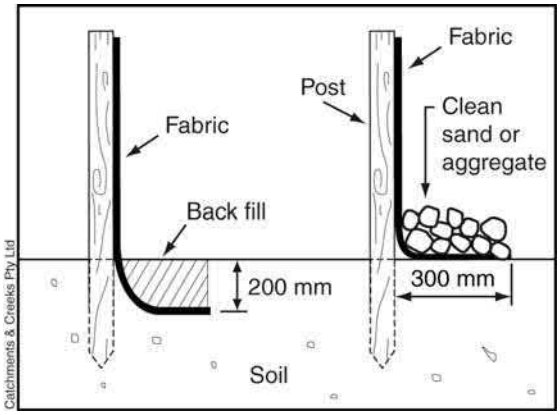


Figure 8 – Anchoring the fabric

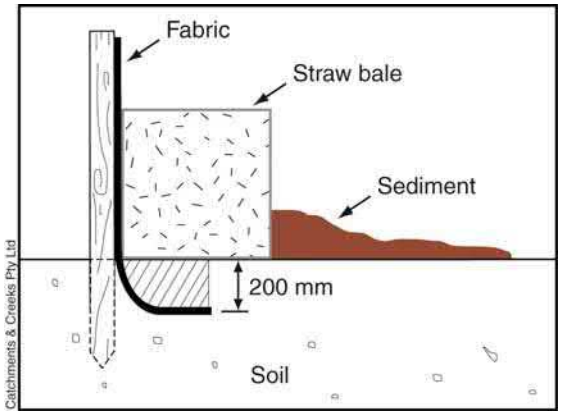


Figure 9 – Use of straw bales as a fabric-sediment separator

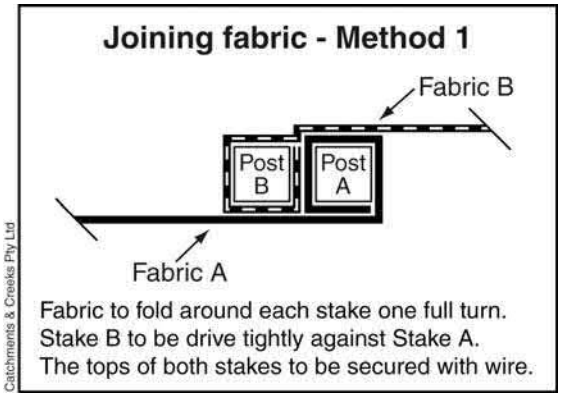


Figure 10 – Joining fabric (Option 1)

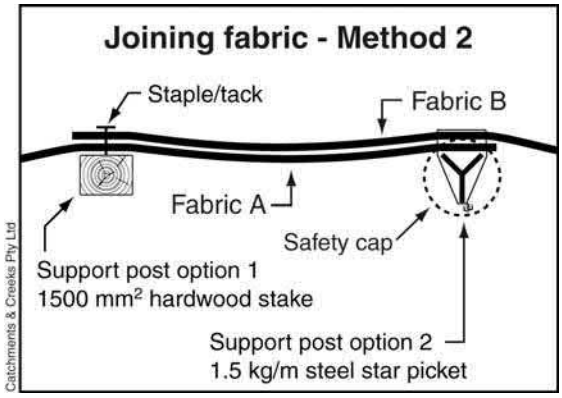


Figure 11 – Overlapping fabric (Option 2)

Photo 9 – Sediment fence placed along the contour

Photo 10 – Use of fence 'returns'

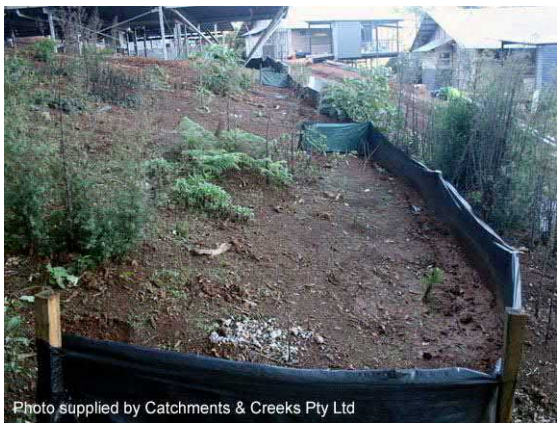


Photo 11 – Placement of fence off the contour with regular fence 'returns'

Photo 12 – Alternative design of a fence 'return'

Photo 13 – Trenching the fabric

Photo 14 – Inappropriate installation

Photo 15 – Bottom of fabric buried under aggregate

Photo 16 – Inappropriate use of sand to bury the fabric

Photo 17 – Straw bales placed up-slope of fence to separate sediment and fabric

Photo 18 – Inappropriate installation of the posts up-slope of the fabric

Photo 19 – Inappropriate junction

Photo 20 – Gaps in fence are not allowed

Photo 21 – Installation without backing weir/mesh

Photo 22 – Installation with top wire support

Photo 23 – Installation with weir mesh

Photo 24 – Installation using fence support

Photo 25 – Installation with safety fencing used as support

Photo 26 – A sediment fence braced for possible high flows

Photo 27 – Example of tacking

Photo 28 – Safety cap on a steel stake

Photo 29 – Flow diversion by fence

Photo 30 – No end return

Photo 31 – Damage by shifting fill

Photo 32 – Fence placed too close to fill

Photo 33 – Evidence of hydraulic wash-out under fence caused by poor trenching

Photo 34 – Sediment not removed after storm

Photo 35 – Flow allowed to bypass the fence

Photo 36 – Spill-through weirs must not discharge onto unstable land

(d) Use of spill-through weirs

Where appropriate, spill-through weirs can be installed into the fence to reduce hydraulic pressure and reduce the risk of hydraulic failure.

The required width (W) of the spill-through weir depends on the nominated design flow rate. The weir flow equation for a rectangular spill-through weir is provided below as Equation 2, as well as tabulated in Table 7.

$$Q = 1.7\ W\ H^{3/2} \qquad \text{(Eqn 2)}$$

where: Q = Design flow rate (usually 0.5 times the 1 in 1 year ARI peak discharge) [m^3/s]
W = Weir width [m]
H = Hydraulic head = height of upstream water level above weir crest [m]

Table 7 – Flow rates passing over a spill-through weir (m^3/s)

Hydraulic head, H (m)	Spill-through weir width, W (m)									
	0.3	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**
0.10	0.016	0.027	0.054	0.081	0.108	0.134	0.161	0.188	0.215	0.242
0.15	0.030	0.049	0.099	0.148	0.198	0.247	0.296	0.346	0.395	0.444
0.20	0.046	0.076	0.152	0.228	0.304	0.380	0.456	0.532	0.608	0.684
0.25	0.064	0.106	0.213	0.319	0.425	0.531	0.638	0.744	0.850	0.956
0.30	0.084	0.140	0.279	0.419	0.559	0.698	0.838	0.978	1.12	1.26
0.35	0.106	0.176	0.352	0.528	0.704	0.880	1.06	1.23	1.41	1.58
0.40	0.129	0.215	0.430	0.645	0.860	1.08	1.29	1.51	1.72	1.94

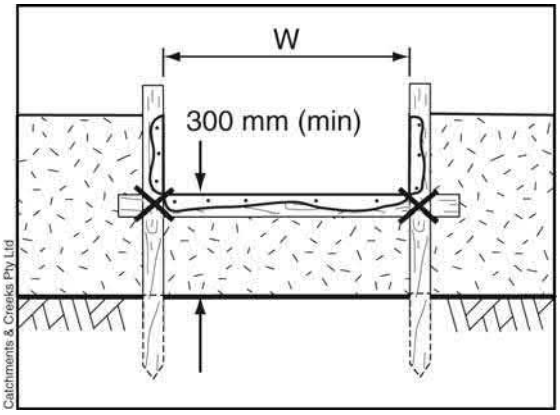


Figure 12 – Spill-through weir profile

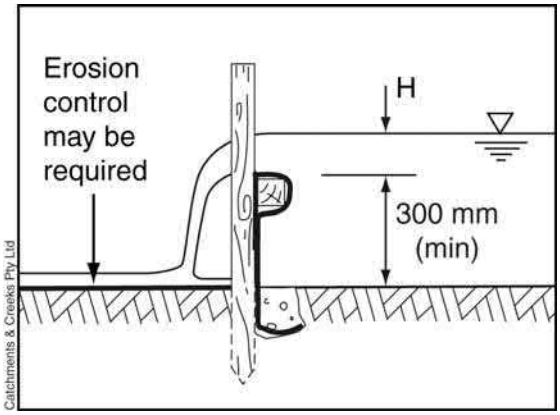


Figure 13 – Side profile of a spill-through weir

Photo 37 – Spill-through weir (down-slope side) with rock splash pad

Photo 38 – Spill-through weir with outlet chute

Photo 39 – Spill-through weir with up-slope aggregate filter

Photo 40 – Inappropriate placement of fence and installation of spill-through weir

If large sediment flows are expected, then a *Coarse Sediment Trap* can be used as an outlet structure for a sediment fence as shown in Figure 14. However, in most circumstances, a more elaborate outlet system would be required such as a Type 1 or Type 2 sediment trap.

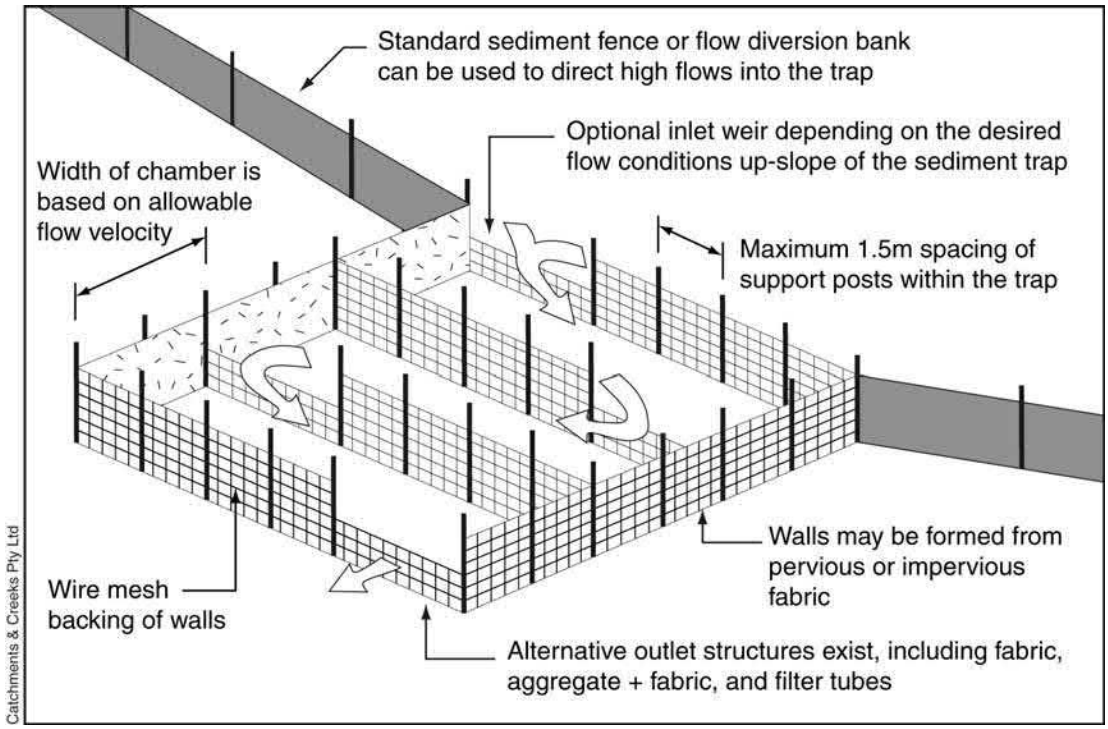


Figure 14 – Coarse sediment trap outlet structure

Description

A sediment fence consists of specially manufactured woven fabric attached to support posts. The typical height of the fence is around 600 to 700mm.

Most sediment fences are self-supporting; however, in appropriate circumstances the fence may be attached to an existing porous structure such as a property fence.

The fabric may be manufactured from either woven fabric, or a composite of woven and non-woven fabrics. The incorporation of a woven fabric is essential for the control of water flow needed to allow adequate temporary ponding up-slope of the fence.

Purpose

Used as a Type 3 sediment trap on small catchments, or as a supplement to Type 1 or 2 sediment traps on large catchments.

Limitations

Though often referred to as a 'silt fence', these Type 3 sediment traps have little impact on fine silts (< 0.02mm).

A sediment fence in its standard installation is only suitable for the treatment of 'sheet' flows. If concentrated flow exist, such as in a minor drain, then a *U-Shaped Sediment Trap*, or other more appropriate sediment trap should be used.

Most fabrics have an effective service life of around 6 months (check with manufacturer or distributor).

Advantages

Reasonably easy to install.

Has the ability to control sediment runoff close to the source of the erosion.

Disadvantages

Time-consuming to install, which often results in poor installation.

Easily damaged by construction equipment and shifting earth (Photos 31 & 32).

Can cause the concentration of stormwater runoff if poorly located, or installed.

Sediment fences are one of the most missed used sediment control devices, usually because they are either not installed in appropriate locations, or are installed in a manner that does not allow adequately water ponding up-slope of the fences.

Common Problems

If not installed along the contour, a sediment fence can result in flows being deflected along the fence (Photo 29).

If the ends of the fence are not turned up the slope, water and sediment can pass around the end of the fence (Photo 30).

If gaps exist in the fence (Photos 19 & 20), then water is prevented from ponding up-slope of the fence, thus sedimentation does not occur.

Excessive spacing between support posts is a common problem. In extreme cases this can result in the fabric sagging close to the ground.

Fabric not adequately connected to the support posts or backing wire.

The bottom of the fabric not adequately buried into the ground or under a suitable layer of sand or aggregate. If such fences are subjected to significant storms, the bottom of the fence can 'blow-out' causing erosion down-slope of the fence (Photo 33).

Spill-through weirs may not have been installed in large catchments or areas of high rainfall, thus increasing the risk of flow damage to the fence.

Crest of spill-through weir set too close to the ground (should be at least 300mm above ground level).

Crest of spill-through weir is set above the ground level at the ends of the fence, thus allowing flow bypassing rather than discharge over the weir (Photo 40).

Special Requirements

Woven fabrics are generally preferred on large sites when the service life is expected to extend over several storm events. Composite fabrics are generally preferred on small soil disturbances such a building sites, or when the sediment fence is the last line of defence prior to the runoff entering a water body.

Ideally, the sediment fence should be installed along the contour, thus maintaining sheet flow conditions across fence. If located across the contour, the fence should be installed with regular 'returns' to avoid water concentrating along the fence.

At least 300mm of fabric must be buried in either a 200mm trench, or under a continuous, 100mm high layer of sand or aggregate, but not earth.

Straw bales can be placed up-slope of the fence to retain bulk sediment away from the fabric, thus improving the ease of sediment removal. Alternatively, a small trench can be formed along the contour, up-slope of the fence. However, in all cases the aim should be to minimise high sediment flows so that such fence modifications become the exception, not the rule!

Where appropriate, spill-through weirs can be installed into the fence to reduce hydraulic pressure and reduce the risk of hydraulic failure.

Location

Install along the contour wherever possible.

Allow at least 4.5m between the fence and single-story buildings; 7.5m between the fence and multiple-story buildings; and at least 2m between the fence and the toe of a fill slope or stockpile.

Site Inspection

Ensure the sediment fence will adequately pond water up-slope of the fence.

Ensure the fabric is adequately buried.

Check the spacing of support posts/stakes.

Check for excessive sediment deposition.

Investigate the source of excessive sediment deposits.

Ensure the selection of appropriate fabric (i.e. woven or composite).

Check for damage to the fabric.

Check for erosion down-slope of any spill-through weirs.

Ensure the fence is not concentrating or diverting flows in an undesirable manner.

Materials

- Fabric: polypropylene, polyamide, nylon, polyester, or polyethylene woven or non-woven fabric, at least 700mm in width and a minimum unit weight of 140GSM. All fabrics to contain ultraviolet inhibitors and stabilisers to provide a minimum of 6 months of useable construction life (ultraviolet stability exceeding 70%).
- Fabric reinforcement: wire or steel mesh minimum 14-gauge with a maximum mesh spacing of 200mm.
- Support posts/stakes: 1500mm^2 (min) hardwood, 2500mm^2 (min) softwood, or 1.5kg/m (min) steel star pickets suitable for attaching fabric.

Installation

1. Refer to approved plans for location, extent, and required type of fabric (if specified). If there are questions or problems with the location, extent, fabric type, or method of installation contact the engineer or responsible on-site officer for assistance.
2. To the maximum degree practical, and where the plans allow, ensure the fence is located:
   (i) totally within the property boundaries;
   (ii) along a line of constant elevation wherever practical;
   (iii) at least 2m from the toe of any filling operations that may result in shifting soil/fill damaging the fence.
3. Install returns within the fence at maximum 20m intervals if the fence is installed along the contour, or 5 to 10m maximum spacing (depending on slope) if the fence is installed at an angle to the contour. The 'returns' shall consist of either:
   (i) V-shaped section extending at least 1.5m up the slope; or
   (ii) sandbag or rock/aggregate check dam a minimum 1/3 and maximum 1/2 fence height, and extending at least 1.5m up the slope.
4. Ensure the extreme ends of the fence are turned up the slope at least 1.5m, or as necessary, to minimise water bypassing around the fence.
5. Ensure the sediment fence is installed in a manner that avoids the concentration of flow along the fence, and the undesirable discharge of water around the ends of the fence.
6. If the sediment fence is to be installed along the edge of existing trees, ensure care is taken to protect the trees and their root systems during installation of the fence. Do not attach the fabric to the trees.
7. Unless directed by the site supervisor or the approved plans, excavate a 200mm wide by 200mm deep trench along the proposed fence line, placing the excavated material on the up-slope side of the trench.

8. Along the lower side of the trench, appropriately secure the stakes into the ground spaced no greater than 3m if supported by a top support wire or weir mesh backing, otherwise no greater than 2m.
9. If specified, securely attach the support wire or mesh to the up-slope side of the stakes with the mesh extending at least 200mm into the excavated trench. Ensure the mesh and fabric is attached to the up-slope side of the stakes even when directing a fence around a corner or sharp change-of-direction.
10. Wherever possible, construct the sediment fence from a continuous roll of fabric. To join fabric either:
    (i) attach each end to two overlapping stakes with the fabric folding around the associated stake one turn, and with the two stakes tied together with wire (Method 1); or
    (ii) overlap the fabric to the next adjacent support post (Method 2).
11. Securely attach the fabric to the support posts using 25 x 12.5mm staples, or tie wire at maximum 150mm spacing.
12. Securely attach the fabric to the support wire/mesh (if any) at a maximum spacing of 1m.
13. Ensure the completed sediment fence is at least 450mm, but not more than 700mm high. If a spill-though weir is installed, ensure the crest of the weir is at least 300mm above ground level.
14. Backfill the trench and tamp the fill to firmly anchor the bottom of the fabric and mesh to prevent water from flowing under the fence.
15. If it is not possible to anchor the fabric in an excavated trench, then use a continuous layer of sand or aggregate to hold the fabric firmly on the ground.

Additional requirements for the installation of a spill-through weir

1. Locate the spill-through weir such that the weir crest will be lower than the ground level at each end of the fence.
2. Ensure the crest of the spill-through weir is at least 300mm the ground elevation.
3. Securely tie a horizontal cross member (weir) to the support posts/stakes each side of the weir. Cut the fabric down the side of each post and fold the fabric over the cross member and appropriately secure the fabric.
4. Install a suitable splash pad and/or chute immediately down-slope of the spill-through weir to control soil erosion and appropriately discharge the concentrated flow passing over the weir.

Maintenance

1. Inspect the sediment fence at least weekly and after any significant rain. Make necessary repairs immediately.
2. Repair any torn sections with a continuous piece of fabric from post to post.
3. When making repairs, always restore the system to its original configuration unless an amended layout is required or specified.
4. If the fence is sagging between stakes, install additional support posts.
5. Remove accumulated sediment if the sediment deposit exceeds a depth of 1/3 the height of the fence.
6. Dispose of sediment in a suitable manner that will not cause an erosion or pollution hazard.
7. Replace the fabric if the service life of the existing fabric exceeds 6-months.

Removal

1. When disturbed areas up-slope of the sediment fence are sufficiently stabilised to restrain erosion, the fence must be removed.
2. Remove materials and collected sediment and dispose of in a suitable manner that will not cause an erosion or pollution hazard.
3. Rehabilitate/revegetate the disturbed ground as necessary to minimise the erosion hazard.

Temporary Watercourse Crossing: Culverts

DRAINAGE CONTROL TECHNIQUE

Low Gradient		Velocity Control		Short Term	✓
Steep Gradient		Channel Lining		Medium-Long Term	
Outlet Control		Soil Treatment		Permanent	

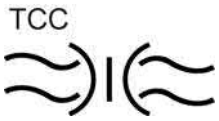
Symbol 

Photo 1 – Temporary culvert formed from recycled steel pipes

Photo 2 – Temporary crossing of minor drainage channel

Key Principles

1. Significant bank damage can occur during the installation and removal of these temporary watercourse crossings; therefore, extreme care must to be taken to minimise such damage.
2. It is important to minimise the risk of sediment-laden runoff from the approach roads being allowed to discharge directly into the watercourse without passing through an appropriate sediment trap or vegetative filter.
3. Critical design parameters are the flood immunity of the road surface and the structural integrity of the culverts during flood flows.
4. Critical operational issue is the minimisation of harm to the watercourse, including any sediment releases.

Design Information

The material contained within this fact sheet has been supplied for use by persons experienced in hydraulic engineering.

Temporary culvert crossing require both structural and hydraulic design. Their design requires input from both structural and hydraulic specialists.

Design parameters include expected traffic loads, required flood immunity, and expected hydraulic and debris loadings. The following information is supplied for general reference purposes only.

Culvert Structure:

Consideration should be given to the potential damage caused to the watercourse if the culverts wash away during a flood event. In critical locations it may be necessary to tether the pipes to the watercourse banks using cables or chains to prevent individual components of the culvert being washed down the watercourse during severe floods.

Sizing:

Where practicable, the hydraulic capacity of the culvert should be equivalent to the in-bank hydraulic capacity of the watercourse, or at least equal to the hydraulic capacity of the watercourse below the level of the road surface. The purpose of this requirement is to minimise the water level difference across the culvert at the point when the road surface is first overtopped. This reduces the risk of bank erosion caused when flood waters re-entering the downstream channel.

The culvert should consist of the largest diameter and greatest number of cells that will fit into the existing channel below the nominated road surface elevation.

The minimum recommended pipe size is 450mm.

The minimum recommended spacing between pipe cells is 300mm.

The culvert cells (pipes or box units) should extend at least 300mm beyond rock fill.

Discharge from the culvert should not cause excessive bed or bank erosion.

The recommended design standard for temporary culvert crossings is presented in Table 1.

Table 1 – Recommended design standard for temporary culverts [1]

Flow Conditions	Design Standard
Significant channel and/or overbank flood flows possible, but unlikely during life of structure	• Minimum 1 in 1 year design standard wherever reasonable and practicable. • Temporary crossing to be structurally sound during 1 in 1 year to 1 in 10 over-topping event depending on flood risk.
Significant channel and/or overbank flood flows likely (wet season)	• Minimum 1 in 2 year design standard wherever reasonable and practicable. • Temporary crossing designed to be structurally sound during a 1 in 10 year over-topping flood event.

[1] Design standard may be reduced in consultation with regulating authorities based on cost analysis, and waterway impact and risk assessment.

Unless otherwise supported by detailed hydraulic analysis, the head loss (ΔH) across a culvert at the point of flow overtopping should be limited to a maximum of 400mm.

