of the MW3840 tributary upstream of the extraction pit haul road.

The designated topsoil retention stockpile and a second temporary stockpile of sand that requires processing through the proposed wash plant, are both located to the east of the hardstand operations area. Figure 1-3 is an aerial image with ground contours taken by Landair Surveys in June 2019 that shows each of these material stockpiles and the temporary overburden stockpile.

The Work Plan Variation (WPV) proposes expanding the currently approved extraction pit, the Fine/Medium Sand Extraction Pit (FMSEP), in a progressive, or staged manner. The initial sand extraction focus will be within the FMSEP, to progressively enlarge it to its southern and western extraction limits, while also deepening the pit below the upper limit of groundwater to form a 'pond' in the FMSEP nearest the farm dam and northern extraction boundary to the hardstand operations area.

With the groundwater exposed and sufficient sand extracted to form a pond/lake within the FMSEP, a cutter suction dredge installed as part of a floating barge will be introduced to extract below water sand as a pumped slurry to the wash plant installed in the hardstand operations area.

The WPV also proposes a separate Coarse Sand Extraction Pit (CSEP), a dry sand extraction operation at higher elevations in the eastern portion of the site, but within the Deep Creek (MW3840) catchment area. The CSEP floor level is designed at 60 m AHD, some 40-50 m above the monitored groundwater table in this area of the WA1488 site.

Other related expert technical reports which form part of and support the WPV application for an expansion of the WA1488 sand extraction activities include, but are not limited to:

- Hydrogeological Assessment by John Leonard Consulting Services (JLCS).
- Geotechnical Assessment of Extraction Pits and accompanying Ground Control Management Plan prepared by GHD.

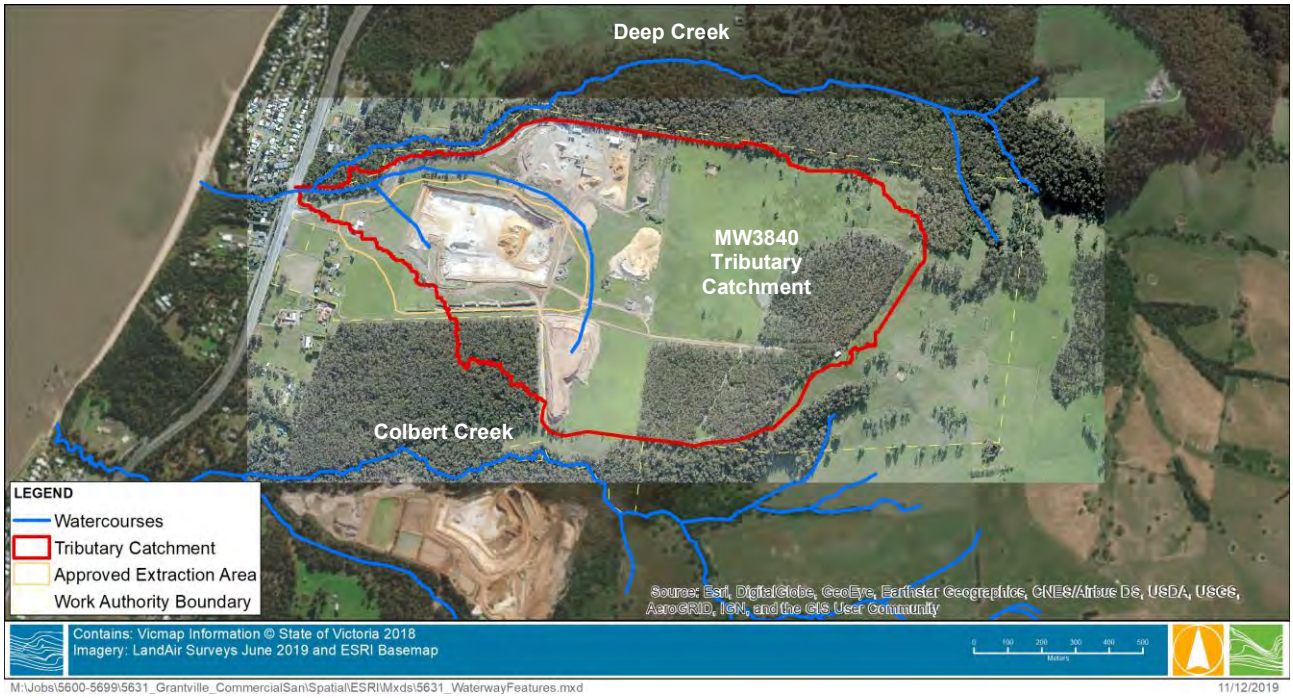

FIGURE 1-1 THE SUBJECT SITE AND RELEVANT SURFACE WATER FEATURES

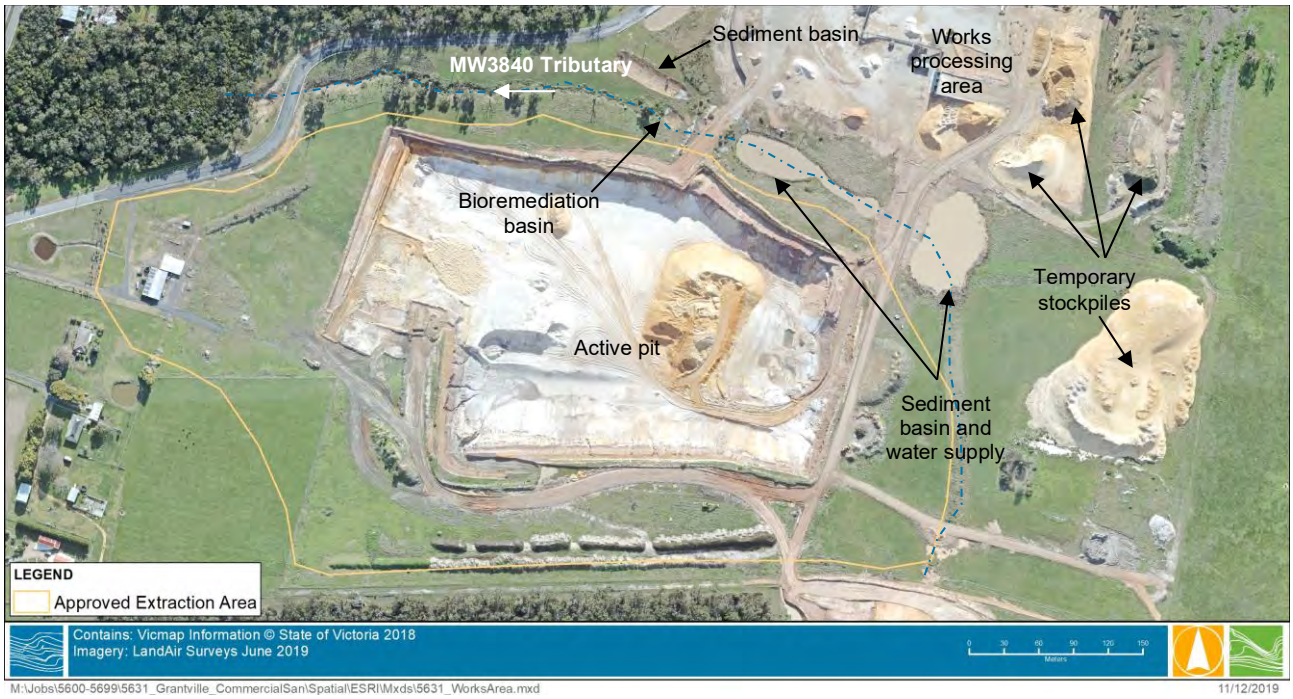

FIGURE 1-2 THE MW3840 TRIBUTARY DRAINING THE SITE AND OTHER RELATED SITE FEATURES

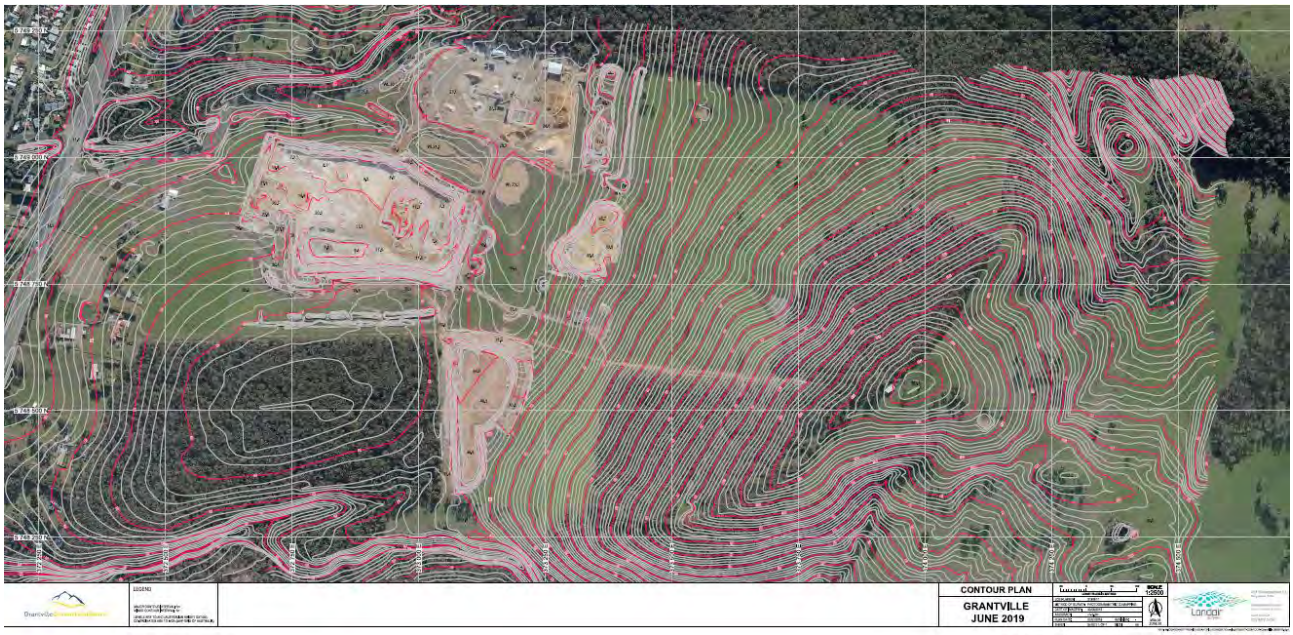

FIGURE 1-3 RECENT AERIAL IMAGERY AND ELEVATION CONTOURS (LANDAIR SURVEY, JUNE 2019)

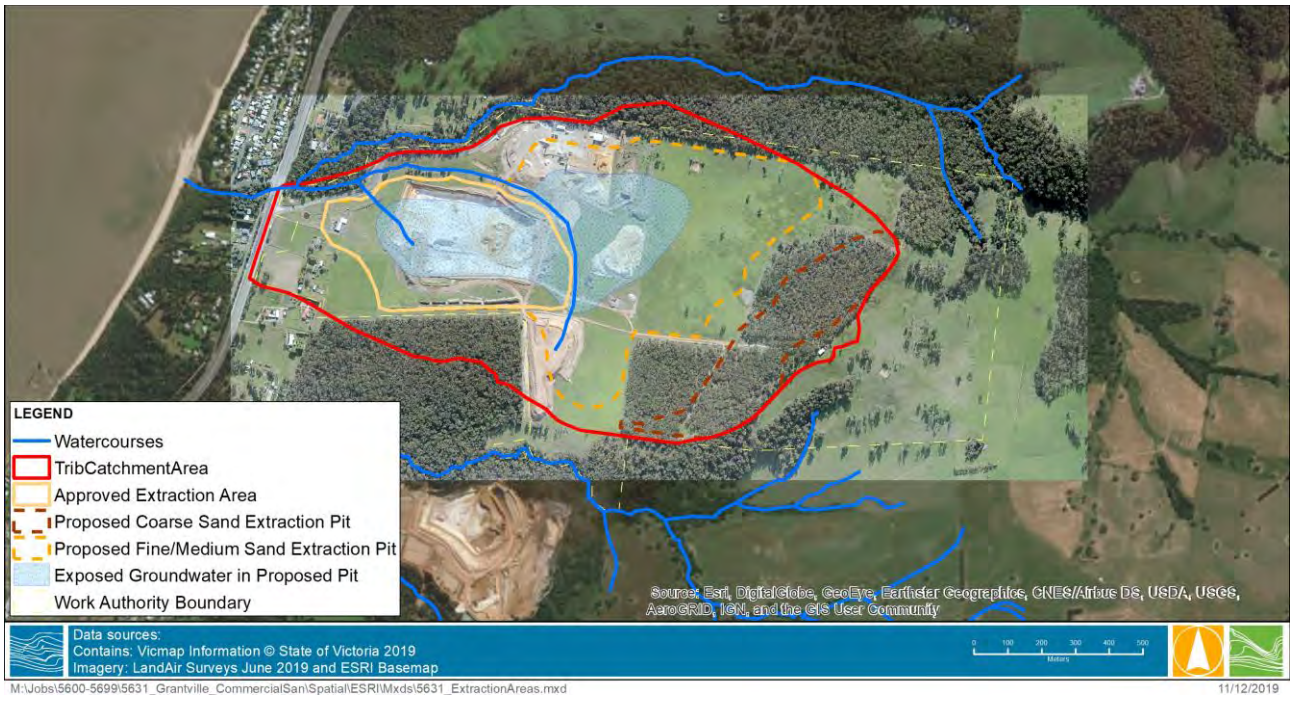

FIGURE 1-4 CURRENT AND PROPOSED SAND EXTRACTION AREAS

2 REVIEW OF NEIL CRAIGIE'S STUDY (MAY 2012)

A detailed assessment of the surface water hydrology of the site was previously provided by Neil Craigie in May 2012. This report has been included in Appendix A. The report has been reviewed and was drawn upon for this investigation. A summary of the key findings from Neil Craigie's report is included below.

The report provides a good background on the site, the proposed staging of the quarry over its first 5-10 years, the characteristics of the catchment and its waterways, and a water balance of the site. As the waterways are ungauged, uncalibrated MUSIC[1] model hydrologic simulations for various catchment conditions were completed. The MUSIC model results were compared to some basic catchment yield estimates from nearby catchments to ensure the results were reasonable. The report concluded that the MUSIC model results were fit for purpose. Water Technology agrees that the MUSIC modelling completed in 2012 was fit for purpose and provides reasonable estimates of catchment runoff.

The report documents three different catchment conditions modelled within MUSIC:

- Pre-existing forested catchment conditions
- Existing grazed farmland (2012) conditions
- Proposed mining development (20 ha pit, 2 ha overburden stockpile) conditions.

The report documents all the assumptions regarding the proposed mining development scenario, including water use demands, etc. A summary of the modelled mean annual flow is provided in Table 2-1.

TABLE 2-1 MUSIC MODEL MEAN ANNUAL FLOW (ML/YR)

Location	Pre-existing forest conditions	Existing conditions	Future conditions with mining	% change (Exist-Future)
Deep Creek upstream of tributary confluence	528	691	691	0
Tributary upstream of Deep Creek confluence	203	265	213	-20%
Deep Creek at Bass Highway	731	956	903	-6%
Deep Creek at WP Bay	743	986	933	-5%

The results showed that mean annual surface water runoff from the Deep Creek catchment to Western Port Bay has been significantly increased with clearing of the catchment and establishment of agriculture (primarily stock grazing) and residential land use. The results indicated the proposed WA1488 quarry development would likely reduce the mean annual runoff from the MW3840 tributary to Deep Creek by 20% compared to existing quarrying conditions, thereby returning the mean annual runoff from the site to a level closer to that which the site would have experienced under pre-existing forested catchment conditions.

As the MW3840 tributary runoff contribution is only a small portion of the total Deep Creek catchment mean annual runoff to Western Port Bay, the impact of the quarry's extraction activities, would see a reduction in the mean annual runoff from Deep Creek to Western Port Bay of approximately 6%.

Neil Craigie (May 2012) suggested it is likely that reduced flows in the tributary, along with revegetation works, will likely further assist with stabilisation of the eroding downstream section of the tributary. After a site visit in August 2019, Ben Tate from Water Technology observed encouraging evidence that the section of the

[1] MUSIC is a hydrologic and water quality model developed by eWater. It is a standard hydrologic water balance model that is widely used within industry for catchment runoff simulations.

MW3840 tributary downstream from the farm dam is being rehabilitated and is stabilising. A more serious erosion threat nearby, unrelated to the WA1488 site, has presented itself along the lower reaches of Deep Creek, this is discussed further in Section 4.1.

The Neil Craigie (May 2012) report also documented that the proposed sand quarry development would have a net water quality benefit, compared to the 2012 existing conditions with stock grazing. The report listed several best practice approaches to dealing with surface water and erosion management that the proposed sand quarry operation would need to implement during the construction (establishment) phase of the site.

As a result of reviewing the WA1488 site, Water Technology is satisfied the Neil Craigie construction phase recommendations were implemented and that current quarry operations continue to conform with the recommendations made by Neil Craigie, such that 'best practice' stormwater and erosion management practices are broadly evident.

Much of the Neil Craigie 'Drainage and Water Quality Management' (May 2012) assessment findings and surface water quality monitoring recommendations, have been verified by Water Technology as still being applicable to the site in 2019.

The report by Neil Craigie (May 2012) was a thorough investigation and Water Technology agrees with the findings of the report.

Accordingly, the Neil Craigie report findings and recommendations are drawn upon for this Water Technology assessment of the WA1488 sand quarry, WPV application to expand sand extraction activities and to introduce sand washing and dewatering (i.e. water recovery, recycling and reuse) on the Grantville site.

3 SURFACE WATER ASSESSMENT

A simple surface water balance approach, similar to that adopted by Neil Craigie (May 2012) was undertaken to understand the impact of the proposed sand quarry expansion at Grantville. A spreadsheet water balance was developed using daily rainfall and evaporation data from the SILO database which provides climate data from 1889 to the present day. Catchment areas were calculated using available LiDAR topographic datasets, aerial images and GIS layers of the proposed quarry expansion.

A schematic of the water balance model is provided in Figure 3-1. The water balance model was developed on a daily timestep. The annual and monthly rainfall data for the site from the SILO database from 1900 to 2018 is presented below in Figure 3-2 and Figure 3-3, average monthly evaporation is also provided in Figure 3-3.

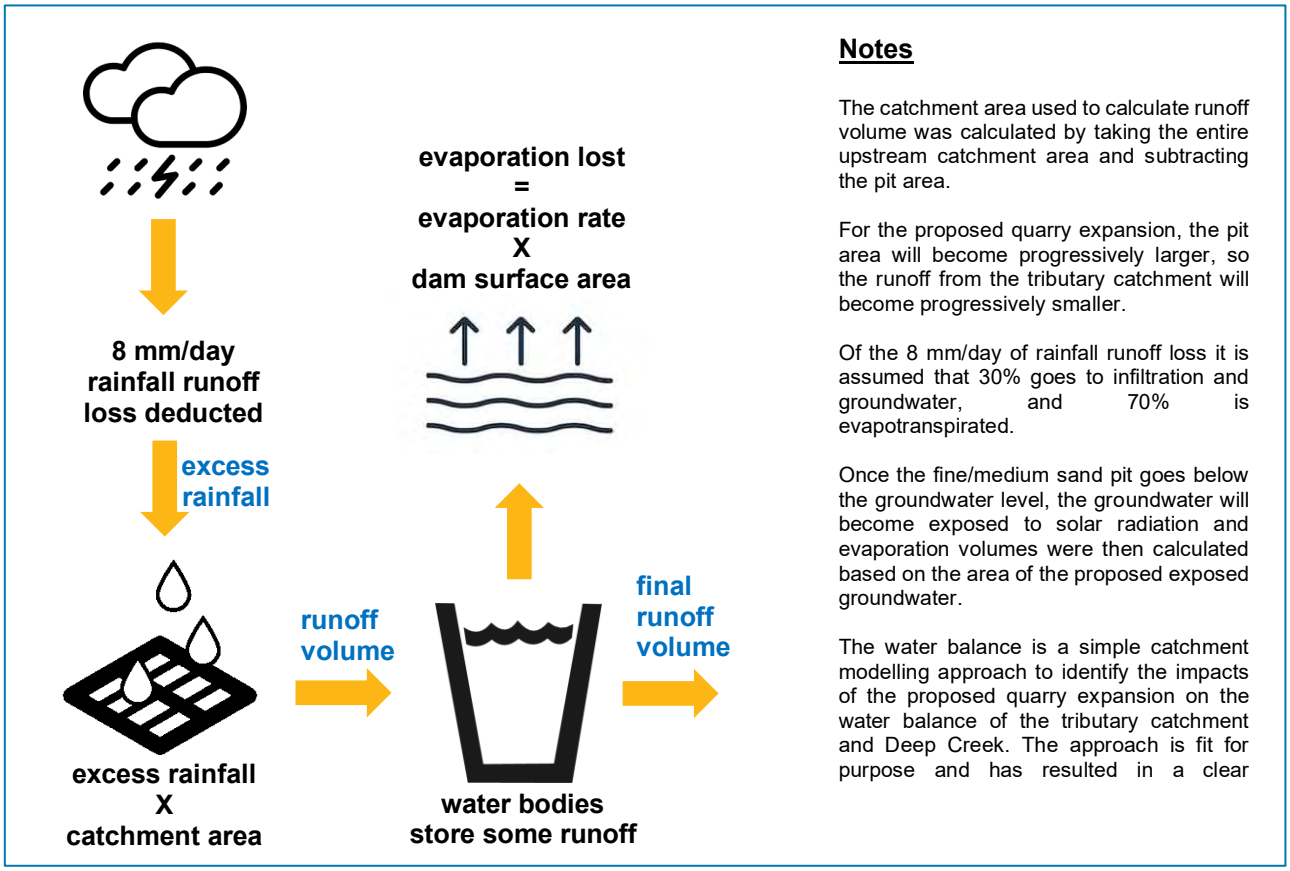

FIGURE 3-1 SCHEMATIC OF DAILY WATER BALANCE MODEL

A selection of photos from a site visit on the 23rd August 2019 are provided in Figure 3-4. Photo 'a' shows the upstream tributary catchment with the stockpile in the distance, the shallow waterbody created upstream of the pit access road which acts as a water supply and sediment basin, and the pit to the right of the photo. Photo 'b' again shows the upstream MW3840 tributary catchment. Photo 'c' shows the augmented farm dam in the foreground and the pit in the background. Photo 'd' shows the augmented farm dam looking from upstream to downstream. Photo 'e' shows the eastern end of the pit with a test pit dug to identify groundwater levels. Photo 'f' shows the sediment basin to the right of the photo and a bioretention pond to the left, which then flows into the MW3840 tributary shown in the top left of the photo.

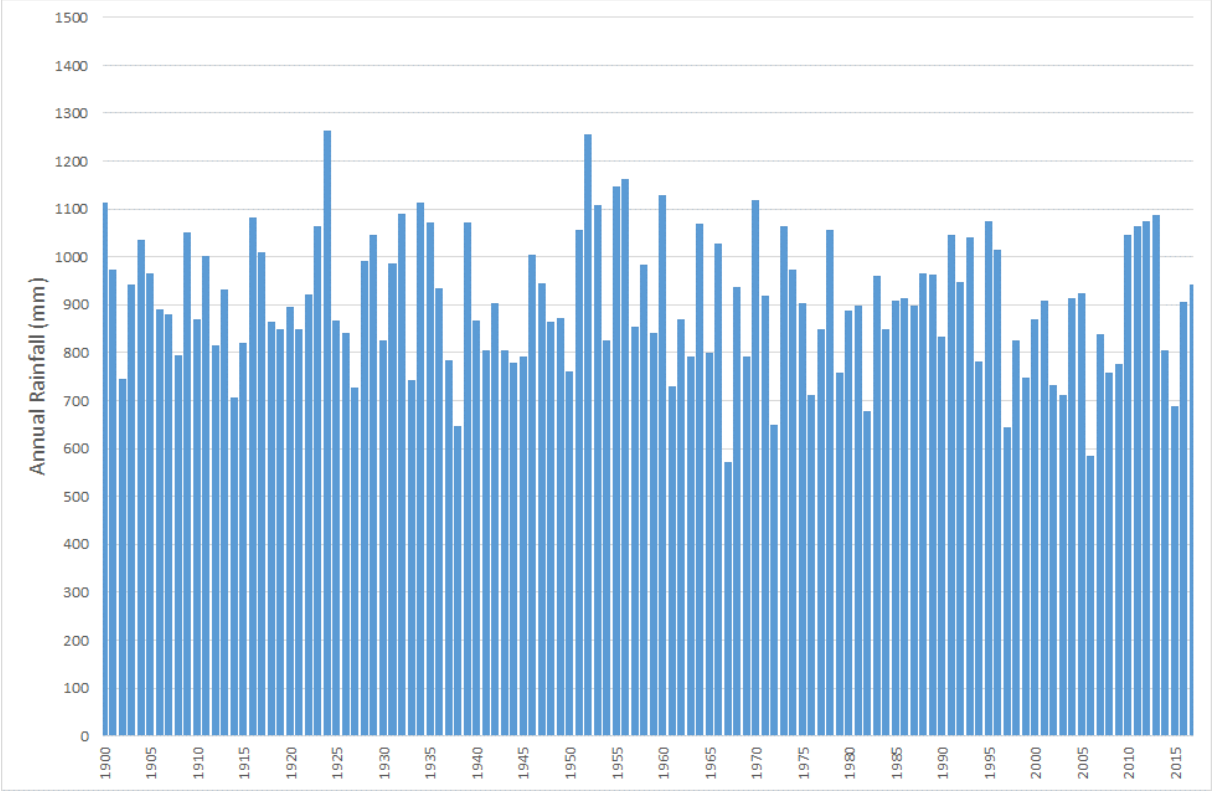

FIGURE 3-2 ANNUAL RAINFALL (SILO DATABASE)

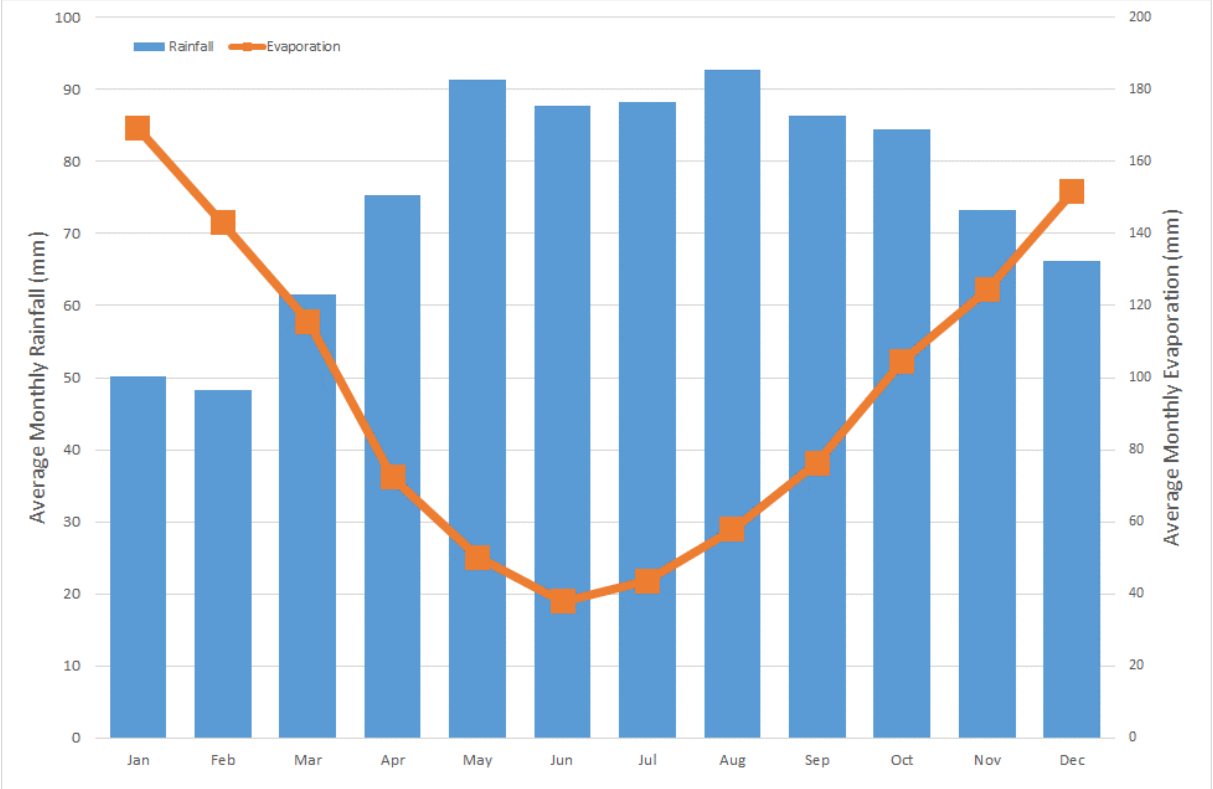

FIGURE 3-3 AVERAGE MONTHLY RAINFALL AND EVAPORATION (SILO DATABASE)



FIGURE 3-4 SELECTION OF PHOTOS FROM SITE INSPECTION (23 AUG 2019)

To complete a water balance for the MW3840 tributary catchment, water usage for the WA1488 site was estimated under the following three development scenarios for the fine/medium sand extraction pit (FMSEP):

- Current level of Extraction Pit (FMSEP) development as approved under existing Work Plan conditions;
- Fully developed Extraction Pit (FMSEP) as approved under current Work Plan conditions; and
- Estimated final (Ultimate) FMSEP and CSEP development as proposed under WPV conditions.

It is noted that Neil Craigie (May 2012) forecasted an annual water usage of approximately 35 ML for the WA1488 site.

With operational experienced gained since the quarry commenced commercial scale sand extraction and sales in March 2015, a refined estimate of water usage was developed and is described below.

Under current operating conditions, water is used for dust suppression on average for 6 months of the year (September to February) on a daily programmed basis. Dust suppression is required to be employed on average during this period, a maximum of 4 days per week, with 4 water truck loads used per day. The current Dandy Premix Grantville water truck has a capacity of 12,000 L. This equates to approximately 7 ML/year. To be conservative, this volume has been rounded up to 10 ML/year.

It was assumed the volume of water required for dust suppression will not change across the numerous development stages of the sand quarry development proposed under the WPV as assessed in the water balance. The volume of water used for dust suppression is currently sourced from the fresh water storages on the site, i.e. predominately from the MW3840 augmented farm dam, with occasional sourcing from the Northern Storage Dam upstream of the haul road.

Under the WPV proposal, the two dams will eventually cease to exist. Water for dust suppression will therefore need to come from groundwater, while the sediment basin, bioremediation pond will be maintained to treat stormwater runoff from some of the heavily trafficked areas and for the mandated truck wheel wash facility. There will be an opportunity to obtain further water for dust suppression from several other stored surface water runoff (lower capacity) dams being indefinitely retained on the site.

The WPV proposal not only expands the areas of sand extraction, but in so doing, also provides for combinations of wet sand only, dry sand only and under the most typically forecast scenario, for a simultaneous blend of wet and dry sand being processed (washed, screened and dewatered). The sand washing process is estimated to use 34 tonne of water per hour. The WA1488 Grantville sand quarry operates 48 weeks per year, on average 5 days per week (processing) at 8 hour per day, which results in the sand washing and dewatering process plant using 65,000 tonne (65 ML) of water per annum.

As previously discussed, the existing surface water storage dams will eventually become part of the FMSEP, and all process water will need to be sourced from a groundwater allocation, rather than from surface water collection and storage.

Water Technology understands Dandy Premix are in the process of obtaining Southern Rural Water (SRW) approval for the ‘temporary transfer’ of 80.5 ML per annum under a SRW groundwater ‘take and use’ licence No.BEE025666 from Mr. Stefan Bleicher. While the ‘temporary transfer’ will require annual approval by SRW, Dandy Premix have an agreement in place with the licence holder for a recurring five year renewal, with first and last right to purchase, should Mr. Bleicher decide to ‘permanently transfer’ (sell) SRW Licence No.BEE025666.

Based on an the above, the ‘temporary transfer’ of 80.5 ML annually against SRW Licence No.BEE025666, will be more than adequate to meet the estimated 65 ML per year process demand use of the proposed sand washing and dewatering plant process.

The assumptions regarding the surface water runoff catchment, the FMSEP and the CSEP areas for each of the three scenarios referenced are provided in Table 3-1. The results of the water balance modelling for current FMSEP conditions, a fully developed FMSEP under the existing Work Plan approval, and the ultimate development under the WPV proposal are provided in Table 3-2.

TABLE 3-1 WATER BALANCE CATCHMENT AREA ASSUMPTIONS

Catchment Areas	Current level of extraction	Fully developed extraction under current approved Work Plan	Ultimate proposed FMSEP and CSEP extraction under WPV conditions
Total catchment area	125.1 ha	125.1 ha	125.1 ha
Upstream catchment area draining to treatment water bodies	85.5 ha	82.7 ha	1.8 ha catchment draining into fine/medium sand extraction pit
Pit area	8.1 ha	22.6 ha	77.3 ha
Catchment area draining to tributary downstream of treatment water bodies	31.6 ha	19.8 ha	45.9 ha of catchment draining around the pit to the tributary
Exposed groundwater area	-	-	24.1 ha

TABLE 3-2 MEAN ANNUAL WATER BALANCE (ML/YEAR) OF THE TRIBUTARY CATCHMENT DRAINING TO DEEP CREEK

Catchment Areas	Current level of extraction	Fully developed extraction under current approved Work Plan	Ultimate proposed FMSEP and CSEP extraction under WPV conditions
Total Rainfall	1,134	1,134	1,134
To Groundwater			
from rainfall falling directly on the pit	73	205	701
from infiltration across the catchment	230	201	94
from surface water runoff upstream of the fine/medium sand extraction pit unable to be diverted around the pit	-	-	5
To Evaporation			
from the catchment	536	470	219
from the dams	9	9	0
from exposed groundwater	-	-	276
Usage	10	10	75*
Runoff to Deep Creek	**277**	**240**	**106**

*Assume that 10 ML/year for dust suppression will be sourced from surface water runoff storage within the works area, and 65 ML/year will be sourced from groundwater. This will be dependant on the detailed design of the site layout.

As a means of validating the Water Technology (2019) water balance modelling, a comparison was undertaken to the Neil Craigie (2012) water balance modelling. In the previous water balance modelling, Neil Craigie estimated a mean annual flow of 213 ML/year from the MW3840 tributary under fully developed FMSEP conditions in accordance with the existing Work Plan approval. This compares favourably with the 240 ML/year estimated by the latest Water Technology (2019) modelling.

The water balance indicates that surface water runoff from the MW3840 tributary catchment will be reduced from 240 ML/year under the current fully developed FMSEP Work Plan conditions, to 106 ML/year under the proposed WPV ultimate FMSEP and CSEP scenario, whereby the upper portion of the tributary catchment is becomes part of the extraction area.

The remaining 106 ML/year of runoff comes from the lower portion of the MW3840 tributary catchment unaffected by the proposed extraction area, and from runoff diverted around the FMSEP from the upper catchment, which will continue to drain to the tributary ahead of its confluence with Deep Creek.

Given that in the May 2012 modelling by Neil Craigie, the flows from Deep Creek, upstream of the MW3840 tributary were estimated to be 691 ML/year, it is Water Technology's opinion that the loss of 134 ML/year from the MW3840 tributary catchment (ultimate FMSEP and CSEP scenario proposed by the WPV, compared to a fully developed FMSEP as approved under the current WA1488 Work Plan), will have no significant impact on the hydrological regime of the lower reaches of Deep Creek.

The reduced MW3840 tributary inflows comprise approximately 14% of the mean annual flow of the lower reaches of Deep Creek. Given that Deep Creek is ephemeral, a key component of the hydrological regime is to maintain refuge pools to support aquatic life in the stream. The reduction in the MW3840 tributary catchment, downstream of the expanded extraction areas proposed under the quarry WPV, will continue to contribute inflows to Deep Creek. Deep Creek's much larger catchment area to the east and north-east of the WA1488 site is unchanged and unaffected by the WPV proposal. Accordingly, Water Technology does not believe the ability to maintain refuge pools along the 300 m section of Deep Creek, downstream of its confluence with the MW3840 tributary, will be impacted.

The water balance modelling shows that as the quarry FMSEP extraction continues to its fully approved development under the current Work Plan, a larger portion of rainfall will be transferred to groundwater. The volume of useable water, i.e. water not converted to evaporation, will be increased by 66 ML/year. Compared to the current level of extraction, the WPV's proposed FMSEP and CSEP ultimate development scenario, will result in a 50 ML/year increase in the volume of useable water.

4 SUMMARY AND RECOMMENDATIONS

The Dandy Premix WA1488 sand quarry (trading as Grantville Commercial Sands – GCS) at 1381-1395 Bass Highway Grantville, has been developing in accordance with its approved Work Plan since 2013. However, it will soon reach the limits of the Extraction Pit (FMSEP) under the current Work Plan. Dandy Premix is seeking by way of a Work Plan Variation (WPV) to expand the extraction limits (areas) within the existing approved WA1488 site boundaries.

Expansion of the extraction areas within the WA1488 site will enable Dandy Premix to supply an ongoing source of concrete and construction sands, estimated to be in the order of 30 million tonne, to the Melbourne Supply Area (MSA) in support of Victoria's growth and in particular, the State Government's transport infrastructure program in the south-east of greater Melbourne.

The proposed expansion of extraction areas under the WPV, will result in the majority of the small and highly ephemeral MW3840 tributary and its catchment, which drains to Deep Creek (MW3839) being extracted for sand. With the proposed expansion of the extraction areas, a greater portion of the rainfall falling on the MW3840 tributary catchment will be captured by the extraction areas and transferred to groundwater rather than surface water runoff.

Hydrological analysis has confirmed the proposed ultimate (final) development of the FMSEP and CSEP, will reduce surface water runoff to Deep Creek by approximately 134 ML/year, as compared to the fully developed extraction area under the current approved work plan. When compared to the current level of extraction, the surface water runoff to Deep Creek under the proposed ultimate (final) development of the FMSEP and CSEP will reduce by approximately 171 ML/year. When considering the larger Deep Creek catchment this reduction in surface water runoff from the MW3840 tributary only represents 14% of the total Deep Creek flows downstream of the Bass Highway. This surface water runoff is not lost, but transferred into groundwater, which results in an increase of approximately 50 ML/annum of useable water within the MW3840 tributary catchment compared to current conditions. This is because the larger portion of water transferred to groundwater means there is less loss to evapotranspiration.

The proposed expansion of the existing fine, medium sand extraction pit (FMSEP) also includes the extraction of sands below water using a pontoon floated Cutter Suction Dredge on the pond/lake formed in the FMSEP exposed groundwater.

Water Technology submits the proposed WA1488 sand quarry expansion of extraction activities within its existing site boundaries, will have no significant, or detrimental impact on the hydrological regime of the lower reaches of Deep Creek, below its confluence with the MW3840 tributary and west of the Bass Highway to Western Port Bay.

Water Technology has observed the current WA1488 quarry operation to have implemented 'best practice' stormwater and erosion management techniques in accordance with the Neil Craigie (2012) recommendations. Dandy Premix quarry management has demonstrated its intent to ensure these practices continue.

Of particular importance, Water Technology is satisfied that as an integral part of the proposed WPV expansion of extraction activities, Dandy Premix will continue to implement 'best practice' stormwater and erosion controls to protect and enhance the downstream receiving waters of Deep Creek and Western Port Bay from any flow leaving the site in the MW3840 tributary.

4.1 Urgent Erosion Threat in Deep Creek

Although unrelated to the surface water assessment for the proposed quarry expansion, Water Technology observed significant erosion occurring within Deep Creek unrelated to the nearby quarry, and we suggest that Melbourne Water consider this issue as a matter of urgency. This active erosion poses a far higher risk to the health of the Deep Creek waterway than the loss of the surface water runoff from the MW3840 tributary catchment.

WATER TECHNOLOGY
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REPORT 4 – LANDSCAPE & VISUAL IMPACT ASSESSMENT

Grantville Sand Quarry – Stage 2

Landscape & Visual Impact Assessment

Final Technical Report
Prepared for Dandy Premix

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6 July 2020

Quality Assurance

Grantville Sand Quarry – Stage 2

Landscape & Visual Impact Assessment
Final Technical Report

Project Number

0317-0730

Revision (see below)

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Glossary of Terms

Analysis	Process of breaking down landscape or visual attributes into component parts to understand how it is made or valued.
Assessment	General term for description, classification and analysis of landscape or visual attributes.
Classification	A process of sorting the landscape into different types using selected criteria, but without attaching relative values to the different kinds of landscape.
Community	A group with shared culture, traditions and activities based within a defined locality.
Community values	Commonly held perceptions and values that the community attach to environmental attributes or qualities.
Cumulative effect	Collective impact of past, present and foreseeable future effects and actions.
Designated landscape	A landscape area formally listed by government as a park, reserve or area with valuable natural or cultural attributes and specific management requirements.
DTM / DEM	Digital Terrain Model / Digital Elevation Model, a 3-dimensional model of the land surface (with or without trees and buildings) generated by computer from contour, survey or remote sensing data.
Duration of effects	Measure of both time and the reversibility of effects.
Effect	A consequence of change.
Enhancement	Landscape improvement through restoration, reconstruction or mitigating action.
Impact	A positive or negative change to the landscape or the visual environment.
Indirect impact	Secondary impacts on the environment that occur away from the development site, as a direct result of the new development.
Intervisibility	Situation where an area is subject to overlapping visibility from more than one visual receptor
Landscape	A distinctive physical area as perceived by people, whose character is the result of the action and interaction of natural and / or human factors**.**
	Human perception of the land conditioned by knowledge and identity with a place.
Landscape assessment	Deals with the potential effects on the quality of the landscape setting, considered as an environmental resource, independent of views of that landscape.
Landscape character	A distinct and recognisable pattern of landscape elements or characteristics that occur consistently in a particular type of landscape.
Landscape Character Type	A broad categorisation of landscape character, generally based on a geographic basis using topography, land cover and land use
Landscape quality	A judgement about the relative physical condition of an area, related to its intactness, character and visual, functional and ecological condition.
Landscape sensitivity	The extent to which a landscape can change without unacceptable adverse effects on its landscape character.
Landscape value	The relative value or importance attached to a landscape, which expresses agreed community values because of its quality, scenic beauty, tranquillity, wildness, cultural associations, conservation or other special value.
Magnitude of effect	Combination of scale, extent and duration of an effect
Mitigation	Measures to avoid, reduce or compensate for adverse landscape and visual effects.
Perception of landscape	The psychology of seeing and potentially attaching value or meaning to a landscape

Receptor	A physical landscape resource, viewer or special element that will experience an effect as a result of change. A place, route, viewer group or interest group which may experience an effect.
Scenic	Attractive scenery, particularly combinations of landscape features and elements which appear 'composed' similar to landscape paintings.
Scenic quality	A relative judgement, based on common community perceptions, about the visual qualities associated with a landscape type or character area.
Sense of place	A relative judgement, based on common community perceptions, about the essential character and spirit of an area.
Sensitivity	The extent to which changes in landscape and visual resources can accept change without unacceptable, adverse effects on its character.
Sensory characteristics	Perceptual characteristics or capacities that underpin a person's ability to view, comprehend and respond to the landscape.
Significance	A relative measure of the importance of a landscape or visual change against a defined value system
Study area	Combination of the proposed development site and the surrounding area, typically to a radius of at least 6km. Landscape character references are likely to relate to a larger regional area.
Viewshed	A region visible to an observer, defined by reference to an actual view or area of theoretical visibility determined by a ZVI analysis.
Visualisation	A computer simulation, photomontage or technique to illustrate the appearance of a proposed development.
Visual absorption capability	The capacity of the landscape to absorb change (usually development-related), without significant detriment to its landscape values (character, scenic quality and integrity). VAC is a function of both slope and vegetation screening capacity.
Visual amenity	The value of a particular area or view in terms of what is seen.
Visual assessment	Deals with potential effects on the visual resources of the setting from changes in the composition and quality of views, people's response to likely changes and the overall effect on visual amenity.
Visual sensitivity	The extent to which a landscape can change without unacceptable adverse effects on its visual character or scenic quality.
Zone of Visual Influence	Or Zone of Theoretical Visibility. An area within which a proposed development may be visible and have an effect on visual amenity (ZVI). ZVI computer-based modelling may not consider all existing site features and viewing factors and therefore does not necessarily provide an exact representation of future views.

1 Executive summary

Scope of assessment

This Landscape and Visual Impact Assessment (LVIA) report has been prepared by Tract Consultants Pty Ltd for Dandy Premix Quarries Pty Ltd.

The report provides a technical evaluation of the potential landscape and visual effects associated with proposed Stage 2 sand extraction works at the existing sand extraction pit and processing operation at 1381 – 1395 Bass Highway, Grantville 3984.

The LVIA assessment forms part of a Work Plan Variation (PLN-001354) lodged by Dandy Premix, the property owner and current operator of the sand quarry.

The assessment is based on information including:

- Existing conditions survey and aerial photography 2019
- Work Plan for Extractive Industry Work Authority No 1488 prepared by Bell Cochrane & Associates 2020. Refer **Figure 2.3**
- The minimal site rehabilitation strategy is described in Appendix B-1 (BCA plan dated 10/1/20)

Policy Context

A key theme of the Bass Coast Planning Scheme and related strategic documents is the substantial emphasis on protecting the significant the landscape character of the municipality. A large element of this is the character and visual attraction of the coastline. These landscapes are regarded for their important contributions to the social, cultural, economic, and environmental growth of the region.

- The Planning Scheme specifically refers to the known sand resources at The Gurdies-Grantville area. The stated objectives and strategies are intended to ensure that extraction of stone is carried out in accordance with high environmental standards and does not have a detrimental impact on the environment or significant landscape areas; that extensive buffer zones of indigenous vegetation are planted around quarries and that quarries are located or designed so as to minimise impacts on areas of high landscape and environmental quality.
- The subject site is not specifically designated by Bass Coast Shire as an area of high landscape or scenic value (evidenced through the absence of either Environmental Significance Overlay or Significant Landscape Overlay) but the location is likely to be considered to have values related to its near coastal location, the adjacent PCRZ land, its position as part of the general Gurdies landscape and its visual relationship to the Bass Highway corridor. These relationships suggest that the siting and design of development within the subject site should be sensitive to the values attached to the broader coastal landscape and specifically managed to limit off site visual effects.
- The Bass Highway is considered to be an important viewing corridor with a relationship to the surrounding coastal landscape and a role as part of a regional tourism route linked to Phillip Island and Gippsland tourism destinations. The appearance of the site from Bass Highway is important. It is worth noting that Grantville is specifically identified as a moderate growth settlement that has capacity for moderate spatial growth.
- The Bass Coast Planning Scheme encourages some growth beyond urban zoned land and infill development within the township boundary. Whilst the Site is located outside of the township boundary, Grantville is strategically planned to intensify in residential, commercial, and industrial use which will invariably have some degree of impact on the current landscape character of the immediate area.

- The Bass Coast Planning Scheme generally has the objective of protecting environmentally and visually sensitive areas, landscapes and open spaces that contribute to the character, identity and sustainability of rural, residential and coastal environments. Conservation strategies include measures to ensure that:
  - new development does not detract from the natural quality of sensitive landscape areas such as bays and coastlines. Not applicable to the subject site.
  - development is subordinate to the natural, visual and landscape character of the setting.
  - locally significant views that contribute to the character of the coastal and coastal hinterland areas are protected. Not applicable to the subject site.
  - the visual and landscape quality of hill tops, ridgelines and other key landforms are protected.
- The GRGP identifies that there are many significant landscapes within the region. Specifically, it relies on the characterisation and assessment of landscape value contained within the Coastal Spaces Landscape Assessment Study (discussed below). The recommendations of this Study being adopted into the planning scheme through the application of the Significant Landscape Overlay (SLO) and the Environmental Significance Overlay (ESO).
- Neither the Significant Landscape Overlay (SLO) nor the Environmental Significance Overlay (ESO) affect the site, nor any land within immediate proximity of the site. A coastal spanning ESO is located west of the site towards Queensferry and a large SLO is located south and east of the site.

Baseline conditions

- The subject site has **no formal status as a significant landscape** and is rated as having a relatively **low scenic quality**; however parts of subject site close to the highway and elevated ridgelines to the east have a higher (moderate) level of landscape sensitivity and some community value related to its near coastal location and its visual relationship to the Bass Highway corridor, Westernport Bay and Bass Hills landscape. These relationships suggest that development changes within the subject site should be managed to minimise visual effects on these receptors.
- The subject site currently includes quarry activities in the central part of the site with adjoining grazing land and remnant native vegetation on elevated locations to the east. The character of site has been substantially modified, however current quarry activities are largely screened by surrounding intervening dense forested area and by landform close to Bass Highway. A low ridge separates the current operational and extraction areas from the Bass Highway. This is an important mitigating factor on views into the site from the Bass Highway.
- Landscape value. Existing planning policy suggests that the potential quarry site is likely to be rated as **low landscape value** on the basis that it is a relatively common landscape type with no distinctive features. The elevated parts of the site (eastern half) will contribute to the overall visual character and quality of the coastal edge and are likely to be subject to a marginally higher scenic value rating.
- The potential extraction and processing areas within the western part of the site has a relatively **high visual absorption capability**. The potential extraction and processing areas within the eastern part of the site has a relatively **low visual absorption capability**.
- In terms of visibility, the eastern elevated part of site has a potentially high exposure to Westernport Bay and the coastal edge, but the nature of actual views depends on landform, vegetation and other existing features near to the view source.
- Land based viewing distances from Westernport Bay viewpoints range from 1.5 to 15km. At the closer distance, views are blocked by landform, vegetation and existing residential features, although second storey views may be possible from isolated locations (not confirmed).
- There are potential water-based views beyond 1.5km distance but this is considered to be a low receptor sensitivity area.

- There is potential to substantially screen elevated areas within the site by planting along the western edges of the subject site, including the low ridgeline close to Bass Highway and through strategic planting at higher elevations within the site.
- The Bass Highway is a regional tourism route linked to Phillip Island and Gippsland tourism destinations. In combination with the adjoining residential area (west of Bass Highway), the highway is considered to be the most important visual corridor and the only sensitive visual receptor. Based on modelled visual exposure, parts of the existing eastern ridgeline is visible from limited viewpoints when no vegetation is present but no views are possible under existing conditions with vegetation.
- Views to the site are restricted by existing landforms and on site / off site vegetation. These features are likely to be maintained over the long term. Zone of Visual Influence (ZVI) modelling and field assessment confirms that there are no views to the existing operational area from major public or private visual receptor areas and that this condition is likely to exist with or without vegetation for all areas except the Gurdies Reserve edge and the Deep Creek / Bass Highway locations which could be exposed to views if vegetation was to be removed within the reserves and the adjoining property (an unlikely scenario).

New conditions assessment

Landscape impacts

- The elevated eastern ridgeline has a relatively higher landscape sensitivity than the western part of the site. Removal of vegetation for quarrying in this location will have at least a **minor adverse impact** on the landscape and potentially a **moderate adverse impact**, depending on the degree of vegetation clearance and the way quarrying and rehabilitation planting is sequenced.

Visual impacts

- Camera viewpoints 1 and 5 are considered to be the most important viewing locations. Both locations have the potential to see small parts of the upper quarry pit and small parts of the overburden stockpile. Actual visibility is likely to be less than the modelled results because the model relies on a 'maximum development' scenario that would not exist due to progressive development of the quarry working areas.
- Residents west of the subject site are likely to experience similar views to Bass Highway and are likely to be unaffected by future quarry developments, provided that mitigation measures are implemented
- Viewing points from Westernport Bay or locations such Corinella Jetty are considered to be low visual sensitivity locations where changes within the subject site are likely to be barely discernible and seen as small changes within a much larger and complex visual field.

Mitigation potential

- Mitigation through maintenance of landforms and existing vegetation, along with new planting is critical to the project.
- The low western ridgeline and its associated planting is critical to view screening from the Bass Highway and locations to the west.
- Existing vegetation and nominated infill planting on the elevated ridgeline to the east is critical to screening / modifying views from the west and east.
- Minimising the height of the overburden stockpile is likely to result in less visibility from the critical viewpoints.

Evaluation

The LVIA study suggests that:

- Bass Highway represents the most sensitive viewpoint and therefore mitigation of impacts from this location are most important factors. Maintaining the landform and vegetation cover of the western face of this ridge are critical elements.
- The elevated ridgeline in the eastern end of the site must be seen as a different landscape element that requires its own mitigation treatments. Maintaining existing vegetation and infill planting are critical elements.
- Progressive extraction and rehabilitation of quarry cells that limit the length of disturbance is an important technique in all areas but particularly the elevated eastern extraction area.

Recommendation

With an optimal mitigation design treatment, the Stage 2 quarry proposal represents an **acceptable change to the landscape and scenic values of the Grantville site**.

2 Introduction

2.1 Introduction

This Landscape and Visual Impact Assessment (LVIA) report has been prepared by Tract Consultants Pty Ltd for Dandy Premix Quarries Pty Ltd.

The report provides a technical evaluation of the potential landscape and visual effects associated with proposed Stage 2 sand extraction works at the existing sand extraction pit and processing operation at 1381 – 1395 Bass Highway, Grantville 3984.

The LVIA assessment forms part of a Work Plan Variation (PLN-001354) lodged by Dandy Premix, the property owner and current operator of the sand quarry.

The assessment is based on information including:

- Existing conditions survey and aerial photography 2019
- Work Plan for Extractive Industry Work Authority No 1488 prepared by Bell Cochrane & Associates 2020. Refer **Figure 2.3**
- A minimal site rehabilitation strategy is described in Appendix B-1 (BCA plan dated 10/1/20)

2.2 Subject site and study area

The subject site is located approximately 1.2km north east of Grantville township. Refer **Figure 2.1**. The existing extraction area is located in the lower (western) part of an irregularly shaped site that extends from the edge of Westernport Bay coastal plain east. Refer **Figure 2.2.**

The existing site is currently used for sand quarrying and processing activities within the approved Working Plan area. The rest of site is used for grazing and is mainly cleared with scattered vegetation along drainage lines and at higher elevations within the eastern parts of the site.

The land to the north of the Work Authority area is privately owned farmland (owned by the proponent) which is partly covered with native vegetation. This site adjoins the Gurdies Conservation Reserve (Crown Land). An area to the south west of the site is a Crown Land woodland conservation reserve. Remaining areas to the south and east are rural properties with a mixture of cleared grazing land and woodland.

There is an existing sand extraction facility approximately 1km south of the study area and a number of existing Work Authorities south and north of the study area. These sites are owned and operated by others.

The land immediately west of the proposed extraction area (eastern edge of the highway) is rural residential farming properties and the land west of the Bass Highway is a combination of residential development and Western Port Coastal Reserve.

For the purpose of this LVIA, a study area extending up to 6km radius from the centre of subject site was defined for desktop study. Field investigations expanded to 10km distance from the subject site.

2.3 Objectives

This baseline study aims to:

- Identify the existing landscape and visual values of the study area within the context of the Bass Hills and Western Port Bay landscapes;
- Identify potential landscape and visual receptors;
- Describe and analyse existing landscape and visual attributes and their likely sensitivity to change.
- Evaluate the effects of landscape and visual changes and the potential significance of these changes.

2.4 Community consultation & community values

No empirical research or consultation relating to community values or perceptions of landscape and visual values was undertaken as a part of this study.

The assessment and analysis of landscape and visual resources and values is based on a range of existing information sources, including the State and Local Planning Policy Framework and the Municipal Strategic Statement which makes specific reference to landscape character values and visual quality and in this context, is considered to represent generally Council and community values.



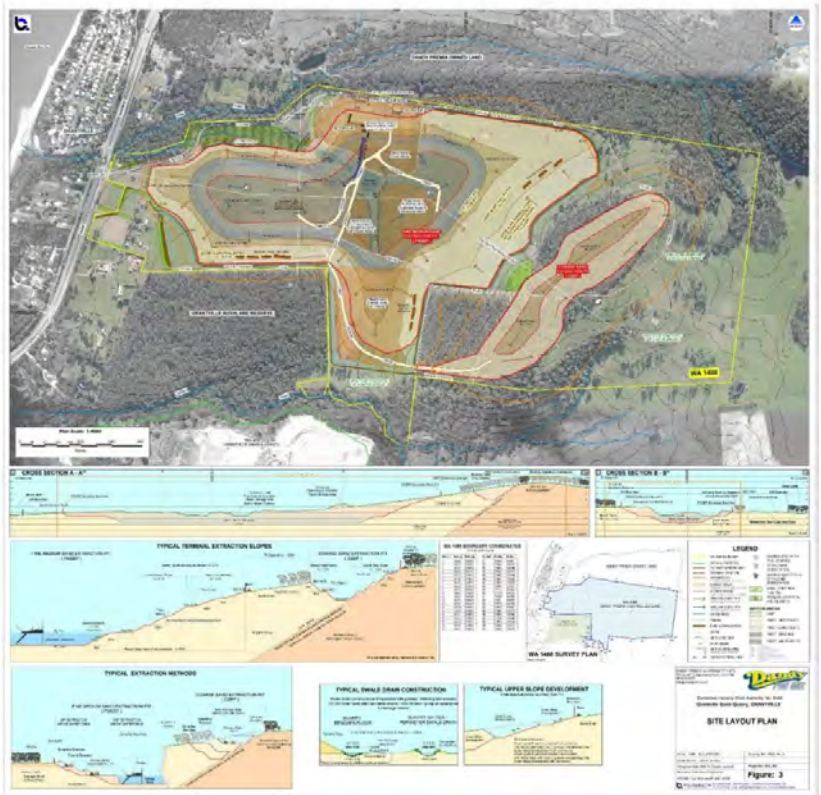
Source: RACV VicRoads Country Street Directory of Victoria

Figure 2.1 – Site location



(Source: Google Earth Aerial Image)

Figure 2.2 – Subject site location and local landscape setting



Source: Bell, Cochrane & Associates Work Plan Oct-2020

Figure 2.3 – Proposed Work Plan Variation

3 Study methodology

3.1 Study Methodology

The following section describes the methodology and methods applied in this study to assess the landscape and visual impacts of the proposed development.

The method applied to assess landscape and visual impacts of the existing quarry development is based on principles outlined in Guidelines for Landscape and Visual Impact Assessment (third edition), The Landscape Institute & Institute of Environmental Management & Assessment, Spon Press, April 2013, which represents a 'best practice' approach within the United Kingdom and has been extensively trialled since 1995 on a range of project types including extractive industry projects, wind farms, property and infrastructure development. This methodology aligns with landscape architectural industry guidelines and is considered to provide a robust approach.

This study covers the following key elements:

- Description of the development proposal
- Planning policy and landscape policy context
- The nature of the existing sand extraction operation, including off-site issues relating to operational activities
- Baseline landscape and visual values for the sand extraction setting and the broader local and regional landscape by field work and desktop study
- Impact assessment for baseline landscape and visual values related to the existing development and further development already approved under the existing Work Authority (supported by GIS modelling)
- Impact assessment for the proposed stage 2 development proposal
- Possible mitigation measures to address likely impacts
- Evaluation and conclusion

The assessment does not consider:

- The effects of future land use changes such as new residential development, road development or tourist activities that are not defined at this time but may occur within the areas adjoining the study area.

Definition

This LVIA covers both 'landscape' and 'visual' assessment:

The **landscape assessment** deals with the potential effects on the character and quality of the landscape setting, considered as an environmental resource, independent of views of that landscape.

The **visual impact assessment** deals with potential effects on the visual resources of the setting from changes in the composition and quality of views, people's response to likely changes and the overall effect on visual amenity.

The overall landscape and visual impact assessment process is outlined in **Figure 3.1**.

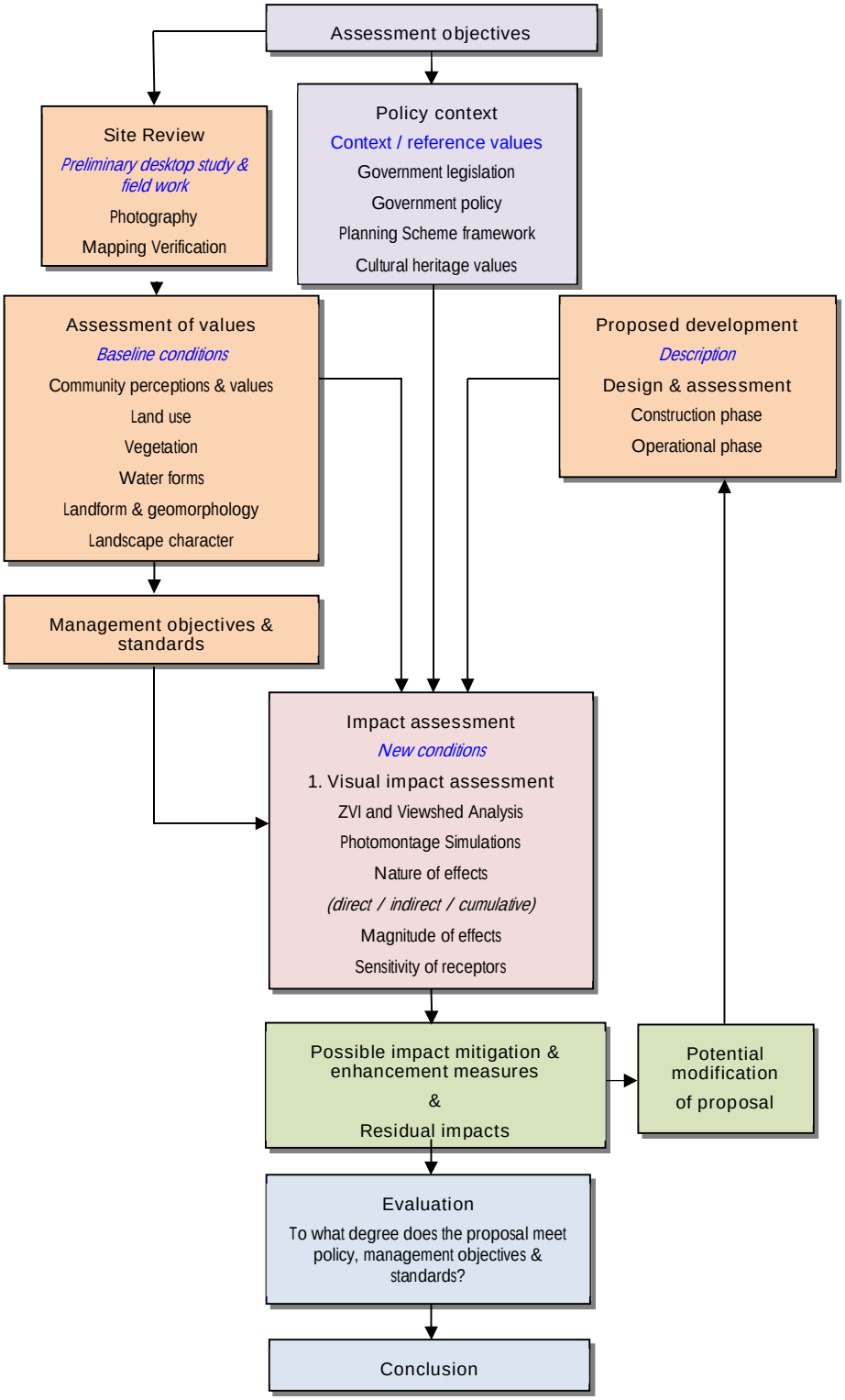


Figure 3.1 – Landscape & visual impact assessment process

3.2 Method for Landscape Assessment

This LVIA considers both landscape character and scenic quality in assessment of landscape values. Landscape character and values are assessed at two levels - status and classification.

The status of the area as a recorded or listed landscape of National, State, Regional or Local importance on the basis of its formal natural, cultural heritage or scenic value. The landscape status is covered in covered in Section 5-Policy Context.

The classification of representative landscape character types and related scenic qualities is derived through the definition of common distinguishing visual characteristics – landform, climate, vegetation, water-form and land use pattern. Under this system of classification, each landscape type establishes its own benchmarks for scenic quality. Assessment of landscape character is provided in Section 6-Baseline Conditions.

3.3 Method for Scenic Quality Assessment

There are several approaches to studying scenic landscape quality which can be classified into two broad groups including objective approach and subjectivist approach which are based on a long-standing debate in the philosophy of aesthetics (Tveit et al., 2012)[2]. In the objective approach, the visual quality is assessed by experts based on formal knowledge by assuming the beauty is 'in the object'. In subjective approach, the visual landscape quality is considered a construct of the observer (in the eye of the beholder) derived from lay people's perceptions and preferences.

Daniel and Vining (1983)[3] have distinguished five models to studying landscape quality which are ranging between the objective and subjective paradigms including: ecological, formal aesthetic, psychophysical, psychological and phenomenological models. Based on their detailed review of these models, they concluded that a careful combination of the psychophysical and psychological approaches would provide the basis for a reliable, valid and useful method for landscape-quality assessment (Daniel and Vining, 1983).

In absence of such a scenic quality assessment based on psychophysical and psychological models in Victoria and Grantville, a previous study of Victorian landscapes, Landscape character types of Victoria: with frames of reference for scenic quality assessment (Leonard, 1984)[4], has been used as a basis in assessment of the scenic quality of subject site within the wider context. This study, which is based on the formal aesthetic model, characterises landscape in terms of formal properties of landscape based on expert evaluations. The descriptions are based on the variety in landform, vegetation covers and watercourses. Descriptive criterion for scenic values for landscape character type is developed which describes the relative range of scenic quality (high, moderate and low).

In this study, the subject site scenic quality is assessed against these criteria.

High scenic quality

- Isolated peaks with form and colour contrast that become focal points;
- Deep valleys or distinctive gorges with steep sides or unusual configuration;

2 Tveit, M.S., Sang, A.O., Hagerhall, C.M. 2012, 'Scenic beauty: visual landscape assessment and human landscape perception' in Linda Steg, Agnes E. van den Berg, Judith I.M. De Groot [eds], 'Environmental Psychology: An Introduction', John Wiley & Sons, London.

3 Daniel, T., Vining J., 1983, Methodological Issues in the Assessment of Landscape Quality, in Irwin Altman, Joachim F. Wohlwill [eds], Behaviour and the Natural Environment, Vol 6, the University of Michigan

4 Leonard, M., Hammond, R. & Forests Commission, Victoria, 1984. Landscape character types of Victoria : with frames of reference for scenic quality assessment, Melbourne]: Forests Commission Victoria

- Strongly defined patterns of vegetation resulting from combinations of Eucalypt forest, scattered conifer plantations, streamside vegetation, open paddocks that are well defined by vegetation;
- Dramatic displays of seasonal colour;
- Stands of vegetation that create unusual form, colour or texture in comparison to the surrounding forest;
- Permanent streams, lakes, reservoirs or wetlands;
- Intermittent stream courses that continually change in character.

Moderate scenic quality

- Broad slopes and / or broad valleys that are not dramatically defined by adjacent landforms
- Rounded hills, ridges and peaks which are not visually dominant but are surrounded by similar landforms
- Predominately open forest or scrub cover with some natural openings and species mix in patterns that offer some visual diversity.
- Vegetative pattern evident but common
- Permanent or intermittent streams with long stretches of similar character

Low scenic quality

- Flat, indistinctly dissected landform that provides little spatial definition
- Significant expanses of undulating landform that lack visual interest in comparison to common landforms
- Extensive areas of similar vegetation such as grassland with very limited variation in texture and/or colour
- Water forms absent.

3.4 Method for Visual Impact Assessment

Impact assessment has been based on the criteria of sensitivity of receptors including landscape and its users (viewers), duration of impacts, nature and magnitude of impacts, and significance of impacts.

Table 1 – **Impact duration** is defined as:

Short term	Project construction and establishment phase (< 3 years)
Medium term	Early project operational phase (3 – 10 years)
Long term	Within projected operational phase (10 – 25 years)
Permanent	Beyond projected operational phase (25 years +)
Reversible	Physical potential for full rehabilitation to original baseline condition within feasible cost parameters and land use objectives To be specified within the decommissioning management plan
Irreversible	Permanent physical change to the baseline condition Beyond feasible cost parameters and land use objectives Specified for retention in the Decommissioning Management Plan

The significance of impacts is defined as (Refer Table 1):

- Significance ratings reflect an assessment of the importance of the predicted impact and also indicate mitigation priorities.
- Impact significance is derived from combining the magnitude of landscape and visual change with sensitivity of the receptor
- Significance values are expressed as three levels (represented by shading).
- A number of 'moderate' rating factors may collectively represent a relatively 'high' degree of change to a receptor (cumulative impact) and therefore mitigation measures may need to be considered for more than 'high significance' rated impacts.
- Ratings are made against the Baseline Condition.

The **nature and magnitude** of visual impact levels on landscape and viewers are described in Table 2.

Table 1 – Magnitude & Sensitivity Impact – significance rating

MAGNITUDE OF CHANGE				
	high	moderate	high	high
	moderate	moderate	moderate	high
	low	low	moderate	moderate
	negligible	low	low	low
		low	moderate	high
		SENSITIVITY (Landscape / Viewers)		

Table 2 – Nature & Magnitude of Impact – significance definitions

Nature of impact Magnitude of impact	Definition Visual Impacts on Landscape	Definition Visual impacts on Receptors
Major adverse HIGH (6)	Total or substantial alteration to key features of the baseline conditions	Total or substantial alteration to key features of the baseline conditions.
	Effects are at considerable variance with the landform, scale and pattern of the landscape and cannot be substantially mitigated.	The proposal forms a significant and dominant part of a view of high scenic quality. Other scenic elements become subordinate and diminished in value.
	Would cause a high quality or designated landscape to be substantially changed and its quality and values diminished.	The valued scenic character of the site is markedly changed.
		Sensitive visual receptors are adversely affected by the change.
Moderate adverse MODERATE (5)	Would be noticeably out of scale with the landscape and clearly at variance with key landscape attributes identified within the baseline conditions.	The proposal forms a clearly visible and recognisable new element within the overall scene that is readily noticed by the receptor.
	Will leave an adverse impact on a landscape of recognised quality	The scenic character and quality of the site is diminished.
Minor adverse LOW (4)	Will have an apparent but not obvious or dominant effect on an area of recognised landscape character or its key attributes.	The proposal constitutes a discernible but minor component of the wider view.
		Awareness of the element will have a negative but not a marked effect on overall scenic quality.
Neutral impact NEGLIGIBLE (3)	Only a very slight change to baseline conditions and maintains existing landscape character and quality.	No part of the development proposal or associated activity is visually discernible.
	New features complement the scale, landform and pattern of the site landscape and its broader setting	The activity or feature is visible but has an insignificant effect on the perceived values or scenic quality of the setting
Minor beneficial NEGLIGIBLE (2)	Likely to enable the restoration of valued landscape characteristics or features lost or diminished through existing land use activities.	The proposal fits comfortably within the existing visual landscape
		The proposal helps to articulate existing visual character and amenity values
	Potential to contribute to the development of a new and higher quality landscape character.	Potential for the proposed development to contribute to the development of a new and higher value visual character.
Moderate / Major beneficial NEGLIGIBLE (1)	Fits comfortably within the existing landscape character and clearly contributes to the development of higher landscape values.	Fits comfortably within the existing landscape character and clearly contributes to the development of higher landscape values.
	Results in a significant improvement to the quality of the landscape through the rehabilitation of damaged areas or the removal of features or activities that have a negative impact on landscape values.	Results in a significant improvement to the visual quality of the landscape through the rehabilitation of damaged areas or the removal of features or activities that have a negative impact on scenic values.
	Results in a distinctive landscape feature that has the potential to add new values to the landscape without diminishing existing valued landscape characteristics.	Results in a distinctive landscape feature that has the potential to add new visual or tourism values to the landscape without diminishing existing valued visual characteristics.

Criteria to assess and judge different levels of magnitude of change and sensitivity are explained separately in the following sections.

3.5 Perception of change

In determining the magnitude of landscape change, the following factors of landscape character will be considered. These findings, in isolation are indicative only factors to be considered as a part of the assessment. The factors are based on physical attributes and do not provide a specific or definitive measure of likely perceptions of visual effects / impacts or the values that may be attached to those changes in the viewed landscape by individuals. These factors do not consider elements such as context, cultural meaning and the manner in which the receptor views the landscape.

Table 3 – Definitions and Principles

Visibility	The magnitude of visual impact is at least partly determined by the nature of that view and whether it is moving or static.
Field of view	**Horizontal line of sight**: The normal binocular field of vision (horizontal line of sight / width of view) is considered to be 124 degrees. Within the binocular field of vision the viewer has depth perception. Either side of the binocular field is a monocular field of 42 degrees for each eye (peripheral vision) which provides the viewer with awareness of movement speed and locational cues. Within the binocular field is a central fovial field (zone of visual acuity) of 2.5 degrees where viewed objects are sharply fixed and in detailed focus. **Vertical line of sight**; the normal vertical field of view is considered to be 120 degrees with the limit of colour discrimination at 55 degrees. **Method of Perception**: These fields of vision indicate a field of view and visual 'recognition' but in isolation, are not meaningful measures of scenic perception. The process of recognising and observing an object or scene (Dynamic Visual Acuity) is complex and involves constant scanning of the seen area, recognition and refocussing within the field of view; a process that is modified (narrowed and simplified) by viewer movement, the speed of movement of the viewer and secondary activities such as driving, but enhanced by colour contrasts, illumination, proximity, size, shape, symbol recognition based on expectation and other factors. **Occupied view area**: The nature and magnitude of the visual impact is likely to have a proportional relationship to the percentage of the available view taken up by development infrastructure, new activities or landscape interventions. Objects may be visible, but not dominant, particularly when they occur within landscapes that have been modified by human activity and where the context and complexity of the natural landscape has been significantly altered. A spread of built elements or landscape changes across a wide view or several viewable areas is likely to result in a perception of greater overall visual impact than a similar number of built elements within a more confined viewable area. Horizontal field of view – as a general guide only, a visual element of less than 5° of a field of view may be considered insignificant, depending on the nature of background visual contrasts and the movement of the viewer. Vertical field of view – as a general guide only, less than 0.5° of a field of view may be considered insignificant, depending on the nature of background visual contrasts and the movement of the viewer.

Speed of movement	As the speed of movement increases, viewer concentration on a fixed area increases and peripheral vision diminishes, effectively shrinking the visual field. Foreground detail begins to fade.
Relative elevation	Objects viewed against a skyline silhouette or at the edge of a break in slope are likely to have a greater visual impact than objects or changes viewed from a location where features are viewed against a land backdrop. Colour contrasts may modify this outcome.
Size, colour and form	The greater proportion of a view occupied by new features or activities the greater the impact. Contrasting colours and forms increase the relative impact of change.
Illumination	Luminance contrast increases the visual definition of the shape, size and location of objects and potentially changes the context in which objects are re viewed. Lighting colour and movement increase the potential level of contrast.
Activity	Movement of objects, including vehicles and light reflection changing with movement will increase impact.
Complexity	Changes to a visually complex field of view with elements of varying scales and form are likely to result in lower impacts than changes to a relatively uniform field of view.
Context	The extent to which the proposed development is in character with the land use and landscape character of the site will affect the perceived level of impact.
Weather conditions	The overall clarity of the view, the angle of the sun and the degree to which skyline silhouettes are masked by clouds etc will affect visibility.
Change	The degree of change in the view and the process of change will affect the degree of impact on the viewer.
Familiarity	Changes to a familiar visual setting or where the viewer interacts with the setting is likely to have a relatively greater impact on the viewer than changes to a setting that is rarely seen or poorly understood.
Cultural context	Changes to a visual setting with significant cultural value or purpose is likely to have a relatively greater impact on the viewer than what may be considered a 'generic' landscape setting with no specific value.
Individual context	The perception of a visual impact or visual improvement within a landscape is likely to differ between communities, cultural groups and among individuals. Personal context and values strongly influence the manner in which visual effects are valued.
Distance	The greater the viewing distance, the less detail is observable and the more difficult it is to distinguish between the site or object and its background, diminishing the impact. Distance is an important factor in assessing the magnitude of change and overall impacts. Other potential aspects of change include scale, proportion, size, height, massing, colour, texture, finish, permanence. For the purposes of this assessment, three distance ranges are applied as described in Table 4.

Table 4 – Distance levels

Distance Levels	Definition
Foreground (<1km)	▪ Obvious or dominant visual change to the landscape and landform characteristics including Colour contrast and textural details are clearly perceived ▪ Views are more likely to be broken by foreground features ▪ Landform characteristics and the relationship between landscape features are clearly discernible.
Middle ground (1 – 3 km)	▪ Obvious or dominant visual change to the landscape and landform characteristics ▪ Views are more likely to be broken by foreground features ▪ Landform characteristics and the relationship between landscape features are clearly discernible.
Background (3 – 5 km)	▪ Likely minimal visual recognition of strong colour and light contrasts and large-scale vegetation clearance only. ▪ Minimal recognition of form and detail and no appreciation of vehicle movement ▪ Distance zone where different landscape elements are visually apparent
Distant views (5 km +)	▪ Textures are no longer visible. Only landform features such as ridges, valleys, skyline and ridgelines are visible ▪ Likely minimal visual recognition of strong colour and light contrasts and large-scale vegetation clearance only. ▪ Minimal recognition of form and detail and no appreciation of vehicle movement ▪ The visual scale of the change may be barely discernible and appear as a relatively minor visual element within a larger landscape complex

3.6 Landscape sensitivity

Landscape character and scenic quality assessments will be used as a basis to assess the landscape sensitivity to change which is used further to assess the visual impacts resulted from proposed development on the landscape. Landscape sensitivity refers to the extent to which a landscape can change without unacceptable adverse effects on its visual character and attributes. Landscape sensitivity levels are described in Table 5.

Table 5 – Landscape Sensitivity

Sensitivity Level	Definition
HIGH	Key characteristics of the landscape are highly vulnerable to the type of change being assessed, with such change likely to result in a significant change in valued character.
MODERATE	Some of the key characteristics of the landscape may be vulnerable to the type of change being assessed. Although the landscape may have some ability to absorb change, some alteration in character may result. Considerable care may be needed in locating and designing change within the landscape.
LOW	Key characteristics of the landscape are less likely to be adversely affected by change. Change can potentially be more easily accommodated without significantly altering character and there may be opportunities to positively create new character. Sensitive design is still needed to accommodate change.

3.7 Receptor Sensitivity

To determine visual receptor sensitivity, consideration is given to those receptors who have the potential to view the proposed change. For the purposes of the detailed impact assessment, viewer sensitivity is defined as a combination of the following factors:

- Interest in the visual environment, viewer distance and the available angle of view (field of view)
- Place attachments and functional relationships with the place;
- Familiarity with the place and expectations;
- The surrounding level of use (number of visual receptors/users);
- The nature of the visual receptors and their familiarity with the place (receiving location and / or viewer type);
- The distance of the receptor from the potential impact.

Visual receptor sensitivity is a measure of the direct or indirect effects that development based changes may have on a view or scenic resource, which could include physical elements, visual character and cultural values. Table 6 defines different levels of receptor sensitivity.

Table 6 – Receptor Sensitivity

Sensitivity Level	Definition
HIGH	▪ Designated state level parks and scenic reserves, major recreation trails, formal scenic view locations & lookouts ▪ Highways (Bass Highway) ▪ Major tourist roads and established scenic routes ▪ Commercial facilities (ie Wineries) or sites that are based specifically around scenic values ▪ Public spaces within town centres ▪ Non rural residential properties
MODERATE	▪ Large volume regional link roads ▪ Secondary tourist roads and recreational driving routes ▪ Major landscape dependant outdoor recreation facilities & settings ▪ Rural residential properties ▪ Schools, hospitals and residential care facilities
LOW	▪ Local rural roads ▪ Farming properties ▪ Industrial land uses ▪ Local sports facilities ▪ Forest areas and other relatively inaccessible locations

3.8 Visibility analysis in GIS

The shape of terrain and its built and natural elements affect the potential visibility from a given point in a landscape. GIS modelling through Zone of Visual Influence mapping (ZVI) allows the determination of the likely visibility from a given point within the surrounding landscape. These modellings provide an objective basis to determine extents of visibility and potential visual receptors associated with the proposed development.

ZVI modelling produces conservative maps of all places with a line of sight to the top-most part of proposed structures. Multiple ZVI maps are produced for various project components during the baseline and impact assessment stage of the study.

High definition LiDAR data (LAS format) was sourced from DELWP to create base models in GIS for ZVI modelling. The provided data was captured in 2013 (Vicmap Coastal LiDAR) and in 2006 (Outer SE Melbourne) with 10cm accuracy. Two models including digital terrain model (DTM) and digital surface model (DSM) were created in GIS for ZVI modelling. DTM only includes the landform while DSM includes the vegetation heights and built form. The existing quarry operations inside the subject site are added to this model for ZVI analysis (Refer Figure 3.2).

Both DTM and DSM models were used for visibility analysis to produce conservative maps. A hypothetical ZVI was modelled based on DTM (landform only) and compared with more accurate ZVI based on DSM (landform, vegetation and building heights). Both options were considered in identification of sensitive receptors and affected areas.

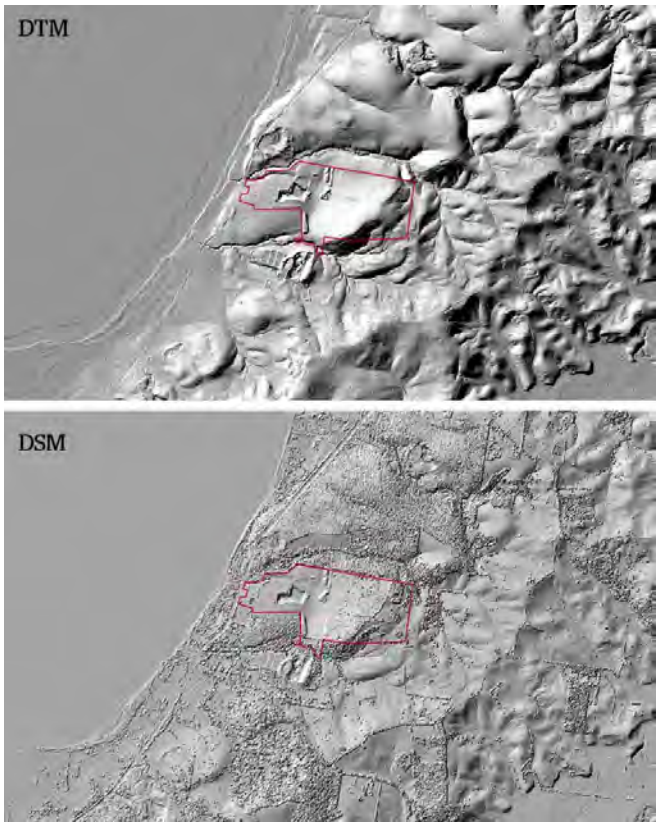


Figure 3.2 DTM (Landform Only) Vs. DSM (Including landform, vegetation & building heights)

Preliminary ZVI modellings informed the site visit to identify major roads, residential areas and areas of high public usage likely to have views to the proposed development. Preliminary mapping was verified by drive-around survey photography (including highway views), taking note of screening vegetation and existing built form as well as local character and features.

In addition to ZVI, multiple viewsheds were modelled from sensitive receptors (viewpoints) to check the visual exposure from these locations. The visibility analysis during the baseline stage of study provides a future input to the siting and design of proposed future extraction areas.

3.9 Photomontage Simulations

The appearance of the proposed quarry extension is further assessed by wireframe photomontage simulations. These results are discussed in Section 7-Impact Assessment. Photographs included within this report were taken and prepared in accordance with the following guideline.

- VCAT guideline Information to accompany photomontages or other computer generated images (Reference No P3030/2005 & P3331/2005 Appendix 1)

Additional reference material

- Landscape Institute (UK) Advice Note 01/09 Use of photography and photomontage in landscape and visual assessment (Feb 2009)
- Scottish Natural Heritage Visual Representation of Windfarms: Good Practice Guidance (Verified Photomontage)
- Institute of Landscape Architects (NZ) Best Practice Guide - Landscape Assessment and Sustainable Management/Best Practice Guide - Visual Simulations (Nov 2010)

Background

The photographic and imaging techniques adopted for this study are intended to produce visual representations that:

- Are as geometrically and aesthetically accurate as possible to permit decision makers, after suitable field inspections, to make a reasonable, balanced judgement of the effects of a proposed change.
- Are based on a transparent, structured and replicable procedure, to allow others to confirm the accuracy of the information presented.
- Are intended to present findings in a manner that is easily understood by non-technical people.
- Photographic images and simulations cannot provide the visual experience that a human observer would receive in the field. The detailed technical assessments and professional judgements presented in this study have been made on the basis of site inspections, modelling and other information.

Note:

- Photo montage images have not been produced for this assessment as Zone of Visual Influence (ZVI) modelling, wire frame imagery and on-site assessment has been adequate to establish the likely nature and magnitude of impacts.

Selection of viewpoints

The potential viewpoints identified within this study and represented within the photo images (Appendix A-10 to A-14) meet the following criteria:

Preliminary study

- Potential viewpoints and potential visual impact issues were initially identified through a preliminary study that included ZVI mapping.
- Field work reviewed potential view areas, view-points and view types.

3.10 Study Team

Mark Reilly: B.Ed. (Env.Studies), M.L.Arch., AILA, RLA,

Principal Landscape Architect, Tract Consultants

- Impact assessment
- Review of findings

Ata Tara: B.Arch., M.L.Arch.,Ph.D., AILA RLA

Senior Landscape Architect, Tract Consultants

- Field assessment, analysis & report preparation
- GIS modelling and photomontage
- Photography
- Field assessment & analysis
- Baseline report preparation

Michael Natoli: B App Sci in Planning (Urban Design)

Senior Principal Urban Designer + GIS modeller

- ZVI modelling

Tristan County-Black

Imaging software modelling

- QGIS (Version 2.14.6)
- Photoshop (Version CS3)
- 3D Studio Max (Version Design 2010)
- Illustrator (Version CS3)

Printed image resolution

- Printed image resolution to match photo resolution (10 megapixel)

4 Project Description

4.1 Project background

The following description of works is based on information supplied by Bell Cochrane & Associates Oct 2017 and Dandy Premix July 2020.

Dandy Premix Concrete Pty Ltd (the proponent), owns and operates four concrete batching plants in the south-east growth corridor of Melbourne, along with a bulk materials heavy vehicle fleet.

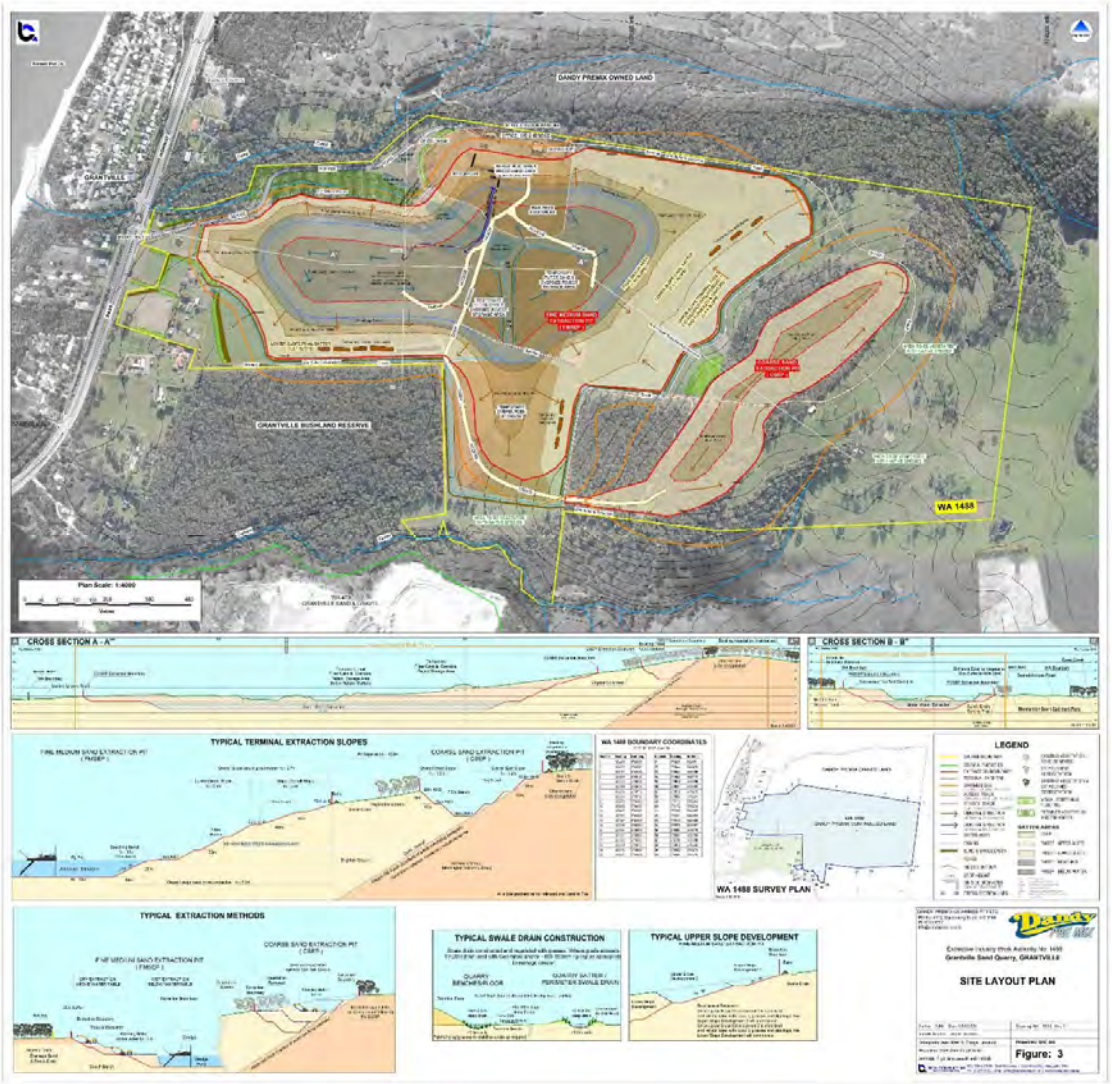
The Grantville site has been strategically acquired by Dandy Premix Quarries Pty Ltd to provide a range of construction sands for their concrete batch plants and the general construction and landscape market.

The existing sand quarry and processing operation (WA 1488) is focussed on the western part of the site.

A full description of the proposed development and operations are provided in the Work Plan Variation description provided in the work plan application reference document PLN-001354. Refer **Figure 4.1**

In addition to the current approved operations, the proposed Work Plan Variation involves:

- An extension to the area and depth of the western extraction pit area;
- The addition of a new extraction area within the elevated eastern half the site. Both extraction areas provide different sand products;
- Development of new sand washing and dewatering processing facilities in the same location as the existing sand processing facilities;
- The processing area is proposed to remain in its existing location before transitioning into the eastern pit in the long term as the extraction area develops.
- An extension to operating hours.
- Development of a signalised intersection treatment at the existing site access & egress point and a resulting change in truck movement patterns (direct movement north)



Source: Bell, Cochrane & Associates-2020

Figure 4.1 – Proposed Work Plan Variation – proposed site layout

4.2 Site location & context

The subject site is located on 156 hectares of rural land at 1381 – 1395 Bass Highway Grantville, 1.2km North of Grantville township. Refer **Figure 2.2**

The site is situated on the eastern side of the Bass Highway and will be accessed directly from Bass Highway.

Surrounding land uses are predominantly agricultural and pastoral to the north, east and south-east and native vegetation on Crown Land on the south-western edge of the site. One rural residential block abuts the south west corner of the Work Authority site.

Holcim GSG operates a sand quarry directly to the south of a section of the Colbert Creek southern boundary of the subject site (WA1488 area).

There is a well-established residential community to the west and north-west of the site on the opposite side of the Bass Highway interspersed with treed coastal reserve and creek reserve areas. The nearest residential property (backing onto the Bass Highway road reserve) is approximately 220 metres from the western extremity of the existing extraction Pit.

4.3 Site description

The subject site is and irregularly shaped block around 2,100m in length and ranging in width from around 480m to around 900m. The site comprises a west facing slope which rises from the western coastal plain at around RL15m, to a peak of around RL120m at the eastern part of the site.

The site includes an existing extractive area; processing area and stockpile area are confined to the western half of the site below RL40m. The remaining of site is mainly cleared pasture with dense remnant woodland on the higher slopes. The proposed new works affect both the western and eastern parts of the site. Refer **Figure 4.1**

An existing localised intermittent waterway runs in an arc around the proposed extractive area. Permanent creeks run in an east-west direction within the Crown Land reserve (south) and private farmland (north) adjoining the subject site.

4.4 Existing operation description

The existing extraction pit is located in the middle/front of the Work Authority site, with extraction planned to generally commence working from the east, north-east terminal face.

- The total depth of excavation in the proposed Extraction Pit is approximately 25 – 30 metres below the natural ground surface.
- Working faces are cut at 1V:1H, with a minimum 15 metre Bench. The southern terminal face are cut at 1V:3H, with a 7.5 metre Bench creating an overall batter of 1V:3.5H. The remaining terminal faces will be cut at 1V:1H with a 7.5 metre Bench, creating an overall 1V:1.5H batter. Faces 15 metres or less in height will remain at 1V:1H overall.
- Ground water was not intersected above approximately 1.0 – 2.0 metres AHD during the Air-Core exploratory drilling program. The proposed Excavation Pit depth is designed to avoid interference to groundwater and this application does not propose any extraction of groundwater.

Sand processing area

Sand processing area is in the northern section of the development area. The processing area of the development has been located to take advantage of the undulating site topography and native vegetation immediately bordering the area.

The sand processing area contains:

- A material stockpile less than 13m in height;
- A radial stacker approximately 13m in height (tallest object);
- An incline conveyor;
- Three feeder bins and loader feed ramp;
- Weighbridge and workshops;

- 1.5m high planted bund with 2.5m high acoustic panels;
- There is operational lighting within the processing area in the mornings, after 6am until sunrise only when required. There is no other lighting within the site or its surroundings. Light sources are static and shielded to minimise light spill beyond the operational area.

Overburden storage area

Overburden storage area is in an area south east of the extraction area.

- Sufficient quantities of top soil are stockpiled for use in planned progressive rehabilitation works. Top soil stockpiled for rehabilitation works (approximately 85,000 m3) will provide a minimum cover of 200mm over all areas requiring rehabilitation.
- Top soil stockpiles will be less than 3.0 metres high.
- The amount of overburden removed in the mid Extraction Pit development stage(s) and required to be temporarily stored is estimated to be approximately 110,000 m3. Overburden remaining in-situ and beyond the above quantities that have been removed, will be used directly in pit backfill rehabilitation works.

Screen bunds and planting

- Several 2.5m high bunds been constructed and sown down to pasture grasses to enhance the natural screening provided by the existing landform.
- Planting of indigenous trees and shrubs has been carried out in strategic locations to add to the natural screening of the operational area.

Buffer areas

- A minimum 20m non-extraction area has been established from the extraction edge to the Work Authority boundary on the southern boundary (to the Crown Land Reserve) and 30m to the centre of a surface water drainage gully to the north (Northern Drainage Tributary) with a further 60m to the Work Authority northern boundary.
- There is a minimum 200m buffer from the proposed Extraction Pit to the nearest residences to the west, north-west and south-west Work Authority boundaries.
- Three residences on the Work Authority land are owned and controlled by Dandy Premix Quarries Pty Ltd.
- One rural residential property located adjacent to the south west corner of the Work Authority area will remain in residential use, protected from environmental effects by earth bunds, screen planting and existing landform characteristics.

Mobile Plant

- On-site, conventional dry extraction mobile plant and equipment are used, including but not limited to an Excavator, Bulldozer, Front-end Wheel Loader, Dump Trucks, Road Grader, Scraper and a Water Tanker(s). Other specialised equipment such as Compactors are used as required.
- Off-site, trucks transport excavated materials on Bass Highway only.

Truck movements

- Refer section 4.6

4.5 Access to the site

Existing and proposed traffic movement is described in the report Traffic Engineering Assessment Proposed Quarry Expansion 1381 Bass Highway, Grantville Traffix Group July, 2020 (ref G23730R-01D)

Existing development

Access to the Work Authority site is directly off the Bass Highway.

The internal site access track is extended from the Bass Highway site entrance to the plant, stockpiles, sales loader and weighbridge hard stand area. The site access track, including the entrance from the Bass Highway to the hard stand area is sealed from initial construction. The entire site access track is constructed and fully maintained for the life of the operation to mitigate noise, dust and to manage stormwater runoff.

The current operation of the site has permission to generate 120 truck movements each day.

Future development

As part of the proposal, and subject to forecast sales over the next 6-8 years, the number of truck movements required to service the site may increase to 240 truck movements per day (120 IN and 120 OUT), an increase of 120 additional truck movements per day.

The operation of the site does not have 'peak periods' but instead operates consistently over the hours of operation throughout the day.

The proposed development includes the signalisation of the current access to remove the need for Melbourne bound trucks making a double pass through Grantville. The existing site access arrangement is already designed to be compatible with the signal design layout.

A proposed speed limit of 80km/h will be extended to north of the subject site.

As the majority of traffic is to and from the north, signalised intersection changes are likely to reduce the overall number of vehicle movements into the Grantville township and areas south of the current site entry.

4.6 Proposed future operation

A full description of the proposed development and operations are provided in the Work Plan Variation description provided in document PLN-001354 and shown in **Figure 4.1.**

4.7 Hours of operation

The extraction, sales, processing operations and truck movements commence from 6:00am and operate continuously through to 6:00pm weekdays, Monday to Friday and between 6.00am and 1.00pm on a Saturday. No site operations or truck movements occur on Sundays or Public Holidays.

Works outside of these hours will only be for essential maintenance unless otherwise authorised in advance by the Responsible Authority (Bass Coast Shire Council) and the Department of Primary Industries (DPI).

4.8 Lighting

There is operational lighting within the processing area in the mornings, after 6am until sunrise and from sunset to 6pm, only when required. Vehicles operating within those times will use headlights.

There is no other lighting within the site or its surroundings. Light sources on infrastructure are static and shielded to minimise light spill beyond the operational area.

5 Policy Context

The purpose of this section is to provide an overview of landscape or visual management policies that directly affect the study site and site surroundings, and that describe community values that can inform or provide an appropriate reference for the landscape and visual assessment process.

The subject site is within the municipal area of the Bass Coast Shire Council and therefore subject to the Bass Coast Planning Scheme. The site is located within the Farming Zone (FZ) and is subject to the Bushfire Management Overlay (BMO). No other overlays apply.

Statutory provisions and policy documents with implications for landscape values are summarised below.

5.1 Bass Coast Planning Scheme

5.1.1 State Planning Policy Framework

Of specific relevance to the characterisation of landscape and visual management policies includes:

SPPF clause 11.04-1 (Open space planning) includes strategies to assist in the creation of regional and local open space networks for both recreation and conservation of natural and cultural environments. The intention of the strategy is to ensure that land use and development adjoining regional open space networks, national parks and conservation reserves "complement" the open space in terms of visual and noise impacts and other factors.

As part of the subject site (lot 2 in PS 300991) directly adjoins land zoned as Public Conservation and Resource (PCRZ), this strategy is likely to generally apply, although the PCRZ reserve area is likely to have local recreation and conservation importance only.

SPPF Clause 11.05-1 (Coastal settlement) seeks to plan for sustainable coastal development. To achieve this objective this clause seeks to identify a clear settlement boundary around coastal settlements, such as Grantville, to protect coastal values which presumably includes the landscape and scenic values inherent in such areas.

The subject site lies within close proximity to the Western Port Bay coastline and the LVIA study should consider potential development impacts on views and vistas to the coast.

SPPF Clause 11.07-1 (Regional Victoria) seeks to develop regions and settlements which have a strong identity. As part of encouraging distinctive regional settlements such as Grantville, planning is to ensure that development 'respects and enhances the scenic amenity, landscape features, and view corridors of each settlement'. **SPPF clause 12.04** (Significant environments and landscapes) has the objective of protecting and conserving environmentally sensitive areas and landscapes, and significant open spaces that contribute to character, identity and sustainable environments.

Strategies include:

- protecting areas with significant recreational value (including Western Port and its foreshores) from development which would diminish their environmental conservation or recreation values;
- ensuring that new development does not detract from the "natural quality" of sensitive landscape areas such as bays and coastlines;

- ensuring that natural key features are protected and enhanced.

SPPF Clause 11.10 (Gippsland) which implements the policy objectives and strategies for the Gippsland region contained in the Gippsland Regional Growth Plan 2014 (discussed below). Of relevance are the following strategies:

- facilitate and manage access to earth resources where appropriate, including sand, minerals and renewable energy potential;
- Protect significant inland and coastal landscapes, and cultural heritage assets and reduce the impact of urban growth on high value coastal and waterway assets such as the Gippsland Lakes, Corner Inlet, Anderson Inlet, Mallacoota Inlet and their source rivers.

SPPF Clause 12.04-2 (Landscapes) which explicitly seeks to 'protect landscapes and significant open spaces that contribute to character, identity, and sustainable environments'.

