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DEFENCE

CHEMICAL WARFARE AGENT SEA DUMPING OFF AUSTRALIA

Chemical Warfare Agent (CWA) Sea Dumping off Australia

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SUMMARY

Although the disposal of material in the sea is now very restricted, historically, the disposal of unwanted waste in the ocean has been a very common practise in many parts of the world. Due to its immense size the ocean was thought to have an unlimited absorptive capacity, with any dumped waste having only a very localised effect. Moreover, the material would be well away from any human activity. Even for fishing trawlers operating in the early 1970s, a depth over 120 metres was considered as "very deep water". Nowadays, however, trawlers work in depths to 1000 metres and material dumped decades before can be accidentally recovered. It is important to know where any hazardous material may lie, both to prevent human contact and to assess the possible ecological consequences.

Sea dumping of unwanted Chemical Warfare Agents (CWA) has occurred at many sites around the world. Most of the dumping episodes occurred after the end of World War II when unused war stocks needed disposal. An estimated 300,000 tonnes of CW munitions was dumped in West European and North Atlantic waters. It appears at least 14,634 tons of Chemical Warfare munitions were dumped into Australian seas at the end of World War II by the United States Army and the defence forces of Australia. This figure probably includes the weight of the containers which housed the agent (be it an artillery shell, bomb or storage vessel) and hence the amount of actual chemical agent would be *less* than 14,634 tons. Records indicate there have been two small dumping episodes of CWA since World War II, one in 1965 and another in 1970.

Dumping can be confirmed in the seas off three states, Queensland, New South Wales and Victoria. Two main dump areas are known, one off Cape Moreton, Queensland and another off Sydney. Some of the CWA was loaded onto disused ships which were scuttled under supervision. The remainder was dumped in containers or as loose shell or bombs. Mustard gas[2] was the most common type of CWA sea dumped.

During the disposal operation there were several contact incidents with workers handling the CWA or members of the public encountering CWA that had floated to the shore. Since World War II there have been only two accidental recoveries of CWA from the marine environment, both one ton cylinders of mustard gas trawled by fishermen. The bulk of the chemical warfare agents dumped off Cape Moreton are away from current trawling areas but could pose a threat to other activities including sea bed mining. The material off Sydney appears to be located in an old ocean dumping ground. The area is not used by trawlers. Mustard gas is only slightly soluble in water, but once it dissolves, it hydrolyses (reacts with water) rapidly. Mustard gas leaking at a slow rate through corroded containers will hydrolyse and should break down close to the dump positions. At worst, leaking mustard gas should only pose a threat to biota living on or near the discarded drums and artillery shells. The hydrolysis products are thought not to have a significant effect on fish and the dump sites do not correlate with designated marine sensitive environments.

Overseas experience has shown that public knowledge of CWA dumping sites can decrease accident rates. Knowledge of the CWA dumping sites in Australia will help to prevent possible exposure. The location of CWA dump sites in Australian waters make the risk of accidental recovery by trawlers low. The risk to the general public contacting a drum is virtually nil. However, if recovered, ANY ordnance (chemical or non-chemical) must not be touched or tampered with. Inappropriately handled ordnance can be very dangerous. Chemical Warfare Agents recovered overseas have caused serious injury even though the material is over 50 years old. When notified, the local police will contact the relevant authority for its appropriate disposal.

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[2] Mustard Gas is the historical name given to sulphur mustard blister agent (2,2' - dichloroethyl sulphide).

SOURCES

The data for this work has been principally gleaned from Federal Government records. It is based on all currently available files. The information is fragmentary, partly due to the lack of records kept at the time the dumping operations were undertaken but also due to the as yet incomplete cataloguing of old archives. Other material may exist on files with a title that may not accurately reflect its contents or may exist in state government archives or in other sources.

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SEA DUMPING

Although the disposal of material in the sea is now very restricted, historically, the disposal of unwanted waste in the ocean has been a common practice in many parts of the world. Due to its immense size the ocean was thought to have an unlimited absorptive capacity with any dumped waste having only a very localised effect. Moreover, the material would be well away from any human activity. Many items, including boats, chemicals, ammunition, inorganic waste and other hazardous material were dumped in the world's seas. There was often little understanding of the possible dangers to human safety and the ecology of the sea[3]. It was not realised the dumping areas would be exploited for their resources in later years. Even for fishing trawlers operating in the early 1970s, a depth over 120 metres was considered as "very deep water". Nowadays, however, trawlers work in depths to 1000 metres and material dumped in previous decades has been accidentally recovered. This was drawn to the public's attention in 1972/1973 when several drums of industrial waste were recovered by trawlers off Sydney. There were immediate moves to limit sea dumping which culminated in the introduction of the Environment Protection (Sea Dumping) Act 1981. Currently, most permits are only issued for dredge spoil disposal and for the creation of artificial reefs.

Chemical Warfare Agents in Australia

During World War II CWA stocks were held at many sites around Australia. The Japanese had reached as far as Papua New Guinea and had been known to use CWA during warfare. Australia had reserved the right to use CWA to retaliate. The stocks of CWA in Australia were held under General MacArthur's Chemical Warfare plan for the Pacific area. Although their use was dependent on the direct order of General MacArthur, the stocks were stored in Australia under either US Army, Royal Australian Air Force (RAAF) or Australian Army supervision (see Appendix A for a description of the sites in Australia where it is known CWA was held during World War II). None of the CWA munitions were used during combat and at the end of the war the material was in need of elimination [see Appendix B, The Gillis Report and Plunkett (in prep.)[4] for more on the history of CWA in Australia].

This report, using all currently available Federal Government records and other published material, details all knowledge of where and how much CWA has been sea dumped in Australian seas. The report also examines what may have happened to the containers after they were dumped, including the corrosion rate of the cylinders and the breakdown of mustard gas as it reacts with the sea water. It is important to know where any CWA may lie, both to prevent human contact and to assess the possible ecological consequences. Although, in most cases, the amount and types of CWA dumped is not known, inventories are available on CWA stocks supervised by the US Army in Australia. This is important, as evidence suggests most of these stocks were eliminated by sea dumping. The RAAF and Australian Army (after conducting tests) burnt, buried or vented (e.g. phosgene) as well as sea dumped a proportion of their supervised stocks.

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[3] Based on conversations with some of those involved in the CWA dumping operations off Australia. See also *A History of Sea Dumping off Australia and its Territories* on Environment Australia's website www.ea.gov.au.

[4] Chemical Warfare Agents in Australia during World War II.

Chemical Warfare Agent (CWA) Sea Dumping Episodes

International Dumping of CWA

The dumping of CWA at the end of World War II is a well documented phenomenon around the world. Large amounts of CWA were dumped in West European and North Atlantic waters. It is estimated 300,000 tonnes of Chemical Warfare munitions was dumped near Europe after WWII. During 1945-1949 Great Britain sank barges with 175,000 tonnes of its own and German CW munitions near Ireland. More than 200,000 tonnes were apparently accumulated in Baltic ports and sent for dumping. The 300,000 tonnes of dumped CW munitions is said to have been dumped in more than 600,000 objects [for detail on CW dumping in European waters see the papers in Kaffa (1996) and Leewis (1991)]. Upwards of 4 900 tons of CWA, (including 118 000 shells and 574 000 canisters) was dumped off Japan by Japanese workers under orders from the US occupation forces (Kurata 1980). Dumping was seen as the best method of disposal, there being too much to store or burn. The dumping was sometimes done by loading an old ship and scuttling the ship and its contents or by dumping loose bombs or containers of CWA. The size of these overseas operations can put some perspective on the scale of the Australian operation.