The head loss 'H' (refer to Figure 1) across a culvert that is not being overtopped (i.e. all water is passing through culvert) can be approximated using the following formulas:

Concrete pipe/box culverts: $\Delta H \approx 1.7 (V^2/2g)$ (Eqn 1)

Steel pipe projecting from fill: $\Delta H \approx 2.0 (V^2/2g)$ (Eqn 2)

where:

ΔH = change in water level across the culvert [m]

V = average flow velocity through the culvert [m/s]

g = gravity [9.8m/s]

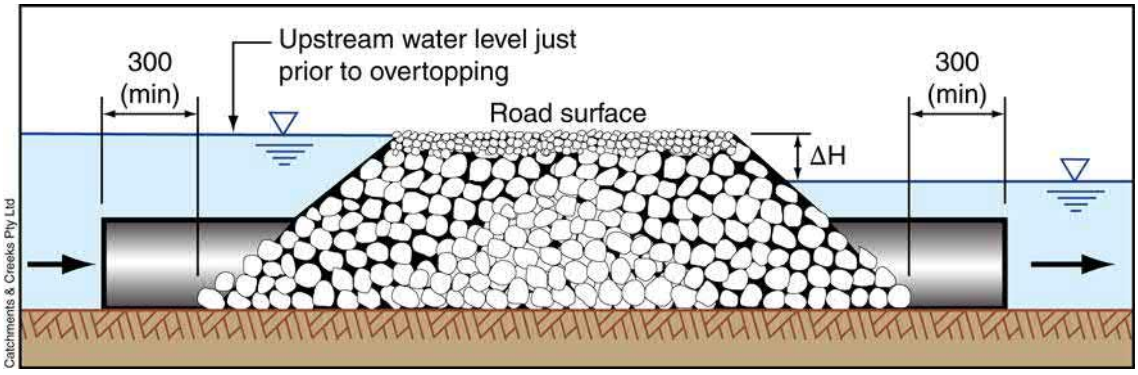


Figure 1 – Culvert hydraulics just prior to overtopping

Culvert pipes should be placed on a geotextile filter overlay covered with a bed of washed rock.

The pipes should be covered with a sufficient rock to prevent their damage by the expected road traffic—refer to manufacturer's specifications for the given pipe material.

The road surface is formed from a 150mm layer of 50 to 75mm washed aggregate.

Wherever practicable, the road surface over the pipes should be raised a minimum of 300mm above the adjoining floodplain elevation (Figure 2) to allow overtopping flows to initially pass around the structure. Such bypassing is not appropriate if the floodplain contains exposed, unstable soil.

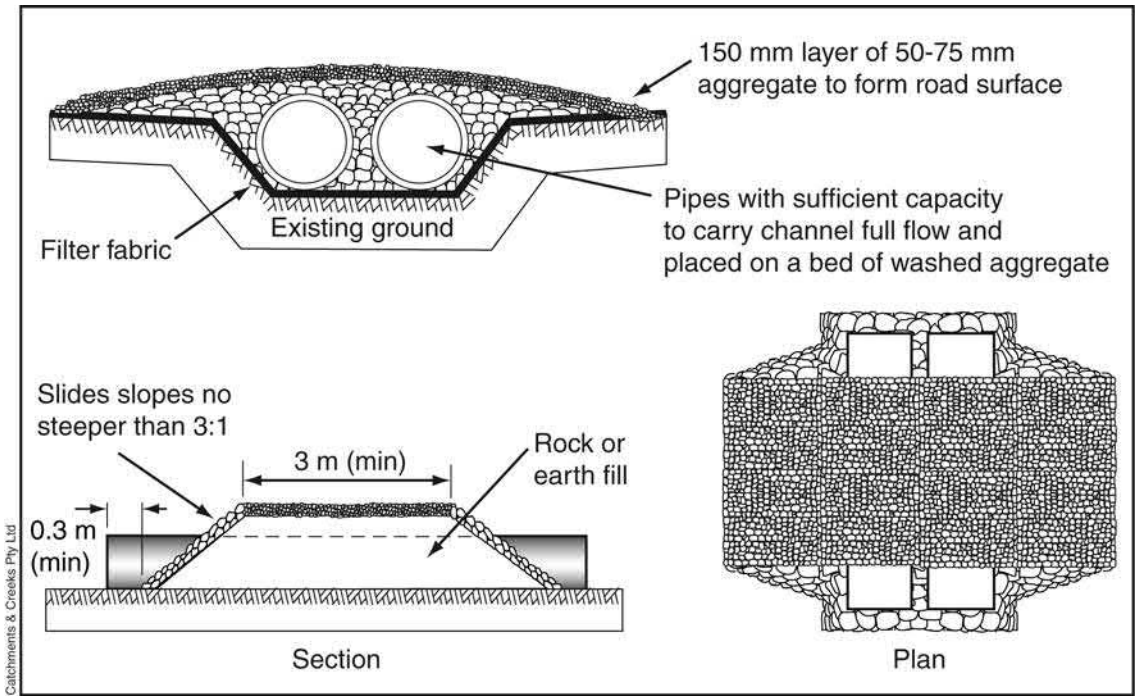


Figure 2 – Preferred arrangement of temporary culvert crossing in a minor stream with low-gradient overbank (floodplain) areas

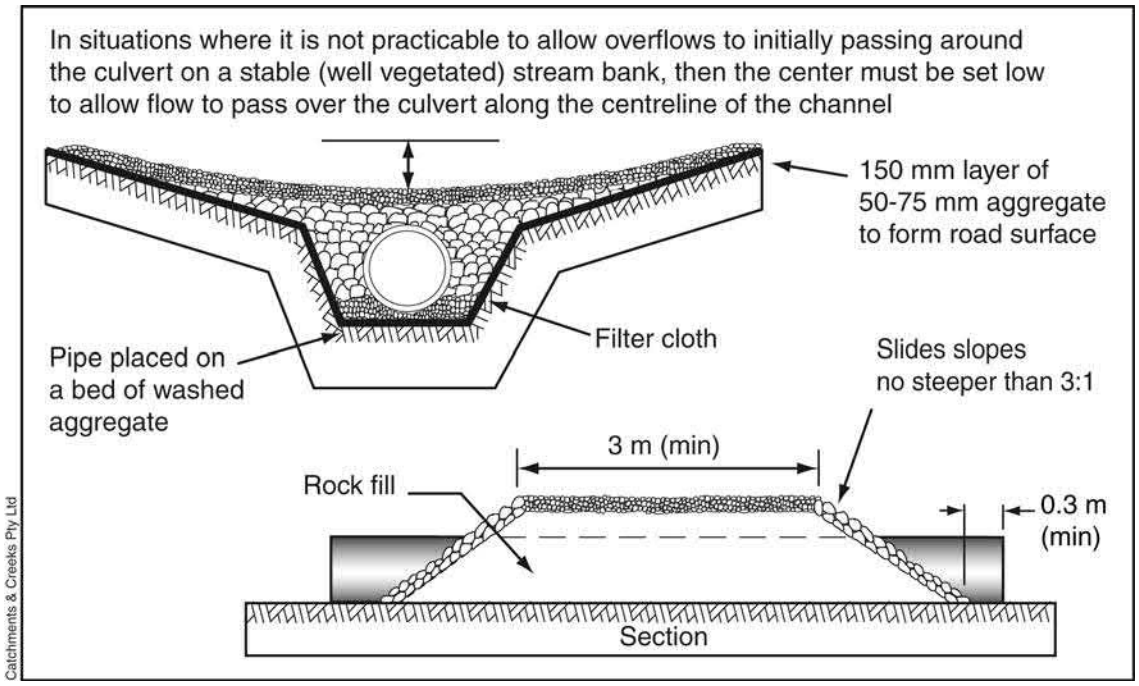


Figure 3 – Single cell culvert placed within a constricted channel with steep overbank slopes

The use of earth or soil as *fill material* placed within the waterway channel during construction of the temporary culvert crossing should be avoided wherever possible.

In wide riverbeds, the roadway embankment can be lowered below the channel banks (Figure 4) to reduce the hydraulic stress during initial overtopping of the culvert. This will reduce the required number of pipes.

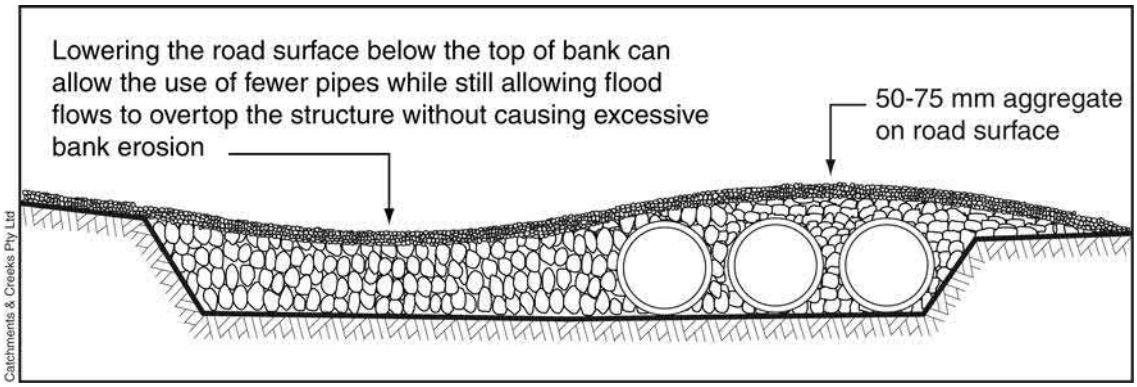


Figure 4 – Profile of temporary culvert crossing within a wide channel

On medium to high-speed roads, the access ramps usually need to be placed along a relatively straight alignment for safety reasons. In such cases, good vegetation coverage is highly desirable on the recessed banks to avoid erosion caused by turbulent eddies. Another benefit of this layout is that the recessed ramps help to create low velocity backwater areas that can be used by fish migrating upstream during flood events as resting areas.

If access ramps need to be cut into the channel banks (Figure 5), and these ramps cannot be cut perpendicular to the channel, then wherever practicable align the ramps such that they fall to the waterway in an upstream direction. The reason for this is to minimise bank erosion caused by eddies resulting from flood flows moving past access ramps that are cut into the channel banks. Pointing the ramps upstream will usually allow a gradual expansion of the stream flow followed by a sudden contraction of the flow at the ramp (which is the preferred hydraulic condition).

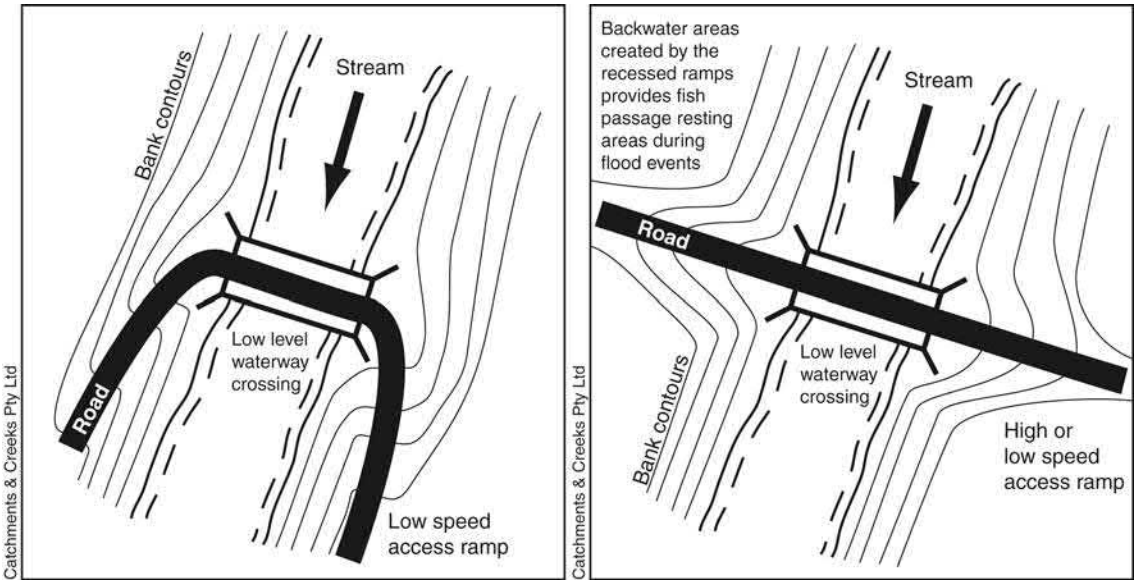


Figure 5 – Preferred alignment of access ramps

It is noted that if an access ramp's design results in a sudden expansion in the channel width, then eddies may form in the water during flood events and these eddies can then move downstream to locations where they can cause bank erosion. To avoid such erosion problems, sudden expansions in flow should be avoided.

Approach roads:

The approach roads should be stabilised (e.g. gravelled) and where practicable, should have appropriate flow diversions (Figure 6) installed to prevent sediment-laden runoff from the roads discharging untreated into the stream. Ideally the approach roads should be straight for at least 10m each side of the crossing, and should align perpendicular to waterway channel.

In locations where sediment-laden runoff from the approach ramps cannot be suitably treated to avoid harm to the watercourse, then these ramps should be stabilised (e.g. gravel, aggregate, or rock) depending of expected channel flow conditions.

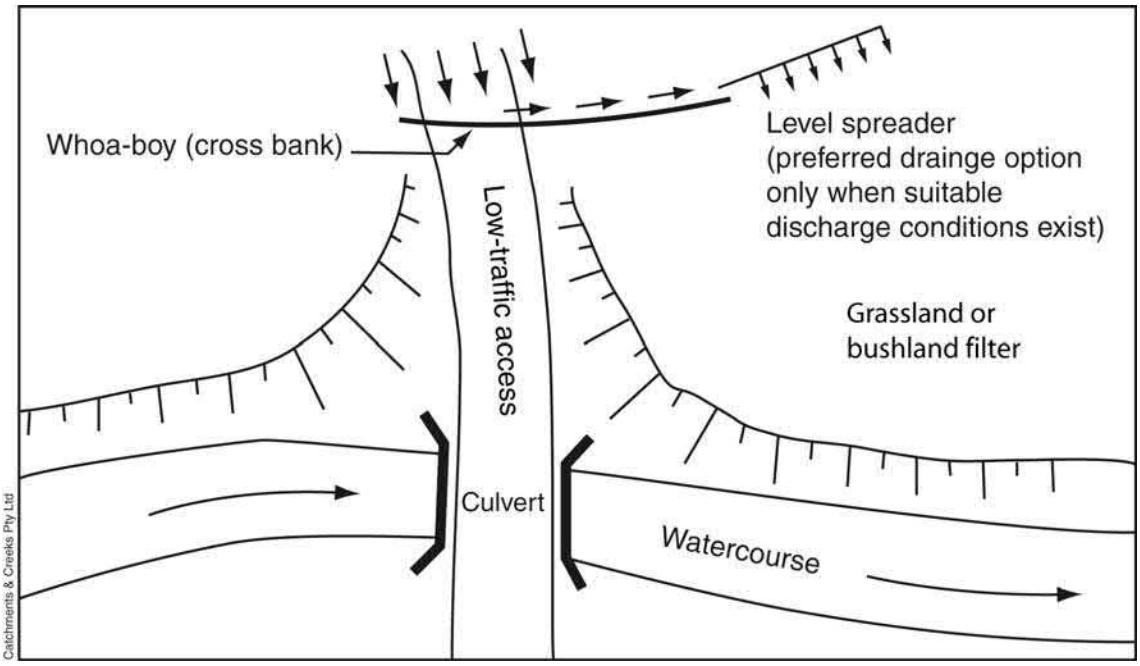


Figure 6 – Typical flow diversion placed on approach roads

Photo 3 – Using only fine aggregate to form the fill embankment can result in severe wash-outs if overtopped

Photo 4 – If the culvert has insufficient hydraulic capacity, then overtopping flows are likely to cause severe bank erosion

Legislative Requirements:

Legislative requirements, permits and approvals vary from state to state, and region to region. Typical permit and approval requirements include:

- Approval for works within a watercourse (typically a department of water resources or natural resources).
- Approval for disturbance to bed, banks, or riparian vegetation.
- Approval for importing materials into a watercourse to form the fill embankment.
- Approval for works that may interfere with fish passage (typically a fisheries authority).

Description

A temporary culvert crossing consists of one or more sections of pipe covered embedded in a suitable rock and aggregate embankment formed as a bridging structure across an open channel.

Temporary culvert crossings are commonly formed from recycled concrete or steep pipes.

Purpose

Used to provide dry weather access to a construction site, or to provide a traffic bypass route during construction of a permanent crossing.

The main purpose of these crossing is to minimise the risk of direct contamination of stream flow by construction traffic.

Limitations

These crossing are generally restricted to drainage channels and minor streams.

Temporary river crossing normally need a more substantial design, possibly involving a bridge structure. In northern Australia, temporary culvert crossings of wide riverbeds may be suitable during the dry season when high flows are most unlikely.

Advantages

A well-designed and operated culvert crossing can minimise sediment releases to streams during a variety of weather conditions.

Installation is often much quicker and cheaper than a temporary bridge crossing.

Culvert crossings have the potential to cause much less disturbance to the stream flow than a causeway or ford crossing.

Disadvantages

Significant damage can be done to the bed and banks of the watercourse during construction and removal of the culvert.

Most temporary culvert crossings will experience some degree of damage during flood events.

A culvert crossing is likely to have a greater adverse impact on fish passage compared to a temporary bridge crossing.

Unless appropriately designed, a culvert crossing can aggravate upstream flood levels, possibly causing damage to adjacent properties.

Temporary culvert crossings can increase the potential for bank erosion immediately adjacent to the crossing. Unfortunately, the use of extensive rock protection of the stream banks to avoid this problem will also increase the total area of bank disturbance.

Failure of a stream crossing or approach road can result in significant sediment loss.

Culvert crossings are highly susceptible to debris blockage.

Special Requirements

When the crossing is no longer required, all materials including pipes, rock, aggregate and filter cloth must be removed. Final clean up also includes restoration of the watercourse to its original condition and cross section.

Special attention will need to be paid to maintaining fish passage if the crossing is in place during a known fish migration period. Seek advice from local Fisheries officers.

Location

Ideally, temporary culvert crossings should be located on a straight section of a watercourse, well downstream of a sharp bend.

In any case, all crossings should be located in a position that will cause the least overall disturbance to the watercourse and associated riparian vegetation, especially to those areas that are required to remain in a ‘natural’ state.

Site Inspection

Temporary stream crossings should be inspected with great care because these structures can contribute to the discharge of sediment directly into a stream causing significant environmental harm. Such harm can occur during their construction, flood events, and during their decommissioning.

Check any overflow or bypass flow paths to make ensure the banks are stable.

Check for erosion cause by stormwater runoff passing down the approach roads.

Check for appropriate erosion controls and flow diversions on the approach roads.

Check for debris blockages.

Check the stability of the approach roads.

Materials

- Culverts: any commercial conduit that is suitable for the required traffic loading.
- Rock: minimum 150mm nominal rock size.
- Aggregate: 50–75mm clean aggregate.
- Geotextile fabric: heavy-duty, needle-punched, non-woven filter cloth (minimum 'bidim' A34 or equivalent).

Installation

1. Prior to commencing any works, obtain all necessary approvals and permits required to construct the temporary watercourse crossing, including permits for the disturbance of bank vegetation, aquatic vegetation (e.g. mangroves) and any temporary instream flow diversion barriers or sediment control measures.
2. Refer to approved plans for location and construction details. If there are questions or problems with the location or method of installation, contact the engineer or responsible on-site officer for assistance.
3. Ensure that the location of the crossing will not interfere with future construction works.
4. Prior to significant land clearing or construction of the approach ramps, establish all necessary sediment control measures and flow diversion works (instream and off-stream as required), clearing only those areas necessary for installation of these measures.
5. To the maximum degree practicable, construction activities and equipment must not operate within open flowing waters.
6. Maintain clearing and excavation of the watercourse bed and banks to a minimum. Initially clear only the area necessary to allow access for construction. Clear the remainder of the approach ramps only when adequate drainage and sediment controls are in place.
7. If flow diversion systems cannot be installed, then conduct bank excavations by pulling the soil away from the channel.
8. Where practicable, construct the watercourse crossing perpendicular to the channel.
9. Where practicable, the approach ramps should be straight for at least 10m and should be aligned with the crossing.
10. Where practicable, direct stormwater runoff from the approach ramps into stable drains, adjacent vegetation, or appropriate sediment traps to minimise the release of sediment into the watercourse.
11. Shape the channel, if necessary, to receive the pipe/s.
12. If highly erosive soils are detected, then appropriately stabilise such soils as soon as practicable.
13. Cover the crossing footing with heavy-duty filter cloth.
14. Cover the filter cloth with a minimum 150mm of clean, 50 to 75mm aggregate.
15. Place the specified size and number of culvert cells and align them with the direction of the downstream channel.
16. Ensure the pipes extend at least 300mm beyond the proposed extend of rock fill.
17. Fill between the pipe/s with 75 to 100mm aggregate.
18. Cover pipe/s with sufficient rock (minimum 300mm layer) to satisfy manufacturer's loading requirements to avoid damage to the pipe/s resulting from the expected traffic load. Slope of rock face upstream and downstream of the culvert no steeper than 3:1 (H:V).
19. Form the shape of the road surface in accordance with the plans and/or standard drawings.
20. Apply a suitable cover of aggregate over the rock fill to form the trafficable road surface.
21. Finish construction and stabilisation of the approach roads including the approach ramps each side of the bridge crossing.
22. Take all reasonable measures to prevent excess rock, debris and construction material from entering the watercourse, especially any still or flowing water.

23. If it is not practicable to stabilise the access ramps against erosion, then install flow diversion banks across the width of each access ramp adjacent the top of the channel bank, and at regular intervals down the ramps (as required) to prevent or minimise sediment-laden runoff flowing directly into the watercourse.
24. Appropriately stabilise any disturbed watercourse banks.
25. Stabilise all disturbed areas that are likely to be subjected to flowing water, including bypass and overflow areas, with rock or other suitable materials.

Maintenance

1. Temporary watercourse crossings should be inspected weekly and after any significant change in stream flow.
2. Debris trapped on or upstream of the crossing should be removed.
3. Repair any damage caused by construction traffic. If traffic has exposed bare soil, stabilised as appropriate. Maintain a minimum 200mm cover over the culverts.
4. Check for erosion of the formed embankment, channel scour, or rock displacement. Make all necessary repairs immediately.
5. Check the bypass floodway making sure the banks are stable.
6. Check for excessive erosion on the approach roads.
7. Check the conditions of any flow diversion channels/banks and the operating conditions of associated sediment traps.

Removal

1. Temporary watercourse crossings should be removed as soon as possible after alternative access is achieved or the culvert is no longer needed.
2. Remove all specified materials and dispose of in a suitable manner that will not cause an erosion or pollution hazard.
3. Restore the watercourse channel to its original cross-section, and smooth and appropriately stabilise and revegetate all disturbed areas.

Appendix G

Unexpected Contamination Protocol

200 Aldington Road Industrial Estate

Unexpected Contamination Procedure

Prepared for Fife Kemps Creek Trust
April 2022

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200 Aldington Road Industrial Estate

Unexpected Contamination Procedure

Report Number

E210906 RP#7

Client

Fife Kemps Creek Trust

Date

7 April 2022

Version

v1 Final

Prepared by	**Approved by**
	
Nena Lane-Kirwan	**David Bone**
Consultant	Associate Director
7 April 2022	7 April 2022

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1 Introduction

This Unexpected Contamination Procedure (UCP) has been prepared for implementation by Fife Kemps Creek Trust (FKC) (and its contractors) for the construction of Stage 1 of the 200 Aldington Road Industrial Estate (the Project). The Project is located in Kemps Creek, New South Wales 2178, within the Penrith Local Government Area (LGA).

The following documents have been reviewed and applicable information incorporated into this ASCHMP:

- Environmental Impact Statement (the EIS), prepared by Ethos Urban, dated 11 November 2020;
- SSDA 10479; and
- Contamination Status Summary Report, prepared by Douglas and Partners, dated 21 September 2021.

1.1 Project overview

1.1.1 Background / context

This UCP forms a Request for Additional Information for the proposed Concept State Significant Development Application for a new industrial estate on land 106 – 228 Aldington Road, Kemps Creek.

The EIS for the project was placed on public exhibition between 18 November 2020 and 15 December 2020. During this period, a total of 18 submissions were received. These submissions were addressed and subsequent amendments to the project were made, as outlined in the Response to Submissions Report (dated 23 March 2021) prepared by Ethos Urban.

In written correspondence dated 28 April 2021, it was requested that FKC provide a further response to additional commentary raised by DPE, as well as additional comments raised by public authorities in their review of the first Response to Submissions Report. This was responded to via a second a Response to Submissions Report outlined by Ethos Urban (dated 22 September 2021).

Additional correspondence was received from DPE dated 15 November 2021 which has necessitated updates and additional information, as contained within this report.