- Specific strategies contained within the clause include:
  - *'Ensure sensitive landscape areas such as the bays and coastlines are protected and that new development does not detract from their natural quality.*
  - *Improve the landscape qualities, open space linkages and environmental performance in green wedges and conservation areas and non-urban areas.*
  - *Recognise the natural landscape for its aesthetic value and as a fully functioning system.*
  - *Ensure natural key features are protected and enhanced.'*
- For a specific area contained within a municipality, a relevant local planning policy will implement these strategies.

SPPF Clause 15.01-5 (Cultural Identity and Neighbourhood Character) which seeks to protect the established character and sense of place. Of specific regard is the strategy which seeks to ensure that development responds to its context and reinforces the special characteristics of local environment and place by emphasising the underlying natural landscape character.

5.1.2 Local Planning Policy Framework

Of specific relevance to the characterisation of landscape and visual management policies includes:

LPPF Clause 21.01-4 (Bass Coast Council Plan 2013-2017) outlines the Councils vision for the municipality:

> **'**Bass Coast Shire will be recognised as a unique place of environmental significance where our quality of life and sense of community is balanced by sustainable and sensitive development, population and economic growth'

This clause also outlines the five key strategic objectives that seek to achieve Councils vision. Of specific relevance is the emphasis on the protection of the natural environment and fostering development that complements the landscape of the municipality. These strategies are further broken down in later sections of the LPPF as detailed below.

LPPF Clause 21.01-5 (The Vision) recognises specific visions contained under the main strategic objectives of Clause 21.01-4. Specific visions of landscape and visual management permeate through several key objectives and include:

- *'Agriculture and rural landscapes maintain non-urban breaks between towns.*
- *Industrial activities bringing prosperity to the local economy, while being responsive to the environment and surrounding land uses.*

- *Quality tourist development responding to tourism market demand, the coastal experience, landscape character and the environment in identified locations throughout the municipality.*
- *National and international recognition as a location for nature-based attractions, as well as for sporting and cultural events.*
- *Rural areas recognised as benefitting from tourism so long as it does not come at the expense of environmental, landscape, social and agricultural values.*
- *Rural landscapes protected.*
- *A high quality built environment enhancing the surrounding natural environment and landscape values.*
- *The coastal and hinterland areas between activity nodes remaining as areas with views, landscape, environmental, or rural values.*
- *The Shire's rural areas, which contain important environmental assets and which contribute to the amenity and landscape, recognised and protected.*
- *Architecture and building design responding to the environment, character and coastal setting.*
- *New developments designed and sited to complement the specific context in which they sit and take account of existing land form, vegetation and urban character.*
- *The rural farmed landscape, combined with coastal views and beach access, as a significant element in the identity, image, and liveability of Bass Coastal'.*

As demonstrated in the main land use visions for the municipality, a substantial onus rests on the context of place in determining the intrinsic landscape and visual character. In this regard, planning in the Bass Coast seeks to ensure that all development is commensurate with this landscape and visual character which underpins the basis for visual management within the municipality. These are further broken down into specific strategies in later sections of the LPPF as detailed below.

LPPF Clause 21.03-7 (Extractive Industry) which recognises the importance of the sand resources at the Gurdies-Grantville areas (immediately east of the Grantville township) and outlines strategies for managing their growth and development. The two objectives seek to simultaneously protect the Gurdies-Grantville areas for future sand extraction and to manage extractive industry in response to surrounding land uses and the natural environment. Specifically, it seeks to ensure that quarries are located or designed so as to minimise impacts of high landscape and environmental quality.

LPPF Clause 21.05 (Landscape and Built Form) recognises the regional and national significance of the environmental and landscape of the Bass Coast Shire. This clause also acknowledges the significance of coastal landscapes and hinterlands to the community 'for their visual, environmental, and cultural values'. Key elements of these landscapes character include coastal views and rural farmed land which should be protected by prohibiting 'ribbon development' between towns.

Six distinct 'character areas' are identified in the clause. The subject site falls within the Westernport Lowlands ecologically distinct area which 'is located on the eastern edge of the Westernport Bay'. The area's character is summarised as 'low-lying and most rural, with beaches, mangrove flats and coastal woodlands along a diverse coastal edge'.

It states that for the northern half of the character area, the future character 'will become increasingly revegetated with local vegetation communities extending from bushland reserves along roadsides and watercourses into open rural land'.

Furthermore, the Site is located on the periphery of the Bass Hills Character Area which is defined as a prominent and important landscape element forming a backdrop to landscapes surrounding Westernport Bay, rising steeply from coastal plains and pastures and forming part of the Strzelecki Highland Character Type stretching between San Remo in the west and Yarram in the east. The subject site is likely to represent the edge of this landscape system.

In terms of future landscape management of the Bass Hills landscape type, it is expected to retain an undeveloped cultural landscape character in which built form is sparsely located and does not dominate the rural character.

Development on the western face viewed from the Bass Highway (the subject site), settlements and other key viewing locations on the eastern side of Westernport Bay will continue to be restricted and carefully

managed to retain the unbuilt character. Cultural vegetation patterns and native vegetation corridors will create contrasts with the historic cleared landscape character. Inland of the coastal view-shed, an open rural character will be maintained by ensuring built form is carefully sited low in slopes and native vegetation and exotic feature planting are used to soften buildings. Increased rural living and lifestyle developments as well as the majority of rural structures will be sited low on inland slopes out of the coastal view-shed.

Pursuant to the clause, the following objectives and strategies are relevant to landscape and visual management:

- **Objective 1** – To ensure that development is subordinate to the natural, visual, and environmental landscape character and significance.
- Strategy 1.1 - Ensure that coastal related development responds appropriately to the landscape setting, character and desired future character directions
- Strategy 1.2 - Strongly discourage development that is unsympathetic to significant landscape areas.
- Strategy 1.3 - Scale the height and form of new development at the coastal edge of settlements to be sensitive to surrounding development, the surrounding landform and the visual setting of the settlement, particularly when viewed from the foreshore.
- **Objective 2** – To protect the undeveloped character of the coastal strip
- Strategy 2.1 - Retain a dominant natural or undeveloped character, by setting development back from the coast, in flatter locations, avoiding loss of vegetation, and minimising the visibility and impact of pedestrian and vehicular access paths and site servicing on the coastal landscape.
- Strategy 2.2 - Ensure ridge tops and visually prominent hill faces are largely kept free of development, particularly slopes visible from the coast and coastal hinterland.
- Strategy 2.3 - Use existing landscape features where they exist (e.g. topography, vegetation coverage, vistas), to define edges to settlements and protect the surrounding landscape character
- **Objective 3** - To protect locally significant views and vistas that contributes to the character of the coastal and coastal hinterland region.
- Strategy 3.1 - Strongly discourage development from locating on hilltops and ridgelines
- Strategy 3.3 - Protect scenic views in undeveloped landscape features along the coastline including views from public recreation areas, lookouts, and roads that abut, or terminate at the coast.

LPPF Clause 21.08-7 (Moderate Growth Settlements – Grantville) which identifies Grantville as a 'moderate growth settlement' and states that:

> 'Grantville is a series of established and separate subdivisions, of varying types and lot sizes, serviced by a small commercial centre. The town is sufficiently established to support light industrial and essential services. Growth in the eastern region of Melbourne is likely to result in increasing demand for commuter and retiree housing in and around Grantville.'

LPPF clause 22.02 (Hilltop, Ridgeline and Prominent Coastal Landform Protection Policy) applies to all land located on and adjacent to significant hilltops, ridgelines and prominent coastal landforms found within the Farming Zone (FZ) (which applies to all of the subject site) as well as other specified zones.

The policy basis is to protect the visual qualities of prominent landforms and ridges and thereby maintain the landscape qualities of the Shire; to protect prominent coastal landforms (including those characterising Western Port) from inappropriate development; and to prevent hilltops and ridgelines along coastal hinterlands such as The Gurdies from being undermined by development.

Objectives include protection of the environmental, landscape and visual significance of hilltops, ridgelines and prominent coastal landforms; and maintenance of panoramic roadside views of the scenic natural landscape along hilltops, ridgelines and prominent coastal landforms.

The Policy concludes that development on ridgelines, prominent hill faces or distinctive coastal landforms should be avoided wherever possible. Where development cannot be avoided, various considerations should be taken into account.

Clause 35.07 (Farming Zone) includes planning provisions specifically applicable to the Farming Zone (FZ). Among the decision guidelines applying to any permit application within this zone, the responsible authority must consider 'the impact on the character and appearance of the area or features of architectural, historic or scientific significance or of natural scenic beauty or importance' and 'The impact of the siting, design, height, bulk, colours and materials to be used, on the natural environment, major roads, vistas and water features and the measures to be undertaken to minimise any adverse impacts'.

Clause 36.03 (Public Conservation and Resource Zone) an area of land known as the Grantville Bushland Reserve, zoned Public Conservation and Resource Zone (PCRZ), adjoins the south west corner of the subject site. The purpose of the PCRZ is to protect and conserve the natural environment and natural processes for their historic, scientific, landscape, habitat, or cultural values'. The development of the land adjacent the PCRZ will need to have to regard to its impact on the visual and landscape values of land within the PCRZ.

Clause 44.06 (Bushfire Management Overlay) applies to the Site and affects a substantial amount of the Grantville-Gurdies region. The purpose of the Bushfire Management Overlay (BMO) is to ensure that the development of land prioritises the protection of human life and strengthens community resilience to bushfire. The BMO does not introduce any additional landscape or visual impact provisions.

Particular Provision 52.09 (Stone Extraction and Extractive Industry Interest Areas) has the purpose of ensuring that use and development of land for extractive industry does not adversely affect the environment or amenity of the area during or after excavation; that excavated areas can be appropriately rehabilitated; and that sand and stone resources are protected for future use from inappropriate development. In deciding any application for a permit for use of land for extractive industry, the decision guidelines to be applied include

- the effect of the extractive industry operation on the natural and cultural landscape of the surrounding land and the locality generally
- the ability to rehabilitate the land to a form compatible with the natural visual appearance of the surrounding area

Bass Coast Rural Land Use Strategy – Directions Paper (2012)

A Rural Land Use Strategy Directions Paper (September 2012), has been prepared for public comment. This document includes themes and strategic directions that will ultimately form the basis of amended planning controls.

Recommendations address the following issues:

- Protection of agricultural land
- Supporting sustainability and encouraging diversity in the agricultural sector
- Protection of rural amenity
- Protection of environmental assets located in rural areas
- Facilitating rural tourism development

Protection of rural amenity is based on the following propositions:

- Protection of agricultural land contributes to the amenity of the area – the character of Bass Coast and its attractiveness as a place to live and visit.
- Preservation of rural outlooks that contribute to the visual attractiveness and amenity of Bass Coast and its attractiveness as a tourism destination.

- Rural living development – limiting conflict between rural living and agricultural land uses.

The implications of the policy (in its current draft form) for the subject site are likely to be that the elevated eastern part of the site will be seen as contributing to the general amenity of the Bass Highway and coastal landscape. The current sand extraction development proposal will have no impact on the area concerned.

5.2 Gippsland Regional Growth Plan (May 2014)

Through Amendment VC106 which amended the Victorian Planning Provisions and all planning schemes in Victoria introduced the Gippsland Regional Growth Plan (GRGP) among other documents. The GRGP covers the Bass Coast, Baw Baw, East Gippsland, Latrobe, South Gippsland, and Wellington municipalities and provides a framework for land use and development in the region to address future growth pressures.

The GRGP outlines a comprehensive vision to manage residential growth, improve economic growth, preserve the regions valued rural and regional character, and improve private and public transport in the region. A set of guiding principles and strategies are adopted as part of the GRGP to achieve this vision.

Of relevance to landscape and visual assessment is Principle two – 'Promote a healthy environment by valuing Gippsland's environmental and heritage assets and by minimising the regions' exposure to natural hazards and risks'. Principle two seeks to protect the distinct rural landscapes and sensitive environments (such as coastlines and natural bushlands) which make up the region. Specifically, it notes that 'Urban and economic development will be managed so as to minimise adverse impacts on these environmental and cultural heritage assets'.

The GRGP identifies that there are many significant landscapes within the region. Specifically, it relies on the characterisation and assessment of landscape value contained within the Coastal Spaces Landscape Assessment Study (discussed below). The recommendations of this Study being adopted into the planning scheme through the application of the Significant Landscape Overlay (SLO) and the Environmental Significance Overlay (ESO).

It should be noted that neither the Significant Landscape Overlay (SLO) nor the Environmental Significance Overlay (ESO) affect the site, nor any land within immediate proximity of the site. A coastal spanning ESO is located west of the site towards Queensferry and a large SLO is located south and east of the site.

5.3 Coastal Spaces Landscape Assessment Study (September 2006)

The Coastal Spaces Landscape Assessment Study (September 2006) report identifies and describes the Westernport Lowlands in a manner consistent with the description implemented in the Planning Scheme (particularly clauses 21.02-7 and 21.08). It also provides some background as to how visual significance of coastal landscapes was assessed – "the landscape is significant for its visual qualities, including landform features, views, edges or contrasts, and for its predominantly natural or undeveloped character, in which development is absent or clearly subordinate to natural landscape characteristics". Using these criteria, places were assigned either a "local", "regional" or "state" level of visual significance.

Within the Gippsland region, the landscape of the eastern short of Westernport Bay (including the subject site) is designated as being of Local Significance. It should be noted, however, that every part of the Victorian coast was considered to be of at least local significance.

The report made recommendations for changes to State Planning Policies and Local Planning Policies to be reflected in each Victorian planning scheme, some of which appear to have been made (and are discussed above), while others were not. Coverage of a number of landscape areas along the Victorian coast by a Significant Landscape Overlay (SLO) was recommended; the subject site was not among the areas recommended for application of an SLO.

5.4 Victorian Coastal Strategy

The Victorian Coastal Strategy (2014) seeks to provide a long-term vision and integrated management framework for the coast of Victoria. It applies to all Victorian coastal waters, which as defined by the Strategy 'encompass coastal, estuarine and marine environments on both public and private land'. This includes the marine environment up to three nautical miles from the coast, foreshores up to 200 metres from the high-water mark, coastal hinterland, catchments, and atmosphere around the coast.

The Strategy acknowledges that the coast provides social, cultural, economic, and environmental benefits for all Victorians. This includes through the distinctive character of coastal townships separated by natural or rural landscapes which the Strategy, alongside State and Local Planning Policy, seeks to protect. It explicitly notes that 'coastal landscapes and biodiversity provide aesthetic, therapeutic and psychological wellbeing benefits'.

This purpose of the Strategy is to provide a framework for related regional coastal plans, regional growth plans, regional catchment strategies, local planning schemes, and management plans for coastal Crown Land.

5.5 Bass Coast Strategic Coastal Framework

This document (prepared in 2008) primarily refers to population and housing projections for coastal townships and is therefore likely to have no direct implications for non-urban uses or their impact on landscape and visual values.

5.6 Tourism values

The Grantville area is not specifically mentioned in the Tourism Victoria Regional Tourism Action Plan 2009 – 2012 however the Bass Highway is a regional route linked to key tourism destinations such as Phillip Island and the wider Gippsland Tourism Region. On that basis landscape and visual quality are likely to be seen as important values that generally support regional and local tourism initiatives.

5.7 Policy Context – Conclusion

A key theme of the Bass Coast Planning Scheme and related strategic documents is the substantial emphasis on protecting the significant the landscape character of the municipality. A large element of this is the character and visual attraction of the coastline. These landscapes are regarded for their important contributions to the social, cultural, economic, and environmental growth of the region.

- The Planning Scheme specifically refers to the known sand resources at The Gurdies-Grantville area. The stated objectives and strategies are intended to ensure that extraction of stone is carried out in accordance with high environmental standards and does not have a detrimental impact on the environment or significant landscape areas; that extensive buffer zones of indigenous vegetation are planted around quarries and that quarries are located or designed so as to minimise impacts on areas of high landscape and environmental quality.
- The subject site is not specifically designated by Bass Coast Shire as an area of high landscape or scenic value (evidenced through the absence of either Environmental Significance Overlay or Significant Landscape Overlay) but the location is likely to be considered to have values related to its near coastal location, the adjacent PCRZ land, its position as part of the general Gurdies

landscape and its visual relationship to the Bass Highway corridor. These relationships suggest that the siting and design of development within the subject site should be sensitive to the values attached to the broader coastal landscape and specifically managed to limit off site visual effects.

- The Bass Highway is considered to be an important viewing corridor with a relationship to the surrounding coastal landscape and a role as part of a regional tourism route linked to Phillip Island and Gippsland tourism destinations. The appearance of the site from Bass Highway is important. It is worth noting that Grantville is specifically identified as a moderate growth settlement that has capacity for moderate spatial growth.
- The Bass Coast Planning Scheme encourages some growth beyond urban zoned land and infill development within the township boundary. Whilst the Site is located outside of the township boundary, Grantville is strategically planned to intensify in residential, commercial, and industrial use which will invariably have some degree of impact on the current landscape character of the immediate area.
- The Bass Coast Planning Scheme generally has the objective of protecting environmentally and visually sensitive areas, landscapes and open spaces that contribute to the character, identity and sustainability of rural, residential and coastal environments. Conservation strategies include measures to ensure that:
  - new development does not detract from the natural quality of sensitive landscape areas such as bays and coastlines. Not applicable to the subject site.
  - development is subordinate to the natural, visual and landscape character of the setting.
  - locally significant views that contribute to the character of the coastal and coastal hinterland areas are protected. Not applicable to the subject site.
  - the visual and landscape quality of hill tops, ridgelines and other key landforms are protected.
- The GRGP identifies that there are many significant landscapes within the region. Specifically, it relies on the characterisation and assessment of landscape value contained within the Coastal Spaces Landscape Assessment Study (discussed below). The recommendations of this Study being adopted into the planning scheme through the application of the Significant Landscape Overlay (SLO) and the Environmental Significance Overlay (ESO).
  Neither the Significant Landscape Overlay (SLO) nor the Environmental Significance Overlay (ESO) affect the site, nor any land within immediate proximity of the site. A coastal spanning ESO is located west of the site towards Queensferry and a large SLO is located south and east of the site.

6 Baseline Conditions

This report section provides a description and analysis of the current conditions of landscape that currently exist within the site and the surrounding study area (baseline conditions). Changes to landscape and visual effects resulted from the proposal are assessed against these baseline conditions.

6.1 Subject site and surrounds

The Grantville Sand Extraction (Stage 1) is currently operating in subject site in accordance with the approved Work Plan and other approvals. The extractive area, processing area and stockpile area are confined to the western half of the site below RL40m.

The remaining of site (approx. 60%) is currently a cleared grazing land. Areas of remnant indigenous woodland have been retained in the elevated eastern and southern parts of the site which will be affected by the future quarrying or processing works.

The subject site is a west facing slope which rises from the coastal plain to the west of the site (around RL14m), to a ridgeline (RL122m) at the eastern part of the site. The land surrounding the site to the north, south and east has a moderately dissected landform related to the Bass Hills landscape character type. Two permanent creeks in north and south of subject site run in an east-west direction. An existing intermittent localised watercourse runs in an arc around the proposed extractive area.

The landform divides the subject site into three zones including edge of Bass Highway, flat area (existing quarry) and sloping cleared land (RL40) to the ridgeline. Three road corridors on surrounded ridgelines including Grantville-Glen Alvie Road, The Shuntoff and Stewart Road define the visual catchment edges of the subject site.

The existing working area and extraction area are approved previously for extraction activities. The existing grazing land and woodland are nominated as potential extended extraction area as part of this study to be investigated for future extractions. Refer **Figure 5.1**.



Figure 6.1 Existing land use

6.2 Climate

The climate of the study area is generally similar to central Melbourne but with a marginally lower average temperature and higher average rainfall. The climate and soil types sustain dense, tall vegetation communities and a relatively high plant growth rate.

6.3 Vegetation

Site vegetation is described in a report by Norris & Schoffel, Proposed Grantville Sand Pit Ecological Assessment with Net Gain Report, 23rd April 2012.

The study site is mainly cleared with areas of remnant woodland areas in the elevated eastern and southern parts of the site. There are substantial areas of woodland within the Crown Land Reserves south and north of the site.

- The Norris & Schoffel report identifies EVC_16 Lowland Forest, ('Vulnerable' EVC), as the vegetation type that once covered the proposed area of extraction and infrastructure. This EVC type forms the basis of remaining woodland within and around the site.
- EVC 16 Lowland Forest is generally described in DSE data as 'Open forest to 25m tall characterised by the diversity of species and life forms in each stratum and includes a variety of heathy understorey shrubs'.
- Downstream from the property boundary (north and west), EVC_53 Swamp Scrub ('Endangered' EVC), extends across the Bass Highway. The trees associated with the tributary of Deep Creek are predominantly Messmate Eucalyptus obliqua with some Narrow-leafed Peppermint Eucalyptus radiata and Swamp Gum Eucalyptus ovata. From the property boundary, the vegetation type changes distinctly into a Swamp Scrub type dominated by Melaleuca and Tea-tree.
- EVC 53 Swamp Scrub is generally described in DSE data as 'Closed scrub to 8m tall at low elevations on alluvial deposits along streams or on poorly drained sites with high nutrient and water availability…..dominated by Woolly Tea-tree Leptospermum lanigerum which often forms a dense impenetrable thicket out-competes other species. Emergent trees (eg Swamp Gum Eucalyptus ovata) may sometimes be present'.

6.4 Landscape character assessment

Based on the classification of 'Landscape Character Types of Victoria', the overall landscape character type is likely to be classified as '**Southern Lowlands'**, although the location has an association with the adjoining Southern Uplands / South Gippsland Hills landscape character type to the west of the subject site (referred to as the 'Bass Hills' landscape in the Planning Scheme).

According to 'Coastal Spaces Landscape Assessment Study (2006)', the study area is located in Westernport Lowlands landscape character area. The area is characterised by low-lying and mostly rural, with beaches, mangroves flats, and coastal woodlands. Elevated hills and rises provide extensive views across Westernport Bay.

At the local level, the broad landscape character area has been further classified by considering landform, land cover and land use patterns verified during the site inspection (**Figure 6.2**). The local area is characterised by a combination of Western Port Bay, grazing across coastal plain and valley, elevated grasslands (Bass hills and ridgelines). Bass Highway and Gippsland Highway are the major viewing corridors in the landscape. Agriculture land mosaics with scattered coastal residential settlements are main patterns in lowland area contributing to the landscape character. The subject site is located in dissected part of Bass hills, divided by the ridgeline in a topographic bowl. This context defines the broad visual catchment of subject site within Westernport Bay area.

Existing extraction areas are major patterns of land use along the western side Bass hills which are surrounded by major stands of native woodlands and conservation areas. The rural character of locality is associated with extractive activities over years due to visibility of signage along main roads and visible activities from coastal communities and rural production areas (Tonby Points and Corinella) (**Refer Figure 6.2**).

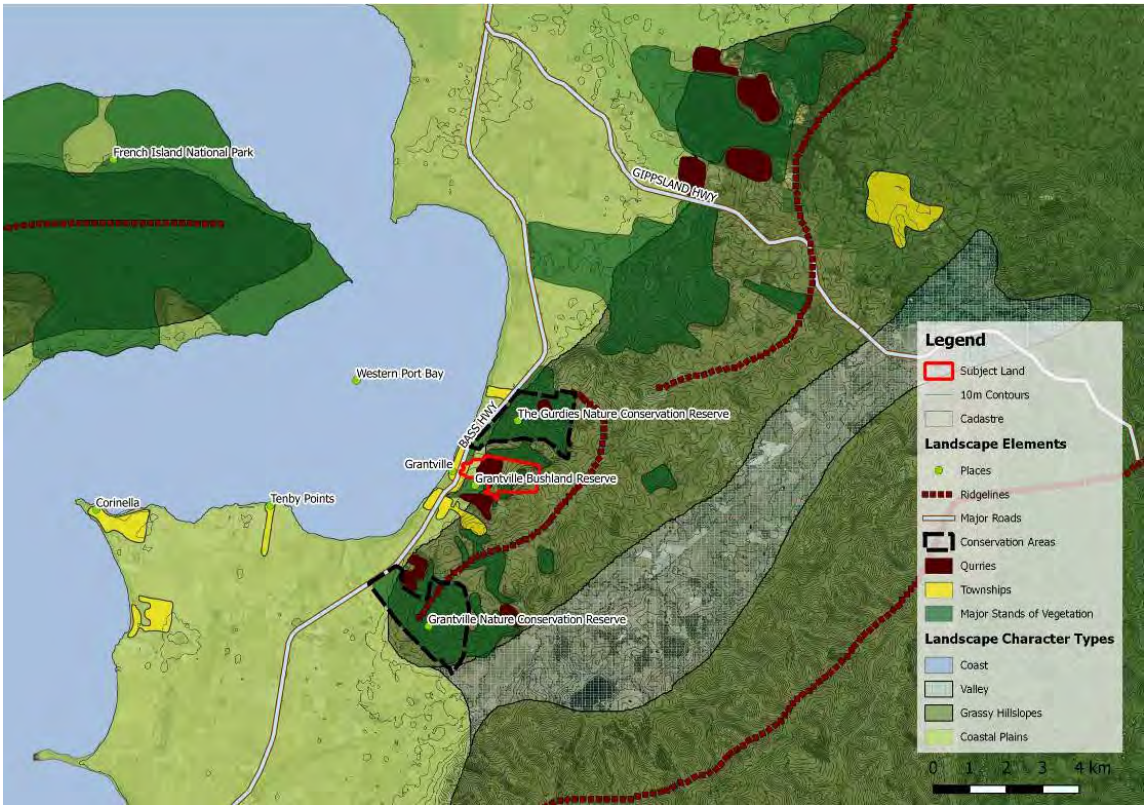


Figure 6.2 Landscape Character Types in Local Area (Refer to appendix a for A3 size figure)

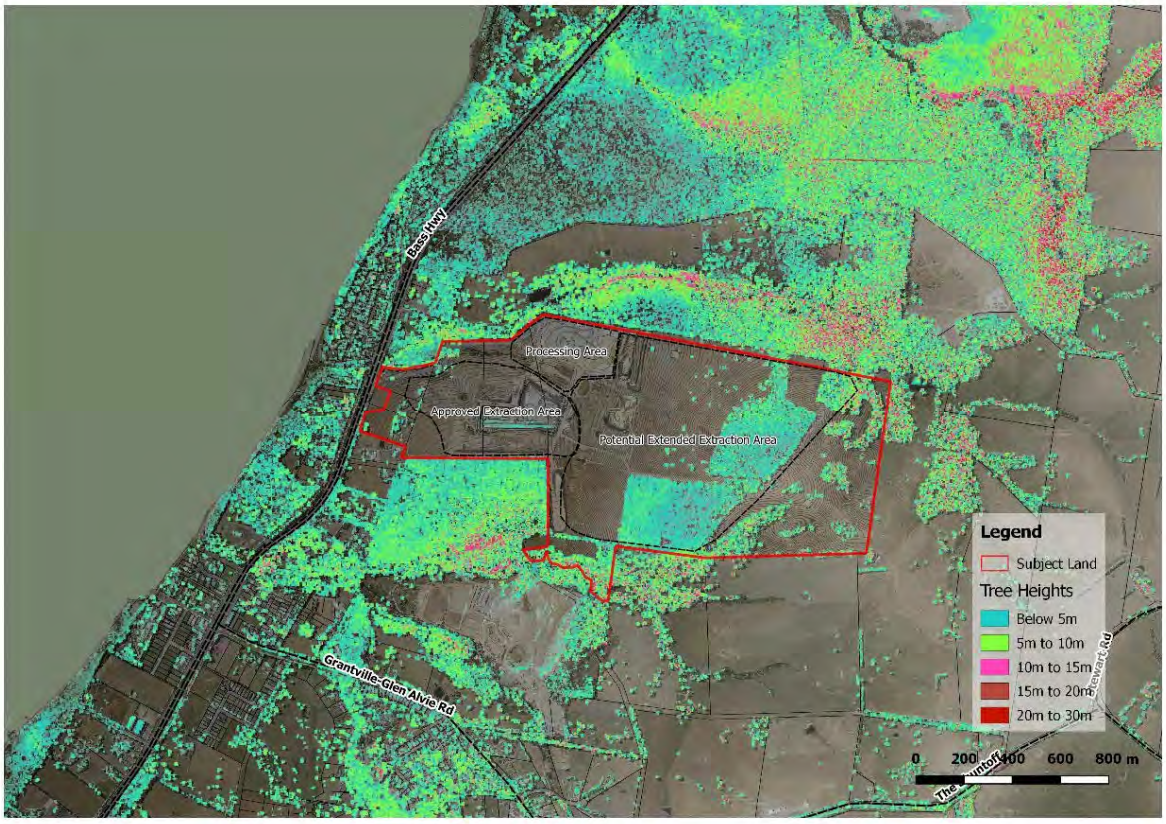


Figure 6.3 Vegetation heights extracted from LiDAR (Refer to appendix a for A3 size figure)

- The landscape within the quarry site boundary has been largely cleared with some remnant blocks of woodland planting in the elevated eastern and southern parts of the site which will remain untouched. The condition of the agricultural land is good and similar to surrounding agricultural land.
- Farm houses, sheds, access roads and other residential development along the Bass Highway edge create the image of a long established, semi developed area where land use is now a combination of residential and agricultural uses. The landscape condition from public viewpoints is likely to be perceived as moderate given the impact and form of housing development and services.

6.5 Landscape status

In terms of formal status of the study area:

- The subject site is not subject to any Significant Landscape Overlay or formal landscape designation at a local or State level. The coastal edge, including the subject site, is rated as having 'Local Significance' within the Coastal Spaces study (2006) but all coastal areas on the Victorian coast have been given this rating.
- The subject site and the surrounding landscape are subject to a series of planning policies and controls that refer to landscape character and scenic quality. On that basis, the landscape of the

broader site setting, particularly the coastal edge, is likely to be considered locally significant. Areas that adjoin the coastal strip, including the subject site, are likely to be seen as supporting the landscape values of the coastal edge.

- The nearby Gurdies reserve area is considered a locally significant landscape feature and the subject site is likely to be considered a part of that landscape system (albeit in an altered condition) (refer **Figure 6.2**).
- Bass Coast Shire Planning Scheme considers that the Bass Hills landscape type is a prominent and important landscape element, particularly as the backdrop to landscapes surrounding Westernport Bay edge (Westernport Lowlands) and as part of a wider cultural landscape (rural). Policy descriptions suggest that the subject site and surrounding elevated landscape east of the Bass Highway are likely to be considered a part of the coastal visual catchment. Planning controls and policies are described in Section 5.

6.6 Scenic quality of subject site

The subject site has a distinct change in topography from west to east. The western half of the site (the extraction and processing area) is relatively flat and appears as part of the typical coastline landscape in terms of landform, water form and vegetation character. The eastern half of the site is elevated and forms part of a larger north-south ridge system.

Key elements of the subject site:

- Existing quarry activities as part of Stage 1(existing extraction and working areas);
- Undulating, rounded topography with indistinct and common forms;
- Presence of native vegetation in common and undifferentiated forms;
- Grazing land uses with well-defined land clearing patterns;
- Permanent creeks are present; mainly on adjoining Crown Land reserves. On-site watercourses are relatively small and indistinct with common forms.
- Farm houses, sheds, access roads and residential development along the Bass Highway edge create the image of a long established, semi developed area

Within this landscape character type, the landscape unit that characterises the subject site is considered to represent an area of generally **low scenic quality** due to the common nature of the landscape and the degree of alteration that has already occurred as a result of agricultural activities and existing quarry works. The eastern edge of edge of the site represents a potentially higher value (**moderate scenic quality**) due its existing vegetation and elevated landform.

6.7 Landscape value

Landscape value is a measure of the likely importance of the landscape to the community, measured as scenic value. There has been no project specific assessment of community values related to site landscapes however overall community values are represented by the Bass Coast Shire Planning Scheme and policy framework (refer Section 5).

Existing planning policy suggests that the potential quarry site is likely to be rated as **low scenic value** on the basis that it is a relatively common landscape type with no distinctive features. The elevated parts of the site (eastern half) will contribute to the overall visual character and quality of the coastal edge and are likely to be subject to a marginally higher scenic value rating. Factors affecting community values are:

- Scenic value is likely to be reduced by the rural residential properties and fences that act as a foreground to highway-based views.
- The general location is likely to have value to the community as a result of its visual relationship to Bass Highway tourist route
- The community are likely to consider overall landscape character and visual amenity as a significant factor and a reason for living within the Grantville area.

6.8 Visual absorption capability

Visual absorbency is a measure of the area's ability to accommodate changes while maintaining existing landscape character and without a significant reduction in landscape and visual quality or amenity.

Three major factors are likely to influence the visual absorption capability within the quarry setting:

- Landform and its ability to visually conceal development changes at the view source or at the location of the development change.
- Vegetation patterns, height and location that have the capacity to visually conceal development at the view source.
- The orientation and location of public roads, recreation trails and potential viewing points.

The potential extraction and processing areas within the western part of the site has a relatively **high visual absorption capability** based on the following characteristics:

- Viewpoints are restricted by localised landforms (a low foreground ridgeline landform) and vegetation patterns. There are effectively no external views of the western part of the subject site from frequently accessed viewpoints.
- Broad scale clearing or modification of vegetation on the adjoining Crown Land reserves through fire would be likely to reduce the visual absorption capability along the Bass Highway edge in the area of Deep Creek.

The potential extraction and processing areas within the eastern part of the site has a relatively **low visual absorption capability** based on the following characteristics:

- Higher elevation locations are potentially more visible from the Bass Highway and areas to the west, although this is highly dependant on local view factors such as fences and existing vegetation.
- Broad scale clearing or modification of vegetation on the adjoining Crown Land reserves through fire would be likely to reduce the visual absorption capability along the Bass Highway edge in the area of Deep Creek.

6.9 Landscape Sensitivity

Landscape sensitivity is a measure of the ability of landscape to resist the change direct or indirect effects of developments on a landscape, which could include physical elements, landscape character and cultural values.

- Ridgelines and elevated areas are likely to be more sensitive to change than valleys and flat areas in this landscape type. Changes to ridgeline landforms are likely to be more significant than changes to vegetation patterns.
- Major creek lines are likely to be sensitive landscape receptors because of well-defined landform characteristics and the visual changes (colour and texture) associated with the EVC type linked to those settings.

- The landscape of the site is primarily cleared grazing land with some remnant woodland. This is a common regional landscape type.
- The character of site has been largely altered by recent quarry activates and extractions which are approved previously. Although near half of subject site is still grazing land with native vegetation on ridgeline, the character of site has been significantly altered and it is less sensitive to change for similar quarry activities. The existing conditions demonstrate significant man-made interventions, including landform changes and processing structures and sand stockpiles with significant heights. Hence, the middle part of site is less sensitive to change due to extensive quarry activities.
- Areas close to the Bass Highway will be highly sensitive to change due to high exposure to regional travellers, including tourists. The landform and current concrete entry walls provide an effective screen to block views to the quarry extraction site and keep the character consistent with other sections along the Bass Highway. Mitigation planting that has been developed within the western edge of the site will increasingly act as a visual screen and is likely to completely screen the site from highway views over time.

6.10 Visibility of Subject Site

The predicted zone of visibility (ZVI) for the subject site including the existing quarry activities is described in **Figures 6.4- 5.7** (a & b variations). As explained in Section 2.4, ZVI modellings are prepared based on two elevation models including DTM and DSM to identify affected areas and potential visual receptors. These figures assess the likely extent of visibility with and without vegetation surrounding the subject site. Viewpoints within the development site are determined by:

- extent of the development area (representative areas);
- structures or other high points within the development (most likely seen areas);
- the most elevated parts of the subject site(ridgeline) to identify maximum visibility of subject site;
- any likely seen areas as verified through the site inspection;

The level of visibility was based on a calculation of the number of visibility points seen from any location. The actual extent of visibility was then modelled from any key viewpoints which had a likely view of the subject site and verified by site inspection and photography as a part of the impact analysis process.

ZVI modelling based on DTM represent a 'worst case scenario' that is likely to show a worse condition than actual site conditions. The second ZVI variation model is based on DSM which provides a more realistic and representation of visibility that takes into account the effect of vegetation and building heights. These two variations are complimentary to check the effect of intervening vegetation or built forms on visibility that block the views to the subject site and identify potential receptors.

Multiple ZVI options are modelled to check visibility of different elements and components inside the subject site. These modellings have been used to identify the potential receptors that might be affected visually by future activities inside the subject site. A combination of these modellings and on-site verification was used to nominate the public viewpoints for further assessment of visual impacts. ZVI options include:

6.10.1 ZVI of the existing extraction area

A total 11 visibility points were positioned on ground level to check the visibility of the existing extraction and earthworks including stockpiles in the surrounding landscape. ZVI is described in different colours which represent the different levels of visibility based on the number of visible points. Based on modelled ZVIs, maximum six viewpoints are visible from the surrounding landscape.

The ZVI modelling without vegetation (Figure 6.4a) confirms that the ZVI is limited to the bay waters, Gurdies Reserve area to the north of the processing area and to the south of subject site and The Shuntoff

Road. ZVI modelling including vegetation heights (Figure 6.4b) shows the screening effect of vegetation around the subject site to block the views to the existing quarry site. The extraction area is only visible from Gurdies Reserve area and The Shuntoff.

The identified areas were inspected during the site visit to verify ZVI modellings and to provide photos from these locations.

Note: 'Without vegetation' modelling results effectively show absolute 'worst case' situations that would only apply after catastrophic bushfire or complete land clearing which are both unlikely in this context. In this scenario, while elements of the quarry may possibly be seen, other quarries, farm buildings and residential properties would also be seen, changing the entire visual context.

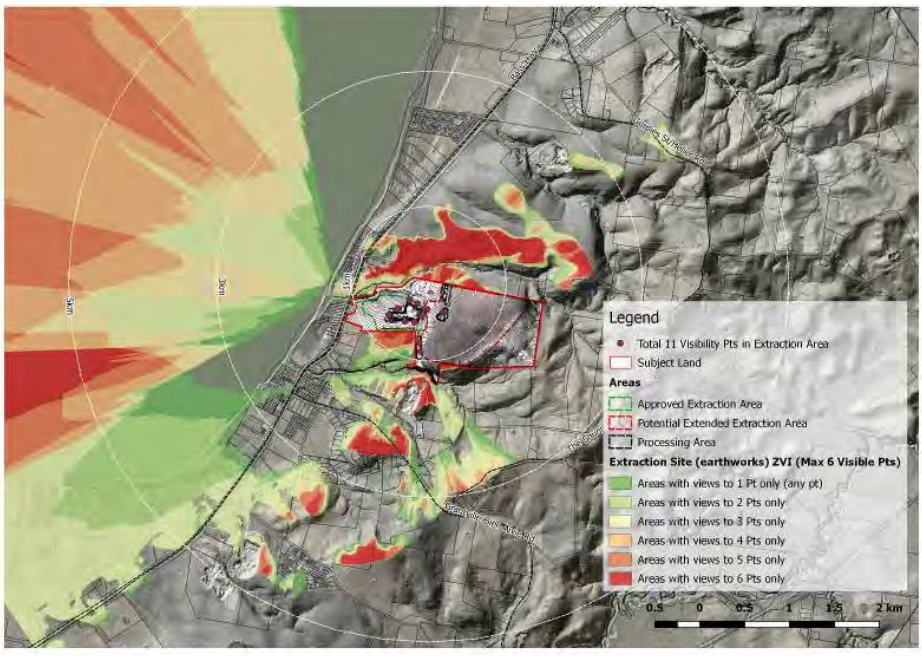


Figure 6.4a ZVI of Existing Extraction Site- without Vegetation (Refer to Appendix A for A3 size figure)

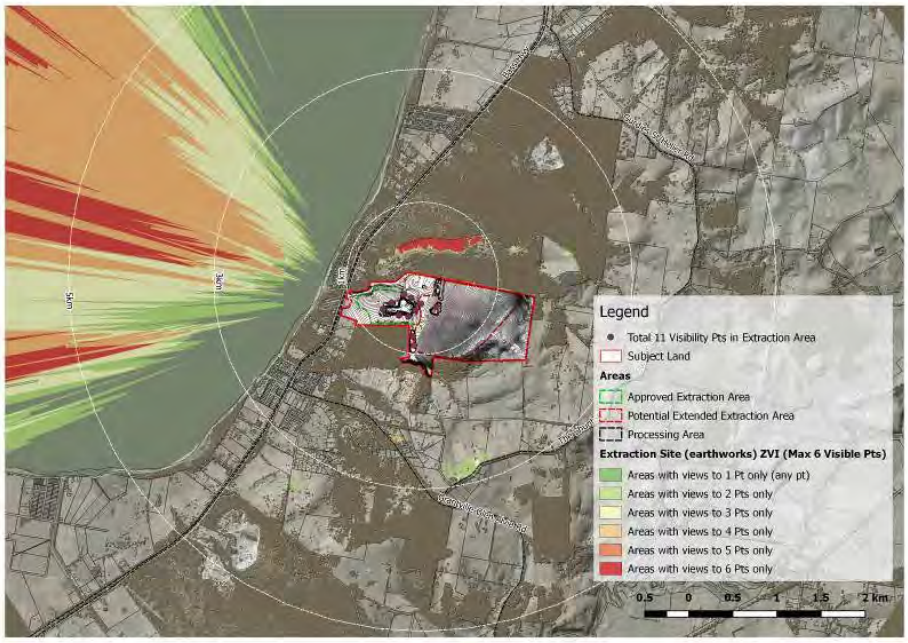


Figure 6.4b ZVI of Existing Extraction Site- with Vegetation (Refer to Appendix A for A3 size figure)

6.10.2 ZVI of machinery in processing area

To model ZVI of existing machinery in the processing area, total five visibility points elevated at 15m AGL were used to model the visibility of these points from the surrounding areas. ZVI describes different levels of visibility based on number of visibility points. Based on modelled ZVIs, maximum four viewpoints are visible from the surrounding areas.

The ZVI modelling without vegetation (Figure 6.5a) confirms that the visibility is limited to coast, Gurdies Reserve area to the north of the processing area and to the residential area in the south of subject site. ZVI modelling including vegetation heights (Figure 6.5b) shows the screening effect of vegetation around the subject site to block the views to the existing quarry site. The machinery is only visible from Gurdies Reserve area in the north. The identified areas in Gurdies Reserve area are not considered as a publicly accessible location to be inspected during the site visit.

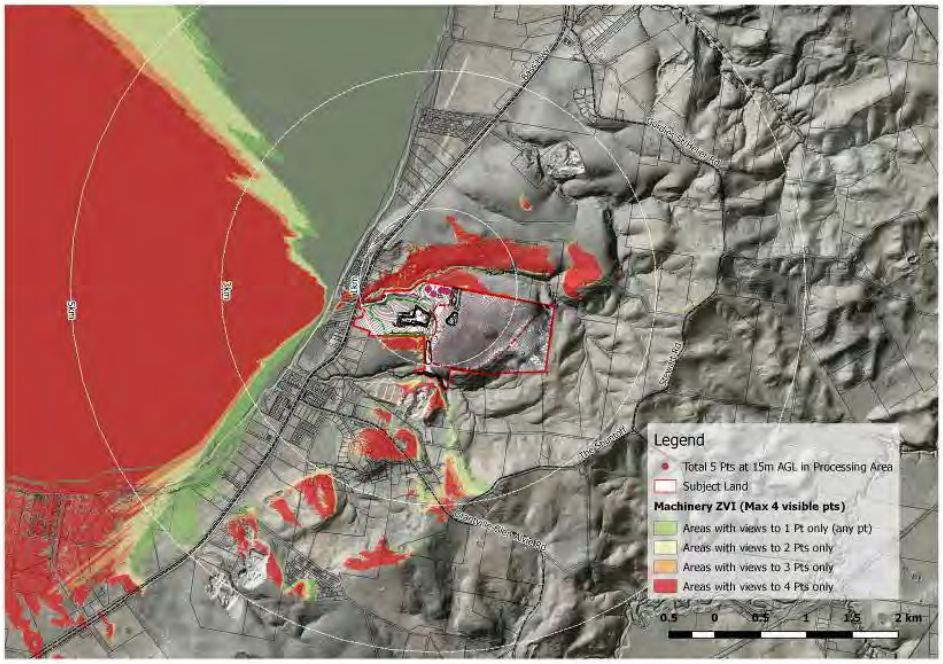


Figure 6.5a ZVI of machinery in processing area - without Vegetation (Refer to Appendix A for A3 size figure)

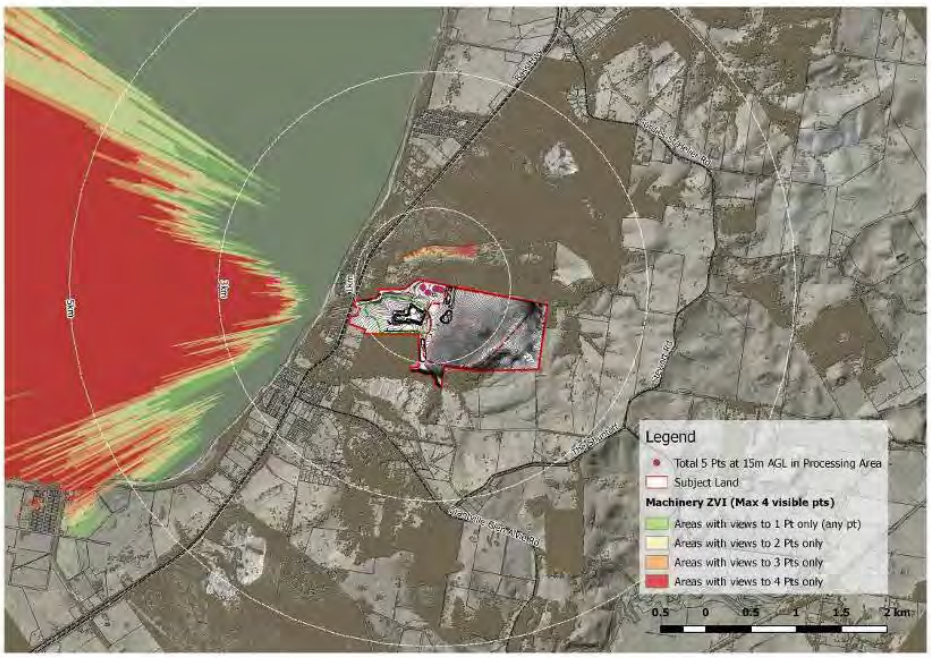


Figure 6.5b ZVI of machinery in processing area - With Vegetation (Refer to Appendix A for A3 size figure)

6.10.3 ZVI of Ridgeline

As part baseline assessment, it is necessary to identify extent possible visibility. The nominated potential extended extraction area includes the elevated parts of subject site. Hence, the most elevated part of site (ridgeline) was used to identify the maximum extents of visibility. Total 10 visibility points were located on top of ridgeline to model the ZVI with and without vegetation.

Based on modelled ZVIs (**Figure 6.6a**), maximum 8 viewpoints are visible from the surrounding landscape. ZVI modelling without vegetation shows that the ridgeline visibility is confined to main roads including Grantville-Glen Alvie Road, The Shuntoff and Stewart Road which define the maximum visual catchment for the subject site. The ridgeline is also visible from low lying and flat farmlands and Westernport Bay waters (**Figure 6.6a**). The ZVI modelling with vegetation shows the visibility of ridgeline in the existing context. Ridgeline is partially visible from elevated public roads due to screening effect of trees along the main roads.

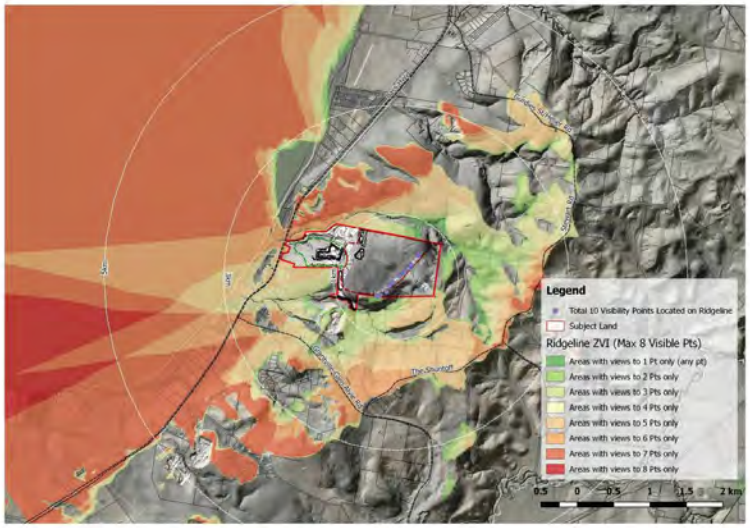


Figure 6.6a ZVI of ridgeline- without Vegetation (Refer to Appendix A for A3 size figure)

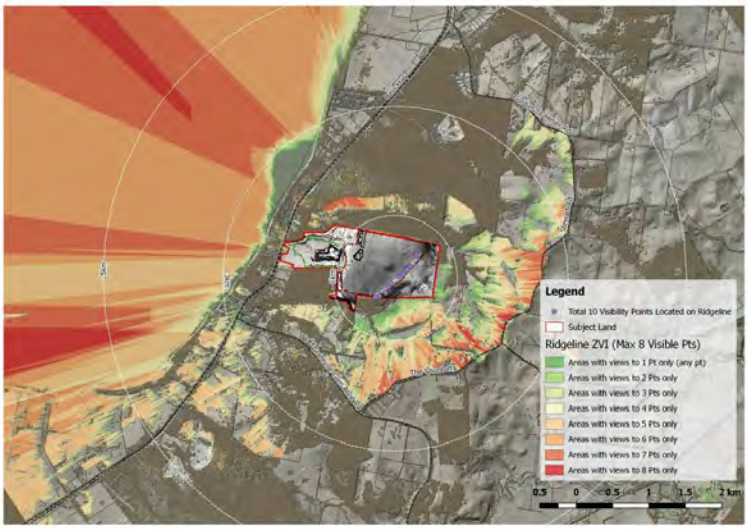


Figure 6.6b ZVI of ridgeline- with Vegetation (Refer to Appendix A for A3 size figure)

In order to nominate potential visual receptors, all ZVI options were combined which shows the overall visibility of subject site (**Figure 6.7**). Based on the modelled ZVIs, identified areas were inspected and several GPS located photos were taken during the site visit. Nine camera points were selected which represent the vantage viewpoints from public roads which are described in Section **6.11 -Table 7**.

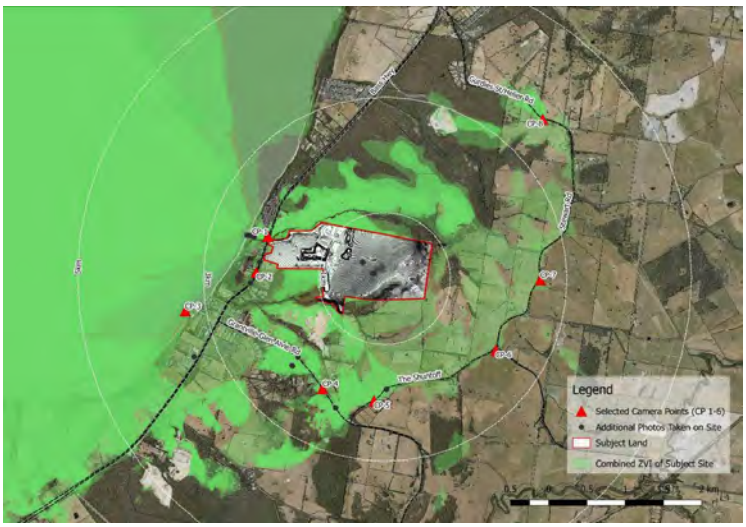


Figure 6.7 ZVI of Existing Extraction Site- without Vegetation (Refer to Appendix A for A3 size figure)

6.10.4 ZVI analysis with vegetation heights (DSM)

Based on the collated ZVI modelling for all viewpoints, the main viewing locations are likely to be:

- Within Westernport Bay, generally at distances of more than 1km.
- The Gurdies Reserve area to the north of the processing and northern extraction areas within the site. (No site photo as no access was available)
- Within the Tenby Point area and Corinella Foreshore around 6km-10km from the subject site. (Photo taken from Corinella, CP-9)
- Visibility catchment to roads along ridgelines (Grantville-Glen Alvie Rd, Shutoff and Stewart Road (CP-4 to CP-8).
- from Bass Highway adjoining the site, and a residential location on the Grantville-Glen Alvie Road at a distance of around 1.5km (CP-1).

6.10.5 ZVI analysis without trees

- The same general locations are evident but the ZVI modelling indicates a more extensive viewing area and a higher number of visibility points.
- An additional potential viewing area on the Bass Highway south of the subject site (CP-2).
- A more extensive viewing area from The Gurdies Reserve to the processing and northern extraction areas within the site. (No site photograph)

6.10.6 Conclusion

The Zone of Visual Influence (seen area) modelling indicates the following:

- The western sand extraction and processing areas have a very low level of potential visibility beyond the site boundaries due to existing landform and dense, tall vegetation.
- The quarry activities are not visible from east and north-east of subject site but vehicles moving to and from the site do represent a visual impact, however as this area already supports extractive industry, the nature of the visual impact is not new.
- Potential visibility to the north is to unpopulated and heavily vegetated areas with no formal access which form part of The Gurdies Conservation Reserve.
- Potential views to the west and south west are to Westernport Bay or to distant developments that are too far from the site to be significantly affected by site changes.
- Potential views to the south and south east are further investigated as they potentially affect the Bass Highway (main road / tourist route), residential locations (Grantville – Glen Alvie Road) and local roads with rural residential properties (The Shuntoff). These areas are subject to specific Viewshed modelling and on-site review.
- Potential views from the eastern areas are limited to the ridgeline within the subject site (ridgeline) and no views available from public areas.
- ‘Without vegetation’ modelling results effectively show absolute ‘worst case’ situations that would only apply after catastrophic bushfire or complete land clearing which are both unlikely in this context. In this scenario, while elements of the quarry may possibly be seen, other quarries, farm buildings and residential properties would also be seen, changing the entire visual context.

6.11 Visual Exposure from Bass Highway

Bass Highway is considered as the major view corridor in planning scheme adjoining the subject site. In addition to field investigation, visual exposure along this corridor was modelled in GIS as shown in Figures 6.8a & 6.8b. A total 15 viewpoints were located with 500m intervals along the Bass Highway to check the visible areas for with and without vegetation models.

Visual exposure mapping without vegetation (Figure 6.8a) shows the visible areas to maximum 14 viewpoints and elevated parts of subject site are only visible from 7 viewpoints. Considering the vegetation height would reduce the visibility to the subject site considerably and the visual exposure of top ridgeline drops to maximum 2 points as shown in Figure 6.8b. Considering the speed of motorists along the highway, modelling confirms that the visibility to the ridgeline inside the subject site is negligible.

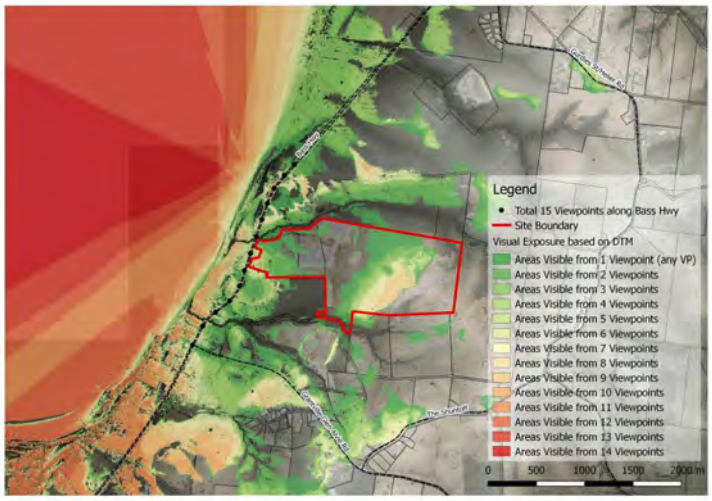


Figure 6.8a Visual Exposure from Bass Highway- without Vegetation (Refer to Appendix A for A3 size figure)

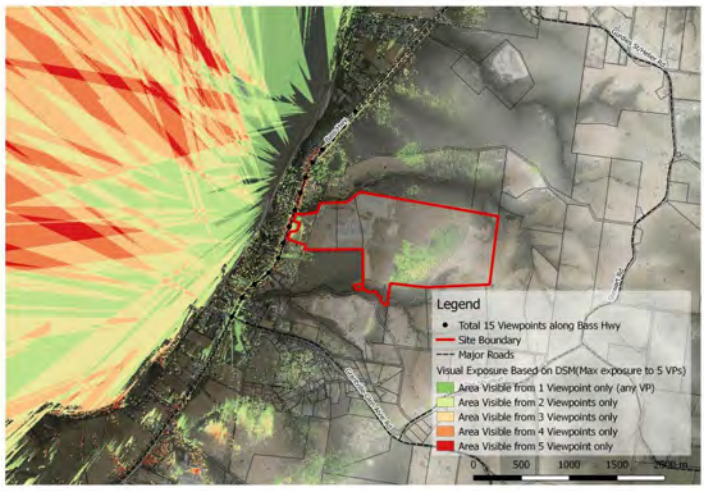


Figure 6.8b Visual Exposure from Bass Highway- with Vegetation (Refer to Appendix A for A3 size figure)

6.12 Potential visual receptors and principal viewpoints

Potential view receptor locations are described in Table 7. Site photographs are shown in Appendices A10 – A14. These points are considered to be representative of the possible range of viewing locations, view types and view quality available from publicly accessible locations within the study area.

Table 7 Baseline condition - potential viewpoints

Viewpoint Camera location	Ref	Name	Viewpoint & context	Landscape elements viewed	Nearest distance (km) to the development site
CP-1	**Appendix A10**	Bass Highway near the Deep Creek crossing	Regional tourism route Highway	▪ Clear views to the front (non quarry) part of the site, sound walls and existing rural residential developments ▪ Views to the extraction area and processing area are screened by existing landform and heavy creek line vegetation (NO VIEW)	approx 50m
CP-2	**Appendix A10**	Bass Highway south of subject site	Regional tourism route Highway	▪ No views to the front of the site – screened by roadside vegetation ▪ Views to the extraction area and processing area screened by existing landform and heavy creek line vegetation (NO VIEW)	approx 150m
CP-3	**Appendix A11**	Grantville Jetty	Public space	▪ Views to the subject site are blocked by intervening vegetation and landform (NO VIEW)	approx 2km
CP-4	**Appendix A11**	Grantville – Glen Alvie Road	Local road Residential area	▪ Elevated view to general subject site location ▪ View to site blocked by existing vegetation and landform (NO VIEW)	approx 2.2km
CP-5	**Appendix A12**	The Shuntoff	Local road Residential area	▪ Low view angle – views likely to be blocked by vegetation and landforms (NO VIEW)	approx. 2.2km
CP-6	**Appendix A12**	Stewart Road View 1	Local road Residential area	▪ Low view angle – views likely to be blocked by vegetation and localised landforms (NO VIEW)	approx. 2.2km
CP-7	**Appendix A13**	Stewart Road View 2	Local road Residential area	▪ Low view angle – views likely to be blocked by vegetation and localised landforms (NO VIEW)	approx. 2.6km
CP-8	**Appendix A13**	Gurdies St / Helier Rd	Local road Residential area	▪ Low view angle – views to northern edge of ridgeline. Changes to vegetated ridgeline are likely to be visible from here ▪ Distance from the site means that the magnitude of the view would be **low to negligible**	approx. 3.7km
CP-9	**Appendix A14**	Corinella Jetty	Public space	▪ Visible western side of subject site including existing quarry activities, grazing foothills and vegetated ridgeline. ▪ Considerable distance from the site means that the magnitude of the view would be **low to negligible.**	approx. 14.5km

6.13 Overall landscape sensitivity

The landscape of the study site and its surrounding area is based on a composition of landscape elements comprising:

- Heavily wooded low hills with well defined, cleared agricultural areas.
- Deeply incised creeks with dense indigenous planting.
- Residential areas with clearly defined boundaries and that appear as visually recessive elements within a dominant natural or rural setting.
- Views that are limited by landform and / or vegetation patterns at the road edge or within properties.
- The site is a combination of quarry and grazing land uses and reads as a part of the larger Gurdies landscape area.
- Visitors travelling on the Bass Highway see low hill landforms and forest vegetation as a component of the coastal edge landscape.

Landscape sensitivity is a function of landscape character, scenic quality and condition (intactness). The landscape sensitivity of subject land varies, depending on the visibility and the level of intactness or modification of landscape.

- The area adjacent to Bass Highway has a **low** landscape sensitivity based on its common landscape character and existing rural residential features but the area is sensitive to changes to landform or non-rural land uses. This area is highly exposed to drivers and residents along Bass Highway.
- The middle section of the site has a **low** landscape sensitivity based on the extensive landscape changes resulting from existing quarry activities and the common nature of the agricultural landscape.
- The elevated ridgeline and land to the east has a higher level of sensitivity based on its more intact vegetation forms and more defined elevated landform. The sensitivity of this part considered to be **moderate.**

Visual character and scenic quality within the overall study area is most likely to be maintained or enhanced by the following:

- Maintaining existing landform structure, scale and visual backgrounds (ridgeline landforms and vegetation silhouettes)
- Maintaining the visual dominance of the rural and bushland setting with any buildings, services infrastructure and development changes screened or visually recessive elements within a dominant agricultural and forested landscape.
- Maintaining an essentially rural residential character to the highway edge landscape.

6.14 Baseline conditions – summary

- The subject site has **no formal status as a significant landscape** and is rated as having a relatively **low scenic quality**; however parts of subject site close to the highway and elevated ridgelines to the east have a higher (moderate) level of landscape sensitivity and some community value related to its near coastal location and its visual relationship to the Bass Highway corridor, Westernport Bay and Bass Hills landscape. These relationships suggest that development changes within the subject site should be managed to minimise visual effects on these receptors.
- The subject site currently includes quarry activities in the central part of the site with adjoining grazing land and remnant native vegetation on elevated locations to the east. The character of site has been substantially modified, however current quarry activities are largely screened by

surrounding intervening dense forested area and by landform close to Bass Highway. A low ridge separates the current operational and extraction areas from the Bass Highway. This is an important mitigating factor on views into the site from the Bass Highway.

- Landscape value. Existing planning policy suggests that the potential quarry site is likely to be rated as **low landscape value** on the basis that it is a relatively common landscape type with no distinctive features. The elevated parts of the site (eastern half) will contribute to the overall visual character and quality of the coastal edge and are likely to be subject to a marginally higher scenic value rating.
- The potential extraction and processing areas within the western part of the site has a relatively **high visual absorption capability**. The potential extraction and processing areas within the eastern part of the site has a relatively **low visual absorption capability**.
- In terms of visibility, the eastern elevated part of site has a potentially high exposure to Westernport Bay and the coastal edge, but the nature of actual views depends on landform, vegetation and other existing features near to the view source.
- Land based viewing distances from Westernport Bay viewpoints range from 1.5 to 15km. At the closer distance, views are blocked by landform, vegetation and existing residential features, although second storey views may be possible from isolated locations (not confirmed).
- There are potential water-based views beyond 1.5km distance but this is considered to be a low receptor sensitivity area.
- There is potential to substantially screen elevated areas within the site by planting along the western edges of the subject site, including the low ridgeline close to Bass Highway and through strategic planting at higher elevations within the site.
- The Bass Highway is a regional tourism route linked to Phillip Island and Gippsland tourism destinations. In combination with the adjoining residential area (west of Bass Highway), the highway is considered to be the most important visual corridor and the only sensitive visual receptor. Based on modelled visual exposure, parts of the existing eastern ridgeline is visible from limited viewpoints when no vegetation is present but no views are possible under existing conditions with vegetation.
- Views to the site are restricted by existing landforms and on site / off site vegetation. These features are likely to be maintained over the long term. Zone of Visual Influence (ZVI) modelling and field assessment confirms that there are no views to the existing operational area from major public or private visual receptor areas and that this condition is likely to exist with or without vegetation for all areas except the Gurdies Reserve edge and the Deep Creek / Bass Highway locations which could be exposed to views if vegetation was to be removed within the reserves and the adjoining property (an unlikely scenario).

7 New Conditions - Impact Assessment

7.1 Scope of assessment

The new conditions described in the Work Plan Variation (Figure 7.10) represents a maximum development scenario that is unlikely to occur because both quarry pits will be developed and rehabilitated progressively over the life of the quarry operation. As a result:

- Haul road locations and the pattern of vehicle movements will change over time as the configuration of the pits change
- The overburden stockpile will change in shape and height as material comes and goes
- Growing vegetation will change the nature of views and mitigate visual impacts

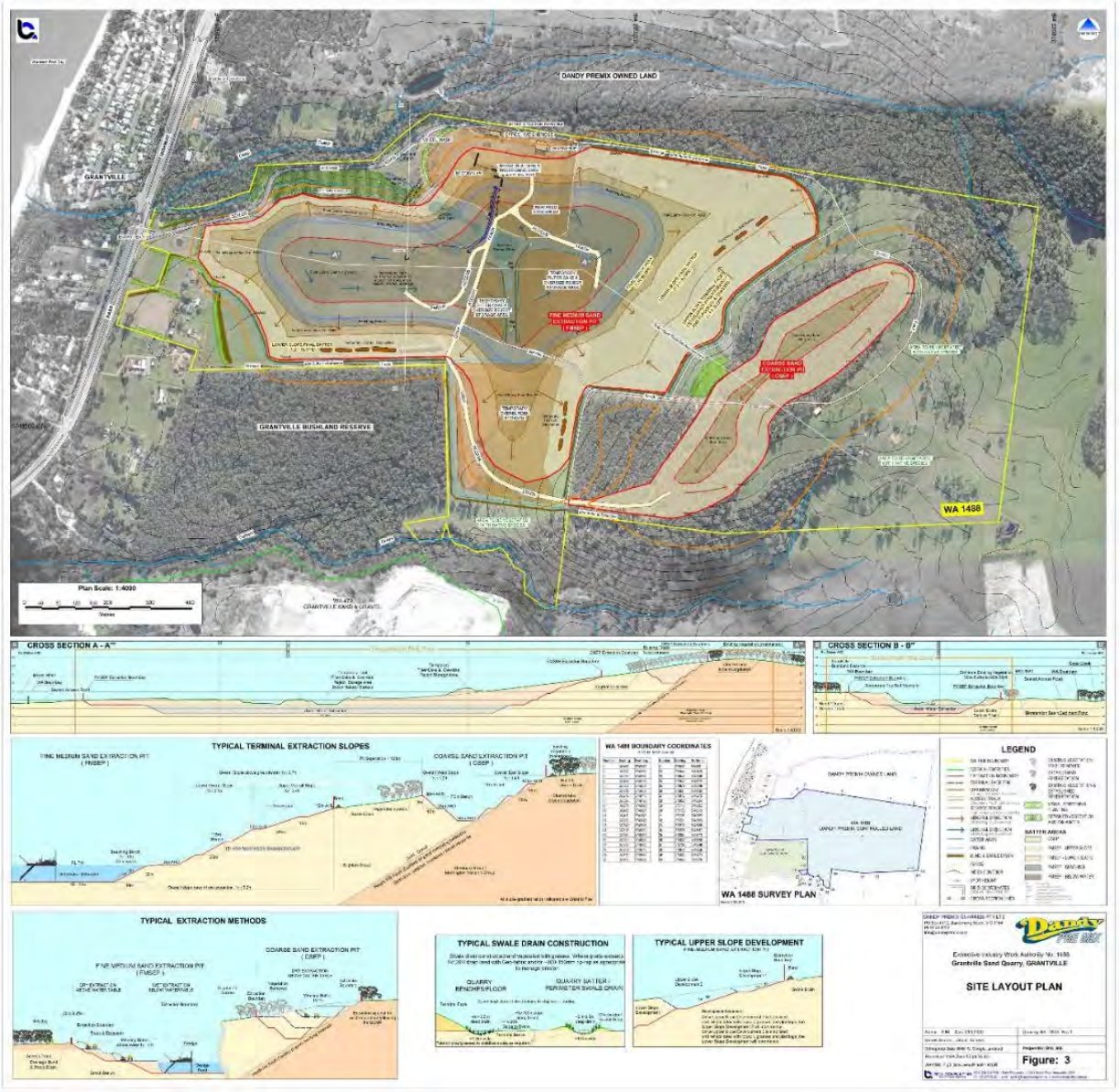
This LVIA is based on this theoretical 'worst case' development scenario and on that basis may describe impacts and impact ratings that may, in reality, prove to be less than those described.

7.2 Potential landscape effects

Objective
The landscape impact assessment (Table 8) describes the likely nature and significance of changes to baseline landscape conditions resulting from the proposed end stage development condition (refer Quarry Plan in Figure 7.1 and Quarry Rehabilitation Plan in Appendix B-1), and the likely consequential effect on landscape resources, independent of views to the site.
The objectives for each assessment element assume that existing site characteristics that underpin high value landscape features and scenic quality should be retained or enhanced where possible.

Definition
Landscape impacts are changes in the fabric, character and quality of the landscape as a result of development and can include:

- Direct impacts on specific landscape elements or values such as scenic quality.
- More subtle effects on the overall pattern of elements that give rise to landscape character and regional and local distinctiveness.
- Impacts upon acknowledged special interests or values such as designated landscapes, conservation sites or cultural associations.
- Cumulative or indirect effects that extend impacts beyond the site boundary.



Source: Bell, Cochrane & Associates Work Plan Oct-2020

Figure 7.1 – Proposed Work Plan Variation

Table 8: Landscape Assessment – New Conditions

Description of impacts	Sensitivity	Nature and magnitude of change	Duration	Significance	Mitigation measure / Recommendations
Land use					
▪ The existing site is used for quarrying and agriculture and contains no features of special landscape or scenic quality value. ▪ The proposed quarry areas will not affect adjoining land ownership or land use. ▪ The long term land use is likely to be a combination of landscape and agricultural based land uses. There is also potential for residential and recreation uses given the nature of the landscape and its surrounding environment. ▪ Traffic movement and operational activities will increase, but the nature of traffic control works (signalised intersection and changes to traffic movement) is likely to result in a decrease in overall visual impact.	LOW	HIGH	Long-term change Partly reversible	MOD	▪ The effects of the land use change will be mitigated by the long term rehabilitation of the site.
Landform					
▪ The central parts of the site will be significantly changed ▪ The eastern edges of the site have a relatively higher value based on landform & existing vegetation but that landform will change as a result of stage 2 quarrying within the ridgeline landscape.	LOW – MOD	HIGH	Long term change Not reversible	MOD	▪ The long-term nature of the land use will determine the character of the site and its relationship to woodland surroundings ▪ Progressive rehabilitation of quarry stages.
Vegetation					
▪ Existing vegetation will be removed as a result of future quarry development in the eastern part of the site. ▪ New buffer planting and screen planting will potentially offset site vegetation losses. ▪ The proposed eastern quarry pit (elevated pit) can potentially be rehabilitated and planted over time.	LOW	MOD	Long term change Partly reversible	MOD	▪ Pre-development planting (as early as possible) ▪ Active management of vegetation areas to ensure maximum performance and habitat value. ▪ Use of indigenous species where possible. ▪ Use of plantations within the site (particularly boundaries) to reference typical regional landscape forms and patterns.
Landscape character					
▪ The site and its principal land use will be changed by future quarrying and related site works, but the extent of visible changes will depend on rehabilitation practices and planting ▪ A new landscape character may be developed for the site based on new landform, vegetation and waterforms	LOW	MOD	Long term change Partly reversible	MOD	▪ Pre-development planting (as early as possible) ▪ Use of indigenous species where possible will match the colours and appearance of the surrounding landscape. ▪ Integrated landform rehabilitation to create more natural site landforms

NOTE: The landscape assessment considers scenic quality as an environmental resource, independent of views.

7.3 Potential visual effects

The visual impact assessment deals with potential effects on visual resources from changes in the composition and quality of views, people's response to likely changes and the overall effect on visual amenity.

7.3.1 Visibility assessment

The ZVI modelling included in Appendices B2 – B13 provides additional analysis of the likely visibility associated with the proposed eastern quarry pit located within part of an elevated ridgeline.

Eastern ridgeline visibility
Appendix B2 – No vegetation model indicates small pockets of potential onshore visibility, including one location where Deep Creek crosses Bass Highway north of the site entry. The model indicates broad visibility offshore but at distances that are likely to have little impact on the viewer.
Appendix B3 – With vegetation model indicates that virtually all land-based views and many offshore views are screened by vegetation

Overburden stockpile visibility
Appendix B4 – No vegetation model indicates minimal view potential
Appendix B5 – With vegetation model indicates minimal view potential and an increase in visual screening from the south and north. Any chance of visibility is likely to relate to the northern face of the stockpile.

Bass Highway visibility
Appendix B6 – No vegetation indicates the likely visibility of the western face of the ridgeline and the northern face of the overburden stockpile
Appendix B7 – With vegetation model indicates the elimination of most views into the site. The model indicates the possible shallow views of the eastern face of the quarry pit where existing vegetation has been removed on the western side of the pit.

Surrounding camera viewpoint locations
Appendix B8 – No vegetation model indicates the overall potential visibility of the ridgeline and the eastern and northern faces of the stockpile.
Appendix B9 – With vegetation model indicates the strong mitigating effect of existing vegetation on views with only the top of the stockpile evident from isolated viewpoints to the east.

Representative camera viewpoints
Appendices B10 – B13 – indicate the specific effects of angle and elevation on view potential around the site with and without vegetation.

7.3.2 Visual impact assessment

The assessment of visual effects (Table 9) describes the nature and scale of changes in the character of the available views (from baseline conditions) resulting from the development and likely changes in the amenity of the visual receptors based on end stage development condition and the likely consequential effect on visual resources.
The objectives for each assessment element assume that existing high value landscape features and scenic quality should be retained or enhanced where possible.

Definition

Visual impacts relate to changes in the available views of the landscape and the effects of those changes on people. Visual impact is therefore concerned with:

- The direct impacts of the proposed development on views of the landscape through intrusion or obstruction.
- The likely reaction of viewers who may be affected.
- The overall impact on visual amenity, which can range from degradation through to enhancement.
- The capacity for impact mitigation and rehabilitation of landscape values

Rating assumption

While no vegetation view potential is considered, the impact rating is based on (at a minimum) existing vegetation being present on the site in the form that is anticipated within the design.

Wireframe modelling – Camera Points 1 and 5

The wireframe modelling shown in Appendices C-1 and C-2 (Figures 7.1 & 7.2 below). It is intended to provide a more detailed viewers perspective of the visibility of development related changes from key representative viewpoints – locations that represent the 'worst case' or most typical view of site changes. These images also confirm the location of infrastructure that will not be seen because of intervening landscape features or mitigation measures such as planting.



Figure 7.1 Camera point 1

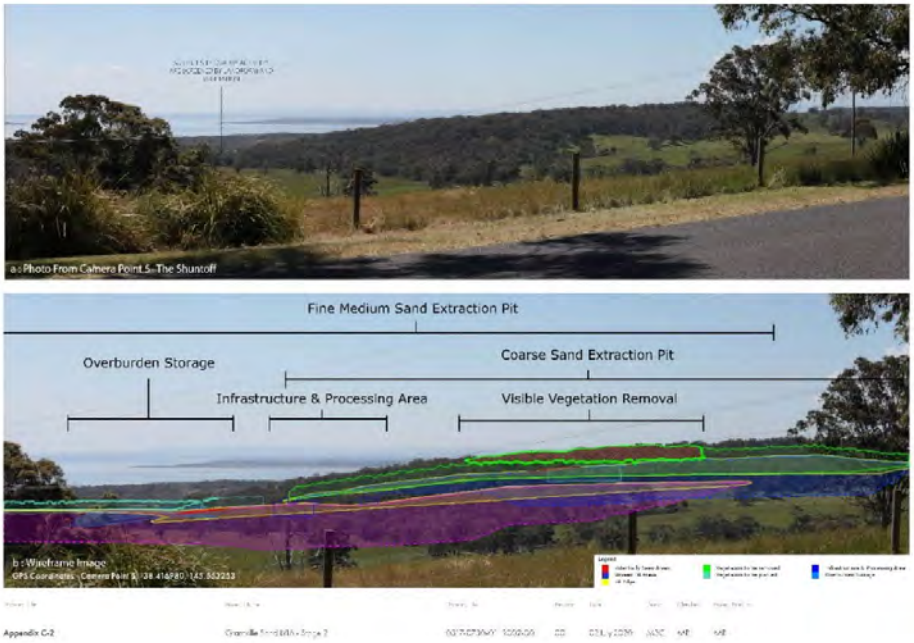


Figure 7.2 Camera point 5

Table 9: Visual Impact Assessment – New Conditions

Camera point ref	Representative view point Description of likely impacts	Receptor Sensitivity	Nature and magnitude of change	Duration	Significance rating	Mitigation measure / Recommendations
Viewpoint 1 KEY VIEW Hwy view	▪ Has the highest view potential from Bass Highway, the major public visual receptor. ▪ While most views are entirely mitigated by existing landform and vegetation, there is a minor view potential to small sections of the upper face of the eastern edge of the upper level pit. ▪ The view potential will depend on the retention of existing vegetation west of the upper level pit (impact ratings depend on this) ▪ There is a minor view potential to a small part of the northern overburden stockpile face ▪ If any part of the low western ridgeline is lost there is potential for road-based views of the lower level pit	High	Low Minor Adverse (depends on upper level veg screening)	Long term Partly Reversible	Low	▪ General design mitigation measures including progressive rehabilitation of all extraction pits ▪ Vegetation screening within the site on the eastern side of the Bass Highway ▪ No change to the existing western ridgeline landform – retaining this landform as the primary visual buffer ▪ Vegetation screening below the western edge of the upper level pit
Viewpoint 2 Hwy view	▪ Without vegetation, there is a minor view potential to small sections of the upper face of the eastern edge of the upper level pit. With vegetation there are no views of any part of the quarry site	High	Neutral Neutral	Long term Reversible	Low	▪ General design mitigation measures, including the retention of all existing landform and vegetation buffers
Viewpoint 3 Beach view	▪ Without vegetation, there is a minor view potential to small sections of the upper face of the eastern edge of the upper level pit. In reality housing and related features are likely to block views ▪ With vegetation there are no views of any part of the quarry site	Low	Neutral Neutral	Long term Reversible	Low	▪ General design mitigation measures, including the retention of all existing landform and vegetation buffers
Viewpoint 4 Road view	▪ Without vegetation, there is a minor view potential to small sections of the southern tip of the eastern edge of the upper level pit. There would also be potential views of the unrelated quarry to the south of the subject site. ▪ With vegetation there are no views of any part of the quarry site	Low	Neutral Neutral	Long term Reversible	Low	▪ General design mitigation measures
Viewpoint 5 KEY VIEW Road view	▪ Without vegetation there is a minor view potential to the eastern face of the upper level pit and the eastern face of the overburden stockpile. ▪ With vegetation there is a thin layer of the upper level of the stockpile visible ▪ This viewpoint is a low sensitivity location due to the nature of road users and low numbers	Low	Low Negligible	Long term Reversible	Low	▪ General design mitigation measures

Viewpoint 6 Road view	▪ Without vegetation there is a minor view potential to the eastern slopes of the upper level pit ▪ With vegetation there is no view of any part of the active quarry site but possible minor views of the eastern slopes of the ridgeline	Low	Neutral Negligible	Long term Reversible	Low	▪ General design mitigation measures
Viewpoint 7 Road view	▪ Without vegetation there is a minor view potential to the eastern slopes of the upper level pit ▪ With vegetation there is no view of the active quarry site but possible minor views of the eastern slopes of the ridgeline	Low	Neutral Negligible	Long term Reversible	Low	▪ General design mitigation measures
Viewpoint 8 Road view	▪ Without vegetation there is a minor view potential to the eastern and northern slopes of the upper level pit ▪ With vegetation there is no view of the active quarry site but possible minor views of the eastern slopes of the ridgeline	Low	Neutral Negligible	Long term Reversible	Low	▪ General design mitigation measures
Viewpoint 9 Corinella Jetty	▪ Views to the quarry site are theoretically possible, but the extreme viewing distance (14.5km) means that landscape changes appear as a small patch of colour within a broader, complex visual field. The nature of site activities are indiscernible. ▪ Visual changes to the elevated ridgeline are likely to be more visible than changes to the lower parts of the site	Mod	Negligible Minor adverse	Long term Reversible	Low	▪ General design mitigation measures

Note: the table colours are graphic only and do not represent a rating

8 Potential Mitigation & Enhancement Measures

8.1 Objective

The objective of mitigation is to avoid, reduce, remedy or offset any significant adverse effects on the environment arising from the proposed development. Mitigation may also compensate for unavoidable effects or residual impacts.

Mitigation measures may potentially involve modifications to intrinsic parts of the proposed development design or other measures, including off-site changes that reduce negative impacts.

8.2 Mitigation measures

Mitigation and overall environmental enhancement is likely to be best achieved by the following measures:

- Retaining the existing landform profiles at the western edge of the site. The low western ridgeline provides the primary visual buffer between Bass Highway and the active quarry areas.
- Developing shelter plantations to the western property boundary to match the agricultural landscape setting surrounding the site. This strategy has already been implemented in parts of the site.
- Maintaining existing vegetation areas east and west of the proposed upper pit. This will provide the primary visual screen to the upper pit.
- Progressive grassing / revegetation of the quarry stages should be undertaken as soon as possible after completion of works to minimise the area of disturbed ground visible from the surrounding landscape and to provide new screening layers. 'Layers' of planting in strategic locations relating to view corridors are important.
- Use plant species that match EVC plant types or exotic species which are typical of the regional agricultural landscape.
- Minimise colour contrasts in on site structures and equipment.
- Shield all lighting to minimise light spill and radiance.
- Consider screen planting in areas that will be used as truck haul roads

The proposed landscape buffer treatments are intended to provide the following:

- A landscape outcome which is sensitive to both the indigenous and cultural landscapes of the regional landscape
- A landscape buffer that will improve the environmental value of the site while providing a softened green edge to the internal works areas
- Opportunities to create, with the exception of windrow plantations, an indigenous environment, using endemic species for an improved landscape character and ecological value.
- Opportunities to create a landscape to develop habitats for indigenous fauna.
- Provide planting that reduces the spread of dust and windborne weeds.

8.3 Rehabilitation plan

A site rehabilitation plan has been prepared by BCA and is shown in Appendix B-1. This represents a minimum site treatment that allows for the environmental stabilisation of the site and for its safe use.

Further detailed design of the site may allow for several future land use scenarios:

Agricultural use – this land use scenario, based around grazing activities, would be achieved through the baseline site rehabilitation shown in Appendix B1

Ecological use – this land use scenario could be achieved through revegetation of all active quarry areas which would link the site to existing bushland reserves north and south of the site.

Residential and recreational use – this land use scenario could be achieved through a limited subdivision of the lower site levels for residential or rural residential use, along with revegetation of parts of the site and development of water based activities and bushland trails.

9 Impact assessment – key findings

The existing quarry site

1. The subject site has an existing quarry operation which results in no direct visual impacts on surrounding areas, including Bass Highway which is the most sensitive visual receptor.
2. The low ridgeline to the west of the site functions as the main visual buffer to quarry operations and both the landform and vegetation framework within this area are critical visual impact mitigation features for any future quarry development.
3. The subject site has **no formal status as a significant landscape** and is rated as having a relatively **low scenic quality**; however parts of subject site close to the highway and elevated ridgelines to the east have a higher (moderate) level of landscape sensitivity and some community value related to its near coastal location and its visual relationship to the Bass Highway corridor, Westernport Bay and Bass Hills landscape. These relationships suggest that development changes within the subject site should be managed to minimise visual effects on these receptors.
4. The elevated eastern part of the site has a relatively higher scenic quality and landscape sensitivity than the lower western part and requires a site-specific design approach.

Landscape impacts

5. The elevated eastern ridgeline has a relatively higher landscape sensitivity than the western part of the site. Removal of vegetation for quarrying in this location will have at least a **minor adverse impact** on the landscape and potentially a **moderate adverse impact**, depending on the degree of vegetation clearance and the way quarrying and rehabilitation planting is sequenced.

Visual impacts

6. Camera viewpoints 1 and 5 are considered to be the most important viewing locations. Both locations have the potential to see small parts of the upper quarry pit and small parts of the overburden stockpile. Actual visibility is likely to be less than the modelled results because the model relies on a 'maximum development' scenario that would not exist due to progressive development of the quarry working areas.
7. Residents west of the subject site are likely to experience similar views to Bass Highway and are likely to be unaffected by future quarry developments, provided that mitigation measures are implemented
8. Viewing points from Westernport Bay or locations such Corinella Jetty are considered to be low visual sensitivity locations where changes within the subject site are likely to be barely discernible and seen as small changes within a much larger and complex visual field.

Mitigation potential

9. Mitigation through maintenance of landforms and existing vegetation, along with new planting is critical to the project.
10. The low western ridgeline and its associated planting is critical to view screening from the Bass Highway and locations to the west.
11. Existing vegetation and nominated infill planting on the elevated ridgeline to the east is critical to screening / modifying views from the west and east.
12. Minimising the height of the overburden stockpile is likely to result in less visibility from the critical viewpoints.

10 Evaluation

The LVIA study suggests that:

- Bass Highway represents the most sensitive viewpoint and therefore mitigation of impacts from this location are most important factors. Maintaining the landform and vegetation cover of the western face of this ridge are critical elements.
- The elevated ridgeline in the eastern end of the site must be seen as a different landscape element that requires its own mitigation treatments. Maintaining existing vegetation and infill planting are critical elements.
- Progressive extraction and rehabilitation of quarry cells that limit the length of disturbance is an important technique in all areas but particularly the elevated eastern extraction area.

With an optimal mitigation design treatment, the Stage 2 quarry proposal represents an **acceptable change to the landscape and scenic values of the Grantville site**.

Appendices

Appendix A – Baseline conditions analysis

Appendix B – New quarry design visibility analysis

Appendix C – Wire frame visualisations

Appendices

Appendix A	Baseline Analysis	02
Appendix B	New Conditions Analysis	19
Appendix C	Wireframe Images	34

Tract

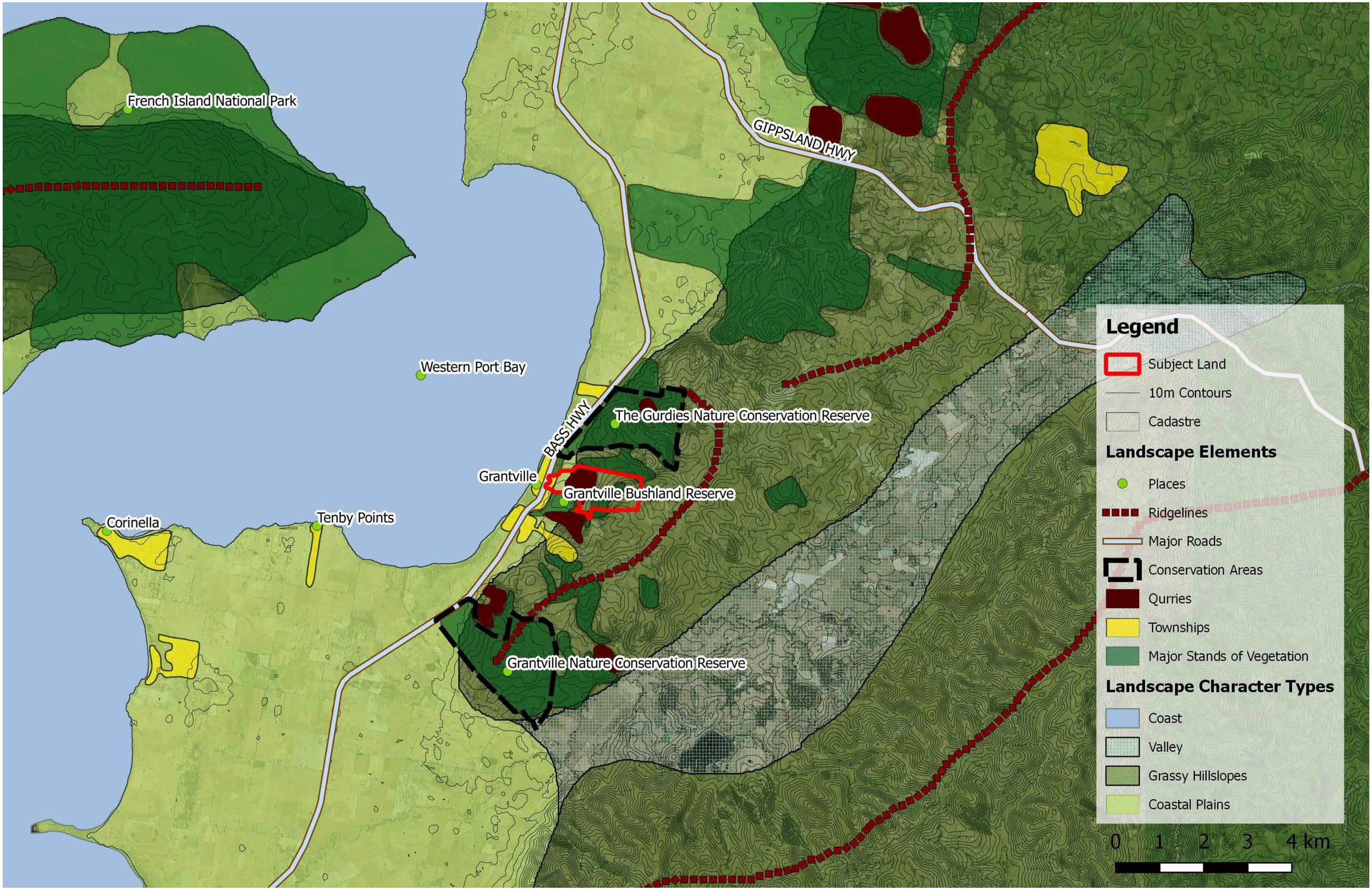
Grantville Sand Quarry Stage 2

LVIA Final Report

Appendix A - Baseline Analysis

Grantville Sand Quarry Stage 2

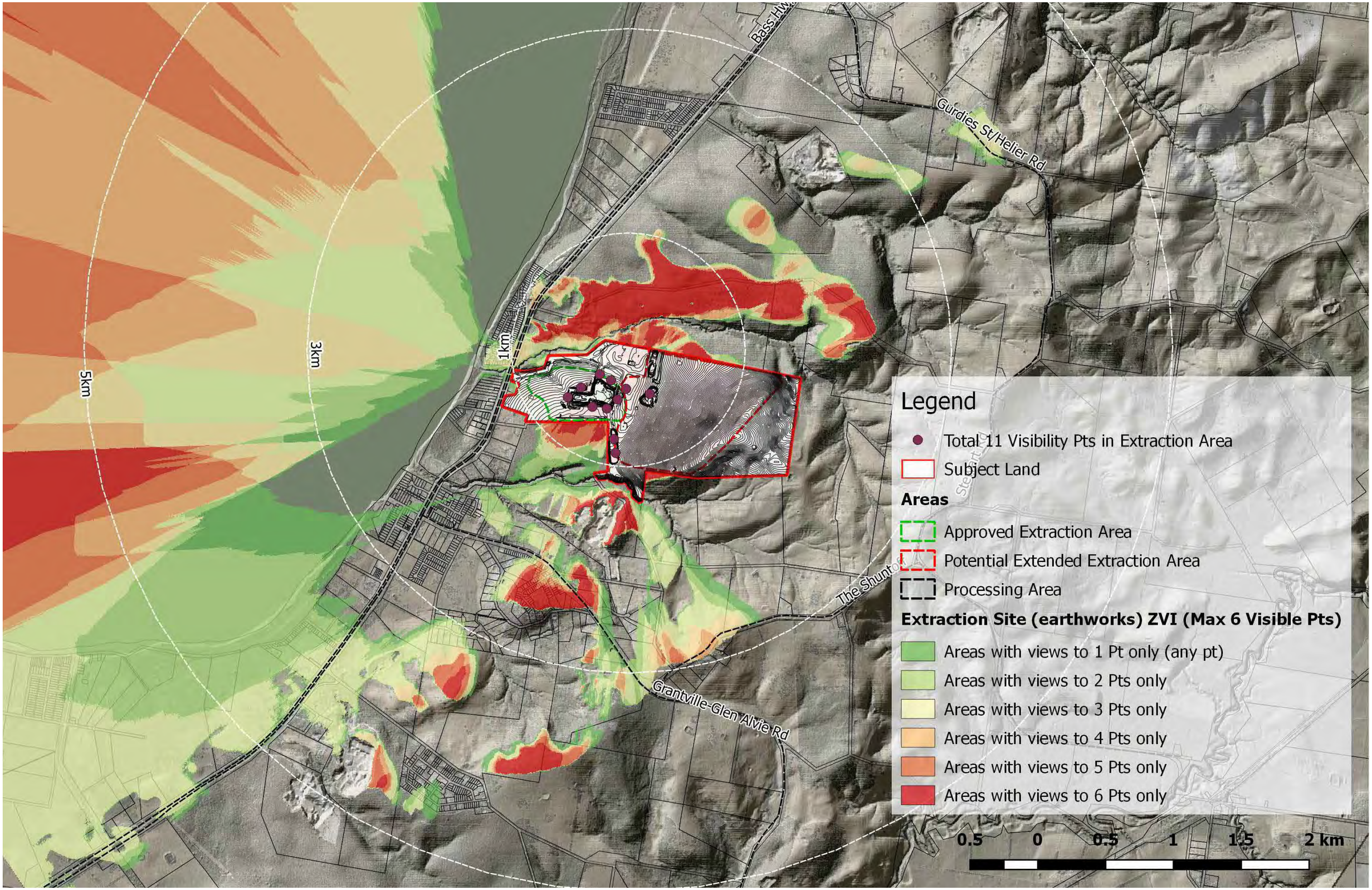
LVIA Final Report



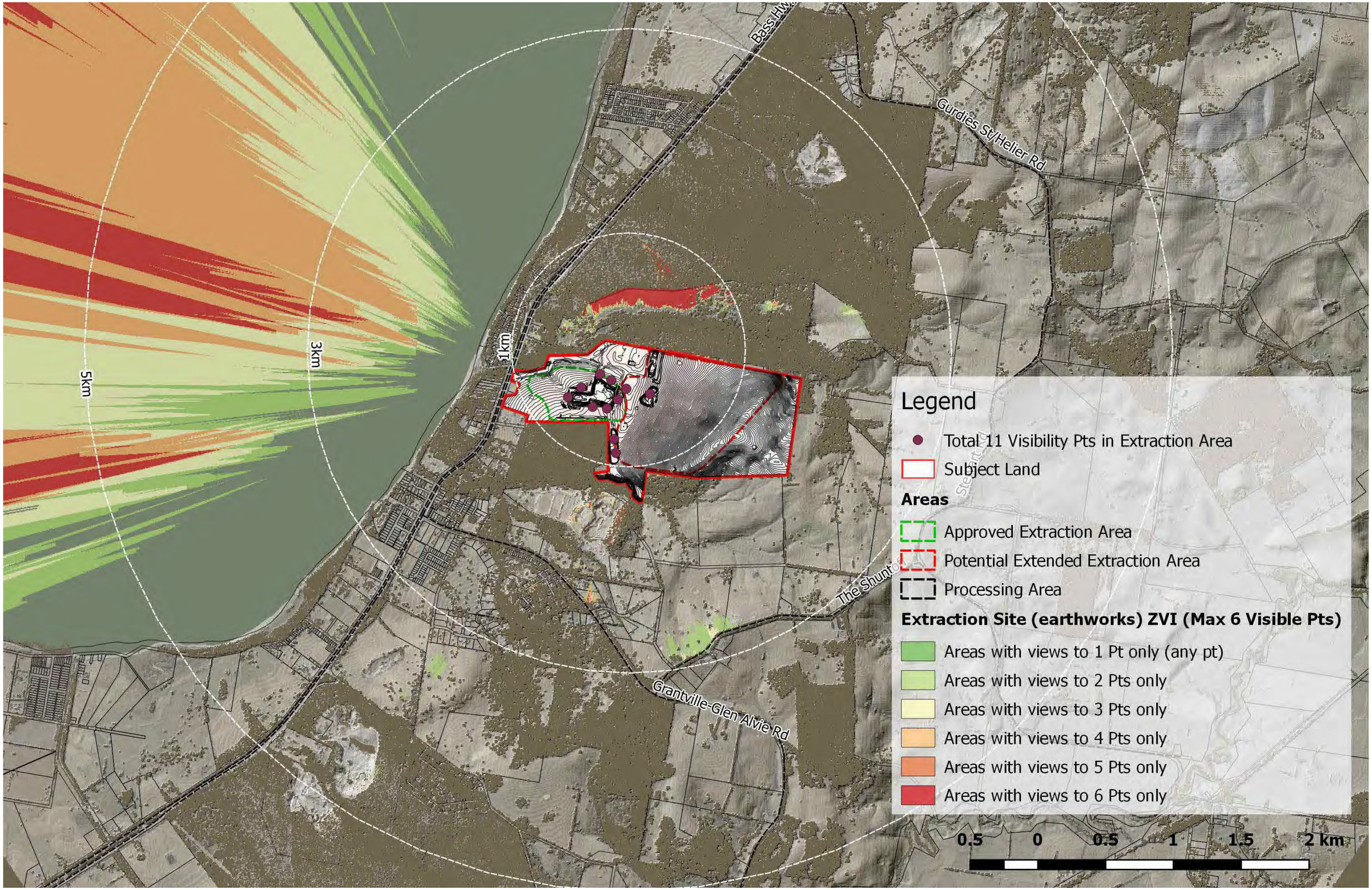
Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-1 **Landscape Character Types & Landscape Features**	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW



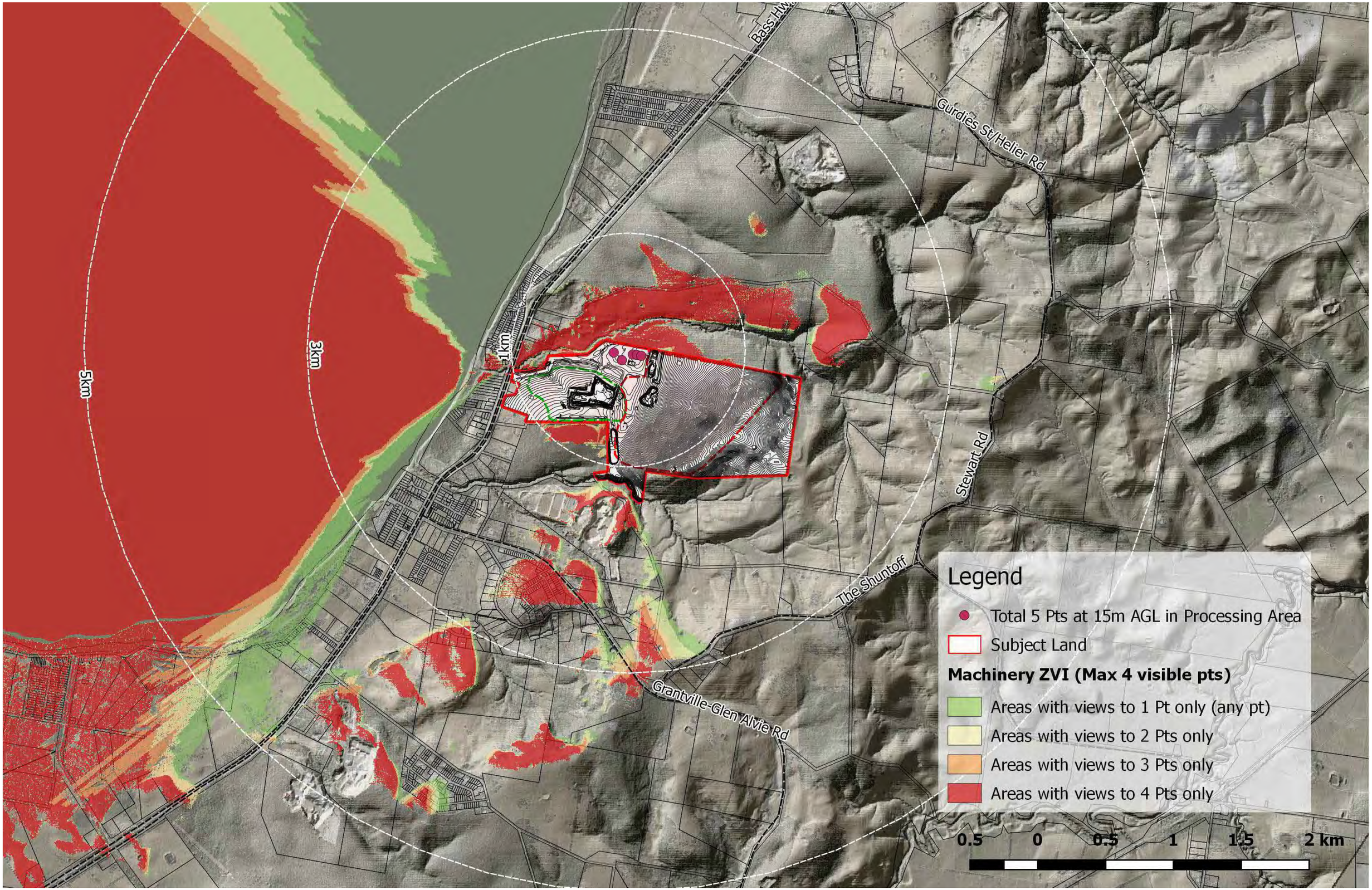
Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-2 **Tree Heights Extracted from LiDAR**	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW



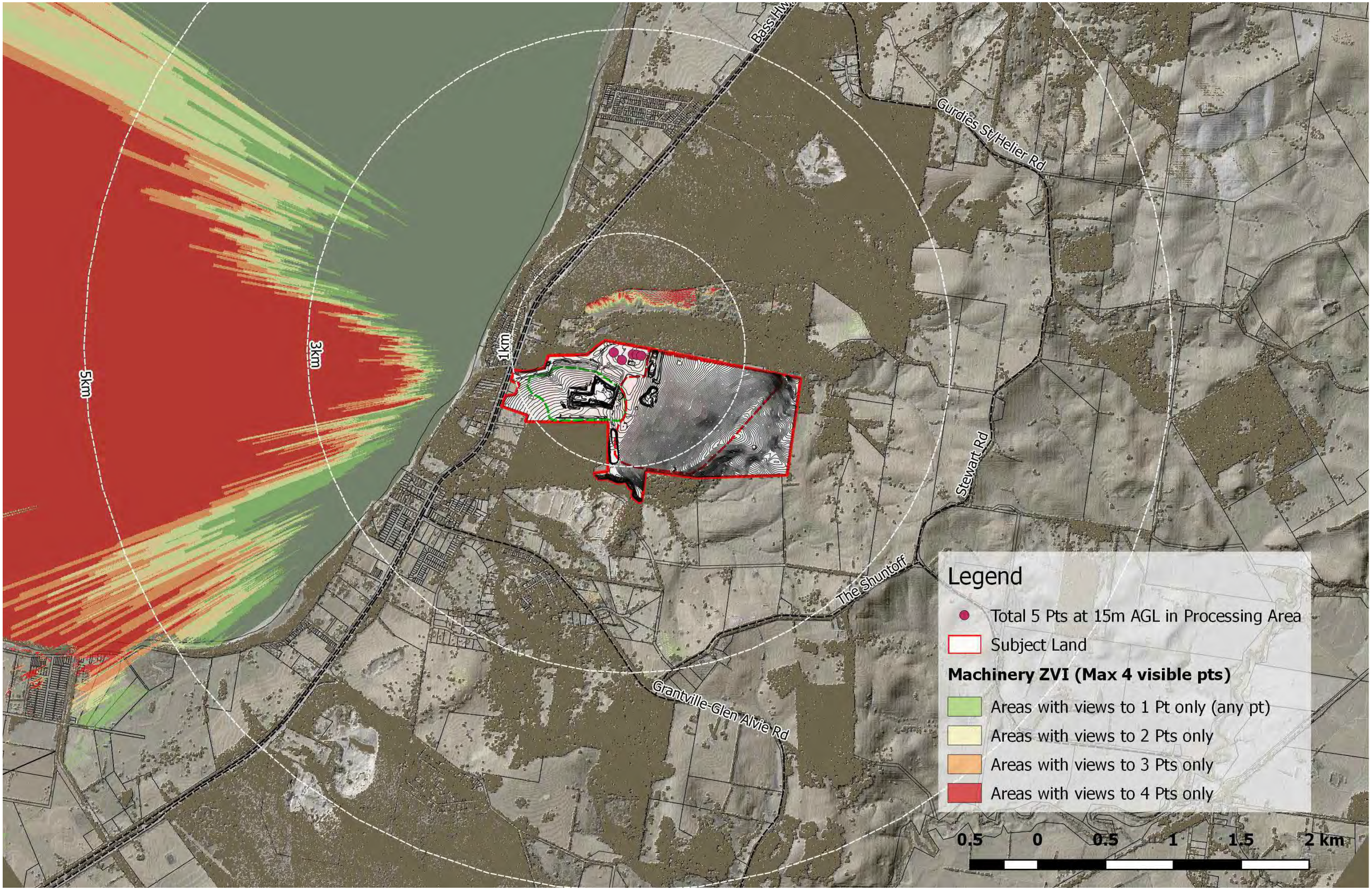
Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-3 - ZVI of Existing Extraction Site based on DTM (Landform Only)	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW



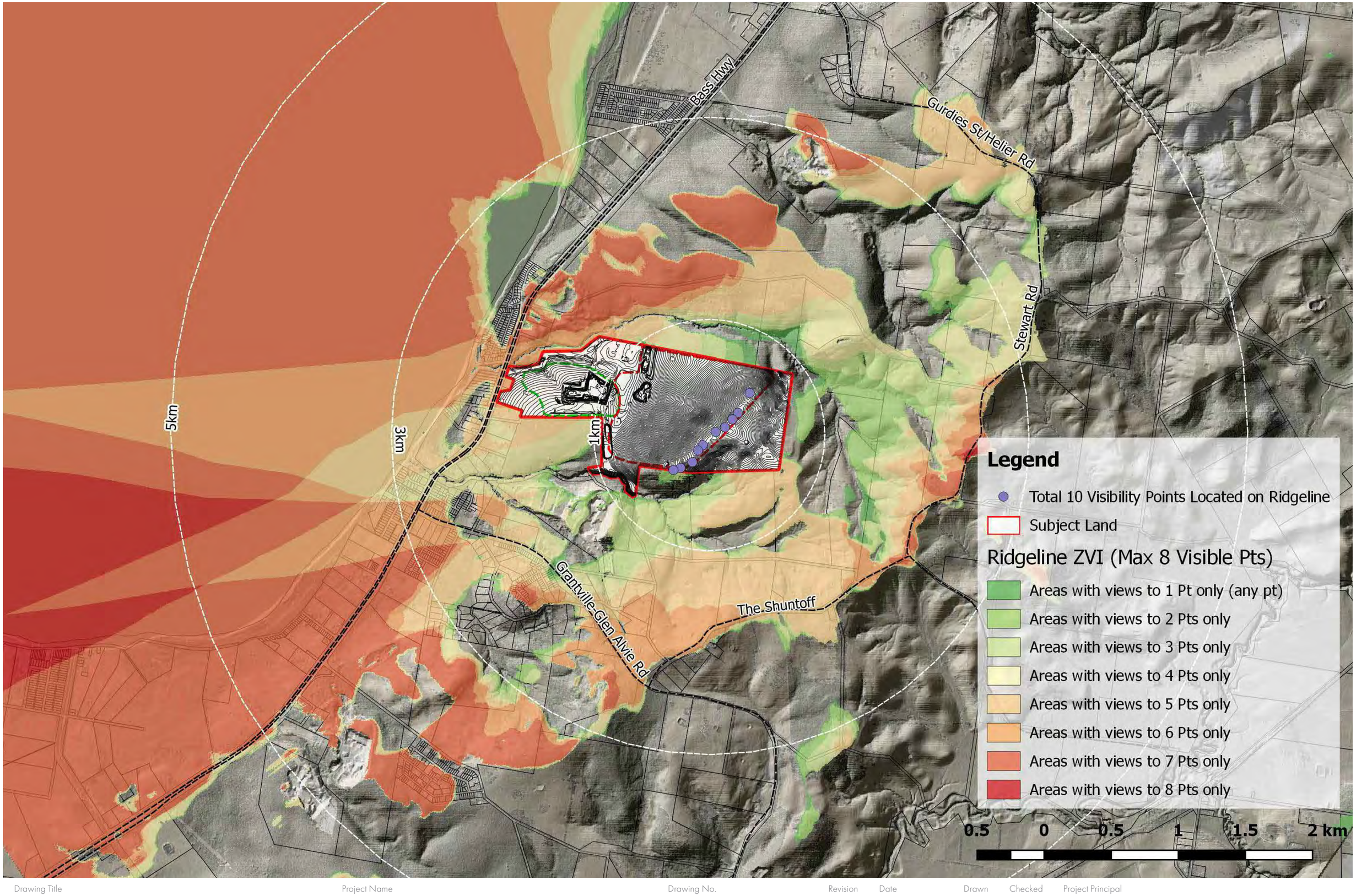
Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Figure A-4 - ZVI of Existing Extraction Site based on DSM (Landform, Vegetation & Building Heights)	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW



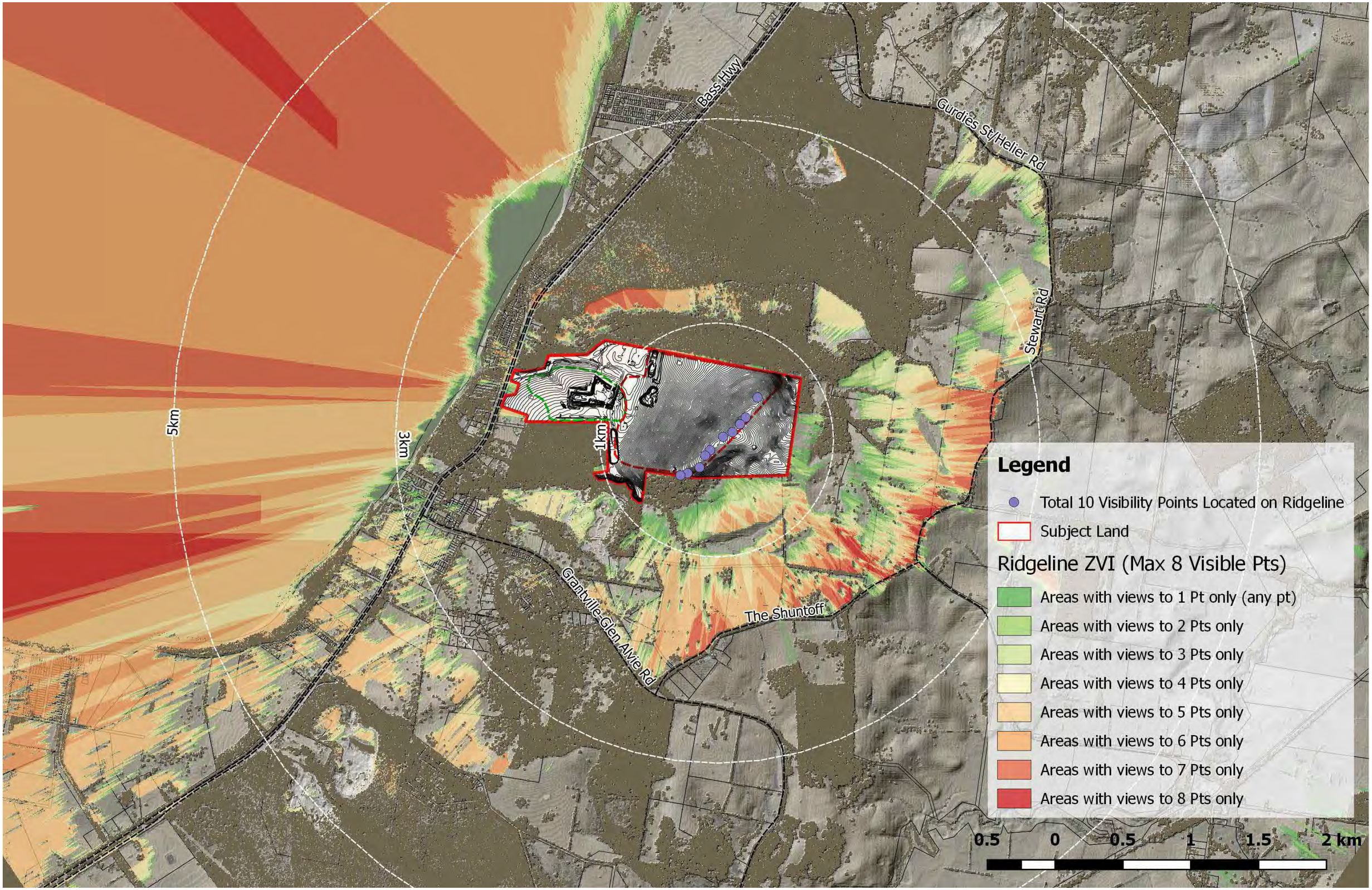
Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-5 - ZVI of Machinery up to 15m in Processing Area - Modelled based on DTM (Landform Only)	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW



Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-6 - ZVI of Machinery up to 15m in Processing Area - Modelled based on DSM (Landform, Vegetation & Building Heights)	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW



Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-7 - ZVI of Ridgeline - Modelled based on DTM (Landform only)	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW



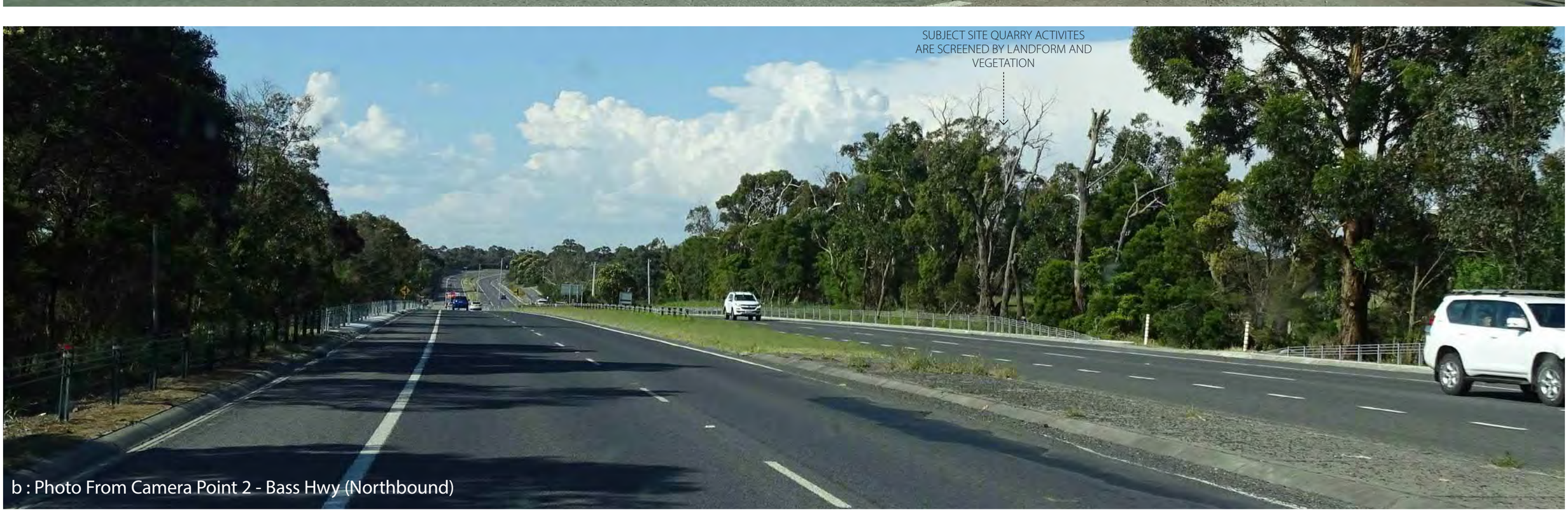
Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-8- ZVI of Ridgeline - Modelled based on DSM (Landform, Vegetation & Building Heights)	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW



Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-9 - Identified Receptors with Potential Views to Subject Land	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW



a : Photo From Camera Point 1 - Bass Highway Near Deep Creek Crossing

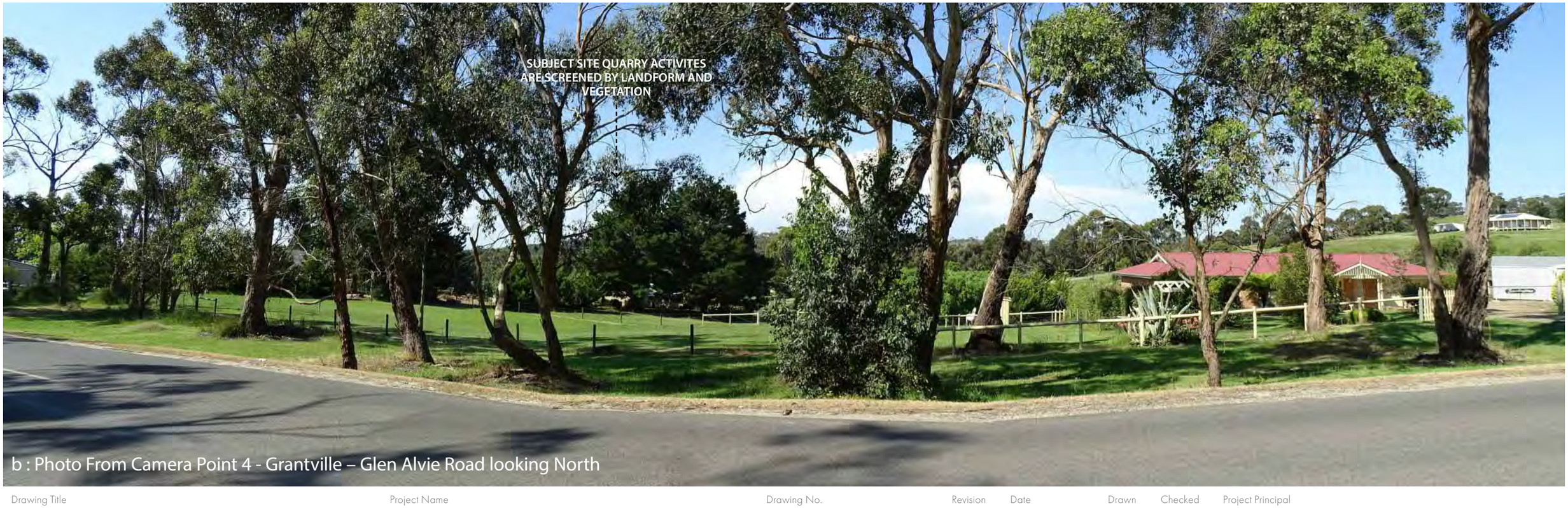


b : Photo From Camera Point 2 - Bass Hwy (Northbound)

Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-10 - Selected Viewpoint Camera Location	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW



a : Photo From Camera Point 3 - Grantville Jetty



b : Photo From Camera Point 4 - Grantville – Glen Alvie Road looking North

Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-11 - Selected Viewpoint Camera Location	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW



a : Photo From Camera Point 5- The Shuntoff

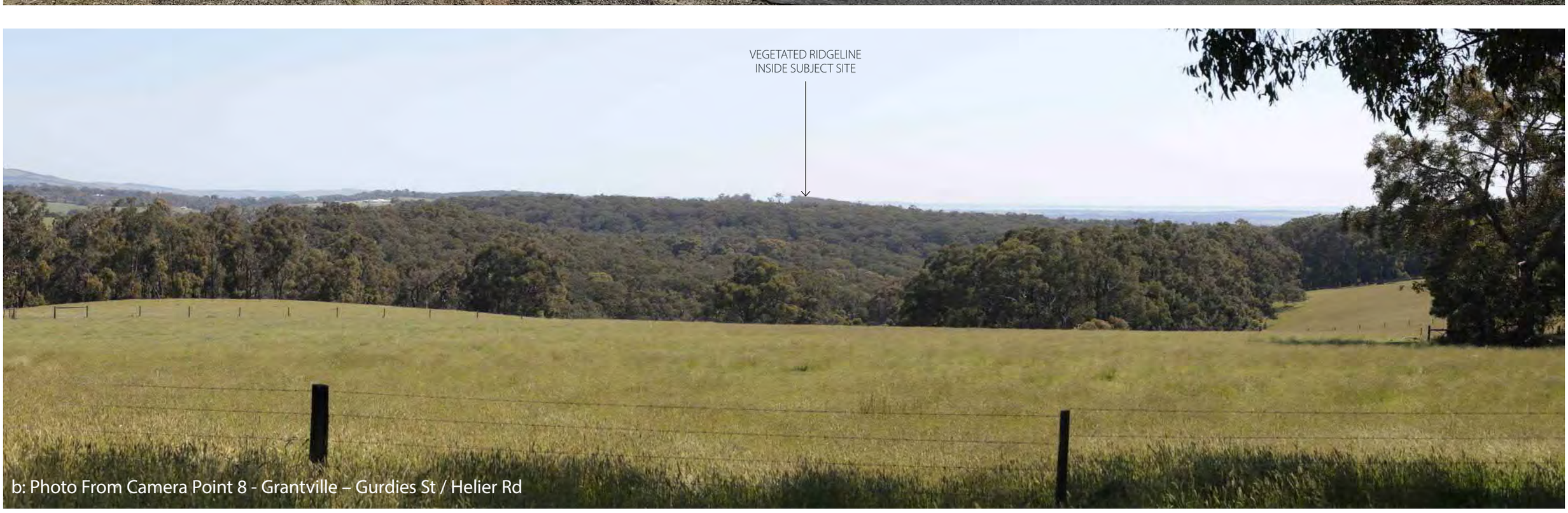


b : Photo From Camera Point 6 - Grantville – Stewart Road

Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-12 - Selected Viewpoint Camera Location	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW

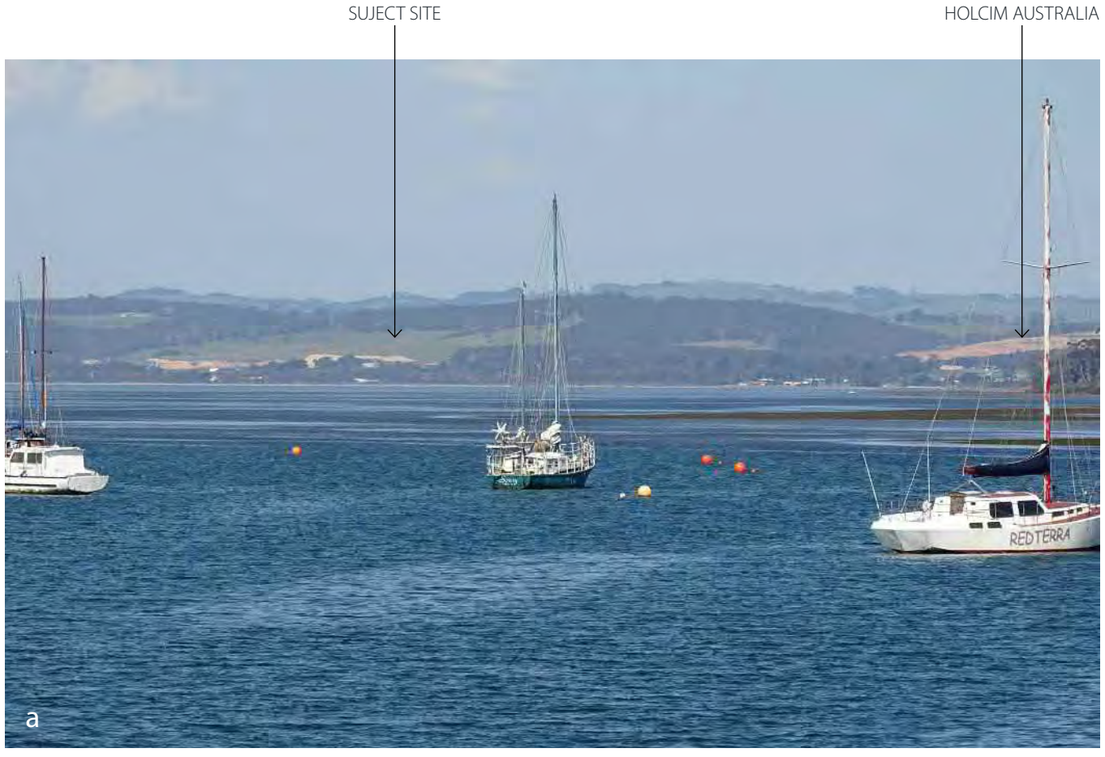


a : Photo From Camera Point 7 - Grantville – Stewart Road



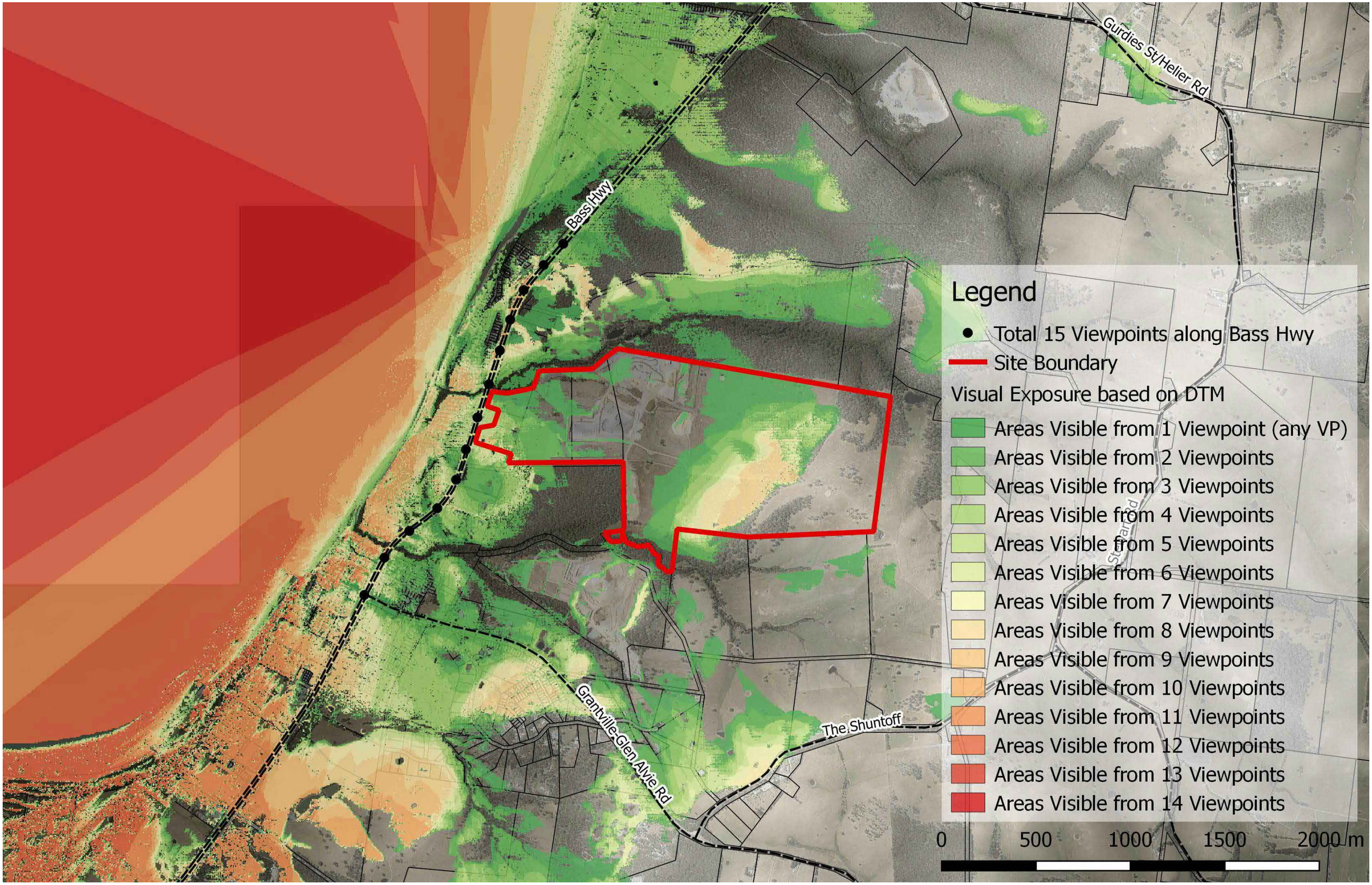
b: Photo From Camera Point 8 - Grantville – Gurdies St / Helier Rd

Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-13 - Selected Viewpoint Camera Location	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW

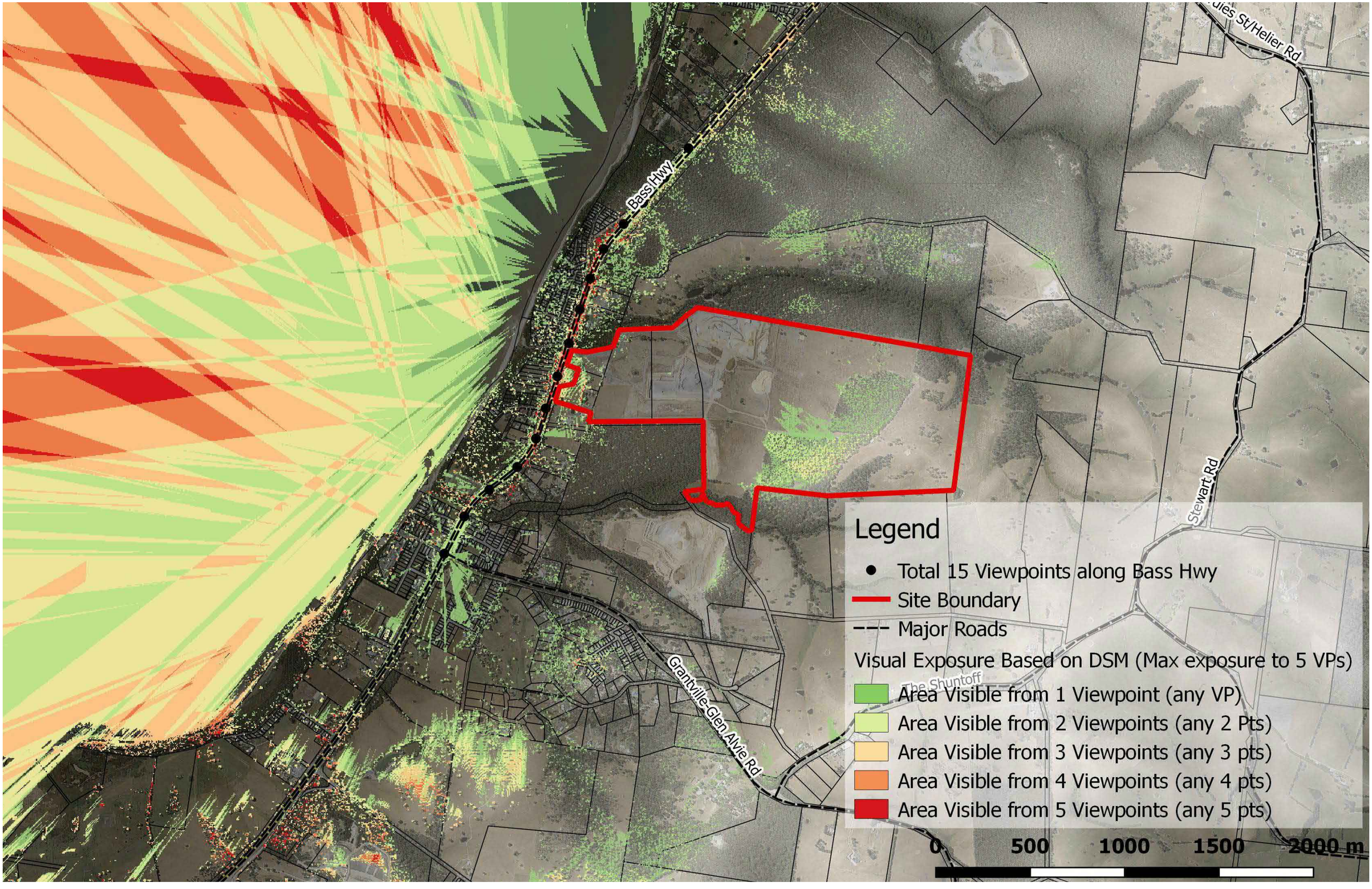




Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-14 - Selected Viewpoint Camera Location	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW



Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-15 - Visual Exposure From Bass Hwy - modelled based on DTM (landform only)	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW

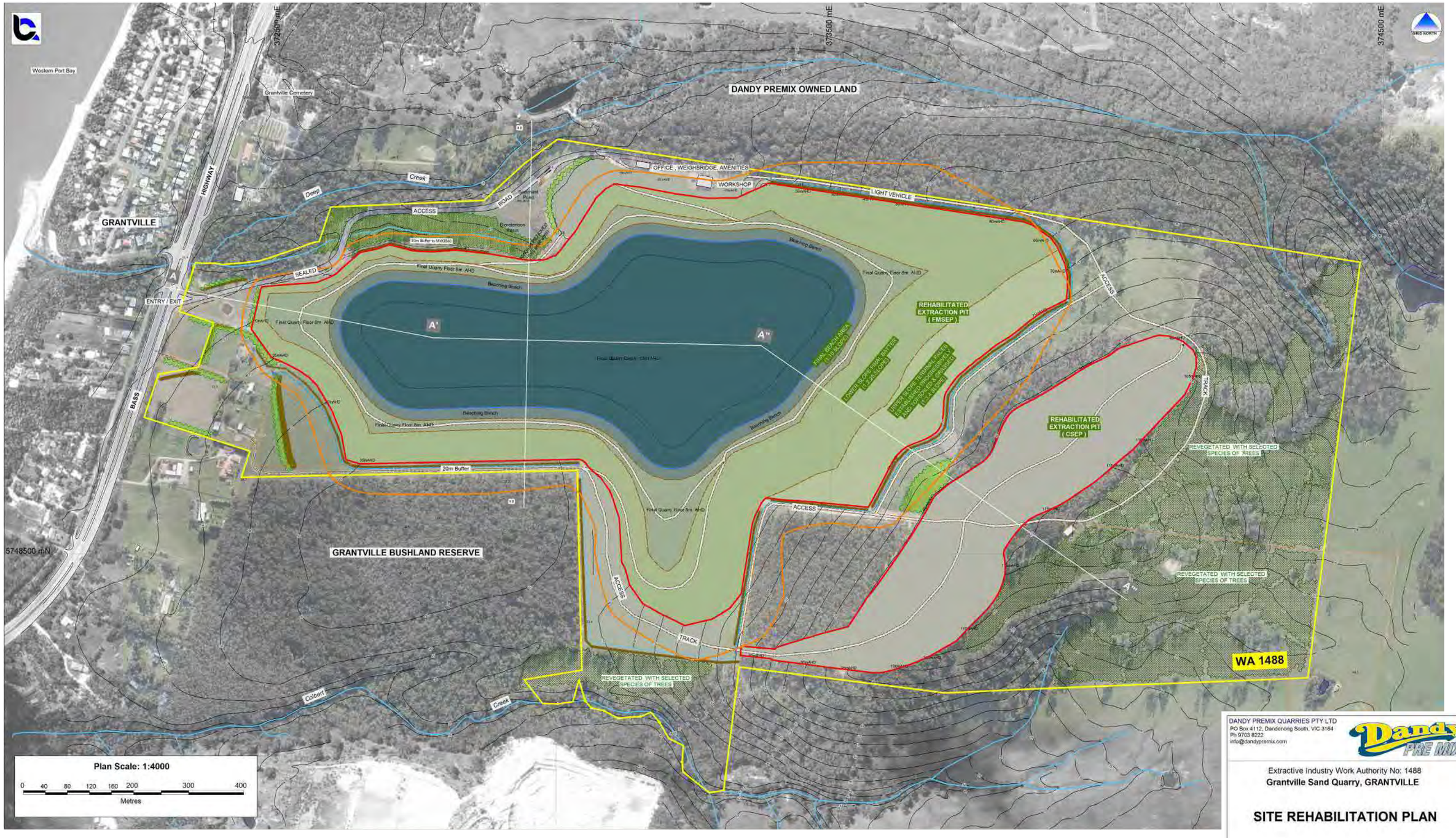


Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix A-16 - Visual Exposure From Bass Hwy - modelled based on DSM (landform + vegetation heights)	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	17January2018	MBC	MR	JW

Appendix B - New Conditions Analysis

Grantville Sand Quarry Stage 2

LVIA Final Report



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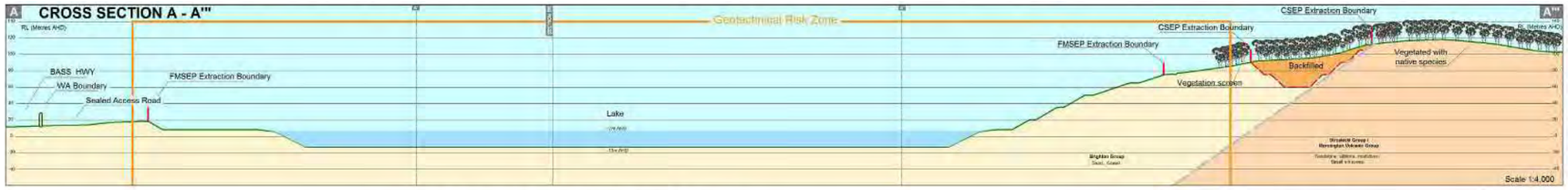
Ph 9703 8222
info@dandypremix.com

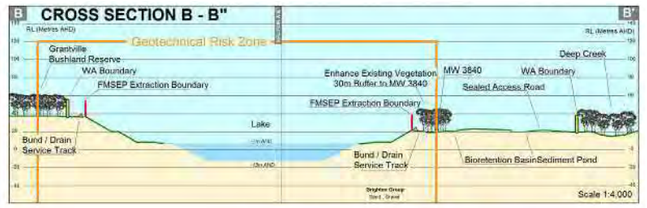
Extractive Industry Work Authority No: 1488
Grantville Sand Quarry, GRANTVILLE

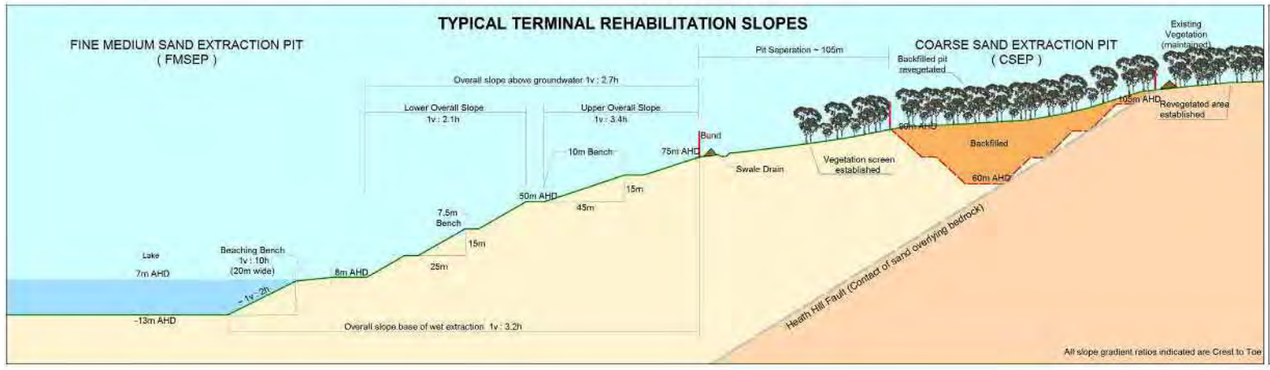
SITE REHABILITATION PLAN

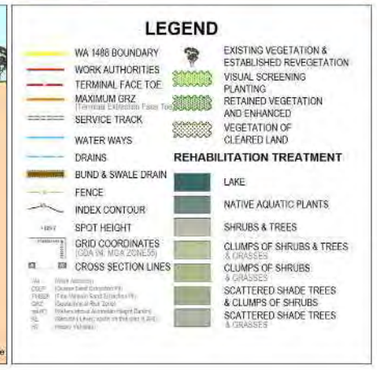
Author: AJM Date:10/01/2020	Drawing: NS - 1904 : Rev 0
Survey Source: Landair Surveys	
Orthophoto Date 30/6/19, Google, undated	**Project No: D10_003**
Projection: MGA Zone 55 (GDA 94)	**Figure: 4**
WA1488_Fig4_RehabPlanR0.WOR	

BCA CONSULTING - Earth Resources | 29/41 Norcal Road Nunawading 3131
Ph: 03 9873 9123 | email: admin@bcaconsulting.com.au | www.bcaconsulting.com.au









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Author: AJM Date:10/01/2020	Drawing: NS - 1904 - Rev 0
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Projection: MGA Zone 55 (GDA 94)	**Figure: 4**
WA1488_Fig4_RehabPlanR0.WOR	

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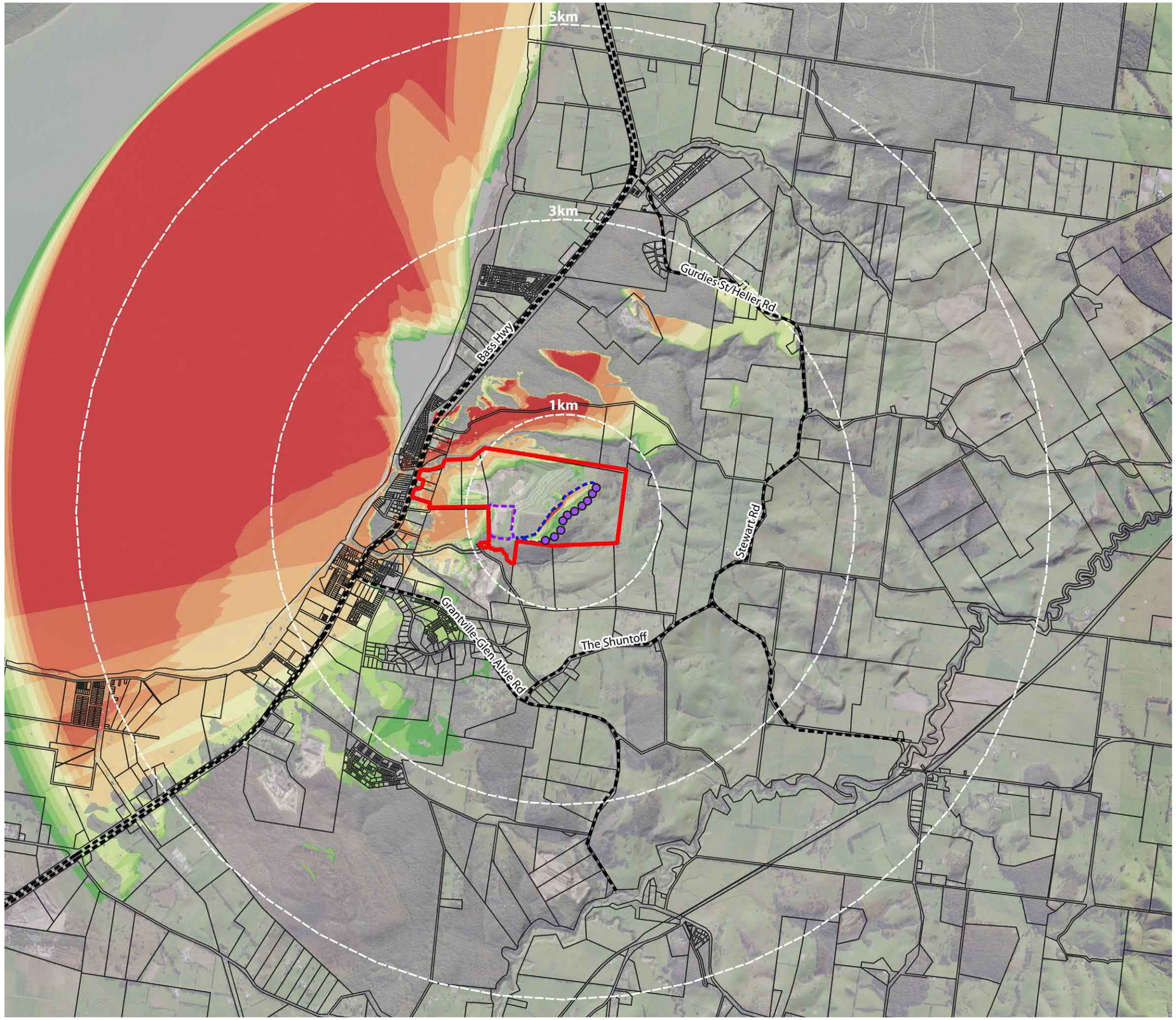
Ph: 03 9873 5123 | email: admin@bcaconsulting.com.au | www.bcaconsulting.com.au



Legend

- Total 10 points along upper pit
- Subject Site
- Upper Pit Boundary
- Overburden Stockpile Boundary

Upper Pit ZVI

- Areas with views to 1 point only (any pt.)
- Areas with views to 2 points only
- Areas with views to 3 points only
- Areas with views to 4 points only
- Areas with views to 5 points only
- Areas with views to 6 points only
- Areas with views to 7 points only
- Areas with views to 8 points only
- Areas with views to 9 points only
- Areas with views to 10 points only

Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal	Scale
Appendix B-2 Zone of Visual Influence Analysis Upper Pit - Without Vegetation	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR	1:40,000 (A3) 0 0.4 1.0 2.0km



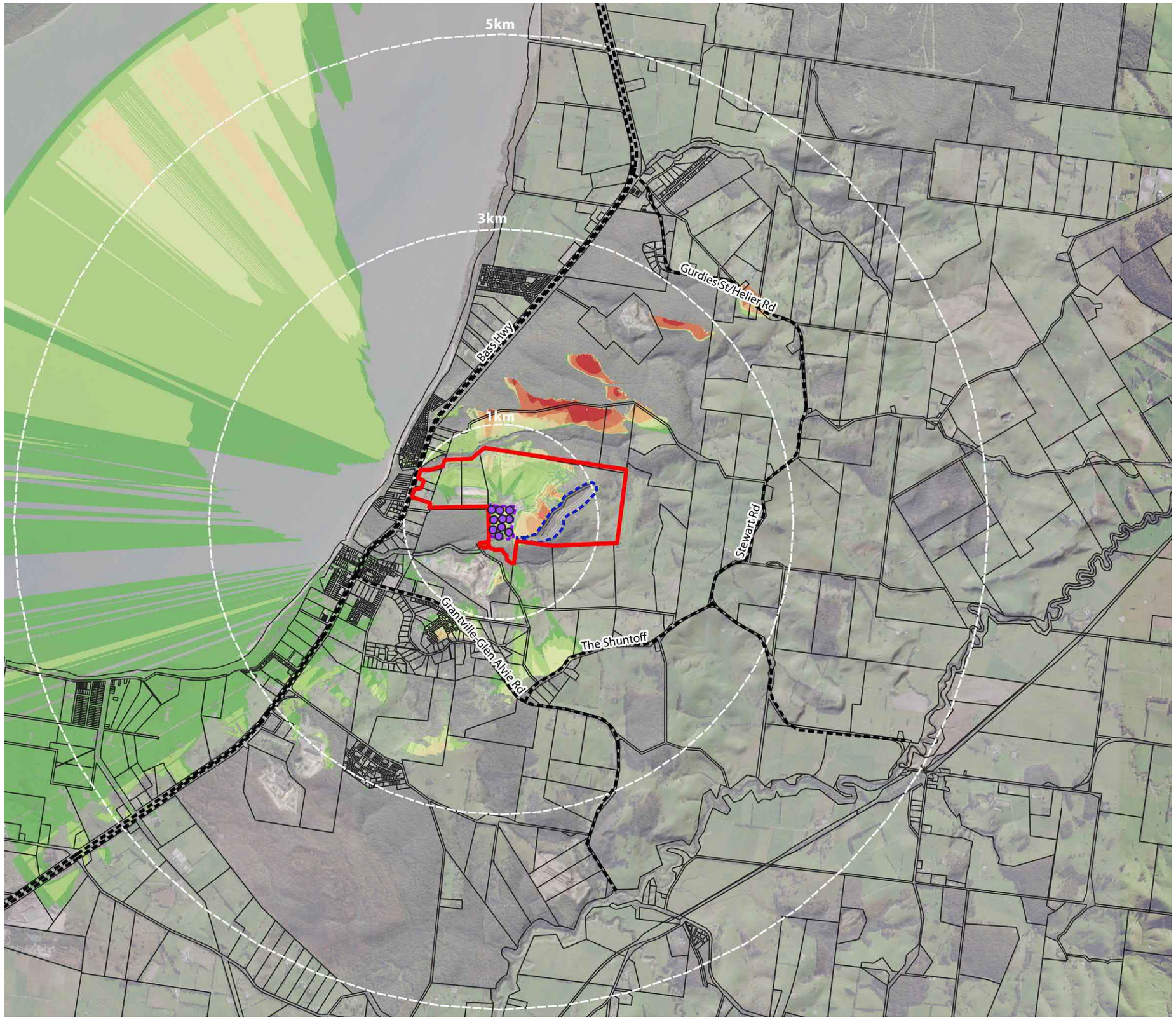
Legend

- Total 10 points along upper pit
- Subject Site
- Upper Pit Boundary
- Overburden Stockpile Boundary

Upper Pit ZVI

- Areas with views to 1 point only (any pt.)
- Areas with views to 2 points only
- Areas with views to 3 points only
- Areas with views to 4 points only
- Areas with views to 5 points only
- Areas with views to 6 points only
- Areas with views to 7 points only

Drawing Title		Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal	Scale
Appendix B-3	**Zone of Visual Influence Analysis of Upper Pit - With Vegetation**	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR	1:40,000 (A3) 0 0.4 1.0 2.0km



Legend

- Total 10 points along overburden stockpile
- Subject Site
- Upper Pit Boundary
- Overburden Stockpile Boundary

Overburden Stockpile ZVI

- Areas with views to 1 point only (any pt.)
- Areas with views to 2 points only
- Areas with views to 3 points only
- Areas with views to 4 points only
- Areas with views to 5 points only
- Areas with views to 6 points only
- Areas with views to 7 points only

Drawing Title		Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal	Scale
Appendix B-4	Zone of Visual Influence Analysis of Overburd Stockpile - Without Vegetation	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR	1:40,000 (A3) 0 0.4 1.0 2.0km



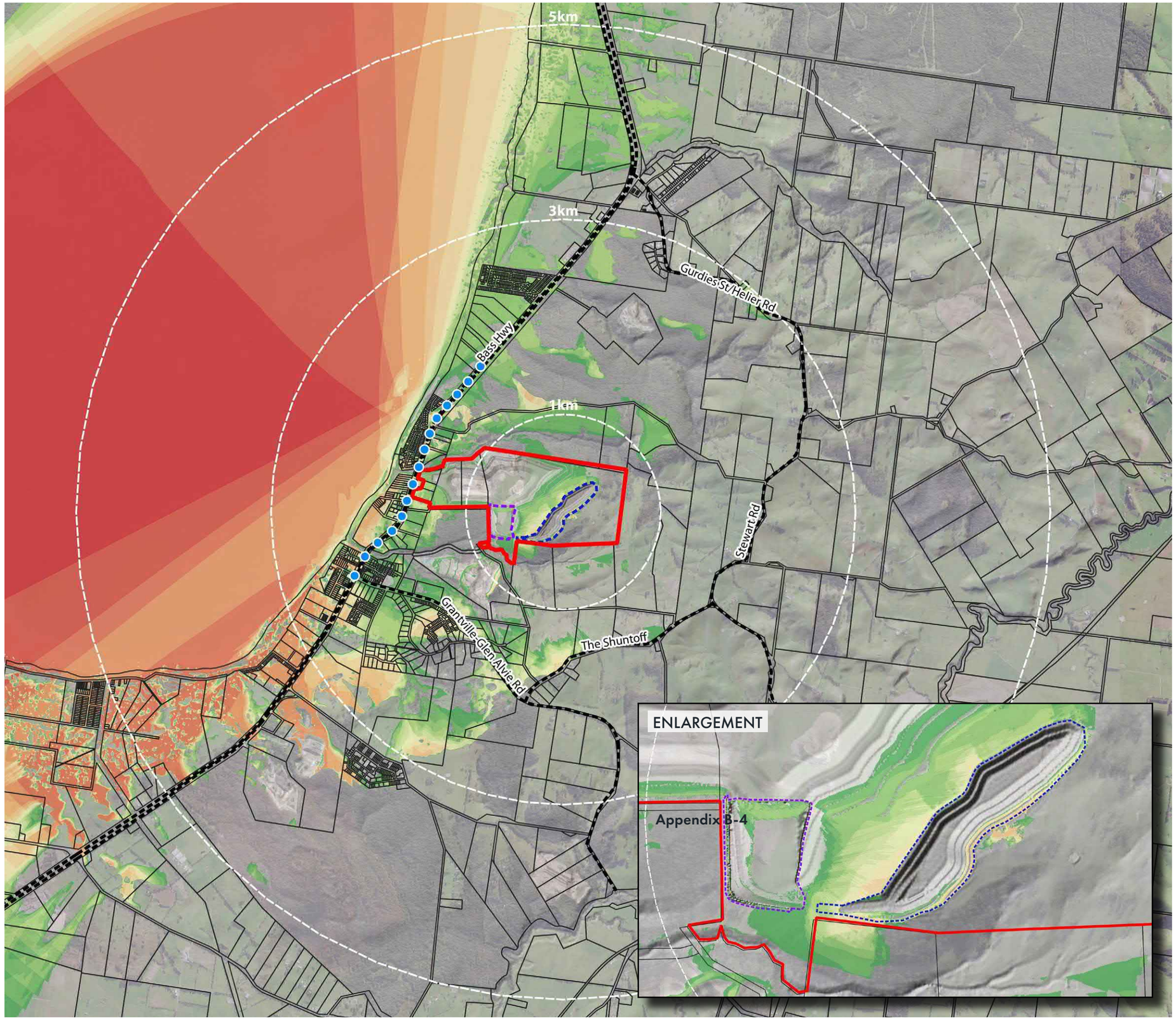
Legend

- Total 10 points along overburden stockpile
- Subject Site
- Upper Pit Boundary
- Overburden Stockpile Boundary

Overburden Stockpile ZVI

- Areas with views to 1 point only (any pt.)
- Areas with views to 2 points only
- Areas with views to 3 points only
- Areas with views to 4 points only
- Areas with views to 5 points only
- Areas with views to 6 points only
- Areas with views to 7 points only
- Areas with views to 8 points only

Drawing Title		Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal	Scale
Appendix B-5	**Zone of Visual Influence Analysis of Overburden Stockpile - With Vegetation**	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR	1:40,000 (A3) 0 0.4 1.0 2.0km

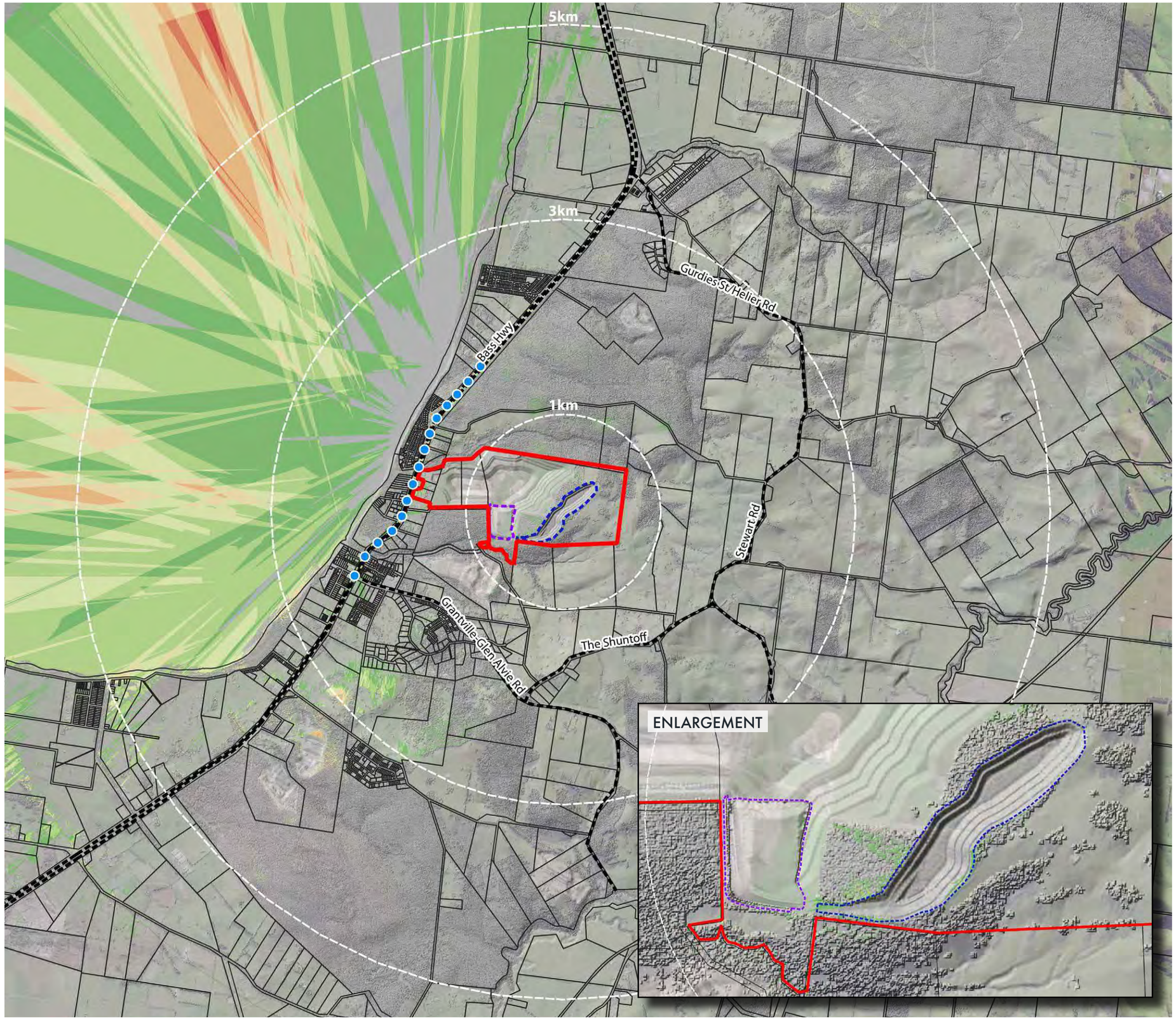


- Total 15 points along the Bass Highway
- Subject Site
- Upper Pit Boundary
- Overburden Stockpile Boundary

Visual Exposure to Bass Highway

- Areas visible from 1 point only (any pt.)
- Areas visible from 2 points only
- Areas visible from 3 points only
- Areas visible from 4 points only
- Areas visible from 5 points only
- Areas visible from 6 points only
- Areas visible from 7 points only
- Areas visible from 8 points only
- Areas visible from 9 points only
- Areas visible from 10 points only
- Areas visible from 11 points only
- Areas visible from 12 points only
- Areas visible from 13 points only
- Areas visible from 14 points only
- Areas visible from 15 points only

Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal	Scale
Appendix B-6 **Visual Exposure from Bass Highway - Without Vegetation**	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR	1:40,000 (A3) 0 0.4 1.0 2.0km

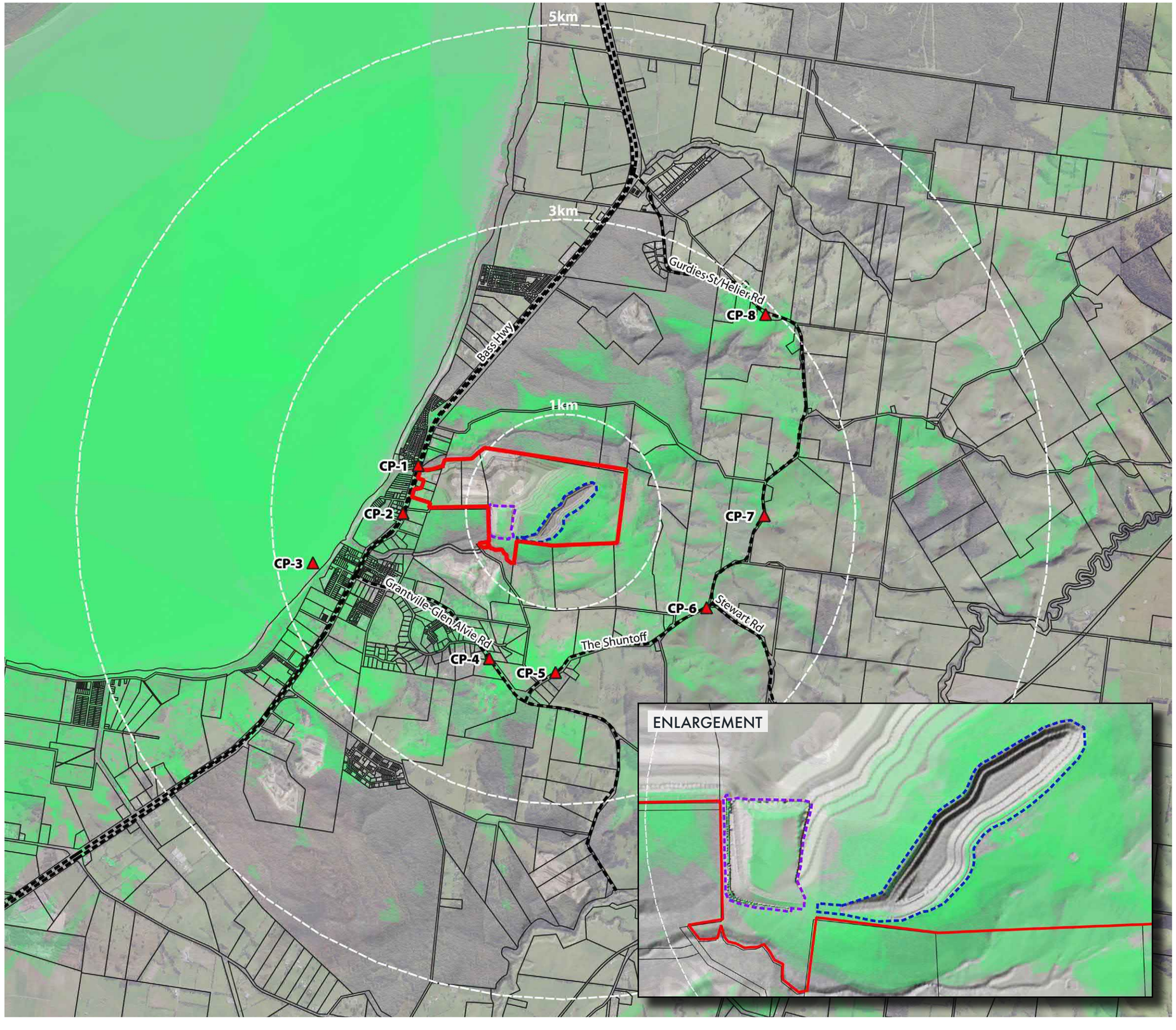


- Total 15 points along the Bass Highway
- Subject Site
- Upper Pit Boundary
- Overburden Stockpile Boundary

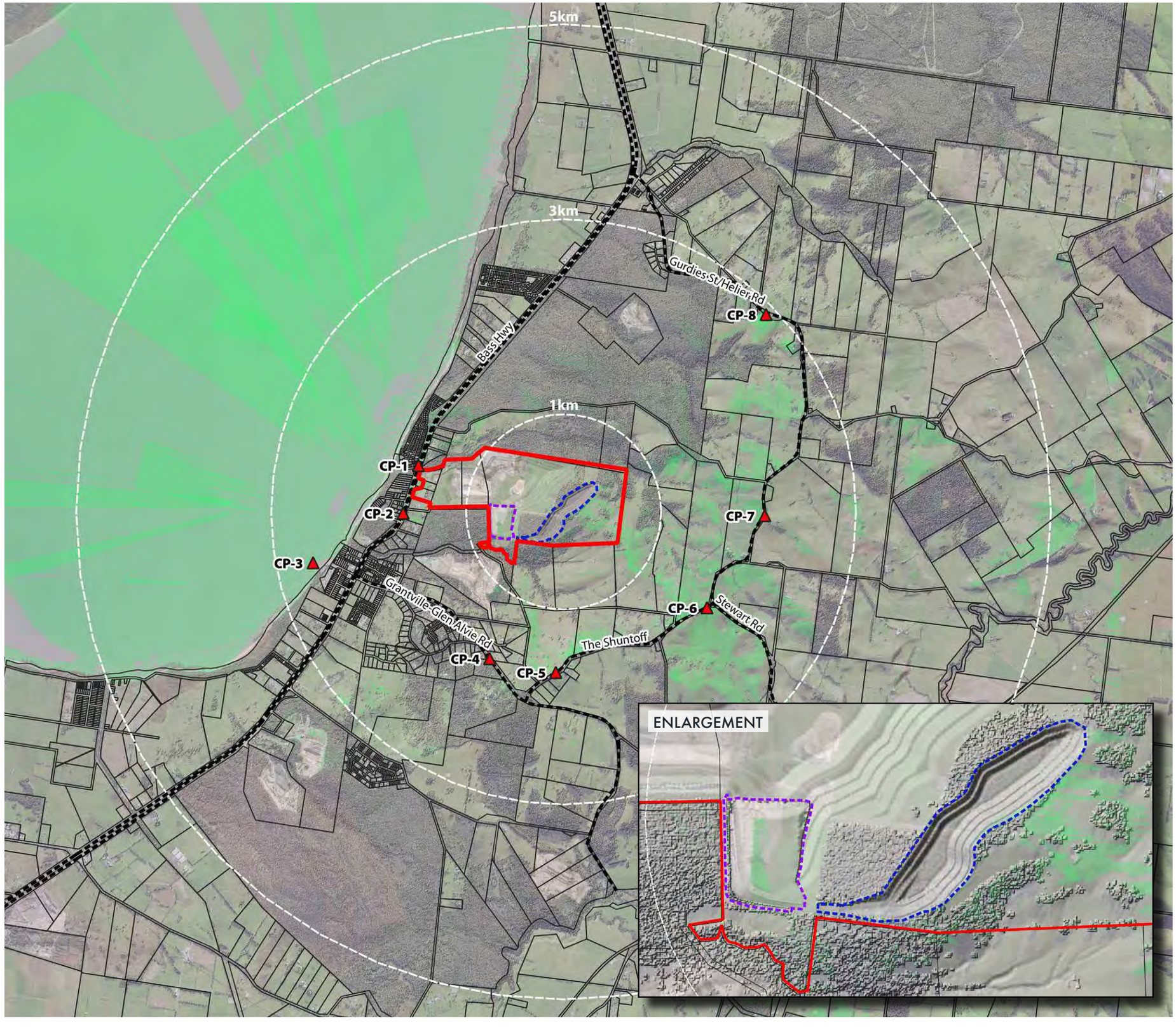
Visual Exposure to Bass Highway

- Areas visible from 1 point only (any pt.)
- Areas visible from 2 points only
- Areas visible from 3 points only
- Areas visible from 4 points only
- Areas visible from 5 points only
- Areas visible from 6 points only
- Areas visible from 7 points only
- Areas visible from 8 points only
- Areas visible from 9 points only
- Areas visible from 10 points only
- Areas visible from 11 points only
- Areas visible from 12 points only
- Areas visible from 13 points only
- Areas visible from 14 points only
- Areas visible from 15 points only

Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal	Scale
Appendix B-7 **Visual Exposure from Bass Highway - With Vegetation**	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR	1:40,000 (A3) 0 0.4 1.0 2.0km

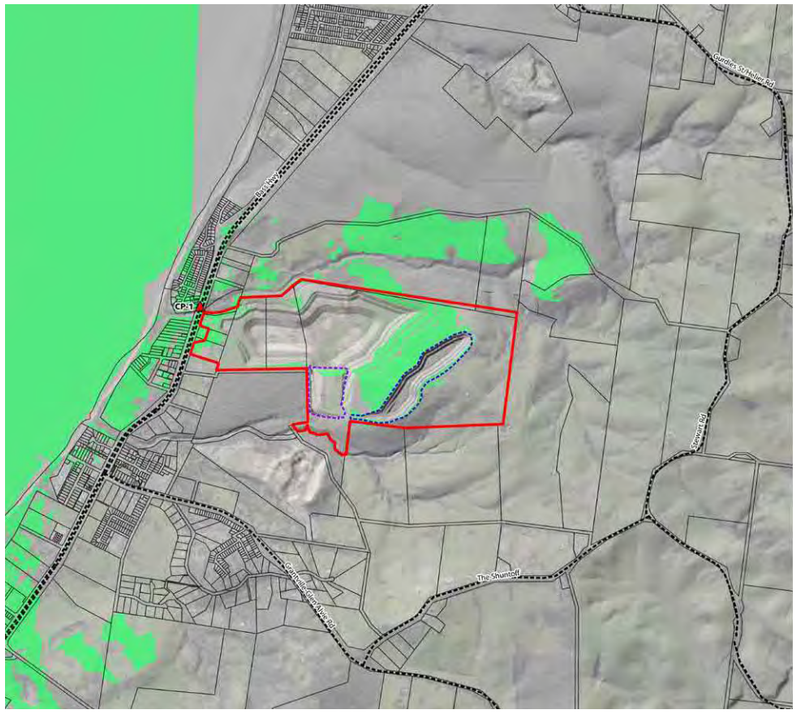


Drawing Title		Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal	Scale
Appendix B-8	**Visibility from Selected Camera Points - Without Vegetation**	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR	1:40,000 (A3) 0 0.4 1.0 2.0km

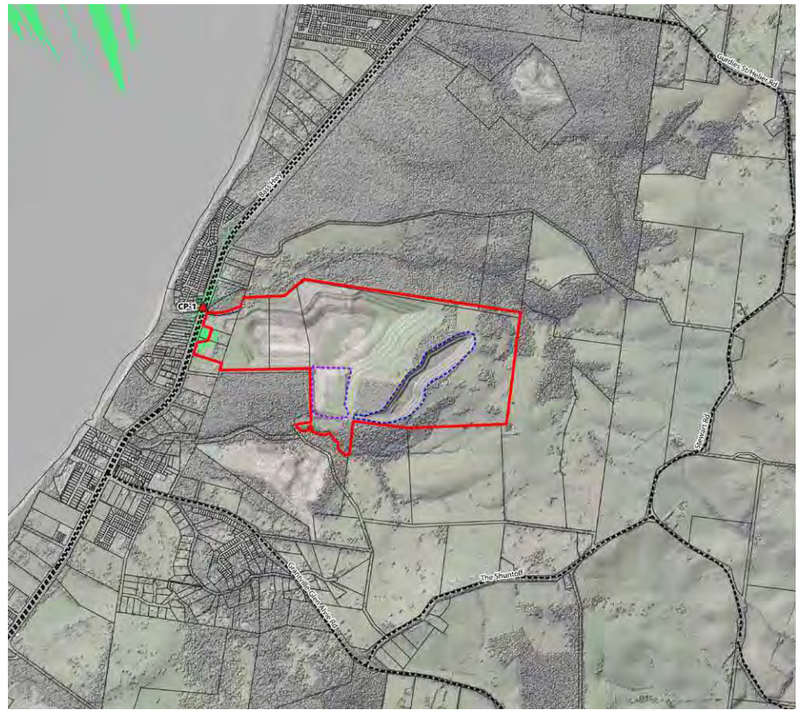


Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal	Scale
Appendix B-9 **Visibility from Selected Camera Points - With Vegetation**	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR	1:40,000 (A3) 0 0.4 1.0 2.0km

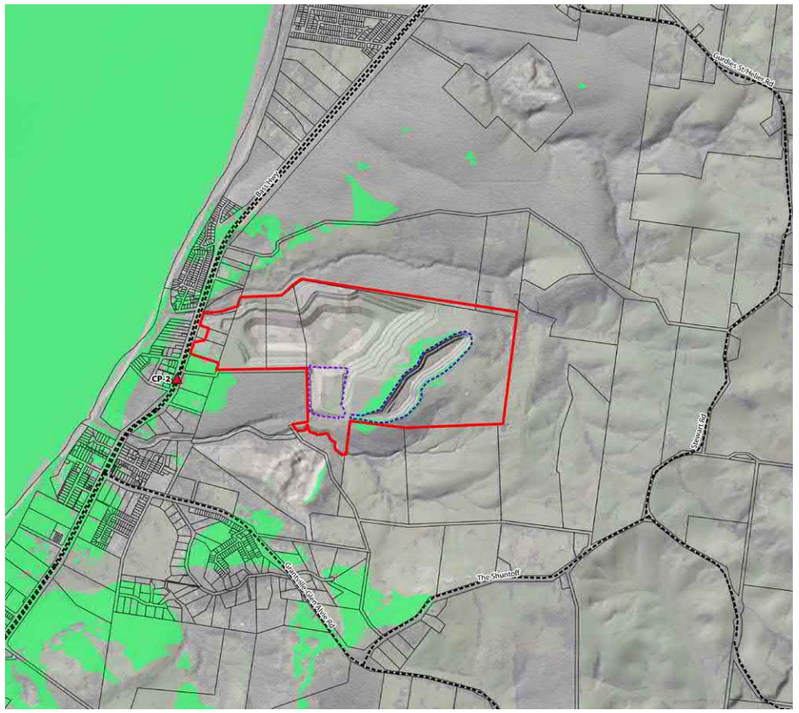
Camera Point 1 - without vegetation



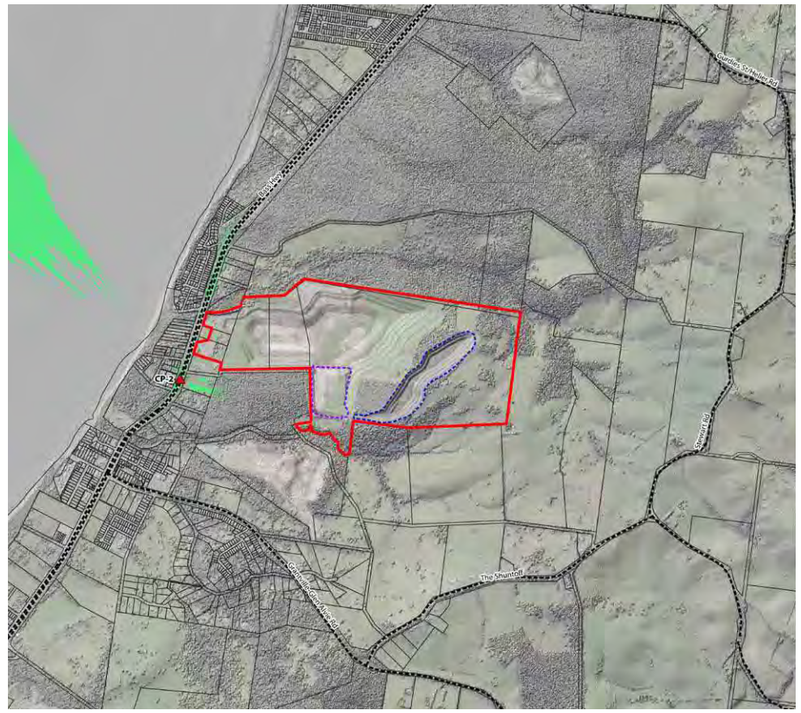
Camera Point 1 - with vegetation



Camera Point 2 - without vegetation



Camera Point 2 - with vegetation



Legend

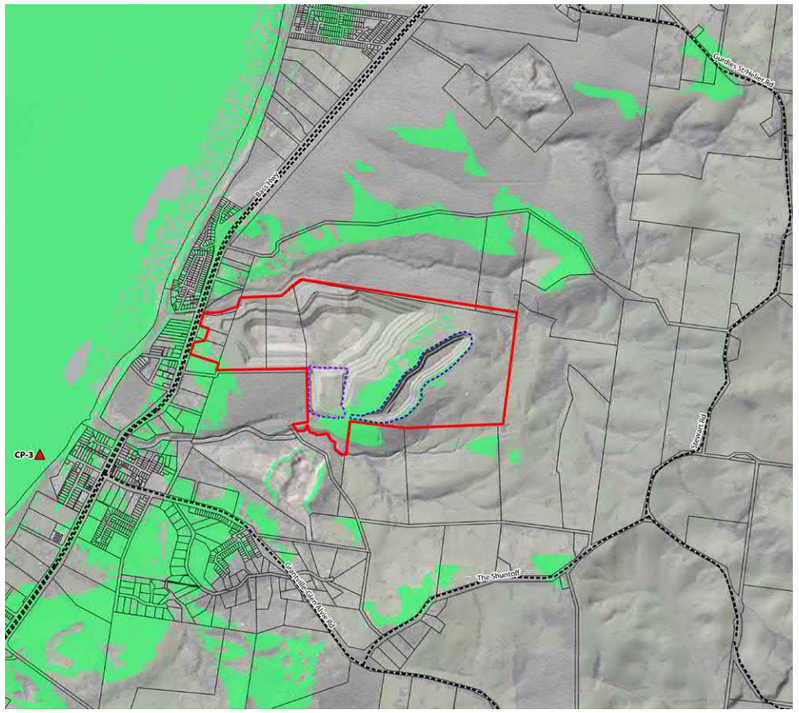
- Selected Camera Point
- Subject Site
- Upper Pit Boundary
- Overburden Stockpile Boundary

Camera Points ZVI

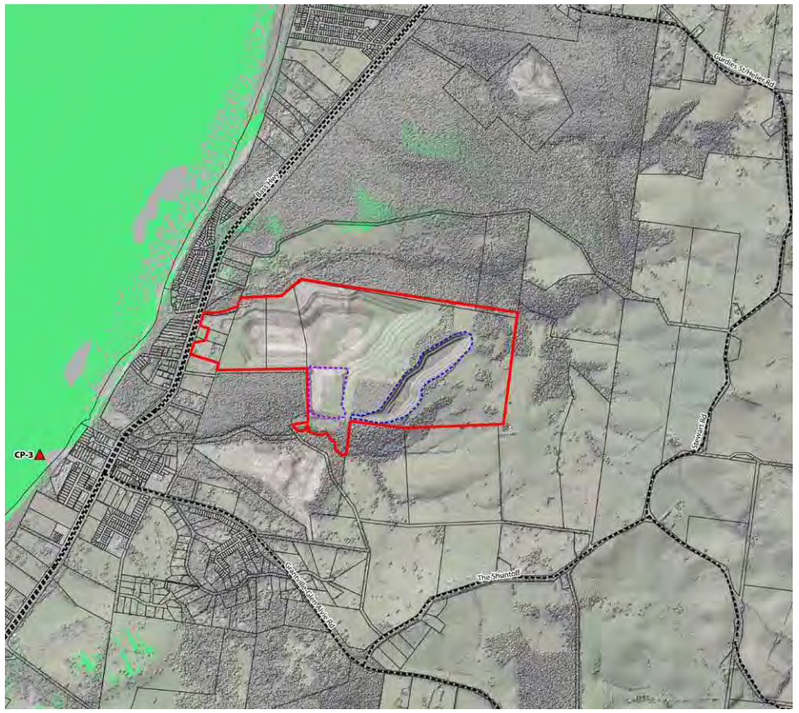
- Areas Visible from Camera Point

Drawing Title		Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix B-10	**Visibility from Camera Points 1 & 2**	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR

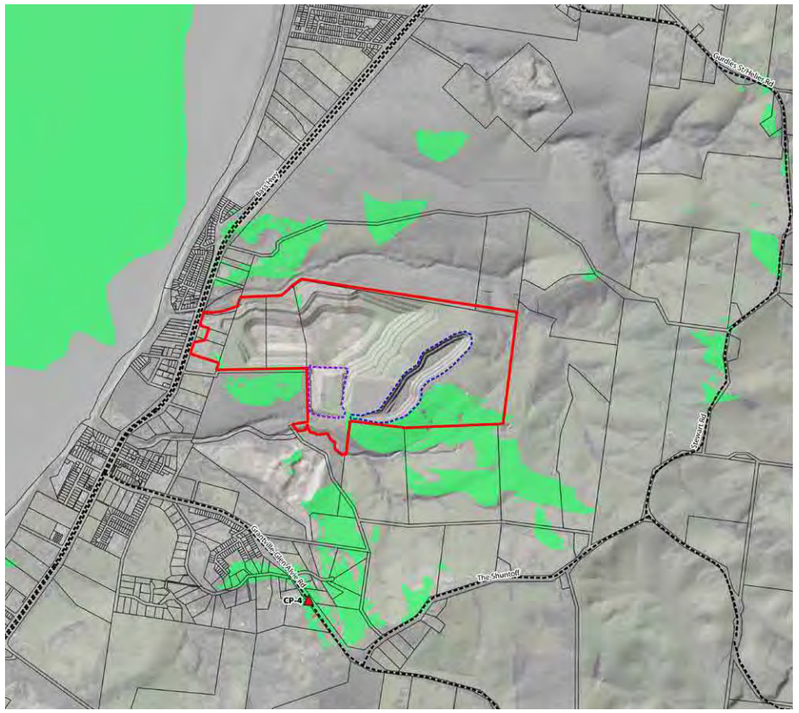
Camera Point 3 - without vegetation



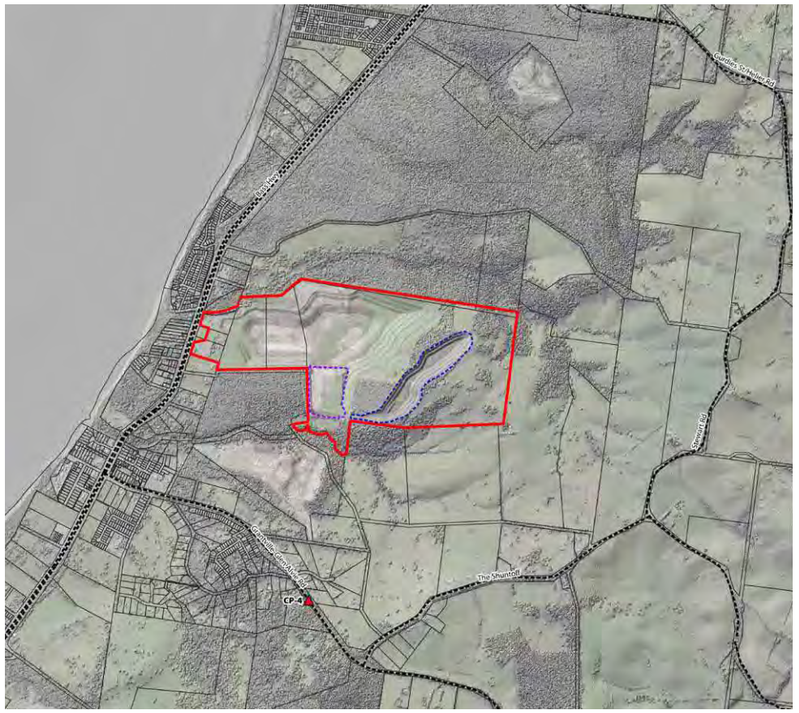
Camera Point 3 - with vegetation



Camera Point 4 - without vegetation



Camera Point 4 - with vegetation



Legend

- Selected Camera Point
- Subject Site
- Upper Pit Boundary
- Overburden Stockpile Boundary

Camera Points ZVI

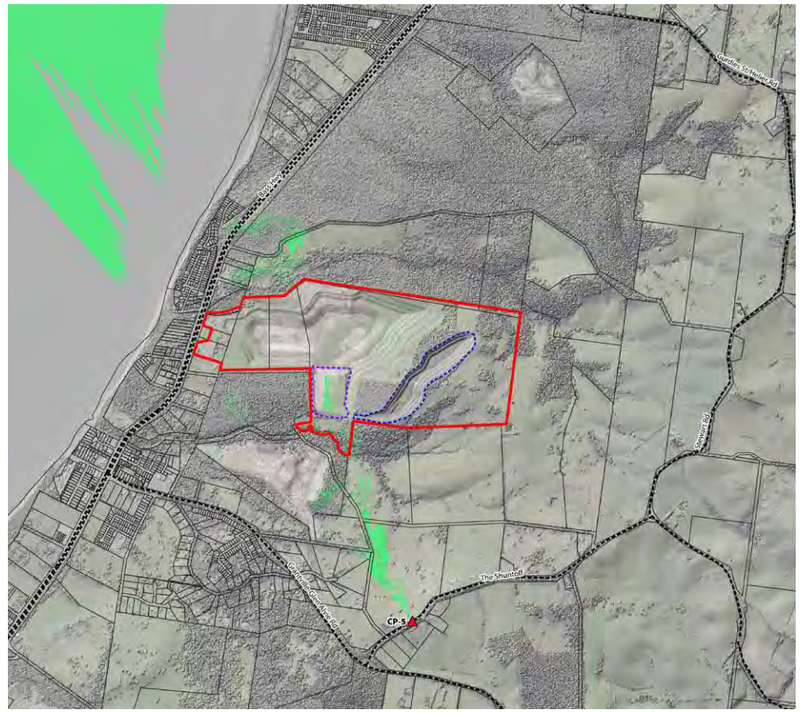
- Areas Visible from Camera Point

Drawing Title		Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix B-11	**Visibility from Camera Points 3 & 4**	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR

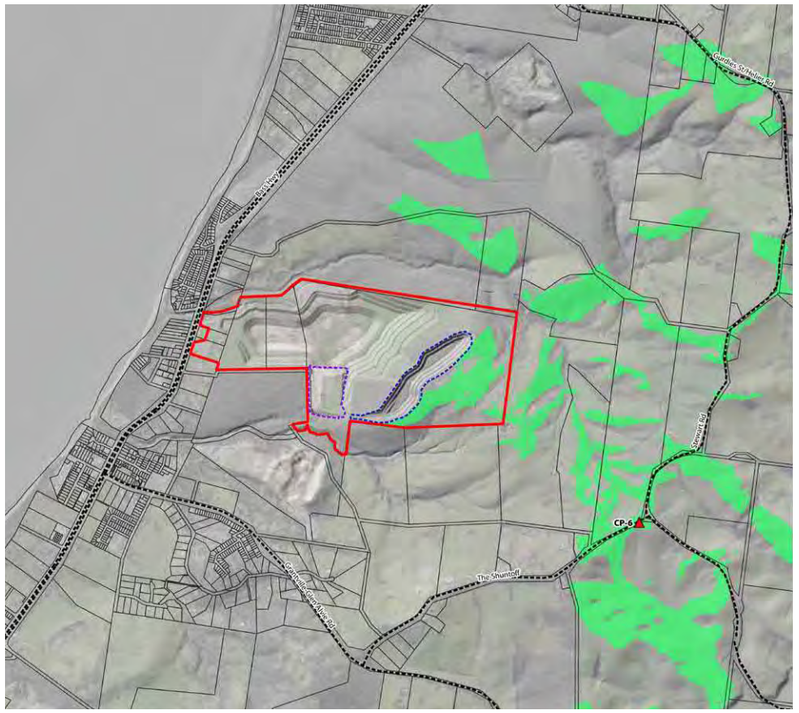
Camera Point 5 - without vegetation



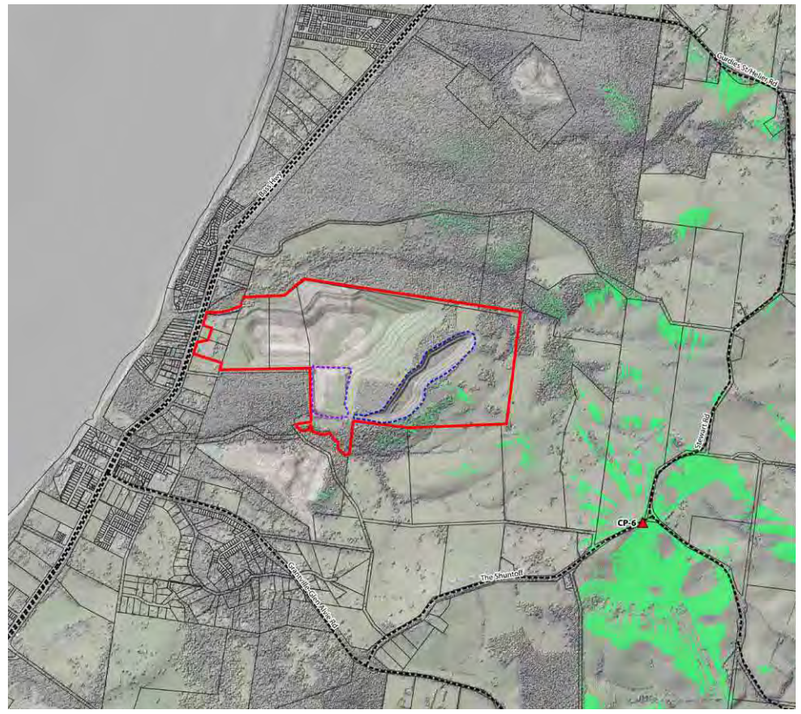
Camera Point 5 - with vegetation



Camera Point 6 - without vegetation



Camera Point 6 - with vegetation



Legend

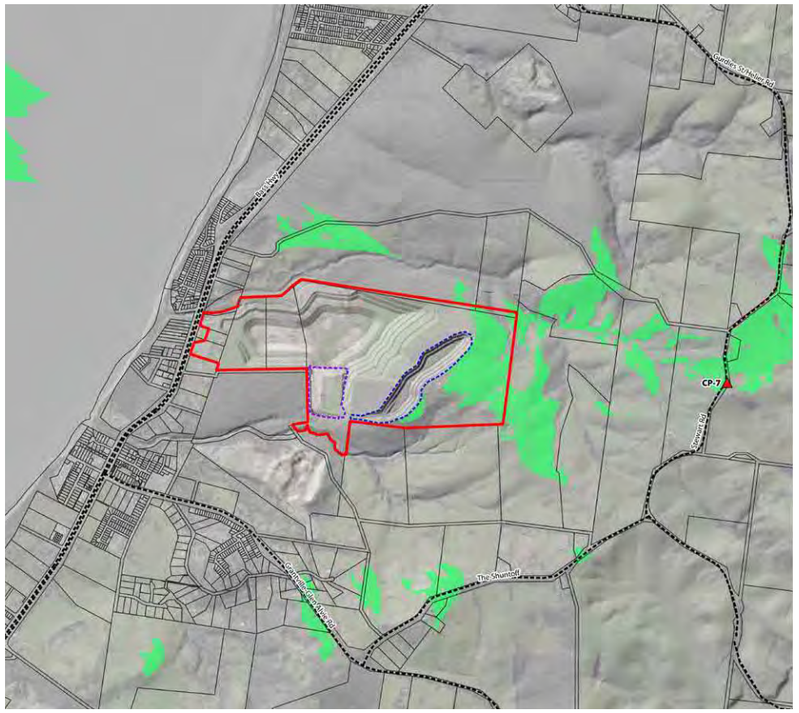
- Selected Camera Point
- Subject Site
- Upper Pit Boundary
- Overburden Stockpile Boundary

Camera Points ZVI

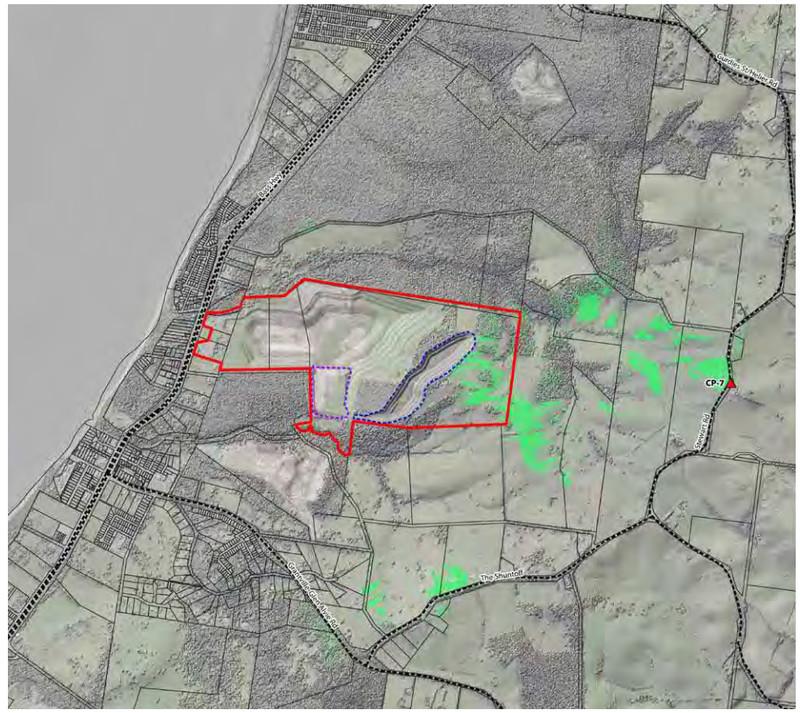
- Areas Visible from Camera Point

Drawing Title		Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix B-12	**Visibility from Camera Points 5 & 6**	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR

Camera Point 7 - without vegetation



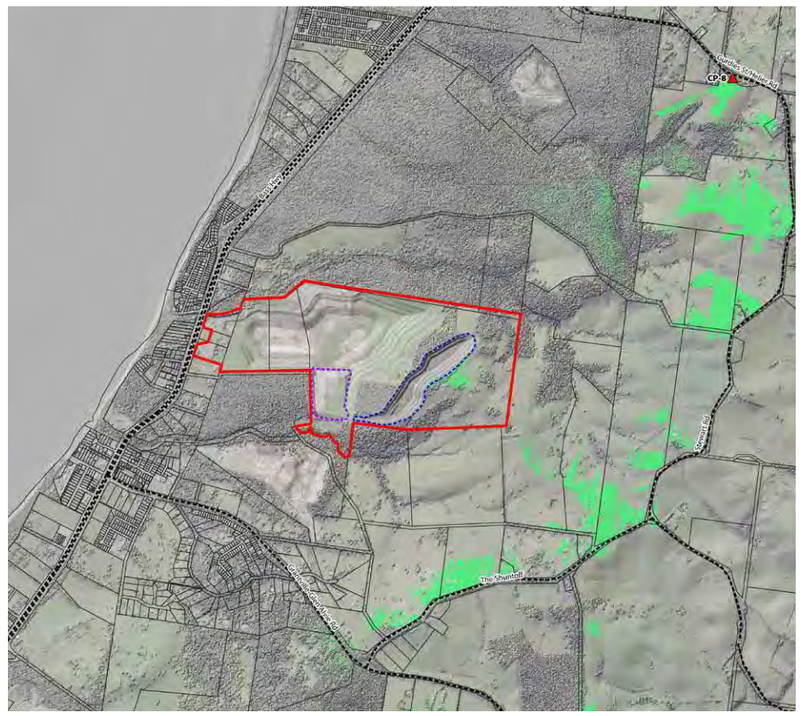
Camera Point 7 - with vegetation



Camera Point 8 - without vegetation



Camera Point 8 - with vegetation



Legend

- Selected Camera Point
- Subject Site
- Upper Pit Boundary
- Overburden Stockpile Boundary

Camera Points ZVI

- Areas Visible from Camera Point

Drawing Title		Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix B-13	**Visibility from Camera Points 7 & 8**	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR

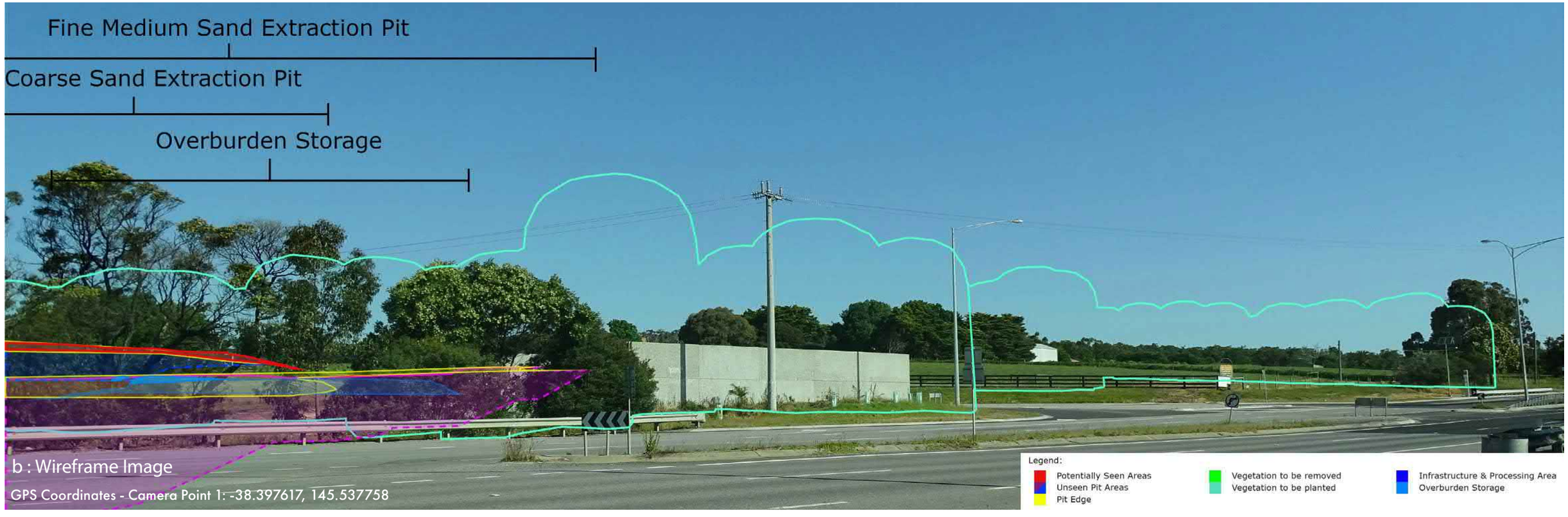
Appendix C - Wireframe Images

Grantville Sand Quarry Stage 2

LVIA Final Report



a : Photo From Camera Point 1 - Bass Highway Near Deep Creek Crossing



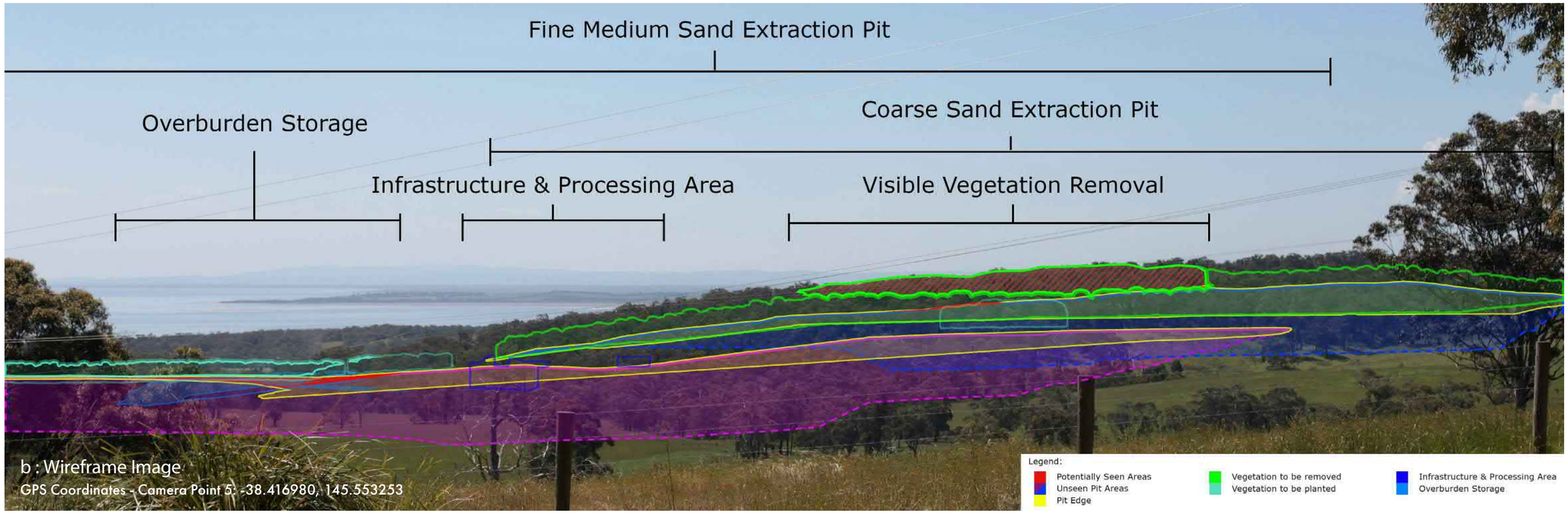
b : Wireframe Image

GPS Coordinates - Camera Point 1: -38.397617, 145.537758

Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix C-1	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR



a : Photo From Camera Point 5- The Shuntoff



b : Wireframe Image
GPS Coordinates - Camera Point 5: -38.416980, 145.553253

Drawing Title	Project Name	Drawing No.	Revision	Date	Drawn	Checked	Project Principal
Appendix C-2	Grantville Sand LVIA - Stage 2	0317-0730-01_R002-00	00	02 July 2020	MBC	MR	MR

REPORT 5 – TRAFFIC ENGINEERING ASSESSMENT

Traffix Group

Traffic Engineering Assessment

Proposed Quarry Expansion

1381 Bass Highway, Grantville

Prepared for
Dandy Premix Pty Ltd

July, 2020

G23730R-01D

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ABN: 32 100 481 570

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Document Control

Our Reference: G23730R-01D

Issue No.	Type	Date	Prepared By	Approved By
A	Initial Issue	07/05/20	Daniel Milder	Jodie Place
B	Second Issue	18/05/20	Daniel Milder	Jodie Place
C	Third Issue	21/05/20	Daniel Milder	Jodie Place
D	Fourth Issue	03/07/20	Daniel Milder	Jodie Place

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2.3. Road Network *7*

2.4. Existing Traffic Volumes *7*

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5. Traffic Impact Assessment **10**

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5.2. Traffic Distribution *10*

5.3. Traffic Impact *11*

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List of Appendices

Appendix A Site Plan

Appendix B Signal Design Layout (Traffix Design Drawing Number G13716A-03)

Appendix C Safety Review

1. Introduction

Traffix Group has been engaged by Dandy Premix Pty Ltd to prepare a traffic engineering assessment for the proposed quarry expansion at 1381 Bass Highway, Grantville.

This report provides a traffic engineering assessment of the traffic issues associated with the proposed development.

2. Existing Conditions

2.1. Site Locality

The subject site is located on the east side of Bass Highway, as shown in Figure 1 below.

