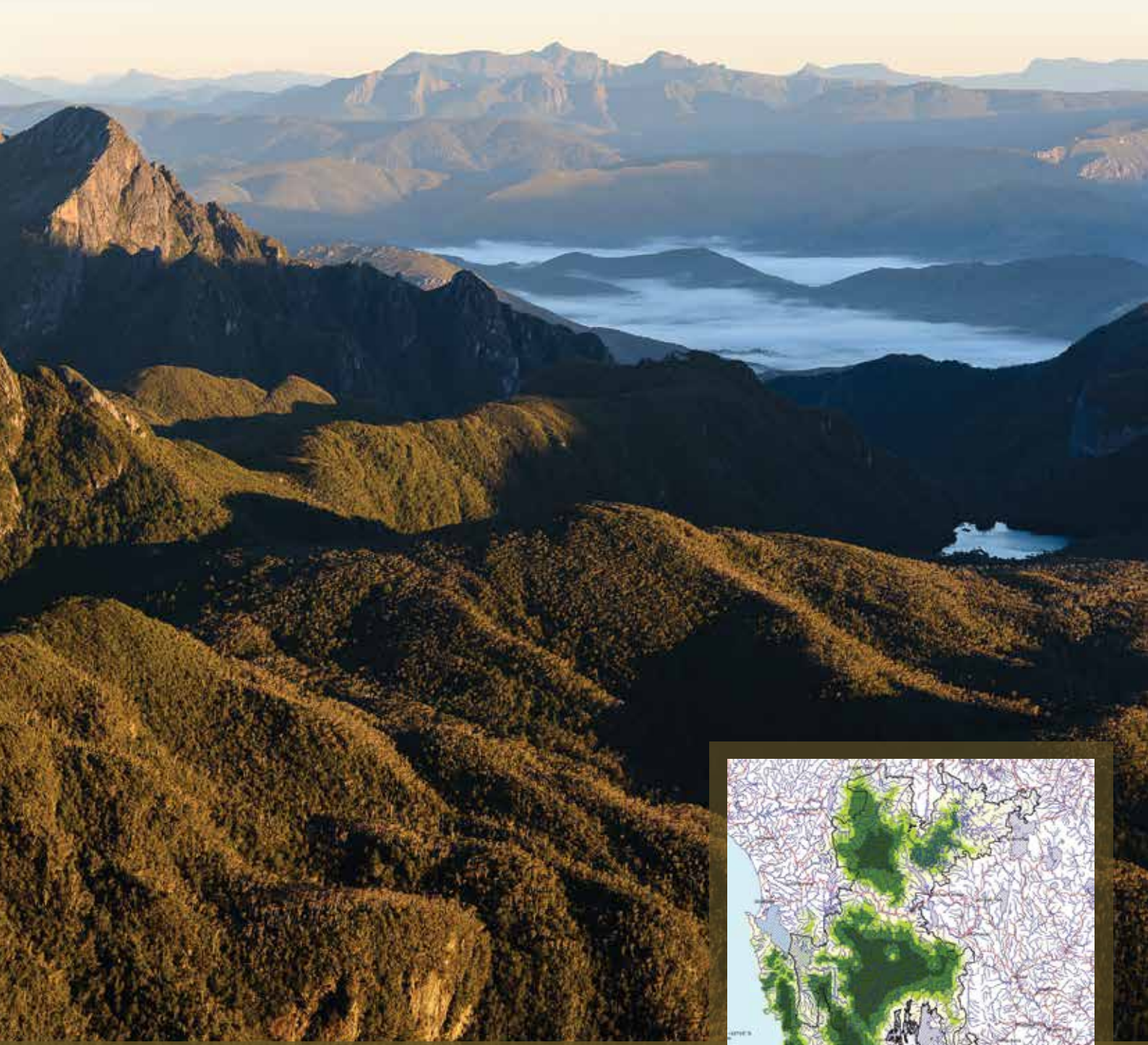
The Tasmanian Wilderness World Heritage Area

Wilderness Mapping Report



By: **Martin Hawes**
Track Management Consultancy Services

For: **Tasmania Parks and Wildlife Service**

2006

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SUMMARY

This paper describes a wilderness-mapping project that has been undertaken by the Tasmanian Parks and Wildlife Service. Initiated in 2005, the project has so far focussed on the Tasmanian Wilderness World Heritage Area (TWWHA) and adjoining wild areas.

The first phase of the project involved reusing a methodology that was used to assess wilderness values across Tasmania in 1995. The National Wilderness Inventory (NWI) methodology assesses wilderness values as a continuous spectrum based on information relating to geographical features such as roads, walking tracks and logging areas.

The 2005 analysis reveals both gains and losses in wilderness values relative to the 1995 results. The gains occur primarily in areas where vehicle tracks have been closed or huts have been removed. The losses are primarily due to track and infrastructure development, such as the tourism development at Heritage Landing.

The second phase of the project involved developing a revised methodology to correct some deficiencies in the NWI approach, mainly by taking terrain and vegetation into account when calculating access-remoteness. The revised methodology gives a broadly similar assessment of wilderness values overall, but it gives different weighting to some features and it highlights the wilderness impact of mechanised boat access on the West Coast.

The Parks and Wildlife Service also proposed developing a methodology to assess the impact of viewfield disturbances on wilderness values. If developed, this should be incorporated into the wilderness-assessment methodology, and the wilderness values of the TWWHA reassessed. The wilderness-assessment program could also be expanded to take in other regions of Tasmania.

1 Background

The value of Australia's natural areas has been recognised for over a century, the country's first national park having been created in 1879. In the 1970s and '80s, conservation battles such as those over Tasmania's Lake Pedder and Franklin River brought the values of the country's remaining wilderness areas to national attention. These values are now recognised as one of the primary reasons for preserving regions such as Kakadu National Park and the Tasmanian Wilderness World Heritage Area.

The first nationwide assessment of Australia's wilderness values was undertaken in the early 1990s using a methodology developed by the Australian Heritage Commission. The National Wilderness Inventory (NWI) methodology identifies remoteness and naturalness as the key components of wilderness value, and assesses wilderness value as a continuum ranging from urban to pristine (Lesslie and Maslen 1995). The methodology was used to assess wilderness values across Tasmania in 1995 as part of the Regional Forest Agreement (RFA) process.

The NWI approach is one of the most comprehensive wilderness-assessment methodologies yet developed, and it has been used to assess wilderness values in several countries. Nevertheless the approach has some deficiencies, particularly when applied in a Tasmanian context. Specifically, the methodology takes no account of viewfield impacts and it ignores the influence of terrain and vegetation on access-remoteness. For this reason, the 1999 TWWHA Management Plan directs the Parks and Wildlife Service to:

> Develop an enhanced methodology for the quantification of wilderness which more accurately reflects the Tasmanian situation eg incorporates the effect of the three dimensional nature of the terrain on viewfields and deals systematically with the effects of walkers' huts and walking tracks.

The Plan notes that this is likely to involve the implementation of a modified version of the NWI methodology.

The current study is one of several attempts to develop a modified or enhanced version of the NWI methodology. British researchers Fritz and Carver (1998) have developed an algorithm for taking walking times into account, based on assumptions about walking speeds across different gradients of terrain. However, the authors note that their algorithm is computationally intensive and would require the use of a supercomputer if it were to be applied to an extensive region.

Carver, Fritz and other researchers have also developed wilderness-assessment methodologies that take user perceptions into account. For example, Carver *et al* (2002) describe a prototype internet-based questionnaire that allows users to assign their own weightings to wilderness-value components and to submit their choice online. This approach may have value for future assessments of wilderness in Tasmania, but it is beyond the scope of the current project.

2 The NWI methodology – How it works

2.1 General comments

The NWI methodology does not attempt to differentiate between wilderness and non wilderness; rather, it assesses wilderness values as a continuum from pristine to urban. As noted in the NWI Handbook (Lesslie and Maslen 1995), “the procedure can more properly be described as a remote and natural lands assessment.”

Wilderness values are assigned to squares in a grid covering the region of interest. The grid size will generally be determined by the area of the region and the computing resources that are available for the analysis.

2.2 Components of Wilderness Value

The NWI methodology estimates a variable called Wilderness Value, which is the sum of four component variables. These are explained in the following table.

Table 1. Component variables of Wilderness Value in the NWI system

Component variable	Explanation
Remoteness from Settlement (RS)	Remoteness from towns, settlements and isolated residences.
Remoteness from Access (RA)	Remoteness from points and corridors of access such as roads, walking tracks and airstrips.
Apparent Naturalness (AN)	Remoteness from features that impinge on the perception of naturalness such as settlements, roads, impoundments and transmission lines.
Biophysical Naturalness (BN)	Extent to which a defined area (typically a grid square) is free from evidence of changes caused by modern technological society – specifically logging and grazing.

The first three of these variables are distance-based. That is, the value assigned to a particular grid-square varies according to the distance of the centre of the square from specified types of geographical features (eg the nearest point on a road).

By contrast, Biophysical Naturalness is determined only by local conditions. That is, the value assigned to a grid-square is determined only by conditions within the square.

For any given grid-square in a region of interest, the values of the four variables are calculated independently and then summed to yield the Wilderness Value of the square.

2.3 Calculating remoteness

For each of the three distance-based variables (i.e. Remoteness from Settlement, Remoteness from Access and Apparent Naturalness), geographical features are assigned weightings to reflect their perceived impact on wilderness values. For example in calculating Remoteness from Access, a walking track one kilometre distant is assigned a 'high grade equivalent' distance of 9 km, so that it has the same impact on RA Class as a major road 9 km away.

The *high-grade equivalent distance* (HGED) of a geographical feature Y from a defined point X is given by

$$HGED = (1 + D)/W - 1$$

where D is the map distance between X and Y, and W is a weighting factor assigned to the category of geographical feature concerned. All distances are in kilometres. For example in calculating Remoteness from Access, roads are assigned a weighting W = 1.0, whereas walking tracks are assigned the weighting W = 0.2. (For a complete list of weighting factors see Table 4; p. 15).

For each of the distance-based variables, the *high-grade equivalent remoteness* (HGER) of a point X is defined as the minimum HGED of X from any of the geographical features relevant to that variable. For example in calculating Remoteness from Access, a point X which is 1 km from a walking track and more than 12 km from all other points or corridors of access (including roads) will be assigned a HGER of 9 km.

2.4 Calculating class for the distance-based variables

For each grid-square in the Study Area and for each of the three distance-based variables, *Class* is calculated from the high-grade equivalent remoteness of the centre X of the square by the formula

$$\text{Class} = 4 \times \sqrt{(\text{HGER}/F)}$$

where HGER is the high grade equivalent remoteness of X in kilometres, and F takes the values 15, 10 and 6 for RS, RA and AN respectively.

Note that the values assigned to F could be adjusted to vary the weighting assigned to each component variable.

Class values for the three distance-based variables are truncated at 5.

One way of illustrating the relationship between remoteness and class is to plot class as a function of map-distance for each category of geographical feature, as has been done in Chart 1, Chart 2 and Chart 3. For example, from Chart 2 one can see that a point X located 5 km from a walking track would have a Remoteness from Access Class of approximately 7. If X were also 10 km from a major road, its RA Class would be reduced to 4.