1.1.2 Summary of the project for which development consent is now sought

Consent is sought for the following development. It represents minor amendments and does not represent a significant material change to what was previously proposed under the second RTS Report (22 September 2021)

- A concept masterplan with an indicative total building area of 342,865 sqm, comprising:
  - 325,865 spm of warehouse gross floor area (GFA);
  - 17,010 sqm of ancillary office GFA;
  - 13 individual development lots for warehouse buildings with associated hardstand areas and two lots for water management infrastructure purposes (each including a bio retention basin);
  - Roads, including:
    - Internal road layouts;
    - Southern road connection to Aldington Road;

        - Northern boundary road (half road corridor) connecting to Aldington Road;
        - Road connections to adjoining landholdings to the north and east;
    - Provision for 1,516 car parking spaces; and
    - Associated concept site landscaping.
- Detailed consent for progressive delivery of site preparation, earthworks and infrastructure works (i.e., Stage 1 works) on the site, including:
    - Demolition and clearing of all existing built form structures;
    - Drainage and infill of existing farm dams and any ground dewatering;
    - Clearing of existing vegetation;
    - Subdivision of the site into 15 individual lots;
    - Construction of a warehouse building with a total of 50,300 sqm of GFA, including:
        - 47,800 sqm of warehouse GFA;2,500 sqm of ancillary office GFA; and
        - 221 car parking spaces.
    - Bulk earthworks including 'cut and fill' to create level development platforms for the warehouse buildings, and site stabilisation works (if required);
    - Roadworks and access infrastructure, including an interim access road and a temporary junction with Aldington Road;
    - Stormwater works including stormwater basins, diversion of stormwater;
    - Utilities services including sewer and potable water reticulation; and
    - Road and boundary retaining walls.

2 Conditions of approval

This UCP forms part of the Construction Environmental Management Plan (CEMP) and has been prepared in accordance with condition XX of the development consent for SSD 10479. The condition requirements and where they have been addressed in this report are summarised in Table 2.1.

Table 2.1 Conditions of Approval

Conditions of Approval (CoA)	Condition	Where addressed in

3 Site Assessments

3.1 Previous contamination studies

Four previous environmental investigations have been undertaken in relation to potential contamination at the existing project site:

- Preliminary Site Investigation for Contamination – 106-142 Aldington Road, Kemps Creek, dated 18 April 2019 (KPMG);
- Preliminary Site Investigation – Due Diligence – 144-228 Aldington Road, Kemps Creek, dated 11 October 2019 (Douglas Partners);
- Supplementary Contamination Investigation – 144-228 Aldington Road, Kemps Creek – dated 23 October 2019 (Douglas Partners); and
- Contamination Status Summary Report – 200 Aldington Road, Kemps Creek – dated September 2021 (Douglas Partners).

Both KPMG (2019) and Douglas Partners (2019) recognise the potential for moderate to high potential for this site to be contaminated; particularly from the previous and current activity surrounding the market gardens and their associated chemicals use.

Various heavy metals and one PAH's sample were identified in excess of the assessment criteria, as well as some samples shown to contain asbestos, likely attributed to both on site market gardens and demolition of former structures.

The Contamination Status Summary Report (DP 2021) detailed the seven AEC's that were identified in the PSI which were investigated and determined by DP to be possible to be remediated and made suitable for the proposed development

DP's Preliminary Geotechnical and Salinity Assessment identified the geotechnical and topographical landscape of the site. 50 salinity samples produced results that demonstrated that only one sample was highly saline and 80% of samples were slightly to not saline. The 19 test pits that were excavated provided a general lithology outlay of the site which was predominantly silty clay fill to approximately 1.4m followed by stiff and hard clays to approximately 3.3m and a bedrock and sandstone and shale.

3.2 Detailed Site Investigation – ADE Consulting Group 2022

A Detailed Site Investigation (DSI) was completed by ADE Consulting Group (ADE). The objective of the DSI was to determine the nature and extent of soil contamination at the site and to provide an opinion, based on these results, on the suitability for the site for the project development in accordance with the development application.

ADE sampled 124 test pit locations as part of the DSI, all but one of these samples has results with concentrations below that of the adopted human health assessment criteria for Tier 1 screen purposes for commercial/industrial sites (HIL-D) and health screening levels for vapour intrusion and direct human contacts (HESL-D), as outlined in the National Environment Protection (Assessment of Site Contamination) Measure (NEPM) (NEPC 2013).

The investigation identified 1 sample (Sample TP27-fill-0.1) had elevated concentrations of comminates in soil materials across the site. Sample TP27-fill-0.1 had an exceedance 4.68 mg/kg of Benzene, however did not exceed 2.5 times SL-D criteria, therefore UCL95 was conducted using samples collected from same strata and

within the same Lot (Lot 21 DP 255560) and returned an acceptable reading of 1.61 mg/kg, below the 3 mg/kg HSL-D criteria.

ADE noted previous AEC's and associated CoPC's outlined in Douglas Partners Contamination Status Summary Report (DP,2021). As such, ADE revised the AEC's and associated CoPC's due to sufficient sampling events and chemical analysis. ADE's revision of AECs as identified by Douglas Partners is included as Table 3.1 below.

Table 3.1 Revision of AEC's and associated CoPC's

AEC #	Potential Source and Assigned AEC	Revision	Requirement for Additional Data and/or Management
AEC 1	Market gardening activities (pesticides)	No OCP, OPP or metal exceedances were identified within ADE's chemical analysis.	AEC 2 and AEC 3 remain open. Therefore, further intrusive investigation is required to assess potential contamination impact to surface soils. (A further assessment of soils and groundwater may be necessary should significant contamination be identified in surface soils).
AEC 2	Building construction, degradation and demolition structures (hazardous building materials)	Must remain in place and revisited post demolition of dwellings and other detached structures.	
AEC 3	Chemical and fuel use/storage (potential chemical spills)	Must remain in place due to access limitations in barns, storage spaces and garages.	
AEC 4	Stockpiles, fill and ground disturbances (unknown contamination status)	No TRH, BTEX, PAH, PCB, metals, OCP, OPP or asbestos exceedances were identified within ADE's chemical analysis.	
AEC 5	Presence of timber power poles	Sufficient sampling events conducted in the near vicinity of timber power poles revealed no elevation of TRH, BTEX, PAHs or metals within ADE's chemical analysis.	
AEC 6	Possible asbestos pipe network	No asbestos was located in ADE's visual inspection or within any of the analysed 500 mL NEMP samples. No pipe work was intercepted.	
AEC 7	Refuse	No asbestos was located in ADE's visual inspection or within any of the analysed 500 mL NEMP samples.	

Based on the results of the soil assessment, and proposed development comprising of hardstand over the majority of the site, ADE considers that groundwater is not likely to be affected by on-site soils and the proposed development. Should development plans change, or should groundwater be encountered during the construction works, further assessment may be required.

ADE notes that certain areas were inaccessible due to market gardens and small-large greenhouses within lots 20, 22, 30 and 32, tall grass and dense vegetation throughout, underground septic tanks adjacent to properties, irrigation and drainage equipment throughout markets gardens and adjacent to dams, overhead height restrictions as well as other infrastructure preventing either the consultant or excavator from accessing a certain sampling point. As such, an adaptive sampling strategy was implemented by the by the on-site consultant which involved targeted sampling in safe and accessible areas. ADE intends to revisit inaccessible sampling points in the near future to take additional samples for chemical analysis.

Based on the results of the investigation and the existing environment of the site, ADE concludes that the identified areas of concern, are proven to no longer be of concern and that the site is considered suitable for the intended land use of the project.

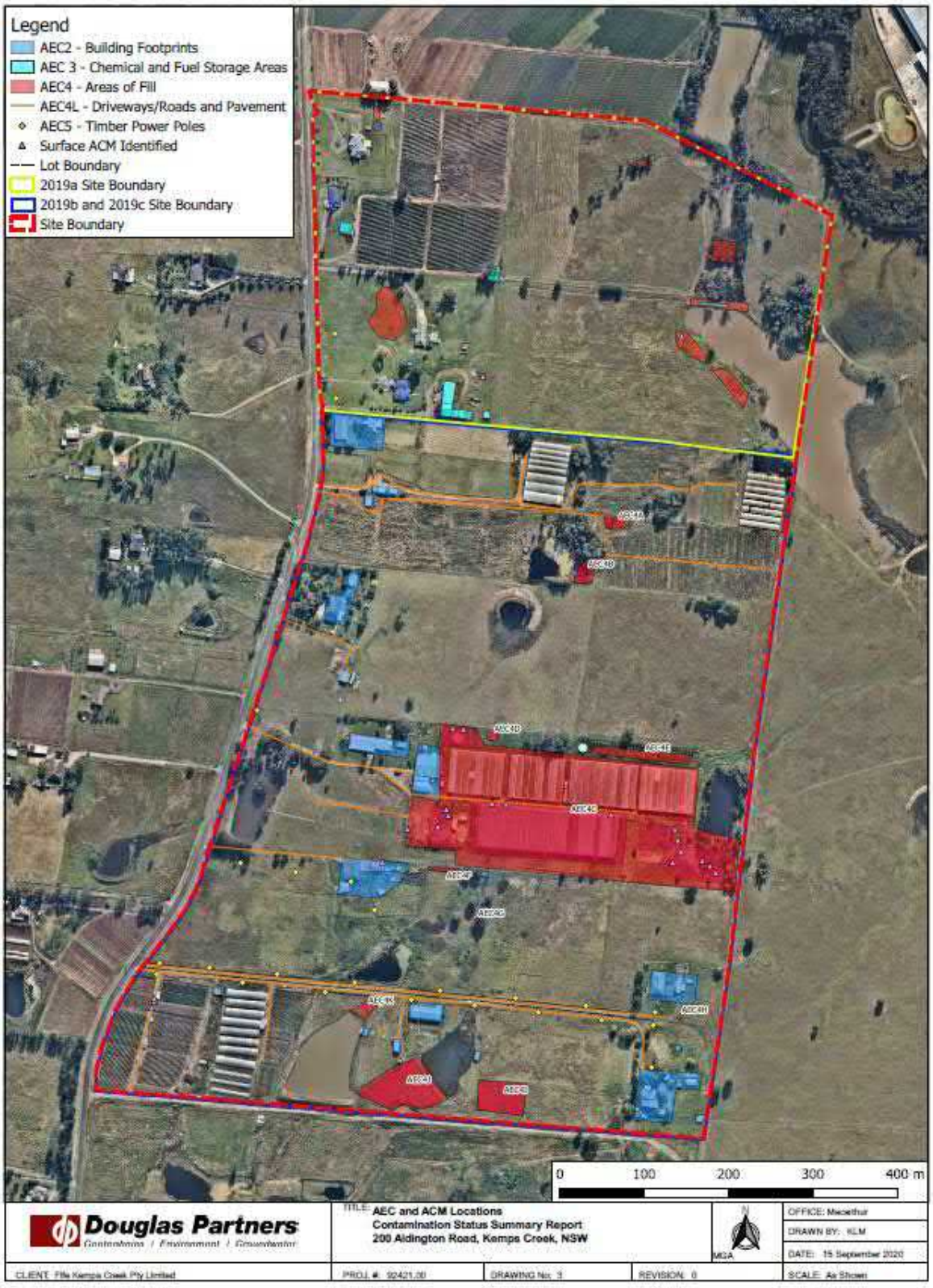

Figure 3.1 Areas of environmental concern

Note: AEC4, AEC4L, and AEC5 in accordance with table 3.1 have been revised by the ADE report (2022) and are no longer areas of concern.

4 Management measures

This section outlines the management measures to be implemented during the construction phase of the Project to mitigate impacts to the environmental from unexpected contamination sources. This includes management measures provided in the XXXX (refer Table 4.1) and the unexpected contamination procedure.

Table 4.1 Environmental management controls for contamination

Measure	Timing	Responsibility	Source
Implement Unexpected Contamination Procedure.	Pre-construction and construction	Contractor Project Manager	Douglas Partner 2020
In the event contamination of soil or waterways occurs, notify NSW EPA immediately.	Construction	Contractor Project Manager	Douglas Partner 2020
All chemicals, fuels and oils used onsite must be stored in accordance with the requirements of relevant Australian Standards and the NSW EPA Storing and Handling of Liquids: Environmental Protection – Participants Manual' if the chemicals are liquids.	Construction	Contractor	Douglas Partner 2020
All demolition will be carried out in accordance with Australian Standard AS 2601-2001 The Demolition of Structures (Standards Australia, 2001).	Construction	Contractor	Douglas Partner 2020
All plant and equipment will be maintained and operated in a proper and efficient manner.	Construction	Contractor	Douglas Partner 2020
In the event contaminated material is found, cease work immediately and notify the Site Supervisor for instructions on what actions to take.	Construction	All site personnel Project Manager	Douglas Partner 2020
Minor asbestos unexpected finds should be assessed in accordance with Managing Asbestos in or on soil (SafeWork NSW 2014).	Construction	Contractor Safety Representative Project Manager	Douglas Partner 2020

Table 4.1 Environmental management controls for contamination

Measure	Timing	Responsibility	Source
Management and removal of greater than 10 m^2 non-friable asbestos materials must be undertaken by a Class B licensed asbestos contractor. Any friable asbestos materials must be removed by a Class A licensed asbestos contactor. A licensed asbestos assessor (LAA) will be required for clearance of friable asbestos impacts.	Construction	Contractor Safety Representative Project Manager	Douglas Partner 2020
Asbestos air monitoring is required during all asbestos related works at the site.	Construction	Project Manager Safety Representative	Douglas Partner 2020

4.1 Unexpected Contamination Procedure

This section outlines the procedure to be applied to the discovery of unexpected contamination sources during the construction phase of the Project, which may have the potential to adversely impact the surrounding environment.

4.1.1 Unexpected finds identification

As recommended in the Contamination Status Summary Report, further investigations are required to confirm the contamination status of selected areas of environmental concern within the site and to provide data to assist in the development of a remediation action plan. A validation assessment will be required at the completion of remediation works to confirm the suitability of the site for the proposed use.

4.1.2 Unexpected finds register

All unexpected finds identified on site should be documented in an unexpected finds register. It will be the responsibility of the sites Environmental Representative to maintain this register.

4.1.3 Assessment of unexpected finds

The sampling strategy for the characterisation and validation of an 'unexpected find' must be prepared by a suitably qualified specialist and in accordance with requirements of the consent and regulatory guidelines (e.g *Sampling Design Guidelines Contaminated Sites* (EPA 1995)). The intent of the sampling is to determine the nature of the substance/material found and whether is it hazardous. It should then be determined if the substance/material exists in concentrations which could cause an unacceptable risk to human health and or the environment.

4.1.4 Validation of unexpected finds

Validation inspection and possible sampling/analysis is required to be undertaken to demonstrate that unexpected finds have been managed to a standard suitable for the proposed land use. The sampling schedule to be undertaken in the event unexpected contaminated sources are found is outlined in Table 4.2.

Table 4.2 Validation sampling and analytical schedule

Validation area	Sampling frequency	Analytes
Excavations formed by the removal of unexpected finds	Minimum of 1 validation sample per 10 m linear of wall and 1 m depth, minimum of 1 validation sample per 100 m2 area for the base (10 m grid).	As appropriate, based on the characteristics of the find
Contaminated material requiring disposal offsite	TBC	TPH/BTEX, PAHs, heavy metals, OCP/PCBs, asbestos and TCLP (if required), or as appropriate based on the characteristics of the find
Residual soils underneath stockpiles where contaminated material has been stored	Minimum of 1 sample per 10 m grid	As appropriate, based on the characteristics of the find

Note: All samples analysed for asbestos validation / re-use purposes (including ENM) will be 500 mL samples in accordance with WA DOH (2009) guidelines, and analysed in accordance with AS 4964-2004. Asbestos samples for waste disposal purposes will be 50 g samples.

Attachment A

Detailed Site Investigation Report – ADE Consulting Group 2022

Detailed Site Investigation

200 Aldington Road, Kemps Creek NSW

Prepared for: Fife Capital Pty Ltd

21.1994 | DSI.v1d | Date: 11.02.2022

ADE CONSULTING GROUP

Document Information

Report Title: Detailed Site Investigation
Prepared for: Fife Capital Pty Ltd
Project Address: 200 Aldington Road, Kemps Creek NSW
File Reference: 21.1994
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Date: 11.02.2022

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Version	Date	Author	Revision description	Reviewer
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For and on behalf of
ADE Consulting Group Pty Ltd
ABN 14 617 358 808

Prepared by:	Reviewed by:	Issued by:
		
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Contents

Abbreviations

ADE	ADE Consulting Group Pty Ltd
ACM	Asbestos Containing Material
ASS	Acid Sulfate Soil
AST	Aboveground Storage Tank
BGL	Below Ground Level
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CoC	Chain of custody
CoPC	Contaminants of Potential Concern
CSM	Conceptual Site Model
DBYD	Dial Before You Dig
DEC	Department of Environment & Conservation
DP	Deposited Plan
DNAPL	Dense Non-Aqueous Phase Liquid
DLWC	Department of Land and Water Conservation
DSI	Detailed Site Investigation
EPA	Environment Protection Agency
HEPA	Heads of EPAs Australia and New Zealand
HILs	Health Investigation Levels
HMS	Hazardous Materials Survey
HSLs	Health Screening Levels
LAA	Licensed Asbestos Assessor
LEP	Local Environment Plan
LIR	Land Insight Resources
LNAPL	Light Non-Aqueous Phase Liquid
LTO	Land Titles Office
LEP	Local Environmental Plan
LGA	Local Government Area
NATA	National Association of Testing Authorities
NEPC	National Environmental Protection Council
NEPM	National Environmental Protection Measure
NSW	New South Wales
OCPs	Organochlorine Pesticides
OEH	Office of Environment & Heritage
OPPs	Organophosphorus Pesticides
PAHs	Polycyclic aromatic Hydrocarbons
PASS	Potential Acid Sulfate Soil
PFAS	Per- and Poly-fluoroalkyl substances
PSI	Preliminary Site Investigation
PCBs	Polychlorinated Biphenyls
RAP	Remedial Action Plan
SAC	Site Assessment Criteria
SCC	Specific Contaminant Concentration
SMF	Synthetic Mineral Fibre
SH&EWMS	Safety, Health & Environmental Work Method Statement
TCLP	Toxicity Leaching Procedure
TRHs	Total Recoverable Hydrocarbons
UCL	Upper Confidence Level
UFP	Unexpected Finds Protocol
UST	Underground Storage Tank
WQM	Water Quality Meter

Executive Summary

Fife Capital intends to redevelop the area subject to this investigation at the site located at 200 Aldington Road, Kemps Creek New South Wales (NSW) (the site), within Lots 20-23 in DP 255560 and Lots 30-32 in DP258949 for a proposed industrial estate for commercial/industrial use with access to soil proposed within Lots A, D & L (*refer to APPENDIX VII - Masterplan and Stage 1 Plans August 2021*). ADE Consulting Group Pty Ltd (ADE) was engaged by Fife Capital to undertake a Detailed Site Investigation (DSI) which is required as part of the Development Consent.

The objective of the DSI is to:

- Prepare a Detailed Site Investigation (DSI) for the site that presents an assessment of the areas of concern identified in the Limited Desktop Preliminary Site Investigation and subsequent inspection, conducted by ADE in 2021, respectively
- Provide an opinion on the suitability for the site for the proposed development in accordance with development application.

As part of this DSI, ADE sampled 124 test pit locations using a 10-tonne excavator. All but 1 sample returned with concentrations below that of the adopted human health assessment criteria for Tier 1 screening purposes for commercial/industrial sites (HIL-D) and health screening levels for vapour intrusion and direct human contact (HSL-D), as outlined in the NEPM (*NEPC, 2013*). The investigation identified 1 elevated concentration of contaminates in soil materials across the site. Sample TP27-fill-0.1 returned an exceedance of 4.68 mg/kg in relation to Benzene, however, did not exceed 2.5 times HSL-D criteria, therefore a UCL95 was adopted from similar samples collected within the same Lot (Lot 21 DP 255560) and returned an acceptable reading of 1.609, which is below the 3 mg/kg HSL-D criteria.

Based on the results of the investigation, and in the context of the proposed industrial estate, ADE has concluded the site can be considered suitable for the intended land use.

1 Introduction

1.1 Background and General Information

ADE Consulting Group Pty Ltd (ADE) was engaged by Fife Capital Pty Ltd (the client) to undertake a DSI within the proposed development area within the property at 200 Aldington Road, Kemps Creek, Lots 20-23 in DP 255560 and Lots 30-32 in DP258949. The area subject to the proposed development (hereafter referred to as 'the site'), is shown in *Appendix I –Figures*.

This report was designed to assess the site regarding areas of concern and contaminants of potential concern (CoPC) identified during the Phase I Preliminary Site Investigation (PSI), completed by Douglas Partners PSI (2019) (refer to Section 3).

The purpose of this DSI is to assess the nature and extent of potential contamination within soil at the site. This was undertaken through:

- Completion of a desktop review of previous investigations and known information sources
- Conduct a detailed soil investigation for the identified CoPCs outlined within the Stage I PSI and subsequent site inspection (refer to Section 3)
- Submission of all samples to NATA accredited laboratories and
- Preparation of a Stage I DSI report outlining the investigations methodology, interpretation of the results, to make conclusions and recommendations concerning contamination impacting both environmental and human health within the site

The site investigation and corresponding sampling regime were undertaken throughout the period of 15 December 2021 to 14 January 2022 which involved the collection and subsequent analysis of soil. The selected samples were compared against the adopted Site Assessment Criteria (SAC) outlined within Section 7, to determine if the site is suitable for the proposed land use**.**

1.2 Proposed Development

ADE understands that the site is to be upgraded for the full property frontage and will include kerb & gutter, street drainage, path paving, landscaping, and undergrounding of all utility assets. An overview of proposed Stage 1 works include:

- Demolition and clearing of all existing built form structures
- Drainage and infill of existing farm dams and any ground dewatering
- Clearing of all existing vegetation
- Bulk earthworks including 'cut and fill' to create flat development platforms for the warehouse buildings, and site stabilization works (if required)
- Roadworks and access infrastructure
- Stormwater and drainage work including stormwater basins, diversion of stormwater lines, gross pollutant traps and associated swale works
- Sewer and potable water reticulation
- Inter-allotment, road and boundary retaining walls
- Subdivision of the site into 15 individual lots
- Construction of a warehouse building with a total of 50,930 sqm of GFA, including: 48,430 sqm of warehouse GFA, 2,500 sqm of ancillary office GFA, 231 car parking spaces.

1.3 Objectives

The primary objective of this investigation is to characterise shallow fill material that may be subject to excavation as part of the proposed development. The objectives of the investigation will be achieved by:

- Summarising past and present potentially contaminating activities through a desktop study supported by information obtained from the Phase I PSI (DP 2019)
- Assessing the contamination status of the site, which may have been impacted by past / present land use and/or off-site contamination from the surrounding area
- Completing an intrusive investigation program developed in accordance with the NSW Environment Protection Authority (EPA) 1995 *Sampling Design Guidelines* (NSW EPA, 1995) and National Environment Protection (Assessment of Site Contamination) Measure 1999, 2013 Amendment (NEPC 2013)
- Assessing and describing the source, type, extent and level of contamination by comparing the collected soil data against the adopted SAC outlined in guidelines including, but not limited to, NEPM (NPEC, 2013), PFAS National Environmental Management Plan v2.0 (NEMP, 2020) and other relevant guidelines, as outlined throughout this report
- Determine the potential risks posed to human health and environment (if present) and
- Provide an assessment of the site and develop recommendations for remedial works or ongoing management based on the findings (if required).

1.4 Scope of Work

The Scope of work for the investigation involved the following:

1.4.1 Phase One – Desktop Review

- Desktop review of the site plans, previous environmental investigations, selected aerial photographs, title records, NSW EPA public registers and council planning records/ certificates
- Obtain and review Dial Before You Dig (DBYD) documentation.

1.4.2 Phase Two – Field Investigation

- Understanding and sign on to a job specific Safety, Health & Environmental Work Method Statement (SH&EWMS) and the completion of a toolbox talk before undertaking works
- Excavation of 124 test pits using a 10-tonne excavator
- Field logging of soil profile and site observations
- Soil sampling of the fill and natural materials to a maximum depth of 2.0 m below ground level (bgl)
- Field screening of collected samples for Volatile Organic Compounds (VOCs) using a calibrated Photo-ionisation Detector (PID)
- Cold storage of all soil samples collected and analysis of samples for the following analytes based on the findings outlined in the Stage I PSI (DP, 2019) and the Conceptual Site Model (CSM):
  - Asbestos (500 mL sample), BTEX, Heavy Metals (Arsenic, Cadmium Chromium, Copper, Lead, Mercury, Nickel and Zinc), OCPs / OPPs, Polycyclic Aromatic Hydrocarbons (PAHs), Phenols, Clay Content, Salinity, Polychlorinated biphenyl (PCB), Recoverable Hydrocarbons (TRHs), Volatile Organic Compounds (VOCs) and Per-and Polyfluoroalkyl Substances (PFAS)

1.4.3 Phase Three – Analytical Test Work

Submission of samples to NATA accredited laboratories for analysis under Chain of Custody (CoC) documentation.

1.4.4 Phase Four – Data Assessment and Conclusions

- Interpretation of analytical results and field observations in accordance with relevant guidelines and codes of conduct described below in Section 1.5
- Preparation of a DSI report outlining the investigation, interpretation of results, and including conclusions and recommendations with reference to the proposed development.

