Part E

Other Environmental Issues

Management of Other Environmental Issues

The environmental risk assessment conducted for the Project categorised issues into 'key and 'other' issues. Part D of the EA Report considered key issues on an individual basis. The remaining other issues are considered in this chapter. Where appropriate, specific management and mitigation measures have been developed to minimise and manage environmental impacts.

16.1 Noise and vibration

A comprehensive noise and vibration assessment has been conducted as part of the environmental assessment for the Project. A summary of the findings is provided in this section. Specific details are provided in Working Paper K *Noise and Vibration*.

During preparation of the EA Report, DECC released the *Draft Construction Noise Guideline* in October 2008 which was subsequently superseded by the *Interim Construction Noise Guideline* (INCG) released in July 2009. These post-dated issue of the DGRs and accordingly were not specifically required to be considered in the assessment. However, the noise assessment has been reviewed with respect to the INCG and the following discussion is generally consistent with the guideline.

16.1.1 Key features of the existing environment

Due to the predominantly rural nature and associated lack of development in the Project area, there are generally low levels of noise emissions. A noise and vibration survey was conducted from 3-9 August 2007 to establish baseline conditions.

Recording instruments were installed at three properties considered to be representative of the different receptors in the locality (refer Figure 16.1). The anticipated types of emissions which could affect the residences on these properties are described in Table 16.1.

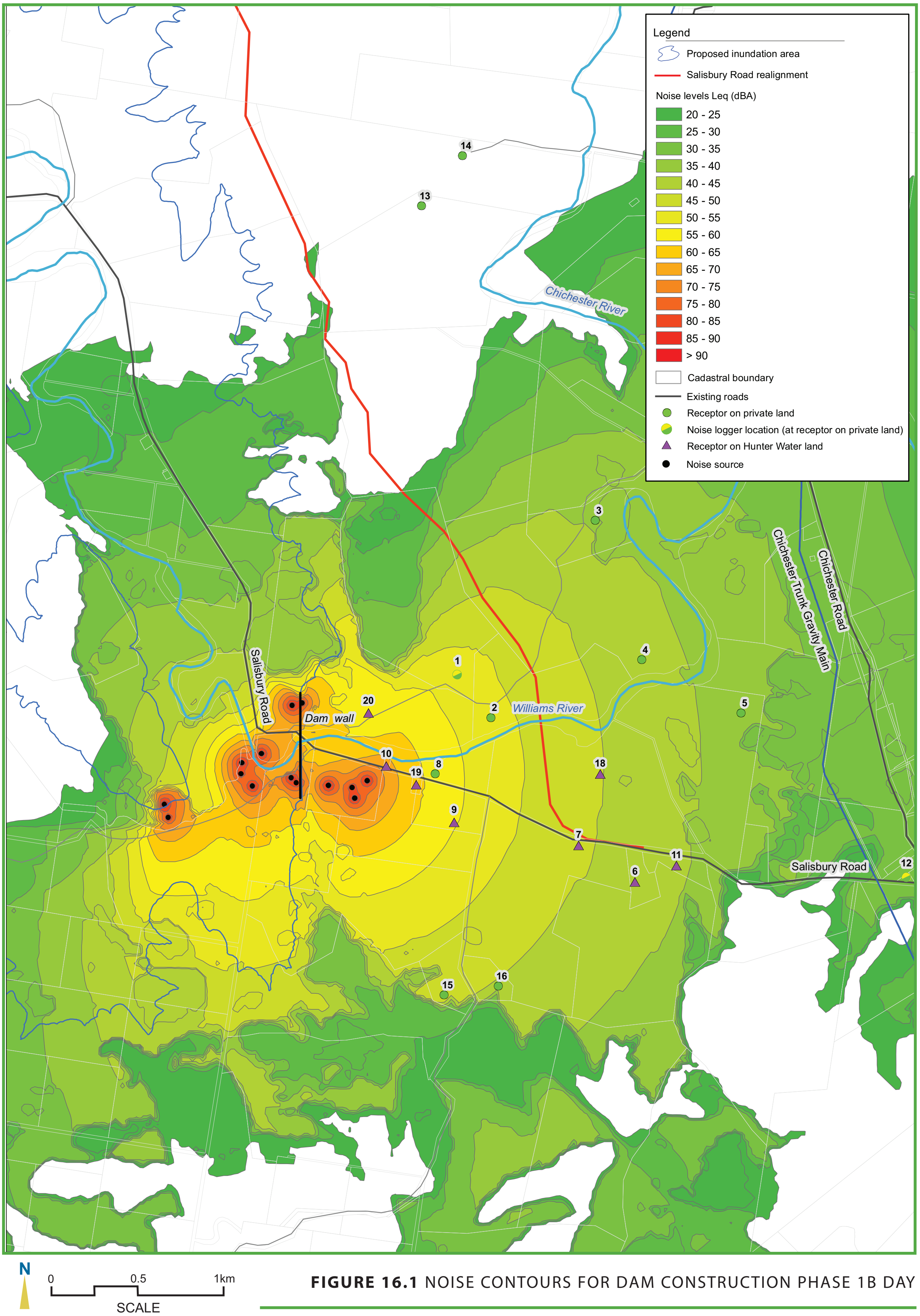

FIGURE 16.1 NOISE CONTOURS FOR DAM CONSTRUCTION PHASE 1B DAY

TABLE 16.1 BASELINE MONITORING LOCATIONS

PROPERTY	LOCATION	EXPECTED NOISE SOURCES FROM DEVELOPMENT
Site 1	Tillegra – below dam (near field)	Dam and road construction, operation, traffic from road realignment
Site 12	Bendolba – below dam (far field)	Pump station, dam construction
Site 17	Underbank – above dam	Construction traffic, road construction, traffic from road realignment

Information on meteorological conditions during the survey period was obtained from the nearest Bureau of Meteorology (BOM) site at Paterson, this being located approximately 35 kilometres south of the noise monitoring locations. A small amount of rain was recorded on 4 August 2007, however no heightened noise event was identified at any of the three monitoring locations as a result of the rainfall.

Noise sources in the area generally consist of rural noise such as livestock (and other farm animals), wind noise from rustling leaves, insects and bird life as well as intermittent operation of farming equipment such as tractors or all terrain vehicles. Traffic noise from intermittent vehicles travelling along Salisbury Road and Chichester Dam Road dominates the noise environment. During quiet evening and night time periods, the flow of water in the Williams River is audible.

The homestead at Site 1 is set back approximately 700 metres north of Salisbury Road near the Tillegra locality. The major expected noise source is vehicle access along the driveway to the property.

Although there are no dwellings at Site 12 at Bendolba, the noise logger was positioned at an equivalent distance from Salisbury Road (30 metres) to homesteads on neighbouring properties. This site was also affected by traffic noise from Chichester Dam Road located approximately 200 metres to the east.

The dwelling at Site 17 is located approximately 40 metres north of Salisbury Road near Underbank. A specific noise source that was expected during the measurement period was regular milk truck deliveries. These occurred once every few days during the morning hours. The effect on ambient noise occurred only during the single 15 minute sample period that the truck was at the property.

Table 16.2 summarises the noise logging results for each of the data collecting properties. The table also shows the rating background level (RBL). The RBL is defined as the median value of the background noise over the monitoring period in each assessment period (ie day, evening or night). Where the RBL was found to be less than 30 dB(A), it was set to 30 dB(A) in accordance with the NSW *Industrial Noise Policy* (INP).

TABLE 16.2 NOISE MONITORING RESULTS

MONITORING LOCATION	TIME PERIOD	AVERAGE AMBIENT NOISE (L_{eq}, dB(A))	CALCULATED RBL (dB(A))	ASSESSMENT RBL (dB(A))
Site 1	Day	47	31	31
	Evening	41	26	30
	Night	42	25	30
Site 12	Day	50	31	31
	Evening	49	37	37
	Night	45	36	36
Site 17	Day	48	30	30
	Evening	37	27	30
	Night	46	27	30

Some data was excluded from the analysis due to impulsive, non-regular single events that did not reflect the normal background and ambient noise environments. A constant, regular noise source was active in the vicinity of the noise logger for a continuous 13 hour period at Site 12 on the evening of 6 August 2007 until the morning of 7 August 2007. As the source of this noise could not be determined, this measurement period was excluded from the analysis due to the significantly heightened background noise level.

It has been assumed that noise levels in the settlements of Dusodie and Bandon Grove would be similar to those measured at Site 1 given the similar rural environment.

Based on spot measurements carried out at each site, all vibration levels recorded were below a peak particle velocity (PPV) of 0.2 mm/s.

16.1.2 Assessment of potential impacts

Given the variety of activities and various stages associated with the construction process, different worst case scenarios were considered and modelled for each stage of construction. A 'snap shot' of each scenario was taken to assess the noise level for that assumed moment in time.

A virtual model of the Project area was developed using the *SoundPLAN* environmental noise modelling software. The model incorporated ground contours as well as meteorological effects to predict noise levels resulting from the various noise sources associated with the Project. The CONCAWE noise model, which is based on noise impact procedures developed in Europe was also implemented in the environmental noise predictions as it contains a degree of conservatism (compared to ISO 9613-2) while allowing direct input of atmospheric stability and wind speed data. Road traffic noise emissions were predicted using the C*alculation of Road Traffic Noise* (CoRTN) model.

Construction

As previously noted, construction noise has been assessed in accordance with the INCG. The guideline covers the generation of noise from demolition, construction and maintenance activities, and aims to minimise impacts from these activities, as opposed to focusing solely on achieving numerical goals.

The ICNG presents two ways of assessing construction noise impacts:

- the quantitative method which is generally suited to longer-term construction, and
- the qualitative method which is generally suited to short-term works (shorter than three weeks) such as infrastructure maintenance.

The construction time for this development is expected to extend over three to four years therefore a quantitative assessment of construction noise is required.

The ICNG sets out standard construction hours, which are as follows:

- Monday to Friday 7.00 am to 6.00 pm
- Saturday 8.00 am to 1.00 pm
- No work on Sundays or public holidays.

The ICNG specifies that the noise level at a noise sensitive receiver (residential) should be less than the Noise Affected Level ($L_{Aeq15\ min}$). The Noise Affected Level is for the standard construction period is calculated based on the Rating Background Level (RBL) +10 dB(A). This level represents the point above which some adverse community reaction to the noise level may be recorded.

