6 Appendices

Appendix 1. Project implementation plan

Appendix 1 is extracted from the project implementation plan and documents the logic behind the sampling strategy used in the project. The unpredictability of the fire seasons coupled with the tight timeline for this project required modification to the some details of the plan, however, the overall strategy was followed. The relevant sections are presented below.

A1.1 Introduction

The Project Implementation Plan presents the methods the consultant proposed to use for Environment Australia's National Dioxins Program contract 13/2002, "*Determination of the levels of emissions of dioxins from bushfires in Australia"*. The scope of the project is specified in the contract work schedule.

This project aims to:

1. Consolidate the current state of knowledge on dioxin emissions from wildfires and prescribed burns in Australia
2. Gain a greater understanding of dioxin emissions from wildfires and prescribed burns by either direct sampling or by carrying out laboratory-controlled experiments or by both. This will be achieved by determination of PCDD/PCDF emission factors, and emission profiles of the toxic PCDD/PCDF
3. Derive an estimated inventory of wildfire and prescribed burn activity in Australia.

A three-stage experimental program will address these aims.

Stage 1 is to establish a program to sample smoke emissions from bushfires, prescribed fire and the field burning of agricultural residues. It will be addressed in two parts:

- A field program for sampling smoke emissions from controlled fires conducted under prescription by State bushfire authorities or farmers, or from non-permitted fires in the tropical savannah woodlands of Northern Australia. If circumstances permit, we will also attempt to sample emissions from wildfires in forest
- A laboratory study for measuring the emissions from cereal stubble, sugar cane slash, savannah woodland fuel and temperate forest leaf litter under controlled conditions.

Stage 2 is the analysis of the PCCD/Fs and CO_2, CO, CH_4, total VOC and NO_X gas samples collected during stage 1.

Stage 3 is the interpretation of the emissions data and the estimation of total PCDD/PCDF emissions from fires in Australia from 1995 to 2001.

This document outlines the methodologies for stages 1 and 2 and the rationale on which they are based.

A1.2 Sampling

Stage 1 consists of two parts. Part A is a field measurement programme principally addressing forest and savannah woodland fires, and Part B is a laboratory programme addressing crop residue and forest litter combustion.

A1.2.1 Field Sampling.

The design of the fire schedule is a central part of this document because it circumscribes the conclusions, which ultimately can be drawn from the data. The programme outlined briefly in the tender proposal, and in detail in this document was developed with a view both to the practical and to the impact of emissions on the Australian population either by direct exposure or by concentration of PCDD/PCDF up the food chain. Less weight was placed on establishing with precision the total national emission. The contribution of different fire classes by state and nationally for the 10 years 1990 to 1999 is shown in Table A1.1.

Table A1.1 The proportion of total carbon emitted by biomass fires in each state from the major vegetation classes

Vegetation	***% Total carbon emitted***								
	NSW	**Tas**	**WA**	**SA**	**Vic**	**Qld**	**NT**	**ACT**	**AUST**
Tropical savannah	0	0	89	0	0	88	100	0	89
Open woodland and temperate grassland	10	6	-	34	5	0	0	0	
Forest, Prescribed	15	13	2	0	41	2	0	10	2
Forest, Wildfire	49	80	8	0	33	3	0	90	6
Cereals	24	1	2	66	21	3	0	0	3
Sugar	2	0	0	0	0	4	0	0	0
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
% National emission	1.2	0.12	36.1	0.50	0.4	15.6	40.9	0.0	100
%National emission excluding tropical savannah	1.2	0.1	3.9	0.5	0.4	1.9	0.0	0.0	8.1

While the tropical savannah fires contribute almost all the emissions, most of the population and the agricultural production occurs in SE Australia from Brisbane to Adelaide, an in SW WA. In these areas prescribed fires, wildfires and agricultural burning are dominant.

To a first order, we can consider the tropical savannah woodlands to be relatively uniform with respect to emissions. Clearly, we can't plan wildfires and remain within the law. Prescribed fires are a significant and sometimes dominant source of carbon emissions, but include a wide range of fire characteristics. Agricultural burning is also important in SE Australia and SW WA, however, while field sampling is difficult sampling in controlled laboratory tests is an option.

The plan presented and discussed below aims to sample the full range of fire classes, with an emphasis on fires that are likely to be accessible, and classes that are important

management tools. We will sample savannah fires at the extremes of their seasonal range. We will attempt to sample the intense and controlled fires, if possible, to gauge their potential significance as PCDD/PCDF emission sources. The principal variable we address with prescribed fires is regional variation. With agricultural fires we aim to use a combination of field and laboratory measurements.

This approach weights the experimental effort and the resulting information to the emission sources of significance towards population centres and agricultural regions.

Field Sampling Locations.

The field-sampling programme will collect smoke samples mostly from operational (i.e. controlled) fires in southern Australian forests, fires in savannah woodland in northern Australia and agricultural residues fires.

The fire classes that will be measured are:

- Wildfires
- High temperature slash burning following logging
- Low temperature prescribed fires in managed native forests for fire hazard reduction
- Low temperature prescribed fires in softwood plantation for fire hazard reduction
- Early and late season fires in the tropical savannah woodlands of the Northern Territory
- Agricultural waste burning of cereal crops and sugar cane.

The forest classes to be investigated are:

- Foothill forest of Central Victoria centred on Creswick
- Dry sclerophyll forest and heath land of the Sydney basin
- Jarrah forest of SW Western Australia centred on Manjimup
- Savannah woodland surrounding Darwin
- Native Eucalypt woodland in the SE Queensland (Brisbane, Maryborough/Gympie)
- Pine plantation in Western Australia or in the event that this is not possible, in southeast Queensland.

The crop classes to be investigated are:

- Irrigated cereal crop in the Murrumbidgee Irrigation Area
- Sugar cane in southeast Queensland.

It is also planned to sample smoke emissions from a wildfire and a windrowed forestry slash fires. There are no controlled high intensity forest fires planned within the lifetime of the project.

For practical reasons most of the fires to be sampled will be either operational prescribed fires, or savannah fires. The timing of these fires is dependent on fuel conditions, soil moisture and the weather and can only be specified within a window of approximately 2 months. The actual timing and the class of fire (i.e. heading or backing) will be decided in the field by the district fire officer.

By definition, wildfires cannot be planned, however, statistically, there is a significant possibility in either Victoria or WA that a wildfire will occur that is of sufficient size and duration for successful sampling. If this occurs on more than one occasion then two wildfires will be sampled at the expense of one of the other scheduled samples. If no wildfire sampling is possible then the planned wildfire samples will be reassigned to other fire classes.

Because the timing of controlled fires is to a large degree dependent on weather, we will need to have several sampling systems on standby at central locations around Australia. Three complete systems will be constructed, with the capacity to quickly configure a fourth if needed.

Rationale for the sampling schedule.

In detail, the rationale on which the sampling schedule is based is described below.

Victoria

On average, there are about 100,000 ha of low intensity prescribed burning, 3,000 ha of high intensity burning (regeneration burning or slash burning) in forest in Victoria and about 50,000 ha of wildfires. Numerically, there are about 1,000 low intensity prescribed fires, about 200 high intensity prescribed fires and about 600 wildfires. However, the total area burnt in any one year can vary by a factor of 10 above or below this average depending on the seasonal conditions.

The greatest amount of prescribed burning takes place in autumn. About 70% of all low intensity prescribed fires and close to 100% of high intensity prescribed burns occur in autumn. This is so for a number of reasons – it is the safest time to burn (stable weather, reducing fire danger), it is ecologically more desirable on average and it is the time when seed regenerating plants such as eucalypts have the best regeneration success. However, spring burning can be more effective at reducing fuel hazards before the summer fire season and may give greater control over the proportion of fuel actually being burnt.

Wildfires occur over about a nine-month period, peaking in January and February. Approximately 99% of all wildfires are smaller than 10 ha and are short-lived (less than 4 hours). The one percent of wildfires that are bigger than 10 ha tend to burn about 90% of the total area burnt for the season. Typically there are less than six large fires each fire season in Victoria.

Only large fires have sufficient duration for smoke sampling. Typically, large fires in the mallee and east Gippsland occur at the end of the fire seasons in November or March. Large fires in the foothill and mountain forests more typically occur in January and February. In this project, the most accessible forests are in the foothill forests within 100 km of Melbourne, therefore, we expect to sample smoke from wildfires in the January-February period.

Sampling of prescribed fires in Victoria will also concentrate on the region within 100 km of Melbourne. This will include the Dandenong Ranges, Macedon Ranges, Wombat State Forest, and Brisbane Ranges. While we have access to both operational and experimental prescribed fires this experiment will confine sampling to the former. The decision has been made because we know that on average, there are usually only about 5 days in the burning season when the prescribed conditions will be met for any

individual site. The advantage of sampling operational fires (in contrast to experimental fires) is that it gives us a much greater chance of achieving our field sampling commitments. The cost of the strategy is the limit it imposes on our sampling options. For example, extensive pre-burn measurements of fuel properties will not be possible and we will need to rely on using a paired-site method for a burnt/unburnt comparison.

We will attempt to sample two spring low-intensity prescribed burns and one autumn burn. If we miss one of the spring burns we will be able to take a second autumn burn to compensate. In the foothill forests around Melbourne, most spring burning takes place from mid-October to the end of November and this is the period when we are most likely to collect smoke samples. Most autumn low intensity prescribed burns take place from mid-March through until the end of April. However, most high intensity prescribed burns take place in March. Where a choice is possible a high intensity prescribed burn will be given priority.

In addition, logging slash fires are a potential source of emissions with significantly different characteristics to prescribed fires and wildfires. The fuel loads are large (Table A1.2), the burning efficiencies are high, and the impact on the soil is large with significant heating through 30 cm of soil as compared to 1-4 cm in a prescribed fire. We will sample one windrowed slash fire to establish the PCDD/PCDF emission characteristics from this class of forest management fires.

Table A1.2 Fuel consumption (fraction of oven dry weight) for different types of fires (from Gould 2002).

Fire type	Fuel consumed (%)	Total fuel load (t ha^{-1})	Fuel burnt (t ha^{-1})
Wildfire			
Eastern States	50	100	50
Western Australia	50	60	30
Prescribed fire[1]			
Spring burning	60	12	7
Autumn	80	16	13
Grassy fuels (Qld)	95	8	8
Clearing burns			
• Broadcast		300	145
< 75 mm	100		
< 300 mm	60		
• Windrow (< 300 mm)	100	300	240
• Stoking	100	300	300
Regeneration		185	135
< 75 mm	100		
< 300 mm	60		
Pine			
• Broadcast	85	80	68
• Windrow	95	80	76

[1] Fuel < 25mm diameter

NSW

The original proposal planned to sample smoke from the high temperature experimental fires planned for the Spray System Field Validation Project, Task IV. This project has

been deferred until summer 2003/2004 and it is beyond the scope and budget of the dioxin project independently to seek planning authority or to implement a high temperature experimental fire in forests. As substitute we propose to sample in operational prescribed fires in heath land in SW Western Australia. These fires are typically more intense, with higher fuel loads than prescribed fires in forest.

The 2001 Sydney bushfires have focussed attention on smoke emissions in the Sydney region and, therefore, we propose to concentrate the NSW fieldwork on the heath lands in this region. The NSW National Parks and Wildlife service have offered assistance with this component of the project. Two prescribed burns in the Sydney basin are scheduled for March - April 2003.

Western Australia

The field program in Western Australia will be centred on the Manjimup Research Station, CALM, WA, which is centrally located in the Jarrah/Karri forests of the Central Forest Region, and is the main centre of forestry in SW WA. Prescribed burning is conducted in this region both in late spring and autumn. The majority of the prescribed burning occurs in spring (Table A1.3). We propose to sample from two prescribed burns conducted in late spring, leaving open the option of sampling autumn burns if the spring season proves to be unsuitable.

As discussed above, we will also sample two prescribed burns conducted in heath land in Autumn.

Table A1.3 Area of prescribed fires in South West-WA in 2000-01

Forest Region	Area (hectares)			
	Winter	Spring	Summer	Autumn
Swan	7,656	9,584	-	4,990
Central Forest	243	22,624	-	13,048
Southern Forest	2,200	24,248	2,240	1,033
Total	**10,099**	**56,456**	**2,240**	**19,071**

Wildfires are less common than prescribed fires in the Central Forest region; in area they are typically less than 25% of the area of prescribed burning. Wildfires in the karri forests of the Southern Forest region are a greater possibility with extensive areas burned in the occasional severe fire year (eg 1996/7). Nevertheless, sampling wildfires will be opportunistic and, therefore, we will sample the first suitable wildfire which occurs, whether in Victoria or in Western Australia.

Northern Territory

The frequency of savannah fires in the Northern Territory is very high with the fire return period for savannah woodland within 200 km of Darwin mostly two years or less. Fires in tropical savannah woodlands of the Northern Territory can be lit under permit prior to June. Fires later in the fire season (July to October) are all classed as wildfire. Fire intensity tends to increase through the season as the fuel dries. While controlled burning is less common in the Northern Territory than in Southern Australia, the high

fire frequency allows us to plan opportunistic sampling of fires within the Darwin region. The Bushfire Council of the NT will notify us of suitable fires.

It is proposed to sample three savannah woodland fires within the greater Darwin Region; one in the late fire season (September/October) and two early in the season (May/June) This covers the two seasonal extremes with respect to intensity (higher and lower) and classification (permitted and non permitted).

Queensland

Sampling of forest fires in Queensland will be confined to the subtropical open woodlands of Maryborough/Gympie and Brisbane. Extensive prescribed burning and wildfire occurs in this forest class. Although the area is typically less than 10% of the area of fires in the savannah woodlands of Cape York, smoke emissions from this region are likely to impact a significant population.

Queensland is also the main state in which prescribed burning is regularly undertaken in pine plantations, typically from 2,000 to 10,000 ha y^{-1}.

The original plan was to conduct most of the fire sampling in Queensland in winter 2002, however, the season has been extremely dry and most prescribed burning has been abandoned. This stage of the programme will be deferred to June/July 2003

Agricultural Waste Burning

Field sampling of agricultural fires at ground level poses a significant challenge because fire duration is short and plume rise is rapid. It is possible that ground level sampling from single fires might not trap sufficient PCDD/PCDF for analysis and, therefore, sampling into each trap might need to be continued through more than one fire. This will only be practicable in a district where extensive burning occurs. Irrigated cereal crops offer the best prospect for this. The emissions from cereal stubble burning will be sampled in the Murrumbidgee Irrigation Area where almost all of the rice stubble in the region, and the majority of maize stubble are burned.

Sugar cane burning poses a similar challenge. Sampling will be conducted in Southern Queensland where typically 50 to 70% of the cane crop is burned before harvest. The harvest season in this area commonly continues from July to November, in poor years the season is sorter. If this is the case for 2002 then sampling might be deferred to 2003. The Canegrower's Association will to advise us on the options.

Samples

During each fire, one or if possible, two dioxin traps will be exposed. These samples will be forwarded to AGAL for analysis. In parallel with the PCDD/PCDF sampling, a second air sample will be accumulated in 80 litre Tedlar bags. This will either be returned directly to Aspendale for analysis or two sub-samples will first be transferred to SUMMA canisters for shipping. In addition, a grab sample of ambient air will be collected upwind of the fire to establish the background levels of CO_2, CO, CH_4, NMHCs and NO_x upstream of the fire.

The ambient concentration of PCDD/PCDF is expected to be less than 5% of the smoke concentrations. Five background air samples will be collected during the campaign to confirm this. Additionally, the ambient air-monitoring programme will have several

sites suitable for establishing background PCDD/PCDF concentrations relevant to the bushfire project.

A1.2.2 Laboratory Experiments

Cereal stubble and sugar cane fires are grass fires. They are, typically, of short duration (1-2h) and rapid spread. This makes field sampling more difficult than for forest fires. The sampling problem can be more easily addressed in the laboratory where the smoke plume is confined and accessible. The challenge is to recreate in the laboratory the fire characteristics (intensity, rate of spread etc.) that occur in the field.

Laboratory experiments are also preferred for collecting true duplicate samples because the sample inlets can be co-located in the smoke plume with certainty. Consequently we propose to collect the duplicate PCDD/PCDF samples for independent analysis in this component of the project.

A series of experimental fires will be conducted in the 10-metre corridor facility, at CSIRO Manufacturing Infrastructure Technology, Highett, Victoria. These experiments will be conducted on four fuels, sugar cane trash, cereal stubble (rice or maize), fine fuel samples from the savannah woodlands near Darwin, and fine fuel samples from a mixed *Eucalyptus viminalis/ Eucalyptus obliqua* production forest 100km west of Melbourne.

The fuels will be spread across the floor of the corridor facility at a density similar to the fuel density in the field and the ventilation rate will be controlled to maintain a slowly moving fire front similar to rate of spread in the field. Forest fuels will be laid across the floor of the test corridor. Crop residues will be raised on a wire mesh to simulate the larger aeration rates of agricultural fuels.

A series of preliminary tests will be conducted to determine the required configuration and control settings for the experimental system before the PCDD/PCDF emission tests are undertaken.

PCDD/PCDF, TSP, CO_2, CO, CH_4, NMVOC and NO_x samples will be collected using the field sampling system. In addition, CO_2, CH_4, NMVOC and NO_x may be also be analysed continuously during combustion.

Tunnel, surface temperature, flame temperature, power output and rate of spread will be recorded during each fire to define the combustion characteristic. Fuel combustion efficiency will also be measured.

The experiment will consist of 10 fires each yielding a single PCDD/PCDF sample. These will be:

- 3 replicate tests of sugar cane trash (samples will be collected in duplicate for two tests)
- 3 replicate burns of maize stubble (samples will be collected in duplicate for two tests)
- 2 replicate burns of savannah woodland fine fuel (samples will be collected in duplicate for one test)
- 2 replicate burns of temperate forest fine fuel.

The fuel charge for each test must be sufficient for 10 g of emitted carbon to be sampled by each PCDD/PCDF trap.

In addition, one ambient sample will be collected.

A1.2.3 Smoke Sampling System

Analysis of the PCDD/PCDF emissions data from the domestic wood combustion study (Gras et al., 2002) and preliminary sampling and analyses of smoke plumes from open woodland in Queensland (Prange, personal communication) suggests that an air sample of between 50 and 250 m^3 containing approximately 10 g of emitted carbon is required for optimal analytical precision for the PCDD/PCDF analyses (Appendix 2). This requires a sampling and trapping system capable of sampling at a flow rate of approximately 1 m^3 min^{-1}. In addition, the concentrations above background of CO_2, CO, CH_4, NMVOCs, NO_x and particle mass are required to establish the total carbon content of the sampled smoke.

The sampling unit will be mounted on the tray of a diesel utility and located as close to the fire front as is practicable and safe and within the smoke plume.

The air will be sampled through an anodised aluminium snorkel, 3-4 m long and 50 mm diameter, which can be manoeuvred into the smoke plume. The inlet will be fitted with a 1 mm stainless steel mesh to exclude embers and large debris. Aluminium will be used in preference to stainless steel to minimise weight. Air will be drawn at high flow rate by either a centrifugal air blower (GAST, SDR5, USA) powered by an 8 HP Honda petrol motor, or by carbon vane pump powered by a petrol driven 5 kVA generator. The PCDD/PCDF sampling heads are modified from the design to be used in the ambient air-monitoring. This comprises an open face filter for condensed phase (10" x 8" pure quartz fibre filters (Pall 10 x 8 QAT-UP), backed up by PUF-XAD2-PUF sandwich gas traps. Traps are constructed from medium-density PUF (polyurethane foam) plugs (nominal density 0.02-0.03 g cm^{-3}, 130 mm diameter, 25 mm and 50 mm thickness) with 40 g of XAD-2 resin per charge. The diameter of these traps is double that of the Supelco PUF holders which will be used in the Ambient Air study to ensure that the linear air velocity through the trap is the same as that in the Ambient Air Study and within the recommended range for complete trapping.

The 50 mm PUF is pre-spiked using a range of isotopically-labelled surrogate standards for sampling loss determination.

The snorkel will be connected to the filter holder with a leak-tight coupling. Exhaust from the petrol motors (generator or pump) will be diluted with exhaust air from the pump and piped away from the vehicle.

Instantaneous flow rate through the trap will be measured continuously by an Annubar flow sensor (Dietrich Standard Corp, Boulder, Co, USA) and will be integrated over the sampling period.

Two additional sample streams will be drawn from the snorkel inlet through a 6 mm diameter stainless-steel sample line. One will samples aerosol mass and CO_2. Air passes through a stretched Teflon filter (2 μm pore Pall-Gelman 47-mm diameter) in a polypropylene filter holder, a fine metering valve, a CO_2 monitor (GasCard II, Edinburgh Instruments, UK), flow meter and pump. The flow rate and CO_2 concentration will be measured continuously and the total mass of emitted CO_2-C

passing through the PCDD/PCDF trap will be calculated and displayed in real time to indicate the progress of the smoke sampling. Particle mass will be determined from the change in filter weight.

A second sample line will be used to collect integrated samples of CO_2, CO, CH_4, NMVOCs and NO_x). Air drawn from the snorkel inlet will be filtered with a 47mm 1 µm Teflon filter and pumped at low flow rate via a fine metering valve, 12V Teflon diaphragm pump (Model MPU487-NO5, KNF Neuberger, NJ, USA) and rotameter flow meter into an 80 L Tedlar bag sheathed within a black polyethylene bag to exclude photochemically active radiation. On completion of sampling the Tedlar Bag will either capped for return to Aspendale for analysis, or the flow line will be reversed and the sample gas pumped into dual-valve SUMMA canisters (Scientific Instrument Services, USA). One or two canisters will be flushed by a minimum of four volumes of gas, after which the outlet valve will be closed and the canisters filled to a pressure of approximately 250 kPa absolute.

The flows, pressures and the output of the CO_2 monitor will be logged continuously via an 8 channel autoranging ATD (ADAM, 4011, Advantech, Ca, USA) and laptop computer.

A1.2.4 Fire Test Facility, at CMIT, Highett, Victoria.

The fire test room and 10 metre corridor facility was initially developed and commissioned for research into the large-scale fire performance of floor coverings. It has since found many other applications.

The corridor is 10 m long, 2.1 m high and 1 m wide. The adjacent burn room is 3.6 by 2.4 by 2.4 m high which are standard ASTM dimensions. The corridor consists of eight modules, each 1.2 m long, framed in galvanised steel and lined with 44 mm of ceramic fibreboard. The far end of the corridor terminates beneath a 3 by 3 m square smoke collection hood connected to an exhaust fan and gas-fired afterburner, which removes harmful and visible emissions from the exhaust gases. For the dioxin project fuel will be arrayed in the burn room and corridor, or corridor only, at floor level or raised on wire mesh support frames, according to ventilation requirements.

A1.3 Analysis

A1.3.1 Dioxins

Analysis

The dioxin analysis protocols will be based on US EPA Method 23.

The gas trap, PUF and XAD-2 resin sandwich components, will be prepared for sampling at AGAL, Sydney. This involves clean up, a batch blank verification analysis, XAD-2 packing, spiking and trap assembly. Cleaned traps will be wrapped in pre-cleaned aluminium foil/parafilm, and labelled for shipping to the sampling contacts. A log of trap number, date sent and associated information will be maintained at AGAL.

Filters will be pre-cleaned at CAR by baking and loaded into filter holders. They will be wrapped in pre-cleaned aluminium foil and labelled for shipping to the sampling contact. Filters details will be logged.

The PCDD/PCDF traps and filters will be analysed by the Australian Analytical Research Laboratories (AGAL). All samples will be analysed at the ultra-trace level to determine the concentrations of the 29 polychlorinated dibenzodioxins (PCDDs), polychlorinated dibenzofurans (PCDFs or furans) and co-planar polychlorinated biphenyls (PCBs) specified in the Contract and listed in TableA1.4.

In addition the five duplicate samples collected during the laboratory tests will be analysed either by MAXXAM Analytics Inc., Ontario, Canada, or the Ministry of the Environment, Laboratory Services Branch, Ontario, Canada.

Quality control

The following quality control procedures will be implemented:

- A laboratory blank will be analysed with each batch of samples
- A matrix spike will be analysed with each batch of samples as a replicate to assess method precision
- Laboratory spike with a range of isotopically labelled standards of the sampling cartridge pre-sampling will be used to assess breakthrough (if any) during the sampling period
- The HRMS resolution, performance and sensitivity will be established for each MS run
- The recoveries of all isotopically labelled surrogate standards will be calculated and reported
- Ten percent of all samples will be analysed by an independent crosscheck QC laboratory.

Analyte identification and quantification criteria

For positive identification and quantification, the following criteria must be met:

- The retention time of the analyte must be within 1 second of the retention time of the corresponding $^{13}C_{12}$ surrogate standard
- The ion ratio obtained for the analyte must be >10% (>20% for PCBs) of the theoretical ion ratio
- The signal to noise ratio must be greater than 3:1
- Levels of PCDD/PCDF and 'dioxin-like' PCB congeners in a sample must be greater than 5 times any level found in the corresponding laboratory blank analysed (3 times the level in the blank for OCDD)
- Surrogate standard recoveries must be in the range 10-120%.

Table A1.4 Dioxin, furan and PCB congeners to be analysed in the study.

Dioxins	**IUPAC No.**	**WHO98-TEF**
2,3,7,8-TetraCDD		1
1,2,3,7,8-PentaCDD		1
1,2,3,4,7,8-HexaCDD		0.1
1,2,3,6,7,8-HexaCDD		0.1
1,2,3,7,8,9-HexaCDD		0.1
1,2,3,4,6,7,8-HeptaCDD		0.01
OctaCDD		0.0001
Furans		
2,3,7,8-TetraCDF		0.1
1,2,3,7,8-PentaCDF		0.05
2,3,4,7,8-PentaCDF		0.5
1,2,3,4,7,8-HexaCDF		0.1
1,2,3,6,7,8-HexaCDF		0.1
1,2,3,7,8,9-HexaCDF		0.1
2,3,4,6,7,8-HexaCDF		0.1
1,2,3,4,6,7,8-HeptaCDF		0.01
1,2,3,4,7,8,9-HeptaCDF		0.01
OctaCDF		0.0001
CDD – chlorinated dibenzo-*p*-dioxin		
CDF – chlorinated dibenzofuran		
Congener	**IUPAC No.**	**WHO98-TEF**
Non-ortho PCBs		
3,3',4,4'-tetrachlorobiphenyl	PCB#77	0.0001
3,4,4',5-tetrachlorobiphenyl	PCB#81	0.0001
3,3',4,4',5-pentachlorobiphenyl	PCB#126	0.1
3,3',4,4',5,5'-hexachlorobiphenyl	PCB#169	0.01
Mono-ortho PCBs		
2,3,3',4,4'-pentachlorobiphenyl	PCB#105	0.0001
2,3,4,4',5-pentachlorobiphenyl	PCB#114	0.0005
2,3',4,4',5-pentachlorobiphenyl	PCB#118	0.0001
2',3,4,4',5-pentachlorobiphenyl	PCB#123	0.0001
2,3,3',4,4',5-hexachlorobiphenyl	PCB#156	0.0005
2,3,3',4,4',5'-hexachlorobiphenyl	PCB#157	0.0005
2,3',4,4',5,5'-hexachlorobiphenyl	PCB#167	0.00001
2,3,3',4,4',5,5'-heptachlorobiphenyl	PCB#189	0.0001

A1.3.2 Aerosol: Mass Loading (TSP)

Total aerosol mass is sampled on line B of the sampling system (Fig. 1). PTFE filters are pre-weighed before sample collection. Each filter is desiccated for a minimum of 24 hours at a maximum relative humidity of 20%. Combined aerosol and filter mass are determined to a precision of 0.1 µg using a Mettler UMT-2 ultramicrobalance, which is also maintained at low humidity. Filters are loaded into the filter holder and capped with aluminium foil for shipping into the field. On return to CAR the filters are removed from the holders, again desiccated at a maximum relative humidity of 20% for 24 hours and reweighed. In both cases this procedure involves repeated weighing until a stable weight is achieved, with a minimum of three determinations. Radioactive neutralisers placed in the balance and balance chamber are used to eliminate static charging artifacts during weighing. The dry aerosol mass is determined from the difference between the pre- and post- collection weights. Typically this procedure results in an uncertainty in aerosol mass of a few micrograms.

A1.4 Sensitivity requirements for the measurement of PCDD/PCDF concentrations in bushfire smoke.

The sample volume required for measuring PCDD/PCDF content in the smoke plume was established by several independent methods; (a) by direct measurement (Prang and Mueller, pers. comm.), (b) by plume dispersion modelling of ground level concentrations of particulate and PCDD/PCDF emissions from controlled fires (Beer and Meyer, 1999) and (c) by extrapolation from the laboratory tests of Gras et al. (2002) and overseas emission data (presented in the review of PCDD/PCDF sources in Australia, EA, 1998).

(a) Direct measurement

There has been one set of measurements of PCDD/PCDF in bushfire smoke in Australia to date. Prang and Mueller conducted some preliminary measurements of PCDD/PCDF emissions from a prescribed fire in open woodland near Maryborough, Qld in August 2001. Sampling of atmospheric PCDD/PCDF was performed using a high volume pump (collecting approx. 35 m^3/hr) located at 1.5 m off the ground and trapping onto XAD 2/PUF traps and a filter (GFF, size 9 Schlecter and Schull 9 cm diameter). The sampling device was located in the clear area in the centre of the burned area, and was stationary during the sample collection period. An air volume of 250 m^3 was sampled. The total particle mass loading on the filters was 105 mg, yielding a mean ambient TSP concentration of sampled air of 400 ug m^{-3}.

Samples were analysed for 2,3,7,8-substituted PCDD/PCDF at ERGO Forschungsgesselschaft, MbH, Hamburg, Germany, using a standardised method. The limit of quantification for PCDD/PCDF in a sample was defined by a signal to noise ratio greater than three times the average baseline variation and an analyte quantity in the sample greater than three times the quantity in the respective blank. The total mass of PCDD/PCDF detected was 23 pg m^{-3} corresponding to 10.8 pg total sample (42 fg m^{-3}) WHO TEq. The concentrations for all of the PCDD/PCDF congeners detected were well above the levels in the corresponding analysis blank and were 30 times larger than detected in ambient atmosphere from the same site prior to the fire. From these measurements it was concluded that fixed-point sampling of 50-250 m^3 of air in the

vicinity of an extensive low-temperature fire would yield accurate measurements of the PCDD/PCDF concentration.

(b) Plume dispersion modelling

Data from the recent Sydney bushfires also support the expectation that fixed-point air sampling in the vicinity of a fire will provide sufficient samples for precise measurements of PCDD/PCDF concentration. The five highest 24-hour averages for PM10 in West Sydney during the recent Sydney bushfire period (supplied by the NSW EPA) were 142.3, 127.1, 110.6, 106.6 and 105.8 $\mu g\ m^{-3}$. From these observations we note that at large distances from large fires PM10 concentrations can reach over 100 $\mu g\ m^{-3}$ equivalent to 500 $\mu g\ m^{-3}$ TSP. These smoke concentrations are comparable to those sampled by Prang and Mueller and support a conclusion that their controlled fire behaved typically.

Beer & Meyer (1999) estimate that about a kilometre downwind of controlled burns, the ground level concentration of total particle matter is about 6,000 $\mu g\ m^{-3}$ (corresponding to PM10 levels of 1250 $\mu g\ m^{-3}$) and PCDD/PCDF concentrations are about 6 $pg\ m^{-3}$. These estimates are also in accord with Prang and Mueller's measurements.

(c) Extrapolation from laboratory measurements

The required sample volume can also be calculated from PCDD/PCDF emission factors. From the few overseas measurements (see EAs review of the sources of PCDD/PCDF and furans in Australia) emission factors for PCDD/PCDF from bushfires (prescribed and wildfire) might range from 0.5 to 30 ng TEq kg^{-1} fuel. These values are similar to the values for PCDD/PCDF emissions from Eucalyptus hardwood fuels of 1 to 26 ng TEQ kg^{-1} fuel reported in our recent study of air toxic emissions from domestic wood combustion commissioned by EA (Gras et al., 2002). Included in the study were some tests with an open-flow fireplace insert similar to the technique used in the US to estimate emissions from wildfire. These yielded a mean PCDD/PCDF emission factor of 11 ng TEq kg^{-1}). The amount of sample that must be collected is limited by the minimum detectable limit (MDL) of the analysis, and the relative toxicity of the dominant congeners. The typical fuel load and dilution in the Gras et al., study were respectively 5 kg and 1:1,000. The measurement uncertainty was calculated assuming that measurement errors in all congeners were independent and normally distributed with a standard deviation equal to half the MDL. The 95% uncertainty in the PCDD/PCDF emissions (as TEQ) were less than 10% for all but the lowest emission rates. From this we established the total carbon emissions from a fuel mass of 5 to 10 g are required to establish the PCDD/PCDF emission with precision.

Most (typically > 90%) of the carbon emitted during combustion appears in the atmosphere as CO_2 raising the ambient concentration above the normal background concentration. The established method used to relate trace gases emitted by combustion in the field is by ratioing the concentrations of the unknown tracer to CO_2 whose emission rate is assumed to approximate the total carbon content in the burned fuel. In the savannah fire study at Kapalga, NT in which Dr Garry Cook, a member of the proposed CSIRO team, participated, the air samples collected at ground level near the fire front had CO_2 concentrations elevated by 100 to 10,000 ppm above background. Taking the lowest figure of 100 ppm enhancement, approximately 100 m^3 air must be sampled to recover the carbon emitted by complete combustion of 10g of fuel.

Therefore, all three estimates of the required sample volume are consistent and indicate that 50m^3 or more of air will contain sufficient PCDD/PCDF concentrations to determine the emission rates (as TEQ) with good precision.

The field systems we propose to use draw air samples at approximately 0.8 m^3 per min and, therefore, a sampling time of at least 1h will be required to collect the minimum required volume of 50 m^3. The systems will be mounted on vehicles so the sampling location will shift as the fire progresses, and the fitted with 3-4 m sampling booms to enable safe sampling of smoke at the front of controlled fires. By actively seeking the smoke plume rather than relying on local mixing and dispersion we expect to sample higher smoke concentrations than fixed-point sampling allows. Typically, a controlled fire burns for 4-6 h, and we expect, by remaining down wind of the fire front at all times, to be able to sample concentrated smoke for at least two hours which is will within the design requirements. Integrated air samples will be collected in parallel with PCDD/PCDF samples to determine the emissions of the criterion pollutants (CO, CH_4, total VOC, NO_x and TSP mass), and CO_2 in order to quantify the fire emission characteristics and to relate PCDD/PCDF concentration measurements to directly to the mass of fuel burned.

