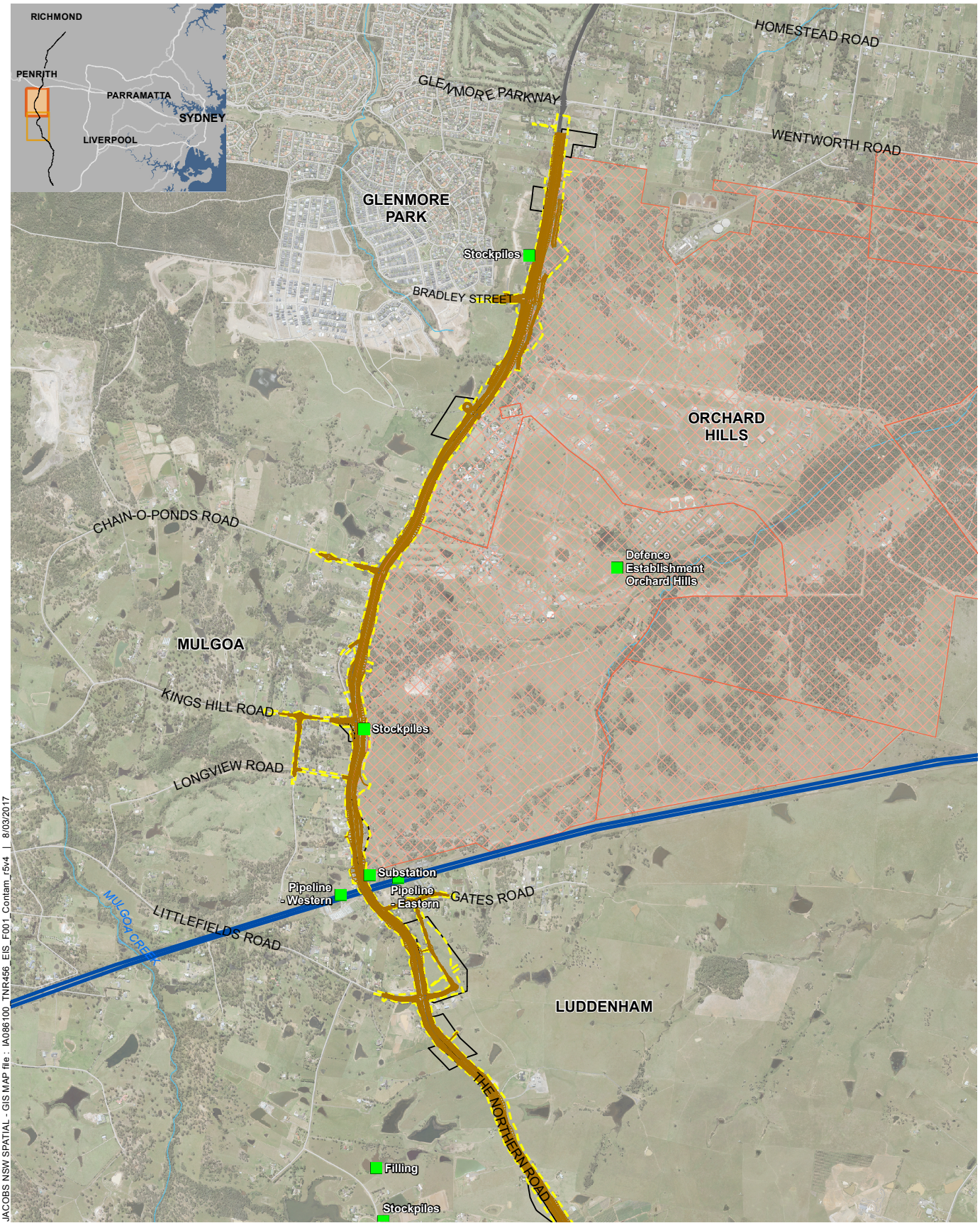

The Northern Road upgrade - Mersey Road to Glenmore Parkway

The Northern Road (Existing)

WaterNSW supply pipelines

Operational footprint

Compound sites

AEI contamination sites

Western Sydney Airport site (Commonwealth Land)

Defence Establishment Orchard Hills (Commonwealth Land)

Commonwealth Lands

0 0.5 1 km

2

1

Figure 2 | AEI contamination sites

4. Site history

Several sources were investigated to determine the history of land use at the site. The following list details the sources of historical information and a summary of information provided by each source.

