



Australian Government  
Australian Transport Safety Bureau

# Derailment of freight train 7AD1

Edith River near Katherine, Northern Territory | 27 December 2011



Investigation

**ATSB Transport Safety Report**  
Rail Occurrence Investigation  
RO-2011-019  
Final





**Australian Government**  

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**Australian Transport Safety Bureau**

**ATSB TRANSPORT SAFETY REPORT**  
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# **Derailment of freight train 7AD1at Edith River near Katherine, Northern Territory**

**27 December 2011**

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**Postal address:** PO Box 967, Civic Square ACT 2608  
**Office:** 62 Northbourne Avenue Canberra, Australian Capital Territory 2601  
**Telephone:** 1800 020 616, from overseas +61 2 6257 4150  
Accident and incident notification: 1800 011 034 (24 hours)  
02 6247 3117, from overseas +61 2 6247 3117  
**Facsimile:**  
**Email:** [atsbinfo@atsb.gov.au](mailto:atsbinfo@atsb.gov.au)  
**Internet:** [www.atsb.gov.au](http://www.atsb.gov.au)

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# SAFETY SUMMARY

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## What happened

At approximately 0542 (CST) on 27 December 2011, freight train 7AD1, owned and operated by Genesee & Wyoming Australia Pty Ltd (GWA), derailed at the Edith River rail bridge near Katherine in the Northern Territory. GWA was also the owner and operator of the rail track.

The train driver was unhurt as a result of the derailment, but the co-driver suffered back injuries and there was significant damage to the bridge and rolling stock. A number of wagons including the crew van, which was unoccupied at the time, derailed into the Edith River.

## What the ATSB found

The ATSB determined that the derailment of train 7AD1 was caused by the wash-away of the south-eastern embankment, associated sub-grade and ballast on the approach side of the Edith River rail bridge. The magnitude of the wash-away meant that the track could not support the weight of train 7AD1 as it passed over the affected track. The track collapsed under the train, initiating the derailment.

The wash-away was the result of a severe flood event caused by torrential rains that fell within the Edith River catchment area in the aftermath of cyclone 'Grant'.

## What has been done as a result

As a result of the derailment at the Edith River rail bridge, on 27 December 2011, GWA has undertaken a range of actions to enhance its policies, procedures and employee training with respect to managing the risks associated with severe weather events. GWA will also enhance its systems for alerting staff to severe weather events, including flood risks.

## Safety message

It is essential that rail network operators have robust systems in place to monitor and mitigate the risks of severe weather events to ensure that the safety of railway operations is not compromised.

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# THE AUSTRALIAN TRANSPORT SAFETY BUREAU

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The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

## **Purpose of safety investigations**

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

## **Developing safety action**

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes appropriate, or to raise general awareness of important safety information in the industry. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

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## TERMINOLOGY USED IN THIS REPORT

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**Occurrence:** accident or incident.

**Safety factor:** an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

**Contributing safety factor:** a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

**Other safety factor:** a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

**Other key finding:** any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which ‘saved the day’ or played an important role in reducing the risk associated with an occurrence.

**Safety issue:** a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

**Risk level:** the ATSB’s assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

**Safety action:** the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

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# 1 FACTUAL INFORMATION

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## 1.1 Overview

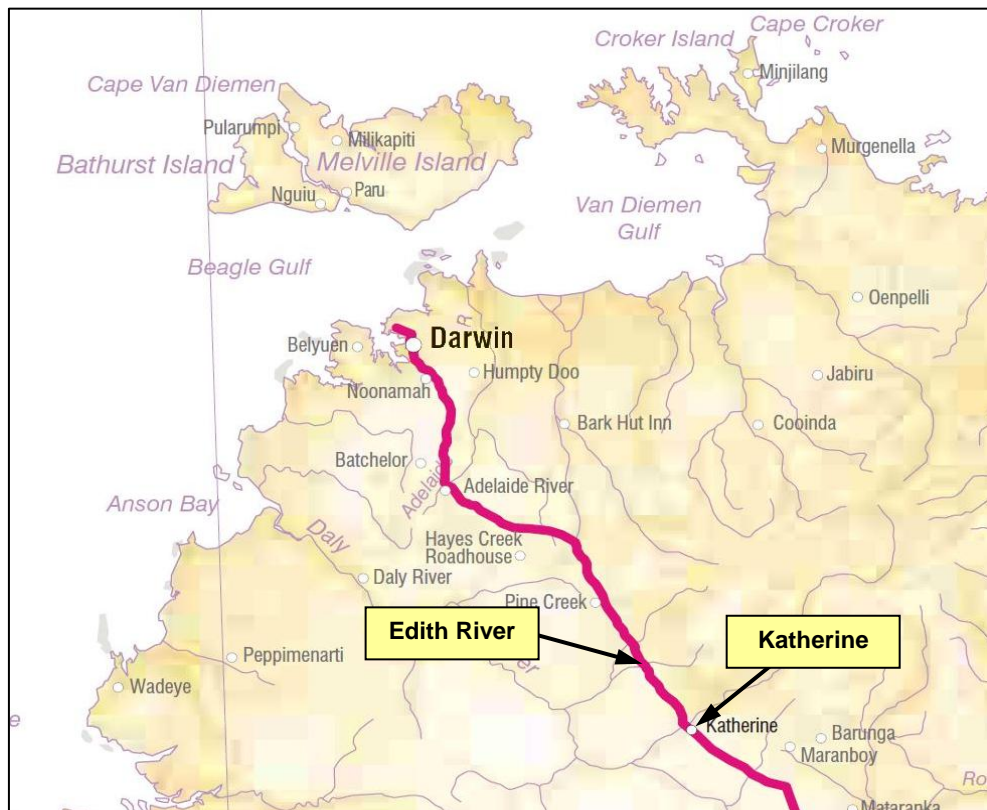
At approximately 0542<sup>1</sup> on 27 December 2011, freight train 7AD1 derailed at the Edith River rail bridge near Katherine in the Northern Territory (NT).

The train driver was unhurt as a result of the derailment, but the co-driver suffered back injuries and there was significant damage to the bridge and rolling stock. A number of wagons and the train's crew van, which was unoccupied at the time, derailed into the Edith River.

## 1.2 Location

The derailment occurred on the Adelaide to Darwin railway line at the 2490.670<sup>2</sup> km mark, the south-eastern embankment of the Edith River rail bridge, which is about 42 km northwest of Katherine (Figure 1). The bridge at this location is about 250 m to the northeast of the Stuart Highway.

**Figure 1: Location of Edith River**



Geoscience Australia. Crown Copyright ©.

<sup>1</sup> The 24-hour clock is used in this report to describe the local time of day, Central Standard Time (CST), UTC +9:30 hours, except where otherwise specified as Central Daylight-saving Time (CDT), UTC +10:30 hours.

<sup>2</sup> Distance in kilometres from a track reference point located at Coonamia in South Australia.

Approaching the bridge from a south-easterly direction the track, although relatively flat, comes off a sweeping left-hand curve, limiting sighting of the bridge until relatively close, about 400 m.

### **1.2.1 Adelaide to Darwin railway line**

In 2000, the AustralAsia Rail Corporation awarded a 50-year build, own, operate and transfer (BOOT) concession to the Asia Pacific Transport Consortium (APTC) for the railway line to Darwin. APTC contracted FreightLink Pty Ltd to implement the project and operate the railway. APTC's construction arm (ADrail) was appointed to undertake the design and construction of works associated with the line between Alice Springs and Darwin, including 1420 km of new track and the construction of 93 bridges. Most of the bridges were located in remote central and northern Australia.

FreightLink commenced operations in January 2004, but in May 2008 the consortium of banks and infrastructure companies financing FreightLink decided to sell the railway and its operating company. Genesee & Wyoming Inc. finalised the acquisition of the assets of FreightLink on 2 December 2010 and began operating as Genesee & Wyoming Australia Pty Ltd (GWA).

At the time of derailment of train 7AD1, the Adelaide to Darwin railway line was operated by GWA with maintenance contracted to BJB Joint Venture (BJB).

#### ***Track***

The Alice Springs to Darwin section of the Adelaide to Darwin railway line consists of a bi-directional single line with crossing loops (short sections of double track) provided at regular intervals to allow trains to cross (travelling in opposing directions) or pass (travelling in the same direction) each other.

The standard gauge (1435 mm) track comprised 50 kg/m continuously welded rail fastened to concrete sleepers using resilient clips. The track structure had a ballast bed with a minimum depth of 150 mm supporting prestressed concrete sleepers spaced at approximately 720 mm centre-to-centre.

The section of track between Alice Springs and Katherine passes over relatively flat arid country, characterised by streams that only flow during the wet season. However, the topography between Katherine and Darwin is more undulating with streams and rivers being well defined, some of them flowing throughout the year.

#### ***Train control***

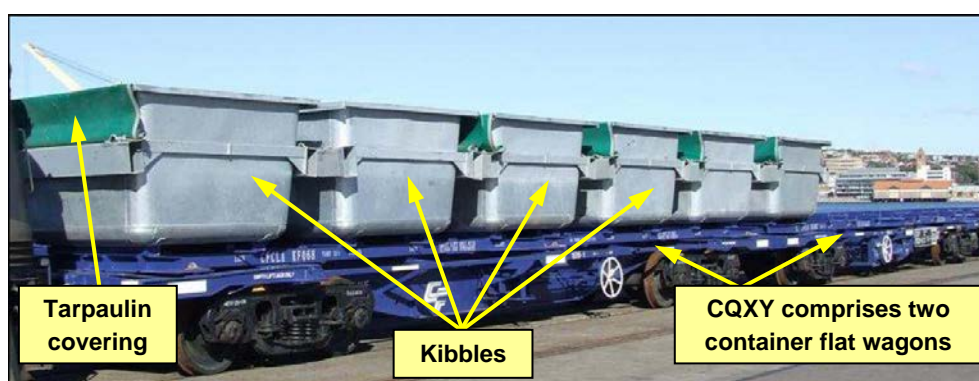
Train control for GWA services was provided at a facility located at Dry Creek in South Australia. GWA control began at the Northgate Block Point, located about 6 km north of Tarcoola in South Australia. GWA controlled all train movements from the Northgate Block Point through to Darwin. At the time of the derailment train 7AD1 was working under the authority of a GWA transport controller located at Dry Creek. Train to control centre communications were provided by a combination of terrestrial and satellite radio systems.