Chart 1. Class as a function of distance – Remoteness from Settlement (NWI methodology)

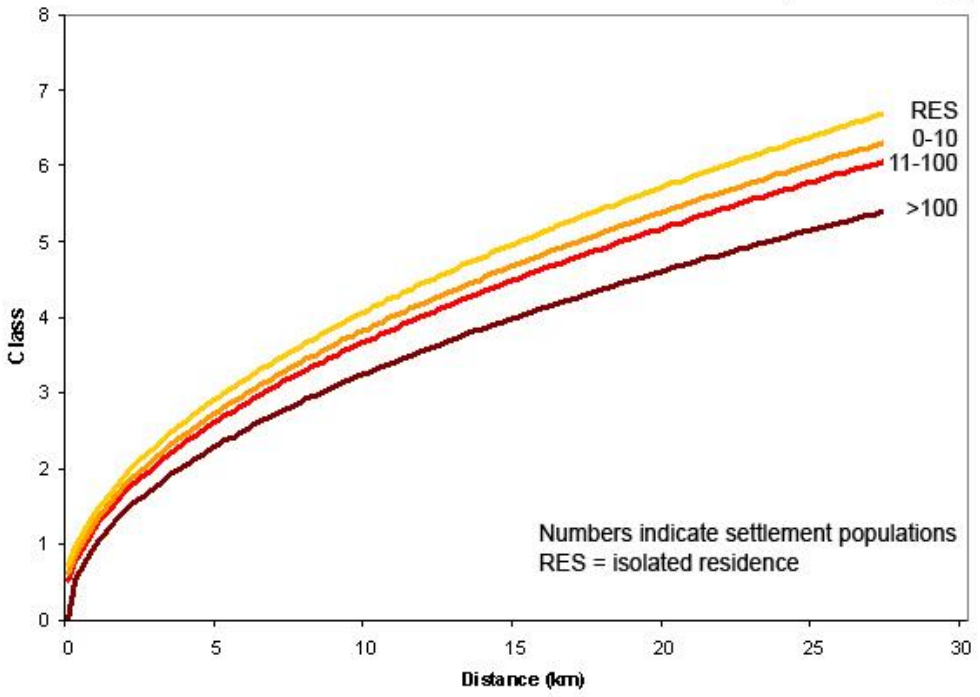


Chart 2. Class as a function of distance – Remoteness from Access (NWI methodology)

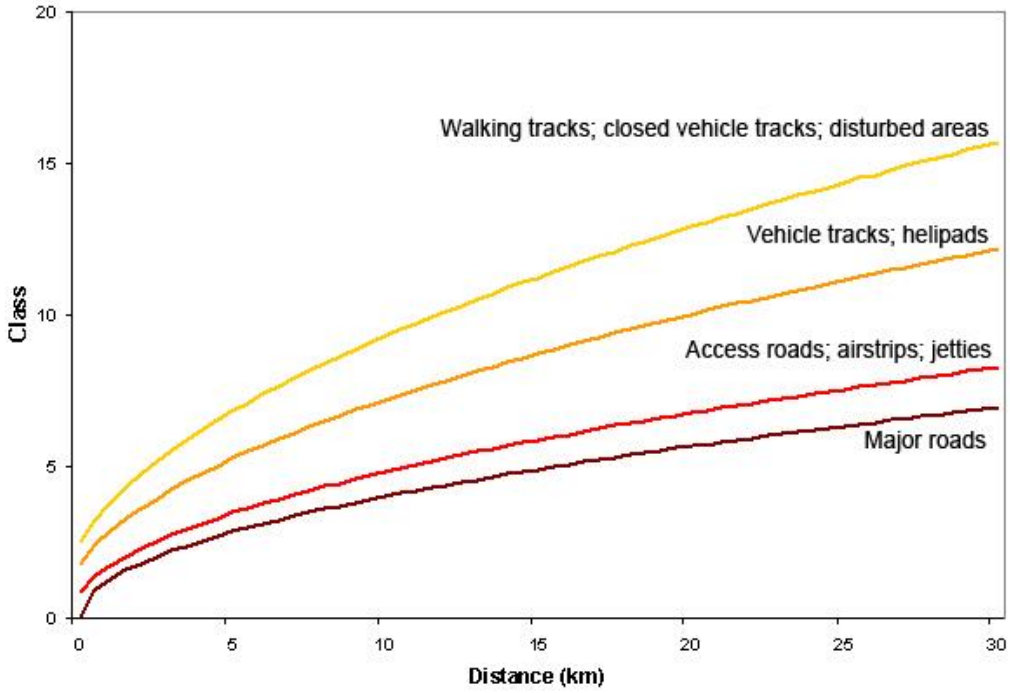
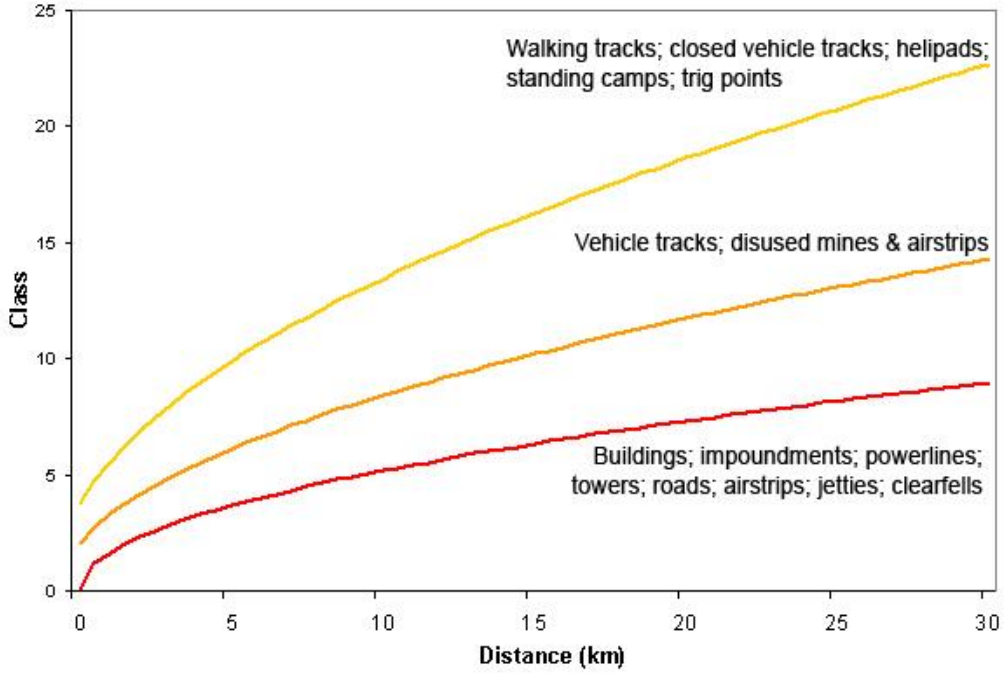


Chart 3. Class as a function of distance – Apparent Naturalness (NWI methodology)



2.5 Calculating class for Biophysical Naturalness

Biophysical Naturalness is assessed on a scale of 1-5, with 5 corresponding to minimum disturbance. In the current study only three values of Biophysical Naturalness were used: 1 (for impoundments, logging coupes, plantations and cleared land), 2 (for selectively logged or intensively grazed land), and 5 (for land or inland waterways with minimal disturbance). Insufficient information was available to assign values of 3 or 4, which correspond to land with low historical levels of grazing or selective logging.

2.6 Calculating Wilderness Value

Wilderness Value (WV) is defined as the sum of the class values of the four component variables. Since none of these exceed 5, WV can take values between 0 and 20. In the NWI-generated map of WV that accompanies this report (see Map 5; p. 36), values in the range 0-10 have been combined as a single group as was done in the 1995 assessment.

2.7 Reliability of the NWI methodology

The NWI Handbook (Lesslie and Maslen 1995) notes that '[the] distance decay functions and class limits used in standardising index values were essentially arbitrary'. The Handbook also suggests that the methodology has 'a level of detail and reliability that satisfy requirements for national and regional evaluations'. But it warns, 'Where there is interest in specific site conditions, (particularly for site evaluation and management planning purposes) results generally should not be relied upon.'

In the context of the current project the NWI methodology has several obvious limitations, notably that it does not distinguish between different grades of walking track and does not take walking speeds or viewfields into account. These points are discussed further in 5.1.

3 NWI methodology – The analytical process

3.1 Data preparation

All data relating to geographical features were entered digitally into a MapInfo file with features recorded as point, linear or polygonal objects.

Some data files (eg on vehicle tracks) were imported more or less ready-made from the Tasmanian government's LIST database, but were subjected to manual editing to incorporate additional information (eg on recent track closures).

Other files were heavily modified, or created from scratch, based on information from a variety of sources including satellite imagery and local knowledge. For example, some logging coupes (visible on satellite images but not recorded on available GIS layers) were entered using the MapInfo polygonal drawing tool over geo-referenced satellite imagery.

For additional notes on the data sources, see Appendix 1.

For a summary of data sources with additional comments, see Table 2 (p. 9-11).

Table 2. Data sources

Geographical feature	Data sources	Comments
Roads	LIST 'Roads_25k' dataset supplemented with satellite images and local knowledge.	• Some recent roading may have been overlooked, but omissions are likely to be minor.
Vehicle tracks	LIST 'Roads_25k' dataset supplemented with satellite images and local knowledge.	• Information on the status of vehicle tracks outside the TWWHA is limited. For example, some tracks south of Macquarie Harbour listed as accessible to vehicles may be inaccessible and vice versa.
Walking tracks	PWS walking tracks database supplemented with local knowledge	• The PWS database is likely to be reliable and up to date, although some minor tracks may be unrecorded. • Only limited information is available on walking tracks outside the WHA, eg south of Macquarie Harbour.
Railways	LIST 'Roads_25k' dataset.	
Airstrips	LIST 'Assets_Prod1' dataset.	• Information supplemented with local knowledge.
Helipads	LIST 'Assets_Prod1' dataset.	• Some Hydro or other helipads may have been overlooked. Unrecorded pads are likely to be used very infrequently.
Jetties / Boat ramps	LIST 'Assets_Prod1' and 'WHA_Hydro_Structures' datasets.	
Hydro impoundments	LIST 'Hydro_Lakes' dataset.	
Mechanised boat access	WHA Management Plan and ranger staff.	• It was assumed that all the navigable areas of Port Davey and Bathurst Harbour are accessible to mechanised boats. Although mechanised access is discouraged on some parts of these waterways, there is no effective prohibition. • The limits of mechanised boat access on the lower Gordon and Franklin Rivers were chosen as points beyond which such access very rarely occurs (i.e. probably no more than once a year).

Geographical feature	Data sources	Comments
Accessible coastline	Ranger staff	• Sections of coastline were listed as accessible to powered boats if they are easily accessed for shore landings under calm to moderate conditions, and/or known to be frequented by fishermen or other users. Most of coastal sections in this category were north of Port Davey.
Logged and grazed areas	LIST 'Tas_Vegetation' dataset supplemented with satellite images and local knowledge.	• Some clearfelled areas may have been overlooked, particularly those with advanced regrowth (which may not have been discernible on the satellite images). Omissions would mainly influence values of Biophysical Naturalness. • Some selectively logged areas may have been omitted, particularly on the Central Plateau.
Pine plantations	LIST 'Tas_Vegetation' dataset.	
Mines and quarries	1:25,000 maps and LIST 'Tas_Vegetation' dataset.	• Information supplemented with local knowledge..
Cleared land	LIST 'Tas_Vegetation' dataset.	
Transmission lines	LIST 'Transmission_Lines_Major' dataset.	
Buildings	LIST 'Assets_Prod1' and 'TWWHA_Hydro_Structures' datasets, supplemented with local knowledge.	• Some walkers' huts and other buildings (eg Hydro huts) may have been omitted.
Standing camps	LIST 'Assets_Prod1' dataset.	• There is only one standing camp in the TWWHA.
Ruin	LIST 'Assets_Prod1' dataset, supplemented with local knowledge.	• Minor ruins (such as Gordonvale) were disregarded since they do not consist of standing structures and have minimal impact on wilderness values.
Lighthouses	LIST 'Assets_Prod1' dataset.	
Towers and beacons	LIST 'Beacons' and 'WHA_Hydro_Structures' datasets.	• Information on Telstra and other private telecommunications infrastructure was not available for this study. • Under the NWI scheme, towers have a major impact on Apparent Naturalness. However, if any towers have been overlooked they are likely to be on the fringes of the TWWHA.
Trig points	LIST 'Beacons' dataset.	
Beacons	LIST 'Beacons' dataset.	

Geographical feature	Data sources	Comments
Hydro sampling stations		• This information was not available for this study.
Towns and settlements	Location data: LIST 'Towns' dataset. Population data: 2001 Census; 1:25,000 maps; local knowledge	• Populations of small settlements were inferred from their size on 1:25,000, supplemented with some local knowledge. • Inaccuracies in population estimates for small settlements would have minimal impact on estimates of wilderness values in the WHA.
Isolated residences	Location and population data: 1:25,000 maps and local knowledge.	• See previous note. • Limited information was available on the location of isolated residences, eg in the Huon Valley and the vicinity of the Great Western Tiers.

3.2 The Study Area

The area in which wilderness values were studied encompassed the entire World Heritage Area together with the Melaleuca–Cox Bight area and the region west and south of Macquarie Harbour (see Map 5). It also encompassed any areas adjacent to the TWWHA that were at least three hours remote from the nearest point of mechanised access (helicopter access excepted). A 1-km grid was constructed covering the entire Study Area.

3.3 Assigning grades to geographical features

Each geographical feature within 30 km of the Study Area was assigned the values RS Grade, RA Grade, AN Grade and BN Grade as shown in Table 3 (p. 13-14). This table was derived directly from the original NWI methodology.