- NSW Land and Property Management Authority, Land and Property Information Division (LPI): Historical aerial photographs (1947 to 2005)
- NSW EPA Contaminated Sites Register and Record of Notices
- Transport for NSW Interactive Crash Statistics Database.

4.1 Historical aerial photography

Historical aerial photographs from the NSW Land and Property Management Authority, Land and Property Information Division were examined for the years: 1947, 1955, 1965, 1975, 1986, 1994 and 2005. The findings of the historical aerial photograph review are described in **Table 4-1**.

Table 4-1: Historical aerial photograph review

Date of aerial photography	Site	Surrounding area
1947	The project area generally comprised agricultural land. Agricultural land use appeared to be generally grazing. There were a small number of building /structures (houses, sheds) likely to be associated with the agricultural activities. Main project area features observable in photographs included The Northern Road, Orchard Hills Defence Facility, Warragamba Pipelines and a large intensive agricultural operation located to the west of the intersection of The Northern Road and Elizabeth Drive. The alignment of The Northern Road at Eaton Road, Luddenham is different than present day	Surrounding land use consisted of rural residential land use to the north of the project area (Penrith, Kingswood) and agricultural land in other areas. Small scale cropping and orchards were present in areas surrounding the northern portion of the project area (ie. north of Orchard Hills) and generally increased grazing land surrounding the southern portion (ie. south of Orchard Hills) of the project area.
1955	Generally, as per observations in the 1947 photograph. The alignment of The Northern Road at Eaton Road, Luddenham is as per present day.	The surrounding area remained largely the same with increased structures observed within the Orchard Hills Defence Facility.
1965	Generally, as per observations in the 1955 photograph with increased structures observed within the Orchard Hills Defence Facility adjacent to The Northern Road, construction site adjacent to the Warragamba Pipelines, large dams constructed to the west of The Northern Road near the intersection with Elizabeth Drive. Larger areas of cropping evident in Greendale.	The surrounding area remained largely the same, with increased low density residential development to the north of the project area, construction of Warragamba Pipelines reservoirs (Orchard Hills) and increased structures within the Orchard Hills Defence Facility. There appeared to be a general reduction in agricultural activities (small scale cropping, orchards) to the north of the project area.
1975	Generally, as per observations in the 1965 photograph with increased shed structures present on large scale agricultural land located to the west of the intersection of The Northern Road and Elizabeth Drive.	The surrounding area remained largely the same, with increased low density residential development in Penrith and Kingswood, construction of the M4 Western Motorway, increased rural residential properties, less agricultural activities with the northern portion of the project area, Penrith golf course has been constructed.
1986	Generally, as per observations in the 1975 photograph. Market gardens have been established on the western side of The Northern Road in Luddenham. Increased residential development adjacent to The Northern Road in Luddenham.	The surrounding land use remained largely unchanged with the exception of an increase in low density residential development to the north of the project area. Quarrying activities were observed in Glenmore Park located to the north west of the project area. A waste water treatment

Date of aerial photography	Site	Surrounding area
		facility has been constructed at the Sydney Water reservoir site in Orchard Hills.
1994	Generally, as per observations in the 1986 photograph with the construction site adjacent to the Warragamba Pipelines no longer in use, numerous shed structures have been constructed adjacent to the Warragamba Pipelines.	The surrounding land use remained largely unchanged. The waste water treatment facility at Orchard Hills has been re-configured.
2005	Generally, as per observations in the 1994 photograph with increased low density residential development occurring in Glenmore Park (adjacent to Penrith Golf Course) and quarrying activities have ceased in Glenmore Park.	The surrounding land use remained largely unchanged with increased residential development around Glenmore Park adjacent to the north western portion of the project area.