1.5 Guidelines and Codes of Practice

The legislative framework for the report is based on guidelines that have been issued and/or endorsed by the NSW Environmental Protection Authority (EPA), formerly the Office of Environment and Heritage (OEH) under the following Acts/Regulations:

- Contaminated Land Management Act 1997
- Environmental Planning and Assessment Act 1979
- Protection of the Environment Operations Act 1997
- State Environmental Planning Policy (SEPP) 55 'Remediation of Land'

The relevant guidelines issued under the provisions of the Acts/Regulations include:

- Guidance for the Preparation of Standard Operating Procedures for Quality-Related Documents (EPA QA/G-6)
- Guidance on Data Quality Indicators, EPA QA/G-5I
- Guidelines for the NSW Site Auditor Scheme (3rd Edition), NSW 2017
- Guidelines on the Duty to Report Contamination (2015) under the Contaminated Land Management Act 1997
- Guidance for the Data Quality Objectives Process (EPA QA/G-4)
- Guidance for Data Quality Assessment: Practical Methods for Data Analysis (EPA QA/G-9)
- National Functional Guidelines for Inorganic Data Review, USEPA, (1994)
- NSW EPA Contaminated Sites: Sampling Design Guidelines (NSW EPA 1995)
- National Environmental Protection Council [NEPC]. (2013). National Environmental Protection Measure 1999, 2013 Amendment (NEPC, 2013)
- New South Wales Environmental Protection Agency [NSW EPA]. (2020). Consultants reporting on contaminated land - Contaminated Land Guidelines (NSW EPA, 2020) and
- The Heads of EPAs Australia and New Zealand [HEPA]. (2020). PFAS National Environmental Management Plan Version 2.0, dated January 2020 (HEPA, 2020).

Australian Standards applied to this investigation:

- Australian Standard AS 4482.2 Guide to the sampling and investigation of potentially contaminated soil. Part 2: Volatile substances, (Standards Australia, 1999)
- Standards Australia Australian Standard AS4964-2004: Method for the qualitative identification of asbestos in bulk samples (Standards Australia, 2004) and
- Australian Standard AS 4482.1 Guide to the sampling and investigation of potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds (Standards Australia, 2005).

The following local government plans have also been taken into consideration for the preparation of this DSI:

- Penrith City Council Environmental Plan (2010).

2 Site Identification and Details

2.1 Site Location

The site entails Lots 20-23 in DP 255560 and Lots 30-32 in DP258949 located at 200 Aldington Road, Kemps Creek NSW and comprises an approximate area of 72.09 hectares (ha). The site is currently used for agricultural purposes. The location of the site is defined by an irregular Shape and is shown below in Figure 1 (refer to *Appendix I - Figures).*

Figure 1. Site boundary outlined in red (image adapted from *Nearmap*; accessed on 19.01.2022).

2.2 Summary of Site Details

Table 1. Summary of Site Identification Details for the Site.

Site Details	
Site Address	200 Aldington Road, Kemps Creek NSW
Title Identification	Lots 20-23, DP 255560 Lots 30-32, DP 258949
LGA	Penrith City Council
Current Land Use Zoning	Agriculture & rural
Site Area	Approximately 72.09 ha
Current Site Owner / Occupier	Fife Capital
Former and current land use	Agriculture
Local Environmental Plan	Penrith City Council Environmental Plan (2010).

3 Previous Environmental Investigations

The summaries of previous environmental investigations made available to ADE have been summarised as follows to inform the conceptual site model and data gaps required to be addressed for the DSI.

3.1 KPMG SGA Property Consultancy Pty Ltd (KPMG) Site Review of Contamination and Assessment (KPMG 2019)

The first investigation on this site was conducted by KPMG to assess the site through a soil sampling program, desktop review of background information (aerial photographs and NSW EPA data base), and a site walkover to identify further possible contamination sites.

A review of historical aerial photographs was conducted from 1955 through to 2018. From 1955 to 1972 only two dams were created in the north and south with the rest of the area being open vacant farmland. In 1972 through to 1982 the construction of serval houses and associated shed along with market gardens were built. By 1992 an additional house in the northwest and glass houses in the south were constructed with more being added in the center in 2004. No discernable changes were observed from 2004 to 2018. There was concern over the houses containing asbestos with fibre cement sheeting (FCS) being observed in all but one house with some having additional structures like chook coops being made of FCS. Further testing would be needed to confirm the presence of asbestos within these structures. Fragments of FCS containing asbestos have been found in demolition dumps within Lot 20 and Lot 22.

The site has a continued history of market gardens and farmland which has led to many decades of chemical use in the form of herbicides and pesticides. Mixing areas of these chemicals were very closely related to the dams on each property (bar Lot 23) and have a high chance to leaked or spill (no bunding was observed) into the water source or adjacent land.

KPMG concluded the site has a moderate potential for significant soil and groundwater contamination to be present, with a low risk of off-site migration of the potential contamination. The primary source of contamination to the site was likely due to the market gardens. Also noted was a further targeted investigation should be considered on the present and former areas of the market gardens.

3.2 Douglas Partners (DP) Preliminary Site Investigation (PSI) - Proposed Commercial/Industrial Subdivision 144-228 Aldington Rd, Kemps Creek NSW Project: 92364, October 2019 (DP, 2019)

The primary objective of DP (2019) was to review previous investigation conducted by KPMG, to identify further potential areas of concern and to provide a preliminary assessment of site contamination. Preliminary geotechnical and salinity investigations were also carried out.

Further review of the historical aerials of the area revealed that Lot 20 (1991-2002) and Lot 22 (2002-2009) have had the demolition of greenhouses. Potential areas of fill in the south of Lot 22 (1991) and a series of multiple fills in the easter section also occurring between 2015 and 2019.

DP found additional areas of concern for contamination from the site inspection. Surficial waste of drums with unknown liquids, burned drums, batteries, metal, pallets, bottles, foam, and plastics were present arounds sheds and dams. Further arounds dams are hummocky land and small stockpiles which DP found a concern for containing more potential contamination; this would need to be further investigated. Timber power poles were also considered to be of risk at leaching timber treatment chemicals into the surrounding soils.

Collection of soil samples from 12 test pits from a grid formation with an additional six targeted test pits on areas of concern. Depths ranging from 0 – 0.2m, 0.2 – 0.5m and repeated at regular intervals until natural soil

is observed (if possible). Sampling sites which were tested for TPH's, heavy metals, PAH's, phenols, BTEX, pesticides (OCP, OPP and PCB), and asbestos. All results for TRH, Btex, OCP's, OPP's, PCB's and Phenols were detected at concentration not exceeding regulation levels. One sample exceeded Ecological and Health Screening and Investigation safe levels of PAH's (SS18 benzo(a)pyrene (BaP) TEQ at 61mg/kg). Heavy metal samples had two zinc samples with exceeding Ecological Screening and Investigation levels (SS15 at 2400mg/kg and SS20 at 780mg/kg) and one had exceeding ESLs/ EILs of arsenic (SS14 at 230mg/kg). Asbestos (chrysotile) was detected in two material samples (MAT-1 and MAT-2) with no soil samples coming back with contamination.

DP concluded that based on their results of the site that there is a moderate to high potential for contamination. Recommendation on further investigations on:

- Current and former market gardens;
- Chemical and fuel mixing and storage areas;
- Dam sediments;
- Stockpiles, fill, driveways, and ground disturbances; and
- Timber power poles.

Also, investigation on the footprints of former sheds and the soils in the vicinity of current structures following demolition to assess for the presence of possible contaminates.

Douglas Partners have devised a Summary of Potential and Assigned AEC which has been used to assess the potential risks and harm being caused to human and ecological receptors from contamination sources on or in the vicinity of the site. The potential source and assigned AEC (1-7) as well as the requirement for additional data and/or management have been provided in **Table 2** below.

3.3 Douglas Partners (DP) Report on Preliminary Geotechnical Investigation and Preliminary Salinity Assessment - Proposed Commercial/Industrial Subdivision 144-228 Aldington Rd, Kemps Creek NSW Project: 92364, October 2019 (DP, 2019)

This report details the geotechnical landscape of the site explaining that surface levels generally fall from a low ridge which runs diagonally across the site in a northwest to southeast direction towards Aldington Road and the northeastern corner at grades of approximately 1 in 30 to 1 in 65. The overall distance in level is estimated to be approximately 27m from the highest parts of the site near the northwest and southeast corners at about RL 86 m relative to AHD to the lowest near the southwest corner at RL 59 m AHD.

DP reference the Map of Salinity Potential for Western Sydney which indicates known salinity and high salinity potential around the primary creek line/ dam in the northeast corner of the site and moderate salinity potential for the remainder of the site. The mapping is based on soil type, surface level and general groundwater considerations and thus is approximate only. The tests conducted on salinity of 50 samples showed results of the following:

- 14 samples non saline
- 25 samples slightly saline
- 10 samples moderately saline
- one sample very saline.

This investigation included the excavation of 19 test pits and 2 boreholes with depths up to 3m below surface level with a backhoe. The boreholes were drilled with truck mounted drilling rigs to depths of 9.7m and 8.4m respectively. The general lithological outlay of the site was identified as the following:

- Topsoil: silty clay and clayey silt topsoil, to depths of 0.1-0.3,

- Fill: silty clay with some anthropogenic materials to depths 0.3-1.4m
- Residual soil: variably stiff and hard clay and silty clay to depths of 0.6-3.3
- Bedrock: very low strength sandstone, shale first contact at depths 0.6-2.6m and continuing to depths of 3 to 8 metres, varying in exact depth of excavation.

3.4 Douglas Partners (DP) Contamination Status Summary Report- Proposed Industrial Development 200 Aldington Road Kemps Creek NSW Project: 92421, September 2021 (DP, 2021)

DP 2021 provided a response to submissions by the Department of Planning Industry and Environment (DPIE) in March 2021 in reference to the DPIE's Secretary's Environmental Assessment Requirements (SEARs). Following the public exhibition of the project, amendments were made to respond to issues raised. This included a full assessment of the project against the Draft Mamre Road Precinct Development Control Program (draft MRP DCP).

This report also summarised findings from the DP PSI which included a recommendation for further contamination investigation. A summary of the AEC and associated COPC identified in the PSI was provided in a table below.

Table 3. AEC's and Associated COPC's

AEC #	Description	COPCs
1	**Market Gardens**- Potential for surface soils in the market gardens to be impacted with pesticide related COPC	OCP, OPP, metals
2	**Current and former structures-** numerous residential structures and sheds are located within the site. The location of several former structures were also identified. Given the age of the structures (often pre 1980's) there is the potential for surface soils in the vicinity of the structures (former and current) to be impacted by hazardous building materials.	Asbestos containing material (ACM), PCBs, metals
3	**Chemical and fuel storage-** former and current sheds may have been used for chemical and fuel storage. Multiple pesticide storage and mixing areas were identified, associated with market gardening activities. Fuel storage and refueling areas, including three above ground storage tanks (AST) were also identified. There is potential for contamination of surface soils in the vicinity of these areas resulting from spillages and storage malpractice.	TRH, BTEX, PAH, PCB, metals, OCP, OPP
4	**Fill Material**- multiple stockpiles, areas of fill and ground disturbance were observed within the site. Stockpiles and fill may have been generated from impacted on or off-site sources. Areas of ground disturbance are potential indicators of filling. Imported aggregate fill has been placed on several access roads within the site. ACM associated with fill was identified in several locations.	TRH, BTEX, PAH, PCB, metals, OCP, OPP, asbestos
5	**Timber power poles-** multiple timber power poles are present within the site. Timber treatment chemicals associated with the poles have the potential to leach into, and impact, surrounding soils.	TRH, BTEX, PAHs, metals
6	**Possible asbestos pipes-** asbestos pipes may be present at the site, both from legacy utility trenches and from private networks installed by lot owners. Degradation and damage of pipes may lead to hazardous materials being present within the near surface soils.	Asbestos

7	**Refuse-** Refuse including building demolition waste was observed in multiple areas of the site. Building demolition waste is a potential indicator for asbestos.	Aesthetic issues and asbestos

Based on the findings of the PSI and SCI, and review of recent aerial photographs taken since the completion of previous reports, DP considered that the site could be made suitable for the proposed industrial land use subject to further investigation and / or remediation of the identified AEC as follows:

- AEC 1: Further investigations are required to confirm the contamination status of surface soils in market gardens within lots 31 and 32. Market gardens in Lots 20- 23 and 30 are considered suitable for the proposed use
- AEC 2: Further investigations are required to confirm the contamination status of surface soils in the vicinity of former and current structures. A hazardous material assessment should be completed for current structures prior to demolition, with structure footprints investigation following demolition
- AEC 3- Further investigations are required to confirm the contamination status of surface soils in chemical and fuel storage areas within Lots 31 and 32 and at SCI sampling locations SS15, SS20, TP 120 and TP122. Other identified chemical and fuel storage areas are considered suitable for the proposed use
- AEC 4- Further investigations are required to confirm the contamination status of fill material within Lots 31 and 32 and at AEC 4 A, B, C, F, G, I, J, K and L. Fill material at AEC 4 D, E and H are considered suitable for the proposed use
- AEC 5- Remediation of soil at the base of power poles is required at Lots 20- 23 and 30. Further investigations are required to confirm the contamination status of soil at the base of power poles within Lots 31 and 32
- AEC 6- Buried asbestos pipes (if present) may become apparent during remediation and would normally require remediation under an unexpected finds protocol
- AEC 7- Removal of surface refuse would be required as part of initial site development works

3.5 Summary of previous reports

Both KPMG (2019) and DP (2019) recognise the potential for moderate to high potential for this site to be contaminated; particularly from the previous and current activity surrounding the market gardens and their associated chemicals use.

Various heavy metals and one PAH's sample were identified in excess of the assessment criteria, as well as some samples shown to contain asbestos, likely attributed to both on site market gardens and demolition of former structures.

The Contamination Status Summary Report (DP 2021) detailed the seven AEC's that were identified in the PSI which were investigated and determined by DP to be possible to be remediated and made suitable for the proposed development

DP's Preliminary Geotechnical and Salinity Assessment identified the geotechnical and topographical landscape of the site. 50 salinity samples produced results that demonstrated that only one sample was highly saline and 80% of samples were slightly to not saline. The 19 test pits that were excavated provided a general lithology outlay of the site which was predominantly silty clay fill to approximately 1.4m followed by stiff and hard clays to approximately 3.3m and a bedrock and sandstone and shale.

4 Site Condition and Surrounding Environment

The following table represents a summary of the site condition and surrounding environment:

Table 4. Summary of Site Condition and Surrounding Environment.

Attribute	Description
Site Inspection Details	The site inspection and soil sampling were undertaken on the throughout the periods of 15 December 2021 to 14 January 2022 by experienced environmental consultants representing ADE.
Topography and Elevation	The north-western portion of the site is generally covered by dwellings, tall grass, and agricultural land, having a moderate slope to the east. The eastern boundary of the site contains a manmade dam. The southern portion of the site generally grades to the west, being predominantly covered by tall grass and greenhouses with dwellings and other structures bordering the eastern boundary. The site was comprised of slopes roughly up to 8 degrees. Local slopes dipping to the northwest at angles up to 12 degrees.
Surrounding Land Use	The site is situated amongst an area comprised predominantly of rural and farming uses, with a major proportion of the land being covered with crops and greenhouses.
Surface Cover and Conditions	Much of the investigation area is overlain by greenhouses and farmland, long-grass, dense vegetation, and dams made for irrigation and drainage.
Local Geology	The precinct is underlain by Bringelly Shale and carbonaceous claystone, laminate, and coal. Bringelly Shale is a major formation of the Wianamatta group that outcrops over the large area of Western Sydney. The shale is comprised predominantly of claystones and siltstones with occasional sandstone layers. It is highly compacted, weakly cemented and contains significant amounts of swelling minerals. Surface levels are seen to fall from a low ridge that runs diagonally across the site in a north western to south eastern direction towards Aldington Road.
Hydrology	The site consists of multiple man-made dams for the purposes of irrigation and drainage. It is ADE's opinion that the ground water will flow in an approximate direction of northwest due to topography and location of Kemps Creek. Ropes creek is a watercourse that is part if the Hawkesbury-Nepean catchment located approximately 450 m east of the site. Kemps Creek located in 1.5km southeast of the site and is a tributary of South Creek which flows into the Hawkesbury River.

5 Data Quality Objectives

As stated in Section 18 Appendix B of Schedule B2 – Guideline on Site Characterisation in the ASC NEPM (NEPC 1999, amended 2013), the data quality objectives (DQO) process is a seven-step iterative planning approach used to define the type, quantity and quality of data needed to support decisions relating to the environmental condition of a site.

5.1 Step 1 – State the Problem

The objective is to determine the nature and extent of soil contamination at the site to assess if the site is suitable (or can be made suitable) for the proposed development of an industrial estate.

5.2 Step 2 – Identify the Decision

Based on a review of previous environmental investigations undertaken at the site, the following decisions need to be made:

- Is contamination present at the site above relevant investigation levels for commercial/industrial use?
- Is contamination present at the site that may present a risk to future inhabitants of the site, neighbouring properties or surrounding receptors?
- Is the remediation of soil required to render the site suitable for the proposed commercial/industrial land use?

5.3 Step 3 – Identify Inputs to the Decision

To address the decision questions outlined in Step 2 of the DQOs (refer to **Section 5.2**), the following inputs to the decision have been identified:

- Information from previous site investigations
- Observations made during the field works
- Results of the soil samples collected during the investigation
- Relevant regulatory guidelines

5.4 Step 4 – Definite Boundaries of the Study

The investigation boundaries are presented in Table 5.

Table 5. Summary of the Study Boundaries

Spatial Boundaries	The lateral boundaries of the site are limited to the proposed development area as shown in Appendix I – Figures, and Appendix VII – Supporting Documents. The vertical boundary for soil contamination within the site is limited to in-situ soils extending from the surface to approximately 0.5 m below ground level.
Temporal Boundaries	The investigation works were undertaken from the period of the 15 December 2021 to 14 January 2022.
Investigation Limit	The limit of the investigation extent was defined by previous investigations and the proposed development plans.
Constraints	Sampling locations were constrained by the presence of active agricultural farmland, overgrown tall grass and access to certain locations within the site. The investigation was limited to the areas of the site accessible at the time of the investigation. ADE notes various locations were inaccessible upon the request of the private owner(s) of the site .
Receptors of Concern	The potential receptors of concern are outlined in **Section 10.**

5.5 Step 5 – Develop a Decision Rule

The purpose of this step was to define the parameters of interest, specify action levels and combine the outputs of the previous DQO steps to develop a series of options if certain trigger events occur.

The key decision rules for this investigation were:

- Have the analytical data collected during this investigation met the DQI (see below)? If yes, then the data can be used to answer the decision rule below and the decision statements developed in Step 2. If no, then additional data/ assessment will be required.
- Are concentrations of CoPC's exceeding the investigation criteria defined in Section 5 (below)? If no, then the contamination does not pose an unacceptable risk. Where results exceed the adopted SAC, this may not necessarily indicate an unacceptable level of risk. Further risk assessment, and potentially additional investigations will be required to determine the potential for unacceptable impacts.

To assess the useability of the data for making decisions, the data has been assessed against a set of DQI, developed based on the following parameters:

- Precision: A quantitative measure of the variability (or reproducibility) of data
- Accuracy: A quantitative measure of the closeness of reported data to the "true" value
- Representativeness: The confidence (expressed qualitatively) that data are representative of each media
- Completeness: A measure of the amount of useable data from a data collection activity
- Comparability: The confidence (expressed qualitatively) that data may be equivalent for each sampling and analytical event

5.6 Step 6 – Specify Acceptable Limits on Decision Errors

There are two sources of error for input to decisions:

- Sampling errors, which occur when the samples collected are not representative of the conditions within the investigation area; and
- Measurement errors, which occur during sample collection, handling, preparation, analysis and data reduction.

The null hypothesis for this study is:

- Contaminant concentrations within the soil at the site are above the adopted investigation levels.

These errors may lead to the following decision errors:

- Deciding that the risks posed by soil within the site are acceptable when these risks are not acceptable. The consequence of this error may be unacceptable impacts to human health, or the receiving environment; or
- Deciding that the risks posed by soil within the site are unacceptable when the risks are acceptable. The consequence of this error is that management actions will be undertaken to reduce risks that are not necessary.

The acceptable limit on decision errors is a 5% probability of a false negative (i.e. assessing that the average concentrations of COPC are less than the adopted soil investigation levels when they are greater than the investigation levels).

Where data sets are sufficiently populated, the 95% upper confidence limit (UCL) of the arithmetic mean will be used to calculate this probability. The 95% UCLs are to be less than the investigation level and standard deviation of the sample population shall be less than 50% of the investigation level.

5.7 Step 7 – Optimise the Design for Obtaining Data

The organisation of the data collection and analysis design for optimising the generation of data to satisfy the DQOs and the objective of the investigation has been achieved via the following procedures outlined in Table 6.

Table 6. Summary of procedures to be undertaken to optimise the design for obtaining data.

Pre-approved work plan	The sampling plan for the investigation at the site has been developed to assess the concentrations of contaminants present in soils at the site through the implementation of the components outlined within NEPM (2013), AS 4482.1 (2005) and AS/NZS 5667.1 (1998).
Compliance with EPA guidelines	• Use of appropriate techniques for the sampling, storage and transportation of samples

	• Implementation of NATA certified laboratory using analytical procedures as outlined in NEPM (2013) • Use of a secondary laboratory for split samples which is NATA certified for the required analyses

6 Sampling Plan, Methodology, Field Investigations and Investigation Pattern

6.1 Pre-work Procedure

Prior to mobilisation to site, a job-specific Safety, Health & Environmental Work Method Statement (SH&EWMS) was developed, which was presented in a pre-start meeting prior to the commencement of works and signed on to by ADE staff.

6.2 Sampling Design Plan Rationale

The site investigation and soil sampling procedures were developed in accordance with the NSW EPA Sampling Design Guidelines (NSW EPA, 1995). Based on the low-risk nature of the proposed development, a reduced sampling density of the recommended sampling points as per the NSW EPA (1995) Sampling Design Guidelines was adopted, including twenty six sampling locations were completed across the site by Douglas Partners (2019).

6.3 Soil Sampling Methodology

The intrusive investigation involved excavation of 124 test pits using an excavator provided by the client for soil sampling.

The sampling was undertaken during the periods of 15 December 2021 to 14 January 2022 by multiple experienced environmental consultants representing ADE. The samples were collected from the fill and natural layer (between approximately 0.0 – 2.0 m bgl).

Samples were collected using dedicated nitrile gloves and placed in laboratory prepared, suitable analyte containers involving sterile glass jars lined with Teflon lids for chemical analysis, High-Density Polyethylene (HDPE) jars for PFAS analysis and 500mL zip lock bags for asbestos analysis.

The samples collected for chemical (excluding PFAS) were placed within a pre-chilled esky or cooler box with ice packs or equivalent to maintain samples at approximately 4^0C. PFAS samples were stored within a separate, designated esky and placed in a cool, dry place out of direct sunlight. The original Chain of Custody (CoC) form was enclosed in the Esky that was then sealed and dispatched to NATA accredited analytical laboratories.

Following the collection of each sample, a PID with a 10.6 eV lamp, pre-calibrated with isobutylene gas at 100 ppm was used to screen the headspace gases of the collected samples to assess for the presence of VOCs. The PID headspace screening was conducted using a resealable zip-lock plastic bag, and the soil sample was agitated as the PID reading was taken inside the zip-lock plastic bag (the bag was appropriately sealed when inserting the PID).

A total of 162 primary soil samples, 15 blind replicate samples, 10 split replicate samples were collected throughout the course of the investigation. All samples were submitted to a NATA accredited laboratory for analysis as per the recommended holding times on a standard (5-day) turnaround time (refer to Table 5 for the adopted sampling and analytical program).

6.4 Equipment Decontamination

Dedicated disposable materials (e.g. nitrile gloves) were changed between each sampling point. All disposable sampling equipment/materials were collected and removed before leaving the site. Documentation
A field observation log was kept by sampling personnel during all phases of soil sampling. Details recorded in the log included:

- Soil profile notes
- Sampling method
- Sample identification
- Sample description
- Sample point measurements

A comprehensive master sample register was maintained. As samples were received, they were given a unique sequential number from the sample register into which details from the labels were entered. Before packing and dispatch of samples for analysis, a CoC form was completed (refer to *Appendix V – Chain of Custody Documentation and Analytical Reports*). This form recorded details of the individual samples being dispatched and the type of analysis required for each sample.