Table 3. Grading system for geographical features (NWI methodology)

MAJ = Major
MED = Medium
LOW = Low
VLO = Very low
N = No grade assigned
RES = Residence

Geographical feature	RSGrade	RAGrade	ANGrade	BNGrade	Comments
Road - Sealed; 2 or more lanes unsealed	N	MAJ	MAJ	0	
1 lane unsealed, 2WD	N	MED	MAJ	0	
4WD track; dozer track	N	LOW	MED	0	
Closed road/ closed vehicle track	N	VLO	MIN	0	
Walking track	N	VLO	MIN	0	
Railway - used	N	MED	MAJ	0	
Airstrip - used	N	MED	MAJ	0	
Helipad	N	LOW	MIN	0	
Jetty / Boat ramp	N	MED	MAJ	0	
Impoundment - accessible to powered boats	N	VLO	MAJ	1	
Inland waterway (natural) - accessible to powered boats	N	VLO	N	5	
Clearfell or intensive grazing	N	VLO	MAJ	1	
Disturbed area - Repeated selective logging or moderate grazing	N	VLO	MAJ	2	
Pine plantation	VLO	VLO	MAJ	1	
Mine or quarry - large, in use	N	N	MAJ	1	
Cleared land	N	VLO	MAJ	1	
Impoundment - inaccessible to powered boats	N	VLO	MAJ	1	
Powerline	N	N	MAJ	0	
Misc. building incl walkers' huts	N	N	MAJ	0	
Mine or quarry < 1 ha and/or abandoned	N	N	MED	0	
Standing camp	N	N	MIN	0	
Ruin	N	N	MAJ	0	
Lighthouse - staffed	RES	N	MAJ	0	
Lighthouse - automatic	N	N	MAJ	0	

Geographical feature	RSGrade	RAGrade	ANGrade	BNGrade	Comments
Tower	N	N	MAJ	0	
Trig point	N	N	MIN	0	
Airstrip - disused	N	N	MED	0	
Dam or weir	N	N	MED	0	
Beacon	N	N	MAJ	0	
Undisturbed land	N	N	N	5	Relevant only to Biophysical Naturalness
Inland waterway (natural) - inaccessible to powered boats	N	N	N	5	Relevant only to Biophysical Naturalness
Cleared area < 1 ha	N	N	MED	0	Cleared areas < 1 ha were either not recorded in this study, or recorded as mines, residences etc.
Hydro sampling station	N	N	MIN	0	Data not currently incorporated into analysis
Railway - disused	N	N	MIN	0	Not relevant to this study
Pipeline	N	N	MAJ	0	Not relevant to this study
Disturbed area - 1ce off selective logging or infrequent grazing	N	N	N	3	Insufficient data available to allow use of this parameter.
Drain	N	N	MED	0	Not relevant to this study
Settlement: >100	MAJ	VLO	MAJ	1	
Settlement: 11-100	INT	VLO	MAJ	1	
Settlement 1-10	MIN	VLO	MAJ	1	
Settlement - residence only	RES	N	MAJ	0	

3.4 Calculating High Grade Equivalent Distance/Remoteness

For each grid square centre X and each geographical feature Y, the high-grade equivalent distance (HGED) between X and Y was calculated by the formula

$$HGED = (1 + D)/W - 1$$

where D is the map distance between X and Y, and W is the weighting factor corresponding to the type of geographical feature, as shown in Table 4 below. All distances are in kilometres.

Table 4. Weighting factors for calculating High Grade Equivalent Distance (NWI methodology)

Component	Grade	Weighting factor (W)
	MAJ	1.00
RS	INT	0.80
	MIN	0.74
	RES	0.66
	MAJ	1.00
RA	MED	0.71
	LOW	0.33
	VLO	0.20
	MAJ	1.00
AN	MED	0.40
	MIN	0.16

Distances from point, linear and polygonal features were calculated using customised algorithms in MapInfo. The analysis was undertaken using MapInfo Professional software and the scripting language MapBasic (version 7.8) to calculate the minimum distance from the centroid of a study cell to a point, polyline or polygonal disturbance feature. For each study cell the algorithm created a buffer around the cell centroid. It then determined if there was an intersect with a feature or features and, if so, calculated and recorded the distance to the closest feature. If there was no intersect with a feature or features, incrementally larger buffers around the study cell centroid were created until a feature was intersected.

The High Grade Equivalent Remoteness HGER of X was calculated as the minimum value of HGED corresponding to all relevant geographical features.

3.5 Calculating Class and constructing wilderness-value maps

For each of the three distance-based component variables (Remoteness from Settlement, Remoteness from Access and Apparent Naturalness), the Class of each grid square was calculated from its HGER by the formula given in 2.4, with values truncated at 5.

The Biophysical Naturalness assigned to each grid square was that of the polygonal geographical feature occupying the highest percentage by area of the square (see Table 3).

Class maps were constructed for each of the component variables (see Map 1, Map 2, Map 3 and Map 4) and Wilderness Value was calculated by summing the four component classes (see Map 5). See the next section for discussion.

Maps were initially generated at a resolution of 5 km until obvious errors had been corrected (see Map 6; p. 37). The final maps were generated at a resolution of 1 km. A comparison of Map 5 and Map 6 shows that a 1 km analysis is far superior in terms of the detail of information provided.

4 NWI methodology – Discussion of results

4.1 General comments on the maps

The choice of data-output ranges should be borne in mind when appraising the maps. Arithmetic ranges (eg 10-12, 12-14) were chosen for all maps because an arithmetic scale was used in the original 1995 map and because the components of Wilderness Value are combined additively.

Note that a different choice of data-output ranges would provide different information. For example, if the range [4-5] were subdivided into the ranges [4.0 - 4.5] and [4.5 - 5.0], the impacts of walking tracks would be more evident on the map of Apparent Naturalness.

4.2 Remoteness from Settlement (Map 1; p. 32)

The impact of towns and settlements is clearly evident around the fringes of the Study Area and in the vicinity of Strathgordon and Melaleuca. Note that isolated residences (such as Melaleuca) have roughly two-thirds the impact of major towns.

4.4 Remoteness from Access (Map 2; p. 33)

The RA map illustrates the impact of roads, vehicle tracks, walking tracks, airstrips, helipads, jetties, and mechanised boat access. Note the relative impact of highways (such as the Lyell Highway), vehicle tracks (eg on the Central Plateau) and walking tracks. Under the NWI scheme all walking tracks are given equal weighting. Hence, the 'Grade 6' track on the Pelion circuit has the same degree of impact as the South Coast Track.

Note: The Murchison Impoundment has an impact on Remoteness from Access (RA), even though it is inaccessible to powered boats. This is because under the NWI system, impoundments have a 'Very Low' RA ranking – the same as for walking tracks – regardless of their accessibility to powered boats.

4.5 Apparent Naturalness (Map 3; p. 34)

The AN map illustrates the impact of the same geographical features that influence Remoteness of Access, as well as buildings, impoundments, beacons, towers, lighthouses, towns and settlements, areas of disturbed land and several other categories.

Note that walking tracks show up only intermittently because AN class increases to 4 at a distance of only 120m from a walking track.

Buildings are among the features that have the greatest impact on AN – hence the large circles of low AN class around walkers' huts and other remote buildings.

Note that AN class values are low across most of the Central Plateau because of the density of vehicle tracks and huts in this area.

4.6 Biophysical Naturalness (Map 4; p. 35)

A disturbance only affects the BN class of a grid square if it occupies more than 50% of the square by area. The only places where this was true were hydroelectric impoundments (eg Lake Augusta), one clearfell coupe in the Picton Valley and one selectively logged area on the southern Central Plateau. Most other logged or cleared areas are outside the Study Area.

The Gell River airstrips, the Murchison Impoundment and the grazed areas at Lees Paddocks were too small and/or narrow to affect BN values in this analysis.

4.7 Wilderness Value (Map 5; p. 36)

The WV map shows the distribution of wilderness values, defined as the sum of the four component variables. The impacts of roads, vehicle tracks, impoundments, buildings and walking tracks are clearly evident.

4.8 Losses and gains in wilderness values between 1995 and 2005 (Map 7; p. 38)

As the numerical values of Wilderness Value were available from the 1995 study, it was possible to construct a map showing losses and gains in WV relative to 1995. However, due to statutory restrictions the original data from which the 1995 values were calculated (eg files showing the location of vehicle tracks) were not available. Hence, while the causes of some of the observed discrepancies can be guessed with confidence, others remain unexplained. Unexplained discrepancies may be due to data errors or other factors.

Dark green and dark red areas indicate significant gains and losses in Wilderness Value respectively.

4.8.1 Gains in Wilderness Value

Significant gains (or apparent gains) in Wilderness Value are evident in the following areas:

- Southern Central Plateau, probably due to the closure and/or disappearance of vehicle tracks.
- Forth Valley – possibly because mining tracks were recorded in 1995 and are no longer listed.
- Little Fisher Valley, probably because logging roads have been downgraded to vehicle tracks.
- Lower Murchison Valley – unexplained. The 1995 analysis may have recorded a Hydro Electric Commission installation in this area.
- Western Central Plateau – possibly due to huts being recorded in 1995 but overlooked in the 2005 survey.
- Alma Valley – due to closure of road.
- Vicinity of King William Saddle – unexplained.
- Gell River airstrips – due to closure of airstrips.
- Middle Denison Valley – unexplained. The 1995 analysis may have recorded a Hydro Electric Commission installation in this area. The discrepancy is in an area too far south to be associated with the (now revegetated) Gell River track.
- Lower Gordon – due to disappearance of walking tracks (which probably occurred before 1995).
- Area southeast of the Gordon Impoundment – unexplained. The assessment of Biophysical Naturalness in the 2005 survey may be inaccurate in this area because only two small logging coupes could be identified from the satellite images, and logged areas in this area are not indicated on the LIST vegetation layer.
- Junction Creek and Cracroft Crossing – due to removal of walkers' shelters.

4.8.2 Losses in Wilderness Value

Significant losses (or apparent losses) in Wilderness Value are evident in the following areas:

- Pelion traverse – probably because of walking track development.
- Lower Gordon – due to development at Heritage Landing and infrastructure on the Elliot Range. The latter was established in the early 1980s and must have been overlooked in the 1995 survey
- Lower Jane River – due to Hydro hut (now a ruin), which must have been overlooked in the 1995 survey.
- Jane River Track – presumably because the mining hut was overlooked in the 1995 survey.
- Extensive areas south of Macquarie Harbour – probably because vehicle tracks in this area were overlooked in the 1995 survey.
- Davey Gorge – probably because the hut there was overlooked in the 1995 survey.

The apparent lack of change in wilderness values along the eastern boundary of the TWWHA south of the Lyell Highway suggests that the additional roading and logging that has occurred near this boundary during the period 1995-2005 has involved no new major incursions into wilderness.

Where incursions have occurred along the eastern boundary, the wilderness impacts may have been offset by other factors – eg the removal of the makeshift walkers' shelter at Blakes Opening.

5 Revised methodology – What's been changed

5.1 Shortcomings of the NWI methodology

The NWI methodology has some shortcomings as a measure of wilderness value, particularly in a Tasmanian context. The main shortcomings are:

- It gives inappropriate weighting to some categories of geographical feature. For example, walkers' huts and other buildings are assigned the same weighting as major roads and impoundments, no distinction is made between different grades of walking track, and there is little difference between the impact of single residences and large towns.
- It takes no account of terrain and vegetation, and hence walking conditions.
- It takes no account of viewfield impacts.

To mitigate these shortcomings the Parks and Wildlife Service has developed a revised methodology, which is modelled on the MWI methodology but incorporates a number of changes. The main changes are as follows:

- The weightings assigned to some categories of geographical features have been changed, and some features have been moved to different categories (see 5.2).
- The formula for calculating class was modified to avoid the need for truncating high values (see 5.3).
- The variable Remoteness from Access has been replaced with a new variable Time Remoteness, which is based on walking times from points of mechanised access (see 5.5).

These changes are explained in detail in the following sections.

Like the NWI methodology, the revised methodology described here makes no attempt to take viewfield impacts into account. The Parks and Wildlife Service has considered developing a technique to assess viewfield impacts so that these can be incorporated into an overall wilderness-assessment methodology (see Section 7).

5.2 Revised grading system

The grading system used in the revised methodology is summarised in Table 5 (p. 20-21).

Table 5. Grading system for geographical features (Revised methodology)

MAJ = Major
MED = Medium
LOW = Low
VLO = Very low
N = No grade assigned
RES = Residence

Geographical feature	RSGrade	ANGrade	BNGrade	Comments
Road - Sealed; 2 or more lanes unsealed	N	MAJ	0	
1 lane unsealed, 2WD	N	MAJ	0	
4WD track; dozer track (accessible to vehicles)	N	MED	0	
Closed road/ closed vehicle track	N	MIN	0	
Walking track Class 1-4	N	MIN	0	
Walking track Class 5-6	N	VLO	0	
Railway - used	N	MAJ	0	
Airstrip - used	N	MAJ	0	
Helipad	N	MIN	0	
Jetty / Boat ramp	N	MED	0	
Impoundment - accessible to powered boats	N	MAJ	1	
Inland waterway (natural) - accessible to powered boats	N	MIN	5	
Exposed coastline	N	VLO		
Coastline accessible from offshore vessels	N	MIN		
Clearfell or intensive grazing	N	MAJ	1	
Disturbed area - Repeated selective logging or moderate grazing	N	MED	2	
Disturbed area - 1ce off selective logging or infrequent grazing	N	N	3	Insufficient data available to allow use of this parameter.
Pine plantation	N	MAJ	1	
Mine or quarry - large, in use	N	MAJ	1	
Cleared land	N	MAJ	1	
Impoundment - inaccessible to powered boats	N	MAJ	1	
Powerline	N	MED	0	
Building incl walkers' huts	N	MED	0	

Geographical feature	RSGrade	ANGrade	BNGrade	Comments
Mine or quarry < 1 ha and/or abandoned	N	MED	0	
Standing camp	N	MIN	0	
Ruin	N	MED	0	
Lighthouse - staffed	RES	MAJ	0	
Navigation light	N	MED	0	
Tower	N	MED	0	
Trig, cairn, pole, pillar	N	VLO	0	
Airstrip - disused	N	MED	0	
Dam or weir	N	MED	0	
Beacon	N	MIN	0	
Cleared area < 1 ha	N	MED	0	Not relevant to this study.
Hydro sampling station	N	VLO	0	Data not currently incorporated into analysis
Railway - disused	N	MIN	0	Not relevant
Pipeline	N	MED	0	Not relevant
Drain	N	MED	0	Not relevant
Undisturbed land	N	N	5	Relevant only to Biophysical Naturalness
Inland waterway (natural) - inaccessible to powered boats	N	N	5	Relevant only to Biophysical Naturalness
Settlement: >100	MAJ	MAJ	1	
Settlement: 11-100	INT	MAJ	1	
Settlement 1-10	MIN	MAJ	1	
Settlement - residence only	RES	MAJ	0	

5.3 Redefining class as an exponential function

Under the NWI system, class is a weighted square root of high-grade equivalent remoteness, and the class values of each of the component variables of Wilderness Value are truncated at 5 (see 2.4).