While these calculations confirm the feasibility of field measurements, there remains a small risk that the main smoke plume could be missed or that the smoke concentration is lower than expected, in which case an inadequate sample quantity could be collected. In the absence of a real-time measure of emitted carbon in the sample stream this problem might be evident only after analysis of the criterion pollutants. To remove the risk each sampling system will be fitted a with real-time NDIR CO_2 analyser. This will allow us to measure and integrate the CO_2 concentration increase above background and smoke density directly in the gas sample stream and, therefore, to measure directly the mass of emitted carbon passing through the PCDD/PCDF traps. Sample collection will continue until a minimum of 10 g of gas-phase carbon emitted by the fire has been sampled. This additional information will allow sampling onto a single trap to be extended over multiple fires if smoke concentration is too low to provide an adequate sample from a single fire.

A1.5 References

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Gras, J, C.P. Meyer, I. Weeks, R. Gillett, I. Galbally, J. Todd, F. Carnovale, R. Joynt, A. Hinwood, H. Berko, and S. Brown (2002) Characterisation of emissions from solid-fuel-burning appliances (wood-heaters, open fireplaces). Final Report to Environment Australia. CSIRO Atmospheric Research, Aspendale, Vic., 103p

Appendix 2. Analytical determination of trace gas emission factors from biomass combustion

The emission factor, the key parameter for estimating emissions is defined as amount of the chemical species emitted by the combustion per unit mass of fuel. To measure this directly requires sampling all the smoke produced from combustion of a known mass of fuel usually in a cone calorimeter, a dilution tunnel (e.g. the AS4013 test for combustion heaters) or a combustion room (e.g. Gullett and Touati, 2003). It is not possible to achieve this in the field. An alternative method, which is suitable for field measurement, is based on the fact that total fuel carbon is a conserved quantity. The approach has been used in many field campaigns over more than 25 years (e.g. Hurst et al., 1994; Andreae et al, 2002). The principles are described below.

The combustion of forest fuel first converts the fuel into smoke compounds. About 50% of fuel mass is carbon, and the carbon-based chemical species formed during combustion are the gaseous compounds comprising CO_2, CO, CH_4, and the VOCs, and semi volatile and non-volatile compounds that condense onto fine particles. Collectively these combustion products are termed "volatilised carbon". The exact species composition may vary but the mass of carbon is conserved and, therefore, if 1 kg of fuel with a carbon content of 50% is burned then the smoke produced will contain a total of 500 g of volatilised carbon.

The smoke mixes with ambient air, diluting some species, and adding to the concentrations of other species already present in the ambient air. The dilution ratio is usually not known, however, assuming that no further chemical transformation occurs and that loss by deposition to the ground surface is negligible in the time between combustion and sampling then the mass ratio of each combustion product to total volatilised carbon in the raw smoke remains unchanged by this dilution. Therefore, if we want to determine the mass of a specific combustion product from combustion of a known mass of fuel of known carbon content, we only need measure the concentrations of the trace species and the total volatilised carbon in each smoke sample and in the background air.

For example, if the emission factor for PCDD/PCDF is 1 pg TEQ $(\text{g fuel})^{-1}$, and the carbon content of the fuel is 50% then 1 kg of fuel will be gasified to produce 1 ng TEQ PCDD/PCDF and 500 g total volatilised carbon. Assuming almost complete combustion the products are mostly CO_2 and H_2O in equal molar volumes. Applying the universal gas law, this gas, undiluted, has a volume of 1.9 m^3 at STP and a CO_2 concentration of about 450,000 ppm. We know from observation that the concentration of CO_2 in smoke from a fire in the field is 100-3,000 ppm above ambient and therefore the combustion gases must be diluted by a factor of 300-9,000 to a final volume of 280-8,400 m^3. Background air contains 370 ppm CO_2, 0.1 ppm CO, 1.8 ppm CH_4 and up to 1 ppm VOC carbon; in total 0.2 g C m^{-3} at STP. The PCDD/PCDF concentration is of the order of 0.05 pg TEQ m^{-3}. This final volume now contains the 500 g C from the fuel and 55-1,680 g carbon from the background air giving a concentration of 480-3,700 ppm C, and 1ng TEQ of PCDD/PCDF at a concentration of 0.15-3.6 pg TEQ m^{-3}. The ratio of emitted PCDD/PCDF to C derived from fuel is unchanged from 2 pg TEQ $(\text{g fuel C})^{-1}$. This mass balance is shown in Figure A2.1.

We can calculate dioxin emission factor by two methods: (1) from the measured fuel mass, measured dilution ratio, and measured volumetric dioxin concentration in the plume; or (2) from the dioxin and the total carbon masses in the smoke sample, and the dioxin and total carbon content in the background air. Both methods are possible in laboratory tests where all parameters can be measured directly. However, in the field,

neither fuel mass nor dilution ratio is measurable and the second method is the only option.

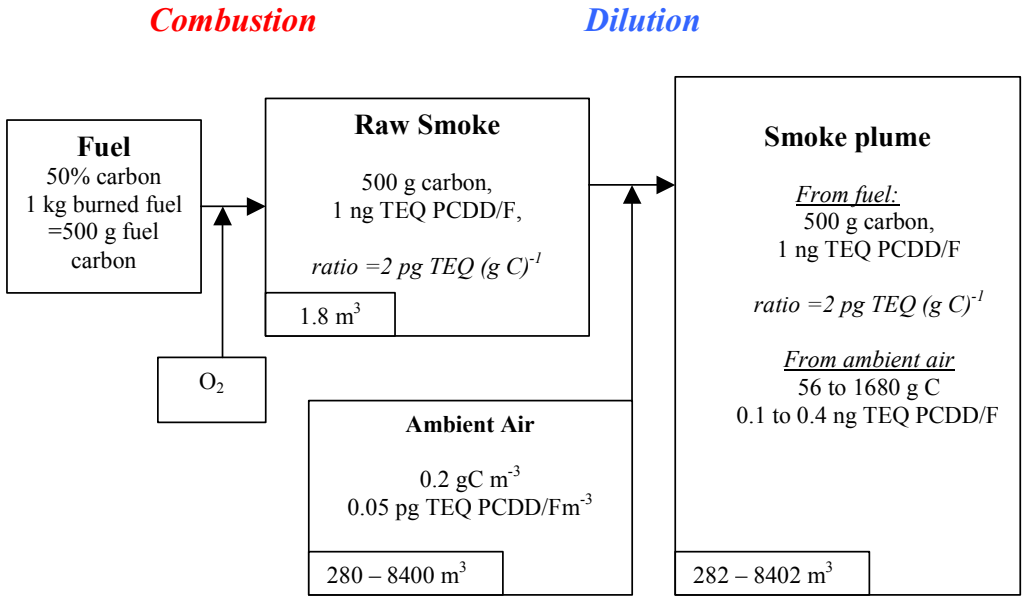


Figure A.2.1 Typical mass balance of PCDD/PCDF and total carbon from biomass combustion.

This approach can be formalised as follows.

$$E_i = EF_i \times Mass_{fuel} \qquad \text{Eq. A.2.1}$$

where E_i is the mass emission of species *i* (g), EF_i is the emission factor of species i and $Mass_{fuel}$ is the mass of fuel burned

For dioxins,

$$E_{PDCDD/F} = EF_{PCDD/F} \times Mass_{fuel}\,1 \qquad \text{Eq. A.2.2}$$

For carbon, because all fuel carbon burned is conserved, the emission factor is equal to the carbon content (CC), therefore,

$$E_C = CC \times Mass_{fuel} \qquad \text{Eq. A.2.3}$$

The concentration of dioxin in a smoke plume of volume V is

$$[PCDD/F]_{smoke} = [PCDD/F]_{amb} + E_{PCDD/F}/V \qquad \text{Eq. A.2.4}$$

and the concentration of total carbon in the smoke is

$$[C]_{smoke} = [C]_{amb} + E_C/V \qquad \text{Eq. A.2.5}$$

Dividing Eq. A.2.4 by Eq. A.2.5 and substituting for $E_{PCDD/PCDF}$ and E_C in Eq. A.2.2 and Eq. A.2.3 gives

$$EF_{PCCD/F} = \frac{1}{CC} \times \frac{[PCDD/F]_{smoke} - [PCDD/F]_{amb}}{\Delta[C]} \qquad \text{Eq. A.2.6}$$

where $\Delta[C] = [C]_{smoke} - [C]_{amb}$

The concentration of PCDD/PCDF in the smoke is the mass of the trapped sample divided by the volume of smoke sampled therefore equation 6 can be rewritten as

$$EF_{PCCD/F} = \frac{1}{CC} \times \frac{1}{\Delta C}\left[\frac{Mass_{PCDD/F}}{V} - [PCDD/F]_{amb}\right] \qquad \text{Eq. A.2.7}$$

Finally, we can define an emission ratio (ER) as the ratio of the emitted mass of the trace species to the total volatilised carbon, i.e.

$$ER_{PCCD/F} = \frac{E_{PCDD/F}}{E_C} = EF_{PCDD/F} \times CC \qquad \text{Eq. A.2.8}$$

This parameter can be determined directly from the smoke and ambient air samples without any knowledge of fuel properties.

While determining emission factors is a straightforward experimental problem it is not a trivial exercise. The measurement of total volatilised carbon usually requires four or five separate analytical procedures, and the measurement of fuel carbon content presents a moderate sampling challenge. Fortunately, there are a couple of practical features of biomass combustion in the field that simplify the measurement of emission factors with only minor loss of accuracy. These are:

1. Fuel carbon content has a small range (0.4 to 0.55) and is reasonably constant with fuel type. A good approximation for forest fuels is 0.5. Therefore, in most situations the emission factor can be equated to emission ratio* 0.5 with less than 10% error
2. Typically more than 85-95% of the volatilised fuel carbon is emitted as CO_2. Therefore, if CO_2-C is used as an approximation of total volatilised carbon, the emission factor will be over-estimated by between 5 and 20%.

In many cases these are acceptable errors when balanced against the complexity of the additional analyses required to measure CO, CH_4, total VOCs, total particulate carbon and fuel carbon content explicitly.

Appendix 3. Summary of dioxin and PCB concentrations

The detailed results of the measurement made during this study are reported in Tables A.3.1 to A.3.22.

Tables A.3.1 to A.3.6 report the raw data from the 40 samples of bushfire smoke, 7 fuel samples and 5 samples of ash and collected during the study. These data are the masses of dioxins, furans and PCBs (PCDD/PCDF/PCB) extracted from the smoke sample, the total volume of smoke that was sampled, and the additional mass of CO_2-carbon added to the air by the combustion processes in this sample volume. The tables present the individual masses of the 7 toxic 2,3,7,8-PCDD species and the10 toxic 2,3,7,8-PCDF species and the total mass of toxic and non-toxic species in each homologue group of PCDD and PCDF. Concentrations less than the limit of detection are report as "<LOD" where LOD is the numerical values of the limit of detection for the batch.

Table A.3.7 to A.3.10 present the PCDD/PCDF/PCB concentrations in the smoke samples (corrected for background) expressed relative to the mass of CO_2 carbon in the sample that was derived from combustion. Because most of the carbon emitted during combustion is present as CO_2, these are can be used emission ratios (mass of PCDD/PCDF/PCB species emitted per mass of fuel carbon burned, Eq. A2.8). These tables also present the total mass of 2,3,7,8-PCDD/PCDF, the total mass of the homologue groups and the proportion of 2,3,7,8-PCDD/PCDF contributing to the total homologue mass.

Tables A.3.11 to A.3.16 present the mass concentrations of 2,3,7,8-PCDD/PCDF weighted by the WHO_{98} TEFs. Because some samples had a significant proportion of non detects among the more toxic congeners which could have a significant impact on the total sample TEQ, the upper, middle and lower bounds for the totals are presented to indicate the maximum uncertainty range due to limits in analytical sensitivity. These bounds are defined as follows:

- Lower bound: non-detected species are assigned a concentration of 0
- Middle bound: non-detected species are assigned a concentration of 0.5 × LOD
- Upper bound: non-detected species are assigned a concentration equal to the LOD.

The limit of detection is determined from the laboratory blanks for each congener with each batch of analyses.

Tables A.3.17 to A.3.19 present the emission ratios and their analytical uncertainty bounds as pg TEQ $(g\ C)^{-1}$ for the total 2,3,7,8-PCDDs, PCDFs and PCBs and their sum.

Table A3.1 Masses, in picograms, of PCDD/PCDF from laboratory-burn samples.

Label	Lab. Straw 1	Lab. Straw 2	Lab. Straw 3	Lab. Straw 4	Lab. Straw 5	Lab. Straw 6	Lab. Straw 7	Lab Sorghum 1	Lab. Sorghum 2	Lab Sorghum 3
Vol (m^3)	49.5	50.4	42.0	35.8	20.3	23.9	13.9	17.7	30.6	31.9
CO_2-C (g)	20.7	24.4	23.7	17.6	48.4	54.8	68.1	20.7	16.9	23.9
Congener										
2,3,7,8-TCDD	100	150	58	37	160	150	66	86	<1	57
Total TCDD isomers	3430	4180	2600	1020	4320	3940	2000	1700	2.4	960
1,2,3,7,8-PeCDD	220	310	170	100	190	380	100	220	<2	87
Total PeCDD isomers	2760	3280	2480	1460	2990	4430	1580	2040	4.2	900
1,2,3,4,7,8-HxCDD	110	140	110	80	81	180	40	98	<1	42
1,2,3,6,7,8-HxCDD	130	140	120	93	130	240	77	100	<2	43
1,2,3,7,8,9-HxCDD	120	140	110	110	110	240	70	98	<2	52
Total HxCDD isomers	1550	1780	1500	1250	1550	2660	930	1090	<7	780
1,2,3,4,6,7,8-HpCDD	230	260	240	250	260	400	140	150	<8	120
Total HpCDD isomers	420	510	410	500	510	750	300	260	12	310
OCDD	240	340	210	260	780	350	200	180	80	290
2,3,7,8-TCDF	470	660	410	150	1070	790	600	410	<2	330
Total TCDF isomers	9730	14600	15600	3310	34400	20900	16600	7140	<8	5220
1,2,3,7,8-PeCDF	500	760	550	250	890	1040	590	580	<0.9	290
2,3,4,7,8-PeCDF	420	700	680	290	910	1080	500	720	<1	300
Total PeCDF isomers	4790	7640	6320	2970	11400	12600	6760	6520	<7	3220
1,2,3,4,7,8-HxCDF	410	650	630	360	600	890	330	600	<1	240
1,2,3,6,7,8-HxCDF	410	620	1130	390	940	920	350	1080	<2	250
2,3,4,6,7,8-HxCDF	210	320	750	310	430	480	150	680	<1	200
1,2,3,7,8,9-HxCDF	78	130	130	67	93	130	47	98	<1	41
Total HxCDF isomers	2820	4400	5520	2690	4850	5990	2310	5100	4.7	1830
1,2,3,4,6,7,8-HpCDF	490	590	1780	690	1130	1080	350	1440	5.9	290
1,2,3,4,7,8,9-HpCDF	180	210	330	220	150	250	65	200	<1	53
Total HpCDF isomers	970	1160	2630	1280	1520	1780	560	2010	<7	420
OCDF	180	160	310	93	160	270	65	250	19	55

Table A3.1 (continued).

Label	Lab. Cane 1	Lab. Cane 2	Lab. Cane 3	Lab Cane 4	Lab. Litter Vic1_1	Lab. Litter Vic1_2	Lab. Litter Vic1_3	Lab. Litter Vic2	Lab. Litter Qld	Lab. Ambient
Vol (m^3)	42.5	51.7	35.9	23.4	127	98.6	120	109	87.6	1172
CO_2-C (g)	16.7	20.8	21.1	13.1	36.0	36.2	52.4	36.7	40.8	
Congener										
2,3,7,8-TCDD	31	<10	26	<6	<5	<5	<4	11	<6	<8
Total TCDD isomers	710	130	550	130	560	630	580	1910	330	97
1,2,3,7,8-PeCDD	74	14	53	23	<6	8.1	6.6	24	4.5	15
Total PeCDD isomers	710	70	340	83	280	420	400	1350	170	110
1,2,3,4,7,8-HxCDD	38	6.8	18	3.4	8.8	12	11	35	3.7	25
1,2,3,6,7,8-HxCDD	41	13	30	25	10	12	11	28	<5	44
1,2,3,7,8,9-HxCDD	59	15	40	24	<20	12	14	33	<5	42
Total HxCDD isomers	560	150	360	230	380	530	580	1330	210	480
1,2,3,4,6,7,8-HpCDD	130	61	99	67	110	140	150	350	66	580
Total HpCDD isomers	300	160	260	210	290	380	430	1060	220	1030
OCDD	540	450	620	390	720	1020	1100	2080	780	1630
2,3,7,8-TCDF	160	93	140	34	39	32	34	59	9.9	54
Total TCDF isomers	3960	1820	3040	790	2850	1840	2040	2390	560	1950
1,2,3,7,8-PeCDF	160	48	100	19	34	21	20	25	5.5	42
2,3,4,7,8-PeCDF	220	59	110	13	22	21	18	18	4.9	61
Total PeCDF isomers	2130	580	1140	110	290	170	170	290	42	470
1,2,3,4,7,8-HxCDF	210	31	70	<5	9.6	9.6	8.3	<9	2	39
1,2,3,6,7,8-HxCDF	230	75	110	9.6	35	34	15	8.2	2.8	38
2,3,4,6,7,8-HxCDF	180	40	57	4.3	25	20	7.9	6	<0.9	32
1,2,3,7,8,9-HxCDF	33	6.4	12	<1	<3	4	<2	<0.7	<0.8	4.5
Total HxCDF isomers	1480	290	520	28	140	130	68	68	13	360
1,2,3,4,6,7,8-HpCDF	360	120	96	<10	64	64	19	14	<3	99
1,2,3,4,7,8,9-HpCDF	92	12	19	3.4	6.5	8.2	<3	<1	<1	11
Total HpCDF isomers	600	140	130	<20	76	78	26	15	<4	200
OCDF	120	42	49	5.7	41	19	40	11	2.7	41

Table A3.2 Masses, in picograms, of PCDD/PCDF from field burn samples.

Label	P. Field WA 1	P. Field WA 2	P. Field WA 3	P. Field WA 4	P. Field WA 5	W. Field Vic 1	W. Field Vic 2	P. Field Vic 1	P. Field Vic 2	P. Field Vic 3	P. Field Vic 4
Vol (m^3)	167	163	198	151	223	432	164	153	209	222	124
CO_2-C (g)	6.6	4.9	27.4	9.0	17.1	9.8	3.5	6.6	4.5	8.3	7.5
Congener											
2,3,7,8-TCDD	<0.5	<3	<3	<2	<3	<0.5	<0.4	<0.7	<1	<1	<2
Total TCDD isomers	780	34	600	150	940	47	100	420	320	1430	380
1,2,3,7,8-PeCDD	4.8	1.9	3.1	1.5	<2	<0.7	2.9	4.5	3	5.2	<2
Total PeCDD isomers	410	17	160	27	190	4.8	52	150	140	550	46
1,2,3,4,7,8-HxCDD	9.4	<1	4.3	1.8	4.1	1.6	2.7	4.1	3.9	13	2.7
1,2,3,6,7,8-HxCDD	11	1.8	5.7	3.6	6	<1	3.6	8.8	3.9	13	4.5
1,2,3,7,8,9-HxCDD	9	<2	<9	<1	<9	<6	<3	<5	3.3	18	<7
Total HxCDD isomers	430	74	160	70	200	76	100	160	170	640	95
1,2,3,4,6,7,8-HpCDD	89	24	42	21	41	22	32	74	47	130	35
Total HpCDD isomers	240	57	96	44	89	47	78	150	130	410	79
OCDD	570	170	320	130	220	<100	<200	<300	370	910	210
2,3,7,8-TCDF	1.2	3	4.9	<2	3	<0.6	<1	3	<6	10	7.5
Total TCDF isomers	340	47	490	270	620	23	60	460	300	1470	1020
1,2,3,7,8-PeCDF	<0.4	<2	<2	0.94	<1	<0.09	<2	<1	3.1	2.2	4.1
2,3,4,7,8-PeCDF	<0.5	1.3	1.6	0.92	<1	<0.4	<2	1.2	3.5	2.6	3
Total PeCDF isomers	9	4.4	6.5	5.6	5.2	<3	20	4.4	33	34	30
1,2,3,4,7,8-HxCDF	<2	<1	<0.7	<1	<0.7	<2	<2	<1	<0.6	<4	<2
1,2,3,6,7,8-HxCDF	<0.1	<0.5	<0.5	0.35	<0.7	<0.2	<1	<0.4	1.5	<2	1.2
2,3,4,6,7,8-HxCDF	<0.8	<0.7	<0.6	0.49	<1	<0.2	<0.9	<1	1.2	1.4	1.1
1,2,3,7,8,9-HxCDF	0.32	2	<0.6	1	<0.9	<0.3	<0.8	<0.6	<0.8	1.9	6.2
Total HxCDF isomers	7	4.9	<4	5	4.1	<7	14	3.7	4.5	18	12
1,2,3,4,6,7,8-HpCDF	<2	2.1	2	2	<3	<1	<4	<3	2.7	6.3	3.6
1,2,3,4,7,8,9-HpCDF	<0.3	<0.5	<0.8	<0.4	<2	<0.3	<0.8	<0.4	<1	<0.7	<0.8
Total HpCDF isomers	<4	7	<3	<3	<5	<4	<8	2.5	<4	8.7	4.4
OCDF	<5	4.6	5.5	<2	<5	<2	3	6	2.6	<5	4.1

Table A3.2 (continued).

Label	Field Cane 1	Field Cane 2	P. Field Qld 1	P. Field Qld 2	P. Field Qld 3	P. Field Qld 4	S. Field NT 1	S. Field NT 2	S. Field NT 3	S. Field NT 4	Field Amb 1
Vol (m^3)	61.9	12.2	108	49.0	83.0	137	91.0	71.4	70.2	98.9	898
CO_2-C (g)	9.6	3.1	17.2	17.7	18.9	14.8	6.9	11.9	8.3	19.4	
Congener											
2,3,7,8-TCDD	<1	<3	<5	<3	<5	<6	38	<3	<2	16	<1
Total TCDD isomers	29	13	430	240	1420	940	1060	28	120	480	13
1,2,3,7,8-PeCDD	5.9	3.7	16	16	38	11	74	<2	<4	57	1.7
Total PeCDD isomers	34	14	170	230	670	85	830	<10	<20	720	7.5
1,2,3,4,7,8-HxCDD	8.3	2.9	22	26	37	<10	38	<3	<1	45	<0.5
1,2,3,6,7,8-HxCDD	<10	6.4	24	34	57	25	48	<3	<1	73	<1
1,2,3,7,8,9-HxCDD	<4	<4	37	32	56	26	52	<6	2.3	110	<1
Total HxCDD isomers	140	52	550	630	940	440	630	25	<3	1250	2.7
1,2,3,4,6,7,8-HpCDD	170	150	380	470	420	340	280	62	22	750	23
Total HpCDD isomers	380	310	930	1190	1010	870	640	140	22	1880	48
OCDD	3500	2100	5230	8260	5170	5110	3880	1170	270	8470	200
2,3,7,8-TCDF	2.7	1.6	13	<4	27	25	250	3.6	<6	6.3	2.1
Total TCDF isomers	160	96	640	240	1160	730	4860	940	1540	300	39
1,2,3,7,8-PeCDF	<0.9	<2	6	<5	37	<6	210	<3	<1	6.3	<0.7
2,3,4,7,8-PeCDF	<1	<1	6	<5	37	10	220	<3	<0.9	6.8	<0.9
Total PeCDF isomers	3.9	4.1	61	<10	240	32	2150	<20	<7	58	2
1,2,3,4,7,8-HxCDF	1.1	<1	<7	<2	34	9	160	<2	<1	4.9	<0.7
1,2,3,6,7,8-HxCDF	<0.5	<0.8	5.4	<0.8	32	<3	260	<2	<1	4.8	<0.3
2,3,4,6,7,8-HxCDF	<0.7	0.7	3	<0.8	26	<4	160	<2	<2	5.4	<0.3
1,2,3,7,8,9-HxCDF	<0.2	<0.8	<1	<2	19	<3	35	<2	<0.7	2.5	<0.2
Total HxCDF isomers	4	8.9	25	<6	180	19	1270	<10	<8	29	2.7
1,2,3,4,6,7,8-HpCDF	<5	8.6	13	<2	41	<3	360	<5	<2	<10	<3
1,2,3,4,7,8,9-HpCDF	<0.5	1.9	<2	<1	18	<5	61	<4	<2	<0.6	<0.4
Total HpCDF isomers	<6	36	18	<3	72	<8	540	<9	<4	<10	<4
OCDF	10	72	<20	<20	51	<9	70	<7	10	6.5	5.4

Table A3.3 Concentrations, in picograms per gram sample, of PCDD/PCDF from unburnt-fuel and ash samples. Measurements <LOD calculated using half LOD.

Label Congener	Fuel Leaf 1	Fuel Sorghum	Fuel Straw 1	Fuel Straw 2	Fuel Cane	Fuel Leaf 2	Fuel NT 4	Ash Straw 1	Ash Cane	Ash Straw 2	Ash Leaf 2	Ash NT 4
2,3,7,8-TCDD	<0.03	<0.05	<0.1	<0.02	<0.05	<0.02	<0.04	1.1	0.43	<0.6	<0.2	0.91
Total TCDD isomers	0.19	<0.3	<0.7	<0.1	0.25	0.28	0.18	12	0.88	9.3	1.5	2.9
1,2,3,7,8-PeCDD	<0.04	<0.04	<0.2	<0.04	<0.2	<0.03	<0.04	<0.5	<0.3	<0.7	<0.8	<0.7
Total PeCDD isomers	<0.2	<0.2	<1	<0.2	<1	<0.2	<0.2	<3	<2	<10	<5	2.7
1,2,3,4,7,8-HxCDD	<0.03	<0.04	<0.3	<0.03	<0.07	<0.04	<0.05	<0.2	<0.1	<0.7	<0.2	1
1,2,3,6,7,8-HxCDD	<0.03	<0.03	<0.3	<0.03	0.18	<0.04	<0.05	0.54	<0.2	3.7	0.28	2.8
1,2,3,7,8,9-HxCDD	<0.03	<0.04	<0.3	<0.03	0.24	<0.03	<0.06	<0.1	<0.3	1.5	<0.1	1.6
Total HxCDD isomers	<0.1	<0.2	<1	<0.1	3.7	<0.2	0.61	7.7	1.2	33	2.8	31
1,2,3,4,6,7,8-HpCDD	<0.2	<0.08	<0.3	<0.1	1.7	<0.1	0.65	3.7	<2	24	2.5	30
Total HpCDD isomers	0.22	0.16	<0.3	0.13	4.9	0.3	2	9.7	2	45	8.5	69
OCDD	<3	<0.6	<2	<3	40	<2	29	15	9.1	56	24	450
2,3,7,8-TCDF	<0.08	<0.08	<0.04	<0.04	0.37	<0.05	0.048	3.4	5	9.6	0.86	0.69
Total TCDF isomers	0.37	0.12	<0.3	<0.3	1.7	0.21	<0.4	33	42	72	3.6	4.8
1,2,3,7,8-PeCDF	<0.03	<0.02	<0.08	<0.03	0.35	<0.02	<0.02	1.3	1.2	4.4	0.23	<0.3
2,3,4,7,8-PeCDF	<0.05	<0.03	<0.1	<0.02	0.22	<0.02	<0.03	0.95	1.2	3.8	<0.3	0.46
Total PeCDF isomers	0.15	<0.2	<0.6	<0.2	1.3	0.065	<0.2	7.3	6.2	8.2	0.75	2.9
1,2,3,4,7,8-HxCDF	<0.04	<0.02	<0.2	<0.03	<0.1	<0.01	<0.02	<0.6	<0.4	2.4	<0.2	<0.5
1,2,3,6,7,8-HxCDF	<0.02	<0.02	<0.2	<0.03	<0.08	<0.01	<0.03	0.5	0.51	3.9	<0.2	0.48
2,3,4,6,7,8-HxCDF	<0.02	<0.009	<0.2	<0.02	<0.05	<0.01	<0.03	0.26	0.49	2	<0.09	0.5
1,2,3,7,8,9-HxCDF	<0.03	<0.02	<0.3	<0.02	<0.03	<0.02	<0.02	<0.1	0.13	<0.7	<0.05	0.17
Total HxCDF isomers	<0.2	<0.1	<1	<0.2	0.42	<0.1	<0.2	2.9	1.5	11	0.6	2.5
1,2,3,4,6,7,8-HpCDF	<0.05	<0.05	<0.1	<0.04	<0.2	<0.03	<0.06	<0.4	0.95	5	<0.3	<2
1,2,3,4,7,8,9-HpCDF	<0.06	<0.04	<0.2	<0.03	<0.05	<0.03	<0.06	<0.2	<0.2	1.2	<0.07	0.4
Total HpCDF isomers	<0.2	<0.1	<0.6	<0.07	<0.5	<0.06	<0.1	<0.6	<2	7.1	<0.4	<3
OCDF	<0.05	<0.05	<1	<0.05	0.12	<0.04	<0.04	0.38	<1	2.1	<0.2	1
Total PCDD/PCDF	2.8	1.2	4.3	2.2	53.1	2.2	32.4	89.8	65.4	249	44.6	568

Table A3.4 Masses, in picograms, of PCBs from laboratory-burn samples.

Label	Lab. Straw 1	Lab. Straw 2	Lab. Straw 3	Lab. Straw 4	Lab. Straw 5	Lab. Straw 6	Lab. Straw 7	Lab Sorghum 1	Lab. Sorghum 2	Lab Sorghum 3
Vol (m^3)	49.5	50.4	42.0	35.8	20.3	23.9	13.9	17.7	30.6	31.9
CO_2-C (g)	20.7	24.4	23.7	17.6	48.4	54.8	68.1	8.9	16.9	23.9
Congener										
PCB 77	360	810	440	99	2840	1470	620	240	<30	250
PCB 81	31	56	100	15	210	77	50	46	7	29
PCB 126	37	70	140	19	290	110	92	100	<2	37
PCB 169	<7	<9	72	<3	75	21	17	65	<1	<3
PCB 105	1570	3160	1670	310	6590	1560	980	640	360	410
PCB 114	<90	250	220	27	600	130	82	100	<20	47
PCB 118	4720	9650	4000	880	17800	4070	2480	1830	1330	1350
PCB 123	200	530	120	33	1140	220	120	120	<40	<50
PCB 156	320	740	680	70	1500	390	300	270	100	130
PCB 157	<30	160	440	30	660	140	94	140	41	11
PCB 167	1070	1370	800	45	<600	<200	<100	150	190	<30
PCB 189	34	<40	500	<10	530	140	78	470	<4	75

Table A3.4 (continued).

Label	Lab. Cane 1	Lab. Cane 2	Lab. Cane 3	Lab Cane 4	Lab. Litter Vic1_1	Lab. Litter Vic1_2	Lab. Litter Vic1_3	Lab. Litter Vic2	Lab. Litter Qld	Lab. Ambient
Vol (m^3)	42.5	51.7	35.9	23.4	127	98.6	120	109	87.6	1172
CO_2-C (g)	16.7	20.8	21.1	13.1	36.0	36.2	52.4	36.7	40.8	
Congener										
PCB 77	170	170	170	140	360	440	320	390	150	310
PCB 81	25	23	23	13	41	29	29	29	7.5	35
PCB 126	37	30	36	8.3	37	31	34	35	11	21
PCB 169	10	<9	10	<3	<5	<3	<2	<2	<1	<3
PCB 105	520	760	620	530	1220	1200	1180	1860	1150	1390
PCB 114	74	71	73	39	<70	110	150	150	56	120
PCB 118	1680	2670	1610	1360	4040	3420	3280	4350	2510	4460
PCB 123	83	100	81	<80	170	78	140	190	56	210
PCB 156	170	210	170	<100	290	270	280	330	230	670
PCB 157	57	89	72	<30	<70	<30	<60	55	25	140
PCB 167	<40	<200	44	<80	370	<100	<100	<200	<100	<100
PCB 189	53	65	96	<20	<60	<8	60	22	<9	69

Table A3.5 Masses, in picograms, of PCBs from field-burn samples.

Label	P. Field	P. Field	P. Field	P. Field	P. Field	W. Field	W. Field	P. Field	P. Field	P. Field	P. Field
	WA 1	WA 2	WA 3	WA 4	WA 5	Vic 1	Vic 2	Vic 1	Vic 2	Vic 3	Vic 4
Vol (m^3)	167	163	198	151	223	432	164	153	209	222	124
CO_2-C (g)	6.6	4.9	27.4	17.1	9.0	9.8	3.5	6.6	4.5	8.3	7.5
Congener											
PCB 77	100	<30	100	87	93	160	120	60	210	140	130
PCB 81	3.4	<5	6.3	4.2	4.7	8.2	6.7	2.8	15	7.9	6.5
PCB 126	8.9	<2	6	5.7	5.6	<3	<6	4.8	8.2	11	8.6
PCB 169	<2	<1	<0.7	<0.5	<1	<0.9	<1	<0.3	<2	<4	<0.9
PCB 105	1700	<500	2940	4000	3170	1400	880	560	1090	650	1700
PCB 114	<100	<30	160	200	180	<100	56	<60	110	<40	<90
PCB 118	3700	<1000	6330	7590	6580	3000	2000	1400	2390	1570	3530
PCB 123	120	<40	99	140	140	<90	<70	<50	54	51	58
PCB 156	650	<200	350	420	300	<300	210	<100	180	130	230
PCB 157	130	39	91	86	<60	63	<40	26	<40	<20	<40
PCB 167	<600	<50	<200	<300	<300	<300	<200	<100	260	<300	<200
PCB 189	<30	<8	<7	13	<5	<6	<4	4.9	<20	<5	<7

Table 3.5 (continued).

