

IS THIS CLIMATE CHANGE? - EXPERIENCES THAT ARE INCREASING OUR RESILIENCE.

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ABSTRACT

The Nelson Regional Sewerage Business Unit (NRSBU) operates the Bell Island wastewater treatment system, and regional wastewater infrastructure. The business unit has had an ongoing focus on resilience and over the last 10 years has invested in infrastructure to accommodate growth, and to mitigate issues with potential disasters, and to mitigate climate change.

The NRSBU resilience work has been tested over 2018 and 2019 by various climatic events, and the issues that have arisen from the events have shown that while NRSBU identified the potential issues associated with many events, our planning has not fully identified secondary effects of these events very well and we have not allowed for the implications of these secondary effects on our infrastructure.

The specific events we examine here are the effects of ex tropical cyclones Fehi and Gita in early 2018 and the drought and subsequent fires that have affected the Nelson region in early 2019.

This paper summarises some of the issues NRSBU has faced, and how our assets have fared and also considers the issues identified during, or because of, the climatic events of 2018/2019.

The paper will outline several secondary effects that were not considered in the initial risk assessments and will discuss the implications that these could have on the system in the future. The effects relate not only to assets, but also to operation and maintenance activities, and to our biosolids disposal system. Some of effects identified could have significant financial implications and NRSBU will have to balance the extra investment against the additional system resilience which is gained.

In this instance, the climatic events have acted as an unwelcome, but valuable stimulus for NRSBU to undertake a broader consideration of risk and resilience and has assisted to highlight the issues in time for NRSBU to mitigate them. NRSBU believes that its increased understanding of the primary and secondary effects of events associated with climate change and our processes to plan for them will be improved as a result.

KEYWORDS

Climate Change, Resilience, Drought, Cyclone, Storm Surge.

PRESENTER PROFILE

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1 INTRODUCTION

The Nelson Regional Sewerage Business Unit (NRSBU) is the joint business unit between Nelson City and Tasman District Councils that is responsible for the conveyance, treatment and disposal of wastes for a significant portion of the population of Nelson City and Tasman District.

The NRSBU facilities are located on the shores of the Waimea Inlet and the Bell Island facility is located on an island in the Waimea inlet. The facility was constructed in 1980 and has been upgraded incrementally since this time. The facility has a connected population of around 45,000 people, with a significant industrial contribution from several large industrial contributors.

In addition to its reticulation system NRSBU also has its treatment facility on an island in the Waimea estuary, and has biosolids reuse facilities on Rabbit Island. NRSBU facilities have some unique features including the requirement to only discharge our treated wastewater for a maximum of three hours after high tide, which requires us to store waste between tides, and to discharge a maximum of 25,000 m³ per day. This maximum discharge means we have to store influent in excess of 25,000 m³ per day in our facility.

Our biosolids facility is an asset NRSBU is proud of. We irrigate our Class A treated biosolids to the Rabbit Island forest without dewatering. Our facility recycles approximately 30% of the nutrients entering in the wastewater, and the irrigation results in a 38% increase in tree growth within the forest, and a 35% increase in economic return from the forest.

The location of our assets around the Waimea estuary is low lying with almost all our existing rising main network, and a portion of our treatment plant within 1m vertically of spring peak tides. Due to the low-lying nature of our assets, inundation risks have been considered over many years. In the early 2000s prior to the installation of a new pump station, assessments were undertaken using information available at the time. At that time suggestions were that a sea level rise allowance of 300mm was appropriate.

In the mid-2000s a brief review of the Bell Island facility for climate change was undertaken, and it was estimated that the cost of shifting the facility would be very significant (Circa 150- 200 million NZD) and would result in additional pumping costs, additional wastewater disposal issues, and additional biosolids management costs.

At the time this was considered the estimated sea level rise being considered was 300mm by 2100 (which was the generalized projection at the time) and this change was not considered enough compared to the risks to justify significant investment. The costs were considered sufficiently large, that no alternatives were considered.

When upgrading our facilities, we have also needed to consider storm flows, and since 2010 we have had number of significant events, which would historically have been classified as long Average Return Interval (ARI) events, but with the changing climate this assessment may no longer be appropriate.

2 OUR EXPERIENCES

Nelson has experienced several events over the last ten years, some of which have been extreme with very long return intervals. While some events of this type can be expected, the frequency and severity of the events leaves us wondering whether this is climate change and whether is this the new normal?

Over the last eight years we have had flooding events with rainfall at levels previously not seen (NIWA, Historic Weather events catalog), and in the last two years we have had storm surges in 2016 and 2018 with Ex Cyclone Fehi having a storm surge coinciding with a king high tide that reached more than 350mm above spring tide levels. This when combined with high wave intensity, and wind direction, this event resulted in inundation of two pump stations within our rising main network.

In addition to the flooding and storm surges, in 2018/2019 summer we also experienced the worst drought seen in many years. This drought led to the region experiencing the largest fires in New Zealand since modern equipment (helicopters) has been available.