A problem with this approach is that information is lost whenever one or more of the component variables has a class value exceeding 5. One consequence of this is that no analysis of wilderness values is possible beyond the value WV = 20.

If class values are not truncated, low values in one component variable can be obscured by high values in others. For example, a grid square whose centre is only 3.4 km from the hut on the Jane River Track has the (non-truncated) class values RS Class = 7.1, RA Class = 4.9, AN Class = 2.9 and BN Class = 5.0. These yield a total WV of 19.9 – a near 'perfect' value despite the proximity of a building.

To avoid this problem, the square-root formula was replaced by an exponential function so that the class values of each of the distance-based variables approach an asymptotic value of 5 as distance increases. For Remoteness from Settlement (RS) and Apparent Naturalness (AN), class is defined by the formula

$$\text{Class} = 5 \times (1 - \exp^{-F * HGER})$$

Where HGER is the high-grade equivalent remoteness in kilometres (see 2.3) and F takes the values 0.10 and 0.15 for RS and AN respectively.

For Time Remoteness (TR), class is given by

$$\text{TRClass} = 5 \times (1 - \exp^{-1.5T})$$

where T is the remoteness in days. Since T only takes the values 0, 0.5, 1.0 and 2.0 (corresponding to the Non-remote, Half-Day, One-Day and Two-Day zones respectively), TR class can take the values 0, 2.64, 3.88 and 4.75.

See 5.5 for more information about Time Remoteness.

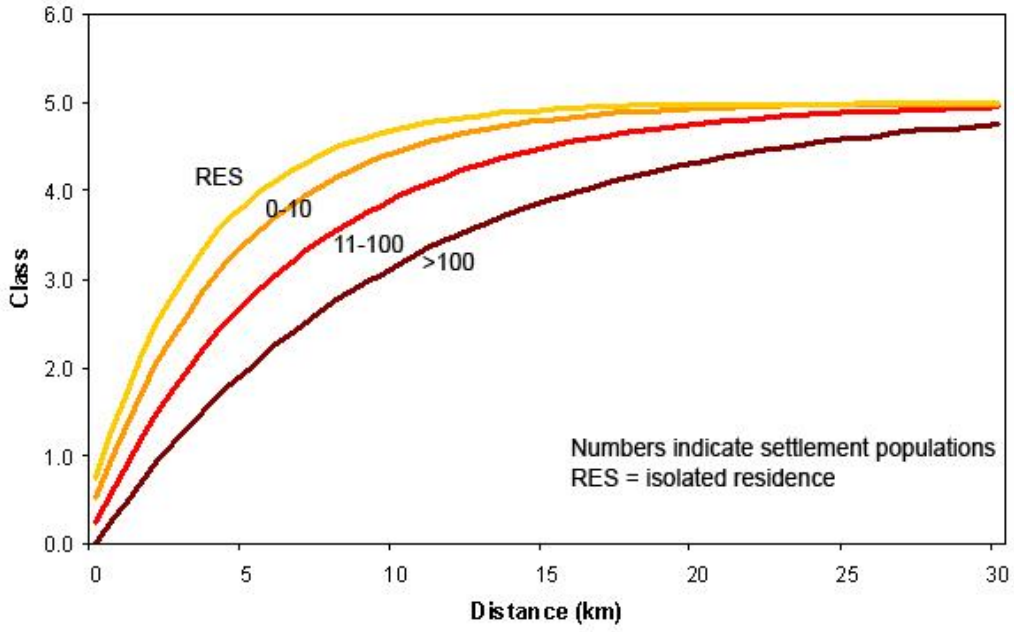
5.4 Remoteness from Settlement

Under the NWI system there is little difference between the impact of settlements with different categories of population (see Chart 1; p. 5). The weightings have been revised to give slightly lower weighting to smaller settlements (see Chart 4; p. 23, and Table 6 below). Note that Charts 1 and 4 have different vertical scales.

Table 6. Weighting factors for calculating High Grade Equivalent Distance (Revised methodology – Remoteness from Settlement)

Grade	Weighting factor (W)
MAJ	1.00
INT	0.67
MIN	0.48
RES	0.38

Chart 4. Class as a function of distance – Remoteness from Settlement (Revised methodology)



5.5 Time Remoteness

5.5.1 Overview of the TR assessment process

Under the NWI system, Remoteness of Access (RA) is assessed by measuring the distance from points and corridors of access such as roads, walking tracks and navigable waterways. As explained in 2.3, these distances are weighted so that (for example) a walking track 1 km distant has the same impact on wilderness values as a road 9 km distant.

One deficiency of this approach is that there is no direct link between wilderness values and remoteness from points of mechanised access. For example, a point in trackless country 5 km from the nearest road will have a higher RA Class (3.45) than a point on a walking track 30 km from the nearest road (RA Class = 2.53). Moreover RA takes no account of the impact of vegetation and terrain on travelling times.

In the revised approach RA has been replaced by Time Remoteness (TR). This is an assessment of the travelling time (on foot, or in rare cases by raft) from points and corridors of mechanised access. The latter include roads, vehicle tracks, functioning airstrips, inland waterways accessible to motorised boats, and sections of coastline that can be accessed easily by boat in calm to moderate conditions.

Four categories of TR were identified: 'Non remote', 'Half-day' (corresponding to 3-6 hours of travelling time, excluding breaks), 'One-day' (6-12 hours) and 'Two-day' (>12 hours). The lines defining these categories were drawn manually based on (a) local knowledge of walking conditions and (b) visual inspection of 1:25,000 maps and the LIST vegetation layer.

Given sufficient resources, a program could be written to automate the TR assessment process. However, the Parks and Wildlife Service does not currently have the resources to create such a program. While automating the analysis would increase the reproducibility of the results, it would not necessarily increase their accuracy because no algorithm can replace detailed local knowledge of walking conditions and travelling speeds.

Given the error margins in estimating TR, the labour intensive nature of the estimation process, and the fact that TR is only one of the four component variables of WV, it was not

considered worthwhile to assess additional TR categories. If sufficient resources were available, it might be worth identifying a 1.5-day zone and a 3-day zone in future studies.

Draft maps of Time Remoteness were compiled by the consultant (Martin Hawes) and subsequently checked by the Parks and Wildlife Service's Track Monitoring Officer, who suggested modifications in places. The fact that the modifications were minor suggests that the TR assessment process is reasonably objective, providing the people doing the assessment have sound knowledge of walking conditions in the TWWHA.

5.5.2 Details of the TR assessment process

The Time Remoteness of any given point is defined as the travelling time via the fastest access route from the nearest point of mechanised access. This definition applies regardless of how frequently (if ever) the route in question is used by walkers. Estimates of travelling times ignore the location of campsites and exclude daytime breaks and time spent in camp.

The following rules of thumb were used in estimating walking speeds:

Table 7. Walking speeds assumed in estimating Time Remoteness

Walking conditions (on level terrain)	Walking speed
Closed vehicle track; walking tracks class 1-3	3 km/hr
Walking tracks class 4-6; open heath or sedge	2 km/hr
Open woodland (mainly Central Plateau)	1-1.5 km/hr
Dense forest and scrub	0.5 km/hr

An additional hour was allowed for every 300m gain in altitude.

Note that the above categories of walking speed do not cover all possible walking conditions in the TWWHA. For example, in extremely dense scrub progress can be as slow as 500 metres per day. However, insufficient information was available to take such factors into account in this analysis.

Helipads were not regarded as points of mechanised access in this analysis, because existing helipads in the Study Area are used infrequently and only for management purposes. (Helicopter access in the TWWHA for non-management purposes requires a permit.)

The shorelines of hydro impoundments were taken as those corresponding to full supply level. It was assumed that powered boats could land anywhere along the shorelines of navigable inland waterways.

Rivers were assumed to be crossable by fording or swimming, except where rapids or fast currents prohibit safe crossing even at low water.

Points in the TWWHA were awarded values of TR Class based on the criteria listed in Table 8 below.

Table 8. TR Class as a function of Time Remoteness

TR Zone	TR (Hours)	TR Class
Non remote	0-3	0.00
Half day	3-6	2.64
One day	6-12	3.88
Two day	>12	4.75

5.6 Apparent naturalness

5.6.1 Overview of changes

The following changes were made to the criteria for assessing Apparent Naturalness (see Table 5):

- An additional category of AN Grade was introduced.
- Major artificial features such as roads and impoundments were given greater weighting than under the NWI system.
- The AN Grade for jetties, boat ramps, disturbed areas, powerlines, buildings, ruins, towers and automatic lighthouses was downgraded from 'Major' to 'Medium'.
- The AN Grade for beacons was downgraded from 'Major' to 'Minor'.
- The AN Grade for trig points was downgraded from 'Minor' to 'Very Low'.
- Walking tracks were divided into two categories. Tracks with classification 1-4 were assigned an AN Grade of 'Minor', and tracks with classification 5-6 were assigned an AN Grade of 'Very Low'.

5.6.2 Water bodies and shorelines

Water bodies and shorelines were assigned AN Grades using the criteria listed in the following table:

Table 9. AN grades for water bodies and shorelines

Category of water body / shoreline	AN Grade	Comments
Natural water bodies inaccessible to powered boats	Not graded	Includes inaccessible lakes, lagoons and rivers.
Exposed coastline where boats cannot put ashore	VLO	The grading reflects the fact that all coastal waters are accessible to powered boats, although the shoreline may be inaccessible.
Natural inland water bodies accessible to powered boats	MIN	Includes the lower Gordon River, Lake St Clair, Macquarie Harbour and Port Davey. It is assumed that powered boats can land anywhere along the shorelines of navigable inland waterways
Sections of coastline where powered boats can put ashore in mild top moderate conditions	MIN	Includes well-sheltered sites (eg New Harbour beach) and sites where fishermen or other visitors regularly put ashore (eg Nye Bay).
Jetties and boat ramps	MED	
Artificial waterways (i.e. impoundments and canals)	MAJ	The 'Major' grade applies regardless of boat access

Chart 3 (p. 6) and Chart 5 (p. 26) show the relationship between map distance and AN class under the NWI and revised methodologies respectively. Note that these charts have substantially different vertical scales.

See Table 10 (p. 26) for a summary of the revised weighting factors.

Chart 5. Class as a function of distance – Apparent Naturalness (Revised methodology)

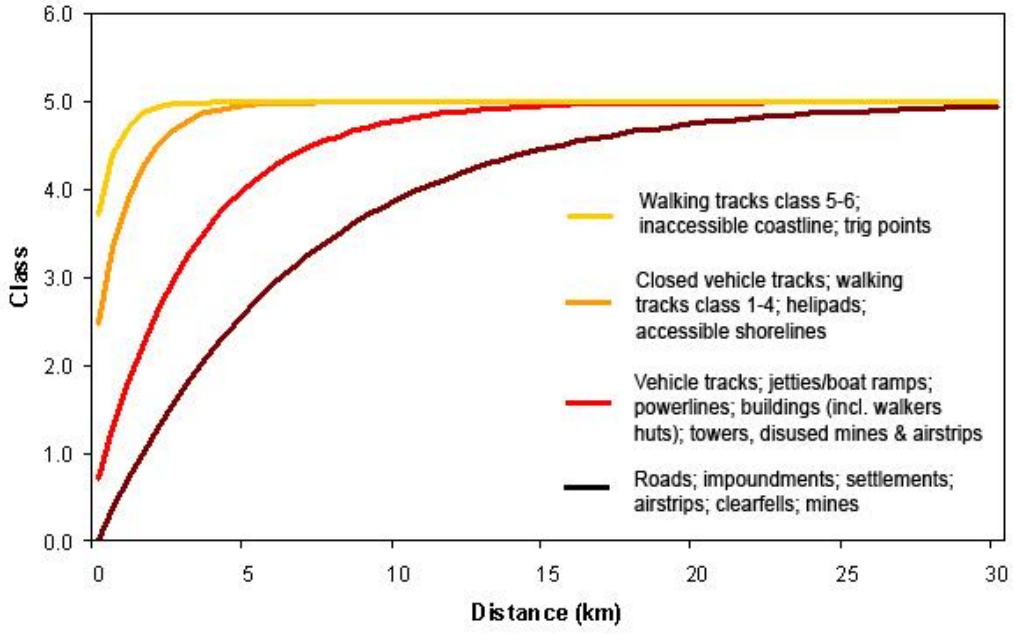


Table 10. Weighting factors for calculating High Grade Equivalent Distance (Revised methodology – Apparent Naturalness)

Grade	Weighting factor (W)
MAJ	1.00
MED	0.50
MIN	0.18
VLO	0.10

6 Revised methodology – Discussion of results

6.1 Remoteness from Settlement (Map 8; p. 39)

Compared to the NWI result (see Map 1), the main difference is that small towns (such as Strathgordon) and residences (such as Melaleuca) have less impact on RS Class. Large towns (such as Maydena) have slightly more impact.