Label	Field Cane 1	Field Cane 2	P. Field Qld 1	P. Field Qld 2	P. Field Qld 3	P. Field Qld 4	S. Field NT 1	S. Field NT 2	S. Field NT 3	S. Field NT 4	Field Amb. 1
Vol (m^3)	61.9	12.2	108	49.0	83.0	137	91.0	71.4	70.2	98.9	898
CO_2-C (g)	9.6	3.1	17.2	17.7	18.9	14.8	6.9	11.9	8.3	19.4	
Congener											
PCB 77	63	110	350	85	250	170	150	41	76	180	190
PCB 81	<3	2.6	15	6	29	<9	19	<3	<3	9.1	8.6
PCB 126	<5	<1	35	11	57	<20	33	<2	<3	14	9.3
PCB 169	<0.5	<0.2	<1	<3	21	<8	16	<2	<0.5	<1	<0.7
PCB 105	610	630	1610	400	860	910	420	410	660	2480	2140
PCB 114	<70	42	98	<20	31	<40	34	49	42	130	120
PCB 118	1400	1500	3930	1070	1760	2230	1140	1330	1360	4800	4550
PCB 123	<90	<50	120	<40	<40	77	49	<70	45	170	130
PCB 156	<100	<100	470	140	230	150	130	100	190	370	280
PCB 157	<20	<40	110	31	64	63	<40	<40	45	<60	<60
PCB 167	120	<60	<400	<60	<80	<100	<10	<80	<40	690	<200
PCB 189	<5	<3	27	15	36	<8	100	<10	7.9	<10	<10

Table A3.6 Concentrations, in picograms per gram sample, of PCBs from unburnt-fuel and ash. Measurements <LOD calculated using half LOD.

Label Congener	Fuel Leaf 1	Fuel Sorghum	Fuel Straw 1	Fuel Straw 2	Fuel Cane	Fuel Leaf 2	Fuel NT 4	Ash Straw 1	Ash Cane	Ash Straw 2	Ash Leaf 2	Ash NT 4
PCB 77	7.3	6.9	4.3	6.6	8.8	3.2	7.8	24	28	14	9.6	26
PCB 81	0.33	0.36	0.22	0.38	0.57	<0.2	0.37	<5	<3	<4	<1	4.7
PCB 126	0.66	<0.07	<0.2	0.19	0.26	<0.1	<0.3	3.6	<3	<3	<0.9	4.5
PCB 169	<0.03	<0.01	<0.1	<0.02	<0.04	<0.03	<0.04	<0.6	<0.7	<0.9	<0.4	1.6
PCB 105	27	67	19	26	56	10	29	<50	51	<30	<20	<40
PCB 114	<1	4.4	<2	2.2	<5	0.88	2.3	3.7	5.3	<2	<3	3.8
PCB 118	63	160	56	66	150	28	73	<100	150	<70	<50	<90
PCB 123	<2	4.2	<2	2.2	<3	<0.9	<2	<5	7.7	<5	<6	5.4
PCB 156	6.6	17	4.2	5	13	<2	4.9	<10	<10	<6	<6	<10
PCB 157	0.81	2.6	<0.7	1.1	2.3	<0.6	<1	3.7	4.1	<2	<2	5
PCB 167	<4	<10	2.9	<3	<10	<2	<3	<6	<7	<4	<3	<7
PCB 189	<0.3	<0.3	<0.4	<0.6	<0.9	<0.8	<0.8	0.9	<0.4	<1	<0.6	1.2
Total PCBs, 0.5 LOD,	109	268	89.3	111	240	45.4	121	124	258	78.0	56.1	126
Total PCBs, 1 LOD	113	273	92.0	113	250	48.7	125	213	270	142	103	199
Total PCBs, 0 LOD	106	262	86.6	110	231	42.1	117	35.9	246	14.0	9.6	52.2

Table A3.7 Emission ratios, in picograms per gram carbon, for PCDD/PCDF from laboratory-burn samples. Measurements <LOD calculated using half LOD.

Label Congener	Lab. Straw 1	Lab. Straw 2	Lab. Straw 3	Lab. Straw 4	Lab. Straw 5	Lab. Straw 6	Lab. Straw 7	Lab Sorghum 1	Lab Sorghum 3
2,3,7,8-TCDD	4.8	6.1	2.4	2.1	3.3	2.7	1.0	4.2	2.4
Total TCDD isomers	165.7	171.1	109.5	57.7	89.1	71.9	29.3	82.2	40.1
1,2,3,7,8-PeCDD	10.6	12.7	7.1	5.6	3.9	6.9	1.5	10.6	3.6
Total PeCDD isomers	133.3	134.2	104.4	82.6	61.7	80.8	23.2	98.7	37.5
1,2,3,4,7,8-HxCDD	5.3	5.7	4.6	4.5	1.7	3.3	0.6	4.7	1.7
1,2,3,6,7,8-HxCDD	6.2	5.7	5.0	5.2	2.7	4.4	1.1	4.8	1.7
1,2,3,7,8,9-HxCDD	5.7	5.7	4.6	6.2	2.3	4.4	1.0	4.7	2.1
Total HxCDD isomers	74.0	72.1	62.5	70.1	31.8	48.4	13.6	52.4	32.1
1,2,3,4,6,7,8-HpCDD	9.9	9.6	9.2	13.2	5.2	7.1	2.0	6.8	4.4
Total HpCDD isomers	18.2	19.1	15.7	26.6	10.2	13.3	4.2	11.8	11.8
OCDD	8.3	11.1	6.4	11.9	15.5	5.8	2.7	7.5	10.3
2,3,7,8-TCDF	22.6	26.9	17.2	8.4	22.1	14.4	8.8	19.8	13.7
Total TCDF isomers	466.6	594.8	655.0	184.4	709.4	380.8	243.3	344.2	216.2
1,2,3,7,8-PeCDF	24.1	31.1	23.1	14.1	18.4	19.0	8.7	28.0	12.1
2,3,4,7,8-PeCDF	20.2	28.6	28.6	16.3	18.8	19.7	7.3	34.8	12.5
Total PeCDF isomers	230.7	312.2	265.8	167.7	235.1	229.9	99.2	315.2	134.2
1,2,3,4,7,8-HxCDF	19.8	26.6	26.5	20.4	12.4	16.2	4.8	29.0	10.0
1,2,3,6,7,8-HxCDF	19.8	25.3	47.6	22.1	19.4	16.8	5.1	52.2	10.4
2,3,4,6,7,8-HxCDF	10.1	13.1	31.6	17.5	8.9	8.8	2.2	32.9	8.3
1,2,3,7,8,9-HxCDF	3.8	5.3	5.5	3.8	1.9	2.4	0.7	4.7	1.7
Total HxCDF isomers	135.7	179.6	232.3	152.0	100.0	109.2	33.8	246.6	76.2
1,2,3,4,6,7,8-HpCDF	23.5	24.0	74.9	39.0	23.3	19.7	5.1	69.6	12.0
1,2,3,4,7,8,9-HpCDF	8.7	8.6	13.9	12.5	3.1	4.6	1.0	9.7	2.2
Total HpCDF isomers	46.5	47.2	110.6	72.3	31.3	32.4	8.2	97.1	17.3
OCDF	8.6	6.5	13.0	5.2	3.3	4.9	0.9	12.1	2.3
Total 2,3,7,8-PCDD/PCDF	211.9	252.4	321.3	208.0	165.9	160.9	54.4	336.3	111.5
Total PCDD/PCDF	1287.6	1547.8	1575.3	830.5	1287.4	977.4	458.4	1267.8	577.9
Percent PCDD	31%	26%	19%	30%	16%	23%	16%	20%	23%

Table A3.7 (continued).

Label Congener	Lab. Cane 1	Lab. Cane 2	Lab. Cane 3	Lab Cane 4	Lab. Litter Vic1_1	Lab. Litter Vic1_2	Lab. Litter Vic1_3	Lab. Litter Vic2	Lab. Litter Qld
2,3,7,8-TCDD	1.8	0.2	1.2	0.2	0.1	0.1	0.0	0.3	0.1
Total TCDD isomers	42.2	6.0	26.0	9.8	15.2	17.2	10.9	51.8	7.9
1,2,3,7,8-PeCDD	4.4	0.6	2.5	1.7	0.0	0.2	0.1	0.6	0.1
Total PeCDD isomers	42.2	3.1	16.0	6.2	7.4	11.3	7.4	36.5	4.0
1,2,3,4,7,8-HxCDD	2.2	0.3	0.8	0.2	0.2	0.3	0.2	0.9	0.0
1,2,3,6,7,8-HxCDD	2.4	0.5	1.4	1.8	0.1	0.2	0.1	0.7	0.0
1,2,3,7,8,9-HxCDD	3.4	0.6	1.8	1.8	0.2	0.2	0.2	0.8	0.0
Total HxCDD isomers	32.4	6.2	16.4	16.8	9.1	13.5	10.1	35.0	4.3
1,2,3,4,6,7,8-HpCDD	6.5	1.7	3.9	4.2	1.3	2.5	1.7	8.1	0.6
Total HpCDD isomers	15.7	5.5	10.8	14.5	4.9	8.1	6.2	26.3	3.5
OCDD	28.7	18.2	27.1	27.3	15.1	24.4	17.8	52.6	16.1
2,3,7,8-TCDF	9.4	4.4	6.6	2.5	0.9	0.8	0.5	1.5	0.1
Total TCDF isomers	232.4	83.3	141.5	57.3	73.2	46.3	35.1	60.2	10.2
1,2,3,7,8-PeCDF	9.5	2.2	4.7	1.4	0.8	0.5	0.3	0.6	0.1
2,3,4,7,8-PeCDF	13.0	2.7	5.1	0.9	0.4	0.4	0.2	0.3	0.0
Total PeCDF isomers	126.2	26.9	53.4	7.7	6.6	3.6	2.3	6.7	0.2
1,2,3,4,7,8-HxCDF	12.5	1.4	3.3	0.1	0.1	0.2	0.1	0.0	0.0
1,2,3,6,7,8-HxCDF	13.7	3.5	5.2	0.7	0.9	0.9	0.2	0.1	0.0
2,3,4,6,7,8-HxCDF	10.7	1.9	2.7	0.3	0.6	0.5	0.1	0.1	0.0
1,2,3,7,8,9-HxCDF	2.0	0.3	0.6	0.0	0.0	0.1	0.0	0.0	0.0
Total HxCDF isomers	87.6	13.2	24.2	1.6	2.8	2.8	0.6	0.9	0.0
1,2,3,4,6,7,8-HpCDF	21.3	5.6	4.4	0.2	1.5	1.5	0.2	0.1	0.0
1,2,3,4,7,8,9-HpCDF	5.5	0.6	0.9	0.2	0.1	0.2	0.0	0.0	0.0
Total HpCDF isomers	35.4	6.3	5.9	0.5	1.5	1.7	0.1	0.0	0.0
OCDF	7.1	1.9	2.3	0.4	1.0	0.4	0.7	0.2	0.0
Total 2,3,7,8-PCDD/PCDF	154.0	46.6	74.3	44.0	23.4	33.3	22.4	66.8	17.1
Total PCDD/PCDF,	650.0	170.5	323.5	141.9	137.0	129.2	91.2	270.3	46.1
Percent PCDD	25%	23%	30%	52%	38%	58%	57%	75%	78%

Table A3.8 Emission ratios, in picograms per gram carbon, for PCDD/PCDF from field-burn samples. Measurements <LOD calculated using half LOD.

Label Congener	P. Field WA 1	P. Field WA 2	P. Field WA 3	P. Field WA 4	P. Field WA 5	W. Field Vic 1	W. Field Vic 2	P. Field Vic 1	P. Field Vic 2	P. Field Vic 3	P. Field Vic 4
2,3,7,8-TCDD	0.0	0.3	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1
Total TCDD isomers	117.2	6.8	21.8	16.5	55.0	4.8	28.6	63.5	71.3	171.7	50.8
1,2,3,7,8-PeCDD	0.7	0.4	0.1	0.2	0.1	0.0	0.8	0.7	0.7	0.6	0.1
Total PeCDD isomers	61.6	3.4	5.8	3.0	11.1	0.5	14.9	22.7	31.2	66.0	6.1
1,2,3,4,7,8-HxCDD	1.4	0.1	0.2	0.2	0.2	0.2	0.8	0.6	0.9	1.6	0.4
1,2,3,6,7,8-HxCDD	1.6	0.4	0.2	0.4	0.3	0.0	1.0	1.3	0.9	1.6	0.6
1,2,3,7,8,9-HxCDD	1.3	0.2	0.2	0.1	0.3	0.3	0.4	0.4	0.7	2.2	0.5
Total HxCDD isomers	64.5	15.0	5.8	7.6	11.6	7.6	28.4	24.1	37.7	76.7	12.6
1,2,3,4,6,7,8-HpCDD	13.3	4.8	1.5	2.2	2.4	2.1	9.1	11.1	10.4	15.6	4.6
Total HpCDD isomers	35.8	11.2	3.4	4.6	5.1	4.4	22.0	22.5	28.6	49.0	10.4
OCDD	85.1	34.0	11.5	13.8	12.7	3.1	26.5	21.7	80.4	108.1	27.3
2,3,7,8-TCDF	0.1	0.5	0.2	0.0	0.2	0.0	0.1	0.5	0.7	1.2	1.0
Total TCDF isomers	50.2	8.4	17.6	29.1	36.0	2.1	17.0	69.5	66.7	176.4	136.3
1,2,3,7,8-PeCDF	0.0	0.2	0.0	0.1	0.0	0.0	0.3	0.1	0.7	0.3	0.5
2,3,4,7,8-PeCDF	0.0	0.2	0.0	0.1	0.0	0.0	0.3	0.2	0.8	0.3	0.4
Total PeCDF isomers	1.1	0.6	0.2	0.4	0.2	0.1	5.7	0.6	7.3	4.1	4.0
1,2,3,4,7,8-HxCDF	0.1	0.1	0.0	0.0	0.0	0.1	0.3	0.1	0.1	0.2	0.1
1,2,3,6,7,8-HxCDF	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3	0.1	0.2
2,3,4,6,7,8-HxCDF	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.2	0.1
1,2,3,7,8,9-HxCDF	0.0	0.4	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.2	0.8
Total HxCDF isomers	1.0	0.9	0.0	0.5	0.2	0.3	4.0	0.5	1.0	2.1	1.6
1,2,3,4,6,7,8-HpCDF	0.1	0.4	0.1	0.2	0.1	0.0	0.5	0.2	0.6	0.7	0.5
1,2,3,4,7,8,9-HpCDF	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1
Total HpCDF isomers	0.3	1.4	0.0	0.1	0.1	0.1	1.1	0.3	0.4	1.0	0.6
OCDF	0.3	0.9	0.2	0.1	0.1	0.1	0.8	0.9	0.6	0.3	0.5
Total 2,3,7,8-PCDD/PCDF	104.4	42.9	14.2	17.6	16.5	6.1	41.5	37.9	98.1	133.2	37.9
Total PCDD/PCDF,	417.1	82.5	66.4	75.6	132.1	23.1	148.9	226.4	325.3	655.5	250.4
Percent PCDD	87%	85%	73%	60%	72%	88%	81%	68%	77%	72%	43%

Table A3.8 (continued).

Label Congener	Field Cane 1	Field Cane 2	P. Field Qld 1	P. Field Qld 2	P. Field Qld 3	P. Field Qld 4	S. Field NT 1	S. Field NT 2	S. Field NT 3	S. Field NT 4
2,3,7,8-TCDD	0.0	0.5	0.2	0.1	0.1	0.1	5.5	0.1	0.1	0.8
Total TCDD isomers	3.0	4.1	36.3	13.6	75.2	63.4	153.1	2.3	14.4	24.7
1,2,3,7,8-PeCDD	0.6	1.2	1.3	0.9	2.0	0.7	10.7	0.1	0.2	2.9
Total PeCDD isomers	3.5	4.5	14.4	13.0	35.5	5.7	119.9	0.4	1.2	37.1
1,2,3,4,7,8-HxCDD	0.9	0.9	1.9	1.5	2.0	0.3	5.5	0.1	0.1	2.3
1,2,3,6,7,8-HxCDD	0.5	2.0	2.0	1.9	3.0	1.7	6.9	0.1	0.1	3.8
1,2,3,7,8,9-HxCDD	0.2	0.6	3.1	1.8	2.9	1.7	7.5	0.2	0.3	5.7
Total HxCDD isomers	14.5	16.6	46.4	35.6	49.8	29.6	90.8	2.0	0.0	64.4
1,2,3,4,6,7,8-HpCDD	17.7	47.9	32.1	26.6	22.2	22.9	40.3	5.1	2.5	38.5
Total HpCDD isomers	39.3	98.9	78.2	67.2	53.3	58.3	92.1	11.6	2.4	96.6
OCDD	364.7	671.3	441.7	467.0	273.8	344.5	558.2	97.4	30.9	435.3
2,3,7,8-TCDF	0.2	0.5	1.0	0.1	1.4	1.6	35.6	0.0	0.0	0.3
Total TCDF isomers	16.5	30.6	53.9	13.5	61.4	49.1	700.3	78.3	184.5	15.2
1,2,3,7,8-PeCDF	0.0	0.3	0.5	0.1	2.0	0.2	30.3	0.1	0.1	0.3
2,3,4,7,8-PeCDF	0.0	0.1	0.5	0.1	1.9	0.6	31.8	0.1	0.0	0.3
Total PeCDF isomers	0.4	1.3	5.1	0.3	12.7	2.1	310.6	0.8	0.3	3.0
1,2,3,4,7,8-HxCDF	0.1	0.2	0.3	0.1	1.8	0.6	23.1	0.1	0.1	0.3
1,2,3,6,7,8-HxCDF	0.0	0.1	0.5	0.0	1.7	0.1	37.6	0.1	0.1	0.2
2,3,4,6,7,8-HxCDF	0.0	0.2	0.3	0.0	1.4	0.1	23.1	0.1	0.1	0.3
1,2,3,7,8,9-HxCDF	0.0	0.1	0.0	0.1	1.0	0.1	5.1	0.1	0.0	0.1
Total HxCDF isomers	0.4	2.8	2.1	0.2	9.5	1.3	183.5	0.4	0.4	1.5
1,2,3,4,6,7,8-HpCDF	0.3	2.7	1.1	0.1	2.2	0.1	52.0	0.2	0.1	0.2
1,2,3,4,7,8,9-HpCDF	0.0	0.6	0.1	0.0	1.0	0.2	8.8	0.2	0.1	0.0
Total HpCDF isomers	0.3	11.5	1.5	0.1	3.8	0.3	78.0	0.4	0.2	0.2
OCDF	0.9	22.9	0.6	0.5	2.6	0.0	10.1	0.3	1.2	0.3
Total 2,3,7,8-PCDD/PCDF	386.2	752.2	487.0	500.7	322.9	375.6	892.0	104.5	36.0	491.8
Total PCDD/PCDF,	**443.6**	**864.6**	**680.2**	**610.8**	**577.6**	**554.2**	**2296.5**	**193.8**	**235.5**	**678.3**
Percent PCDD	96%	92%	91%	98%	84%	90%	44%	59%	21%	97%

Table A3.9 Emission ratios, in picograms per gram carbon, for PCBs from laboratory-burn samples. Measurements <LOD calculated using half LOD.

Label Congener	Lab. Straw 1	Lab. Straw 2	Lab. Straw 3	Lab. Straw 4	Lab. Straw 5	Lab. Straw 6	Lab. Straw 7	Lab. Sorghum 1	Lab. Sorghum 3
PCB 77	16.8	32.6	18.1	5.1	58.5	26.7	9.0	11.4	10.1
PCB 81	1.4	2.2	4.2	0.8	4.3	1.4	0.7	2.2	1.2
PCB 126	1.7	2.8	5.9	1.0	6.0	2.0	1.3	4.8	1.5
PCB 169	0.2	0.2	3.0	0.1	1.5	0.4	0.2	3.1	0.1
PCB 105	73.1	127.0	68.3	15.2	135.5	28.0	14.1	30.0	15.6
PCB 114	1.9	10.0	9.1	1.3	12.3	2.3	1.2	4.8	1.8
PCB 118	219.2	387.5	162.0	42.2	365.8	72.6	35.6	85.3	51.4
PCB 123	9.2	21.3	4.7	1.5	23.5	3.9	1.7	5.7	0.8
PCB 156	14.1	29.1	27.7	2.8	30.7	6.9	4.3	12.6	4.7
PCB 157	0.4	6.3	18.3	1.5	13.6	2.5	1.4	6.7	0.3
PCB 167	51.7	56.0	33.7	2.5	6.2	1.8	0.7	7.2	0.6
PCB 189	1.5	0.7	21.0	0.2	10.9	2.5	1.1	22.7	3.1
Total PCBs	391.3	676.0	375.9	74.1	668.9	151.1	71.6	196.4	91.1

Table A3.9 (continued). Measurements <LOD calculated using half LOD.

Label Congener	Lab. Cane 1	Lab. Cane 2	Lab. Cane 3	Lab. Cane 4	Lab. Litter Vic1_1	Lab. Litter Vic1_2	Lab. Litter Vic1_3	Lab. Litter Vic2	Lab. Litter Qld
PCB 77	9.5	7.5	7.6	10.2	9.1	11.4	5.5	9.8	3.1
PCB 81	1.4	1.0	1.0	0.9	1.0	0.7	0.5	0.7	0.1
PCB 126	2.2	1.4	1.7	0.6	1.0	0.8	0.6	0.9	0.2
PCB 169	0.6	0.2	0.5	0.1	0.1	0.0	0.0	0.0	0.0
PCB 105	28.1	33.6	27.4	38.3	29.7	29.9	19.8	47.2	25.6
PCB 114	4.2	3.2	3.3	2.8	0.6	2.8	2.6	3.8	1.2
PCB 118	90.7	118.8	69.9	97.0	98.7	84.1	53.9	107.3	53.3
PCB 123	4.5	4.4	3.5	2.7	4.1	1.7	2.3	4.6	1.0
PCB 156	8.7	8.7	7.1	2.8	6.0	5.9	4.0	7.3	4.4
PCB 157	3.1	4.0	3.2	0.9	0.6	0.1	0.3	1.1	0.4
PCB 167	1.1	4.7	2.0	3.0	10.1	1.3	0.9	2.6	1.1
PCB 189	3.0	3.0	4.5	0.7	0.6	0.0	1.0	0.4	0.0
Total PCBs	157.0	190.3	131.8	160.0	161.5	138.6	91.3	185.8	90.5

Table A3.10 Emission ratios, in picograms per gram carbon, for PCBs from field-burn samples. Measurements <LOD calculated using half LOD.

Label	P. Field WA 1	P. Field WA 2	P. Field WA 3	P. Field WA 4	P. Field WA 5	W. Field Vic 1	W. Field Vic 2	P. Field Vic 1	P. Field Vic 2	P. Field Vic 3	P. Field Vic 4
Congener											
PCB 77	13.5	1.1	3.2	8.2	4.9	13.4	31.3	7.6	43.9	15.1	16.3
PCB 81	0.4	0.4	0.2	0.4	0.2	0.7	1.7	0.3	3.2	0.8	0.8
PCB 126	1.3	0.1	0.2	0.6	0.3	0.1	0.8	0.7	1.8	1.3	1.1
PCB 169	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.2	0.1
PCB 105	247.0	39.6	104.7	435.8	182.4	123.9	232.3	75.0	223.6	66.9	220.4
PCB 114	6.9	2.3	5.7	21.6	10.3	3.7	14.5	3.8	23.0	1.6	5.5
PCB 118	534.0	72.5	224.4	821.0	377.1	260.7	525.2	188.4	486.0	161.6	455.3
PCB 123	17.3	3.2	3.4	14.9	7.9	3.2	8.5	3.1	10.6	5.3	7.2
PCB 156	96.6	18.9	12.4	45.5	17.1	12.9	57.6	6.3	37.7	14.2	29.9
PCB 157	19.3	7.7	3.3	9.3	1.7	6.0	5.3	3.7	4.0	1.0	2.5
PCB 167	44.0	3.6	3.3	15.5	8.4	12.6	25.8	6.2	55.2	16.4	12.4
PCB 189	2.2	0.8	0.1	1.4	0.1	0.2	0.5	0.7	2.2	0.3	0.4
Total PCBs	982.7	150.1	361.0	1374.2	610.6	437.5	903.8	295.8	891.2	284.6	752.0

Table A3.10 (continued). Measurements <LOD calculated using half LOD.

Label Congener	Field Cane 1	Field Cane 2	P. Field Qld 1	P. Field Qld 2	P. Field Qld 3	P. Field Qld 4	S. Field NT 1	S. Field NT 2	S. Field NT 3	S. Field NT 4
PCB 77	6.4	35.0	29.3	4.7	13.1	11.2	20.7	3.0	8.5	8.2
PCB 81	0.1	0.8	1.2	0.3	1.5	0.3	2.7	0.1	0.1	0.4
PCB 126	0.2	0.1	2.9	0.6	3.0	0.6	4.7	0.1	0.2	0.7
PCB 169	-0.6	-0.4	-0.9	-0.3	0.2	-0.9	2.3	0.1	0.0	0.0
PCB 105	61.2	200.0	132.7	21.6	43.9	57.9	55.0	31.9	75.9	115.6
PCB 114	0.5	11.6	4.0	-0.3	-0.4	-0.9	4.6	4.0	4.8	6.0
PCB 118	141.0	476.6	325.4	58.4	89.9	143.4	150.3	105.4	154.8	221.5
PCB 123	4.3	7.7	9.6	1.0	0.8	4.6	6.7	2.8	5.2	8.0
PCB 156	4.8	15.7	39.1	7.7	11.9	9.5	18.1	8.1	22.5	17.5
PCB 157	0.7	6.2	8.8	1.6	3.1	3.7	2.7	1.6	5.3	1.4
PCB 167	12.2	9.4	16.4	1.6	1.9	2.9	0.4	3.2	2.2	35.0
PCB 189	-0.1	0.2	1.7	0.7	1.6	-0.3	14.4	0.4	0.9	0.2
Total PCBs	230.6	763.0	570.3	97.5	170.5	231.9	282.5	160.7	280.5	414.5

Table A3.11 Toxic equivalent emission ratios, in picograms per gram carbon, for PCDD/PCDF from laboratory-burn samples. Measurements <LOD calculated using half LOD.

Congener	Toxic equivalent factors	Lab. Straw 1	Lab. Straw 2	Lab. Straw 3	Lab. Straw 4	Lab. Straw 5	Lab. Straw 6	Lab. Straw 7	Lab. Sorghum 1	Lab. Sorghum 3
2,3,7,8-TCDD	1	4.83	6.14	2.44	2.09	3.30	2.74	0.97	4.16	2.38
1,2,3,7,8-PeCDD	1	10.61	12.68	7.15	5.65	3.92	6.93	1.47	10.64	3.62
1,2,3,4,7,8-HxCDD	0.1	0.53	0.57	0.46	0.45	0.17	0.33	0.06	0.47	0.17
1,2,3,6,7,8-HxCDD	0.1	0.62	0.57	0.50	0.52	0.27	0.44	0.11	0.48	0.17
1,2,3,7,8,9-HxCDD	0.1	0.57	0.57	0.46	0.62	0.23	0.44	0.10	0.47	0.21
1,2,3,4,6,7,8-HpCDD	0.01	0.10	0.10	0.09	0.13	0.05	0.07	0.02	0.07	0.04
OCDD	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,3,7,8-TCDF	0.1	2.26	2.69	1.72	0.84	2.21	1.44	0.88	1.98	1.37
1,2,3,7,8-PeCDF	0.05	1.20	1.55	1.16	0.71	0.92	0.95	0.43	1.40	0.60
2,3,4,7,8-PeCDF	0.5	10.10	14.29	14.29	8.17	9.38	9.85	3.66	17.40	6.24
1,2,3,4,7,8-HxCDF	0.1	1.98	2.66	2.65	2.04	1.24	1.62	0.48	2.90	1.00
1,2,3,6,7,8-HxCDF	0.1	1.98	2.53	4.76	2.21	1.94	1.68	0.51	5.22	1.04
2,3,4,6,7,8-HxCDF	0.1	1.01	1.31	3.16	1.75	0.89	0.88	0.22	3.29	0.83
1,2,3,7,8,9-HxCDF	0.1	0.38	0.53	0.55	0.38	0.19	0.24	0.07	0.47	0.17
1,2,3,4,6,7,8-HpCDF	0.01	0.23	0.24	0.75	0.39	0.23	0.20	0.05	0.70	0.12
1,2,3,4,7,8,9-HpCDF	0.01	0.09	0.09	0.14	0.12	0.03	0.05	0.01	0.10	0.02
OCDF	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PCDD/PCDF, 0.5 LOD		36.48	46.50	40.27	26.07	24.95	27.83	9.05	49.76	18.02
Total PCDD/PCDF, 1 LOD		36.48	46.50	40.27	26.07	24.95	27.83	9.05	49.76	18.02
Total PCDD/PCDF, 0 LOD		36.48	46.50	40.27	26.07	24.95	27.83	9.05	49.76	18.02

Table A3.11 (continued). Measurements <LOD calculated using half LOD.

Congener	Toxic equivalent Factors	Lab. Cane 1	Lab. Cane 2	Lab. Cane 3	Lab. Cane 4	Lab. Litter Vic1_1	Lab. Litter Vic1_2	Lab. Litter Vic1_3	Lab. Litter Vic2	Lab. Litter Qld
2,3,7,8-TCDD	1	1.84	0.23	1.23	0.22	0.06	0.06	0.03	0.29	0.07
1,2,3,7,8-PeCDD	1	4.39	0.64	2.49	1.73	0.04	0.19	0.10	0.62	0.08
1,2,3,4,7,8-HxCDD	0.1	0.22	0.03	0.08	0.02	0.02	0.03	0.02	0.09	0.00
1,2,3,6,7,8-HxCDD	0.1	0.24	0.05	0.14	0.18	0.01	0.02	0.01	0.07	0.00
1,2,3,7,8,9-HxCDD	0.1	0.34	0.06	0.18	0.18	0.02	0.02	0.02	0.08	0.00
1,2,3,4,6,7,8-HpCDD	0.01	0.07	0.02	0.04	0.04	0.01	0.03	0.02	0.08	0.01
OCDD	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
2,3,7,8-TCDF	0.1	0.94	0.44	0.66	0.25	0.09	0.08	0.05	0.15	0.01
1,2,3,7,8-PeCDF	0.05	0.47	0.11	0.23	0.07	0.04	0.02	0.01	0.03	0.00
2,3,4,7,8-PeCDF	0.5	6.51	1.35	2.57	0.45	0.21	0.22	0.11	0.17	0.00
1,2,3,4,7,8-HxCDF	0.1	1.25	0.14	0.33	0.01	0.01	0.02	0.01	0.00	0.00
1,2,3,6,7,8-HxCDF	0.1	1.37	0.35	0.52	0.07	0.09	0.09	0.02	0.01	0.00
2,3,4,6,7,8-HxCDF	0.1	1.07	0.19	0.27	0.03	0.06	0.05	0.01	0.01	0.00
1,2,3,7,8,9-HxCDF	0.1	0.20	0.03	0.06	0.00	0.00	0.01	0.00	0.00	0.00
1,2,3,4,6,7,8-HpCDF	0.01	0.21	0.06	0.04	0.00	0.01	0.02	0.00	0.00	0.00
1,2,3,4,7,8,9-HpCDF	0.01	0.05	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
OCDF	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PCDD/PCDF, 0.5 LOD		19.17	3.70	8.84	3.27	0.68	0.85	0.42	1.59	0.18
Total PCDD/PCDF, 1 LOD		19.17	3.70	8.84	3.27	0.68	0.85	0.42	1.59	0.18
Total PCDD/PCDF, 0 LOD		19.17	3.70	8.84	3.27	0.68	0.85	0.42	1.59	0.18

Table A3.12 Toxic equivalent emission ratios, in picograms per gram carbon, for PCDD/PCDF from field-burn samples. Measurements <LOD calculated using half LOD.

Congener	Toxic equivalent factors	P. Field WA 1	P. Field WA 2	P. Field WA 3	P. Field WA 4	P. Field WA 5	W. Field Vic 1	W. Field Vic 2	P. Field Vic 1	P. Field Vic 2	P. Field Vic 3	P. Field Vic 4
2,3,7,8-TCDD	1	0.03	0.30	0.05	0.11	0.09	0.02	0.05	0.05	0.11	0.06	0.13
1,2,3,7,8-PeCDD	1	0.72	0.38	0.11	0.16	0.06	0.02	0.82	0.67	0.66	0.62	0.13
1,2,3,4,7,8-HxCDD	0.1	0.14	0.01	0.02	0.02	0.02	0.02	0.08	0.06	0.09	0.16	0.04
1,2,3,6,7,8-HxCDD	0.1	0.16	0.04	0.02	0.04	0.03	0.00	0.10	0.13	0.09	0.16	0.06
1,2,3,7,8,9-HxCDD	0.1	0.13	0.02	0.02	0.01	0.03	0.03	0.04	0.04	0.07	0.22	0.05
1,2,3,4,6,7,8-HpCDD	0.01	0.13	0.05	0.01	0.02	0.02	0.02	0.09	0.11	0.10	0.16	0.05
OCDD	0.0001	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
2,3,7,8-TCDF	0.1	0.01	0.05	0.02	0.00	0.02	0.00	0.01	0.05	0.07	0.12	0.10
1,2,3,7,8-PeCDF	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.01	0.03
2,3,4,7,8-PeCDF	0.5	0.00	0.11	0.02	0.04	0.01	0.01	0.14	0.09	0.39	0.15	0.20
1,2,3,4,7,8-HxCDF	0.1	0.01	0.01	0.00	0.00	0.00	0.01	0.03	0.01	0.01	0.02	0.01
1,2,3,6,7,8-HxCDF	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.01	0.02
2,3,4,6,7,8-HxCDF	0.1	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.02	0.01
1,2,3,7,8,9-HxCDF	0.1	0.00	0.04	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.02	0.08
1,2,3,4,6,7,8-HpCDF	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00
1,2,3,4,7,8,9-HpCDF	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OCDF	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PCDD/PCDF, 0.5 LOD		1.37	1.04	0.28	0.42	0.29	0.14	1.42	1.23	1.69	1.74	0.91
Total PCDD/PCDF, 1 LOD		1.36	1.02	0.28	0.42	0.29	0.13	1.41	1.23	1.68	1.73	0.91
Total PCDD/PCDF, 0 LOD		1.38	1.05	0.28	0.42	0.29	0.15	1.44	1.24	1.70	1.75	0.92

Table A3.12 (continued). Measurements <LOD calculated using half LOD.