The Noise Affected Level for construction outside of the standard hours is calculated based on RBL+5dB(A). A strong justification would typically be required for exceedance of the Noise Affected Level outside of standard hours. If noise emissions from construction exceed the RBL +10 dB(A), community consultation is required.

The RBL is the median assessment background level (based on the daily 10th percentile background noise level) as described in the NSW *Industrial Noise Policy*.

Where the construction noise emissions exceed the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of the works to be carried out, the expected noise levels and duration as well as contact details.

Where noise levels during standard periods are above 75 dB(A), a strong community reaction against the noise can be expected. In this case, the relevant authority may impose respite periods, and restriction of construction activities taking into account:

- times identified by the community when they are less sensitive to noise
- whether the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

For non residential receivers, the noise affected levels are as follows:

- Industrial: 75 dB(A)
- Office/Retail 70 dB(A).

The Project would be constructed over three to four years in stages (refer Chapter 7), each stage being of different durations and comprising differing types of construction activities. These activities would also be spread over a large area, the principal locations being the site of the dam wall and spillway, and the route of the new section of Salisbury Road. With regard to the latter, the nature (and intensity) of construction activities would also vary along the route and would change over time as specific phases of construction were completed in various localities before shifting along the route to a new location.

Some works such as the delivery of oversize construction plant, the establishment of the two coffer dams and major concrete pours would need to be undertaken outside of the standard construction hours.

Each noise source was modelled assuming operation at full power and emitting its maximum sound power. This is a conservative assumption as most equipment would not be operating at full power constantly and simultaneously. As such, it is expected that there would be noise reductions away from the worst case scenario during periods when machinery is idle, operating with reduced power, or not operating at all. It is considered reasonable to assume that each machine would only be operating at full power for at most 30 per cent of the construction time, leading to a 5 dB decrease in the predicted noise levels outlined in the following sections.

The effective noise limits are shown in Table 16.3. The Noise Management Level L_{Aeq} is calculated based on the on the Assessment RBL measured at each site.

TABLE 16.3 EFFECTIVE NOISE LIMITS FOR CONSTRUCTION

	TIME OF DAY	EXISTING RATING BACKGROUND LEVEL (DB(A))	NOISE MANAGEMENT LEVEL $L_{eq,\ 15min}$ (DB(A))	
			NOISE AFFECTED	HIGHLY NOISE AFFECTED
Underbank	Standard hours	30	40	75
	Non–Standard Hours	30	35	40*
Tillegra, Bandon Grove, Dusodie	Standard hours	31	41	75
	Non–Standard Hours	30	35	40*
Bendolba	Standard hours	31	41	75
	Non–Standard Hours	36	41	46*

* Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

Due to the large number of receivers in the vicinity of the proposed works, in order to maintain a constant assessment criterion for standard and non–standard hours, it is proposed that the strictest criteria be applied to all residences. The assessment criteria for the construction noise emissions on this basis are shown in Table 16.4:

TABLE 16.4 CONSTRUCTION NOISE CRITERIA

TIME OF DAY	NOISE MANAGEMENT LEVEL $L_{eq,\ 15min}$ (DB(A))	
	NOISE AFFECTED	HIGHLY NOISE AFFECTED
Standard hours	40	75
Non–Standard Hours	35	40

The ICNG stipulates that a strong justification is required for work outside of the standard construction hours. Construction activities which the ICNG determine as being generally acceptable outside of the standard hours include:

- the delivery of oversized plant or structures that require special arrangements to transport along public roads
- emergency work to avoid loss of life, damage to property or prevent environmental harm
- maintenance and repair of public infrastructure where disruption to essential services and/or consideration of worker safety do not allow work within standard hours
- public infrastructure works that shorten the length of the project and are supported by the affected community
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

It is expected that some construction will be required outside of the standard hours, and an assessment of construction noise for both standard and non–standard hours should be conducted.

To assess sleep disturbance during the night time periods, the following external noise criteria are applicable:

- Continuous noise level: 40 dB(A)
- Individual noise event: 55 dB(A)

Design vibration criteria are based on *Assessing Vibration: a technical guideline* (Dept of Environment and Conservation 2006b) and are presented in Table 4.3 of Working Paper K. Vibration levels from construction activities (excluding blasting) should not exceed the allowable levels due to large propagation activities between the source and receptor (minimum of 200 metres). Typical vibration levels from construction plant are shown in Table 16.5 and include a predicted vibration transmission.

TABLE 16.5 TYPICAL VIBRATION LEVELS FOR CONSTRUCTION PLANT

PLANT	PPV (mm/S) AT 10 M	PREDICTED PPV (mm/S) AT 200 M	PREFERRED DAYTIME CRITERIA (mm/S)
Loader (breaking kerbs)	6–8	0.07–0.09	0.28*
15t roller	7–8	0.08– 0.09	0.28
7t compactor	5–7	0.06–0.08	0.28
Roller	5–6	0.06–0.07	0.28
Pavement breaker	4.5–6	0.05–0.07	0.28
Dozer	2.5–4	0.03–0.04	0.28
Backhoe	1	0.01	0.28
Jackhammer	0.5	0.01	0.28

* Continuous vibration criteria

Blasting would likely be required for construction of the new section of Salisbury Road (potential locations for blasting are identified in Figure 7.4). Blasting activities would follow the ANZECC (1990) guidelines *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* as recommended by DECC. These guidelines have been developed to prevent damage from ground vibration along with minimising annoyance and discomfort of the local residents. The criteria are summarised as follows:

Blasting noise criteria:

- airblast overpressure must not be more than 115 dB (linear) peak for 95 per cent of total blasts initiated in a 12 month period (regardless of the interval between blasts)
- airblast overpressure must not exceed 120 dB (linear) peak at any time.

Blasting vibration criteria:

- ground-borne vibration must not exceed PPV of 5 mm/s for 95 per cent of total blasts initiated in a 12 month period (regardless of the interval between blasts)
- ground-borne vibration must not exceed PPV of 10 mm/s for any blast.

Construction of the dam wall

Chapter 7 identifies the nominal phases for dam-related construction activities. Of these, Phases 1B and 2C/2D are considered likely to have the greatest levels of noise emissions associated with construction activities and represent the 'worst case' scenarios used for the assessment.

Night time works would be limited during most construction phases, however work at night would be required during Phases 1B and 2C/2D. Night works during Phase 1B would be in general limited to periods of several weeks at any one time, these relating to the establishment of the upstream and downstream coffer dams. Additionally, continuous concrete pours of 24 hour duration may need to be undertaken during Phase 2C/2D.