CWA Dumping in Australian Waters

Before the chemical warfare agents were sea dumped, tests were often held on the individual types to assess their buoyancy in the marine environment[5]. It is known, however, that not all the dumped CWA sank to the seabed as some material was recovered from the shore (see below). Sea dumping of CWA will be discussed for each State.

Northern Territory

An area north of Bathurst Island was designated as a disposal area for CWA stocks held in No. 5 Central Reserve. The area was bounded by the following coordinates, [(8 degrees 51 minutes S, 129 degrees 12 minutes E); (8 degrees 56 minutes S, 129 degrees 12 minutes E); (8 degrees 51 minutes S, 129 degrees 16 minutes E); (8 degrees 56 minutes S, 129 degrees 16 minutes E)][6]. It is not known if any CWA material was dumped here.

Queensland

Two sites were chosen near Bowen to dump CWA from the RAAF No.19 Replenishing Centre at Talmoi and the RAAF Chemical Research Unit (CRU) at Bowen (figure 3). For the most westerly site the bounding coordinates were [(18 degrees 00 minutes S, 147 degrees 55 minutes E); (18 degrees 15 minutes S, 147 degrees 55 minutes E); (18 degrees 00 minutes S, 148 degrees 10 minutes E); (18 degrees 15 minutes S, 148 degrees 10 minutes S)]. The more easterly site had an area described by the following geographic locations [(18 degrees 05 minutes S, 148 degrees 30 minutes E); (18 degrees 20 minutes S, 148 degrees 30 minutes E); (18 degrees 05 minutes S, 148 degrees 45 minutes E); (18 degrees 20 minutes S, 148 degrees 45 minutes E)][7]. Two experimental sea dumpings to assess the buoyancy of the material were made using stocks of CWA from the CRU and the Australian Field Experimental Station at Prosperine[8]. The tug "Keera" was loaded with 320 mustard charged 100 pound bombs which were dumped at 18 degrees 30 minutes S, 148 degrees 5 minutes E at 1098 metres (600 fathoms) on 12 October 1945. On 14 October 1945 the same boat dumped 700 mustard charged 65 pound bombs at 18 degrees S, 148 degrees E at a depth of 1098 metres (600 fathoms). The CW munitions from this latter dumping fall within the coordinates of the more westerly dump square (see figure 3).

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5 For an example see the table in Appendix A, CW stocks at No. 1 C.R. (Central Reserve), Data to show behaviour on immersion in sea water. National Archives of Australia, Parkes ACT. Series A705, item 15/31/19.

6 National Archives of Australia, Parkes ACT. Series A705, item 15/31/19. We determined the coordinates from an old map found on these files.

7 National Archives of Australia, Parkes ACT. Series A705, item 15/31/19. We determined the coordinates from an old map found on these files.

8 National Archives of Australia, Parkes ACT. Series A705, item 15/31/19. An entry in the CRU war records also states that 65lb bombs were loaded onto trucks and transported to the marine section FBMU for disposal at sea on 15 February 1945.

In late 1945[9] sea dumpings also occurred off Cape Moreton near Brisbane. Records state a total of 8000 tons of CW munitions, believed to represent all the stocks of CWA stored in Australia under US Army control were disposed of here[10]. This figure probably includes the weight of the containers which housed the agent (be it an artillery shell, storage container or bomb) and hence the amount of actual chemical agent would be *less* than 8,000 tons. What was dumped is unknown, however an inventory from 1943 is available which shows the US Army CWA reserves included bulk mustard, tear gas, lewisite and solid adamsite candles (see Appendix C). As shown in Appendix C, the US Army controlled stocks of CWA at sites far removed from Brisbane including Geelong in Victoria, Kingswood in New South Wales, Charters Towers and Kangaroo in northern Queensland. It is very unlikely the stocks at these sites were transported to Brisbane to be dumped off Cape Moreton[11]. Only the US Army stores of CWA in South East Queensland are likely to have been dumped off Cape Moreton.

The US Army originally proposed to dump the 8000 tons of CWA munitions along the 183 metre line (100 fathoms) (see figure 1), some 10 to 12 miles off Cape Moreton. At 12.5 nautical miles east of the northern tip of Cape Moreton there was a designated dumping site as proclaimed by the *Beaches, Fishing Grounds, and Sea Routes Protection Act 1932,* with a centre point of [27 degrees S, 153 degrees 42 minutes E at 256 metres (140 fathoms)] and a diameter of five nautical miles (being the most westerly circle in figure 1). This was one of fourteen dumping sites designated around Australia by a Federal Government Act of Parliament. Although originally chosen as sites to dump derelict boats, these sites were used as general waste dumping grounds where chemicals and other material were dumped. This site became an official Australian Army dumping position for unserviceable ammunition although the date of its first use is unknown. It is known some of the 8000 tons of CWA was dumped beyond the 183 metre line (100 fathom line)[12] and it is almost certain a proportion was dumped within the designated dump site[13]. Some government records also indicate some of the CWA was dumped further out to sea at 25

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[9] Bowers (1994) has the dumping operation occurring from 2 October 1945 to 20 December 1945. Based on a memorandum it is known tear gas grenades that had washed ashore at Maroochydore, 60 to 70 miles north of Brisbane, had been jettisoned by US personnel on or before 4 September 1945 [Memorandum dated 4 September 1945 signed by the Acting Deputy Director of Navigation and Lighthouses, State of Queensland. Ref NQ 45/5 W/S, M45/195/1/3846. Former Department of Transport file. EPA 94/6789 {This number refers to specific files in the former Environment Protection Agency (EPA) (files now held by Environment Australia, Canberra) file series: EPA - Waste Management Bch - Sea Dumping Records - Database. Federal Government and other records concerning CWA sea dumping have been compiled and collected into this file series}]. Also it is known mustard gas shells were dumped before 3 October 1945 [Letter dated 3 October 1945, signed by Assistant Secretary (Marine) - Department of Supply and Shipping. M45/195/1/3849. Former Department of Transport file. EPA 94/6789]. Although it is not known where the Maroochydore material had been sea dumped by the US, the mustard gas shells had definitely been dumped off Cape Moreton. Although this data does not dispute 2 October 1945 as a start date for sea dumping off Cape Moreton we can conclude other CWA dumping operations were underway, somewhere north of Brisbane, by early September 1945.

[10] The amount dumped varies between records. Bowers (1994) who had access to other dumping records states 8000 tonnes (should this be tons?) of adamsite candles alone were dumped here [Her entry is ambiguous. It reads {...876 containers of mustard, 93 containers of Lewisite, 8000 tonnes of adamsite candles, projectiles (75mm, 105mm and 155mm) containing an unidentified gas, 314 drums (55 gallon) of CNS, and 432 drums (55 gallon) of CNB} It could mean a combination of adamsite and projectiles at 8000 tonnes]. The available data on stocking rates tends to be contradictory. The differences could be due to a number of variables including the inventories being undertaken at different times (it is known CWA stocks were moved between sites, that stocks were added to and that defective stock was destroyed). The listings could also have been made by different personnel with possibly different objectives or be due to record transcription errors. A number of records have 8000 tons as the figure dumped. They include records from 1945, made just prior to the dumping operation, which state 8000 tons was soon to be dumped [Memorandum dated 3 October 1945 signed by the Acting Deputy Director of Navigation and Lighthouses, State of Queensland. Ref NQ 45/5. Former Department of Transport file. EPA 94/6789]. It is not known whether this was an up to date estimate of the CWA stocking levels or based on an older estimate. It is also not known what the stocking levels of CWA were at the storage sites in Australia at the end of World War II prior to their elimination.