Congener	Toxic equivalent Factors	Field Cane 1	Field Cane 2	P. Field Qld 1	P. Field Qld 2	P. Field Qld 3	P. Field Qld 4	S. Field NT 1	S. Field NT 2	S. Field NT 3	S. Field NT 4
2,3,7,8-TCDD	1	0.02	0.46	0.16	0.07	0.11	0.15	5.49	0.13	0.12	0.82
1,2,3,7,8-PeCDD	1	0.61	1.18	1.34	0.90	2.01	0.73	10.69	0.08	0.24	2.93
1,2,3,4,7,8-HxCDD	0.1	0.09	0.09	0.19	0.15	0.20	0.03	0.55	0.01	0.01	0.23
1,2,3,6,7,8-HxCDD	0.1	0.05	0.20	0.20	0.19	0.30	0.17	0.69	0.01	0.01	0.38
1,2,3,7,8,9-HxCDD	0.1	0.02	0.06	0.31	0.18	0.29	0.17	0.75	0.02	0.03	0.57
1,2,3,4,6,7,8-HpCDD	0.01	0.18	0.48	0.32	0.27	0.22	0.23	0.40	0.05	0.03	0.39
OCDD	0.0001	0.04	0.07	0.04	0.05	0.03	0.03	0.06	0.01	0.00	0.04
2,3,7,8-TCDF	0.1	0.02	0.05	0.10	0.01	0.14	0.16	3.56	0.00	0.00	0.03
1,2,3,7,8-PeCDF	0.05	0.00	0.02	0.03	0.01	0.10	0.01	1.52	0.01	0.00	0.02
2,3,4,7,8-PeCDF	0.5	0.01	0.07	0.23	0.06	0.97	0.32	15.89	0.06	0.02	0.17
1,2,3,4,7,8-HxCDF	0.1	0.01	0.02	0.03	0.01	0.18	0.06	2.31	0.01	0.01	0.03
1,2,3,6,7,8-HxCDF	0.1	0.00	0.01	0.05	0.00	0.17	0.01	3.76	0.01	0.01	0.02
2,3,4,6,7,8-HxCDF	0.1	0.00	0.02	0.03	0.00	0.14	0.01	2.31	0.01	0.01	0.03
1,2,3,7,8,9-HxCDF	0.1	0.00	0.01	0.00	0.01	0.10	0.01	0.51	0.01	0.00	0.01
1,2,3,4,6,7,8-HpCDF	0.01	0.00	0.03	0.01	0.00	0.02	0.00	0.52	0.00	0.00	0.00
1,2,3,4,7,8,9-HpCDF	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.09	0.00	0.00	0.00
OCDF	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PCDD/PCDF, 0.5 LOD		1.04	2.77	3.03	1.90	4.98	2.09	49.09	0.42	0.48	5.67
Total PCDD/PCDF, 1 LOD		1.04	2.77	3.02	1.89	4.98	2.08	49.08	0.42	0.47	5.67
Total PCDD/PCDF, 0 LOD		1.05	2.78	3.04	1.90	4.99	2.10	49.09	0.43	0.48	5.67

Table A3.13 Toxic equivalent emission ratios, in picograms per gram carbon, for from unburnt-fuel and ash. Measurements <LOD calculated using half LOD.

Congener	Toxic equivalent factors	Fuel Leaf 1	Fuel Sorghum	Fuel Straw 1	Fuel Straw 2	Fuel Cane	Fuel Leaf 2	Fuel NT 4	Ash Straw 1	Ash Cane	Ash Straw 2	Ash Leaf 2	Ash NT 4
2,3,7,8-TCDD	1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.1	0.4	0.3	0.1	0.9
1,2,3,7,8-PeCDD	1	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.3	0.2	0.4	0.4	0.4
1,2,3,4,7,8-HxCDD	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1,2,3,6,7,8-HxCDD	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.4	0.0	0.3
1,2,3,7,8,9-HxCDD	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2
1,2,3,4,6,7,8-HpCDD	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.3
OCDD	0.0001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2,3,7,8-TCDF	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	1.0	0.1	0.1
1,2,3,7,8-PeCDF	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.0	0.0
2,3,4,7,8-PeCDF	0.5	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.5	0.6	1.9	0.1	0.2
1,2,3,4,7,8-HxCDF	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
1,2,3,6,7,8-HxCDF	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.4	0.0	0.0
2,3,4,6,7,8-HxCDF	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1
1,2,3,7,8,9-HxCDF	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1,2,3,4,6,7,8-HpCDF	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
1,2,3,4,7,8,9-HpCDF	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OCDF	0.0001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total PCDD/PCDF, 0.5 LOD		0.0	0.0	0.1	0.0	0.2	0.0	0.0	1.0	1.3	4.0	0.2	0.5
Total PCDD/PCDF, 1 LOD		0.0	0.0	0.2	0.0	0.2	0.0	0.0	1.0	1.3	4.0	0.3	0.5
Total PCDD/PCDF, 0 LOD		0.0	0.0	0.0	0.0	0.2	0.0	0.0	1.0	1.3	4.0	0.1	0.5

Table A3.14 Toxic equivalent emission ratios, in picograms per gram carbon, for PCBs from laboratory-burn samples. Measurements <LOD calculated using half LOD.

Congener	Toxic equivalent factors	Lab. Straw 1	Lab. Straw 2	Lab. Straw 3	Lab. Straw 4	Lab. Straw 5	Lab. Straw 6	Lab. Straw 7	Lab. Sorghum 1	Lab. Sorghum 3
PCB 77	0.0001	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
PCB 81	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 126	0.1	0.17	0.28	0.59	0.10	0.60	0.20	0.13	0.48	0.15
PCB 169	0.01	0.00	0.00	0.03	0.00	0.02	0.00	0.00	0.03	0.00
PCB 105	0.0001	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00
PCB 114	0.0005	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
PCB 118	0.0001	0.02	0.04	0.02	0.00	0.04	0.01	0.00	0.01	0.01
PCB 123	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 156	0.0005	0.01	0.01	0.01	0.00	0.02	0.00	0.00	0.01	0.00
PCB 157	0.0005	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00
PCB 167	0.00001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 189	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PCBs, 0.5 LOD		0.22	0.37	0.67	0.11	0.70	0.22	0.15	0.54	0.16
Total PCBs, 1 LOD		0.22	0.37	0.67	0.11	0.70	0.22	0.15	0.54	0.16
Total PCBs, 0 LOD		0.22	0.37	0.67	0.11	0.70	0.22	0.15	0.54	0.16

Table A3.14 (continued). Measurements <LOD calculated using half LOD.

Congener	Toxic equivalent factors	Lab. Cane 1	Lab. Cane 2	Lab. Cane 3	Lab. Cane 4	Lab. Litter Vic1_1	Lab. Litter Vic1_2	Lab. Litter Vic1_3	Lab. Litter Vic2	Lab. Litter Qld
PCB 77	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 81	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 126	0.1	0.22	0.14	0.17	0.06	0.10	0.08	0.06	0.09	0.02
PCB 169	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 105	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 114	0.0005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 118	0.0001	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PCB 123	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 156	0.0005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 157	0.0005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 167	0.00001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 189	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PCBs, 0.5 LOD		0.24	0.17	0.19	0.08	0.12	0.10	0.07	0.11	0.03
Total PCBs, 1 LOD		0.24	0.17	0.19	0.08	0.12	0.10	0.07	0.11	0.03
Total PCBs, 0 LOD		0.24	0.17	0.19	0.08	0.12	0.10	0.07	0.11	0.03

Table A3.15 Toxic equivalent emission ratios, in picograms per gram carbon, for PCBs from field-burn samples. Measurements <LOD calculated using half LOD.

Congener	Toxic equivalent Factors	P.Field WA 1	P.Field WA 2	P.Field WA 3	P.Field WA 4	P.Field WA 5	W.Field Vic 1	W.Field Vic 2	P.Field Vic 1	P.Field Vic 2	P.Field Vic 3	P.Field Vic 4
PCB 77	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 81	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 126	0.1	0.13	0.01	0.02	0.06	0.03	0.01	0.08	0.07	0.18	0.13	0.11
PCB 169	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 105	0.0001	0.02	0.00	0.01	0.04	0.02	0.01	0.02	0.01	0.02	0.01	0.02
PCB 114	0.0005	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.01	0.00	0.00
PCB 118	0.0001	0.05	0.01	0.02	0.08	0.04	0.03	0.05	0.02	0.05	0.02	0.05
PCB 123	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 156	0.0005	0.05	0.01	0.01	0.02	0.01	0.01	0.03	0.00	0.02	0.01	0.01
PCB 157	0.0005	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 167	0.00001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 189	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PCBs, 0.5 LOD		0.27	0.04	0.06	0.22	0.10	0.06	0.20	0.10	0.29	0.16	0.20
Total PCBs, 1 LOD		0.27	0.04	0.06	0.22	0.10	0.06	0.20	0.10	0.29	0.16	0.20
Total PCBs, 0 LOD		0.27	0.04	0.06	0.22	0.10	0.06	0.20	0.10	0.29	0.16	0.27

Table A3.15 (continued).

Congener	Toxic equivalent Factors	Field Cane 1	Field Cane 2	P.Field Qld 1	P.Field Qld 2	P.Field Qld 3	P.Field Qld 4	S.Field NT 1	S.Field NT 2	S.Field NT 3	S.Field NT 4
PCB 77	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 81	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 126	0.1	0.02	0.01	0.29	0.06	0.30	0.06	0.47	0.01	0.02	0.07
PCB 169	0.01	-0.01	0.00	-0.01	0.00	0.00	-0.01	0.02	0.00	0.00	0.00
PCB 105	0.0001	0.01	0.02	0.01	0.00	0.00	0.01	0.01	0.00	0.01	0.01
PCB 114	0.0005	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 118	0.0001	0.01	0.05	0.03	0.01	0.01	0.01	0.02	0.01	0.02	0.02
PCB 123	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 156	0.0005	0.00	0.01	0.02	0.00	0.01	0.00	0.01	0.00	0.01	0.01
PCB 157	0.0005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 167	0.00001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 189	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PCBs, 0.5 LOD		0.04	0.10	0.36	0.07	0.33	0.08	0.53	0.03	0.06	0.12
Total PCBs, 1 LOD		0.04	0.10	0.36	0.07	0.33	0.08	0.53	0.03	0.06	0.12
Total PCBs, 0 LOD		0.04	0.10	0.36	0.07	0.33	0.08	0.54	0.03	0.06	0.12

Table A3.16 Toxic equivalent emission ratios, in picograms per gram sample, for PCBs from unburnt-fuel and ash. Measurements <LOD calculated using half LOD.

Congener	Toxic equivalent factors	Fuel Leaf 1	Fuel Sorghum	Fuel Straw 1	Fuel Straw 2	Fuel Cane	Fuel Leaf 2	Fuel NT 4	Ash Straw 1	Ash Cane	Ash Straw 2	Ash Leaf 2	Ash NT 4
PCB 77	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 81	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 126	0.1	0.07	0.00	0.01	0.02	0.03	0.01	0.02	0.36	0.15	0.15	0.05	0.45
PCB 169	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
PCB 105	0.0001	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00
PCB 114	0.0005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 118	0.0001	0.01	0.02	0.01	0.01	0.02	0.00	0.01	0.01	0.02	0.00	0.00	0.00
PCB 123	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 156	0.0005	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 157	0.0005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 167	0.00001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCB 189	0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total PCBs, 0.5 LOD		0.08	0.04	0.02	0.03	0.06	0.01	0.03	0.38	0.18	0.16	0.05	0.48
Total PCBs, 1 LOD		0.08	0.04	0.03	0.03	0.06	0.02	0.05	0.39	0.34	0.33	0.11	0.49
Total PCBs, 0 LOD		0.08	0.04	0.01	0.03	0.06	0.00	0.01	0.37	0.03	0.00	0.00	0.47

Table 3.17 Toxic equivalent emission ratios, in picograms per gram carbon, for dioxins, furans and PCBs from laboratory burn samples.

	Lab. Straw 1	Lab. Straw 2	Lab. Straw 3	Lab. Straw 4	Lab. Straw 5	Lab. Straw 6	Lab. Straw 7	Lab. Sorghum 1	Lab. Sorghum 3
Dioxins, 0.5 LOD	17.33	20.68	11.15	9.52	7.94	10.95	2.73	38.03	6.65
Dioxins, 1 LOD	17.33	20.68	11.15	9.52	7.94	10.95	2.73	38.03	6.65
Dioxins, 0 LOD	17.33	20.68	11.15	9.52	7.94	10.95	2.73	38.03	6.65
Furans, 0.5 LOD	19.32	25.98	29.25	16.70	17.04	16.91	6.33	78.10	11.47
Furans, 1 LOD	19.32	25.98	29.25	16.70	17.04	16.91	6.33	78.10	11.47
Furans, 0 LOD	19.32	25.98	29.25	16.70	17.04	16.91	6.33	78.10	11.47
PCBs, 0.5 LOD	0.22	0.37	0.68	0.12	0.70	0.22	0.15	1.27	0.17
PCBs, 1 LOD	0.23	0.37	0.68	0.12	0.70	0.22	0.15	1.27	0.17
PCBs, 0 LOD	0.22	0.37	0.68	0.12	0.70	0.22	0.15	1.27	0.17
Total TeQ, 0.5 LOD	36.88	47.02	41.08	26.34	25.69	28.09	9.21	117.40	18.28
Total TeQ, 1 LOD	36.88	47.03	41.08	26.34	25.69	28.09	9.21	117.40	18.29
Total TeQ, 0 LOD	36.88	47.02	41.08	26.34	25.69	28.09	9.21	117.40	18.28

Table A3.17 (continued).

	Lab. Cane 1	Lab. Cane 2	Lab. Cane 3	Lab. Cane 4	Lab. Litter Vic1_1	Lab. Litter Vic1_2	Lab. Litter Vic1_3	Lab. Litter Vic2	Lab. Litter Qld
Dioxins, 0.5 LOD	7.18	1.11	4.22	2.44	0.27	0.43	0.26	2.50	0.22
Dioxins, 1 LOD	7.18	1.35	4.22	2.67	0.45	0.50	0.30	2.50	0.31
Dioxins, 0 LOD	7.18	0.87	4.22	2.21	0.08	0.36	0.23	2.50	0.14
Furans, 0.5 LOD	12.18	2.77	4.75	0.96	0.68	0.61	0.32	0.94	0.11
Furans, 1 LOD	12.18	2.77	4.75	0.99	0.68	0.61	0.32	0.97	0.11
Furans, 0 LOD	12.18	2.77	4.75	0.94	0.67	0.61	0.32	0.92	0.10
PCBs, 0.5 LOD	0.25	0.17	0.20	0.08	0.12	0.11	0.08	0.23	0.04
PCBs, 1 LOD	0.25	0.18	0.20	0.09	0.13	0.11	0.08	0.23	0.04
PCBs, 0 LOD	0.25	0.17	0.20	0.08	0.12	0.11	0.08	0.23	0.04
Total TeQ, 0.5 LOD	19.61	4.06	9.16	3.48	1.07	1.15	0.66	3.67	0.37
Total TeQ, 1 LOD	19.61	4.30	9.16	3.74	1.25	1.22	0.70	3.70	0.46
Total TeQ, 0 LOD	19.61	3.82	9.16	3.23	0.88	1.08	0.62	3.65	0.28

Table A3.18 Toxic equivalent emission ratios, in picograms per gram carbon, for dioxins, furans and PCBs from field-burn samples.

	P.Field WA 1	P.Field WA 2	P.Field WA 3	P.Field WA 4	P.Field WA 5	W.Field Vic 1	W.Field Vic 2	P.Field Vic 1	P.Field Vic 2	P.Field Vic 3	P.Field Vic 4
Dioxins, 0.5 LOD	1.34	0.82	0.24	0.19	0.49	0.14	1.21	1.08	1.14	1.38	0.46
Dioxins, 1 LOD	1.38	1.15	0.31	0.26	0.82	0.23	1.31	1.17	1.25	1.44	0.77
Dioxins, 0 LOD	1.31	0.48	0.17	0.13	0.16	0.04	1.10	0.99	1.03	1.32	0.15
Furans, 0.5 LOD	0.07	0.27	0.05	0.05	0.09	0.03	0.25	0.17	0.57	0.37	0.46
Furans, 1 LOD	0.11	0.31	0.06	0.06	0.14	0.06	0.49	0.19	0.66	0.41	0.47
Furans, 0 LOD	0.02	0.24	0.05	0.04	0.03	0.00	0.00	0.14	0.49	0.34	0.45
PCBs, 0.5 LOD	0.28	0.05	0.07	0.12	0.20	0.08	0.22	0.11	0.30	0.17	0.21
PCBs, 1 LOD	0.29	0.10	0.07	0.12	0.20	0.10	0.31	0.12	0.31	0.18	0.21
PCBs, 0 LOD	0.28	0.00	0.07	0.12	0.20	0.05	0.12	0.11	0.30	0.17	0.20
Total TeQ, 0.5 LOD	1.69	1.14	0.36	0.37	0.78	0.24	1.67	1.36	2.02	1.93	1.13
Total TeQ, 1 LOD	1.78	1.56	0.44	0.44	1.16	0.39	2.11	1.49	2.22	2.03	1.46
Total TeQ, 0 LOD	1.61	0.72	0.28	0.30	0.39	0.09	1.23	1.23	1.82	1.83	0.80

Table A3.18 (continued).

	Field Cane 1	Field Cane 2	P.Field Qld 1	P.Field Qld 2	P.Field Qld 3	P.Field Qld 4	S.Field NT 1	S.Field NT 2	S.Field NT 3	S.Field NT 4
Dioxins, 0.5 LOD	1.04	2.57	1.81	1.82	3.19	1.59	18.64	0.32	0.43	5.37
Dioxins, 1 LOD	1.17	3.11	1.95	1.91	3.32	1.82	18.64	0.58	0.81	5.37
Dioxins, 0 LOD	0.92	2.03	1.66	1.74	3.06	1.35	18.64	0.06	0.06	5.37
Furans, 0.5 LOD	0.08	0.25	0.35	0.11	1.84	0.61	30.53	0.14	0.10	0.32
Furans, 1 LOD	0.12	0.38	0.37	0.21	1.84	0.66	30.53	0.24	0.19	0.32
Furans, 0 LOD	0.04	0.11	0.32	0.00	1.84	0.57	30.53	0.03	0.00	0.31
PCBs, 0.5 LOD	0.05	0.11	0.26	0.08	0.34	0.10	0.54	0.03	0.06	0.13
PCBs, 1 LOD	0.09	0.14	0.26	0.08	0.34	0.17	0.54	0.04	0.08	0.13
PCBs, 0 LOD	0.02	0.08	0.26	0.08	0.34	0.03	0.54	0.02	0.04	0.12
Total TeQ, 0.5 LOD	1.17	2.92	2.42	2.01	5.37	2.30	49.71	0.49	0.59	5.81
Total TeQ, 1 LOD	1.37	3.63	2.59	2.20	5.50	2.66	49.71	0.87	1.08	5.81
Total TeQ, 0 LOD	0.98	2.22	2.25	1.81	5.24	1.95	49.71	0.11	0.10	5.81

Table A3.19 Toxic equivalent emission ratios, in picograms per gram sample, for dioxins, furans and PCBs from unburnt-fuel and ash.

	Fuel Leaf 1	Fuel Sorghum	Fuel Straw 1	Fuel Straw 2	Fuel Cane	Fuel Leaf 2	Fuel NT 4	Ash Straw 1	Ash Cane	Ash Straw 2	Ash Leaf 2	Ash NT 4
Dioxins, 0.5 LOD	0.04	0.05	0.20	0.04	0.19	0.03	0.06	1.46	0.62	1.45	0.57	2.15
Dioxins, 1 LOD	0.08	0.10	0.39	0.07	0.32	0.06	0.11	1.72	0.81	2.14	1.09	2.50
Dioxins, 0 LOD	0.00	0.00	0.00	0.00	0.06	0.00	0.01	1.19	0.43	0.77	0.06	1.80
Furans, 0.5 LOD	0.02	0.02	0.08	0.01	0.18	0.01	0.02	0.99	1.30	4.01	0.20	0.46
Furans, 1 LOD	0.05	0.03	0.15	0.03	0.19	0.02	0.03	1.03	1.32	4.04	0.31	0.50
Furans, 0 LOD	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.96	1.28	3.97	0.10	0.42
PCBs, 0.5 LOD	0.08	0.04	0.02	0.03	0.06	0.01	0.03	0.38	0.18	0.16	0.05	0.48
PCBs, 1 LOD	0.08	0.04	0.03	0.03	0.06	0.02	0.05	0.39	0.34	0.33	0.11	0.49
PCBs, 0 LOD	0.08	0.04	0.01	0.03	0.06	0.00	0.01	0.37	0.03	0.00	0.00	0.47
Total TeQ, 0.5 LOD	0.14	0.11	0.29	0.08	0.43	0.05	0.11	2.83	2.11	5.62	0.83	3.09
Total TeQ, 1 LOD	0.21	0.18	0.58	0.13	0.57	0.10	0.18	3.15	2.48	6.50	1.50	3.49
Total TeQ, 0 LOD	0.08	0.04	0.01	0.03	0.28	0.00	0.03	2.51	1.74	4.74	0.15	2.69

Table A3.20 ^{13}C labelled surrogate recoveries from laboratory burns (%).

Label Congener	Lab. Straw 1	Lab. Straw 2	Lab. Straw 3	Lab. Straw 4	Lab. Straw 5	Lab. Straw 6	Lab. Straw 7	Lab Sorghum 1	Lab. Sorghum 2	Lab Sorghum 3
2,3,7,8-TCDD	75	84	75	48	73	55	48	19	12	19
1,2,3,7,8-PeCDD	64	74	60	36	67	54	46	17	9.8	15
1,2,3,4,7,8-HxCDD	142	116	110	114	110	114	109	108	5.6	138
1,2,3,6,7,8-HxCDD	76	86	76	53	77	59	53	26	14	18
1,2,3,4,6,7,8-HpCDD	85	98	74	44	77	57	51	23	12	17
OCDD	109	126	85	32	54	38	34	25	14	20
2,3,7,8-TCDF	82	91	79	52	78	54	46	21	13	22
1,2,3,7,8-PeCDF	67	76	63	41	69	52	45	19	8.7	15
2,3,4,7,8-PeCDF	101	87	85	88	97	115	95	89	4.3	100
1,2,3,4,7,8-HxCDF	118	99	99	101	103	117	107	96	6.1	122
1,2,3,6,7,8-HxCDF	88	96	85	64	80	63	55	30	16	21
1,2,3,4,6,7,8-HpCDF	86	97	75	49	78	63	53	25	14	22
1,2,3,4,7,8,9-HpCDF	106	92	89	86	85	94	83	85	4.5	71
PCB 77	55	44	43	39	68	52	44	13	10	16
PCB 81	61	45	41	37	69	51	45	11	10	15
PCB 126	85	88	85	62	65	52	43	25	16	26
PCB 169	77	87	70	48	66	47	46	23	14	21
PCB 105	126	127	115	88	71	50	65	40	16	35
PCB 114	129	113	105	83	64	49	58	37	12	31
PCB 118	112	106	102	79	68	50	63	35	11	29
PCB 123	106	104	106	84	70	55	67	36	13	29
PCB 156	144	104	90	65	60	44	65	29	16	23
PCB 157	113	90	82	67	64	42	65	33	16	25
PCB 167	80	91	86	65	69	47	64	26	13	24
PCB 189	129	161	103	69	62	35	54	31	21	23

Table A3.20 (continued)

Label Congener	Lab. Cane 1	Lab. Cane 2	Lab. Cane 3	Lab Cane 4	Lab. Litter Vic1_1	Lab. Litter Vic1_2	Lab. Litter Vic1_3	Lab. Litter Vic2	Lab. Litter Qld	Lab. Ambient
2,3,7,8-TCDD	33	32	44	27	54	30	23	50	41	58
1,2,3,7,8-PeCDD	26	26	35	25	42	19	17	46	41	47
1,2,3,4,7,8-HxCDD	100	94	121	81	117	126	126	91	105	111
1,2,3,6,7,8-HxCDD	33	35	45	28	55	29	23	54	47	64
1,2,3,4,6,7,8-HpCDD	29	31	43	30	61	28	23	60	46	59
OCDD	33	35	53	19	76	38	30	42	29	65
2,3,7,8-TCDF	38	34	50	30	59	34	27	53	43	65
1,2,3,7,8-PeCDF	31	28	39	27	46	25	22	47	41	52
2,3,4,7,8-PeCDF	80	83	93	70	87	100	100	81	103	89
1,2,3,4,7,8-HxCDF	91	86	103	77	98	112	113	88	110	104
1,2,3,6,7,8-HxCDF	39	40	55	32	63	36	27	56	48	73
1,2,3,4,6,7,8-HpCDF	31	32	46	31	64	31	25	59	49	58
1,2,3,4,7,8,9-HpCDF	86	79	96	62	85	102	100	69	83	97
PCB 77	26	24	38	26	46	25	20	47	40	55
PCB 81	25	22	38	25	46	25	20	48	39	58
PCB 126	34	33	53	26	54	33	27	45	41	70
PCB 169	28	31	43	25	55	25	22	45	40	60
PCB 105	37	40	58	24	79	33	31	51	41	88
PCB 114	31	40	53	22	79	32	25	44	37	81
PCB 118	31	34	56	23	65	29	28	47	39	77
PCB 123	32	36	56	23	74	31	26	48	41	79
PCB 156	31	32	46	23	52	29	26	43	37	69
PCB 157	29	32	42	21	60	27	22	45	38	66
PCB 167	24	31	41	21	59	24	18	46	36	60
PCB 189	34	40	49	17	65	29	26	45	31	94

Table A3.21 ^{13}C labelled surrogate recoveries from field burns (%)

Label Congener	P.Field WA 1	P.Field WA 2	P.Field WA 3	P.Field WA 4	P.Field WA 5	W.Field Vic 1	W.Field Vic 2	P.Field Vic 1	P.Field Vic 2	P.Field Vic 3
2,3,7,8-TCDD	95	67	51	103	42	82	58	68	72	54
1,2,3,7,8-PeCDD	76	63	35	76	27	52	39	55	56	41
1,2,3,4,7,8-HxCDD	89	109	89	110	104	94	86	88	118	148
1,2,3,6,7,8-HxCDD	113	78	56	114	42	104	105	86	74	55
1,2,3,4,6,7,8-HpCDD	106	78	52	114	40	87	88	66	73	52
OCDD	99	84	38	84	27	75	72	50	79	44
2,3,7,8-TCDF	99	70	52	104	42	68	55	68	79	54
1,2,3,7,8-PeCDF	74	66	38	79	30	53	41	56	60	43
2,3,4,7,8-PeCDF	81	90	78	88	84	91	87	91	84	118
1,2,3,4,7,8-HxCDF	85	93	90	102	101	95	91	97	99	134
1,2,3,6,7,8-HxCDF	114	85	61	126	49	110	111	83	88	60
1,2,3,4,6,7,8-HpCDF	98	87	54	118	42	93	91	66	75	60
1,2,3,4,7,8,9-HpCDF	71	74	70	80	79	72	73	76	82	105
PCB 77	90	50	49	94	39	82	87	75	61	54
PCB 81	88	49	49	92	39	74	83	77	63	53
PCB 126	82	87	33	74	28	84	81	61	82	39
PCB 169	93	82	48	108	40	73	72	71	74	58
PCB 105	76	72	42	62	38	81	73	76	100	42
PCB 114	80	68	41	61	35	78	75	71	77	41
PCB 118	70	65	39	61	34	72	61	63	87	39
PCB 123	74	74	42	62	35	82	68	71	116	43
PCB 156	116	74	56	84	48	90	104	71	92	59
PCB 157	107	69	56	79	46	88	109	68	92	58
PCB 167	99	71	61	90	51	94	100	72	99	58
PCB 189	64	63	38	60	33	85	76	65	112	39

Table A3.21 (continued)

Label Congener	Field Cane 1	Field Cane 2	P.Field Qld 1	P.Field Qld 2	P.Field Qld 3	Prs.Field Qld 4	S.Field NT 1	S.Field NT 2	S.Field NT 3	S.Field NT 4	F-Amb-1
2,3,7,8-TCDD	66	64	51	19	73	59	33	50	67	66	53
1,2,3,7,8-PeCDD	61	66	36	20	73	55	32	40	57	57	37
1,2,3,4,7,8-HxCDD	123	102	123	83	91	101	108	88	116	96	107
1,2,3,6,7,8-HxCDD	80	79	55	24	88	69	31	53	64	77	77
1,2,3,4,6,7,8-HpCDD	65	66	53	24	79	57	31	52	63	75	74
OCDD	48	47	42	19	57	52	22	65	48	50	50
2,3,7,8-TCDF	67	68	51	19	78	59	36	57	66	63	42
1,2,3,7,8-PeCDF	62	69	36	19	74	55	36	44	67	54	35
2,3,4,7,8-PeCDF	116	89	108	93	87	78	81	74	71	98	107
1,2,3,4,7,8-HxCDF	124	99	116	93	90	101	89	80	93	98	109
1,2,3,6,7,8-HxCDF	77	82	60	23	98	76	41	61	82	78	76
1,2,3,4,6,7,8-HpCDF	67	65	55	24	85	66	36	54	71	76	76
1,2,3,4,7,8,9-HpCDF	93	81	93	84	72	75	69	75	69	82	84
PCB 77	65	50	51	19	71	61	33	43	64	61	57
PCB 81	57	51	50	18	71	64	32	44	71	61	58
PCB 126	67	44	36	20	82	75	38	57	84	56	59
PCB 169	76	65	50	15	82	64	34	51	70	65	64
PCB 105	48	46	49	18	72	64	41	87	82	48	48
PCB 114	51	39	48	28	81	74	34	83	77	48	51
PCB 118	47	41	46	25	76	65	36	75	86	48	48
PCB 123	52	39	49	25	80	73	28	76	83	47	50
PCB 156	56	56	61	14	73	72	39	77	95	58	58
PCB 157	58	55	58	12	63	65	35	60	98	58	56
PCB 167	57	54	58	8	82	64	36	73	91	65	70
PCB 189	59	53	44	22	74	63	34	74	83	37	43

Table A3.22 ^{13}C labelled surrogate recoveries from unburned fuel and ash residue (%)

Label Congener	Fuel Leaf 1	Fuel Sorghum	Fuel Straw 1	Fuel Straw 2	Fuel Cane	Fuel Leaf 2	Fuel NT 4	Ash Straw 1	Ash Cane	Ash Straw 2	Ash Leaf 2	Ash NT 4
2,3,7,8-TCDD	60	53	66	45	61	73	42	43	49	51	31	52
1,2,3,7,8-PeCDD	49	49	41	39	52	59	34	36	48	41	24	45
1,2,3,4,7,8-HxCDD	86	75	73	65	85	100	58	69	98	42	136	135
1,2,3,6,7,8-HxCDD	83	71	62	60	77	90	54	50	82	40	118	104
1,2,3,4,6,7,8-HpCDD	68	72	62	67	72	86	54	42	69	46	91	91
OCDD	43	49	87	44	47	55	34	44	43	30	96	78
2,3,7,8-TCDF	59	51	69	43	61	71	41	49	52	52	30	58
1,2,3,7,8-PeCDF	45	46	43	38	50	54	33	37	47	42	33	44
2,3,4,7,8-PeCDF	46	48	42	39	50	56	35	40	48	44	38	48
1,2,3,4,7,8-HxCDF	78	73	64	59	76	93	54	65	90	41	81	117
1,2,3,6,7,8-HxCDF	82	76	63	62	77	94	54	52	84	39	74	111
1,2,3,4,6,7,8-HpCDF	66	69	55	56	66	81	48	47	71	44	113	98
1,2,3,4,7,8,9-HpCDF	59	63	49	55	63	73	45	46	57	37	101	77
PCB 77	51	44	60	38	55	62	35	31	30	32	17	36
PCB 81	52	42	62	37	56	62	35	39	34	40	20	46
PCB 126	51	48	59	41	53	63	36	58	62	54	43	69
PCB 169	54	55	51	44	57	67	40	64	70	72	36	76
PCB 105	52	48	53	36	45	55	31	65	75	59	53	75
PCB 114	55	52	58	37	46	57	31	61	75	61	37	71
PCB 118	52	47	54	36	43	56	30	56	70	56	52	64
PCB 123	56	49	59	38	47	58	31	60	69	119	64	72
PCB 156	56	55	61	40	51	63	35	65	85	74	63	77
PCB 157	56	54	60	38	52	66	35	68	83	85	80	81
PCB 167	92	59	68	51	53	74	40	70	85	81	73	82
PCB 189	40	38	40	27	35	45	23	70	81	51	56	86

Appendix 4. Inventory of dioxin emissions from biomass combustion in Australia

A4.1. Inventory Methodology

The measured emission ratios are the primary parameters required for estimating National emissions of PDCC/Fs and PCBs using inventory methods. This study uses methods that are modified from those developed for the National Greenhouse Gas Inventory Methodology Workbook 5.1 Non CO_2 emissions from the Biosphere (NGGIC, 1998). These methods use equations that are essentially equivalent to current IPCC methodology (IPCC, 1996) and IPCC Good Practice Guidance.

For savanna fire, prescribed forests and wildfires the emission of species i from State j (Eij, g) is given as:

$$E_{ij} = A_{ij} \times M_{jk} \times \xi_{jk} \times C_j \times EF_{ik} \times 10^{-6} \text{ (g)} \qquad \text{Equation 1}$$

Where:

A_{jk} is the mean annual area burned (ha) average over 10 years from the inventory year-8 to the inventory year +1

M_{jk} if the mean fuel load for state j (t ha^{-1})

ξ_{jk} is a combined burning efficiency, which accounts for the proportion of the scar that burns and the proportion of fuel exposed to fire that is volatilised

C_{jk} is the carbon content of the fuel

EF_{ik} is the emission ratio for species *i* for fire class *k* (pg (g C)$^{-1}$)

Given the small number of emission factor estimates available for Australia, there were insufficient data for stratifying by region or state (although there were indications from the PCDD/PCDF congener profiles that prescribed fire emissions showed some regional variation). Emission ratios presented in this inventory are stratified solely by fire class.