6.2 Time Remoteness (Map 9; p. 40)

Compare the maps of Time Remoteness (Map 9) and Remoteness from Access (Map 2). The main effects of substituting TR for RA are as follows:

- TR is lower than RA in the vicinity of Port Davey, Bathurst Harbour and the West Coast, because these areas are accessible to powered boats. Indeed TR is zero along much of the West Coast, substantially lowering overall wilderness values in this region.
- Unlike RA, TR is not directly dependent on distance from walking tracks.
- TR is clearly influenced by terrain and vegetation. For example, TR values tend to be lower than the corresponding RA values on the Central Plateau and throughout much of the upper Huon, Crossing and lower Davey catchments.

6.3 Apparent Naturalness (Map 10; p. 41)

The main differences relative to the NWI results (Map 3) are:

- Major features such as roads and impoundments have greater impact.
- Minor features such as buildings, jetties, beacons and trig points have less impact.
- Tracks of class 1-4 have greater impact.
- AN is slightly reduced in the vicinity of accessible shorelines.

6.4 Biophysical Naturalness (Map 11; p. 42)

The result is identical to the NWI result (Map 4), since the criteria were not changed. The only exception is that in the revised analysis, historical logging on the Raglan Range was taken into account.

6.5 Wilderness Value (Map 12; p. 43)

Compared to the NWI methodology (Map 5), the revised methodology shows slightly lower wilderness values overall. The category WV > 18 derived from the NWI methodology corresponds approximately to the category WV > 17 under the revised system.

This does not imply that the revised methodology identifies less wilderness than the NWI methodology; it simply means that the scales for measuring wilderness are different.

The revised methodology also shows:

- Substantially lower wilderness values in the country bordering Port Davey, Bathurst Harbour and the West Coast, and in the country south of Macquarie Harbour.
- More extensive wilderness impacts due to roads, impoundments and other major artefacts.
- Reduced impacts due to low-grade walking tracks.

- Reduced impacts due to walkers' huts and other buildings.

Although the influence of terrain and vegetation on wilderness values is discernible in some areas using the revised methodology, it is not especially pronounced. This is partly because Time Remoteness is only one of four component variables, and partly because in the Central Plateau, where walking times are substantially faster than in most other parts of the TWWHA, wilderness values are substantially reduced by other factors – notably the presence of numerous huts and vehicle tracks.

7 The next stage – incorporating viewfield impacts

As mentioned elsewhere, the Parks and Wildlife Service proposed developing a methodology for assessing the impact of viewfield disturbances on wilderness values. The development process would involve the following steps:

- Identifying and classifying the geographical features that have an impact on wilderness values.
- Developing formulas that relate disturbance type and distance to viewfield disturbance.
- Developing criteria for assigning viewfield-disturbance values to grid squares, based on the values at specific viewpoints within the square.
- Developing algorithms for automating the assessment process.

The automation of the process is made possible by the availability of programming facilities in MapInfo, including line-of-sight assessments based on elevation grids.

If the viewfield-assessment methodology has been developed, it could be incorporated into the revised wilderness-assessment methodology and applied to the TWWHA and other regions of Tasmania.

References

Carver, S., Evans, A. and Fritz, S. 2002. Wilderness attribute mapping in the United Kingdom. *International Journal of Wilderness* 8:1 24-29, April.

Fritz, S. and Carver, S. 1998. Accessibility as an important wilderness indicator: Modelling Naismith's Rule. http://www.geog.leeds.ac.uk/papers/98-7/

Lesslie, R. and Maslen, M. 1995, *National Wilderness Inventory Australia: Handbook of Procedures, Content and Usage* (2nd ed), Australian Heritage Commission, May.

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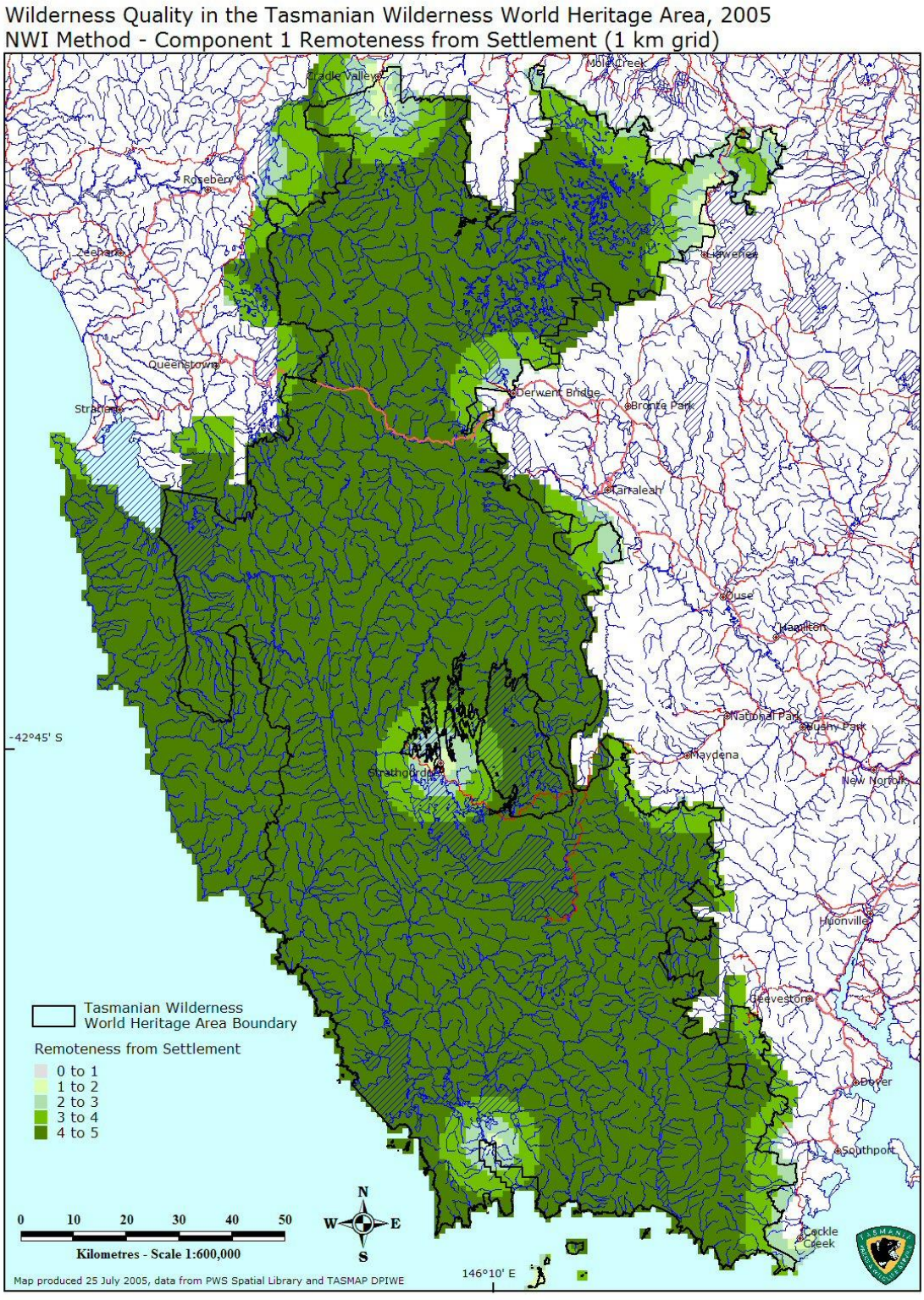
Appendix 1: Notes on data sources

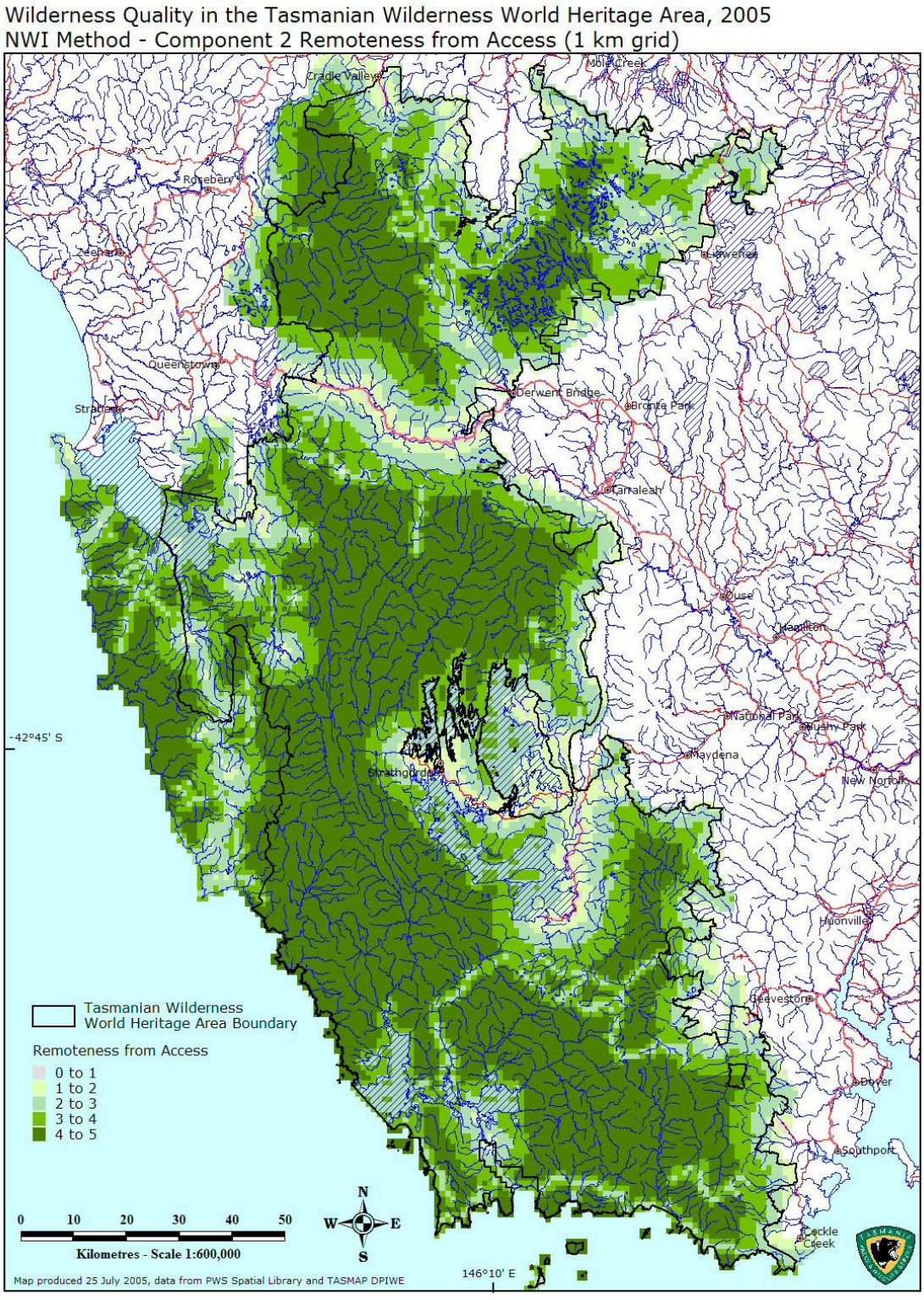
The assessments described in this paper were based on data derived from the following sources:

- The Tasmanian Government's LIST database – specifically the layers on Assets, Roads, Towns, Hydro Lakes, Hydro structures, Beacons, Vegetation and Transmission lines. Information on the currency and accuracy of this data is available at www.thelist.tas.gov.au/asdd/.
- Visual-light, colour-adjusted SPOT satellite imagery recorded in 2002. The satellite image files covered most of the Study Area and were mostly cloud-free. The nominal resolution of 20 metres allowed identification of most roads and recent clearfell coupes. It also allowed identification of some selectively logged areas on the southern Central Plateau, and of the cleared corridor associated with a dismantled power line near the Great Lake.
- The Tasmap 1:25,000 topographic coverage of the region.
- The Parks and Wildlife Service's walking tracks database.
- A field trip undertaken by the consultant in the Butlers Gorge area, to record the location of new logging roads using a GPS.
- Personal knowledge – principally that of ranger staff, the Parks and Wildlife Service's Tracks Monitoring Officer and the consultant.
- The 2001 Census count on the Australian Bureau of Statistics website, which provides information on the populations of larger towns. No official figures are available for the populations of small towns and settlements such as Lune River and Miena. These were estimated from the size of the towns as indicated on 1:25,000 maps, supplemented in some cases by local knowledge.