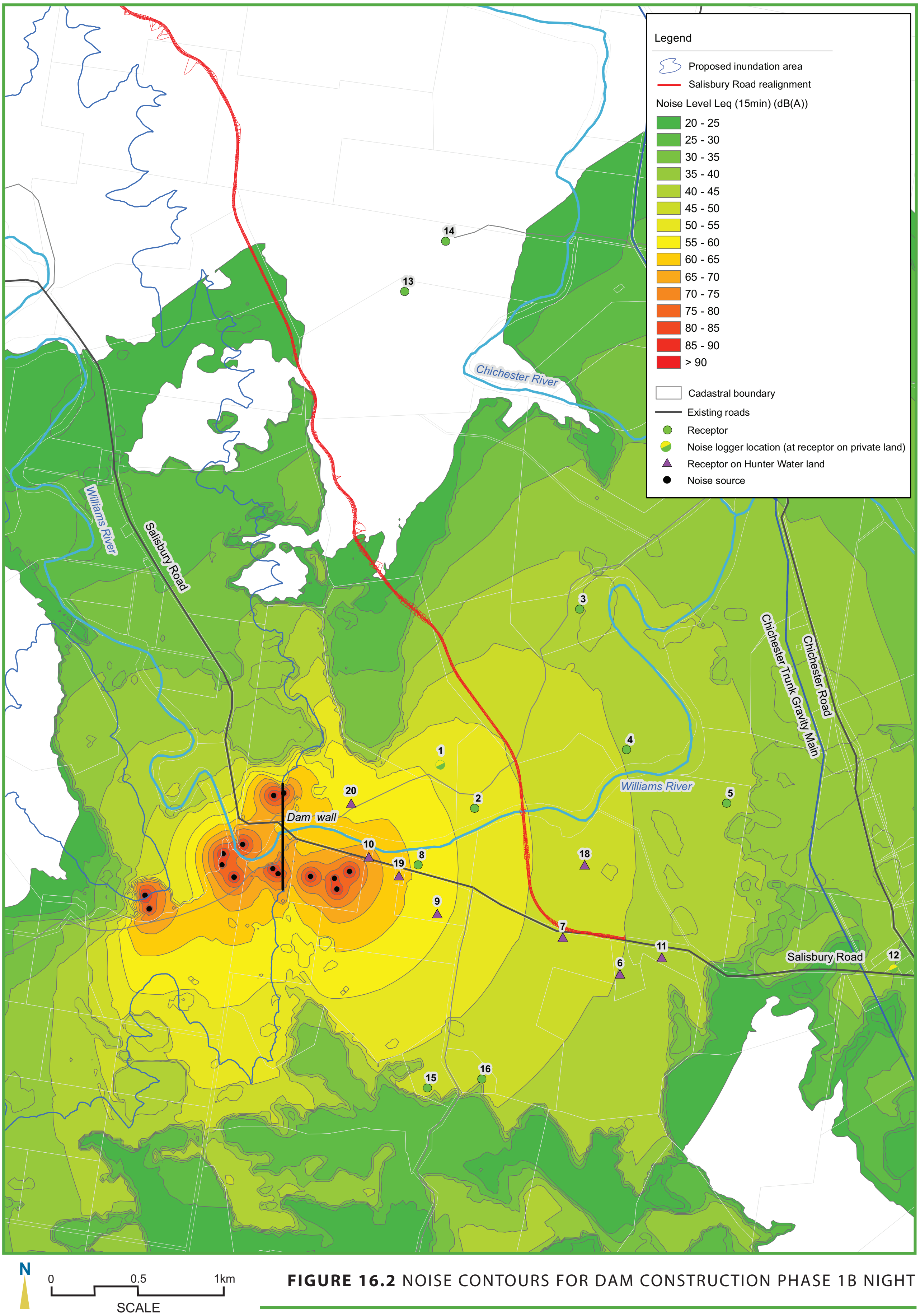

FIGURE 16.2 NOISE CONTOURS FOR DAM CONSTRUCTION PHASE 1B NIGHT

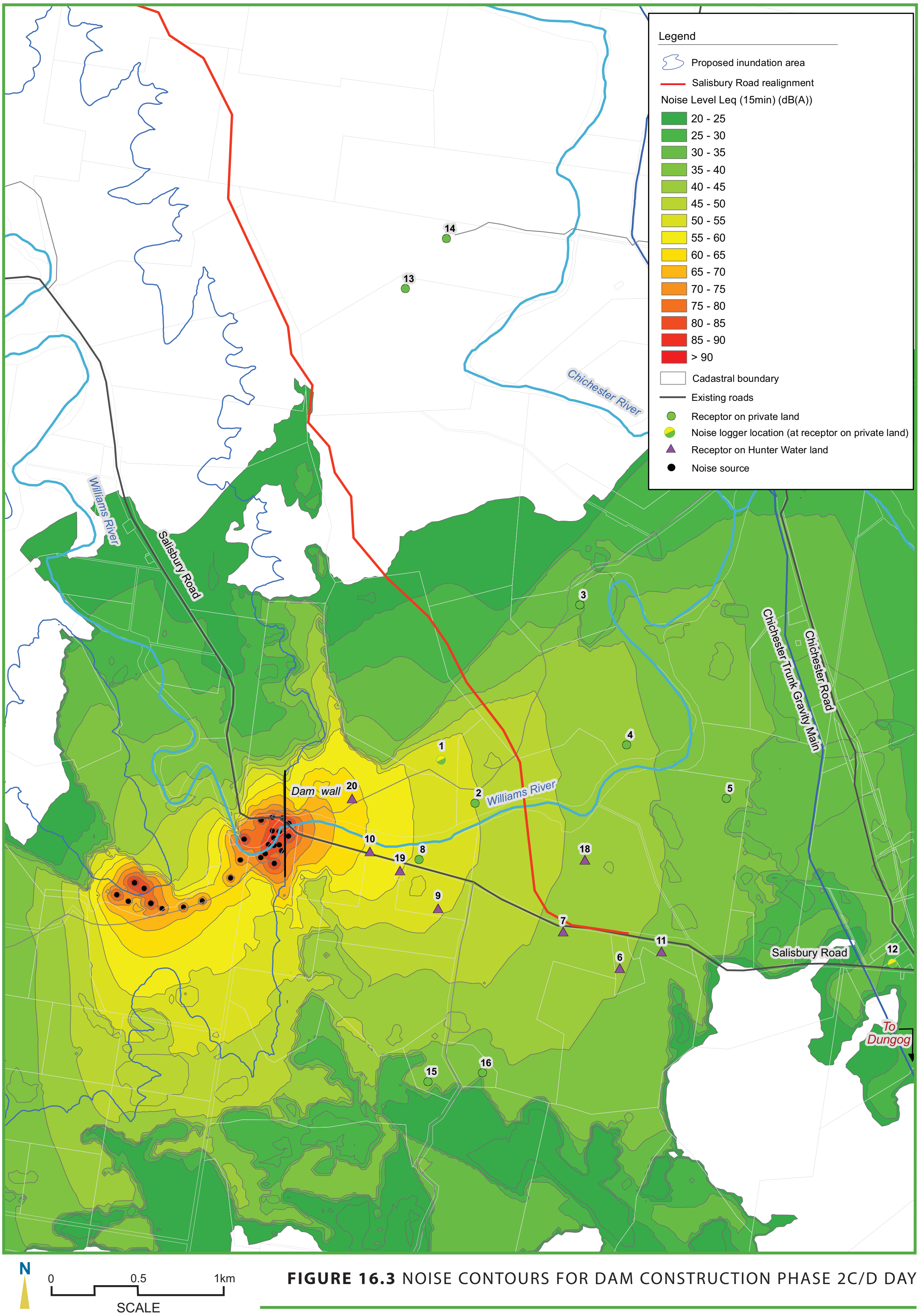

FIGURE 16.3 NOISE CONTOURS FOR DAM CONSTRUCTION PHASE 2C/D DAY

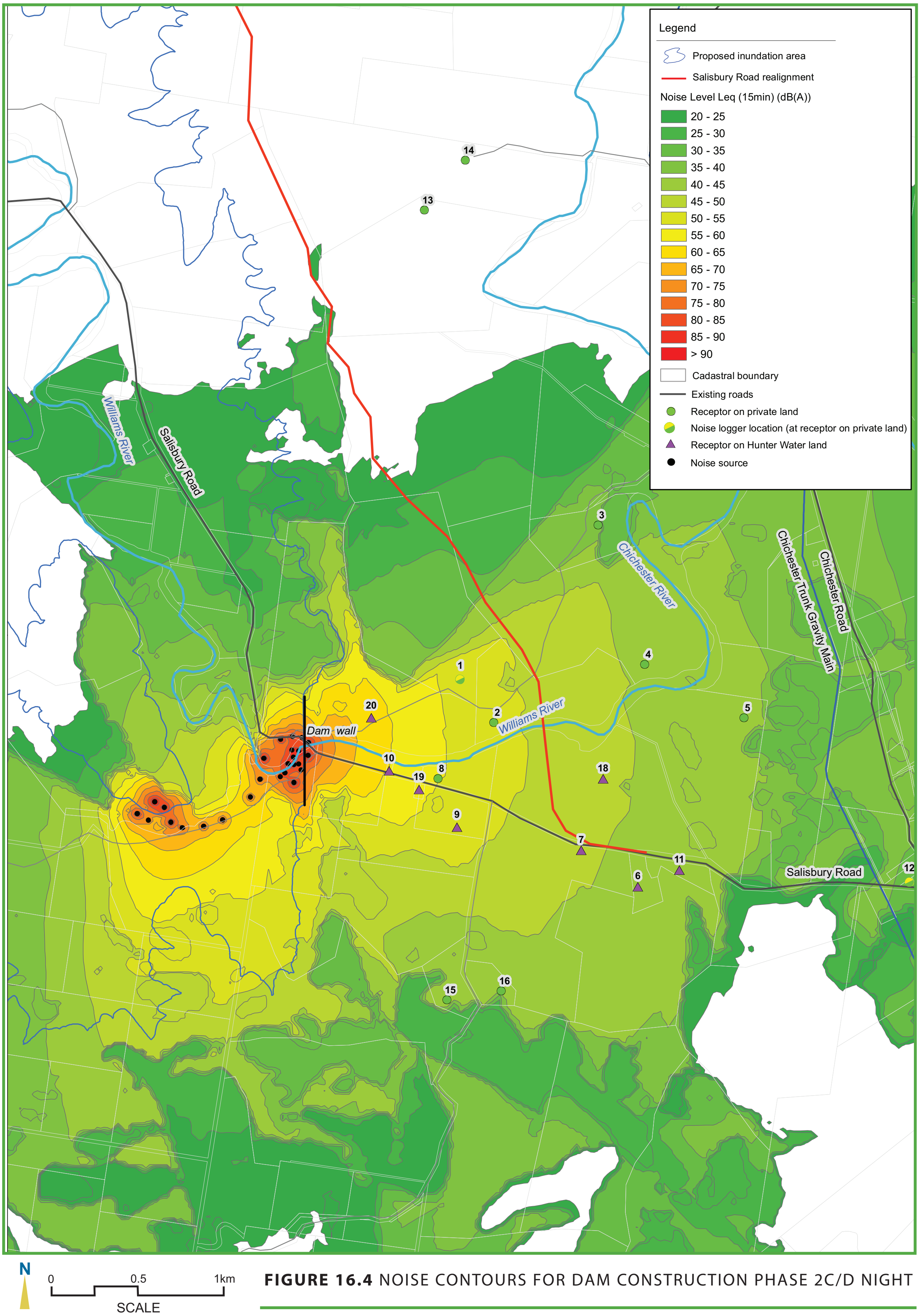

FIGURE 16.4 NOISE CONTOURS FOR DAM CONSTRUCTION PHASE 2C/D NIGHT

For the purpose of the assessment, a conservative position was adopted in that it was assumed that the plant listed in Table 6.2 of Working Paper K would be operating concurrently and constantly. For night time (non-standard hours), construction activities were modelled assuming the same operating equipment as during standard hours. Detailed scopes and schedules of plant and equipment for the proposed night time works were unavailable during the assessment and so only general night time construction has been assessed. Different meteorological conditions have been taken into account between the standard and non-standard periods.

This list is provisional and the final inventory of plant would be subject to construction programming needs. Additional equipment (especially plant with lower noise emission levels) would not significantly contribute to noise levels in the environment.

Noise levels predicted for each scenario are considered worst case as once construction of the dam wall commences, 'natural' noise barriers would be created by topography as well as the dam wall itself. These would significantly decrease the noise level at the receptor.

Predicted noise levels at the sensitive receptors for Phase 1B and Phase 2C/D are presented in Table 16.6. Blue shading is used to denote receptors that are Noise Affected as per the ICNG while orange shading denotes those receptors where community consultation would also be required.

Receptors 13, 14 and 17 have been omitted from the table as the modelling has indicated they would not be affected by construction noise associated with the

Predicted noise contours have also been derived. These are shown in Figures 16.1 and 16.2 for standard hours and non-standard hours respectively for Phase 1B. Figures 16.3 and 16.4 show the noise contours for standard hours and non-standard hours respectively for Phase 2C/D.

TABLE 16.6 PREDICTED NOISE LEVELS FOR DAM WALL CONSTRUCTION

	PHASE 1B $L_{eq, 15min}$ (dB(A)) TYPICAL OPERATIONAL NOISE		PHASE 2C/D $L_{eq, 15min}$ (dB(A)) TYPICAL OPERATIONAL NOISE	
	Standard Hours	Non-Standard Hours	Standard Hours	Non-Standard Hours
1	47	49	47	48
2	44	46	41	43
3	34	37	28	31
4	37	39	36	39
5	33	36	32	35
6	37	40	35	38
7	41	43	38	41
8	53	54	49	50
9	50	51	45	47
10	60	62	54	54
11	35	38	34	37
12	25	30	24	29
15	29	31	22	25
16	32	34	25	27
18	40	42	38	41
19	59	60	53	53
20	55	55	56	56

For the standard construction period, noise levels are predicted to be exceeded at nine receptors (three HWC-owned) for Phase 1B and at seven receptors (two HWC-owned) for Phase 2C/D. For construction during non-standard hours, exceedances are predicted at 14 receptors for Phase 1B and at 13 receptors for Phase 2C/D. Of these, consultation would also be required for 10 receptors for Phase 1B and for nine receptors for Phase 2C/D.