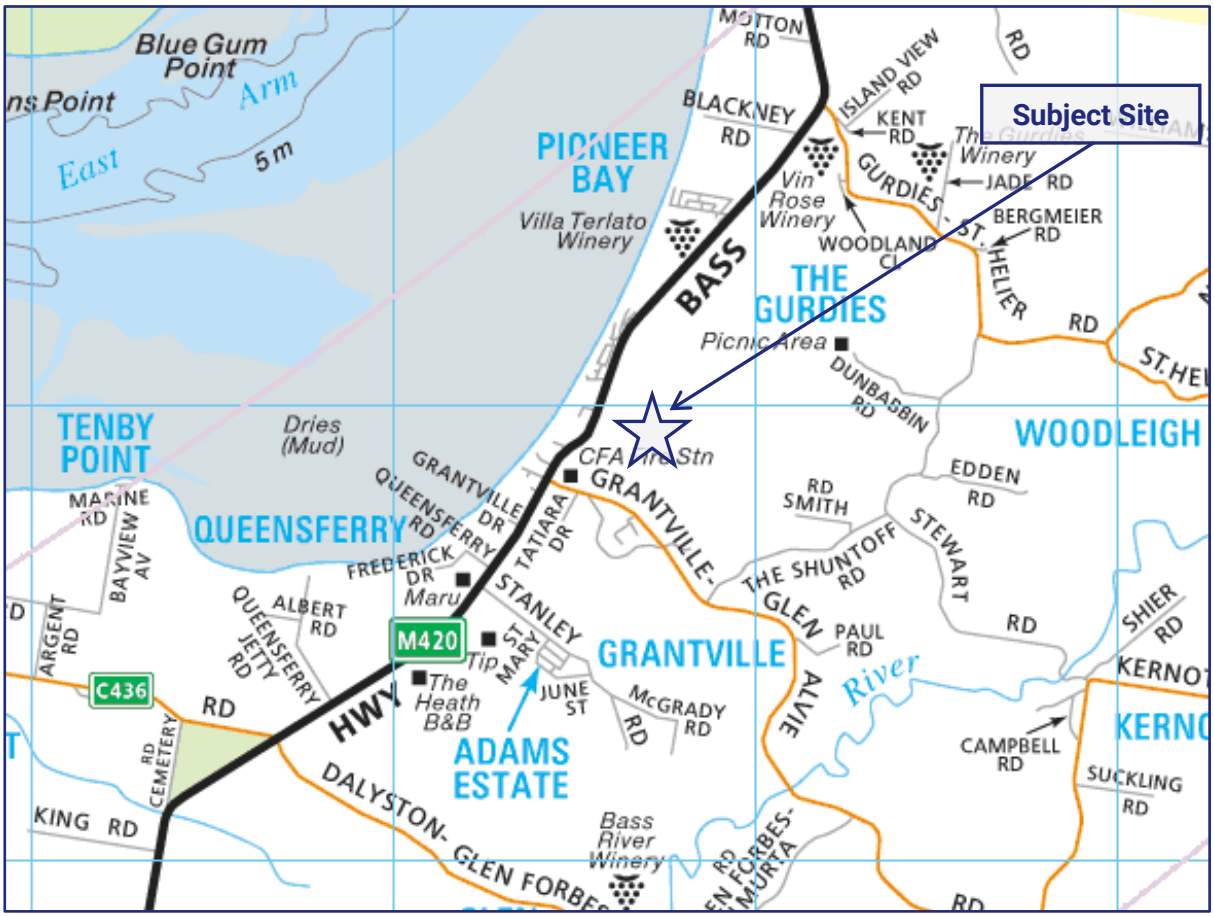


Figure 1: Locality Map

Reproduced with permission from Melway Publishing Pty Ltd

The subject site is currently occupied by Dandy Premix Pty Ltd for the quarrying of sand and production of cement mix.

The site's frontage and intersection with Bass Highway is shown in Figure 2 below.



Figure 2: Aerial Photograph

2.2. Land Use

The subject site is zoned Farm Zone, as is the majority of the land in the vicinity, east of Bass Highway.

The site is also affected by a Bushfire Management Overlay (BMO).

Other significant land uses include:

- Residential dwellings on the west side of Bass Highway including 145 lots accessed via Deep Creek Street and Bonney Road.
- Public Conservation and Resource Zone further to the northwest and south-east, and
- Public Park and Recreation Zone further to the west.

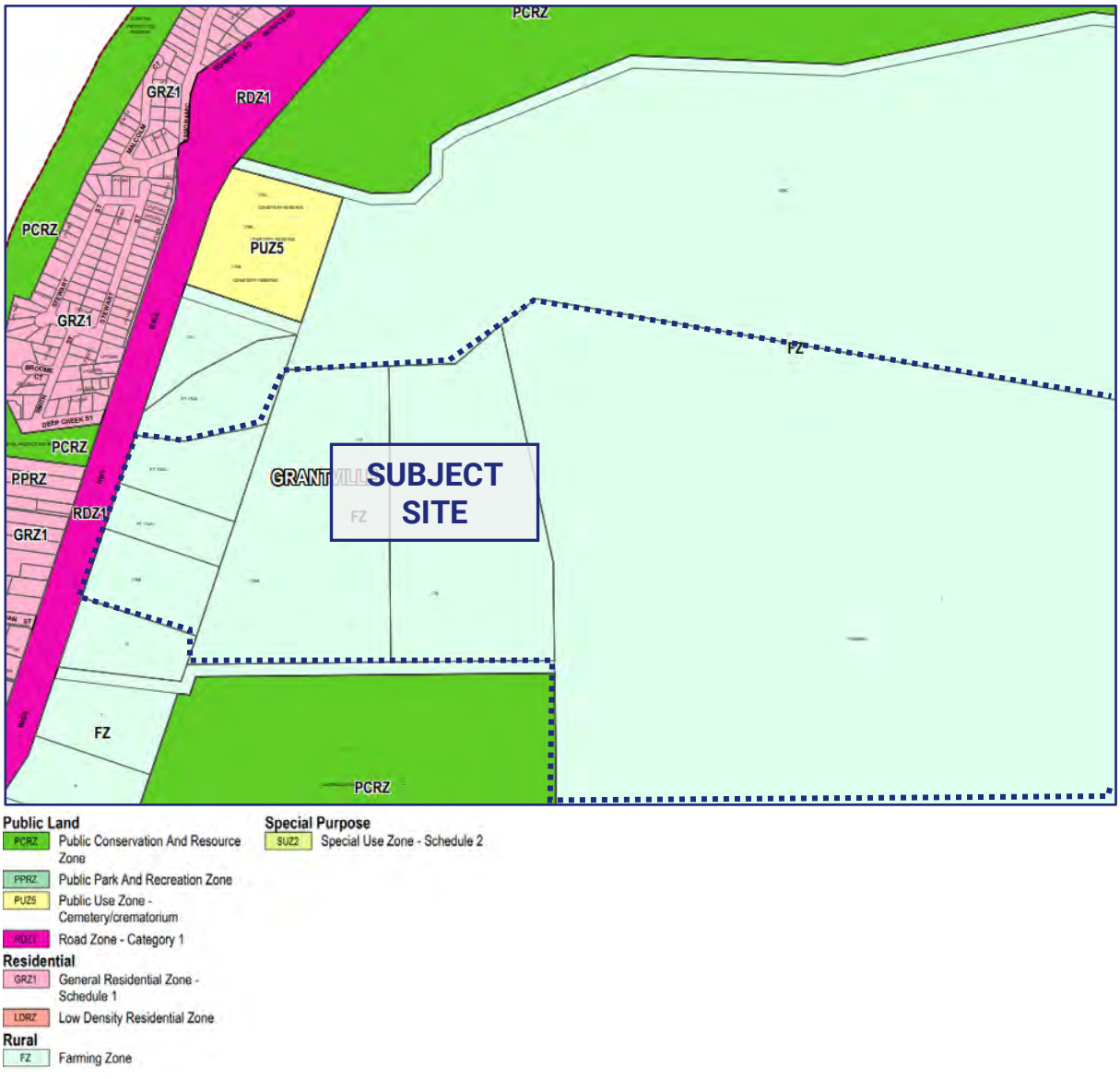


Figure 3: Land Use Zoning Map

2.3. Road Network

Bass Highway is a Road Zone Category 1 road extending south from the South Gippsland Highway along the Bass Coast through Wonthaggi and Inverloch before heading inland to Leongatha.

In the vicinity of the site Bass Highway is constructed with a dual carriageway, each carrying two lanes of traffic, separated by a narrow median.

A posted speed limit of 100km/h applies to Bass Highway in the vicinity of the subject site.

2.4. Existing Traffic Volumes

Traffix Group has undertaken traffic volume counts in October/November, 2017 to determine the extent of traffic along Bass Highway and turning to and from the subject site.

The data showed an average weekday two-way traffic volume of 12,772 vehicles (6,336 southbound and 6,154 northbound) along Bass Highway and 100 movements to/from the subject site (50 entry and 50 exit).

The weekday peak periods are shown in Figure 4 below.

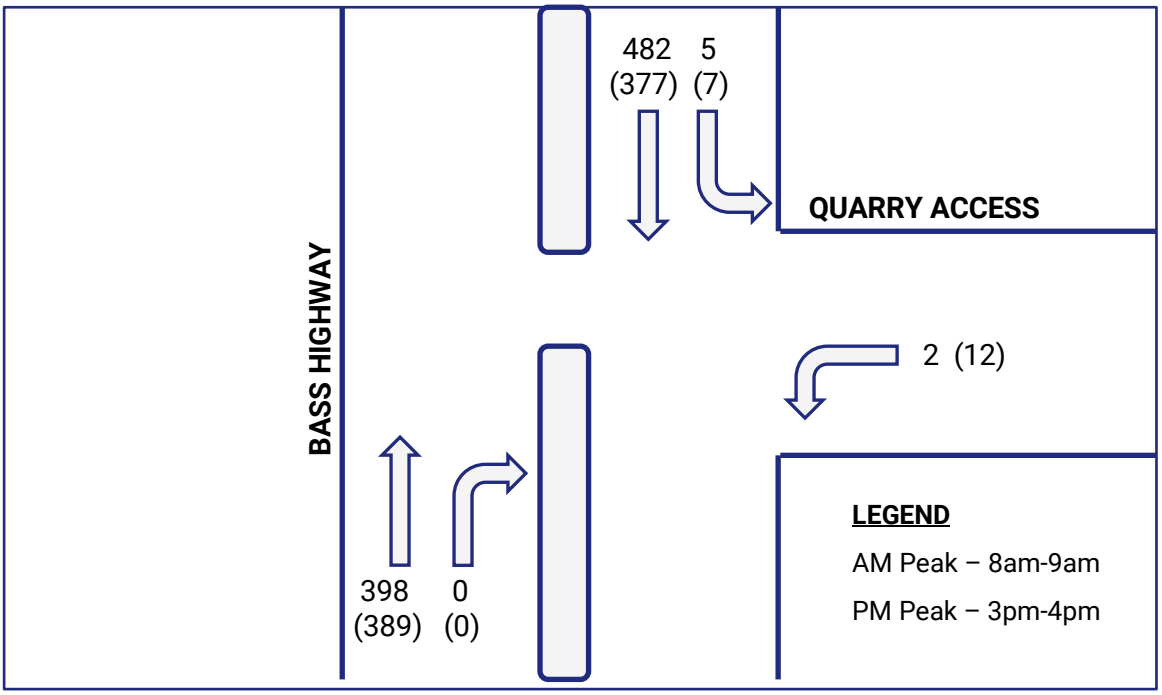


Figure 4: Existing AM & PM Peak Hour Traffic Movements

3. Proposal

The application is for an expanded material extraction use of the subject site.

The proposed works and new uses to be undertaken include:

- Further development of the existing Fine Medium Sand Extraction Pit (FMSEP),
- Extraction of Fine Medium Sands from below Groundwater,
- Establishment of new Coarse Sand Extraction Pit (CSEP),
- Introduction of Sand Washing Plant (SWP),
- Introduction of Belt Press Dewatering Plant (BPDP).

It is forecast that Sales from the quarry will rise by approximately 50,000 tonne per year over the next six years (to 800,000 tonne per year).

The application also seeks to amend current permit conditions for this site which restrict the number of truck movements from 120 per day (60 IN and 60 OUT) to 240 per day (120 IN and 120 OUT).

A copy of the proposed site layout plan prepared by BCA Consulting (dated March, 2020) is attached at Appendix A.

4. Access Arrangements

The current permit originally incorporated a signalised access as shown on Traffix Design Drawing Number G13716A-03, attached at Appendix B.

As a result of a VCAT mediation, the signal arrangement was deferred and the subject site is currently configured with a left-IN/left-OUT and right-IN unsignalised intersection treatment at Bass Highway.

The permit mandates that all traffic turn left out of the site. Heavy vehicles (sand trucks) which have a destination towards Melbourne are required to travel through the township of Grantville to a wide median opening on the south side of town, undertake a U-turn and then travel northbound through Grantville again.

While the operation of this access was acceptable as an interim treatment while the quarry generated fewer truck movements a day, the expansion of the site creates an unnecessary and inappropriate number of truck movements through the Grantville township.

Traffix Group has prepared a safety review, attached at Appendix C, which further demonstrates from a safety perspective that the current arrangement does not represent a logical or practical outcome for either the applicant or the township.

Right-OUT movements would not be supported in an unsignalised arrangement due to the traffic volumes, configuration and speed along Bass Highway.

Accordingly, the proposed development includes the signalisation of the current access to remove the need for Melbourne bound trucks making a double pass through Grantville.

Significantly, the existing access arrangement is designed to be compatible with the original signal design layout.

5. Traffic Impact Assessment

5.1. Traffic Generation

The current operation of the site has permission to generate 120 truck movements each day.

As part of the proposal, and subject to forecast sales over the next 6-8 years, we are advised that the number of truck movements required to service the site may increase to 240 truck movements per day (120 IN and 120 OUT).

Accordingly, the additional works and uses proposed on this site may generate 120 additional truck movements per day.

We understand that the operation of the site does not have peak periods but instead operates consistently over the hours of operation throughout the day.

5.2. Traffic Distribution

We are advised that all of the site traffic is to and from the north, servicing the Melbourne supply area (MSA).

The current intersection arrangement does not allow for right-OUT movements.

This application includes provision to install traffic signals at the site's access to Bass Highway.

5.3. Traffic Impact

Traffix Group has undertaken an assessment of the current intersection with the future traffic volumes allowing for right-OUT movements.

To ensure that the operation of the intersection will work well into the future, a growth rate of 2% has been adopted for 10 years.

The analysis shows that there is no capacity for this movement to occur and right turning vehicles would be required to queue for an average of 6.5 minutes!

To allow for right-OUT movements, the access must be signalised. A summary of the SIDRA output for a signalised access arrangement is provided in Table 1 below.

Table 1: SIDRA Summary

Approach	Degree of Saturation	Average Delay (sec)	95th Percentile Queue (m)
South – Bass Highway	0.164	3.4 sec	28.9m
East – Site Access	0.195	71.3 sec	21.3m
North – Bass Highway	0.203	3.6 sec	37.3m

For signalised intersections, degrees of saturation up to 0.9 are considered to be good operating conditions.

With signals, each approach has a degree of saturation significantly less than 0.9 and accordingly, the intersection will operate with very good operating characteristics.

We note that the signals would be activated by a loop sensor on the quarry approaches (right-IN and right-OUT), which would mean that delays to through traffic would be minimal.

In order to mitigate the risks for a new signalised intersection at this location, we recommend that the speed limit of 80km/h be extended to north of the subject site.

5.4. Additional Benefits

We note that a bus stop exists on the eastern side of the Bass Highway, to the south of the existing intersection. The stop is serviced by a V-line coach offering services between Cowes and Melbourne and Inverloch and Melbourne – via Koo-Wee-Rup and Dandenong and operates eight times per day on weekdays with a reduced number of services on the weekend. Additionally, we understand that the stop is used by school bus services and that a number of school children residing in the residential areas on the western side of Bass Highway use these services.

The provision of a signalised intersection at this location would have significant safety benefits for pedestrians accessing the bus stop, as it would provide a signalised pedestrian crossing where pedestrians are currently required to cross unaided.

In addition, the signals would be able to provide controlled egress for the Bass Highway Service Road on the west side of the highway.

Furthermore, we note that the proposed signalised intersection would provide additional gaps in highway traffic for vehicles exiting the residential community at Deep Creek Street allowing them to access the highway with greater ease. We note that this is especially beneficial as most local traffic would be heading south towards Grantville and hence be required to make a right turn across the northbound carriageway.

6. Conclusion

Having undertaken a detailed traffic engineering assessment for the proposed quarry expansion at 1381 Bass Highway, Grantville, we are of the opinion that:

a) the previously proposed signals at the site access to Bass Highway should now be installed,

b) the provision of a signalised access with Bass Highway will facilitate all turning movements and is a necessary arrangement to remove heavy vehicle traffic from the Grantville township,

c) the site may generate up to 120 additional heavy vehicle movements per day,

d) the majority of traffic is to and from the north which emphasises the importance of having a controlled right-OUT movement onto Bass Highway, thereby removing in excess of 100 daily truck movements from the Grantville township,

e) the traffic generated by the subject site can be easily accommodated by the provision of a signalised intersection and the existing road network,

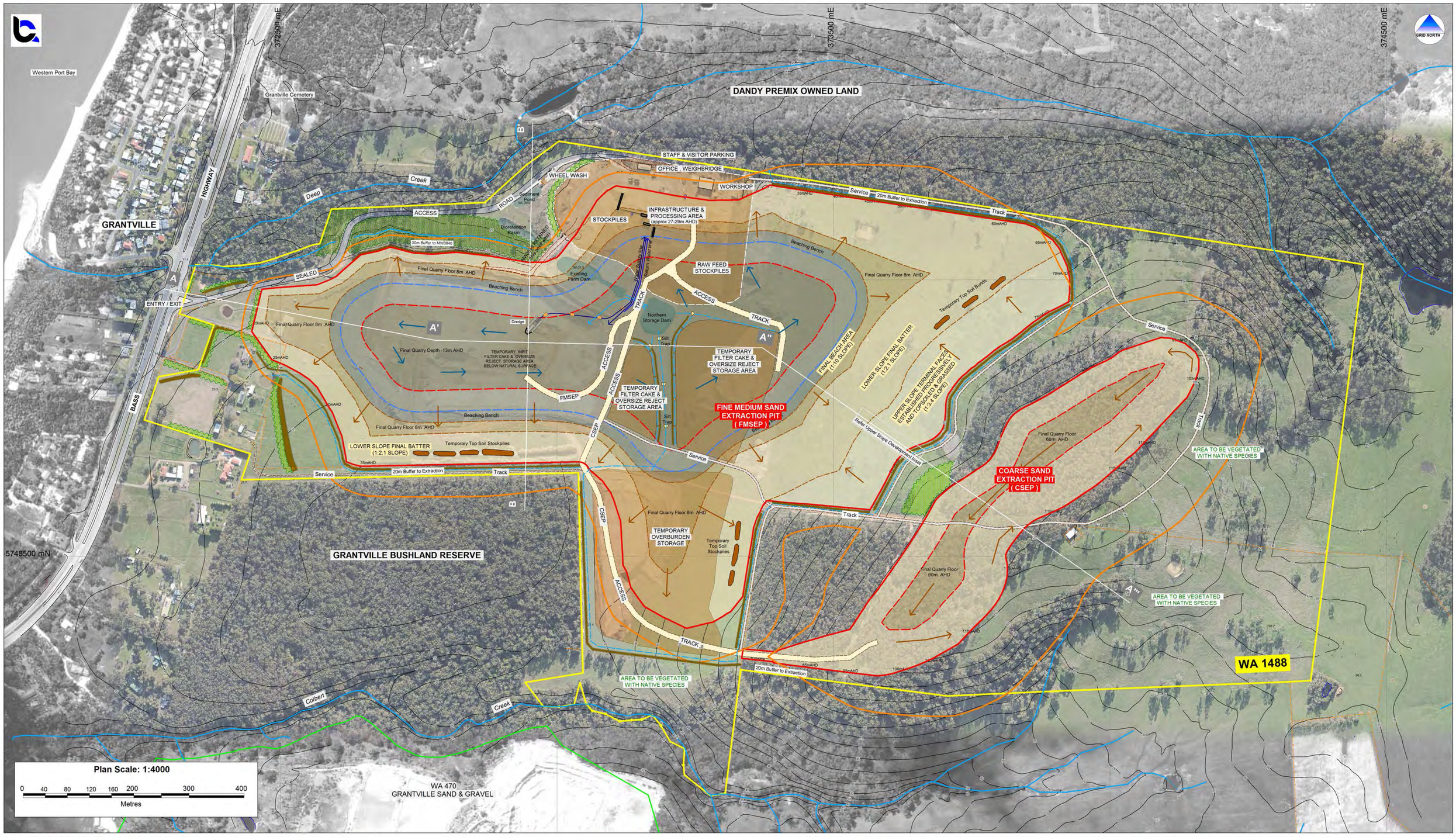
f) the signalised intersection will enable the provision of a signalised pedestrian crossing of Bass Highway,

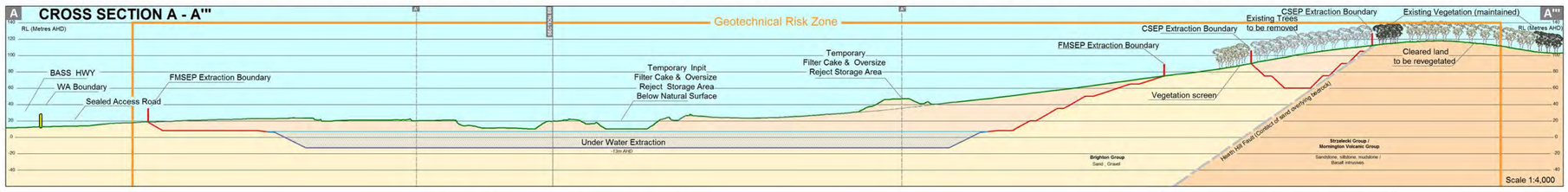
g) the signalised intersection will assist movements from the Bass Highway Service Road by providing a separate phase for the west approach, and

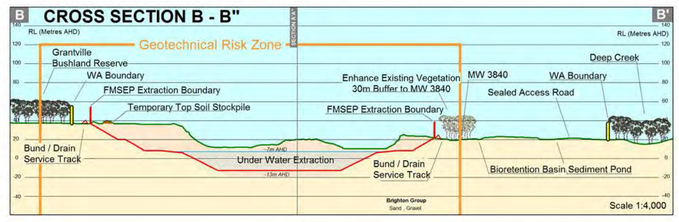
h) there are no traffic engineering reasons why a planning permit for the proposed quarry expansion at 1381 Bass Highway, Grantville, should be not be granted.

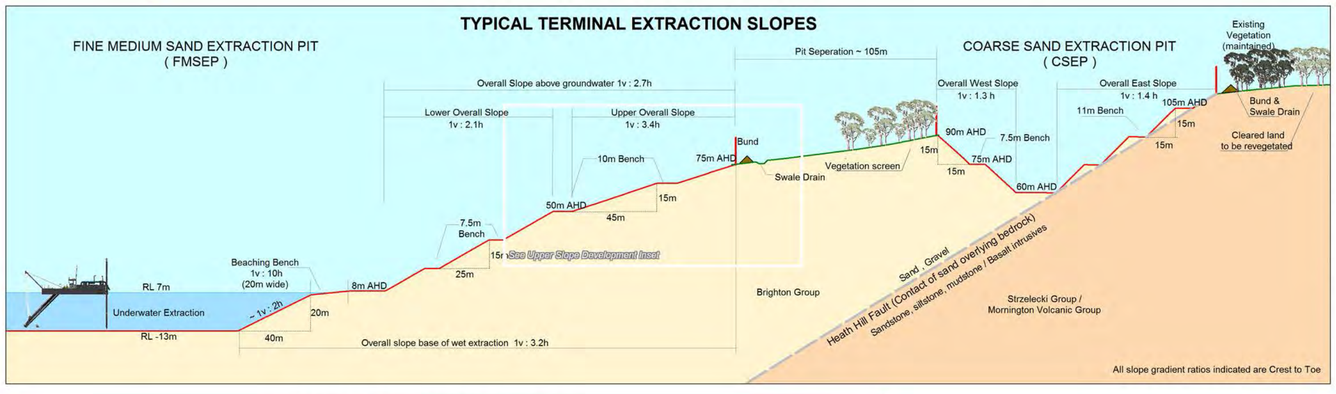
Appendix A

Site Plan









WA 1488 BOUNDARY COORDINATES

GDA 94, MGA Zone 55

Number	Easting	Northing
1	374458	5749027
2	374308	5749051
3	374032	5749094
4	373453	5749181
5	373003	5749251
6	372944	5749207
7	372870	5749140
8	372592	5749128
9	372571	5749066
10	372486	5749037
11	372430	5749027
12	372382	5749026
13	372347	5749028
14	372318	5748939
15	372380	5748918
16	372352	5748838
17	372280	5748825
18	372254	5748747
19	372446	5748686
20	372430	5748639
21	373039	5748651
22	373044	5748429
23	373047	5748289
24	372942	5748272
25	372976	5748229
26	373031	5748232
27	373042	5748272
28	373053	5748234
29	373113	5748202
30	373172	5748213
31	373205	5748165
32	373231	5748153
33	373230	5748105
34	373278	5748067
35	373304	5748072
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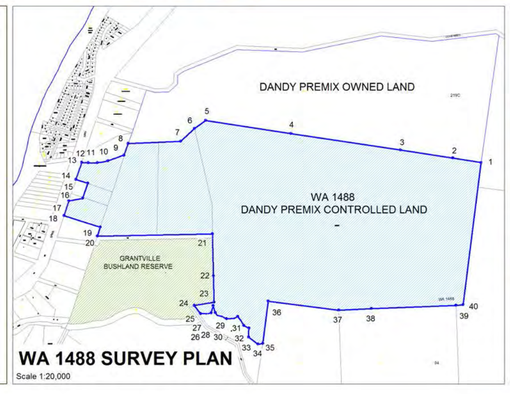
38	373878	5748256
39	374325	5748274
40	374363	5748276

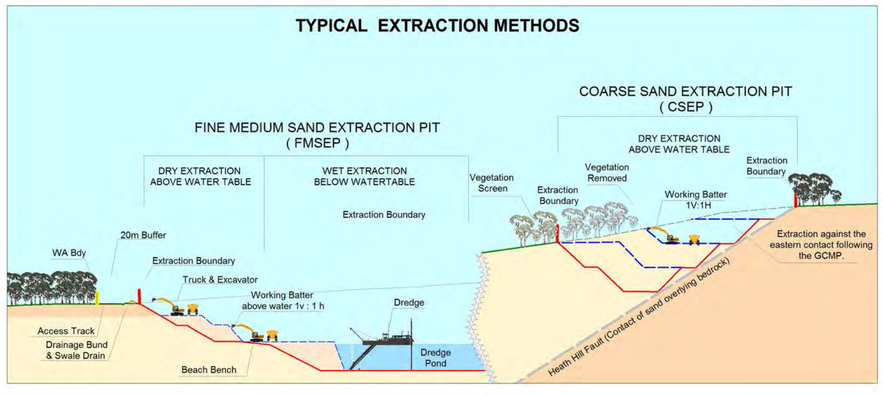


LEGEND

- WA 1488 BOUNDARY
- WORK AUTHORITIES
- EXTRACTION BOUNDARY
- TERMINAL FACE TOE
- MAXIMUM GRZ (Terminal Extraction Face Toe)
- ACCESS TRACK (Operations HV & Light Vehicles)
- SERVICE TRACK (Light Vehicles & Occasional HV)
- GENERAL DIRECTION (of Working Dry Extraction)
- GENERAL DIRECTION (of Working Wet Extraction)
- WATER WAYS
- DRAINS
- BUND & SWALE DRAIN
- FENCE
- INDEX CONTOUR
- SPOT HEIGHT
- GRID COORDINATES (GDA 94, MGA ZONE 55)
- CROSS SECTION LINES
- EXISTING VEGETATION TO BE REMOVED
- ESTABLISHING REVEGETATION
- EXISTING VEGETATION & ESTABLISHED REVEGETATION
- VISUAL SCREENING PLANTING
- RETAINED VEGETATION AND ENHANCED

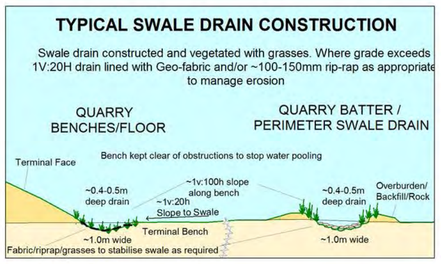
BATTER AREAS

- CSEP
- FMSEP - UPPER SLOPE
- FMSEP - LOWER SLOPE
- FMSEP - BEACHING
- FMSEP - BELOW WATER



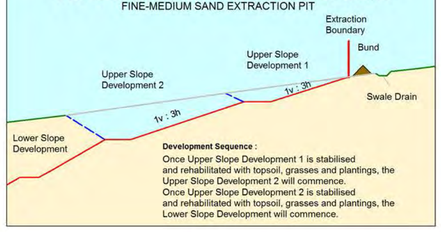
TYPICAL SWALE DRAIN CONSTRUCTION

Swale drain constructed and vegetated with grasses. Where grade exceeds 1V:20H drain lined with Geo-fabric and/or ~100-150mm rip-rap as appropriate to manage erosion



TYPICAL UPPER SLOPE DEVELOPMENT

FINE-MEDIUM SAND EXTRACTION PIT



Development Sequence :

Once Upper Slope Development 1 is stabilised and rehabilitated with topsoil, grasses and plantings, the Upper Slope Development 2 will commence.
Once Upper Slope Development 2 is stabilised and rehabilitated with topsoil, grasses and plantings, the Lower Slope Development will commence.

DANDY PREMIX QUARRIES PTY LTD
PO Box 4112, Dandenong South, VIC 3164
Ph 9703 8222
info@dandypremix.com

Extractive Industry Work Authority No: 1488

Grantville Sand Quarry, GRANTVILLE

SITE LAYOUT PLAN

Author: AJM Date:2/03/2020	Drawing: NS - 1903 : Rev 1
Survey Source: Landair Surveys	
Orthophoto Date 30/6/19, Google, undated	**Project No: D10_003**
Projection: MGA Zone 55 (GDA 94)	**Figure: 3**
WA1488_Fig3_SiteLayoutPlanR1.WOR	

BCA CONSULTING - Earth Resources | 29/41 Norcal Road Nunawading 3131
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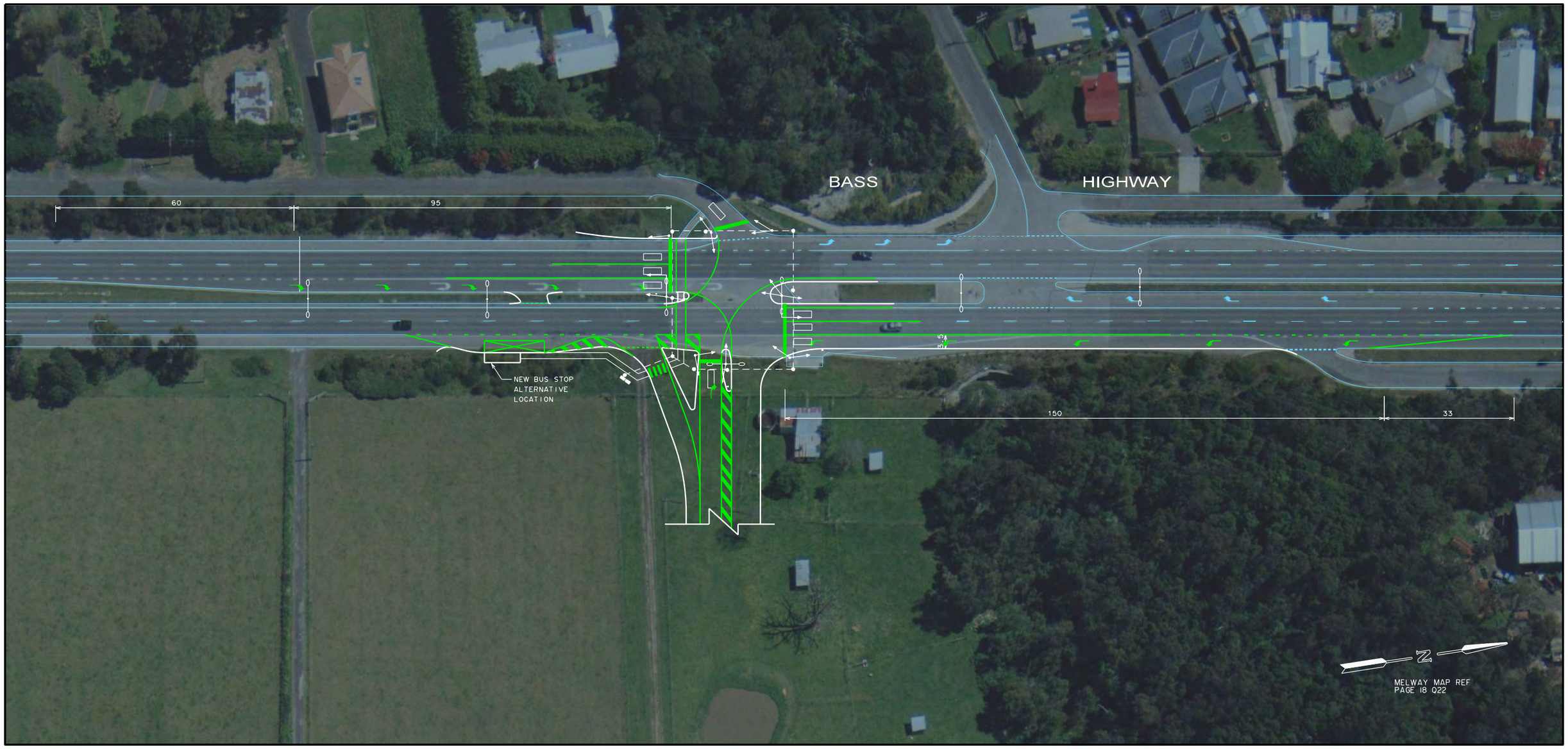
Appendix B

Signal Design Layout
(Traffix Design Drawing Number G13716A-03)



PRELIMINARY PLAN
FOR DISCUSSION PURPOSES ONLY

WARNING
BEWARE OF UNDERGROUND SERVICES
The locations of underground services shown are approximate only and their exact position should be proven on site.

REVISION	REVISION NOTES	REVISION DATE

GENERAL NOTES
1. BASE INFORMATION FROM AERIAL PHOTOGRAPHY AND SITE INSPECTION.
2. MAIN ROAD - BASS HIGHWAY (SPEED ZONE 100km/h).

DESIGNED
G. RAKITA 26 SEPTEMBER 2012

CHECKED/APPROVED
H. TURNBULL 26 SEPTEMBER 2012

FILE NAME
G13716.dgn

ISSUE
A

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1393-1395 BASS HIGHWAY
GRANTVILLE
BASS COAST SHIRE COUNCIL
FUNCTIONAL LAYOUT PLAN - OPTION 3

SCALE 0 5 10 15 20

SHEET No.

DWG No. G13716A-03

Appendix C

Safety Review

Traffix Group

To:	Dandy Premix Quarries	From:	Ross Thomson (Traffix Group)
Our Ref:	G23730M-02A	Date:	Thursday 21st May, 2020

1381-1395 Bass Highway, Grantville – Safety Review of Access Arrangements

Introduction

Dandy Premix Quarries operates a commercial sand quarry facility at 1381-1395 Bass Highway, Grantville, located approximately 1km to the north of the Grantville Township.

Access to the quarry is currently provided via an unsignalised intersection permitting left and right turn entry movements as well as left turn exit movements as seen in the aerial photograph below.



Existing Site Access

Trucks wishing to turn right to exit the quarry to head towards the Melbourne supply area (MSA) are currently required to detour approximately 4.5km to the south-west, through the other side of the Grantville township, where there is a U-turn facility provided which is suitable to accommodate large trucks. This involves a total additional travel distance of approximately 9km for the round trip resulting in an additional travel time of approximately 17 minutes.

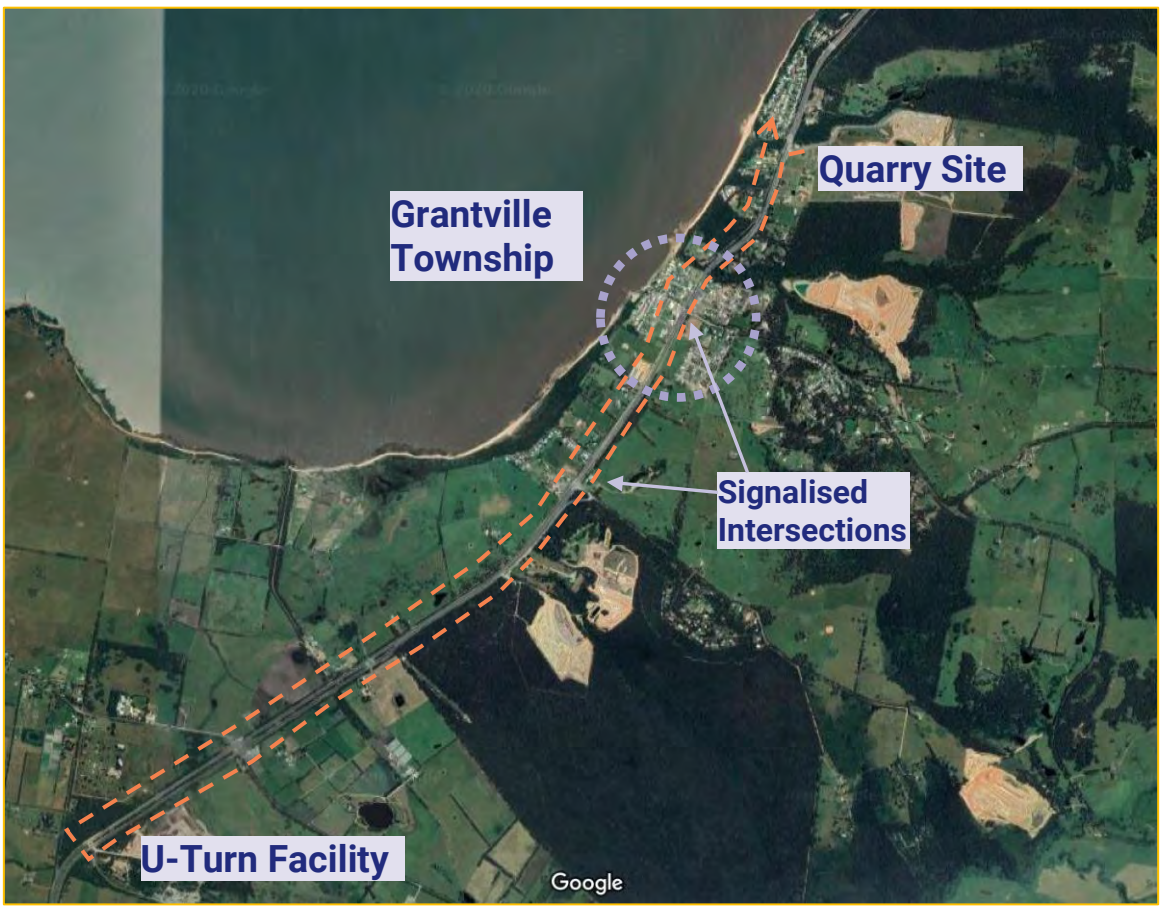
Traffix Group has been requested to review the safety of the existing access arrangement compared to an alternative scenario whereby traffic signals are installed directly at the quarry access enabling a direct right turn movement onto Bass Highway.

Existing Conditions

We understand that the quarry site currently operates between the hours of 6am and 6pm with an average of 100 truck movements per day, including 50 entry movements and 50 exit movements. With all of trucks exiting the site towards Melbourne, this results in 50 truck movements undertaking the 9km detour, 50 truck movements in each direction through the Grantville township.

In the future we understand that production at the quarry will increase and that up to 240 truck movements are expected per day including 120 in each direction and 240 additional movements through the Grantville township associated with the required U-turn movement.

A diagram illustrating the route of the 9km truck detour is presented on the aerial photograph below.



Existing Truck Detour Route

The detour route requires trucks to travel past the following locations and perform the following tasks:

- Travel twice through the Grantville township where there are risks of conflicts with pedestrians and local traffic within the township,
- Travel twice through signalised intersections at Pier Road/Grantville-Glen Alvie Road and Stanley Road where there are risks associated with rear-end collisions and intersection crashes,

- Perform a U-turn at an uncontrolled median opening where U-Turning vehicles must wait for gaps in traffic in the northbound carriageway within a 100km/h speed zone,
- Travel twice past six uncontrolled median openings along Bass Highway between the quarry site and the U-Turn facility where there are risks associated with intersection crashes, and
- Travel past one unsignalised side road intersection on the eastern side of the Bass Highway southbound carriageway and seven unsignalised side road intersections on the western side of the northbound carriageway.

At each of these above locations there is an increased risk of collisions occurring that would results in serious injury on account of increased exposure to heavy vehicle movements along Bass Highway, with the increased risk at the unsignalised U-turn facility and the increased risk to pedestrians within the Grantville township considered to represent the greatest overall risk.

Alternative Treatment

The alternative treatment involving a signalised right turn movement directly at the quarry access to Bass Highway would eliminate all the existing increased road safety risks identified above, with the only increase in risk being confined to the signalised intersection itself. The main risks at this signalised intersection would be confined to the risk of additional rear end collisions on Bass Highway and intersection type crashes if a vehicle were to proceed through a red signal.

Risks at the signalised intersection could be mitigated by reducing the speed limit on Bass Highway to 80km/h through the intersection, increasing the length of the existing 80km/h speed limit which applies through the township to the south and ensuring that the right turn exit movement from the site operates during a separate phase, i.e. not associated with the service road exit opposite.

If a Safe System Assessment were to be undertaken comparing the alternative treatment with the existing conditions incorporating the unsignalised U-turn movement and detour route through Grantville township, we are confident that the alternative treatment incorporating the signalised intersection would produce a lower score and would therefore present the preferred outcome from a safety perspective.

The signalised option would also be consistent with other quarries that operate in the area including:

- the Grantville Landfill site to the south of the Grantville township which has signalised access via Stanley Road,
- the Grantville Sand and Gravel site on Grantville-Glen Alvie Road which has access via the signals within the township, and
- the Sand Supplies site at 1113 Bass Highway which has direct access to Bass Highway via its own set of signals to the north of the township.

We trust that these comments are of assistance. Should you have any questions or require further information in relation to this matter please contact Ross Thomson at the Traffix Group offices.

TRAFFIX GROUP PTY LTD



ROSS THOMSON
SENIOR ASSOCIATE/SENIOR ROAD SAFETY AUDITOR

REPORT 6 – NOISE EMISSION ASSESSMENT

WatsonMossGrowcott Acoustics

CONSULTANTS: ACOUSTICS, NOISE & VIBRATION CONTROL

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GRANTVILLE COMMERCIAL SANDS QUARRY WA 1488

1381-1395 BASS HIGHWAY GRANTVILLE

Proposed Work Plan Variation

Noise Emission Assessment

A report prepared for:

Dandy Premix Quarries Pty Ltd
21-23 Bennet Street
Dandenong South, VIC 3164

Ref. 12460-1.1ng.docx
16 December 2019

EXECUTIVE SUMMARY

Watson Moss Growcott Acoustics Pty Ltd (WMG) has been engaged to carry out an assessment of noise emissions associated with the proposed further development of the extraction area at the Dandy Premix Quarries Pty Ltd (T/a Grantville Commercial Sands) quarry, 1381-1395 Bass Highway Grantville, Work Authority No.1488 (WA1488).

The assessment is required as part of the approvals process for the proposed further development of the quarry sand extraction areas within the approved WA1488 site and the introduction of sand washing.

The proposed further development of the extraction area will involve extraction further towards the east than the current Work Plan approved extent, meaning that the assessment includes residential premises further to the east than was the case with the original assessment in relation to commencement of the quarry.

The extraction areas development proposal covered by the Work Plan Variation (WPV) application also includes deepening the existing fine medium sand extraction pit (FMSEP) to below the water table, with wet sand extraction utilising a cutter suction dredge. This will also require a new wet sand processing plant and a dewatering plant.

Noise constraints under EPA publication 1141 *NOISE FROM INDUSTRY IN REGIONAL VICTORIA* (NIRV) were determined for residential premises in the vicinity of the western extent of the quarry site during the noise assessment work for the quarry commencement. These have been reviewed and revised in response to an increase in the ambient background noise levels that has occurred since the initial noise assessment was conducted in 2012. NIRV Recommended Maximum Noise Levels for residential premises further to the east have also been determined as part of the current assessment.

A three-dimensional noise model for the site has been developed, which has been used to assess compliance with the noise limits at residential receptors and determine operational strategies to allow the proposed quarry pit extension to proceed in compliance with the noise constraints.

It has been found that by implementation of minimal operational strategies the proposed extension of the quarry extraction areas and installation of additional processing plant can be implemented while remaining in compliance with the NIRV RMNLs.

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1. INTRODUCTION

Watson Moss Growcott Acoustics Pty Ltd (WMG) has been engaged to carry out an assessment of noise emissions associated with the proposed Work Plan Variation (WPV) for further development of extraction activities within the approved WA1488 site and the introduction of sand washing at the Grantville Commercial Sands quarry, 1381-1395 Bass Highway Grantville.

The proposed extraction areas will move the quarry extraction activities further towards the east than its currently approved extent, meaning that the assessment includes residential premises further to the east than was the case with the original assessment in relation to commencement of the quarry in 2013.

The proposal is also to include deepening the FMSEP to below the water table, with wet sand extraction utilising a cutter suction dredge. This will also require a new wet sand processing plant and a dewatering plant.

The assessment is required as part of the WPV approvals process for the proposed further development and sand washing at the WA1488 site.

Noise emission to residential premises has been considered in terms of EPA publication 1141 *NOISE FROM INDUSTRY IN REGIONAL VICTORIA* (NIRV). NIRV sets Recommended Maximum Noise Levels (RMNLs) for residential premises.

WMG prepared a noise emission assessment in 2012 as part of the approvals process for the commencement of the quarry. NIRV RMNLs were determined for relevant residential premises in the vicinity of the western extent of the initial quarry and those RMNLs have been used in the current assessment.

NIRV RMNLs have also been determined for residential premises further to the east as part of this assessment and noise modelling has been extended to include these residential receptors.

This report sets out the methodology and findings of the noise assessment and covers the following aspects:

- Determination of NIRV RMNLs for residential premises;
- Prediction of noise levels at potentially affected residential locations resulting from the proposed extension of the quarry extraction area, using a three-dimensional noise modelling software package;
- Consideration of appropriate noise mitigation strategies in order to achieve compliance with the NIRV RMNLs for residential premises.

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2. NOISE ASSESSMENT TERMINOLOGY

The following terms are used in this report:

dB(A) Decibels recorded on a sound level meter, which has had its frequency response modified electronically to an international standard, to quantify the average human loudness response to sounds of different character.

L_{90} the level exceeded for 90% of a measurement period, The L90 value will be representative of the typical lower levels in a varying noise environment. It is the noise measure defined by the EPA as the measure of the ambient background noise level and can be used in determining noise limits. In reviewing noise logging results, the L90 also provides an indication of the more constant noise levels over which more variable higher levels occur.

L_{eq} the equivalent continuous level will be a single value descriptor of a noise level varying in level with time. The Leq value will have the same total acoustic energy over the measurement period as the actual varying noise level under consideration. It is the noise measure defined by the EPA as the measure of the noise to use in assessing compliance with noise limits.

In short, L_{90} is the measure of background noise (in the absence of industrial noise) used in determining noise limits, and L_{eq} is the measure of commercial noise used in assessing compliance with noise limits.

3. LOCALITY AND BACKGROUND INFORMATION REGARDING NOISE ASSESSMENT

The Grantville Commercial Sands Quarry is located at 1381–1395 Bass Highway Grantville.

A plan of the site showing the proposed extended extraction area appears in Appendix One. This plan has been annotated with residential locations to the east of the subject site that were not considered in the assessment for the initial quarry extent in 2012 but have been considered in this assessment as the proposed extraction area extends significantly further to the east than the initial extraction area.

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4. QUARRY OPERATING REGIME

The quarry operating regime is defined by the current Bass Coast Shire Council Planning Permit No.120388.

Permitted 'Hours of Operation' are on Page 4 of the Permit, the following being particularly relevant in relation to the relevant equipment with the potential to emit noise to off-site locations:

- Extraction (Excavators, Bulldozers, etc.):
  - 7.00am to 6.00pm Monday to Friday
  - 7.00am to 1.00pm Saturday
- Processing (Plant Operations):
  - 6.00am to 6.00pm Monday to Friday
  - 6.00am to 1.00pm Saturday

Some parts of the combined Wash Plant and Dewatering Plant will be required to 'run on' after 6.00pm Monday to Friday and 1.00pm Saturday to meet the processing requirements. These are:

- 18m Diameter, 5m high Water Clarifier/Mud Thickener - Rake Mechanism with approx. 20hp Transmission Drive in Clarifier/Thickener, 1 x Radial Slurry Pump & Motor, plus minimum 2 x Electric Motor Gland Type Water Pumps
- Mud Buffer Tanks - 1 x Helical Rotor Pump to deliver 'liquid sludge' to Belt Press and Electric Motor to drive Stirrers and Baffles
- Polymer Make-up and Dosing Unit - 1 x Helical Rotor Pump and Electric Motor to pump Mud to Belt Press and 1 x Pump and Electric Motor to drive Stirrers and Baffles with Mud Buffer Tank
- Return Water Tank - Total of 7 x Electric Motor Pumps of which Six (6) could be running in 'run on' time – Polymer Dilution, Thickener Water, Dilution Water, Overflow from Fresh Water Tank to Return Water Tank, Recycled Water to Dredge Pond & Wash Down Water
- Belt Press & In-Ground Sump - Further to associated Mud Buffer Tank(s), Polymer Make-up & Dosing, Return Water Tank pumps and motors listed above, also requires 3 x (Approx.) 4.0kW Electric Motors for initial Reaction Chamber, then Belt Drive System, plus 1 x Belt Washing pump and Electric Motor, approx. 18.5kW

Dewatering Belt Press Plant aside, the above elements of the 'Sand Wash Plant' required to 'run on' in conjunction with (part of) the Dewatering Belt Press Plant are essentially electric motor pumps to move fresh dilution water, liquid sludge, return water, polymer dosing and make-up, dewatered cake from the Belt Press, recycled water to Dredge Pond and plant wash-down water.

The daily 'run on time' for the Clarifier/Thickener, Mud Buffer Tanks and Dewatering Belt Press is estimated at 8 hours per operating day, i.e. 6.00pm to 2.00am Monday to Friday and 1.00pm to 10.00pm Saturday.

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Unlike the actual Sand washing process (scalping screen, cyclone cuts to particle size, washing, dewater screens, etc.), the 'run on' operations are comparatively "quiet" by nature and operation, essentially electric motors on pumps.

With regard to extraction, the coarse sand extraction pit (CSEP) area is the most easterly and at the highest elevation, therefore potentially most exposed to the residences east of the site. It is proposed to work this area towards the north east extent in a manner that means excavators and trucks are always operating below the natural surface to take advantage of topographical shielding, and to then work back towards the south west. This is illustrated in the figure below.

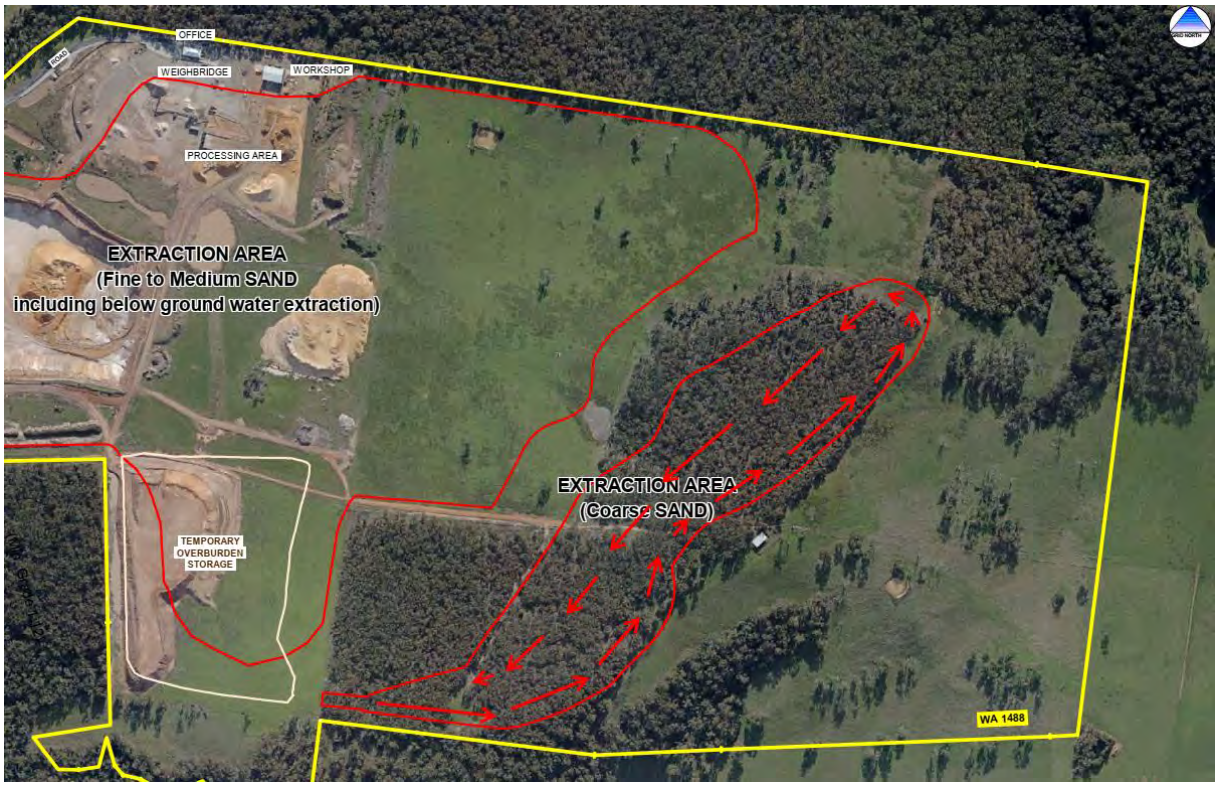

Figure 1: Proposed method of working the elevated coarse sand extraction area to provide acoustic shielding of extraction operations

Targeted productions rates equate to approximately 100 trucks per day exiting the site. Averaged over the 16 hours from 6am to 10pm this would be just over 6 per hour, but up to 10 per hour has been allowed for in the modelling to reflect an uneven distribution over the course of a day. 10 trucks leaving the site per hour implies 20 movements along the access road.

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5. NOISE CRITERIA

5.1 *NOISE FROM INDUSTRY IN REGIONAL VICTORIA* (NIRV)

When considering noise emissions associated with the existing operations and the proposed additional plant and extraction areas at the subject site, resultant noise levels at residential receptors are considered in accordance with the following guideline and policy:

- *Environment Protection Authority Publication 1411 Noise from Industry in Regional Victoria – Recommended Maximum Noise Levels from Commerce, Industry and Trade Premises in Regional Victoria (NIRV); and*
- *State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1 (SEPP N-1).*

The NIRV document was introduced in 2011 to provide guidance on suitable noise emission assessment criteria for regional areas within Victoria but outside Metropolitan Melbourne.

The Grantville Commercial Sands quarry when it first commenced was one of the first quarries to be assessed in accordance with NIRV. The quarry has remained in compliance with the NIRV RMNLs since its inception.

SEPP N-1 is applicable within Metropolitan Melbourne, but is also a reference document for NIRV, providing noise assessment methodologies.

Under the noise assessment procedures set out in NIRV, recommended maximum noise levels are set using State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N-1 (SEPP N-1) within the Urban Centre Boundaries of major urban centres in Victoria (defined as a population greater than 7000).

In areas outside Urban Centre Boundaries, NIRV sets out specific procedures for determining the Recommended Maximum Noise Levels (RMNLs) for General Commerce Industry and Trade, with a separate procedure for Earth Resources, which is applicable for the sand quarry under consideration.

For Earth Resources projects, the NIRV RMNLs are determined based on the Planning Scheme land use zonings of the noise sensitive residential receptors. Using NIRV methodology, RMNLs vary depending on the time of the day, evening or night, with the highest permitted values typically occurring during week daytimes, and the lowest during the night period.

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The relevant EPA-defined 'day', 'evening', and 'night' assessment periods are shown in the table below.

Table 1: EPA Assessment Periods

EPA Assessment Period	Relevant Days	Relevant Time Periods
'Day'	Monday to Friday	7:00am to 6:00pm
	Saturday	7:00am to 1:00pm
'Evening'	Saturday	1:00pm to 6:00pm
	Sunday, Public Holidays	7:00am to 6:00pm
	All Days	6:00pm to 10:00pm
'Night'	All Days	10:00pm to 7:00am

In 'background relevant areas' where background levels may be higher than usual for a rural area, the background level can also influence the RMNLs. 'Background-relevant areas' are typically near major roads or the coast, locations which include ongoing sources of ambient noise. The residences along the Bass Hwy which were the focus of the original assessment conducted in 2012 are in a 'background relevant area'.

Derivation of the RMNLs for the residences west of the subject site, which are subject to noise from the nearby Bass Highway, takes into account planning scheme zonings and ambient background noise, with a final check related to the traffic noise environment.

The NIRV RMNLs for the residences on both sides of the Bass Hwy west of the subject site were determined during the 2012 assessment. At that time the hours of operation for the quarry were 6am to 6pm Monday to Friday (7am to 6pm for extraction) and 7am to 1pm Saturday.

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The table below summarises the NIRV RMNLs determined in 2012, noting that the evening period from 6pm to 10pm Monday to Friday was not included at that time.

Table 2: Summary of Derived Recommended Maximum Noise Levels from the 2012 assessment

Residential Location/s	NIRV Recommended Maximum Noise Levels Determined in 2012, dB(A)	
	'Day' 7am-6pm Mon-Fri, 7am-1pm Sat	6am-7am Mon-Fri
Residences nearest to the quarry site, approximately 200m east of the highway, such as 1421B Bass Highway.	50	45
Residences in the vicinity of the highway, such as Deep Creek Street.	55	45

Compliance with the RMNLs is not relevant for properties in the ownership of the quarry proponents, which includes the residences at 1381, 1393 and 1395 Bass Highway.

The NIRV RMNLs at locations in the vicinity of the Bass Hwy have been reviewed on the basis of background noise levels measured in June 2019. This was done to check whether the passage of time has changed the background levels and therefore the RMNLs, and because the previously determined RMNLs did not include the evening period.

Background noise monitoring was carried out at the locations indicated Appendix Three. Graphs of the noise logging results are in Appendix Four.

Observations have indicated that noise from the quarry did not influence the ambient background noise level results, defined as the level exceeded for 90% of the time.

The tables below summarise the background levels obtained at 9 Deep Creek St west of the Bass Hwy and 1421B Bass Hwy east of the Bass Hwy during June 2019, and the subsequent NIRV RMNLs.

The lowest background level for each period obtained during a week of monitoring was used to determine the NIRV RMNLs, consistent with EPA practice.

Where the background level is high relative to the zone level, the Recommended Maximum Noise Level equals the background level plus 8 dB for the day period and background level plus 5 dB for the 'evening' and 'night' periods.

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Table 3: June 2019 background levels and NIRV RMNLs at 9 Deep Creek St west of the Bass Hwy

	Background noise level, dB(A) L_{90} in defined periods.			
9 Deep Creek St	'night'	'day'	'evening'	6am to 7am
Mon 24 June			43	
Tue 25 June	35	50	45	54
Wed 26 June	34	50	47	53
Thu 27 June	35	51	48	53
Fri 28 June	35	50	48	50
Sat 29 June	41	53	54	46
Sun 30 June	50		52	51
Minimum	34	50	43	46
NIRV RMNL	39	58	48	51

Table 4: June 2019 background levels and NIRV RMNLs at 1421B Bass Hwy east of the Bass Hwy

	Background noise level, dB(A) L_{90} in defined periods.			
1421B Bass Hwy	'night'	'day'	'evening'	6am to 7am
Mon 24 June			47	
Tue 25 June	40	49	48	55
Wed 26 June	40	50	49	55
Thu 27 June	42	52	49	56
Fri 28 June	42	53	51	53
Sat 29 June	44	53	54	47
Sun 30 June	48		55	49
Minimum	40	49	47	47
NIRV RMNL	45	57	52	52

The ‘day’ and ‘6am to 7am’ results were within 1 dB of each other at the two locations and there was a 4 dB(A) difference during the ‘evening’ period. This difference is likely to be due to faunal noise associated with the dam at 1421B Bass Hwy, which may not be present all the time.

Taking the lower of the two for each time period gives NIRV RMNLs of 57 dB(A) for the ‘day’ period, 48 dB(A) for the ‘evening’ and 51 dB(A) for 6am to 7am.

The higher figure obtained for 6am to 7am is a reflection of the very steep increase in the noise level commonly found near main roads between 4am and 7am.

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For any processing plant sources that may operate further into the night period such as the belt press, the noise limit over the whole of the night period would be 39 dB(A).

The assessment of noise emission from the quarry is made using the L_{eq} noise measure. The ambient L_{eq} due to the Bass Highway traffic noise is at times higher than the derived recommended maximum noise level at some locations, as indicated in the graphical noise monitoring results included in Appendix Four.

This indicates a high level of protection of residential amenity by the NIRV RMNLs, but also indicates that assessment of compliance with the RMNLs would be difficult in the ambient noise environment. This is consistent with the objective of noise criteria, which is to have noise due to commercial, industrial or trade sources 'blend in with' and not dominate the ambient noise environment.

The residences to the east of the subject site are not subject to elevated background noise levels associated with the Bass Highway, so the NIRV RMNLs are based purely on the planning scheme zonings.

A planning scheme zoning map is included in Appendix Two. This shows that the subject site and the relevant residential locations are all located in the Farming Zone, FZ.

Under NIRV this gives zone levels of 46, 41 and 36 dB(A) for the 'day', 'evening' and 'night' periods as defined above for the remote residences east of the subject site.

There is therefore a significant difference between the RMNLs at residences to the west of the subject site near the Bass Hwy and the residences at remote locations east of the subject site.

The derived NIRV RMNLs are set out in the table below.

Table 5: Summary of Derived Recommended Maximum Noise Levels for the 2019 assessment

Residential Location/s	NIRV Recommended Maximum Noise Levels Determined in 2019, dB(A)			
	'Day' 7am-6pm Mon-Fri, 7am-1pm Sat	'Evening' 6pm-10pm Mon-Fri, 1pm-10pm Sat	6am-7am Mon-Sat within the 'night' period	'Night' period, 10pm-7am Mon-Sat
Residences west of the quarry site, with Deep Creek St and Bass Highway addresses.	57	48	51	39
Residences east of the site, remote from the Bass Hwy.	46	41	36	36

Compliance with the RMNL is assessed using the L_{eq} noise measure over a 30-minute period, excluding extraneous noise and applying adjustments as required for the noise characteristics.

These noise limits apply outdoors at a location representative of the noise exposure of residential premises, within 10m of the external walls of a residential dwelling. The limits apply to noise from commercial, industrial and trade sources. Noise from other sources such as traffic, birds, insects, rainfall, wind, aircraft and the like must be excluded from the analysis when assessing compliance with the limits.

If necessary and appropriate, the measured 30-minute L_{eq} is adjusted using the SEPP N-1 procedures to account for noise characteristics such as tonality, impulsiveness and intermittency (positive adjustments that increase the measured level) or for duration if the commercial, industrial or trade source/s are not audible for the full 30-minute assessment period.

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5.2 NOISE ALLOWANCES FOR OTHER INDUSTRY

The Recommended Maximum Noise Levels apply to the total of all industrial noise emissions affecting a noise-sensitive area. A site may need to meet lower levels when more than one industry contributes or will contribute to the total noise level affecting a noise-sensitive area.

There are no other industries in the vicinity of the subject site of significance with respect to noise emission and there appears to be little prospect of that occurring, so the proposed use can 'use up' the full noise limit.

6. NOISE SOURCES ASSOCIATED WITH QUARRY OPERATION

WMG conducted an assessment of noise emission from quarry at the time it was initially established, with the noise sources set out below:

- Excavator operating at the quarry face, Hitachi 470LCH or similar.
- Volvo off road haul trucks of 40 tonne capacity, either hauling overburden to the temporary overburden storage area south east of the proposed FMSEP or sand to the raw sand stockpile at the sand screening and sales hardstand area from both the FMSEP and the CSEP.
- CAT 980H or similar wheel loader operating at the sand screening and stockpile area.
- Hawke 20' x 7' Twin Deck Dry Screen operating in the sand screening and blending section of the hardstand area.
- On-road bulk quarry material trucks accessing the site along the sealed site access road for product sales and distribution.

Noise source data for equipment used at the quarry were obtained from noise measurements at the existing sand quarry.

The proposed quarry extension will introduce the following additional noise sources to the site:

- Wet sand washing
- Wet sand dewatering
- Cutter suction dredge.

Source noise levels for these plant items have been obtained from other quarry sites with equivalent equipment to that proposed for this site.

Relevant noise data has been included in Appendix Five.

The noise assessment under the EPA procedures is based on the equivalent continuous noise level in a 30-minute period. The number of road trucks accessing the site during a 30-minute period is therefore a relevant factor in the assessment of noise emission. Allowance has been made for up to 10 sales truck arrivals and departures per hour.

7. NOISE MODELLING

7.1 NOISE PREDICTION METHODOLOGY

Modeling of operational noise emissions has been conducted using the CadnaA software package, implementing the ISO 9613-2 sound propagation algorithms. The ISO 9613-2 method aims to determine the average sound level under meteorological conditions favorable to propagation, that is, moderately downwind propagation, or propagation under a well-developed, but moderate, ground-based temperature inversion, such as can occur at night.

Environment Protection Authority assessment methodology indicates that residual noise levels at noise sensitive receivers should be considered when weather conditions assist with propagation of noise emissions in the direction of the receivers. This condition is implemented by the noise modelling software.

For quarries the critical stage with respect to noise emission is typically the initial overburden and establishment works that require earthmoving equipment to operate at or near the natural surface level, where acoustic shielding is only provided by intervening topography between the noise sources and receptor locations.

As the excavation proceeds, acoustic shielding of the noise sources increases.

The focus of the noise modelling has therefore been progressing the extraction areas eastwards towards the residences east of the site, particularly the coarse sand deposit which is the most elevated and nearest to those residences.

7.2 INPUT PARAMETERS

The following assumptions have been adopted for the noise level predictions:

- It has been assumed that two haul trucks will be operating on a continuous basis.
- Sand extraction as occurs in the existing FMSEP will proceed beyond establishment of the initial 15 m benching.
- All noise sources have been assumed to be operating 100% of the time. This is approach is conservative.
- A tonal adjustment of +2 dB has been included to allow for a degree of tonality associated with mobile equipment and dewatering screens.
- All Mobile equipment operating at the site is fitted with broadband reversing beepers, not conventional tonal reverse beepers. This avoids the potential annoyance to residents and SEPP N-1 and a larger +5 dB tonal adjustment potentially associated with conventional reversing beepers.
- The combinations of noise sources included in the noise modelling reflect the following hours of operation:
    - 6am-7am Mon-Sat full processing plant operation plus product dispatch.

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- 7am-6pm Mon-Fri and 7am-1pm Sat full processing plant operation plus product dispatch and extraction.
- 6pm-2am Mon-Fri and 1pm-10pm Sat 'quiet' components of the processing plant only.

7.3 NOISE MODELLING FINDINGS

The noise modelling results have been summarised in the table below.

Table 6: Summary of Modelled Noise Levels and Comparison with the Derived Recommended Maximum Noise Levels for the 2019 assessment

Residential Location/s	EPA Assessment Period			
	'Day' 7am-6pm Mon-Fri, 7am-1pm Sat	'Evening' 6pm-10pm Mon-Fri, 1pm-10pm Sat	6am-7am Mon-Sat within the 'night' period	'Night' period, 10pm-7am Mon-Sat
Residences west of the quarry site, with Deep Creek St and Bass Highway addresses.				
NIRV Recommended Maximum Noise Levels determined in 2019, dB(A)	57	48	51	39
Maximum modelled noise levels during quarry operation including +2 dB(A) tonal adjustment	51	35	42	35
Compliance?	Y	Y	Y	Y
Residences east of the site, remote from the Bass Hwy.				
NIRV Recommended Maximum Noise Levels determined in 2019, dB(A)	46	41	36	36
Maximum modelled noise levels during quarry operation including +2 dB(A) tonal adjustment	40	32	35	32
Compliance?	Y	Y	Y	Y

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The resultant noise level has therefore been found to comply with the NIRV RMNLs at all locations for all time periods.

8. RISK ASSESSMENT

8.1 ASSESSMENT METHODOLOGY

The Risk Assessment in relation to noise has been considered in terms of the Risk Matrix as set out in Appendix A of *Preparation of Work Plans and Work Plan Variations GUIDELINE FOR EXTRACTIVE INDUSTRY PROJECTS*, December 2018 prepared by the Department of Economic Development, Jobs, Transport and Resources.

The risk matrix used for the risk assessment is presented in Table 3 below, with the definitions of likelihood and consequence applied to the assessment of risk described further below.

Table 7: Risk assessment matrix

Likelihood	Almost certain	Medium	High	Very High	Very High	Very High
	Likely	Medium	Medium	High	Very High	Very High
	Possible	Low	Medium	Medium	High	Very High
	Unlikely	Low	Low	Medium	High	High
	Rare	Low	Low	Medium	Medium	High
		Insignificant	Minor	Moderate	Major	Critical
		Consequence				

The following general definitions of consequence were applied to the risk assessment:

- Critical - Hazard has critical impact, in terms of severity and/or duration. Treatment or remediation effort is required, although some effects may be irreversible. Remediation of environmental contamination would require significant private and public resources. Hazard event would be the subject of widespread community outrage. In terms of noise effects, community or multiple individuals continuously experience major losses of amenity from noise over periods of weeks or longer.
- Major - Hazard has major impact, in terms of severity, duration and/or frequency of occurrence. Treatment or remediation effort is required. Some effects may be irreversible. Remediation of environmental contamination would require significant

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private and public resources. Hazard event would be the subject of widespread community concern. In terms of noise effects, community or multiple individuals regularly experience (weekly-monthly basis) major losses of amenity due noise for multiple days on end.

- Moderate - Hazard has moderate, noticeable impact, in terms of severity, duration and/or frequency of occurrence. Moderate treatment or remediation effort may be required. Hazard event would be the subject of limited community concern. In terms of noise effects, community or multiple individuals regularly (weekly-monthly basis) experience significant loss of amenity from noise.
- Minor - Hazard is perceived but has minor and typically temporary effects. Some remediation may be required. In terms of noise effects, infrequently (no more than monthly) has a minor effect on the amenity of the community or individuals.
- Insignificant - Impacts are barely recognised and/or quickly recovered from. No specific remediation required. In terms of noise effects, noise infrequently (no more than monthly) contributes to a small reduction in the amenity of the community or individuals.

The following general definitions of likelihood were applied to the risk assessment:

- Almost Certain - The risk event is expected to occur in most circumstances (90-100% probability)
- Likely - The risk event will probably occur in most circumstances (70-90% probability)
- Possible - The risk event might occur at some time (30-70% probability)
- Unlikely - The risk event could occur at some time (5-30% probability)
- Rare - Highly unlikely, but the risk event may occur in exceptional circumstances (0-5% probability)

For those unmitigated risks assessed as medium or higher, it will be necessary to apply mitigation measures to reduce the risk to low, or as low as practicable. In this instance the effectiveness of the mitigation measures applied by Grantville Commercial Sands have been incorporated into the assessment of mitigated risk.

Grantville Commercial Sands has been successfully managing the risk of noise emission from the existing operations for many years.

8.2 Assessment Summary

A summary table of the unmitigated and mitigated risks as they relate to noise for current quarrying activities and the proposed extension are presented below.

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Table 8: Risk assessment summary

Source	Receptor	Risk Event	Risk Assessment – no controls			Mitigation measures	Risk Assessment – with controls		
			Likelihood	Consequence	Inherent Risk		Likelihood	Consequence	Inherent Risk
Construction activities (movement and handling of materials etc).	Neighbours	Impact on residential amenity due to excessive noise.	Possible	Moderate	Medium	Implementation of EPA Guidelines for Construction and Demolition Site Noise.	Rare	Minor	Low
	Staff	Noise exposure above the occupational noise exposure standard	Likely	Moderate	High	Staff training and PPE as required.	Unlikely	Minor	Low
Overburden stripping	Neighbours	Impact on residential amenity due to noise in excess of NIRV RMNLs.	Possible	Moderate	Medium	Apply recommended noise mitigation strategies.	Rare	Minor	Low

Source	Receptor	Risk Event	Risk Assessment – no controls			Mitigation measures	Risk Assessment – with controls		
			Likelihood	Consequence	Inherent Risk		Likelihood	Consequence	Inherent Risk
	Staff	Noise exposure above the occupational noise exposure standard	Likely	Moderate	High	Staff training and PPE as required.	Unlikely	Minor	Low
Overburden stockpiling	Neighbours	Impact on residential amenity due to noise in excess of NIRV RMNLs.	Possible	Moderate	Medium	Apply existing Grantville Commercial Sands practices.	Rare	Minor	Low
	Staff	Noise exposure above the occupational noise exposure standard	Likely	Moderate	High	Staff training and PPE as required.	Unlikely	Minor	Low

Source	Receptor	Risk Event	Risk Assessment – no controls			Mitigation measures	Risk Assessment – with controls		
			Likelihood	Consequence	Inherent Risk		Likelihood	Consequence	Inherent Risk
Product excavation	Neighbours	Impact on residential amenity due to noise in excess of NIRV RMNLs.	Unlikely	Moderate	Medium	Apply recommended noise mitigation strategies.	Rare	Minor	Low
	Staff	Noise exposure above the occupational noise exposure standard	Likely	Moderate	High	Staff training and PPE as required.	Unlikely	Minor	Low
Product processing	Neighbours	Noise Impact on residential amenity due to noise in excess of NIRV RMNLs.	Possible	Moderate	Medium	Apply existing Grantville Commercial Sands practices.	Rare	Minor	Low

Source	Receptor	Risk Event	Risk Assessment – no controls			Mitigation measures	Risk Assessment – with controls		
			Likelihood	Consequence	Inherent Risk		Likelihood	Consequence	Inherent Risk
	Staff	Noise exposure above the occupational noise exposure standard	Likely	Moderate	High	Staff training and PPE as required.	Unlikely	Minor	Low
Loading of product	Neighbours	Impact on residential amenity due to noise in excess of NIRV RMNLs.	Possible	Moderate	Medium	Apply existing Grantville Commercial Sands practices.	Rare	Minor	Low
	Staff	Noise exposure above the occupational noise exposure standard	Likely	Moderate	High	Staff training and PPE as required.	Unlikely	Minor	Low

Source	Receptor	Risk Event	Risk Assessment – no controls			Mitigation measures	Risk Assessment – with controls		
			Likelihood	Consequence	Inherent Risk		Likelihood	Consequence	Inherent Risk
Rehabilitation works (movement of soil, planting etc).	Neighbours	Impact on residential amenity due to noise in excess of NIRV RMNLs.	Possible	Moderate	Medium	Apply noise mitigation strategies equivalent to those recommended for overburden stripping when working in areas exposed to neighbours.	Rare	Minor	Low
	Staff	Noise exposure above the occupational noise exposure standard.	Likely	Moderate	High	Staff training and PPE as required.	Unlikely	Minor	Low

9. NOISE CONTROL RECOMMENDATIONS

9.1 INITIAL PIT ESTABLISHMENT WORK

In principle, excavation of the CSEP should be worked towards the north and east with machinery operating within the excavation, not on the natural surface.

A similar principle applies to the extension of the FMSEP at it develops towards the east, north-east.

9.2 BROADBAND REVERSE ALARMS

Any new, or replacement mobile equipment operating at the site must be fitted with a broadband reverse alarm selected to emit the lowest possible noise level consistent with safe operation.

10. CONCLUSION

It has been found that by implementation of minimal operational strategies the proposed extension of the quarry extraction areas and installation of additional processing plant can be implemented while remaining in compliance with the NIRV RMNLs.

Neville Goddard

NEVILLE GODDARD
WATSON MOSS GROWCOTT
acoustics pty ltd

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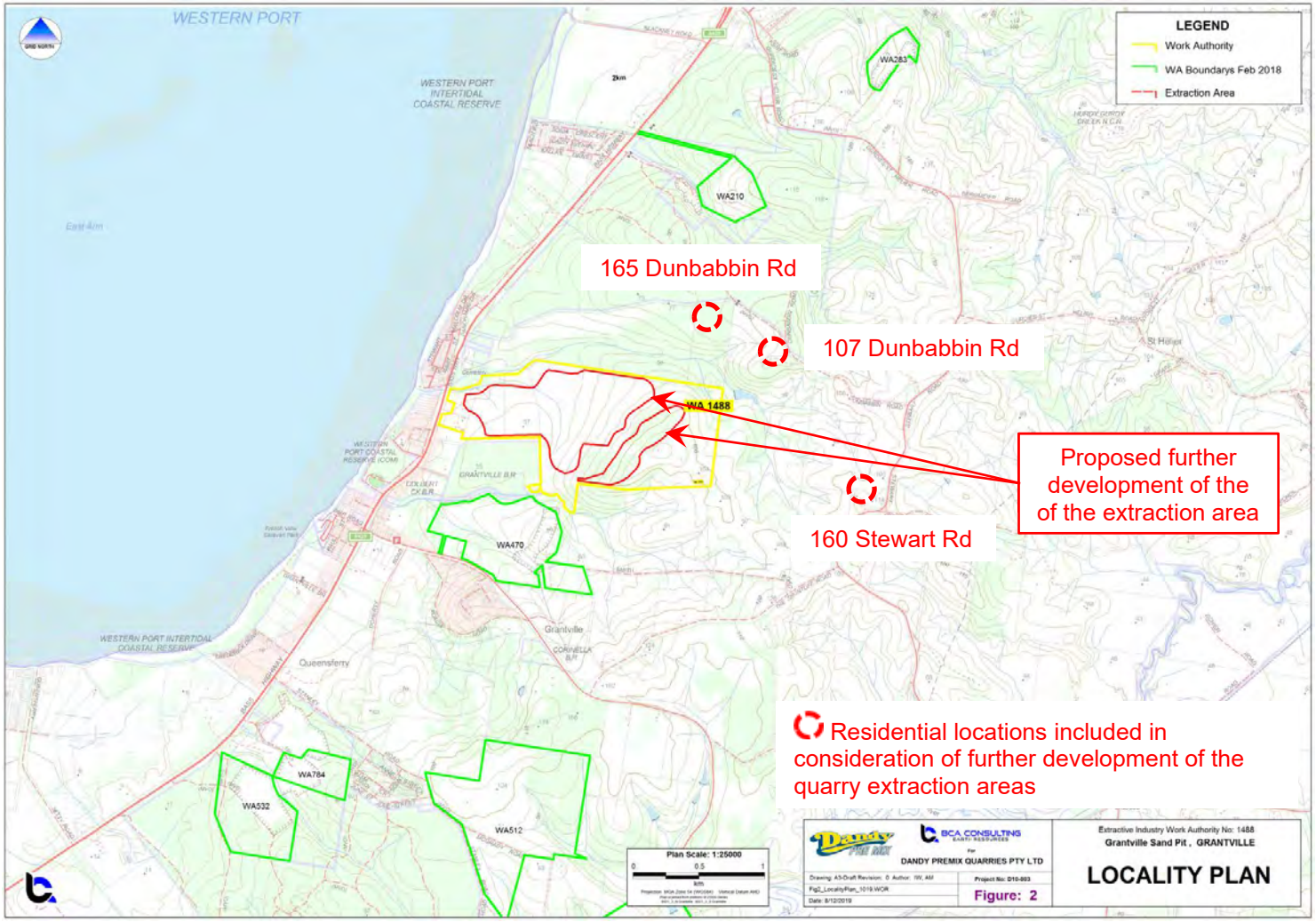
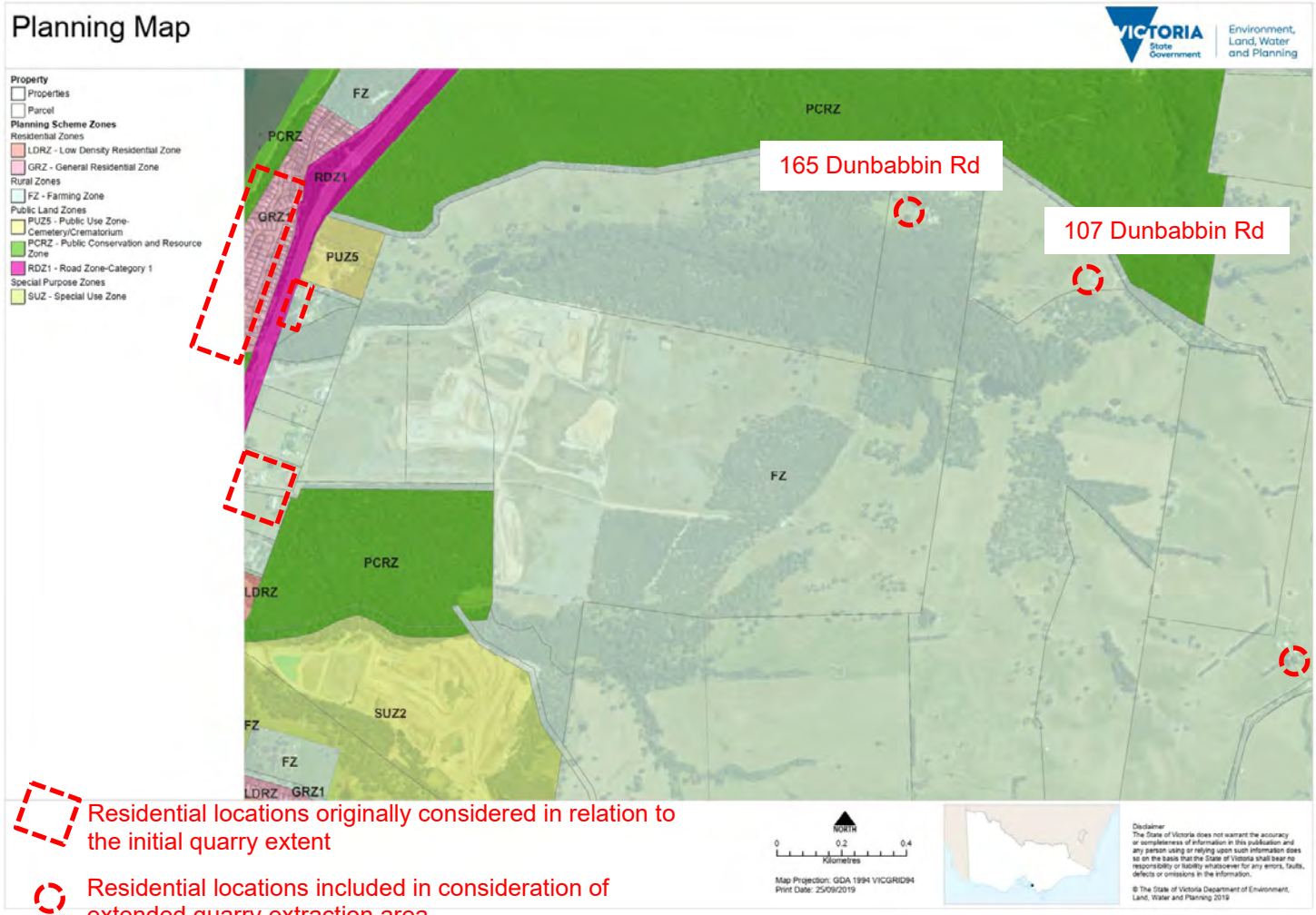
APPENDIX ONE: SITE LOCATION PLAN SHOWING PROPOSED EXTRACTION AREA EXTENSION AND RELEVANT RESIDENTIAL LOCATIONS



APPENDIX TWO: PLANNING SCHEME ZONING MAP

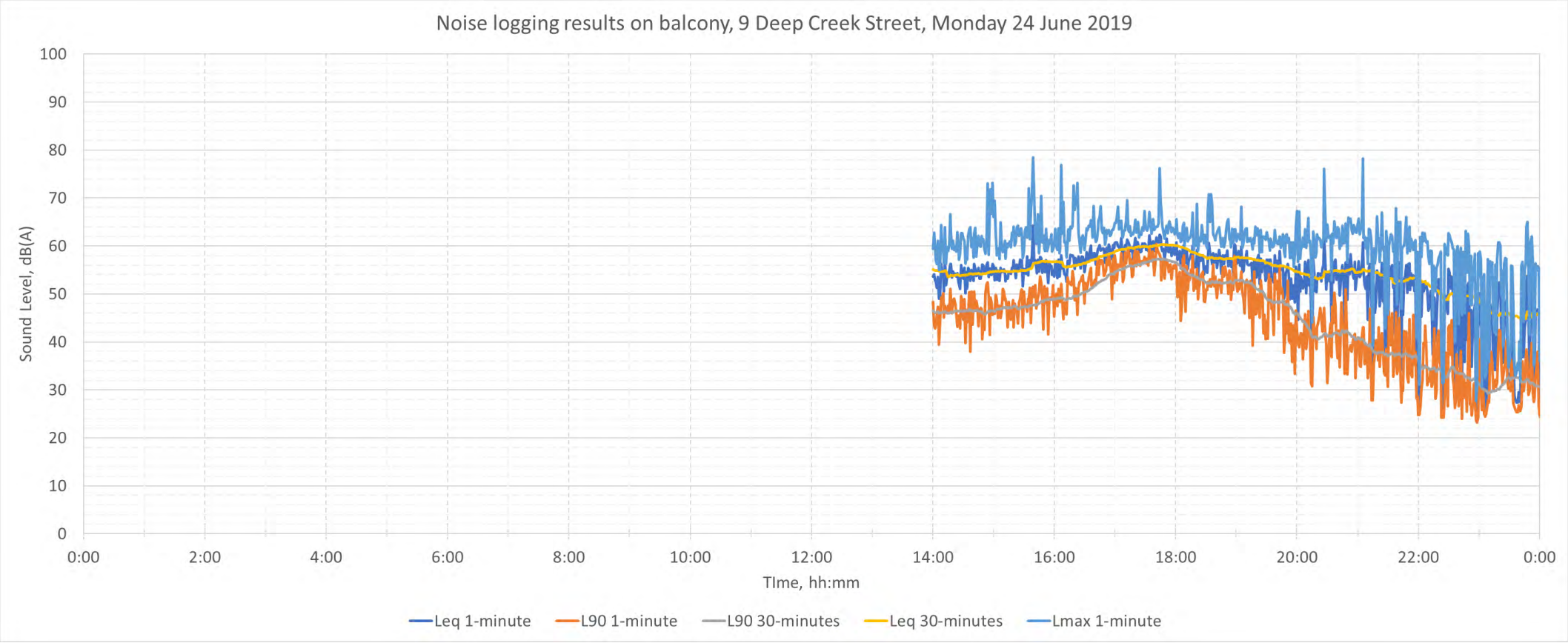


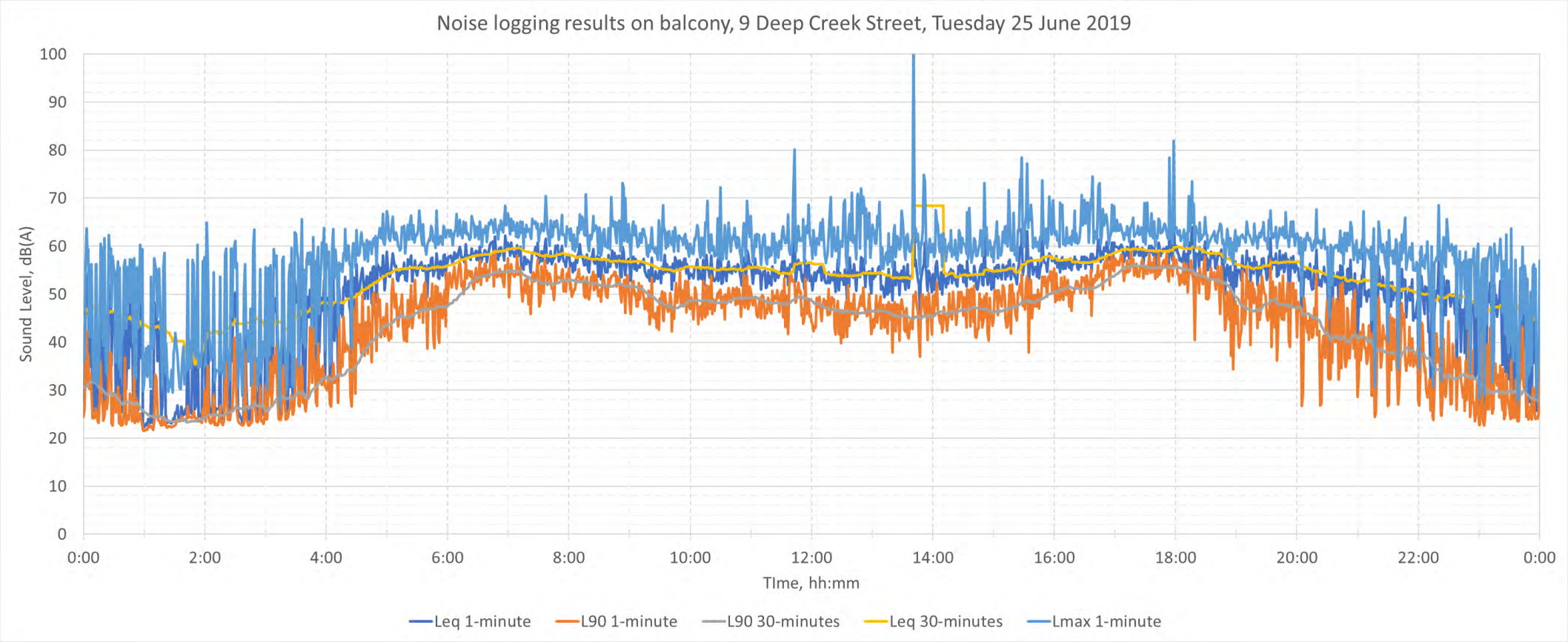
APPENDIX THREE: MORE DETAILED SITE PLAN INCLUDING NOISE MONITORING LOCATIONS



APPENDIX FOUR: GRAPH OF NOISE MONITORING RESULTS

9 Deep Creek St




Noise logging results on balcony, 9 Deep Creek Street, Tuesday 25 June 2019
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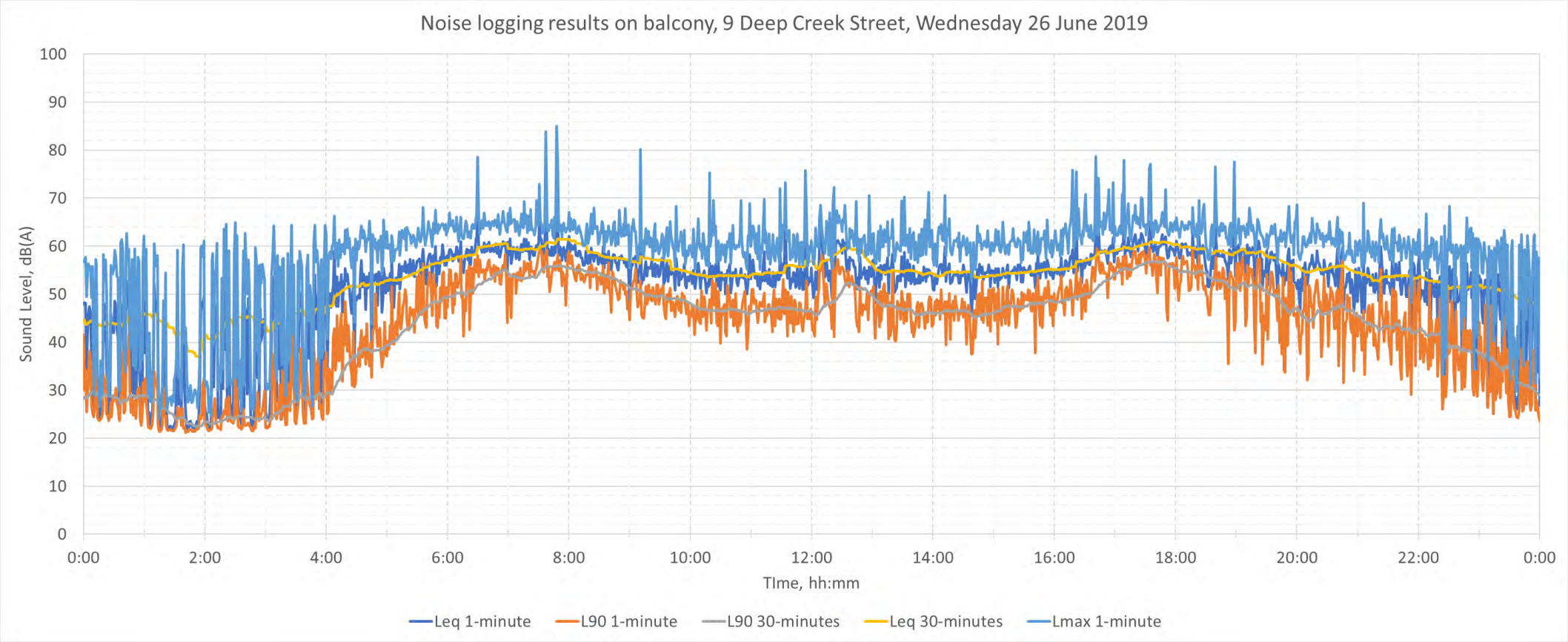
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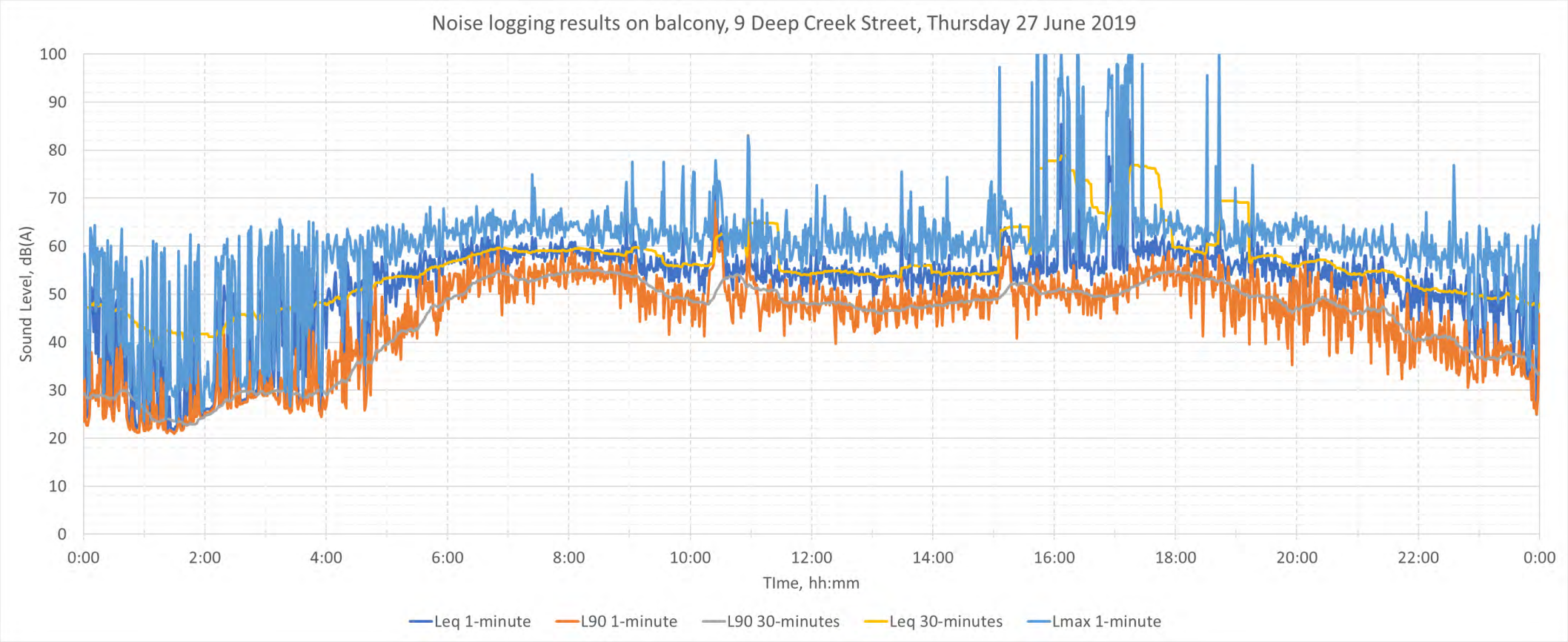
Noise logging results on balcony, 9 Deep Creek Street, Thursday 27 June 2019
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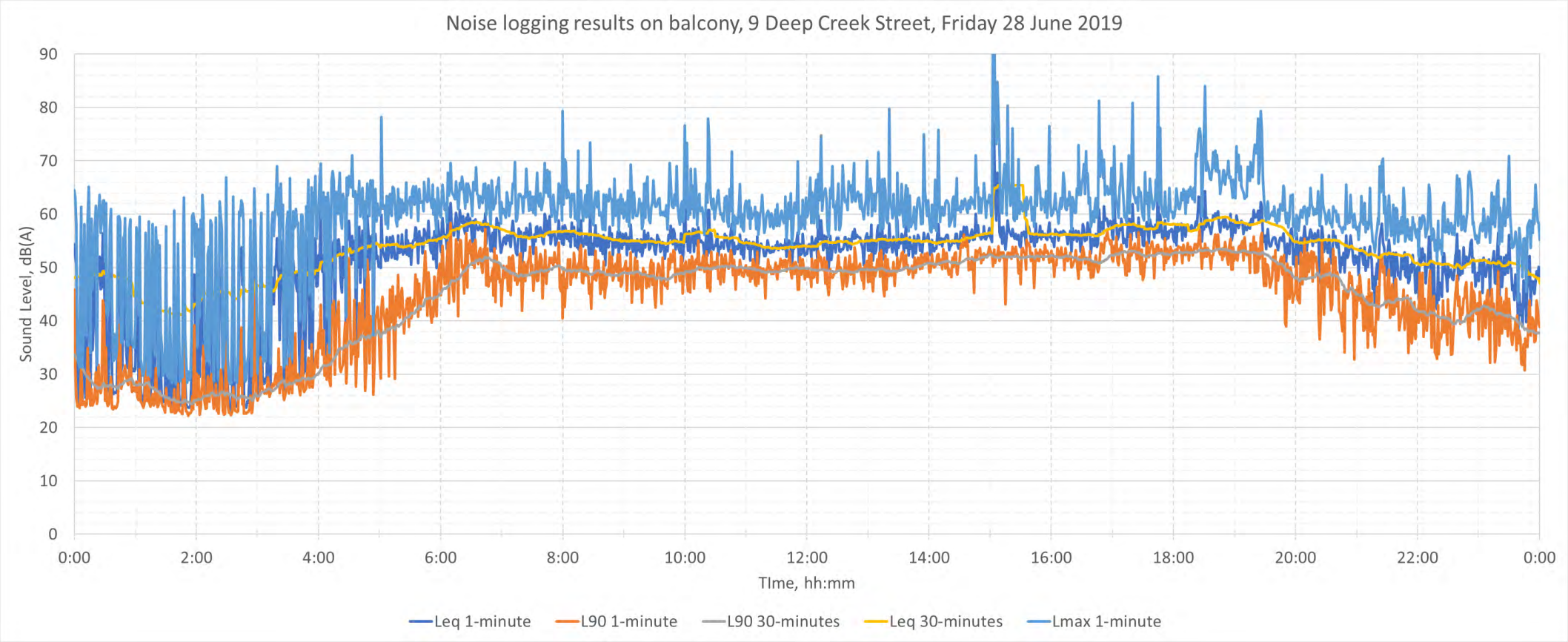
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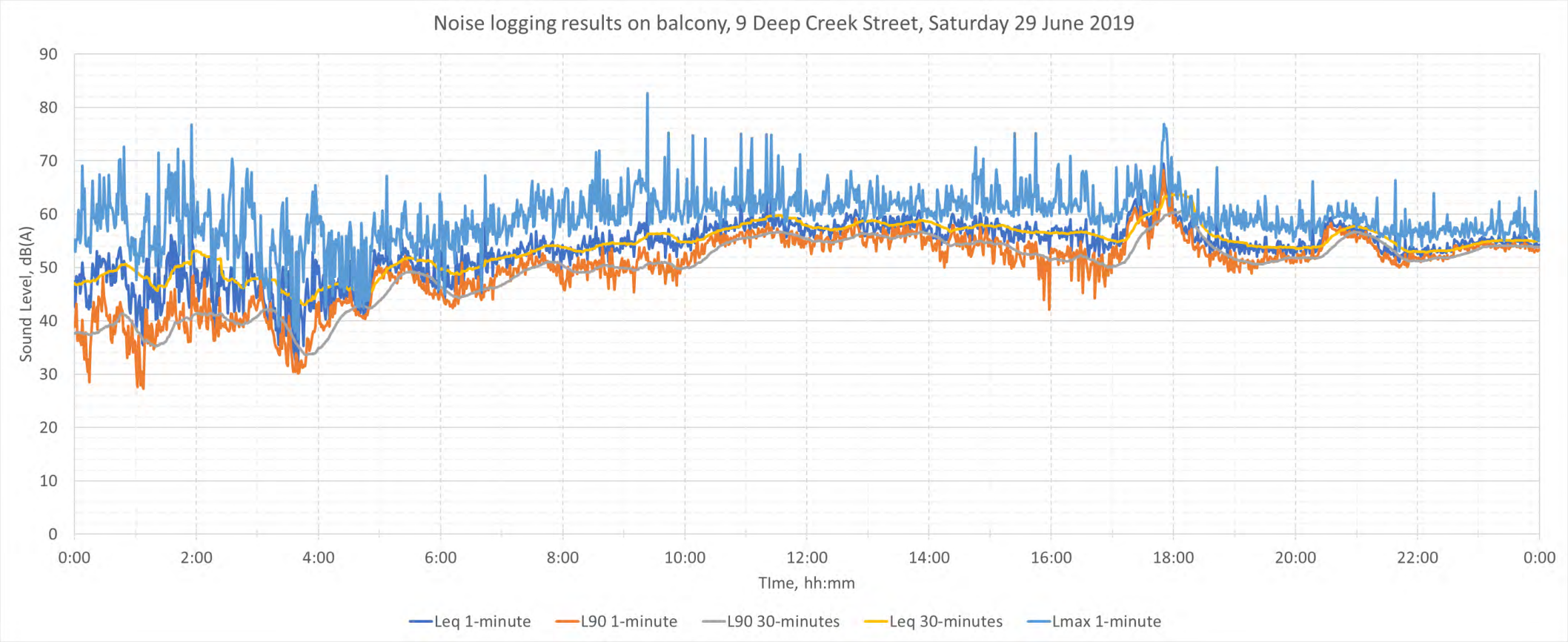
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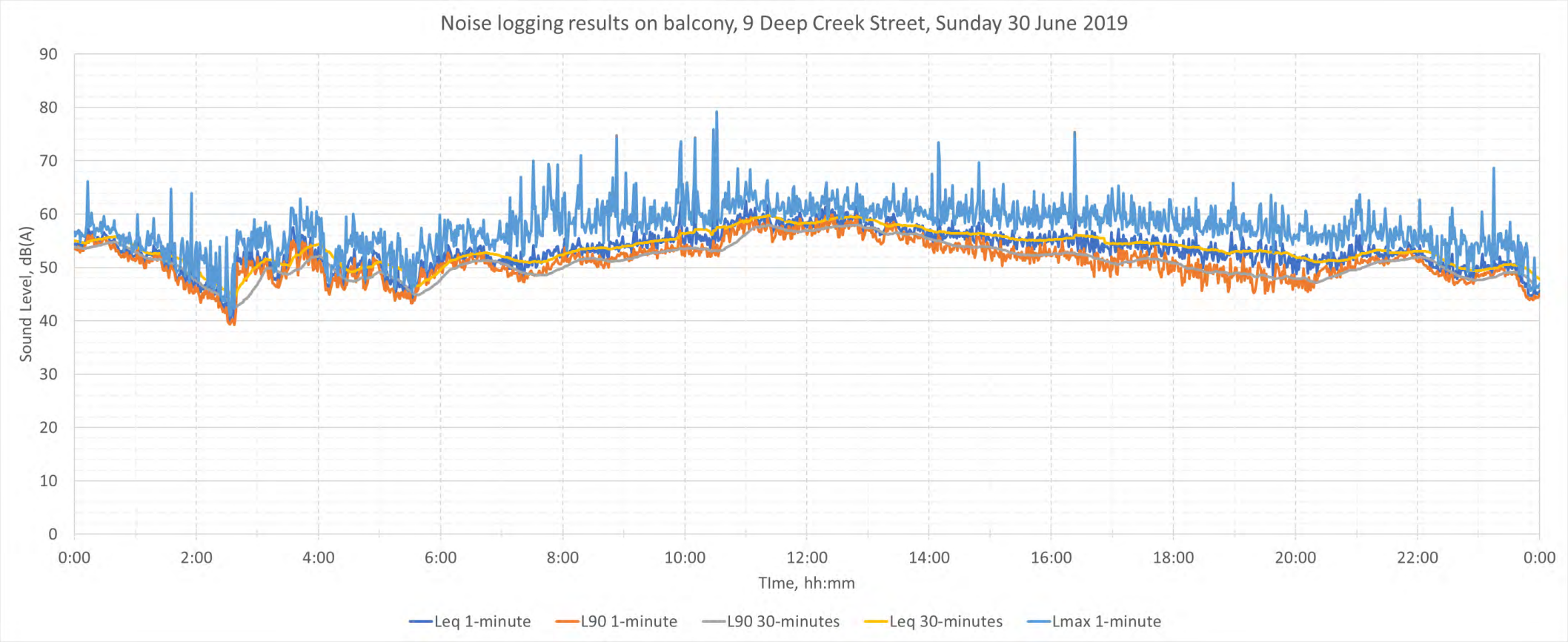
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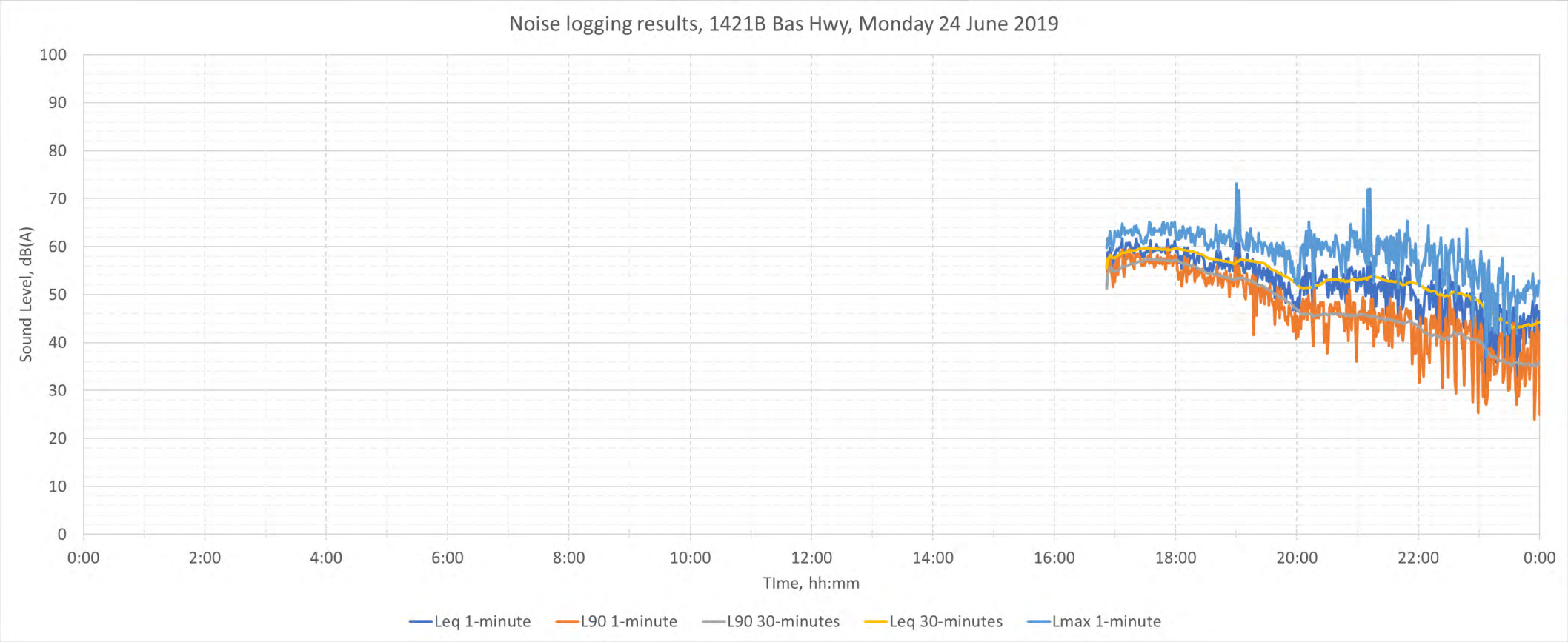
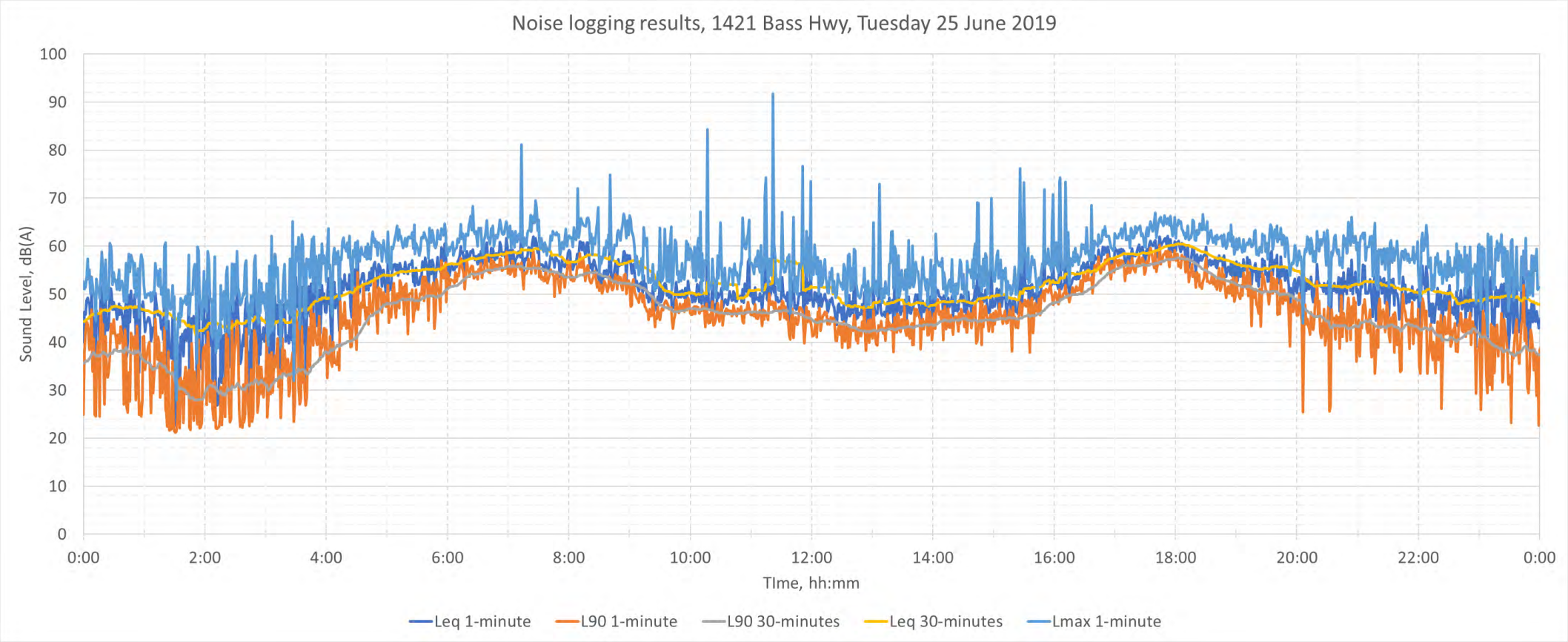
1421B Bass Hwy