## 1.2.2 Train information

Freight train 7AD1 was a regular GWA operated service consisting of three locomotives (GWA001 leading followed by FQ02 and CLF6 trailing) hauling 33 vehicles comprising a crew van and mixed freight vehicles. The mixed freight consisted of single and multi-platform vehicles including a 5-unit FQAY<sup>3</sup> wagon carrying a 26000 litre container of liquid carbon dioxide (positioned at sequence number 6 behind the lead locomotive GWA001) and fifteen 2-unit CQXY wagons (Figure 2) used for the transportation of copper concentrate<sup>4</sup>. The CQXY wagons were located at sequence numbers 8 through to 22. Each 2-unit CQXY wagon was carrying 10 kibbles (a tarpaulin covered bin-like container) of copper concentrate.

Train 7AD1 was 1352 m long with a trailing mass of 4296 t.

**Figure 2: CQXY wagon used for transportation of copper concentrate**



Extract from CFCLA (Chicago Freight Car Leasing Australia Pty Ltd) CQXY Wagon Data Sheet. Copyright ©.

Provisions for the transportation of products like refrigerated liquefied carbon dioxide and copper concentrate<sup>5</sup> are contained in the *Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG7)*.

ADG7 came into force on 1 January 2009 (South Australia) and 1 April 2011 (Northern Territory). As a result Class 9 substances like copper concentrate require the use of closed containers having rigid lids for transportation in lieu of tarpaulin covered kibbles, unless exemption<sup>6</sup> is sought and approved by the regulating authority, in this case NT Worksafe and/or SafeWork SA. The use of rigid lid containers is primarily intended to minimise loss of product (dust loss) under

- 
- <sup>3</sup> Australian rail wagons are classified according to a four-letter code that indicates who owns the vehicle, its type and operating characteristics.
- <sup>4</sup> Copper concentrate is the raw/mined material used to produce copper. Copper is widely used by communities as a conductor of heat and electricity and has uses such as cooking utensils.
- <sup>5</sup> Copper concentrate is covered by *UN 3077 - Environmentally hazardous substances, solid*, based on eco-toxicological testing to determine whether a particular mineral concentrate is sufficiently soluble in fresh or marine water to exhibit toxicity to aquatic organisms. Substances classified as *UN 3077* generally do not fall into any other dangerous goods classification and have no significant hazardous properties other than aquatic toxicity.
- <sup>6</sup> The use of 'sheeted bulk containers' (tarpaulin covered kibbles) continues to be allowed in some Australian jurisdictions, e.g. [www.dmp.wa.gov.au/6626.aspx#8296](http://www.dmp.wa.gov.au/6626.aspx#8296)

normal conditions of transport and any potential long term risk to aquatic organisms.

### **1.2.3 Weather**

In the 48 hour period preceding the derailment, tropical cyclone ‘Grant’ had developed and then crossed the Australian mainland about 200 km east of Darwin in the Northern Territory.

As the cyclone crossed the mainland heading south towards Katherine it began weakening before being downgraded to a tropical low. As the tropical low moved inland and southwards towards Katherine, it slowed and produced significant rainfall throughout the Edith, Cullen, Fergusson and Katherine river catchment areas.

In the 24 hours to 0900 on 27 December 2011, rainfall of 385 mm was recorded at Edith Falls Ridge about 32 km north of Katherine.

## **1.3 The occurrence**

On Wednesday 21 December 2011 at about 1415 the Bureau of Meteorology (BoM) in Darwin identified the existence of a tropical low off the northern coast of Australia that would potentially develop into a cyclone. The movement and strength of the system was monitored by the BoM with regular alerts being publicly issued. On Saturday 24 December 2011 at 1653 the BoM upgraded a previously issued ‘Tropical Cyclone WATCH’ to a ‘Tropical Cyclone WARNING’ covering the Darwin area. Tropical cyclone ‘Grant’ was officially named at 0448 on Sunday 25 December 2011.

Train 6AD1 (service preceding) and train 7AD1 (service that derailed) both originated at the Adelaide Freight Terminal (AFT), South Australia, with a final destination of the Berrimah Freight Terminal (BFT) in Darwin, NT. Train 6AD1 was scheduled to depart Adelaide at 2350 on Friday 23 December 2011 and arrive at the BFT at 1710 on 25 December 2011. Train 7AD1 was scheduled to depart Adelaide at 1500 on 24 December 2011 and arrive at the BFT at 0940 on Monday 26 December 2011.

Staff from GWA had been actively monitoring the BoM weather alerts with respect to the scheduling of its train movements. Following the issue of the ‘Tropical Cyclone WARNING’ GWA set in motion its ‘Cyclone Response Plan’. As part of the GWA response plan locomotives and rolling stock located at the BFT in Darwin were moved to the Union Reef siding located about 200 km south of Darwin. Trains 6AD1 and 7AD1 were held at Katherine and Alice Springs respectively.

Cyclone Grant continued to move south crossing the Australian mainland as a category 2 cyclone near Croker Island, about 230 km northeast of Darwin, at 2230 on 25 December 2011. The cyclone then travelled south/southwest over the eastern portion of the Van Diemen Gulf. As the cyclone moved further inland it weakened to a category 1 cyclone and was further downgraded to a tropical low at 1353 on 26 December 2011. The BoM continued to issue severe weather and flood warnings. The tropical low continued to move further south, slowing in the vicinity of Katherine and producing torrential rain in its path.

Staff from GWA continued to monitor the BoM weather alerts and as soon as the cyclone risk had been assessed as diminished, authorised train 7AD1 to depart Alice Springs for Katherine, at approximately 1130 on 26 December 2011. At about the same time GWA arranged for BJB to inspect the track section between the BFT and Katherine for any evidence of flood damage. Minimal damage was identified<sup>7</sup>, so a decision was made to resume services between Katherine and Darwin.

A fresh crew was despatched from Darwin to operate train 6AD1 previously held over at Katherine. The drivers signed on for duty at the BFT at 1600 and then drove to Katherine by road vehicle. Whilst in transit they noted heavy rain and water covering the Stuart Highway in several locations, but considered this to be normal for that time of year. On arrival at Katherine the driver prepared train 6AD1 while the co-driver said he checked on-line BoM weather information and river depths, noting in particular that river levels were quite low, ranging between 1.5 m and 2.5 m, for the Edith, Fergusson and Cullen rivers.

Train 6AD1 departed Katherine at 2020 on 26 December 2011 after receiving authorisation from the GWA transport controller. Train 6AD1 passed over the Edith River rail bridge at about 2120 followed closely by the Fergusson and the Cullen River rail bridges. As the train traversed each bridge the driver and co-driver shone their torches on the river surface to observe the river heights. Train 6AD1 arrived safely at the BFT at 0120 on Tuesday 27 December 2011 with the driver reporting that no abnormalities had been observed whilst in transit. Unbeknown to the drivers of train 6AD1, transport controllers and other GWA staff, heavy rains from the tropical low had caused a rapid rise of the Edith River behind train 6AD1.

Train 7AD1 continued on its northward journey from Alice Springs arriving in Katherine early on 27 December 2011. The train crew (Alice Springs/Katherine) comprised two drivers operating the train with a further two relief drivers<sup>8</sup> resting in a crew van marshalled behind locomotive CLF6. The Alice Springs/Katherine crew, including the relief drivers in the crew van, left the train at Katherine. These drivers were to rest in Katherine and be rostered for the return trip to Alice Springs.

A fresh crew dispatched from Darwin, the crew involved in the derailment, comprised a driver and co-driver only. They were rostered to take train 7AD1 the short distance through to Darwin and booked on for duty at Katherine at 0500. They inspected the locomotive, checked the train manifest and following authorisation from the transport controller departed Katherine at 0510. The journey was uneventful until they neared the Edith River rail bridge.

Travelling at a speed of about 74 km/h train 7AD1 approached the 2490 km mark through the sweeping left-hand-curve before the Edith River rail bridge. At about this time the driver said he selected throttle notch eight and sounded the locomotive horn for the Edith Falls road level crossing (2490.325 km). On traversing the level crossing, at about 0542, he observed a large expanse of flood water covering the rails and the Edith River rail bridge. He immediately throttled off, warned the co-driver, and both prepared for the imminent water entry.

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<sup>7</sup> During the inspection, BJB noted some minor water scouring alongside the track between the 2534.400 to 2534.896 km mark and imposed a 'Temporary Speed Restriction' (TSR) of 20 km/h as a safety precaution.

<sup>8</sup> Train crews work in relay on the Adelaide to Darwin line and rest at regular intervals.

**Figure 3: View from lead locomotive GWA001, looking southeast towards Edith River, about one hour after the derailment**



Driver of 7AD1. Copyright ©.

The driver stated that the train continued towards the bridge, shuddering forcefully as it entered the flooded section of track and then lurching heavily as it advanced onto the bridge structure. The drivers said they were thrown violently in their seats and feared for their safety.

The lead locomotive GWA001 continued across the bridge coming to a stand about 500 m beyond the south-eastern side of the bridge. The lead locomotive was upright but surrounded by floodwaters, about 1 m deep on either side of the track (Figure 3).

### **1.3.1 Post occurrence**

The driver activated the emergency alarm at 0543 and then communicated with the GWA transport controller in Adelaide advising that train 7AD1 had collided with floodwaters on the Edith River Rail Bridge and had come to a stand on the northern side of the bridge. He further advised that although he was uninjured the co-driver had suffered what appeared to be a back injury. The GWA transport controller responded by requesting assistance from the emergency services and then reported events internally.

At about 0800 the floodwaters had subsided enough to allow the train driver to leave the locomotive cab and walk back along the track to assess the extent of damage. He determined that the lead locomotive GWA001 had derailed its leading wheel set. Approximately 80 m to the southeast, the second locomotive FQ02 was upright, all wheels derailed and a further 30 m southeast, the third unit CLF6 was upright, all wheels derailed. The crew van and the leading portion of the train had derailed into the Edith River.

Thirteen of the CQXY wagons containing copper concentrate derailed into the Edith River and the surrounding flood-affected area. An estimated 1200 t of copper concentrate was spilled in the derailment.

At about 1000 a rescue helicopter arrived near the derailment site. The driver and co-driver walked over to the helicopter where the co-driver was treated for his injuries. Both the driver and co-driver were evacuated to the Katherine hospital for further treatment and observation.

### **1.3.2 Track rectification and clean up**

On the evening of 28 December 2011 the rear undamaged portion of the train was returned to Katherine where freight was transported by road through to Darwin once the Stuart Highway had reopened. By 2 January GWA had fully assessed the damage at the site and constructed access roads to allow equipment and personnel to access the site to commence the recovery of the damaged rolling stock and to start the clean-up.

On 28 December 2011 the Northern Territory Department of Natural Resources, Environment, the Arts and Sport (NRETAS) started a program of testing sediment and water from a number of locations above and below the Edith River rail bridge. Results indicated that on 31 December 2011 copper levels between the Edith River

rail and road bridges were above national sediment quality guideline trigger levels<sup>9</sup>. On 3 January and 5 January 2012, the level of copper at the same locations was below national sediment quality guideline trigger levels.