The drought and fires affected our facilities to a small extent, but because of these events we learned how vulnerable some of our assets are. This paper is intended to promote discussion of the issues, and particularly around secondary effects of events, and to assist us to learn together from our collective experiences.

2.1 FLOODING

2.1.1 DECEMBER 2011 STORM

In December 2011 an active front, preceded by a strong and very humid northeasterly flow, moved very slowly eastwards across New Zealand, resulting in very heavy rainfall in the Tasman-Nelson region.

Between 3am December 14 and 3 am December 15, 423mm rain fell at Takaka, 368mm at Anatoki, 329mm at Brook, 205mm at Richmond, and 323mm at Roding.

NRSBUs Bell Island WWTP received storm flows over five times ADWF for six days in a row, which resulted in all storage capacity being used, and an extended discharge period being implemented as an emergency measure, resulting in a breach of our resource consent conditions.

2.1.2 APRIL 2013 STORM

Clashes of cold southeasterly and warm northerly air masses brought wet and unsettled weather to many areas of New Zealand. On the 21st April, very heavy rainfalls occurred in the Nelson region. The maximum 1-hour rainfall total during the storm was 101mm in the Roding catchment area near Richmond, a rainfall total which has a 500-year return period in this area. The highest 24-hour rainfall total recorded during the event was 216mm, recorded at the Tasman District Council office in Richmond.

On the 20th April 113mm of rainfall was recorded in 90 minutes at the Tasman District Council office in Richmond.

This event resulted in overflows from our and our contributors facilities.

2.1.3 MARCH 2016 STORM

A period of extreme weather on 24 March affected many areas of New Zealand. There was flooding around the Nelson area.

Civil Defence activated its Emergency Operations Centre in Richmond and a Civil Defence team was in place at the Motueka Recreation Centre.

Due to overflows from reticulation systems and pump stations the Nelson council warned against collecting shellfish and swimming in Tahunanui Beach, Waimea Estuary and Nelson Haven.

2.2 EX CYCLONE FEHI AND EX CYCLONE GITA

2.2.1 STORM EVENTS DURING FEBRUARY 2018

Ex Cyclone Fehi - the combination of a very low-pressure system, king high tides and high winds drove a lot of water and storm surge into the head of Tasman Bay and parts of Golden Bay.

Incoming seawater along with large waves caused significant flooding in areas normally protected by the Waimea estuary.

The graphs below outline the characteristics of the storm surge. Figure 1 shows the storm surge estimates on top of the king tide event that was occurring at that time. It is estimated that the storm surge was around 350mm on top of the king tide.