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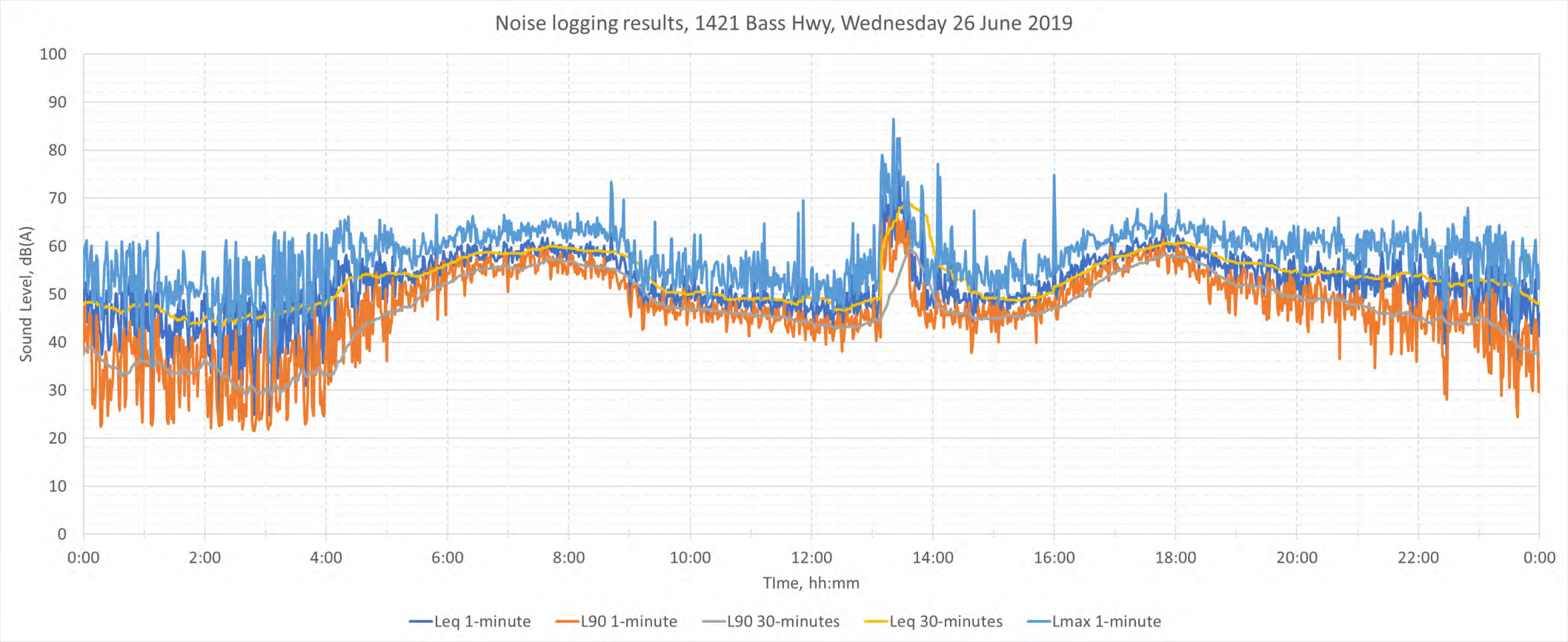
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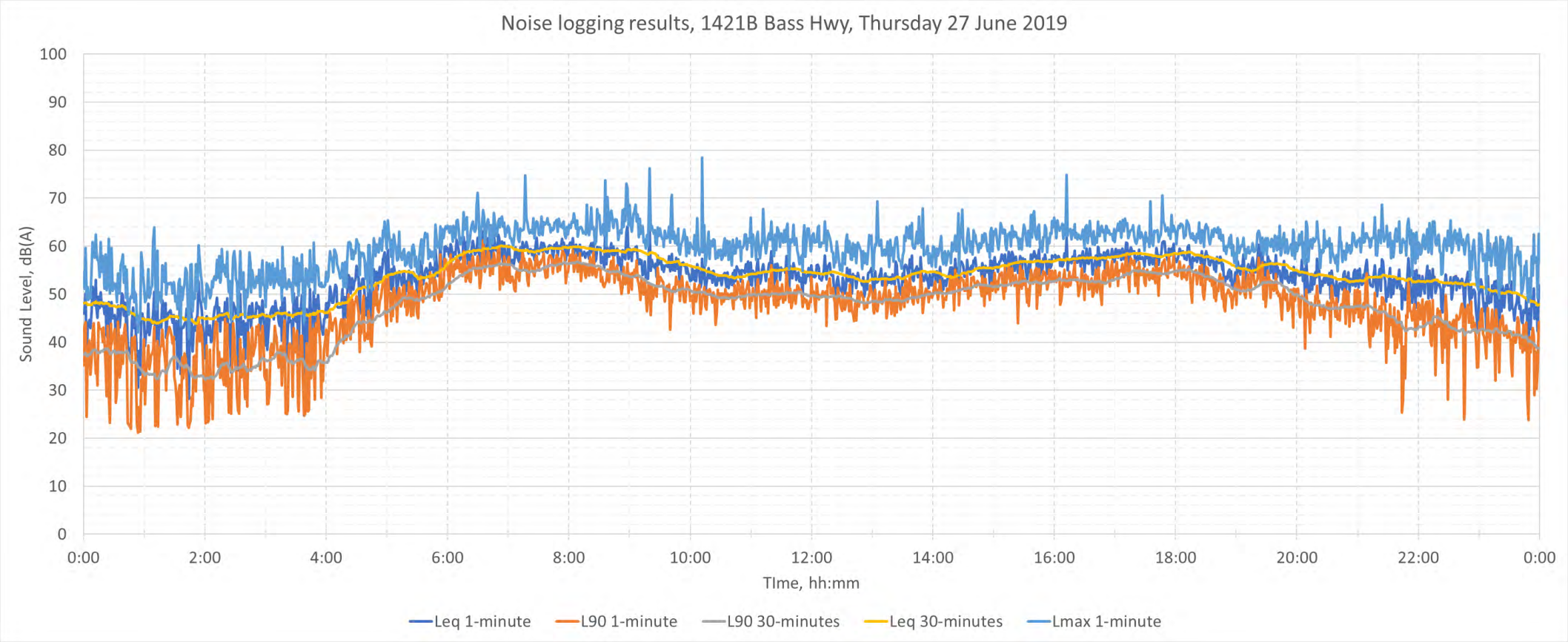
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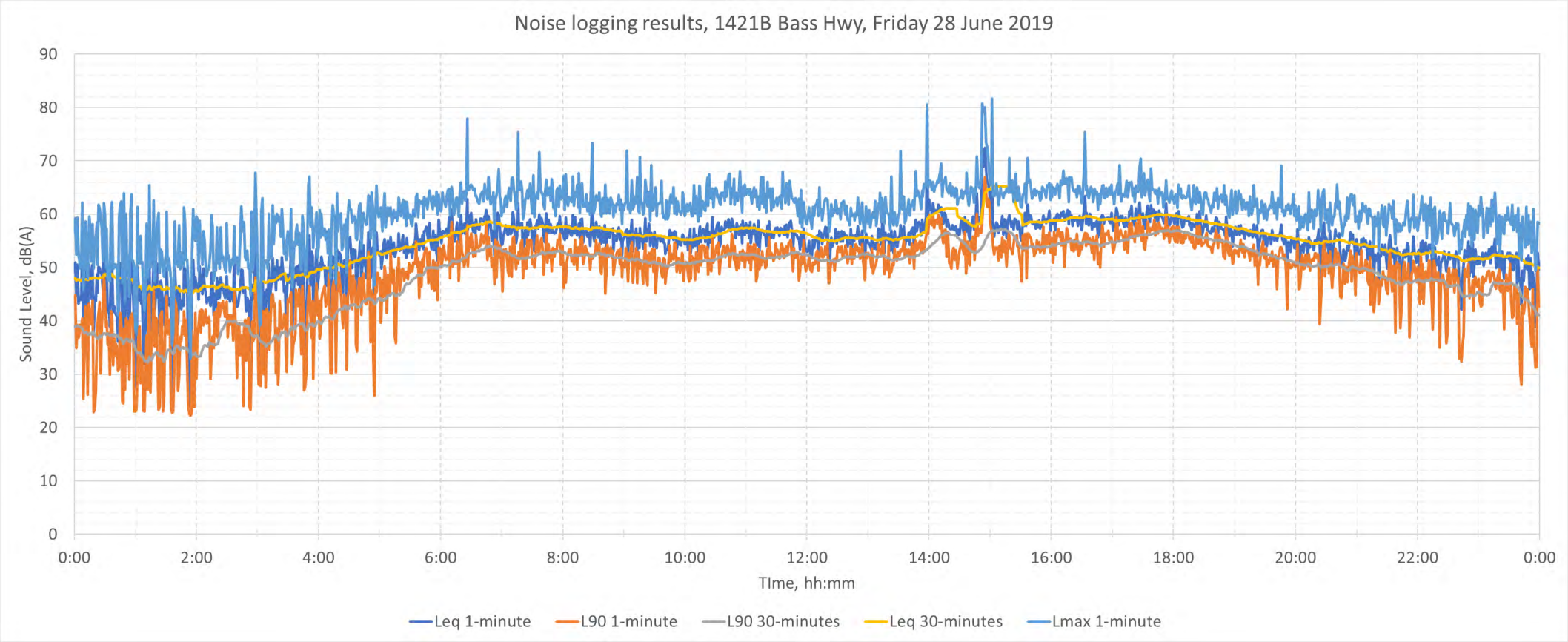
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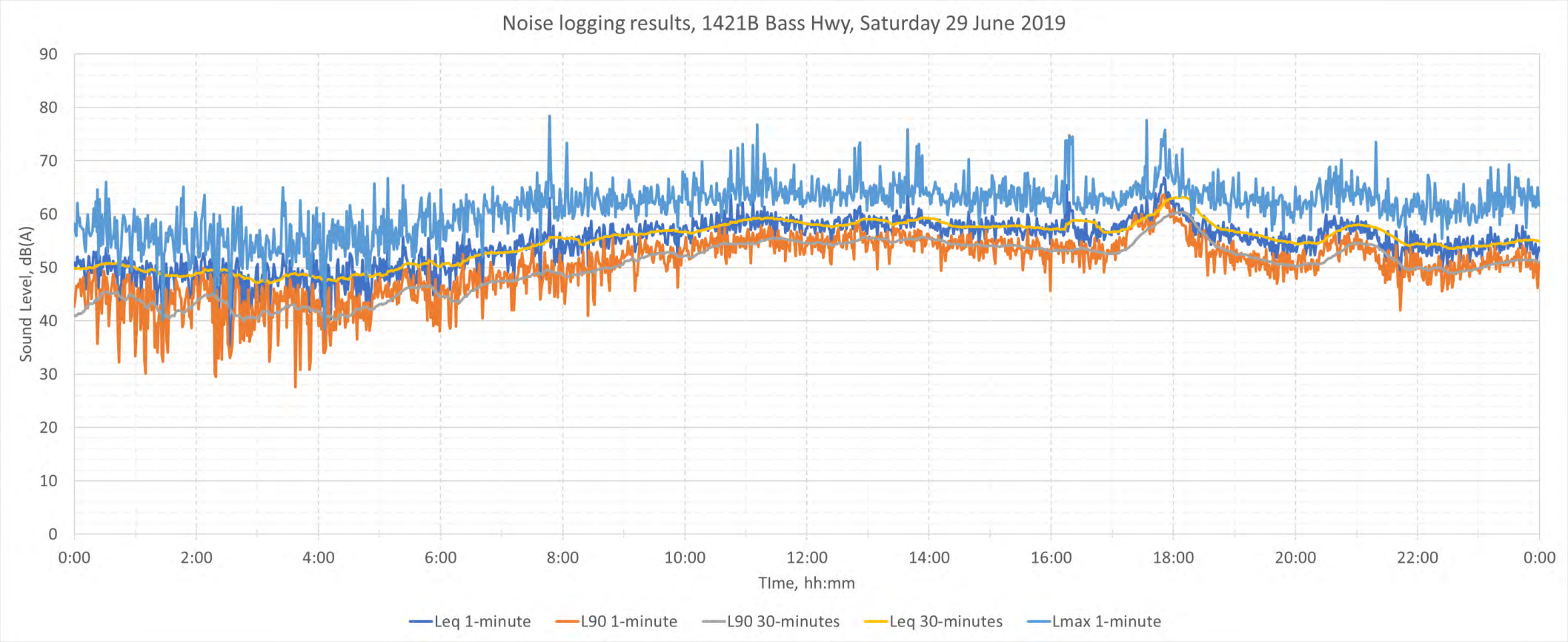
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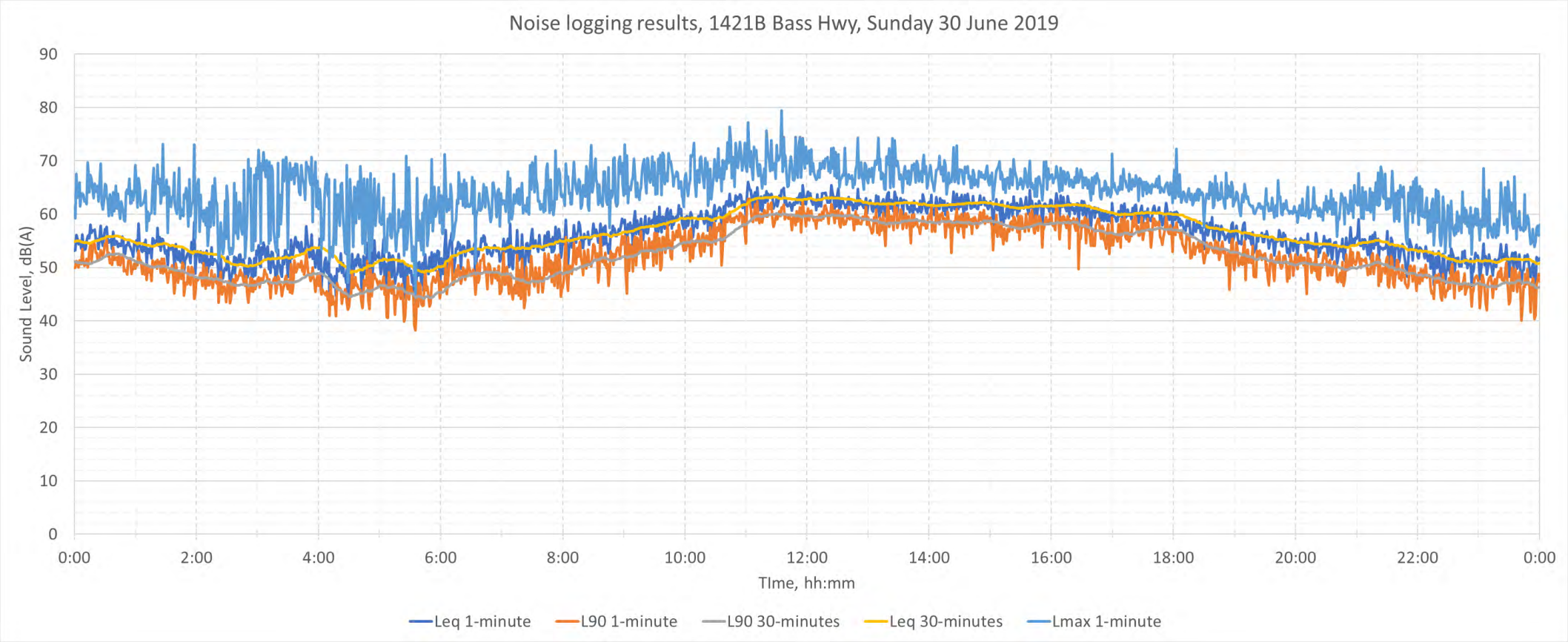
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APPENDIX FIVE: QUARRY NOISE SOURCE DATA

NOISE SOURCE	SOUND POWER LEVEL (dB re. 1pW) IN OCTAVE FREQUENCY BANDS (Hz)							
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**dB(A)**
Haul truck	113	104	103	103	103	100	90	107
Excavator	112	116	106	101	100	101	92	111
CAT wheel loader	119	113	103	100	101	95	90	105
Dry screen	111	106	105	101	98	97	93	105
Road truck	113	107	102	100	99	98	91	104
Fines Dewatering Screen (Sand Supplies noise data for 2 screens - 3 dB)	108	102	93	94	91	89	85	102
Coarse Dewatering Screen (Sand Supplies noise data for 2 screens - 3 dB)	108	102	93	94	91	89	85	102
Belt press	88	85	88	89	90	90	90	101
Cutter suction dredge	114	106	103	99	96	94	89	102

REPORT 7 – DUST ASSESSMENT

Dandy Premix Quarries Pty Ltd – WA1488

PROPOSED FURTHER DEVELOPMENT OF SAND EXTRACTION OPERATIONS AND INTRODUCTION OF SAND WASHING & DEWATERING, 1381-1395 BASS HIGHWAY GRANTVILLE

DUST ASSESSMENT

14 December 2019

Environmental Science Associates
18 Goldsmith Crescent Castlemaine 3450

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1. INTRODUCTION

Environmental Science Associates (ESA) has been retained by Dandy Premix Quarries Pty Ltd (DPQ) to review the effectiveness of dust control measures which have been applied at its existing sand extraction operation at Grantville and their applicability to the proposed expansion of the operation. The existing and proposed operations are located within the boundaries of Extractive Industry Work Authority No 1488.

1.1 Background

The Work Plan for DPQ's existing sand extraction operation was approved in August 2013 with site establishment works commencing in early November 2013. Facilities on the site currently include a sealed internal road (with truck wheel wash) between the Bass Highway to the weighbridge, office, workshop and sand processing/stockpiling area.

Following removal of overburden (which is stored on-site for use in site rehabilitation) sand is extracted from the existing fine/medium sand extraction pit (**FMSEP**) by excavators and screened to produce a range of products (primarily concrete sand, which is produced by blending in-situ sand with imported coarse washed sand). Sand washing is not currently permitted, or undertaken on the WA1488 site.

Dust monitoring has been conducted on a monthly basis at three locations adjacent to the nearest residences, located between the extraction area and the Bass Highway since 2013.

DPQ plans to lodge a Work Plan Variation (WPV) for further development of the currently approved sand extraction area at the WA1488 quarry. The WPV proposes access to a coarse sand deposit on the site and further extraction of fine/medium sands, including below the water table (using a Cutter Suction Dredge) in an enlargement of the current FMSEP.

The WPV also seeks the introduction of sand washing, associated dewatering and water recycling processes. The expansion will enable the quarry production rate to be increased from the current rate of 400,000 t/annum to between 750,000 and 1,000,000 t/annum.

1.2 The Site

The site is located at 1381-1395 Bass Highway, Grantville and has an area of approximately 156 ha (Attachment 1). The (relative) surface elevation of the existing and proposed fine/medium sand extraction area increases from approximately 10m in the west to 120m in the east, while the proposed coarse sand extraction area (**CSEP**) is located along the northeast face of a ridge where the surface elevation is generally between 90m and 120m.

1.3 Zoning and Nearby Land Uses

The site is situated within an extensive Farming Zone (**FZ**) which extends to the east from the Bass Highway. The Grantville General Residential 1 Zone is located on the western side of the highway (approximately 200 m from western edge of the currently approved extraction area.

The two nearest off-site dwellings are situated in the FZ: (1) approximately 200 m to the southwest (at 1421 and 1421A Bass Highway); and (2) about 230 m to the northwest (at 1353 Bass Highway). A small Low Density Residential Zone, supporting a few dwellings accessed from the highway via Shackleford Rise, is located about 330 m to the southwest. A bushland reserve (zoned PCRZ) is situated between the southern boundary of the proposed extraction area and a Special Use 2 Zone (further to the south) which supports a major sand extraction operation.

DPQ also owns a 70 ha area of bushland adjoining the northern boundary of WA 1488 (zoned FZ). The (largely) native vegetation on this property will be preserved as an "offset" to compensate for removal of vegetation in the proposed CSEP.

2. OUTLINE OF PROPOSAL

Attachment 1 is "Figure 3 – Extent of Proposed Extraction Areas", prepared by BCA Consulting – Earth Resources (**BCA**). The plan is overlaid on a June 2019 aerial photograph, which shows the current FMSEP, temporary overburden storage area and the hardstand processing, stockpile and sales loading area.

The currently approved WA 1488 site extends to the site boundary (marked as a yellow line in Attachment 1. The red lines show the extent of the proposed extraction areas, the FMSEP for fine to medium sand and the CSEP for coarse sand (the boundary of the FMSEP area at the western end of the site is unchanged from that approved under the current WA1488 Work Plan).

The proposed sand extraction and processing operations will be detailed by BCA and other specialist expert consultants.

Aspects of direct relevance to the air quality assessment are summarised below:

- on-going removal of overburden, which will be transported to the temporary overburden storage area for subsequent use to progressively create the final terminal pit faces (very little overburden will be produced in developing the CSEP, as the resource is overlain by little, if any overburden, with coarse sand outcropping in most areas);
- dry extraction of fine medium sand above the water table (at about 6 m AHD) in the current and further developed FMSEP;
- wet extraction below the water table in the FMSEP using a Cutter Suction Dredge on a floating pontoon vessel, with the dredged sand slurry pumped through a floating and fixed pipeline to the sand processing area;
- Fine "slimes" generated by sand washing will be coagulated with a (biodegradable polymer) flocculant and dewatered with a belt press – most of the dewatered slime "cake" will be co-disposed with oversize material and used to rehabilitate the final pit batters, included underwater in the FMSEP (no slime dam(s) are proposed);
- construction of an extension to the existing gravel haul road between the existing (approved) FMSEP to the west and the proposed further development of the FMSEP to the east (effectively forming a causeway) to provide uninterrupted access from the hardstand processing area, over the purpose constructed temporary overburden stockpile to the CSEP in the elevated south east part of the WA1488 site;
- installation and operation of an additional bulk feed bin, wash plant scalping and wet screens, cyclones, water clarifier/thickener, mud buffer tank, polymer make-up and dosing unit, dewatering belt filter press, motor control centre and transfer conveyors to integrate with the existing radial stacker for stockpiling specific grades of sand (all potentially dusty equipment will be equipped with water sprays for dust control); and
- design and development of revised surface water management controls to account for increased extraction areas, resulting in reduced surface water catchment and removal of part of the ephemeral waterway (MW3840) which is located within the WA 1488 area.

3. POTENTIAL DUST SOURCES

Experience with dust management at a range of extractive industry and mining operations indicates that the main potential dust sources at DPQ's Grantville operation (if uncontrolled) will be: (1) overburden removal and placement (during periods when soil moisture is low); (2) movement of trucks and loaders on haul roads and within the processing area; (3) (dry) blending, screening and stockpiling sand; and (4) suspension of dust from any bare, exposed and erodible surfaces by strong winds (experience has shown that wind erosion of exposed areas, including the temporary overburden stockpile is not a significant issue).

Samples of the DPQ Grantville sand resource have undergone particle sieve and clay fine silts analysis to determine processing, blending and finished product use. The majority of the sand to be extracted is a very clean, free running resource with a low to negligible clay silt content. The sand resources proposed to be extracted do not contain a significant level of very fine (potentially erodible) material.

As discussed below, DPQ's dust control management plan has been designed to provide a high degree of dust control through a range of measures, including proactive initiatives triggered by predicted adverse weather conditions.

4. EPA BUFFER DISTANCES GUIDELINES

EPA Publication 1518 lists buffer distance guidelines for a wide range of operations which have the potential to impact on the local amenity of sensitive land uses through emissions to atmosphere[1]. The publication does not list a recommended separation distance for sand extraction/processing operations.

5. LOCAL WINDS

The closest Bureau of Meteorology (**BOM**) wind recording station is at Wonthaggi, which is about 23 km to the SSE. Figure 1 is a windrose prepared by the BOM, based on 42 year's observations at 3 pm at Wonthaggi (the 3 pm data provide the most relevant information on winds during periods of the day when the site will be operational).

The frequency of occurrence of calms is 12%, while the predominant winds are from the northwest and west sectors (each with a frequency of occurrence of about 20%. In contrast, winds from the northeast (which would place DPQ's proposed operations upwind from the nearest dwelling) occur for only about 2.5% of the time. Similarly, the frequency of winds from the east and southeast (which would place DPQ's proposed operations upwind from the nearest parts of the Grantville township) are relatively infrequent.

[1] EPA (March 2013). "Recommended separation distances for industrial residual air emissions" EPA Publication 1518.

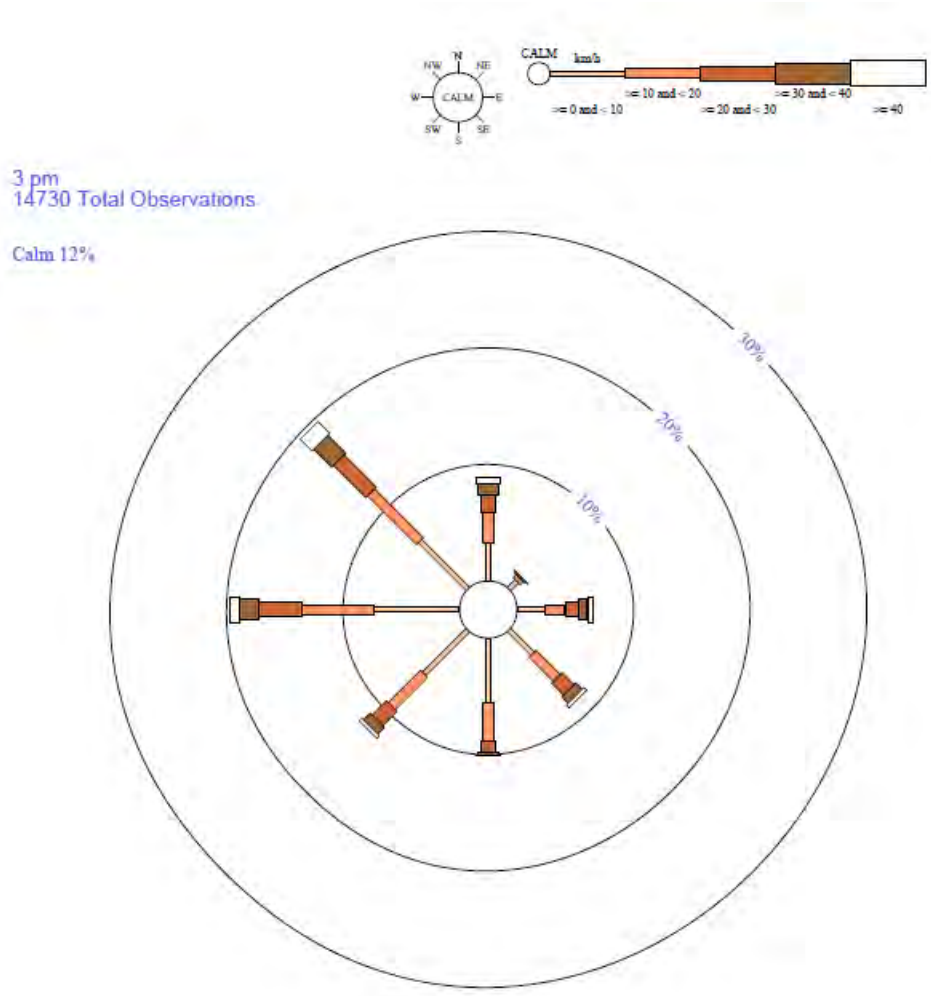


Figure 1. BOM Windrose for 3 pm Winds at Wonthaggi

It is also relevant that weather conditions which have the greatest potential to generate elevated dust emissions during the summer and autumn months are strong, hot winds from the north to northwest sector.

6. RELEVANT AIR QUALITY REQUIREMENTS

This section reviews air quality requirements which are directly applicable to the Grantville sand extraction/processing operation.

Schedule A of [SEPP (AQM)] defines design ground level criteria for particulate (dust) emissions from point sources; however, these criteria are not applicable to emissions from area or diffuse sources such as sand extraction/processing operations.

The Protocol for Environmental Management for Mining and Extractive Industry[2] (the PEM) is an incorporated document of EPA's State Environment Protection Policy (Air Quality Management). The PEM sets out the requirements for assessment and management of emissions from the mining and extractive industries. Relevant provisions of the PEM are summarised below:

Section 1.1 of the PEM notes that:

> *"An air quality assessment in accordance with this PEM is required only for proposals requiring an Environment Effects Statement or an EPA Works Approval and Licence or where specifically required by DPI. DPI are likely to request an air quality assessment only when activities that are likely to generate increased emissions of the indicators specified in this PEM or will have significantly increased emissions at sensitive locations".*

The PEM does not require monitoring for suspended particulates at sites where air quality assessments are not required (Section 6.2). However, Section 4 notes that:

> *"Deposited dust is an indicator of the effectiveness of site management practices and the potential for off-site nuisance - - Results of monitoring* [at upwind and downwind locations] *should not exceed 4 g/m^2/month (no more than that 2 g/m^2/month above background) as a monthly average".*

DPQ has been monitoring dust deposition rates at three locations (on the Bass Highway and adjacent to the nearest residence). The results are summarised in the following section.

7. DUST MONITORING

Dust deposition rates have been determined by Ektimo each month since January 2013 at the three locations shown in Fig 1. The results, recorded as grams of inorganic solids per square meter per month, for 2017 and 2018 are presented in Attachment 2, and may be summarised as follows:

- the annual average dust deposition rates for the three gauges varied between 0.35 and 1.5 g/m^2.month in 2017 and between 0.85 and 1.3 g/m^2.month in 2018;
- these values are broadly typical of background levels and suggest that the dust emissions from the current sand extraction operation is not having any significant effect on the amenity of nearby residents; and
- the highest value of 7.4 g/m^2.month was recorded in April 2017 at gauge 5 (located at the entrance/exit to the site on the Bass Highway) – this is not indicative of elevated emissions from the sand extraction operations, because the results for that month at the other two gauges were around 0.5 g/m^2.month. Subsequent investigation revealed the abnormally high reading at gauge 5 was due to works (installation of TAC wire barriers) on the Bass Highway in close proximity to gauge 5 during this period).

2 EPA (December 2007). "Protocol for Environmental Management for Mining and Extractive Industry". EPA Publication 1191.



Fig 1. Dust deposition gauge locations as shown in Ektimo report (the satellite image reflects the development of the project in 2017

8. EXPERIENCE WITH SIMILAR OPERATIONS

My experience in environmental investigations at numerous quarries and mines over the past 25 years indicates that, while there is a widely-held community perception that such sites are major dust sources, this is not the case for well-managed operations.

One of the most important factors which determines the extent of off-site dust emissions from a particular operation is the calibre of the site management, and their level of commitment to conduct an environmentally sound operation and protect the amenity of nearby landowners. A good site manager will make use of weather forecasts. The Bureau of Meteorology's 10-day climate model forecasts are available online from Weatherzone, in the form of "meteorograms", which present 6-hourly predictions (for the next 10 days) of a range of parameters, including temperature, relative humidity, rainfall, and wind speed and direction). Reference to the meteorograms enables pro-active control measures to be implemented in advance of potentially adverse weather situations.

Such measures can include increasing water application rates in advance of hot windy conditions and deferring or curtailing any potentially dusty site operations during adverse weather conditions. Good managers are also pro-active in seeking to establish good relations with neighbours and have effective systems in place to record and respond to any complaints (including modifying operations where appropriate to minimise dust emissions).

This approach invariably results in substantially lower off-site dust levels as compared with operations where a low priority has been placed on protecting local amenity during design, development or operational stages.

DPQ site personnel have demonstrated that they are well aware of the need to minimise off-site dust emissions and have been implementing proactive measures to minimise particulate emissions from the operation.

9. DUST MANAGEMENT PLAN

DPQ's Dust Control Management Plan, endorsed as part of Planning Permit No.120388, is provided as Attachment 3. The provisions of the plan, reviewed and updated as applicable at December 2019 are summarised below.

1. **Air Quality (Dust Control) Objectives and Performance Indicators**
   - The applicable objectives are: (1) to ensure that no visible dust emissions are detected beyond the site boundaries; and (2) to ensure that dust emissions comply with relevant guidelines in EPA's Mining and Extractive Industries PEM.
   - Corresponding performance indicators are: (1) visual observations of dust beyond; and (2) measured dust deposition rates at the site boundary.

2. **Dust Control Program**
   - Trafficable Areas:
     - Water will be applied to trafficable areas through the use of a water tanker truck fitted with spray bars and a cannon, fixed sprays and sprinkler systems;
     - Water will be applied proactively as a dust control measure before the onset of potentially dusty weather conditions (based on Bureau of Meteorology weather predictions);
     - Approved chemical dust suppressants may also be applied where appropriate to enhance dust control and to reduce the volume of water required for effective dust control;
     - All Haul Truck movements will be kept to designated haul routes to minimise the extent of trafficked areas; and
     - Ancillary and administrative vehicle speeds on-site will be limited to 25 kilometres per hour (kph).

   - Truck Movements – Entry & Exit to Site:
     - The site entry and exit to the Bass Highway will be sealed and swept as required to control the accumulation of dust;
     - Loads will be covered or be wet-down as required to prevent dust emissions;
     - The tailgates of all trucks leaving the site will be securely closed; and
     - Where sediment or mud is deposited on a public road, this will be cleaned-up immediately by DPQ.

- Plant and Processing Hard Stand Area:
    - Surfaces on which front-end wheel loaders operate will be treated with water (including dust suppressants where appropriate);
    - Loader operations will be conducted in a manner designed to minimise dust generation;
    - Periodic watering of the remainder of the Plant and Processing Hard Stand Area will be undertaken as required;
    - Water sprays will be installed, fully maintained and used whenever the screening and blending plant is operating; and
    - All sections of the Hard Stand Area shall be kept in a clean and tidy condition at all times.

- Stockpiles:
    - Sprinklers will used to apply water to the raw sand and finished product stockpiles as required to minimise dust generation;
    - Approved dust suppressants may be used to seal surfaces and minimise dust emissions
    - Sprinklers shall have the ability to operate out of working hours; and
    - The DPQ Grantville Site Quarry Manager/Supervisor will monitor the condition of the stockpiles.

- Site Supervision:
    - The Manager/Supervisor will monitor those areas and operations of the site that have the potential to generate dust - all staff will be required to immediately advise the Quarry Manager/Supervisor if they observe significant dust generation.

- Contingencies:
    - During those times of the year with higher evaporation rates (September – April) 10-day Bureau of Meteorology climate model of meteorograms will be downloaded to provide advance warning of strong winds and very hot weather conditions - this will assist with the daily and proactive management of dust suppressant measures, which may include the suspension of extraction and screening and blending operations for the duration of the adverse weather conditions;
    - Where strong winds are forecast which will place operations upwind from nearby sensitive uses, proactive dust suppression measures will be implemented; and
    - If off-site dust emissions are observed, or indicated by elevated dust deposition monitoring data, additional/proactive dust suppression measures will be implemented until such time as effective dust control is achieved or conditions abate.

- Scheduling Potentially Dusty Operations:
    - Potentially dusty operations, such as overburden removal and placement, and installation of screening bunds will, whenever practicable, be conducted between the Autumn break and the end of November (this may not be possible in the case of the initial development works in Year 1, which will be predominately towards the eastern end of the development).

- Dust Monitoring
    - The dust monitoring program is designed to facilitate an adaptive management approach to the control of dust;
    - The Quarry Manager/Supervisor will undertake daily visual site inspections for dust generation including an assessment of the dust suppression measures;
    - Two dust deposition gauges will be located on the DPQ Grantville Sand Quarry site boundaries at locations to be determined in consultation with DPI. The results of monthly sampling will be used to assess compliance with the PEM dust deposition guidelines. This monitoring may be discontinued after a period of 24 months, subject to compliance with the PEM guidelines.

10. POTENTIAL EFFECTS ON LOCAL AMENITY

My assessment of DPQ's proposal to expand its Grantville sand extraction operation is that, providing the dust control management plan (Attachment 3) is implemented, dust emissions should not have any significant adverse impacts on local amenity. Key factors which led me to this conclusion include:

- the nearest sensitive land uses (dwellings) are located more than 200 m from the edge of the existing (and proposed) extraction zone and over 500 m from the sand processing/stockpiling area;
- the nearest (rural) residence to the northeast is over 900m from the proposed) extraction zone;
- the proposed wet extraction and sand washing operations will not make any significant contribution to dust emissions;
- local winds are predominantly from the west and northwest sectors, which will place the operation downwind of the nearest sensitive uses – in particular, weather conditions which have the greatest potential to generate elevated dust emissions during the summer and autumn months are strong, hot winds from the north to northwest sector;
- the internal access road between the Bass Highway and the weighbridge and stockpile area is sealed, while trucks exiting the site are required to drive through a wheel wash;
- the measures and safeguards set out in DPQ's dust control management plan are comprehensive, achievable and more stringent than those described in EPA's Best Practice Management Guidelines for Major construction Sites[3];
- the December 2019 report by Water Technology[4] has reviewed actual annual water demand for site dust suppression over the last five years and projected future peak annual demand for dust suppression for the expanded operation to be less than 10ML. The report confirms that this water will be sourced from on-site storage dams and groundwater and forms part of its overall water balance for the site;

[3] EPA (December 1995). "Environmental Guidelines for Major construction Sites". Best Practice Management Guidelines Series, Publication 480.

[4] Water Technology (December 2019). "WA 1488 Grantville – work plan variation expansion of sand extraction operations, sand washing & dewatering plant." Prepared for DPQ.

- the site construction (infrastructure establishment) phase has been completed, reducing the demand for dust suppression water on open areas of earthworks;
- importantly, the dust control management plan provides for operations to be suspended during extreme weather conditions which could result in significant off-site dust emissions upwind from nearby sensitive uses; and
- ongoing dust monitoring will provide an indication of the contribution of the operation to dust deposition rates in the vicinity of the nearest sensitive land uses



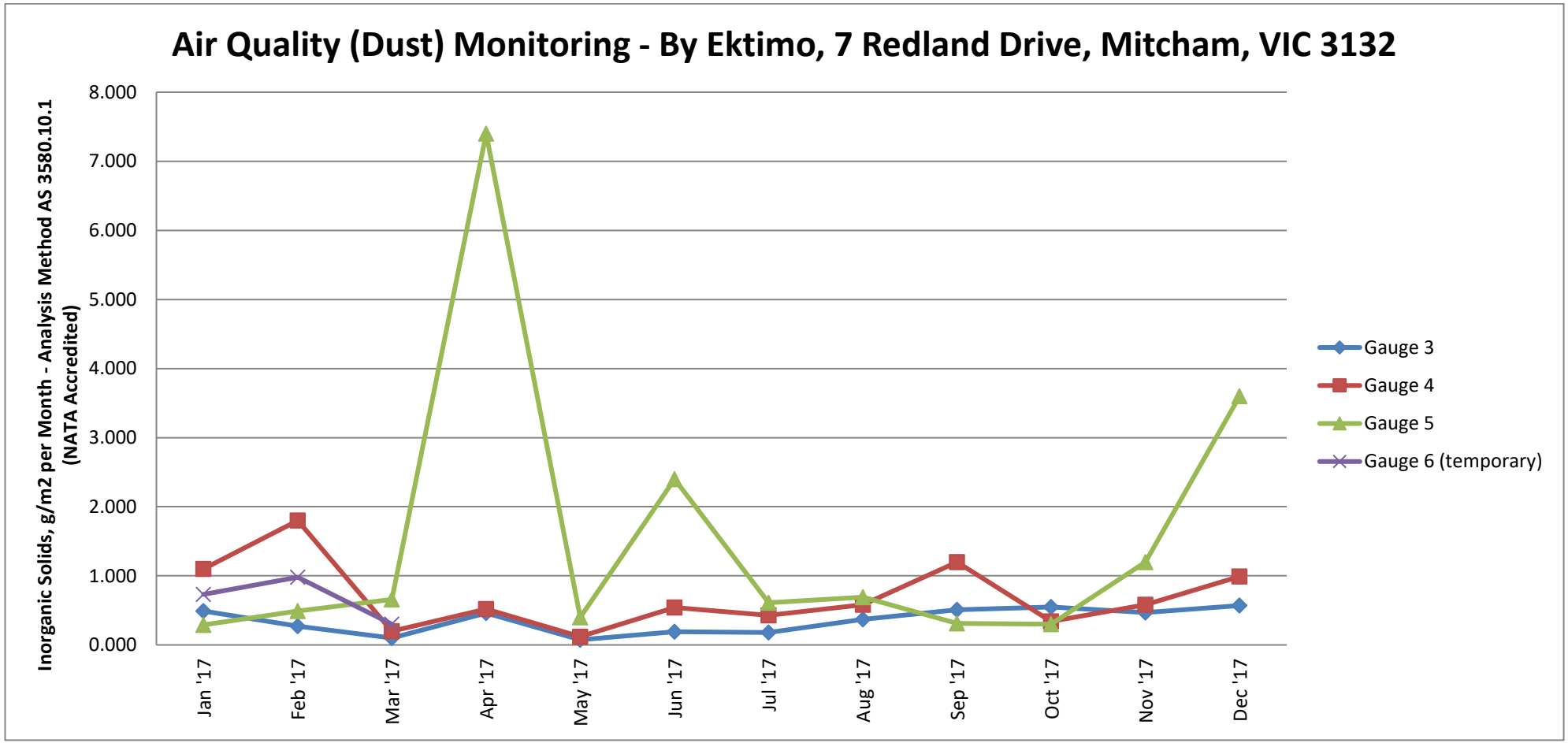
(Dr) Terry Bellair FVEPLA, FEIANZ

ATTACHMENT 1. EXTENT OF PROPOSED EXTRACTION AREAS

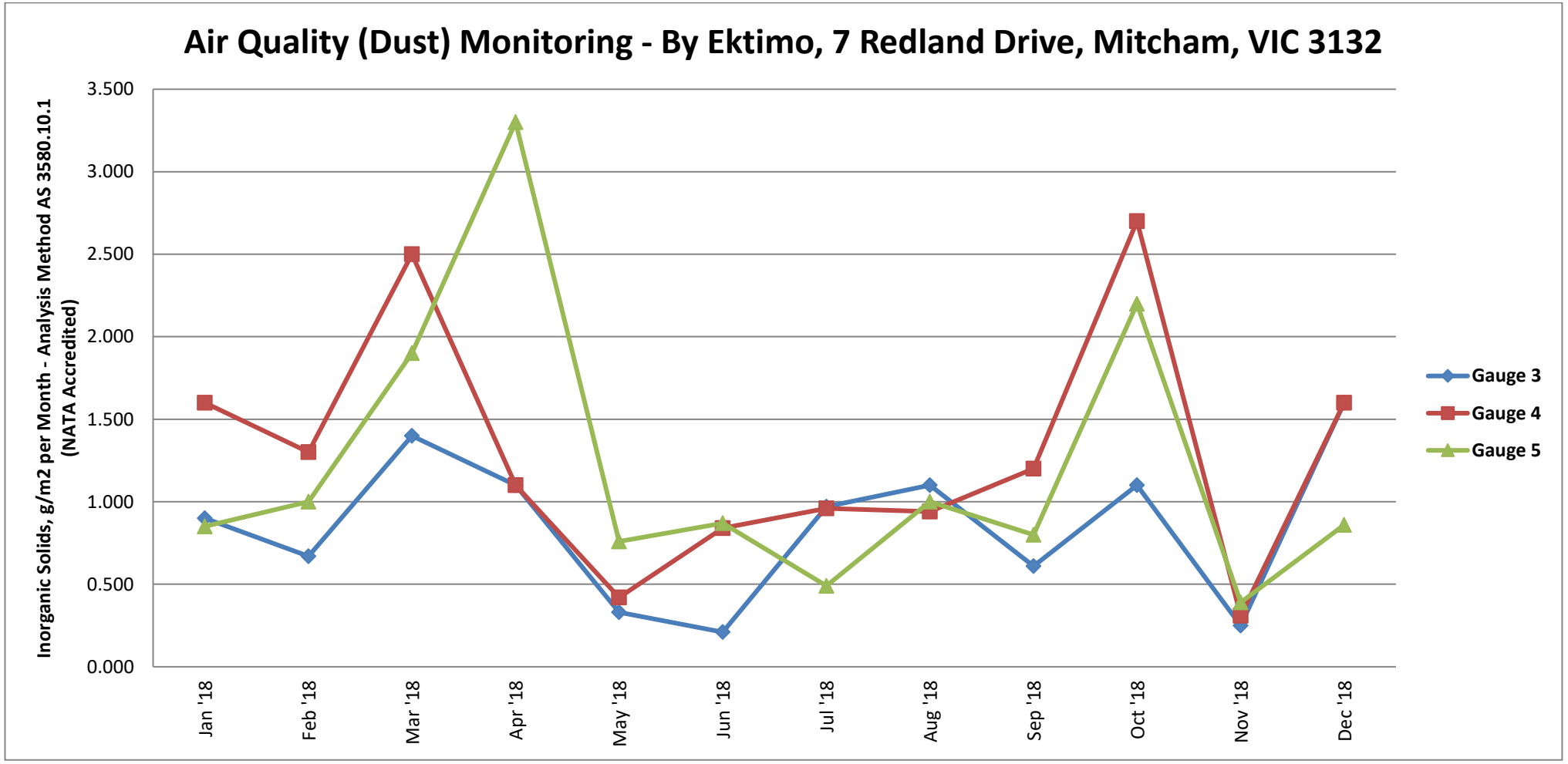


ATTACHMENT 2. DUST MONITORING RESULTS, 2017 AND 2018

2017



2018


Air Quality (Dust) Monitoring - By Ektimo, 7 Redland Drive, Mitcham, VIC 3132
Inorganic Solids, g/m2 per Month - Analysis Method AS 3580.10.1 (NATA Accredited)
3.500
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Gauge 5

ATTACHMENT 3. DUST MANAGEMENT PLAN

DPQ GRANTVILLE SAND QUARRY
DRAFT DUST CONTROL MANAGEMENT PLAN – Updated 12 December 2019

1. Air Quality (Dust Control) Objectives and Performance Indicators

The Dandy Premix Quarries Grantville Sand Quarry site objectives applicable to air quality and dust control are:

- ***To ensure that no visible dust emissions generated by the quarry operations are detected beyond the site boundaries; and***

- ***To ensure that dust emissions comply with relevant guidelines in the Mining and Extractive Industries PEM.***

Corresponding performance indicators to be used to monitor the achievement of these objectives are:

- Visual observations of dust beyond the quarry site boundary; and
- Measured dust deposition rates as recorded through the site monitoring program in accordance with the operational control requirements of the PEM.

2. Dust Control Program

Dust will be controlled by implementation of the actions below:

Trafficable Areas:

- Water will be applied to trafficable areas around the processing plant, raw sand and finished product stockpiles on the Hard Stand Area through the use of a water tanker truck fitted with spray bars and a cannon, fixed sprays and sprinkler systems;

- Water will be applied to designated Haul Roads by fixed sprinklers where road moisture content is low and dust would otherwise be generated from Haul Truck passage;

- Water will be applied proactively as a dust control measure before the onset of potentially dusty weather conditions (based on Bureau of Meteorology weather predictions);

- Approved chemical dust suppressants may also be applied where appropriate to enhance dust control and to reduce the volume of water required for effective dust control;

- All Haul Truck movements will be kept to designated Haul Roads to minimise the extent of trafficked areas; and

- Ancillary and administrative vehicle speeds on-site will be limited to 25 kilometres per hour (kph).

Truck Movements – Entry & Exit to Site:

- The DPQ Grantville site entry and exit to the Bass Highway is sealed (paved) and swept as required to control any accumulation of dust;

- Loads will be covered or be wet-down when required to prevent the emission of dust from materials being transported;

- The tailgates of all trucks leaving the site will be securely closed to prevent any loss of materials;

- Trucks will be required to drive through the wheel wash when wet conditions on the hardstand result in significant material attached to their tyres; and

- Where sediment or mud is deposited on a public road, by trucks departing DPQ Grantville, this will be cleaned-up immediately by DPQ.

Plant and Processing Hard Stand Area:

- Surfaces on which front-end wheel loaders operate will be treated with water (inclusive of approved chemical dust suppressants where appropriate) to ensure minimal dust generation;

- Loader operators are trained and will operate in accordance with their training to fill bins, hoppers, stockpiles and delivery trucks in a manner that minimises dust generation;

- Approved chemical dust suppressants may be applied to the most trafficked sections of the sales (loading) and sand processing Hard Stand Area;

- Periodic watering of the remainder of the Plant and Processing Hard Stand Area is to be undertaken with a water tanker truck as required;

- Water sprays will be installed, fully maintained and used whenever the screening and blending plant , including the raw feed bins and the radial conveyor (transfer) stacker are operating; and

- All sections of the Hard Stand Area including the sales loading, weighbridge and the sand processing and dewatering plant shall be kept in a clean and tidy condition at all times.

Stockpiles:

- Sprinklers will be maintained and operated to apply water to the surfaces of the raw sand and finished product stockpiles as required to minimise dust generation;

- Approved chemical dust suppressants may be used to seal surfaces and minimise dust emissions where appropriate;

- Sprinklers shall have the ability to operate out of working hours if required; and

- The DPQ Grantville Site Quarry Manager/Supervisor will monitor the condition of the stockpiles.

Site Supervision:

- The DPQ Grantville Quarry Manager/Supervisor will monitor those areas and operations of the site that have the potential to generate dust to ensure dust control actions are being satisfactorily undertaken as required to mitigate and/or minimise dust generation. All staff will be required to immediately advise the Quarry Manager/Supervisor if they observe significant dust generation.

Contingencies:

- During those times of the year with higher evaporation rates (September – April) the DPQ Grantville Quarry Manager/Supervisor will download 10-day Bureau of Meteorology climate model predictions (available in the form of meteorograms to "Weatherzone" subscribers) which provide advance warning of likely strong winds and very hot weather conditions. This will assist with the daily and proactive management of dust suppressant measures. These measures may include the suspension of overburden, or sand extraction and sand washing, screening and blending operations for the duration of the adverse weather conditions.

- Where strong winds are forecast which will place operations upwind from nearby sensitive uses, the DPQ Grantville Quarry Manager/Supervisor shall implement proactive dust suppression measures such as undertaking additional dust suppression measures on stockpiles and haul routes; and

- If off-site dust emissions are observed or indicated by elevated dust deposition monitoring data, additional/proactive dust suppression measures will be implemented. These may include:

    - Increased use of water and approved chemical dust suppressants;
    - A reduction of all vehicle speeds on site; and
    - The suspension of works in the area generating the dust;

    Until such time as effective dust control is achieved or conditions abate.

Scheduling Potentially Dusty Operations:

- Potentially dusty operations, such as overburden removal and placement, and installation of screening bunds will, whenever practicable, be conducted between the Autumn break and the end of November (this is particularly the case for overburden removal and other potentially dust generating works predominately towards both the western end of the FMSEP and the site).

3. Dust Monitoring Actions

The DPQ Grantville Sand Quarry dust monitoring program is designed to facilitate an adaptive management approach to the control of dust. The monitoring of dust generation and dust emissions will be undertaken as follows:

- The DPQ Grantville Quarry Manager/Supervisor will undertake daily visual site inspections for dust generation including an assessment of the dust suppression measures in operation at the time of inspection;

- Three dust deposition gauges are located on the DPQ Grantville Sand Quarry site boundaries at locations determined in consultation with DPI. The results of monthly sampling are used to assess compliance with the PEM dust deposition guidelines. This monitoring is ongoing, subject to compliance with the PEM guidelines and is reported every four months to the Grantville Environmental Review Committee (ERC).

REPORT 8 – ECONOMIC AND SOCIAL IMPACT STUDY



CONTINUED OPERATION AND EXTENSION OF THE DANDY PREMIX SAND QUARRY AT GRANTVILLE: ECONOMIC AND SOCIAL IMPACTS

A report for

DANDY PREMIX CONCRETE PTY LTD

Prepared by the

National Institute of Economic and Industry Research

JUNE 2020

Continued operation and extension of the Dandy Premix Sand Quarry at Grantville: Economic and social impacts

A report for
DANDY PREMIX CONCRETE PTY LTD

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June 2020

While the National Institute endeavours to provide reliable forecasts and believes the material is accurate, it will not be liable for any claim by any party acting on such information.

Photographs throughout the document courtesy of Dandy Premix Quarries Pty Ltd.

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Executive summary

Currently Dandy Premix operates a sand quarry at 1381-1395 Bass Highway Grantville. The sand reserves to which the present planning permit allows access are limited and will be exhausted within a few years. The Department of Jobs, Precincts and Regions, Earth Resources Regulation branch (DJPR/ERR) has endorsed variations to the Work Authority to allow the quarry to be further developed. More specifically:

- the area from which sand can be extracted will increase, including the opening of a new quarry face in the eastern part of the property which will allow the extraction of coarse sand;
- sand extraction from below the water table will be permitted using a dredge and de-watering equipment (see Sections 4.2, 4.3); and
- the introduction of sand washing plant and operations are endorsed.

These changes will be accompanied by environmental safeguards, including offsets for native vegetation, a groundwater management plan and measures to ensure that surface water runoff meets required standards before leaving the quarry site. The further development of the sand quarry is expected to extend the life of the quarry by approximately forty years, but requires amendment to the existing planning permit.

The proposal has a number of advantages for Bass Coast.

1. Job generation

Bass Coast experienced a minor boom when the desalination plant was under construction but since 2016 job generation in two important parts of its economic base, agriculture and tourism, appears to have faltered. In addition to these adverse trends, over the past few months coronavirus restrictions have seriously reduced employment in food services and accommodation and the resulting uncertainties have dampened the confidence required to support further investment in tourism and related industries. In this context construction, and specifically sand quarrying, have been a bright spot. Not only has employment been maintained but positive investment is in prospect (see Chapter 2, The Bass Coast Economy).

In the financial year 2020-21 it is expected that, in addition to the jobs required for continued operation of the current quarry, the project will generate:

- jobs in on-site construction amounting to 8.4 FTE positions over the year;
- other jobs in Bass Coast due to local purchase of services and other inputs amounting to 13.2 FTE positions; and
- a further 8.4 FTE jobs in Bass Coast as local employees among the two groups already mentioned spend the incomes which they receive.

After a period of transition over the next two years, from 2023-4 onwards it is projected that the project will generate, each year:

- 15 FTE jobs in on-site operations (possibly more if local residents can be found who are experienced and available to drive heavy trucks);
- 5 FTE jobs due to local purchase of services and other inputs; and
- 12.4 jobs in Bass Coast as the 20 employees so far mentioned spend their incomes. These increases will be spread across all of the Shire's industries.

The expanded employment will include:

- opportunities for workers to upgrade their qualifications and hence incomes; and
- several positions in management and laboratory services which are likely to attract highly qualified personnel to the Shire. The attraction of such personnel can have major benefits in broadening business networks in the Shire and in ensuring that enterprising and qualified people are available to identify and take advantage of emerging opportunities.

It is estimated that, in the long run, the upgrading of skills and entrepreneurship has the capacity to generate, at 50 per cent probability, something like 13 further jobs (see Section 4.5).

These employment increases will be accompanied by similar – indeed in percentage terms, slightly larger – increases in gross value added (Gross Regional Product) in the Shire. All estimates derive from the investment proposal itself and from an assessment using NIEIR's dynamic model of the Bass Coast economy, which covers trade and commuting relationships with other regions and the input-output relationships between the Shire's industries and residents (see Chapter 5).

2. Environmental benefits

While in operation, sand quarries are not regarded as scenic assets. However, in the present case:

- the proposed operations are well buffered from neighbouring landholders;
- effects on traffic on the Bass Highway can be minimised by the provision of vehicle-activated traffic lights at the quarry exit. These will reduce truck traffic through the Grantville town centre. Inclusion of pedestrian actuation will improve access to the southbound bus stop on Bass Highway (see Section 4.4);
- ongoing implementation of native vegetation plantings under the Landscape and Revegetation Plan, Spring 2013 (an endorsed document forming part of Planning Permit No.120388) on the western portion of the property will provide additional site screening and improved visual appearance to Bass Highway traffic; and
- progressive rehabilitation will also being forward some of the benefits of the redeveloped site, especially at higher site elevations.

When the site is vacated, the retention and offset program for native vegetation will have created a continuous, more sustainable belt of lowland forest linking *The Gurdies Nature Conservation Reserve* with the *Grantville Bushland Reserve* via the eastern part of the property. Final remediation will afford three main opportunities.

- The extended bushland can be managed for public benefit.
- The upper elevations of the site will become available for imaginative re-use, potentially including some residential development.
- It will not be possible to rehabilitate (backfill) all of the lower (western) part of the site to its original pre-quarrying state, nor will it necessarily be desirable, since the original state of the property at the commencement of operations in 2012 was marginal pasture devoid of native vegetation. Approximately 24 hectares of this part of the site will be retained as a freshwater lake. There will be opportunities to develop the lake and its surrounds both for the benefit of wildlife and for recreational and/or commercial purposes.

Putting these three groups of opportunities together, the WA1488 and adjoining Dandy Premix sites have significant potential for redevelopment as a Gateway to the Bass Coast. This would take advantage of its location where the Highway, having traversed the Koo Wee Rup swamp and The Gurdies bushland, emerges into the attractive scenery of Bass Coast at Grantville (see Section 4.6).

3. Role in the construction industry

Extension of the sand quarry accords with state government strategy for the extractive industries, which is designed to maintain the supply of construction materials at affordable costs provided environmental and planning considerations are satisfied. It will contribute to continued supply of construction inputs at competitive prices (see Chapter 3). Even though the Dandy Premix sand quarry is purposed to supply the Melbourne Supply Area (MSA) market, its potential to also supply Bass Coast will contribute to the continued competitive pricing of construction materials within the Shire (see Section 4.1).

1. Introduction

In 2012 NIEIR prepared an economic and social impact study for the then-proposed Dandy Premix sand quarry at Grantville. A planning permit having been granted, the quarry was constructed and has now been in operation for several years.



Grantville FMSEP resource investigation, 2 December 2014.

The 2012 report foreshadowed that 'if the prevailing and forecast economic conditions are appropriate, if the demand for the site resource (sands) is well established and performance against the DPI (now DJPR/ERR) Work Authority and Council Planning Permit has been to the satisfaction of both DJPR/ERR and Bass Coast Shire Council' a proposal will be developed to proceed with a Phase 2 Development. That time has now arrived.

The present study builds on the 2012 report to assess the economic and social impact of the further development of the sand quarry within the currently approved Work Authority area, i.e. it is not a quarry expansion encompassing additional land. The proposal includes deeper extraction and development eastwards of the existing Fine Medium Sand Extraction Pit (FMSEP) and establishment of a Coarse Sand Extraction Pit (CSEP) on the upper, eastern levels of the site, running parallel to the Heath Hill Fault line.

These further extraction area developments, in conjunction with the introduction of sand washing and slimes dewatering, go beyond what is permitted under the present planning permit.

The impact of extending the quarry is assessed by comparing two cases.

- A Base-case in which the current (FMSEP) extraction area is exploited to its approved limits set out in Permit No.120388. At current rates of production the quarry will be exhausted by 2023, after which the rehabilitation plan incorporated in the DJPR/ERR approved Work Authority will be implemented and the site returned to pasture with substantial plantings of native vegetation. However, as noted in 2012, the original pasture was of poor quality. Its substratum of sand, underlying a substantial layer of plastic clay, meant that the thin layer of low quality topsoil dried out rapidly between rain events. It will not be possible to remedy this deficiency in the course of remediation.
- A Quarry-extension case in which the present quarry is deepened (allowing sand extraction below the Groundwater table) and is extended eastwards and a coarse sand extraction pit is established to access a large deposit of coarse sands. Coarse sand is required to blend with the medium to fine particle sized sands already produced to produce concrete sand. This will overcome the need to externally purchase coarse sand and is expected to extend the date of quarry closure by 40 years, after which the site will be available not only for rehabilitation, but for imaginative regeneration and repurposing. Opportunities will include reafforestation of the eastern upper hillside and opportunities associated with the creation of the 24 hectares surface area lake, including wetland, recreational and commercial developments.

These cases are compared in the context of the Bass Coast economy as a whole.

2. The Bass Coast economy

By road, Bass Coast Shire is located between 100 and 170 km south-east of the Melbourne city centre. The Shire has a lengthy coastline, including Phillip Island and further frontages to both Westernport Bay and Bass Strait. Inland, the Shire extends up to 40 km into the South Gippsland hill country.

As in much of Gippsland, European settlement took place a little later than in most of Victoria. However, Cowes gained a Post Office in 1869 and Inverloch in 1883. Both townships served as minor ports for their coastal hinterlands and have grown into rural service centres with a strong resort and retirement component.

By contrast, Wonthaggi, where the main municipal offices are now located, was founded in 1910 to serve the coal mine by which the Victorian Railways hoped to reduce their reliance on NSW coal. The mine closed in 1968 and became a heritage park as Wonthaggi moved to diversify its economic base.

In addition to the three major towns of Wonthaggi, Cowes and Inverloch, the Shire has several smaller towns, most of them along the coast. Among the smaller settlements, Grantville, located on the eastern shore of Westernport Bay, is the first of the Bass Coast towns encountered by travellers arriving from Melbourne via the Bass Highway. It is developing as a service centre for the northern part of the Shire and has untapped potential to become a true 'gateway' to the Bass Coast.



Bass Coast Shire

2.1 Population, employment and the structure of income

The rate of growth of the Shire's population has fluctuated. In the mid-1990s the rate was low, but at the turn of the 21st Century the Shire experienced a burst of population growth. The growth rate fell away around 2002 but revived after 2007 and from 2015 to 2019 averaged 2.6 per cent a year. In 2019 the Shire had a usual resident population of 36,000.

In that residents require dwellings, population growth generates dwelling construction. However, in Bass Coast this relationship has been mediated by two further variables.

- The dwelling vacancy rate has long been above state or national average due to the Shire's prominent role as a location for holiday homes. In 2019 this rate stood at 44 per cent compared to the national rate of around 11 per cent. (The Census is taken on a late winter weekday when most holiday homes are vacant. Even if they are occupied, they may be deemed vacant after their occupants have been reallocated to their place of usual residence).
- As is to be expected in a Shire with a generous sprinkling of retirees, the average number of residents per occupied dwelling is also below national average, 2.39 in 2019 as compared to the national average of 2.66.

In the 1990s the vacancy rate stood at around 34 per cent of all dwellings in the Shire, while the average occupancy rate fell from 2.50 to 2.38 during the course of the decade. A burst of population growth from 1998 to 2001 reduced the vacancy rate to 31 per cent and reversed the decline in the occupancy rate.

This reversal kick-started a burst of dwelling construction which resulted in an increase in the vacancy rate to 48 per cent in 2006 accompanied by renewed decline in the occupancy rate, which fell to 2.34 in 2013. The dwelling construction rate responded by declining and from 2010 to 2019 was less than the population growth rate, with corresponding gradual falls in the vacancy rate and, more recently, increases in the occupancy rate.

The high proportion of retirees and pre-retirees in the population is reflected in a low workforce participation rate.

In 2019, 43 per cent of the population held jobs, as compared with 46 per cent in Gippsland as a whole (Bass Coast, South Gippsland, Baw Baw, Latrobe, Wellington and East Gippsland) and 50 per cent in all of Australia.

Work incomes are also limited by the high proportion of part-time workers. In 2019 weekly hours per employed resident averaged 19, compared to 24 in both Gippsland as a whole and Australia-wide.

Average weekly hours worked per person employed in Bass Coast fell as low as 16 at the turn of the 21st Century, but rose to 20 during the years when the desalination plant was under construction. High reliance on part-time labour is a strong characteristic of the tourist industry that is very prevalent in Bass Coast.

Thanks largely to the prominence of retirees in the population, but also to the high reliance on part-time jobs, the structure of incomes received by Bass Coast households differs from the national average. In aggregate, Bass Coast households depend more on Centrelink incomes (especially the age pension) and less on wage incomes. The proportion of income received from social security is around double the national average.

With the gradual maturing of the national superannuation provisions one might expect that many retirees would be receiving superannuation pensions and other property incomes. However, in Bass Coast the proportion of income derived from such receipts is around national average. This indicates that Bass Coast retirees are not especially wealthy.

The proportion of income received as small-business profits is not far below national average, but the proportion received as wages and salaries is well below, around two-thirds of the national average. In partial compensation, the proportion returned to the government in direct taxes is around half national average.

Given this structure of incomes, it is no surprise that income per capita in Bass Coast is below Australian average. The exact amount by which it is below depends on the definition of income. Using disposable income per capita, in 2019 Bass Coast residents received average incomes roughly 19 per cent below the Australian average and 18 per cent below the average for Gippsland as a whole.

It is estimated that per-capita disposable incomes in Bass Coast grew slowly in the 1990s (around 1 per cent a year); rapidly during the national residential construction boom of 1999-2007 (over 4 per cent a year) and less rapidly during the following 'mining' boom (around 2 per cent a year).

Since 2014 they have declined at around 1 per cent a year – aggregate disposable income grew at 1.5 per cent a year, well below the population growth rate of 2.6 per cent a year. These growth rates are all broadly consonant with those for the Australian economy as a whole.

Bass Coast participated fully in the property boom of the early 2000s, less fully in the mining boom (which missed much of Victoria), but once again participated fully in the period of malaise, which followed the end of the mining boom.

There are preliminary indications that the lacklustre growth of incomes in Bass Coast in the years from 2014 to January 2020 was related to the decline in the rate of dwelling construction: less construction, less business income and less rental income. However, the rate of growth of wage income held up, partly because of an increase in commuting to jobs located outside the Shire.

Figure 1: Bass Coast – Population and dwellings – 1999-2019

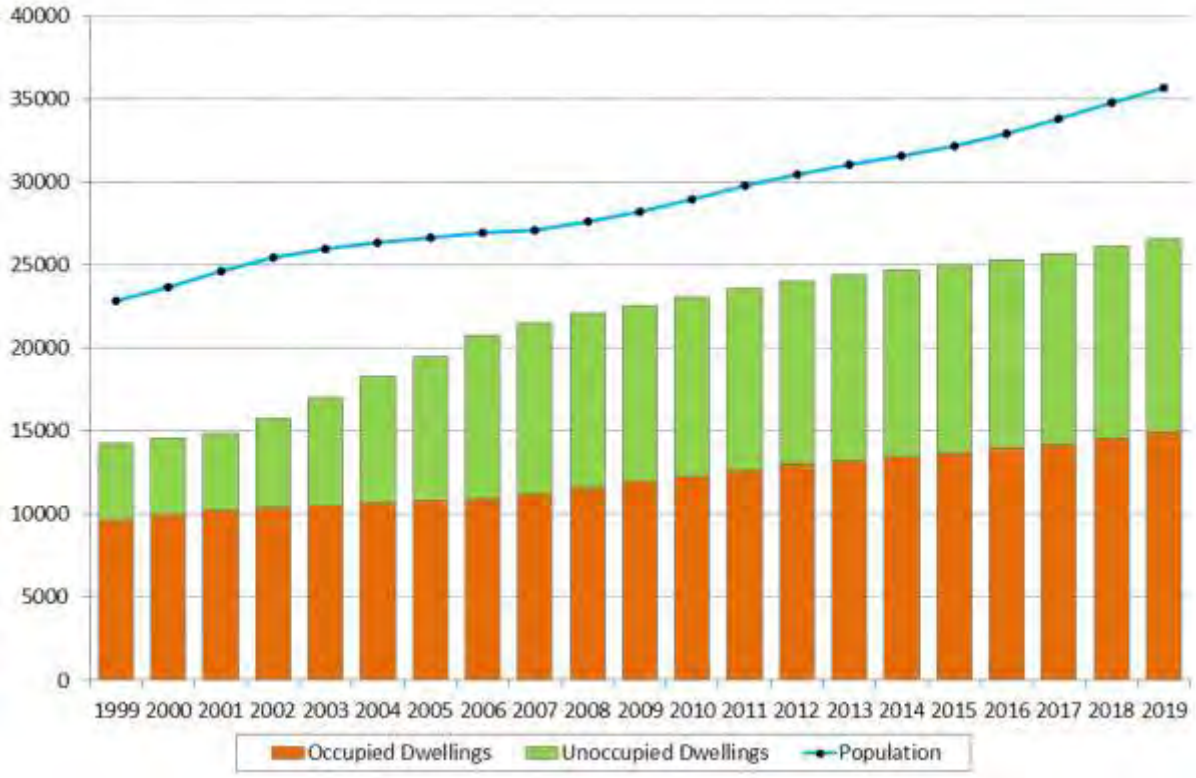


Figure 2: Bass Coast – Increase in population and dwelling stock – 1999-2019 (per cent per annum)

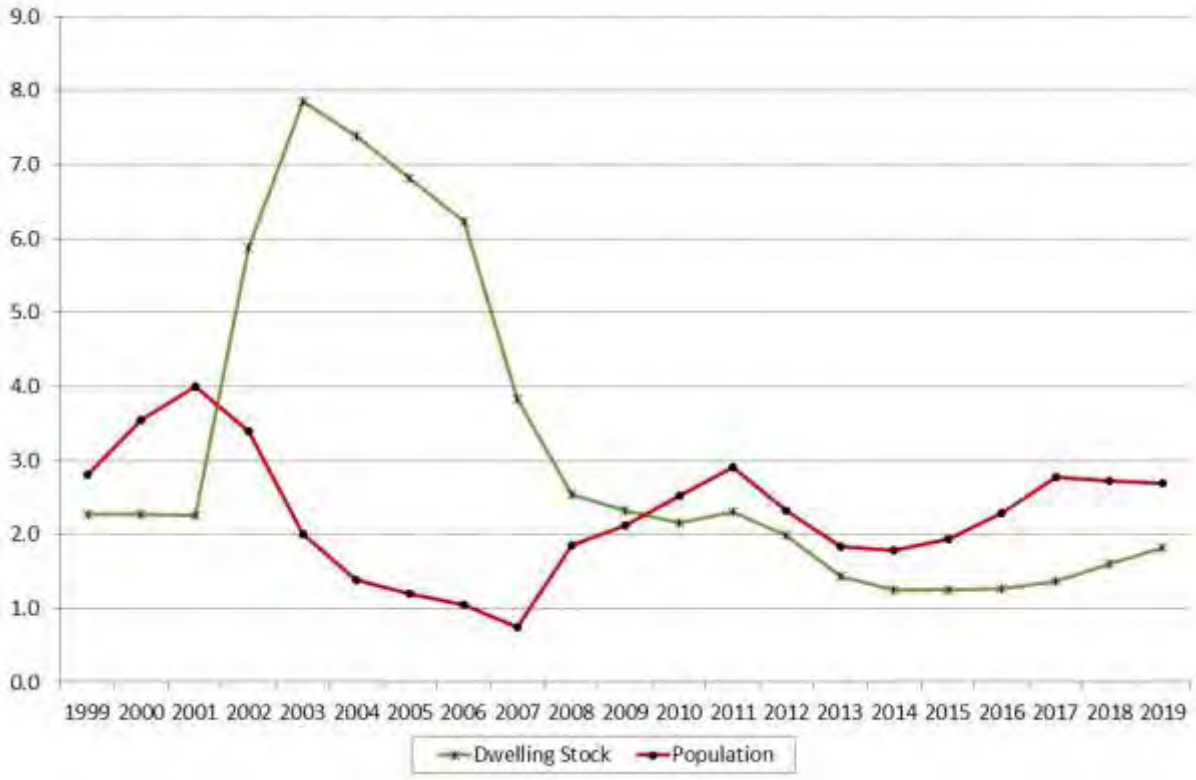
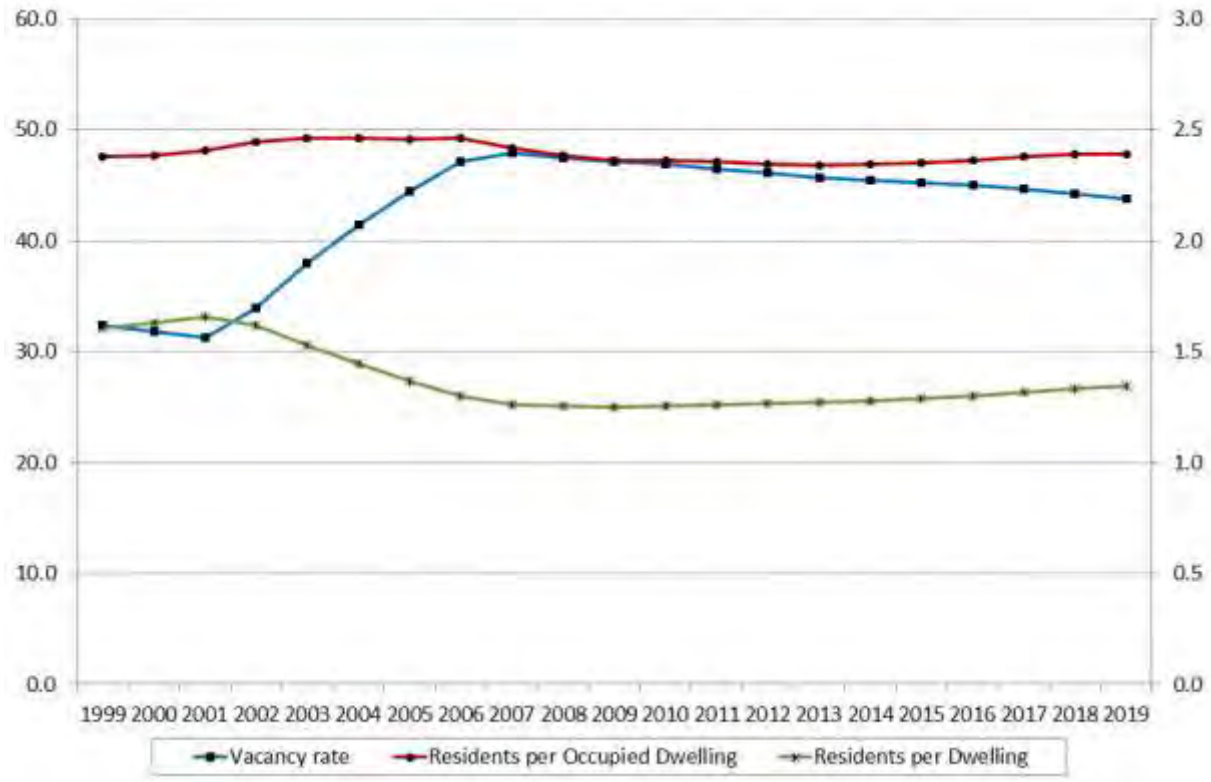


Figure 3: Bass Coast – Dwelling vacancy rate (per cent, left hand side) and persons per dwelling (right hand side) – 1999-2019



2.2 Employment

- Labour markets are tight in the core metro regions.
- They are slack in the outer metro regions.

In 2019 there were 12,500 jobs in the Shire, sufficient to employ 35 per cent of the population if none were taken by commuters from outside the Shire. However, 43 per cent of the Shire's population were employed, meaning that at least 19 per cent of employed residents were working outside the Shire – the actual proportion would be higher after making allowance for incoming commuters.

Net outbound commuting from Bass Coast increased rapidly during the period from 2010 to 2019. During the 1990's a minimum of 12 per cent of employed residents worked outside the Shire.

This proportion did not change during the dwelling construction boom in the years around 2000 but disappeared while the Wonthaggi desalination plant was under construction – from the middle of 2010 to early 2012 there was net inbound commuting into the Shire. This reflected the temporary nature of the construction project: many of those engaged in the project, and especially those with specialised skills, did not expect to keep working in the Shire after the completion of the project and therefore elected to commute rather than to transfer residence.

Since 2012 there has been a substantial increase in net outbound commuting. Over the five years 2014-19 the number of jobs generated within the Shire grew by 1 per cent a year but the number of employed residents grew by 3 per cent a year, with the difference made up by the increase in outbound commuting.

By comparison with Gippsland as a whole, Bass Coast relies less heavily on agriculture for employment and relatively heavily on three other key industries:

- Construction – even though the heady days of the turn of the century boom and the building of the desalination plant have passed, the Shire's peri-metropolitan location has sustained dwelling construction;
- Accommodation and food services, reflecting the importance of the tourist industry; and
- Arts and recreation, once again related to the tourist industry.

The second and third of these industries generate relatively low incomes per hour worked, a factor which contributes to the low incomes in Bass Coast overall.

By comparison with Australia as a whole, but in common with non-metropolitan Australia, Bass Coast has little employment in finance and insurance (a high-income industry), but high employment in construction (a moderately low-income industry).

In Bass Coast, employment concentrations in accommodation, the arts and recreation are higher than in Australia as a whole, along with concentrations in agriculture (low by Gippsland standards but high by all-Australia standards) and in water supply (the operating employment of the Wonthaggi desalination plant, South Gippsland Water – Lance Creek Water Supply). The proportion of local employment in manufacturing, transport and retail services is also below national average.

2.3 The economic base of Bass Coast

As has been pointed out, in Bass Coast wage, salary and business incomes are considerably supplemented by social security and property incomes. Further, a significant proportion of the wages and salaries earned in such services as education and health care, like social security incomes, are funded from the central Commonwealth, or Victorian State Government treasuries. Unlike the outflow of tax payments, the inflow of social security payments and of government funds for service provision is not directly related to economic activity within the Shire. This is also true for the earnings of residents who work outside the Shire.

However, two major types of economic activity within the Shire earn incomes from outside Bass Coast. They are:

- construction activity financed from outside the Shire, including non-resident investment in holiday accommodation and resident investment financed by borrowing; and
- incomes earned by businesses, which sell goods and services to non-residents of the Shire. Most of the Shire's businesses have such customers, but the proportion of total sales to outside customers is relatively low in industries such as retail and health services and services to business, while it is high in water supply, tourism (arts and recreation, accommodation, food services) and agriculture (including related manufacturing).

This is also true for sand extracted and/or processed in Bass Coast for use in construction outside the Shire, especially in the MSA.

These flows of funds generate income for Shire residents, and to the extent that residents spend their incomes on locally-provided services (including via Council rates) further incomes are generated.

2.4 Recent trends in Bass Coast

Trends in employment between 2016-17 and 2018-19 indicate that the Bass Coast economy has experienced continued restructuring.

As reported in Table 1, during the two financial years preceding the impact of coronavirus, average weekly hours worked in employment within the Shire were increasing, but the average real rate of pay was falling and with it therefore, the level of incomes earned within the Shire.

However, increased outbound commuting by Bass Coast residents was adding significantly to the level of employment and the average weekly hours worked. This was also responsible for an increase in the average income of Bass Coast residents.

Table 1 Rates of growth of jobs and earned incomes, Bass Coast Shire, 2017-19, for jobs located within the Shire and for residents of the Shire including commuters (per cent per annum)

Measure	Place of work basis	Residential basis
Employment	1.95	2.95
Hours worked	2.19	3.71
Income earned	-0.80	1.63

Source: NIEIR estimates.

These trends raise questions about the quality of employment generation within Bass Coast. It is true that the Shire is not alone – during this period, income per hour worked, and behind that productivity, failed to grow in Australia as a whole. The story within Bass Coast can be elaborated by considering trends on an industry basis. The latest available data are provided in Table 2. These data are preliminary estimates and are liable to revision.

Table 2 Employment in Bass Coast by industry, 2019, with rate of growth 2016-17 to 2018-19				
Industry	Employment numbers (2019)	Proportion of total employment – 2019 (per cent)	Rate of growth – 2017-19 (% per annum)	Average income per job – 2019 ($'000 per annum)
Agriculture	644	5.1	-18	70
Mining, quarries, construction	783	6.2	26	43
Food manufacturing	274	2.2	7	65
Other manufacturing	314	2.5	-1	40
Water and utilities	209	1.7	6	92
Wholesale trade	1239	9.9	10	68
Retail trade	1593	12.7	-3	31
Accommodation & food services	1387	11.1	-6	35
Transport and storage	309	2.5	-2	48
Telecommunications and media	126	1.0	27	56
Real estate and rentals	148	1.2	1	76
Professional & technical services	216	1.7	1	87
Other office and administrative	1396	11.1	0	79
Education	1097	8.8	13	60
Health and welfare	1658	13.2	3	52
Recreation, arts & other services	1127	9.0	9	44
TOTAL	**12518**	**100.0**	**2**	**54**

Source: NIEIR estimates from multiple sources, involving projections. Estimates are liable to revision as additional data are published, e.g. by the Australian Tax Office.

Notable recent trends include the following.

- A decline in employment in agriculture, due perhaps to a switch to less labour-intensive production and farm aggregations, but also partly to conversion of land to other uses. In particular, there is evidence that areas of the less farm productive country between Western Port Bay and the western extent of the Heath Hill fault is being withdrawn from solely agricultural use to other use options.
- Steady employment in industries ranging from retail and the various office-based industries to health and welfare services.
- Decline in accommodation and food services. This was in progress before the drop in tourist traffic due to the coronavirus and may indicate that capacity was overbuilt during the previous few years. The decline in accommodation and food services was partly offset by growth in the arts and recreation, which are at least partly attributable to inward Bass Coast tourist traffic.
- Growth in wholesale trade, possibly indicating that the Shire is becoming a distribution centre for elsewhere, further east in Gippsland and perhaps the SE metropolitan and peri-urban areas for processed agricultural (food) products.
- There was rapid growth in telecommunications employment from a very low base, presumably due to the NBN installation catch-up.
- Employment in education also increased rapidly.

- Employment grew very rapidly in construction and also in the construction materials sector, e.g. sand quarrying and processing. Due to difficulties in the classification of businesses which supply construction materials, the demarcation between these two industry sectors in the Shire is uncertain. In a context where employment was steady or declining in many of the Shire's industries, construction and construction materials-related quarrying made a major contribution to the overall employment growth rate of 2 per cent a year. Average earnings per employee in the construction industry as a whole were below Shire average, but this was due to the high incidence of part-time work and relatively low hourly earnings in the actual construction sector of the industry.

The ability of the quarrying industry to continue to contribute to the growth of employment and income in Bass Coast depends on three factors.

- Planning security and continued access to the available natural resources.
- The optimisation of established site opportunities through a combination of varied regulatory approvals and value-adding private investment.
- The commitment and capacity of quarry owners to not only rehabilitate exhausted sites, but to do so in a way that repurposes those sites so they enhance community outcomes, including to generate subsequent employment and income opportunities.

In this report we argue that these factors all argue in favour of the proposed further development of their existing Dandy Premix sand quarry at Grantville. The argument is particularly cogent given the present economic outlook.

2.5 The macroeconomic outlook

As summarised above, trends in employment and income in Bass Coast over the years 2017-19 were mixed. Resident employment and incomes grew, even if the productivity performance was disappointing. However, a simple projection of these trends is unlikely to be realised. At the macroeconomic level, covering Australia in its entirety, recent trends have been threatened by three factors.

1. Unsustainable reliance on private debt

As was pointed out in discussing the recent history of income growth in Bass Coast, since the end of the mining boom and at least since 2014, Australia has suffered a period of malaise, both in the sense of lacklustre growth in income per capita and of unease as to the future.

Recent prosperity has been founded on the accumulation of debt, both household debt (to the banks) and overseas debt (overseas borrowing by the banks). On the household side, indications are this source of prosperity is failing for two reasons:

- aggregate household debt has reached the point where it can only be serviced if interest rates remain at historically low levels in combination with employment levels remaining high; and

- the concentration on private (as opposed to public) housing construction, unaccompanied by measures to increase the supply of accessible land for continued residential development, has increased dwelling prices to the point whereby they are unaffordable to a great many potential buyers, particularly young families with modest to average household incomes.

The lack of household capacity to take on further debt, coupled with the inability of many households to qualify to purchase a house, underlies a malaise in dwelling construction. It may also be noted that the heavy reliance on bank borrowing has been exceptionally profitable to the finance sector and is linked to another aspect of the malaise – the stagnation of real wage rates while corporate profits and executive salaries continue to increase.

The malaise is also evident in Australia's net overseas debt-servicing obligations, which are manageable in times of low interest rates and growing exports, but could become burdensome should export revenues falter. Recent evidence already brings into question the ability of Australia's banks and other large businesses to service their overseas borrowings and has contributed to the decline in the AUD foreign exchange rate. The position is not immediately threatening, but the volume of debt is such that a continuation of the trend could easily deteriorate in any troubled times ahead.

2. The bushfires and climate change

In late 2019 and early 2020 a wild bushfire season raged across much of Australia. Though thankfully Bass Coast was not too directly affected, the fires were sufficiently widespread to affect prospects for the Australian economy as a whole, if only by creating a need to rebuild, which will require expenditures beyond the capacity of private finance.

The fires also raised public consciousness of the need to tackle climate change through greenhouse gas emission abatement. The Commonwealth is still reluctant to take drastic action, but long run change is now regarded as inevitable. As regards Bass Coast:

- the Wonthaggi coal mine closed decades ago – the Shire's experience may provide lessons for other towns faced with colliery closures;
- given time, it is considered that emissions can be reduced considerably, at little net cost, by further investments in energy efficiency. It is also likely that road and rail transport can be converted to renewable energy with no great increase in costs. Infrastructure investment may, however, likely be required to improve the energy-efficiency of transport modes both within Bass Coast and indeed, throughout Australia; and
- using present technologies and those likely to be available in the near future, the aviation industry cannot readily be converted to renewable power. This may represent a threat to the international component of the Bass Coast tourism industry and also those agricultural products which are exported by air freight.

As Bass Coast well knows from its experience with coal mining, when an economy requires major restructuring, not all of the skills and physical capital in the declining industries can be directly transferred to the growth industries and not all those growth industries will be in the required replacement locations.

However, it does not appear that the Bass Coast Shire will be greatly impacted by Commonwealth and/or State Government greenhouse gas emission abatement policies. While there are industries and regions elsewhere in Australia, which are so threatened, there are also countervailing opportunities to be grasped.

3. Coronavirus

Unlike global warming, which is slow and insidious, the coronavirus produced an almost immediate halt to tourism throughout Australia including to the Bass Coast. It has also produced significant and potentially, yet to fully realised, greater disruption to other industries. This is likely to be due to international supply chain shortages of critical inputs from countries where production has been stopped, or severely curtailed due to health precautions.

Unlike global warming, it is presumed that business conditions will return to 'normal' at some time in the not too distant future – six months? A year or two? The question for the present study is whether this event will produce permanent scars. Locally, these are likely to take the form of businesses disappearing through insolvency, discretionary spending and social habits altered for the foreseeable future.

Business failures are a normal part of a capitalist economy. In normal times disappointing returns in failing businesses are offset by high returns in growing businesses, job losses are compensated by new job opportunities and most physical capital can be productively repurposed. However, during a recession there can be permanent losses, not only of productive output, but through the loss of skills, and through failure to maintain and update physical capital. This is generally regarded as a macroeconomic problem.

The Reserve Bank has dropped interest rates to encourage households to go further into debt, and the Commonwealth is providing income support, largely financed from the issue of new debt. Given that excessive debt is part of the underlying problem, it remains to be seen whether these policies are effective in minimising the depth and longevity of the current coronavirus led recession. The medium to long term macroeconomic effects will depend heavily on how the coronavirus affects global production and international monetary policies, both directly through trade effects and indirectly, as governments experiment with differing policy responses.

Alterations to social habits are more difficult to predict. The response to the coronavirus required Australians to become a great deal less gregarious. This is not likely to become permanent in cases where gregariousness is part of the enjoyment of life, just as the telephone did not end the desire for physical proximity.

However, experience during the period of limited gregariousness is likely to accelerate the substitution of electronic contact for previous physical proximity in areas such as retail purchasing, tertiary education and various professional and office-based activities. Overall, these immediate trends have the potential to benefit Bass Coast, provided telecommunications capacity can keep pace with increased demand and local opportunities for a range of socially gregarious activities are maintained and indeed enhanced.

2.6 The economic outlook for Bass Coast

Weighing all these factors together, one may proffer the following scenarios as to the impending trends underlying the Bass Coast economy.

- Such tourism facilities as have survived the coronavirus pandemic are likely to revive towards the end of calendar year 2020, or through the first third (summer and autumn seasons) of 2021. However, sustainable confidence in the industry will take longer to revive and its focus, in the prolonged absence of international tourist numbers, will undoubtedly shift back to domestic tourism.
- The water supply industry is likely to continue relatively unscathed.
- Agriculture may have to respond to changed patterns of demand, but could benefit from reduced import competition, especially in the areas of dairy, meat and seafood consumer products.
- Commuter incomes will depend on the duration and course of the economic recession in eastern Melbourne and in the medium-longer term, on the timing and magnitude of public expenditure necessary to transition transport to renewable power and improved productivity. However, there will be an offset by way of increased working from home, including work which can be performed in Bass Coast supplemented by part-time commuting. Increased local Bass Coast residential demand may be generated as a result.
- Property and investment incomes will fall due to the Reserve Bank's low interest policies and as a consequence of profit reductions in those industries owned, or substantially invested in by superannuation funds.
- Short of the Commonwealth Government experiencing acute budgetary stringency, social security incomes are likely to be maintained and indeed, possibly increased.
- Commonwealth Government and Reserve Bank efforts to maintain the level of residential construction may be effective for a year or two. Much will depend on whether there is a significant slump in metropolitan property (essentially land) prices and peri-urban residential development land values. The immediate effect of such a slump will be quite depressive – speculative demand will disappear, along with much of the retiree demand in Bass Coast, substantially financed as it is from the sale of their metropolitan homes. However in the long term a slump will permit the re-entry into the housing market of households currently excluded by high entry level prices. A revival in residential construction could be hastened should governments heed calls for increased public housing investment.
- However, short of the Commonwealth and State governments invoking acute budgetary stringency, public sector spending on public infrastructure works are highly likely to increase as the focal point of government stimulus, and hence the demand for concrete and related construction materials, e.g. sand and aggregates.

In summary, at a time when the tourism industry is facing serious uncertainty, along with some aspects of construction, the long lead-time extractive industries are optimistic enough regarding continuing future demand levels to be prepared to invest.

They are accordingly a bright spot on the uncertain economic horizon, an industry sector with the need and capacity to generate new employment opportunities provided access to resources, especially those on their freehold land, is guaranteed.