By 26 January the majority of the derailed rolling stock and freight containers had been removed from the site and environmental remediation works including the recovery of the copper concentrate from the river bed were well underway. Work had also started on repairing the flood damage to the abutments on the northern and southern ends of the bridge. Inspection of the bridge also revealed some unexpected structural damage to one of the girders that required further work.

In the last two weeks of February the river had receded to a level that allowed three final containers to be removed from the river bed. One container was still unaccounted for and was believed to have broken up. The river banks were also patrolled and cleaned of debris for five kilometres downstream. On 28 February the Edith River rail bridge was reopened to rail traffic.

Testing sediment and water quality has continued and in its last press release, issued 16 May 2012, NRETAS advised:

Some results for March 2012 identified levels for Cadmium, Copper and Zinc at or above the guideline trigger levels in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality at some of the sampling locations.

However, all levels were below the guideline levels throughout April 2012 with the exception of copper being at the guideline level on 24 April 2012 at one sample point.

NRETAS will soon finalise its twice weekly water and sediment sampling and determine if further testing is required. Results will continue to be released when available.

NRETAS further advised:

As confirmed by the Department of Health<sup>10</sup>, all levels are well below the health guideline levels in the Australian Drinking Water Guidelines 2011, and unlikely to present a human health or safety concern.

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<sup>9</sup> Associated with each environmental value are 'guidelines' or 'trigger values' for substances that might potentially impair water quality (e.g. pesticides, metals or nutrients). If these values are exceeded, they may be used to trigger an investigation or initiate a management response. Source: An Introduction to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

<sup>10</sup> Refers to the Department of Health – Northern Territory.

Investigators from the Australian Transport Safety Bureau (ATSB) were dispatched from Adelaide early on 29 December 2011, flying to Darwin then travelling by road to the Edith River, arriving on site at about 1400. Once on site the positions of rolling stock, containers and track were examined and photographed. The train drivers were interviewed at the Berrimah Freight Terminal, Darwin on 30 December 2011.

The responsibility for administering the provisions of the *Code for the Transport of Dangerous Goods by Road and Rail (ADG7)* is vested with the States and Territories of Australia. Early in the investigation it was agreed that NT WorkSafe, the authority responsible for administering ADG7 in the Northern Territory, should examine the issues specifically related to the carriage of the dangerous goods on the train including the copper concentrate. NT WorkSafe initiated an investigation on 28 December 2011 to examine issues in relation to the carriage of the copper concentrate including:

- containment
- storage
- placarding
- notifications
- authorisations
- transport and emergency planning documentation.

The ATSB is responsible for examining the underlying cause of the derailment and any rail safety issues.

The preliminary examination of evidence by the ATSB established that:

- The train was travelling at a speed of 74 km/h as it approached and entered the curve in advance of the Edith River rail bridge. The speed was below the authorised track speed of 95 km/h.
- Train speed and train braking performance were discounted as a possible cause for the derailment.
- Rolling stock abnormalities were discounted as a possible cause for the derailment.
- The lead locomotive GWA001 followed by FQ02 and CLF6 traversed the bridge but the crew van, a number of container flat wagons and 13 CQXY class wagons containing copper concentrate, derailed into the river/flood affected area.
- The train drivers were qualified, assessed as competent and medically fit for duty at the time they signed on at 0500 on Tuesday 27 December 2011.
- The train driver and co-driver were observed<sup>11</sup> for the presence of alcohol by the NT Police and were not considered to be affected.

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<sup>11</sup> Due to the severity of the flood event and need to provide medical assistance for the injured co-driver, the NT Police did not test for the presence of alcohol. However officers on site were of the opinion that the train drivers were not affected by alcohol.

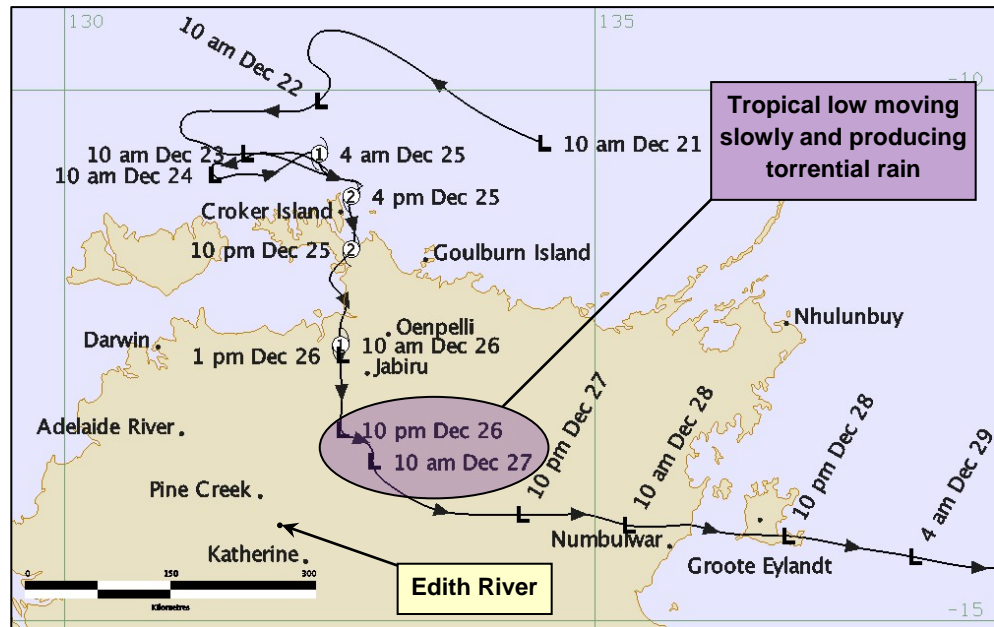
## 2.1 Sequence of events analysis

At 1415 on Wednesday 21 December 2011 the BoM identified a developing cyclone off the north coast of Australia, near Darwin (Figure 4). The BoM monitored the progress and strength of the system with cyclone 'Grant' being officially named at 0448 on Sunday 25 December 2011. During this period GWA began implementing its 'Cyclone Response Plan' (RS-PRC-017).

The cyclone moved south crossing the Australian mainland at about 2200 on 25 December 2011. As it continued south it weakened before being downgraded to a tropical low at 1353 on Monday 26 December 2011.

Following the cyclone cancellation GWA planned for the resumption of services between the BFT and Katherine. A track inspection undertaken by BJB, between 0726 and 1310, determined the track to be operationally safe<sup>12</sup>, following which GWA decided to recommence services.

**Figure 4: Track of Tropical Cyclone Grant**



Bureau of Meteorology (BoM). Crown Copyright ©.

During this period (26 December 2011) the BoM continued to issue Tropical Cyclone Watch, Severe Weather and Flood warnings that in particular highlighted:

HEAVY RAIN is expected to cause localised flooding and significant stream rises over the northern Darwin-Daly, Arnhem and Roper-McArthur Districts.

Further, through a final Flood Threat Advice Warning issued on 26 December 2011 at 2351, the BoM advised:

<sup>12</sup> During the inspection, BJB noted some minor water scouring alongside the track between the 2534.400 to 2534.896 km mark and imposed a 'Temporary Speed Restriction' (TSR) of 20 km/h as a safety precaution.

## RAINFALL SUMMARY

Most falls in the 24 hours to 9am Monday have been 15-40mm, reaching 40-80mm in the north. Since 9am Monday there have been heavy falls 100 to 200mm reported in the in the Edith, Cullen, Fergusson and Katherine River catchments. Heaviest fall recorded was 260mm at Edith Falls Ridge.

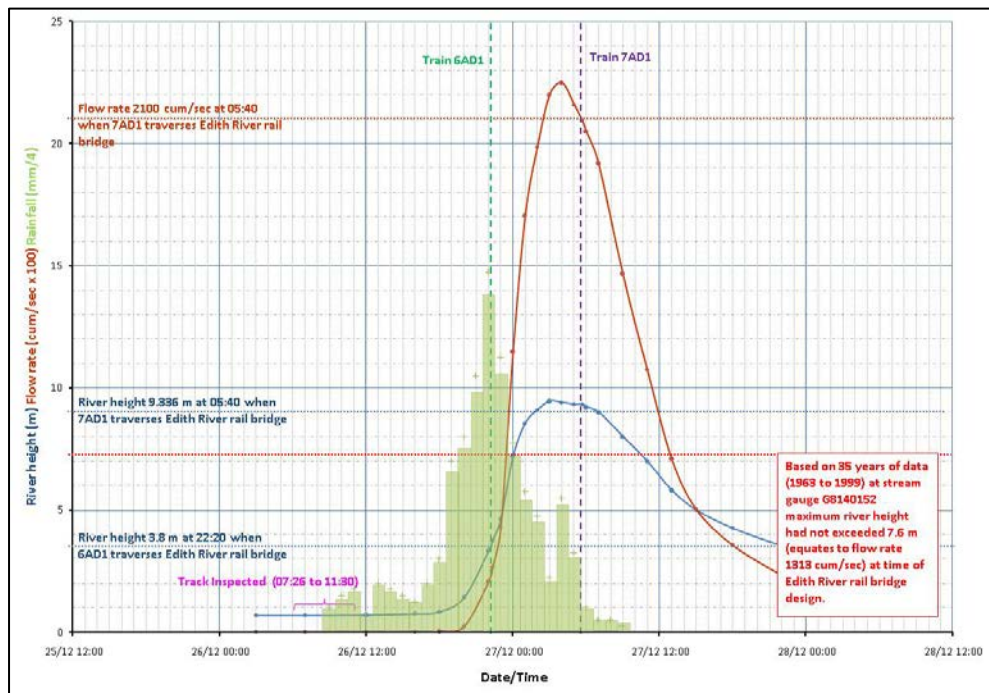
FORECAST for the rest of today and Tuesday

A persistent and slow moving rain band to the southwest of Ex-Grant in the Katherine and Pine Creek area and will cause further heavy falls 100 to 200mm for the next 12 hours. Scattered showers and gusty storms with widespread falls 30-50mm over the Top End and developing in the Roper-McArthur District. Showers and storms becoming more isolated in the western Top End from Tuesday as the low moves towards the Gulf of Carpentaria.

Isolated heavier falls over 100mm along the north and east coasts and close to the tropical low. These falls may lead to localised flooding and significant stream rises in the Arnhem and northern Darwin-Daly Districts. Localised flooding may develop in the Roper-McArthur District.

Examination of evidence established that at the time BJB was undertaking the track inspection the centre of the tropical low was north (Figure 4) of the Edith River catchment area.

**Figure 5: Plot<sup>13</sup> showing - River height (m), Flow rate m<sup>3</sup>/sec, Rainfall (mm)**



Only light rain had commenced falling near Edith River Falls (Figure 5- green highlighted area) and the height of the river,<sup>14</sup> (Figure 5 - blue line) was quite low at about 0.7 m.