For agricultural residue burning the fuel load is derived from crop production. For this inventory we will use the standard categories of wheat and coarse grains and sugar cane. Coarse grains are defined as oats, barley, rye, rice, maize, sorghum, and millet. The emission of species from state *j* of crop class *k* (E_{ijk}) is given as:

$$E_{ij} = P_{ij} \times R_{jk} \times S_{jk} \times DM_{jk} \times F_{jk} \times \xi_{jk} \times C_{jk} \times Ef_{ijk} \qquad \text{Equation 2}$$

Where:

P_{ijk} is the mean annual production of crop k (Mg) averaged over 3 years bracketing the inventory year (year-1 to year +1)

Rj_k is the residue to crop ratio

S_{jk} is the fraction of residue remaining at the time of burning

DM_{jk} is the dry matter content

F_{jk} is the fraction of crop production that is burned

ξ_{jk} is a combined burning efficiency that accounts for the proportion of the crop in the field that burns and the proportion of fuel exposed to fire that is volatilised

C_{jk} is the carbon content of the residue

EF_{ijk} is the emission factor for species *i* in state *j* of crop class *k*.

There were no measurements made for field burning of cereal residues in this study and because the laboratory test yielded qualitatively different results and so it was decided to apply the emission ratios from the field measurements of sugar cane fires to cereal crops.

All factors other than the PCDD/PCDF and PCB emission ratios were sourced from the National Greenhouse Gas Inventory for 2001 (AGO, 2003). Factors that are year and state specific are, F_{jk} for sugar cane, M_{jk} for savanna, prescribed and wild fires. Other factors are national means and are treated as time invariant for these inventories in the absence are suitable annual and spatial data.

All activity data (A_{ijk}, P_{ijk}) are sourced from the National Greenhouse Gas Inventory for 2001 (AGO, 2003).

The emission ratios were estimated by stratifying the emissions measurement data presented above into four classes: cane fires, prescribed fires in forests, wildfires, and savanna fires. While there was no explicit stratification by State, in practice this occurred to some degree because both cane fire measurements were made in SE Queensland, the two wildfire estimates were made in NE Victoria and the savanna fire measurements were conducted in Darwin and Kakadu. Only the prescribed fires were averaged from measurements from SW Western Australia in Jarrah/Karri forests, Central Victoria in Messmate forests and SE Queensland in coastal woodland. One measurement was excluded from the field data set, sample S-NT-1 from Wildman Reserve in Arnhem Land, where, as discussed above, the congener profile was sufficiently at variance with all other field measurements and sufficiently similar to the laboratory tests to suspect that a labelling error had occurred during shipping or analysis. The emission ratios used in the following estimates are arithmetic means of the remaining stratified field measurements.

Because many of the toxic congener concentrations were close to, or below, detection limit, the emission ratios were calculated for the lower bound (non-detects set to zero concentration), the middle bound (non-detects set to half LOD) and upper bound (non-detects set to LOD). Emission ratios were calculated for total PCDDs, PCDFs and PCB mass and TEQ.

The inventory presented here was calculated by a Monte Carlo simulation, setting the probability density functions (PDF) for all parameters except emission ratios to those used in sectors 4E (savanna burning), 4F (agricultural crop residue burning) and 5E (prescribed fires and wildfires in forests) in the National Greenhouse Gas Inventory for 2001. The emission estimates are reported as means and the 95% confidence intervals with the latter defined as the interval between the 2.5 percentile and the 97.5 percentile. The simulation was disaggregated to state level, with only the forest fire burning efficiency parameter ξ_{jk} loosely correlated with fuel load, probably because higher fuel loads potentially support fires of greater intensity and, therefore, greater burning efficiencies.

The emission ratios are assumed to be lognormally distributed with mean and standard deviations of the measured emission ratios grouped by fire class (Table A.4.1.1a-f). Emission ratios were calculated for the three uncertainty bounds, lower, middle and upper bound, where concentrations below the limit of detection (LOD) were set respectively at zero, half and one times LOD. Only the emission ratios measured in the field were used in the inventory calculations due to the uncertainty in the applicability of laboratory-measured emissions to the field. The middle bound emission ratios were used by default except where otherwise identified. Emission ratios used in this analysis were uncorrected for background air concentration.

The field emission ratios for different congener classes are weakly correlated (Table A.4.1.2). These correlations are explicitly included in the uncertainty model, Analyses are run using @RISK Version 4 using latin hypercube sampling of the PDFs with 1,000 or 3,000 iterations. Output variables typically converged to less than 1% change of the mean and standard deviation in 500 to 1,000 iterations, which is within the tolerance appropriate for this study. However, it should be remembered that even at this tolerance level separate runs with identical parameters will produce small but noticeable variation in both the mean and the confidence limits.

Table A.4.1a. PCDD/PCDF and PCB emission ratios. Middle bound estimates where non-detects are set to half LOD.

Emission Factor, (pg TEQ) $(g\ C)^{-1}$

Field samples					
Species	**Cane**	**Prescribed**	**Wildfire**	**Savanna**	**All**
PCDD	1.77 (1.1)	1.23 (0.89)	0.65 (0.76)	2.03 (2.88)	1.35 (1.27)
PCDF	0.14 (0.13)	0.36 (0.48)	0.13 (0.15)	0.16 (0.14)	0.29 (0.4)
PCB	0.07 (0.04)	0.18 (0.11)	0.13 (0.1)	0.07 (0.04)	0.15 (0.1)
Total	**1.98 (1.26)**	**1.77 (1.32)**	**0.91 (1.01)**	**2.26 (3.05)**	**1.78 (1.53)**
Fan-forced laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD		0.69 (0.75)		7.2 (4.16)	4.23 (4.24)
PCDF		0.2 (0.25)		13.41 (6.14)	6.92 (8.11)
PCB		0.07 (0.06)		0.36 (0.3)	0.22 (0.25)
Total		**0.96 (1.05)**		**20.97 (10.27)**	**11.36 (12.4)**
Naturally-ventilated laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD	4.1 (3.03)	0.23 (0.1)	11.45 (6.85)	14.61 (5.23)	7.86 (7.21)
PCDF	6.47 (4.95)	0.41 (0.17)	22.44 (15.6)	22.72 (5.81)	13.04 (11.88)
PCB	0.2 (0.04)	0.1 (0.02)	0.35 (0.27)	0.34 (0.24)	0.25 (0.19)
Total	**10.77 (7.92)**	**0.74 (0.23)**	**34.24 (22.71)**	**37.67 (8.72)**	**21.14 (18.77)**
All laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD	3.67 (2.62)	0.42 (0.46)	11.45 (6.85)	11.43 (5.92)	6.65 (6.48)
PCDF	5.07 (4.91)	0.33 (0.21)	22.44 (15.6)	18.73 (7.36)	11. (10.93)
PCB	0.17 (0.07)	0.09 (0.03)	0.35 (0.27)	0.35 (0.24)	0.24 (0.2)
Total	**8.92 (7.45)**	**0.83 (0.57)**	**34.24 (22.71)**	**30.51 (12.36)**	17.88 (17.2)

Table A.4.1b. PCDD/PCDF and PCB emission ratios. Middle bound estimates where non-detects are set to half LOD.

Emission Factor, pg $(g\ C)^{-1}$

Field samples					
Species	**Cane**	**Prescribed**	**Wildfire**	**Savanna**	**All**
PCDD	610 (262)	293 (220)	70 (71)	274 (335)	300 (249)
PCDF	44 (36)	65 (51)	16 (18)	96 (84)	63 (54)
PCB	497 (376)	521 (389)	671 (330)	285 (127)	498 (348)
Total	1,151 (674)	879 (377)	757 (419)	654 (388)	861 (395)
Fan-forced laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD		119 (118)		167 (82)	136 (83)
PCDF		39 (41)		741 (347)	395 (439)
PCB		138 (67)		297 (324)	221 (224)
Total		296 (226)		1,205 (716)	752 (680)
Naturally-ventilated laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD	99 (61)	60 (13)	192 (85)	339 (78)	185 (134)
PCDF	282 (185)	60 (24)	731 (402)	972 (306)	531 (449)
PCB	160 (29)	130 (36)	144 (74)	379 (246)	223 (176)
Total	541 (235)	250 (60)	1,067 (562)	1,690 (569)	939 (713)
All laboratory samples					
Species	**Cane**	**Forest**	**sorghum**	**straw**	**All**
PCDD	93 (51)	83 (68)	192 (85)	265 (117)	168 (119)
PCDF	229 (185)	51 (29)	731 (402)	873 (320)	486 (438)
PCB	160 (24)	134 (42)	144 (74)	344 (259)	222 (186)
Total	481 (226)	268 (123)	1,067 (562)	1,482 (632)	876 (688)

Table A.4.1c. PCDD/PCDF and PCB emission ratios. Lower bound estimates where non-detects are set to zero.

Lower Bound.(pg TEQ) $(g\ C)^{-1}$

Field samples					
Species		**Prescribed**	**Wildfire**	**Savanna**	**All**
PCDD	1.47 (0.79)	1.1 (0.91)	0.57 (0.75)	1.82 (3.06)	1.19 (1.3)
PCDF	0.07 (0.05)	0.33 (0.49)	0. (0.0)	0.11 (0.18)	0.24 (0.41)
PCB	0.04 (0.04)	0.17 (0.12)	0.07 (0.05)	0.06 (0.05)	0.13 (0.11)
Total	1.58 (0.88)	1.6 (1.34)	0.64 (0.8)	1.99 (3.29)	1.56 (1.57)
Fan-forced laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD		0.66 (0.81)		7.2 (4.16)	4.18 (4.27)
PCDF		0.19 (0.24)		13.41 (6.14)	6.92 (8.11)
PCB		0.07 (0.06)		0.36 (0.3)	0.22 (0.25)
Total		0.93 (1.11)		20.97 (10.27)	11.31 (12.45)
Naturally-ventilated laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
	4.03 (3.16)	0.17 (0.12)	11.45 (6.85)	14.61 (5.23)	7.83 (7.25)
PCDD	6.47 (4.95)	0.41 (0.17)	22.44 (15.6)	22.72 (5.81)	13.04 (11.88)
PCDF	0.2 (0.04)	0.09 (0.02)	0.35 (0.27)	0.34 (0.24)	0.25 (0.19)
PCB	10.5 (7.98)	0.58 (0.2)	33.89 (22.44)	37.34 (8.57)	20.86 (18.67)
Total	4.03 (3.16)	0.17 (0.12)	11.45 (6.85)	14.61 (5.23)	7.83 (7.25)
All laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD	3.56 (2.74)	0.37 (0.49)	11.45 (6.85)	11.44 (5.93)	6.61 (6.52)
PCDF	5.07 (4.92)	0.33 (0.21)	22.44 (15.6)	18.73 (7.36)	11. (10.93)
PCB	0.17 (0.07)	0.09 (0.03)	0.35 (0.27)	0.35 (0.24)	0.24 (0.2)
Total	8.8 (7.57)	0.78 (0.59)	34.25 (22.71)	30.52 (12.37)	17.84 (17.24)

Table A.4.1d. PCDD/PCDF and PCB emission ratios. Lower bound estimates where non-detects are set to zero.

Emission Factor, pg.(g C)$^{-1}$

Field samples					
Species	**Cane**	**Prescribed**	**Wildfire**	**Savanna**	**All**
PCDD	610 (262)	291 (221)	56 (54)	273 (335)	297 (251)
PCDF	44 (36)	65 (51)	15 (18)	95 (84)	62 (54)
PCB	470 (357)	495 (394)	628 (326)	281 (131)	473 (348)
Total	1124 (655)	851 (393)	698 (398)	649 (392)	832 (401)
Fan-forced laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD		119 (118)		167 (82)	136 (83)
PCDF		39 (41)		741 (347)	395 (439)
PCB		136 (66)		294 (321)	218 (222)
Total		294 (225)		1202 (713)	748 (679)
Naturally-ventilated laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD	99 (61)	60 (13)	192 (85)	339 (78)	185 (134)
PCDF	282 (185)	60 (24)	731 (402)	972 (306)	531 (449)
PCB	158 (27)	129 (36)	143 (76)	379 (246)	222 (176)
Total	539 (236)	248 (60)	1066 (563)	1689 (569)	937 (713)
All laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD	93 (51)	83 (68)	192 (85)	265 (117)	168 (119)
PCDF	229 (185)	51 (29)	731 (402)	873 (320)	486 (438)
PCB	156 (22)	132 (42)	143 (76)	342 (258)	220 (186)
Total	477 (229)	267 (123)	1066 (563)	1480 (632)	874 (688)

Table A.4.1e. PCDD/PCDF and PCB emission ratios. Upper bound estimates where non-detects are set to one LOD.

Emission Factor, (pg TEQ).(g C)$^{-1}$

Field samples					
Species	**Cane**	**Prescribed**	**Wildfire**	**Savanna**	**All**
PCDD	2.09 (1.39)	1.38 (0.88)	0.74 (0.76)	2.24 (2.69)	1.51 (1.26)
PCDF	0.23 (0.2)	0.4 (0.47)	0.27 (0.31)	0.23 (0.08)	0.34 (0.39)
PCB	0.1 (0.04)	0.19 (0.1)	0.19 (0.14)	0.08 (0.04)	0.16 (0.1)
Total	2.42 (1.63)	1.96 (1.32)	1.19 (1.21)	2.54 (2.8)	2.02 (1.51)
Fan-forced laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD		0.73 (0.69)		7.2 (4.16)	4.27 (4.21)
PCDF		0.2 (0.25)		13.41 (6.14)	6.93 (8.1)
PCB		0.07 (0.06)		0.36 (0.3)	0.22 (0.25)
Total		1.0 (1.0)		20.97 (10.27)	11.42 (12.36)
Naturally-ventilated laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD	4.17 (2.91)	0.32 (0.09)	11.45 (6.85)	14.6 (5.23)	7.9 (7.16)
PCDF	6.47 (4.95)	0.42 (0.17)	22.44 (15.6)	22.72 (5.81)	13.04 (11.88)
PCB	0.2 (0.04)	0.1 (0.02)	0.35 (0.27)	0.34 (0.24)	0.25 (0.19)
Total	10.84 (7.81)	0.83 (0.27)	34.24 (22.71)	37.67 (8.72)	21.18 (18.73)
All laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD	3.78 (2.5)	0.48 (0.42)	11.45 (6.85)	11.43 (5.92)	6.69 (6.44)
PCDF	5.08 (4.91)	0.33 (0.21)	22.44 (15.6)	18.73 (7.36)	11.0 (10.93)
PCB	0.17 (0.07)	0.09 (0.03)	0.35 (0.27)	0.35 (0.24)	0.24 (0.2)
Total	9.03 (7.33)	0.9 (0.54)	34.24 (22.71)	30.51 (12.36)	17.93 (17.15)

Table A.4.1f. PCDD/PCDF and PCB emission ratios. Upper bound estimates where non-detects are set to one LOD.

Emission Factor, pg (g C)$^{-1}$

Field samples					
Species	**Cane**	**Prescribed**	**Wildfire**	**Savanna**	**All**
PCDD	610 (262)	295 (219)	87 (87)	274 (334)	302 (247)
PCDF	44 (36)	65 (51)	17 (18)	97 (85)	63 (54)
PCB	525 (394)	550 (382)	714 (333)	289 (123)	525 (348)
Total	1,179 (692)	910 (358)	817 (439)	660 (384)	890 (387)
Fan-forced laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD		119 (118)		167 (82)	136 (83)
PCDF		39 (41)		741 (347)	395 (438)
PCB		140 (68)		300 (327)	225 (225)
Total		298 (227)		1,208 (719)	756 (680)
Naturally-ventilated laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD	99 (61)	60 (13)	192 (85)	339 (78)	185 (134)
PCDF	282 (185)	60 (24)	731 (402)	972 (306)	531 (449)
PCB	162 (32)	132 (36)	145 (73)	380 (246)	224 (176)
Total	543 (234)	252 (61)	1067 (561)	1691 (569)	940 (712)
All laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD	93 (51)	83 (68)	192 (85)	265 (117)	168 (119)
PCDF	229 (185)	51 (29)	731 (402)	873 (320)	486 (438)
PCB	164 (27)	136 (43)	145 (73)	346 (260)	225 (187)
Total	486 (223)	270 (124)	1,067 (561)	1,484 (633)	879 (687)

Table A.4.2. Correlation matrix of field emission ratios for PCDDs, PCDFs and PCBs.

	PCDD-mass	PCDF-mass	PCDD/PCDF-mass	PCB-mass	Total-mass	PCDD-TEQ	PCDF-TEQ	PCB-TEQ	PCDD/PCDF-TEQ	Total-TEQ
PCDD-mass	1									
PCDF-mass	-0.013	1								
PCDD/PCDF-mass	0.977	0.202	1							
PCB-mass	-0.120	-0.015	-0.121	1						
Total-mass	0.526	0.117	0.540	0.77	1					
PCDD-TEQ	0.798	-0.099	0.760	-0.12	0.391	1				
PCDF-TEQ	0.323	0.229	0.366	-0.19	0.075	0.454	1			
PCB-TEQ	0.267	0.199	0.304	0.51	0.623	0.321	0.574	1		
PCD/F-TEQ	0.764	-0.022	0.744	-0.15	0.352	0.971	0.654	0.427	1	
Total TEQ	0.759	-0.008	0.741	-0.11	0.383	0.963	0.673	0.481	0.998	1

Annual emissions were calculated for 1990 to 2001 for the NGGI sectors of savanna burning (IPCC sector 4E), burning of agricultural crop residues (IPCC sector 4F), prescribed fires in forests and wildfires (sector 5E). The results of the inventory estimates are presented in detail in Appendix 4.2.

The most recent review of dioxin emissions in Australia presented emission estimates for 1994 (EA, 2002) and, therefore, for purposes of comparison, 1994 will be used here as a reference year.

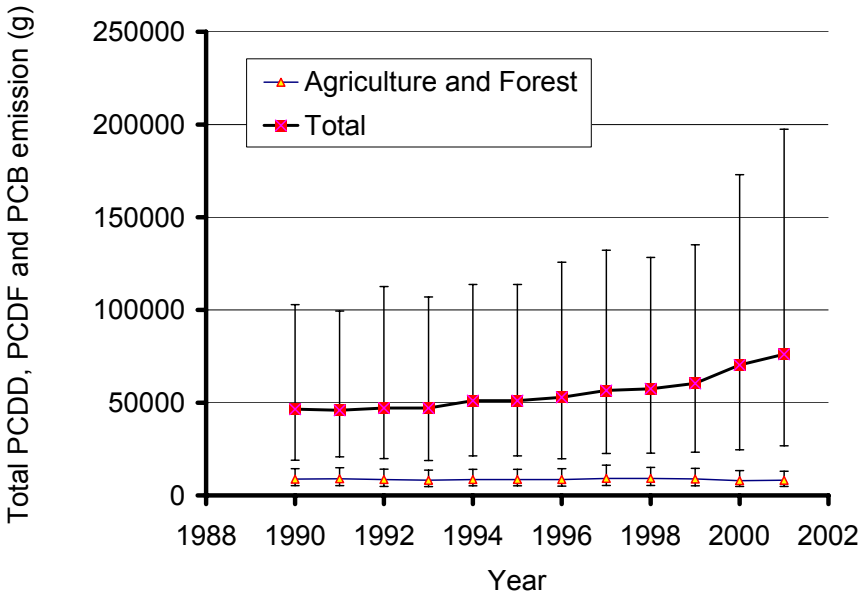


Figure A.4.1. Trends in mean emission of PCDD/PCDF/PCB from 1990 to 2001.

In 1990, total annual emissions of PCCD/F and PCBs were approximately 44.6 kg (Table A.4.2.1) or 140 g TEQ (Table A.4.2.2). By 2001, these emissions increased 65% to 72.2 kg (Table A.4.2.34) or 229 g TEQ (Table A.4.2.35, Figure.A.4.1). Savanna fires were the dominant source of these emissions accounting for between 81 and 89% of all emissions in 1990 and 2001, respectively (Figure A.4.1.2). This increase is due entirely to a substantial apparent increase in fires in the Northern Territory and the Kimberley region of Western Australia. However, estimates of savanna fire areas supplied by regional bushfire authorities were used prior to 1995, while subsequently, fire areas were measured from satellite imagery. The change in data source might have introduced a systematic error (Meyer, 2002). Therefore, it is possible that the change in emissions from savanna fires could be an artefact of the methods used to estimate fire scar areas. The issue is currently under review.

There was little change, however, in emissions from the other sectors, as shown in Figure A.4.1.3, with emissions changing from 8.2 kg or 12.2 g TEQ in 1990 to 7.8 kg or 11.8 g TEQ in 2001. Wildfire was the major source, followed by agricultural waste burning and prescribed burning in forests (Figure A.4.1.2). These sources are located in agricultural regions or near population centres and, therefore, most likely to impact the Australian population either by direct exposure or through deposition onto crops pastures and transfer via the food chain.

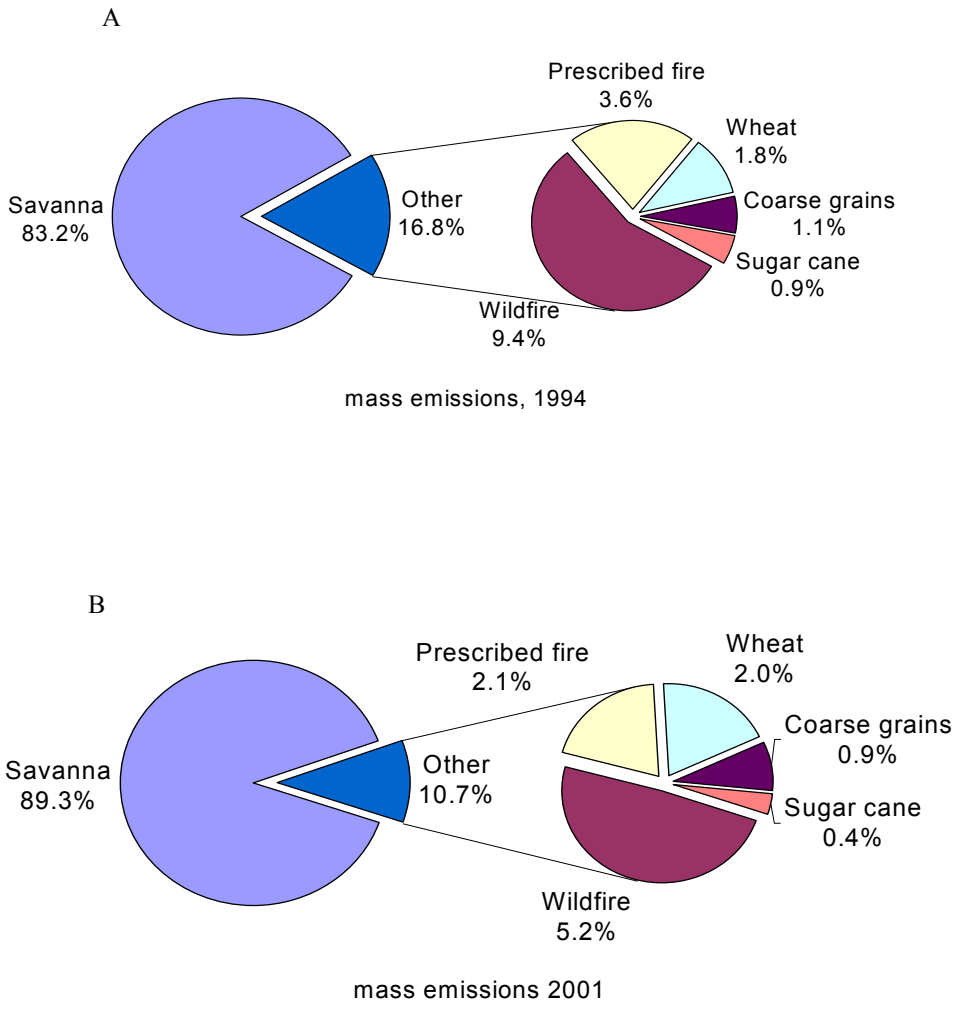
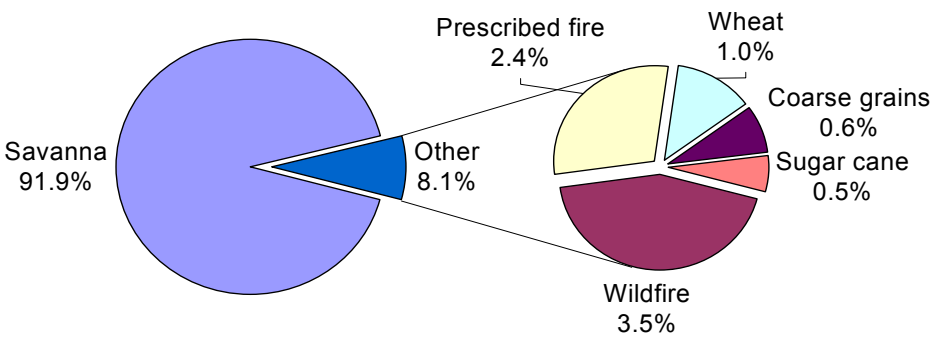


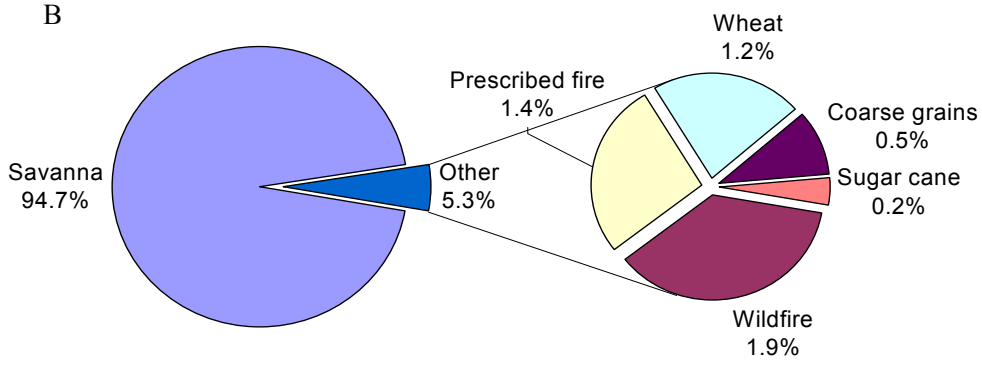
Figure A.4.2. Sectoral contributions of PDCDD/F and PCB mass emissions

A



TEQ emissions, 1994

B



TEQ emissions, 2001

Figure A.4.3. Sectoral contributions of PCDD/PCDF/PCB TEQ emissions

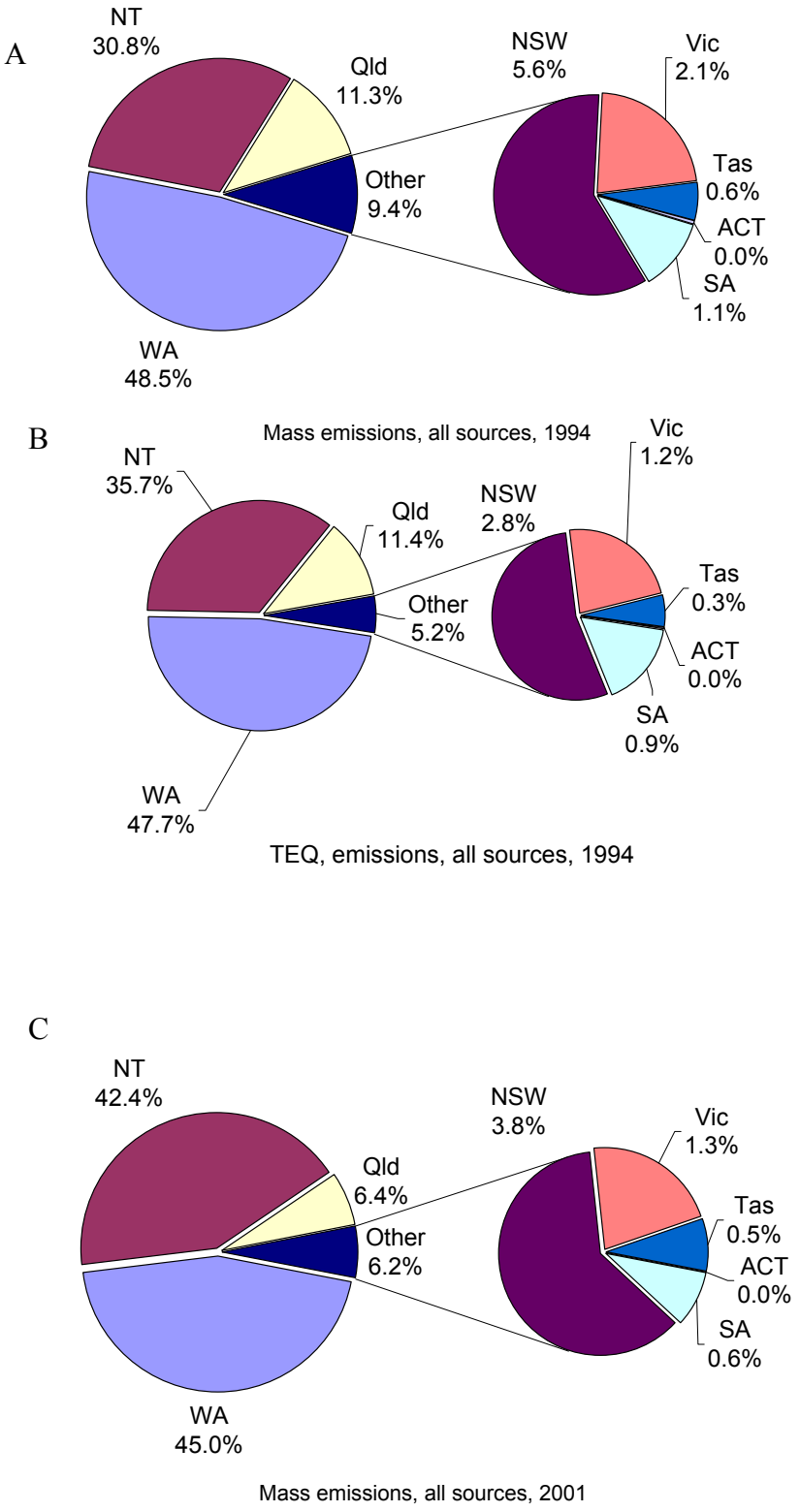


Figure A.4.4. Distribution between States.

The emissions, expressed as TEQs, were weighted even more to the savanna fires (Figure A.4.1.3). The non-savanna emissions were sourced from forest fires, wildfires principally, with emissions from crop residue fires and prescribed fires in forests contributing in similar proportion. Of the crop emissions, wheat stubble was by far the dominant source, comprising 50% in 1990 and 60% in 2001. Emissions from sugar

cane fires declined by approximately 30% during this period due to the substantial and continuing increase in green cane harvesting.

Consistent with the dominance of savanna fires as a national dioxin source, Western Australia, Northern Territory and to a lesser degree, Queensland were the main regions of PCDD/PCDF and PCB emissions, accounting for more than 90% of mass emissions and nearly 95% of TEQ emissions in 1994 (Figure A.4.1.4). Of the other states, New South Wales exceeded the combined emissions of all other states. The increase in savanna fires through the last decade, particularly in the Northern Territory, further reduced the significance of the southern states for national emissions.

Western Australia was the main source of PDCC/F and PCBs in agricultural and forest burning due to both the extensive wheat production and a very active programme of prescribed burning in the SE forests and wildfires. Wildfires and cropping were big contributors in New South Wales, while in Victoria, prescribed fires were the main emitters. The proportions changed with time as the extent of wildfires varied with season (Figure A.4.1.4).

The principal question to be addressed by the inventory, however, is the extent to which improved local measurements of emission ratios have changed the previous estimates of national dioxin emissions and reduced the uncertainties. The previous national dioxin emission estimates from fires were reported in the *Revised Review of sources of Dioxins and Furans in Australia* (EA, 2002) from activity data sourced from the 1994 National Greenhouse Gas Inventory and a range of emission factors from overseas sources. Dioxin emission factors presented in this review ranged from 0.5 µg TEQ (t fuel)$^{-1}$ reported by US EPA to from 0.5 µg TEQ (t fuel)$^{-1}$ from agricultural waste burning and 13.5 to 28.5 µg TEQ (t fuel)$^{-1}$ from residential wood stoves. From these studies the review recommended a PCDD/PCDF emission factor range of 0.5 to 10 µg TEQ (t fuel)$^{-1}$ for agricultural waste burning, prescribed burning in forests, savanna woodlands and temperate grasslands and 0.5 to 28 µg TEQ (t fuel)$^{-1}$ for wildfires. These factors were combined with the 1994 estimates of biomass burning to yield estimated dioxin emissions of 3.4 to 68 g PCDD/PCDF TEQ from agricultural waste burning and prescribed fires in forests, 62 to 1240 g PCDD/PCDF TEQ from fires in savanna woodlands and temperate grasslands, and 7 to 400 g PCDD/PCDF TEQ from bushfires.

The revised emissions ratios measured in this study clearly favour the lower end of these ranges. The uncertainties are still large at -70% to +170% of the mean estimates. However, even at the upper limit (494 g TEQ, our current assessment is 70% of than the former EA estimate (Table A4.2.14). There are a significant number of assumptions in the inventory analysis, including expert judgment of the uncertainties in parameters, (other than emission factors) and activity data such as fire scar areas and crop production. Other factors, such as sample size and detection limits may affect the accuracy of the measured emission factor, as may our assumption that these emission ratios are similar to emission ratios for other trace gas species emitted from combustion and conform to lognormal population distributions.

An often ignored, but potentially relevant issue is the change in toxic equivalency factors (TEF) in 1998. In order to support comparison with TEQ emissions estimated using pre-1998 emission ratios, the current emission ratios have been recalculated with I-TEFs (Table A.4.1.3). Other assumptions that could affect our estimate of the uncertainties include the analysis sensitivity where 2,3,7,8-PCDD/PCDF congeners that might contribute significantly to toxicity go undetected, and the probability function used to describe the emission ratios. Experience from more extensively studied combustion products suggests that a lognormal distribution is the most appropriate,

however, a normal distribution is a more conservative choice and might tend to favour a smaller range. Finally, if the emission rates are small and concentrations in the smoke plume are close to ambient air concentrations, then undetected variation in background air concentration might introduce significant error into the emission ratios. Table A.4.1.4a and b show the effect of varying these assumptions. The reference analysis uses emission ratios uncorrected for ambient air concentrations of dioxin, lognormally distributed with non-detects assigned values of 0.5 LOD.

Table A.4.3. I-TEF emission ratios.