[11] The fate of the CWA at these more distant sites is not known, however, it is possible it was sea dumped near the site of storage.

[12] Information based on a letter dated 3 October 1945, signed by Assistant Secretary (Marine) - Department of Supply and Shipping. M45/195/1/3849. Former Department of Transport file. Also various newspaper articles including the Melbourne "Sun", 19 November 1945; "Daily Telegraph" and "Courier Mail" - Queensland, both dated 17 November 1945. Also the fact that a one ton cylinder of mustard gas was retrieved at a depth of less than 110 fathoms off Cape Moreton (see further on) EPA 94/6789.

[13] If only because the west point of the dump circle is very close to the 100 fathom line (see figure 1 ; note the 100 fathom line is actually closer to the dump circle than is shown in this figure) and any boats dumping beyond this line would land some of the CWA within this dumping ground. More importantly, we know the dump circle was an official "Old" Australian Army dumping ground that was being deliberately targeted by the forces before and after World War II for the dumping of unserviceable ammunition and *dangerous materials* (my emphasis - based on a warning notice to fisherman issued by the Australian Army; an equivalent dump ground off Sydney was also being used by the Defence forces during 1945/1946; see figure 2 and footnote 49).

The "Old" Army dump circle was replaced by a "New" Army dumping ground (date unknown) located further to the east and in deeper water at 27 degrees S, 154 degrees E (figure 1 shows the "Old" dump circle being the most westerly and the "New" dump

miles east of Cape Moreton at 27 degrees S, 154 degrees E [1098 metres (600 fathoms)][14]. This co-ordinate was the centrepoint for another official Australian Army dumping site, again with a diameter of 5 nautical miles. This second Army dump circle replaced the Army dump circle closer to Cape Moreton at an unknown date (see footnote 13 & 47). In conclusion, CWA could be found scattered from the 183 metre line (100 fathom line) to the 1097 metre line (600 fathom line) within the rectangle shown in figure 1. It is not known where the majority of the chemical warfare munitions are located within this area.

In the Gillis Report, an eyewitness involved with CWA operations during the war remembers dumping mortars (number unspecified) in Mourilyan Harbour. Originating from Innisfail they had been fired experimentally. After firing, fifty percent were UXBs (unexploded bombs) which were sea dumped in order to avoid further mustard gas contamination of the firing range. Other dumping operations appear to have been undertaken off Queensland. A one ton cylinder of bulk mustard gas was encountered by a trawler at 20 degrees 42.8 minutes S, 153 degrees 35.7 minutes E in 69 fathoms (19 January 1970) and later in the 1970s a one ton cylinder came ashore in the same area (both from Bowers 1994). Two 155mm/6 inch Mustard Gas (HD) filled projectiles have been recovered in the last 4 years from the Moreton Bay area. It is understood that they were recovered during dredging operations in the shipping channel which passes between Moreton Island and Bribie Island[15].

Another record indicates half of a ton of mustard gas was dumped within the second dumping circle 25 nautical miles east of Cape Moreton at 26 degrees 59 minutes 30 seconds S, 153 degrees 57 minutes E on 23 January 1970 at 450 fathoms. It is not known where the material originated.

New South Wales[16]

An eyewitness report from the person responsible for overseeing the sea dumping of Australian Army supplies of CWA stated most of the chemical munitions were dumped 18 miles south south east of Sydney's South Head[17]. This correlates with (or is at least very near) the dump circle designated off Sydney by the *Beaches, Fishing Grounds, and Sea Routes Protection Act 1932* where it is known the defence forces dumped ordinary ammunition and other material after World War II (figure 2). This dump circle had a centrepoint at 34 degrees S, 151 degrees 36 minutes E with a 5 nautical mile diameter. The depth at the centrepoint is approximately 275 metres (150 fathoms).

About 5000 tons of CW munitions from the Army site at Albury is believed to have been disposed off Sydney. The initial dumping operations consisted of loading chemical munitions into the hulks of ships damaged by enemy action or ships no longer required. These ships were towed to the dumping site under escort and sunk using explosive charges placed in the ship's keel (at both bow and stern) or by naval gunnery fire using solid armour piercing rounds. Records exist for two of the dumped boats. These were scuttled away from the main dump site 18 miles from Sydney Heads. The first ship used was the SS

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circle further to the east; see also footnotes 46 & 47). One record states the CWA was most likely dumped in the two gazetted areas off Cape Moreton as stated in the Notice to Mariners. The Notice to Mariners lists the dump areas as proclaimed by the *Beaches, Fishing Grounds, and Sea Routes Protection Act 1932* and as there is only *one* gazetted area off Cape Moreton, this reference must be referring both to the gazetted area and the "new" Army dump ground in deeper water. Another file is said to exist in Queensland State Archives further confirming CWA was dumped in the dump circle as proclaimed by the act. This is yet to be confirmed.

[14] Letter dated 23 November 1945, signed by Acting Deputy Director, Navigation and Lighthouses, State of Queensland, M45/195/1/3949, former Department of Transport file. EPA 94/6789. This letter was in response to a query as to where the boat, the "City of Fort Worth" was dumping CWA. However an eyewitness on the boat (accepting he is recalling events of 50 years ago) believes it was unlikely the boat would have been able to travel the approximate 60 miles required on the daily trip and concludes the material was probably dumped closer to Cape Moreton (exact location between the 100 and 600 fathom line unknown) (R. Parsons, pers. comm). *See also* Bowers (1994).

[15] Considerable rust scaling had occurred reducing the outside diameter of the projectiles by up to 12mm. The most likely leakage point for CWA from these type projectiles is the at the fuze adapter in the nose of the projectile. This is the thinnest point on the projectile and therefore the most vulnerable point for the action of corrosion and erosion. The long period which these projectiles have been in the sea makes accurate identification extremely difficult if not impossible, given the condition of identifying features (length, diameter, shape, stamped markings, driving band etc) and the addition of heavy marine growth. It was later found that the projectiles, initially believed to be safe to move (no initiating mechanism - fuze), were now likely to contain CWA. The exact site of their recovery and their origin is not known (Captain Peter Ritchey pers. comm.).

[16] Most of the following information was collected by Major Chris Hely.

[17] Based on an interview conducted 26 May 1992 with the overseer of the dumping operation. This dump circle is more strictly *south east* than south south east of South Head. However, the point 18 nautical miles from south head in a south south east direction gives a depth of 144 metres, some 2 nautical miles short of the continental shelf. It was explicitly stated the CW was dumped over the shelf.