In the much longer term, the extractive industries can also offer attractive legacy propositions, as when the temporary activity of sand extraction at a quarry site such as at Dandy Premix Grantville ceases through exhaustion of the resource, not only is the site rehabilitated, but regenerated and repurposed to the economic and environmental benefit of the Bass Coast.

3. The extractive industries

There is no doubt that the current State government regards the continued supply of construction raw materials at competitive prices as both a competitive advantage for the State of Victoria and as a policy priority. To quote a 2018 media release:

> "*The Andrews Labor Government is ensuring quarries around the state are ready to supply raw materials for the new railways, roads, houses, hospitals and schools being built across the state*.
>
> *We want to secure quarry resources of strategic importance from urban encroachment and keep transport and building costs down, while ensuring harmony with existing and future land uses.*"
>
> Tim Pallas

3.1 The role of the extractive industries in the development of Victoria

Early Melbourne was fortunate in that it was located close to supplies of major building materials, especially stone, clay, gravel and sand – now known as extractive resources. As the city grew some nearby supplies of extractive resources were depleted and others were overbuilt.

More recently, potential sources of supply have also been sequestered for environmental reasons and/or sterilised by the growth of peri-urban, or interface municipal and rural shires, where residential development has encroached into areas containing, or neighbouring deposits of natural construction materials and eroded mandatory buffer zones.

In response it has been necessary to obtain supplies from sources further from the Melbourne Supply Area (MSA) than economically advantageous. This response has been made possible by the construction of improved roads and the development of high-productivity trucks.

However, even with improved modern transport equipment, it remains that freight costs contribute disproportionately to the cost of extractive materials delivered to metropolitan construction sites and concrete plants. The simplest way to minimise these costs is to ensure that the extractive industries have access to Victoria's generous deposits of hard rock, clay and sand, as close as possible to the location of their use.

In the 1990s concern over the supply of extractive materials led to the identification of 'Extractive Industry Interest Areas' (EIIAs), defined as "land that has been identified as containing, or potentially containing, sand and stone resources of sufficient quantity and quality to support commercial extractive industry operations and which have limited environmental (or other) constraints to the establishment of such operations. EIIAs serve as a geographic indicator in the planning scheme for the purpose of planning permit applications only. EIIAs … are not prescribed planning controls" (Source: SERA pilot project report p. v).

Subsequent experience has led the Victorian State Government to conclude that the EIIAs have 'failed to provide a well-defined, visible and binding mechanism in the planning system to secure these resources' (p. viii).

3.2 Demand and supply for extractive materials

In 2016 the Victorian Department of Employment Development Jobs Transport and Resources (DEDJTR) received a report it had commissioned from EY entitled *Demand Analysis of Extractive Resources in Victoria.* This report derived the demand for construction materials, including sand, from population growth forecasts and economic projections provided by the Victorian Treasury.

The report discussed the outlook for the various construction sectors (residential and non-residential buildings, transport infrastructure and utilities including energy, e.g. wind farms) and possible changes to their input mix.

The baseline demand projection at the State level was for continuing steady growth transitioning to higher demand by 2050 (88m tonne per annum), with a few minor hesitations due to fluctuations in population growth rates. These blips in the projections may be treated as warning signals: the interruption to immigration in 2020, and the consequent impact on the immediate population growth rate, is already impacting the demand for construction materials, although increased private investments in non-residential construction, coupled with the State Government's transport infrastructure and utilities investment pipeline, is currently offsetting the temporary reduction in the residential demand characteristic of 2020.

The EY study broke down its projections by LGA. DEDJTR then commissioned PwC to project the balance of supply and demand by LGA. This resulted in a report entitled *Extractive Resources in Victoria Demand and Supply 2015-2050.* The underlying assumption of this report was that the inflation-adjusted costs of resource extraction would remain relatively constant, or flat in real terms, an assumption supported by the observation that the industry is highly competitive and essentially volume-driven with low unit cost pricing.

The report goes on to state that, although four major companies produce 55 per cent of Victoria's supply of extractive resource construction materials, a further 16 mid-tier to SME businesses produce another 20 per cent with several hundred smaller businesses and Councils responsible for the remaining 25 per cent. This industry structure is highly competitive.

The report then notes that the freight costs of quarry products from their source to the construction sites and/or concrete batching plants where they are used, add significantly, at times disproportionately to quarry-gate prices.

The report therefore matches demand and supply on a LGA basis, with supply forecast at capacity within several of the existing Work Authority LGA areas, supported by forward estimates of both demand and supply side from companies heavily committed in the construction industry.

Though the major result of this exercise was a shortfall in capacity in the Western and Northern LGA areas of Melbourne (reflecting population growth projections in their new urban growth zone suburbs, e.g. Wyndham) there was also a shortfall in the south eastern suburbs and their hinterland LGAs such as Casey, Cardinia and Baw Baw, including a projected shortfall in sand production in Bass Coast.

The EY report argued that these shortfalls in extractive materials supply would be met by transporting materials quarried at sites further distanced from the MSA than previously experienced, or economically desirable. Accordingly, its main policy recommendation was that potential sites for extractive industries should be better protected from encroachment by incompatible land uses.

This argument is essentially similar to that used in NIEIR's 2012 Grantville report, which is that a lack of access to the substantial sand deposits at Grantville and adjacent locations, will considerably increase construction costs in Melbourne, to the detriment of the State's "big build" and more significantly, the Victorian economy.

In the course of developing this argument, PwC used an estimate that in 2015 the cost of transport of extractive products averaged 15 cents per tonne km. This estimate was based on EY's interpretation of two sources: Transport and Infrastructure Council: *National Guidelines for Transport System Management in Australia* (2015 update) and Transport for NSW: *Principles and Guidelines for Economic Appraisal of Transport Initiatives* March 2013 – the former for the cash operating costs of laden vehicles and crash costs, the latter source for externalities such as environmental pollution costs.

The resulting estimate of 15 cents a tonne km is significantly less than that used in the NIEIR 2012 report, which was 25 cents per tonne km in 2012 prices, sourced from a costing exercise by Dandy Premix. Some of the difference would be due to conservative assumptions incorporated into the source materials and EY's interpretation of them. These include wage rates, vehicle payloads and speeds, road maintenance, capital costs and so on.

However, the major reason for the difference appears to be EY's failure to include the cost of the dead (empty) running of vehicles which is unavoidable when materials are predominately conveyed one-way only in specialised vehicle combinations. The resultant effect was to underestimate the freight costs of bulk extractive materials and hence, to underestimate costs occasioned by the separation of extractive industries quarries from their eventual construction sites use.

Adopting the all-encompassing Dandy Premix 25 cents per tonne km estimate, or a compromise figure of say, 20 cents per tonne km, further strengthens the EY conclusion that major additional costs are occasioned when freight distances are extended for extractive industries construction materials such as sand and aggregates.

3.3 Current Victorian extractive industry strategies

Against the background of these reports, in 2018 the Victorian Government published a policy paper entitled *Helping Victoria Grow: Extractive Resource Strategy.* The strategy reiterates the importance of expediting extractive industry access to resources, subject to relevant environmental safeguards.

The paper regrets that resources included in the Extractive Industry Interest Areas (EIIAs) in the 1990s have not all been safeguarded from developments which preclude their extractive resource use and recommends that protections be tightened. The government responded by developing the concept of Strategic Extractive Resource Areas (SERAs). A SERA is defined as areas:

- located within existing EIIAs … which;
- includes actual and/or potential extractive resources across the area, wholly or in part, and may support current or new extractive industry operations or their buffers;

- has manageable environmental and planning constraints and is accessible to markets; and
- is implemented in the planning scheme by the State Resource Overlay as a special use zone (p v).

Two pilot projects, one in the City of Wyndham and the other adjacent to Bass Coast in the Shire of South Gippsland (but incorporating South Gippsland and Bass Coast), were undertaken and are now under evaluation. The State government expects the SERA concept will be refined in the light of experience with the two pilot projects and thereafter extended in consultation with Councils, the industry and nearby communities.

The EIIAs in Bass Coast are obvious candidates for this extension, but the necessary consultations must await the evaluation of the pilot projects. The present situation is that the Dandy Premix property at Grantville lies in an Extractive Industry Interest Area and the State government favours the development of extractive industries in such areas, but there is no formal state resource overlay covering the property. Even if there were such an overlay, it would still be necessary to prove compliance with appropriate environmental and other legislation.

Given the competitive nature of the industry, continued sourcing of sand from the deposits in Cardinia, South Gippsland and Bass Coast is expected to maintain the price of sand in the eastern part of the Melbourne metropolitan area at inflation-adjusted current levels for several decades.

However, should this supply be constrained, the nearest alternative source is near Traralgon. Resort to sand from the Latrobe Valley has the potential to raise the price per tonne of sand delivered to Dandenong and the greater MSA by as much as 50 per cent, primarily driven by increased freight costs.

Hence the State Government's anxiety to maintain access to extractive industries (construction materials) sites closer to the MSA end-use requirements. The South Gippsland LGA location of one of the SERA pilot project sites near Nyora further confirms the importance which the State Government attaches to these and the equally accessible neighbouring Cardinia and Bass Coast sand resources.

4. The Grantville project

The proposal assessed in this report is for further incremental development of the current Dandy Premix sand quarry at 1381 Bass Highway, Grantville.

4.1 Sand quarrying in Bass Coast

The Heath Hill Fault (HHF) runs approximately northeast-southwest through Bass Coast Shire. To the west of the fault, forming part of the slope down from the South Gippsland hills to the Westernport/Koo Wee Rup lowlands, a belt of Cainozoic sands stretches from Yannathan in Cardinia Shire through the north-west corner of South Gippsland Shire near Nyora then on to Grantville and Almurta in Bass Coast.



Grantville Plant Area and Stockpile Area, April 2015.

Local sand deposits have long underpinned numerous aspects of the construction industry in Bass Coast, but it is only more recently that these sand deposits west of the Heath Hill Fault have become acutely relevant to the Melbourne metropolitan construction market. The first metropolitan use of fine particle Heath Hill sands was from Lang Lang to the former Australian Consolidated Industries (ACI) for glass-manufacturing at their Dandenong (now Oceania) and Spotswood (now Owens-Illinois Inc.) plants and which was initially able to be freighted by rail due to the then availability of rail in South Gippsland. The former ACI/Sibelco sand quarry at Lang Lang has more recently been acquired by Holcim with the strategic direction to focus quarry operations on the production of construction (concrete) sands to address an identified strategic need.

More recently, with the exhaustion of supplies of construction sands from the 'sand belt' to the south-east of the Melbourne metropolitan area (Clayton, Heatherton, Lyndhurst, Langwarrin and Cranbourne), the Heath Hill sands have become a major source of supply of sand for construction purposes in the CBD, south-east and eastern regions of the greater Melbourne metropolitan supply area.

Within the Bass Coast Shire, sand quarries located at The Gurdies/Pioneer Bay and the current Holcim/Boral JV quarry at Grantville, began to supply the outer south-east metropolitan market thirty or forty years ago. In 2015 the opening of the Dandy Premix Grantville sand quarry generated eight new full-time jobs in quarry operations, which during peak periods, increase to between 10-12 jobs. In 2019 Hanson announced establishment of a coarse sand pit south of Grantville, promised to create 20 additional jobs, though sand extracted from this site is to be transported to their Yannathan (Cardinia LGA) wash and dewatering plant for processing.

The great majority of premixed concrete to the construction industry within Bass Coast is produced by Donmix, an established family business based in Wonthaggi, but which operates concrete batching plants at several locations in the Shire.

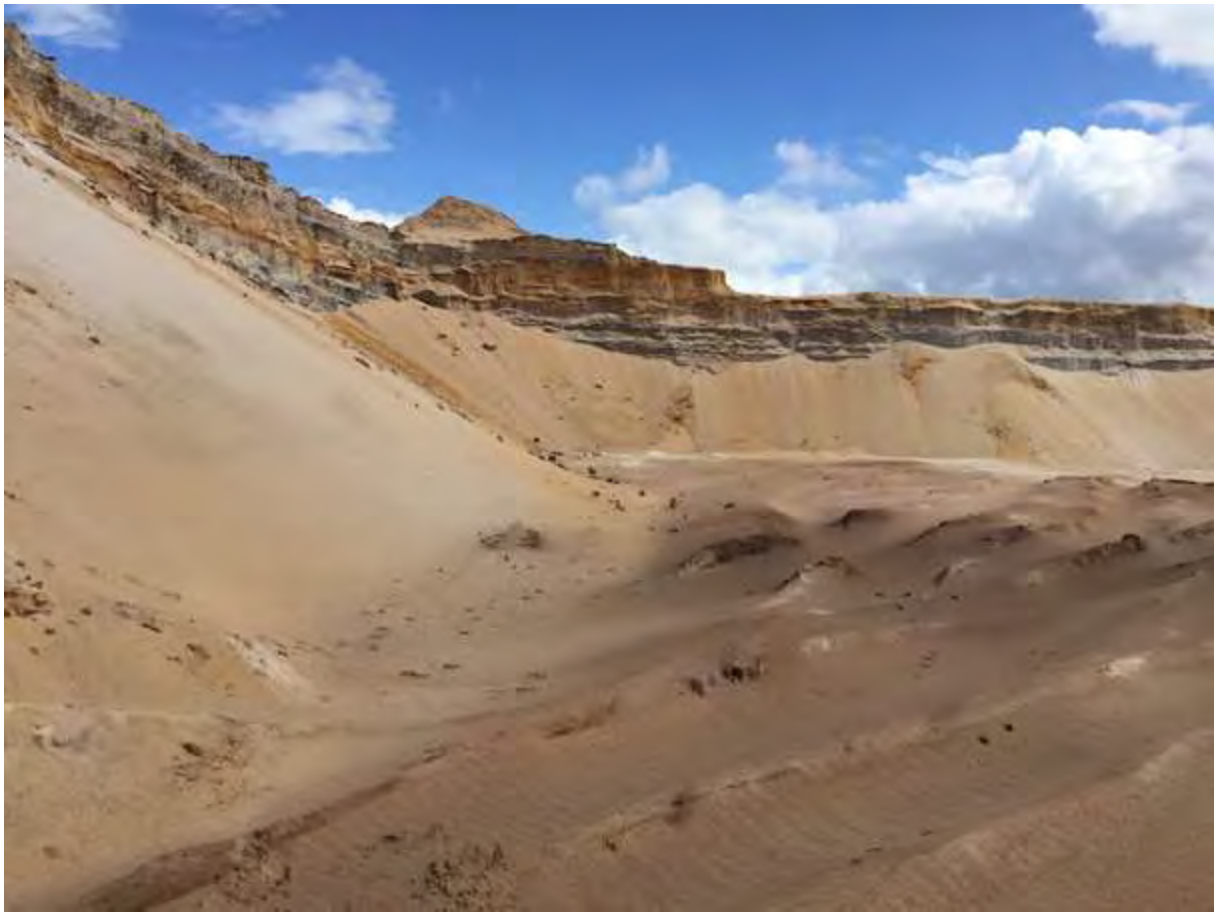
Neither Dandy Premix, nor any of the other established suppliers of premixed concrete to the Melbourne metropolitan and outer south-east area markets, e.g. Pakenham and Cranbourne, compete directly with Donmix in Bass Coast.

When Pronto, one of the Melbourne metropolitan majors, gained the contract for supply of premixed concrete to construction of the desalination plant they entered into an agreement with Donmix to upgrade and use their Wonthaggi concrete batching plant.

Nonetheless, there is indirect Bass Coast competition – should Donmix, or any future owner of the Donmix business, attempt to raise premixed concrete prices, businesses sourcing sand from other nearby quarries, such as the Dandy Premix quarry at Grantville, will be in a position to assist in the maintenance, or restoration of prices to competitive market levels. Accordingly, continued production from the Dandy Premix site has real potential to help contain construction costs in the Shire.

4.2 The current Dandy Premix sand quarry at Grantville

The currently permitted fine medium sand extraction pit (FMSEP) at the Dandy Premix quarry occupies less than 23 hectares in the western part of the freehold property, comprising 156 hectares situated at 1381-1395 Bass Highway Grantville.



Extraction pit, March 2019.

The immediate neighbours of the Dandy Premix Grantville quarry site are as follows.

- To the west, the property opens onto the Bass Highway, a four lane, divided Category 1 Road administered by Regional Roads Victoria (formerly VicRoads). The property rises by about 12m in elevation from the Bass Highway for a distance of approximately 150m to a gentle ridge on which three long established and occupied residential dwellings are located. These homes and the surrounding mature trees and plantings form a very effective screen to the extractive and sand processing operations further east on the site. The Bass Coast Shire Council Permit No.120388 endorsed 'Landscape & Revegetation Plan, 2013, Bass Coast Landcare Network (BCLN)' provides for progressive landscaping and native vegetation planting in this western exposure frontage of the site to further screen quarry operations and enhance the view from the Bass Highway viewshed.

- Private (waterline) homes to the west of Bass Highway incur some level of impact from vehicle noise and pollutants generated by the volume of highway traffic. However, we do not believe these near neighbours suffer any adverse amenity impacts from the Dandy Premix operations, apart from the undoubted impact of additional heavy vehicle quarry traffic from the Dandy Premix property, more particularly, as it proceeds north to Melbourne (on the west side of the highway) having first exited left to travel 4.6km to the south of Grantville and undertaken a U-turn in order to commence the north-bound journey to Melbourne.
- To the north, the immediately neighbouring 70 hectares property is owned by Dandy Premix. There is no intention to extract sand from this property, which is partly pasture, but more predominately, contains native vegetation regrowth along the banks of Deep Creek. This native vegetation and Deep Creek are designated as important native vegetation offset areas by Dandy Premix and will be protected in perpetuity under a section 69 Agreement (*Conservation, Forests and Lands Act* 1987) with DELWP. To the north again, the Dandy Premix property abuts The Gurdies Nature Conservation Reserve, Crown Land which is managed by Parks Victoria (PV).
- To the east, the property ends in varying distances from 280m to 675m over the ridge line of the Heath Hill Fault and the native vegetation coverage of this geological characteristic. Beyond the Dandy Premix land lie very fertile and highly productive farmland – the rolling hills of West Gippsland. Within the remaining eastern portion of the WA1488 site, are patches of native vegetation, scattered trees and pasture, which is under active revegetation for conservation purposes. Between the current FMSEP and the processing works area in the west of the site and the upper eastern hill paddocks the property is covered with a mixture of pasture grasses and several only scattered trees. These paddocks slope steeply up to the high elevation of the Heath Hill Fault and are of limited productivity due to their shallow topsoil, minimal moisture retention ability and exposure to winds not only from the west and south-west but also to the very drying north-westerlies.
- To the immediate south of the WA1488 site is the Grantville Bushland Reserve, which is a regrowth forest managed by PV. While reafforestation has been achieved in the reserve by fencing and well-managed native vegetation grow-back, it is problematic whether the majority of this regrowth, excluding the grass trees, bears close resemblance to the natural vegetation as it was pre-European settlement. This reserve, in turn, abuts the Holcim sand quarry, which has a short common boundary with the Dandy Premix site on Colbert Creek. A strip of lowland forest along Colbert Creek separates the Holcim quarry from the cleared paddocks of the Dandy Premix site. It is expected that the Holcim quarry will be worked out and rehabilitated within 10-15 years, having operated in-situ for approximately 35 years to date.

Experience over the five years of site operations to June 2020 supports the position that these WA1488 neighbours do not have their amenity disturbed by the current sand extraction and processing operations, save for additional heavy vehicle quarry traffic on Bass Highway. There is no evidence of noise or dust impacts on neighbouring residences and certainly not on commercial operations in Grantville, approximately 1.2km kilometres further south. Monthly dust monitoring results, along with several other environmental conditions, are reported to the Grantville Environmental Review Committee (ERC) that meets tri-annually as a minimum, is independently chaired and comprises seven Community Representatives, a Ward Councillor and a Council officer, in addition to representatives of each of the quarries in the area.

The current sand quarry has been developed in accordance with the endorsed Work Plan (part of WA 1488) authorised in 2012, save that it does not yet extend as far eastwards as is currently permitted. As per the plan, an infrastructure area has been developed on a further 6 hectares located on the northern side of the site.



Grantville Plant Area and Loading Area, May 2015.

All sand on the WA1488 quarry site is dry extracted and is blended with coarse washed sand, purchased locally and transported to the site, to manufacture concrete sands. The site has been developed so that all surface water runoff from the works area is captured, then filtered in a Bioretention Basin, such that only clean, settled water overflows to the lower level of the MW3840 tributary which feeds ephemerally into Deep Creek and so under the Bass Highway and westward into Western Port Bay.

In the Base-case for the present study, it is assumed the currently approved quarry will be exhausted of resource and closed in late 2022. Current operations employ 8 persons EFT, who earn approximately $500,000 per annum, of which $480,000 is directly attributable to sand production costs and $20,000 to rehabilitation costs. In addition, the purchase of operational supplies and services directly adds to the sales of local businesses and adds approximately $30,000 per annum to their value-added revenues.

In the Base-case direct production (salary) payments will cease at the end of FY 2022. Remediation will then be completed, as provided for under the Work Authority and the Bass Coast Planning Permit.

All fixed plant and equipment, mobile plant and services will be removed and the land surface will be reprofiled as necessary in compliance with the approved Rehabilitation Plan, restoring as best achievable the natural topography and drainage profile of the property to ensure that continued excess flows of surface water are directed to Deep Creek. Topsoil, which has been stockpiled, will be spread across the clay overburden which has also been stockpiled for redistribution over the extraction area to establish a safe and stable final land form, rehabilitated as close as possible to the original, pre-quarrying low-fertility pasture paddocks.

The current Rehabilitation Bond of $250,000 lodged with DJPR/ERR will ensure these rehabilitation requirements are met, otherwise the bond will not be refunded, or alternatively, it will be used by DJPR/ERR for this purpose and to their ultimate satisfaction. It is anticipated that approximately 75 per cent of the rehabilitation cost will comprise wages, amounting to approximately $190,000. It is expected $10,000 of this would be expended in FY2022 and the remaining balance of about $180,000 in FY 2023.

4.3 The proposal

The 2012 study foreshadowed a medium to long term intention to further develop extraction activities eastwards, within the property limits of the currently approved WA1488 site, towards the Heath Hill fault, where a very substantial deposit of medium, coarse and very coarse particle sized sands and small pebbles has been identified through extensive geological investigation.

The present extraction pit yields only fine to medium particle sized sands which have to be blended with coarse washed sand, purchased externally and freighted into WA1488, for Dandy Premix to blend with its fine-medium sands in order to meet the very specific concrete sands ‘envelope’ requirements for the production of premix concrete for the construction industry.

The permit amendment proposal before Council, in accordance with the DJPR/ERR May 2020 endorsed Work Plan, is to continue and intensify operations on the WA1488 site as follows.

- Establish a coarse sand extraction pit (CSEP) further east of the FMSEP, in the upper eastern elevations of the site, containing native vegetation, some of which will need to be removed and will be offset.
- Further develop fine medium sand extraction in an easterly direction from the currently approved FMSEP.
- Develop fine medium sands extraction below the groundwater level.



CDE-DW Fracline.



CDE-DW Fracline.

The extension of extraction below groundwater level will involve:

(a) operation of a pontoon mounted cutter suction dredge;

(b) installation of a liquid slurry delivery pipe system – partly replacing the current haul truck methodology of delivering fine medium sands to the screening and blending plant;

(c) installation of a sand wash plant that will wash, screen, grade and blend three different sand inputs (below groundwater medium-fine sands, above groundwater fine-medium sands and coarse sands). In addition to concrete-grade sand this washing and blending process will produce a residual clay fine silt slime; and

(d) installation of a de-watering, filter belt press to recover water from the slimes that have been pre-treated through the clarifier/thickener and mud buffer tank. The resultant filter cake, with a solids content of approximately 65 per cent, will be stored and blended with clay overburden for use in rehabilitation works.





Plant concept, November 2019.

The wash and dewatering plants, along with the clarifier/thickener, mud buffer tank, polymer dosing and PLC control system will all be co-located in the existing plant operations area.

Most of the present water storage dams, the sediment pond and bioretention basin will be retained and enhanced, to ensure that the quality of site surface water and drainage water flows to Deep Creek from the sand processing area operations is maintained.

It should be noted that, both currently and with further development of the FMSEP, surface water and drainage flow volumes from the WA1488 site are reduced as a natural consequence of rainfall over the surface area of the opened FMSEP acting to directly recharge the groundwater aquifer.

In summary, the permit amendment proposal is to further develop extraction activities and the sand processing capability of the Dandy Premix quarry to independently manufacture concrete-grade sands by accessing and utilising the mix of fine, medium and coarse particle sized sand resources available on the WA1488 site. This overcomes the current need to import approximately 80,000 tonne per annum of coarse washed sand. In so doing, it underpins both the operational and commercial sustainability of the quarry and extends its operating life expectancy by around 40 plus years.

It should be noted that the extent of sand extraction proposed under this amendment application does not fully exhaust the volume of resource available on the site.

A native vegetation 'First Party Offset' security agreement with DELWP will be executed before any native vegetation is removed in relation to the CSEP. Site rehabilitation activities will take place progressively throughout the operating life of the quarry. Final site rehabilitation will be completed to the satisfaction of DJPR/ERR following the completion of sand extraction and processing operations and quarry closure.

The further development proposal is in relation to existing Work Authority No 1488 as varied by the DJPR/ERR endorsed Work Plan Variation PLN-001354 of May 2020.

Subject to planning permit amendment approval, in terms of economic and social benefit to the Bass Coast, the proposal involves the following.

- continued local employment in sand production (extraction, processing and freight operations), which means that the remedial employment scheduled for 2022 in the Base-case will not take place.
- On-site infrastructure works, installation of significant and more complex new plant, modifications to existing plant, a site power upgrade, additional PLC control system installations, etc. and commissioning works, are projected to take place in the second half of the 2020-2021 financial year.
- The civil works component of this work is estimated at $750,000 with a labour component of $588,000 gross earnings (14 persons mostly part-year to yield 8.4 EFT jobs.) During the period it is estimated that approximately $7.0m worth of plant and equipment will be purchased in addition to the civil works. Where possible, this specialised plant equipment will be sourced from within Australian (if available and competitively priced), but some major aspects will by necessity, come from overseas. While this CAPEX will be outside Bass Coast, locally-sourced labour and contractors will be actively recruited to fulfil requirements such as in civil design, construction of foundations for new plant, electrical installation works, supply and installation of prefabricated buildings to house plant and controls, structural steel design, fabrication and

installation, supervision and technical support, with an estimated expenditure on labour and services from within the Shire estimated at $750,000.

- From 2021-22 continuing quarry operations are expected to employ 15 persons in sand production, site management, laboratory services, freight operations, mechanical service and maintenance works, environmental services, and progressive rehabilitation with annual gross earnings of approximately $1.0m per annum. Native vegetation and other site environmental responsibilities are ongoing and require continuous resource allocations, both internal and locally external, e.g. Bass Coast Landcare Network. Progressive rehabilitation will considerably reduce the rehabilitation task on closure of the quarry.
- The Quarry-extension Case assumes that in 2062 the site will be made available for regeneration and repurposing, including the likelihood of redevelopment of parts of the property for a mix of commercial and residential options. The relevant investment expenditures are difficult to estimate, but are likely to considerably exceed the cost of rehabilitation as required by State Government regulation. They have not been included in the present assessment.

Comparing the proposal to the Base-case

Comparing the proposal with the Base-case, in which production ceases at the end of FY 2022 and rehabilitation is completed in FY 2023, the proposal generates:

- An increase in civil design, site construction activities and other investment-related jobs in FY 2021, a net increase of 8.4 FTE jobs;
- In FY 2022 there are 15 direct operational jobs in the Quarry- extension case, but only 8 in the Quarry-closure case, a net increase of 7 ongoing operational jobs;
- In FY 2023 there are 15 direct operational jobs in the Quarry- extension case with an offset of 2.9 rehabilitation jobs in the Quarry-closure case, a net increase of 12.1 direct jobs;
- From FY 2024 onwards to 2061 there are 15 direct operational jobs in the Quarry-extension case and none in the Quarry-closure case.

In both the Quarry-closure and the Quarry-extension cases, direct jobs are supplemented by jobs generated in Bass Coast through the engagement of local suppliers and contractors.

The financial expenditure on these has been estimated by Dandy Premix and converted into employment estimates by NIEIR. The pattern of net increases is similar to that for direct employment.

4.4 Transport (trucking)

Currently, almost the entire output of the Dandy Premix Grantville sand quarry is transported by bulk quarry materials heavy vehicle combinations (trucks) to concrete batching plants and civil construction sites in the Melbourne Supply Area (MSA).

When the current quarry was planned, Dandy Premix intended to base four, or five of these trucks in Grantville, but the response to local driver recruitment and retention has been such that this intention has met with limited success and currently only one truck is based at the quarry– the remainder of the fleet of 26 continue to be based at the Dandy Premix Cranbourne site.

In the light of this experience the current study has adopted conservative estimates for the generation of heavy vehicle driving jobs in Bass Coast. Should the demand for such jobs increase, the number of trucks based in Grantville will be commensurately increased. If this were to transpire, the number of direct jobs in Bass Coast generated by the project would (potentially) be four (4), or five (5) more than is assumed in the present evaluation.

Current traffic in and out of the site at 1381 Bass Highway averages approximately 60 heavy vehicle movements each way per day (Traffix Group). When operations at the quarry are further developed and fully operational, it is anticipated that the number of these heavy vehicle movements will increase to 120 inward entries, followed by 120 outward exits.

All heavy and light vehicle movements at the Grantville quarry are directly from and to the Bass Highway, a Road Zone Category 1 road, administered by Regional Roads Victoria (formerly VicRoads). The Dandy Premix quarry does not generate heavy vehicle traffic over Shire roads, with the exception of supply to infrequent local infrastructure projects, such as the Lance Creek to Korumburra water supply pipeline in 2018-19. Dandy Premix supplied approximately 25,000 tonnes of embedment sand to this project, in part using both Bass Coast and South Gippsland Shire local roads.

All vehicles, heavy and light, departing the site are currently required to make a left-hand turn onto the Bass Highway. Heavy vehicle combinations (trucks) carrying sand to the metropolitan market are accordingly obliged to travel south for 4.6 km, through Grantville to a dedicated U-turn opening in the median of the highway, where they execute a U-turn. The trucks then travel 4.6 km back, traversing Grantville a second time, in order to reach their initial Bass Highway exit location from the quarry to effectively commence their 'positive' northbound route journey to the MSA.

Should, on referral, Regional Roads Victoria (RRV) direct that traffic signals be installed at the quarry's Bass Highway entry/exit location, to permit vehicles, including heavy vehicle combinations to turn right, thus saving 9.2 km per loaded truck trip and two passes through Grantville, the benefits of this are as follows.

- Removal of significant levels of Dandy Premix heavy vehicle truck traffic through Grantville. The removal of the Dandy Premix traffic will be complemented by removal of the Holcim/Boral JV's WA470 present traffic when their quarry is exhausted, as anticipated in a decade or so. These traffic reductions will assist in developing Grantville as a retail hub and community service centre. The staged reductions in heavy vehicle sand quarry traffic will also reduce Bass Highway maintenance costs borne by the State Government (RRV) in Grantville and its approaches.

- Importantly, the above reductions in heavy quarry vehicle movements through Grantville, currently 100 movements forecast to increase up to 240 per day by Dandy Premix alone, must improve pedestrian, bike and light vehicle road safety in Grantville.
- In the event RRV mandate the installation of traffic signals at 1381 Bass Highway, the provision of a pedestrian request button to activate the lights would greatly enhance pedestrian access safety between residential dwellings to the west of the highway and the southbound public transport Bus Stop on the east side of the highway. Equally, passengers departing this southbound service to return to their homes on the west side of the highway will be improved, especially after dusk. It should also be recognised that a number of local children use School Bus services from these Bus Stops on a daily basis, to and from secondary schools at Koo Wee Rup and Newhaven College on Phillip Island.
- Access to Bass Highway from the west side service lane that opens to the highway opposite the Dandy Premix quarry land will also be improved if signals are installed. Gaps in traffic created by the activation of the signals will also assist light vehicles joining the highway to travel both north and south of the signals. This equally applies to the significant volume of traffic accessing the highway via Deep Creek Street from the residential waterline estate, west of the highway, opposite and north of the quarry land.
- As previously noted, each loaded truck leaving the quarry for the MSA, will save 9.2 km of unnecessary travel. The direct cash cost of this may be valued at 15 cents a tonne km, as estimated by EY for trucks that are fully laden for both legs of a two-way journey (see Section 3.2). Against annual weighbridge sales of 750,000 tonnes, simple arithmetic produces a cost saving of a little over $1.0m per annum. In the first instance it can be argued this cost saving will accrue directly to Dandy Premix, but the benefits are likely to be more widespread, either in the form of lower sand sales prices (the saving will increase the market competitiveness of the Grantville quarry vis-a-vis those in South Gippsland and Cardinia Shires) and/or in the form of employee benefits such as employment security.

Several offsetting costs are anticipated.

- Traffic on the Bass Highway will experience traffic signal delays when vehicles departing the quarry activate the signals. Installation of traffic signals may also be augmented by a reduced speed limit from the current 100kph to (say) 80kph. These localised Bass Highway general traffic delays would be mitigated by the reduction in delays experienced from merging, heavily laden quarry vehicles commencing their southbound travel through Grantville, subsequent U-turn manoeuvres and a second, northbound pass through Grantville.
- The average signal delay is anticipated at between three and four seconds per vehicle on Bass Highway, but improved traffic flow south of the signals, as just noted, should claw back all, or at least some of this.
- Traffic noise may increase slightly due to stopping and starting at traffic signals should they be installed. There is acknowledged potential for noise amenity impact to residents who live in proximity to a signalised intersection, in particular, those in the estate between the Bass Highway and the Western Port shoreline.

- However, this impact would be largely mitigated by the fact the signals would only be activated by exiting quarry traffic, during quarry operating hours. This negates the ability for signals to be activated (Stop Red on Bass Highway) after 10.00pm on weeknights, 4.00pm on Saturdays and completely on Sundays and Public Holidays. A four month trial in 2019 of extended loading and despatch hours to 10.00pm weeknights and 4.00pm on Saturday was noise-logged at two nearby residences, one on Bass Highway, the other in Deep Creek Street. This monitoring established no discernible increase in noise disturbance as a consequence of infrequent Dandy Premix traffic on Bass Highway during these extended hours, which mirror the same operational activity hours sought in the permit amendment application.

We conclude, therefore, that any Regional Roads Victoria direction for signalisation of the quarry's Bass Highway intersection is strongly justified in economic and social benefit (pedestrian safety) terms, as well as on environmental grounds.

4.5 Employee skill upgrades



Grantville Stage 2 resource drilling, March 2018.

The current quarry operations at Grantville broadly involve overburden stripping, dry sand extraction, bulk hauling, grading, blending, laboratory testing and sales loading of finished construction sands for road transport to end-use.

The range of operations to be carried out under the DJPR/ERR endorsed Work Plan and this permit amendment application will be rather more sophisticated and technically complex. It will include the cutter suction dredging of sands from below water level, the operation of a slurry delivery pipeline system to the wash plant and the blending of washed sand with dry extracted sands from two other sources elsewhere on the site. The process will involve multiple screening, washing and cyclone separation by particle size.

The clay fine silt slimes generated as a by-product of this highly controlled sand washing process are then settled to the bottom of a large scale 'thickener' weir with clarified water from the weir directed to recycled use in the wash plant, or if excess to requirements, returned by dedicated pipeline to the groundwater dredge pond – the initial source of this water.

The thickened slimes are pumped to a mud-buffer tank in preparation for polymer dosing and controlled feed to the filter belt press, where water is again recovered for reuse, with the resultant 60-65 per cent dry content filter cake destined for end-use in conjunction with stockpiled clay overburden in rehabilitation works.

These operations are in addition to the far simpler dry screen and blend functions presently being conducted at the quarry. These new operations will require considerably greater laboratory services and technical plant and process supervision. Employment opportunities will accordingly be more diverse than at present and will include a higher proportion of relatively better-paid positions. This has been allowed for in the average earnings estimates.

The widened range of skills required will create new opportunities for motivated employees to upgrade their qualifications. Dandy Premix encourages workers to gain TAFE qualifications such as Certificates III and IV and diplomas in Extractive Industry Operations and also to upgrade various elements of their industry capabilities through CMPA, Skills DMC and other accredited training programs, including weighbridge operation, crushing and screening plant operation, slimes management, work safety at heights and numerous other courses and industry workshops.

Such skill upgrades can yield wage upgrades of between $10,000 and $15,000 a year to previously unskilled or low-skilled workers. Allowing for worker turnover, these skill upgrades will benefit not only Dandy Premix, but other employers who subsequently employ these personnel after their period of employment and training at Dandy Premix.

In addition to quarry manager, the positions of plant manager along with those engaged in the laboratory, quality control, health and safety and the environmental management aspects of the operation are of particular interest, since they require qualified skills and typically involve, or promote business interconnections, sometimes referred to as global knowledge skills.

Lack of such global knowledge skills constitutes one of the chief barriers to employment development in regional areas. The provision of such positions at the Dandy Premix Grantville quarry, even if limited in number, can be expected to increase business activity in the Shire in two ways:

- through the business activities of these personnel after they move on from employment at the quarry; and
- by the business activities of their spouses, or partners, who are likely to be similar global knowledge personnel in their own right.

Historically, this is not a rapid process, but it can make major contributions to a region's economic development. In a developing Shire like Bass Coast, in which new economic challenges and business specific opportunities are arising, these can only be realised if people with the right skills and entrepreneurship are available to take advantage, and moreover, to optimise these to their personal and regional benefit.

4.6 Offsets and remediation

An important aspect of the proposal is the opening of a new coarse sand extraction pit (CSEP) in the upper, eastern section of the WA1488 site that will require the removal of areas of native vegetation, including ground cover, which in both cases have been somewhat degraded by decades of bush grazing by wallabies, feral pigs, other native fauna and occasionally, stray, or lost cattle.

First Party Offsets for this temporary loss of native vegetation will be secured under a section 69 agreement with DELWP under the *Conservation, Forests and Lands Act* 1987. The security agreement involves mature, high quality vegetation in immediately adjoining Dandy Premix freehold land and will also provide for the revegetation and conservation of several parts of the WA1488 land that are of minimal vegetation quality.

Areas to be secured and maintained as native vegetation offset areas, or to be enhanced through revegetation and secured in perpetuity on title as native vegetation offsets, covers the following.

- Almost 53 hectares of the adjoining 70 hectares Dandy Premix land (Lot 2, Dunbabbin Road) north of the WA1488 site to its common northern boundary with *The Gurdies Nature Conservation Reserve*.
- An area of 2.3 hectares to Colbert Creek on a section of the southern boundary of the quarry site to improve the sustainability of Colbert Creek vegetation.
- A buffer strip of land in the upper western section of the site, below the Heath Hill Fault, with elevation ranging from 75m – 90m AHD. This section of land, with outstanding views to Western Port Bay, separates the fine medium sand extraction pit (FMSEP) to the lower west and the coarse sand extraction pit (CSEP) to the upper east on the site.
- All that land to the east (back of) the Heath Hill Fault and CSEP, to the eastern site boundary of WA1488. This represents an area of 30 hectares, which is currently under active revegetation and security.
- No sand extraction, or other quarrying activities will take place in these secured native vegetation offset areas.

- Further, the 32 hectares upper eastern section of native vegetation on the site that contains the Heath Hill Fault and therefore the CSEP, will also be rehabilitated, revegetated and secured for conservation purposes on completion of coarse sand extraction.
- A total of 117 hectares of Dandy Premix land within the WA1488 title boundary and the allotment adjoining to the north will be secured in perpetuity on title for conservation management to the environmental benefit of Bass Coast and Victorians more generally. These areas of protected and/or regrown native vegetation will form a long term, sustainable biolink between the two existing Parks Victoria reserves to the north and south and align well with the Bass Coast 'Biodiversity Biolink Plan 2018'.

The removal of approximately 30,000,000 tonnes of sand over a projected 40 years will require the remediation of a total of 84 hectares, in three main components:

- an area of about 20 hectares on the Heath Hill Fault ridgeline, containing the CSEP. This CSEP area is above the retained FMSEP buffer strip, which will retain some native vegetation screening to both the west and east and will be fully restored to its pre-quarrying condition through progressive revegetation following coarse sand extraction;
- an area of a little more than 40 hectares in the western portion of the site characterised by a topography mix of relatively flat and gently elevated land; surrounding
- the lake formed through the below groundwater extraction of sands. The lake will be designed to have a finished surface area of approximately 24 hectares with a gentle 'beaching' profile making it access safe and suitable for a range of future water sport, recreational and environmental purposes, including as a valuable source of water for bushfire response.

The latter point is especially important, given that the site itself and near surrounding area is dominated by valuable native vegetation *including The Gurdies Nature Conservation Reserve* to the north and the *Grantville Bushland Reserve* to the south. Coupled with Victoria's recent and devastating bushfire experiences, including a severe bushfire immediately south of Grantville in 2018 and the increasing threat of further and more intense bushfire danger as a consequence of climate change, good local proximity and access to a ready supply of fire-fighting water will become a major consideration and end-use repurposed benefit of the WA1488 site.

In this context, a return to the low-quality pasture that previously dominated land use in the western part of the site would be inappropriate. The site is located where Bass Highway vehicle traffic from the direction of Melbourne, having crossed the Koo Wee Rup flats and passed through native bushland to the east (the former GMH Testing Grounds and *The Gurdies Nature Conservation Reserve*) first encounters the more scenic views of Western Port Bay combined with the coastal and undulating rural countryside of Bass Coast.

The Dandy Premix site therefore has wonderful long-term potential for regeneration and repurposing from a redevelopment perspective and could well become established as a recreational (tourism), commercial and residential gateway to not only Grantville, but effectively, the Bass Coast.

The upper elevations of the western frontage of the site provide unrivalled views of Western Port Bay, French Island and parts of Phillip Island to the south-west, with retained and regrowth native vegetation behind to their east. Because of their outlook, including over the balance of the site to the Bass Highway frontage, it is likely that this upper area, or potential residential sites, will also be highly complementary to the lower areas of the site containing the 24 hectares lake and other facilities.

In the 20th century a number of sand quarries in the 'sand belt' suburbs of south-east Melbourne were remediated as golf courses, while a more recent remediation created the Cranbourne Botanic Gardens. Whatever concept and designs are finally adopted, the conjunction of a 24 hectares lake with 60 hectares of other rehabilitated areas will provide an opportunity for creative and entrepreneurial consideration.

Much will depend on the economic and social context over the next forty years, but it should be possible to repurpose the site so that it adds value to other nearby properties in the Shire, particularly in Grantville and nearby areas such as Corinella.

Appropriate rehabilitation, revegetation and the security of highly valued tracts of native vegetation has the long run potential to stimulate the value of nearby private land holdings above the levels which would have been attained had the WA1488 site been maintained as farming land, or if the important sand resource not been extracted and the site thereafter appropriately repurposed in the context of its regional, Bass Coast location.

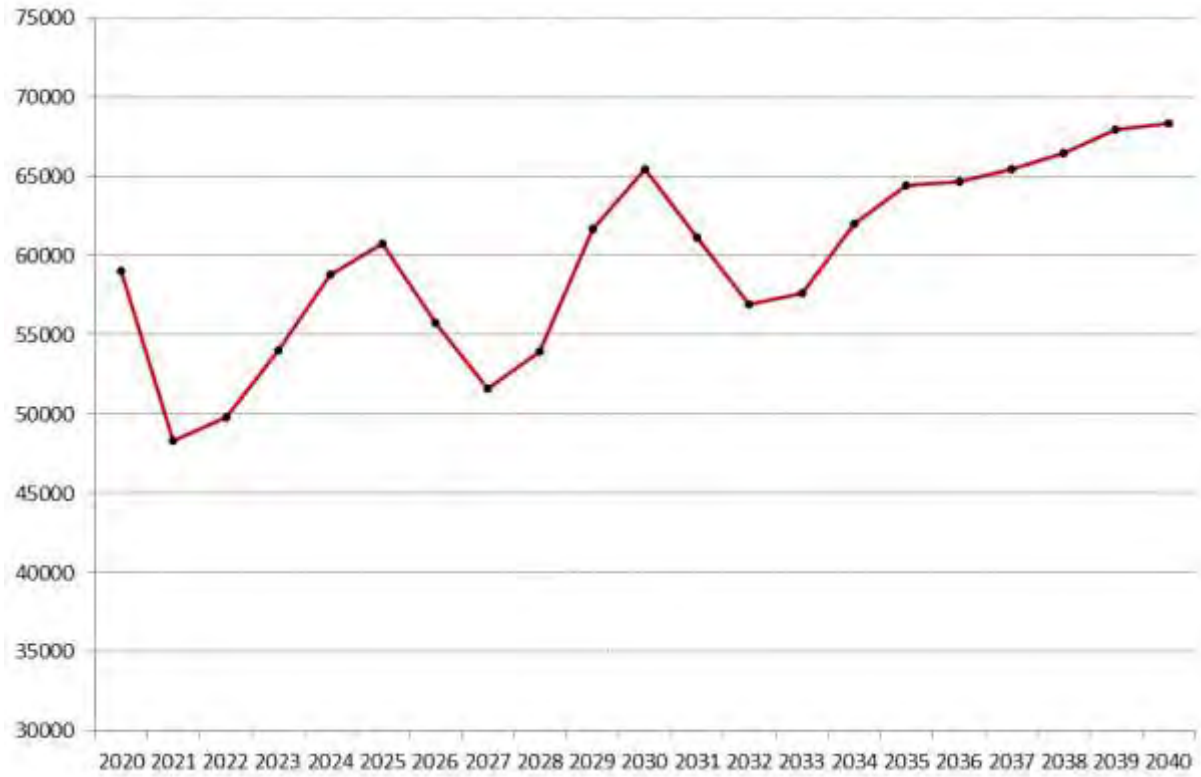
5. Employment and income

Chapter 2 of this report provides detail on the recent history and current outlook for employment and incomes in Bass Coast. In brief, that outlook is uncertain. Even before the impact of the coronavirus, growth in tourism industry employment had paused. The outlook for residential construction is also subject to negative influences.

In these circumstances the growth of the extractive industries has been a bright spot, with employment growing rapidly, admittedly from a low base. The prospect of continued growth and investment in this industry contrasts with the low level of investment confidence in many other industries in the Shire.

Figure 4 provides a projection of the value of construction activity in Victoria for the next two decades. This projection was prepared by NIEIR taking into account the impact of the coronavirus and government responses to the virus, in so far as they can be forecast. As always in construction, activity is cyclical but the trend remains upwards.

Figure 4: Total Victorian construction activity – 2020-2040



The increase in direct employment due to the project has been estimated in Section 4.3, along with the increase in employment due to the purchase of inputs from within the Shire. The increase in value added within the Shire has also been estimated, not directly from Dandy Premix accounts but from the relationship of employment to value added normal in the non-metallic mineral quarrying industry in Victoria. This is shown as the direct increase in value-added in Table 3.

The increase in value-added in industries supplying inputs to the quarry has also been estimated using NIEIR's dynamic input-output for Bass Coast, which includes allowance for inter-regional trade and commuter flows.

While the jobs directly created by the project are located within the Shire, they will not necessarily be taken by Shire residents – Grantville is not far from the boundaries with South Gippsland and Cardinia. However, given the scope for increased labour force participation in Bass Coast and high current levels of unemployment, it is expected that many of the jobs will be taken by local residents.

To the extent that workers on the project spend their additional incomes within the Shire, a further round of employment generation is created. This effect, as regards both employment and value added, has been estimated using the NIEIR model, and is provided in Tables 3, 4 and 5.

The employment and value-added projections shown in Table 3 for the transition period 2021-2023 are for the difference between the Base Case and Quarry Extension case – i.e. the additions to employment and value added caused by the investment program. The pattern of employment increases over base case in FY 2021 is detailed in Table 4. From 2024 onwards the base case assumes quarry closure and zero employment so there is no base-case offset to employment numbers in the extended quarry.

Finally, in Table 3 allowance has been made for the effect on employment and value added via skill upgrades and the attraction to the Shire of professionally qualified and entrepreneurial residents (see Section 4.5). The additional jobs resulting from the quarry-extension case add a new set of skill requirements to the site operations. Because of the additional complexity of site operations and equipment operation and maintenance, more complex scientific monitoring, ongoing remediation of site and so on, a range of increasingly sophisticated skills will be required.

It is likely that the additional skills created in the quarry-extension case will benefit the Bass Coast Shire economy for a significant period. At least some of these new job opportunities will be suitable for young workers and will provide jobs and develop skills for young people in a local context.

As pointed out in Section 4.5, this type of spinoff from primary job generation is very uncertain – it can be negligible, it can be very large. Table 3 includes estimates of the benefits at a roughly 50 per cent level of probability.

As compared to the quarry-closure case, the quarry extension case is expected to increase employment in the Shire by 32 plus gains from skill development, estimated at a further 13 jobs. In terms of value added, the gains are nearly $3m per annum (2020 prices) with a probably further gain of $1m per annum from skill development.

As reported in Table 5, roughly half of the 32 jobs generated within the Shire are expected to be in the mining industry (which includes quarrying), with the rest spread across all of the rest of the industries in the Shire including retail at 2.5 additional jobs and professional, scientific and technical services at 2.1 jobs. These latter have potential to generate further jobs, not included in Table 5, through skill development.

In similar vein, a little less than half the expected increase in value added accrues to the mining industry, around 8 per cent to financial and insurance services and around 6 per cent to professional, scientific and technical services.

In addition, it is estimated that a couple of jobs will be generated in other Victorian LGAs, not counting the jobs generated from the continuing supply of low-cost construction materials to the Melbourne market (the MSA) and to south-east hinterland markets.

Table 3	Impact of the extended quarry on employment and value added in Bass Coast – financial years 2020-2061 (net increases over base case)									
	Employment					Value added ($m)				
Year	Direct	Indirect	Consump-tion	Develop-ment	Total	Direct	Indirect	Consump-tion	Develop-ment	Total
2020	0	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.00	0.00
2021	8	13.2	8.4	0.0	30.0	1.28	1.36	0.74	0.00	3.38
2022	7	2.5	5.9	6.4	21.8	0.58	0.28	0.53	0.42	1.80
2023	12	5.0	10.6	11.5	39.2	1.04	0.50	0.95	0.76	3.24
2024	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2025	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2026	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2027	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2028	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2029	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2030	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2031	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2032	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2033	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2034	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2035	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2036	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2037	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2038	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2039	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2040	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2041	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2042	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2043	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2044	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2045	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2046	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2047	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2048	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2049	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2050	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2051	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2052	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2053	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2054	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2055	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2056	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2057	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2058	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2059	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2060	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
2061	15	5.0	12.4	13.5	46.0	1.22	0.58	1.11	0.89	3.79
Average (years >0)	**15.2**	**5.1**	**12.6**	**13.7**	**46.7**	**1.23**	**0.59**	**1.12**	**0.90**	**3.85**
Sum	**640.0**	**214.3**	**530.8**	**577.1**	**1962.2**	**51.84**	**24.96**	**47.17**	**37.88**	**161.85**

Source: NIEIR modelling. Direct = On-site. Indirect = via input purchases in Bass Coast. Consumption = via expenditure of earnings. Development = via skill developments.

Table 4 Net impact of the project on the Bass Coast economy during the construction phase – 2020-2061				
	Output ($m)	**Value added ($m)**	**Local jobs**	**Residents jobs**
Starting position of the region				
Heavy and civil engineering construction	30.19	10.21	67.04	95.74
All industries	2,760.70	1,113.71	12,247.64	15,264.57
Impacts on region economy				
Direct impact	3.78	1.28	8.40	–
Industrial impact	3.44	1.36	13.20	–
Consumption impact	1.70	0.74	8.40	–
Total impact on the region	8.92	3.39	30.00	23.60
Type 1 multiplier (direct and industrial)	–	–	2.58	–
Type 2 multiplier (direct, industrial and consumption)	–	–	3.57	–
Impact on state economy				
Impact outside of region with the state	0.72	0.32	3.40	9.20
Total impact state economy	9.64	3.71	33.40	32.80
Impact on Australian economy				
Impact outside of the state	0.10	0.05	0.40	1.10
Total impact on Australian economy	9.74	3.75	33.80	33.80
Industry sectors (1-digit ANZSIC)	**Value added $m Change (Type 1) – Region**	**Value added $m Change (Type 2) – Region**	**Value added $m Change (Type 2) – State**	**Value added $m Change (Type 2) – Australia**
Agriculture, forestry and fishing	0.01	0.04	0.05	0.06
Mining	0.05	0.06	0.07	0.07
Manufacturing	0.16	0.20	0.21	0.22
Electricity, gas, water and waste services	0.04	0.07	0.08	0.08
Construction	1.64	1.66	1.67	1.67
Wholesale trade	0.05	0.09	0.11	0.11
Retail trade	0.03	0.11	0.15	0.15
Accommodation and food services	0.01	0.05	0.06	0.06
Transport, postal and warehousing	0.08	0.11	0.12	0.13
Information media & telecommunications	0.03	0.07	0.09	0.09
Financial and insurance services	0.09	0.20	0.25	0.26
Rental, hiring and real estate services	0.02	0.07	0.08	0.09
Professional, scientific & technical services	0.30	0.36	0.38	0.39
Administrative and support services	0.09	0.12	0.13	0.14
Public administration and safety	0.02	0.03	0.03	0.03
Education and training	0.00	0.03	0.05	0.05
Health care and social assistance	0.00	0.05	0.07	0.07
Arts and recreation services	0.00	0.01	0.02	0.02
Other services	0.02	0.06	0.08	0.08
Total industries	**2.64**	**3.39**	**3.71**	**3.75**
Industry sectors (1-digit ANZSIC)	**Local jobs Change (Type 1) – Region**	**Local jobs Change (Type 2) – Region**	**Local jobs Change (Type 2) – State**	**Local jobs Change (Type 2) – Australia**
Agriculture, forestry and fishing	0.1	0.4	0.5	0.5
Mining	0.5	0.6	0.6	0.6
Manufacturing	1.9	2.4	2.6	2.6
Electricity, gas, water and waste services	0.1	0.2	0.3	0.3
Construction	10.6	10.7	10.8	10.8
Wholesale trade	0.5	0.8	1.0	1.0
Retail trade	0.5	2.1	2.7	2.8
Accommodation and food services	0.4	1.1	1.4	1.5
Transport, postal and warehousing	0.9	1.3	1.4	1.4
Information media & telecommunications	0.3	0.5	0.6	0.6
Financial and insurance services	0.3	0.8	0.9	1.0
Rental, hiring and real estate services	0.4	0.6	0.7	0.7
Professional, scientific & technical services	3.8	4.6	4.8	4.9
Administrative and support services	0.7	1.0	1.1	1.1
Public administration and safety	0.2	0.3	0.3	0.3
Education and training	0.0	0.6	0.9	1.0
Health care and social assistance	0.0	0.7	1.0	1.1
Arts and recreation services	0.1	0.2	0.3	0.3
Other services	0.4	1.1	1.4	1.4
Total industries	**21.6**	**30.0**	**33.4**	**33.8**

Table 5 Net impact of the project on the Bass Coast economy, per annum during the production phase – 2022-2061				
	Output ($m)	**Value added ($m)**	**Local jobs**	**Residents jobs**
Starting position of the region				
Heavy and civil engineering construction	2.24	1.41	17.38	10.89
All industries	2,760.70	1,113.71	12,247.64	15,264.57
Impacts on region economy				
Direct impact	1.94	1.22	15.00	–
Industrial impact	1.29	0.58	5.00	–
Consumption impact	2.52	1.11	12.40	–
Total impact on the region	5.75	2.91	32.50	27.30
Type 1 multiplier (direct and industrial)	–	–	1.33	–
Type 2 multiplier (direct, industrial and consumption)	–	–	2.16	–
Impact on state economy				
Impact outside of region with the state	0.40	0.18	2.00	6.40
Total impact state economy	6.15	3.09	34.40	33.70
Impact on Australian economy				
Impact outside of the state	0.08	0.04	0.30	1.10
Total impact on Australian economy	6.22	3.12	34.70	34.70
Industry sectors (1-digit ANZSIC)	**Value added $m Change (Type 1) – Region**	**Value added $m Change (Type 2) – Region**	**Value added $m Change (Type 2) – State**	**Value added $m Change (Type 2) – Australia**
Agriculture, forestry and fishing	0.01	0.05	0.06	0.06
Mining	1.36	0.38	1.38	1.38
Manufacturing	0.03	0.09	0.10	0.10
Electricity, gas, water and waste services	0.05	0.09	0.10	0.10
Construction	0.08	0.11	0.11	0.11
Wholesale trade	0.02	0.08	0.10	0.10
Retail trade	0.01	0.13	0.16	0.16
Accommodation and food services	0.01	0.05	0.06	0.06
Transport, postal and warehousing	0.03	0.07	0.08	0.08
Information media & telecommunications	0.01	0.06	0.07	0.07
Financial and insurance services	0.07	0.24	0.27	0.28
Rental, hiring and real estate services	0.01	0.07	0.08	0.08
Professional, scientific & technical services	0.07	0.17	0.18	0.19
Administrative and support services	0.03	0.08	0.08	0.09
Public administration and safety	0.01	0.02	0.02	0.02
Education and training	0.00	0.05	0.06	0.06
Health care and social assistance	0.00	0.07	0.08	0.08
Arts and recreation services	0.00	0.02	0.02	0.02
Other services	0.01	0.08	0.09	0.09
Total industries	**1.80**	**2.91**	**3.09**	**3.12**
Industry sectors (1-digit ANZSIC)	**Local jobs Change (Type 1) – Region**	**Local jobs Change (Type 2) – Region**	**Local jobs Change (Type 2) – State**	**Local jobs Change (Type 2) – Australia**
Agriculture, forestry and fishing	0.1	0.5	0.5	0.6
Mining	16.1	16.2	16.2	16.2
Manufacturing	0.4	1.1	1.2	1.3
Electricity, gas, water and waste services	0.2	0.3	0.3	0.3
Construction	0.5	0.7	0.7	0.7
Wholesale trade	0.2	0.7	0.8	0.9
Retail trade	0.2	2.5	3.0	3.1
Accommodation and food services	0.2	1.3	1.5	1.5
Transport, postal and warehousing	0.3	0.9	0.9	1.0
Information media & telecommunications	0.1	0.5	0.5	0.5
Financial and insurance services	0.3	0.9	1.0	1.0
Rental, hiring and real estate services	0.1	0.4	0.5	0.5
Professional, scientific & technical services	0.9	2.1	2.2	2.3
Administrative and support services	0.2	0.6	0.7	0.7
Public administration and safety	0.1	0.2	0.2	0.2
Education and training	0.0	0.8	1.1	1.1
Health care and social assistance	0.0	1.0	1.2	1.2
Arts and recreation services	0.0	0.3	0.3	0.3
Other services	0.2	1.4	1.5	1.6
Total industries	**20.0**	**32.5**	**34.4**	**34.7**

REPORT 9 – GEOTECHNICAL ASSESSMENTS



Dandy Premix Quarries Pty Ltd

Grantville Quarry (WA1488)
Geotechnical Assessment

December 2019

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1. Introduction

1.1 General

Dandy Premix Quarries Pty Ltd (the Client) intends to expand the development and extraction of the sand resources at the Grantville Quarry (the site), Work Authority 1488 (WA1488), situated in Grantville, Victoria (refer Figure 1). The proposed developments includes the coarse sand extraction pit (CSEP) in the eastern area of WA1488 and the enlarged wet fine medium sand extraction pit (FMSEP) in the western area of the Work Authority (refer Figure 2).

GHD Pty Ltd (GHD) was commissioned by Mr Garry Cranny of Dandy Premix Quarries to undertake a geotechnical assessment of the site and evaluate pertinent stability considerations of the proposed development. The assessment is required, as part of a work plan variation (WPV) submission to Earth Resources Regulation (ERR).

This report presents the results of the geotechnical assessment.

1.2 Scope of Works

The following scope of works is based on GHDs proposal (GHD ref: 12510945-94899, dated 22 August 2019) and subsequent liaison with ERR and the Client.

- Undertake a desktop study of existing reports and information to:
  - Develop a geotechnical model, based on the available information and testing works undertaken across the site (refer GHD report: 3136345-36363, Rev 0, dated 10 August 2018).
- Undertake a geotechnical assessment as follows:
  - 2D Limit-equilibrium analysis to calculate stability outcomes of the proposed development of a coarse sand extraction pit in line with the Earth Resources Regulation (ERR) guidelines (DJPR, 2018).
  - Determine the adequacy of the proposed ‘stand-off’ distances from the crest of the proposed developments to the Work Authority boundary.
- Investigate any geotechnical implications of deepening the existing quarry excavation (i.e. via wet extraction).

This report presents the geotechnical parameters derived to build the geotechnical model and the findings and recommendations of the geotechnical assessment pertinent to the proposed development. The findings from this study has formed the basis of a site Ground Control Management Plan (GCMP).

These are presented in the subsequent sections of this report.

1.3 Limitations

This report has been prepared by GHD for Dandy Premix Quarries Pty Ltd and may only be used and relied on by Dandy Premix Quarries Pty Ltd for the purpose agreed between GHD and the Dandy Premix Quarries Pty Ltd as set out in this report.

GHD otherwise disclaims responsibility to any person other than Dandy Premix Quarries Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Dandy Premix Quarries Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

1.4 Client Supplied Information

We have relied upon the following sources of information for the slope stability analyses, detailed in this report. Relevant information was extracted from the following documents:

- BCA Consulting:
  - Resource definition (Res Def) logs
- ATC Williams reports:
  - Geotechnical Investigation of Earthworks Construction Materials and Embankment Foundations (ref: 113189.01R01, dated January 2014)
  - Geotechnical Investigation for Sound Walls and Weigh Bridge Building (ref: 113189.02R01, dated May 2014)
- A.S. James report:
  - Infrastructure & Access Road – Proposed Sand Mine (ref: 115134, dated 4 July 2013)

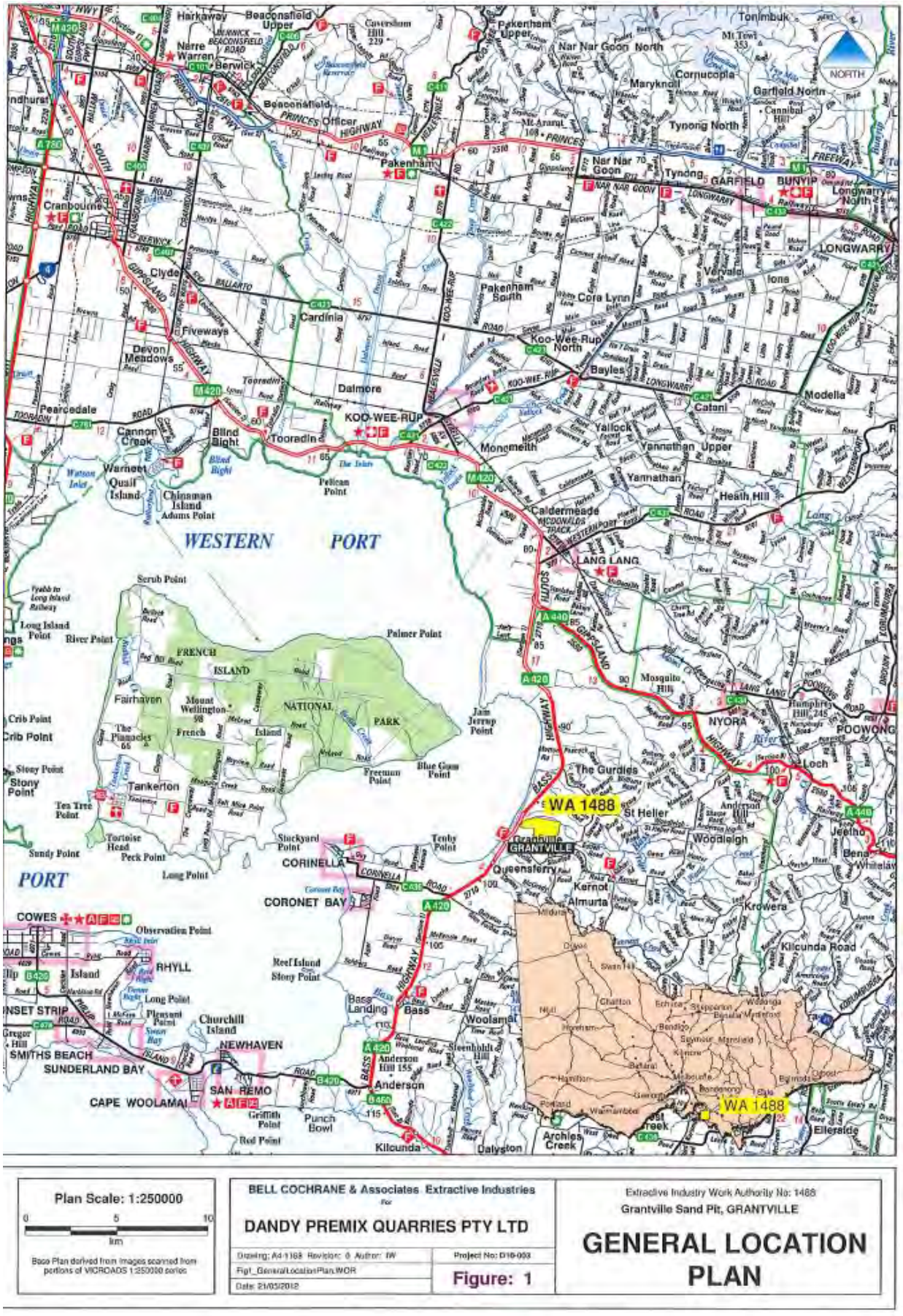


Figure 1 Grantville Quarry Site Location Plan



Figure 2 Grantville Quarry Proposed Development Plan (As at Aug 2019)

2. Background

2.1 General

Dandy Premix Quarries currently operate an existing sand extraction site on the western portion of WA1488, approximately 400 m east of the Western Port Bay coastline. The operation of this pit commenced in 2014 and has gradually been developed on relatively flat land to the east of the Bass Highway site frontage.

The Grantville Quarry site is located to the north of the Grantville township on the Bass Highway. In close proximity to the quarry site, to the north and south, are bushland parks and conservation reserve land. It should be noted that Dandy Premix owns the land immediately to the north of the site (WA 1488). Public infrastructure assets and environmental receptors are located within a 1 km radius proximity to the Grantville Quarry.

The site is bound by Bass Highway to the west, the Nature Conservation Reserve to the north and abutting the site to a part of its southern boundary is the Grantville Bushland Reserve, other free hold land owned by Dandy Premix forms the 156Ha site area..

The existing site extraction area comprises a Fine to Medium Sand Extraction (FMSE) pit to the west of the proposed Coarse Sand development, a processing plant to the north and central of the existing (FMSE) pit and on-site surface water storage dams.

The site surface elevation of the current pit (western part of WA1488) varies between 20 m and 35 m Australian Height Datum (AHD), which is relatively flat. The existing (FMSE) pit is limited to a maximum extraction depth of 10 m AHD. Further development of the existing pit is proposed below the currently approved extraction depth.

Available information indicates that the topography of the proposed CSEP descends from east to west with elevation 115 m AHD (eastern extent of development) declining to 60 m AHD (south western corner of proposed development).

A number of investigatory drilling campaigns have been carried out in WA1488 by Dandy Premix with input from a number of consultants as outlined in the previous section, involving borehole drilling, soil logging and sampling and in-situ testing and laboratory testing to document the encountered subsurface conditions from a geological and geotechnical perspective.

2.2 Regional and Site Geology

The regional and site geological setting has been studied and described by John Leonard Consulting Services (JLCS), their report titled "*WA 1488, 1381-1395 Bass Highway, Grantville Work Plan Variation Phase 2 Development Hydrogeological Assessment*", dated December 2019. The sections below pertaining to the site and regional geological have been sourced from the aforementioned report.

2.2.1 Regional Setting

WA1488 is located towards the western extent of the extensive (46,000 km2) Gippsland Basin, an east-to-west to northwest-to-southeast trending rift basin that lies along Australia's southern margin. The Gippsland Basin unconformably overlies the Palaeozoic basement and extends more than 400 km west to east from the Mornington Peninsula (western boundary ill-defined) to Cape Howe. The basin was initiated during the Late-Jurassic in response to rifting of Australia and Antarctica. Rift and sag phases continued into the Early Cretaceous. Cretaceous to Recent phases of compression have resulted in inversion and wrenching of pre-existing rift structures (Holford et al, 2010). Miocene-Quaternary compression has also resulted in onshore deformation

in the Gippsland Basin (King, et al., 2012). Post-rift sedimentary initiated during the early Oligocene infilled created the large Tertiary Gippsland Basin and smaller Western Port, Moe Swamp and Tarwin basins.

The majority of WA1488 (western portion) lies within a down-thrown Tertiary geological basin referred to as the Western Port Basin, a small (900 km^2), relatively shallow basin infilled by Cainozoic sedimentary and volcanic rocks developed at the western end of the older Gippsland Basin. However, the eastern, small portion of WA1488 is situated on a up thrown block of Cretaceous rocks (Strzelecki Group) that form the Strzelecki Ranges thought to have been uplifted since the late Miocene (Dickinson et al, 2001).

2.2.2 Outcrop Geology

The outcropping geology in the Grantville area is shown below, the upper (near surface) portion of the Brighton Group across WA1488 is predominantly clay or silt which in the context of sand extraction is referred to as “overburden”. The thickness of the clay/silt overburden varies from absent to about 19 m and is mostly between 5 m and 10 m across the lower elevated, western portion of the site but is thinner to absent on the hill in the south-eastern part of the site.

2.2.3 Structural Geology

Numerous faults have been mapped with both the Western Port and Gippsland Basins. Movement along faults within the Gippsland Basin formed the up-thrown Strzelecki Ranges and the down-thrown Western Port Sunklands (Lowlands). Major faults in (greater) Grantville area are shown in the figure below. Faulting was initially by northwest to southeast extension during the Miocene resulting in faults striking northeast to southwest which produced a series of horsts (up thrown blocks) and grabens (down thrown blocks) striking northeast to southwest.

The area is still undergoing compression and uplift (Holdgate et al., 1998; Hillis, 2000; Tuitt et al., 2001; Brown et al., 2013). The eastern (small) portion of WA1488 is situated in the westernmost up thrown block of the Strzelecki Ranges referred to as the Heath Hill Block. The Heath Hill Block is bounded to the west by the Heath Hill Fault and to the east by the Bass Fault. These faults as with most of the major faults across the Gippsland Basin were initiated during the Late- Jurassic period in response to rifting of Australia and Antarctica. Rift and sag phases continued into the Early Cretaceous period. Phases of compression have resulted in inversion and wrenching of the pre-existing rift structures (Holford et al, 2010).

The principal control of relief and geological outcrop pattern in the Grantville area is the Heath Hill Fault, a major regional fault of late Pliocene or early Pleistocene age (probably a reactivated older fault). The Heath Hill Fault has juxtapositioned Tertiary rocks of the Western Port Basin against the Cretaceous Strzelecki Group rocks of the Gippsland Basin. In the Heath Hill area, uplift of up to 150 metres to the east is indicated by the relative elevations of Older Volcanics (Mornington Volcanic Group) on both sides of the fault. North of the Lang Lang River at Heath Hill the scarp is prominent, rising almost 100 metres above the flood plain.

The fault location in the Grantville is less obvious as the topographic relief is smaller. The Heath Hill Fault is aligned northeast to southwest and extends from the foothills of the Great Dividing Range near Drouin to southeast of Grantville and possibly further southwest towards the Anderson area. On a regional scale the position of the trace of the Heath Hill Fault has been shown differently on at least three published maps, namely 1) Jenkin (1962); 2) Mines Department (1971) undated by NNRE (1997); and Thompson (1974). [The Heath Hill Fault is not shown in the DPI (Welsh et al., 2011) published map (Map 51 Western Port-Warragul)].

The general position of the Heath Hill Faults has been remapped for this project by BCA (A Marshall) based on more geological exposures at a number of sand quarries and more detailed

topographic models (digital elevation and terrain relief models). The location of the fault at WA1488 has been further constrained by targeted drilling to intersect the fault, specifically drillholes.

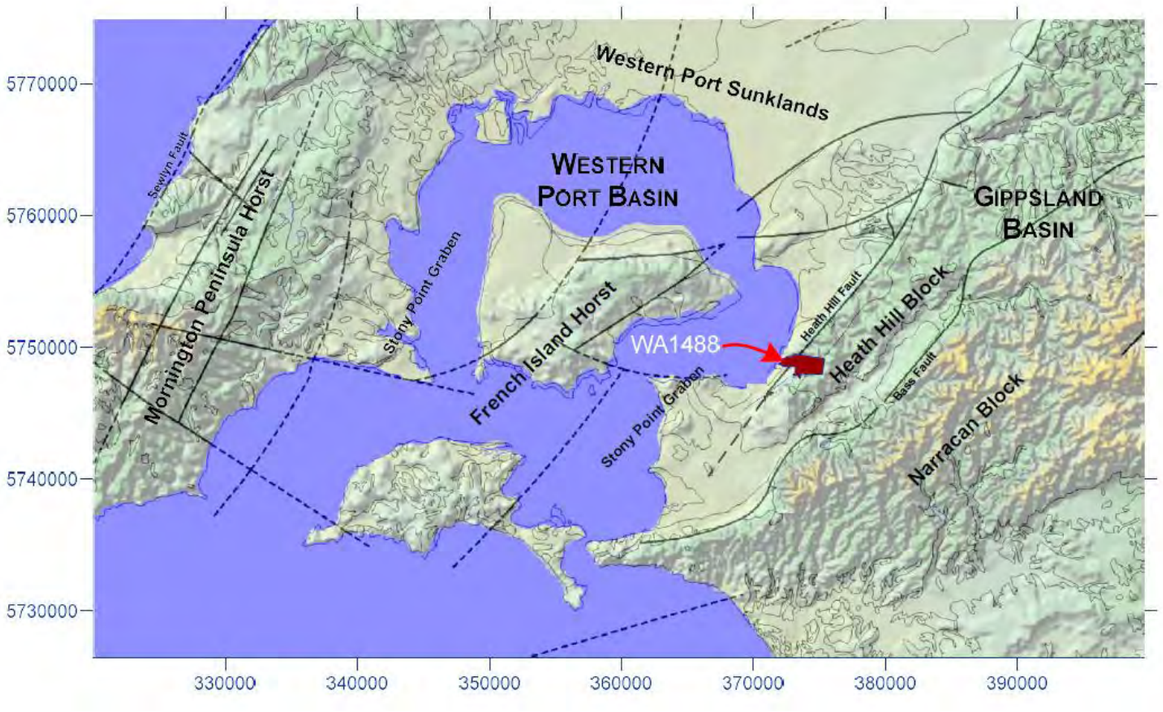


Figure 3 Grantville Area Major Faults, after Leonard (2019)

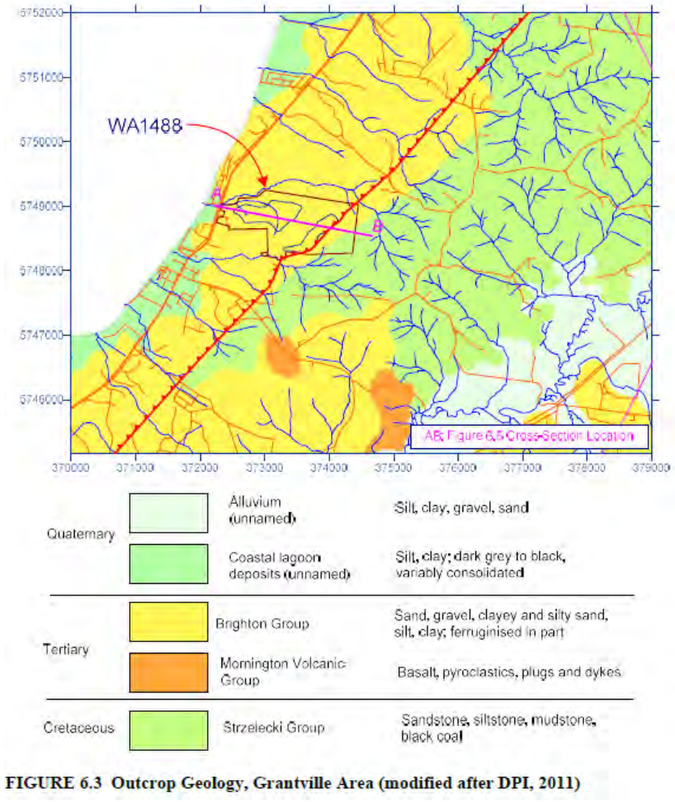


FIGURE 6.3 Outcrop Geology, Grantville Area (modified after DPI, 2011)

2.2.4 Regional and Site Stratigraphy

The stratigraphic sequence in the Western Port Basin ranges from less than 50 m to over 300 m in the Koo Wee Rup Dalmore area. The main stratigraphic units within the basin from oldest to youngest are:

- Strzelecki Group (siltstone, mudstone, sandstone, minor black coal and volcanics). -
- Childers Formation (sand, clay, gravel, conglomerate, thin brown coal seams).
- Mornington Volcanic Group (Older Volcanics: basalt, basaltic clay).
- Yallock Formation (sand, gravel).
- Brighton Group formerly referred to as “Baxter Formation” (silt, sand, clay).
- Unnamed Quaternary deposits (clay, peat, silt, sand minor gravel).

Strzelecki Group

The Upper Strzelecki Group rocks are relatively uniform, consisting of a generally ‘upwards fining’ sequence of massive coarse- to fine-grained sandstone. These interfinger with a range of minor rock types including siltstone, fine-grained sandstone, paleosoils, coal seams and lacustrine shale. The sediments were originally deposited in fluvial environments dominated by internally braided channels flowing through extensive floodplains with marginal alluvial fans. Rapid subsidence led to accumulation of multi-storied channel complexes, with numerous erosion surfaces.

The sediments were mainly reworked tuffaceous material from rift-related explosive volcanism roughly contemporaneous with deposition, as well as some detritus from nearby outcropping Paleozoic rocks. The sequence exceeds 3 km in thickness and covers at least 30,000 km2 (Duddy, 2003). The Strzelecki Group outcrops extensively in the South Gippsland highlands and along coastal sections between San Remo and Inverloch in South Gippsland. Outcropping Strzelecki Group were mapped in the south-eastern corner of WA 1488 to the east of the Heath Hill Fault in the south-eastern corner of WA1488 (Welsh et al., 2011).

Older Volcanics

Tertiary aged volcanics rocks referred to as the Mornington Volcanic Group are widespread within both the Western Port Basin and the eastern part of the Gippsland Basin. The volcanics consist of variably weathered to fresh basalt, agglomerate and tuff, interbedded with conglomerate, sandstone and carbonaceous claystone (Edwards, 1939). In some cases, the weathering has decomposed the basalts to variably coloured volcanic clays and other pedogenic soil profiles (Holdgate and Gallager, 2003). These rocks outcropping across most of Phillip Island, at San Remo, Corinella, and along the southern coast of French Island.

These rocks also occur as extensive sheet-flows at depth over a large area extending from Cranbourne to Lang Lang where they are overlain by younger Cainozoic sedimentary rocks. Drillholes logs indicate that the Older Volcanics are mostly absent in the Grantville area except for a few outcrops on the upthrown Strzelecki Ranges inland from the Grantville Township. Volcanic rocks (tuff and varyingly weathered basalt) were intersected in bore BH08 located near the top of the topographic high in the south-eastern corner of WA1488. Volcanics were logged between 28.0 and 61.7 m depth beneath 12.6 m of unconsolidated silt-clayey-sandy sediments overlying 15.4 m of consolidated and indurated sedimentary rocks (siltstone and claystone) by Anderson (2018).

Photographs of cores from BH8 provided by Anderson are presented below. The stratigraphic sequence intersected in BH8 is considered to be: Brighton Group Overlying Strzelecki Group

above Older Volcanics. This interpreted stratigraphy is consistent with a volcanic plug associated with the Heath Hill Fault.

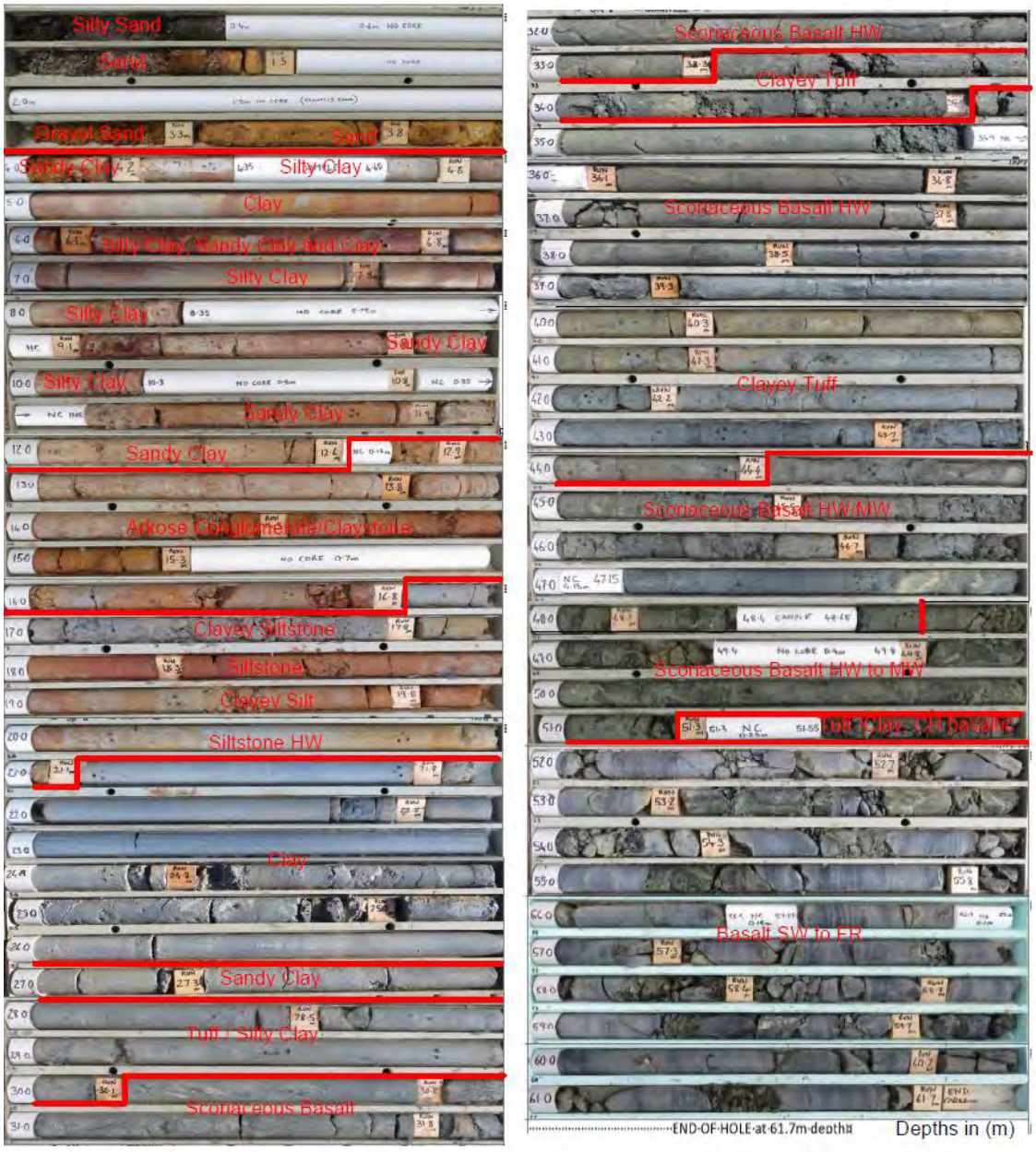


Figure 4 BH08 Core Photographs (modified from photographs provided by R Anderson, 2018)

Brighton Group

The outcropping sediments to the west of the Heath Hill Fault scarp (including at WA1488) were mapped by Jenkin (1962, 1974) as Grantville Gravels formed as alluvial fan materials developed from scarp erosion and retreat. Thompson (1974) and Spencer-Jones et al. (1975) regarded these as an upper unit of the Baxter Formation and not the result of the process described by Jenkin (1962, 1974).

These sediments were mapped as Brighton Group in the Geological Survey of Victoria (GSV) seamless geology mapping project (Welsh et al., 2011). Re-examination of the Brighton Group type sections in the adjoining Port Phillip Catchment by VandenBerg (2016) indicated that the unit is entirely of paralic origin, with no evidence for fluvial deposition. Movement along the

Heath Hill Fault most likely dragged-up Brighton Group and other Tertiary stratigraphic units on the western side of the fault which would explain the reported steep dips in the Tertiary sediments and the greater than expected thickness of the Brighton Group close to the Tertiary-Cretaceous contact.

2.2.5 Heath Hill Fault at WA 1488

The location of the Heath Hill Fault across WA1488 has been mapped based on findings of on-site drilling targeted to intersect the fault, e.g., drillholes AC18-01, AC18-02, as described by Leonard (2019). The Strzelecki Group-Brighton Group faulted contacted was intersected at 13 m depth in AC18-01 and at 21 m depth in AC18-02; the elevations of the fault surface were 101.0 and 92.6 m AHD, respectively. Trigonometric analysis indicated that the fault plane dipped at 30 degrees measured from the horizontal to the NWbW, (i.e., fault strike bearing of 148 degrees see Figure below, after Leonard (2019). The faulted relationship between the Strzelecki Group and Brighton Group is shown in the approximated west-east geological cross-section below (see Figure 5).

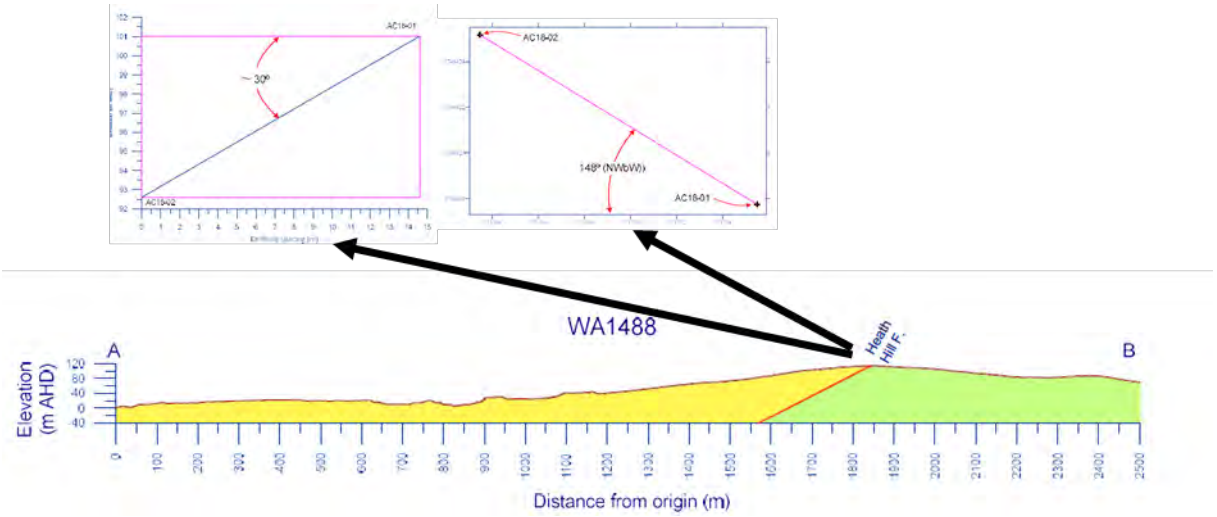


Figure 5 Schematic West East Cross Section Heath Hill Fault, after Leonard 2019

2.3 Site Surface and Groundwater Conditions

2.3.1 Groundwater

A detailed groundwater and Hydrogeological assessment has been undertaken by John Leonard Consulting Services, as presented in their report titled '*WA 1488, 1381-1395 Bass Highway, Grantville Work Plan Variation Phase 2 Development Hydrogeological Assessment* ' dated December 2019. This report incorporates the recent drilling findings and groundwater monitoring results and update the hydrogeological models.

The groundwater table beneath WA1488 within the Western Port Basin is located in the sands of the Brighton Group sands beneath the near surface more silty and clayey facies (overburden). The groundwater in the Brighton Group aquifer is unconfined despite being below lower permeability silts and clays (if the groundwater table was within finer grained material, the aquifer would be classified as “semi-unconfined”). The elevation of the groundwater table within the Brighton Group varies from about 11 m AHD toward the Heath Hill Fault to 5.4 m AHD near the western boundary of WA1488 sloping from east to west with groundwater flowing toward (and discharging into) Western Port Bay. Monitoring over the past 7-years has indicated that the groundwater table elevation is relatively static, across the WA 1488 site, refer to Figure 6.

Flow system analysis based on geology, observed groundwater table elevations including in a monitoring bore close to and west of the Heath Hill Fault, local topography and field observations (drainage lines at lower elevations east of the fault were observed to be dry during a number of inspections) indicates that the groundwater in the volcanics is perched, and hydraulically isolated from the groundwater in the Brighton Group, i.e., the groundwater on the western side on the Heath Hill Fault is in a different groundwater compartment to that on the eastern side of the fault with the fault acting as a hydrogeological barrier boundary. — Compartmentalized groundwater systems are well documented including in the Great Artesian Basin (Ransley and Smerdon eds, 2012a and 2012b; Ransley et al., 2015) and at mine sites in Western Australia (Manewell, 2008) and Queensland (JLCS, 2016).

Field groundwater observations recorded on the air core logs are generally consistent with groundwater monitoring results recorded in the past 5 years. Based on the air core logs, some minor seepages in the upper batters of the proposed expansion of the existing pit and CSEP can be expected which will most likely to be related to localised perched groundwater tables.

As the proposed CSEP operations deepen it is possible that groundwater inflows could occur, should the quarry extend below the unconfined groundwater table.

GHD understands that the groundwater levels will continue to be monitored via the network of existing and planned monitoring points. The objective is to verify geotechnical conditions to inform an assessment of the long-term slope stability. Through the planned monitoring, any substantial changes will be noted and reported to a geotechnical engineer in order to implement the necessary engineering controls (as required).

The stability modelling of the terminal batters includes the consideration for groundwater conditions as presented in Section 4.

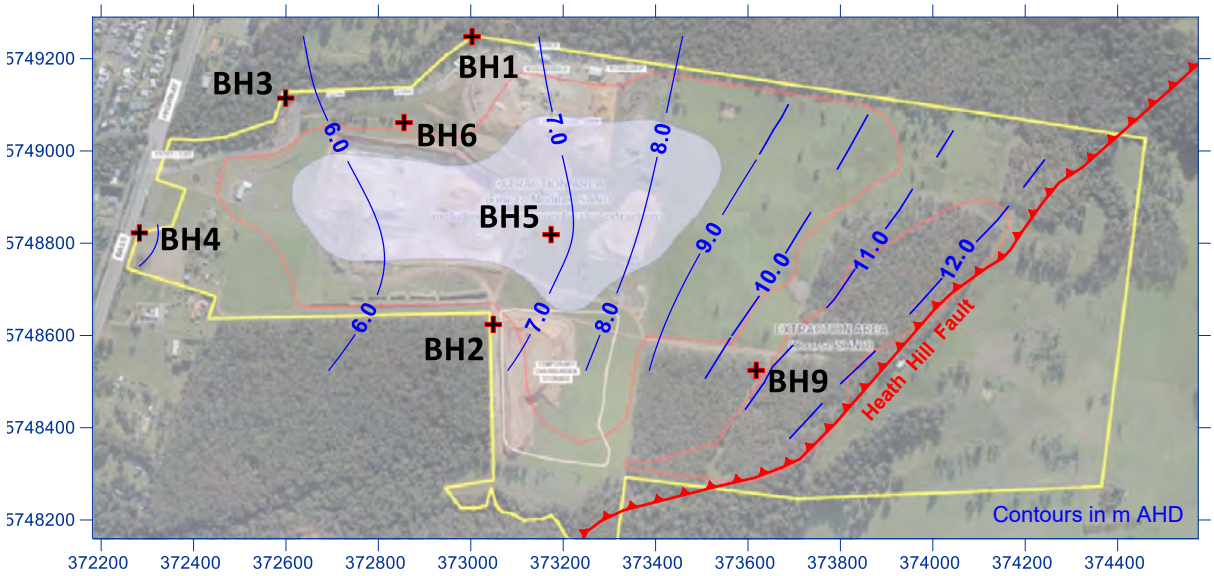


Figure 6 Interpreted Groundwater Depths after JLCS 2019

2.4 Surfacewater at WA 1488

The regional and local surfacewater aspects have been considered and assessed by Water Technology, in their report titled “Grantville Sand Quarry Expansion – Surface Water Report”, dated November 2019. The points below have been paraphrased from their report is presented below.

The proposed site expansion footprint would see the majority of a small tributary (MW3840) catchment which drains to Deep Creek become a quarry, which would capture rainfall and convert surface water runoff to groundwater. The proposed expansion would also see a deepening of the existing quarry to below groundwater, with an area of wet quarry and exposed groundwater table.

The hydrological analysis completed by Water Technology has demonstrated that the proposed ultimate pit scenario will reduce surface water runoff to Deep Creek. This is because under the proposal the majority of the tributary catchment which drains to Deep Creek upstream of the Bass Highway will be part of the FMSEP and will capture the rainfall directly. The Deep Creek mean annual flow downstream of the Bass Highway would likely reduce.

With a larger portion of the surface water being converted to groundwater, the mean annual evaporation loss is reduced. This sees an increase of approximately 50 ML/year of useable water within the catchment compared to current conditions. It is Water Technology's opinion that the proposed quarry expansion will have no significant impact on the hydrological regime of the lower reaches of Deep Creek downstream of the Bass Highway.

Water Technology has observed the current Dandy PRemix have implemented best practice stormwater and erosion management techniques, at the WA 1488 site. Water Technology is satisfied that the proposed works under the work plan variation will continue to implement best practice stormwater and erosion control to protect the downstream receiving waters of Deep Creek and Western Port Bay, via MW 3840.



Figure 7 WA1488 and Surrounds Pre-Quarrying Filled Topographic Contours, after Water Technology 2019

3. Geotechnical Model and Domains

3.1 Geological Model

Summarised in this section of the report are the findings from the past investigations undertaken across the site, which have formed the basis of the geological model, upon which the subsequent geotechnical model and domains have been formulated. These studies have focused on delineating the extent, mechanical characteristics and intra material variability of the overburden and sand resources. The findings from the respective studies are presented in the impending sub sections.

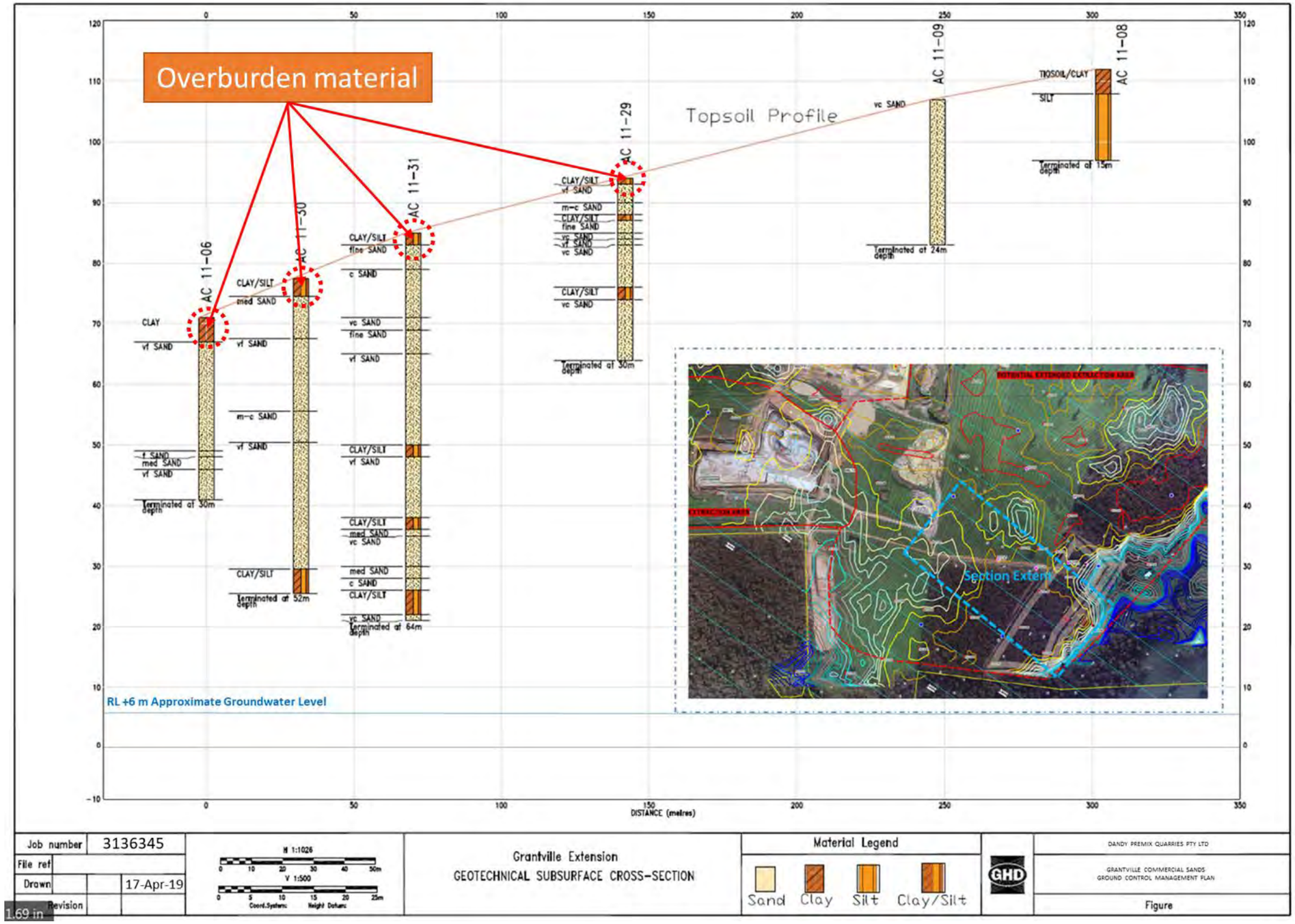


Figure 8 Interpreted Geotechnical Cross Section Based on AS 1726 Classification System (Representative of Conditions within the CSEP and the Wet Extraction Pit)

3.2 Summary of Past Investigations

3.2.1 General

A.S. James (2013 and 2014)

A.S. James (refer 113154, dated 4 July 2013) undertook a limited characterisation exercise, the findings and limitations are documented in the geotechnical report (refer: 113154, dated 4 July 2013). The intrusive investigation associated with this exercise was carried out by Dandy Premix and Stewart Young.

The overburden materials typically comprised, clay, silt and sand. The clays were of medium to high plasticity, with variable sand content and were of stiff consistency. 12 boreholes were drilled to a maximum depth of 6.5 metres below ground surface level.

ATC Williams undertook a field characterisation exercise with benefit of laboratory classification, across the OB material to delineate the respective material types encountered. The findings and limitations are documented in ATC Williams report dated (January and May, 2014).

No free standing groundwater was encountered at the time of the site investigations.

ATC Williams (2014)

Table 1 below summarises the findings from this investigation.

Table 1 Summary of Subsurface Ground Conditions (ATC Williams, Jan 2014)

Unit	Approximate Depth to upper contact level (m)	Approximate Thickness (m)	Generic Description & Origin
1	Surface	0.2 – 0.6	Silty CLAY (CL) / Clayey SILT (ML) / Silty SAND (SM) **(TOPSOIL)** Fine to medium grained, low plasticity to non-plastic, pale grey, with fine roots and other organic material, dry to wet. (Sedimentary colluvial Origin)
2A	0.2 – 0.6	1.1 – 1.8	CLAY (CL / CI / CH) Stiff to very stiff, low to high plasticity, orange brown with pale grey and trace of red brown, with sand, W > Wp. (Sedimentary alluvial Origin)
2B	1.7 – 2.0	Not determined	CLAY (CI /CH) Stiff to very stiff, medium to high plasticity, red brown and pale grey, with sand, with iron oxide staining and weakly cemented gravel, W > Wp. Clayey SAND (SC) Fine to medium grained, red brown and pale grey, with iron oxide staining and weakly cemented gravel, moist. (Sedimentary alluvial Origin)

Table 2 presents an excerpt of the summary of laboratory testing undertaken by ATC Williams (2014).