<sup>13</sup> River gauging and rainfall based on information sourced from NRETAS and was available for viewing on the BoM web site.

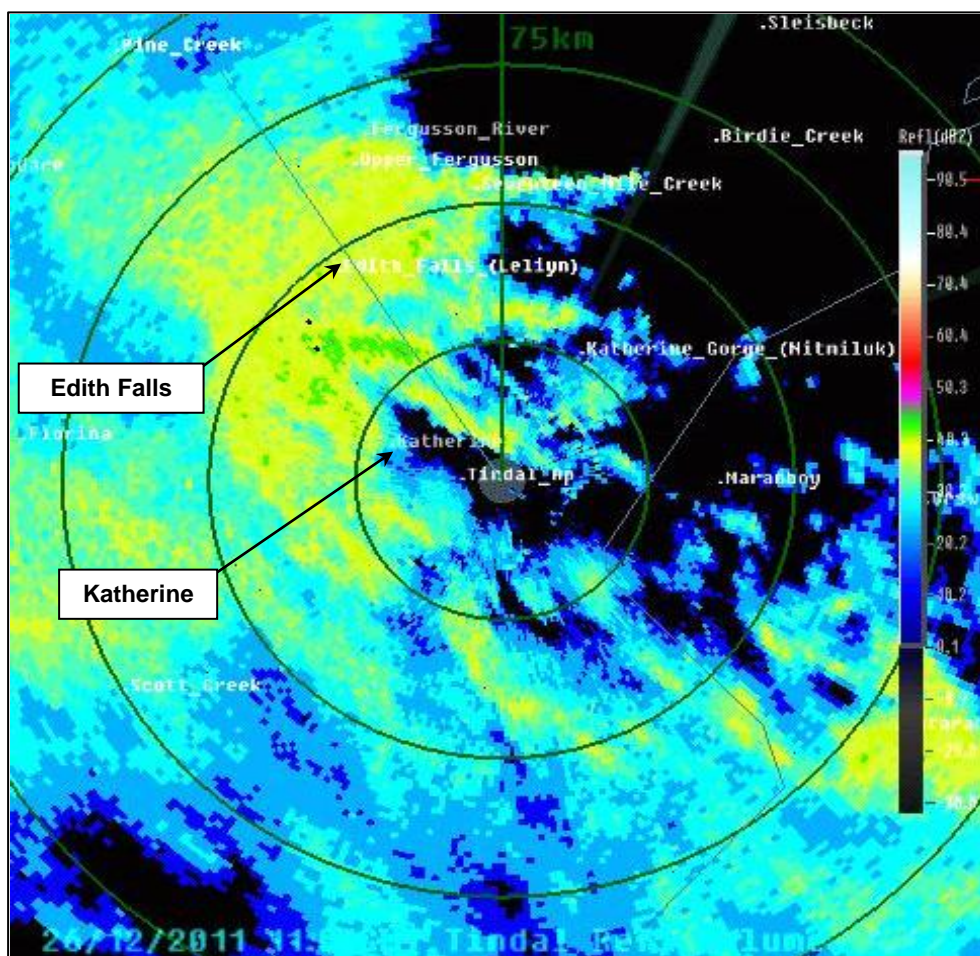
<sup>14</sup> As measured at gauging station G8140152, located about 4.75 km upstream of the rail bridge.

The weather system continued to move further south, slowing in the vicinity of the Edith River catchment area (Figure 4 - mauve highlighted area). Heavy rain commenced falling at about 1700 on 26 December 2011. At this time the Darwin based relief drivers, for train 6AD1, were travelling by road along the Stuart Highway and nearing Katherine. They noted heavy rain falling and water lying over sections of the Stuart Highway; however, they considered that this was not unusual for the time of year.

Following arrival at Katherine the drivers joined train 6AD1. They received authority to depart at 2020. At this time the co-driver said he checked the BoM website radar image, (Figure 6) it was raining heavily. He also stated that he checked the web site for river levels and noted that the heights for the Edith, Fergusson and Cullen rivers ranged up to a maximum of about 2.5 m and therefore in his opinion did not pose a flood risk for their train movement.

As indicated in Figure 5, the actual height of the Edith River at gauging station G8140152 was 1.68 m at 2020. The green highlighted area of Figure 5 shows that the intensity of the rainfall increased rapidly after about 1700, peaking at 59 mm during the period from 2130 to 2230. At 2120, just before the rainfall had peaked, train 6AD1 passed over the Edith River rail bridge. As the train traversed the bridge the two drivers said they shone their torches onto the river surface. They observed the river height and considered it to be relatively low.

**Figure 6: Tindal Radar image taken at 2030 (1100 UTC) on 26 December 2011**

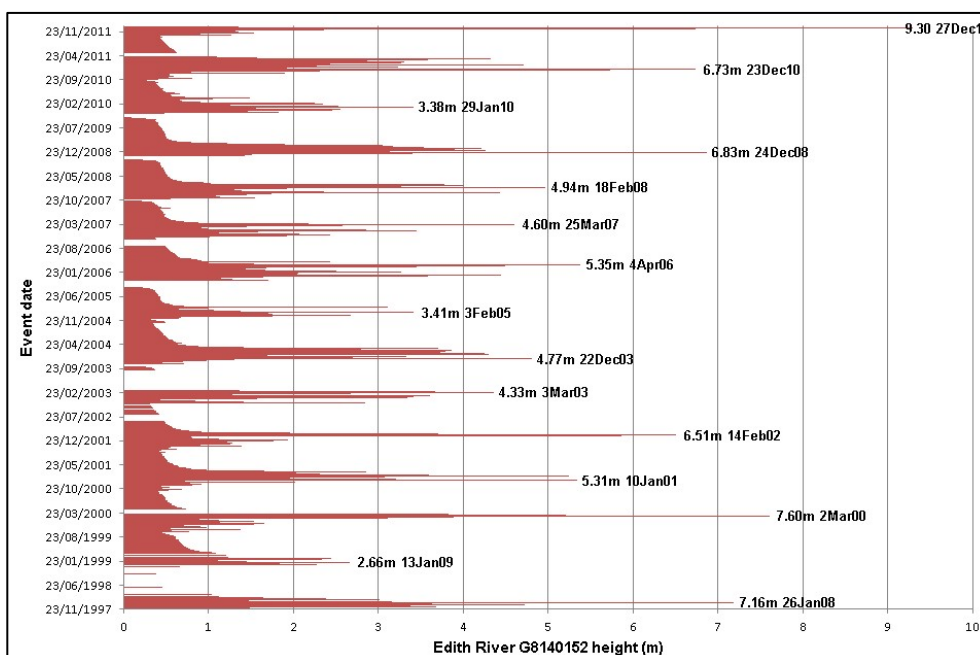


Bureau of Meteorology Crown (BoM). Copyright ©.

This observation was subsequently corroborated against Edith River gauge (G8140152) data, which showed the height of the river to be 3.76 m at the time. Train 6AD1 arrived safely at the BFT at 0120 on Tuesday 27 December 2011 with the driver reporting completion of the movement to transport control.

After 2220 the rain began to ease, but runoff was still being channelled into the Edith River catchment. The Edith River began to swell with a previous record height of 7.6 m (Figure 7 - 2 March 2000) being reached just after midnight, about 2.5 hours after train 6AD1 had passed over the bridge. The river level continued to rise, reaching a height of 9.305 m by 0230; this level was now well in excess of any previously recorded maximum.

**Figure 7: Edith River recorded river height from 1996 to 2011**



Data source - NT Department of Natural Resources, Environment, the Arts and Sport

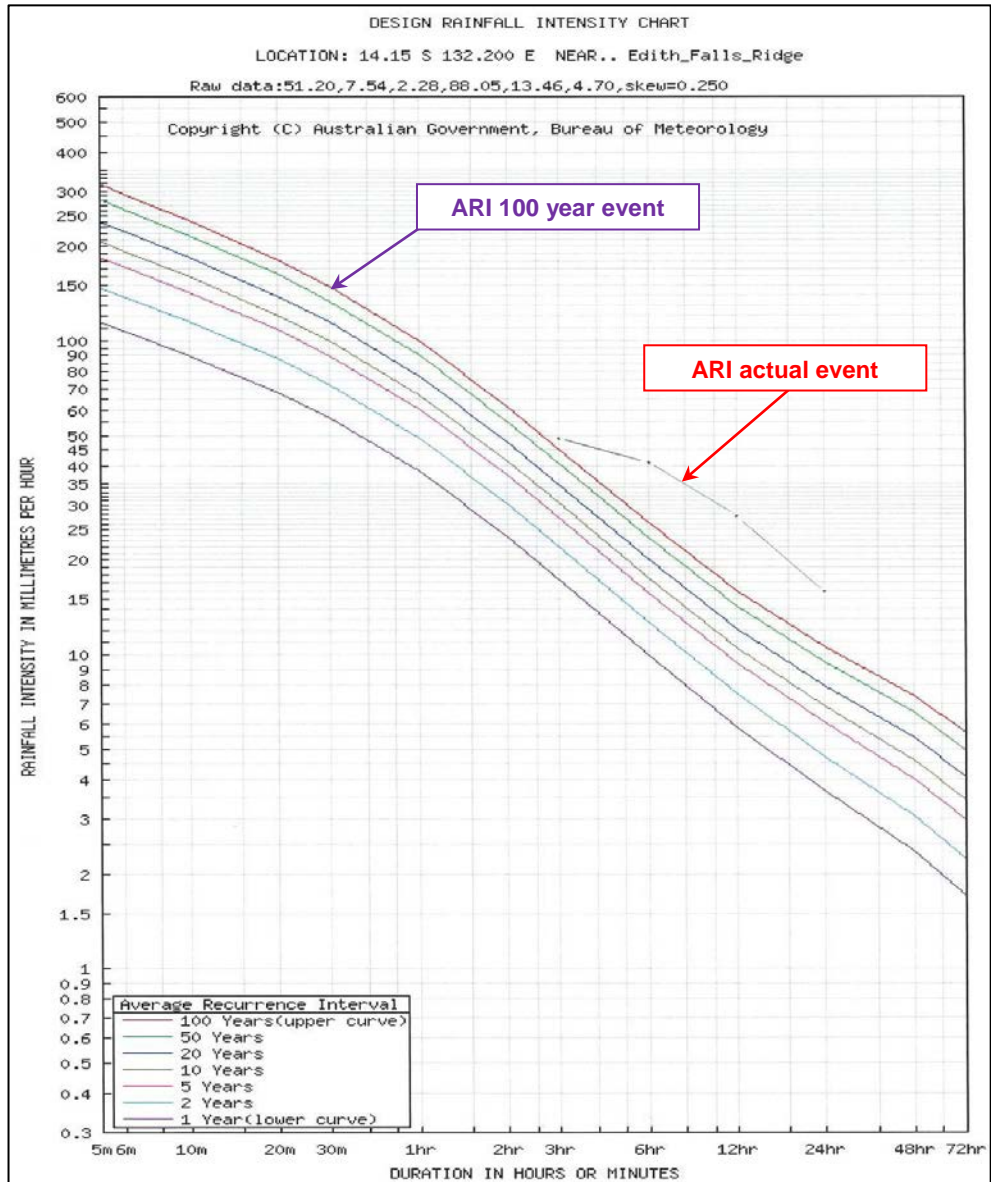
At about 0230 the NT Emergency Service (NTES) ‘Duty Officer’ received an emergency call advising that two motorists had become stranded when their vehicle was washed away by flood waters that had engulfed the Edith River road bridge. The NTES and NT Police mobilised and were on site with a rescue boat at about 0330. At this time train 7AD1 was standing within the Katherine Yard waiting on the relief crew that was to take train 7AD1 through to Darwin.