4.2 NSW EPA contaminated sites register

At the time of preparing the Stage 1, a search of the NSW EPA Contaminated Sites Register and Record of Notices (under Section 58 of the Contaminated Land Management Act 1997) was undertaken to ascertain the presence of registered sites that were either regulated or had been notified within the suburbs within the project area. The notified/regulated sites within 1km of the project area are summarised in **Table 4-2**.

Table 4-2: Notified sites within one kilometre of the project area.

Suburb	Notified site address	Notified site activity	Contamination status	Location relative to Project
Luddenham	Caltex Service Station The Northern Road	Service Station	Under assessment	Outside project area (> 250m)

Based on the location of notified site relative to the project area, the Luddenham service station site is unlikely to be in the near vicinity of the construction footprint and as such is likely to pose a low contamination risk.

4.3 Interactive crash statistics

At the time of preparing this Stage 1 report, a search of the Transport for NSW Interactive Crash Statistics was undertaken to ascertain the potential for localised contamination associated with vehicle accidents to be present within the project area.

The database indicated that vehicle accidents have been recorded on The Northern Road and most of the local roads within the project area. The database did not provide information with respect to potential contamination including fuel release, fires etc.

4.4 Department of Defence unexploded ordinance website

A search of areas of concern from the Department of Defence Unexploded Ordinance (UXO) website was undertaken.

At the time of undertaking this assessment, no known areas of concern with respect to UXO were identified within or adjacent to the project area including Defence Establishment Orchard Hills.

4.5 Site history summary

The historical aerial photography review indicated that the project area has remained largely agricultural since the late 1940s. The major developments occurring within the project area included residential development within and adjacent to the northern portion of the project area, construction of the Orchard Hills Defence Facility, the Warragamba Pipelines and the Luddenham Pastoral Company.

There was one NSW EPA contaminated site notice for land within the project area at Luddenham. The site at Luddenham was under assessment.

4.6 Integrity assessment

Historical and site information was sourced from NSW Government departments with no known interest in the site. Jacobs have relied on the accuracy of the documentation provided and our experience in historical document interpretation. Whilst there is a small margin for error in interpretation, Jacobs considers the information presented in this assessment to be accurate.

5. Potential areas of environmental interest

A number of potential AEIs were identified during the information review and site inspection. **Table 5-1** outlines the potential AEIs located within and in the near vicinity of the project area and their associated risks to environmental receptors and site users (associated with the construction of the road upgrades). Please note the risks have been assessed qualitatively. The potential risks have not been confirmed / quantified through a sampling and analysis program.

Table 5-1: Potential areas of environmental interest

AEI	Location	Contaminants	Potential Contamination Distribution	Exposure Risk
Stockpiles	Private Property, western side of The Northern Road between Glenmore Parkway and Bradley Street, Glenmore Park	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos	Surface and shallow soils	Low - Contamination (if present) likely to be localised and construction activities are unlikely on the site.
Defence Establishment Orchard Hills (Commonwealth land)	Eastern side of The Northern Road, Orchard Hills	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos, explosive residues	Surface and shallow soils	Low - Contamination (if present) from the use of the site for military purposes unlikely to be in the vicinity of the project area.
Defence Establishment Orchard Hills (Commonwealth land)	Eastern side of The Northern Road, Orchard Hills	UXO	Surface and shallow soils	Moderate – Likelihood of encountering UXO during construction activities is likely to be low; however the consequence if encountered could be high.
Stockpiles	Eastern side of The Northern Road between Kingshill and Longview Roads, Orchard Hills	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos	Surface and shallow soils	Moderate – Stockpiles may need to be removed during construction activities.
Sub-station	Eastern side of The Northern Road, Orchard Hills	Heavy metals, hydrocarbons, polychlorinated biphenyls, asbestos	Surface and shallow soils	Low - Contamination (if present) likely to be localised and substantial construction activities are unlikely on the site. Should construction activities occur on the site, then exposure risk would increase.
Warragamba Pipelines	Eastern and western sides of The Northern Road, Orchard Hills	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos	Surface and shallow soils	Moderate – Increased with excavation in areas of potential contamination.
Filling	Private property, eastern side of Galaxy Road, Luddenham	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos	Surface and shallow soils	Low - Contamination (if present) likely to be localised and construction activities are unlikely on the site.
Stockpiles	Private property, eastern side of Galaxy Road, Luddenham	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos	Surface and shallow soils	Low - Contamination (if present) likely to be localised and construction activities are unlikely on the site.
Market Gardens	Private property, north east of the intersection of The Northern Road and Elizabeth Drive.	Heavy metals, hydrocarbons, pesticides, nutrients	Soils and groundwater	Moderate – Contamination could be both localised and diffuse. Agricultural areas are likely to be disturbed as part of the upgrade.
Stockpiles	Western side of The Northern Road, north of Park Road, Luddenham	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos	Surface and shallow soils	Moderate – Stockpiles may need to be removed during construction activities.