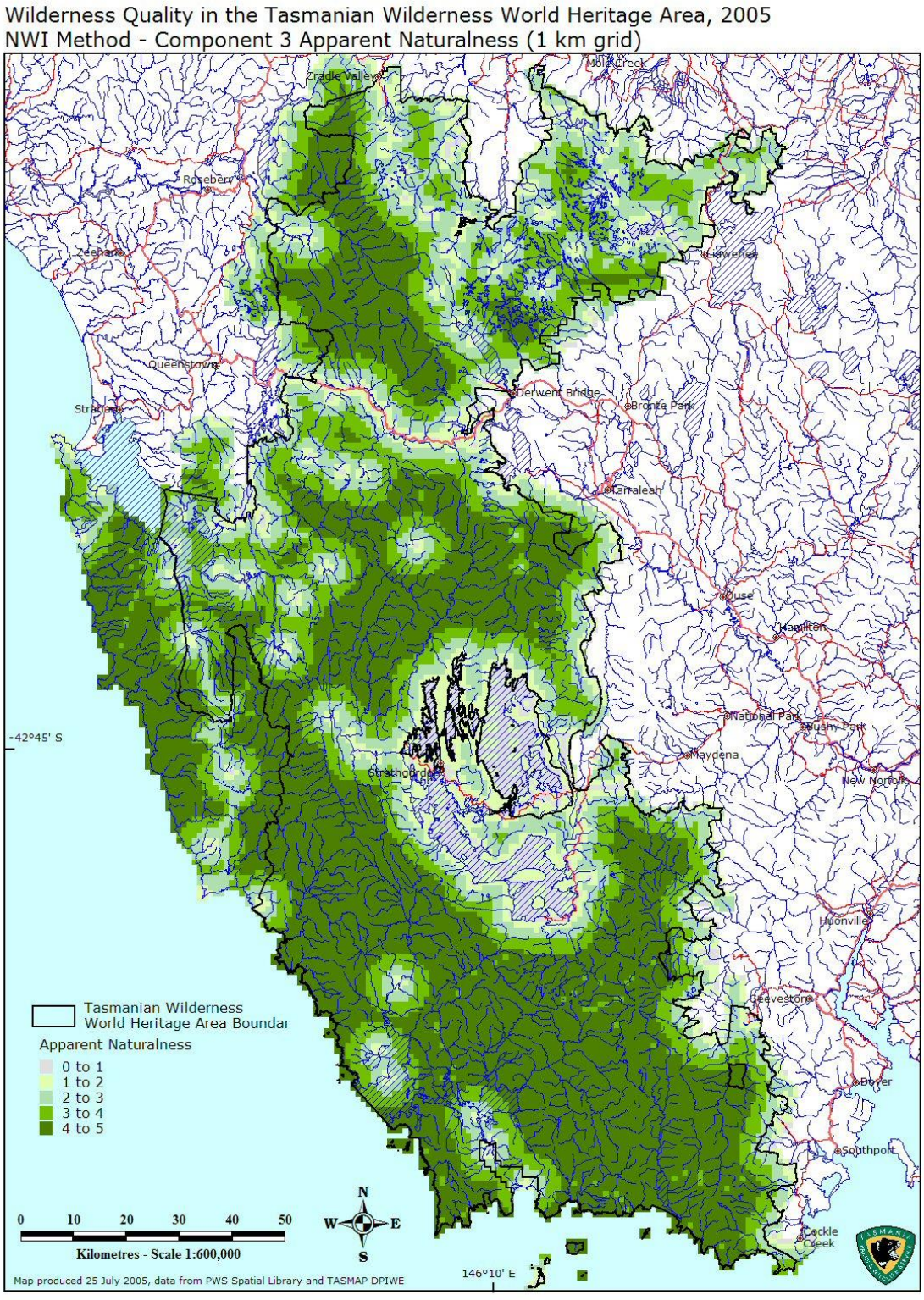
Map 1. Remoteness from Settlement



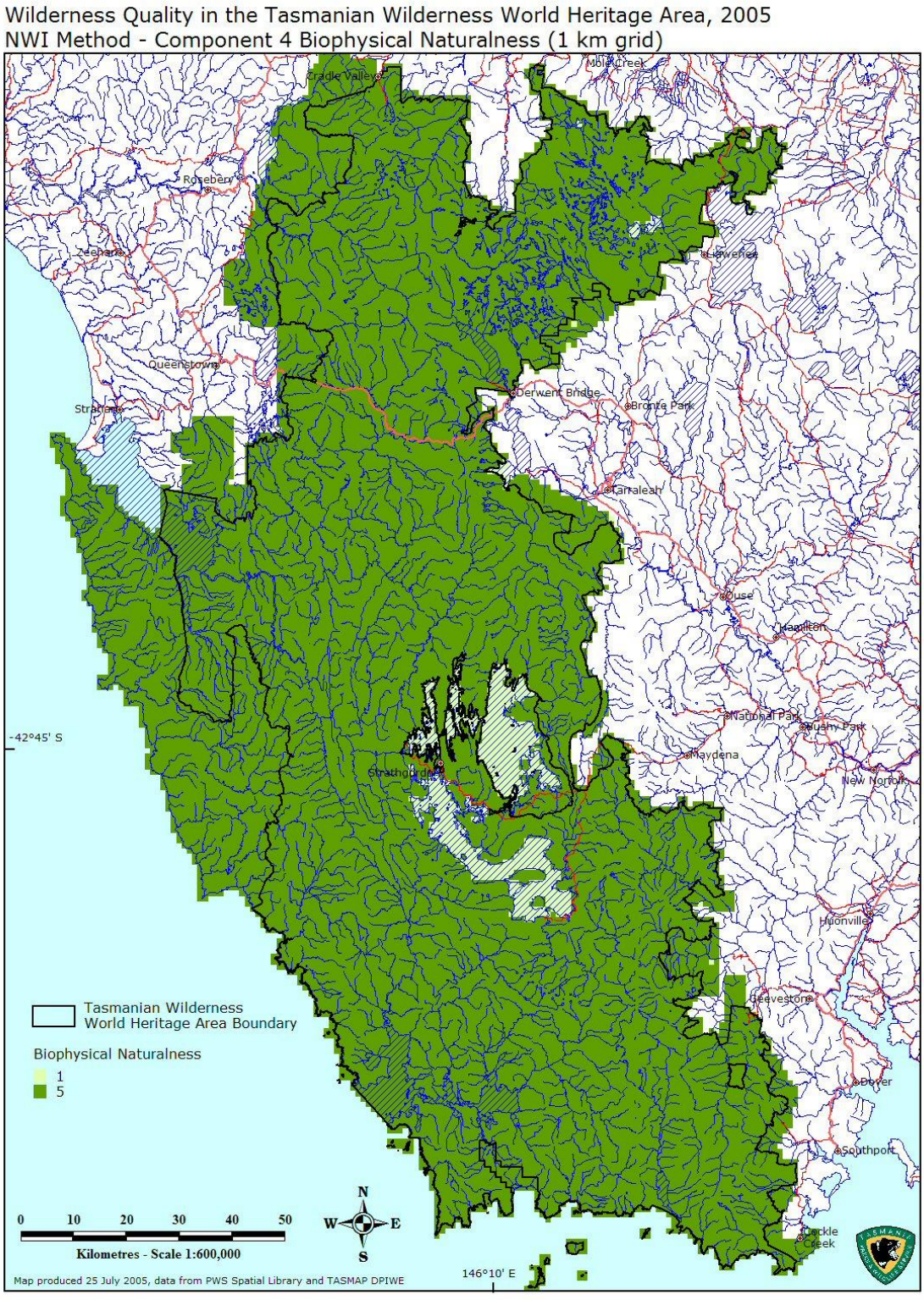
Map 2. Remoteness from Access



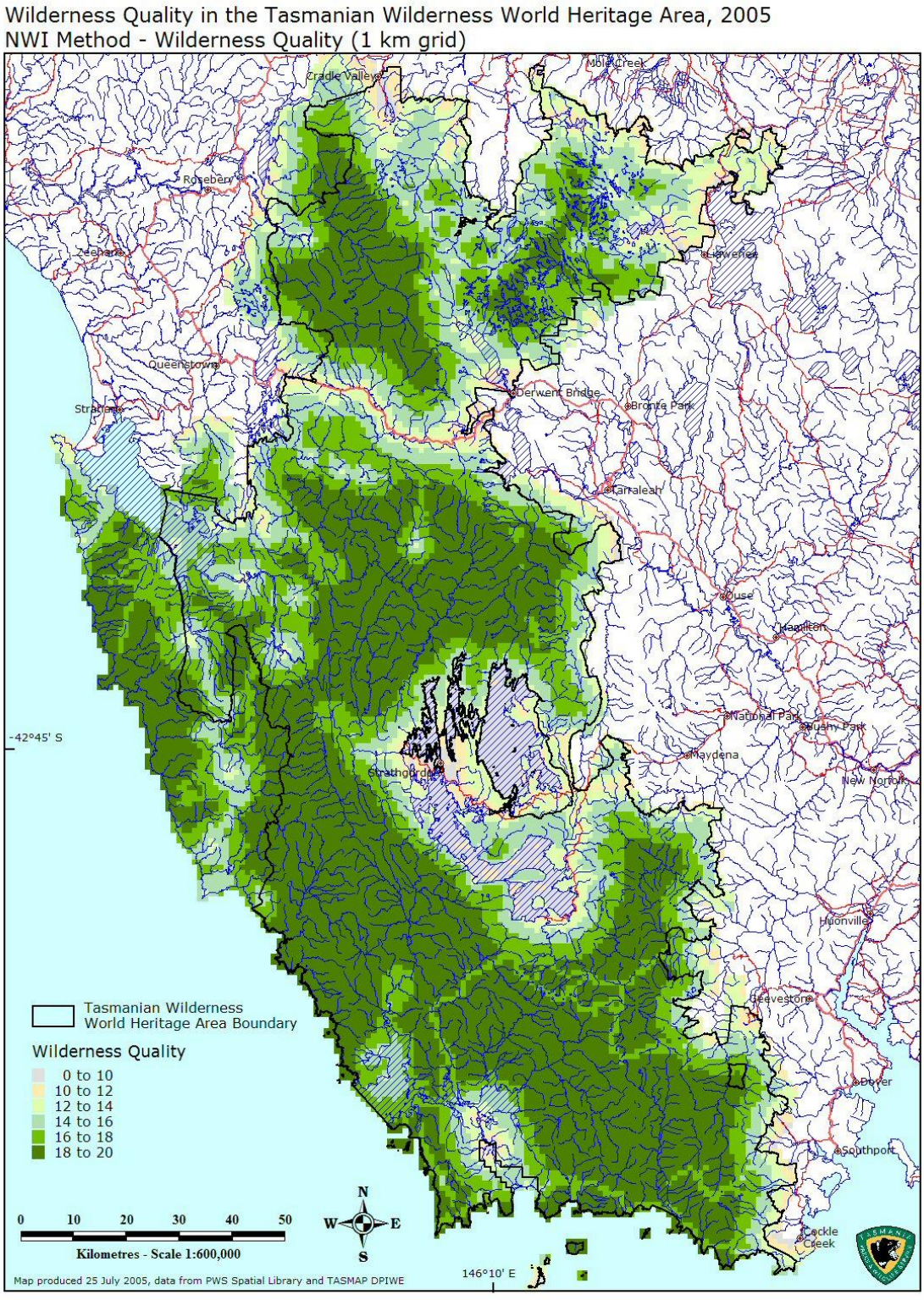
Map 3. Apparent Naturalness



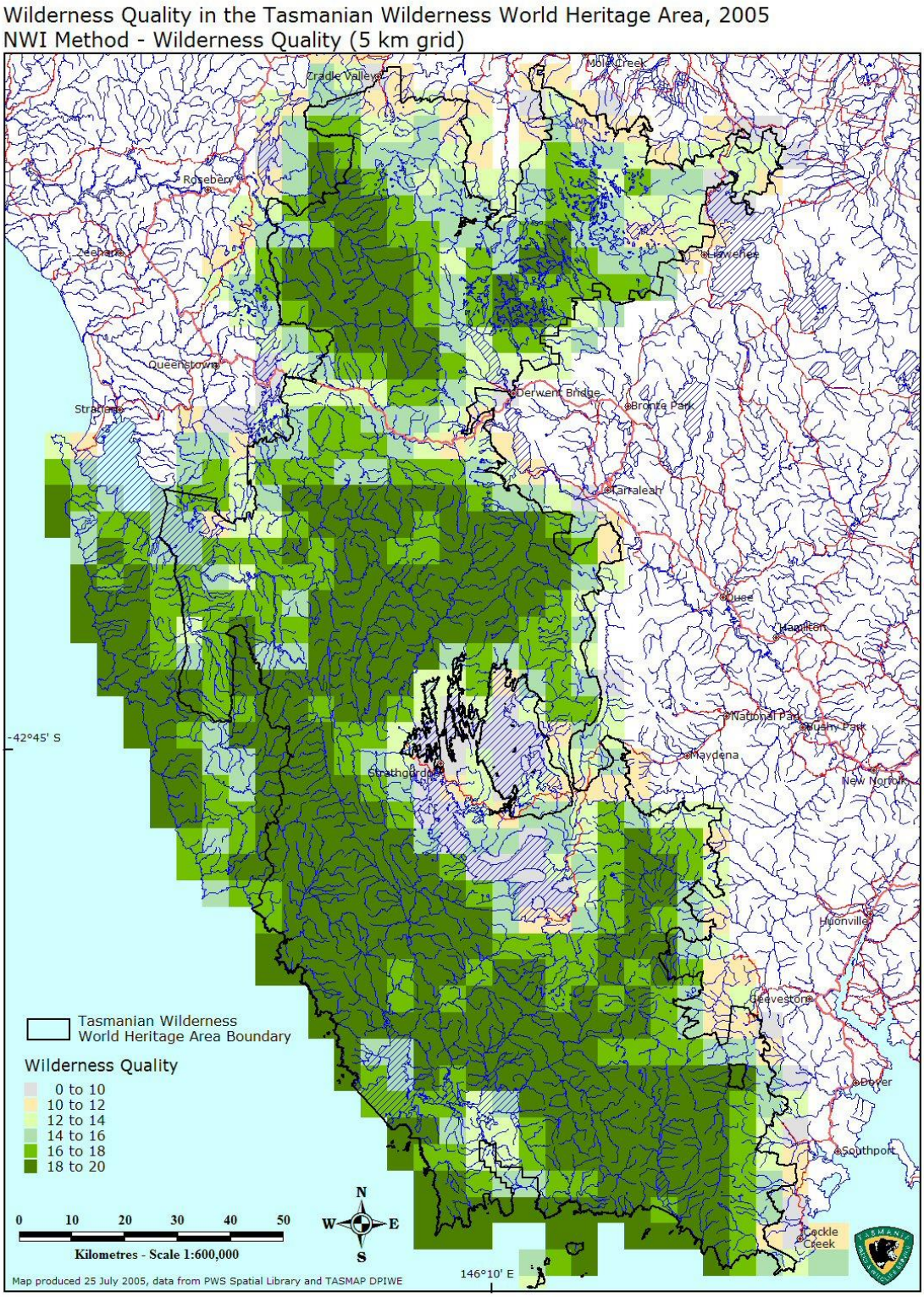
Map 4. Biophysical Naturalness