The river continued to rise and by 0300 had reached a recorded peak of 9.454 m. At 0500, at about the time the crew for train 7AD1 signed on for duty at Katherine, the river level had started to subside but was still at a height of 9.324 m.

During the 12 hour period preceding the derailment, that is, from 1700 on 26 December 2011 to 0500 on 27 December 2011, in excess of 330 mm of rain had fallen near Edith Falls Ridge. This is well in excess of the rainfall assumed for a 100 year Average Recurrence Interval<sup>15</sup> (ARI) event (Figure 8) for this region.

<sup>15</sup> Average Recurrence Interval - ARI (Rainfall event). The average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration. It is implicit in this definition that the periods between exceedances are generally random. Source: BoM.

Figure 8: Rainfall Intensity Frequency Duration - Edith Falls Ridge

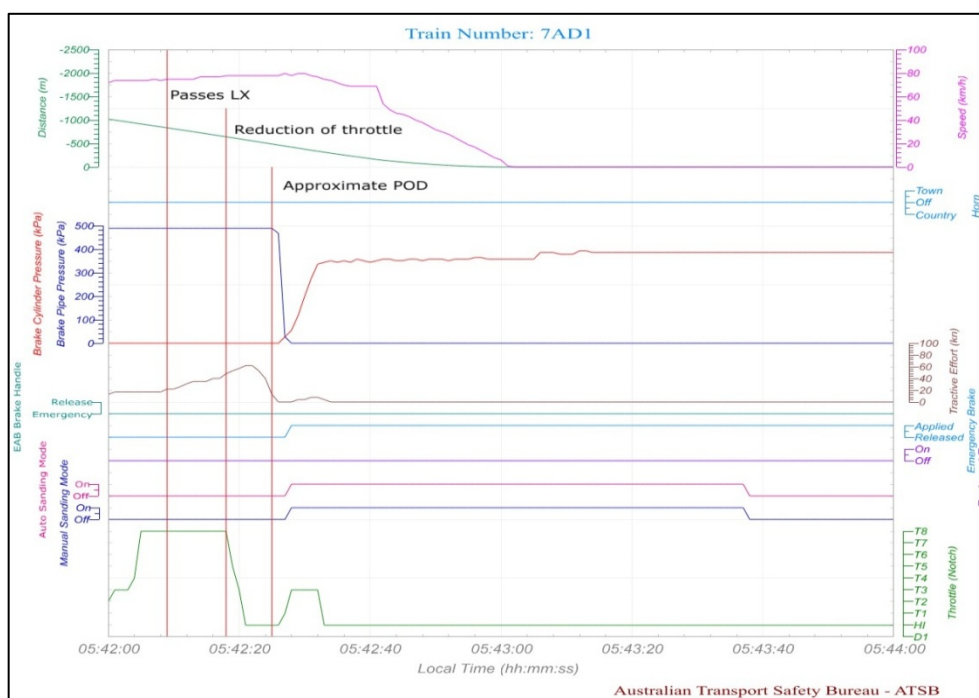


Bureau of Meteorology Crown Copyright ©.

The relief crew inspected the train, checked the manifest and following authorisation from the transport controller departed Katherine in darkness at 0510. On this occasion however, no one checked the river levels and there had been no communication to GWA about the flood event that was engulfing the Edith River road bridge.

The journey from Katherine approaching Edith River was uneventful and proceeded without incident. Examination of the loco log plot (Figure 9) corroborates the driver's recollection of events showing the train as passing over the Edith Falls level crossing (2490.325 km) at 0542:08, in darkness<sup>16</sup>, travelling at a speed of 74 km/h. At about this time (0542:10) the driver said he observed a large expanse of flood water ahead, illuminated by the train's headlights.

**Figure 9: Loco log plot 7AD1**



The loco log file shows that the driver throttled off at 0542:19. The loco log then shows a significant loss of 'Brake Pipe Pressure' at 0542:24, this probably coincides with the train colliding into the south-eastern face of the bridge causing the train to part. At this stage it was likely that the south-eastern embankment had substantially washed away but the three locomotives fortuitously rode the suspended track and then up onto the bridge before the track collapsed under the weight of subsequent vehicles. The three locomotives traversed the length of the bridge, the crew van and some wagons also partially traversed the bridge until they fully derailed and fell into the flood swollen river. The lead locomotive GWA001 continued along the track coming to a stand about 512 m beyond the initial Point of Derailment (POD) with the south-eastern bridge face.

<sup>16</sup> The train traversed the Edith River Falls road level crossing close to 'Astronomical Twilight', 0547. At this time illumination due to scattered light from the sun ( $18^\circ$  below horizon) is less than that from starlight and other natural light sources in the sky. The moon was  $45^\circ$  below horizon and therefore provided no illumination. In addition there was significant cloud cover; this would have further contributed to the level of darkness.

## **Summary**

In the lead up to the derailment of train 7AD1 there had been adequate warning of the cyclone and associated severe weather events.

The initial response by GWA to the cyclone event was well executed and generally in accordance with the organisation's 'Cyclone Response Plan' (RS-PRC-017).

Following the cancellation of the 'Cyclone WARNING' GWA responded appropriately, initially with the track inspection by BJB Joint Venture.

The rainfall event (385 mm in the 24 hours to 0900 on 27 December 2011) at Edith Falls Ridge significantly exceeded a 100 year ARI statistical event.

The maximum river height at gauging station G8140152 (Edith River) was 9.454 m, recorded at 0300 on 27 December 2011. This was significantly higher than any event recorded in the previous 48 years.

Not being warned of the flood event at Edith River, the train driver assumed that track integrity from Katherine to Darwin remained safe for the passage of train 7AD1.

### **2.1.2 Examination of track**

When examined by the ATSB, the track on the approach side of Edith River Falls Road level crossing was intact and in good condition with no evidence (Figure 10) of wash-away. The first evidence of any significant undermining of the track by floodwaters was on north-western side of the Edith River Falls road level crossing, about 150 m beyond the crossing. The ballast, formation and embankment (Figure 10 and Figure 11) beyond that point were in many locations noticeably washed away by flood waters. Looking back towards Katherine from the south-eastern bridge abutment, about 22 m of embankment had been washed away by floodwaters.

At the time of the derailment and as recounted by the crew of train 7AD1, flood waters were within about 50 m of the north-western side of the Edith River Falls road level crossing<sup>17</sup> and had overtopped the track and the Edith River rail bridge. The driver indicated that he could not see the track or the bridge kerb as the train crossed the bridge.

Based on ADrail design documentation (Figure 12 Part of ADrail Longitudinal Section Plan 01-1210-2725) it was determined that the height from the bottom of the river bed to the top of the track formation was 10.58 m. Allowing for a ballast depth of 150 mm and rail height of 154 mm the overall height from the bottom of the river bed to top of rail was calculated to be 10.884 m.

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<sup>17</sup> There was evidence to indicate that the Edith River Falls road level crossing had been overtopped by floodwaters, this probably occurred earlier in the morning before train 7AD1 arrived at the site.

Figure 10: Approach to Edith River rail bridge early on 27 December 2011



As already indicated (see Figure 5) the maximum recorded river height at stream gauge G8140152 (4.75 km upstream from the Edith River rail bridge) was about 9.454 m. Based on observations made by the train drivers, photographic evidence (Figure 3- taken about one hour after derailment) and ADrail design documents, the ATSB determined that the flood level at the Edith River rail bridge, was about 10.9 m at the time of the derailment.

### **Summary**

The flood event on the morning of 27 December 2011 overtopped the Edith River rail bridge and probably exceeded a height of 10.9 m.



**Figure 13: South-eastern approach to Edith River rail bridge about 1 hour after the derailment**



## 2.2 Edith River rail bridge

### *Hydrology*

In constructing the railway line between Alice Springs and Darwin, ADrail commissioned various reports in determining the requirements for bridge and culvert design. Aspects of the hydrological investigation were covered by report:

Alice Springs – Darwin Railway Project, Design Report 225, ‘Hydrology – Katherine Section’

This report specifically explores issues such as flood estimation and flow rates for identified watercourses, including the Edith River.

Hydrological estimations were based on a combination of the Rational Method<sup>18</sup>, Regional Method<sup>19</sup> and RORB Model<sup>20</sup> to determine theoretical flood flows throughout the area. This was supplemented by data sourced from NRETAS stream gauge locations, such as G8140152 (Figure 14) located 4.75 km up stream of the Edith River rail bridge. At the time of bridge design, ADrail had about 35 years of

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<sup>18</sup> The ‘Rational Method’ is an accepted method for estimating peak discharges for small drainage areas of up to about 10 km<sup>2</sup> in which no significant flood storage appears.

<sup>19</sup> The ‘Regional Method’ in particular the ‘Cameron McNamara Method’ – regional flood frequency method was adopted for catchments with an area greater than 50 km<sup>2</sup>.

<sup>20</sup> RORB – Runoff Routing modelling was used for flood estimation for larger catchment areas requiring a more detailed analysis of catchments, such as required for significant bridges and areas of more complex flows, such as Edith River.

NRETAS data, broadly covering the period 1963 to 1999, with the highest gauging of 7.6 m recorded on 2 March 2000.

Based on the NRETAS data and supplemented by calculations, ADrail determined that the highest potential flood levels would be contained within the river cross section.

**Figure 14: Location of the Edith River stream gauge G8140152**



Extract ADrail - Design Report 225. Copyright ©.