Roads and Maritime Stockpile	North of the intersection of The Northern Road and Park Road, Luddenham.	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos	Surface and shallow soils	Low - Contamination (if present) likely to be localised and construction activities are unlikely on the site.
Service Station	South of the intersection of The Northern Road and Park Road, Luddenham.	Heavy metals, hydrocarbons	Deeper soils, groundwater and soil vapour	Low - Contamination (if present) likely to be localised and construction activities are unlikely on the site.
Cemetery	South of the intersection of The Northern Road and Roots Avenue, Luddenham.	Heavy metals, nutrients, formaldehyde, biological	Deeper soils and groundwater	Low – Site and contamination (if present) likely to be too far away to pose a risk to construction activities
Non-operational service station	Shops – The Northern Road, Luddenham.	Heavy metals, hydrocarbons	Deeper soils, groundwater and soil vapour	Moderate – Risk increased if deep excavations occur in the vicinity of the site
Service Station	Shops – The Northern Road, Luddenham.	Heavy metals, hydrocarbons	Deeper soils, groundwater and soil vapour	Moderate – Risk increased if deep excavations occur in the vicinity of the site.
Dumped tyres	Southern side of Adams Road, Luddenham	Heavy metals, hydrocarbons	Surface and shallow soils	Low - Contamination (if present) likely to be localised and substantial construction activities are unlikely on the site.
Filling	Private property, western side of Willowdene Road, Luddenham	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos	Surface and shallow soils	Low - Contamination (if present) likely to be localised and construction activities are unlikely on the site.
Stockpile	Western side of Willowdene Road, Luddenham	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos	Surface and shallow soils	Low - Contamination (if present) likely to be localised and construction activities are unlikely on the site.
Septic Systems	Numerous tanks and pump out points observed within the project area	Heavy metals, nutrients, biological	Deeper soils and groundwater	Low – Contamination source likely to be highly degraded
Agricultural Land Use	Numerous locations within and adjacent to the project area	Heavy metals, hydrocarbons, pesticides, asbestos	Soils and groundwater	Moderate – Contamination could be both localised and diffuse. Agricultural areas are likely to be disturbed as part of the upgrade.
Vehicle Accidents	Numerous locations within and adjacent to the project area	Hydrocarbons, aqueous firefighting foam (AFFF).	Surface and shallow soils	Low to Moderate – Very localised contamination (if present) likely to be disturbed as part of the upgrade.

5.1 Summary of potential areas of interest

The majority of AEI identified are likely to pose a low risk of exposure to site users and environmental receptors to contamination during construction of the upgrade.