I- TEF Emission Factor (pg TEQ).(g C)$^{-1}$

Field samples					
Species	**Cane**	**Prescribed**	**Wildfire**	**Savanna**	**All**
PCDD	1.79 (1.09)	1.04 (0.75)	0.45 (0.49)	1.66 (2.27)	1.15 (1.06)
PCDF	0.28 (0.22)	0.62 (0.65)	0.16 (0.19)	0.21 (0.2)	0.48 (0.56)
PCB	0	0	0	0	0
Total	2.07 (1.3)	1.66 (1.25)	0.62 (0.68)	1.86 (2.47)	1.63 (1.37)
Fan-forced laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD		0.55 (0.59)		5.15 (2.84)	3.02 (2.98)
PCDF		0.52 (0.62)		19.45 (8.47)	10.21 (11.47)
PCB		0		0	0
Total		1.07 (1.21)		24.61 (11.09)	13.23 (14.33)
Naturally-ventilated laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD	2.87 (2.1)	0.2 (0.07)	7.89 (4.36)	10.11 (3.63)	5.45 (4.94)
PCDF	9.19 (5.95)	0.71 (0.24)	29.16 (17.32)	30.25 (7.84)	17.42 (15.17)
PCB	0	0	0	0	0
Total	12.06 (7.98)	0.91 (0.27)	37.05 (21.68)	40.36 (10.19)	22.87 (19.84)
All laboratory samples					
Species	**Cane**	**Forest**	**Sorghum**	**Straw**	**All**
PCDD	2.54 (1.84)	0.34 (0.36)	7.89 (4.36)	7.98 (4.03)	4.64 (4.45)
PCDF	7.36 (6.08)	0.63 (0.37)	29.16 (17.32)	25.62 (9.38)	15.02 (14.13)
PCB	0	00	0	0	0
Total	9.9 (7.81)	0.97 (0.64)	37.05 (21.68)	33.61 (12.8)	19.66 (18.36)

Table A.4.4a. Effect of uncertainty scenarios on national total PCDD/PCDF and PCB TEQ emissions

		EA, 2002	Total PCDD/PCDF and PCB emissions (g TEQ)					
			Middle bound	Lower bound	Upper bound	I-TEF	Normal EFs	Ambient-corrected
Savanna	Mean	62	139.9	114.5	149.1	115.9	135.9	129.9
	Lower		19.3	15.9	28.9	21.4	21.4	20
	Upper	1240	555	465	476	417	504	476
Wildfires	Mean	7	5.3	3.5	6.7	3.5	5.1 [1,2]	4.9
	Lower		1.2	0.7	1.8	0.9		1.1
	Upper	400	16.2	11.1	20.0	10.6	15.4	15.2
Prescribed fires	Mean		3.8	3.3	4.2	4.2	3.7	3.6
	Lower		1.5	1.2	1.7	1.7	1.5	1.4
	Upper		7.7	7.7	9.0	8.7	8.3	7.9
Crop residues	Mean		3.3	2.6	4.0	3.3	3.3	3.2
	Lower		1.8					
	Upper		5.6					
Agriculture and prescribed fires	Mean	68	7.1	5.9	8.2	7.5	7.0	6.8
	Lower		4.0	3.3	4.9	4.3	4.0	3.9
	Upper		11.4	10.4	13.8	12.4	12.2	11.8
Agriculture, prescribed fires and wildfires	Mean	10.4	12.3	9.4	14.9	10.9	12.1	11.7
	Lower		6.2	5.0	8.3	6.4	6.6	6.2
	Upper	468	24.0	17.9	28.4	19.1	23.5	23.2
Total	Mean	72.4	152.2	123.9	164.0	126.8	148.0	141.6
	Lower		31.8	24.5	42.9	31.5	32.6	30.8
	Upper	1708	571	474	489	428	511	494

The salient features of these comparisons are:

(1) Changing from lower bound to upper bound while affecting the mean estimate has negligible effect on the upper 95% confidence limits and minor effect on the lower limits. This is caused by an increase in standard deviation when PCDD/PCDF species below the detection limit are removed from the analysis

(2) Both normally and lognormally distributed emission ratios produced similar emission estimates

(3) The TEF revisions in 1998 to WHO_{98} increased the emission estimates by approximately 20% and upper error bounds by approximately 25%, partly because I-TEF did not include PCBs

(4) The concentrations of PCDD/PCDF and PCBs in the sampled smoke plumes were very much greater than ambient and, therefore, correction for ambient air concentration had only a minor effect on the TEQ emissions and virtually no affect on the estimates of the mass emissions.

Therefore, the emission estimates are not significantly affected by sample size and analytical sensitivity and variation in ambient air concentrations of PCDD/PCDF are unlikely to have significant impact on emission estimates. Neither is the choice of probability distribution likely to bias the result. However, using I-TEF based emission ratios does lead to reduced emission estimates, because 1,2,3,7,8-PeCDD, whose TEF was doubled in the WHO_{98} revision is present in many of the field emissions, and the PCBs contributed significantly to toxicity in some fire classes. The emission ratios used in the EA review were mostly calculated using I-TEFs and, therefore, strictly speaking, the emission ranges presented in the review should be revised upwards before comparison with the new estimates. Overall, the analysis is robust with respect to several important factors that potentially might change the error bounds.

Table A.4.4b. Effect of uncertainty scenarios on national total PCDD/PCDF and PCB mass emissions.

		Total PCDD/PCDF and PCB emissions (g)					
		Middle bound	Lower bound	Upper bound	I-TEF	Normal EFs	Ambient-corrected
Savanna	Mean	38894	38861	39189	39998	40193	37656
	Lower	10892	11271	12118	11983	11724	10949
	Upper	97151	99474	98771	104257	113549	95942
Wildfires	Mean	4482	4161	4821	4502	4481	4061
	Lower	1686	1710	1923	1811	1768	1598
	Upper	9606	9015	10256	9696	10214	8879
Prescribed fires	Mean	1851	1789	1916	1918	1860	1793
	Lower	977	842	988	970	935	952
	Upper	3297	3287	3405	3387	3278	3124
Crop residues	Mean	1868	1826	1915	1759	1870	1845
	Lower						
	Upper						
Agriculture and prescribed fires	Mean	3720	3615	3831	3677	3731	3638
	Lower	2244	2059	2320	2128	2009	2175
	Upper	6182	5951	6152	5767	5832	5790
Agriculture, prescribed fires and wildfires	Mean	8201	7776	8652	8178	8211	7699
	Lower	4773	4598	5199	490	4541	4445
	Upper	13705	13297	14621	13493	14066	12758
Total	Mean	47095	46637	47841	48176	48405	45355
	Lower	18784	18356	20494	19239	19014	18581
	Upper	107027	107726	107416	115013	121630	101876

The following discussion addresses the details of the uncertainty analysis. The input probability function of the prescribed burning emission factor is a lognormal distribution with mean of 1.84 and a standard deviation of 1.36 derived from a population of 10 measurements. While this population is too small to accurately determine (let alone fit) an exact probability distribution, comparison between the density function and the measured emission ratios is good (Figure A.4.1.5).

The sensitivities of total emissions and the agriculture and forestry components to variation in input parameters and activity data are shown in Figures A.4.1.6 and A.4.1.7.

The national total emissions are sensitive primarily to variation in emission ratios and fuel loads in the savanna regions of Northern Territory and Western Australia (Figure A.4.1.7). While uncertainty in annual fire scar areas is large, its effect is substantially reduced by averaging over ten years to smooth the influence of inter-annual variation and errors caused by differences in the timing of the northern and southern fire seasons. Sensitivity to errors in all other parameters is insignificant.

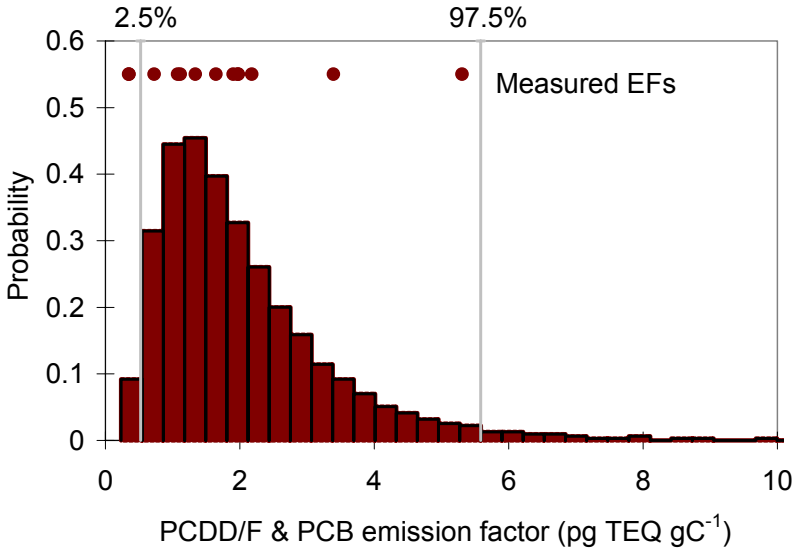
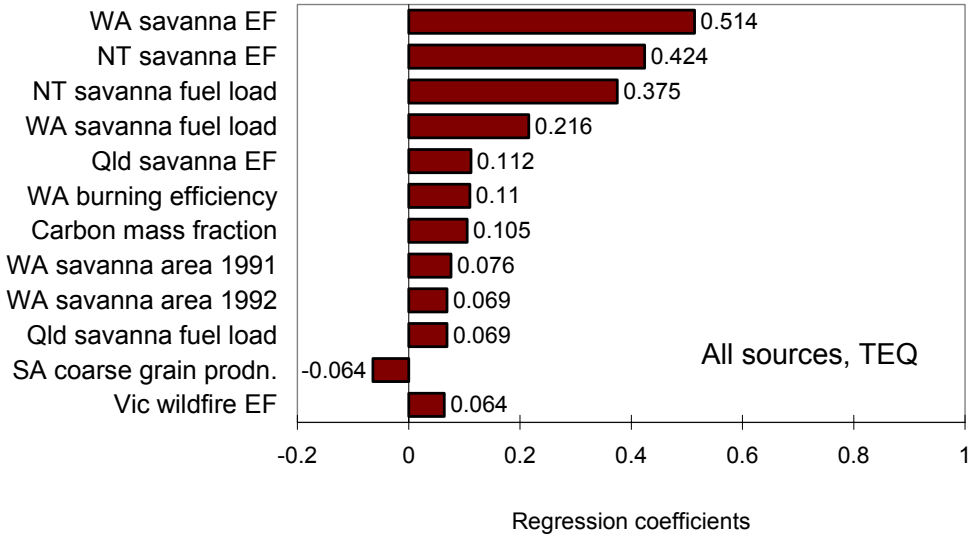


Figure A.4.5 The Input probability density function for total PCDD/PCDF and PCB emission ratios in the inventory analysis compared with the measured emission ratios.

Southern Australia is not affected by savanna fires but by the burning of crop residues, by prescribed fires and by wildfires in forests. The estimated national emission from these sources is sensitive to a wide range of parameters (Figure A.4.1.6). Uncertainties in emission ratios for wildfires and prescribed fires in Western Australia and New South Wales, the two major sources in this sector have the greatest influence on the national emissions, however, other significant parameters include burning efficiencies, the proportion of crop burned and fuel loads which are determined or affected by farm and forest management practice.

A



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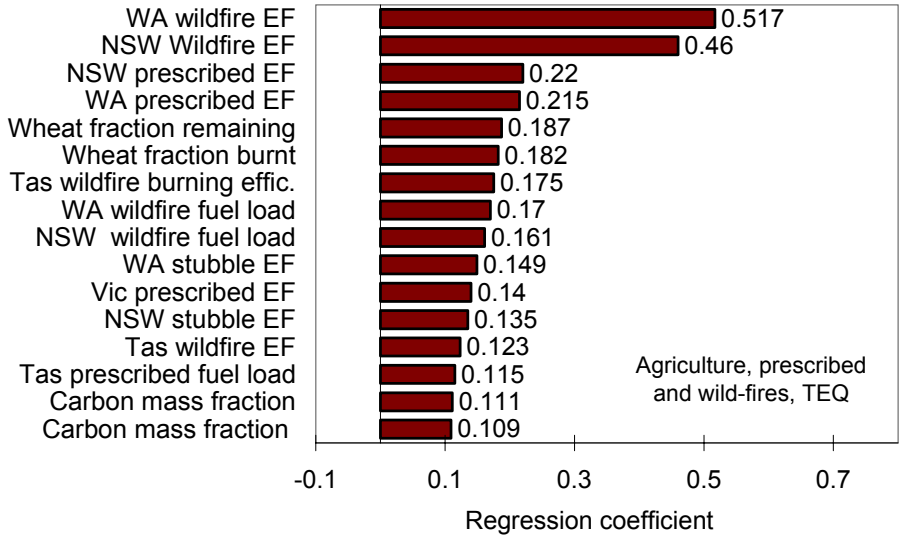
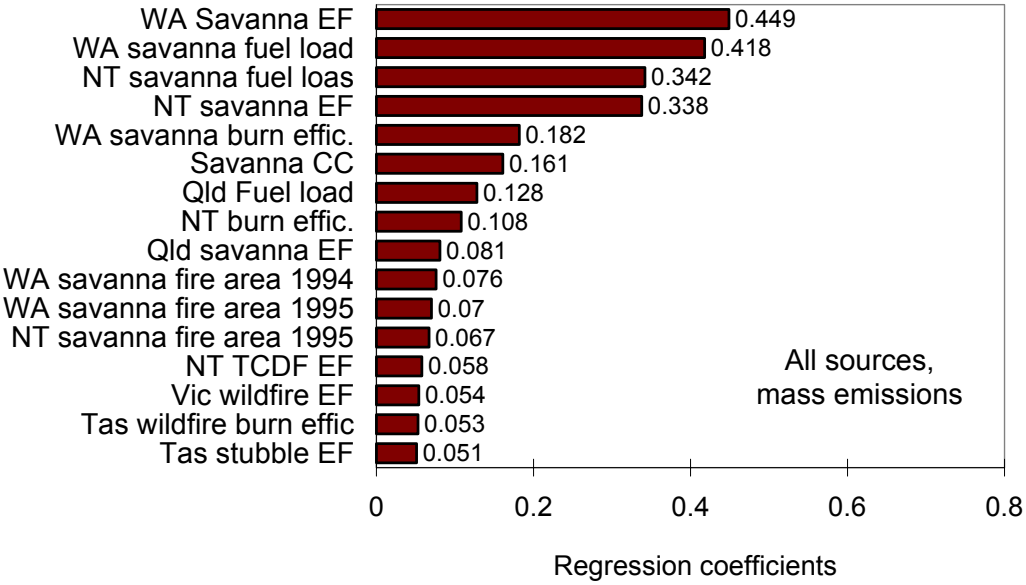


Figure A.4.6. Input sensitivity of total PCDD/PCDF and PCB TEQ emissions.

A. All field combustion sources
B. Agriculture, prescribed fires and wildfires.

A



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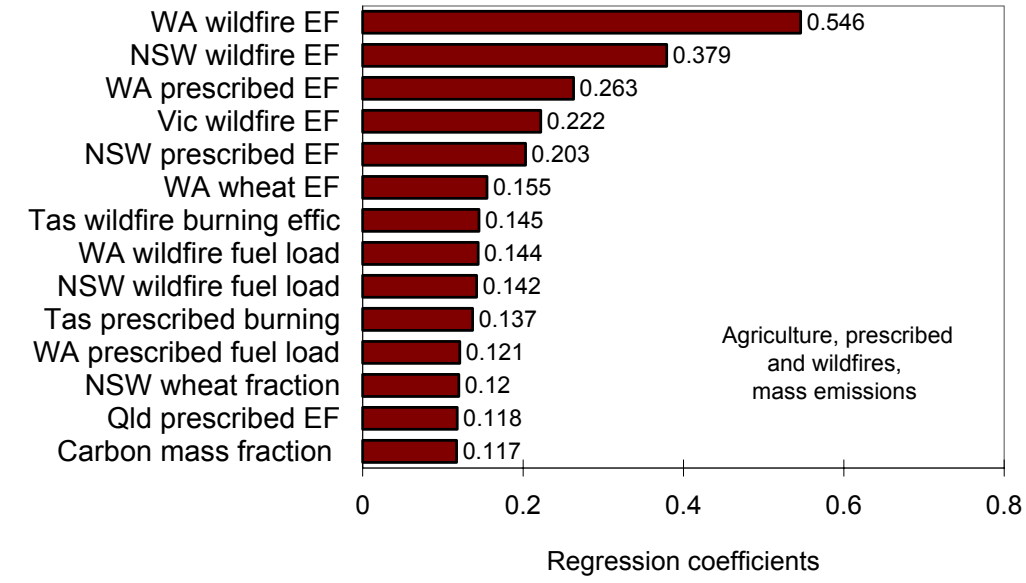

Figure A.4.7. Input sensitivity of total PCDD/PCDF and PCB mass emissions

A. All sources
B. Agriculture, prescribed fires and wildfires.

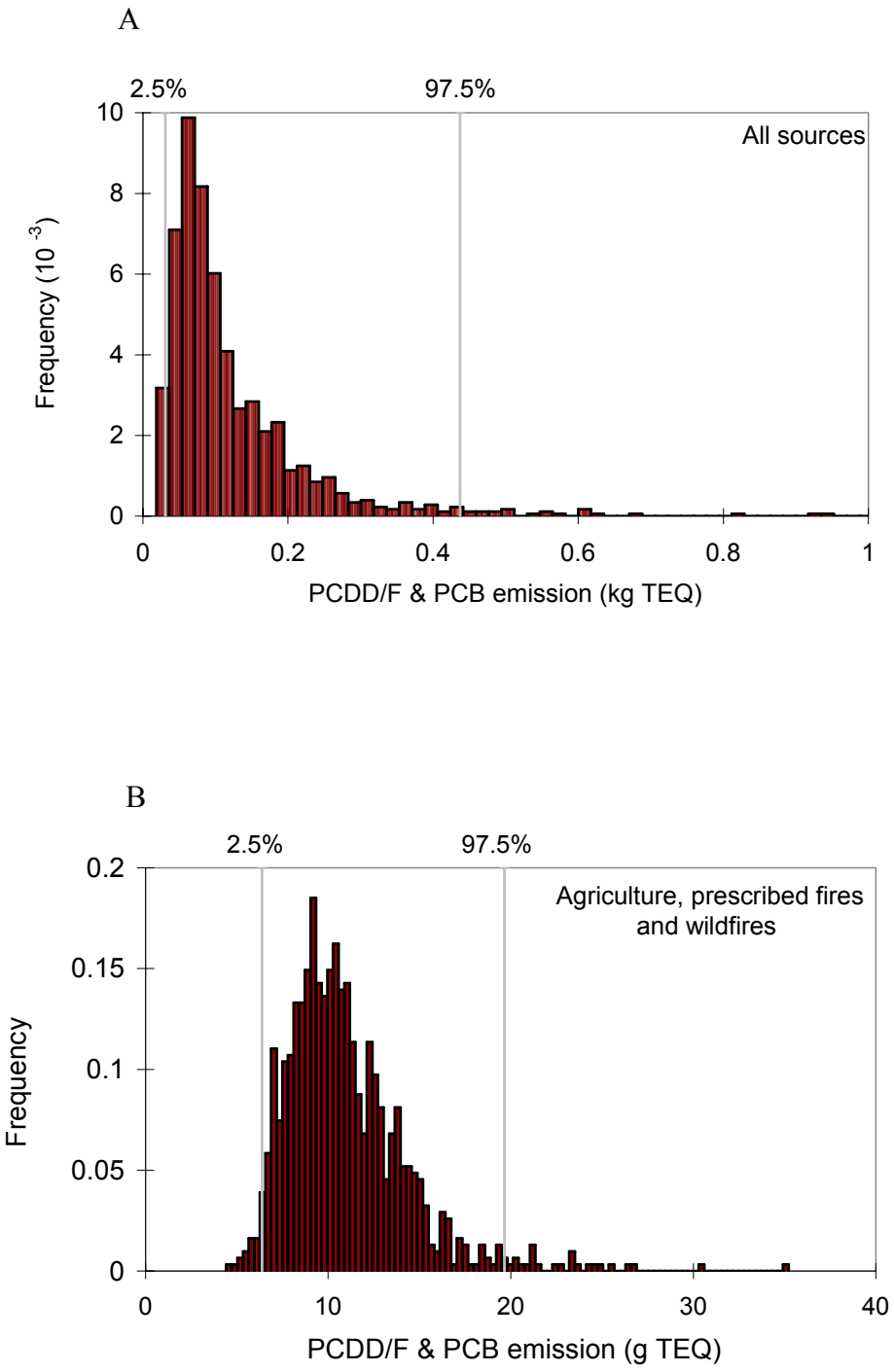

Figure A.4.8. Probability distribution of PCDD/PCDF and PCB TEQ emissions.

A. All field combustion sources
B. Agriculture, prescribed fires and wildfires in 1994.

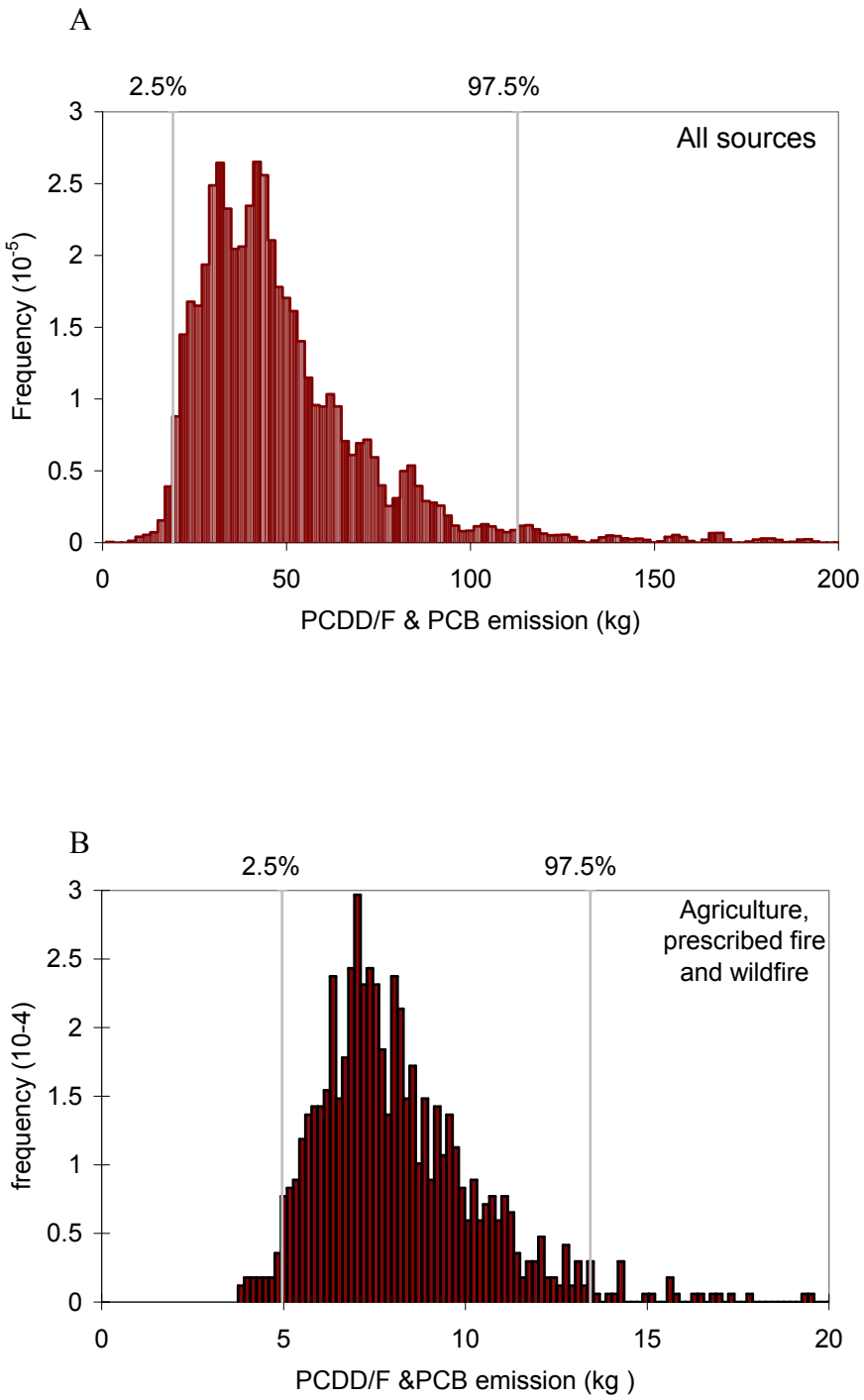

Figure A.4.9. Probability distribution of PCDD/PCDF and PCB mass emissions

A. All sources
B. Agriculture, prescribed fires and wildfires in 1994.

The uncertainty ranges presented in this analysis, therefore, are determined only in part by the uncertainties in the emission ratios. This is in contrast to the previous estimate (EA, 2002) in which the range was derived solely from the range in observed or assumed emission ratios. The current uncertainties are estimated from observed variability in emission ratios and assessed uncertainty in activity data aggregated

correctly from region and sector to national totals. The estimated probability distributions of the total emissions and emission from agriculture and forestry are shown in Figures A.4.8 and A.4.9.

The main purpose for illustrating the probability distributions of the emission estimates is to emphasise that by using measured emission ratios we are now able to indicate where within the potential range the most likely emission estimate occurs. Previously, this was not possible and all values in the range were considered equally probable. Because the upper limit of the previous range was equally probable and extra to all others the current study has been able to reduce the most likely estimate of Australia's emission from 1,708 to 152 g TEQ.

A4.2. Inventory Tables

The emissions of PCDDs, PCDFs and PCBs from Savanna fires, Wildfires in forests, and agricultural waste burning were calculated using activity data sourced for the National Greenhouse Gas Inventory, 2001 (AGO, 2003), and middle bound emission ratios (Table A.5.1a,b), corrected for ambient background concentration. The 95% ranges are defined as the 2.5 percentile to the 97.5 percentiles of the output frequency distributions. The emissions of total mass of the dioxin and furan homologue groups (TCDD/F to OCDD/F) and PCBs, and the emissions of 2,3,7,8,-PCDD/PCDF as TEQ are presented in Tables A.5.1 to A.5.35.

Table A.4.5. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1990. Mass emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g)								
1990	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	612	1491	397	256	154	28	836	2327	2939
	71 - 2051	272 - 4700	107 - 981	60 - 722	34 - 441	8 - 78	384.9 - 1606	928.9 - 5608	1241 - 6650
Tas	43.2	173	92.5	0.2	2.5	0.0	95	268	311
	4 - 150	28 - 519	24 - 245	0 - 0	1 - 7	0 - 0	26.5 - 247	89 - 681	116 - 749
WA	17996.1	1784	590.1	338.0	73.1	0.0	1001	2785	20782
	2766 - 61535	364 - 5431	156 - 1368	76 - 955	16 - 201	0 - 0	410.4 - 1993	1102.5 - 6373	5249 - 65469
SA	261.5	13.3	0.4	130.8	96.8	0.0	228	241	503
	33 - 961	2 - 42	0 - 1	31 - 363	20 - 262	0 - 0	83.1 - 506	94.1 - 526	179 - 1186
Vic	158.0	915	457.1	111.8	57.3	0.0	626	1541	1700
	21 - 570	168 - 2922	115 - 1410	28 - 299	13 - 149	0 - 0	238.9 - 1566	605.5 - 3450	739 - 3674
Qld	4168	230	226.2	107.9	73.4	387.0	795	1025	5193
	504 - 16281	39 - 679	60 - 586	25 - 302	17 - 198	98 - 1116	370.5 - 1524	518.8 - 1847	1428 - 17016
NT	13175	0.0	0.0	0.0	0.4	0.0	0.4	0	13176
	1626 - 48581	0 - 0	0 - 0	0 - 0	0 - 1	0 - 0	0.1 - 1	0.1 - 1.3	1626 - 48581
ACT	0.0	34.9	2.3	0.0	0.0	0.0	2.3	37.3	37.3
	0 - 0	7 - 104	1 - 7	0 - 0	0 - 0	0 - 0	0.6 - 7	8.6 - 105.7	9 - 106
Total	**36414**	**4642**	**1766**	**945**	**457**	**415**	**3580**	**8222**	**44636.1**
	11207 - 89715	1926 - 9778	879 - 3133	379 - 1970	174 - 963	113 - 1138	2070 - 6101	4763 - 13556	18960 - 100176

Table A.4.6. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1990.TEQ emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g TEQ)								
1990	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	2.26	1.72	0.79	0.44	0.26	0.05	1.54	3.27	5.52
	0.1 - 11.4	0.1 - 7.2	0.1 - 2.5	0.1 - 1.3	0.1 - 0.8	0.0 - 0.1	0.6 - 3.5	1.1 - 9.4	1.6 - 16.4
Tas	0.15	0.21	0.19	0.00	0.00	0.00	0.19	0.40	0.55
	0.0 - 0.7	0.0 - 0.9	0.0 - 0.7	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.7	0.1 - 1.2	0.1 - 1.6
WA	65.47	2.14	1.19	0.58	0.12	0.00	1.90	4.04	69.51
	2.9 - 354.2	0.2 - 9.0	0.2 - 4.0	0.1 - 1.7	0.0 - 0.4	0.0 - 0.0	0.6 - 4.8	1.2 - 11.6	6.0 - 356.8
SA	0.93	0.02	0.00	0.23	0.17	0.00	0.39	0.41	1.33
	0.0 - 4.9	0.0 - 0.1	0.0 - 0.0	0.0 - 0.7	0.0 - 0.5	0.0 - 0.0	0.1 - 0.9	0.1 - 0.9	0.3 - 5.3
Vic	0.54	1.11	0.90	0.19	0.10	0.00	1.19	2.30	2.84
	0.0 - 2.7	0.1 - 5.1	0.1 - 3.1	0.0 - 0.6	0.0 - 0.3	0.0 - 0.0	0.3 - 3.4	0.7 - 6.7	0.9 - 7.9
Qld	13.71	0.28	0.46	0.19	0.13	0.66	1.43	1.72	15.43
	0.6 - 63.0	0.0 - 1.3	0.1 - 1.6	0.0 - 0.6	0.0 - 0.4	0.1 - 2.0	0.6 - 3.0	0.7 - 3.6	2.1 - 65.5
NT	44.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.47
	2.0 - 225.6	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	2.0 - 225.6
ACT	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.05	0.05
	0.0 - 0.0	0.0 - 0.2	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.2	0.0 - 0.2
Total	**127.5**	**5.5**	**3.5**	**1.6**	**0.8**	**0.7**	**6.7**	**12.2**	**139.7**
	21.0 - 496	1.6 - 15.8	1.4 - 7.3	0.4 - 4.9	0.2 - 2.4	0.2 - 2.	3.7 - 11.1	6.7 - 22.7	31.9 - 504.4
EA review (2002)	**62-1240**	**7-400**					**3.4-68**	**10.4 - 468**	**72.4 -1708**

Table A.4.7. Australian National PCDD, PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1990. Mean and 95% confidence ranges.

	1990	Savanna fires	Wildfire	Prescribed fires	Crops	Agriculture and managed forests	Agriculture and forestry	Total	95% confidence range	
									Agriculture and forestry	Agriculture prescribed fires and wildfires
Mass	TCDD	15060.3	426.0	589.9	962.3	1552.2	1978.2	17038.4	963.4 - 2444	1268.6 - 3026
g	TCDF	5389.4	96.2	130.4	69.1	199.5	295.7	5685.1	100.2 - 362	157.1 - 547
	PCB	16079.4	4113.5	1038.0	781.5	1819.5	5933.0	22012.4	1043 - 3115	3418.9 - 10339
	TCDD/F	20766.9	520.6	721.1	1031.6	1752.7	2273.3	23040.2	917.6 - 3265.8	1262.7 - 4034
	Total	**36414**	**4642**	**1766**	**1814**	**3580**	**8222**	**44636**	**2070 - 6101**	**4763 - 13556**
TEQ	TCDD	116.5	4.0	2.5	2.8	5.2	9.3	125.8	2.4 - 8.5	5.1 - 16.9
g	TCDF	8.9	0.8	0.7	0.2	1.0	1.8	10.7	0.4 - 2.5	0.8 - 3.9
	PCB	3.7	0.8	0.4	0.1	0.5	1.3	5.0	0 - 0.8	0.7 - 2.4
	TCDD/F	126.7	4.8	3.2	3.0	6.2	11.0	137.6	3.6 - 10.8	6.0 - 20.5
	Total	**127.5**	**5.5**	**3.5**	**3.1**	**6.7**	**12.2**	**139.7**	**3.7 - 11.1**	**6.7 - 22.7**

Table A.4.8. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1991. Mass emissions (mean and 95% confidence ranges).

