REPORT ON TORNADO INVESTIGATION—SMITHTOWN (N.S.W.),
AUGUST 1964

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ABSTRACT

A small but intense tornado which struck Smithtown, on the lower
Macleay about 10 miles northeast of Kempsey, was investigated
on the spot two to three days after the event.

The estimated path of the tornado and some of the damage and
destruction are illustrated in diagrams and photographs.

Evidence along most of the track favoured a cyclonic sense of
rotation of the tornado.

The synoptic situation prevailing about the time of the occur-
rence is discussed and copies of isallobaric charts over the
geographic area, the relevant surface synoptic chart, aerological
diagram and pluviograph charts are shown.

Noteworthy features of the tornado are listed and discussed.
A definition and some notes on tornadoes are given.

1. INTRODUCTION

Shortly after 1 a.m. on the morning of 24 August 1964 a small tornado caused severe
damage to houses and farm buildings in and near the town of Smithtown, situated on a narrow
peninsula formed by a deep "U" shaped bend in the Macleay River about 10 miles downstream
from Kempsey and an equal distance from the mouth of the river (see Fig. 1). The town is an
important centre in a rich dairying district consisting of low lying, mostly cultivated, flat
country.

The tornado is presumed to have developed about one mile north of the town at
approximately 1.15 a.m. and then travelled southward, as no damage of any sort could be
found north of this point (position A, Fig. 1). After causing severe damage to farm buildings
and a house, the tornado moved in a general south-southwest direction across open fields to
Main Street and then left a trail of destruction as it passed across to the western side of the
town, finally dissipating over the river to the southward.

After studying a report made by the Police Officer in charge, Constable 1st Class,
R. Southam, the path was plotted by following the trail of damage, inspecting the position of
wreckage, interviewing residents (including the only eyewitness in the town) and the Foremen in
charge of County Council and P.M.G. repair crews. The actual investigation at Smithtown was
not commenced by the author until the afternoon of the 26th, by which time all damage to the
electricity supply system had been made good, much clearing up had been done and the extensive
damage to the fence and other parts of the football ground had been repaired. However, many
damaged buildings and much debris remained undisturbed, particularly at the Public School
which, fortunately, was closed for the holidays.

Reconstruction of the sequence of events is somewhat conjectural due to the fact that
most of the people were asleep when the storm struck and, generally speaking, only those whose
houses were damaged were awakened, while because of the blackout no one seemed to have taken
note of the time. However, the time of the blackout can be fixed fairly accurately as reliable
electric clocks at Radio Station 2KP and at two widely separated private houses stopped at
1.18 a.m., while the Smithtown telephones went off the Board at the West Kempsey Exchange at
about 1.15 a.m.
There is strong evidence of very rapid ascending currents but little of descending currents. Section 2 gives an account of significant features of the track and of events as pieced together from the position and nature of damage, the sequence of occurrence of faults in the electricity supply lines in the area and remedial action detailed by Mr. Lardner (the Macleay River County Council "on call" man for the lower River) and the report of the eye-witness, Mr. Carroll, whose house is in Belmore Street near Main Street.

A series of Press photographs, taken only six hours after the occurrence and kindly supplied by the Macleay "Argus", and photographs taken on 27th August by the author are included and are referred to lettered positions on the sketch map (Figure 1).

Interesting features of the Smithtown tornado are discussed in Section 3. A brief description of the synoptic situation, together with various charts, diagrams and autographic records, are given in Section 4.

2. FEATURES OF THE TRACK AND RECONSTRUCTION OF THE PASSAGE OF THE TORNADO

The estimated path of the tornado is shown in Fig. 1 and the nature of the damage can be seen from the photographs (note lettered positions). The width of the band of destruction was small, of the order of 30ft to 50ft generally, while severe damage appeared to be chiefly on the left flank with the exception of Main Street between Rawson and Belmore Streets, where depending on the interpretation of the evidence a number of different paths could be worked out. The inconsistent pattern of the damage in this area could possibly be the result of "skipping" or "zigzagging".