As noted previously, the noise levels predicted for the two scenarios are considered worst case. As construction of the dam wall proceeds, noise barriers would be created by topography as well as the dam wall itself. These would significantly decrease the noise level at receptors.

The average number of construction vehicle movements (two way) is expected to peak at approximately nine per day (over a six–day working week) though at times, depending on the nature of construction activities, this could be higher. Overall however, construction traffic is expected to increase daily heavy vehicle movements by less than one per cent on both MR101 and MR301. This level of heavy vehicle movements would have a negligible effect on the overall noise environment.

Salisbury Road realignment

The estimated construction time for the 17 kilometre realignment of Salisbury Road is 104 weeks. Construction activities would be distributed along the route and not necessarily equally, ie construction would focus on certain areas for a certain length of time (eg such as earthworks) and then move to another location.

As for dam construction activities, the assessment has taken a conservative position in assuming that the plant listed in Table 7.2 would be operating concurrently and constantly. Again, the list of plant is provisional and the final inventory would be subject to construction programming needs.

Given that some plant such as graders, rollers and other moving plant would not be operating in the same location for a continuous period of time, an adjustment to their effective emitted noise level has been made based on the assumption that each item would operate at the closest location to the sensitive receptor for approximately five minutes in each 15 minute period. This creates a more realistic prediction of the emitted noise by the construction plant rather than the instantaneous worst case which does not represent accurately the average noise level at the receptor. This is consistent with the estimated 30 per cent plant operation adjustment applied for the construction of the dam wall.

Construction noise at three worst case locations along the Salisbury Road new alignment was calculated to assess noise at receptors. Predicted noise levels at sensitive receptors for the three areas are shown in Table 16.7. Noise contours (standard hours) for the three areas (1, 2 and 3 moving south to north) are shown in Figures 16.5, 16.6 and 16.7 respectively.