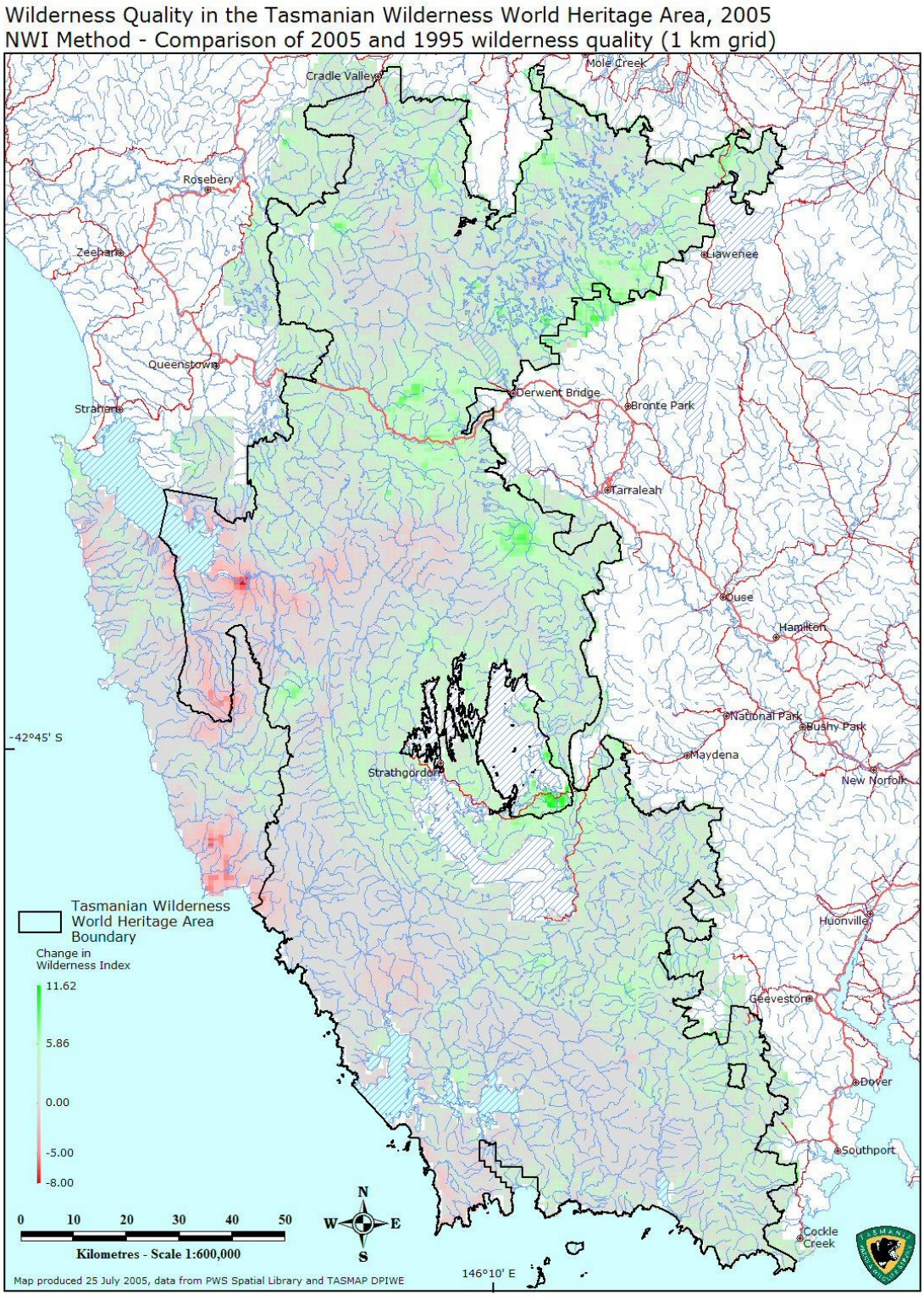
Map 5. Wilderness Value (1km grid)



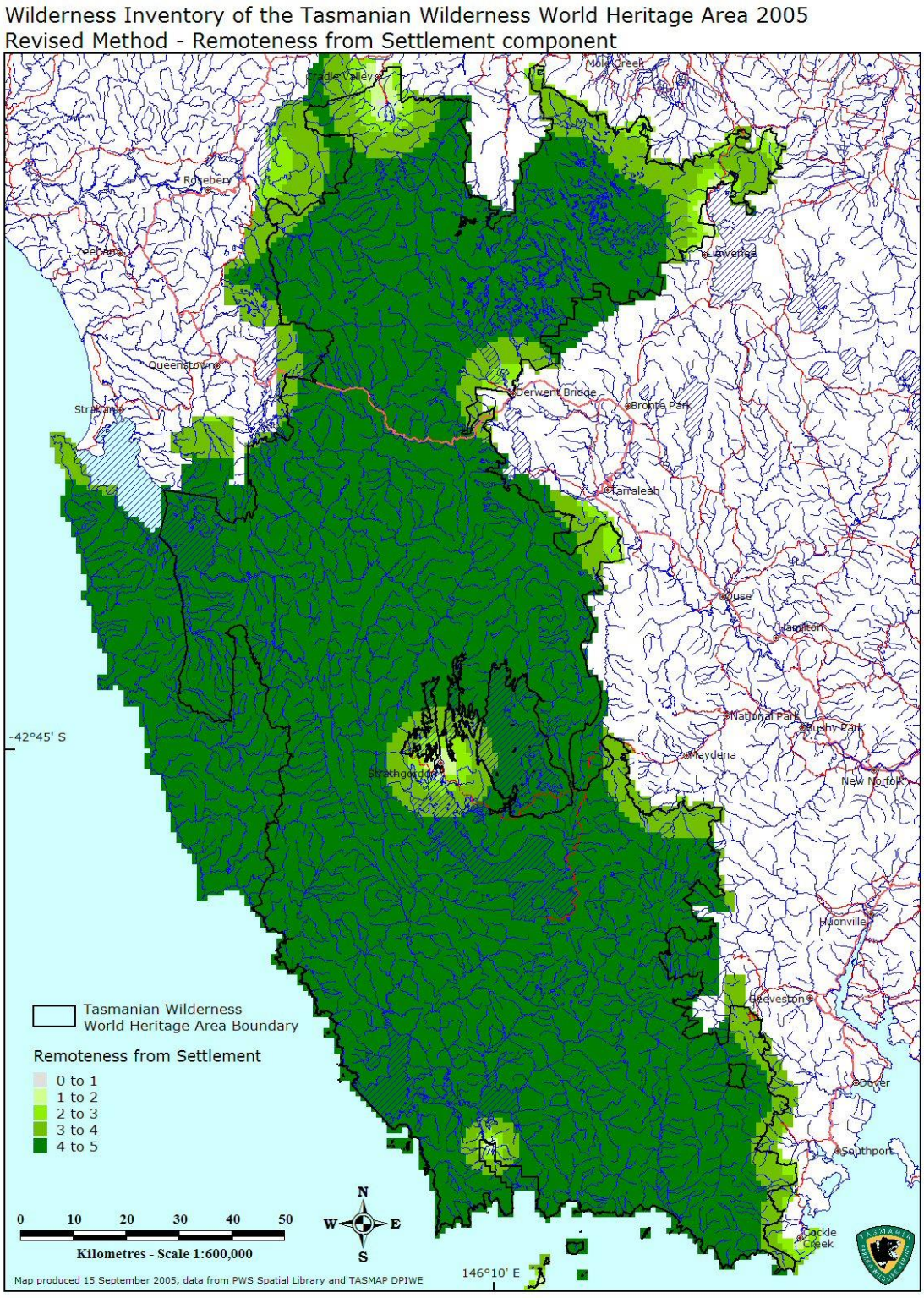
Map 6. Wilderness Value (5km grid)



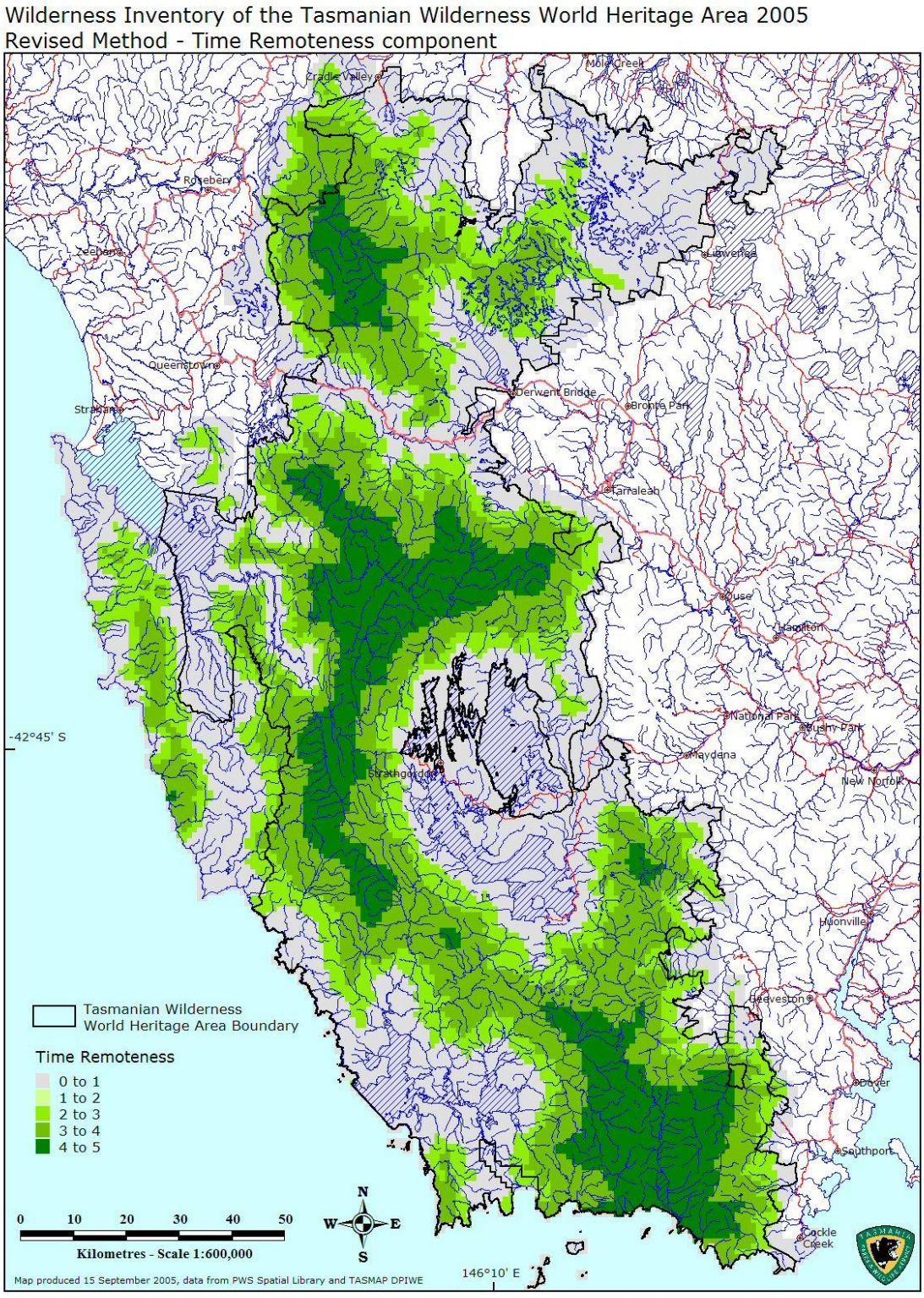
Map 7. Losses and gains in wilderness values between 1995 and 2005