BANTAM which had been bombed and badly damaged at Oro Bay, New Guinea 1943 (see Parsons and Plunkett 1995). It was towed to Sydney and after the war was loaded with 27,500 chemical rockets, 8,000 4.2 inch chemical mortars and High Explosive shells and was scuttled 136 degrees Macquarie Light at 32 miles on 24 September 1946 (34 degrees 18.8 minutes S, 151 degrees 43.6 minutes E at 1829 metres)[18] - see figure 2. The ammunition disposed of in the BANTAM was all stored inside the ship's hold. The ships used for scuttling became progressively smaller until eventually old Manly ferries and dredges were used. In the case of these the ammunition was not always stored in the hold. Another ship the ex Manly ferry the BINNGARRA was scuttled 11 December 1946 with an unknown quantity of CWA. The disposal position was 122 degrees Macquarie Light, 35.6 miles at 2195 metres (1100 fathoms or 2013 metres in one source) [34 degrees 10.2 minutes S, 151 degrees 53.1 minutes E] which is within a proposed RAAF CWA dumping area (see figure 2 and below). Eventually the supply of old ships was exhausted and dumping operations continued by taking the ammunition out as deck cargo and pushing it overboard. The CWA was shipped by train from Albury to the timber wharf at Rozelle. It was then loaded on ships for dumping. From 1 July 1946 to 1 September 1946 records show at least 10 trainloads of CWA stores consisting of 3 inch mortar, 4.2 inch mortar and 25 pounder ammunition were shipped to Sydney for seadumping[19]. Also on 2 December 1946 a shipment of 334 tons of 5 inch bombs and 25 pounders was moved to the coast for sea dumping[20]. An inventory from 1943 gives an idea of the range of types of CWA that may have been dumped (Appendix D).

A few other very short records are available regarding sea dumping of CWA off New South Wales. CWA munitions (amount unspecified) from the RAAF store at Clarence were dumped at sea via Sydney, during 1947 and 1948, the Clarence site being clear by August 1948. A short record dated February 1948 states the RAAF store at Picton tunnel was finally cleared when heavy stocks, such as 500 pound bombs, filled with British thickened mustard gas were transported to Sydney for sea dumping. There were apparently sea dumpings from the RAAF site at Marangaroo (Stoneman 1990) although no data is currently available from Federal records. An old map shows a proposed munitions disposal area for RAAF supplies of CWA [with coordinates (34 degrees 02 minutes S, 151 degrees 42.5 minutes E); (34 degrees 12 minutes S, 151 degrees 42.5 minutes E); (34 degrees 02 minutes S, 151 degrees 55 minutes E); (34 degrees 12 minutes S, 151 degrees 55 minutes E)]. (figure 2). This was near the designated dump circle apparently used by the Army (figure 2). An inventory (Appendix E) shows the range of CWA held at No. 1 Central Reserve. It is important to note some of this material was probably burnt or buried on land.

One dumping is known since World War II off New South Wales. Nine filled and two empty mustard gas bottles weighing over 4 pounds were dumped in position 34 degrees 23 minutes S, 151 degrees 26 minutes E on 12 October 1965 in 310 fathoms. These had come from the Nuclear Biological Chemical Defence (NBCD) school[21].

Victoria[22]

On the 10th of August 1948, loading of chemical warfare shell was commenced at Williamstown, Victoria, with 400 tons being dumped within a 3 mile radius of (39 degrees 45 minutes S, 142 degrees 34 minutes E[23]) (see figure 4). On the 24th of August 1948, 402 tons of chemical warfare shell was loaded and then dumped the following day (25 August 1948). On the 3rd September and 10th of September, 1948, 400 and 432 tons respectively, were dumped west of King Island. The coordinates of these latter three

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[18] See also the Sydney Morning Herald, 9 April 1992, frontpage.

[19] War records for Albury (Australian War Memorial, ACT - Unit Records 1 BAD - 52 13/14/2) detail the following (all Mustard gas unless otherwise stated); 1 July 1946, Issued 168 tons 4.2" (inch) mortar for destruction by sea dumping; 7 July 1946, Owing to leakers with first shipment of 4.2" mortar decided to change to 25 pounder (pdr) until all 4.2" inspected. Loaded 270 tons 25 pdr; 8 July 1946, loaded 90 tons 25 pdr completing train of 360 tons; 14 July 1946, Issued 360 tons 25 pdr to Sydney for destruction; 21 July 1946, Loaded 315 tons 25 pdr; 22 July 1946, Loaded 45 tons 25 pdr completing train of 360 tons to Sydney; 29 July 1946, Issued 285 tons 25 pdr to Sydney. Unable to complete train due to shortage of transport; 4 August 1946, 150 tons 4.2" mortar and 118 tons 25 pdr; 11 August 1946, Issued 6907 boxes 4.2" mortar and 25 pdr for movement to Sydney; 18 August 1946 340 tons of 3" mortar, 4.2" mortar and 25 pdr for Sydney; 25 August 1946, 360 tons 25 pdr to Sydney; 1 September 1946, Issued 279.5 tons to Sydney. This shipment included B [probably meaning BBC (tear gas)].

[20] This shipment included B4, thickened BBC (tear gas).

[21] Letter stamped 29 October 1965, HMAS ANZAC at sea, ref. No. 169/13. EPA 94/7012.

[22] All from record of proceedings for LST3017 (later HMAS Tarakan) - J. Harker notes.

[23] In excess of 1000 metres. Royal Australian Navy (RAN) Hydrographic Office (pers. comm.).

dumpings were apparently not given but were possibly in the same dump zone.

Other

Bowers (1994) has data indicating another dumping of 7996 tonnes of CWA projectiles and small arms ammunition was undertaken by the US Army at an unknown site off Australia. No records have been found in Australia to confirm this.

Exposure to Dumped CWA

International Incidents

There are several recorded accidental recoveries of drums filled with CWA. During the spring of 1984, eleven Danish fishermen were exposed to mustard gas and were burned while fishing in the Baltic Sea (Aasted 1985). Many accidental recoveries have resulted from trawling in fishing areas around Japan (Kurata 1980). Eight areas off the Japanese coast were designated for sea dumping, although dumping outside these areas is known to have occurred. Fifty two people were wounded in eleven accidents at one dumping site alone. Kurata identified several key factors in the occurrence of accidents.

1. The sites where the CWA was dumped often violated the guidelines developed for dumping in Japanese waters (1000m depth and 18.5 km from shoreline), as they were much closer to the shore.

2. In Japan little attention was paid to the correlation of sites with fishing areas and ecologically sensitive areas.

3. There was insufficient public knowledge of dumping site locations.

Australian Incidents

The Australian public became aware of CWA dumping in Australia in November 1945 when the dumping operation off Brisbane was under way. As US soldiers were loading CWA at the Darra depot in readiness for sea dumping off Brisbane a US soldier was killed and two were injured when a gas shell was dropped and exploded[24]. Other newspaper reports in 1945 revealed a one ton cylinder dumped by the boat, the "City of Fort Worth" and only partially filled, had floated with most of the cylinder underwater[25]. With prevailing currents it was expected to wash up in the northern part of New South Wales. Obviously, it posed a problem for the public if opened deliberately or if accidentally smashed against rocks. Apparently, it was never recovered and most likely sank south of the dump site. Being just south of Cape Moreton it can be assumed this material had been dumped off Cape Moreton. Two members of the tug "Keera" were severely burnt while disposing of mustard gas bombs. These bombs had been hung over the side of the tug and axes were used to smash holes in them to prevent flotation. Jettisoned tear gas grenades in wooden boxes also washed ashore at Maroochydore, 60 to 70 miles north of Brisbane in 1945[26].

On 25 August 1983 two trawlermen snagged a one ton cylinder of bulk mustard off Cape Moreton[27]. The cylinder was brought ashore on a beach on Moreton Island and the contents were neutralised using chlorine. As trawlers off Cape Moreton do not operate beyond 110 fathoms the cylinder must have been dredged in a shallower depth than this, probably due east of the northern tip of Cape Moreton[28]. As previously mentioned on 19 January 1970 a one ton cylinder of bulk mustard gas was encountered by a trawler at 20 degrees 42.8 minutes S, 153 degrees 35.7 minutes E in 69 fathoms and later in the 1970s a one ton cylinder came ashore in the same area (Bowers 1994). This is north of the Cape Moreton dumping site and it is not known how material ended up here.