Unsettled weather developed on the afternoon prior to the tornado, and rain and sporadic thunderstorm activity commenced in the area about 7 p.m. There was general agreement that the surface wind was between north and northeast at about 10 to 15 knots up to the time of the tornado. This is consistent with the plotted track which shows a mean line of advance of SSW from the first to the last point of severe damage, a distance of about 1.1 miles.

The northern point (marked A on the sketch map) was at Kyle's farm about three-quarter miles from Main Street on Croad's Esplanade, where a shed was demolished, its roof timbers and sides being blown to the southwest. As no damage or debris could be found to the northward, the tornado apparently developed near here and then moved in a southwesterly direction, unroofing the western side of the dairy bails and lifting an old 500 gallon corrugated iron tank, which was found about 100 yards to the south on the northern side of an electricity pole on the river bank at position B. The position of the tank and the shape of the dents in the top were consistent with the opinion held by the County Council repairmen that the tank had struck the cross arm and brought down a wire, although this did not cause the blackout.

Pieces of roofing iron and other debris were scattered over the ploughed field between the dairy and a P.M.G. staff cottage about 140 yards to the southward along Croad's Esplanade (Position C). The vortex at the ground apparently swung sharply to the east or "skipped" at this point as the timber house, which was new and strongly constructed, was lifted from its brick piers and slewed round so that the northern end was displaced about 25 feet to the eastward and yet the palings fence and stack of empty bottles only 14 feet or so to the north were not disturbed (see Fig. 2). Damage to the house was so extensive that doubts were expressed as to whether it was worth repairing.

A tree about 6 to 8 inches in diameter was snapped off close to the ground and lay parallel to the river about 20 yards further south along the river bank, while an adjacent dead tree about 10 inches diameter was uprooted and hurled across the road to the Australian Broadcasting Commission's (2KP) fence (position D) where it was found with its branches on the fence and its butt inside the fence pointing to the southwest. A few feet further south the fence was broken by a piece of iron from the westward, while an electricity pole on the roadside had a length of roofing iron impaled on it about 7 feet from the ground from a direction just north of west.
Fig. 1 Locality maps
(a) SMITHTOWN
(b) Surrounding Districts.
About 10 yards to the southwest a small aerial system about 12 ft above the ground was brought down from the northeast by flying sheets of iron and timber, numerous pieces of which were found lying together nearby. Apart from a hole high up in the fibro wall on the western side of the transmitter building, there was no other damage to the station or to the Manager's house which occupies the block between the station and the P.M.G. cottage (Position C).

An eyewitness at Gladstone, on the eastern bank of the river opposite Smithtown, reported that the red lights on the steel aerial mast at 2KP "swayed" unusually and quite noticeably during a thunderstorm some time after 1 a.m.

Trees and reeds blown over to the northeast on the river bank, about 90 yards to the south (Position E), indicated that the vortex had probably moved eastward from the ABC land and then southwest along the river, as no damage or debris was visible for a distance of about 350 yards. At this point the tornado apparently returned inland and skirted a house near the roadside, unroofing a room on the southwest corner of the verandah but causing no other damage.

About 170 yards further south along the Esplanade (Position F) a 6 ft length of corrugated roofing iron was found doubled over and hanging from the western of the three power lines attached to the cross-arm of the pole (Fig. 3), while a willow nearby was snapped off to the southwest. This is discussed in Section 3.

Heavy damage was caused at Sutherland's Farm (Position G), where a shed was demolished and the roof and sides of a garage were blown away and the framework partly destroyed. Two 44 gallon drums, a heavy square iron tank, bags of fertiliser, timber and iron were lifted and carried some yards to the southwest, and wreckage was littered over the fields for hundreds of yards in a direction between south and southwest. The homestead, a double-storied timber building one hundred years old and only about 50 yards from the garage suffered no damage. A large piece of matted wire netting, which showed burn marks, was apparently blown on to the power lines on the road outside this farm, causing a fault which was believed by the County Council foreman to be responsible for the blackout.

The track could be followed for the 600 yards across open fields in a southwesterly to southerly direction to Main Street by the wreckage and damage to a split rail fence (Position H) and to a small windmill (Position J), whose fin arm was bent back through 180° towards the sails which were partially blown out. The fin arm had previously been adjusted at an angle for reduced speed.