The following information summarises the AEI assessed as low to moderate and moderate risk:

- The stockpiles located on the eastern side of The Northern Road between Kingshill and Longview Roads, Orchard Hills are located close to the current road verge and could be disturbed as part of construction activities. The quality of the material within the stockpiles is unknown.
- Although there is no evidence of UXO occurrence (from Department of Defence website) within or directly adjacent to the project area, explosives are used and are known to have been used at Defence Establishment Orchard Hills. Although the likelihood of encountering UXO during construction activities is likely to be low, the consequence if encountered could be high.
- The market gardens located to the north and north east of the intersection of The Northern Road and Elizabeth Drive have been used historically and currently for intensive agricultural land use within and in the vicinity of the proposed upgrade. This land use could represent a potential source of contamination which could be exposed during construction activities. The contamination from agricultural activities is generally either point source (eg. localised chemical storage and use, waste disposal) or diffuse (broad acre pesticide or herbicide application). The biggest risk of exposure to agricultural contamination would be associated with point sources of contamination.
- The stockpiles located on the western side of The Northern Road, north of Park Road, Luddenham are located close to the current road verge and could be disturbed as part of construction activities. The quality of the material within the stockpiles is unknown.
- The Warragamba Pipelines corridor represents a potential source of contamination associated with the degradation of the external surfaces of the pipeline and areas of observed fill materials. The construction activities to be undertaken within the pipeline corridor poses an increased risk of exposure to contamination (if present) especially associated with excavations works within the corridor.
- The non-operational service station (identified by concrete covered fill points in the carpark and vent stacks on adjacent building) located within the carpark of the Luddenham shops represents a potential source of contamination associated with leaks and spills from former fuel storage infrastructure (i.e. hydrocarbons and heavy metals). The location of the former service station in the near vicinity of the construction footprint of the upgrade poses an increased risk of exposure to contamination (if present) especially associated with deeper excavations.
- The service station located to the south of the Luddenham shops on The Northern Road represents a potential source of contamination associated with leaks and spills from fuel storage infrastructure (i.e. hydrocarbons and heavy metals). The location of the service station in the near vicinity of the construction footprint of the upgrade poses an increased risk of exposure to contamination (if present) especially associated with deeper excavations.
- The widespread agricultural land use within and in the vicinity of the proposed upgrade represent a potential source of contamination which could be exposed during construction activities. The contamination from agricultural activities is generally either point source (eg. localised chemical storage and use, waste disposal) or diffuse (broad acre pesticide or herbicide application). The biggest risk of exposure to agricultural contamination would be associated with point sources of contamination.
- Although the location of car accidents are not accurately known, the release of fuels and oils from vehicle accidents and the potential use of AFFF in the event of a vehicle fire could cause residual contamination in the vicinity of the accident site. Although contamination is likely to be very localised at these sites, the risk of exposure to contamination from these accident sites (if present) during construction of the upgrade is likely to increase as the accidents sites are likely to have occurred on the majority of the current road system which is within the construction footprint.

6. Conclusions and recommendations

6.1 Conclusion

Following a review of the available historical and government records, and a site inspection, the key findings of the Stage 1 Assessment include:

- There are five sensitive environments located within the vicinity of the project area which could be potentially impacted by contamination within the site (if present). Additionally, localised features including dams and wetlands should also be considered as sensitive environments.
- The project area remained largely agricultural since the late 1940s. The major developments occurring within the project area included residential development adjacent to the northern portion of the project area, construction of the Orchard Hills Defence Facility, the Warragamba Pipelines and the Luddenham Pastoral Company.
- There was one site within one kilometre of the Project that had been notified by the NSW EPA.
- A number of AEIs have been identified within or in close proximity to the project area. The majority of the AEIs are considered to represent a low risk with respect to contamination impacting upon construction of the upgrades.
- Numerous car accidents have been recorded within the project area and potential contamination associated with these accidents is considered to represent a low to moderate risk. Although contamination is likely to be very localised at these sites, the risk of exposure to contamination from these accident sites (if present) during construction of the upgrade is likely to increase as the accidents sites are likely to have occurred on the majority of the current road system which is within the construction footprint.
- A number of service stations (operating and non-operating) sites, stockpiles and areas of agricultural land use located within and in the near vicinity to the project area are considered to represent a moderate risk. The risks of exposure to contamination (if present) associated with construction of the proposed upgrade at these locations is higher than other AEIs as these areas are likely to be subject to physical disturbance during construction.
- There is a possibility of encountering UXO within Defence Establishment Orchard Hills in consideration of known use of explosives on this site.