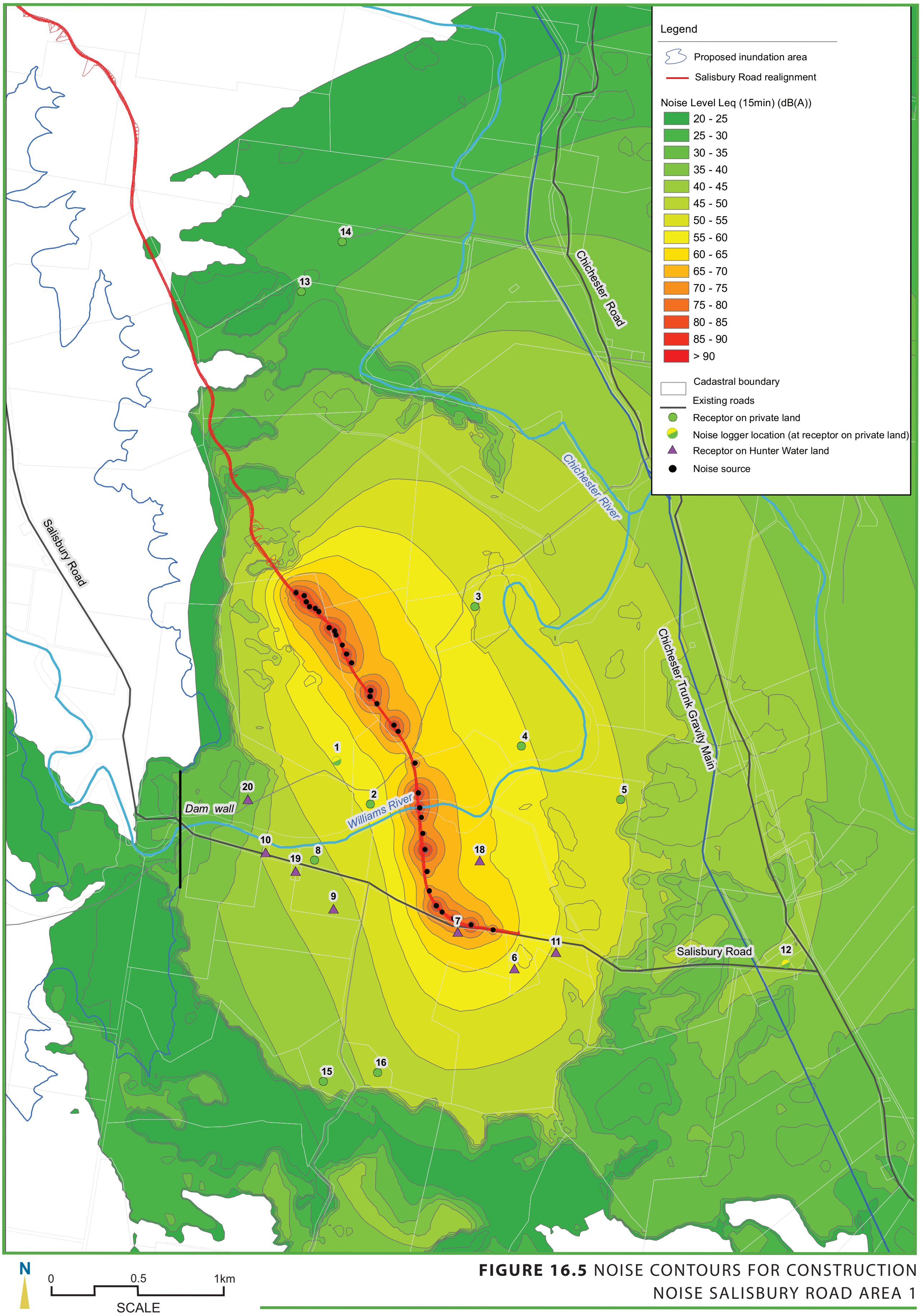

FIGURE 16.5 NOISE CONTOURS FOR CONSTRUCTION NOISE SALISBURY ROAD AREA 1

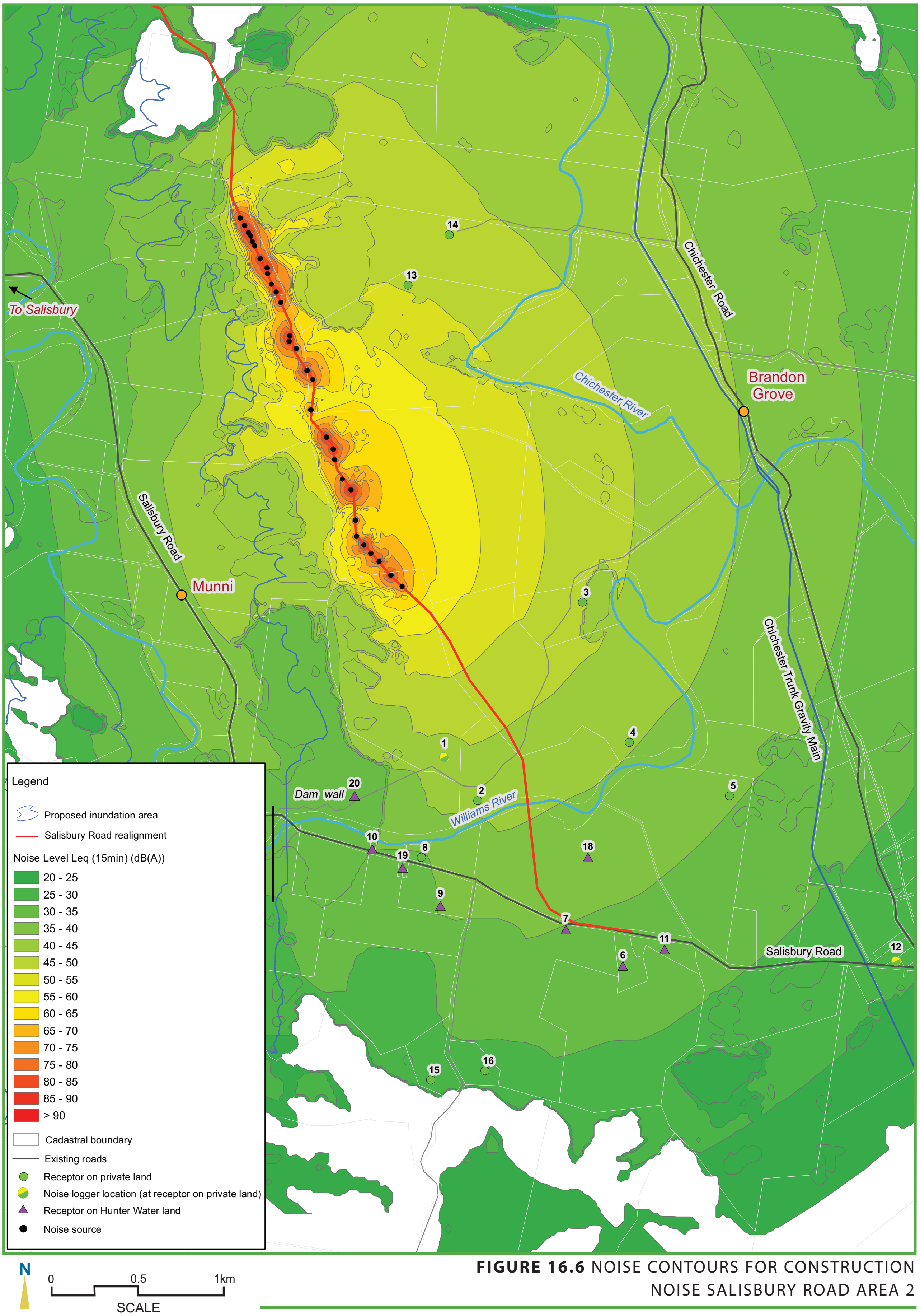

FIGURE 16.6 NOISE CONTOURS FOR CONSTRUCTION NOISE SALISBURY ROAD AREA 2

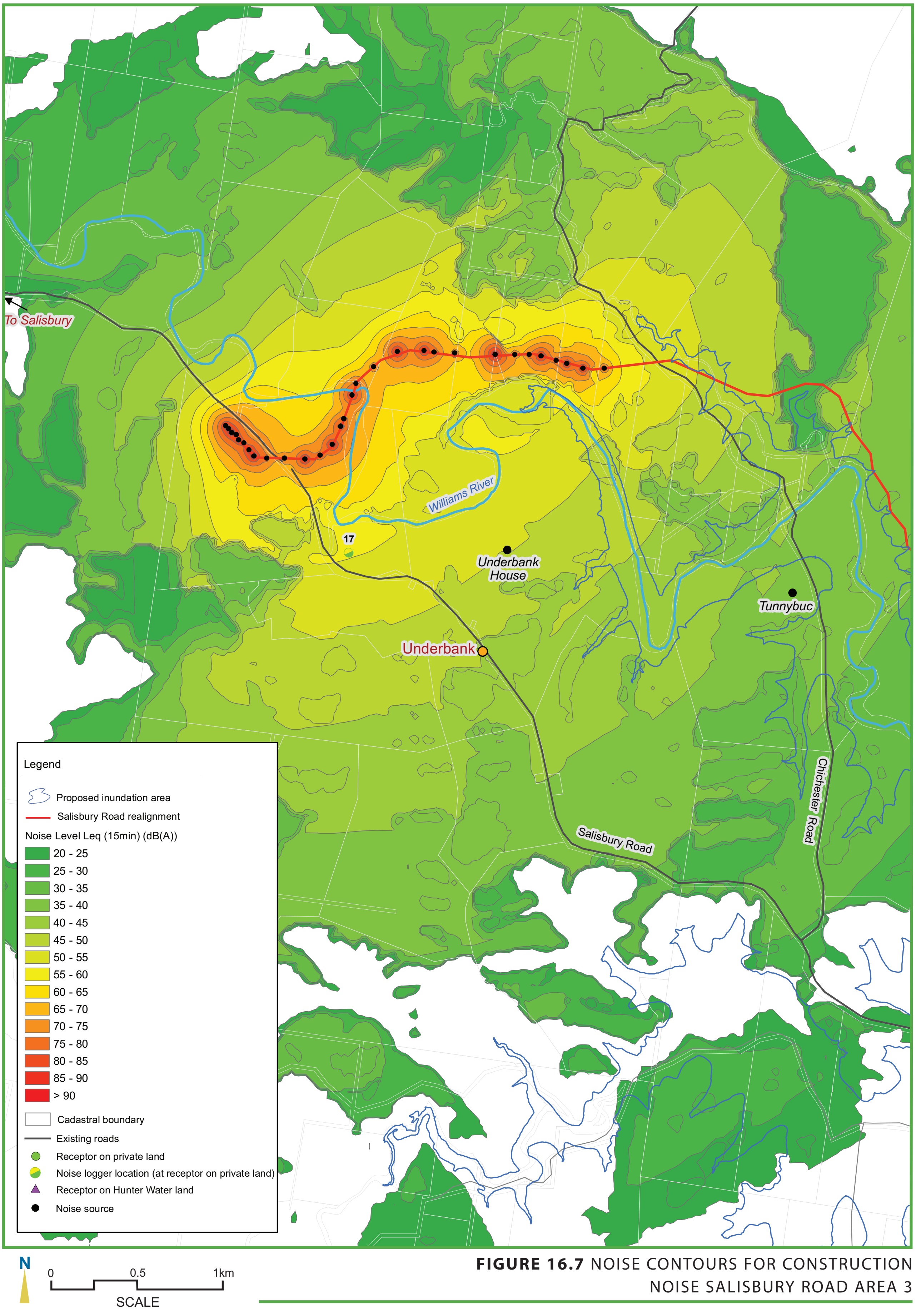

FIGURE 16.7 NOISE CONTOURS FOR CONSTRUCTION NOISE SALISBURY ROAD AREA 3

TABLE 16.7 PREDICTED NOISE LEVELS (STANDARD HOURS) FOR SALISBURY ROAD CONSTRUCTION

RECEPTOR	AREA 1[a]	AREA 2[a]	AREA 3[a]
1	50	38	–
2	56	38	–
3	49	42	–
4	50	35	–
5	45	30	–
6[b]	52	27	–
7[b]	66	30	–
8	44	30	–
9[b]	43	30	–
10[b]	40	27	–
11[b]	49	27	–
12	36	21	–
13	24	44	–
14	23	41	–
15	39	23	–
16	41	23	–
17	–	–	50
18[b]	60	32	–
19[b]	42	28	–
20[b]	30	37	–

a $L_{eq\ 15min}$ dB(A)
b HWC-owned property; blue highlighted cells show exceedance of 50 dB(A) noise criterion

Table 16.7 shows that for road construction works undertaken during standard hours, exceedances are predicted at 13 receptors (six of these are HWC-owned) in Area 1, at three receptors (all private) in Area 2, and at one receptor (private) in Area 3.

Construction noise emissions associated with the mini HEP plant was not considered in the noise assessment. As noted elsewhere in this report, the Project is only making provision for the HEP plant and the actual plant would be installed at a later date. The impacts associated with installation and operation would be addressed at this time.

As previously noted, assuming a six-day per week construction schedule and the need for trucks to arrive and depart along the haulage route, the expected average number of truck movements is nine per day. This level of heavy vehicle movements would not cause a significant impact on noise environment at the sensitive receptors given their infrequency.

Impacts associated with blasting activities have been predicted according to Sections J7.2 and J7.3 for airblast overpressure and ground vibration respectively from *AS 2187.2-2006 Explosives–Storage* and use Part 2: Use of explosives (Standards Australia 2006). Table 16.8 shows the minimum recommended distance between the blasting site and nearest sensitive receptor to comply with the ANZECC vibration criteria. Average conditions have been put into the model, and predictions using a 10 dB safety factor (overpressure less than 105 dB) have also been produced. In all cases the minimum airblast overpressure distance is the driving factor.

TABLE 16.8 MINIMUM RECOMMENDED DISTANCES BETWEEN BLASTING AND SENSITIVE RECEPTORS

EFFECTIVE CHARGE MASS PER DELAY (kg)	DISTANCE (m) TO ACHIEVE AIRBLAST OVERPRESSURE		DISTANCE (M) TO ACHIEVE PPV < 5mm/S (m)
	< 115 dB (Lin)	< 105 dB (Lin)	
5	185	409	67
25	316	699	149
50	398	881	210
100	502	1110	298
200	632	1398	421
500	858	1898	666

It should be noted that the prediction methods outlined in the AS 2187.2-2006 do not take into account topographical shielding or meteorological effects for airblast overpressure and variations in ground conditions. Accordingly, final design for any blasting would take into account specific location and ground conditions evident on the day to meet the ANZECC vibration criteria.

Operation

A qualitative assessment of the operational noise impacts has been undertaken, as a more detailed analysis was not possible given the limited available information regarding equipment specification and the position of such infrastructure relative to the dam. However a qualitative assessment was considered appropriate as the operational noise impacts related to the dam would be relatively minor and are unlikely to exceed allowable criteria. The following operational activities and their potential noise impacts have been considered:

- spillway–spillway noise could become a dominating noise source depending on the volume of water associated with the flow. Given design constraints, difficulty and large costs to directly mitigate the noise at its source level any potential noise treatment would be better applied to sensitive receptors (eg sound insulation of dwellings). The need for any such treatment at receptors would be considered on a case-by-case basis.
- substation–noise emitted from the substation (predominantly from the transformer) would comply with the operational noise criteria due to the relatively low emitted sound powers and the large propagation distance to the closest receptor.
- maintenance noise–emissions associated with maintenance activities would be generally minor though an exception would be testing of the emergency warning siren. This would be performed during day time hours and limited in duration to no longer than necessary to confirm satisfactory operation.

Road traffic noise levels have been considered as part of operation of the Project. The road traffic noise predicted consisted of the worst case hourly exposure which would occur at receptor 7 during morning and afternoon peak volumes. These were found to be within the ECRTN level of $L_{eq(1h)}$ 55 dB(A) (Environment Protection Authority 1999). Given the anticipated low traffic volumes along Salisbury Road, it is expected the ECRTN criterion would be satisfied.

16.1.3 Mitigation and management measures

Construction

- construction activities would generally be limited to the following times:
  - Monday to Saturday – 7.00 am to 6.00 pm
  - Sunday – office administration and/or servicing of plant only
  - Phase 1B (rapid establishment of coffer dams) – 24hrs day for four weeks
  - Phase 2B/2C – 24hrs day for intermittent periods during continuous concrete pours on upstream face of dam wall

  Should work be required to be undertaken outside of these times, prior approval would be sought from the DECC and affected residents would be consulted.

- noisy activities (eg blasting) would be undertaken between 9.00 am and 3.00 pm as far as practicable
- implementation of recommended controls, as appropriate, in *AS 2436:1981-Guide to Noise Control on Construction, Maintenance and Demolition Sites*
- use of low noise emission plant where possible
- placement of stationary equipment such as crushing plants, air compressors and generators as far as practicable from noise-sensitive receptors
- minimise idling stationary plant where possible
- development of a noise management plan which would include logging and assessment of complaints, as well as routine monitoring of noise levels during construction
- provide advance notification to the affected community of any expected noise disruptions that might occur
- engage with the community to establish variations to noise criteria to allow for louder construction noise during certain times, as well provide regular updates informing them of upcoming work and whether they should expect any heightened disturbance
- temporary relocation of residents during worst case noise emitted during construction.

For out of hour works, such as continuous concrete pours, it is recommended that the management approach set out in the *Interim Construction Noise Guideline* (DECC 2009) be followed. This sets the $L_{Aeq(15\ min)}$ management level at the affected receptor at the RBL + 5 dB(A). In applying this management approach, the guideline indicates that:

- a strong justification would typically be required for works outside the recommended standard hours
- all feasible and reasonable work practices should be implemented to meet the noise affected level (ie RBL + 5 dB(A))
- where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

Specific works at affected residences may also be undertaken. This may include the installation of insulation, double glazing and other measures to intercept noise. In certain circumstances, temporary relocation of residents and/or livestock may be considered during peak noise periods. In this regard, two to three HWC-owned houses located closest to the construction site/works compound may not be privately leased during anticipated peak noise periods or the matter further discussed with tenants. The management of noise needs to be considered on the merits of each particular circumstance as related to each individual residence. On this basis HWC has currently liaised with each of the affected landholders and tenants below the dam wall and spillway to determine the most appropriate mitigation measure.

Operation

Dam:

- monitoring during the compliance period at the closest sensitive receptors to determine if the design noise criteria have been exceeded
- regular communication with the local community would be carried out to advise them of any unusual or irregular activities or noise sources which might cause a disturbance
- specification of acoustic enclosures for the pump station and turbine enclosure would be provided during the design stage once detailed specifications of the chosen equipment is available
- specification of noise limits for major items of equipment (ie turbine, generator and transformer) would be provided during the design stage.

Road:

Traffic noise associated with use of the new section of Salisbury Road is expected to comply with ECRTN criteria therefore no specific mitigation measures are considered necessary.