6.5 Laboratory Submission

Samples were analysed by Sydney Laboratory Services (SLS) (primary laboratory), Eurofins (secondary laboratory), specifically:

- 162 primary soil samples collected by ADE throughout the period of 15 December 2021 to 14 January for analysis of Heavy Metals, TRHs, PAHs, BTEX, VOCs, TBT, OCPs, OPPs, PFAS (Short-suite), were submitted to SLS
- 34 primary soil samples collected by ADE throughout the period of 15 December 2021 to 14 January for analysis of asbestos (500 mL) were submitted to SLS
- 15 blind replicate samples (QAQC) collected by ADE throughout the period of 15 December 2021 to 14 January for analysis of Heavy Metals, TRHs, PAHs, BTEX, OCPs and OPPs were submitted to SLS
- 10 split replicate samples (QAQC) collected by ADE throughout the period of 15 December 2021 to 14 January for analysis of Heavy Metals, TRHs, PAHs, BTEX, OCPs, OPPs were submitted to Eurofins

Table 7 outlines the sampling and analytical program for analysis of soil and soil QAQC samples collected within the site during the investigation. Refer to *Appendix V – Analytical Reports* and *Chain of Custody* for the analytical methods by the selected laboratories.

Inclusive within **Table 7** are pervious soil samples collected by Douglas Partners (DP) 30 September 2019 within the immediate vicinity of identified potential sources of contamination across the site from a total of 26 surface sample locations and 6 test pit locations. An additional 12 test pits and 2 bore holes, excavated for geotechnical and salinity purposes, were utilised as inspection test pits.

Table 7. Sampling and Analytical Program for the Site Investigation (refer to Appendix I – Aerial Figure).

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP01FILL_0.0-0.3	0.0-0.3	Fill	x							x
TP02FILL_0.0-0.2	0.0-0.2	Fill	x							x
TP03FILL_0.0-0.3	0.0-0.3	Fill	x							x
TP03NAT_0.3-1.3	0.3-1.3	Natural		x						x
TP04FILL_0.0-0.2	0.0-0.2	Fill	x							x
TP05FILL_0.0-0.5	0.0-0.5	Fill	x							x
TP05NAT_0.5-1.8	0.5-1.8	Natural		x						x
TP06FILL_0.0-0.2	0.0-0.2	Fill	x							x
TP07FILL_0.0-0.2	0.0-0.2	Fill	x							x
TP07FILL_0.0-0.2_BR	0.0-0.2	Fill	x							x
TP08FILL_0.0-0.2	0.0-0.2	Fill	x							x
TP08NAT_0.2-1.3	0.2-1.3	Natural		x		x				x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP08NAT_1.3-1.6	**1.3-1.6**	Natural		x						x
TP09FILL_0.0-0.3	**0.0-0.3**	Fill	x							x
TP09NAT_0.3-0.7	**0.3-0.7**	Natural		x						x
TP09NAT_0.7-1.4	**0.7-1.4**	Natural		x						x
TP10FILL_0.0-0.2	**0.0-0.2**	Fill	x							x
TP10FILL_0.2-0.7	**0.2-0.7**	Fill	x							x
TP10NAT_0.7-1.0	**0.7-1.0**	Natural		x						x
TP11FILL_0.0-0.3	**0.0-0.3**	Fill	x							x
TP12FILL_0.0-0.3	**0.0-0.3**	Fill	x							x
TP13FILL_0.0-0.2	**0.0-0.2**	Fill	x							x
TP14FILL_0.0-0.2	**0.0-0.2**	Fill	x							x
TP14NAT_1.3	**1.3**	Natural		x		x				x
TP15FILL_0.0-0.3	**0.0-0.3**	Fill	x							x
TP16FILL_0.0-0.45	**0.0-0.45**	Fill	x							x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP16NAT_0.45-1.0	**0.45-1.0**	Natural		x						x
TP17FILL_0.0-0.3	**0.0-0.3**	Fill	x							x
TP18FILL_0.0-0.3	**0.0-0.3**	Fill	x							x
TP19FILL_0.0-0.3	**0.0-0.3**	Fill	x							x
TP19FILL_0.0-0.3_BR	**0.0-0.3_BR**	Fill	x							x
TP20FILL_0.0-0.3	**0.0-0.3**	Fill	x							x
TP21FILL_0.0-0.2	**0.0-0.2**	Fill	x							x
TP22FILL_0.0-0.2	**0.0-0.2**	Fill	x							x
TP23-fill-0.1	**0.1**	Fill	x							x
TP23-fill-0.1	**0.1**	Fill	x							x
TP23-natural-0.4	**0.4**	Natural		x						x
TP24-fill-0.1	**0.1**	Fill	x		x	x	x	x		x
TP24-natural-0.4	**0.4**	Natural								x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP25-fill-0.1	**0.1**	Fill	x							x
TP25-fill-0.1	**0.1**	Fill	x							x
TP26-fill-0.1	**0.1**	Fill	x							x
TP26-natural-0.4	**0.4**	Natural		x						x
TP27-fill-0.1	**0.1**	Fill	x					x		x
TP27-fill-0.1	**0.1**	Fill	x							x
TP27-natural-0.4	**0.4**	Natural	x						x	x
TP28FILL_0.0-0.3	**0.0-0.3**	Fill	x							x
TP29FILL_0.0-0.3	**0.0-0.3**	Fill	x							x
TP30FILL_0.0-0.2	**0.0-0.2**	Fill	x							x
TP31FILL_0.0-0.3	**0.0-0.3**	Fill	x		x					x
TP32FILL_0.0-0.3	**0.0-0.3**	Fill	x							x
TP33FILL_0.0-0.2	**0-0.2**	Fill	x							x
TP34FILL_0.0-0.3	**0.0-0.3**	Fill	x							x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP34NAT_0.3-1.0	**0.3-1.0**	Natural		x		x				x
TP35-Fill-0.1	**0.1**	Fill	X							x
TP36-fill-0.2	**0.2**	Fill	x							x
TP36-natural-0.3	**0.3**	Natural		x						x
TP36-BR2-0.2	**0.2**	Fill	x							x
TP37-natural-0.4	**0.4**	Natural		x						x
TP37-fill-0.3	**0.3**	Fill	x	X	x	x	x	x		x
TP38-fill-0.3	**0.3**	Fill	x							x
TP39-fill-0.5	**0.5**	Fill	x				x			x
TP39-fill-0.5	**0.5**	Fill	x							x
TP39-BR1-0.5	**0.5**	Fill	x							x
TP40-fill-0.5	**0.5**	Fill	X							x
TP41-fill-0.5	**0.5**	Fill	x					x		x
TP41-fill-0.5	**0.5**	Fill	x							x
TP42-fill-0.5	**0.5**	Fill	x							x
TP43-fill-0.2	**0.2**	Fill	x							x
TP43-fill-0.2	**0.2**	Fill	x							x
TP43-natural-0.3	**0.3**	Natural	x							x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP44-fill-0.3	**0.3**	Fill	x							x
TP44-natural-0.4	**0.4**	Natural		x						x
TP45-fill-0.3	**0.3**	Fill	x							x
TP46-fill-0.3	**0.3**	Fill	x							x
TP46-natural-0.4	**0.4**	Natural		x						x
TP47-fill-0.1	**0.1**	Natural	x		x	x	x	x		x
21.1994.TP47-BR	**0.1**	Fill	x							x
TP47-natural-0.3	**0.3**	Natural		x						x
TP48-fill-0.1	**0.1**	Fill	x							x
TP48-natural-0.3	**0.3**	Natural		x						x
TP49-fill-0.1	**0.1**	Fill	x							x
TP49-fill-0.1	**0.1**	Fill	x							x
TP50-fill-0.2	**0.2**	Fill	x					x		x
TP50-fill-0.2	**0.2**	Fill	x							x
TP50-natural-0.4	**0.4**	Natural		x						x
TP51-fill-0.9	**0.9**	Fill	x							x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP51-natural-1.0	**1.0**	Fill	x		x	x		x		x
TP52-fill-0.3	**0.3**	Fill	x							x
TP52-fill-0.3	**0.3**	Fill	x							x
TP52-natural-0.4	**0.4**	Natural	x							x
TP53-fill-0.1	**0.1**	Fill	x							x
TP54-fill-0.1	**0.1**	Fill	x							x
TP54-fill-0.1	**0.1**	Fill	x							x
TP54-fill-0.2	**0.2**	Fill	x							x
TP54-BR2-0.1	**0.1**	Fill	x							x
TP55-fill-0.1	**0.1**	Fill	x							x
TP56-fill-0.4	**0.4**	Fill	x							x
TP56-fill-0.4	**0.4**	Fill	x					x		x
TP56-natural-0.5	**0.5**	Natural	x							x
TP57-fill-0.1	**0.1**	Fill	x							x
TP57-natural-0.2	**0.2**	Natural	X							x
TP58-fill-0.1	**0.1**	Fill	x							x
TP58-fill-0.1	**1.0**	Fill	x							x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP59-fill-0.1	**0.1**	Fill	x		x	x	x	x		x
TP59-natural-0.2	**0.2**	Natural		x						x
21.1994.BR1	**0.1**	Fill	x							x
TP60-fill-0.1	**0.1**	Fill	x							x
TP60-fill-0.1	**0.1**	Fill	x							x
TP61-fill-0.2	**0.2**	Fill	X							x
TP61-natural-0.3	**0.3**	Natural		x						x
TP62-fill-0.2	**0.2**	Fill	x							x
TP62-fill-0.2	**0.2**	Fill	x							x
TP62-natural-0.3	**0.3**	Natural		x						x
TP63-fill-0.1	**0.1**	Fill	x							x
TP64-fill-0.2	**0.2**	Fill	x							x
TP64-fill-0.2	**0.2**	Fill								x
TP64-natural-0.3	**0.3**	Natural		x						x
TP65-fill-0.1	**0.1**	Fill	x		x	x	x	x		x
TP65-natural-0.25	**0.25**	Natural		x						x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP66-fill-0.1	**0.1**	Fill	x							x
TP66-fill-0.1	**0.1**	Fill	x							x
TP67-fill-0.1	**0.1**	Fill	x							x
TP67-natural-0.2	**0.2**	Natural		x						x
TP68-fill-0.1	**0.1**	Fill	x					x		x
TP68-fill-0.1	**0.1**	Fill	x							x
TP68-natural-0.3	**0.3**	Natural		x						x
TP69-fill-0.1	**0.1**	Fill	x							x
21.1994.BR2	**0.1**	Fill	x							x
TP70-fill-0.2	**0.2**	Fill	x							x
TP70-fill-0.2	**0.2**	Fill	x							x
TP70-natural-0.4	**0.4**	Natural		x						x
TP71-fill-0.1	**0.1**	Fill	x		x	x	x	x		x
TP71-natural-0.3	**0.3**	Natural		x						x
TP72-fill-0.2	**0.2**	Fill	x							x
TP72-fill-0.2	**0.2**	Fill	x							x
TP73-fill-0.1	**0.1**	Fill	x							x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP73-natural-0.2	**0.2**	Natural		x						x
TP74-fill-0.1	**0.1**	Fill	x							x
TP74-fill-0.1	**0.1**	Fill	x							x
TP74-natural-0.1	**0.1**	Natural	x							x
TP75-fill-0.1	**0.1**	Fill	x							x
TP75-natural-0.3	**0.3**	Natural		x						x
TP76-fill-0.3	**0.3**	Fill	x							x
TP76-fill-0.3	**0.3**	Fill	x						x	x
TP76-BR1	**0.1**	Fill	x							x
TP77-fill-0.5	**0.5**	Fill	x	x	x	x	x	x		x
TP77-natural-0.6	**0.6**	Natural		x						x
TP78-fill-0.3	**0.3**	Fill	x							x
TP78-fill-0.3	**0.3**	Fill	x							x
TP79-fill-0.2	**0.2**	Fill	x							x
TP79-natural-0.3	**0.3**	Natural		x						x
TP80-fill-0.2	**0.2**	Fill	x					x		x
TP80-fill-0.2	**0.2**	Fill	x							x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP80-natural-0.3	**0.3**	Natural		x						x
TP81-fill-0.2	**0.2**	Fill	x							x
TP82-fill-0.2	**0.2**	Fill	x							x
TP82-fill-0.2	**0.2**	Fill	x							x
TP82-fill-0.3	**0.3**	Fill		x						x
TP83-fill-0.3	**0.3**	Fill	x	x	x	x	x	x		x
TP83-natural-0.4	**0.4**	Natural		x						x
TP84-fill-0.2	**0.2**	Fill	x							x
TP84-fill-0.2	**0.2**	Fill	x							x
TP85-fill-0.3	**0.3**	Fill	x							x
TP85-natural-0.4	**0.4**	Natural		x						x
TP86-fill-0.3	**0.3**	Fill	x					x		x
TP86-fill-0.3	**0.3**	Fill	x							x
TP86-natural-0.4	**0.4**	Natural		x						x
TP86-BR2-0.3	**0.3**	Fill	x							x
TP87-fill-0.3	**0.3**	Fill	x							x
88 (yet to be sampled)										

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
89 (yet to be sampled)	-									
90 (yet to be sampled)	-									
91 (yet to be sampled)	-									
TP92-fill-0.4	**0.4**	Fill	x	x	x	x	x	x		x
TP92-fill-0.4	**0.4**	Fill	x							x
TP92-natural-0.5	**0.5**	Natural		x						x
TP93FILL_0.0-0.4	**0.0-0.4**	Fill	x							x
TP93NAT_0.8-1.1	**0.8-1.1**	Natural		x						x
TP94FILL_0.0-0.2	**0.0-0.2**	Fill			x					x
TP95FILL_0.0-0.1	**0.0-0.1**	Fill	x							x
TP95NAT_0.1-0.5	**0.1-0.5**	Natural		x		x				x
TP96FILL_0.0-0.3	**0.0-0.3**	Fill	x							x
TP96FILL_0.0-0.3_BR	**0.0-0.3**	Fill	x							x
TP97-fill	**0.1**	Fill	x							x
TP97-nat	**0.3**	Natural	x							x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP97-BR	**0.1**	Fill	x							x
TP98-fill	**0.1**	Natural	x					x		x
TP98-nat	**0.3**	Natural	x							x
TP99-fill	**0.25**	Fill	x							x
TP100-fill	**0.1**	Fill	x							x
TP100-fill	**0.1**	Fill	x							x
TP100-nat	**0.2**	Natural	x							x
TP101FILL_0.0-0.4	**0.0-0.4**	Fill	x							x
TP102FILL_0.0-1.1	**0.0-1.1**	Fill	x							x
TP102NAT_1.1-1.9	**1.1-1.9**	Natural		x						x
TP103FILL_0.3	**0.3**	Fill	x							x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP104FILL_0.0-0.3	**0.0-0.3**	Fill	x							x
TP104NAT_0.3-0.8	**0.3-0.8**	Natural		x						x
TP105-fill	**0.0-0.3**	Fill	x							x
TP106-fill	**0.0-0.3**	Fill	x							x
TP106-fill	**0.0-0.3**	Fill	x							x
TP106-nat	**0.3-0.5**	Natural	x							x
TP107-fill	**0.1-0.2**	Fill	x		x	x		x		x
TP107-nat	**0.2-0.5**	Fill	x							x
TP108-fill	**0.1-0.2**	Fill	x							x
TP108-fill	**0.1-0.2**	Fill	x							x
109 (yet to be sampled)	**-**	Fill								
TP110-fill	**0.05**	Fill	x					x		x
TP110-nat	**0.1**	Natural	x							x
TP111-fill	**0.1**	Fill	x							x
TP112-fill	**0.1**	Fill	x							x
TP112-fill	**0.1**	Fill	x							x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
TP113-fill	**0.1**	Fill	x		x	x		x		x
TP113-nat	**0.3**	Natural	x							x
TP114-fill	**0.1**	Fill	x							x
TP114-fill	**0.1**	Fill	x							x
TP114-BR2	**0.1**	Fill	x							x
TP115-fill	**0.1**	Fill	x							x
TP115-nat	**0.3**	Natural	x							x
TP116-fill	**0.1**	Fill	x							x
TP116-fill	**0.1**	Fill	x					x		x
TP116-nat	**0.3**	Natural	x							x
TP117-fill	**0.1**	Fill	x							x
TP117-BR2	**0.1**	Fill	x							x
TP118-fill	**0.1**	Fill	x							x
TP118-nat	**0.2**	Natural	x							x
TP119-fill	**0.1**	Fill	x		x	x		x		x
TP119-nat	**0.3**	Natural								x
TP119-BR	**0.1**	Fill	x							x
TP120-fill	**0.1**	Fill	x							x

Table 7 continued…

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis							
			Standard Suite	8 HM, TRH, BTEX, PAHs	PFAS- short suite	VOCs / sVOCs and phenols	Salinity	NEPM	CEC / Clay Content	PID Field Screening
121 (yet to be sampled)	-	-								
TP122-fill	0.1	Fill	x					x		x
TP122-nat	0.3	Natural	x							x
TP123-fill	0.1	Fill	x							x
TP124-fill	0.1	Fill	x		x	x		x		x
TP124-nat	0.3	Natural	x							x
TP125-fill	0.1	Fill	x							x
TP126-nat	0.2	Natural	x							x
TP126-fill	0.1	Fill	x							x
TP127-nat	0.2	Natural	x							x
TP127-fill	0.1	Fill	x					x		x
TP128-fill	0.1	Fill	x							x
TP129-nat	0.3	Natural	x							x
TP129-fill	0.1	Fill	x		x	x		x		x
TP130-fill	0.1	Fill	x							x

Table 7a. Sampling conducted by DP 30.07.2019

Test pit ID / Sample No.	Depth (m bgl)	Sample Type	Analysis								
			Metals	PAH	TRH & BTEX	OCP	OPP & PCB	Phenols	PH & CEC	Asbestos 50g	Asbestos Bulk
DP-SS1	0.1	Fill	X	X	X	X				X	
DP-SS2	0.1	Fill	X	X	X					X	
DP-SS3	0.1	Fill	X	X	X	X	X	X		X	
DP-SS4	0.1	Fill	X	X	X						
DP-SS5	0.1	Fill	X	X	X	X				X	
DP-SS6	0.1	Fill	X	X	X	X				X	
DP-SS7	0.1	Fill	X	X	X	X	X			X	

DP-SS8	0.1	Fill	X	X	X	X					
DP-SS9	0.1	Fill				X					
DP-SS10	0.1	Fill	X	X	X	X				X	
DP-SS11	0.1	Fill				X			X		
DP-SS12	0.1	Fill				X					
DP-SS13	0.1	Fill	X	X	X	X	X	X		X	
DP-SS14	0.1	Fill	X	X						X	
DP-SS15	0.1	Fill	X	X	X	X	X			X	
DP-SS16	0.1	Fill				X	X		X		
DP-SS17	0.1	Fill		X							
DP-SS18	0.1	Fill		X	X						
DP-SS19	0.1	Fill		X							
DP-SS20	0.1	Fill	X	X	X	X	X	X		X	
DP-SS21	0.1	Fill	X	X	X	X	X			X	
DP-SS22	0.1	Fill	X	X	X	X				X	
DP-SS23	0.1	Fill	X	X	X	X				X	
DP-SS24	0.1	Fill	X			X				X	
MAT-1											X
MAT-2											
MAT-3											X
MAT-4											X
BD1											
BD2				X							
BD3											

Notes to Table 7

1 – Full suite of analysis includes BTEX, Heavy Metals, OCPs / OPPs, PAHs, PCB, TRHs, VOCs, PFAS and 10L asbestos screening

2 – 500 mL asbestos sample for asbestos fines/fibrous asbestos (AF/FA), as per NEPM (2013)

3 – Replicate suite of analysis includes Heavy Metals, OCPs / OPPs, PAHs, TRH and PCB

7 Assessment Criteria

7.1 Soil Assessment Criteria

The assessment criteria specified in the following publications were employed for this DSI:

- NEPC, National Environmental Protection Measure [NEPM] Schedule B1 (NEPC, 2013)
- NSW EPA, Waste Classification Guidelines. Part 1: Classifying Waste (NSW EPA, 2014)
- HEPA, PFAS National Environmental Management Plan (NEMP) v2.0 (HEPA, 2020)

7.1.1 Health Investigation Level (HILs)

The NEPM (2013) guidelines stipulate 4 generic land-use settings for assessment used in the first stage (Tier 1 or 'screening') of potential risks to human health for a broad range of metals and organic substances. The HIL's are applicable for assessing human health risk via all relevant pathways of exposure. The 4 HIL categories are used to evaluate human health risk via all relevant pathways of exposure for the following broad land use categories:

- HIL-A - Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake, no poultry, also includes children's day care centres, preschools and primary schools
- HIL-B - Residential with minimal opportunities for soil access includes dwellings with fully and permanently paved yard space such as high-rise buildings and flats
- HIL-C - Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. It does not include undeveloped public open space (such as urban bushland and reserves), which should be subject to a Site-specific assessment where appropriate and
- HIL-D - Commercial/industrial such as shops, offices, factories and industrial sites.

Based on available information, which includes future land use as an industrial estate, commercial/industrial (HIL-D) criteria has been adopted for the purposes of this investigation, refer to Table 8 below.

Table 8. Summary of HILs-D in Soil, adapted from Table 1A(1), Schedule B1 of NEPM (2013).

Analyte	HILs D - Commercial/Industrial (mg/kg)
Arsenic (total)	3,000
Cadmium	900
Chromium (total)	3,600
Copper	240,000
Lead	1,500
Mercury (inorganic)	730
Nickel	6,000
Zinc	400,000
Carcinogenic PAHs (as BaP TEQ[1])	40
Total PAHs	4,000
Total PCBs	7
DDT+DDE+DDD	3,600
Aldrin and Dieldrin	45
Chlordane	530
Endosulfan	2,000
Endrin	100
Heptachlor	50
Hexachlorobenzene	80
Methoxychlor	2,500

Analyte	HILs D - Commercial/Industrial (mg/kg)
Chlorpyrifos	2,000

7.1.2 Health Screening Level (HSLs)

HSLs have been developed for selected petroleum compounds and fractions and are applicable to assessing human health risk via the inhalation and direct contact pathways. The HSLs depend on specific soil physicochemical properties, land use scenarios, and the characteristics of building structures.

Health screening levels for petroleum hydrocarbon compounds are outlined in section 2.4 of Schedule B1 of NEPM (2013), and include tier 1 screening criteria for BTEX, naphthalene, TRH fractions C_6-C_{10} and C_{10}-C_{16} for vapour intrusion. As there is a potential pathway of exposure in relation to direct contact and ingestion for both construction workers and future users of the site, the HSL-D levels for direct human contact have also been adopted from CRC CARE (2011) and are further outlined in table 9 below**.**

Table 9. Site Assessment Criteria – HSLs for Soil Contamination.

Analyte	Health Screening Levels (HSLs)	
	Soil HSLs for Vapour Intrusion - HSL-D (mg/kg) (0m to <1m)	Soil HSLs for Direct Contact - HSL-D (mg/kg)[1]
Benzene	3	430
Toluene	-	99,000
Ethylbenzene	-	27,000
Xylene	230	81,000
Naphthalene	-	11,000
TRH: C6 – C10(F1)[3]	260	26,000
TRH: C10 – C16 (F2)	-	20,000
TRH: C16 – C34(F3)	-	27,000
TRH: C34 – C40(F4)	-	38,000

Notes to Table 9

1- Human exposure settings based on intended land use have been established for HILs/HSLs (see Taylor and Langley 1998). HIL-D – Commercial/Industrial such as shops, offices, factories and industrial sites, was the land use setting adopted for this investigation;

2- Carcinogenic PAHs: HIL is based on the 8 carcinogenic PAHs and their Toxic Equivalency Factor (TEFs) (potency relative to B[a]P). The B[a]P TEQ (Toxic Equivalency Quantity) is calculated by multiplying the concentration of each carcinogenic PAH in the sample by its B(a)P TEF.

3- To obtain F1, subtract the sum of BTEX from the C_6-C_{10} fraction.

7.1.3 Ecological Investigation Levels (EILs) and Ecological Screening Levels (ESLs)

The EILs assigned by the NEPM (2013) Schedule B5a - *Guideline on Ecological Risk Assessment* presents the methodology for deriving terrestrial EILs using both fresh and aged (i.e. > 2 years old) contamination for soil with the following land use types:

- Areas of ecological significance
- Urban residential/public open space, and
- **Commercial/industrial**.

The EILs are calculated by summing the added contaminant limit (ACL) and the ambient background concentration (ABC) of contaminants to derive the site-specific soil quality guideline (SQG). This process considers the pH, cation exchange capacity (CEC), total iron, total organic carbon and clay content in soil that can affect concentration toxicity data. The methodology was developed to protect soil processes, soil biota (flora and fauna) and terrestrial invertebrates and vertebrates.