The row of houses on Croad's Esplanade on the eastern edge of these fields was not affected, with the exception of adjacent houses at Position K where TV aerials were blown horizontal by the wind or by flying debris. One aerial was bent over to the north, but the other had been removed and the direction of its fall could not be established.

The track of the tornado as shown in the sketch map and covering the period in which the destruction was caused in Main Street should be accepted as an informed guess, as it was impossible to establish the sequence of events from the accounts of people who were asleep up to the time of the damage to their houses. The only exception was Mr. Carroll who was looking towards Main Street from a window of his house in Belmore Street (the third from Main Street on the western side). During heavy thunder and lightning, he saw for a few seconds a "whitish cloud" rolling rapidly towards him along the full width of Belmore Street and instinctively leaned against the window as the wind struck with "a terrific roar", bulging the window and shaking the house. Torrential rain lasted for about 15 minutes, then ceased abruptly, followed by a complete calm.

It was apparent that the tornado had already caused most of the heavy damage in Main Street between Rawson and Belmore Streets before passing Carroll's house. On the northern side, opposite Rawson Street (Position L), at Watson's Garage, heavy double doors suspended from steel tracks at front and back were blown inwards and outwards respectively to the north, causing damage inside the garage, while a plate glass window at the east end of the front was broken inwards.
Fig. 2 Macleay Argus photo taken about 0730 EST on 24 August 1964, PMG house (Waters) Croads Esplanade position C looking north towards unroofed dairy balls where Tornado apparently started. House on right lifted from piers and northern end slewed round 25 feet to eastward.

Note: paling fence and 5 feet high stack of bottles undisturbed. Width of drive 13 feet 6 inches.

Fig. 3 Croads Esplanade position F, taken 27 August 1964. Piece of roofing iron shown was hanging from an inside power line near cross arm of pole on morning of 24 August 1964. Removed by repair gang. Wires not broken.
Opposite the garage on the south side of Main Street, two adjacent houses (Neil and Brady; Position M) were completely unroofed, but little other damage was caused on this side apart from a broken plate glass window at McCairn's garage at the corner of Belmore Street.

On the northern side, however, one house was unroofed and the remainder between Rawson and Belmore Streets suffered considerable damage. Most of the power lines in this vicinity were brought down.

It seemed likely that after passing the northern side of Carroll's house the vortex "skipped" in a westerly to southwesterly direction, causing considerable damage to outbuildings and trees at the back of Main Street (Position O) and unroofing a house occupied by Mrs. Bourke in Rawson Street (Position F). Substantial willow trees were snapped off about 6 to 8ft from the ground in these positions (Fig. 4) before the storm crossed over Rawson Street to the football ground, flattening the fences and forcing all the electricity poles some 20° over to the west or southwest.

Fig. 4 Position O facing south from Rawson Street. Willow trees snapped to southwest. Taken 27 August 1964.
The track was westerly along Cannane Street (Position Q) to the Public School where the tornado apparently swung to the southeast, completely demolishing a 40ft x 15ft shed on the northern side of the school tennis court (Position R) and spreading wreckage to the southwest or south.

The distances to which heavy timber beams and posts were hurled and the deformation of sheets of iron, provided spectacular evidence of the violence of the storm at this point. This is discussed in Section 3.

Some rows of cabbages in the field south of the tennis court were "flattened" and banana trees in a clump near the river bank at Position S, 150 yards to the southwest, were snapped off, while a medium size tree was uprooted and blown over to the southwest at the western end of Jeffery Street (Position T).

Although houses were located close to both positions, no damage was reported and the vortex apparently followed the river towards the Butter Factory where the Duty Engineer, who was on one of the upper floors of the furnace building at the time, which he estimated to be about 1.30 a.m., reported that a wind storm struck the building with a roaring noise. All the windows, which were of the scuttle type hinged at the top, blew open outwards, while much of the fire was blown out of the furnace on to the floor of the fire room.

The tornado is presumed to have dissipated over this part of the river, as no other damage was reported anywhere in the vicinity apart from electrical faults at dairy farms on the western bank.

At Position V power lines leading to the house were wrapped together as if by violent "whipping", while a fault was caused at Position W by a piece of fencing wire wrapped around the power lines, apparently carried across the river from the northeast.