16.2 Air quality

A comprehensive air quality assessment was conducted as part of the environmental assessment for the proposed Project. A summary of the findings is provided in this section. The detailed technical report is provided as Working Paper J *Air Quality*.

16.2.1 Key features of the existing environment

Air quality within the general area is influenced primarily by fugitive emissions of particulate matter as PM_{10} (particulate matter with diameter less than 10 micrometres). Sources of particulate matter include windblown dust, prescribed burning or bushfires, domestic combustion of solid fuel, quarrying and motor vehicle emissions. Emissions of particulate matter from construction activities are the principal concern for the Project. As such, it was necessary to establish baseline conditions for the Project area with monitored data from a representative location.

In the absence of publicly accessible site-specific air quality monitoring data, a continuous day of monitoring was undertaken near Underbank and Tillegra. The ground level concentration (GLC) profile of a single day (7 August 2007) showed that levels were maximised early in the morning and in the early evening when temperature inversions, which inhibit air mixing, results in accumulation of pollutants at ground level. The daily averaged concentration was found to be approximately 20.5 $\mu g/m^3$.

While this provides a limited 'snapshot' of local air quality, the recorded data was not considered to be of sufficient length to accurately characterise baseline conditions nor the seasonal variations in recorded ground level concentrations at Tillegra with any reasonable degree of confidence.

Accordingly, a suitable alternative information source was required.

Identification of a suitable alternative data source initially involved a review of the DECC air quality monitoring network to identify firstly the station closest to the site and secondly, other stations with surrounding land uses similar to Tillegra. In both instances, it was desirable for a station to have suitable records of at least 12 months duration to consider seasonal variations.

The nearest DECC monitoring station is located at Beresfield; approximately 60 kilometres to the south of Tillegra. Concentrations of ozone, particulates as PM_{10}, nitrogen dioxide (NO_2), and sulphur dioxide (SO_2) are recorded at this site. However, ground-level concentrations are likely to be influenced by emissions from urban and industrial sources from nearby Newcastle as well as from intermittent sea spray effects.

Given the differing locational contexts of Tillegra and Beresfield, it was considered that use of data from Beresfield would likely overestimate pollutant levels and not accurately characterise background conditions at Tillegra and therefore impacts on receptors. There are two other stations in the lower Hunter (Newcastle, Wallsend) but neither were considered suitable for similar reasons to the Beresfield station.

Other DECC stations that were potentially more representative (relatively) and which monitored PM_{10} levels included Bathurst, Albury, Wagga Wagga, and Tamworth. Of these stations, Bathurst was considered potentially the most suitable. The station is located at the Bathurst wastewater treatment plant which is on the northern outskirts and is adjacent to a substantial rural/semi-rural area.

However, there is a notable difference in agricultural land use between Tillegra and the Bathurst monitoring station. The former is under pastoral/grazing while the latter is under cropping. Use of the Bathurst monitoring data could therefore potentially overestimate particulate emissions at Tillegra due to the greater exposure, both in terms of extent and duration, of bare soil surfaces. Additionally, all stations are located within or on the outskirts of substantial settlements and as such, likely not directly comparable with the Tillegra locality.

Given the considered limitations of the DECC stations, a search was then undertaken of other potential information sources in the lower Hunter region. A number of possible sites, principally associated with mining developments were identified. Publicly available ambient air quality information was obtained for two locations, namely Stratford Coal Mine and Glennies Creek Open Cut Mine. For the former, 24-hour average PM_{10} concentration data was available for the period 5 July 2001 to 27 June 2006, while data for the latter covered the period 25 August 2005 to 26 August 2006.

Monitoring was undertaken at two sites initially for the Stratford Coal Mine with a further two sites added in March 2003. For the Glennies Creek Open Cut Mine, monitoring was undertaken at two sites.

The monitoring results for the Stratford Coal Mine included annual 24-hour average PM_{10} concentrations and are reproduced in the following table.

TABLE 16.9 STRATFORD COAL MINE ANNUAL 24-HOUR AVERAGE PM_{10} CONCENTRATIONS[1]

PERIOD	WHEATLEYS RD	CRAVEN	ELLIS RESIDENCE	CLARKE RESIDENCE
Jul 2001 to Jun 2002	8.6	11.0	N/A	N/A
Jul 2002 to Jun 2003	16.2	16.6	N/A	N/A
Jul 2003 to Jun 2004	13.0	11.9	16.2	13.3
Jul 2004 to Jun 2005	11.6	10.7	13.2	10.0
Jul 2005 to Jun 2006	10.3	9.2	14.5	6.9

1 Concentrations inµg/m^3

The average of the above readings is approximately 12 µg/m^3. In view of this, it was considered reasonable to adopt a background of 15 µg/m^3 for the Tillegra locality.

Estimates of background levels for annual average PM_{10} and monthly average dust deposition (TSP, total solid particulates) were sourced from a review of high volume dust monitoring in the townships of Stratford and Craven which are located approximately 30 kilometres to the northeast of Tillegra.

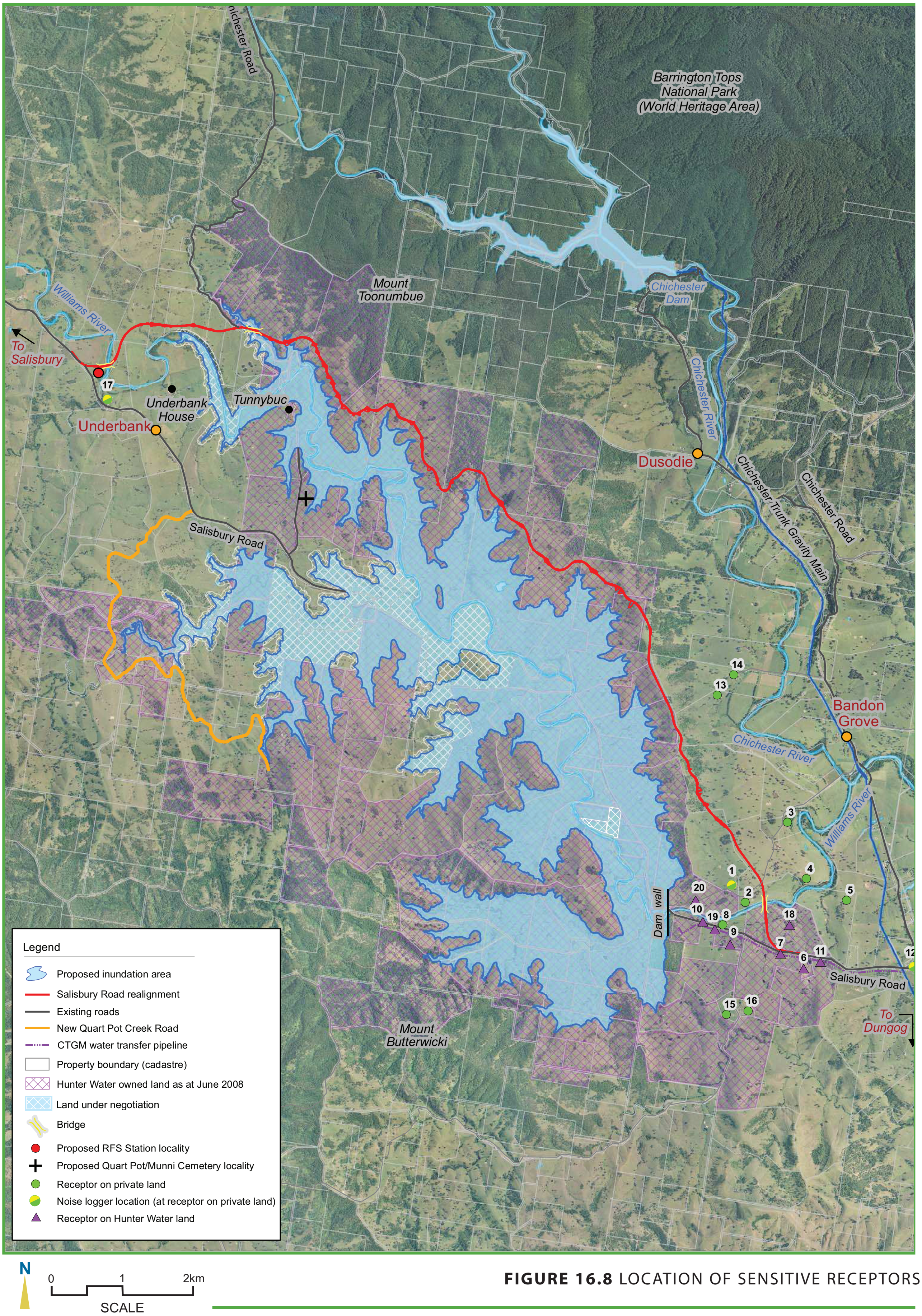

FIGURE 16.8 LOCATION OF SENSITIVE RECEPTORS

The Stratford data is considered to provide the more accurate representation of the background levels given it is approximately one kilometre from the nearest pit. From a review of the data for the period December 2006 to December 2007, values of 10 μg/m^3 and 0.8 g/m^2/mth were adopted for annual average PM_{10} and monthly average TSP respectively.

Data representing annual average TSP concentrations was not provided in these reports. Reference was subsequently made to monitoring results collected from a high volume sampler operated for 24 hours every six days as per AS3580.9.3 for two sites, one in the upper Hunter and the other at Mayfield in Newcastle. The former site has exposure to coal mining operations while the latter is exposed to a busy road and a large remediation site, so neither could be considered representative of the Tillegra locality, where land use is predominantly rural, agricultural (grazing).

They were, however, still considered to be of value in assessing quantitatively where the Tillegra locality might sit relative to these locations. The annual average TSP values for 2008 for these the upper Hunter and Mayfield sites were 79 μg/m^3 and 36 μg/m^3 respectively. Based on these values, it is expected that annual average TSP for the Tillegra locality would be less than the lower of these values. Accordingly, a value of 30 μg/m^3 was adopted for the assessment.

There are a number of sensitive receptors in the Tillegra locality and these are identified in Figure 16.8. There are seven residences (1, 2, 8, 9, 10, 19, 20) located between the dam construction site and the new section of Salisbury Road. Four (9, 10, 19, 20) have been purchased by HWC and lie within the dam construction site boundary. One non HWC-owned residence (8) is also located within this boundary. It is expected that impacts would likely be greatest at these locations. Minor localised air quality impacts could also be associated with the relocation of telecommunications and electrical supply infrastructure.