For the determination of the ABCs, ADE utilised the method based on 25% of urban metal levels in Olszowy et al. (1995) for old and low traffic areas for NSW, as assigned by the NEPM (2013) – Schedule B1. CEC and clay content tests have not been conducted for developing site-specific EILs/ESLs.

In the absence of physiochemical properties data, ADE adopted the conservative values for assessing selected contaminants as outlined in NEPM 2013. A review of the NSW OEH 'eSPADE' was conducted for estimated value of soil CEC and clay content within the site, however the source location was not identified as having the relevant data. As such, conservative values were adopted for setting up the preliminary EILs / ESLs as outlined in **Table 10**. Values presented for Arsenic, Naphthalene and DDT are generic EILs based on total concentrations and aged (>2 years) / old contaminants.

Table 10. Derivation of site specific EILs as per NEPM (2013), with concentrations in mg/kg.

Contaminant	ABC[1]	ACL[2]	EIL
Arsenic (As)	-	-	160
Dichlorodiphenyltrichloroethane (DDT)	-	-	640
Naphthalene	-	-	370
Lead (Pb)	100	1800	1,900
Copper (Cu)	20	280	300
Nickel (Ni)	5	290	295
Chromium (Cr III)	8	660	668
Zinc (Zn)	75	130	205

Notes to Table 10

1 - ABC values derived from (Olszowy et al., 1995); and

2 - Since the absence of analytical data for EC and clay content, conservative values are adopted for assessing selected contaminants.

ESLs are presented based on a review of Canadian guidance for petroleum hydrocarbons in soil and application of the Australian methodology (Schedule B5b) to derive Tier 1 ESLs for BTEX, B(a)P and F1 and F2. The Canadians have adopted risk-based TPH standards for human health and ecological aspects for various land uses, refer to the technical supplement Canada-wide standard for petroleum hydrocarbons (PHC) in soil (CCME, 2008) directed by the Canadian Council of the Ministers of the Environment (CCME). The standards established soil values (refer to Table 1B (6) of the NEPM 2013) including ecologically based criteria for sites affected by TPH contamination for coarse-grained and fine-grained soil types.

Table 11. ESLs for TPH Fractions F1 – F4, BTEX and Benzo(a)pyrene (B[a]P) in Soil as per NEPM 2013.

Contaminant	Soil Texture	ESLs (mg/kg dry soil)
F1 TRH C_6-C_{10}	Coarse	215*
F2 TRH >C_{10}-C_{16}	Coarse	170*
F3 TRH >C_{16}-C_{34}	Coarse	1,700
F4 TRH >C_{34}-C_{40}	Coarse	3,300
Benzene	Coarse	75
Toluene	Coarse	135
Ethylbenzene	Coarse	165
Xylene	Coarse	180
B(a)P	Coarse	1.4

Notes to Table 11

1 – ESLs are of low reliability except where indicated by * which indicated that the ELS is of moderate reliability.

2 – To obtain F1, subtract the sum of BTEX from the C_6-C_{10} fraction.

7.1.4 Asbestos

ADE collected 34, 500 mL soil samples for analysis of asbestos fines (AF) and fibrous asbestos (FA). Collection of asbestos samples was restricted to the shallow surface/ fill layer at each sampling location. No soil samples were collected for asbestos analysis from the natural layer.

For soils to be considered suitable to remain on site they must comply with the HSL-D criteria outlined within the NEPM (NEPC, 2013). Refer to Table 12.

Table 12. HSLs for Asbestos in Soil.

Asbestos Form	Health Screening Level (w/w)			
	HSL A	HSL B	HSL C	HSL D
Non-friable Asbestos	0.01 %	0.04 %	0.02 %	0.05 %
FA and AF	**0.001%**			
All forms of asbestos	**No visible asbestos on the soil surface**			

7.1.5 Management Limits

Petroleum hydrocarbon management limits are a set of assessment criteria outlined in Section 2.9, M=management limits for petroleum hydrocarbon compounds, in Schedule B1, of NEPM (2013) applicable to petroleum hydrocarbon compounds which aim to avoid or minimise the potential effects of:

- Formation of observable light non-aqueous phase liquids (LNAPL)
- Fire and explosive hazards
- Effects on buried infrastructure e.g. penetration of, or damage to, in-ground services by hydrocarbons

The Management Limits provide Tier 1 screening levels following evaluation of human health and ecological risks and risks to groundwater resources. They are considered relevant for operating sites where significant sub-surface leakage of petroleum compounds may have occurred and decommissioned industrial and commercial sites. A summary of the adopted Management Limits for this site is provided in **Table 13**.

Table 13. Summary of Site Management Limits.

Chemical	Soil Type	Commercial/Industrial (mg/kg)
F1: TRH C6 – C10	Fine	700
F2: TRH C10 – C16	Fine	1 000
F3: TRH C16 – C34	Fine	3 500
F4: TRH C34 – C40	Fine	10 000

7.1.6 PFAS Assessment Criteria

To assess the potential risk of PFAS related contamination to human health, ADE has adopted the Health Investigation Levels assigned for commercial/industrial sites as referenced within the HEPA *PFAS National Environmental Management Plan Version 2.0 (2020)*. A summary of the PFAS related assessment criteria for the site is provided within Table 14.

Table 14. Site Assessment Criteria - PFAS HILs for Soil Contamination.

Analyte	Commercial/Industrial (mg/kg)
Sum of PFOS & PFAS	20
PFOA	50
PFOS	-

Notes to Table 14

1- Human exposure settings based on land use have been established for HILs/HSLs (see Taylor and Langley 1998). HIL-B – Residential with no use for home-grown produce and poultry and includes dwellings with fully and permanent paved yard space such as high rise-buildings and flats.

7.2 Aesthetics

As outlined in Section 3.6, in Schedule B1, aesthetic considerations of NEPM (2013) aesthetic quality of accessible soils should be considered even if analytical testing demonstrates that concentrations of CoPCs are within the SAC. It should be noted that there are no quantifiable guidelines in determining if soils are appropriately aesthetic. As stated in Section 3.6.3, the Assessment process for aesthetic issues, in Schedule B1, of NEPM (2013), professional judgement concerning the quantity, type and distribution of foreign materials and/or odours in relation to the specific land use should be employed.

The following examples would trigger further aesthetic assessment:

- Hydrocarbon sheen on surface water
- Anthropogenic soil staining
- Odorous soils (i.e. hydrocarbon or hydrogen sulphide odours)

7.3 Statistical Treatment

Analytical results from the soil sampling program are statistically analysed to determine their applicability to the assessment and recommendation of remedial actions in the event of Site assessment criteria exceedances.

A contaminant concentration in soil will be deemed a non-exceedance if:

- The maximum concentration of all samples meets the specified acceptance criteria; or
- The 95% Upper Control Limit (UCL) is below the acceptance criteria with the following criteria:
- The standard deviation of the results should be less than 50% of the relevant investigation or screening level; and
    - No individual exceedance should exceed 250% of the relevant investigation or screening level.

If the 95% UCL of the arithmetic mean of a contaminant concentration is above the acceptance criteria, then the soil will be classified as contaminated and will require further assessment, remediation, removal, or management.

If the 95% UCL of the arithmetic average concentrations is below the acceptance criteria, and no concentrations are at a hotspot level, slight elevations above the acceptance criteria may be considered to pose insignificant human health or environmental risk. The location will hence be considered a non-exceedance requiring no further assessment, remediation, removal, or management. The statistical analysis for the assessment of ACM is not considered appropriate.

8 Data Quality Assessment

To carry out the assessment of the data acquired during the investigation, the US EPA Guidelines including, but not limited to, the *'Guidance on Assessing Quality Systems'* (2003) and *'Guidance on Systematic Planning Using the Data Quality Objectives Process'* (2006) were used.

The guidelines provide a general strategy for assessing data quality criteria and performance specifications for decision making. The following is the output from most of the steps of the Data Quality Assessment (DQA) Process provided in the guidelines. Quality control reports from the laboratories for sample analyses were reviewed. The review included an assessment of blank, duplicate, control, and spiked samples. The review of the QA/QC program was conducted in accordance with NSW EPA recommendations.

8.1 Data Review

Quality control reports from the laboratories subcontracted for sample analyses were reviewed. Laboratory blank samples, duplicate samples, control samples, spiked samples and method blanks were evaluated (refer to *Appendix VI – QA/QC Output*).

This review was conducted in accordance with the items recommended by the NSW EPA for inclusion in the consultants' reports. Some additional recommendations from the US EPA methodology, as referred to by AS 4482.1, were also followed.

Following the QA/QC assessment, the validity of the results is determined based on the assessment criteria adopted, with the results expressed as either valid or invalid data (acceptable or unacceptable). The laboratory QA/QC sections can be found in their corresponding internal laboratory QA/QC reports (refer to *Appendix V – Chain of Custody Documentation and Laboratory Analytical Reports).*

8.1.1 COC

Australian Standard AS 4482.1 defines the Chain-Of-Custody (COC) documentation as the link in the transfer of samples between the time of collection and arrival at the laboratory.

The COC utilised by ADE included the items recommended by the Standard:

- Person transferred the samples;
- Person who received the samples
- Date the samples were collected
- Date the samples were received at the laboratory
- Contact name and details for the client.

Copies of the COCs completed during the course of this investigation are provided in *Appendix V – Chain of Custody Documentation and Laboratory Analytical Reports.*

8.1.2 Record of Holding Times

The objective is to ascertain the validity of the analytical results based on meeting the holding time for the samples from the time of collection to the time of analysis.

All samples collected over the course of the investigation were submitted within one day of the initial sampling event. As such, the holding times of all samples to the final submission to the laboratories used (SLS and Eurofins) meet the recommended holding time criteria, with all samples analysed within 7 days from the time of collection with the exception of test pit 35 (refer to *Appendix VI – QA/QC Output*).

8.1.3 Field Equipment Calibration

Field equipment requiring calibration included the use of a pre-calibrated PID with a 10.6 eV lamp. The item is calibrated by a qualified external technician every 12 months or as prescribed by the technician, which is followed by an onsite calibration (bump test) using isobutylene gas at 100 ppm before each sampling event and/or per every ten (10) consecutive readings by a trained environmental consultant.

8.1.4 Analytical Methods Used

Analysis was undertaken by NATA accredited laboratories using US EPA approved methodologies. Refer to *Appendix V – Chain of Custody Documentation and Laboratory Analytical Reports* for the analytical methods used by the laboratories, which in all cases were deemed appropriate for the required analyses.

8.1.5 Laboratory Accreditation for Analytical Methods Used

Analysis was undertaken in NATA accredited laboratories using US EPA approved methodology. Refer to *Appendix V – Chain of Custody Documentation and Laboratory Analytical Reports,* for the details of laboratory accreditations for analytical methods used. The laboratory accreditation of SLS and Eurofins were deemed suitable for the required analyses.

8.1.6 Detection Limits / Practical Quantification Limits

The smallest amount of a substance that can be detected by the laboratories used – SLS and Eurofins, above the background method noise in a procedure and within a stated confidence level is referred to as the detection limit. The current practice identifies several detection limits, including the following: (1) the instrument detection limit (IDL), (2) the lower level detection limit (LLD), the method detection limit (MDL) and the practical quantitation limit (LOR). The relationship among these levels is approximately IDL: LLD: MDL: LOR = 1: 2: 4: 10. Refer to SLS and Eurofins for the list of LORs provided by their respective laboratories. When dilution of a sample is involved in the sample preparation, the method detection limit is adjusted by the dilution factor.

8.2 Field QA/QC

A summary of the QA/QC samples collected during field works is provided in Table 15.

Table 15. Summary of Field QA/QC Samples.

Field QA/QC	Frequency	Sample Details	Field QA/QC Frequency Achieved?
Blind replicate sample (soil)	1 per 10 samples	• 15 blind replicate sample was collected during the investigation. - BR1 is an intra-laboratory replicate of primary sample TP07 - BR is an intra-laboratory replicate of primary sample TP19 - BR2 is an intra-laboratory replicate of primary sample TP36 - BR1 is an intra-laboratory replicate of primary sample TP39 - BR is an intra-laboratory replicate of primary sample TP47 - BR2 is an intra-laboratory replicate of primary sample TP54 - BR1 is an intra-laboratory replicate of primary sample TP59 - BR2 is an intra-laboratory replicate of primary sample TP69 - BR1 is an intra-laboratory replicate of primary sample TP76 - BR2 is an intra-laboratory replicate of primary sample TP86 - BR is an intra-laboratory replicate of primary sample TP96 - BR is an intra-laboratory replicate of primary sample TP97 - BR2 is an intra-laboratory replicate of primary sample TP144 - BR2 is an intra-laboratory replicate of primary sample TP117 - BR is an intra-laboratory replicate of primary sample TP119	Yes

Field QA/QC	Frequency	Sample Details	Field QA/QC Frequency Achieved?
Split Replicate sample (soil)	1 per 20 samples	• 10 split replicate sample was collected during the investigation. - SR1 is an inter-laboratory replicate of primary sample TP76 - SR2 is an inter-laboratory replicate of primary sample TP36 - SR is an inter-laboratory replicate of primary sample TP51 - SR is an inter-laboratory replicate of primary sample TP47 - SR is an inter-laboratory replicate of primary sample TP59 - SR is an inter-laboratory replicate of primary sample TP119 - SR is an inter-laboratory replicate of primary sample TP96 - SR1 is an inter-laboratory replicate of primary sample TP97 - SR is an inter-laboratory replicate of primary sample TP07 - SR is an inter-laboratory replicate of primary sample TP19	
Trip Blank	6	• 6 trip blank samples was collected during the investigation.	
Trip Spike	6	• 6 trip spike samples was collected during the investigation.	

8.2.1 Blind and Split Replicate Samples

Australian Standard 4428.1 and the NEPM (2013) specifies the typical Relative Percentage Data (RPD) values for replicate samples to be below 30%. If both samples values are less than the Limits of Reporting (LOR), the RPD is not calculated. Valid values are sample concentrations that fall within the control limits of 0-30% described above. Invalid values are concentrations that are outside of the control limits.

8.3 Soil

- 15 intra-laboratory blind replicate soil sample was collected to determine the variability of the sampling process. The replicate samples was collected simultaneously from the same source and under identical conditions as the primary samples which can be seen in table 16 below.

Table 16.

Sample Name	Valid Values	Invalid Values
TP39-BR1-0.5	79	0
TP54-BR2-0.1	78	1
TP36-BR3-0.2	79	0
21.1994.TP47-BR	78	1
21.1994.BR1	79	0
21.1994.BR2	78	1
TP76-BR1	77	2
TP86-BR2-0.3	79	0
TP07FILL_0.0-0.2_BR	79	0
TP114-BR2	79	0
TP117-BR2	79	0
TP119-BR	77	2
TP19FILL_0.0-0.3_BR	79	0
TP96FILL_0.0-0.3_BR	79	0
TP97-BR	78	1

- 10 inter-laboratory split replicate sample was collected to measure the variability between the laboratory analysis process. The primary samples were submitted to SLS and were compared to the replicate samples submitted to Eurofins. The results can be seen below in table 17.

Table 17.

Sample Name	Valid Values	Invalid Values
TP47-fill-0.1 21.1994.SR	65	0
TP51-fill-0.9 TP51.SR	50	15
TP36-fill-0.2.SR2	0	0
TP59-fill-0.1.21.1994.SR	65	0
TP76-fill-0.3.SR1	64	1
TP07FILL_0.0-0.2.SR	65	0
TP119-SR	65	0
TP19FILL_0.0-0.3.SR	65	0
TP96FILL 0.0-0.3 SR	65	0
TP97-SR1	65	0

8.4 Laboratory QA/QC

8.4.1 Laboratory Duplicates

- Duplicate sample determinations were provided by the laboratories to demonstrate acceptable method precision at the time of analysis.
- Duplicates are generally analysed at a frequency of one (1) for every ten (10) samples. Australian Standard 4482.1 provides an acceptable range of the RPD values up to 50% for quality control samples, depending on the magnitude of results compared to the LOR.
- Analysis of laboratory duplicates showed nil invalid values.

8.5 QA / QC Data Evaluation

The qualitative and quantitative descriptors, so called Data Quality Indicators (DQIs), were used in interpreting the degree of acceptability of the data acquired in the course of the investigation.

The principle DQIs are precision, accuracy, representativeness, comparability, and completeness, referred to by the acronym PARCC. Precision and accuracy are quantitative measures, representativeness and comparability are qualitative, and completeness combines both quantitative and qualitative measures. Table 18 summarises the DQO reconciliation.

Table 18. Summary of DQO Reconciliation.

QA/QC Item	DQO Criteria	Valid Data	Invalid Data	Completeness	Conclusion
Blind Replicate Samples	75%	1177	8	99.32%	Acceptable
Split Replicate Samples	75%	569	16	97.19%	Acceptable
Trip Spike Samples	75%	620	0	100%	Acceptable
Trip Blank Samples	95%	567	0	100%	Acceptable
Overall Completeness:	**95%**	**2933**	**24**	**99.13%**	**Acceptable**

Notes to Table 18

1 - The one (1) invalid value was less than one (1) order of magnitude from the adopted LOR and was thus not considered to have an impact on the overall chemical assessment. .

*LOR – Limits of Reporting

A total of twenty-four 'invalid' values were recorded throughout the data quality assessment. ADE considers the 'invalid' results are likely attributed to the difficulties in obtaining a homogeneous sample from heterogeneous matrices. The ratio of the valid data to the total number of analyses conducted in the QA/QC program yielded **99.13%**%, thereby meeting the DQO criteria of 95% completeness.

9 Summary of Investigation Results

9.1 Field Observations

During site investigations, the soil matrix was observed to primarily consist of natural topsoil and medium clays. Some organic material and fine gravels were observed throughout the soil matrix. Shipping containers, water pumps and irrigation equipment as well as various vehicles were present throughout the site.

9.1.1 Site Soil and Sub Soil Geology

The profile of the soil materials within the investigation area consisted of natural material extending from 0.0 – 0.4 m bgl. Natural material was observed at 0.4m – 2.0m bgl.

9.1.2 PID Field Screening

Soil samples were screened for the presence of VOCs using a PID. The PID readings reported negligible concentrations across the Site, which ranged from 0.0 ppm to 0.3 ppm. This indicates that volatile petroleum hydrocarbons were not present at high concentrations. Refer to *Appendix II - Analytical Results Table* for PID Results.

9.2 Soil Results

Soil analytical results from each sample collected during the course of the investigation are presented in *Appendix II - Analytical Results Table*.

Laboratory results indicate that all samples collected returned with concentrations of CoPC below the SAC

9.2.1 Soil Suitability Assessment – Human Health

Of the 162 primary soil samples analysed for the full chemical suite that was utilised for the investigation, all samples returned with concentrations below that of the adopted human health assessment criteria for Tier 1 screening purposes for commercial/industrial sites (HIL-D) and health screening levels for vapour intrusion and direct human contact (HSL-D), as outlined in the NEPM (*NEPC, 2013*).

9.2.2 Asbestos Assessment

No asbestos was observed within any of the 500mL samples submitted for analysis (refer to *Appendix V - Chain of Custody Documentation and Analytical Reports*).

10 Conceptual Site Model

10.1 Potential Contamination Types

NEPM (NEPC, 2013) identifies a Conceptual Site Model (CSM) as a representation of information regarding contamination sources, exposure pathways and the potential receptors. The essential elements of a CSM include:

- Known (and potential) contamination sources and contaminants of concern
- Impacted media (e.g. soil, groundwater, surface water, soil vapour etc.)
- Human/ecological receptors and
- Potential/complete exposure pathways.

The CSM developed for the site was based on previous environmental data and the soil analytical results reported in this investigation. This provided an understanding of the CoPC and their likely pathways. For the purposes of this report, the following qualitative risk assessment has been applied:

- Low Risk – the activities and related CoPC are likely to pose no or a low potential human health/environmental impact. Any impact is likely localised to a specific area of the Site
- Moderate Risk – the activities and related CoPC are likely to pose potential for moderate human health/environmental impact. Any impact is likely localised to a specific area of the Sit
- High Risk – the activities and related CoPC could pose a significant environmental impact. There is potential for impacts of the immediate local area of the Site or off-Site migration impacting surrounding human and/or environmental receptors

10.2 Sources of Contamination and Contaminants of Potential Concern

The investigation identified 1 elevated concentration of contaminates in soil materials across the site. Sample TP27-fill-0.1 returned an exceedance of 4.68 mg/kg in relation to Benzene, however, did not exceed 2.5 times HSL-D criteria, therefore UCL95 was conducted using samples collected from same strata and within the same Lot (Lot 21 DP 255560) and returned an acceptable reading of 1.61 mg/kg, below the 3 mg/kg HSL-D criteria.

10.3 Model

Primary sources of contamination may include the following:

- On-site migration of unidentified contamination in adjacent lots/imported material in the event of excavation/movement of soil materials.
- Historical use of roadways for transport purposes
- Topsoil impacted by petroleum hydrocarbons
- Pesticides used throughout the site

Receptors of the contamination include:

- Construction workers and intrusive site workers
- Future owners/users of the site

Potential exposure pathways from the contamination to the receptors include:

- Exposure of construction workers and personnel on-site to contaminated site soils is possible. The risk is assessed as low due to the ability to manage the work site and implement appropriate controls.

ADE notes that none of the soil results reported in this investigation exceeded the adopted human health criteria (HSL-D)

- Exposure of the public to contaminated soils is unlikely. The site soil will be inaccessible to the public due to hardstand cover over most of the site

11 Discussion

11.1 Soil Contamination

From the 164 samples that were collected from 124 test pit locations throughout the Site, the samples returned with concentrations of CoPCs below the adopted human health and ecological criteria.

ADE understands any remediation of soils within the site may result in increased potential for dust by disturbing those soils. Given that major excavation work is proposed during the construction phase and chemical concentrations were below tier 1 assessment levels, ADE is of the opinion that remediation of soils under the proposed industrial estate are not required.

It is noted that soil materials at depth (>2.0 m) were not assessed as part of this investigation.

ADE notes previous AEC's and associated CoPC's outlined in Douglas Partners (DP) Contamination Status Summary Report (DP, 2021) **table 3**. As such, ADE wishes to revise said AEC's and associated COPC's due to sufficient sampling events and chemical analysis. See **table 19** below.

Table 19. Revision of AEC's and associated CoPC's

AEC #	Potential Source and Assigned AEC	Revision	Requirement for Additional Data and/or Management
AEC 1	Market gardening activities (pesticides)	No OCP, OPP or metal exceedances were identified within ADE's chemical analysis.	AEC 2 and AEC 3 remain open. Therefore, further intrusive investigation is required to assess potential contamination impact to surface soils. (A further assessment of soils and groundwater may be necessary should significant contamination be identified in surface soils).
AEC 2	Building construction, degradation and demolition structures (hazardous building materials)	Must remain in place and revisited post demolition of dwellings and other detached structures.	
AEC 3	Chemical and fuel use/storage (potential chemical spills)	Must remain in place due to access limitations in barns, storage spaces and garages.	
AEC 4	Stockpiles, fill and ground disturbances (unknown contamination status)	No TRH, BTEX, PAH, PCB, metals, OCP, OPP or asbestos exceedances were identified within ADE's chemical analysis.	
AEC 5	Presence of timber power poles	Sufficient sampling events conducted in the near vicinity of timber power poles revealed no elevation of TRH, BTEX, PAHs or metals within ADE's chemical analysis.	
AEC 6	Possible asbestos pipe network	No asbestos was located in ADE's visual inspection or within any of the analysed 500 mL NEMP samples. No pipe work was intercepted.	
AEC 7	Refuse	No asbestos was located in ADE's visual inspection or within any of the analysed 500 mL NEMP samples.	

Douglas Partners (DP) had previously collected soil samples from 12 test pits from a grid formation with an additional six targeted test pits on areas of concern. Depths ranging from 0 – 0.2m, 0.2 – 0.5m. Sampling sites which were tested for TPH's, heavy metals, PAH's, phenols, BTEX, pesticides (OCP, OPP and PCB), and asbestos. All results for TRH, BTEX, OCP's, OPP's, PCB's and Phenols were detected at concentration not exceeding regulation levels. One sample exceeded Ecological and Health Screening and Investigation safe levels of PAH's (SS18 benzo(a)pyrene (BaP) TEQ at 61mg/kg). Heavy metal samples had two zinc samples with exceeding Ecological Screening and Investigation levels (SS15 at 2400mg/kg and SS20 at 780mg/kg) and one had exceeding ESLs/ EILs of arsenic (SS14 at 230mg/kg). Asbestos (chrysotile) was detected in two material samples (MAT-1 and MAT-2) with no soil samples coming back with contamination.