3. NOTEWORTHY FEATURES OF THE TORNADO

(i) Rotation

Inspection of damage and the throw of debris provide unmistakable evidence of gyratory motion and favour cyclonic sense of rotation.

(ii) Diameter of vortex

The width of the band of destruction along most of the path and the evidence of the eyewitness, Mr. Carroll, confirm that the diameter of the tornado near the ground would be of the order of 30 to 50 feet only. Fig. 2 also gives graphic confirmation as the 5ft high stack of empty bottles would need only a gentle push to cause a collapse and yet was within 15ft of the violent action of very powerful forces required to lift and slew the cottage from its foundations. At the other end of the cottage the tanks, shrubs and the next-door house were also unscathed.

(iii) Rain

Periods of fairly heavy rain and some thunderstorm activity was reported in the area from 7 p.m. onwards on the night of 23rd August, but all those affected by the tornado agreed that the torrential rain which accompanied the tornado lasted about 15 minutes. 350 points were recorded on the morning of the 24th by unofficial gauges at Smithtown and Gladstone, while 9 a.m. readings at official stations were as follows:-


(iv) Hail

No reliable reports of hail were received.
Fig. 5 Three photographs of a sheet of corrugated roofing iron after being wrapped around a post by the wind.
(v) Thunder and Lightning

Thunder and lightning were reported by eyewitnesses at about the time of the tornado, while the majority of those whose houses were damaged recollected a "terrific clap" like thunder as the wind struck.

(vi) Sound

As most of the residents were asleep when the tornado struck, the usual reports of the characteristic roar were absent, but the eyewitness, Mr. Carroll, and the engineer at the Butter Factory both reported a roaring noise.

(vii) Appearance

The only eyewitness, Mr. Carroll, reported seeing a whitish cloud approaching rapidly down Belmore Street from Main Street for a few seconds before the wind struck his house (a distance of about 50 yards). It is interesting to note that there was a considerable amount of rain water lying in pools on the ground which has heavy soil and is level over the whole area, and it is probable that the surface water was sucked up at the bottom of the vortex to make a cloud of spray. An example of this formation of a waterspout over flooded land at Richmond (N.S.W.) is described by Dunstan (1956), with a remarkable photograph of the pendant cloud taken from the air, showing the white cloud at the surface.

(viii) Wind Speed

Evidence of very high wind speeds was deduced from the damage, chiefly from the deformation of sheets of corrugated roofing iron and the distances which heavy pieces of timber were carried. One such sheet, approximately 6ft x 2½ft, found on the school tennis court had apparently been wrapped around a post by the wind with many folds reducing its width in the middle to about 6 inches and forming a perfect mould of more than the semi-diameter of the post. The sheet was identified as being from the house occupied by Mr. Neil in Main Street (Position M). This piece was forwarded to the Aeronautical Research Laboratory, Department of Supply, Fishermen's Bend, Melbourne for analysis with a view to obtaining an estimate of the wind speed. The following report was received:

"An estimate of the wind velocity of the tornado in Smithtown (24/8/64) has been made on the basis of the deformation and breaking of a piece of corrugated iron-sheet (roofing iron) which had been wrapped around a wooden post.

The piece, three photographs of which are shown in Fig. 5, was 0.024 in. thick and the corrugations were ¼ in. deep and 3 in. wide. The piece was double folded before wrapping around a post 5.5 in. in diameter.

Tests carried out on specimens cut from the piece gave a yield stress of 36400 psi. A very crude "tear" test was carried out, which gave 75 lb. In order to establish the ultimate bending moment the corrugated section can support, a test was carried out in which a concentrated load was applied at the end of a cantilever beam 3 corrugations wide and 21½ in. long. The failing moment per corrugation width was found to be 365 lb. in.

A theoretical study was then carried out to check the validity of the obtained figure. It was based on the assumption that the whole cross-section becomes plastic before failure. The theoretical value obtained was 508 lb. in. per corrugation width. Under the circumstances the discrepancy should not be considered excessive and the figure of 365 lb. in. can be accepted as sufficiently accurate.