16.2.2 Construction activities and timing

Subject to HWC securing all necessary approvals, work is expected to start as soon as possible after the planning and assessment period is completed with construction of the new bridges for the realigned section of Salisbury Road, together with the approaches to these waterway crossings.

Construction of the dam would commence approximately 6–12 months later, depending on the finalisation of detailed design. It may be necessary to commence works concurrently if delays to detailed design process are experienced. Once initiated, work would continue for about four years. The majority of construction works are expected to be completed within the first three years with ancillary works and decommissioning of the work site in the final 12 months.

Working hours would be subject to the final approval but construction would generally be restricted to Monday to Saturday between 7.00 am and 6.00 pm. Some construction activities (eg major concrete pours) may be need to take place outside of this period and would be addressed on a case-by-case basis. It is possible that dust emissions could be associated with these out of hours activities.

Construction of the dam would occur in three major phases while road construction works would comprise two major phases, these overlapping to some extent. These are described briefly in Table 16.10 together with the anticipated dust generating activities.

16.2.3 Emission estimates

Dust emission rates from the described construction activities were quantified from the National Pollution Inventory (NPI) *Emissions Estimation Technique Manual for Mining and Processing of Non-metallic Minerals Version 2.0* (Environment Australia 2000) and for emissions from sources/activities not covered by NPI handbooks the *US EPA AP42 Compilation of Air Pollutant Emission Factors* (United States Environmental Protection Agency 1995) for concrete batching and crushed stone processing was used. The emission factors for total suspended particulates (TSP) and PM_{10} from various construction activities are listed in Table 16.11.

Dust emissions from all three on-site quarries were not included in the air dispersion model simultaneously as it is very unlikely that all three sites would be worked concurrently. Instead the approach taken was to use the worst-case scenario for the quarrying operation that would lead to the highest air emissions. The bulk of material for construction is expected to be won from Quarry B; accordingly this site was adopted for the assessment of emissions.

TABLE 16.10 CONSTRUCTION PHASES AND LIKELY DUST-GENERATING ACTIVITIES

CONSTRUCTION PHASE AND MAIN ACTIVITIES	TIMING AND DURATION	LIKELY DUST-GENERATING ACTIVITIES
Road construction – Stage 1 • bridges and approaches	Year 1 48 weeks	Clearing, grubbing and stripping of vegetation – mulching and stockpiling using dozers and mulchers Excavation for road – haulage of waste Construction of roads Establishment of quarry, batching facilities, crushing plant Dust generation from earthmovers Wheel-generated dust from vehicular traffic on unsealed roads
Road construction – Stage 2 • remaining works	Year 2 96 weeks	
Dam construction – Stage 1 • site clearing • establishment of site access roads, quarry, crushing plant • excavation of inlet and outlet channels, lower spillway, embankment (above river level) and upstream coffer dam • excavation of diversion tunnel and upper spillway • preparation of embankment foundations below river level	Year 2 44 weeks	Rock excavation – open cut blasting Drilling pre-split holes Spillway excavation Drilling of drainage holes Quarry stripping – rockfill haulage Foundation excavation/preparation – waste rock haulage Main embankment – rockfill haulage, placement and compacting Main embankment – foundation grouting Wind erosion from exposed areas Concrete batching – toe slab, parapet wall, face slab Crushing of aggregate Wheel generated dust emissions from vehicular traffic on unsealed roads Erosion from stockpiles Dust generation from earthmoving activities
Dam construction – Stage 2 • completion of excavation of lower spillway (through Salisbury Road) • construction of coffer dams and diversion of river through tunnel • construction of embankment • closure of river diversion • construction of CTGM transfer pipeline	Year 3 110 weeks	
Dam construction – Stage 3 • valve block and outlet • parapet wall and embankment road • amenities, landscaping, etc	Year 4 24 weeks	Wheel generated dust emissions from vehicular traffic on unsealed roads Emissions from excavation activities Concrete batching Rock crushing Waste haulage

TABLE 16.11 EMISSION FACTORS FOR PROPOSED CONSTRUCTION ACTIVITIES

ACTIVITY	EMISSION FACTORS		UNITS	DUST CONTROL	REFERENCE
	TSP	PM_{10}			
Loading trucks (excavator)	0.0022	0.0011	kg/ton	Moisture ~2%	NPI Mining and Processing Handbook
Excavation of rock from quarry	0.029	0.014	kg/ton	–	NPI Mining and Processing Handbook
Excavation of overburden from quarry	0.025	0.012	kg/ton	–	NPI Mining and Processing Handbook
Excavation of alluvium	0.005	0.002	kg/ton	Assumed to be material with 100% moisture content	NPI Mining and Processing Handbook
Dozer on stockpiles	16.74	4.07	kg/ha	Silt content = 10 Moisture = 2% 8 hrs/day	NPI Mining and Processing Handbook
Wind erosion from exposed areas	4,969	2,485	kg/ha/year	50% control with water sprays 109 rain days pa 14.8% winds >5.3 m/s	NPI Mining and Processing Handbook
Wheel generated dust >50t haul trucks	4.1	1.0	kg/VKT	75% control with water sprays Silt content = 10 Moisture = 2%	US EPA AP 42
Blasting	97.2	50.5	kg/blast	Average area ~90 m^2 Blast depth ~10 m Moisture ~2%	US EPA AP 42
Drilling	0.177	0.093	kg/hole	70% control with water sprays/ fabric filter	NPI Mining and Processing Handbook
Crushing aggregate	0.0027	0.0012	kg/ton	Wet suppression (spray nozzles)	US EPA AP42 Crushed Stone Processing
Concrete batching	0.0045	0.0024	kg/ton	Baghouse on silo transfers, watering down of aggregate stockpiles and clean paved areas around plant	US EPA AP42 Concrete Batching
Trucks dumping overburden	0.012	0.0043	kg/ton	–	NPI Mining and Processing Handbook
Embankment wind erosion	4,969	2,485	kg/ton	–	NPI Mining and Processing Handbook

The emission factors in Table 16.11 were used in conjunction with the predicted construction activity rates for each type of activity listed in Table 3.3 of Working Paper J in order to determine the TSP and PM_{10} emission rates. The activity rates were sourced from the dam options study report (Department of Commerce 2007).

The emissions quantified are representative of the latter part of Stage 1 and a large proportion of Stage 2 of the dam construction program as outlined in the options study report. The emissions were quantified for a one year period commencing in the final quarter of Year 2 when construction activities are expected to result in the most significant degree of airborne emissions.

16.2.4 Assessment criteria

In NSW, the *Protection of the Environment Operations (Clean Air) Regulation 2002* replaced a multitude of legislation that governed air quality impact for a range of industrial and domestic polluting activities. Part 4 of the Regulation deals with emissions of air impurities sourced from activities and plant. In particular, the Regulation:

- sets maximum limits on emissions from activities and plant for a number of substances including nitrogen oxides, smoke, solid particles, chlorine, dioxins, furans and heavy metals
- imposes operational requirements for certain afterburners, flares, vapour recovery units and other treatment plant
- deals with the transport and storage of volatile organic liquids (Part 5)
- restricts the use of high sulphur liquid fuel (Part 6).

The first of the above bullet points is of relevance to the air quality assessment of construction and operational activities for the Tillegra Dam project. The NSW air quality guidelines sourced from the *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW* (Dept of Environment and Conservation 2005) applicable to the Project are shown in Table 16.12.

TABLE 16.12 NSW AIR QUALITY GUIDELINES

POLLUTANT	AVERAGING PERIOD	CONCENTRATION	
		$\mu g/m^3$	g/m^2/MONTH
PM_{10}	24 hours	50	–
	Annual	30	–
TSP	Annual	90	–
Deposited dust	–	–	2^a , 4^b

a Maximum increase in deposited dust level
b Maximum total deposited dust level

At the Commonwealth level, the National Environment Protection Council (NEPC) has developed National Environmental Protection Measures (NEPM) which outline agreed national objectives for protecting and managing aspects of the environment. The Air NEPM set standards and goals at levels that protect human health and wellbeing, aesthetic enjoyment and local amenity. The goals in the Air NEPM specify a maximum permissible number of days per year when the standards may be exceeded and a timeframe of 10 years (1998-2008) within which these goals must be met (Environment Protection and Heritage Council, National Environment Protection Council Service Corporation 2003).

The Air Pollution Model

The Air Pollution Model (TAPM) is a CSIRO-developed prognostic meteorological and air dispersion modelling tool. TAPM produces meteorological data, upper air information and temperature profiles for a simulation period in three dimensions for all the grid points across the modelling domain. The model was used to accurately account for complex terrain effects on air quality in the Project area and to pre-process spatially varying hourly meteorological data.

Measured meteorological conditions were simulated for a full year using data sourced from the BOM for the closest weather station located at Paterson, 40 kilometres south of Tillegra. A reference year of 2004 was selected for the simulation, and wind and rainfall data for this year was compared to the long term average to assess that 2004 was in fact climatologically representative of the long term climatic conditions in the region.

Prediction of wind conditions in TAPM is important to enable an assessment of potential worst case scenarios such as low wind speeds which could inhibit pollutant dispersion and enhance accumulation of pollutant concentrations. The application of the dispersion model in this assessment also required an adequate prediction of high wind speeds to allow for dispersion of surface-borne dust emissions into sensitive regions beyond the construction site boundary.

The ability of TAPM to accurately predict the magnitude and direction of wind speed on a seasonal, annual and cumulative wind class frequency basis against the measured BOM data is discussed in Section 7.1.1 of Working Paper J. A reasonable frequency of high wind speeds must also be predicted to enable dispersion of pollutants outside of the construction site boundary. Analysis of the TAPM data shows that the predicted meteorology would disperse emissions in a manner that represents a worst case scenario.

All emission sources listed in Table 3.3 of Working Paper J with the exception of rockfill haulage and emissions from alluvium excavation, were input as area sources within TAPM in tracer mode (with deposition and settling). This approach is standard industry practice when performing dispersion modelling in TAPM. Dust emissions were assumed to cycle every 24 hours with non-zero emissions occurring between the hours of 7.00 am and 6.00 pm daily. Results were adjusted to remove Sundays to reflect this generally being a non-work day.

Emissions from dam construction activities

All particulate matter airborne concentrations are published as daily averaged levels. Analysis of maximum predicted levels at the nearest receivers has been undertaken through study of the contours generated for daily averaged (GLC) ground level concentrations of $PM_{2.5}$, PM_{10} and TSP.