Table 2 Summary of ATC Williams Laboratory Test Results (excerpt)

Test Pit / Depth (m)	Description	MC (%)	Atterberg Limits			PSD <75 µm (%)	Emerson Class Number	Permeability k (m/sec)	Standard Compaction	
			LL (%)	PL (%)	PI (%)				MDD (T/m^3)	OMC (%)
B1 1.0	CLAY (CH)	23.7	61	20	41	83.5	4	1.1×10^{-9}	1.58	23.0
B1 2.0	CLAY (CH)	28.0								
B1 3.0	CLAY (CH)	21.1	82	21	61	73.0	4	5.5×10^{-10}	1.63	21.5
B1 5.0	Clayey SAND (SC)	11.3	64	13	51	33.6	4		1.91	12.0
B2 1.0	CLAY (CH)	23.8								
B2 2.0	CLAY (CH)	21.6	83	18	65	67.8	4		1.61	22.5
B2 4.0	CLAY (CH)	19.0	82	20	62	67.4	4	2.1×10^{-10}	1.65	21.5
B3 1.0	CLAY (CH)	19.9	59	15	44	81.3	4		1.68	20.0
B3 2.0	CLAY (CH)	30.2								
B3 3.0	CLAY (CH)	23.7	87	21	66	75.5	4	1.2×10^{-10}	1.59	23.5
B3 5.0	CLAY (CH)	14.8	67	15	52	58.4	4	2.3×10^{-10}	1.75	16.5
F2 1.0	CLAY (CI)	17.0	38	11	27	75.5				
F5 1.0	CLAY (CH)	22.4	60	15	45	82.3				
F8 0.1	Silty SAND (SM)	15.5	-	22	NP	48.8				
F8 1.0	CLAY (CL)	13.4	27	12	15	52.5				

From ATC Williams (2014), the Atterberg Limits testing undertaken on soil units 2A and 2B (refer Table 2) indicates that the materials generally comprise clays of high plasticity, with some low to medium plasticity clays typically at about 1m depth. The key findings here are generally aligned with the findings from A.S. James (2013).

Emerson Class Number (i.e. a dispersion test) testing was conducted on collected clay samples. The results of this testing indicated that the clays have intermediate dispersion potential (Emerson Class of 4) in nature (refer Table 2).

Pocket penetrometer testing conducted on recovered undisturbed tube samples indicate that the soil stiffness ranged from 125 kPa to 300 kPa. No laboratory shear strength testing was conducted on samples recovered from the ATC Williams investigations.

No free standing groundwater was encountered at the time of the site investigation.

BCA Consulting

Dandy Premix carried out a drilling campaign in early 2018 with input from BCA Consulting, involving resource definition (Res Def) air core borehole drilling, soil and rock logging and sampling, for the purposes of resource (Sand) exploration. Supplied borehole / stratigraphy logs indicate that the clay and silt overburden material varies in layer thickness between 1 m and 19 m and overlies sand and clayey sand layers of variable thickness.

Shown in Figure 8 is a long section interpreted by GHD using Client supplied information. This interpretation forms the fundamental basis for the subsequently interpreted geotechnical domains. These interpretations have been made using a selection of representative boreholes from within the CSEP. These outcomes have been cross referenced with the geological conditions within the wet extraction area and are noted to be in conformance.

GHD (2018)

GHD undertook an interpretative assessment of the material strengths within the OB and sand unit(s). The findings and limitations are documented in our report dated August 2018.

The laboratory test campaign consisted of the following suites of tests from a geotechnical / stability perspective.

- Triaxial Strength Testing - consisting of Consolidated Drained and Unconsolidated Undrained strength testing
- Soil classification testing consisting of Atterberg Testing and Emerson Class Number and Particle Size Distribution (PSD)

Summarised below in Table 3 are the material samples subjected to geotechnical testing.

Table 3 Summary of Laboratory Test Work

Hole ID	Lab Sample ID	Depth (m)	Test Type
HS01	LMEL20180416128	Unknown	Triaxial/PSD
HS01	LMEL20180416131	Unknown	Triaxial
HS01	LMEL201805099	Unknown	Triaxial
BH8	LMEL20180416165	4.35 – 4.65	Atterberg
BH8	LMEL20180416166	5.18 - 5.40	Triaxial
BH8	LMEL20180416167	5.40 - 5.65	Triaxial/Atterberg
BH8	LMEL20180416168	5.70 - 5.95	Triaxial/Emerson
BH8	LMEL20180416169	7.20 – 7.45	Triaxial/Atterberg
BH8	LMEL20180416170	20.55 - 23.00	Triaxial
BH8	LMEL20180416171	23.25 - 23.50	Triaxial/Atterberg
BH8	LMEL20180416172	23.50 - 23.75	Triaxial
BH8	LMEL20180416173	26.00 - 26.25	Triaxial
BH8	LMEL20180416174	26.50 - 26.75	Atterberg
BH8	LMEL20180416175	26.75 - 27.00	Triaxial
BH8	LMEL20180416176	29.20 – 29.45	Atterberg
BH8	LMEL20180416177	42.65 – 42.90	Atterberg
BH8	LMEL20180416178	47.50 – 47.70	Atterberg
BH8	LMEL20180416180	35.25 – 35.50	Triaxial
BH8	LMEL20180416181	37.40 – 37.65	Triaxial
BH8	LMEL20180416182	48.40 – 48.65	Triaxial
BH8	LMEL20180416113	27.78 – 28.00	Triaxial
IBS01	LMEL20180416126	Unknown	Triaxial
IBS01	LMEL20180416129	Unknown	Triaxial/Atterberg
IBS01	LMEL201805020	Unknown	Triaxial/Atterberg/Emerson
YIS01	LMEL20180416127	Unknown	Triaxial
YIS01	LMEL20180416130	Unknown	Triaxial/PSD
YIS01	LMEL2018050910	Unknown	Triaxial

Material Classification Test Work

The results of the laboratory soil classifications are plotted a Casagrande chart below and is also presented in the 2018 GHD report titled “Derivation of Geotechnical Parameters” (GHD ref: 3136345-36363, dated 18 August 2018). The plot depicts the distribution of the Atterberg Limits (of tested samples) in relation to the plasticity classifications after Casagrande (1984).

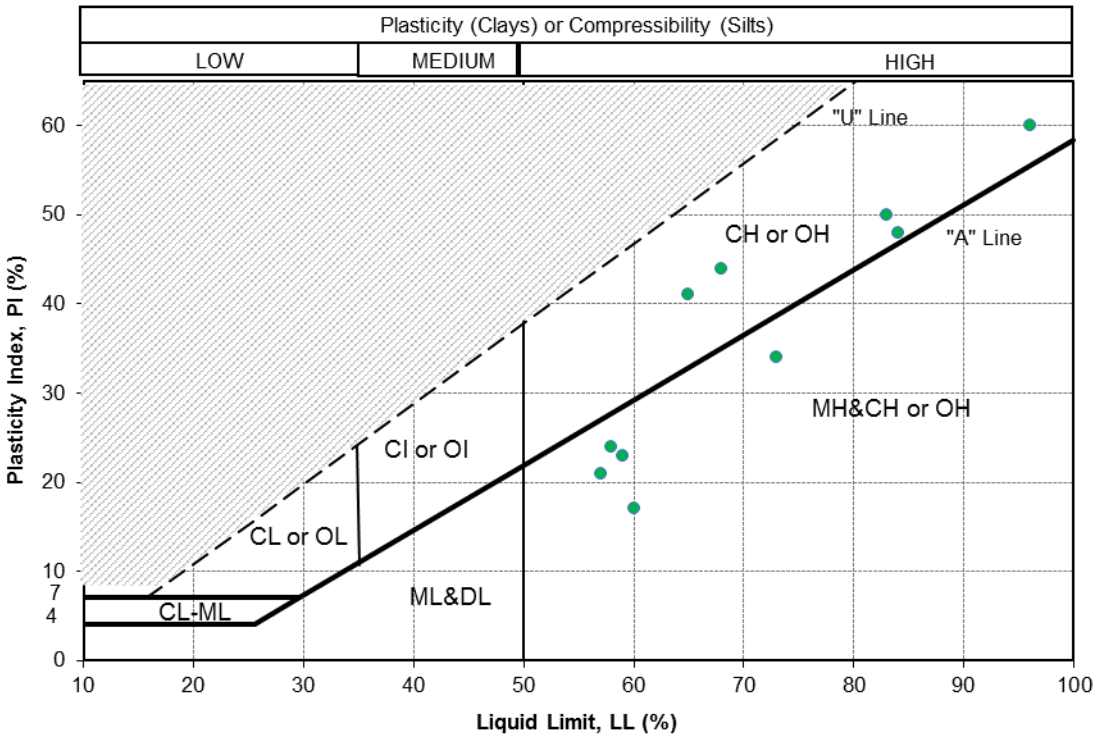


Figure 9 Casagrande Plot after GHD (2018)

Based on Figure 9 above it can be seen that the encountered materials characterised at WA1488 broadly fall within the high plasticity range. This corresponds to the Clay and Slit materials encountered in much of the Res Def drill core and site investigation logs from A.S. James (2013) and ATC Williams (2014), refer to cross section above (Figure 8).

It is considered that the past geotechnical sampling campaigns have suitability targeted 'critical' units and these have been appropriately characterised as part of the laboratory test work.

Interpretation of Triaxial Strength Results – Insitu Overburden

GHD has also undertaken analyses, based on the Golder Associates laboratory test certificates (2018) provided by Dandy Premix Quarries, to determine the distribution of interpreted triaxial shear strength results for testing conducted on cohesive soils encountered on site.

Plotted in the histogram below (Figure 10) is a distribution of the interpreted (undrained) shear strengths for the respective cohesive material types.

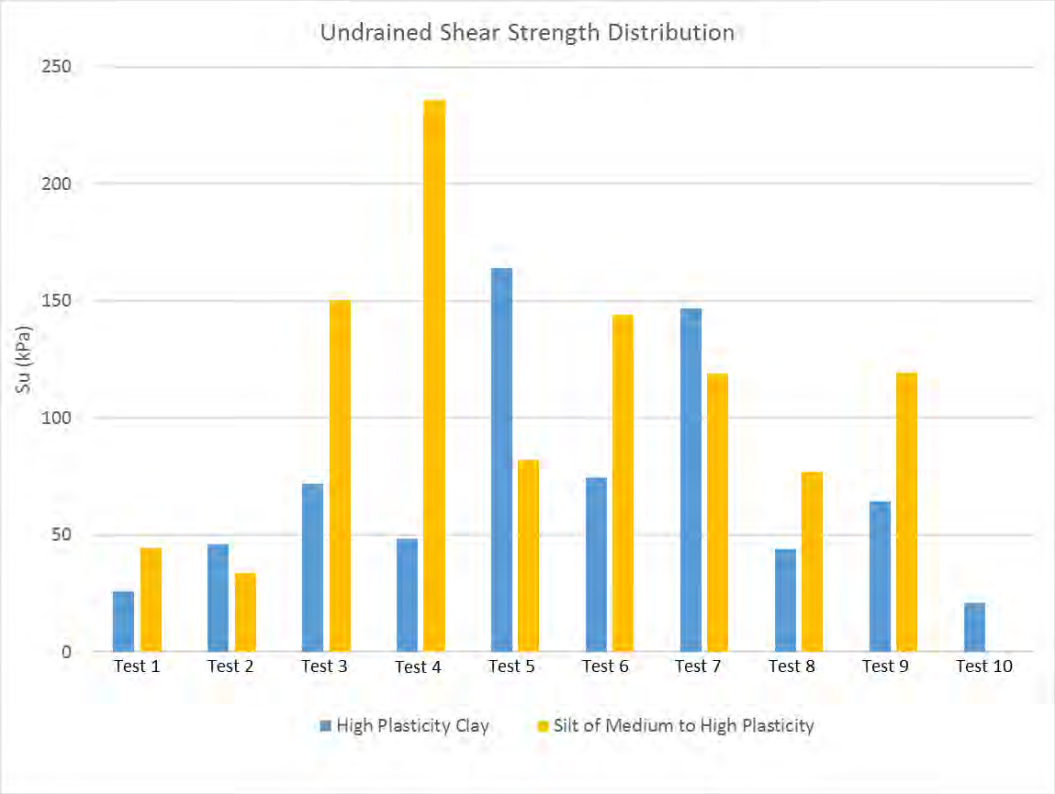


Figure 10 Distribution of Overburden Undrained Shear Strengths

Summarised in Table 4 below are the mean and minimum and maximum ranges respectively for the undrained shear strengths for the high plasticity clays and medium to high plasticity silt.

Table 4 Ranges of Undrained Shear Strengths

Material	Max (kPa)	Min (kPa)	Mean (kPa)
High Plasticity Clay	147	21	71
Silt of Medium to High Plasticity	236	34	112

From Table 4 above it can be seen that the range of undrained strengths for the high plasticity clay unit varies between 21 kPa and 147 kPa, with a mean of 71 kPa. This higher plasticity material has been noted to occur in close proximity to the Heath Hill Fault, and has been noted to have lower (undrained) shear strengths.

The range of undrained strength for the medium to high plasticity silt unit varies between 34 kPa and 236 kPa, with a mean of 112 kPa.

Interpretation of Triaxial Strength Results – Sand (i.e. resource)

The effective shear strength parameters of the foundation (sand) material were obtained from Consolidated Drained Triaxial data and the P-Q method (refer Figure 11). The p-q diagram is a method of analysis of triaxial and other stress data which are commonly used in soil mechanics. This is a graphical way to represent the interaction of stresses with the Mohr-Coulomb failure criterion, and enables the simplified calculation of a materials shear strength components (cohesion and friction angle).

The results indicate that cohesion of the non-cohesive sand material ranged between 2 and 5 kPa. The friction angle of the non-cohesive sand material was interpreted to be 33°.

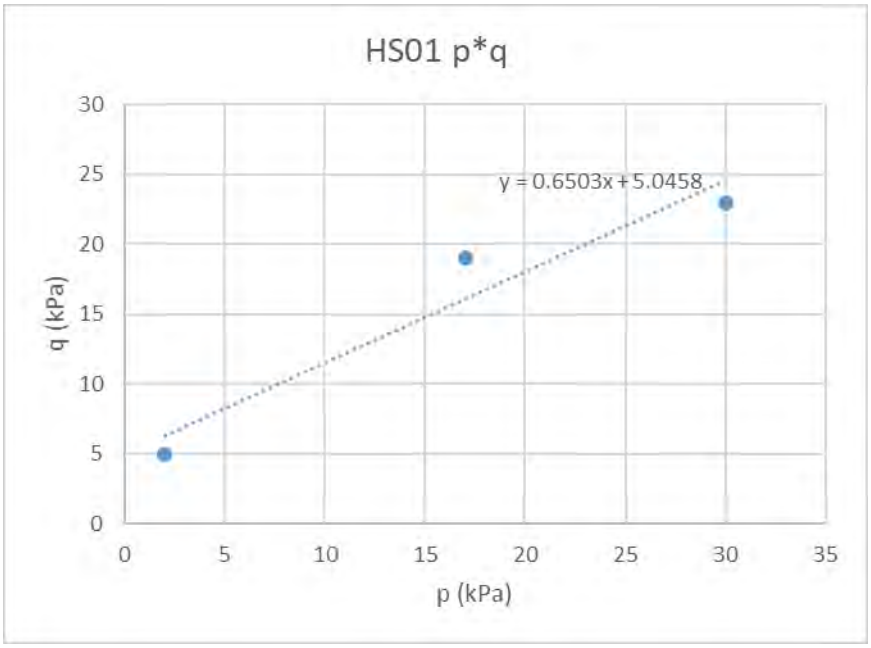


Figure 11 P - Q Method Interpretation

Based on the chart above the following parameters have been factually interpreted:

- Cohesion approximately: 5 kPa
- Friction Angle: 33°

In relation to the parameters above, GHD is of the opinion that the interpreted friction angle is within an acceptable range for what could be expected for medium to coarse sands.

3.2.2 Heath Hill Fault Interface Characterisation

Whilst the material in proximity to the Heath Hill Fault comprises of high plasticity clays the fault itself is comprised of fresh material, as noted during the field investigation programme (see Plate 1).



Plate 1 Core at Borehole BH08 (after R Anderson 2018)

It should be noted that extraction of the fresh material along the Heath Hill Fault is not planned, material strength parameters have been derived based on the observations in the drill core and the laboratory strength testing information.

Generalised Hoek-Brown strength parameters have been evaluated for the fresh material along the Heath Hill Fault. These parameters have been derived with the benefit of laboratory testing and further interpretation utilising the Rocscience software package Rocdata.

The following input parameters were utilised in Rocdata:

- The Uniaxial Compressive Strength (UCS) = 120 MPa - based on the laboratory strength testing.

- Geological Strength Index: 70 - based on an assessment of drill core samples of the fresh rock structure and surface conditions (i.e. massive structure and good surface conditions).
- Intact Rock Constant, Mi: 25 - based on an encountered material conditions.
- Disturbance Factor: 0.7.

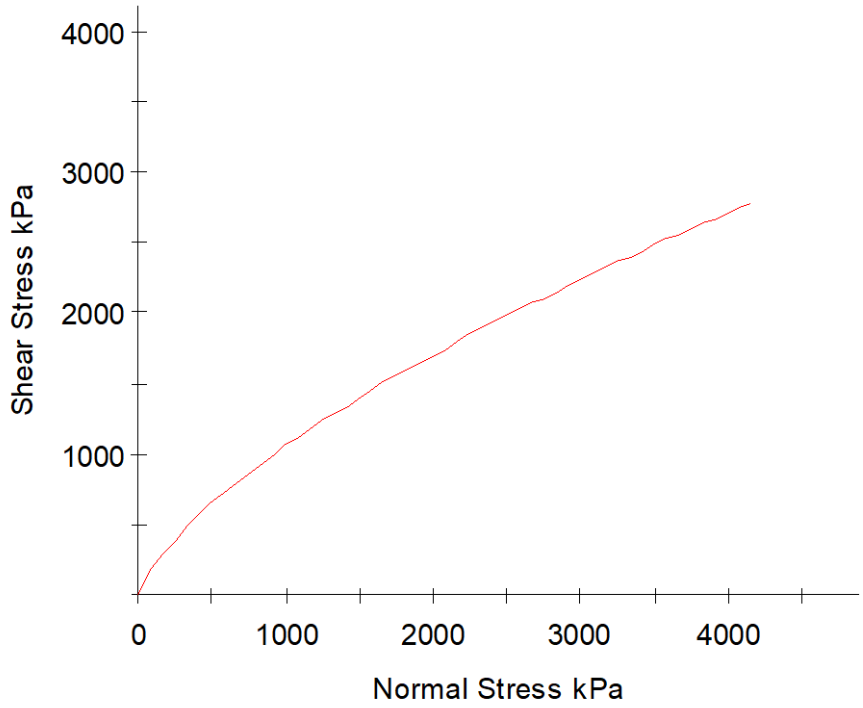


Figure 12 Interpreted Strength Curve

Based on the above interpreted strength curve (Figure 12) the below tabulated Hoek-Brown parameters have been evaluated.

Table 5 Interpreted Strength Parameters

Unit	Unit description	Density (kN/m3)	Uniaxial Compressive Strength, UCS (MPa)	Hoek-Brown Parameters
1	HHF (Fresh Material)	29.2	120	mb: 4.81 s: 0.013 a: 0.50

3.3 Material Parameters for Stability Modelling

The geotechnical model for this site has been developed based on the findings from the various campaigns of investigations.

Outlined below is a summary of the process adopted to determine suitable soil material strength parameters for the encountered cohesive and non-cohesive soils on site. The outcomes from this assessment has formed the basis for delineating geotechnical domains, as outlined in Section 3.4.

3.3.1 Cohesive Soils (Clay and Silt)

The process outlined below was applied to interpret material strength parameters for the purposes of geotechnical domaining and stability modelling.

- Quantify the variability and the distribution of the laboratory assessed Atterberg Limits, which consisted of evaluating the Plasticity Index and Liquid Limit respectively.
- Upon completing the above, subsequent classification utilising the Casagrande (1948) method was undertaken.
- The provisions catered for in Australian Standard 1726 along with analytical material strength testing, were utilised to interpret and assign corresponding material strengths for the respective classification categories, i.e. high plasticity Clay and medium to high plasticity Silt.
- It should be noted that the results of analyses identified the presence of slightly 'weaker' material in proximity to the Heath Hill Fault, i.e. this material tends to have a higher plasticity and somewhat lower shear strengths.

The resultant material parameters are presented in Table 6.

3.3.2 Non-Cohesive Soils (i.e. Sand)

- The shear strengths for non-cohesive soils were analytically assessed from laboratory strength assessments to interpret cohesion and friction angle parameters.

Table 6 presents GHD's interpretation on the range of material parameters for the respective units.

3.3.3 Heath Hill Fault Zone

Whilst the material in proximity to the Heath Hill Fault comprises of high plasticity clays, as described above, the fault itself is comprised of fresh material, as noted during the field investigation programme. Generalised Hoek-Brown strength parameters have been evaluated for this material along the Heath Hill Fault. These parameters have been derived with the benefit of laboratory testing and further interpretation utilising the Rocscience software package Rocdata, as outlined in Section 3.2.2.

3.3.4 Summary of Material Parameters

The resultant material parameters are presented below in Table 6.

Table 6 Interpreted Geotechnical Strength Parameters

Unit	Unit description	Density (kN/m^3)	Undrained Shear Strength Su (kPa)	Effective Shear Strength	
				Cohesion, c' (kPa)	Friction Angle, ϕ'(degrees)
1	(CLAY)	20	71	-	-
2	Clayey Bands (High Plasticity)	20	112		
3	SAND (Medium to Coarse Grained)	21	-	0-5	33-35
In Proximity to Heath Hill Fault					
1a	(CLAY)	20	21	-	-
2a	Clayey Bands (High Plasticity)	20	34	-	-
3	SAND (Medium to Coarse Grained)	21	-	0-5	33-35
	Unit Description	Density (kN/m^3)	Uniaxial Compressive Strength, UCS (MPa)	Hoek-Brown Parameters	
1	Fresh Material HHF Zone	29.2	120	mb: 4.81 s: 0.013 a: 0.50	

The above interpreted geotechnical and material strength models have formed the basis for the delineation of geotechnical domains upon which sections can be defined for the purposes of undertaking stability analyses. This is discussed in further detail within the Section 4.

3.4 Geotechnical Domains

3.4.1 Outline

The basis of formulating geotechnical domains is to segregate the quarry pit into sectors or zones which have similar geological characteristics and are anticipated to exhibit similar geotechnical attributes and failure modes. Outlined in the figure below are the considerations that are taken into account when formulating site specific geotechnical domains at Grantville.

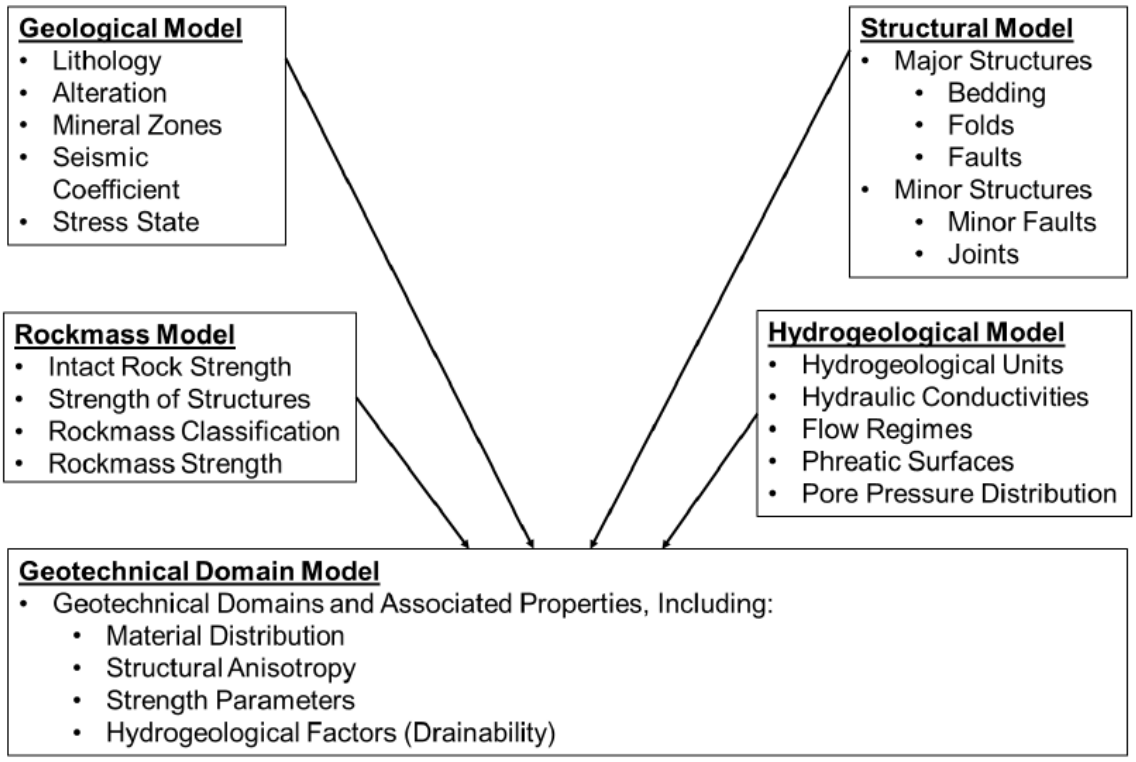


Figure 13 Development of Geotechnical Domain Model, after Read and Stacey (2009)

The geotechnical domaining of the Grantville quarry has relied upon the philosophy set out by Read and Stacey (2009) supplemented by the findings from the geological and geotechnical models interpreted above.

The most easily identifiable geotechnical domains within the quarry footprint is the overburden, coarse sand and Heath Hill Fault zone. Specifically the following considerations would give rise to the domain specific delineation(s):

- The presence of the high plasticity clay bands within the overburden and sand unit(s). For example, should these bands be present in a substantial capacity, these can have a significant bearing on the stability of the quarry slopes.
- The presence of the fault zone can have an impact on the stability of quarry slopes, particular where the effects of groundwater are considered.

The subsequent section of the report, analyses the above considerations in further detail.

3.4.2 Spatial Extent of High Plasticity Clay Bands

GHD has undertaken an analyses on the spatial extents of the clay bands. This was undertaken by analysing the information from the individual resource definition boreholes. The process applied involved identifying the clay bands within an individual boreholes and 'tracing' their extents across adjacent bores. This was done was the functionality afforded within the programme GINT, which enables the construction of long sections across multiple boreholes.

Depicted in the figure below is a representative section through the proposed pit area, from which the following can be noted:

- The clay bands appear to be more extensive within the overburden unit. Noting that this material will be stripped and stockpiled within the overburden dump.
- The clay bands within the sand resource while present in a number of boreholes are not extensive and tend to occur intermittently at disparate intervals (See figure below).
- Based on the interpretation undertaken GHD is of the opinion that the clay bands are not anticipated to have a significant influence on stability within the sand resource with the exception of the overburden unit.
- Accordingly the following geotechnical domains are proposed within the majority of the pit extent:
  - The overburden unit should be treated as a singular domain for the purposes of undertaking stability modelling.
  - The sand (resource) unit should be treated as a separate domain.
- It is acknowledged that there is added geological complexity around the Heath Hill Fault which requires further consideration with respect to geotechnical domaining, and is discussed further in the subsequent section.

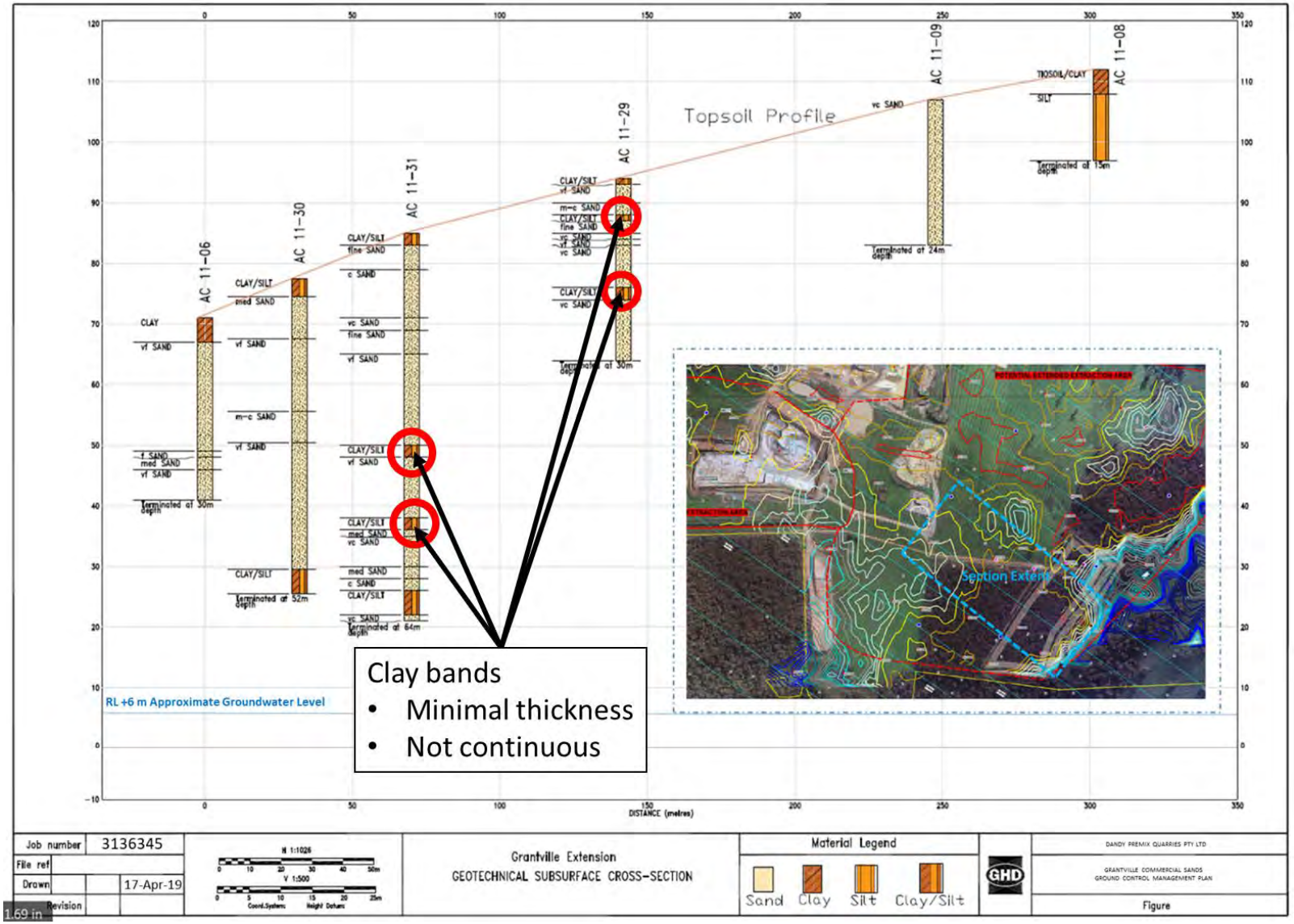


Figure 14 Cross section of Grantville Quarry (Northern Batter) Showing Typical Geological Morphology

3.4.3 Heath Hill Fault Zone

The Heath Hill Fault zone warrants consideration in relation to delineating a segregated geotechnical domain in proximity to it. This is owing to the following reasons:

- The morphology of the fault zone, i.e. an igneous intrusion is geologically dissimilar to the surrounding (sand) resource.
- The presence of this 'tight' fault zone, acts to compartmentalise the hydrogeological regime either side of the fault (see Figure 15), after Leonard (2019). Whilst this potentially lends itself to the interpretation of a number of possible models, the most plausible interpretation is outlined below.
- This fault zone acts to compartmentalise the hydraulic regime either side of it, after Leonard (2019), whereby:
  - The groundwater level down dip of the fault (i.e. within the Brighton Group sands) is in the order of 5 to 6 m AHD.
  - The groundwater table up dip of the fault zone is approximately 11 m AHD.
- Accordingly, the area in proximity to the Heath Hills Fault has been segregated as a separate domain for the purposes of analyses.

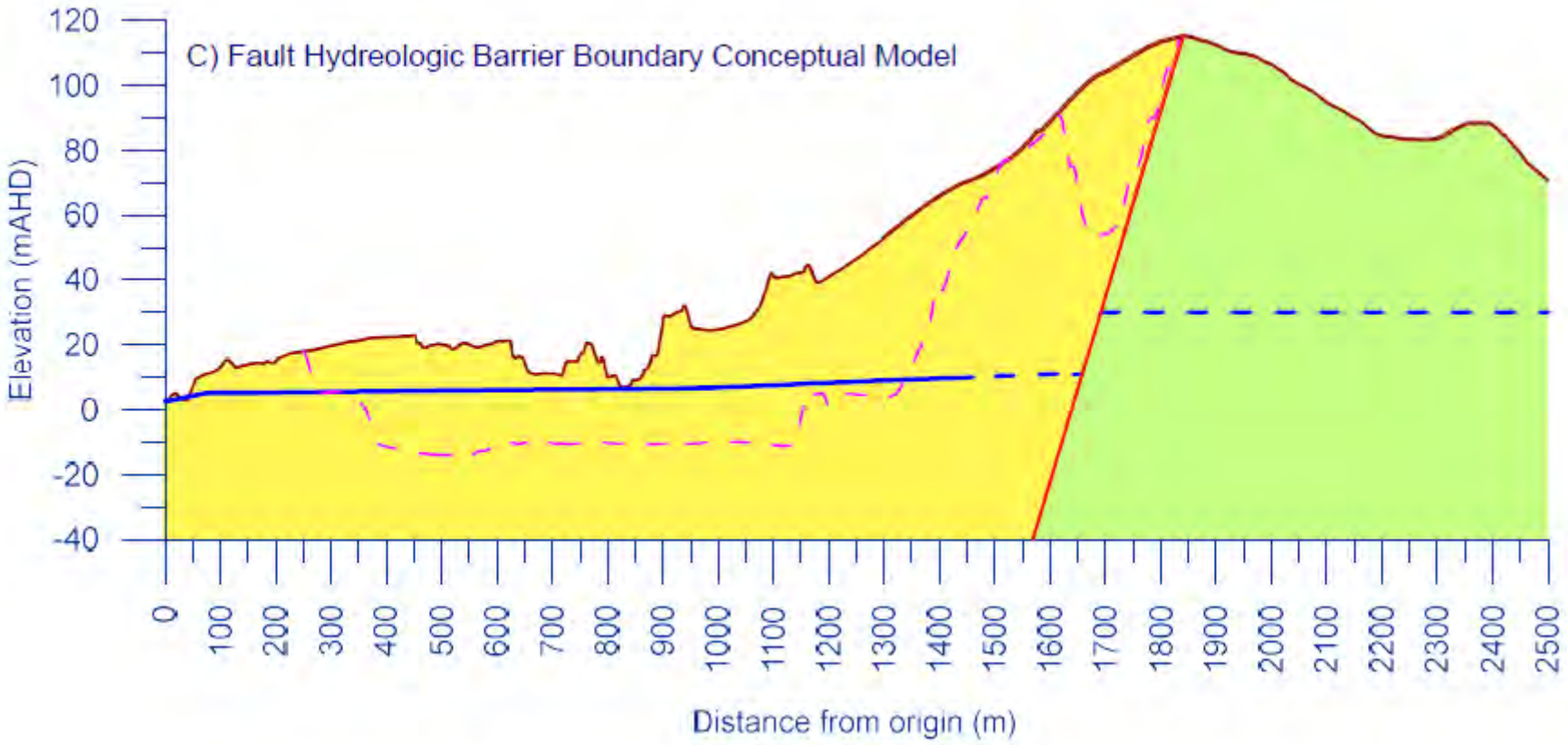


Figure 15 Fault Hydrogeological Barrier Boundary Interpretation after Leonard (2019)

3.5 Anticipated Failure Mechanisms

Based on the geological information presented in the previous section, it is possible to interpret potential critical slope instability (failure) mechanisms that need to be analysed and catered for as part of the slope design process. The scale and mode of anticipated instabilities form a crucial component of the geotechnical domaining process which is outlined in the subsequent section of this report.

This section outlines the mechanics involved with the respective instability mechanisms and identifies the areas where they are likely to occur within the Grantville Quarry pit.

3.5.1 Circular Failure (Primary Mode)

Circular failure typically occurs in soil materials such as the overburden and the sand resources at Grantville Quarry (see Figure 16). This instability mechanism can also result in highly disturbed materials, particularly near the HHF zone.

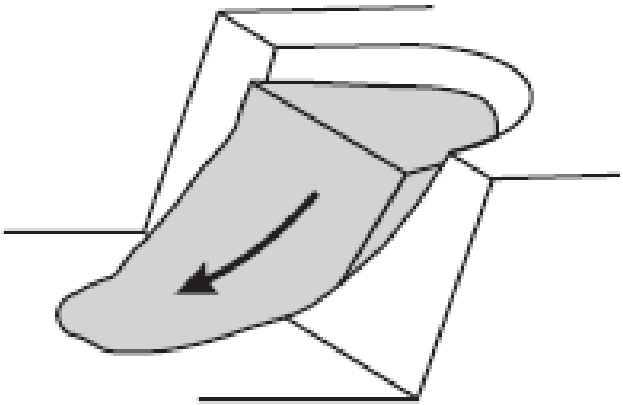


Figure 16 Schematic of a Circular Failure

Circular failure is dependent upon the shear strength characteristics of the soil materials (i.e. overburden and sand resources), the slope angle of the cut face and the phreatic conditions within the soil materials.

Circular failure occurring as potential failure mechanism has been identified primarily for the overburden and sand units at the Grantville. This failure mechanism is not considered to pose any significant risk, providing adequate surface water management measures are coupled with a suitable pit geometry.

A typical subsurface profile of the proposed development is shown below in Figure 17. Cohesive soils (i.e. clays and silts) overly mostly sand resources, with discontinuous and relatively thin layers of interburden (i.e. clays and silts).

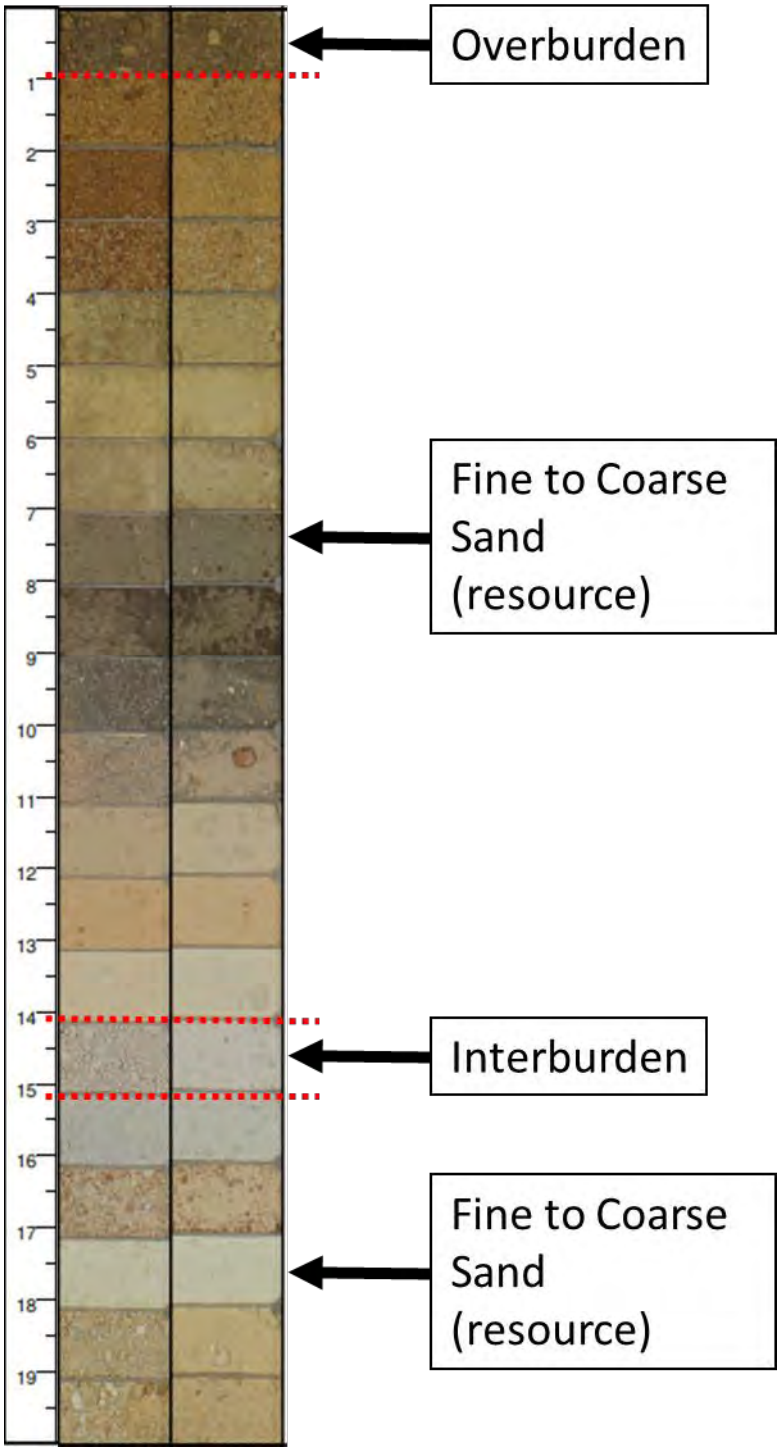


Figure 17 Typical Subsurface Profile at WA1488

Based on the encountered materials, it is likely that the primary mechanism of failure is circular failure. Circular failure can also result in the wet extraction pit, particularly where the standing groundwater level interfaces with the exposed sand batters above pond level. Undercutting of the base/foundation could potentially increase the likelihood of circular failure of the overlying batter slope. This instability mechanism can be managed with suitable batter design (including offset from base of slope) and surface water management, as the initiation of instabilities within this unit is usually governed by build of pore water pressures as a result of uncontrolled / excessive surface water ingress. These materials will also be susceptible to internal piping and erosion.

3.5.2 Wedge and Toppling Failure (Secondary Mode in Rock) – Not Part of Extraction Plan

It should be noted that the extraction of fresh material (rock) will not be undertaken at WA 1488. However, given the presence of the fresh material (plugs) in areas, the sections below outline the conditions for which wedge and toppling mechanisms can theoretically result. It is noted that these kinematic movements can only occur as a result of the intersection of open joints (or discontinuity planes). Based on the rock core recovered in the boreholes drilled at WA1488, no open joints were identified, as such, the below kinematic failures are not likely to manifest.

Wedge Sliding

Wedge failure occurs when two or more planes of discontinuity intersect with the slope face (see Figure 20).

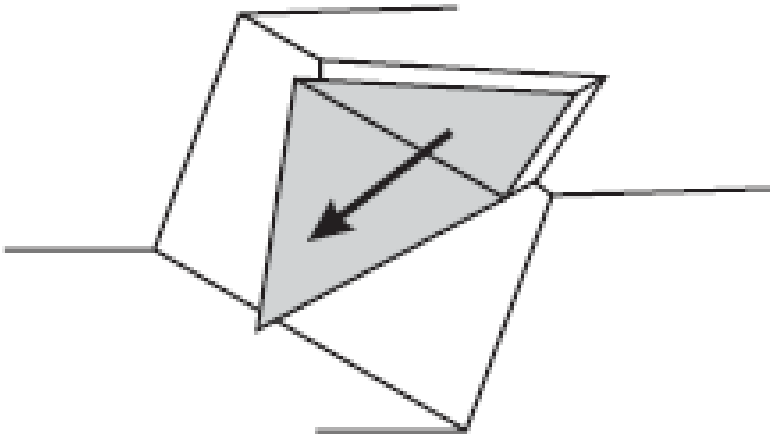


Figure 18 Schematic of Kinematically Feasible Wedge

From a kinematic perspective wedge instabilities require a specific occurrence of structural conditions to become kinematically feasible, which includes:

- The dip of the discontinuity planes is flatter than the angle of the slope face
- The dip of at least one discontinuity plane is greater than friction angle of the discontinuity surface

Given that a wedge is formed by the intersection of at least two discontinuity planes, the direction of sliding (i.e. the daylight envelope), is less restrictive than that of planar failures because there are two plane to form release surfaces. The daylight envelope for wedge formations is the locus of all poles representing lines of intersection whose dip directions lie in the plane of the slope face, where a steeper slope face results in a larger envelope. For example, the daylight envelope for a slope angle (Ψ_f) of 60° is highlighted in green an envelope for a slope angle of 80° is highlighted in blue in Figure 19 below.

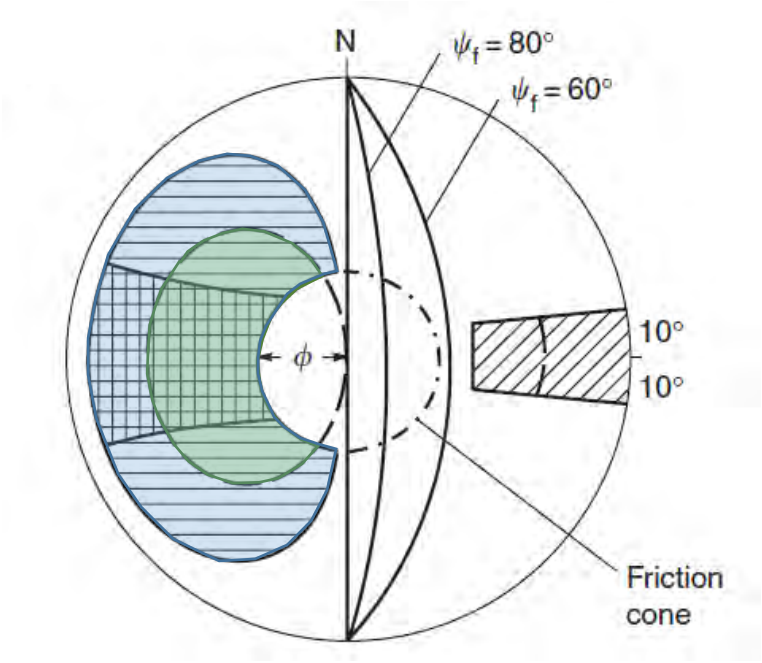


Figure 19 Example Stereographic Projection Depicting Wedge Failure Daylight Envelopes

A stereographic projection of a kinematically feasible wedge is depicted below in Figure 20 in terms of the intersection between discontinuity planes ‘A’ and ‘B’.

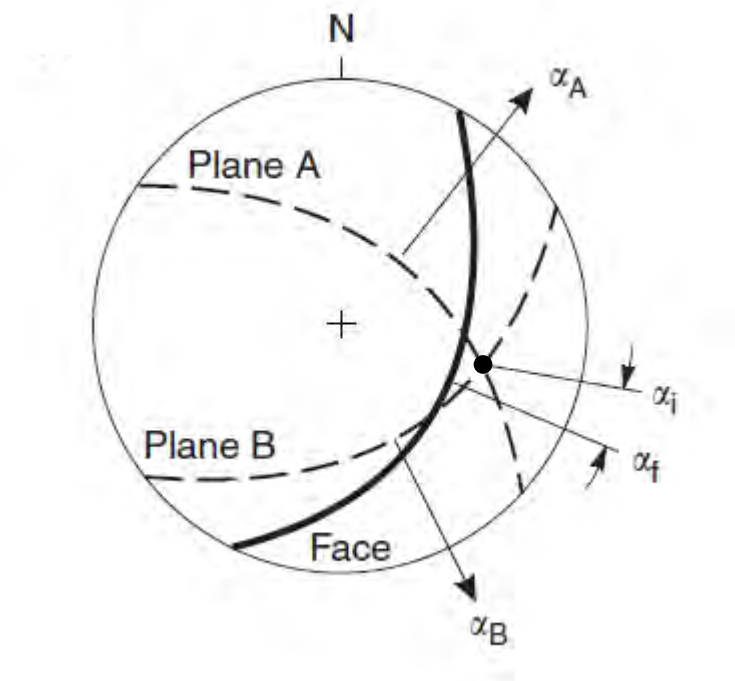


Figure 20 Stereographic Projection Depicting Intersection of Two Discontinuity Planes

Based on the observations made from the recovered drill core, it was noted that the material encountered was ‘massive’ with no open joints noted. Hence this mechanism is not considered feasible.

Toppling

Toppling occurs due to the presence of steep (vertical or sub-vertical) defects within a rock mass that eventually leads to slippage along the defect interface and the outward and downward movement of a column of rock see (Figure 21).

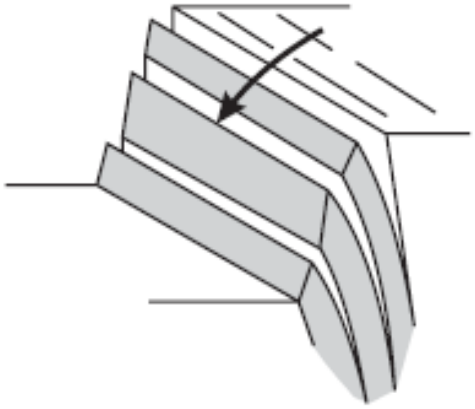


Figure 21 Schematic of Toppling Failure

Toppling failure is not feasible when the dip direction of the discontinuity differs from the dip direction of the face by more than approximately 10°. A daylight envelope showing the zone for which toppling failure is feasible is highlighted in purple in Figure 22 below.

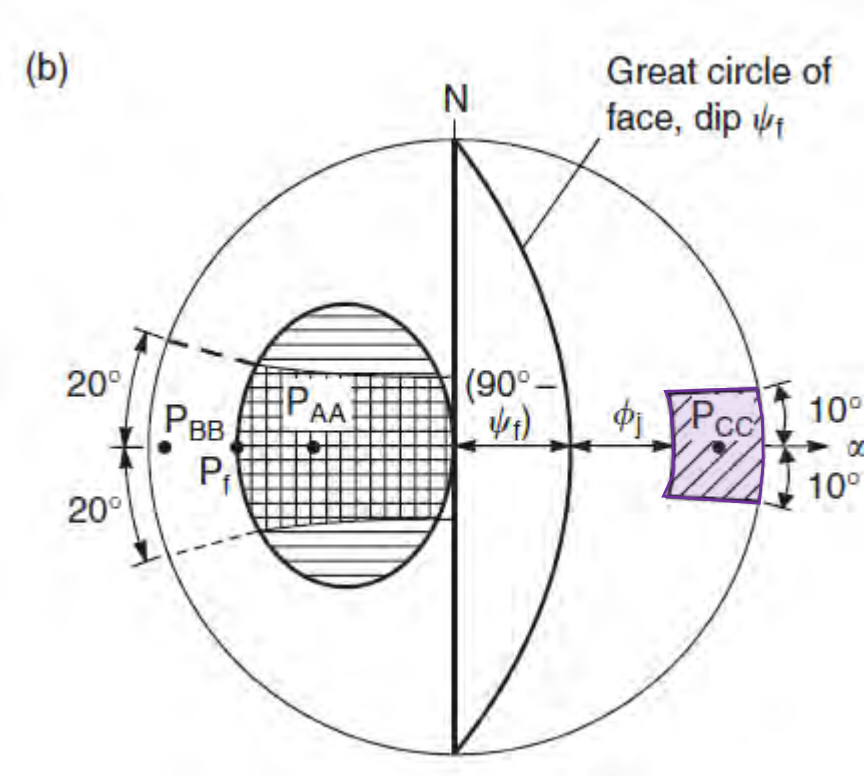


Figure 22 Example Stereographic Projection of Toppling Failure Daylight Envelope

Based on the observations made from the recovered drill core, it was noted that the material encountered was ‘massive’ with no open joints noted. Hence this mechanism is not considered feasible.

3.6 Summary of Quarry Domains and Anticipated Failure Mechanisms

Presented in Figure 23 and summarised in Table 7 below is a pictorial depiction of the respective domains across the quarry footprint and the anticipated instability mechanisms within each domain, respectively.

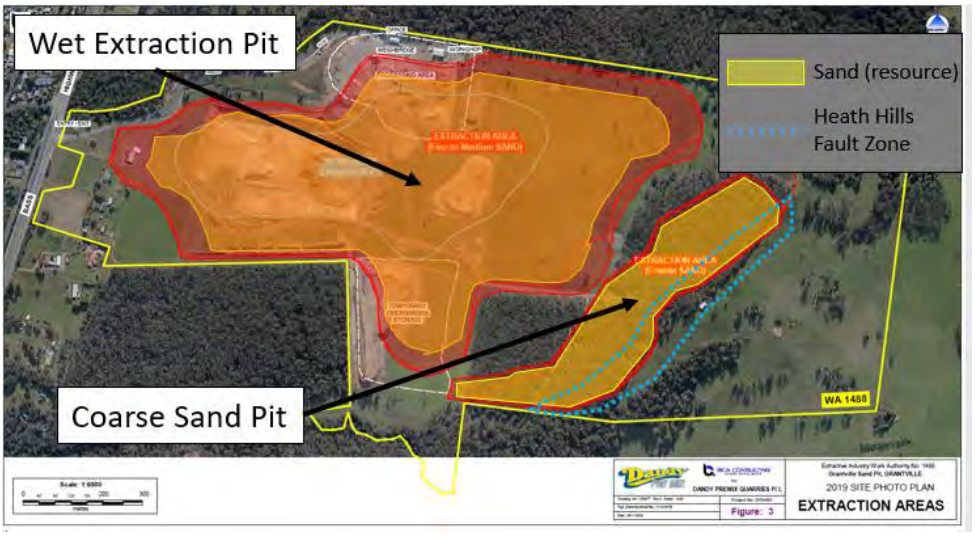


Figure 23 WA1488 Domain Layout

Summarised in Table 7 below are the anticipated instability mechanisms across the respective areas of WA1488.

Table 7 Summary of Anticipated Instability Mechanisms at WA1488

Domain	Anticipated Instability Mechanisms Present	
	Primary (Critical)	Secondary
(FMSEP) & Wet Extraction Pit (overburden and sand resources)	Circular failure – Instability controlled primarily by shear strength characteristics of the soil materials, the slope angle of the cut face and phreatic conditions within the soil materials.	Localised slumping at interface of quarry floor and pit lake. -
(CSEP) Coarse Sand Pit	Circular failure – Instability controlled primarily by shear strength characteristics of the soil materials (i.e. overburden and sand resources), the slope angle of the cut face and phreatic conditions within the soil materials.	Internal piping / erosion
Heath Hills Fault Zone (Sub domain within CSEP)	Wedge - Instability controlled by the presence of geological structures. Toppling - Instability controlled by the presence of geological structures.	N/A

4. Stability Analyses

4.1 Overview

Stability analyses have been undertaken on the batter slopes comprising the proposed work plan variation extraction areas associated with the Grantville site, pit using Limit-equilibrium modelling (LEM) to investigate the slope stability for each of the above identified geotechnical domains considering the global (overall slope) scales. LEM slope stability modelling was carried out using Rocscience's Slide 2018 software package.

Slope stability analyses was carried out for each domain (see Figure 23). The location of stability section lines were chosen for its representativeness of the given domain. Material strength properties obtained in the previous section (3.1) were used as the strength input parameters in the slope stability models.

4.2 Design Acceptance Criteria

4.2.1 General

The nomination of suitable acceptance criteria is a key part of the design and development of stability management protocols. The basis of nomination of suitable acceptance criteria, will need to demonstrate that the deterministic Factor of Safety (FoS) for a particular batter is acceptable in light of the scale and potential instability and the associated consequences posed by it.

Published precedents for mine and quarry batter slope designs based on the consequence of failure were sourced from the guidelines given by CSIRO's 'Guidelines for Open Pit Slope Design' (Read and Stacey, 2009). These guidelines have been used as a basis to develop the design acceptance criteria for the Grantville Quarry.

4.2.2 Data Uncertainty

In the context of quarry operations, data uncertainty arises from the challenges encountered when attempting to quantify the variability in properties and characteristics of the insitu materials (rock / soil) that forms the quarry batters. The uncertainty associated with the materials that form the Grantville Quarry slopes can be broadly categorised under three categories, which are: geological uncertainty, material strength parameter uncertainty and model (geometry) uncertainty.

In the context of most quarries it is not uncommon for some level of data uncertainty to exist. The Grantville Quarry, has been subjected to geological, and geotechnical studies, as outlined in the reference section. These factors essentially render the risk(s) associated geotechnical data uncertainty as 'low'.

4.2.3 Nominated Design Acceptance Criteria

In nominating the design acceptance criteria for the Grantville Quarry, in line with the guidelines set out by CSIRO (2009), consideration has been given to the data uncertainty associated with the respective geological units as well as the risk associated with potential instability.

Based on above outlined aspects, and in light of the anticipated risk of instability within the confines of the Grantville Quarry slopes, the following design acceptance criteria has been nominated:

- A Factor of Safety (FoS) of 2.0 is proposed for all Rehabilitated batters.

- A Factor of Safety for 1.5 is proposed for Terminal batters.
- A Factor of Safety of 1.2 is proposed for Operating batters.
- A Factor of Safety of 1.0 for seismic conditions.

4.3 Slope Stability Analyses

4.3.1 Effective Slope Formation at Grantville Quarry

Owing to the mechanical properties of the soil anticipated within the sand pit excavations at the site and broadly, the subsurface conditions within the WA 1488 site, suitable mechanical excavation techniques at appropriate slope angles will be essential. Two slope design geometries (i.e. 1 and 2) have been considered as follows, with due considerations to the domains identified in Section 3.3:

- Slope design geometry 1 is suitable for pit faces that are in close proximity to the Work Authority (1488) boundary and external receptors. These pit slopes should be designed to flatter slopes to minimise the potential for large scale slope instabilities.
- Slope design geometry 2 can be constructed where the proposed pit faces are offset (by a significant distance) from the project boundary and external receptors. Any slope instabilities would be contained within the project boundary and are highly unlikely to affect external receptors.

4.3.2 Design Geometry 1 – In Proximity to External Receptors / Extraction Boundary

Figure 24 presents the results of the stability analyses undertaken to determine a range of suitable slope excavation angles for corresponding slope heights for the proposed pit excavations near to the project boundary and external receptors.

Two (2) design curves for slope design geometry 1 have been presented, thus are for:

- Rehabilitated batters – Factor of Safety 2.0
- Terminal batters – FoS 1.5

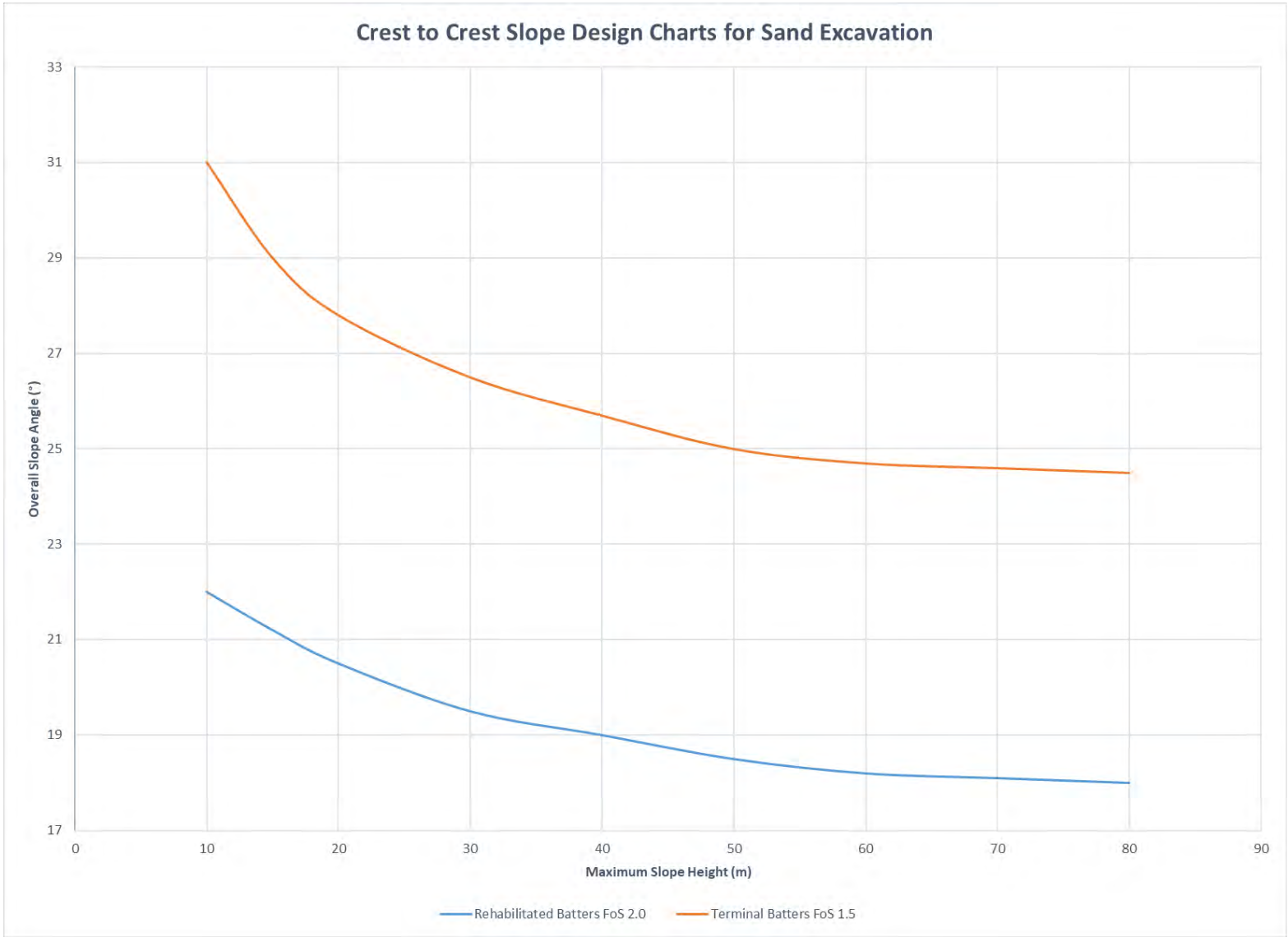


Figure 24 Slope Design Geometry 1 - Charts for Pit Face Excavation

NB – Above chart depicts 'dry slopes.' Where saturated slope conditions result within the working (operational) batters of the sand pits, FoS's can fall below 1.0. (see S 4.4 for Wet Extraction Pit)

4.3.3 Design Geometry 2 – No Risk to External Receptors

The proposed wet extraction from the existing (FMSE) pit and the development of the CSEP (i.e. the proposed eastern pit face and the proposed western, northern and eastern slope faces of CSEP are considered to be of low geotechnical risk due to their significant offset distance from the project boundary and external receptors. The CSEP may be up to 60 m deep along the eastern face, which itself is offset by more than 300 m from the nearest project boundary.

As a result of the low consequence associated with potential slope instabilities within this area, an acceptance criteria of FoS 1.2 is proposed for global instabilities. Figure 25 presents the results of the slope stability analysis (using RocScience's Slide 2D software package).

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
Sand		21	Mohr-Coulomb	3	35	Water Surface	Custom	1

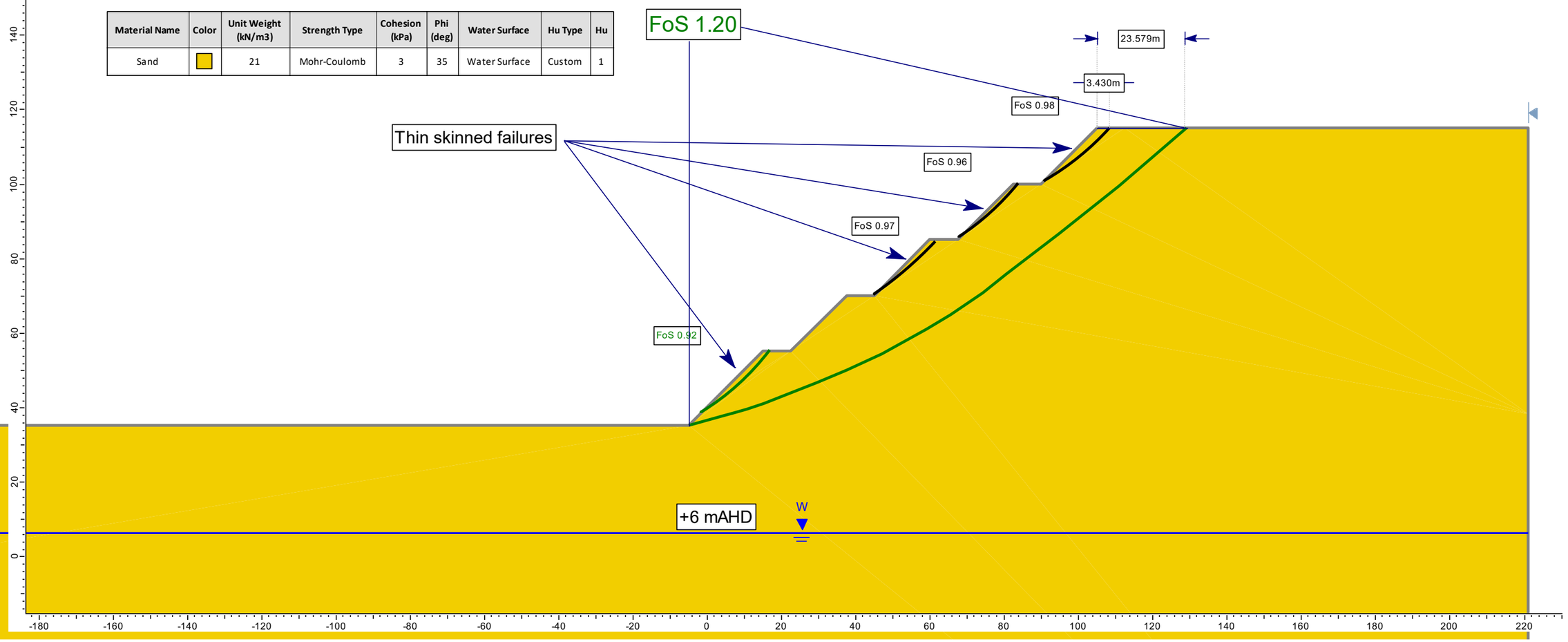
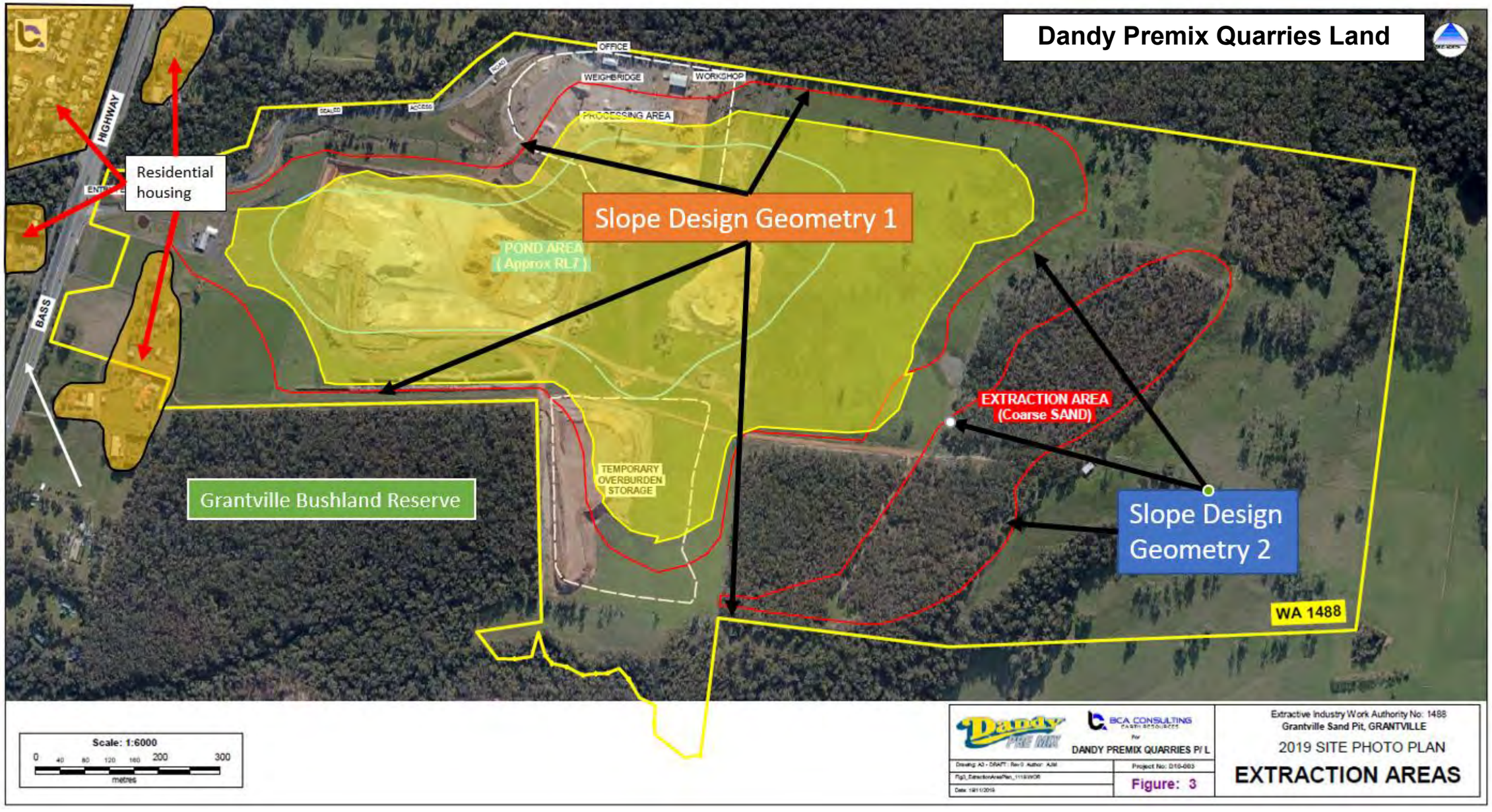


Figure 25 Slope Design Geometry 2 - Calculated FoS


Dandy Premix Quarries Land
OFFICE
WEIGHBRIDGE
WORKSHOP
PROCESSING AREA
ACCESS
SEALED
ROAD
HIGHWAY
Residential housing
BASS
Slope Design Geometry 1
POND AREA
(Approx RL?)
EXTRACTION AREA
(Coarse SAND)
TEMPORARY OVERBURDEN STORAGE
Grantville Bushland Reserve
Slope Design Geometry 2
WA 1488
Scale: 1:6000
0 40 80 120 160 200 300
metres
BCA CONSULTING
For
DANDY PREMIX QUARRIES P/ L
Project No: D10-003
Figure: 3
Extractive Industry Work Authority No: 1488
Grantville Sand Pit, GRANTVILLE
2019 SITE PHOTO PLAN
EXTRACTION AREAS

4.4 Stability of Underwater Extraction Area

Quarrying the sand below groundwater level in the developed FMSEP is proposed to be undertaken using a cutter suction dredging. Accordingly it should be appreciated that the proposed excavations below the waterline will always have the reinforcing effect of the quarry lake forces providing a suitable 'counter weight' to the (below waterline) slopes. Owing to this understanding there will not be a need or indeed practical basis for forming a profiled slope below the waterline. Any instability below the waterline would manifest as a surficial shear / slump at the water line interface, it will therefore be important to carefully manage this interface to ensure that it does not inadvertently undercut the 'dry' slopes above. Outlined in this section are the nominated considerations / approaches to mitigate this occurrence.

Where 'soft' ground conditions are encountered at the waterline interface a geotechnical engineer or suitably qualified person should inspect the area to ensure geotechnical stability related risks are minimised. Any plant (fixed or mobile) should be located at a safe standoff distance from the crest of the interface. A field bearing capacity assessment, using dynamic cone penetrometers should be undertaken within these locations, prior to undertaking any underwater excavation.

Measures should be undertaken to operate and maintain suitably robust ground conditions at the water line interface, so as to ensure that the material beneath the up-dip (dry slopes) are not undermined. Based on the guidance provided in BS 8004, bearing capacities in the range of 100 to 300 kN / m^2 can be anticipated for the sand unit(s). Accordingly any proposed extraction stockpiles, pads or fixed / mobile equipment should be designed to meet these requirements. Exceeding these requirements may lead to circular failure of the underlying Sand and subsequent affect the stability of the dry batters above.

Cutter suction dredging should be undertaken at a safe distance from the toe of the waterline interface on which any plant or infrastructure maybe located on to ensure that this zone is not compromised from excavation of the resource.

Additionally, any stockpiling of the excavated / washed material should be undertaken at a safe standoff distance from the crest of the underwater excavation to ensure it is not adversely affected by the stockpile or from leached water. Ongoing assessments should be undertaken to determine the safe offset require for stockpiling operations.

A suitably design surface drainage system should be implemented and maintained to prevent water from ponding in and around the toe of the dry batter above the waterline. Saturation of the toe of the dry batters may lead to a loss of strength of the pad and any associated stability risks. Regular inspections and engineering control should be undertaken and implemented in order to minimise the risk of instability of the pad, prior to and during excavation.

It should be noted that where suction dredgers positioned on floating pontoons are utilised for underwater extraction a number of the above outlined risks, in relation to bearing capacity failure of pads can be mitigated, provided that any plant or infrastructure is built on competent ground. An example is shown in Plate 2.



Plate 2 Photograph of General Conditions for Suction Dredger Excavation

4.5 Seismicity

The Melbourne area inclusive of the Grantville Quarry is within a relatively intermediate to high risk seismic zone. GHD has undertaken additional stability assessments on the critical slope profiles to determine the sensitivity of the proposed pit to seismic events.

According to the 'Atlas of Seismic Hazard Maps of Australia' 2013, Melbourne and surrounding areas have among the highest Peak Ground Acceleration (PGA) compared to the rest of the nation. The Spectral Acceleration (SA) hazard value at 500 and 2500 year return periods are PGA 0.0627 g (refer to Figure 27) and PGA 0.1704 g respectively. Both these values have been considered when assessing quarry batter stability, and return factors of safety greater than or equal to 1.0 for the terminal and remediated batters, the results of the analyses are presented in Section 4.2.3.

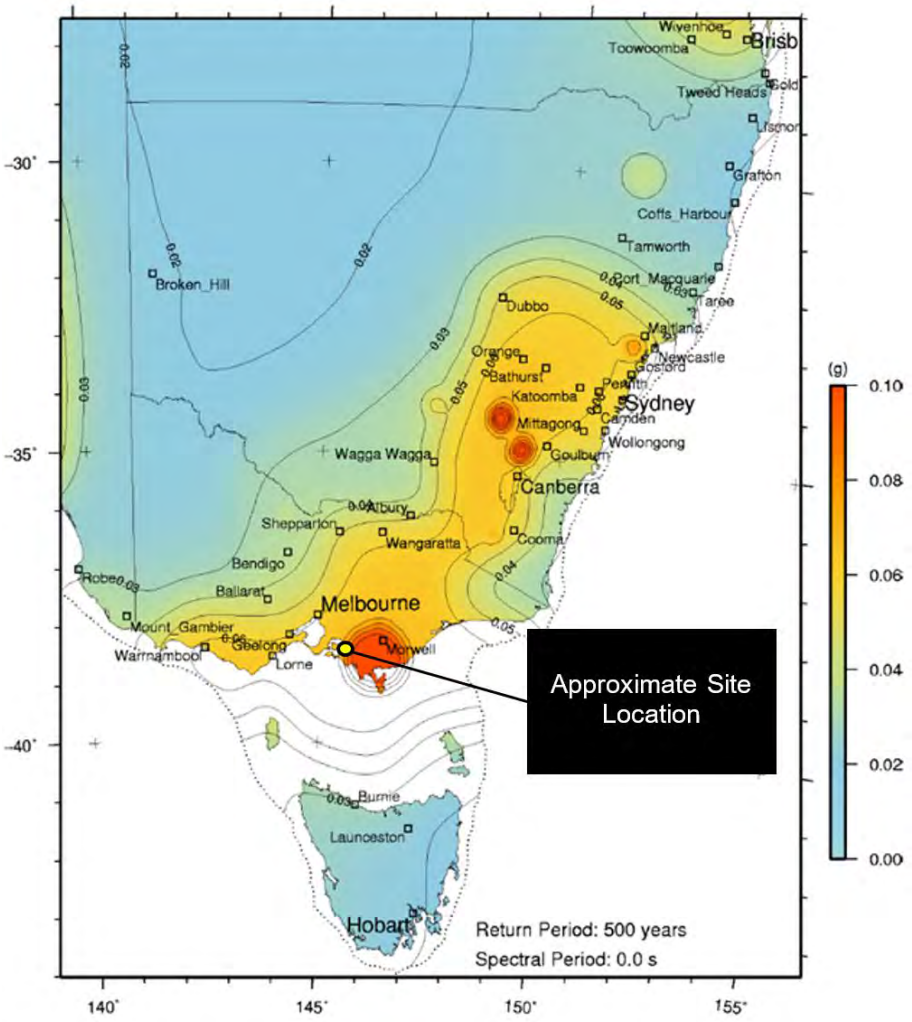


Figure 27 Seismic Hazard Map after Geosciences Australia for a 1 : 500 year return event

4.6 Heath Hill Fault Zone – Pore Pressures

Owing to the morphology of the Heath Hill Fault, extraction of the coarse sand resource abutting the fault itself may lead to potential kinematic instability mechanisms occurring within the fresh material interface. Any slope instability in this part of the quarry (i.e. eastern batters of the proposed CSEP) is not likely to impact on any external receptors or the work authority boundary.

Based on the hydrogeological modelling undertaken after Leonard (2019), it is understood that there will be groundwater compartmentalised either side of the Heath Hill Fault. This compartmentalisation results in a hydraulic head difference of approximately 6 m, which would act on the interface of the Heath Hill Fault.

Accordingly GHD has considered the likelihood of the development of excessive pore pressures behind the fault, as a result of the difference in groundwater levels either side of this feature. Based on the calculations undertaken, in the Slide (2018) software package, approximately 33 kPa is induced at this interface. (See figure below).

As the fault itself is comprised of ‘massive’ unjointed rock, with an unconfined compressive strength of 120 MPa, it is very unlikely that the induced pore pressures behind the fault zone would result in an ‘in rush’ of water.

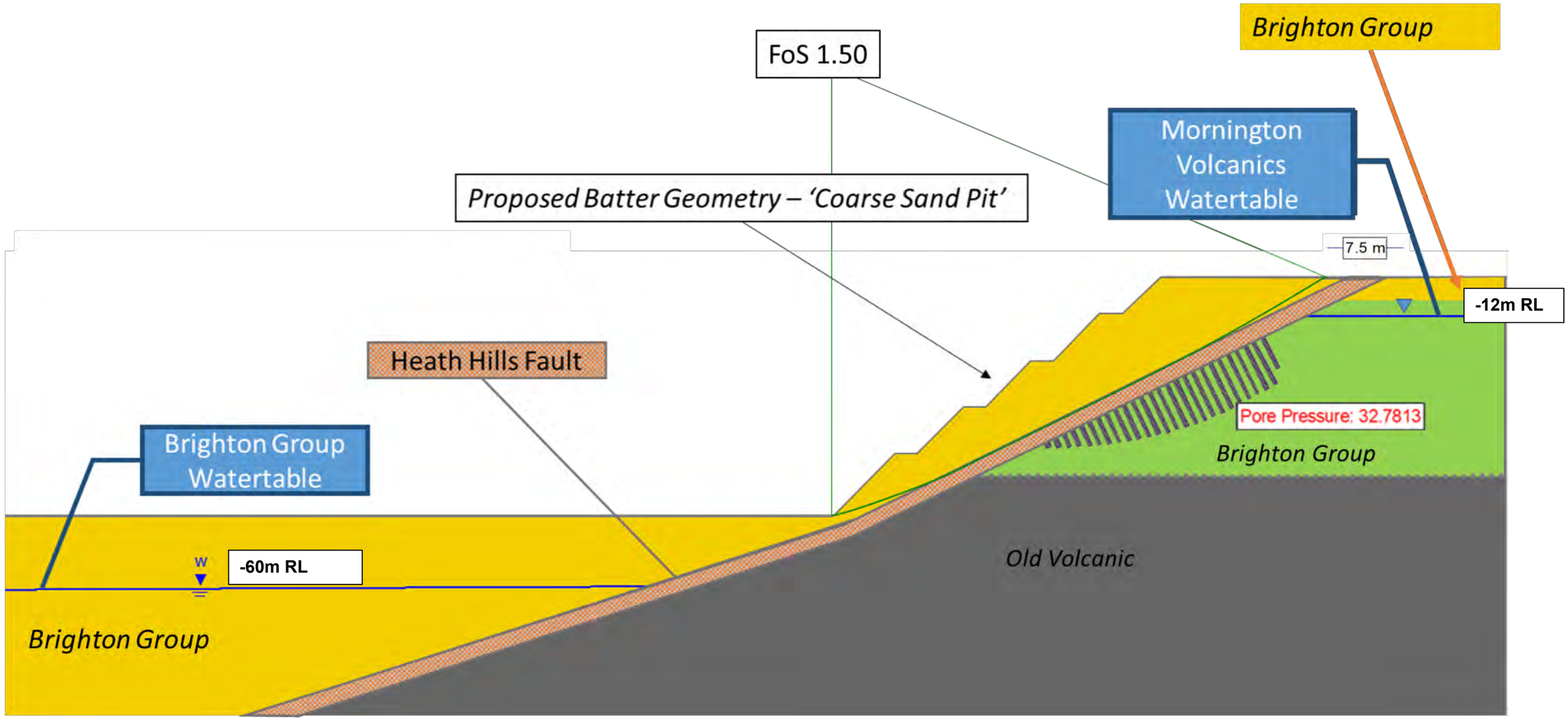


Figure 28 Minimum Offset Required from Heath Hills Fault (Schematic Representation only, Not to Scale)

4.7 Discussion of Stability Results

The proposed development of the wet extraction pit and the CSEP at the Grantville site are not likely to result in geotechnical or ground stability related hazards for public receptors surrounding the quarry site as long as the prescribed designs are followed. Dandy Premix Quarries have previously developed buffer zones from key public receptors.

Internal erosion (piping) of the geological materials into the closed quarry may be caused by any localised perched water (i.e. from heavy rainfall events), in the sand batters. The strength and permeability of the materials are conducive to development of this type of failure, particularly in highly disturbed and / or poorly graded sand material. Suitable drainage measures should be developed and engineered to reduce uncontrolled water flow into the sand batters.

Excavation in the sand pits at the site, particularly near the Heath Hill Fault, will require suitable excavation techniques to be employed. Excavation at steeper angles than recommended in Section 4 for the respective batters, may cause slope instability when quarrying in the sand resource. Suitable slope excavation angles as described above, as well as effective surface and groundwater management, should minimise the risks associated with unplanned slope instabilities in the sand / clay material.

It is recommended that an iterative approach, focussed on reconciling the performance of the sand batter slopes, be adopted to ensure that on-going quarrying activities are undertaken in a safe manner. A suitably qualified person should periodically undertake audits and analyses (as needed) to ensure that that the geotechnical risks are controlled to within acceptable limits.

4.8 Operational Geotechnical Considerations

Quarrying of the Grantville site may result in a number of geotechnical and ground stability related hazards that may affect worker safety within the quarry. These aspects are outlined below:

- Stability of Operational (working) Quarry Batters
- Stability of Permanent (terminal and rehabilitated) Quarry Batters
- Temporary Sand stockpile (if any) stability (e.g. during excavation)
- Presence of any infrastructure along and / or within quarry batters, including Haul Road(s)
- Surface and groundwater impacts leading to slope instability

Geotechnical management protocols as outlined in the GCMP should be carried out to ensure these (potential) geotechnical risks are adequately managed at the site.

4.9 External Geotechnical Considerations

Geotechnical management protocols have been developed to ensure these (potential) geotechnical risks are adequately managed at the site.

A ground control management plan (GCMP) has been formulated for the site and outlines the requisite stability management protocols.

5. References

Australian Standards 1726 (2017) – 'Geotechnical Site Investigations'.

Casagrande, A., 1948. *Classification and identification of soils*. Transactions, ASCE, vol. 113, pp 901-930.

VandenBerg, AHM (2016). *Depositional Facies and Extent of the Late Neogene Sandringham Sandstone In Southern Victoria, Australia*. CSIRO Publishing www.publish.csiro.au/joumals/rs The Royal Society of Victoria, 128, 7-24, 2016 10.1071/RS16009.

Welsh, S.I., Higgins, D.V., Callaway, G.A. (eds) (2011). *Surface Geology of Victoria*. Geological Survey of Victoria, Department of Primary Industries.

Ransley, T.R., Smerdon, B.D. (eds) (2012). *Hydrostratigraphy, hydrogeology and system conceptualisation of the Great Artesian Basin*. A technical report to the Australian Government from the CSIRO Great Artesian Basin Water Resource Assessment. CSIRO Water for a Healthy Country Flagship. Australia. December 2012.

Ransley, T.R., Radke, B.M., Feitz, A.J., Kellett, J.R., Owens, R., Bell, J., Stewart, G., Carey, H. (2015). *Hydrogeological Atlas of the Great Artesian Basin*. Geoscience Australia. Canberra.

Manewell, N. (2008). *The Hydrogeology and Hydrochemistry of the Mt. Tom Price Mine, Pilbara, Western Australia - A Groundwater Flow Model*. MSC. Thesis, University of Canterbury, New Zealand (Unpublished).

JLCS (2019). *WA 1488, 1381-1395 Bass Highway, Grantville Work Plan Variation Phase 2 Development Hydrogeological Assessment*, December 2019.

Client Supplied Information:

- Air Core Borehole logs, including field observations.
- Soil and Rock laboratory test certificates

Fronek, A., (2017). *Walking Dragline Excavator Massice Machine in Action*, video recording, YouTube, viewed 14 January 2019, <https://www.youtube.com/watch?v=8UCOv2v4hv4>.

GHD (2018), *Grantville Quarry Site (Work Authority 1488) – Interpretation of Laboratory Test Results and Derivation of Geotechnical Parameters*, GHD report number: 3136345-36363, dated 10 August 2018.

Legislations:

- Environment Protection Act 1970 (Vic)
- Environmental Protection and Biodiversity Conservation Act (1999)
- Flora and Fauna Guarantee Act (1988) (VIC)
- Mineral Resources (Sustainable Development) Act 1990 (VIC)
- Mineral Resources (Sustainable Development) (Mineral Industries) Regulations 2013 (Vic)
- Occupational Health and Safety Act 2004 (VIC)
- Occupational Health and Safety Regulations (2007) (VIC)
- Planning and Environment Act 1987
- State Planning Policy Frame Work (SPPF)
- Water Act 1989 (Vic)

Leonard, M., Burbidge, D., Edwards, M., 2013. *Atlas of seismic hazard maps of Australia: seismic hazard maps, hazard curves and hazard spectra*. Record 2013/41. Geoscience Australia: Canberra.

Read, J., Stacey, P. (2009). *Guidelines for Open Pit Slope Design*, first edition, CRC Press, published 18 November 2009.

Standards Australia and Standards New Zealand (2004) – AS/NZS 4360:2004 – 'Risk Management', Sydney, NSW.

VandenBerg, A.H.M., 1997. Warragul SJ 55-10 Edition 2, 1:250 000 scale Geological Map Series, Geological Survey of Victoria.

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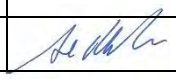
1	J Stipcevich	S Narendranathan		S Kacavenda		18/12/2019

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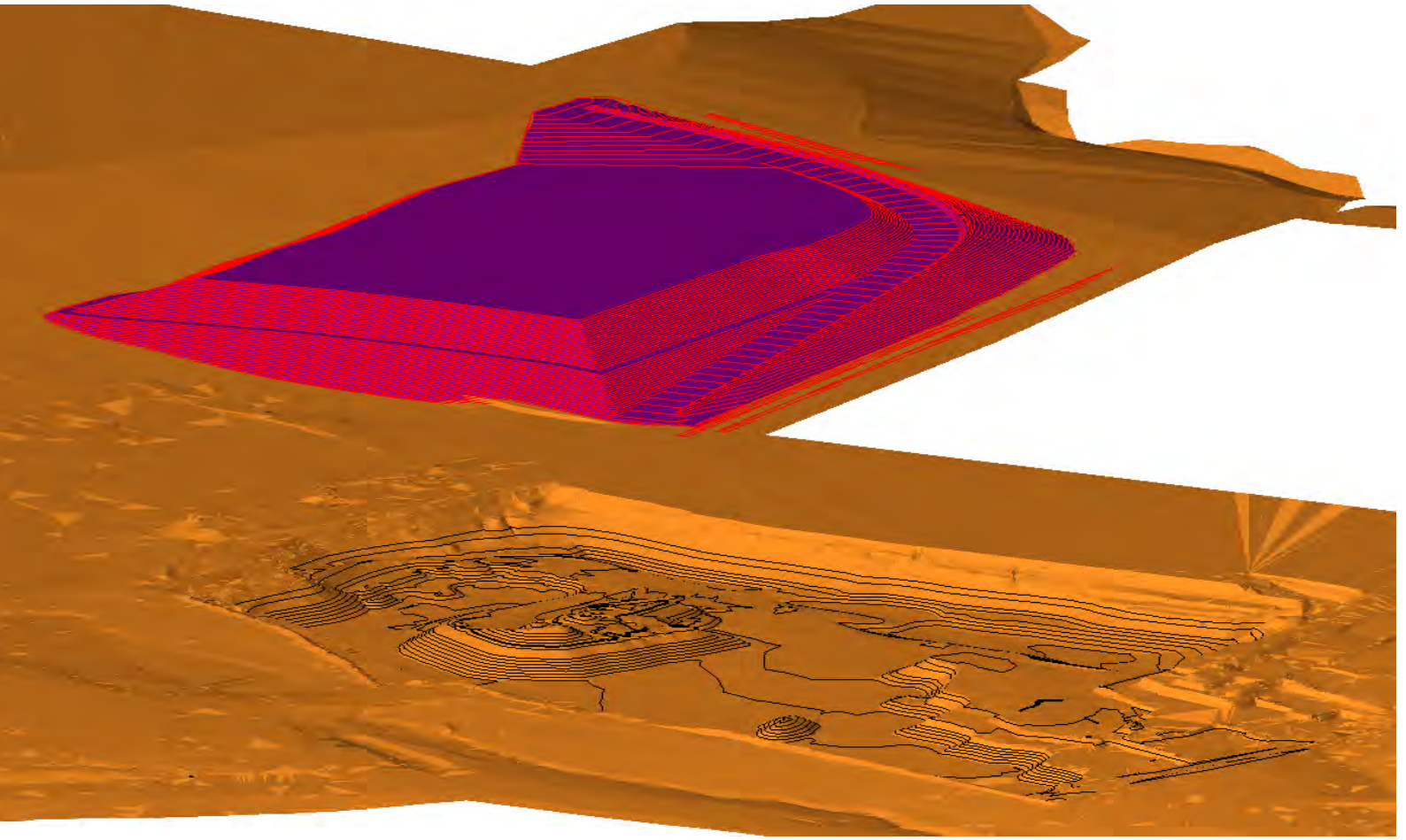

Dandy Premix Quarries Pty Ltd

Grantville Quarry WA 1488

Geotechnical Assessment of Overburden Stockpile and Haul Road

December 2019

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Appendices

Appendix A - (Slide Model Outputs)

1. Introduction

1.1 General

In response to a request from Earth Resources Regulation (ERR), GHD Pty Ltd (GHD) was commissioned by Mr Garry Cranny of Dandy Premix Quarries (the Client) to undertake a geotechnical assessment of the overburden (OB) stockpile and proposed haul road. These are located near the southern boundary (subject area) of the Grantville Quarry, Work Authority 1488 (WA1488) (the Site), situated in Grantville, Victoria (refer to Figure 1).

GHD understands that it is the Client's intent to vary the currently proposed OB stockpile by 'notification' to ERR in concert with the submission of an impending work plan variation (WPV). ERR requires a geotechnical assessment to be carried out on the overburden stockpile and proposed haul road in the subject area. The assessment is required, in part, to obtain approval from ERR to proceed with further development of the site prior to the submission of the WPV.

This report presents the results of the geotechnical assessment and geotechnical risk assessment.

1.2 Scope of Work

The following scope of work is based on the GHD proposal (GHD Ref: 12510945, dated 29 July 2019) and subsequent liaison with ERR and the Client:

- Undertake a desktop study of existing reports:
  - Review of the previously completed surface water study, refer to the 'Water Technology' report (2019), for input into the slope stability assessment.
  - Undertake a review of the A.S. James (2013) and ATC Williams (January 2014 and May 2014) geotechnical reports and the Resource Definition logs for input into the slope stability assessment.
  - Review the findings of the above reports in relation to the findings from the recent geotechnical investigation (2018) carried out across the Site.
- Undertake geotechnical stability assessments as follows:
  - 2D Limit-equilibrium analysis to calculate stability outcomes of the proposed overburden stockpile and haul road design (including consideration of foundation slope, foundation shape, overburden material type and variability, foundation competency, and proposed earthworks plant loading on the haul road (including offset distances from the crest).
  - Determine the adequacy of the proposed 'stand-off' distances from the toe of the stockpile to the Work Authority boundary.
  - Undertake sensitivity analyses, accounting for fluctuations in phreatic conditions and seismic loading.
- Undertake a geotechnical risk assessment of the OB Stockpile and Haul Road.

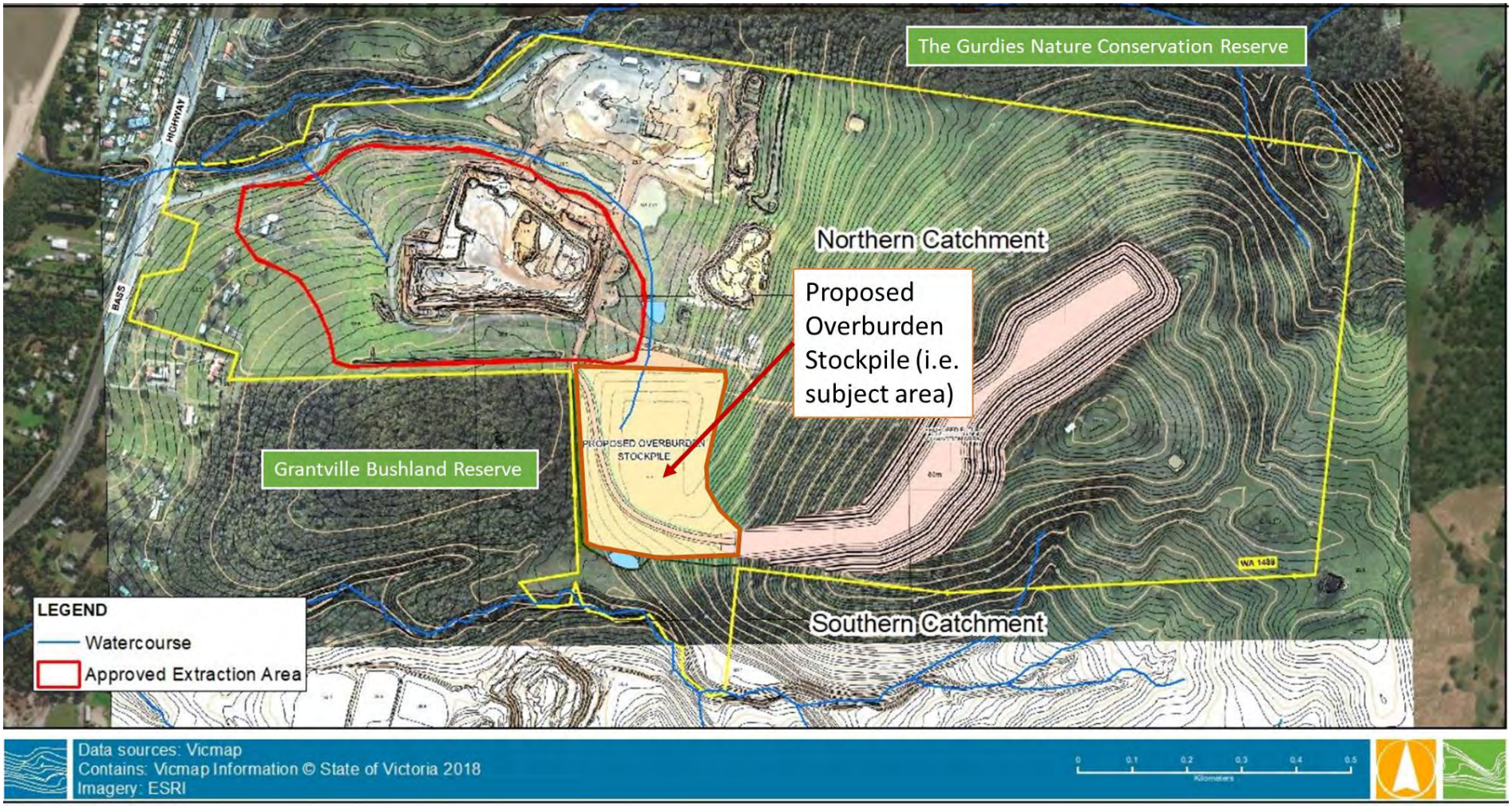


Figure 1 Grantville Quarry, WA1488- Site Layout Plan (after Water Technology, 2019)

1.3 Limitations

This report has been prepared by GHD for Dandy Premix Quarries Pty Ltd and may only be used and relied on by Dandy Premix Quarries Pty Ltd for the purpose agreed between GHD and the Dandy Premix Quarries Pty Ltd as set out in Section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Dandy Premix Quarries Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Dandy Premix Quarries Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

1.4 Assumptions

We have relied upon the following sources of information for the OB Stockpile and Haul Road slope stability and geotechnical risk assessments detailed in this report. Relevant information was extracted from the following documents:

Material Parameters

- GHD report:
  - Interpretation of Laboratory Test Results and Derivation of Geotechnical Parameters (ref: 3136345-36363, dated 10 August 2018)
- BCA Consulting:
  - Resource definition (Res Def) air core logs.
- ATC Williams reports:
  - Geotechnical Investigation of Earthworks Construction Materials and Embankment Foundations (ref: 113189.01R01, dated January 2014).
  - Geotechnical Investigation for Sound Walls and Weigh Bridge Building (ref: 113189.02R01, dated May 2014).
- A.S. James report:
  - Infrastructure & Access Road – Proposed Sand Mine (ref: 115134, dated 4 July 2013)

Overburden Stockpile and Haul Road Geometry

- BCA Consulting design and contour files (dxf's) provided on 27 August 2019:
  - 2019-3 cut solid from 2019 topo
  - 2019-3 drain bund contours
  - 2019-3 intersect surface
  - WA boundary
  - 2019 toposurface.

2. Background

2.1 General

Dandy Premix Quarries currently operate an existing sand extraction site on the western portion of WA1488, approximately 800 m east of the Western Port Bay coastline. The operation of this pit commenced in 2014 and has gradually been developed on relatively flat land to the east of the Bass Highway site frontage.

The existing license of the Client has an approved overburden stockpile site with an area of approximately 2.4 hectares. The existing overburden stockpile is located at the bottom of a natural slope, near the southern boundary of WA1488.

The Client intends on establishing a second extraction area on the eastern portion of WA1488 for coarse sand resources. As part of this, the overburden stockpile needs to be expanded to approximately 8.8 hectares (Water Technology, 2019).

A number of investigatory drilling campaigns have been carried out in WA1488 by various consultants (i.e. A.S. James, ATC Williams, BCA Consulting and Sonnekus Associates), involving borehole drilling, soil logging and sampling and in-situ testing and laboratory testing to document the encountered subsurface conditions from a geological and geotechnical perspective.

2.2 Quarry Surroundings

The Grantville Quarry site is located to the north of the Grantville township on the Bass Highway. Surrounding the quarry site, to the north and south, are bushland parks and a conservation reserve. It should be noted that there are residential homes, public infrastructure assets and environmental receptors located within a 1 km radius of the Grantville Quarry.

The site is bound by Bass Highway to the west, the Gurdies Nature Conservation Reserve to the north and east, Grantville Bushland Reserve to the south and covers approximately 160 hectares.

2.3 Regional Geology

The Geological Survey of Victoria seamless geology mapping project (Welsh et al., 2011) indicates that the uppermost Tertiary unit at WA1488, west of the Heath Hills Fault, is the Brighton Group. Movement along the Heath Hill Fault zone most likely dragged-up Brighton Group and other Tertiary stratigraphic units on the western side of the fault which would explain the steep dips in the Tertiary sediments and the greater than expected thickness of the Brighton Group close to the Tertiary-Cretaceous contact. The upper (near surface) portion of the Brighton Group across WA1488 is predominantly clay or silt which in the context of sand extraction is referred to as “overburden”. The thickness of the clay/silt overburden varies from absent to about 19 m and is mostly between 5 m and 10 m across the lower elevated, western portion of the site but is thinner on the hill in the southeastern part of the site.

Outcropping Strzelecki Group were mapped in the southeastern corner of WA 1488, to the east of the Heath Hill Fault (Welsh et al., 2011). However, investigative drilling in this area during 2018 intersected weathered basalt (Mornington Volcanics Group). Interpretation of geophysical survey data and field inspection indicates that the basalt is localized and is most likely a volcanic plug along the Heath Hill Fault.

An excerpt of the map sheet is presented in Figure 2.