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[24] Newspaper article, Sydney "Daily Telegraph", 17 November 1945.

[25] Newspaper article, "Courier Mail", 19 November 1945. EPA 94/6789.

[26] Although not a CWA incident, press reports also revealed a member of the public had been severely burned from liquid chlorine gas after opening a 44 gallon drum near Evans Head in November 1945, EPA 94/6789.

[27] Newspaper article, "Courier Mail", 31 August 1983.

[28] Peter Seib, a long time trawlerman in the area, pers comm.

THE FATE OF CWA AFTER DUMPING

Most of the CWA would have sunk close to its dump position, although, under the influence of sea currents there would have been some drift of the lighter material. As mentioned, it is known at least one cylinder floated from the original dump position.

Once on the seabed the cylinders may be buried by sediment or could become encrusted by sea life. The rate of release of CWA will depend on the corrosion rate of the cylinders. Once released it is necessary to understand how the CWA will breakdown in water. With the release of the agent it is also necessary to assess the possible environmental effects and risks to the public. These issues will be considered in turn.

Corrosion of cylinders

The corrosion of ammunition shells is a complex phenomenon. A Russian study (reported in Stock 1996) concluded sea current was the important determinant of corrosion rate. Other reports argue sea conditions are very complex and combinations of external factors can create different scenarios. We do know the 1 ton cylinder retrieved off Cape Moreton had developed a number of small "pinholes" which allowed leakage of the mustard. It was also reported some of the cylinders were already partially rusted when dumped. Bulk cylinders were typically made from relatively thin steel when compared with artillery ammunition, filled with thickened or unthickened mustard gas. Heavy walled artillery projectiles are likely to remain intact longer than other cylinders (Major Keith Parker pers. comm.).

The breakdown of CWA in sea water

Although a variety of CWA was sea dumped, mustard gas was the primary agent dumped[29]. Mustard gas, also known as sulfur mustard [di(2-chloroethyl)sulfide] is actually an oily liquid at room temperature. As mustard gas was the primary CWA dumped, this section will concentrate on its behaviour in sea water.

Factors affecting the breakdown of mustard gas in sea water

Although mustard gas has a low solubility in water, once it dissolves it quickly hydrolyses (reacts with water) to primarily form thiodiglycol, together with other compounds including sulphonium and chloride salts[30]. The final products of the hydrolysis are said to be non-toxic (Stock 1996). The dissolution (dissolving) rate and hydrolysis rate are dependent on water quality and other environmental conditions. Some of these important variables include the following; the rates increase with increased temperature, increase with decreased salinity and increase with increased current/ turbulence[31]. The effect of sea current and sea temperature at the two main dump sites will be assessed.

Effect of sea currents and temperature on breakdown rate

Sea currents on the east coast of Australia (from about 18 degrees S to 32 degrees S) are dominated by the East Australian Current (EAC) which flows strongly southward (Middleton 1995). Current velocity generally decreases with depth. As the mustard gas leaks at both of the main dump sites (Cape Moreton and Sydney) it should mix in the bottom boundary layer, be diluted and hydrolyse near the dump site. Under the influence of the EAC it will most likely travel to the south at approximately the same depth. The dissolution and hydrolysis rate will be aided by the temperature found at the dump positions. The temperature at 200 metres depth off Sydney is approximately 12 to 14 degrees Celsius during summer[32]. Off Cape Moreton the summer temperature at 250 metres[33] is slightly higher being approximately 15 degrees Celsius. During the year the temperature at both sites can vary around this average by a few degrees. At the outer limit of the Cape Moreton dumping rectangle eg. 1098 metres (600 fathoms)

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[29] Dumping of CWA was often referred to as "sea drowning" at the time.

[30] The production of these salts will have different consequences depending on location. Within containment it is likely to concentrate to some extent and lower the pH. This may facilitate corrosion. Outside the container the salts will be diluted by seawater and have little effect (M. Mcleod and R. Mathews pers. comm.).

[31] See Khordagui & Al-Ajmi 1994 and Trapp 1985 for the chemistry of mustard gas hydrolysis and the measured effect of these different environmental variables on the rate of hydrolysis.

[32] New South Wales Environment Protection Authority pers. comm.

[33] This is the depth of the dump circle closest to Cape Moreton. This depth is used for the following modelling purposes.

temperatures in the range 4 to 6 degrees Celsius have been measured[34]. While the melting point of pure mustard gas is 14.4 degrees Celsius, in order for it to be maintained in a solid state, the material would need to be maintained in an environment many degrees below the melting point eg. at least at the freezing point of water, since any impurity would lower the melting point. As the surrounding temperature would be at least 10 degrees Celsius at the shallower dump sites it is virtually certain the material would be present in a liquid state. Even at 4 degrees Celsius at the deepest site off Cape Moreton it should remain liquid[35]. This contrasts with the cooler Baltic waters where the mustard gas is said to be in a solid state[36]. This higher temperature has a favourable implication for the hydrolysis rate. Conditions in Australia more closely approximate those found in Kuwait waters where Khordagui H & Al-Ajmi (1994) have modelled the hydrolysis rate of mustard gas at 15 degrees Celsius, being the average minimum sea temperature in winter. They predicted a half-life (where half of the mustard gas is hydrolysed) of 3 hours. This is a considerably faster rate than for mustard gas present in a solid state e.g. Epstein J et al (1973)[37] have estimated that a one ton *solid* cylinder of mustard gas in sea water (presumably without a casing and in still water) would take 5 years to hydrolyse.

Current measurements are available close to the shallower dump circle off Cape Moreton, at a couple of degrees to the south and north. A current meter placed to the south in 1983 (29 degrees 00.4 minutes S, 153 degrees 50.3 minutes E at 190m[38]) revealed a current velocity up to a maximum of approximately 50 centimetres/second. At another site north of the dumped mustard gas (25.85S, 153.90E at 300m[39]), Merrifield and Middleton (1994) found flows to a maximum of approximately 25 centimetres/seconds. Current flows off Sydney at 120 metres can reach speeds of 60 to 80 centimetres/second[40].

Water will ingress through the holes and hydrolyse some of the mustard gas within its housing. This was seen in the 1 ton bulk cylinder dredged off Cape Moreton which contained a substantial amount of water and hydrolysis products[41]. Any remaining mustard will leach slowly through the holes and with the large volumes of water washing past the container, would remain at low concentrations[42] and hydrolyse quickly.

In conclusion we can surmise that mustard gas will slowly leak as its housing corrodes[43] and small egress points develop. The combination of slow leakage rate, warm sea temperature and currents will quickly dissolve and hydrolyse the mustard gas, both within its housing and as it diffuses through the holes. At Cape Moreton and Sydney, the hydrolysis products will be rapidly dispersed to the south by the EAC.

Risks to the public in Australia

Due to its location, the risk of trawlers encountering the dumped CWA is low. Only two cylinders have been snared since the war which indicates the majority of the material is away from current trawling operations. The CWA retrieved would appear to have been stray cylinders (or the others are now buried) eg: the area up to 100 fathoms off Cape Moreton has been extensively trawled by prawn fishermen. The site off Sydney is a well known foul ground and is generally avoided by trawlers. Only one cylinder has washed ashore since world war two so the risk to the general public is virtually nil. This contrasts with

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34 South Pacific Cruise Data 1990-1993. New South Wales Environment Protection Authority pers. comm.