6.2 Recommendations

Based on the results of the Stage 1 Contamination Assessment, Jacobs recommends further contamination investigation at areas of moderate risk within the project area.

The proposed scope of work for the contamination investigation has been planned to address the moderate risk areas identified in Section 5.

For the service station sites (operational and non-operational), soil should be sampled from boreholes drilled within the footprint of the proposed construction works adjacent to the respective sites to a depth below the possible source of contamination (i.e. leaking USTs). Assume an investigation depth of six metres below ground level within this area.

For the Warragamba Pipelines coridor, shallows soils (nominal 1m below ground level) should be sampled across the areas to be disturbed as part of the proposed construction activities.

For stockpiles, soil should be sampled from test pits from stockpiles which would need to be excavated and relocated as part of the proposed construction works.

For market gardens, shallows soils (nominal 1m below ground level) should be sampled across the areas to be disturbed as part of the proposed construction activities.

Despite the low to moderate rating of the remainder of the potential AEIs within and adjacent to the project, the risk of contamination impacting upon proposed construction activities would be increased if excavation works take place within these areas.

Where excavation works are required within low risk areas or other moderate risk areas (ie. moderate risk areas other than service station sites, areas of filling and stockpiles), a Construction Environmental Management Plan (CEMP) should detail contingency measures. These measures would manage potentially contaminated materials if materials are suspected and/or encountered during construction activities.

In these low risk areas or other moderate risk areas (ie. moderate risk areas other than service station sites, areas of filling and stockpiles), no testing is required unless contamination is suspected or encountered during construction activities. The process for the testing and/or management of suspected or encountered contamination in these lower risk areas should be addressed in the CEMP.

For UXO's, an investigation should be undertaken to confirm the risk of UXO's being present within the areas of the project within Defence Establishment Orchard Hills. The investigation should be undertaken prior to construction activities by a suitably qualified consultant registered on the Department of Defence UXO Panel (DUXOP) now subsumed into the Defence Environment and Heritage Panel (DEHP).

Appendix B. Operational water quality assessment

The Water Quality assessment has provided indicative locations and sizes for operational water quality swales. An outline of the design approach used is provided below.

B.1 Design Criteria

The proposed strategy is to provide water quality treatment through swales for pavement runoff prior to discharging into receiving creeks and waterways. The proposed swales are located throughout the project at all locations where pavement runoff is conveyed to the receiving waterways and creeks through a table drain that has been designed as part of the drainage system. The objective is to provide as much treatment as possible and to optimise the swales sizes upstream, predominantly at areas of sensitive receiving waterways and creeks by increasing the dimensions of some swales where possible and introducing rock check dams.

B.2 Swale locations

The proposed swale locations have been identified from the 20% detailed design. There are ten pavement runoff discharge locations that are located upstream of the five identified sensitive waterways as mentioned in **Section 3** of this report. A further fourteen swales are proposed at other locations to provide additional water quality treatment along the alignment. The proposed swales locations are shown on **Table 7-2** in **Section 7** of this report. The locations and lengths of the proposed swales may change when the detailed design is further progressed and the water quality modelling will need to be assessed again prior to the final detailed design.

B.3 Swale water quality modelling methodology

MUSIC modelling

MUSIC water quality modelling was undertaken to determine the pollutant load reductions that can be achieved by permanent water quality swales for Total Suspended Solids (TSS), Total Nitrogen (TN) and Total Phosphorus (TP).

The catchment draining to an individual control measure was delineated by considering the formation of the proposed carriageway and the proposed pipe drainage network. The total catchment area was divided into two sub-catchments according to the different land-use characteristics of the ‘impervious road catchment’ area, and the batter slope or ‘pervious road side’ area.

A water quality model was set up to represent proposed catchment conditions. Models of the swales were created by adopting the sub-catchment areas estimated in the catchment analysis. Rock check dams were also added to the model as per the detailed design typical swale details.