11.2 Surface water

Based on the scope of the investigation, no groundwater assessment was undertaken. Surface water will be assessed and included within the final version of the report.

11.3 Duty to Report Contamination

For the purposes of section 60(3)(b) of the CLM Act, notification of contamination in, or on, soil on the land is required where:

- The 95 % UCL on the average arithmetic concentration of a contaminant in or on soil is equal to or above the HIL and/or HSL for that contaminant for the current or approved use of the respective on-site land, as specified in Section 6, Schedule B1 of the NEPM (2013) or
- The concentration of a contaminant in an individual soil sample is equal to or more than 250% of the HIL and/or HSL for that contaminant for the current or approved use of the respective on-site land, as specified in Section 6, Schedule B1 of the NEPM (NEPC, 2013) and
- A person has been or foreseeably will be exposed to the contaminant or a by-product of the contaminant

Based on the results of this investigation, ADE considers there is no duty to report contamination.

12 Conclusions

Based on the data and evidence collected from the Stage I DSI, the following conclusions can be made:

12.1 Soil Assessment

- At the time of the inspection, soil materials primarily consist of natural topsoil and medium clays. Some organic material and fine gravels were observed throughout the soil matrix.
- All field PID readings returned negligible concentrations in between 0.0 - 0.2 ppm
- Of the 162 primary soil samples analysed, no exceedances were recorded against any of the adopted human or ecological health SAC
- No asbestos was observed within any of the 10L samples screened on site, or detected within any of the 34 500 mL soil samples analysed
- Sample TP27-fill-0.1 returned an exceedance of 4.68 mg/kg in relation to Benzene, however, did not exceed 2.5 times HSL-D criteria, therefore a UCL95 was conducted using samples collected within the same strata and same Lot (Lot 21 DP 255560) and returned an acceptable reading of 1.61 mg/kg, which is below the 3 mg/kg HSL-D criteria.

12.2 Data Gaps

Based on the results of the soil assessment, and proposed development comprising of hardstand over the majority of the site, ADE considers that groundwater is not likely to be affected by on-site soils and the proposed development. Should development plans change, or should groundwater be encountered during the construction works, further assessment may be required.

ADE notes that certain areas were inaccessible due to market gardens and small-large greenhouses within lots 20, 22, 30 and 32, tall grass and dense vegetation throughout, underground septic tanks adjacent to properties, irrigation and drainage equipment throughout markets gardens and adjacent to dams, overhead height restrictions as well as other infrastructure preventing either the consultant or excavator from accessing a certain sampling point. As such, an adaptive sampling strategy was implemented by the by the on-site consultant which involved targeted sampling in safe and accessible areas. ADE intends to revisit inaccessible sampling points in the near future to take additional samples for chemical analysis.

12.3 Site Suitability

In the context of the proposed industrial estate development for warehousing, ADE concludes that the site can be considered suitable for the proposed commercial/industrial land use.

13 Limitations and Disclaimer

This report has been prepared for the exclusive use of the client and is limited to the scope of the work agreed in the terms and conditions of contract (including assumptions, limitations and qualifications, circumstances, and constraints). ADE has relied upon the accuracy of information and data provided to it by the client and others.

ADE has used a degree of care and skill ordinarily exercised in similar investigations by reputable members of the environmental industry in Australia. No other warranty, expressed or implied, is made or intended. No one section or part of a section, of this report should be taken as giving an overall idea of this report. Each section must be read in conjunction with the whole of this report, including its appendixes and attachments. The report is an integral document and must be read in its entirety.

To the fullest extent permitted by law, ADE does not accept or assume responsibility to any third party (other than the client) for the investigative work, the report or the opinions given.

The scope of work conducted, and report herein may not meet the specific needs (of which ADE is not aware) of third parties. ADE cannot be held liable for third party reliance on this document. Any third party who relies upon this report does so at its own risk.

The subsurface environment can present substantial uncertainty due to it complex heterogeneity. The conclusions presented in this report are based on limited investigation of conditions at specific sampling locations chosen to be as representative as possible under the given circumstances. However, it is possible that this investigation may not have encountered all areas of contamination at the site due to the limited sampling and testing program undertaken.

The material subject to classification pertains only to the site and subject area outlined within the report and must be consistent with the waste description reported. If there are any unexpected finds that are not consistent with this classification, ADE must be notified immediately.

ADE does not verify the accuracy or completeness of, or adopt as its own, the information or data supplied by others and excludes all liability with respect to such information and data. To the extent that conditions differ from assumptions set out in the report, and to the extent that information provided to ADE is inaccurate or incomplete or has changed since it was provided to ADE, the opinions expressed in this report may not be valid and should be reviewed.

ADE's professional opinions are based upon its professional judgement, experience, training, and results from analytical data. In some cases, further testing and analysis may be required, thus producing different results and/or opinions. ADE has limited its investigation to the scope agreed upon with its client.

This Limitation and Disclaimer must accompany every copy of this report.

14 References

- Australian Standard AS 4482.1 Guide to the sampling and investigation of potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds
- Australian Standard AS 4482.2 Guide to the sampling and investigation of potentially contaminated soil. Part 1: Volatiles substances
- Department of Land and Water Conservation (DWLC). (2002). *Site Investigations for Urban Salinity*. Sydney NSW.
- Department of Environment and Conservation (DEC). (2005). NSW Contaminated Sites: Guidelines for Assessing Former Orchards and Market Gardens, dated June 2005
- Department of Environment and Conservation (DEC). (2017). *Guidelines for the NSW Site Auditor Scheme*, 3rd Edition
- Guidance for the Data Quality Objectives Process (EPA QA/G-4)
- Guidance on Quality Assurance Project Plans (EPA QA/G-5)
- Guidance for the Preparation of Standard Operating Procedures for Quality-Related Documents (EPA QA/G-6)
- Guidance for Data Quality Assessment: Practical Methods for Data Analysis (EPA QA/G-9)
- Guidance on Data Quality Indicators, EPA QA/G-5I
- Guidelines on the Duty to Report Contamination under the Contaminated Management Act 1997
- National Environmental Protection (Assessment of Site Contamination) Measure 1999, 2013 Amendment
- NSW EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)
- NSW EPA Sampling Design Guidelines (1995)
- NSW EPA. (2000). Contaminated Sites: Guidelines for Consultants Reporting
- NSW EPA. (2001) Waste Avoidance and Recovery Act
- NSW EPA. (2014). Waste Classification Guidelines Part 1: Classifying Waste. NSW EPA, November 2014.
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- NSW EPA. (2017) Contaminated Land Management: Guidelines for the NSW Site Auditor Scheme 3rd Ed.
- NSW EPA (2020) Contaminated Land Guidelines: Consultant Reporting on Contaminated Land, 2020
- NSW Safework Australia Code of Practice - How to Safely Remove Asbestos, 2019
- Standards Australia. (2004). Australian Standard AS4964-2004: Method for the qualitative identification of asbestos in bulk samples. Sydney, NSW.
- The Heads of EPAs Australia and New Zealand [HEPA]. (2020). PFAS National Environmental Management Plan Version 2.0, dated January 2020 (HEPA, 2020).
- Western Australia Department of Health (WA DoH). (2009) Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia, dated May 2009.
- Workcover NSW Storage and Handling of Dangerous Goods (2005)
- Work Health and Safety Act 2011
- Work Health and Safety Regulation 2017

APPENDIX A - FIGURES

APPENDIX B – ANALYTICAL RESULTS TABLE

APPENDIX C - PHOTOGRAPHS

Photograph 1. Soil matrix throughout TP79. Date: 16.12.2021.

Photograph 2. Soil matrix throughout TP87. Date: 16.12.2021.

Photograph 3. Soil matrix throughout TP37. Date: 16.12.2021.

Photograph 4. Soil profile throughout TP62. Date: 15.12.2021.

Photograph 5. Soil matrix throughout TP27. Date: 20.12.2021.

Photograph 6. Fill materials throughout TP49. Date: 20.12.2021.

Photograph 7. Soil matrix throughout TP29. Date: 15.12.2021.

Photograph 8. Fill materials observed at TP65. Date: 15.12.2021.

APPENDIX D – TEST PIT LOGS

APPENDIX E - CHAIN OF CUSTODY DOCUMENTATION AND ANALYTICAL REPORTS

APPENDIX F - QAQC OUTPUT

APPENDIX G – SUPPORTING DOCUMENTS

ADECONSULTINGGROUP
SOLUTIONS THROUGH INNOVATION

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Appendix H

Construction Traffic Management Plan

asongroup

Prepared for

FIFE STOCKLAND TRUST

Preliminary Construction Traffic Management Plan

200 Aldington Road, Kemps Creek

Ref: 1294r03
30/09/2020

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Document Control

Project No: 1292

Project: Industrial Precinct SSDA, 200 Aldington Road, Kemps Creek

Client: Fife Stockland Trust

File Reference: 12924r03 Draft CTMP_200 Aldington Rd, Issue

Revision History

Revision	Date	Details	Author	Approved by
-	30/09/2020	Issue	V. Cheng	R. Butler-Madden

Table of Contents

Appendices

1 Introduction

1.1 Overview

Ason Group has been engaged by Fife Capital and Stockland (Fife Kemps Creek Trust) to prepare a Draft Construction Traffic Management Plan (CTMP) in regard to the future construction of industrial development at 200 Aldington Road, Kemps Creek (the Site).

This CTMP details the proposed construction management strategies which would provide for the safe and efficient completion of the proposed works while minimising construction traffic impacts on the surrounding road network and public road network users.

From the outset, it is noted that the this CTMP is designed to be updated over time as additional details in regard to the construction proposal are revised / finalised as is standard in any major construction project, noting that all such updates would be completed in consultation with Penrith City Council (Council) in whose Local Government Area (LGA) the Site lies; and / or with the relevant authorities such as Transport for NSW (TfNSW) where special road occupancy or the like are required.

Importantly, Ason Group has been responsible for the preparation of this Draft CTMP, which has been prepared with reference to all available information in regard to the construction program, and all relevant CTMP preparation guidelines. The implementation of the recommendations and strategies detailed in this CTMP are the strict responsibility of Fife Kemps Creek Trust and / or the designated construction Project Manager.

2 The Site

2.1 Site Location

The Site is comprised of 7 separate allotments with a total area of approximately 72 Hectares (ha). The Site is located approximately 5km north-east of the future Western Sydney International (Nancy-Bird Walton) Airport (WSA), 13.5km south-east of the Penrith CBD and 40km west of the Sydney CBD.

The Site in its sub-regional context is shown in **Figure 1**, as well as the broader Mamre Road Precinct as designated by DPIE.

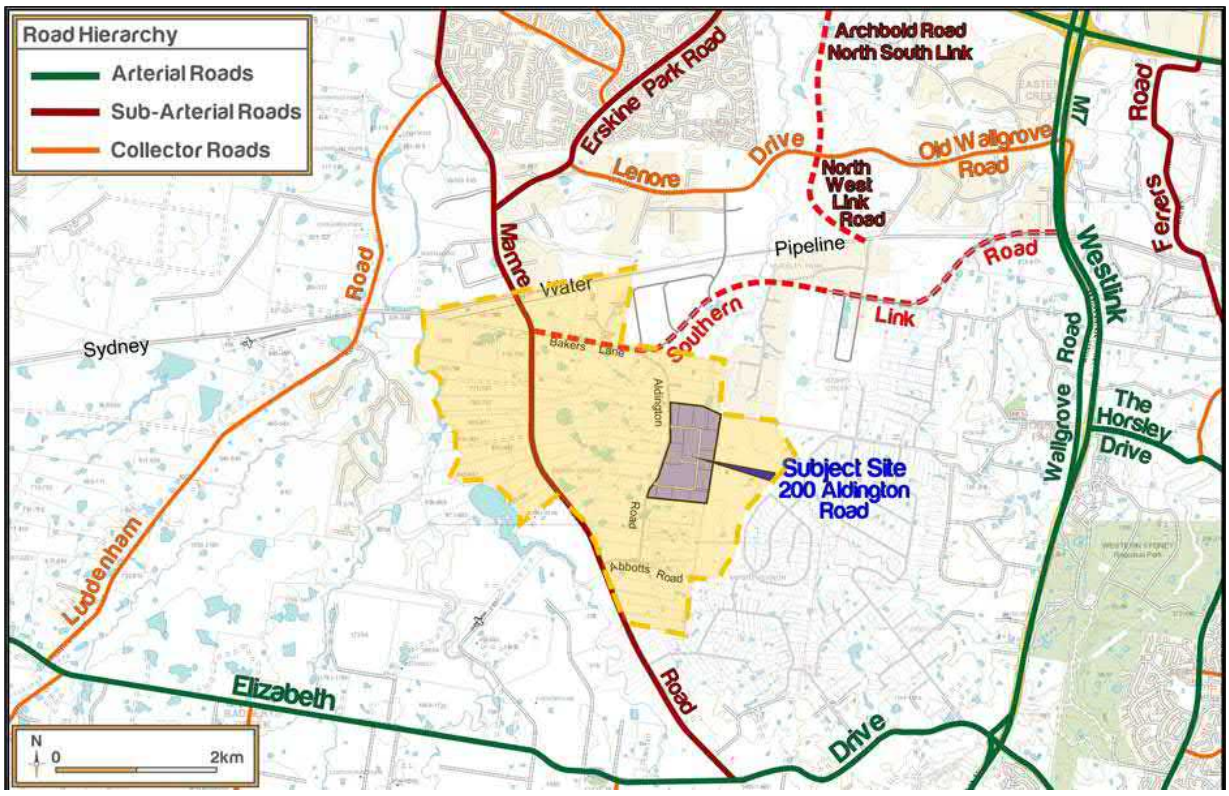


Figure 1: Site Location

2.2 Road Network

Key roads in the vicinity of the Site are shown in **Figure 1**, and include:

- **Westlink M7 Motorway:** M7 Motorway is a high capacity road link of state significance and was built to accommodate future traffic growth in the Western Sydney region. It provides a key north-south link between the M2 Motorway to the north and the M5 Motorway to the south as part of the Sydney orbital road network. A major interchange between the M7 Motorway and M4 Western Motorway is located approximately 3.5 km north of the Site, which connects the Sydney CBD and

western Sydney suburbs. The M7 Motorway provides 4 lanes (2 lanes per direction, divided carriageway) and has a posted speed limit of 100 km/h

- **(Future) M12 Motorway**: A proposed 16km motorway generally running in an east-west between the existing M7 motorway and the Northern Road. It is expected to run in parallel with Elizabeth Drive and is to have 2 lanes in each direction separated by a central median. Construction is expected to commence in 2020.
- **Wallgrove Road:** Wallgrove Road is an arterial road that runs in a north-south direction to the east of the Site and parallel (to the west of) the M7, functioning as a service road. The 2-lane, two-way road provides a link between the Great Western Highway to the north and Elizabeth Drive to the south. As with the M7, Wallgrove Road connects to the M4 motorway approximately 2.5 kilometres to the north of the Site.
- **Elizabeth Drive:** An TfNSW classified main road (MR 535) that runs in an east-west direction to the south of the site. Elizabeth Drive in the vicinity of the site generally provides 2 lanes (1 lane per direction) and has a posted speed limit of 80km/h. This road forms the Site's southern frontage and provides a vital link between Westlink M7 Motorway and The Northern Road.
- **The Northern Road:** The Northern Road is TfNSW classified main road (MR 154) that runs in a north-south direction to the west of the site. The Northern Road section near the vicinity of the site generally provides 3 lanes (1 to 2 lanes per direction) and has a posted speed limit of 80km/h. Currently, The Northern Road is undergoing multiple stages of road upgrades by RMS, including a realignment of the road in the south. The road upgrades between The Old Northern Road, Narellan and Peter Brock Drive, Oran Park, has been completed.
- **Mamre Road:** Mamre Road is an arterial road servicing traffic between the Great Western Highway and M4 to the north and Elizabeth Drive to the south. In the vicinity of the Site, Mamre Road generally provides 2 lanes for two-way traffic, with additional through movement and turning infrastructure at key intersections to the north through the Erskine Park and Mamre West industrial precincts, and at Elizabeth Drive to the south. Mamre Road has a posted speed limit of 80km/h in the vicinity of the Site. TfNSW has confirmed road upgrades will be undertaken for Mamre Road between Elizabeth Drive and Luddenham Road.

Further to the above, it is clear that the Site is well located in regard to immediate access to the local and sub-regional road network, as shown in **Figure 2** with specific reference to the current TfNSW Restricted Access Vehicle (RAC) routes, which allow for up to 25m/26m B-Double combinations.

Figure 2: TfNSW Approved 25/26m B-Double Routes

3 Overview of Construction Works

3.1 Staging and Duration of Works

While there is no Contractor engaged for the project, for the purposes of the Draft CTMP, staging and duration of works has been based on similar developments in the area. Based on this, it is anticipated that construction works would commence in 2021 and be completed over a duration between 2-3 years, subject to authority approvals and inclement weather delays.

The following summarises key aspects of the construction stages:

- Demolition works are set to have a duration for 8-12 weeks commencing in 2021.
- Excavation activities would continue for 12-18 months commencing in 2021 finishing Mid-Late 2022.
- General Construction works are estimated to continue concurrently to excavation activities for 12-24 months commencing Mid-End 2021.

3.2 Construction Hours

The type of work being undertaken will remain consistent throughout the duration of construction and associated activities. All works will be undertaken within the following hours:

- Monday to Friday (other than Public Holidays): 7:00am – 6:00pm.
- Saturday: 8:00am – 1:00pm
- Sunday & Public Holidays: No works to be undertaken.

Any work to be undertaken outside of the standard construction hours will be required to obtain an Out of Hours (OOH) approval; any such works would necessarily be undertaken in accordance with the appropriate OOH protocols and approval processes.

3.3 Site Access

3.3.1 Construction Vehicle Access

All construction vehicles will enter and depart the Site from / to Mamre Road via Abbotts Road and not Bakers Lane, to avoid conflict with the School peak periods. A temporary access driveway will be provided, which will be constructed on the alignment of the future Southern Site Access Road.

It is anticipated that the largest vehicle accessing the Site would be a 19.6m Truck & Dog combination, which the temporary access driveway will be designed for.

The following **Figure 3** shows the indicative Site access location and **Figure 4** details the likely key access strategy into the routes between the Site and the regional road network.

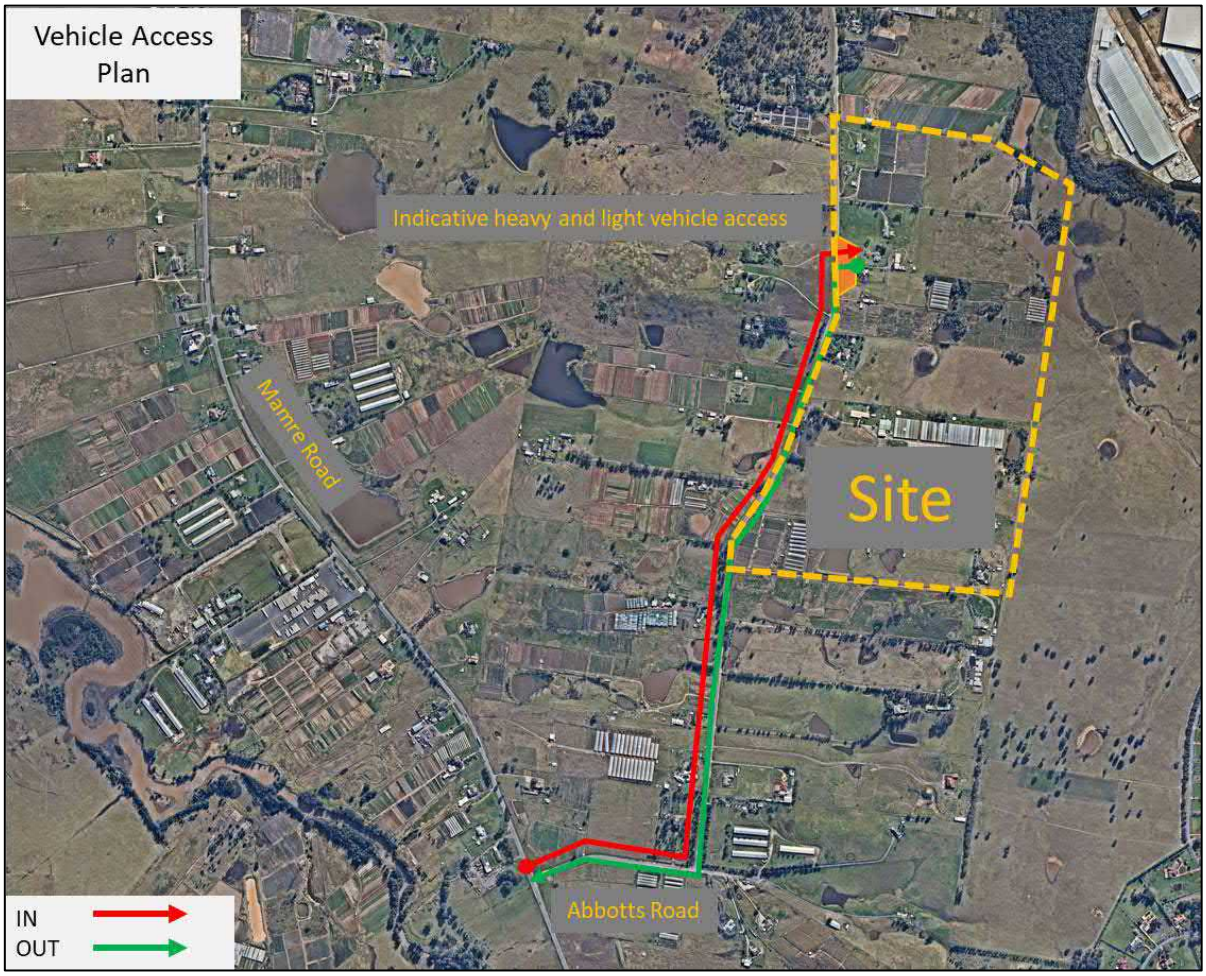


Figure 3: Indicative Vehicle Access Plan

3.3.2 Emergency Vehicle Access

Emergency vehicle access to and from the Site will be available at all times while the Site is occupied by construction workers; emergency protocols during the works will be developed by the Project Manager for inclusion within the final CTMP.

3.3.3 Pedestrian Access

There are currently no pedestrian amenities or footpaths along Aldington Road adjacent to the Site. However, the grassed verge on both sides of the road remains usable for any pedestrian that may wish to walk along Aldington Road.

Further to the above, while there is no expectation of pedestrians crossing the future construction access road, pedestrian safety will be managed through the provision of appropriate signage and pedestrian barriers. Construction personnel will also be able to access the Site by foot via a secure access gate

along the temporary access road, though with all construction staff (and vehicle) parking to be provided within the Site there is again little potential for such pedestrian demand.

3.4 Construction Vehicle Access Routes

As discussed, all construction vehicles will enter and exit the Site via Aldington Road.

It is anticipated that all heavy vehicles will access Site via the following routes:

- Arrival Trips:
  - Route 1: From M4 Western Motorway, southbound along Mamre Road and left into Abbotts Road, right into Site.
  - Route 2: From Westlink M7, westbound on Old Wallgrove Road, Lenore Drive and Erskine Park Road, then south along Mamre Road and left into Abbotts Road.
- Departure Trips:
  - Route 1: From the Site, left onto Aldington Road then south on Mamre Road to Elizabeth Drive and left to the M7 Motorway and sub-regional routes to the east.
  - Route 2: From the Site, left onto Aldington Road then south on Mamre Road to Elizabeth Drive and right to Badgerys Creek and The Northern Road to the west.

These routes are shown in **Figure 4**.

A copy of the approved routes will be distributed by the Project Manager to all drivers as part of their induction process.

In the event that an oversized or over-mass vehicles is required to travel to and / or from the Site, a permit from Roads and Maritime Services and / or the National Heavy Vehicle Register (NHVR) will be required prior to arrival to the site. Notwithstanding, this CTMP relates to general construction which does not seek the use of oversize vehicles; a separate application would be submitted if such access is required.