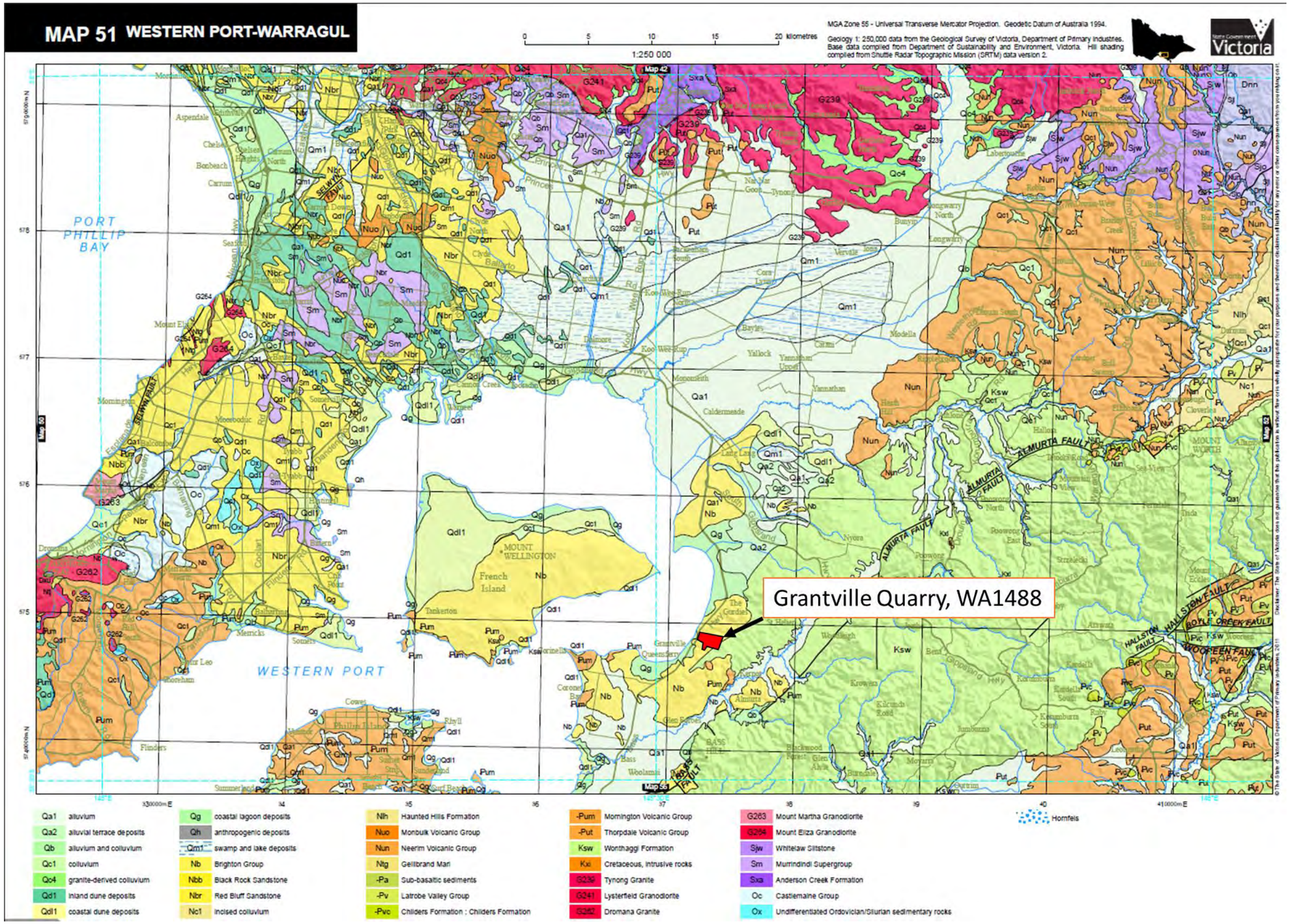


Figure 2 The Geological Survey of Victoria (Welsh et al., 2011) – Grantville Quarry WA1488

2.4 Summary of Past Investigations

Summarised in this section of the report are the findings from the past investigations undertaken within the overburden material across the site. These studies have focused on delineating the extent, mechanical characteristics and intra material variability. The findings from the respective studies are presented in the impending sub sections.

2.4.1 Field Investigations

ATC Williams undertook a field characterisation exercise with benefit of laboratory classification, across the OB material to delineate the respective material types encountered. The findings and limitations are documented in ATC Williams report dated (January and May, 2014).

A.S. James (2013)

A.S. James (refer 113154, dated 4 July 2013) undertook a limited characterisation exercise, the findings and limitations are documented in the geotechnical report (refer: 113154, dated 4 July 2013).

The overburden materials typically comprised, clay, silt and sand. The clays were of medium to high plasticity, with variable sand content and were of stiff consistency. 12 boreholes were drilled to a maximum depth of 6.5 metres below ground surface level.

No free standing groundwater was encountered at the time of the site investigation.

ATC Williams (2014)

Table 1 below summarises the findings from this investigation.

Table 1 Summary of Subsurface Ground Conditions (ATC Williams, Jan 2014)

Unit	Approximate Depth to upper contact level (m)	Approximate Thickness (m)	Generic Description & Origin
1	Surface	0.2 – 0.6	Silty CLAY (CL) / Clayey SILT (ML) / Silty SAND (SM) **(TOPSOIL)** Fine to medium grained, low plasticity to non-plastic, pale grey, with fine roots and other organic material, dry to wet. (Sedimentary colluvial Origin)
2A	0.2 – 0.6	1.1 – 1.8	CLAY (CL / CI / CH) Stiff to very stiff, low to high plasticity, orange brown with pale grey and trace of red brown, with sand, W > Wp. (Sedimentary alluvial Origin)
2B	1.7 – 2.0	Not determined	CLAY (CI /CH) Stiff to very stiff, medium to high plasticity, red brown and pale grey, with sand, with iron oxide staining and weakly cemented gravel, W > Wp.

Unit	Approximate Depth to upper contact level (m)	Approximate Thickness (m)	Generic Description & Origin
			Clayey SAND (SC) Fine to medium grained, red brown and pale grey, with iron oxide staining and weakly cemented gravel, moist. (Sedimentary alluvial Origin)

Table 2 presents an excerpt of the summary of laboratory testing undertaken by ATC Williams (2014).

Table 2 Summary of ATC Williams Laboratory Test Results (excerpt)

Test Pit / Depth (m)	Description	MC (%)	Atterberg Limits			PSD <75 µm (%)	Emerson Class Number	Permeability k (m/sec)	Standard Compaction	
			LL (%)	PL (%)	PI (%)				MDD (T/m^3)	OMC (%)
B1 1.0	CLAY (CH)	23.7	61	20	41	83.5	4	1.1×10^{-9}	1.58	23.0
B1 2.0	CLAY (CH)	28.0								
B1 3.0	CLAY (CH)	21.1	82	21	61	73.0	4	5.5×10^{-10}	1.63	21.5
B1 5.0	Clayey SAND (SC)	11.3	64	13	51	33.6	4		1.91	12.0
B2 1.0	CLAY (CH)	23.8								
B2 2.0	CLAY (CH)	21.6	83	18	65	67.8	4		1.61	22.5
B2 4.0	CLAY (CH)	19.0	82	20	62	67.4	4	2.1×10^{-10}	1.65	21.5
B3 1.0	CLAY (CH)	19.9	59	15	44	81.3	4		1.68	20.0
B3 2.0	CLAY (CH)	30.2								
B3 3.0	CLAY (CH)	23.7	87	21	66	75.5	4	1.2×10^{-10}	1.59	23.5
B3 5.0	CLAY (CH)	14.8	67	15	52	58.4	4	2.3×10^{-10}	1.75	16.5
F2 1.0	CLAY (CI)	17.0	38	11	27	75.5				
F5 1.0	CLAY (CH)	22.4	60	15	45	82.3				
F8 0.1	Silty SAND (SM)	15.5	-	22	NP	48.8				
F8 1.0	CLAY (CL)	13.4	27	12	15	52.5				

From ATC Williams (2014), the Atterberg Limits testing undertaken on soil units 2A and 2B (refer Table 1) indicates that the materials generally comprise clays of high plasticity, with some low to medium plasticity clays typically at about 1m depth. The key findings here are generally aligned with the findings from A.S. James (2013).

Emerson Class Number (i.e. a dispersion test) testing was conducted on collected clay samples. The results of this testing indicated that the clays have intermediate dispersion potential (Emerson Class of 4) in nature (refer Table 2).

Pocket penetrometer testing conducted on recovered undisturbed tube samples indicate that the soil stiffness ranged from 125 kPa to 300 kPa. No laboratory shear strength testing was conducted on samples recovered from the ATC Williams investigations.

No free standing groundwater was encountered at the time of the site investigation.

BCA Consulting

BCA Consulting carried out a drilling campaign in early 2018, involving resource definition (Res Def) air core borehole drilling, soil and rock logging and sampling, for the purposes of resource (Sand) exploration. Supplied borehole / stratigraphy logs indicate that the clay and silt

overburden material varies in layer thickness between 1 m and 19 m and overlies sand and clayey sand layers of variable thickness.

Shown in Figure 3 is a long section interpreted by GHD using Client supplied information.

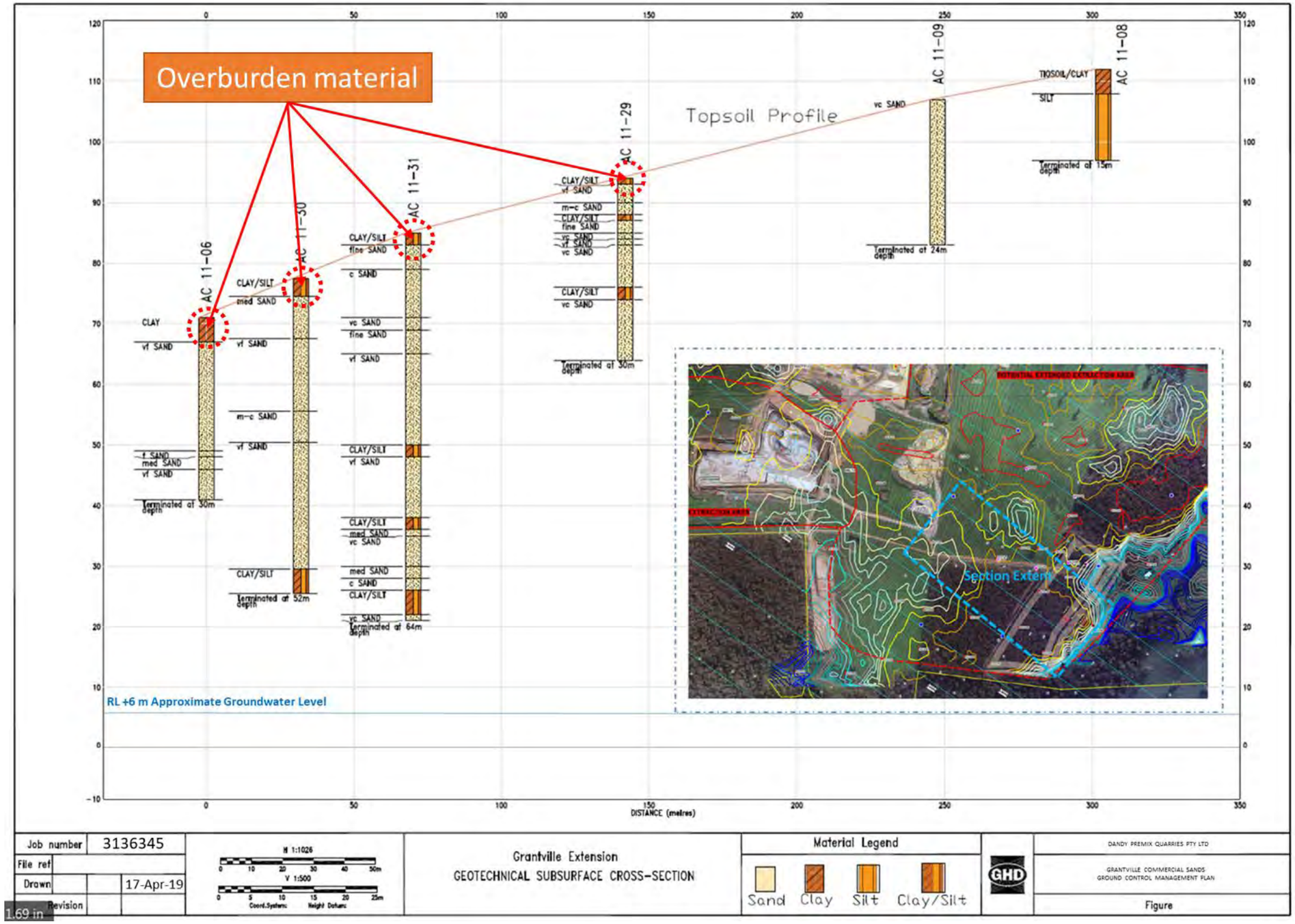


Figure 3 Interpreted Geotechnical Cross Section Based on AS 1726 Classification System

GHD (2018)

GHD undertook an interpretative assessment of the material strengths within the OB and foundation sand unit(s). The findings and limitations are documented in our report dated August 2018.

The laboratory test campaign consisted of the following suites of tests from a geotechnical / stability perspective.

- Triaxial Strength Testing - consisting of Consolidated Drained and Unconsolidated Undrained strength testing.
- Soil classification testing consisting of Atterberg Testing and Emerson Class Number and Particle Size Distribution (PSD).

Summarised below in Table 3 are the material samples subjected to geotechnical testing.

Table 3 Summary of Laboratory Test Work

Hole ID	Lab Sample ID	Depth (m)	Test Type
HS01	LMEL20180416128	Unknown	Triaxial/PSD
HS01	LMEL20180416131	Unknown	Triaxial
HS01	LMEL201805099	Unknown	Triaxial
BH8	LMEL20180416165	4.35 – 4.65	Atterberg
BH8	LMEL20180416166	5.18 - 5.40	Triaxial
BH8	LMEL20180416167	5.40 - 5.65	Triaxial/Atterberg
BH8	LMEL20180416168	5.70 - 5.95	Triaxial/Emerson
BH8	LMEL20180416169	7.20 – 7.45	Triaxial/Atterberg
BH8	LMEL20180416170	20.55 - 23.00	Triaxial
BH8	LMEL20180416171	23.25 - 23.50	Triaxial/Atterberg
BH8	LMEL20180416172	23.50 - 23.75	Triaxial
BH8	LMEL20180416173	26.00 - 26.25	Triaxial
BH8	LMEL20180416174	26.50 - 26.75	Atterberg
BH8	LMEL20180416175	26.75 - 27.00	Triaxial
BH8	LMEL20180416176	29.20 – 29.45	Atterberg
BH8	LMEL20180416177	42.65 – 42.90	Atterberg
BH8	LMEL20180416178	47.50 – 47.70	Atterberg
BH8	LMEL20180416180	35.25 – 35.50	Triaxial
BH8	LMEL20180416181	37.40 – 37.65	Triaxial
BH8	LMEL20180416182	48.40 – 48.65	Triaxial
BH8	LMEL20180416113	27.78 – 28.00	Triaxial
IBS01	LMEL20180416126	Unknown	Triaxial
IBS01	LMEL20180416129	Unknown	Triaxial/Atterberg
IBS01	LMEL201805020	Unknown	Triaxial/Atterberg/Emerson
YIS01	LMEL20180416127	Unknown	Triaxial
YIS01	LMEL20180416130	Unknown	Triaxial/PSD
YIS01	LMEL2018050910	Unknown	Triaxial

Material Classification Test Work

Owing to findings and the limitations noted in the A.S. James (2013) and ATC Williams (2014) geotechnical reports, further assessment on the overburden materials to better classify its plasticity and strength parameters was undertaken. This work was undertaken to facilitate the formulation of a geotechnical model suitable for the purposes of undertaking slope stability modelling the findings of which will be a crucial input for the geotechnical risk assessment.

Shown below in Figure 4 is an excerpt from our 2018 report, depicting the distribution of the Atterberg Limits (of tested samples) in relation to the plasticity classifications after Casagrande.

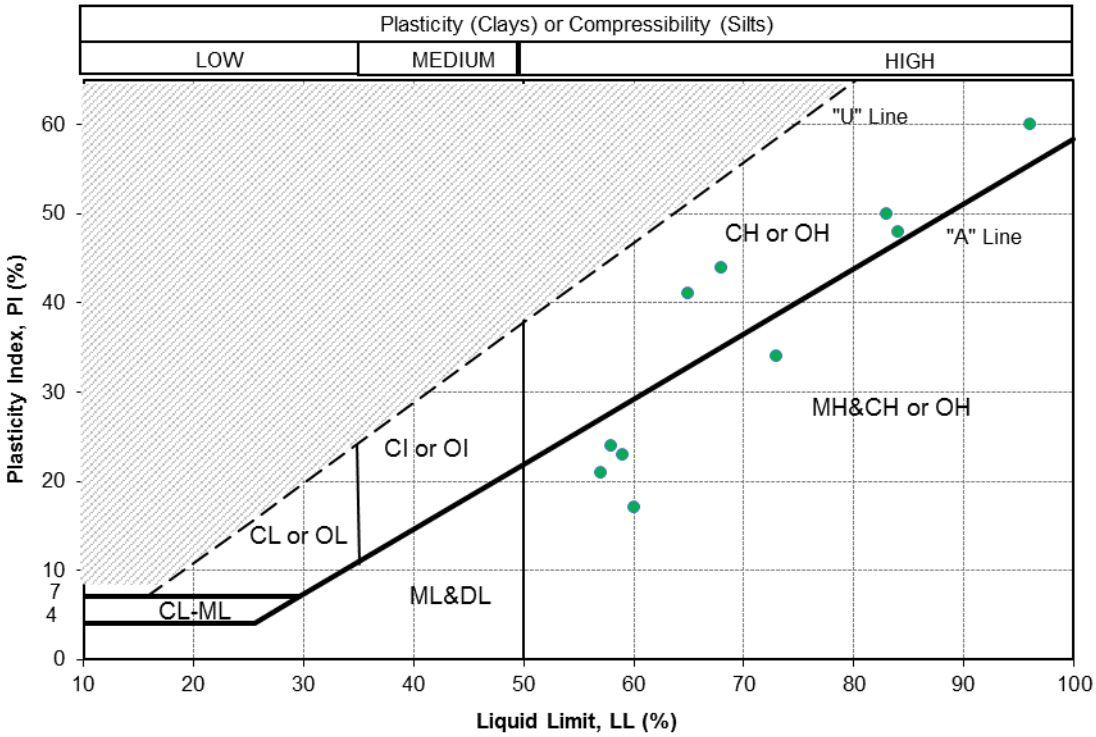


Figure 4 Casagrande Plot after AS 1726, after GHD (2018)

Based on Figure 4 above it can be seen that the overburden materials characterised at WA1488 broadly fall within the high plasticity range. This corresponds to the Clay and Slit materials encountered in much of the Res Def drill core and site investigation logs from A.S. James (2013) and ATC Williams (2014), refer to cross section above (Figure 3).

It is considered that the overburden sampling campaigns have suitability targeted 'critical' geotechnical units and these have been appropriately characterised as part of the laboratory test work.

Interpretation of Triaxial Strength Results – Insitu Overburden

GHD has also undertaken analyses, based on the provided laboratory test certificates, to determine the distribution of interpreted triaxial shear strength results for testing conducted on cohesive insitu overburden soils.

Plotted in the histogram below (Figure 5) is a distribution of the interpreted (undrained) shear strengths for the respective cohesive material types.

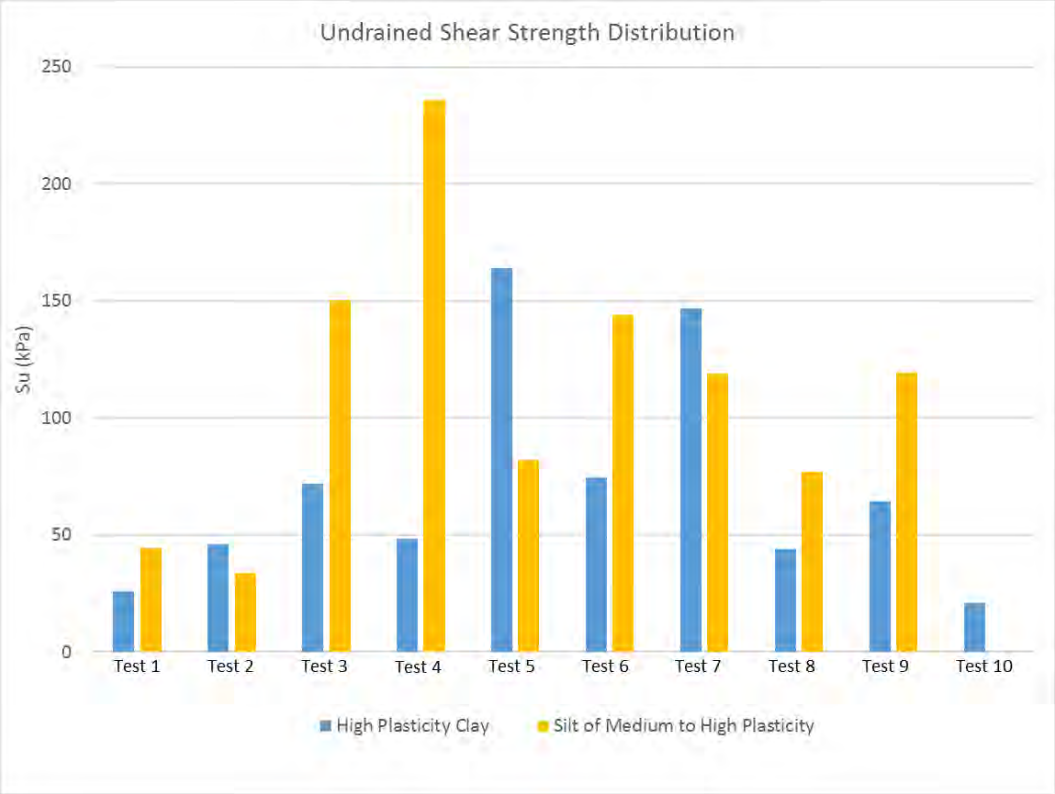


Figure 5 Distribution of Overburden Undrained Shear Strengths

Summarised in Table 4 below are the mean and minimum and maximum ranges respectively for the undrained shear strengths for the high plasticity clays and medium to high plasticity silt.

Table 4 Ranges of Undrained Shear Strengths

Material	Max (kPa)	Min (kPa)	Mean (kPa)
High Plasticity Clay	147	21	71
Silt of Medium to High Plasticity	236	34	112

From Table 4 above it can be seen that the range of undrained strengths for the high plasticity clay unit varies between 21 kPa and 147 kPa, with a mean of 71 kPa. The range of undrained strength for the medium to high plasticity silt unit varies between 34 kPa and 236 kPa, with a mean of 112 kPa.

2.4.2 Discussion of Insitu Material Parameters

GHD's review and further analyses of the supplied information generally confirms consistency between the Client supplied information and published geological information (refer Figure 2). The results of various site investigation campaigns undertaken at WA1488 indicate that the overburden materials primarily consists of cohesive soils (i.e. clay and silt) and are typically of high plasticity. The sand content within the clays and silt are variable and comprises very fine to very coarse grained particle sizes.

A range of undrained shear strength values (min, mean and max) were obtained for each type of insitu overburden material, from the Client supplied information. The statistically interpreted results indicate that the shear strength of the high plasticity clay ranged between 21 kPa and 147 kPa, and the medium to high plasticity silt ranged from 34 kPa to 236 kPa. The lower bound shear strength result for the highly plasticity clay is indicative of material affected by the Heath Hills Fault, which is not considered to 'suitable' for use as engineered fill and should not be used in the construction of the overburden stockpile. It is therefore important that the recommendations outlined in Section 5 of this report are adhered to during construction.

Owing to the above, and with due consideration for the variability associated with the insitu overburden material it can be reasonably argued that a lower bound (cut-off) material strength of 34 kPa can be considered reasonable, as achieved for testing conducted on medium to high plasticity silt.

An ‘upper bound’ insitu shear strength of 112 kPa can be considered conservative. This capped value corresponds to the mean interpreted shear strength value of the medium to high plasticity silt, which is higher than the mean value for the high plasticity clay. The range of insitu material strength parameters are summarised in Table 5 below.

The effective shear strength parameters of the foundation (sand) material were obtained from Consolidated Drained Triaxial data and the P-Q method. The results indicate that cohesion of the foundation material ranged between 0 and 2 kPa, however, it is noted that the observed ranged of cohesion is likely to be artificial due to the effects of sample remoulding. As such, a cohesion value of 0 kPa was adopted for this stability analyses. The friction angle of the foundation material was interpreted to be 33°.

A summary of the insitu shear strength parameters are summarised in Table 5 below. It is should be noted, that in general these shear strength parameters are somewhat ‘lower’ than those interpreted previously by AS James and ATC Williams.

Table 5 Summary of Interpreted Insitu OB Geotechnical Parameters

Material	Density (kN/m^3)	Shear Strength		
Undrained (kPa) – Su				
Overburden	20	Min	Mean	Max
		34	71	112
Drained (effective shear strength parameters)				
SAND (Medium to Coarse Grain)	21	Cohesion, c’ (kPa)	Friction Angle, ϕ’ (°)	
		0	33	

The above parameters serve as a basis for interpreting undrained and effective strength parameters for the placed overburden materials within the proposed dump. These are discussed in the subsequent section.

2.4.3 **Interpreted ‘Placed’** Overburden Material Strengths

It should be noted that the overburden dump and haul road, will be constructed in accordance with the recommendations outlined in Section 5 of this report. Accordingly, the excavated and placed overburden material that will form the overburden dump can be considered ‘engineered fill’.

The parameters adopted for the stability modelling as outlined in Section 3.5 are summarised in Table 6.

Table 6 Summary of Interpreted Placed OB Geotechnical Parameters

Material	Density (kN/m^3)	Shear Strength					
Undrained Strength (Short term*)	17	60 kPa					
Drained (effective shear strength parameters)							
Drained (effective shear strength parameters)	17	Cohesion, c' (kPa)			Friction Angle, ϕ' (°)		
		Min	Mean	Max	Min	Mean	Max
		5 kPa	7.5 kPa	10 kPa	25.0	27.5	30.0

Note: * Short term loading considers the haul truck loading and seismic loading scenarios.

For the purposes of undertaking stability analyses, a uniform distribution has been applied to the above interpreted effective strength parameters. A uniform distribution essentially ensures that the stability models conservatively 'sample' the lower bound (minimum) strengths in equal proportion to the mean strengths. These outcomes are reflected in the results presented in Section 3.5.

2.5 Surface and Ground Water

2.5.1 Surface Water

Water Technology (2019) have undertaken an assessment of the proposed overburden stockpile enlargement at WA1488, in relation to the hydrology of the site. The assessment was undertaken with the intent to assess what (if any) impact enlarging the stockpile will have on surface water and drainage within the Site and the broader catchments.

The findings of the surface water assessment detailed that the extension of the overburden stockpile will not adversely impact on catchment hydrology at and around the Site. Installation of an interception drain around the toe of the stockpile will collect runoff from the stockpile and surrounding area (see Figure 6). A sediment pond is located in the south west corner of the proposed overburden stockpile. A slope stability analysis has been undertaken on a cross-section through this sediment pond, assuming a flooded scenario (refer Figure 6). This analysis is detailed in Section 3.6.2.

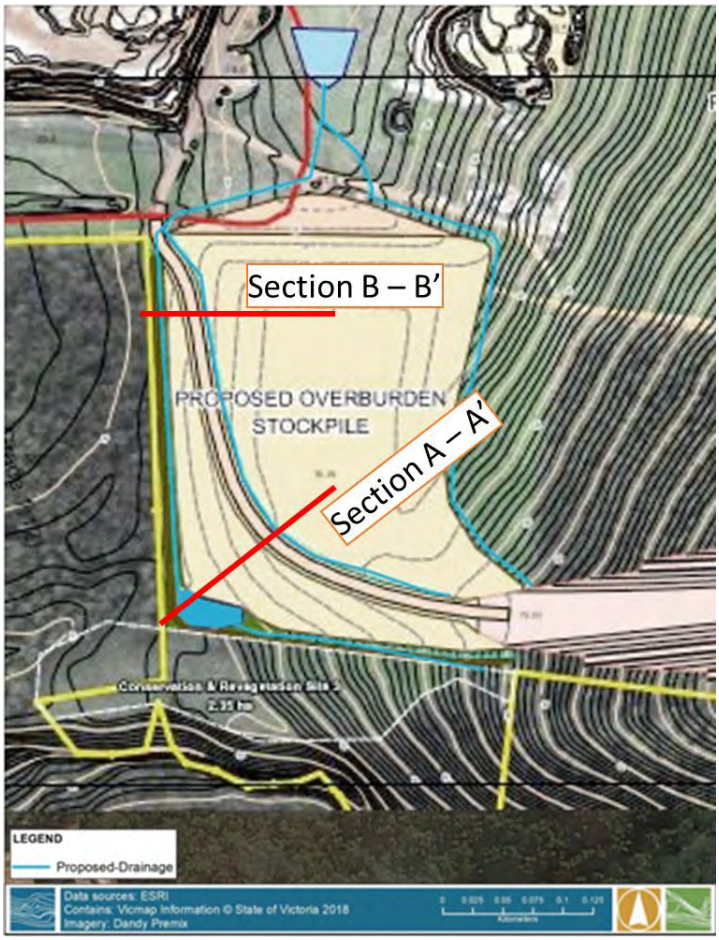


Figure 6 Proposed Drainage of Overburden Stockpile (after Water Technology, 2019)

2.5.2 Groundwater

A detailed groundwater and hydrogeological assessment has been undertaken by John Leonard Consulting Services, as presented in their report titled '*Dandy Premix Quarries, Hydrogeological Assessment Sand Extraction Proposal, 1381-1395 Bass Highway, Grantville*' dated May 2012.

Field groundwater observations recorded on the air core logs indicates that the unconfined groundwater table is typically located between 2 and 6 m AHD across WA1488. The observed groundwater levels are generally consistent with groundwater monitoring results recorded in the past 5 years. Based on the air core and stratigraphy logs from completed site investigations, some minor seepages in the sand resource (i.e. beneath the overburden unit) can be expected which will most likely to be related to localised perched groundwater tables.

Based on the provided information, groundwater is about 28 metres below the floor of the swale drain. As such, it is not likely that groundwater will affect slope stability of the overburden stockpile and proposed haul road. Nonetheless, GHD has undertaken a sensitivity analysis on an unlikely scenario where the toe of the dump is fully saturated. The findings of this assessment are presented in Section 3.5.

GHD understands that the groundwater levels will continue to be monitored via the network of existing and planned monitoring points. Through the planned monitoring, any substantial changes will be noted and reported to a geotechnical engineer in order to implement the necessary engineering controls (as required).

3. Stability Assessment

3.1 General

Owing to the (anticipated) nature of the overburden stockpile (i.e. the measured variability in the composition of the overburden materials), GHD considered that probabilistic slope stability analyses is the most appropriate approach to be undertaken on the proposed overburden stockpile extension and haul road.

Rocscience's 2D Limit-equilibrium software, Slide 2018, was utilised to analyse localised and deep seated circular slope instability mechanisms, across critical cross-sections (i.e. A-A' and B-B' – refer Figure 7) of the overburden stockpile.

These stability sections were chosen as 'critical' sections based on the following:

- The location of the overburden stockpile slope toe, relative to the Work Authority boundary (i.e. closest distance) and external receptors (e.g. Grantville Bushland Reserve) as indicated in Figure 1; and
- The cross-section of the stockpile with the maximum height.

Suitable material parameters, as presented in Table 6, have been derived for the slope stability assessment of the overburden stockpile and proposed haul road.

3.2 Designed Overburden Stockpile and Haul Road Geometry

The proposed overburden stockpile has been designed with a 15 m wide haul road to allow trafficability of haul trucks during construction. Design checks were undertaken to investigate the implications of various loading scenarios (e.g. haul truck loading) on the stockpile stability. Additional sensitivity analyses, including seismic loading and fully saturated foundation scenarios, were undertaken to assess the stability of the stockpile and haul road under extreme conditions. The results from the probabilistic stability analyses were compared against the nominated design acceptance criteria as per CSIROs (2017), 'Guidelines for Mine Waste Dump and Stockpile Design', Table 8.5)

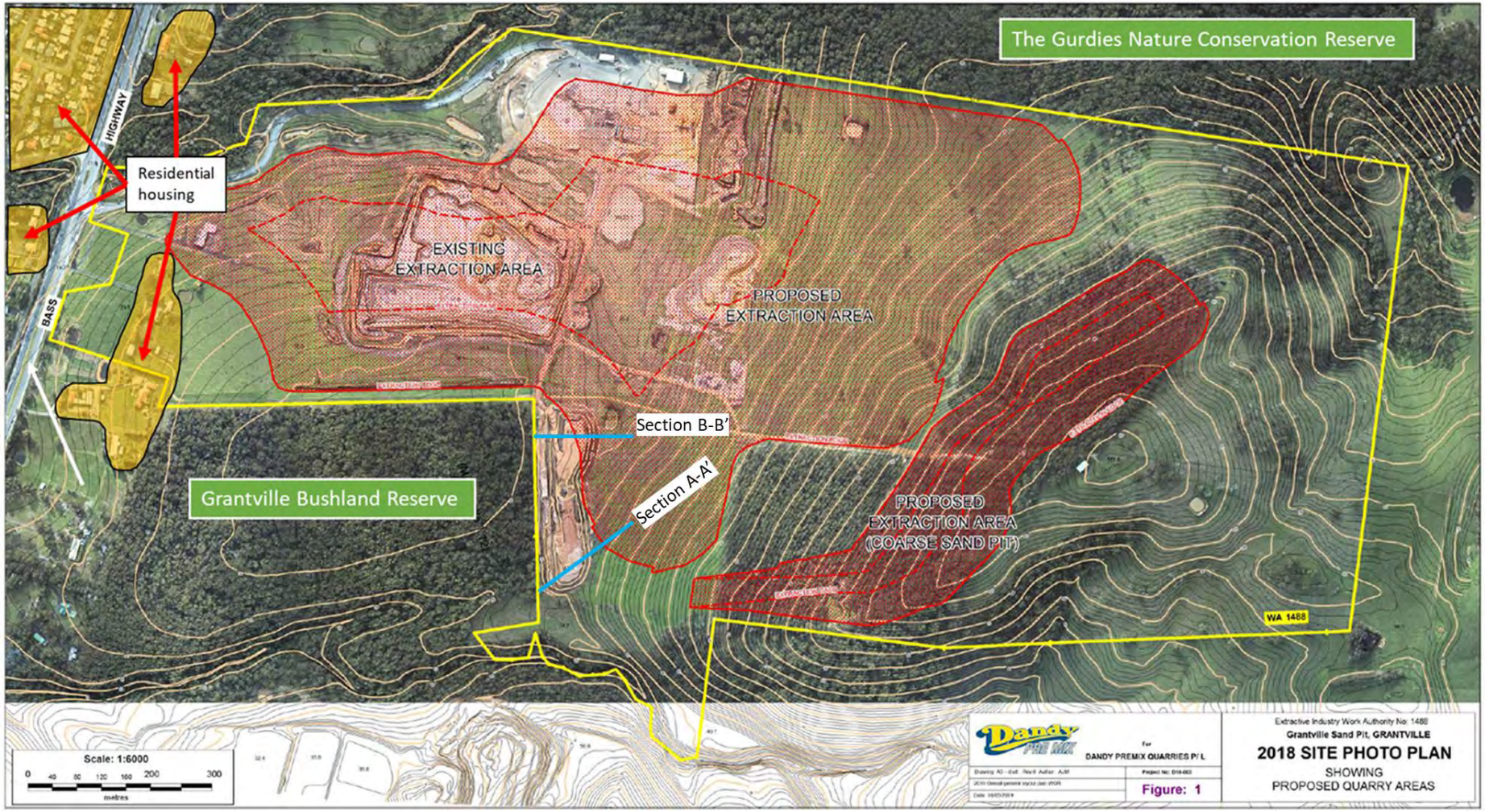


Figure 7 Stability Cross Section Layout Plan

3.3 Probabilistic Slope Stability Checks

The intent of probabilistic modelling is to assess the implications, to slope stability, based on the variability of input parameters (i.e. material shear strengths and phreatic conditions). Slide 2018 software was utilised to calculate the factor of safety (FoS) and probability of failure (PoF) for the proposed overburden stockpile and haul road design geometry.

The process employed within the software package Slide to undertake the probabilistic stability modelling is outlined below:

- Input the statistical distributions for the overburden stockpile materials (as summarised in Table 6).
- Input the mean values, along with the 'absolute' lower bound and upper bound values, and standard deviation.
- Determine and input external loading effects (i.e. groundwater levels, seismic and truck loading).
- Run the analyses using a Monte-Carlo sampling algorithm to select material parameter combinations to perform iterative stability calculations. This process ensures all conceivable strength combinations will be considered.

3.4 Design Acceptance Criteria

The nomination of suitable acceptance criteria is a key part of any design. The basis for nomination of suitable acceptance criteria is the need to confirm that the probability of failure for a particular batter is acceptable. Published precedents for waste dump designs were examined and conventionally applied criteria were sourced from CSIRO's 'Guidelines for Mine Waste Dump and Stockpile Design' (2017).

The PoF used was based on the probability that the identified FoS for each stability section was equal to or less than 1.0 as indicated below:

$$\boldsymbol{PoF = P[FoS \leq 1]}$$

Table 7, below, outlines the nominated design acceptance criteria adopted for this assessment.

Table 7 Stability Guidelines (CSIRO, 2017)

Consequence	Confidence	Static Analysis		Pseudo-Static Analysis
		Minimum FoS	Maximum PoF	Minimum FoS
Low	Low	1.3 - 1.4	10 - 15%	1.05 - 1.1
	Moderate	1.2 -1.3	15 - 25%	1.0 - 1.05
	High	1.1 - 1.2	25 - 40%	1
Moderate	Low	1.4 - 1.5	2.5 - 5%	1.1 - 1.15
	Moderate	1.3 - 1.4	5 - 10%	1.05 - 1.1
	High	1.2 - 1.5	10 - 15%	1.0 - 1.05
High	Low	≥ 1.5	≤ 1%	1.15
	Moderate	1.4 - 1.5	1 - 2.5%	1.1 - 1.15
	High	1.3 - 1.4	2.5 - 5%	1.05 - 1.1

To determine a suitable design acceptance criteria for the overburden stockpile assessment, the consequence of failure and confidence in overburden material parameters (e.g. variability in material properties), needs to be known. 'Consequence' includes consideration of both the impact of potential instability and the service life of the structure. It should be noted that the CSIRO (2017) has provided some guidance on the consequence with relevance to Table 8.5 in their publication, however, the document further states that *"where consequence is unclear, selection of the appropriate consequence level (or confidence) should be based on judgement, and the rationale for the selection should be documented".* Given the volume of available information and understanding of the Site, GHD considers that the Dump Stability Rating (DSR) and subsequently the Dump Stability Class (DSC) to be the most appropriate measure for the consequence.

3.4.1 Overburden Stockpile Stability Rating and Hazard Classification

The DSR utilises design considerations detailed after BCMWRPC (1991) to provide a qualitative way to assess key design parameters affecting stockpile stability. The DSR is comprised of a numerical index based on 11 stockpile design factors (e.g. height and composition etc), assigning a weighting to each (see Table 8), where the DSR for the overburden stockpile is highlighted in yellow.

Table 8 Dump Stability Rating (DSR) 1991 after BCMWRPRC (1991)

Key Factors Affecting Stability	Range of Conditions or Description		Point Rating
Dump Height	Low	< 50 m	0
	Moderate	50 – 100 m	50
	High	100 – 200 m	100
	Very High	> 200 m	200
Dump Volume	Small	< 1x 10^6 BCM (Bank Cubic Metres)	0
	Medium	< 1x 10^6 BCM to 5 x 10^7 BCM	50
	Large	> 5 x 10^7 BCM	100
Dump Slope	Flat	< 26°	0
	Moderate	26° – 32°	50
	Steep	> 32°	100
Foundation Slope	Flat	< 10°	0
	Moderate	10° – 25°	50
	Steep	25° – 32°	100
	Extreme	> 32°	200
Degree of Confinement	Confined	Concave in plan or section; valley or cross-valley fill, toe buttressed against opposite valley wall; incised gullies that can be used to limit foundation slope during development	0
	Moderately Confined	Natural benches or terraces on slope; even slopes; limited natural topographic diversity; heaped sidehill or broad valley or cross valleys	50
	Unconfined	Convex slope in plan or section; sidehill or ridge crest fill with no toe confinement; no gullies or benches to assist development	100
Foundation Type	Competent	Foundation materials as strong or stronger than dump materials; not subject to adverse pore pressures; no adverse geological structure	0

Key Factors Affecting Stability	Range of Conditions or Description		Point Rating
	Intermediate	Intermediate between competent and weak, soils gain strength with consolidation; adverse pore pressures dissipate if loading rate controlled	100
	Weak	Limited bearing capacity; soft soil; subject to adverse pore pressure generation upon loading; adverse groundwater conditions, springs or seeps, strength sensitive to shear strain; potentially liquefiable	200
Dump Material Quality	High	Strong, durable; ≤10% fines	0
	Moderate	Moderately strong; ≤ 10 - 20% fines	100
	Poor	Predominantly weak rocks of low permeability; ≥ 25° fines, overburden	200
Method of Construction	Favourable	Thin lifts (< 25m thick)), wide platforms; dumping along contours; ascending construction; wraps around or terraces.	0
	Mixed	Moderately thick lifts (25 – 50 m); mixed construction methods	100
	Unfavourable	Low piezometric pressures, no seepage in foundation; development of phreatic surface within dump unlikely; limited precipitation; minimal infiltration into dump; no snow or ice layers in dump or foundation.	200
Piezometric and Climatic Conditions	Favourable	Moderate piezometric pressures, some seeps in foundation; limited development of phreatic surface within dump possible; moderate precipitation; high infiltration into dump; discontinuous snow or ice lenses in dump or foundation	0
	Intermediate	High piezometric pressures, springs in foundation; high precipitation; significant potential for development of phreatic surface or perched water tables in dump; continuous layers of snow or ice in dump or foundation	100
	Unfavourable	< 25 BCM/m of crest/day; crest advancement rate <0.1 m/d	200
Dump Rating	Slow	25 - 200 BCM /m of crest/day; crest advancement rate 0.1 - 1.0 m/day	0
	Moderate	> 200 BCM/m of crest/day; crest advancement rate > 1.0 m/day	100
	High	Seismic Risk Zones 0 and 1	200
Seismicity	Low	Seismic Risk Zones 2 and 3	0
	Moderate	Seismic Risk Zones 4 or higher	50
	High	Low piezometric pressures, no seepage in foundation; development of phreatic surface within dump unlikely; limited precipitation; minimal infiltration into dump; no snow or ice layers in dump or foundation	100

The calculated DSR for the overburden, using the input factors outlined in Table 8, is 350. Using the DSR point rating system a DSC can be attributed to the stockpile and a hazard rating

assigned (see Table 9). GHD has interpreted the hazard rating in terms of 'consequence', which was used in the nomination of the design acceptance criteria.

Table 9 Dump Stability Class (DSC) after BCMWRPRC (1991)

Dump Stability Rating (DSR)	Dump Stability Class (DSC)	Failure Hazard	Consequence
< 300	I	Negligible	Low
300 - 600	II	Low	
600 - 1200	III	Moderate	Moderate
> 1200	IV	High	High

A DSR score of 350 was obtained using Table 8, which corresponds to a DSC class of 2 and a low consequence (Table 9). An additional consideration to the consequence of instability is the impact of slope failure on the surrounding environment. Given that the proposed stockpile extension is in close proximity to the Work Authority boundary, GHD has attributed a moderate failure consequence rating to the proposed stockpile and haul road.

3.4.2 Confidence Level

The confidence level attributed to the stockpile is dependent upon the information available to undertake stability analyses. Hawley and Cunning (2017) provide guidance on selecting the most appropriate confidence level, which are categorised as either low, medium or high. For this assessment a 'medium' confidence level was selected, which infers that there is – "*moderate confidence in foundation conditions, waste material properties, piezometric pressures, analysis technique or possible failure mechanism(s). Input parameters are adequately define; moderate data variability*".

3.4.3 Selection of Design Acceptance Criteria

Owing to the above, the following design acceptance criteria for the stability analyses has been adopted (from Table 7) and is based on a 'moderate' consequence and confidence rating:

- PoF < 5%
- FoS_{STATIC} > 1.4
- $FoS_{SEISMIC}$ > 1.1

In addition to the above the following FoS acceptance criteria was adopted for fully saturated toe conditions:

- FoS_{SAT}> 1.0

3.5 Slope Stability Analyses

3.5.1 Overall and Local Stability

Slope stability analyses were carried out for Sections A-A' and B-B' of the overburden stockpile (refer Figure 7). Stability models were constructed using contour files provided by BCA Consulting (refer Section 1.4).

The following approach was employed by GHD in undertaking the stability modelling:

- Slide 2018 was utilised to undertake slope stability modelling for sections A-A' and –B-B' using the proposed mine geometry and the interpreted strength parameters summarised in Section 2.4.2 above.

- Undertake design checks to understand the implications of haul truck loading on slope stability, considering single and bi-direction travel.
- Perform sensitivity analyses to understand the implications of seismic loading and fully saturated toe conditions on the slope stability as well as the effects of temporary flooding of the toe drain at the base of the stockpile slope.
- Notwithstanding the planned surface water drainage measures, an additional sensitivity assessment has been undertaken assuming that a local phreatic gradient develops within the OB dump as a result of sustained surcharge and ponding of water from heavy rainfall events.

The proposed stockpile geometry used in the stability analyses for sections A-A' and B-B' are depicted below in Figure 8 and Figure 9 respectively.

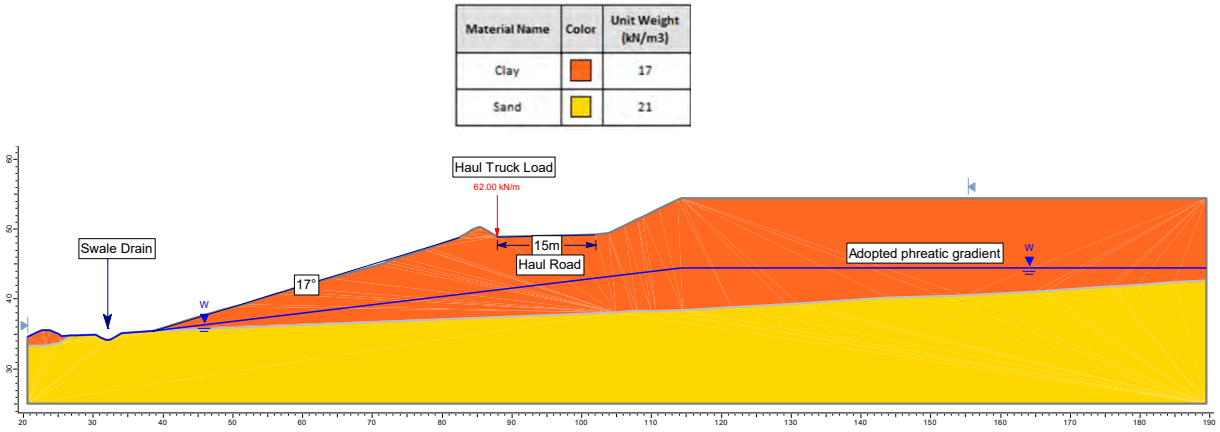


Figure 8 Schematic Representation of Section A-**A'**

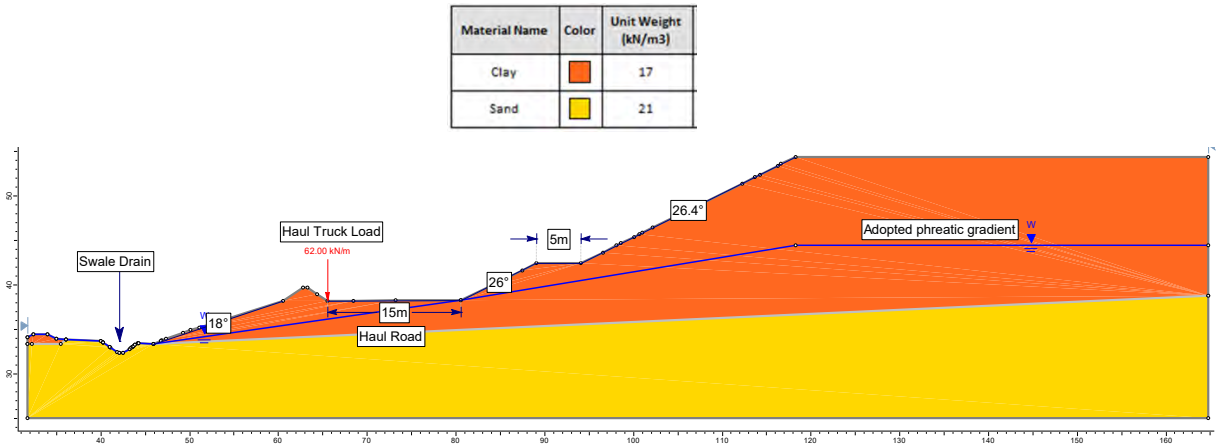


Figure 9 Schematic Representation of Section B-**B'**

A summary of the base case (i.e. no loading) slope stability analyses for Section A-A' and B-B' are summarised in Table 10. The stability model outputs are provided in Appendix A.

Table 10 Summary of Stability Modelling Results (i.e. Base Case)

Section	Design Acceptance Criteria	FoS	PoF (%)
A-A'	FoS > 1.4 PoF > 5.0 %	2.29	< 0.1
B-B' Upper slope (i.e. above haul road)		1.72	< 0.1
B-B' Lower slope (i.e. under haul road)		2.47	< 0.1

The results from the stability analysis indicate that:

- The achieved FoS for Section A-A' was calculated to be 2.29. The calculated PoF was less than 0.1%.
- For Section B-B', the upper slope (i.e. above the haul road) and lower slope (i.e. underside of the haul road) were assessed. Respectively, the FoS was calculated to be 1.72 and 2.47. The PoF's were calculated to be less than 0.1% for both slopes.
- The nominated design acceptance criteria was satisfied for both of the stability sections analysed.

3.5.2 Design Check – Haul Truck Loading

Stability analyses were carried out for Sections A-A' and B-B' considering various haul truck loading scenarios, which include a single (i.e. left) pass and dual pass. 40 T articulated haul trucks are operated at the Site and have been modelled as point loads for the slope stability assessment (see Figure 8 and Figure 9). The point load of a fully laden haul truck was calculated to be 62.0 kN/m.

Based on the proposed haul road design geometry at Section B-B', GHD has assessed the stability of the lower slope (i.e. underside of haul road) given that the haul truck loads will be exerted on the lower slope (i.e. critical slope) and not the upper.

The results for the stability analyses, considering the various haul truck loading scenarios, are summarised below in Table 11. The stability model outputs are presented in Appendix A.

Table 11 Summary of Haul Truck Loading Results

Section	Haul Loading	Design Acceptance Criteria	FoS	PoF (%)
A-A'	Left Pass	FoS > 1.4 PoF > 5.0 %	2.24	< 0.1
	Dual Pass		2.21	< 0.1
B-B'	Left Pass		2.39	< 0.1
	Dual Pass		2.33	< 0.1

The calculated results from the Haul Truck loading analyses indicate that:

- There is a slight reduction in the calculated FoS for Section A-A' when haul trucks make a dual pass in comparison to a single (i.e. left) pass. The calculated FoS indicates a decrease from 2.24 (i.e. single pass) to 2.21 (i.e. dual pass).

- There is a marginal reduction in the calculated FoS for the lower slope at Section B-B' when haul trucks make a dual pass in comparison to a single (i.e. left) pass. The calculated FoS indicates a decrease from 2.39 (i.e. single pass) to 2.33 (i.e. dual pass).
- All assessed scenarios (i.e. for haul truck loading) satisfy the nominated design acceptance criteria.

3.6 Sensitivity Analyses

Sensitivity analyses have been undertaken on Section A-A' and B-B' to assess the implications of seismic loading and flooding of the swale drain at the toe of the stockpile resulting in fully saturated toe conditions.

3.6.1 Seismic Sensitivity Analyses

The Grantville Quarry lies in a relatively seismic active zone compared to the rest of Victoria. According to the 'Atlas of Seismic Hazard Maps of Australia' (Australian Government, 2013), a Peak Ground Acceleration (PGA) of 0.0627 is attributed to the Grantville area for a 1 in 500 year return period (see Figure 10). For this assessment a seismic load equal to approximately half of the 1 in 500 year return period was adopted after Hynes-Griffin and Franklin (1984). The results of the seismic analyses are summarised below in Table 12. The stability model outputs are presented in Appendix A.

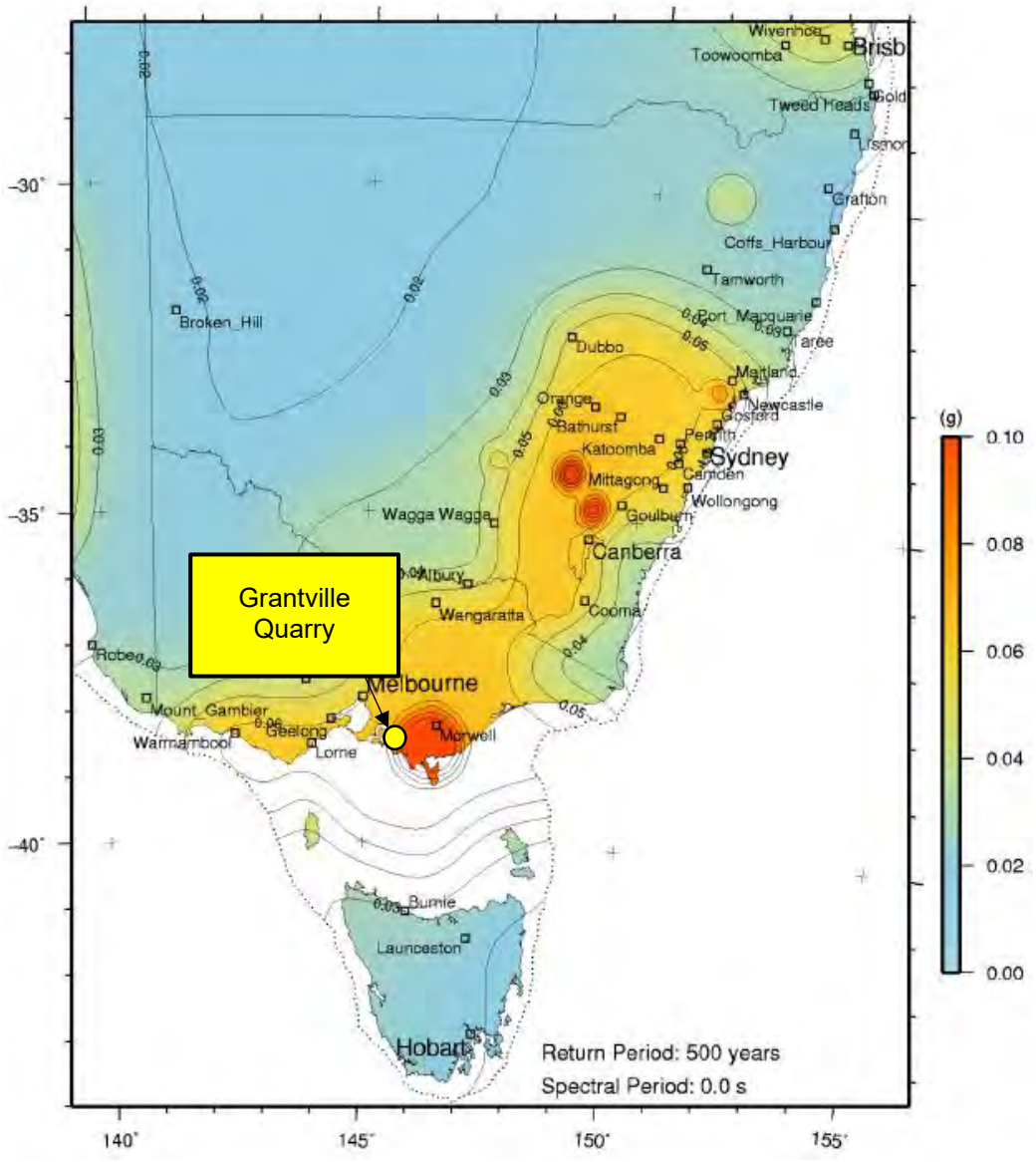


Figure 10 Seismic Hazard Map (2013) Depicting the Grantville Quarry Site

Table 12 Results of Seismic Sensitivity Analyses

Section	Design Acceptance Criteria	FoS	PoF (%)
A-A'	FoS > 1.1	2.07	< 0.1
B-B'		1.60	< 0.1

The results from the seismic analyses indicates that:

- A reduction in the FoS of approximately 0.22 (i.e. decrease from the base case) was calculated for Section A-A' as a result of seismic loading.
- A reduction in the FoS of approximately 0.12 (i.e. decrease from the base case) was calculated for Section B-B' as a result of seismic loading.
- All assessed scenarios (i.e. for seismic loading) satisfy the nominated design acceptance criteria.

3.6.2 Flooding of the Swale Drain

The proposed overburden stockpile extension includes the use of a swale drain located at the toe of the stockpile. The purpose of this sensitivity analyses is to assess the implications of temporary flooding on the stockpile's stability. The results from the swale drain flooding analysis is provided below in Table 13. The stability model outputs are presented in Appendix A.

Table 13 Summary of Temporary Flooding of Swale

Section	Design Acceptance Criteria	FoS	PoF (%)
A-A'	FoS > 1.4	2.18	< 0.1
B-B'	PoF > 5.0 %	2.38	< 0.1

The results of the temporary flooding of the swale drain indicate that:

- The FoS for Section A-A' under temporary flooding of the swale was calculated to be 2.18 and for Section B-B' was calculated to be 2.38.
- The PoF's for Section A-A' and B-B' were calculated to be less than 0.1%.
- Section A-A' and B-B' under a temporary flood scenario met the nominated acceptance criteria.

3.7 Summary of Analyses Results

Probabilistic slope stability analyses have been undertaken on the proposed overburden stockpile extension and haul road using Limit Equilibrium Modelling (LEM) methods to investigate the stability of critical sections A-A' and B-B'. Design checks were undertaken to assess the effects of various haul loading scenarios on the slope stability. Sensitivity analyses was also undertaken considering seismic loading, temporary flooding of the swale drain and fully saturated conditions.

The analysis results indicate the following:

Base Case (i.e. no loading)

- The FoS for the global scale failure of sections A –A' was calculated to be 2.29. The corresponding PoF value was calculated to be less than 0.1%.
- For Section B-B', slope failure of the upper slope (i.e. above the haul road) and lower slope (i.e. underside of the haul road) were calculated to be 1.72 and 2.47 respectively. The calculated PoF's were calculated to be less than 0.1% for both slopes.
- The calculated results for the proposed stockpile extension and haul road are within the nominated design criteria.

Haul Truck Loading (i.e. left and dual pass)

- For Section A-A': Haul Truck loading on the side of the road closest to the crest of the stockpile (i.e. left pass) resulted in a marginal decrease in FoS from FoS 2.29 to 2.24.
- For Section A-A': Haul Truck loading on both sides of the road (i.e. dual pass) resulted in a decrease in the calculated FoS from 2.29 to 2.21.
- For Section B-B': Haul Truck loading on the side of the road closest to the crest of the stockpile (i.e. left pass) resulted in a decrease in FoS from FoS 2.47 to 2.39.
- For Section A-A': Haul Truck loading on both sides of the road (i.e. dual pass) resulted in a decrease in the calculated FoS from 2.47 to 2.33.

Seismic Loading

- The stability of the stockpile is slightly sensitive to the effects of the expected seismic loading. The calculated FoS for Section A-A' decreased from FoS 2.47 (base case) to 2.07 (seismic case).
- Similarly, the FoS for Section B-B' decreased from FoS 1.72 (base case) to 1.60 (seismic case).

Swale Drain Flooding

- For temporary flooding of the swale drain, there was a slight decrease in the calculated FoS of Section A-A' from FoS 2.29 (base case) to 2.18 (flood case).
- For temporary flooding of the swale drain, there was a slight decrease in the calculated FoS of Section B-B (i.e. for the lower / critical slope) from FoS 2.47 (base case) to 2.38 (flood case).

For all analyses undertaken, the calculated results (FoS and PoF) meet the nominated design acceptance criteria as outlined in Section 3.4.

3.8 Discussion of Stability Results

For the stability analyses carried out for the proposed overburden extension and haul road, the proposed geometry is unlikely to result in large scale instabilities of the stockpile even when extreme cases were analysed. All analysed scenarios meet the nominated industry acceptance criteria after CSIRO (2017).

For the haul truck loading and swale drain flooding analyses, the lower slope of Sections A-A' and B-B' were considered to the be the 'critical' batters under these particular loading conditions. The results of the commensurate analyses indicated that both stability sections had a decrease in the calculated FoS, relative to the base case, but still within the nominated acceptance criteria.

The results of the seismic load scenario indicated a decrease in the calculated FoS for both stability sections, but still within the nominated design acceptance criteria.

Notwithstanding the results of the analyses, it is important that the recommendations outlined in Section 5 of this document are adhered to during construction and the nominated surface water management protocols outlined in the Water Technology Report are adhered to during operation.

4. Geotechnical Risk Assessment

4.1 General

A key part of the overburden stockpile and proposed haul road assessment is the geotechnical risk assessment. The risk assessment is used to identify and address any perceived or known threats to the:

- Safety of people – including the public and site personnel
- Environment
- Risk to quarry employees
- Key infrastructure within and around the quarry
- Nearby public infrastructure (where applicable)

Outlined in this section are the outcomes of the risk assessment for the respective geotechnical and stability related hazards that are anticipated to be encountered for the overburden stockpile and proposed haul road.

Specifically this risk assessment demonstrates that these risk mitigation protocols reduce the latent risk to tolerable thresholds in line with industry norms and legislative requirements.

The findings of the risk assessment help the tailoring of management protocols to ensure that risks are maintained within acceptable thresholds.

4.2 Geotechnical Hazards/Threat Identification

The following hazard categories have been identified:

Hazard Type 1 (*Slumping/erosion of the overburden stockpile batters*) – This hazard eventuates as a result of the slumping and / or sloughing of the any dump batter faces, which may be exacerbated due haul truck loading, seismic loading, flooding of the swale drain and fully saturated conditions forming within the stockpile.

Potential causes for slumping include, but are not limited to, highly disturbed or poorly compacted overburden materials (used to construct the stockpile), improper surface and groundwater management during construction and operation of the stockpile and / or inappropriate as-constructed geometry (i.e. steeper than that assessed in this report).

The consequence of this hazard may include the health and safety of quarry personnel and earthworks equipment.

Hazard Type 2 (*deep seated circular failure*) – This hazard is represented by moderate to larger volumes of soil, which may slip (in a circular manner) on low strength material and or through planes of weaknesses in the foundation or stockpiled materials, which may be exacerbated by haul truck loading, seismic loading, prolonged flooding of the swale drain and fully saturated conditions forming within the stockpile.

Potential causes for slumping include, but are not limited to, highly disturbed or poorly compacted overburden materials (used to construct the stockpile), improper surface and groundwater management during construction and operation of the stockpile and / or inappropriate as-constructed geometry (i.e. steeper than that assessed in this report).

The consequence of this hazard type may include full loss of the overlying pit crest, haul road, flow of failed material outside the Work Authority Boundary (and therefore impact to the Grantville Bushland Reserve) and to health and safety of quarry personnel and equipment.

Hazard Type 3 (*saturation of the stockpile toe from swale drain flooding*) – This hazard is represented by small to (potentially) larger volumes of soil, which may slip (in a circular manner) on oversaturated (and softened) soil in the foundation or deeper stockpiled materials, which may be exacerbated by haul truck loading, seismic loading, prolonged flooding of the swale drain and fully saturated conditions forming within the stockpile.

Potential causes for slope instability include, but are not limited to, oversaturation of foundation and deeper stockpiled material, poor compaction of the stockpile material, prolonged and / or repetitive flooding of the swale drain at the stockpile toe, improper surface and groundwater management during construction and operation of the stockpile and / or inappropriate as-constructed geometry (i.e. steeper than that assessed in this report).

The consequence of this hazard type may include full loss of the overlying pit crest, haul road, flow of failed material outside the Work Authority Boundary (and therefore impact to the Grantville Bushland Reserve) and to health and safety of quarry personnel and equipment.

4.3 Risk Management Framework

Risk assessment is the overall process of risk identification, risk analysis and risk evaluation. These three stages of the risk assessment process are outlined in further detail in the context of the geotechnical risks associated within the Grantville Quarry overburden stockpile extension and proposed haul road.

Risk analysis involves consideration of the source of risks, their consequences and the likelihood of those consequences occurring. Risks are usually analysed by combining their likelihoods and consequences. The risk evaluation process involves comparing the level of risk derived from the risk analysis with the risk criteria established when the context for the risk management process was considered. The purpose of the risk evaluation is to use the outcomes of risk analysis to decide which risks require treatment, and the treatment priorities.

A semi quantitative risk assessment process has been utilised as outlined in the risk assessment matrix Table 14 below, which is broadly in line with AS/NZS 4360: 2004 (Standards Australia 2004).

Table 14 Risk Assessment Matrix

Likelihood	Insignificant	Minor	Moderate	Major	Critical
Almost Certain	Medium	High	Very High	Very High	Very High
Likely	Medium	Medium	High	Very High	Very High
Possible	Low	Medium	Medium	High	Very High
Unlikely	Low	Low	Medium	High	High
Rare	Low	Low	Medium	Medium	High
	Consequence				

Risk level	Description
Very High	Totally unacceptable level of risk. Controls must be put in place to reduce the risk to lower levels.
High	Generally unacceptable level of risk. Controls must be put in place to reduce the risk to lower levels or seek specific guidance from ERR.
Medium	May be acceptable provided the risk has been minimised as far as reasonably practicable.
Low	Acceptable level of risk provided the risk cannot be eliminated risk.

Element at risk	Quarry Boundary	Hazard type	Risk Rating	Consequence Category	Corrective / Management Action(s)	Residual Risk Rating	Geotechnical Comments
Overburden Stockpile (stability)	Internal	***Hazard Type 1***: Small scale slumping of overburden stockpiled material. Likelihood of slumping can be exacerbated if overtopped drainage systems (during heavy rainfall events) cause water to flow over the stockpile batters and / or poor compaction of the stockpiled material.		Moderate	Daily inspections, suitable as-constructed geometry, erosion control measures, dedicated site surface water management plans will be implemented. GPS monitoring and / or prisms and pins should be installed.		• The proposed overburden stockpile is located at a suitable distance from the Work Authority boundary. • Dedicated site surface water management plans have be developed and will be implemented to minimise surface erosion and risk of localised instability. • Stockpiles will be built with EPA compliant erosion and sediment control features to minimise the likelihood of slumping. • Regular visual observations / monitoring will be undertaken. • In addition to which visual monitoring is proposed as an additional measure to ensure slope performance is monitored and where necessary stockpile designs amended. • Groundwater monitoring data will be collected regularly to identify any adverse trends (if any).
Overburden Stockpile (stability)	Internal	***Hazard Type 2 & 3***: Moderate to large scale circular failure of the stockpiled material. Likelihood of circular failure can be exacerbated if overtopped drainage systems (during heavy rainfall events) cause water to flow over the stockpile batters, prolonged and / or repetitive flooding of the swale drain at the toe of the stockpile and saturation of the stockpiled material.		Moderate	Daily inspections, suitable as-constructed geometry, erosion control measures, dedicated site surface water management plans will be implemented. GPS monitoring and / or prisms and pins should be installed.		• Regular visual observations / monitoring will be undertaken. • In addition to which visual monitoring is proposed as an additional measure to ensure slope performance is monitored and where necessary stockpile designs amended. • Groundwater monitoring data will be collected regularly to identify any adverse trends (if any).

Element at risk	Quarry Boundary	Hazard type	Risk Rating	Consequence Category	Corrective / Management Action(s)	Residual Risk Rating	Geotechnical Comments
Grantville Bushland Reserve	Southern	***Hazard Type 2 & 3***: Moderate to large scale circular failure of the stockpiled material. Likelihood of circular failure can be exacerbated if overtopped drainage systems (during heavy rainfall events) cause water to flow over the stockpile batters, prolonged and / or repetitive flooding of the swale drain at the toe of the stockpile and saturation of the stockpiled material.		Moderate	Daily inspections, suitable as-constructed geometry, erosion control measures, dedicated site surface water management plans will be implemented. GPS monitoring and / or prisms and pins should be installed.		• The proposed overburden stockpile is located at a suitable distance from the Work Authority boundary. • Dedicated site surface water management plans have be developed and will be implemented to minimise surface erosion and risk of deep seated instability. • Stockpiles will be built with EPA compliant erosion and sediment control features to minimise the likelihood of slumping. • Regular visual observations / monitoring will be undertaken. • Groundwater monitoring data will be collected regularly to identify any adverse trends (if any). • Survey monitoring is proposed as an additional measure to ensure slope movements are monitored and do not extend beyond the extraction boundary into the Grantville Bushland Reserve.
Overburden Stockpile (OH&S)	Internal	***Hazard Type 1, 2 & 3***: Small to large scale slope failure in the stockpiled material Likelihood of circular failure can be exacerbated if overtopped drainage systems (during heavy rainfall events) cause water to flow over the stockpile batters, prolonged and / or repetitive flooding of the swale drain at the toe of the stockpile and saturation of the stockpiled material.		High	Daily inspections, suitable as-constructed geometry, erosion control measures, dedicated site surface water management plans will be implemented. GPS monitoring and / or prisms and pins should be installed.		• Suitable stand-off distances for haul trucks and vehicles will be maintained from the crest of the underside stockpile batter. • Bunding will be constructed to reduce the risk of vehicle roll-overs. • Dedicated site surface water management plans have be developed and will be implemented to minimise surface erosion and risk of localised instability. • Regular visual observations / monitoring will be undertaken.

4.4 Risk Assessment Results

The qualitative risk assessment determined that the risk to infrastructure and the environment within the default Geotechnical Risk Zone, as outlined by the DJPR's guidelines 'Guidance Material for the Assessment of Geotechnical Risks in Open Pits and Quarries' caused by geotechnical failure of the proposed overburden stockpile and haul road is "Low".

5. Earthworks Recommendations

Based on the available information (i.e. laboratory test certificates and stratigraphy logs), GHD consider that the cohesive overburden soils, with no organic material, are suitable for use in engineered fill construction provided that suitable earthworks construction methodology are followed.

ATC Williams (2014) indicated that Unit 1 (refer Table 1) and soils containing organic topsoil material, should be stripped from the footprint of any embankments or hardstands. GHD consider the same applies for the foundation of the proposed overburden stockpile and haul road development. Overburden materials containing organic content (e.g. topsoil) are unsuitable for use in engineered fill construction.

GHD recommends the following construction approach for the proposed stockpile and haul road:

- Prepare the foundation of the stockpile area by removing unsuitable material including clearing and grubbing and removal of site infrastructure.
- Excavate overburden material from the proposed sand pits using dozer or bucket excavator. Unsuitable material (i.e. containing any organic content) should not be placed in the proposed stockpile and haul road. It should be diverted to an alternative location and may be suitable for use as topsoil.
- Construct the stockpile and haul road using truck and dozer methods, compacting the overburden material in horizontal layers. The layers should be placed in lifts no greater than 0.5 m in thickness. Earthworks should be undertaken so that the material strengths reported in this assessment are achieved. In addition lines, grades and cross sections should be completed within a reasonable tolerance (same or flatter) of the approved design.
  - Daily inspections of the overburden stockpile and haul road should be carried out by the site supervisor or suitably qualified personnel to identify tension cracks or any other signs of instability that may arise during construction and operation of the haul road (and stockpile).
- Ensure adequate surface and where applicable subsurface drainage measures are incorporated to facilitate the maintenance of stability during construction and operation of the haul road. Regular inspections of the swale drains at the toe of the stockpile should be undertaken to ensure that the drains are free draining. Prolonged flooding of the stockpile should not be allowed.
  - If the stockpile material becomes oversaturated then in-situ treatment of material should be undertaken, which includes ripping the surface to a depth of 250 mm and re-compacting the area.

Table 15 Foundation Preparation

No	Activity	Test & Frequency	Acceptance Criteria	Inspection & Responsibility
1	Identify and treat suitable / unsuitable material at foundation level	Visual inspection	• Excavated / trimmed foundation surface is dry, competent and is suitable for operation of construction plant and placement / adequate compaction of fill. • All unsuitable materials encountered at foundation level have been removed, treated and placed back as compacted fill if suitable or and replaced by suitable overburden materials. • Where localised sustained moisture seepage / inflow is noted within the foundation, free draining material (road base or similar) should be utilised to construct a rubble drain.	Quarry Foreman
2	Surface water management during construction	Visual inspection & during construction	• Temporary drainage system intercepting and diverting water away from the stockpile construction. • All drainage systems shall be constructed as per the relevant surface drainage design. • Free from depressions capable of retaining water. • No overtopping of the swale drain, outside of the Work Authority boundary.	Quarry Foreman
4	Integrity of construction	Visual inspection	• The area outside the limits of the construction (i.e. within Work Authority boundary) was not unduly disturbed. • Any unstable or unsafe batters have been inspected and assessed and any recommendations by the Quarry Manager, implemented.	Quarry Foreman Quarry Manager
5	Test roll final foundation level (subgrade) upon which fills are to be constructed	Visual inspection Proof roll	• Test roll via suitable earthworks mobile plant, achieved the following criteria: – No visually observable additional settlement on final pass of suitable plant, with number of passes limited to no more than two.	Quarry Foreman
6	Identify and treat suitable / unsuitable material at foundation level	Visual inspection	• Excavated / trimmed foundation surface is dry, competent and is suitable for operation of construction plant and placement / adequate compaction of fill. • All unsuitable materials encountered at foundation level have been removed, treated and placed back as compacted fill if suitable or and replaced by suitable overburden materials .	Quarry Foreman

Table 16 Fill Placement

No	Activity	Test & Frequency	Acceptance Criteria	Inspection & Responsibility
1	Fill placement	Visual inspection Survey	• Material spread and compacted in horizontal layers, not exceeding 0.5 m maximum (compacted) thickness using suitable construction methodology (e.g. truck and shovel).	Quarry Foreman
2	Fill compaction	Visual inspection	• Material compacted in horizontal layers, not exceeding 0.5 m maximum (compacted) thickness using suitable construction methodology (e.g. truck and shovel). • Traversing the area with fully laden haul trucks to help achieve material compaction. • Minimum compaction to 92% of maximum dry density • Supervised by Quarry Foreman or suitably qualified personnel	Quarry Foreman
3	Compaction Testing	1 test pit per lift Compaction test at surface and bottom 300 mm of layer	• Test pits excavated to allow compaction (HILF) testing • Compaction acceptance criteria achieved: o ≥92% of maximum dry density, based on average value per compacted layer	
4	Integrity of construction	Visual inspection	• The area outside the limits of the construction (i.e. Work Authority boundary) was not unduly disturbed • Any unstable or unsafe batters have been inspected and assessed and any recommendations are implemented	Quarry Manager
5	Surface water management during construction	Visual inspection & during construction	• Temporary drainage system intercepting and diverting water away from the stockpile construction. • All drainage systems shall be constructed as per the relevant surface drainage design. • Free from depressions capable of retaining water. • No overtopping of the swale drain, outside of the Work Authority boundary.	Quarry Foreman

Table 17 Drainage System

No	Activity	Test & Frequency	Acceptance Criteria	Inspection & Responsibility
1	Inspect location of drainage to determine/verify location and extent of drainage system	Visual inspection Survey	• Key components of the existing drainage system verified, any variations noted • Proposed drainage systems inspected and site suitability verified • Any amendments to the locations and alignments of the final drainage system made to plans prior to commencement of construction	Quarry Foreman / Quarry Manager

6. References

A.S. James (2013). *Infrastructure and Access Road Proposed Sand Mine 1381-1395 Bass Highway Grantville*, reference: 115134, dated 4 July 2013.

ATC Williams (2014). *Geotechnical Investigation of Earthworks Construction Materials and Embankment Foundations*, reference: 113189.01R01, dated 31 January 2014.

ATC Williams (2014). *Geotechnical Investigation for Sound Walls and Weigh Bridge Building*, reference 113189.02R01, dated 5 May 2014.

Australian Standards: AS/NZS: ISO 31000: 2009 Risk management – Principles and guidelines.

BCMWRPRC (1991). *Investigation and Design Manual – Interim Guidelines*. Mine Rock and Overburden Piles 1. Prepared by Piteau Associates Engineering Ltd, May 1991.

Casangrande, A. (1948). *Classification and identification of soils*. Transactions, ASCE, vol. 113, 901-930.

GHD (2018). *Grantville Quarry Site Work Authority 1488 – Interpretation of Laboratory Test Results and Derivation of Geotechnical Parameters*, reference: 3136345-36363, dated 10 August 2018.

Hawley, M., Cunning, J. (2017). *Guidelines for Mine Waste Dump and Stockpile Design*, CSIRO Publishing, Clayton South, Victoria, Australia and CRC Press/Balkema, Netherlands.

Leonard, M., Burbridge, D., Edwards, M. (2013). *Atlas of seismic hazard maps of Australia: seismic hazard maps, hazard curves and hazard spectra.* Record 2013/41. Geoscience Australia: Canberra.

Read. J., Stacey, P. (2009). *Guidelines for Open Pit Slope Design*. CSIRO Publishing, Melbourne and CRC Press/Balkema, Rotterdam.

VandenBerg, AHM (2016). *Depositional Facies and Extent of the Late Neogene Sandringham Sandstone In Southern Victoria, Australia*. CSIRO Publishing www.publish.csiro.au/journals/rs The Royal Society of Victoria, 128, 7-24, 2016 10.1071/RS16009.

Water Technology (2019). *Surface Water and Drainage for Enlarged Overburden Stockpile*. Reference: 5631_Grantville_LetterV02, dated 10 April 2019.

Welsh, S.I., Higgins, D.V., Callaway, G.A. (2011). *Surface Geology of Victoria*. Geological Survey of Victoria, Department of Primary Industries.

Appendices

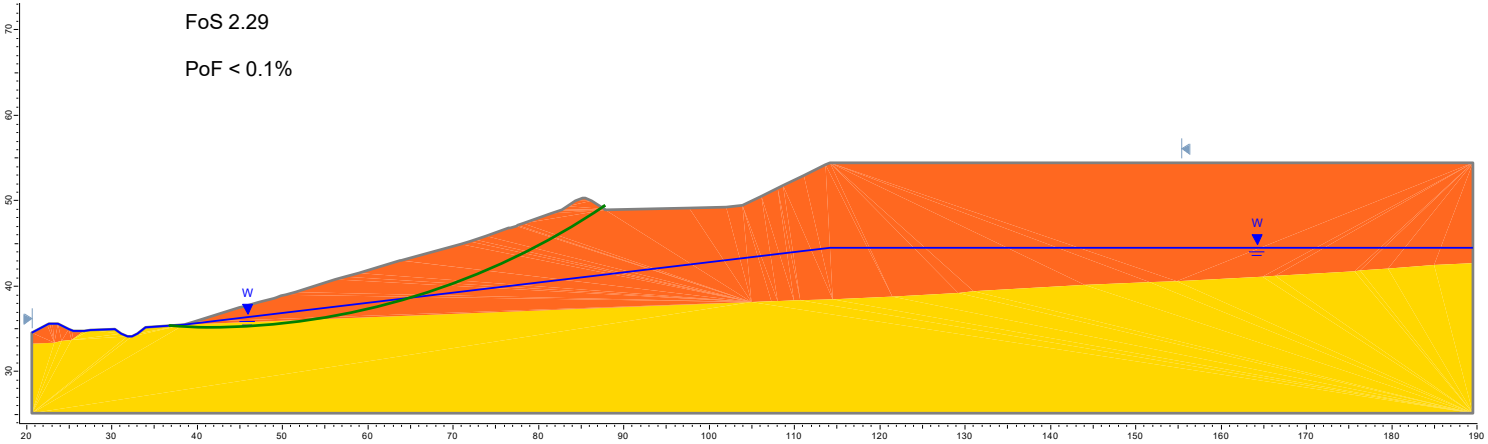
Appendix A - (Slide Model Outputs)

Section A-A Stability Outputs

Sec A – Base Case

FoS 2.29

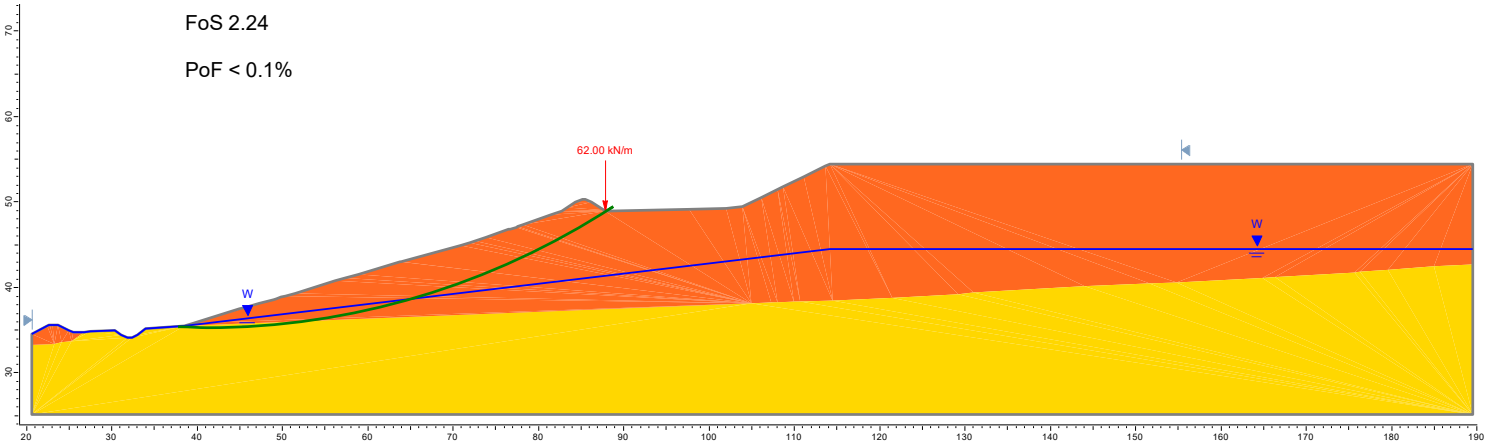
PoF < 0.1%



Sec A – Left Pass

FoS 2.24

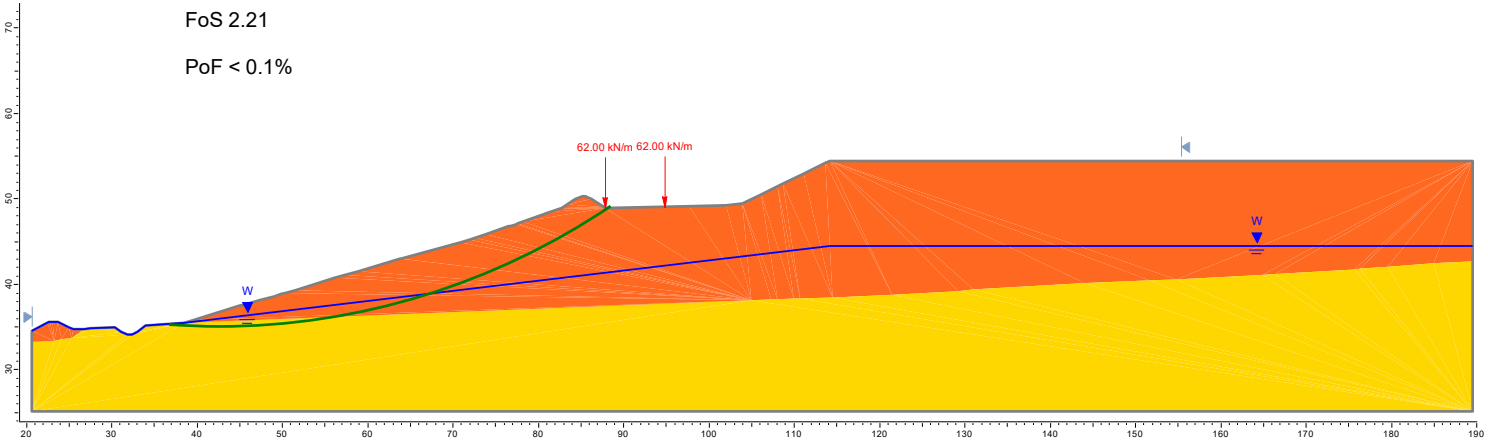
PoF < 0.1%



Sec A-A – Dual Pass

FoS 2.21

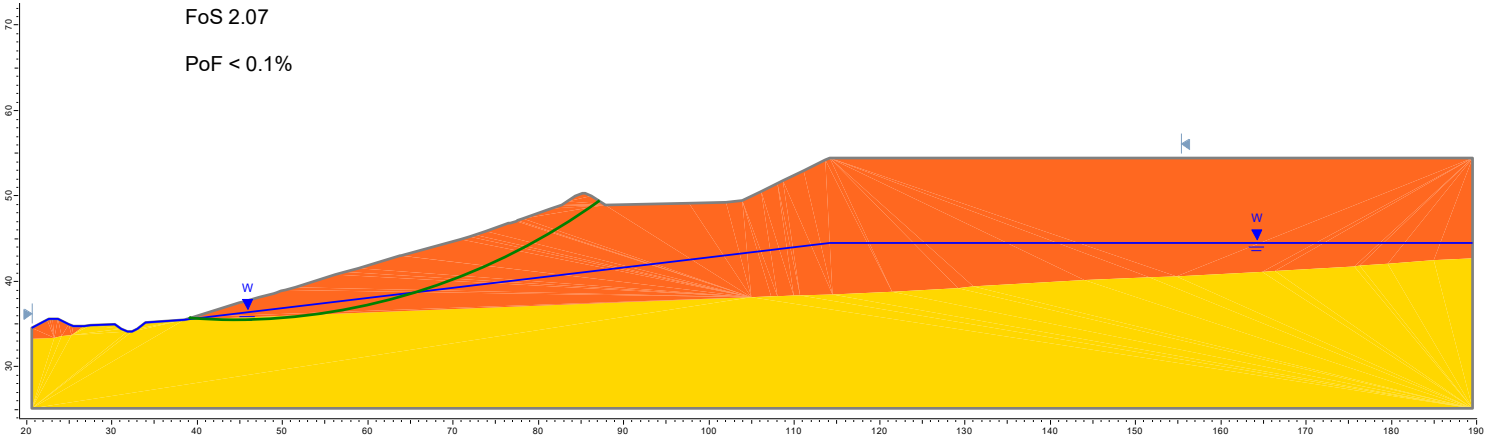
PoF < 0.1%



Sec A-A – Seismic

FoS 2.07

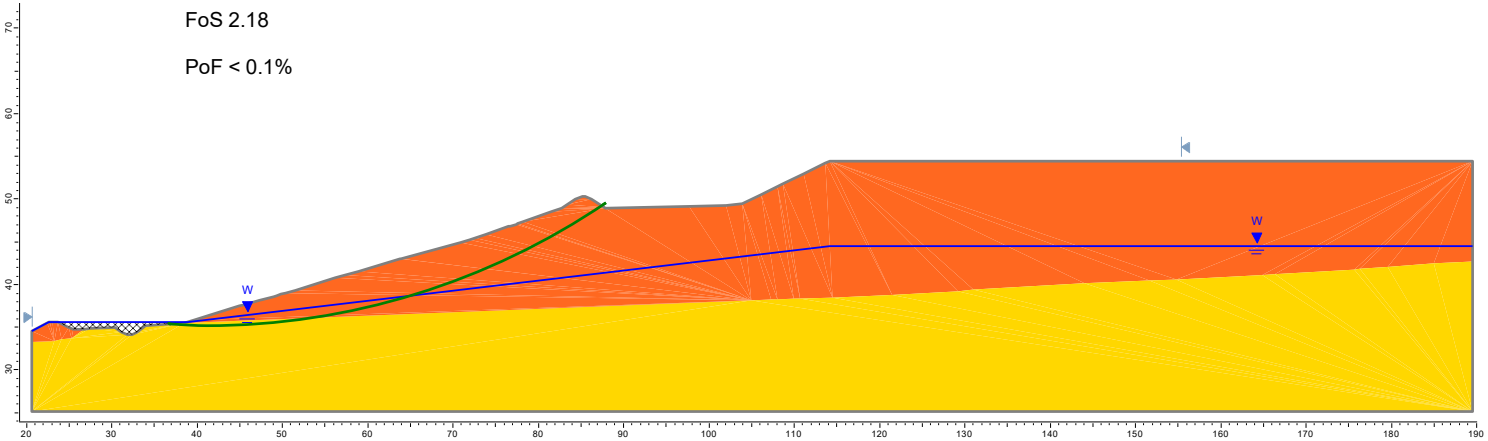
PoF < 0.1%



Sec A-A – Flood of Swale Drain

FoS 2.18

PoF < 0.1%

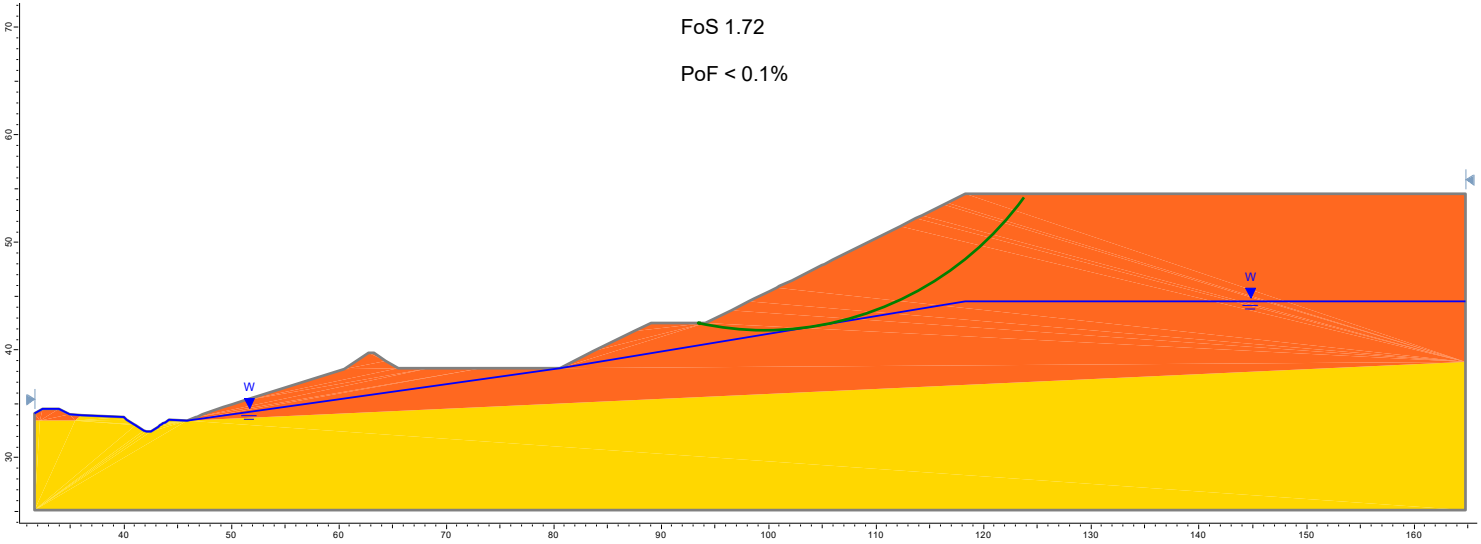


Section B-B Stability Outputs

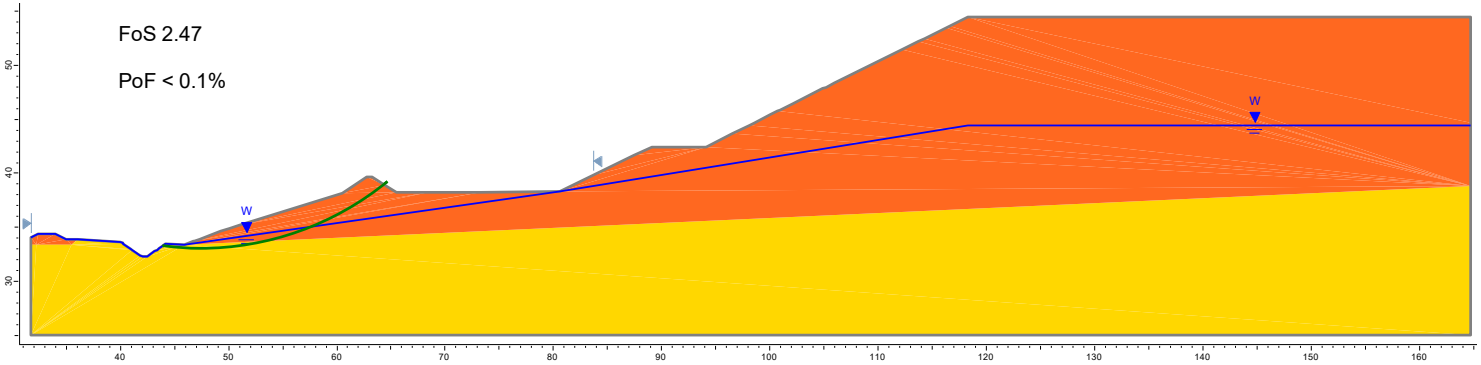
Sec B-B – Base Case: Upper Slope

FoS 1.72

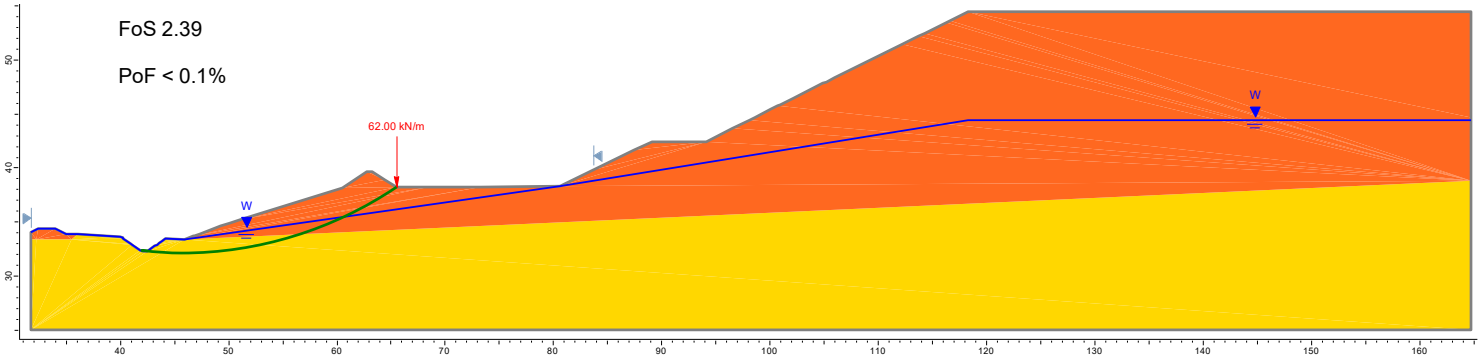
PoF < 0.1%



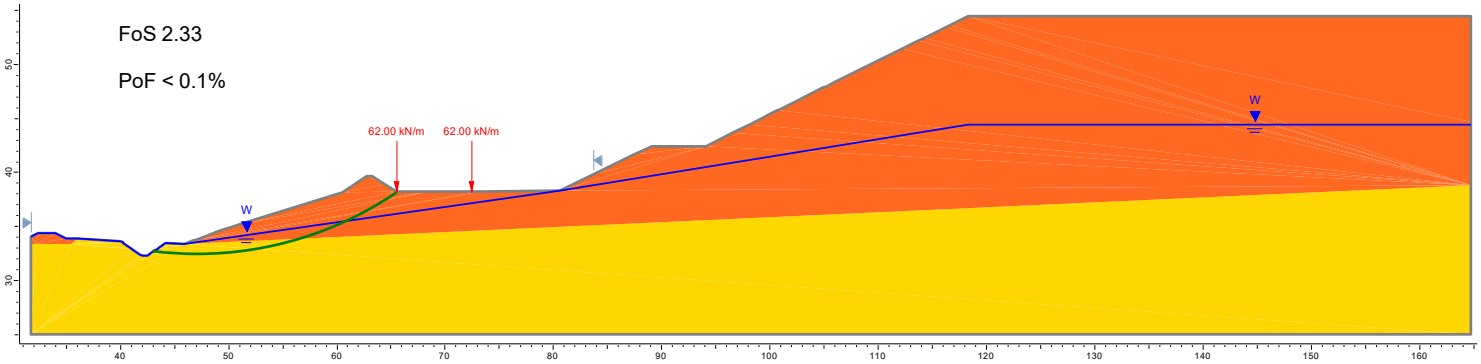
Sec B-B – Base Case: Lower Slope



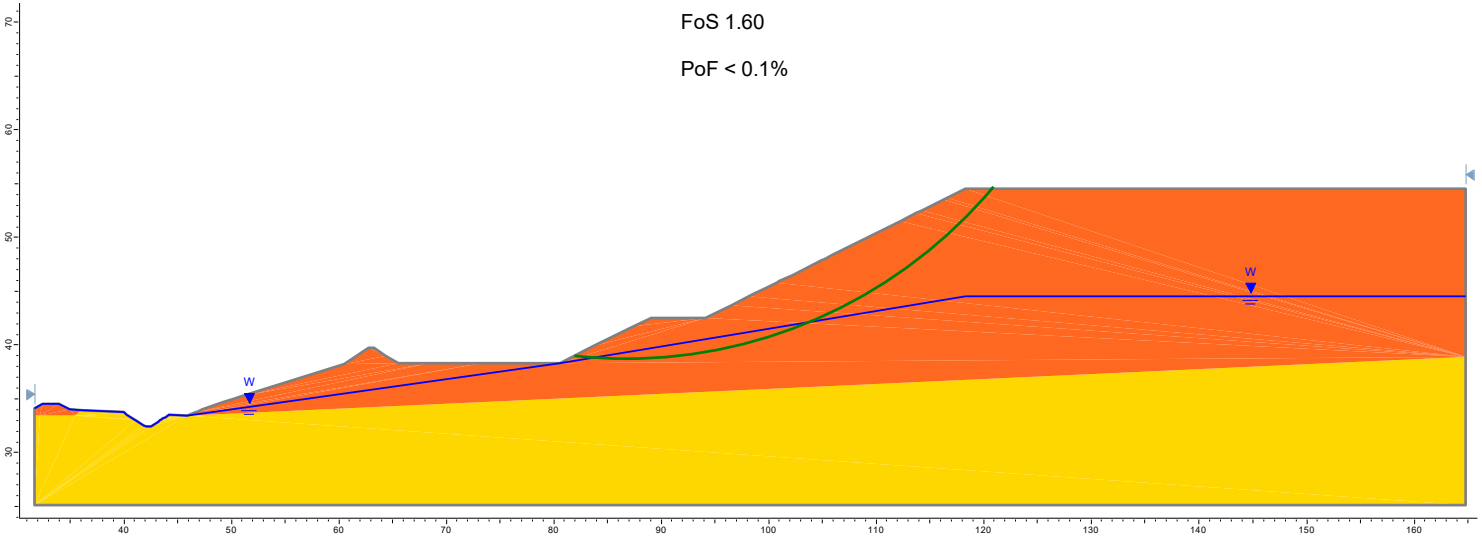
Sec B-B – Left Pass



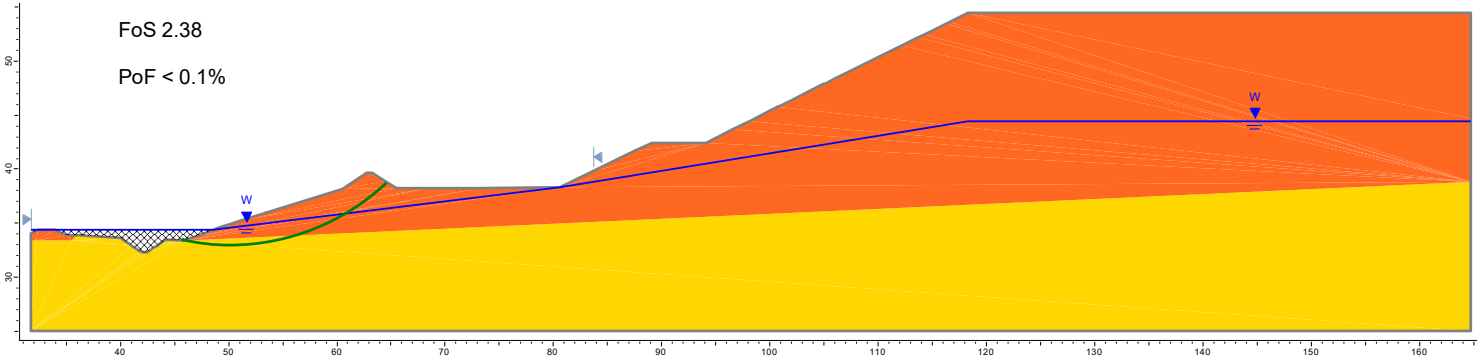
Sec B-B – Dual Pass



Sec B-B – Seismic



Sec B-B – Flood of Swale Drain



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Document Status

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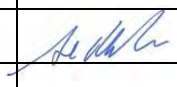
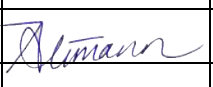
0	N Patel S Narendranathan	S Kacavenda		J Altmann		17/12/2019

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