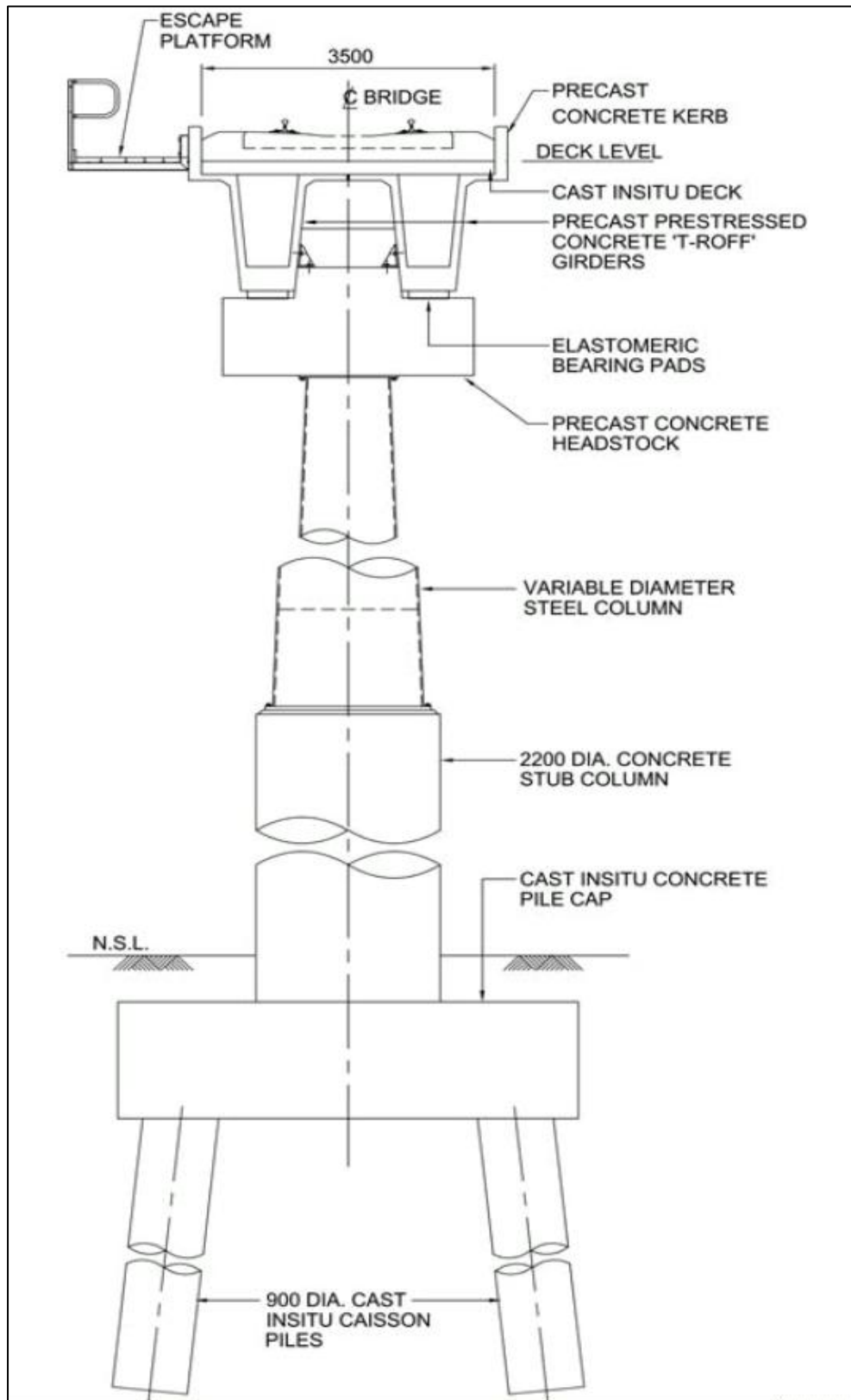
### ***Bridge design***

The Edith River rail bridge was one of five major rail bridges constructed between Alice Springs and Darwin for crossing the Elizabeth, Adelaide, Cullen, Edith and Katherine rivers.

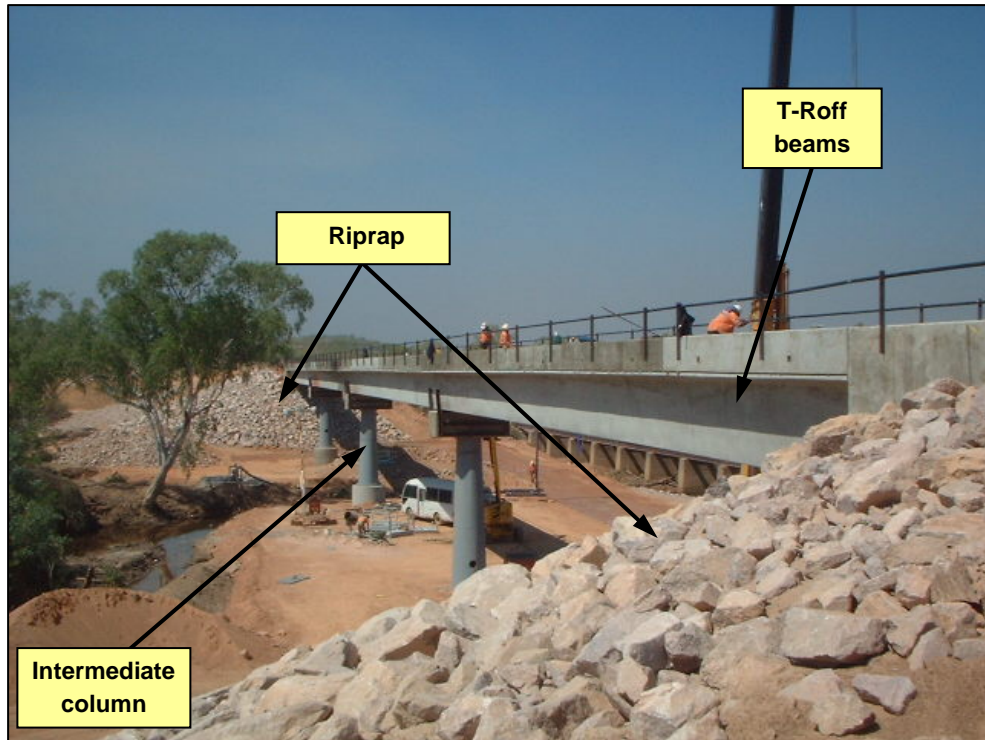
Construction of the Edith River Bridge was completed early in August 2002. It was 120 m long, divided into four sections. Each section comprised a simply supported pre-tensioned concrete T-Roff beam (T shaped beam) 30 m in length with a cast in-situ composite slab deck.

The supporting structures comprised three intermediate tapered steel columns carrying precast concrete headstocks (Figure 15). The steel columns were in turn supported on a concrete column/footing anchored into the river bedrock. These columns had a nominal height of 8 m, including the headstock, above the river bed. At each end of the bridge, the T-Roff beams were supported by abutments comprising a concrete headstock/column (pier) mounted on a concrete footing with integrated wing-wall.

Figure 15: Typical bridge cross section

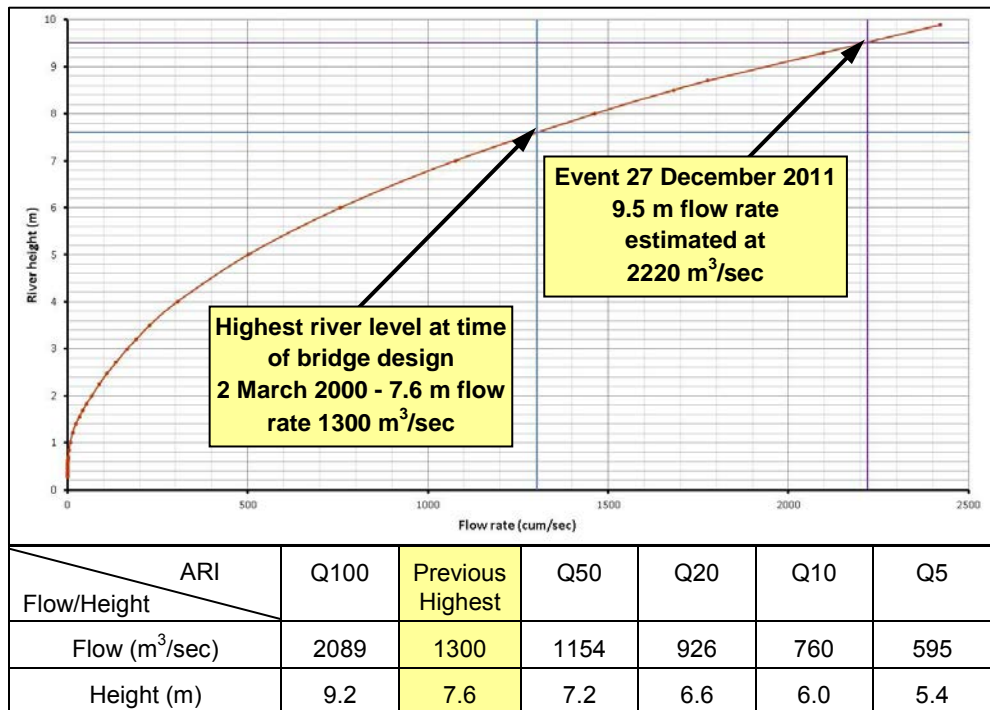


**Figure 16: Edith River rail bridge under construction**



Brooklyn Engineering Pty Ltd. Copyright ©.

**Figure 17: Theoretical flow data for Edith River at gauge G8140152**



NT Department of Natural Resources, Environment, the Arts and Sport. Copyright ©.

The northwest and southeast bridge abutments and associated track approach embankments were protected by riprap<sup>21</sup> to guard against scour damage caused by water erosion arising from flood events (Figure 16).

The design of the Edith River Rail Bridge was covered by report:

Alice Springs – Darwin Railway Project, Design Report 273, ‘Edith River Bridge’

The design brief included a range of requirements such as:

- Minimum performance criteria
- Minimum design criteria
- Codes and Standards, etc.

These requirements were used in coming to a determination of the final bridge design. Of particular note was the requirement to comply with the Australian Bridge Design Code (Austroads) HB77 including Railway Supplement which prescribes a design capacity to withstand the flood flow arising from a 100 year Average Recurrence Interval<sup>22</sup> (ARI) event.

Figure 17 ‘Theoretical flow data for Edith River at gauge G8140152’, sourced from NRETAS, indicates the assumed height of a 100 year ARI event as 9.2 m, which was calculated to result in a flow rate of 2089 m<sup>3</sup>/sec.

This corresponded closely to the 100 year (ARI) event determined by ADRail in their calculations at the Edith River rail bridge which prescribed the:

Bridge to provide for 100 year average recurrence interval (ARI) flood without the water level rising above the soffit level.