The wind strength was computed on the assumption that the failing moment is equal to the sum of the 'static' moment (caused by wind pressure) and the 'kinetic' moment caused by the rotational energy of the bent piece. This calculation has yielded a wind velocity of 102 m. p. h.
Fig. 6 Wreckage of a public school weather shed, between trees and house in left background, facing north and looking towards position R. Roof of shed (timber and iron) in foreground approximately 100 yards from foundations. Taken 27 August 1964.

Fig. 7 MSL Analysis at 0300 EST 24 August 1964.
Another calculation was based on the tearing strength of the piece. Making some crude assumptions about lift coefficients, a minimum speed of 74 m.p.h. was obtained.

When assessing the true velocity one must bear in mind that both figures are minimum figures, seeing that an increase in velocity could not deform the piece any further. Thus one must draw the conclusion that the wind velocity must have been in excess of 102 m.p.h."

Sheets of iron were found folded over a power line (Fig. 3) and over the top wire of a fence on the eastern side of the school tennis court. In the latter case the wire was pulled out about 20 ft from the fence posts to the southwest.

(ix) Updraught

There is considerable evidence of very strong updraughts.

At Sutherland's farm (Position G) a 10 ft pole 3 inches in diameter was lifted from its horizontal stowage near the demolished shed and was found on the morning of the 24th impaled about 2 feet into the ground in the field to the southwest of the shed.

The 500 gallon tank at Position B was apparently airborne to a height at least equal to that of the electricity pole.

Many unattached roofing nails were found in yards at the back of Main Street and strewn over the football ground.

The distance which various parts of the school shed were hurled and the size of some of the baulks of timber are given below and indicate the violence of the updraught at this point.

The timber floor and joists of the 40 ft x 15 ft shed, which rested on short piers on the northern end of the tennis court (its long side was aligned east/west and it had no wall on the northern side), was thrown over upside down onto the tennis court over the top of the southern wall, while the roof and roof timbers were carried 100 yards to the south (Fig. 6).

A timber beam 9 1/2 inches x 2 1/2 inches x 20 feet, part of the shed, was found 78 yards south of the shed foundations, while hardwood corner posts 5 1/2 inches x 5 1/2 inches x 9 feet, were hurled distances varying from 10 to 60 yards to the southeast and south.

(x) Pressure Reduction

The sudden outward opening of the hinged windows in the Butter Factory and the blow-back of the fire from the furnace are consistent with pressure reduction in a vortex which was probably decaying at this time.

4. THE SYNOPTIC SITUATION

The abnormally strong and persistent westerlies which were experienced in the first half of August weakened about the 15th, when the anticyclonic belt over the continent moved to its normal August position between latitudes 30°S and 35°S. On 23 August an early spring type circulation replaced the westerly regime.

A low in the easterlies formed over South Australia and western New South Wales, and an anticyclone developed rather suddenly to the southwest and south of Tasmania, while the receding high pressure belt drifted out on to the eastern Tasman Sea and New Zealand.

The inland depression deepened and progressed further eastwards into New South Wales and then southeasterwards during the 23rd/24th preceded by a moist, unstable northerly air stream which developed between the Tasman Sea high and the inland low, flowing over Queensland into northeastern New South Wales and bringing widespread rain and thunderstorms.
Fig. 8 Aerological Diagram for Williamtown 1100 GMT 23 August 1964.
Figure 7 shows the surface chart for 3 a.m. (E.S.T.) on 24th August. Upper lows at the 700 mb and 500 mb levels progressed eastwards from South Australia on 23 August and were over western New South Wales by 9 a.m. on the 24th. In each 3 hour period from 6 p.m. on 23 August to 3 a.m. on 24 August surface pressures over northeast New South Wales fell by 2 mb or more.