35 D. Ridley pers. comm.

36 Trapp (1985) has noted mustard gas containers dumped in the Baltic Sea are leaking and that the bulk of the mustard gas "remains as dangerous as it was when dumped, being protected against sea-water attack by its solid state, its very low tendency to dissolve, side products of hydrolysis and dimerization products forming a protective phase when turbulence is lacking, and by the container itself".

37 Viewed in abstract form only.

38 Freeland H, Church J, Smith R and Boland F (1985) *Currents Meter Data from the Australian Coastal Experiment; a Data Report.* Report No. 169. CSIRO Marine Laboratories. The current meter was 12m above the sea bed.

39 The current meter was 50m above the sea bed.

40 New South Wales Environment Protection Authority pers. comm. As measured during the summer of 1995. The rate of current flow during this summer would be slightly faster than "normal" due to the East Australian Current being particularly active.

41 R. Mathews pers. comm.

42 And would never reach saturation level.

43 As already noted the corrosion rate will be faster for bulk cylinders than artillery shells.

overseas experience where there have been many encounters and accidents with trawled or washed up cylinders[44]. Although the areas are not currently trawled the CWA may still pose a threat to future possible trawling or other activities including sea mining. As the containers deteriorate, they may become more likely to break open when they hit the deck. If they are heavily corroded their contents will be mainly sea water and hydrolysis products. The more intact the containers, the more likely there will be mustard present.

Potential environmental effects

Literature that addresses the effects of CWA exposure on marine biota is very limited. Ecotoxicity experiments conducted in an aquarium apparently show mustard gas has no significant effect on fish. It is also believed fish do not bioaccumulate the agent (due to its solubility in water) [both reported in Stock (1995)]. There are two sites off Australia where many thousands of tons of mustard gas have been dumped. The site off Cape Moreton covers a large area and as mentioned includes a designated dumping site as proclaimed by the *Beaches, Fishing Grounds, and Sea Routes Protection Act 1932* near Cape Moreton. Originally chosen as a site to abandon derelict boats away from shipping routes and trawling operations, it became a general dumping ground for many sorts of unwanted material. To my knowledge, no biological surveys have been undertaken at the site. The sea bed at the centrepoint is described as sand and shell[45]. Although knowledge of non-CWA dumping episodes over the half century this area was available as a waste dumping ground is limited, the data that exists (for the 1960s) gives an indication of the amount of waste that may have accumulated[46]. There have been many dumpings close to the CWA dumped 25 miles east of Cape Moreton[47]. Other material would lie on the sea bed within this rectangle[48]. If the cylinders, bombs or shells started leaking they would pose a danger only to biota surviving in this accumulated debris. The hazard, if any, would depend on the rate of leakage of mustard from the container and as argued it should be a slow and gradual leak. Based on the data provided above, fish using the dump areas as artificial reefs should not be affected by the leakage of mustard gas. The nearest *identified* environmentally sensitive area to the dump site is the Moreton Bay Marine Park, declared in 1993. Surrounding Cape Moreton, its boundary extends three nautical miles from the coast. It is a significant distance from the 100 fathom line and thus the closest of the dumped CWA. As discussed, current flows around the mustard gas will be to the south. As the Marine Park is to the west of the dumping circle, the mustard gas should pose no threat. A similar situation exists at the major dumping site off Sydney. At least 68 boats have been dumped here. There are also submarine cables running through the area. It was definitely known and used by the defence forces immediately after World War II[49]. The nearest sensitive areas are well away from this dump site.

The Future of Dumped CWA in Australian Waters

As the two main dump areas do not coincide with any sensitive marine environments there is unlikely to

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[44] CWA effects on health are numerous (see Pechura and Rall 1993) and include respiratory and skin problems. Mustard gas and Lewisite are blister agents, blistering the skin after contact. Mustard gas combines with DNA (that is, it is an alkylating agent).

[45] Royal Australian Navy (RAN) Hydrographic Office (pers. comm.).

[46] Federal Government records indicate 1,022.5 tons of ammunition were dumped in the dumping circle between 7 March 1962 and 30 June 1964. A further 4,000 pounds of ammunition was dumped in February 1968 and an old dredge in 3 June 1969.

[47] This second site was the centrepoint of a second official Army dump site which replaced the one closer to Cape Moreton. It had coordinates of 27 degrees S, 154 degrees E with a diameter of 5 nautical miles. Data does not indicate when it was first used as a dump circle by the Australian Army. Within the second dump circle the following is known to have been dumped; October 1968, 600lbs of boxed rifle barrels and sulphur bottles; January 1969, 2649 lbs of electric plating vats; 1 ton of ordnance stores on 6 November 1965; 0.5 tons medical stores and sulphur drugs, 2 February 1966; 20 December 1966 - medical stores from water pouce 0.25 tons; 0.5 tons of metal, 22 January 1969 and 1 ton of scrap metal, 17 August 1971.

[48] Records show after the war non CWA ammunition was dumped beyond the 100 fathom line. US supplies including vehicles, old barges with ammunition and general stores (Peter Seib, pers comm, whose father in law was involved in the postwar dumping) were dumped after the war. Material trawled off Cape Moreton includes typewriters, clothing and medical supplies (Peter Seib pers comm). Six hundred tons of grenades were dumped in the rectangle after the war also (T Davis pers comm). Conventional ammunition was dumped in unknown quantities by boats such as the M.V. Katoora.

[49] Limited data shows 300 tons of ammunition was dumped here in August/September 1945. 18 pounder with shell fuzes removed and boxed, and cartridges SAA 50 boxed were dumped 15 April 1945. In 1946 bombs, incendiary rolls, obsolete war planes and engines and more ammunition was dumped. Material dumped in 1976 includes the BOSUN, a crane lighter and sodium filled exhaust valves. More valves were dumped between 1978 and 1982. More recently, in 1993, a human body was buried at sea here.

be any major environmental impacts from material remaining at the site (however, as noted earlier, material could have floated away from the site during dumping operations, possibly to marine sensitive areas[50]). Retrieval of the dumped CWA would seem to pose an unnecessary risk, both a risk inherent in handling the material and a risk associated with the dangerous waste dumped with the CWA (known to include ammunition and most likely to also include chemicals). Further, it would seem to be impractical to individually locate thousands of scattered bombs and artillery shells, many now presumably buried by sediment and other waste.

International experience has shown that, wherever possible, public knowledge of the location of CWA dumps has been beneficial in avoiding contact incidents. Kurata (1980) has shown that since a national public inquiry in 1972, when information was released regarding the Japanese dumping sites, there have been no casualties from accidents. This compares with several deaths and dozens of wounded from dumped CWA contact in the period from World War II to 1972. He urged the release of such information in other countries to prevent future accidents. As the CWA dumping sites in Australia are not known to the general public their locations have been revealed to prevent possible exposure. The location of CWA dump sites in Australian waters make the risk of accidental recovery by trawlers low. As stated there have been only 2 cylinders trawled in the last 55 years. The risk to the general public contacting a drum is extremely small. However, if recovered, ANY ordnance (chemical or non-chemical) must not under any circumstances be touched or tampered with[51]. Inappropriately handled ordnance can be very dangerous. Chemical Warfare Agents recovered overseas have caused serious injury even though the material is over 50 years old[52]. Any incidents should be reported to the local police. They will in turn contact the relevant authority responsible for its appropriate disposal. If possible one should keep the general public away from the object in question.