Stream flow data from the Edith River gauge (G8140152, 4.75 km upstream from the bridge) shows a recorded peak river height on 27 December 2011 of 9.454 m. This exceeded the height projected for a 100 year ARI event and was calculated to have produced a flow rate of 2220 m<sup>3</sup>/sec. Examination of available evidence shows that the flood event clearly overtopped the bridge itself and attained a height of at least 10.9 m at the time of the derailment. It is likely that the flood peak was even greater than 10.9 m. The ATSB concluded that the flood exceeded a 100 year (ARI) event and in these circumstances it is not unreasonable to expect partial failure of the bridge structure or approaches.

### **Summary**

The Edith River rail bridge was designed to Australian Bridge Design Code (Austroads) HB77 including Railway Supplement which prescribes a design capacity to withstand the flood flow arising from a 100 year ARI event. The flood on the morning of 27 December 2011 exceeded a 100 year ARI event.

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<sup>21</sup> Riprap: Rock or other material used to armour bridge abutments, pilings, etc against scour damage caused by water erosion

<sup>22</sup> Average Recurrence Interval - ARI (Flood event, measured in years) is a term used to describe flood size. It is a means of describing how likely a flood is to occur in a given year. For example, a 100 year ARI flood is a flood that occurs or is exceeded on average once every 100 years. Source: Glossary of Terms. The Canberra Spatial Plan.

## 2.3 Organisation – safety management system

At the time of the derailment GWA, as an accredited rail operator in the Northern Territory, was required to demonstrate safe operations through a comprehensive Safety Management System (SMS) as prescribed in the *Rail Safety Act 2010 (No 10 of 2010)*. Division 4 Part (1) of the Act requires that an organisation:

- (b) identifies and assesses any risks to safety that have arisen or may arise from the carrying out of railway operations on or in relation to the rail transport operator's rail infrastructure or rolling stock; and
- (c) specifies the controls (including audits, expertise, resources and staff) to be used by the rail transport operator to manage risks that have been identified and to monitor safety in relation to those railway operations;

In developing an effective SMS it is essential to establish clear policies, procedures and instructions, supplemented by employee training and systems so that operational risks can be effectively managed.

Since commencing services in 2004 FreightLink/GWA have maintained records of track performance including wash-away/flood events on the track between Alice Springs and Darwin. During this period, the ATSB has not received incident reports or undertaken investigations that indicate widespread issues with the track through the Northern Territory. Further, in the time leading up to the derailment, there was no record of any flood event at or near the Edith River rail bridge to indicate a heightened probability of flooding. As the bridge was designed to withstand a 100 year flooding event, GWA's assessment of the residual risk of an event such as the derailment on 27 December 2011 was probably low.

However, severe weather events do pose a significant operational risk and, although infrequent, the consequences can involve fatalities, injuries and significant infrastructure damage. Severe weather events are a recognised hazard and risk management standards require the development and application of all reasonable and practicable measures to mitigate the effects of the associated risk. It is therefore a requirement that operators understand the nature of severe weather events, as they relate to their operations, and develop strategies that ensure the safety of rail services.

GWA had two operational procedures for monitoring and responding to severe weather events.

### 2.3.1 Extreme Weather Event Monitoring and Response Procedure<sup>23</sup> (FL-PRO-06-010)

The FreightLink 'Extreme Weather Event Monitoring and Response Procedure' (FL-PRO-06-010) was intended for use by GWA staff in the determination and response to extreme weather events, excluding tropical cyclones. The procedure was divided into five sections.

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<sup>23</sup> The procedure was an existing FreightLink procedure (previous operator) and was in use by GWA at the time of derailment.

Section 2 ‘Purpose’ defines the primary intent of the procedure as:

... the allocation of responsibilities and preventative measures that can be taken for the management of extreme weather threats and events - Excluding Tropical Cyclones - ...

Although the procedure excludes tropical cyclones it identifies for severe weather events:

... primary threats will come from extreme rain events impacting on rail infrastructure and extreme wind conditions threatening double stack services.

Section 5 deals with response strategies for specific BoM warning levels. There are four stages of warning identified as:

Stage 1 – Weather Watch (Potential event identified)

Stage 2 – Weather Event Warning (Potential corridor impact identified)

Stage 3 – Stop Trains – Track Inspection

Stage 4 – Confirmed Event

Each stage identifies specific ‘Communication’ responsibilities between the operator (GWA) and the maintenance provider (BJB) with weather ‘Monitoring’ responsibilities vested in BJB. However, the extent of BJB’s obligations with respect to weather monitoring was not clearly communicated in GWA documentation. Further, it was noted that GWA actively monitored the weather events, upon which operational decisions to dispatch train 7AD1 were made, without seeking input from BJB.

The Stage 3 response prescribes that where ‘Train crew or other reports confirm likelihood or potential for track issues’ trains shall be stopped and BJB shall ‘confirm track integrity and advise Transport Control as soon as track integrity or damage is known.’

### ***Weather monitoring***

The BoM is the primary source for weather service and near real-time weather event information throughout Australia. The services are freely available for public and private use and can also be tailored (at cost) to meet specific end user needs.

It was established that in the lead-up to the derailment of train 7AD1 a range of warnings (cyclone, severe weather and flood) were available to GWA and/or BJB via the BoM web site, together with radar, rainfall, and the near real-time<sup>24</sup> river height information. There was also a BoM 1300 telephone service available for warning products.

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<sup>24</sup> The term near real-time refers to the ‘time delay’ between an event observation on site (river height) and when the data becomes available for public use. It typically involves transmission and processing delays. For example, in the case of the Edith River gauge G8140152 this involves the time taken to electronically transmit, process and re-process the information from NRETAS through to the BoM, then up-load onto the BoM web site. An examination of BoM data established that the time delay for data recorded at the Edith River gauging station to public availability was typically about 1 hour.

At the time of the derailment, neither GWA nor BJB were on any BoM direct distribution list<sup>25</sup> for these services and were therefore solely reliant on sourcing weather and flood information using internal resources. Further, it was established that neither GWA nor BJB had formal arrangements in place with police, emergency services, road authorities, etc. who could pass information to assist with the identification of localised impacts resulting from severe weather events.

In conclusion, information available through the BoM was probably sufficient to identify the potential risk of an extreme flood event at the Edith River rail bridge. If the BoM warnings including river levels had been effectively monitored and there was a closer working relationship with the local emergency services responding to the stranded motorists, it is probable that GWA would have reinspected the line in the time immediately before train 7AD1 was released from Katherine.

### 2.3.2 Cyclone Response Plan (RS-PRC-017)

The GWA 'Cyclone Response Plan' (RS-PRC-017) specifically deals with cyclone events; it is not used in conjunction with FreightLink's 'Extreme Weather Event Monitoring and Response Procedure' (FL-PRO-06-010). The 'Cyclone Response Plan' was divided into ten sections.

Section 1 'Purpose' defines the primary intent of the plan as:

... to provide guidance to operational personnel and users of the Tarcoola-Darwin Railway regarding the steps to be taken in the event of a tropical cyclone.

Section 4 'Definitions' points out that:

... the term 'in the event of a Tropical Cyclone' shall include the formation, passage and aftermath of a Tropical Cyclone ...

Section 6 'Tropical Cyclone Information and Warning Levels' provide definition of the specific warning levels and stages of cyclone activation issued by the BoM.

Section 8 deals with GWA's response for the specific BoM warning levels, with Clause 8.13 through to 8.17 covering the 'All Clear and Stand Down' responses following cancellation of a cyclone warning. In particular clause 8.13 mandates:

Once the cyclone has passed and the Regional Counter Disaster Controller has issued the 'Cyclone All Clear' advice, an inspection of track and civil infrastructure **SHALL** be conducted in all affected areas in a bid to confirm the integrity of the railway.

**Until confirmation has been received, the railway SHALL remain closed to all train movements.**

Following the downgrading of cyclone Grant to a tropical low, GWA planned for the resumption of services. The track from the BFT through to Katherine was inspected by BJB, in accordance with the Cyclone Response Plan, and determined to be operationally safe. GWA then recommenced services. However the Cyclone Response Plan did not identify consequential dangers arising from severe localised

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<sup>25</sup> The BoM now also provides an RSS feed at site <http://www.bom.gov.au/rss/?ftr>. RSS (Really Simple Syndication) provides a new way to view existing BoM information and details of when the information was issued.

flooding in the aftermath of a cyclone, or the need for BJB to conduct ongoing monitoring of flood waters as is prescribed in the 'Extreme Weather Event Monitoring and Response Procedure'.

Clause 8.17 makes reference to an 'After the Cyclone' checklist and mandates:

The Regional Operations Manager Darwin **SHALL** complete the **After the Cyclone** checklist (GW-FRM-06-021-E) - on notification of cyclone All Clear.

An examination of the checklist (included at Appendix B) shows that the form was only ever intended to validate the integrity of the BFT located near Darwin following a cyclone event. The checklist provides no validation or practical guidance in understanding consequential risks, for example flooding, in the aftermath of a cyclone as occurred near the Edith River.

### 2.3.3 Employee training - severe weather events

The 'Extreme Weather Event Monitoring and Response Procedure' and the 'Cyclone Response Plan' are the two main documents providing guidance for GWA employees or their contractors in managing operational risks associated with severe weather events. There was no other guidance, policies or procedures and/or training in place to assist employees in understanding the consequential dangers and nature of severe weather events, cyclones, etc, including the duration and ongoing responses appropriate to severe weather events which could affect the safety of rail operations. Information in GWA's SMS regarding severe weather events was deficient and thus the organisation relied heavily on employee and contractor knowledge and local experience to effectively manage this risk.

#### **Summary**

Following the cancellation of the tropical cyclone warning<sup>26</sup>, GWA arranged for BJB to inspect the track between the BFT and Katherine, as mandated at Clause 18.3 in the GWA Cyclone Response Plan. BJB found the track to be operationally safe, following which GWA recommenced services.

Train 6AD1 (train that preceded 7AD1, the train that derailed) was the first service to operate between Katherine and the BFT following cancellation of the cyclone warning. The river height (3.76 m) was not a threat when train 6AD1 traversed the Edith River rail bridge at 2220 on 26 December 2011. Train 6AD1 arrived safely at the BFT at 0120 on 27 December 2011 with the driver reporting no abnormalities had been observed whilst in transit.

No further checks were made of track or infrastructure integrity, including flood risk, prior to the dispatch of train 7AD1 from Katherine to Darwin at 0510 on 27 December 2011. If the Edith River height information available from the BoM had been actively monitored by GWA/BJB, it is likely that another inspection would have been initiated immediately prior to the train being dispatched.

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<sup>26</sup> The 'Cyclone WARNING' was formally cancelled by the BoM vide TROPICAL CYCLONE ADVICE NUMBER 32, Issued at 1353 CST on Monday 26 December 2011.