Rainfall inputs

The MUSIC model uses pluviograph data and user-defined event mean concentrations (EMCs) to estimate pollutant loads. Pluviograph data was obtained from the Bureau of Meteorology for Station 067113 called Penrith, which is the most appropriate pluviograph station to the project with half-hour time increments. The data was available for the period 4/12/1996 to 31/5/2010. The model was run at half-hour time steps for the available duration.

Event mean concentrations

A literature review was undertaken to identify the event mean concentrations for the proposed road pavement areas for TSS, TN and TP to use in the MUSIC model. The following references were used to assess the typical concentrations:

- RTA (2003), Procedure for Selecting Treatment Strategies to Control Road Runoff (Version 1.1).
- CRC for Catchment Hydrology (1997), Best Practice Environmental Management Guidelines for Urban Stormwater.
- CSIRO (1997), Metals and Hydrocarbons in Stormwater Runoff from Urban Roads.

- CRC for Catchment Hydrology (2000), Water Sensitive Road Design, Design Options for Improving Stormwater Quality of Road Runoff.
- CRC for Catchment Hydrology (1999), Urban Stormwater Quality, A Statistical Overview.
- Austroads (2001), Road Runoff and Drainage: Environmental Impacts and Management Options.
- CRC for Catchment Hydrology and Monash University (2004), Stormwater Flow and Quality and the Effectiveness of Non-Proprietary Stormwater Treatment Measures, A review and Gap Analysis.

The adopted event mean concentrations from the literature review for the proposed pavement and for the existing pervious areas are outlined in Table B.1.

Table B.1 : Typical stormwater runoff concentrations for existing and operational phases

Pollutant Concentration (mg/L)	TSS		TP		TN	
	Event (wet)	Base (dry)	Event (wet)	Base (dry)	Event (wet)	Base (dry)
Road pavement	141	15	0.25	0.14	1.8	0.8
Agricultural areas (Existing)	158	12	0.5	0.15	5	2.5

Swale characteristics

From a hydrology and hydraulics perspective, the minimum dimensions of these trapezoidal open channel swales are: base width =1.2m, side slopes V:H=1:2 with a minimum depth of 0.5m. At locations where space is available, additional water quality treatment has been provided by increasing the base width of the swales.

B.4 Results

The results of the water quality assessment indicate that some pollutant load reduction can be achieved by the proposed swales. These results that have been achieved at the twenty-four swales including those located upstream of the locations where the pavement runoff discharges into sensitive receiving waterways as shown on **Table B.2**. The proposed swales are highly efficient at providing suspended solid capture and reasonably efficient at reducing nutrients. The reduction of pollutant loads by the proposed swales is considered to be adequate, however if further capture of nutrients is required, this would only be achieved through the use of other water quality controls such as permanent wet basins or biofiltration basins.

Table B.2 : Annual average pollutant load reductions for the proposed swales

Swale	Total Suspended Solids (%)	Total Phosphorous (%)	Total Nitrogen (%)
S1	88	48	24
S2	86	43	18
S3	88	43	23
S4	89	55	49
S5	89	55	48
S6	87	45	32
S7	87	47	22
S8	86	46	17
S9	86	46	19
S10	90	51	28
S11	90	48	29
S12	88	48	29
S13	84	44	16

Swale	Total Suspended Solids (%)	Total Phosphorous (%)	Total Nitrogen (%)
S14	81	45	14
S15	87	44	31
S16	87	46	19
S17	87	44	20
S18	86	46	17
S19	86	44	18
S20	86	46	18
S21	88	45	22
S22	88	48	24
S23	87	44	26
S24	87	46	26

B.5 Conclusion

The proposed road upgrade has the potential to generate increased pollutant loads into the receiving waterways including five sensitive waterways that have been identified; however if adequate water quality controls are adopted throughout the project by using vegetated swales and rock check dams as proposed, then this increase in pollutant loads is mitigated to a reasonable extent. It is therefore recommended that the proposed water quality treatment swales listed on **Table 6-2** of this report and the remaining swales identified throughout the project on the drainage plans be implemented to provide water quality controls for the project.