The publication of this paper will, hopefully, prevent any accidents occurring at the CWA dump sites where co-ordinates have been revealed. It will also, hopefully, encourage other governments to reveal locations of their CWA sea dump sites for the same purpose.

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[50] There is anecdotal evidence to suggest some trawler operators, off both Cape Moreton and Sydney, after snaring conventional ammunition within fishing areas, redump the material at sea at a site away from trawling operations. This transmigration of the dumped material means that the original co-ordinates of the dumping sites may no longer hold. It is possible CWA material has been trawled in the past and redumped in this fashion. I thank Major Keith Parker for this suggestion.

[51] In the case of fishermen, no attempt should be made to transfer the container or munition onto the deck.

[52] These incidents are usually associated with thickened mustard in shallow water (R. Mathews pers. comm.).

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APPENDIX A

Storage sites for CWA in Australia during World War II

US Sites

The US Army appears to have had 8 stockpile sites in Australia (cf: Bowers who listed 6 locations). Six of these were in Queensland being Charters Towers, Kangaroo (26 miles north of Townsville, Darra, Columboola (200 miles west of Brisbane) and two in Brisbane itself [one at Crosby Park and another called 0-695 (location in Brisbane not designated)]. There was one site in New South Wales, Kingswood (25 miles west of Sydney) and one in Victoria, Geelong (40 miles south west of Melbourne).

Royal Australian Air Force (RAAF) sites[42]

The Royal Australian Air Force (RAAF) supervised stocks of CWA in three states, New South Wales, Queensland and the Northern Territory. In New South Wales CWA was held at Marrangaroo (known as No. 1 Central Reserve). The No. 1 Central Reserve had several sub-depots including No.1 sub-depot at Moorebank, No. 2 sub-depot at Glenbrook, No. 3 sub-depot at Picton, No. 4 sub-depot at Clarence and No. 5 sub-depot at Bowral. In Queensland there was CWA at the Research & Experimental Section at Innisfail, CW Physiology School at Townsville, 2/1 Australian Laboratory (Royal Australia Engineers) (location not determined), the Field Experimental Station at Prosperine, LAQ Gas (CW) School Cabalah, Experimental Centre Canungra, RAAF No.19 Replenishing Centre Talmoi, Chemical Research Unit (CRU) at Bowen. In the Northern Territory there was the No.5 Centre Reserve at Darwin and 87 mile storage facility.

Australian Army

The Australian Army supervised stocks at Albury, New South Wales.

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[42] I was assisted by Major Keith Parker and Major Chris Hely in the compilation of this list.

APPENDIX B

Chemical Warfare Agents in Australia
Written by Major Keith Parker

For the first time, during World War 1, CWA had been used in large quantities to gain a significant military advantage. The effectiveness of the munitions in both the numbers of casualties caused and the devastating effect it had on morale, caused a belief that any future world war would almost certainly involve the use of CWA.

The Japanese were known to have used CWA in their conflict in China and Australia reserved the right to use CWA if their forces were attacked by chemical agents. For a time, the devastating loss of life in the South West Pacific area battles made the use of CWA a potential acceptable strategic weapon, especially on islands that were solely occupied by Japanese forces. There was an extensive period of testing in the northern part of Australia. However, no CWA were used by the allies during combat. Although a separate department of the Munitions Supplies Laboratories had been established to study the latest procedures for chemical defence, filled munitions did not come to Australia until ships that had been carrying CWA to both Singapore and Java were diverted to Australia with the fall of those locations to the advancing Japanese forces. This delivery was the first of six CWA filled ships that arrived in Australia during the period August 1942 until September 1943 which remained under the general control of Australia with operational control vested in the Supreme Allied Commander. Further stocks of CWA came from American supply and generally remained under the control of the United States Forces throughout the war and who were also responsible for the disposal of unused stocks of US origin at the completion of hostilities.

APPENDIX C

Annex No. 1 To Chemical Warfare Plan, SouthWest Pacific Area. Stockage of Chemical Munitions, 1 November 1943.

US Munitions

Advance Chemical Depot, Aviation, Charters Towers, Q'LD

81 tons Mustard (H), in bulk
94 tons Lewisite (L), in bulk
15 tons CNS, in bulk
23,500 Bombs, M47A2, 100-lb (H)
100 Bombs, M47, 100-lb (L)
600 Bombs, M47, 100-lb (empty)
496 M10 Spray tanks, empty
204 M20 Spray tanks, empty

Kangaroo (SOS Dump) (26 miles North of Townsville)

15,540 Bombs, M47A2, (H) 100-lb
18,168 - 75 mm Gun (H)
14,370 - 75 mm Howitzer (H)
198 - 105 mm Howitzer (H)
1,401 - 155 mm Howitzer (H)
1,171 - 155 Gun (H)
300 DM Candles (toxic smoke)

Darra (near Brisbane Q'LD)

373 tons Mustard (H), in bulk
101 tons Lewisite (L), in bulk
82 tons Tear Gas Solution (CNS) in bulk
4,945 Bombs, empty, 100-lb
5,595 DM Candles (toxic smoke)
5,489 - 105 mm Howitzer (H)

Columboola (200 Miles west of Brisbane)

26,023 Bombs, (H) 100-lb
4,815 - 75 mm Gun (H)
36,036 - 75 mm Howitzer (H)
83,994 - 105 mm Howitzer (H)
10,856 - 155 mm Howitzer (H)
585 - 155 Gun (H)

Brisbane

4,216 Chemical land mines (US) empty
134 M10 Tanks, Airplane smoke, empty
240 M20 Spray tanks, empty
6 M33 Spray tanks, empty

Geelong (40 miles SW of Melbourne)

431 tons Mustard (H), in bulk

Kingswood (25 miles west of Sydney)

56,909 - 105 mm Howitzer (H)
10,825 - 155 mm Howitzer (H)

Note: H=General British code symbol for mustard gas
L= British code symbol for Lewisite
CNS=British code symbol for CN-PS-chloroform mixture (tear gas)

APPENDIX D

Annex No. 1 To Chemical Warfare Plan, SouthWest Pacific Area, Stockage of Chemical Munitions, 1 November 1943.

Australian Army Munitions

Albury NSW

85,300 - 25 pounder shell, base ejection, filled BBC (tear gas)
258,000 - 25 pounder shell, base ejection, filled Mustard
26,900 - 6 inch Howitzer shell, base ejection, filled Mustard
8,000 - 4.2 inch Mortar Bombs, filled Phosgene
39,500 - 4.2 inch Mortar Bombs, filled Mustard
22,500 - 5 inch Rocket Bomb, filled Phosgene
3,900 - Mines, Chemical, filled Mustard

Note: BBC=General British code symbol for Bromobenzlcyanide

APPENDIX E

Annex No. 1 To Chemical Warfare Plan, SouthWest Pacific Area. Stockage of Chemical Munitions, 1 November 1943.

RAAF Munitions

No. 1 Central Reserve (50 miles west of Sydney)

8,000 bomb, 30-lb L.C. charged Mustard
400 bombs, 65-lb L.C. (empty)
4,800 bombs, 250-lb L.C. Charged Mustard
3,600 bombs, 250-lb L.C. Charged Phosgene
200 bombs, 250-lb L.C. (empty)

X 92,000 gallons bulk mustard for charging empty bombs
XX 550 S.C. ls 500-lb. Type S/G charged thickened Mustard. 14, 500 drums (3.5 gal) charged thickened Mustard – for re-charging S.C. ls.