GWA's Extreme Weather Event Monitoring and Response Procedure and Cyclone Response Plans provided little if any guidance for employees and their contractors in quantifying the duration and consequential dangers (flooding) associated with the aftermath of a cyclone.

If GWA's SMS had contained appropriate guidance, supported by appropriate employee and contractor training in relation to severe weather events, in particular the potential for severe flooding in the aftermath of a cyclone, the derailment on 27 December 2011 may have been averted.

### 3.1 Context

At approximately 0542 on 27 December 2011, freight train 7AD1 derailed at the Edith River Rail Bridge near Katherine in the Northern Territory.

As a result of the derailment the train driver was unhurt, but the co-driver suffered back injuries and there was significant damage to the bridge and rolling stock. A number of wagons including the crew van, which was unoccupied at the time, derailed into the Edith River.

Based on the available evidence, the following findings are made with respect to the derailment but should not be read as apportioning blame or liability to any particular individual or organisation.

### 3.2 Contributing safety factors

- The intensity of rainfall in the vicinity of the Edith River catchment area in the 12 hour period preceding the derailment of train 7AD1 significantly exceeded the level projected for a 100 year statistical event and resulted in flood waters that overtopped the Edith River rail bridge causing significant damage to the south-eastern bridge embankment.
- The loss of the bridge embankment, sub-grade and ballast meant the track could not support the weight of train 7AD1 and this initiated the derailment as it traversed the track leading into the bridge.
- GWA did not have systems in place to adequately monitor the level of the Edith River although near real-time river height information was available from the Bureau of Meteorology.
- GWA did not re-check track or infrastructure integrity, including flood risk, prior to the dispatch of train 7AD1 from Katherine to Darwin on 27 December 2011.
- GWA policies, procedures and training had little if any guidance for employees or contractors with respect to quantifying the duration, consequential dangers and responses to severe weather events.  
*[Significant safety issue]*
- The warning systems in place to alert GWA staff as to the severity of a flood event at the Edith River Rail Bridge were ineffective.  
*[Significant safety issue]*
- Without pre-warning of the flood event at the Edith River the train driver assumed that the track from Katherine to Darwin was safe for the passage of train 7AD1.

### 3.3

#### Other key findings

- In the lead up to the derailment of train 7AD1 there had been adequate warning of the cyclone event, the subsequent heavy rainfall and resultant flooding.
- The initial response by GWA to the cyclone event was well executed and generally in accordance with the organisation's policies and procedures.
- Following the cancellation of the 'Cyclone WARNING' GWA responded appropriately, checking for track integrity before dispatching train 6AD1 from Katherine to Darwin.
- The Edith River rail bridge was designed and constructed to the Australian Bridge Design Code (Austroads) HB77 including Railway Supplement which prescribed a requirement to withstand a design flood flow for a 100 year Average Recurrence Interval (ARI) event.
- The flood on the morning of 27 December 2011 well exceeded a 100 year ARI event.
- There was no record of previous flood events, since the construction of the Edith River rail bridge, at or near the site that may have heightened the alertness of GWA to the risk of a wash-away event as occurred on 27 December 2011.

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## 4 SAFETY ACTION

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The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

Depending on the level of risk of the safety issue, the extent of corrective action taken by the relevant organisation, or the desirability of directing a broad safety message to the rail industry, the ATSB may issue safety recommendations or safety advisory notices as part of the final report.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

### 4.1 Genesee & Wyoming Australia Pty Ltd

#### 4.1.1 Policies, procedures and training

##### ***Safety issue***

GWA policies, procedures and training had little if any guidance for employees quantifying the duration, consequential dangers and responses to severe weather events.

##### ***Action proposed by Genesee & Wyoming Australia Pty Ltd***

GWA is currently reviewing the FreightLink Extreme Weather Event Monitoring and Response Procedure FL-PRO-06-010E with the aim of developing a GWA document which incorporates features of this procedure and learnings from the Edith River Bridge derailment. GWA is also reviewing its Cyclone Response Plan (RS-PRC-017) in conjunction with Network Users, once again with the aim of incorporating learnings from the derailment into the document.

Work has also commenced on developing an awareness package for delivery to all GWA train crews which details the recommended response to flooded track, storms and associated extreme wind events and line side fires. It is envisaged that the package will also be delivered to Transport Controllers, operational staff, track inspectors and members of senior management involved in the decision-making process.

##### ***ATSB assessment of action***

The Australian Transport Safety Bureau is satisfied that the action proposed by Genesee & Wyoming Australia Pty Ltd will, when completed, adequately address the safety issue.

## 4.1.2 **Monitoring of severe weather and flood events**

### ***Safety issue***

The warning systems in place to alert GWA staff as to the severity of a flood event at the Edith River Rail Bridge were ineffective.

### ***Action proposed by Genesee & Wyoming Australia Pty Ltd***

GWA is actively engaged in the assessment of a range of systems designed to provide advance warning of extreme weather events and flooding at predetermined locations. To this extent, GWA is also reviewing the risk profile of the Tarcoola-Darwin railway relative to its structures and local hydrology with the aim of focussing attention and mitigating strategies against future flood events to potential high risk locations.

At the same time, GWA is establishing closer relationships with a range of Government agencies including the NT BoM and the Department of Natural Resources, Environment, the Arts and Sport with the aim of fostering a better understanding of the resources these agencies may be able to provide and any limitations that may exist in relation to the monitoring and reporting of extreme weather events and potential flooding.

Lastly, GWA is pursuing the installation of Stream Flow Detection (SFD) system for the six (6) major bridges (as defined by ADrail and having a 30 metre span) north of Katherine. The system will comprise of a detection unit, communication modem and two aspect signals. The position of these signals is yet to be determined but GWA is working towards having them sighted 2.5 km from the bridges. The unit will detect when water levels are about to reach the 'top of formation' and will provide an alert to both train control and train crews. This technology has been successfully implemented in the Pilbara region recently.

### ***ATSB assessment of action***

The Australian Transport Safety Bureau is satisfied that the action proposed by Genesee & Wyoming Australia Pty Ltd will, when completed, adequately address the safety issue.

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## APPENDIX A : SOURCES AND SUBMISSIONS

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### Sources of Information

The sources of information during the investigation included the:

Bureau of Meteorology (Darwin)

Genesee & Wyoming Australia Pty Ltd

Northern Territory Department of Natural Resources, Environment, the Arts and Sport

Northern Territory Police

OZ Minerals Ltd

### References

ADRail Alice Springs – Darwin Railway Project, Design Report 225, ‘Hydrology – Katherine Section

ADRail Alice Springs – Darwin Railway Project, Design Report 273, ‘Edith River Bridge’

Australian Code for the Transport of Dangerous Goods by Road and Rail (7<sup>th</sup> Edition)

FreightLink ‘Extreme Weather Event Monitoring and Response Procedure’ (FL-PRO-06-010)

GWA ‘Cyclone Response Plan’ (RS-PRC-017)

Northern Territory - *Rail Safety Act 2010 (No 10 of 2010)*.

### Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the Transport Safety Investigation Act 2003, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to:

- Bureau of Meteorology (Darwin).
- Genesee & Wyoming Australia Pty Ltd.
- Northern Territory Department of Natural Resources, Environment, the Arts and Sport.
- Northern Territory Police.
- Northern Territory Railway Safety Regulator.

- NT Worksafe.
- OZ Minerals Ltd.
- SafeWork SA.
- Witnesses and individuals.

Submissions were received from Bureau of Meteorology (Darwin), Genesee & Wyoming Australia Pty Ltd, OZ Minerals Ltd, SafeWork SA. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

# APPENDIX B : CYCLONE CHECKLIST



## Cyclone Checklist AFTER

ITEM NO.	CHECKLIST	STATUS Please ✓ once completed
1.	The Regional Operations Manager Darwin shall contact the emergency services or police and ascertain if any reported damage has occurred at Bemimah Rail Terminal (Darwin).	
2.	The BJB track inspector will inspect track for damage, after emergency services has given the all clear to leave shelter, and ensuring the cyclone is clear of the areas to be inspected.	
3.	The Regional Operations Manager Darwin shall obtain the cyclone emergency kit, checking the operation of the portable radio and monitor weather reports and relevant information.	
4.	Regional Operations Manager Darwin shall request the assistance of one (1) employee to accompany him/her to the terminal and evaluate the environments safety and suitability to resume train operations.	
5.	Regional Operations Manager Darwin shall contact Pacific National's State Manager and Terminals Manager informing them of their planned actions.	
6.	Regional Operations Manager Darwin or assistant shall contact the security monitoring company and inform them, they are about to enter the terminal.	
7.	Regional Operations Manager Darwin and assistant shall with extreme caution, enter the terminal together and assess all safety aspects of the terminal.	
8.	Regional Operations Manager Darwin to call in expert advice or assistance if unable to determine the safe operation of equipment.	
9.	When all hazards have been identified and protected the Regional Operations Manager Darwin shall contact the GWA Chief Operating Officer and/or the GWA Network Services Manager, Pacific National's State Manager and Terminals Manager advising them of the situation.	
10.	Regional Operations Manager Darwin and assistant shall record details of the terminal's condition: digital images and report information digital audio/ or text, emailing information to GWA Chief Operating Officer and/or GWA Network Services Manager and Pacific National as soon as practicable.	
11.	When safe and with all information/evidence recorded, the Regional Operations Manager Darwin shall contact as appropriate Pacific National terminal personnel and request assistance.	
12.	Regional Operations Manager Darwin shall brief each employee of the terminal conditions before they enter the site.	
13.	Regional Operations Manager Darwin and available employees shall prepare an operational recovery plan.	
14.	Issue portable radios/mobile phone to employees and start the recovery plans.	
15.	Regional Operations Manager Darwin shall inform all personnel involved in the recovery plans; if any safety concerns exist, contact him and expert advice or assistance shall be sought.	
16.	Regional Operations Manager Darwin to debrief all terminal personnel involved in the recovery plans; seeking any opportunity to improve safety, operations recovery and minimising property damage.	
17.	Regional Operations Manager Darwin shall advise; Chief Operating Officer and/or Network Services Manager, GWA Transport Control, PNL State Manager, Terminals Manager and GSR of approximate time when the terminal will be reopened for operations.	



**Australian Transport Safety Bureau**

**24 Hours** 1800 020 616

**Web** [www.atsb.gov.au](http://www.atsb.gov.au)

**Twitter** @ATSBinfo

**Email** [atsbinfo@atsb.gov.au](mailto:atsbinfo@atsb.gov.au)

**Investigation**

**ATSB Transport Safety Report**

Rail Occurrence Investigation

Derailment of freight train 7AD1 at  
Edith River near Katherine, Northern Territory on  
27 December 2011

RO-2011-019  
Final