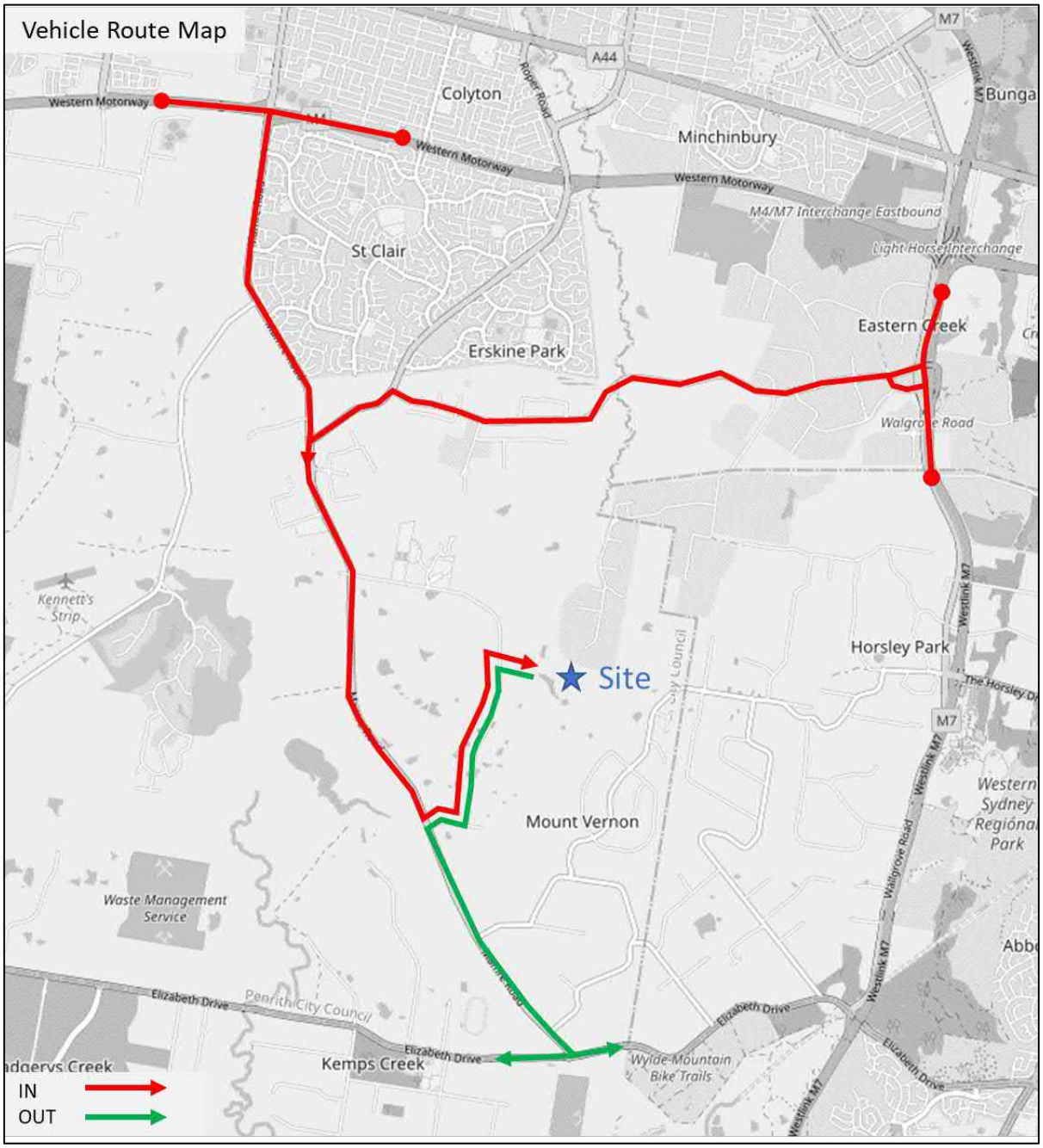


Figure 4: Construction Vehicle Routes

3.5 Fencing Requirements

Security fencing will be erected along the entire boundary of the Site and will be maintained for the duration of the construction works to ensure that unauthorised persons are kept out of the Site. The fencing will either be ATF or 2.4m chain wires.

Site access gates would be provided at the temporary driveway which would remain closed at all times outside of the permitted construction hours.

3.6 Materials Handling

All material loading will be undertaken wholly within the Site, and all construction equipment, materials and waste will similarly be strictly kept within the Site.

While not anticipated, should any materials handling (or other constructed related activity) be required from the public roadway (i.e. Aldington Road) then prior approval shall be sought and obtained from the appropriate authorities.

3.7 Additional Site Management

Although it is not expected, in the event that any Site construction traffic management outside of that described in this CTMP is required, the Project Manager will be required to notify adjacent properties of any temporary traffic restrictions (or the like) at least fourteen (14) days in advance.

3.8 Road Occupancy

The potential exists for future road occupancy requirements to facilitate the construction of the temporary driveway, and then any further upgrades to the intersection of Aldington Road. Road occupancy permits will necessarily be procured prior to starting intersection construction works, while a detailed intersection-specific CTMP would be prepared in consultation with Council and Roads & Maritime to ensure traffic along Aldington Road would continue to operate adequately during any such occupancy period.

3.9 CTMP – Monitoring & Review Process

This CTMP has been prepared referencing the existing Site conditions. Consultation with Council, Roads and Maritime and neighbouring developments will continue to be undertaken to ensure that the cumulative traffic impacts of construction within the area do not adversely impact the operations of the neighbouring developments or the local road network.

4 Assessment of Traffic & Transport Impacts

4.1 Construction Vehicle Traffic Generation

Table 1 provides a breakdown of potential vehicle movements throughout the proposed works (to be confirmed by Contractor once appointed, based on similar projects in area):

Table 1: Movement Overview

Stage	Demolition	Excavation	General Construction
Worker Numbers (Maximum on-site at any one time)	50 - 100	50 – 200	50 – 400
Truck Frequency (Maximum movements per day)	100 (50 in / 50 out)	600 (300 in / 300 out)	600 (300 in / 300 out)
Peak Hour Heavy Vehicle Movements	50 (25 in / 25 out)	120 (60 in / 60 out)	120 (60 in / 60 out)
Largest Vehicle Size	Truck & Dog	Truck & Dog	Truck & Dog

4.1.1 Light Vehicle Movements

It is anticipated that a peak construction workforce of up to 400 workers on-site at any one time (based on the specific constructions tasks being undertaken). Light vehicle traffic generation would generally be associated with construction staff movements to and from the Site, including Project Managers, trade and general employees.

With respect to the potential impacts of light vehicle traffic, the overwhelming majority of trips would occur in the short workforce arrival and departure periods, being (based on the proposed construction hours) 6:30am – 7:00am and 6:00pm – 6:30pm respectively; as such, these movements would occur outside of the existing (commuter) peak periods in the local network.

4.1.2 Heavy Vehicle Movements

As indicated in **Table 1**, the construction works are estimated to generate a peak demand for up to 600 truck movements per day (300 vehicles arriving / 300 vehicles departing). To provide a conservative assessment of intersection operations, a peak hour truck generation of up to 120 movements (60 vehicles arriving / 60 vehicles departing) has been assigned; on average, it is expected there would be approximately 60 truck movements per hour (30 vehicles arriving / 30 vehicles departing).

4.2 Vehicle Management – Principles

In accordance with TfNSW requirements, all vehicles transporting loose materials would have the entire load covered and/or secured to prevent any large items, excess dust or dirt particles depositing onto the roadway during travel to and from the Site.

Further to covering/securing the load to prevent deposits onto the roadway, a Shaker Grid is proposed and installed at the point of vehicle egress to minimise the risk of dirt tracking out onto Aldington Road. The responsibility of the driver to ensure that the Shaker Grid is driven over would be included as part of the Driver Code of conduct; this requirement, and indeed all driver requirements, will be detailed during an induction process for all drivers prior to commencing work at the Site, and will be further detailed in the Driver Code of Conduct, a copy of which included in **Appendix A**.

4.3 Construction Staff Parking

All construction staff and contractors will be required to park wholly within the Site, noting that there will be significant area available (at all times) to meet the peak parking demand.

5 Traffic Control

5.1 Traffic Control

The RMS guide "Traffic Control at Worksites" (TCAW) manual contains standard traffic control plans (TCPs) for a range or work activities. The manual's objective is to maximise safety by ensuring traffic control at worksites complies with best practice.

The RMS TCAW outlines the requirements for a Vehicle Movement Plan (VMP) for construction works such as proposed; a VMP is a diagram showing the preferred travel paths for vehicles associated with a work site entering, leaving or crossing the through traffic stream. A VMP should also show travel paths for trucks at key points on routes remote from the work site such as places to turn around, accesses, ramps and side roads.

Regarding construction work on roads with an average daily total (ADT) in excess of 1,500 vehicles, approach speeds of between 60 km/hr and 80 km/hr, with truck movements > 20 veh/shift, and sight distance is less than 2d, (where d equals the posted speed limit and in this instance the sight distance is required to be up to 120 metres), it would be expected for the following to be required by the RMS TCAW:

- A detailed Traffic Control Plan (TCP) with Traffic controllers
- A VMP.
- Warning Signs required during shifts.

With regard to the proposed temporary access road, a site-specific version of TCP 195 (as shown in **Appendix B**) would be implemented for the duration of the works.

5.2 Authorised Traffic Controller

An authorised Traffic Controller(s) is to be present on-site throughout the proposed works. Responsibilities of the Traffic Controller will include:

- The supervision of all construction vehicle movements into and out of site at all times,
- The supervision of all loading and unloading of construction materials during the deliveries in the construction phase of the project, and
- Pedestrian management, to ensure that adverse conflicts between vehicle movements and pedestrians do not occur, while maintaining radio communication with construction vehicles at all times.

6 Monitoring and Communication Strategies

6.1 Development of Monitoring Program

The development of a program to monitor the effectiveness of this CTMP shall be established by the Project Manager and should consider scheduled reviews as well as additional reviews should construction characteristics be substantially changed (from those outlined in the Final CTMP). All and any reviews of the CTMP should be documented, with key considerations expected to include:

- Tracking heavy vehicle movements against the estimated heavy vehicle flows during the Stage 1 works.
- The identification of any shortfalls in the CTMP, and the development of revised strategies / action plans to address such issues.
- Ensuring that all TCPs are updated (if necessary) by "Prepare a Work Zone Traffic Management Plan" card holders to ensure they remain consistent with the set-up on-site.
- Regular checks to ensure all loads are departing the Site covered as outlined within this CTMP.

6.2 Communications Strategy

A Communications Strategy shall be established by the Project Manager for implementation throughout the construction works; this strategy will outline the most effective communication methods to ensure adequate information within the community and assist the Project Team to ensure the construction works have minimal disruption on the road network. The Communications Strategy will include:

- The erection of appropriate signage providing advanced notice of works and any traffic control measures to be implemented.
- Written notices to surrounding landowners (and tenants) likely to be directly affected by the works, prior to commencement.

Ongoing communication is also required so that all stakeholders are kept up to date of works and potential impacts.

7 Summary

This CTMP has been prepared to ensure appropriate traffic management is undertaken during the proposed industrial development.

Ultimately, this CTMP report has been prepared with regard to the management principles outlined in the RMS Traffic Control at Worksites Manual (2018) and AS1742.3, and per the detailed strategies outlined in the CTMP is recommended for adoption at the Site.

In summary though – and further to a determination that the proposal's construction traffic will not impact the local road network - the following measures are recommended to minimise the potential traffic impacts associated with the proposal:

- Traffic control would be required to manage and regulate construction vehicle traffic movements to and from the Site during construction.
- All vehicles transporting loose materials will have the load covered and/or secured to prevent any items depositing onto the roadway during travel to and from the Site.
- All vehicles are to enter and depart the Site in a forward direction, with reverse movements to occur only within the Site boundary.
- All contractor parking is to be contained wholly within the Site, and.
- Pedestrian and cyclist traffic along the Site frontage will be managed appropriately at all times.

In summary, the CTMP report is proposed in accordance with the RMS TCAW.

Appendix A

Driver Code of Conduct

- Driver Code of Conduct -

Drivers Code of Conduct

Safe Driving Policy for the 200 Aldington Road, Kemps Creek.

Objectives of the Drivers Code of conduct

- To minimise the impact of earthworks and construction on the local and regional road network;
- Minimise conflict with other road users;
- Minimise road traffic noise; and
- Ensure truck drivers use specified routes

Code of Conduct

All vehicle operators accessing the site must:

- Take reasonable care for his or her own personal health and safety.
- Not adversely, by way of actions or otherwise, impact on the health and safety of other persons.
- Notify their employer if they are not fit for duty prior to commencing their shift.
- Obey all applicable road rules and laws at all times.
- In the event an emergency vehicle behind your vehicle, pull over and allow the emergency vehicle to pass immediately.
- Obey the applicable driving hours in accordance with legislation and take all reasonable steps to manage their fatigue and not drive with high levels of drowsiness.
- Obey all on-site signposted speed limits and comply with directions of traffic control supervisors in relation to movements in and around temporary or fixed work areas.
- Ensure all loads are safely restrained, as necessary.
- Drive over cattle grids – located at the Site's access – to vibrate off any loose material attached to construction vehicles.
- Operate their vehicles in a safe and professional manner, with consideration for all other road users.
- Hold a current Australian State or Territory issued driver's licence.
- Notify their employer or operator immediately should the status or conditions of their driver's license change in any way.

- Comply with other applicable workplace policies, including a zero tolerance of driving while under the influence of alcohol and/or illicit drugs.
- Not use mobile phones when driving a vehicle or operating equipment. If the use of a mobile device is required, the driver shall pull over in a safe and legal location prior to the use of any mobile device.
- Advise management of any situations in which you know, or think may, present a threat to workplace health and safety.
- Drive according to prevailing conditions (such as during inclement weather) and reduce speed, if necessary.
- Have necessary identification documentation at hand and ready to present to security staff on entry and departure from the site, as necessary, to avoid unnecessary delays to other vehicles.

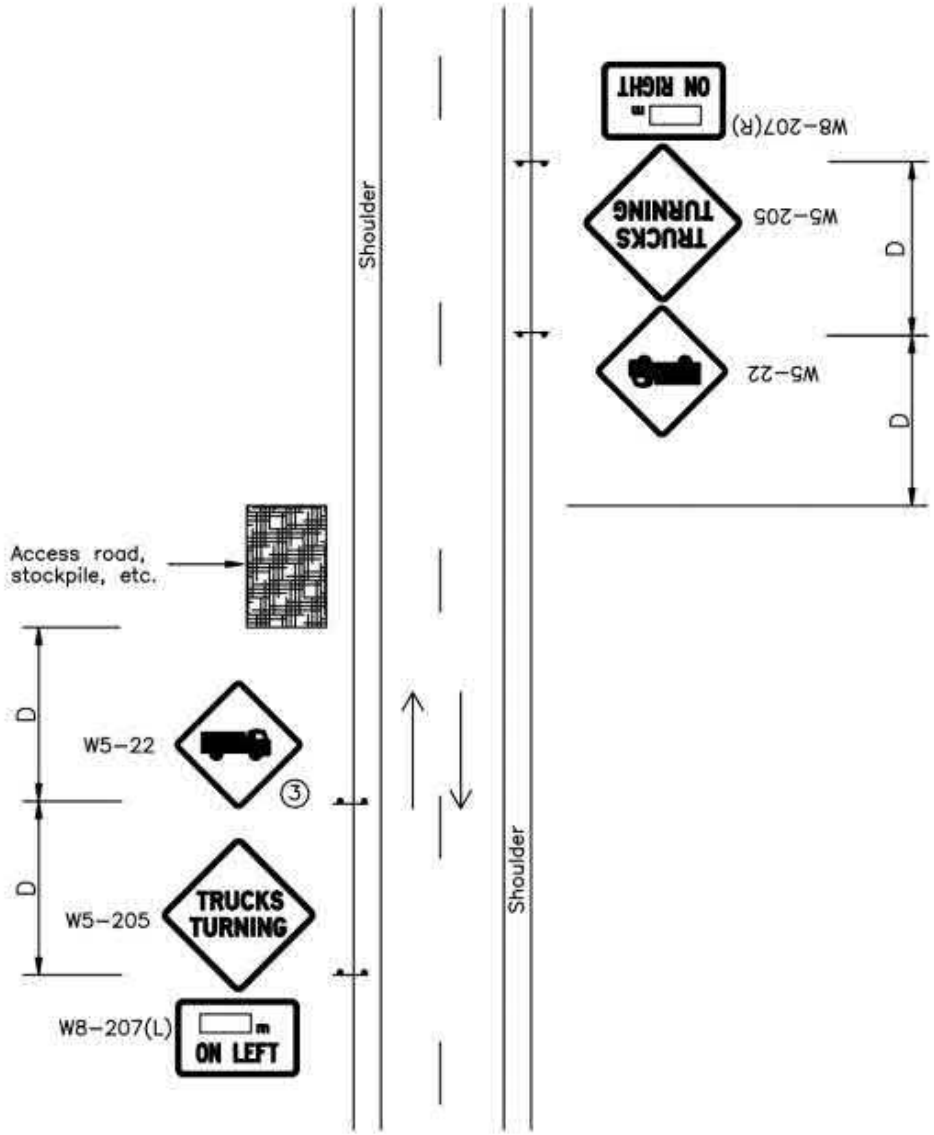
Crash or incident Procedure

- Stop your vehicle as close to it as possible to the scene, making sure you are not hindering traffic. Ensure your own safety first, then help any injured people and seek assistance immediately if required.
- Ensure the following information is noted:
  - Details of the other vehicles and registration numbers
  - Names and addresses of the other vehicle drivers
  - Names and addresses of witnesses
  - Insurers details
- Give the following information to the involved parties:
  - Name, address and company details
- If the damaged vehicle is not occupied, provide a note with your contact details for the owner to contact the company.
- Ensure that the police are contacted should the following circumstances occur:
  - If there is a disagreement over the cause of the crash.
  - If there are injuries.
  - If you damage property other than your own.
- As soon as reasonably practical, report all details gathered to your manager.

Appendix B

Traffic Control Plan(s)

TCP 195



NOTE:

① For use where roadside is generally undeveloped, ADT is more than 1,500 vehicles per day, sight distance is restricted and there are more than 20 truck movements per shift.

② See ***Traffic control at work sites,*** Section 7.7, ***Signs for depots, stockpiles, quarries, gravel pits etc.***

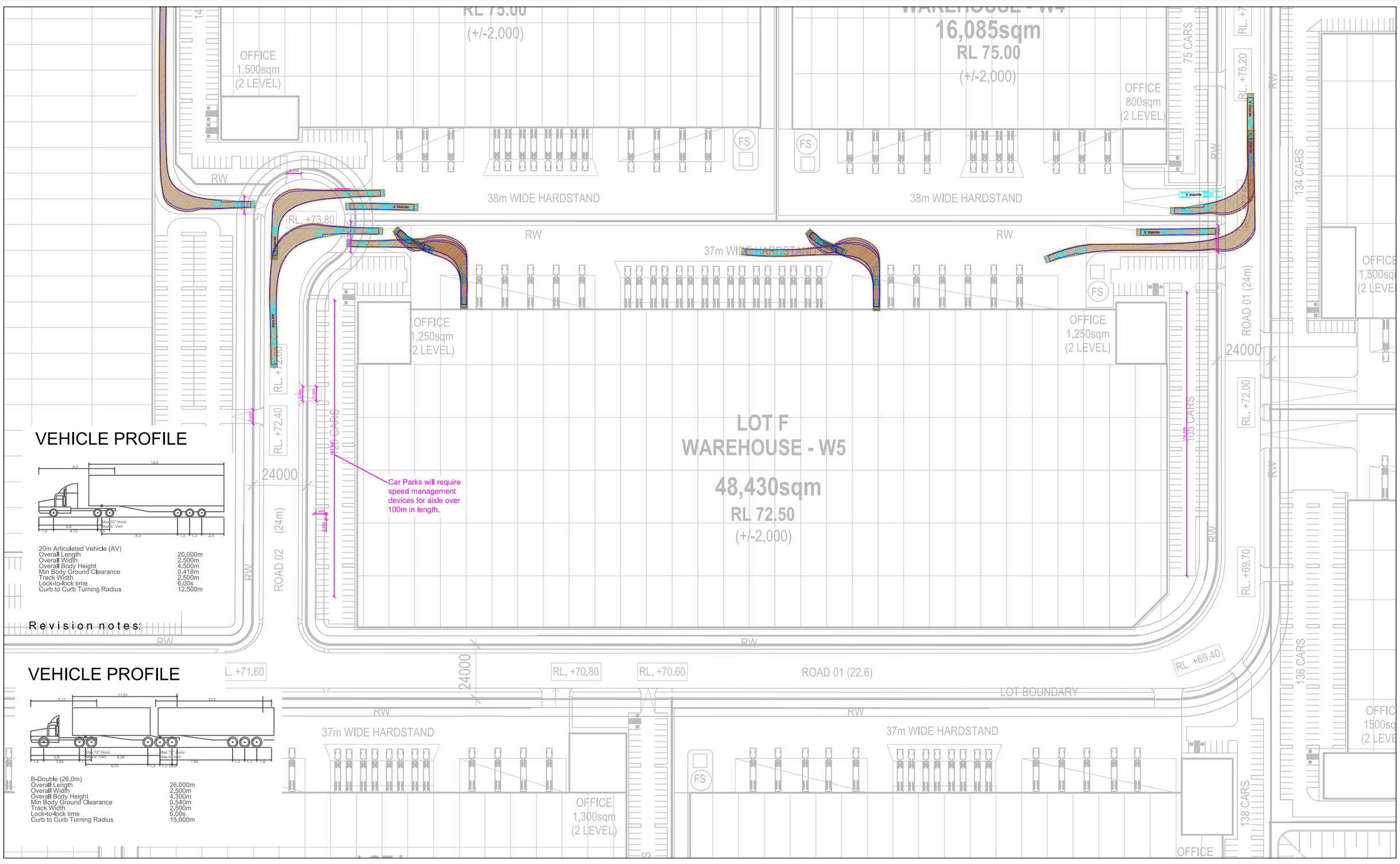
③ For short term works use T2–25.

ACCESS TO DEPOT, STOCKPILE, QUARRY, GRAVEL PIT ETC.
ALL ROADS
LONG TERM USE

T000195

Appendix E

Swept Path Analysis – Stage 1



VEHICLE PROFILE

20m Articulated Vehicle (AV)	
Overall Length	20,000m
Overall Width	2,500m
Overall Body Height	4,500m
Min Body Ground Clearance	0.418m
Track Width	2,500m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	12.500m

Revision notes:

VEHICLE PROFILE

B-Double (26.0m)	
Overall Length	26.000m
Overall Width	2,500m
Overall Body Height	4,300m
Min Body Ground Clearance	0.540m
Track Width	2,500m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	15.000m

Revision notes:

Rev:	Date:	Notes:

For information purposes only - not for construction

Drawn By: VC

Client: Fifie Stocklands Trust

Project: 1292 — 200 Aldington Road - Stage 1

Drawing Title: 26m B-Double Access and 19m AV Access

Date: 29/09/2020

Scale @ A3: n/a

Drawing Number: 01

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LOT J
EHOUSE - W9
,000sqm
RL 73.00
(+/-2,000)

LOT H
WAREHOUSE - W7
28,960sqm
RL 75.00
(+/-2,000)

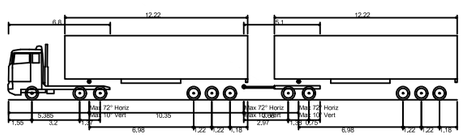
LOT E
WAREHOUSE - W4
16,085sqm
RL 75.00
(+/-2,000)

LOT F
WAREHOUSE - W5
48,430sqm
RL 72.50
(+/-2,000)

RW
FIRE BRIGADE
141 CARS
OFFICE
1,500sqm
(2 LEVEL)
38m WIDE HARDSTAND
FS
75 CARS
OFFICE
800sqm
(2 LEVEL)
RL. +80.60
RL. +77.50
RL. +75.20
CAFE
200sqm
30 CARS
RL. +78.50
134 CARS
OFFICE
1,500sqm
(2 LEVEL)
37m WIDE HARDSTAND
OFFICE
1,250sqm
(2 LEVEL)
ROAD 01 (24m)
24000
RL. +72.60
RL. +72.40
120 CARS
105 CARS
RL. +72.00
RL. +69.70
ROAD 02 (24m)
136 CARS
OFFICE
1500sqm
(2 LEVEL)
RL. +71.60
RL. +70.80
RL. +70.60
ROAD 01 (22.6)
RL. +69.40
LOT BOUNDARY
37m WIDE HARDSTAND
OFFICE
1,300sqm
138 CARS

VEHICLE PROFILE

30m PBS Type 2 Vehicle



Vawdrew 30m A-Double	
Overall Length	29.995m
Overall Width	2.500m
Overall Body Height	4.300m
Min Body Ground Clearance	0.332m
Track Width	2.500m
Lock-to-lock time	7.00s
Curb to Curb Turning Radius	15.000m

Revision notes:

Rev:	Date:	Notes:

For information purposes only - not for construction

Drawn By: VC

Client: Fifie Stocklands Trust

Project: 1292 200 Aldington Road - Stage 1

Drawing Title: 30m PBS Type 2 Vehicle

Date: 29/09/2020

Scale @ A3: n/a

Drawing Number: 02

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