Notes:

X 24,000 bombs, 65-lb L.C. being locally manufactured.
XX More of the items marked XX to arrive. Ex. UK.

FIGURE 1—LIKELY DUMP AREA FOR 8000 TONS OF CHEMICAL WARFARE AGENT DUMPED OFF BRISBANE

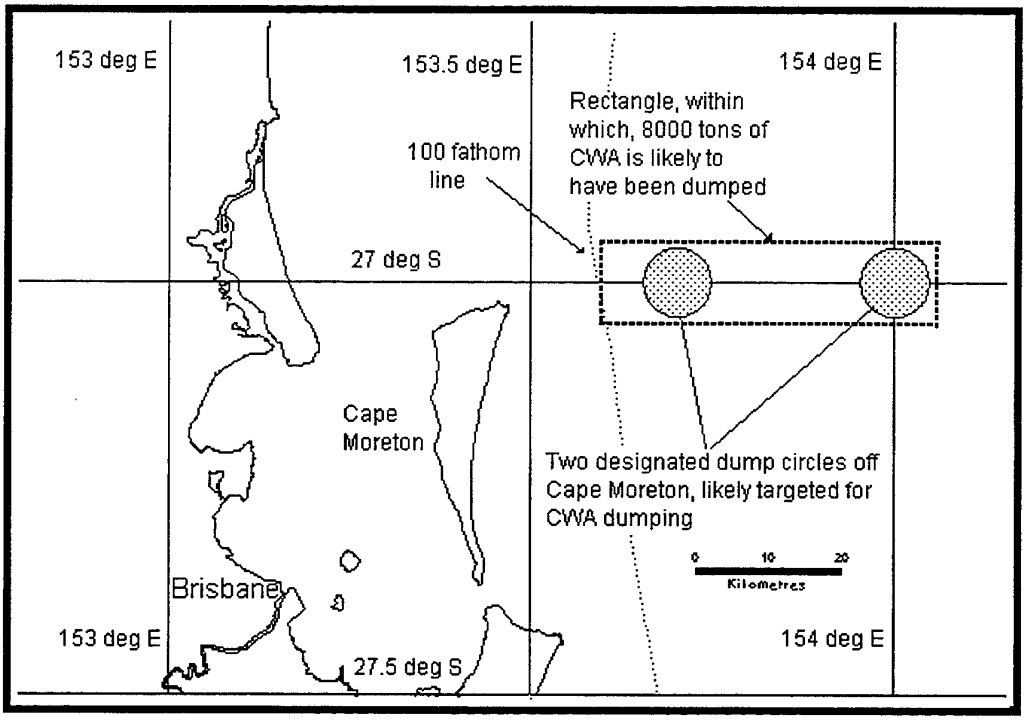

FIGURE 2—CHEMICAL WARFARE AGENT DUMP AREAS OFF SYDNEY

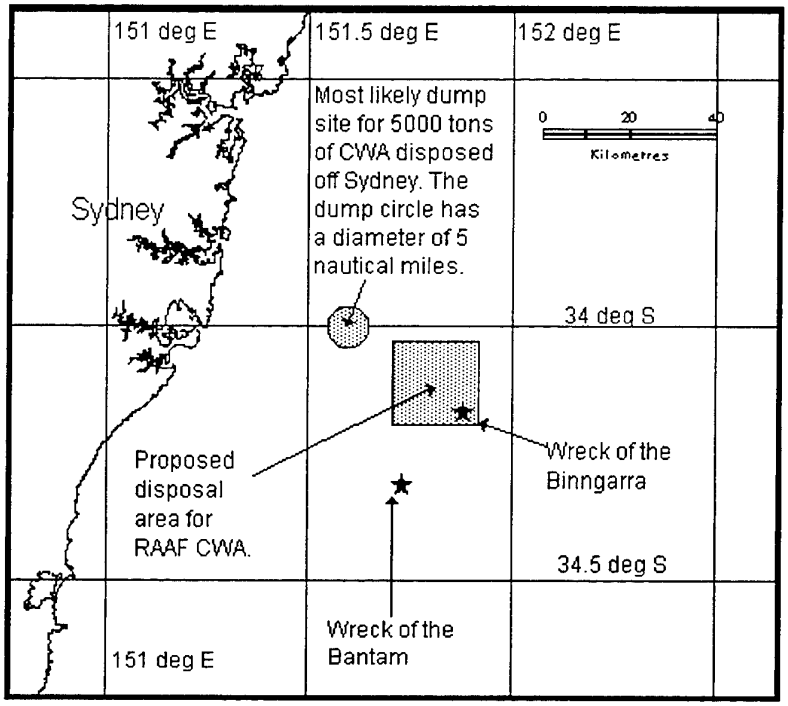

FIGURE 3—CHEMICAL WARFARE AGENT DUMP AREAS OFF TOWNSVILLE

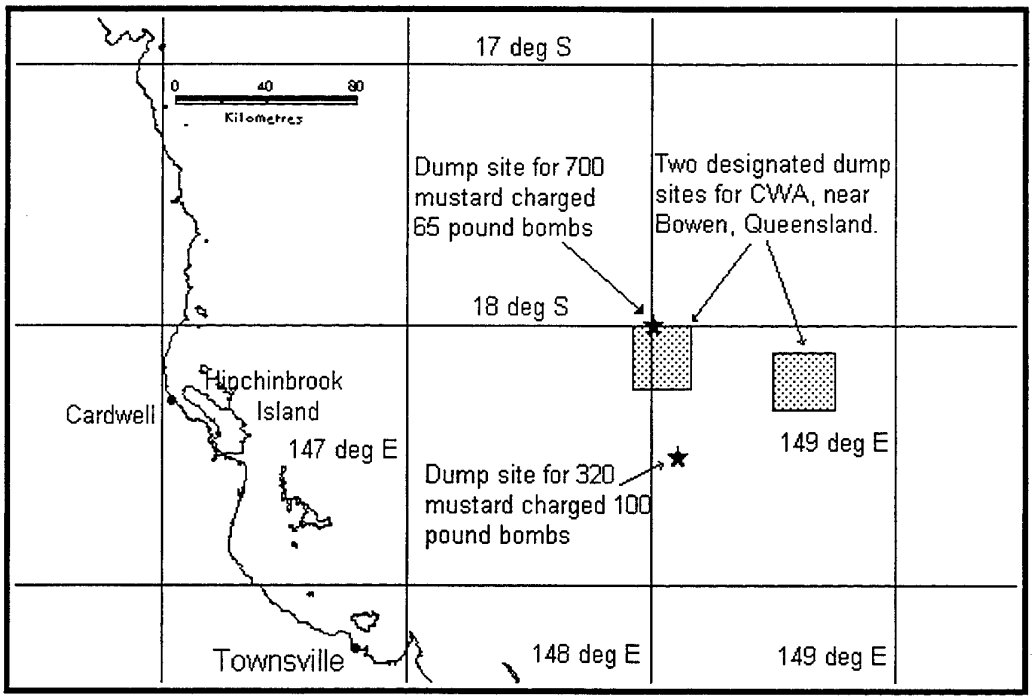

FIGURE 4—CHEMICAL WARFARE AGENT DUMP AREA OFF VICTORIA