=State	PCDD/PCDF and PCB Emission (g)								
1991	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	586	1727	380	213	155	27	776	2502	3088
	65 - 2306	326 - 5255	106 - 971	50 - 572	35 - 435	7 - 73	358.8 - 1513	943.9 - 6205	1290 - 6993
Tas	39.4	171	85.5	0.2	2.7	0.0	88	259	298
	4 - 136	31 - 575	20 - 241	0 - 0	1 - 8	0 - 0	21.9 - 247	88 - 704	112 - 747
WA	18117.4	1824	600.5	324.8	82.1	0.0	1007	2832	20949
	2629 - 57080	366 - 5273	167 - 1491	78 - 872	20 - 249	0 - 0	426.6 - 1980	1071.5 - 6422	5471 - 61232
SA	262.5	12.0	0.6	146.6	114.3	0.0	261	273	536
	34 - 1001	2 - 38	0 - 2	36 - 415	26 - 326	0 - 0	100.4 - 570	112.6 - 591	204 - 1348
Vic	145.1	838	441.7	102.1	64.7	0.0	608	1447	1592
	19 - 548	134 - 2578	109 - 1276	23 - 291	15 - 174	0 - 0	243.1 - 1409	560.8 - 3343	653 - 3444
Qld	4224	226	227.7	82.1	69.0	337.0	716	942	5166
	531 - 15318	43 - 722	62 - 640	19 - 233	16 - 185	82 - 931	332.4 - 1367	462.4 - 1758	1353 - 15952
NT	13220	0.0	0.0	0.0	0.4	0.0	0.4	0	13220
	1727 - 47820	0 - 0	0 - 0	0 - 0	0 - 1	0 - 0	0.1 - 1	0.1 - 1.1	1727 - 47820
ACT	0.0	34.6	2.4	0.0	0.0	0.0	2.4	36.9	36.9
	0 - 0	7 - 105	1 - 7	0 - 0	0 - 0	0 - 0	0.6 - 7	8.5 - 107.2	8 - 107
Total	**36595**	**4832**	**1738**	**869**	**489**	**364**	**3457**	**8289**	**44883.2**
	12027 - 94666	2083 - 9976	909 - 3119	352 - 1877	191 - 1025	98 - 962	2064 - 5603	5020 - 13683	19888 - 101437

Table A.4.9. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1991. TEQ emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g TEQ)								
1991	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	1.92	2.05	0.76	0.36	0.27	0.05	1.44	3.49	5.41
	0.1 - 9.7	0.2 - 9.6	0.1 - 2.5	0.1 - 1.1	0.1 - 0.8	0.0 - 0.1	0.6 - 3.4	1.1 - 10.8	1.7 - 16.8
Tas	0.14	0.21	0.17	0.00	0.00	0.00	0.18	0.38	0.53
	0.0 - 0.8	0.0 - 0.9	0.0 - 0.6	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.6	0.1 - 1.2	0.1 - 1.5
WA	62.32	2.20	1.22	0.56	0.14	0.00	1.92	4.13	66.45
	3.3 - 287.7	0.2 - 8.7	0.2 - 4.4	0.1 - 1.6	0.0 - 0.4	0.0 - 0.0	0.6 - 5.0	1.3 - 11.2	7.2 - 293.3
SA	0.84	0.01	0.00	0.25	0.20	0.00	0.45	0.47	1.31
	0.0 - 4.4	0.0 - 0.1	0.0 - 0.0	0.1 - 0.7	0.0 - 0.6	0.0 - 0.0	0.1 - 1.1	0.2 - 1.1	0.3 - 4.8
Vic	0.48	1.01	0.88	0.17	0.11	0.00	1.17	2.18	2.66
	0.0 - 2.3	0.1 - 3.9	0.1 - 3.0	0.0 - 0.5	0.0 - 0.3	0.0 - 0.0	0.3 - 3.3	0.7 - 5.7	0.9 - 6.9
Qld	13.97	0.28	0.47	0.14	0.12	0.58	1.31	1.59	15.56
	0.6 - 70.8	0.0 - 1.1	0.1 - 1.6	0.0 - 0.4	0.0 - 0.3	0.1 - 1.7	0.5 - 2.9	0.7 - 3.4	1.9 - 72.7
NT	45.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.43
	2.1 - 244.3	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	2.1 - 244.3
ACT	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.05	0.05
	0.0 - 0.0	0.0 - 0.2	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.2	0.0 - 0.2
Total	**125.1**	**5.8**	**3.5**	**1.5**	**0.9**	**0.6**	**6.5**	**12.3**	**137.4**
	19.2 - 444	1.5 - 17.9	1.4 - 7.3	0.3 - 4.3	0.2 - 2.7	0.1 - 1.9	3.8 - 11.0	6.9 - 24.8	31.9 - 455.0
EA review (2002)	**62-1240**	**7-400**					**3.4-68**	**10.4 - 468**	**72.4 -1708**

Table A.4.10. Australian National PCDD, PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1991. Mean and 95% confidence ranges.

1991	Savanna fires	Wildfire	Prescribed fires	Crops	Agriculture and managed forests	Agriculture and forestry	Total	95% confidence range	
								Agriculture and forestry	Agriculture prescribed fires and wildfires
TCDD	15008.9	454.4	581.1	916.2	1497.3	1951.7	16960.7	939.2 - 2378	1263.2 - 3124
TCDF	5302.0	101.3	128.1	65.8	193.9	295.2	5597.2	99.4 - 352	156.9 - 536
PCB	15869.3	4274.6	1031.2	742.1	1773.3	6048.0	21917.3	972 - 3030	3374.8 - 10532
TCDD/F	20328.1	554.0	716.2	985.6	1701.8	2255.7	22583.8	884.8 - 3077.6	1261.3 - 3870
Total	**36595**	**4832**	**1738**	**1719**	**3457**	**8289**	**44883**	**2064 - 5603**	**5020 - 13683**
TCDD	110.2	4.2	2.5	2.6	5.1	9.3	119.5	2.4 - 8.7	5.2 - 17.4
TCDF	8.9	0.8	0.7	0.2	1.0	1.8	10.7	0.4 - 2.4	0.8 - 4.0
PCB	3.7	0.8	0.4	0.1	0.5	1.3	5.0	0 - 0.9	0.7 - 2.4
TCDD/F	119.2	5.0	3.2	2.9	6.1	11.1	130.3	3.4 - 10.5	6.0 - 21.3
Total	**125.1**	**5.8**	**3.5**	**3.0**	**6.5**	**12.3**	**137.4**	**3.8 - 11.0**	**6.9 - 24.8**

Table A.4.11. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1992. Mass emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g)								
1992	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	564	1454	394	217	170	31	811	2266	2830
	54 - 2197	258 - 4654	106 - 1031	50 - 604	40 - 504	8 - 84	371.4 - 1579	879.4 - 5261	1157 - 6429
Tas	35.5	114	82.9	0.2	3.1	0.0	86	201	236
	4 - 124	19 - 355	21 - 229	0 - 1	1 - 9	0 - 0	24.5 - 231	69 - 483	95 - 524
WA	17492.1	1961	601.0	353.5	91.6	0.0	1046	3007	20499
	2696 - 60233	402 - 6183	167 - 1527	80 - 958	22 - 253	0 - 0	464.8 - 2141	1261.7 - 7501	5352 - 63190
SA	242.1	2.4	0.6	143.1	115.7	0.0	259	262	504
	27 - 906	0 - 7	0 - 2	36 - 391	28 - 327	0 - 0	92.4 - 613	95.2 - 615	177 - 1142
Vic	118.7	817	417.5	102.4	75.7	0.0	596	1412	1531
	13 - 413	152 - 2528	100 - 1179	22 - 303	18 - 214	0 - 0	227.7 - 1364	547.9 - 3247	630 - 3358
Qld	4140	148	232.4	66.7	62.0	336.1	697	845	4985
	588 - 15690	28 - 445	55 - 660	16 - 173	15 - 176	80 - 897	311.3 - 1414	410.3 - 1595	1312 - 16560
NT	12156	0.0	0.0	0.0	0.3	0.0	0.3	0	12156
	1418 - 42993	0 - 0	0 - 0	0 - 0	0 - 1	0 - 0	0.1 - 1	0.1 - 0.8	1418 - 42993
ACT	0.0	23.9	2.2	0.0	0.0	0.0	2.2	26.1	26.1
	0 - 0	4 - 72	1 - 6	0 - 0	0 - 0	0 - 0	0.6 - 6	6.1 - 74.2	6 - 74
Total	**34749**	**4520**	**1730**	**883**	**518**	**367**	**3482**	**8002**	**42750.7**
	10484 - 87199	1768 - 9996	871 - 3178	349 - 1950	203 - 1080	108 - 927	2006 - 5492	4745 - 13237	18164 - 95850

Table A.4.12. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1992. TEQ emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g TEQ)								
1992	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	1.90	1.73	0.78	0.37	0.29	0.05	1.50	3.23	5.13
	0.1 - 10.8	0.2 - 7.2	0.1 - 2.7	0.1 - 1.1	0.1 - 0.9	0.0 - 0.2	0.6 - 3.5	1.0 - 9.2	1.5 - 16.5
Tas	0.12	0.14	0.17	0.00	0.01	0.00	0.17	0.31	0.43
	0.0 - 0.6	0.0 - 0.7	0.0 - 0.6	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.6	0.1 - 1.0	0.1 - 1.2
WA	60.98	2.37	1.20	0.61	0.16	0.00	1.98	4.34	65.32
	3.4 - 364.2	0.2 - 9.9	0.2 - 4.4	0.1 - 1.8	0.0 - 0.5	0.0 - 0.0	0.7 - 5.4	1.4 - 11.9	6.2 - 369.1
SA	0.84	0.00	0.00	0.25	0.20	0.00	0.45	0.45	1.29
	0.0 - 4.9	0.0 - 0.0	0.0 - 0.0	0.0 - 0.7	0.0 - 0.6	0.0 - 0.0	0.2 - 1.0	0.2 - 1.0	0.3 - 5.4
Vic	0.40	0.97	0.83	0.17	0.13	0.00	1.14	2.11	2.51
	0.0 - 2.1	0.1 - 4.1	0.1 - 2.8	0.0 - 0.5	0.0 - 0.4	0.0 - 0.0	0.3 - 3.0	0.6 - 6.0	0.8 - 6.7
Qld	14.45	0.18	0.47	0.11	0.11	0.58	1.26	1.44	15.89
	0.6 - 70.4	0.0 - 0.7	0.1 - 1.7	0.0 - 0.3	0.0 - 0.3	0.1 - 1.7	0.5 - 2.8	0.6 - 3.0	1.9 - 72.0
NT	42.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	42.33
	1.7 - 229.4	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	1.7 - 229.4
ACT	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.03
	0.0 - 0.0	0.0 - 0.1	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.1	0.0 - 0.1
Total	**121.0**	**5.4**	**3.5**	**1.5**	**0.9**	**0.6**	**6.5**	**11.9**	**132.9**
	20.2 - 461	1.3 - 15.5	1.4 - 7.7	0.3 - 4.5	0.2 - 2.8	0.1 - 1.8	3.8 - 11.4	6.4 - 22.3	31.7 - 471.5
EA review (2002)	**62-1240**	**7-400**					**3.4-68**	**10.4 - 468**	**72.4 -1708**

Table A.4.13. Australian National PCDD, PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1992. Mean and 95% confidence ranges.

	1992	Savanna fires	Wildfire	Prescribed fires	Crops	Agriculture and managed forests	Agriculture and forestry	Total	95% confidence range	
									Agriculture and forestry	Agriculture prescribed fires and wildfires
Mass	TCDD	14471.9	423.7	578.1	938.4	1516.5	1940.2	16412.0	923.7 - 2414	1226.0 - 2971
g	TCDF	5157.5	92.6	128.0	67.5	195.4	288.1	5445.5	99.5 - 368	149.6 - 523
	PCB	15217.9	3973.5	1018.1	760.0	1778.1	5751.7	20969.6	988 - 3014	3278.1 - 9923
	TCDD/F	19982.3	508.9	712.6	1007.4	1719.9	2228.8	22211.2	857.3 - 3242.8	1233.4 - 3882
	Total	**34749**	**4520**	**1730**	**1752**	**3482**	**8002**	**42751**	**2006 - 5492**	**4745 - 13237**
TEQ	TCDD	108.6	3.9	2.4	2.7	5.1	9.0	117.6	2.4 - 8.2	5.1 - 16.6
g	TCDF	8.3	0.8	0.7	0.2	0.9	1.7	10.0	0.4 - 2.3	0.8 - 3.6
	PCB	3.6	0.8	0.3	0.1	0.5	1.2	4.9	0 - 0.8	0.7 - 2.5
	TCDD/F	116.9	4.6	3.1	2.9	6.1	10.7	127.6	3.4 - 10.5	5.7 - 20.8
	Total	**121.0**	**5.4**	**3.5**	**3.0**	**6.5**	**11.9**	**132.9**	**3.8 - 11.4**	**6.4 - 22.3**

Table A.4.14. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1993. Mass emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g)								
1993	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	609	1546	424	237	189	34	885	2430	3039
	72 - 2299	248 - 4870	115 - 1045	58 - 656	45 - 518	9 - 90	438.8 - 1698	988.5 - 5752	1348 - 6588
Tas	33.1	105	73.8	0.3	3.4	0.0	77	183	216
	4 - 128	21 - 349	19 - 216	0 - 1	1 - 9	0 - 0	21.5 - 218	63 - 446	82 - 471
WA	17964.2	2126	603.0	383.7	105.5	0.0	1092	3218	21182
	2805 - 62811	439 - 6260	180 - 1651	87 - 1144	25 - 310	0 - 0	475.4 - 2350	1275.3 - 7414	5278 - 66788
SA	251.1	2.4	0.6	146.2	129.9	0.0	277	279	530
	32 - 916	0 - 8	0 - 2	34 - 395	28 - 367	0 - 0	100.5 - 603	101.7 - 606	187 - 1237
Vic	120.3	397	458.1	113.6	92.4	0.0	664	1061	1181
	14 - 443	68 - 1145	115 - 1240	28 - 323	23 - 263	0 - 0	271.4 - 1453	472.4 - 2094	541 - 2219
Qld	4203	160	233.7	36.1	63.9	349.1	683	842	5045
	535 - 15662	28 - 459	54 - 625	9 - 107	15 - 184	84 - 902	294.2 - 1390	394.7 - 1603	1216 - 16577
NT	13154	0.0	0.0	0.0	0.2	0.0	0.2	0	13154
	1544 - 45483	0 - 0	0 - 0	0 - 0	0 - 1	0 - 0	0.1 - 1	0.1 - 0.6	1544 - 45483
ACT	0.0	21.4	2.1	0.0	0.0	0.0	2.1	23.5	23.5
	0 - 0	4 - 64	1 - 6	0 - 0	0 - 0	0 - 0	0.5 - 6	5.6 - 65.2	6 - 65
Total	**36334**	**4357**	**1795**	**917**	**584**	**384**	**3690**	**8047**	**44381.1**
	11474 - 91750	1625 - 9648	897 - 3196	349 - 2045	235 - 1207	107 - 942	2132 - 6316	4787 - 13785	19208 - 97989

Table A.4.15. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1993. TEQ emissions (mean and 95% confidence ranges).

=State	PCDD/PCDF and PCB Emission (g TEQ)								
1993	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	2.18	1.88	0.84	0.41	0.32	0.06	1.64	3.52	5.70
	0.1 - 11.0	0.1 - 8.1	0.1 - 2.9	0.1 - 1.2	0.1 - 1.0	0.0 - 0.2	0.7 - 3.9	1.1 - 9.9	1.7 - 18.2
Tas	0.11	0.13	0.15	0.00	0.01	0.00	0.15	0.28	0.40
	0.0 - 0.6	0.0 - 0.5	0.0 - 0.5	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.5	0.1 - 0.9	0.1 - 1.1
WA	60.31	2.53	1.22	0.65	0.18	0.00	2.05	4.58	64.89
	3.0 - 279.8	0.2 - 11.1	0.2 - 4.2	0.1 - 1.9	0.0 - 0.6	0.0 - 0.0	0.7 - 5.4	1.4 - 12.7	6.2 - 285.5
SA	0.85	0.00	0.00	0.25	0.22	0.00	0.48	0.48	1.33
	0.0 - 4.7	0.0 - 0.0	0.0 - 0.0	0.1 - 0.7	0.0 - 0.7	0.0 - 0.0	0.2 - 1.1	0.2 - 1.1	0.3 - 5.0
Vic	0.41	0.47	0.92	0.20	0.16	0.00	1.28	1.75	2.17
	0.0 - 2.2	0.0 - 2.0	0.1 - 3.2	0.0 - 0.6	0.0 - 0.5	0.0 - 0.0	0.4 - 3.6	0.6 - 4.5	0.7 - 5.7
Qld	14.63	0.19	0.47	0.06	0.11	0.60	1.24	1.44	16.06
	0.6 - 74.1	0.0 - 0.9	0.1 - 1.9	0.0 - 0.2	0.0 - 0.3	0.1 - 1.8	0.5 - 2.8	0.6 - 3.2	1.7 - 75.2
NT	43.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.18
	1.9 - 224.1	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	1.9 - 224.1
ACT	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.03
	0.0 - 0.0	0.0 - 0.1	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.1	0.0 - 0.1
Total	**121.7**	**5.2**	**3.6**	**1.6**	**1.0**	**0.7**	**6.8**	**12.1**	**133.8**
	20.3 - 415	1.2 - 16.8	1.3 - 7.7	0.3 - 4.7	0.2 - 2.9	0.2 - 1.8	3.9 - 11.4	6.4 - 24.1	32.2 - 422.7
EA review (2002)	**62-1240**	**7-400**					**3.4-68**	**10.4 - 468**	**72.4 -1708**

Table A.4.16. Australian National PCDD, PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1993. Mean and 95% confidence ranges.

	1993	Savanna fires	Wildfire	Prescribed fires	Crops	Agriculture and managed forests	Agriculture and forestry	Total	95% confidence range	
									Agriculture and forestry	Agriculture prescribed fires and wildfires
Mass	TCDD	15200.3	397.8	601.5	999.2	1600.6	1998.5	17198.8	1009.7 - 2558	1235.9 - 3129
g	TCDF	5209.2	89.5	132.4	72.1	204.4	294.0	5503.1	108.2 - 390	159.7 - 541
	PCB	15789.5	3831.3	1066.3	811.3	1877.6	5708.9	21498.4	1050 - 3264	3219.6 - 10189
	TCDD/F	20297.1	494.7	738.4	1075.1	1813.6	2308.3	22605.3	905.9 - 3410.5	1209.0 - 4108
	Total	**36334**	**4357**	**1795**	**1895**	**3690**	**8047**	**44381**	**2132 - 6316**	**4787 - 13785**
TEQ	TCDD	114.2	3.7	2.5	2.9	5.4	9.1	123.3	2.4 - 8.9	4.9 - 16.8
g	TCDF	8.9	0.7	0.8	0.2	1.0	1.7	10.6	0.4 - 2.5	0.8 - 3.9
	PCB	3.7	0.7	0.4	0.1	0.5	1.2	4.9	0 - 0.9	0.6 - 2.5
	TCDD/F	120.4	4.5	3.3	3.1	6.4	10.9	131.3	3.7 - 11.2	5.6 - 21.1
	Total	**121.7**	**5.2**	**3.6**	**3.2**	**6.8**	**12.1**	**133.8**	**3.9 - 11.4**	**6.4 - 24.1**

Table A.4.17. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1994. Mass emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g)								
1994	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	255	1348	447	209	172	39	867	2215	2470
	29 - 920	269 - 4368	117 - 1205	53 - 618	42 - 481	10 - 108	398.7 - 1834	880.7 - 5200	1040 - 5404
Tas	36.8	156	66.3	0.3	3.2	0.0	70	226	263
	5 - 129	27 - 479	16 - 191	0 - 1	1 - 9	0 - 0	18.9 - 194	80 - 553	100 - 622
WA	18490.9	2141	593.7	393.9	98.5	0.0	1086	3227	21718
	2901 - 60616	454 - 6165	155 - 1431	96 - 1007	24 - 260	0 - 0	474.1 - 2106	1268.4 - 7314	5474 - 64200
SA	242.9	0.6	0.6	131.8	114.6	0.0	247	248	490
	33 - 892	0 - 2	0 - 2	31 - 395	28 - 318	0 - 0	87.5 - 561	87.8 - 561	181 - 1241
Vic	67.7	202	468.1	109.1	82.4	0.0	660	862	929
	8 - 236	38 - 606	112 - 1263	25 - 311	20 - 237	0 - 0	250.8 - 1485	390.9 - 1801	440 - 1895
Qld	4160	194	215.3	33.2	59.5	395.6	704	898	5058
	497 - 15944	35 - 606	49 - 584	7 - 93	13 - 166	105 - 1053	307.5 - 1429	431.5 - 1741	1289 - 16488
NT	14403	0.0	0.0	0.0	0.2	0.0	0.2	0	14403
	1580 - 54530	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0.0 - 0	0.0 - 0.5	1580 - 54530
ACT	0.0	18.8	1.9	0.0	0.0	0.0	1.9	20.7	20.7
	0 - 0	3 - 59	0 - 5	0 - 0	0 - 0	0 - 0	0.4 - 5	4.9 - 63.5	5 - 64
Total	**37656**	**4061**	**1793**	**877**	**530**	**435**	**3638**	**7699**	**45354.9**
	10949 - 95942	1598 - 8879	952 - 3124	344 - 1883	206 - 1132	133 - 1092	2175 - 5790	4445 - 12758	18581 - 101867

Table A.4.18. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1994. TEQ emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g TEQ)								
1994	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	0.85	1.65	0.91	0.36	0.30	0.07	1.63	3.28	4.14
	0.0 - 4.8	0.1 - 7.4	0.1 - 3.1	0.1 - 1.1	0.1 - 0.8	0.0 - 0.2	0.6 - 3.9	1.1 - 9.6	1.4 - 11.4
Tas	0.12	0.19	0.13	0.00	0.01	0.00	0.14	0.33	0.45
	0.0 - 0.6	0.0 - 0.9	0.0 - 0.4	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.5	0.1 - 1.1	0.1 - 1.3
WA	66.10	2.55	1.20	0.69	0.17	0.00	2.05	4.61	70.71
	3.3 - 317.2	0.2 - 10.9	0.2 - 3.9	0.1 - 2.0	0.0 - 0.5	0.0 - 0.0	0.6 - 4.9	1.4 - 12.7	6.6 - 320.1
SA	0.89	0.00	0.00	0.23	0.20	0.00	0.42	0.42	1.31
	0.0 - 4.6	0.0 - 0.0	0.0 - 0.0	0.0 - 0.7	0.0 - 0.6	0.0 - 0.0	0.2 - 1.0	0.2 - 1.0	0.3 - 5.0
Vic	0.22	0.24	0.95	0.19	0.14	0.00	1.27	1.51	1.73
	0.0 - 1.0	0.0 - 1.0	0.2 - 3.5	0.0 - 0.6	0.0 - 0.4	0.0 - 0.0	0.4 - 3.8	0.5 - 4.2	0.6 - 4.5
Qld	14.01	0.24	0.43	0.06	0.10	0.68	1.27	1.51	15.52
	0.5 - 71.4	0.0 - 1.1	0.1 - 1.6	0.0 - 0.2	0.0 - 0.3	0.2 - 2.0	0.5 - 2.9	0.6 - 3.3	1.9 - 73.3
NT	47.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.75
	2.2 - 263.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	2.2 - 263.0
ACT	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.03	0.03
	0.0 - 0.0	0.0 - 0.1	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.1	0.0 - 0.1
Total	**129.9**	**4.9**	**3.6**	**1.5**	**0.9**	**0.7**	**6.8**	**11.7**	**141.6**
	19.8 - 476	1.1 - 15.2	1.4 - 7.9	0.4 - 4.5	0.2 - 2.6	0.2 - 2.1	3.9 - 11.8	6.2 - 23.2	30.8 - 494.4
EA review (2002)	**62-1240**	**7-400**					**3.4-68**	**10.4 - 468**	**72.4 –1708**

Table A.4.19. Australian National PCDD, PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1994. Mean and 95% confidence ranges.

	1994	Savanna fires	Wildfire	Prescribed fires	Crops	Agriculture and managed forests	Agriculture and forestry	Total	95% confidence range	
									Agriculture and forestry	Agriculture prescribed fires and wildfires
Mass	TCDD	15445.6	376.8	595.3	979.8	1575.2	1952.0	17397.6	1001.0 - 2478	1219.9 - 3070
g	TCDF	5440.0	84.3	132.5	70.3	202.7	287.0	5727.0	108.2 - 379	149.3 - 529
	PCB	16324.8	3596.3	1064.4	795.3	1859.6	5455.9	21780.7	1032 - 3251	3114.6 - 9336
	TCDD/F	21226.5	462.9	728.7	1048.9	1777.5	2240.4	23467.0	955.3 - 3368.3	1266.1 - 4080
	Total	**37656**	**4061**	**1793**	**1845**	**3638**	**7699**	**45355**	**2175 - 5790**	**4445 - 12758**
TEQ	TCDD	116.3	3.5	2.5	2.8	5.4	8.9	125.2	2.5 - 8.7	4.9 - 16.4
g	TCDF	9.2	0.7	0.8	0.2	1.0	1.7	10.9	0.4 - 2.6	0.8 - 3.9
	PCB	3.9	0.7	0.4	0.1	0.5	1.2	5.1	0 - 0.9	0.6 - 2.4
	TCDD/F	126.9	4.2	3.3	3.1	6.3	10.6	137.5	3.5 - 10.9	5.6 - 20.8
	Total	**129.9**	**4.9**	**3.6**	**3.2**	**6.8**	**11.7**	**141.6**	**3.9 - 11.8**	**6.2 - 23.2**

Table A.4.20. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1995. Mass emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g)								
1995	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	249	1340	448	232	183	40	902	2242	2491
	29 - 873	253 - 4195	131 - 1103	48 - 604	42 - 502	10 - 109	417.1 - 1732	945.1 - 5258	1152 - 5484
Tas	28.1	211	53.0	0.3	3.3	0.0	57	267	295
	4 - 108	35 - 660	14 - 141	0 - 1	1 - 9	0 - 0	16.4 - 146	80 - 719	99 - 758
WA	20119.3	2405	617.3	415.3	105.0	0.5	1138	3543	23662
	3143 - 69427	524 - 7134	182 - 1600	95 - 1136	24 - 302	0 - 1	498.8 - 2304	1367.2 - 8265	6046 - 73671
SA	240.0	0.5	0.7	138.6	116.5	0.0	256	256	496
	25 - 944	0 - 2	0 - 2	33 - 393	28 - 344	0 - 0	93.9 - 569	94.5 - 569	174 - 1220
Vic	64.9	203	478.8	108.6	86.9	0.0	674	877	942
	8 - 223	38 - 628	126 - 1314	24 - 308	22 - 250	0 - 0	271.8 - 1491	381.7 - 1765	431 - 1860
Qld	4283	198	188.0	28.6	74.5	401.5	693	891	5174
	471 - 15288	35 - 619	45 - 538	6 - 78	15 - 208	99 - 1068	304.6 - 1410	424.2 - 1722	1237 - 16254
NT	16321	0.0	0.0	0.0	0.1	0.0	0.1	0	16321
	1934 - 60948	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0.0 - 0	0.0 - 0.4	1935 - 60948
ACT	0.0	16.8	1.7	0.0	0.0	0.0	1.7	18.5	18.5
	0 - 0	3 - 51	0 - 5	0 - 0	0 - 0	0 - 0	0.4 - 5	4.9 - 53.9	5 - 54
Total	**41305**	**4373**	**1787**	**923**	**569**	**442**	**3715**	**8089**	**49393.6**
	12430 - 103351	1627 - 10282	903 - 3291	332 - 2022	233 - 1172	125 - 1143	2187 - 6255	4686 - 14357	20684 - 112177

Table A.4.21. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1995. TEQ emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g TEQ)								
1995	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	0.90	1.61	0.90	0.40	0.31	0.07	1.68	3.30	4.20
	0.0 - 4.9	0.1 - 6.9	0.2 - 3.0	0.1 - 1.2	0.1 - 0.8	0.0 - 0.2	0.6 - 4.0	1.1 - 9.0	1.4 - 11.8
Tas	0.10	0.24	0.11	0.00	0.01	0.00	0.11	0.35	0.45
	0.0 - 0.5	0.0 - 0.9	0.0 - 0.4	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.4	0.1 - 1.1	0.1 - 1.3
WA	69.75	2.81	1.25	0.72	0.18	0.00	2.15	4.96	74.71
	3.6 - 328.0	0.2 - 10.9	0.2 - 4.3	0.2 - 2.1	0.0 - 0.5	0.0 - 0.0	0.7 - 5.4	1.6 - 13.1	7.5 - 331.8
SA	0.84	0.00	0.00	0.24	0.20	0.00	0.44	0.44	1.28
	0.0 - 4.1	0.0 - 0.0	0.0 - 0.0	0.0 - 0.7	0.0 - 0.7	0.0 - 0.0	0.1 - 1.0	0.2 - 1.0	0.3 - 4.4
Vic	0.23	0.24	0.97	0.18	0.15	0.00	1.31	1.55	1.78
	0.0 - 1.3	0.0 - 1.0	0.1 - 3.4	0.0 - 0.5	0.0 - 0.5	0.0 - 0.0	0.4 - 3.8	0.5 - 4.2	0.6 - 4.6
Qld	14.25	0.23	0.37	0.05	0.13	0.69	1.23	1.47	15.72
	0.6 - 73.4	0.0 - 1.0	0.1 - 1.1	0.0 - 0.1	0.0 - 0.4	0.2 - 2.0	0.5 - 2.7	0.6 - 3.1	1.9 - 74.0
NT	56.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56.40
	2.4 - 293.5	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	2.4 - 293.5
ACT	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.02
	0.0 - 0.0	0.0 - 0.1	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.1	0.0 - 0.1
Total	**142.5**	**5.2**	**3.6**	**1.6**	**1.0**	**0.8**	**6.9**	**12.1**	**154.6**
	20.9 - 559	1.4 - 14.7	1.4 - 8.0	0.3 - 4.6	0.2 - 2.7	0.2 - 2.2	4.0 - 12.2	6.6 - 22.0	32.1 - 572.2
EA review (2002)	**62-1240**	**7-400**					**3.4-68**	**10.4 - 468**	**72.4 -1708**

Table A.4.22. Australian National PCDD, PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1995. Mean and 95% confidence ranges.

	1995	Savanna fires	Wildfire	Prescribed fires	Crops	Agriculture and managed forests	Agriculture and forestry	Total	95% confidence range	
									Agriculture and forestry	Agriculture prescribed fires and wildfires
Mass	TCDD	16646.3	405.5	597.5	1025.2	1622.7	2028.2	18674.5	1027.1 - 2589	1269.9 - 3200
g	TCDF	6014.1	91.8	132.1	73.5	205.6	297.4	6311.4	114.4 - 381	159.3 - 564
	PCB	18145.3	3891.7	1059.4	827.1	1886.5	5778.2	23923.6	1074 - 3339	3181.3 - 10405
	TCDD/F	24017.6	494.8	726.3	1101.9	1828.2	2322.9	26340.6	893.1 - 3500.6	1214.0 - 4226
	Total	**41305**	**4373**	**1787**	**1928**	**3715**	**8089**	**49394**	**2187 - 6255**	**4686 - 14357**
TEQ	TCDD	124.7	3.7	2.5	3.0	5.4	9.1	133.8	2.4 - 8.8	5.2 - 17.2
g	TCDF	10.2	0.7	0.7	0.2	1.0	1.7	11.9	0.4 - 2.6	0.7 - 3.9
	PCB	4.2	0.7	0.4	0.1	0.5	1.2	5.5	0 - 0.8	0.6 - 2.6
	TCDD/F	139.5	4.6	3.2	3.2	6.4	11.0	150.5	3.5 - 10.9	5.8 - 22.2
	Total	**142.5**	**5.2**	**3.6**	**3.3**	**6.9**	**12.1**	**154.6**	**4.0 - 12.2**	**6.6 - 22.0**

Table A.4.23. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1996. Mass emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g)								
1996	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	236	1137	463	297	201	43	1004	2141	2377
	28 - 914	214 - 3362	134 - 1218	74 - 794	44 - 567	11 - 113	456.1 - 1929	945.1 - 4386	1116 - 4659
Tas	22.9	247	46.0	0.3	3.3	0.0	50	296	319
	3 - 79	44 - 753	11 - 125	0 - 1	1 - 10	0 - 0	14.2 - 128	83 - 812	98 - 821
WA	20859.4	2328	667.6	428.5	110.1	1.6	1208	3535	24395
	3250 - 71894	485 - 6631	193 - 1738	107 - 1138	26 - 334	0 - 4	508.2 - 2455	1470.1 - 7847	5956 - 75329
SA	227.0	0.5	0.7	151.5	112.5	0.0	265	265	492
	26 - 818	0 - 1	0 - 2	36 - 410	27 - 327	0 - 0	100.5 - 590	100.8 - 590	178 - 1139
Vic	60.1	201	458.8	111.3	85.4	0.0	655	857	917
	7 - 208	37 - 628	114 - 1343	27 - 295	19 - 230	0 - 0	266.5 - 1525	387.3 - 1815	432 - 1889
Qld	4099	197	169.4	59.9	82.2	379.5	691	888	4987
	522 - 14694	36 - 572	45 - 478	14 - 170	18 - 232	100 - 999	329.2 - 1346	439.2 - 1616	1292 - 15465
NT	17499	0.0	0.0	0.0	0.1	0.0	0.1	0	17499
	1854 - 68296	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0.0 - 0	0.0 - 0.3	1854 - 68296
ACT	0.0	14.5	1.5	0.0	0.0	0.0	1.5	16.0	16.0
	0 - 0	3 - 44	0 - 4	0 - 0	0 - 0	0 - 0	0.4 - 4	4.1 - 46.4	4 - 46
Total	**43003**	**4124**	**1807**	**1049**	**594**	**424**	**3890**	**8015**	**51017.6**
	11887 - 115131	1608 - 8998	871 - 3433	434 - 2173	228 - 1238	132 - 1051	2263 - 6520	4621 - 13176	19760 - 124105

Table A.4.24. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1996. TEQ emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g TEQ)								
1996	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	0.84	1.40	0.93	0.52	0.34	0.07	1.86	3.26	4.11
	0.0 - 4.4	0.1 - 6.7	0.1 - 3.0	0.1 - 1.5	0.1 - 1.0	0.0 - 0.2	0.7 - 4.2	1.2 - 9.2	1.5 - 11.1
Tas	0.08	0.30	0.09	0.00	0.01	0.00	0.10	0.40	0.48
	0.0 - 0.4	0.0 - 1.4	0.0 - 0.4	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.4	0.1 - 1.5	0.1 - 1.8
WA	70.23	2.80	1.36	0.74	0.19	0.00	2.30	5.09	75.33
	3.6 - 352.5	0.3 - 12.0	0.2 - 4.6	0.2 - 2.1	0.0 - 0.6	0.0 - 0.0	0.8 - 5.8	1.5 - 14.7	8.0 - 355.0
SA	0.76	0.00	0.00	0.27	0.19	0.00	0.46	0.46	1.23
	0.0 - 3.9	0.0 - 0.0	0.0 - 0.0	0.1 - 0.8	0.0 - 0.6	0.0 - 0.0	0.2 - 1.1	0.2 - 1.1	0.3 - 4.5
Vic	0.21	0.24	0.94	0.19	0.15	0.00	1.28	1.52	1.73
	0.0 - 1.2	0.0 - 1.1	0.1 - 3.5	0.0 - 0.6	0.0 - 0.4	0.0 - 0.0	0.4 - 3.8	0.5 - 4.2	0.6 - 4.5
Qld	14.38	0.24	0.34	0.10	0.14	0.66	1.25	1.48	15.86
	0.7 - 73.4	0.0 - 1.0	0.1 - 1.3	0.0 - 0.3	0.0 - 0.4	0.2 - 1.8	0.5 - 2.7	0.6 - 3.2	2.0 - 75.3
NT	63.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.44
	2.5 - 292.8	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	2.5 - 292.8
ACT	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.02
	0.0 - 0.0	0.0 - 0.1	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.1	0.0 - 0.1
Total	**149.9**	**5.0**	**3.7**	**1.8**	**1.0**	**0.7**	**7.2**	**12.2**	**162.2**
	24.0 - 595	1.1 - 15.5	1.4 - 8.6	0.4 - 5.5	0.2 - 3.1	0.2 - 2.	4.2 - 12.9	6.6 - 23.9	35.4 - 603.0
EA review (2002)	**62-1240**	**7-400**					**3.4-68**	**10.4 - 468**	**72.4 -1708**

Table A.4.25. Australian National PCDD, PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1996. Mean and 95% confidence ranges.