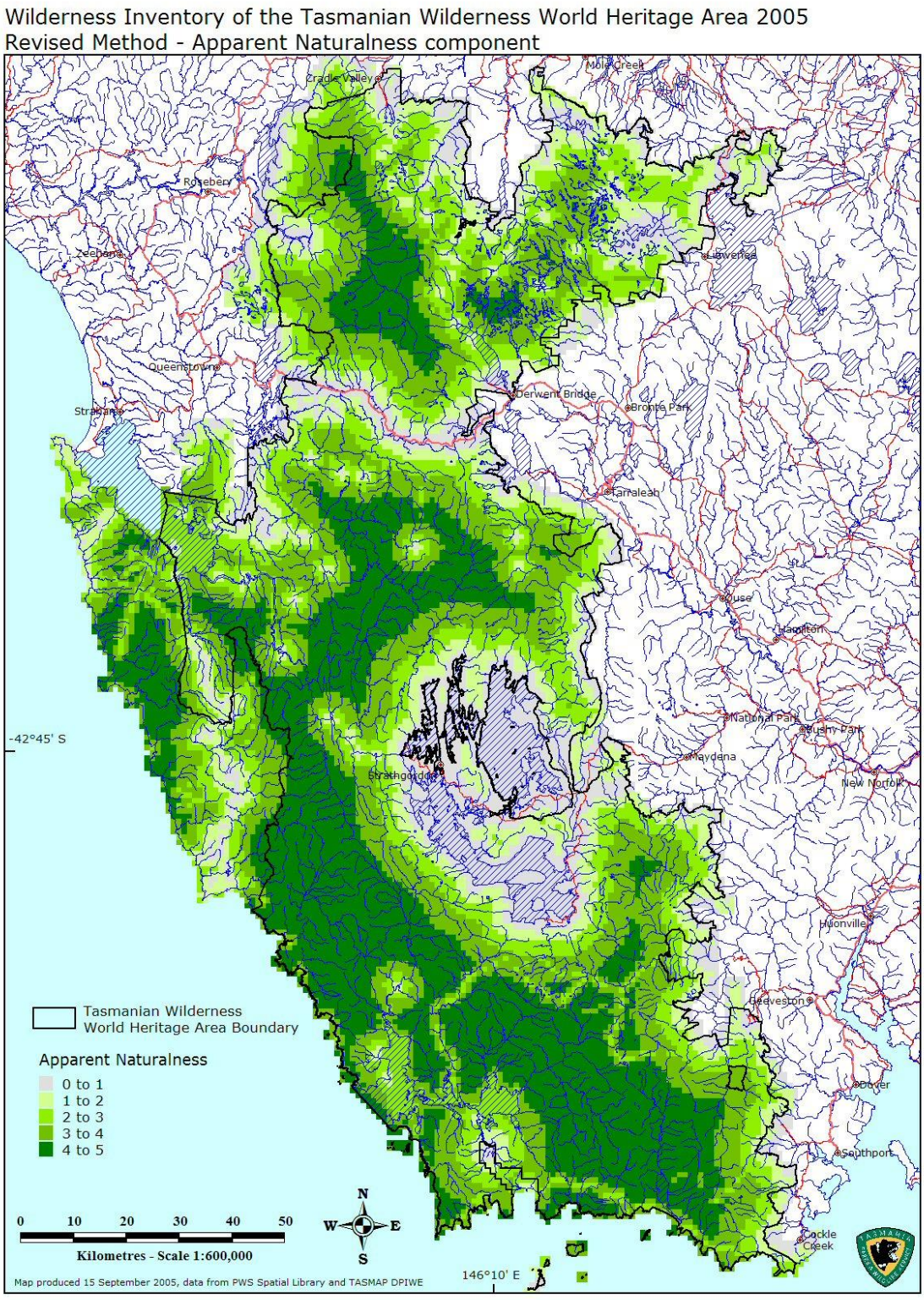
Map 8. Remoteness from Settlement (revised)



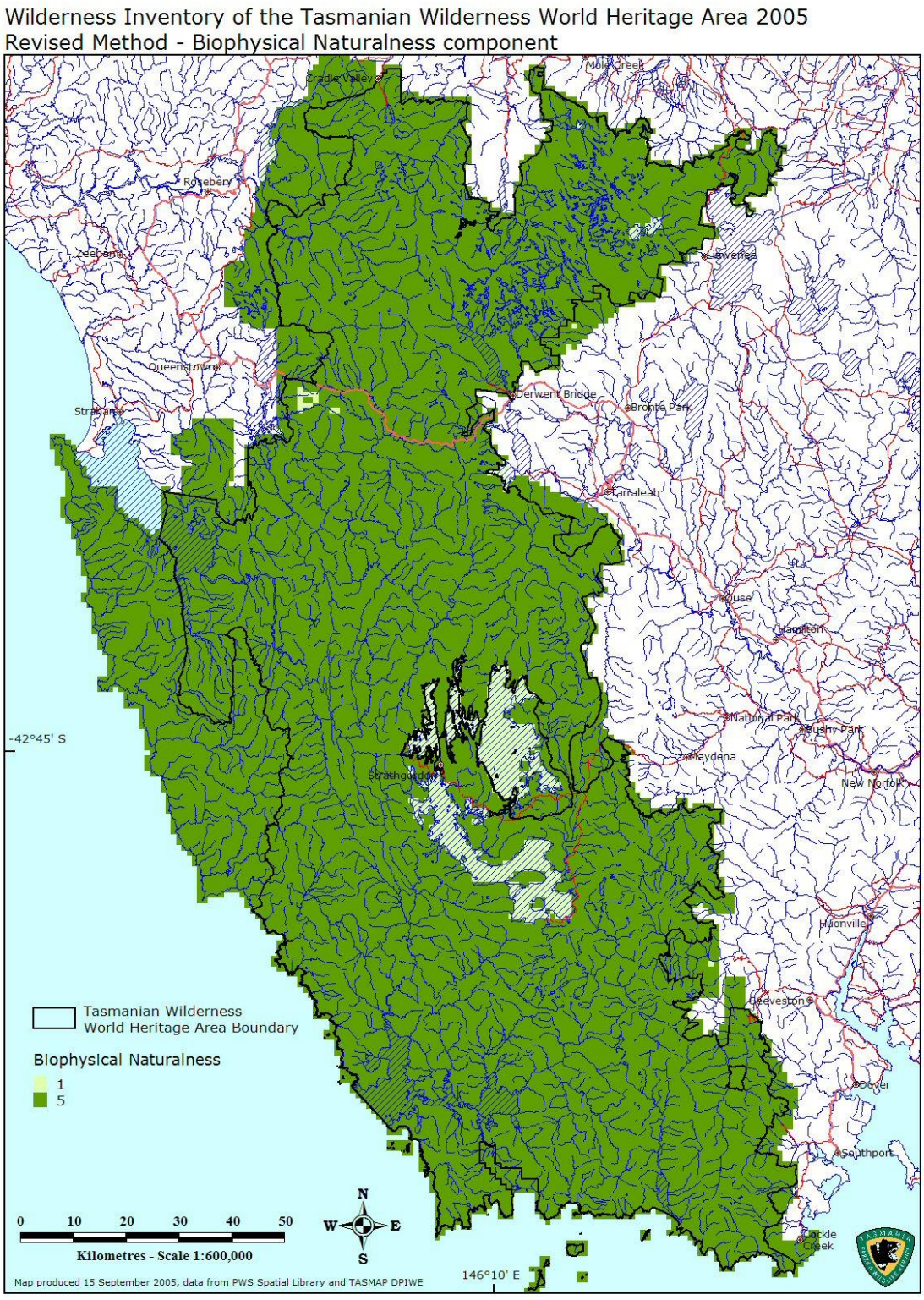
Map 9. Time Remoteness



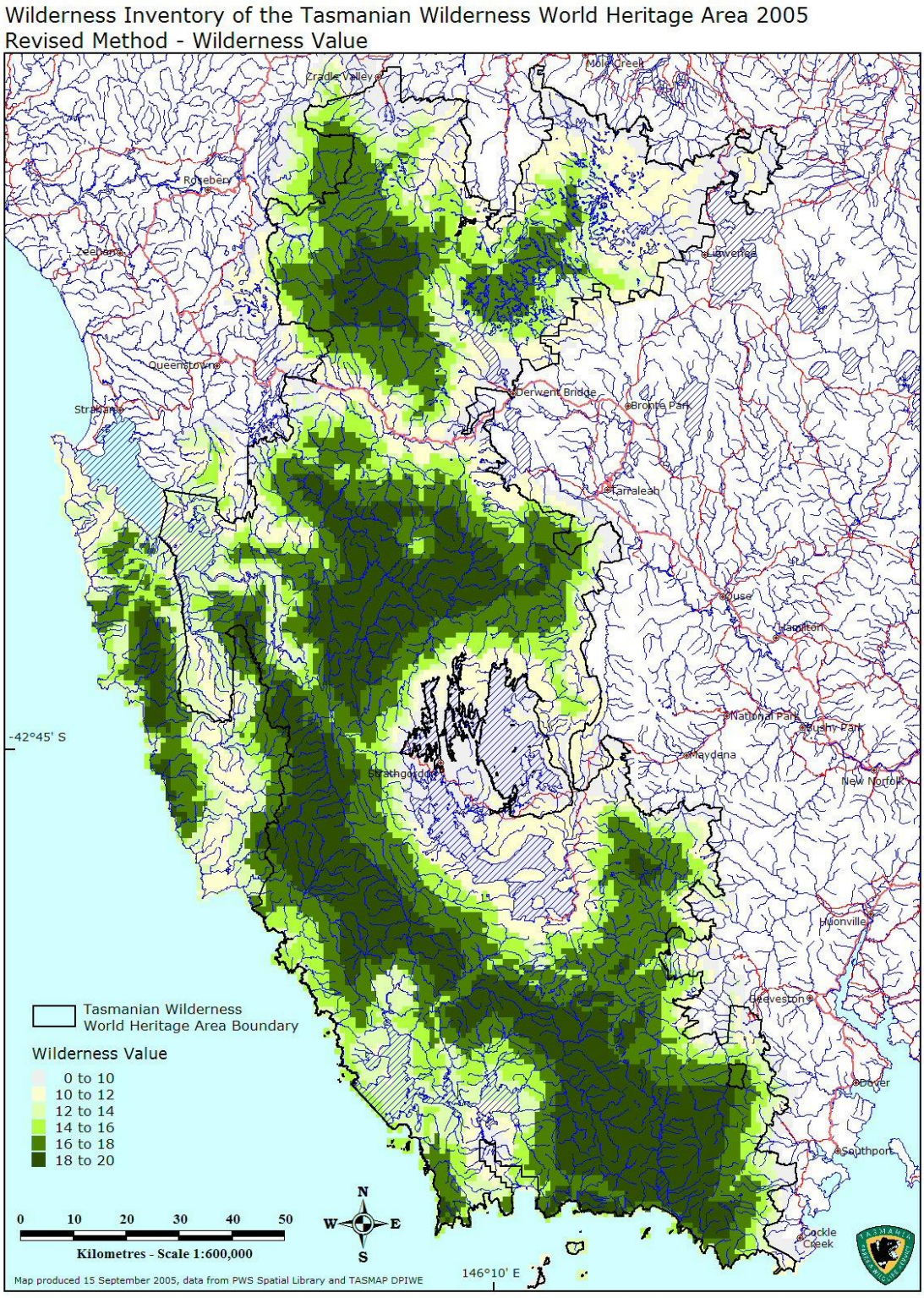
Map 10. Apparent Naturalness



Map 11. Biophysical Naturalness (revised)



Map 12. Wilderness Value (revised)



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