A summary of the model predictions for each pollutant type is provided in Table 16.13 together with relevant NSW and Commonwealth goals.

TABLE 16.13 PREDICTED GROUND LEVEL CONCENTRATIONS AT NEAREST SENSITIVE RECEPTORS

UNITS – µg/m³ (UNLESS OTHERWISE SPECIFIED)	$PM_{2.5}$	PM_{10}		TSP	MAXIMUM ADDITIONAL DEPOSITED DUST (g/m²/MONTH)
Averaging period	**Daily**	**Daily**	**Annual**	**Annual**	**Cumulative Monthly**
Background level	–	15	10*	30^	0.8#
Maximum predicted level at nearest receptor on HWC-owned land	22	55	18	75	3.2
Maximum predicted level at nearest receptor on private land	15	45[1]	16	65	2.4
NSW cumulative criterion/goal	–	50	30	90	4
NEPM advisory criterion/goal	25	50	–	–	–

All units are µg/m³ unless otherwise specified
* Stratford NSW – high volume PM_{10} dust monitoring over Dec 2006 – Dec 2007
\# Stratford NSW – monthly dust deposition Dec 2006 – Dec 2007
^ Assumed based on 2008 monitoring results for Upper Hunter and Mayfield sites

$PM_{2.5}$

The modelling shows that the maximum daily averaged $PM_{2.5}$ concentrations at the nearest sensitive receivers are about or less than 20 µg/m³ (Figure 16.9). The nearest sensitive receivers where this ground level concentration is predicted are located within the nominal construction site boundary on HWC-owned land. This level is the maximum expected concentration from the construction activities including emissions from wind erosion, stockpiling and wheel dust from haulage routes and is less than the NEPM advisory air quality goal for $PM_{2.5}$ (25 µg/m³). Receptors further east of the nearest receiver are predicted to experience levels less than 10 µg/m³ at the height of construction activities.

PM_{10}

The modelling of the dispersion of PM_{10} emissions shows that predicted levels from dam construction activities (and allowing for background) at the nearest sensitive receivers are approximately 55 µg/m³ for average daily PM_{10} (Figure 16.10) and 18 µg/m³ for average annual PM^{10} (Figure 16.11). These are HWC-owned properties which are currently leased but which would likely have the leases terminated prior to construction. Sensitive receptors located further east of the construction site experience ground level concentrations in the region of 35 µg/m³ and 20 µg/m³ for average daily PM_{10} and average annual PM_{10} respectively.

Table 16.4 shows the estimated concentrations at the nearest sensitive receptors for average daily PM_{10} and average annual PM_{10}. Receptors with exceedances are denoted by shading.

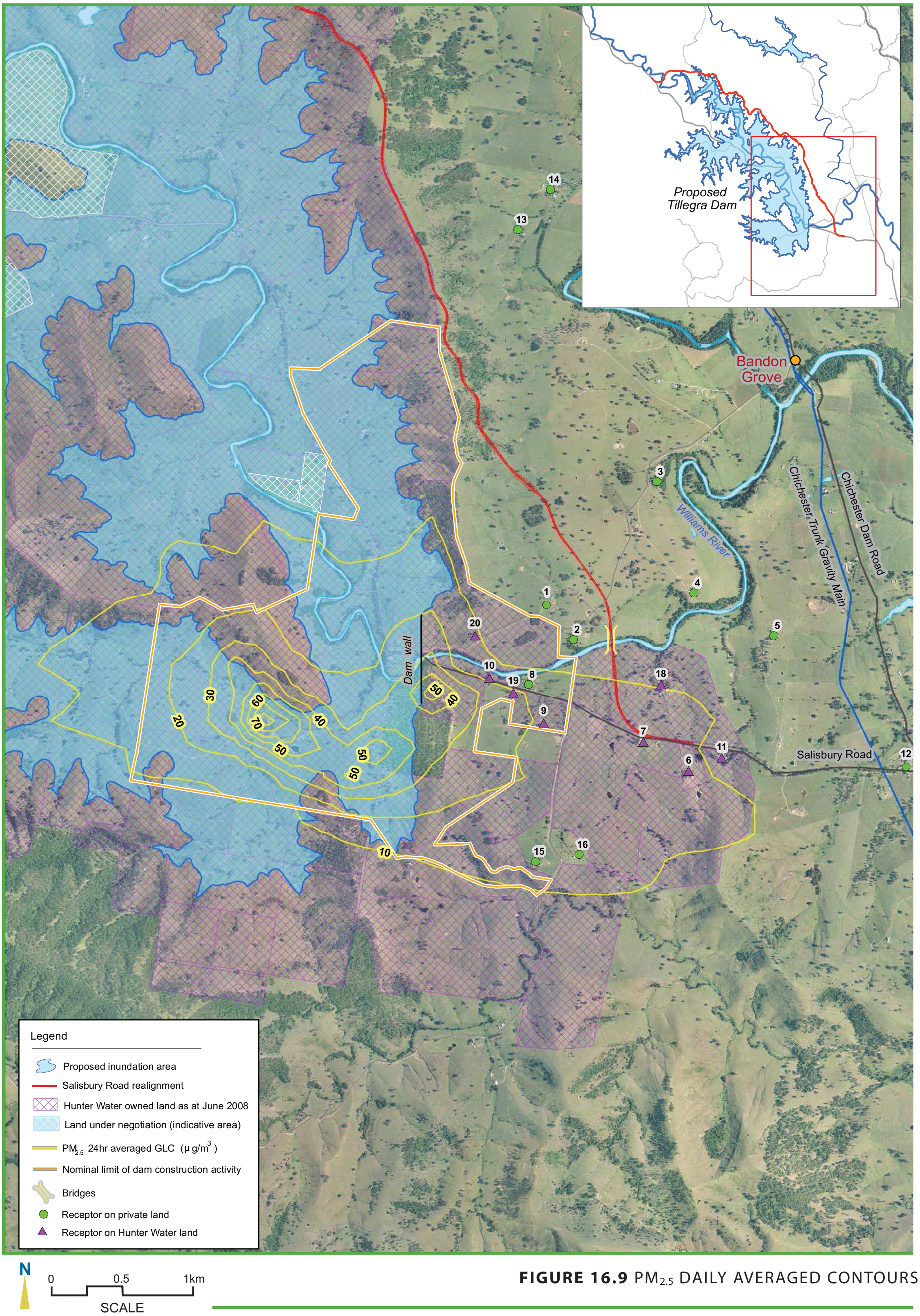

FIGURE 16.9 $PM_{2.5}$ DAILY AVERAGED CONTOURS

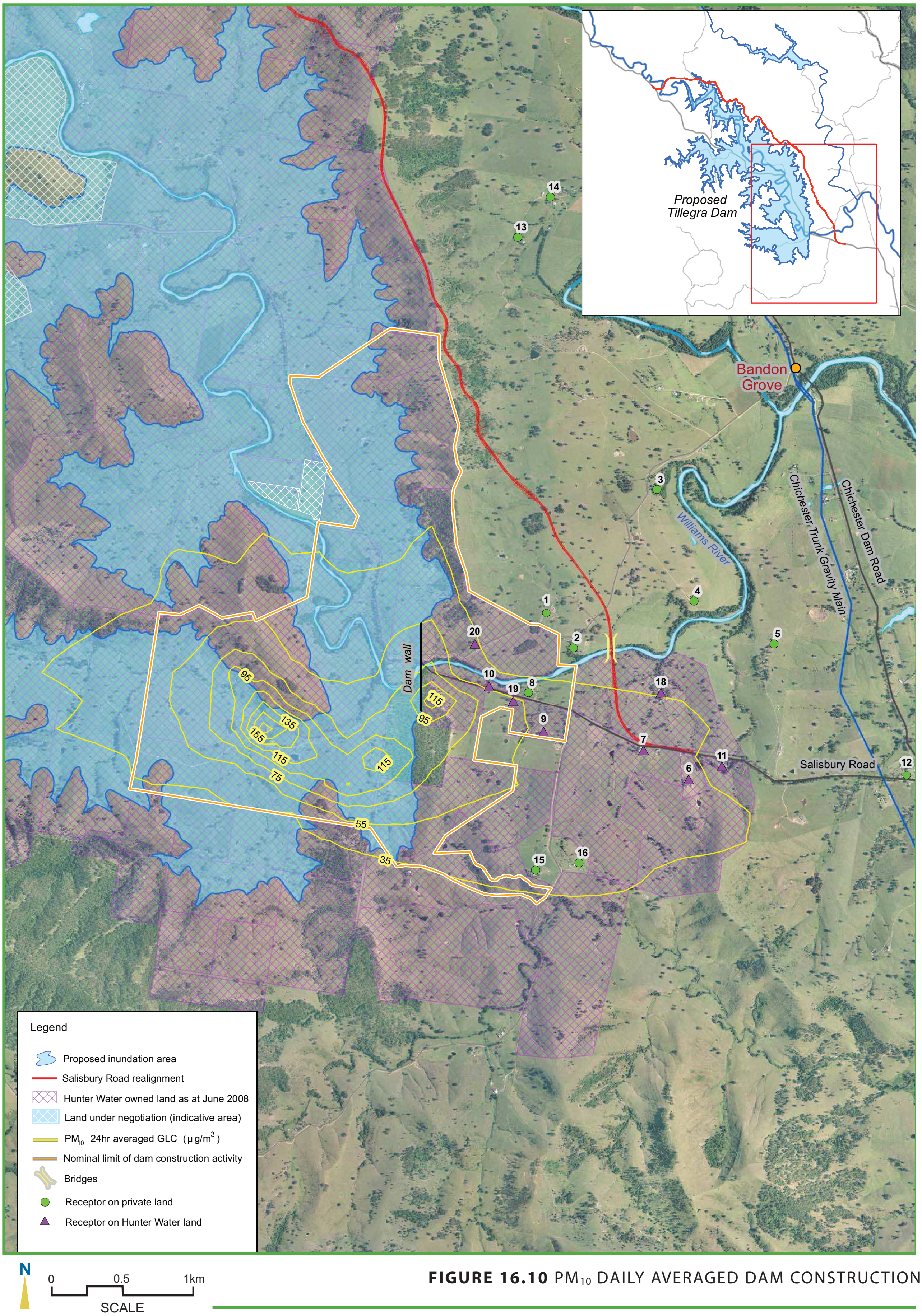

FIGURE 16.10 PM_{10} DAILY AVERAGED DAM CONSTRUCTION