	1996	Savanna fires	Wildfire	Prescribed fires	Crops	Agriculture and managed forests	Agriculture and forestry	Total	95% confidence range	
									Agriculture and forestry	Agriculture prescribed fires and wildfires
Mass	TCDD	17648.5	387.9	597.7	1103.9	1701.6	2089.5	19737.9	1050.1 - 2696	1310.7 - 3274
g	TCDF	6192.4	87.3	134.1	79.5	213.7	300.9	6493.3	113.4 - 410	159.3 - 567
	PCB	18653.1	3702.5	1080.6	900.1	1980.7	5683.3	24336.4	1066 - 3552	3240.0 - 10174
	TCDD/F	24444.2	468.5	731.3	1174.2	1905.5	2374.0	26818.2	1020.8 - 3558.7	1332.1 - 4119
	Total	**43003**	**4124**	**1807**	**2083**	**3890**	**8015**	**51018**	**2263 - 6520**	**4621 - 13176**
TEQ	TCDD	126.4	3.6	2.6	3.2	5.7	9.4	135.7	2.3 - 9.6	5.1 - 17.7
g	TCDF	10.3	0.7	0.8	0.3	1.0	1.7	12.0	0.4 - 2.7	0.7 - 4.1
	PCB	4.4	0.7	0.4	0.1	0.5	1.2	5.6	0 - 0.9	0.6 - 2.4
	TCDD/F	138.3	4.5	3.3	3.5	6.8	11.2	149.5	3.9 - 12.0	5.7 - 22.6
	Total	**149.9**	**5.0**	**3.7**	**3.6**	**7.2**	**12.2**	**162.2**	**4.2 - 12.9**	**6.6 - 23.9**

Table A.4.26. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1997. Mass emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g)								
1997	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	256	1312	479	412	240	47	1178	2490	2746
	33 - 952	240 - 3906	130 - 1228	98 - 1152	54 - 680	12 - 119	570.3 - 2285	1094.6 - 5116	1267 - 5384
Tas	21.4	249	45.3	0.5	3.4	0.0	49	298	319
	3 - 77	46 - 778	11 - 130	0 - 1	1 - 10	0 - 0	14.9 - 137	88 - 861	103 - 881
WA	22761.6	2495	662.7	485.4	134.2	3.8	1286	3781	26542
	3361 - 84471	558 - 6985	191 - 1734	107 - 1343	30 - 370	1 - 11	549.5 - 2682	1496.6 - 8606	6566 - 87392
SA	110.0	0.4	0.7	181.1	133.7	0.0	316	316	426
	11 - 399	0 - 1	0 - 2	43 - 487	30 - 400	0 - 0	113.7 - 736	114.1 - 736	172 - 913
Vic	40.8	222	399.3	124.3	100.5	0.0	624	846	887
	5 - 151	41 - 678	95 - 1118	28 - 346	23 - 290	0 - 0	257.5 - 1363	369.1 - 1624	404 - 1708
Qld	3913	209	150.0	85.8	81.1	356.6	674	882	4796
	512 - 12719	38 - 610	43 - 409	20 - 246	19 - 222	95 - 993	331.5 - 1358	462.6 - 1671	1290 - 13377
NT	19154	0.0	0.0	0.0	0.1	0.0	0.1	0	19154
	2509 - 62196	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0.0 - 0	0.0 - 0.2	2509 - 62196
ACT	0.0	11.8	1.3	0.0	0.0	0.0	1.4	13.1	13.1
	0 - 0	2 - 35	0 - 4	0 - 0	0 - 0	0 - 0	0.3 - 4	3.3 - 36.6	3 - 37
Total	**46257**	**4499**	**1739**	**1289**	**693**	**407**	**4127**	**8626**	**54883.5**
	14567 - 127487	1760 - 10070	881 - 3215	480 - 2654	258 - 1557	127 - 1040	2410 - 6984	4956 - 14437	22062 - 137921

Table A.4.27. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1997. TEQ emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g TEQ)								
1997	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	0.92	1.62	0.97	0.72	0.41	0.08	2.18	3.79	4.71
	0.0 - 5.1	0.1 - 7.4	0.1 - 3.3	0.1 - 2.3	0.1 - 1.2	0.0 - 0.2	0.9 - 4.8	1.3 - 9.9	1.6 - 11.7
Tas	0.08	0.31	0.09	0.00	0.01	0.00	0.10	0.41	0.48
	0.0 - 0.4	0.0 - 1.4	0.0 - 0.3	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.3	0.1 - 1.5	0.1 - 1.7
WA	77.51	3.01	1.35	0.83	0.23	0.01	2.42	5.43	82.94
	3.7 - 379.7	0.2 - 13.4	0.2 - 4.8	0.2 - 2.4	0.0 - 0.7	0.0 - 0.0	0.8 - 6.2	1.6 - 15.9	7.8 - 386.1
SA	0.37	0.00	0.00	0.31	0.23	0.00	0.54	0.54	0.91
	0.0 - 1.9	0.0 - 0.0	0.0 - 0.0	0.1 - 0.9	0.0 - 0.7	0.0 - 0.0	0.2 - 1.2	0.2 - 1.2	0.3 - 2.6
Vic	0.13	0.28	0.81	0.21	0.17	0.00	1.19	1.47	1.60
	0.0 - 0.7	0.0 - 1.1	0.1 - 2.7	0.0 - 0.7	0.0 - 0.5	0.0 - 0.0	0.4 - 3.1	0.5 - 3.7	0.6 - 4.0
Qld	13.43	0.25	0.31	0.15	0.14	0.61	1.20	1.45	14.88
	0.6 - 74.4	0.0 - 1.1	0.0 - 1.1	0.0 - 0.4	0.0 - 0.4	0.1 - 1.8	0.5 - 2.6	0.7 - 3.0	1.9 - 76.9
NT	63.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	63.72
	2.9 - 342.5	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	2.9 - 342.5
ACT	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.02
	0.0 - 0.0	0.0 - 0.1	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.1	0.0 - 0.1
Total	**156.2**	**5.5**	**3.5**	**2.2**	**1.2**	**0.7**	**7.6**	**13.1**	**169.3**
	22.6 - 573	1.2 - 17.7	1.3 - 8.4	0.5 - 6.9	0.3 - 3.5	0.2 - 2.	4.6 - 12.8	7.1 - 26.0	35.2 - 588.7
EA review (2002)	**62-1240**	**7-400**					**3.4-68**	**10.4 - 468**	**72.4 -1708**

Table A.4.28. Australian National PCDD, PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1997. Mean and 95% confidence ranges.

	1997	Savanna fires	Wildfire	Prescribed fires	Crops	Agriculture and managed forests	Agriculture and forestry	Total	95% confidence range	
									Agriculture and forestry	Agriculture prescribed fires and wildfires
Mass	TCDD	19238.4	415.3	582.4	1266.1	1848.6	2263.9	21502.3	1168.4 - 2891	1411.6 - 3556
g	TCDF	6666.9	94.2	128.8	90.8	219.7	313.9	6980.8	115.7 - 388	164.6 - 583
	PCB	19853.5	4014.2	1026.5	1024.6	2051.0	6065.3	25918.8	1127 - 3503	3392.8 - 11369
	TCDD/F	25445.1	521.4	704.7	1356.5	2061.2	2582.6	28027.7	1075.6 - 4085.5	1468.7 - 4721
	Total	**46257**	**4499**	**1739**	**2389**	**4127**	**8626**	**54883**	**2410 - 6984**	**4956 - 14437**
TEQ	TCDD	139.8	3.9	2.4	3.7	6.1	10.0	149.8	2.7 - 9.9	5.6 - 21.2
g	TCDF	11.1	0.8	0.7	0.3	1.0	1.8	12.9	0.4 - 2.6	0.8 - 3.7
	PCB	4.7	0.8	0.4	0.1	0.5	1.3	5.9	0 - 0.9	0.7 - 2.4
	TCDD/F	149.6	4.8	3.1	4.0	7.1	11.9	161.5	4.0 - 12.2	6.4 - 22.5
	Total	**156.2**	**5.5**	**3.5**	**4.1**	**7.6**	**13.1**	**169.3**	**4.6 - 12.8**	**7.1 - 26.0**

Table A.4.29. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1998. Mass emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g)								
1998	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	248	1270	488	449	256	49	1242	2513	2761
	29 - 970	208 - 4048	140 - 1267	117 - 1190	62 - 712	12 - 130	574.7 - 2349	1126.3 - 5272	1263 - 5453
Tas	18.6	248	50.5	0.8	3.3	0.0	55	303	321
	2 - 68	43 - 771	12 - 135	0 - 2	1 - 9	0 - 0	16.3 - 139	77 - 815	99 - 842
WA	21288.8	2470	657.8	509.6	136.9	5.9	1310	3780	25069
	3602 - 71967	511 - 7066	180 - 1610	132 - 1374	29 - 403	2 - 16	574.5 - 2553	1492.0 - 8708	6643 - 77029
SA	106.6	0.3	0.7	192.5	138.1	0.0	331	332	438
	13 - 356	0 - 1	0 - 2	45 - 579	31 - 389	0 - 0	121.2 - 772	121.4 - 772	181 - 932
Vic	32.9	253	421.0	112.8	93.6	0.0	627	881	914
	4 - 115	39 - 764	98 - 1175	29 - 301	22 - 256	0 - 0	260.4 - 1422	398.5 - 1796	423 - 1839
Qld	3861	192	163.7	117.2	83.0	312.2	676	868	4730
	462 - 13573	36 - 605	41 - 428	27 - 327	20 - 234	72 - 856	327.0 - 1333	444.0 - 1672	1216 - 14425
NT	20037	0.0	0.0	0.0	0.1	0.0	0.1	0	20037
	2398 - 73133	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0.0 - 0	0.0 - 0.3	2398 - 73133
ACT	0.0	9.3	1.1	0.0	0.0	0.0	1.1	10.5	10.5
	0 - 0	2 - 29	0 - 3	0 - 0	0 - 0	0 - 0	0.3 - 3	2.5 - 29.2	3 - 29
Total	**45593**	**4444**	**1783**	**1382**	**711**	**367**	**4225**	**8669**	**54261.5**
	13706 - 125069	1720 - 10008	869 - 3349	583 - 2940	282 - 1497	113 - 932	2412 - 7146	5149 - 14373	21286 - 134829

Table A.4.30. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1998. TEQ emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g TEQ)								
1998	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	0.88	1.51	0.99	0.79	0.44	0.08	2.30	3.80	4.68
	0.0 - 5.0	0.1 - 6.0	0.2 - 3.4	0.2 - 2.5	0.1 - 1.3	0.0 - 0.2	0.9 - 5.1	1.4 - 9.1	1.8 - 11.1
Tas	0.06	0.30	0.10	0.00	0.01	0.00	0.11	0.41	0.48
	0.0 - 0.3	0.0 - 1.3	0.0 - 0.4	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.4	0.1 - 1.5	0.1 - 1.5
WA	72.43	2.98	1.32	0.88	0.23	0.01	2.44	5.42	77.84
	3.8 - 358.2	0.3 - 13.3	0.2 - 4.0	0.2 - 2.6	0.0 - 0.7	0.0 - 0.0	0.8 - 5.5	1.6 - 15.5	7.9 - 361.8
SA	0.38	0.00	0.00	0.33	0.24	0.00	0.57	0.57	0.95
	0.0 - 2.0	0.0 - 0.0	0.0 - 0.0	0.1 - 1.0	0.1 - 0.7	0.0 - 0.0	0.2 - 1.3	0.2 - 1.3	0.3 - 2.8
Vic	0.12	0.31	0.86	0.20	0.17	0.00	1.23	1.54	1.66
	0.0 - 0.6	0.0 - 1.3	0.1 - 3.0	0.0 - 0.6	0.0 - 0.5	0.0 - 0.0	0.4 - 3.5	0.5 - 3.9	0.6 - 4.2
Qld	12.53	0.23	0.34	0.20	0.14	0.53	1.22	1.45	13.98
	0.6 - 64.7	0.0 - 0.9	0.0 - 1.4	0.0 - 0.5	0.0 - 0.4	0.1 - 1.5	0.5 - 2.5	0.6 - 3.0	1.9 - 67.1
NT	70.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	70.40
	2.9 - 372.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	2.9 - 372.0
ACT	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	0.0 - 0.0	0.0 - 0.1	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.1	0.0 - 0.1
Total	**156.8**	**5.3**	**3.6**	**2.4**	**1.2**	**0.6**	**7.9**	**13.2**	**170.0**
	25.4 - 596	1.4 - 16.2	1.3 - 7.9	0.6 - 7.1	0.3 - 3.6	0.2 - 1.7	4.6 - 13.2	7.2 - 24.7	37.1 - 617.0
EA review (2002)	**62-1240**	**7-400**					**3.4-68**	**10.4 - 468**	**72.4 -1708**

Table A.4.31. Australian National PCDD, PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1998. Mean and 95% confidence ranges.

	1998	Savanna fires	Wildfire	Prescribed fires	Crops	Agriculture and managed forests	Agriculture and forestry	Total	95% confidence range	
									Agriculture and forestry	Agriculture prescribed fires and wildfires
Mass	TCDD	19094.2	409.6	587.7	1308.3	1896.0	2305.6	21399.8	1188.8 - 2907	1491.2 - 3572
g	TCDF	6826.4	93.1	131.8	93.8	225.6	318.6	7145.0	119.6 - 401	175.1 - 598
	PCB	20054.2	3945.8	1051.8	1065.4	2117.2	6063.0	26117.2	1166 - 3581	3294.1 - 10350
	TCDD/F	25477.9	509.3	724.6	1398.9	2123.5	2632.8	28110.7	1021.5 - 3936.7	1408.4 - 4726
	Total	**45593**	**4444**	**1783**	**2442**	**4225**	**8669**	**54261**	**2412 - 7146**	**5149 - 14373**
TEQ	TCDD	137.4	3.8	2.5	3.8	6.3	10.1	147.5	3.2 - 10.8	5.7 - 18.4
g	TCDF	11.3	0.8	0.7	0.3	1.0	1.8	13.1	0.4 - 2.5	0.8 - 3.9
	PCB	4.7	0.8	0.4	0.2	0.5	1.3	6.0	0 - 0.9	0.7 - 2.5
	TCDD/F	156.9	4.7	3.2	4.1	7.3	12.0	168.9	4.4 - 12.2	6.5 - 23.1
	Total	**156.8**	**5.3**	**3.6**	**4.2**	**7.9**	**13.2**	**170.0**	**4.6 - 13.2**	**7.2 - 24.7**

Table A.4.32. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1999. Mass emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g)								
1999	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	218	1163	452	463	242	50	1206	2369	2587
	26 - 786	215 - 3309	125 - 1155	113 - 1345	61 - 687	13 - 139	565.1 - 2273	1062.0 - 4639	1250 - 4921
Tas	16.6	256	53.5	1.1	2.9	0.0	57	313	330
	2 - 55	45 - 775	13 - 146	0 - 3	1 - 8	0 - 0	17.3 - 149	83 - 861	103 - 866
WA	23162.3	2344	637.8	540.1	123.4	7.2	1308	3653	26815
	3893 - 76052	510 - 6865	167 - 1653	126 - 1435	29 - 362	2 - 20	552.4 - 2623	1501.9 - 8540	7017 - 80637
SA	137.8	0.2	0.5	190.3	124.8	0.0	316	316	454
	13 - 545	0 - 1	0 - 1	44 - 564	28 - 330	0 - 0	112.2 - 742	112.4 - 742	176 - 1073
Vic	32.3	243	397.3	122.8	94.3	0.0	614	857	889
	4 - 118	50 - 728	99 - 1122	30 - 372	22 - 254	0 - 0	239.3 - 1316	382.2 - 1719	410 - 1767
Qld	4255	172	162.4	115.5	86.7	285.8	650	822	5077
	544 - 16303	32 - 567	40 - 476	27 - 321	20 - 241	74 - 764	311.6 - 1234	417.0 - 1479	1261 - 17488
NT	22212	0.0	0.0	0.0	0.1	0.0	0.1	0	22212
	2922 - 84324	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0.0 - 0	0.0 - 0.2	2922 - 84324
ACT	0.0	6.9	1.0	0.0	0.0	0.0	1.0	7.9	7.9
	0 - 0	1 - 20	0 - 3	0 - 0	0 - 0	0 - 0	0.2 - 3	2.0 - 21.2	2 - 21
Total	**50034**	**4184**	**1704**	**1433**	**674**	**343**	**4174**	**8359**	**58392.7**
	15684 - 128513	1611 - 9175	802 - 3174	542 - 2950	265 - 1406	108 - 842	2284 - 7461	4693 - 14470	23292 - 137613

Table A.4.33. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1999. TEQ emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g TEQ)								
1999	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	0.78	1.41	0.91	0.78	0.42	0.09	2.19	3.60	4.38
	0.0 - 3.9	0.1 - 6.1	0.2 - 3.1	0.2 - 2.2	0.1 - 1.2	0.0 - 0.2	0.9 - 4.7	1.4 - 8.7	1.7 - 10.4
Tas	0.06	0.29	0.10	0.00	0.00	0.00	0.11	0.41	0.46
	0.0 - 0.3	0.0 - 1.3	0.0 - 0.4	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.4	0.1 - 1.4	0.1 - 1.4
WA	83.21	2.82	1.27	0.94	0.21	0.01	2.44	5.26	88.47
	4.3 - 407.5	0.2 - 11.8	0.2 - 4.0	0.2 - 2.8	0.0 - 0.6	0.0 - 0.0	0.8 - 5.4	1.7 - 15.0	8.5 - 413.3
SA	0.45	0.00	0.00	0.33	0.22	0.00	0.54	0.54	1.00
	0.0 - 2.2	0.0 - 0.0	0.0 - 0.0	0.1 - 0.9	0.0 - 0.6	0.0 - 0.0	0.2 - 1.2	0.2 - 1.2	0.3 - 2.9
Vic	0.11	0.30	0.80	0.21	0.16	0.00	1.17	1.47	1.58
	0.0 - 0.6	0.0 - 1.4	0.1 - 2.6	0.0 - 0.7	0.0 - 0.5	0.0 - 0.0	0.4 - 3.0	0.5 - 3.6	0.6 - 3.8
Qld	14.29	0.20	0.32	0.20	0.15	0.50	1.17	1.37	15.65
	0.5 - 72.4	0.0 - 0.8	0.0 - 1.2	0.0 - 0.6	0.0 - 0.4	0.1 - 1.4	0.5 - 2.3	0.6 - 2.7	1.8 - 74.0
NT	79.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	79.81
	3.7 - 421.5	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	3.7 - 421.5
ACT	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0
Total	**178.7**	**5.0**	**3.4**	**2.5**	**1.2**	**0.6**	**7.6**	**12.7**	**191.4**
	25.2 - 632	1.2 - 15.6	1.3 - 7.5	0.5 - 7.6	0.3 - 3.6	0.1 - 1.7	4.3 - 12.4	6.9 - 24.3	38.1 - 642.0
EA review (2002)	0.73	1.50	0.95	0.81	0.44	0.09	2.30	3.80	4.53

Table A.4.34. Australian National PCDD, PCDF and PCB emissions from bushfires and agricultural waste residue burning for 1999. Mean and 95% confidence ranges.

	1999	Savanna fires	Wildfire	Prescribed fires	Crops	Agriculture and managed forests	Agriculture and forestry	Total	95% confidence range	
									Agriculture and forestry	Agriculture prescribed fires and wildfires
Mass	TCDD	20922.8	383.1	568.6	1304.4	1873.0	2256.1	23178.9	1147.8 - 2945	1398.5 - 3458
g	TCDF	7480.8	85.4	125.8	93.7	219.5	304.9	7785.6	121.3 - 392	172.8 - 551
	PCB	21946.8	3716.2	1014.1	1060.6	2074.7	5791.0	27737.7	1118 - 3520	3233.2 - 10124
	TCDD/F	28367.5	474.4	696.1	1390.7	2086.8	2561.2	30928.7	1061.0 - 3835.6	1368.2 - 4567
	Total	**50034**	**4184**	**1704**	**2470**	**4174**	**8359**	**58393**	**2284 - 7461**	**4693 - 14470**
TEQ	TCDD	156.4	3.6	2.4	3.8	6.1	9.7	166.1	2.8 - 9.8	5.5 - 17.7
g	TCDF	11.8	0.7	0.7	0.3	1.0	1.7	13.5	0.4 - 2.4	0.8 - 3.8
	PCB	5.2	0.7	0.3	0.2	0.5	1.2	6.4	0 - 0.9	0.6 - 2.4
	TCDD/F	168.2	4.3	3.1	4.1	7.2	11.5	179.7	4.0 - 11.9	6.5 - 22.7
	Total	**178.7**	**5.0**	**3.4**	**4.2**	**7.6**	**12.7**	**191.4**	**4.3 - 12.4**	**6.9 - 24.3**

Table A.4.35. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 2000. Mass emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g)								
2000	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	146	1139	427	506	255	45	1233	2372	2519
	18 - 495	198 - 3340	115 - 1015	122 - 1372	60 - 703	11 - 119	567.5 - 2318	1037.3 - 4754	1150 - 5040
Tas	17.4	281	51.8	1.4	2.8	0.0	56	337	354
	2 - 64	53 - 843	12 - 143	0 - 4	1 - 7	0 - 0	16.3 - 147	90 - 885	110 - 899
WA	28048.7	1670	588.0	505.6	106.4	7.8	1208	2878	30926
	3999 - 89459	358 - 4869	162 - 1530	122 - 1447	23 - 312	2 - 22	529.4 - 2456	1316.9 - 6142	6565 - 92148
SA	81.0	0.1	0.3	219.5	131.8	0.0	352	352	433
	10 - 298	0 - 0	0 - 1	51 - 618	29 - 372	0 - 0	122.9 - 839	123.0 - 839	174 - 930
Vic	37.3	230	343.2	157.9	111.4	0.0	612	843	880
	5 - 133	43 - 724	88 - 975	37 - 448	26 - 287	0 - 0	259.1 - 1313	387.8 - 1737	413 - 1770
Qld	4008	170	175.3	109.4	97.2	248.1	630	800	4808
	501 - 13673	31 - 523	44 - 522	25 - 318	21 - 277	66 - 674	296.4 - 1206	400.4 - 1449	1215 - 14435
NT	26548	0.0	0.0	0.0	0.1	0.0	0.1	0	26548
	3316 - 96838	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0.0 - 0	0.0 - 0.3	3316 - 96839
ACT	0.0	4.5	0.8	0.0	0.0	0.0	0.8	5.3	5.3
	0 - 0	1 - 14	0 - 2	0 - 0	0 - 0	0 - 0	0.2 - 2	1.5 - 15.6	1 - 16
Total	**58886**	**3494**	**1586**	**1499**	**705**	**301**	**4075**	**7570**	**66456.1**
	16530 - 149943	1419 - 7374	783 - 2879	570 - 3234	277 - 1513	107 - 732	2263 - 7113	4548 - 12451	23390 - 155907

Table A.4.36. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 2000. TEQ emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g TEQ)								
2000	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	0.54	1.35	0.86	0.86	0.44	0.08	2.24	3.59	4.14
	0.0 - 2.9	0.1 - 5.2	0.1 - 2.7	0.2 - 2.6	0.1 - 1.3	0.0 - 0.2	0.9 - 4.7	1.4 - 8.7	1.7 - 9.5
Tas	0.06	0.34	0.10	0.00	0.00	0.00	0.11	0.45	0.51
	0.0 - 0.3	0.0 - 1.5	0.0 - 0.4	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.4	0.1 - 1.6	0.1 - 1.7
WA	96.50	2.03	1.17	0.86	0.18	0.01	2.23	4.26	100.76
	5.5 - 487.2	0.2 - 7.8	0.2 - 3.9	0.2 - 2.4	0.0 - 0.5	0.0 - 0.0	0.8 - 5.3	1.3 - 10.6	9.0 - 492.1
SA	0.29	0.00	0.00	0.38	0.23	0.00	0.61	0.61	0.90
	0.0 - 1.7	0.0 - 0.0	0.0 - 0.0	0.1 - 1.2	0.0 - 0.7	0.0 - 0.0	0.2 - 1.4	0.2 - 1.4	0.3 - 2.5
Vic	0.13	0.28	0.68	0.27	0.19	0.00	1.14	1.42	1.54
	0.0 - 0.6	0.0 - 1.2	0.1 - 2.4	0.1 - 0.8	0.0 - 0.6	0.0 - 0.0	0.4 - 2.7	0.6 - 3.2	0.6 - 3.4
Qld	13.48	0.20	0.35	0.19	0.16	0.43	1.13	1.33	14.80
	0.7 - 67.8	0.0 - 0.8	0.1 - 1.2	0.0 - 0.5	0.0 - 0.5	0.1 - 1.2	0.5 - 2.3	0.6 - 2.7	1.9 - 69.3
NT	85.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	85.94
	3.4 - 425.2	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	3.4 - 425.2
ACT	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0
Total	**196.9**	**4.2**	**3.2**	**2.6**	**1.2**	**0.5**	**7.5**	**11.7**	**208.6**
	28.6 - 741	1.2 - 12.3	1.2 - 7.1	0.5 - 8.	0.3 - 3.7	0.1 - 1.5	4.4 - 12.5	6.7 - 21.1	38.8 - 767.3
EA review (2002)	**62-1240**	**7-400**					**3.4-68**	**10.4 - 468**	**72.4 -1708**

Table A.4.37. Australian National PCDD, PCDF and PCB emissions from bushfires and agricultural waste residue burning for 2000. Mean and 95% confidence ranges).

	2000	Savanna fires	Wildfire	Prescribed fires	Crops	Agriculture and managed forests	Agriculture and forestry	Total	95% confidence range	
									Agriculture and forestry	Agriculture prescribed fires and wildfires
Mass	TCDD	24694.7	326.7	526.9	1325.0	1851.9	2178.6	26873.3	1178.9 - 2808	1425.3 - 3323
g	TCDF	8549.6	74.6	117.9	95.3	213.2	287.8	8837.4	116.3 - 396	157.3 - 503
	PCB	26037.3	3134.2	934.1	1083.2	2017.4	5151.6	31188.9	1197 - 3397	2991.0 - 8579
	TCDD/F	33638.7	391.3	642.8	1413.5	2056.4	2447.7	36086.4	1047.1 - 3778.1	1376.8 - 4345
	Total	**58886**	**3494**	**1586**	**2489**	**4075**	**7570**	**66456**	**2263 - 7113**	**4548 - 12451**
TEQ	TCDD	185.0	3.0	2.2	3.8	6.1	9.1	194.1	2.9 - 10.4	5.2 - 15.8
g	TCDF	13.9	0.6	0.7	0.3	1.0	1.6	15.5	0.4 - 2.3	0.7 - 3.6
	PCB	6.0	0.6	0.3	0.2	0.5	1.1	7.1	0 - 0.8	0.6 - 2.0
	TCDD/F	204.5	3.6	2.9	4.1	7.0	10.6	215.1	4.1 - 11.6	6.1 - 18.3
	Total	**196.9**	**4.2**	**3.2**	**4.3**	**7.5**	**11.7**	**208.6**	**4.4 - 12.5**	**6.7 - 21.1**
		24694.7	326.7	526.9	1325.0	1851.9	2178.6	26873.3	1178.9 - 2808	1425.3 - 3323

Table A.4.38. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 2001. Mass emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g)								
2001	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	166	1276	470	543	245	42	1301	2576	2743
	19 - 676	242 - 3984	135 - 1124	115 - 1551	58 - 700	11 - 111	625.6 - 2563	1097.6 - 5256	1222 - 5349
Tas	18.7	275	54.1	1.5	2.6	0.0	58	333	352
	2 - 66	51 - 908	13 - 146	0 - 4	1 - 7	0 - 0	16.2 - 150	95 - 974	107 - 988
WA	29946.8	1631	540.9	485.9	98.3	8.8	1134	2764	32711
	4707 - 102212	329 - 4788	145 - 1411	120 - 1351	22 - 273	2 - 24	502.3 - 2224	1195.4 - 6115	7308 - 104689
SA	69.2	0.1	0.1	219.4	124.6	0.0	344	344	413
	8 - 289	0 - 0	0 - 0	54 - 613	30 - 336	0 - 0	127.8 - 766	127.9 - 766	163 - 870
Vic	40.4	274	332.0	186.3	121.5	0.0	640	914	954
	6 - 136	48 - 837	78 - 894	44 - 509	30 - 334	0 - 0	280.6 - 1274	416.3 - 1802	449 - 1848
Qld	3858	172	171.1	101.6	97.5	244.5	615	787	4645
	417 - 13729	30 - 488	46 - 486	24 - 292	23 - 292	64 - 650	308.5 - 1143	401.5 - 1444	1144 - 14731
NT	30465	0.0	0.0	0.0	0.1	0.0	0.1	0	30465
	3515 - 112865	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0.0 - 0	0.0 - 0.2	3516 - 112865
ACT	0.0	2.0	0.6	0.0	0.0	0.0	0.6	2.7	2.7
	0 - 0	0 - 6	0 - 2	0 - 0	0 - 0	0 - 0	0.2 - 2	0.8 - 6.8	1 - 7
Total	**64564**	**3630**	**1569**	**1538**	**690**	**296**	**4091**	**7720**	**72284.0**
	17447 - 166881	1450 - 7996	788 - 2916	595 - 3298	291 - 1456	92 - 731	2306 - 7466	4672 - 12639	24684 - 173644

Table A.4.39. Total Australian National PCDD/PCDF and PCB emissions from bushfires and agricultural waste residue burning for 2001. TEQ emissions (mean and 95% confidence ranges).

State	PCDD/PCDF and PCB Emission (g TEQ)								
2001	Savanna	Wildfire	Prescribed fire	Wheat	Coarse grains	Sugar cane	Agriculture and managed forests	Agriculture and forests	Total
NSW	0.54	1.53	0.93	0.93	0.42	0.07	2.35	3.88	4.42
	0.0 - 2.5	0.1 - 6.7	0.2 - 3.0	0.2 - 2.4	0.1 - 1.2	0.0 - 0.2	0.9 - 4.9	1.5 - 9.3	1.7 - 10.6
Tas	0.06	0.33	0.11	0.00	0.00	0.00	0.12	0.44	0.51
	0.0 - 0.3	0.0 - 1.5	0.0 - 0.4	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.4	0.1 - 1.6	0.1 - 1.7
WA	100.58	1.97	1.10	0.83	0.17	0.02	2.11	4.08	104.66
	5.4 - 505.7	0.2 - 8.7	0.2 - 3.5	0.2 - 2.4	0.0 - 0.5	0.0 - 0.0	0.8 - 4.9	1.4 - 11.0	8.9 - 521.4
SA	0.22	0.00	0.00	0.38	0.22	0.00	0.60	0.60	0.82
	0.0 - 1.2	0.0 - 0.0	0.0 - 0.0	0.1 - 1.2	0.0 - 0.7	0.0 - 0.0	0.2 - 1.5	0.2 - 1.5	0.3 - 2.1
Vic	0.14	0.33	0.65	0.32	0.21	0.00	1.18	1.52	1.66
	0.0 - 0.7	0.0 - 1.5	0.1 - 2.3	0.1 - 1.0	0.0 - 0.6	0.0 - 0.0	0.4 - 2.9	0.6 - 3.4	0.6 - 3.7
Qld	12.83	0.20	0.35	0.17	0.17	0.41	1.11	1.31	14.14
	0.6 - 60.5	0.0 - 0.8	0.1 - 1.3	0.0 - 0.5	0.0 - 0.5	0.1 - 1.3	0.5 - 2.3	0.6 - 2.5	1.7 - 61.2
NT	102.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	102.53
	4.9 - 545.8	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	4.9 - 545.8
ACT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0	0.0 - 0.0
Total	**216.9**	**4.4**	**3.1**	**2.6**	**1.2**	**0.5**	**7.5**	**11.8**	**228.7**
	29.6 - 826	1.1 - 13.0	1.3 - 6.7	0.6 - 7.6	0.2 - 3.4	0.1 - 1.5	4.5 - 12.3	6.7 - 21.2	40.8 - 838.7
EA review (2002)	**62-1240**	**7-400**					**3.4-68**	**10.4 - 468**	**72.4 -1708**

Table A.4.40. Australian National PCDD, PCDF and PCB emissions from bushfires and agricultural waste residue burning for 2001. Mean and 95% confidence ranges.

	2001	Savanna fires	Wildfire	Prescribed fires	Crops	Agriculture and managed forests	Agriculture and forestry	Total	95% confidence range	
									Agriculture and forestry	Agriculture prescribed fires and wildfires
Mass	TCDD	26918.7	336.2	528.4	1339.9	1868.3	2204.5	29123.2	1140.5 - 2873	1400.2 - 3353
	TCDF	9426.1	74.3	115.6	96.2	211.8	286.1	9712.2	111.3 - 379	164.6 - 505
	PCB	28479.8	3179.6	930.3	1088.2	2018.5	5198.1	33677.9	1090 - 3347	2949.9 - 8392
	TCDD/F	36812.5	408.3	642.9	1435.4	2078.3	2486.6	39299.1	1090.0 - 3946.3	1410.6 - 4378
	Total	**64564**	**3630**	**1569**	**2522**	**4091**	**7720**	**72284**	**2306 - 7466**	**4672 - 12639**
TEQ	TCDD	195.0	3.1	2.2	3.9	6.1	9.2	204.2	2.8 - 9.8	5.3 - 16.1
	TCDF	16.0	0.6	0.7	0.3	1.0	1.6	17.6	0.4 - 2.3	0.7 - 3.6
	PCB	6.6	0.6	0.3	0.2	0.5	1.1	7.7	0 - 0.8	0.6 - 2.0
	TCDD/F	214.2	3.7	2.8	4.2	7.0	10.8	224.9	4.0 - 11.7	6.3 - 19.4
	Total	**216.9**	**4.4**	**3.1**	**4.3**	**7.5**	**11.8**	**228.7**	**4.5 - 12.3**	**6.7 - 21.2**