Dew points at Coff’s Harbour, Smoky Cape and Port Macquarie showed a marked rise between 9 a.m. and 3 p.m. on 23rd August and were greatly in excess of normal at 3 p.m.:

<table>
<thead>
<tr>
<th>Station and Distance from Smithtown</th>
<th>Rise of 9 a.m. to 3 p.m. Dew points</th>
<th>Anomaly at 3 p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coff’s Harbour (58mi NNE)</td>
<td>54° to 59°</td>
<td>Of the order of +10°</td>
</tr>
<tr>
<td>Smoky Cape (12mi NE)</td>
<td>64° to 66°</td>
<td>Of the order of +15°</td>
</tr>
<tr>
<td>Port Macquarie (30mi South)</td>
<td>52° to 64°</td>
<td>Of the order of +15°</td>
</tr>
</tbody>
</table>

At 6 p.m. and 9 p.m. on the 23rd, these stations reported overcast conditions with base of cumulus cloud between 2000 ft and 3500 ft and northerly winds at 10/20 knots. Upper winds at Coff’s Harbour, about 50 mi NNE of Smithtown, at 1700 GMT 23 August were as follows:

<table>
<thead>
<tr>
<th>Height (ft)</th>
<th>Speed (kt)</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>10000</td>
<td>360/26</td>
<td></td>
</tr>
<tr>
<td>3000</td>
<td>010/31</td>
<td></td>
</tr>
<tr>
<td>5000</td>
<td>010/51</td>
<td></td>
</tr>
<tr>
<td>7000</td>
<td>010/39</td>
<td></td>
</tr>
<tr>
<td>10000</td>
<td>350/27</td>
<td></td>
</tr>
</tbody>
</table>

This indicates warm air advection between 7000 and 15000 ft and cold air advection between 15000 and 20000 ft. Although a low level jet was present at 5000 ft the 200 mb jet axis was about 5° north of Smithtown. With the development of the low level jet a tongue of moist air was advected southward from SE Queensland.

The 1100 GMT (9 p.m. E.S.T.) sounding for the nearest radiosonde station, Williamstown, about 100 mi SSW of Smithtown, on the 24th (Fig. 8) shows a fairly moist layer up to 1500 ft surmounted by a shallow layer of drier, cold air below 4,000 feet and a deeper layer of cold, dry air between 8, 500 ft and 13,000 ft with the lifting condensation level at 940 mb, the freezing level at 734 mb and with a Showalter Index of +3.0.

The sounding was convectively unstable to 13000 ft. Convergence in the northerly stream ahead of the depression probably provided the lifting to trigger off violent convection prior to the tornado development.

5. CONCLUSIONS

Although this wind storm occurred at night and was only witnessed briefly by one person, there is ample evidence that it was a true tornado - small but intense.

Forecasts of tornadoes are never likely to be specific enough to be of any practical use in preventing damage or injury in any particular place in the vast area of Australia over which these brief, local storms are liable to occur.

One hesitates to speculate on the possible casualties at Smithtown if this tornado had struck in the day-time when children might have been using the "wet weather" shed.
It is perhaps significant that buildings which were demolished or lifted bodily in the path of the tornado were those which were open at one side or end, such as the farm buildings (Positions A and G) and the school weather shed (Position R), and those which were raised 3 feet or more on piers and left open underneath; for example, compare the badly damaged P. M. G. cottage (Position C) with Carroll's house (in Belmore Street) which was about 6 feet above ground level but enclosed underneath by a brick wall and was undamaged.

The tornado formed in a convectively unstable northerly stream in which a low level jet was present. At the same time a tongue of moist air was advected over eastern New South Wales from the north.

ACKNOWLEDGMENTS

The co-operation and assistance of various people in Kempsey and Smithtown are gratefully acknowledged, in particular Constable R. Southam, the Officer-in-Charge at Smithtown, who received high praise in the district for his untiring efforts in clearing up the damage and helping victims of the storm, and to Mr. R. A. Landers of the County Council staff at Gladstone, who with Constable Southam spent much time in personally conducting the author over the area.

Thanks are also due to Mr. B. Chattaway (Junior) of the Macleay Argus for providing the excellent photographs and for permission to publish them in this report, also to Mr. Donald, the Macleay Shire Clerk, who arranged the storage and despatch of the piece of deformed iron, the Shire and County Councils and the P. M. G. Department who provided full co-operation.

The ready co-operation of the Aeronautical Research Laboratories, Victoria, in providing an assessment of the wind strength from analyses of the deformed iron sheet is also gratefully acknowledged.

REFERENCE