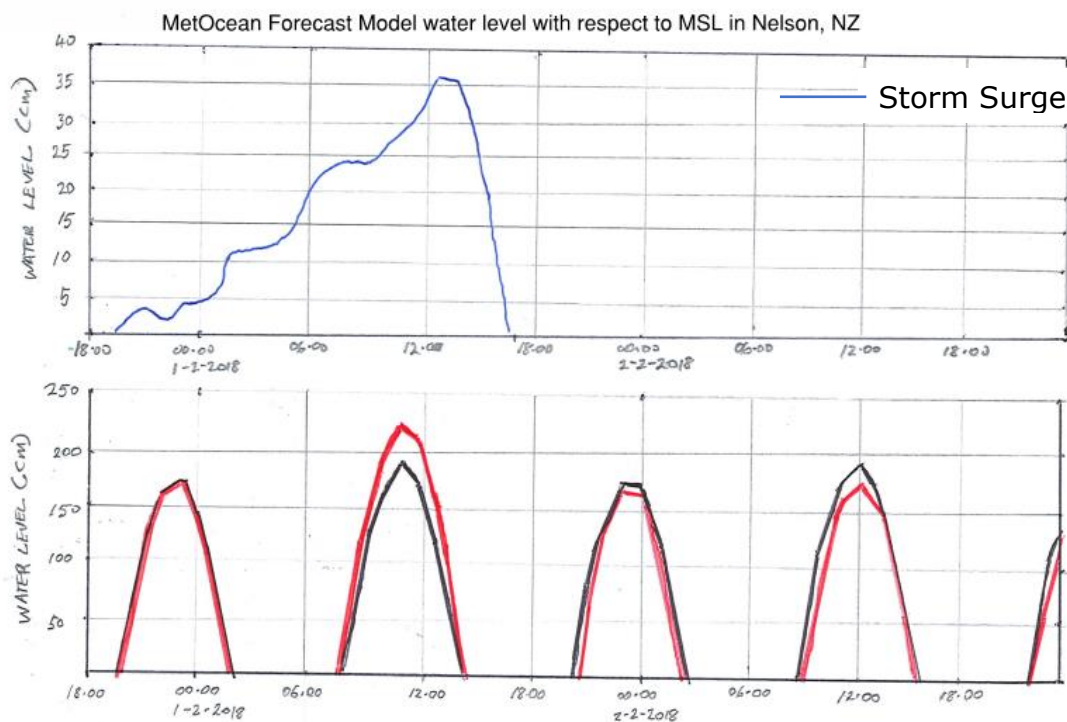


Figure 1: Storm surge height – MetOcean Solutions Ltd, 2018

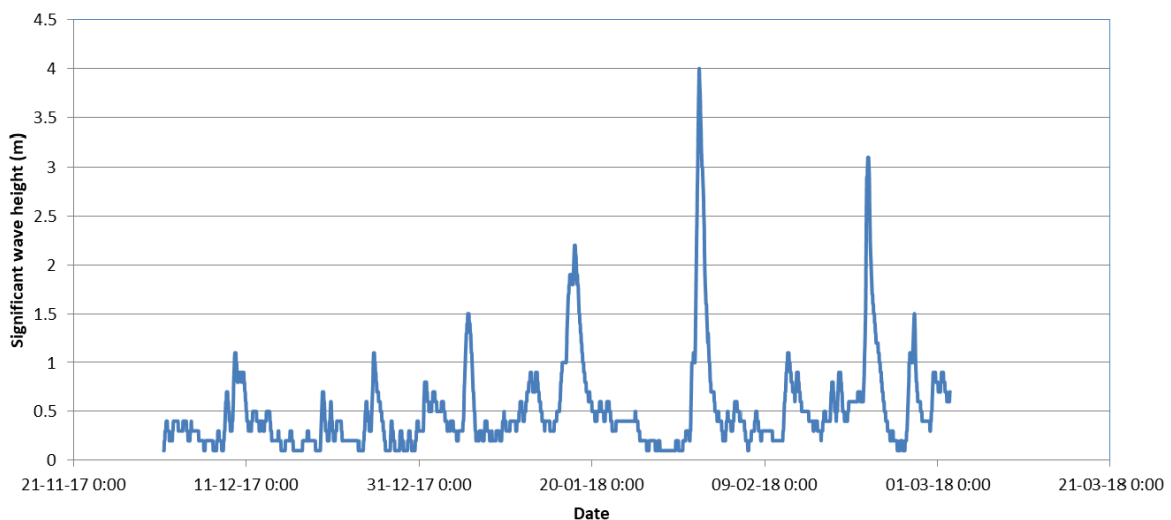


Figure 2: Significant wave height experienced -MetOcean Solutions Ltd, 2018.

Figure 2 shows the wave height experienced within the region during the storm. While our assets are protected from a significant portion of this energy, the waves added to the high level experienced at the Beach Road Pump station.

For NRSBU this event caused two of our pump stations to be inundated.

One pump station had total electrical failure, with main switchboards and VFDs failing due to seawater inundation. The pump station was out of service of nearly 12 hours before a temporary diesel-powered system could be implemented. This resulted in wastewater from around 25,000 residents overflowing to the Waimea estuary for approximately 12 hours.



Photograph 1 & 2: Beach Road Pump Station inundated by storm surge

The second pump station was inundated but the facility was protected from wave action and the Busbars and the VFDS were sitting higher on the walls than the Beach Road Pump station. Electrical failure was avoided by 50mm.



Photograph 3 & 4: Songer Street Pump Station (with water mark)

This pump station is our newest pump station, having been installed in 2010/2011. It was designed for sea level rise considerations as they were understood at the time.

NRSBU was lucky that this pump station was protected from wave action. It is likely that if the wind direction had been toward the unprotected side of the facility then this pump station would also have failed due to the electrical systems being inundated.

Despite the pump station wet well being completely submerged by water the system remained working effectively. The reason for this was the fact that our wet well covers were well sealed and were strong enough to withstand the force of the water overtop of them. As a result, we experienced no loss of service from the station.

2.3 2018/19 SUMMER DROUGHT AND FIRES

During the summer of 2018/2019 the Nelson Region experienced our longest dry period (more than 40 days) for many years. This drought is the fourth worst in more than 150 years since record began, (NIWA Climate Summary, March 2019)

On 5 February, tinder-dry conditions in the Tasman District fueled a large scrub fire in Pigeon Valley near Wakefield.

On the 6 February, a new fire started in the Tasman District on Rabbit Island near Nelson city. The fire was approximately 100 by 100m and was the second fire on Rabbit Island in the space of three weeks. This was significant to NRSBU due to Rabbit Island being the location of our biosolids reuse facility.

By 13 February, the wildfires had burned through 2300 hectares in the Nelson-Tasman region, destroyed one home and led to evacuations of more than 1000 people. Also, on the the same day a total fire and equipment ban was initiated in the Nelson area which put up to 240 forestry contract workers out of jobs and closed two saw mills.

It was reportedly the largest aerial fire fighting operation in New Zealand's history, with 23 helicopters and two planes used at the peak of the fire. (NIWA Climate Summary, March 2019)



MARY SULLIVAN

Photograph 5: Smoke rising from forest fire on Rabbit Island - Photo curtesy of Stuff, 6 Feb 2019.

3 DISCUSSION –

3.1 HOW DID WE FARE?

Over the last two years we have had significant loss of services resulting from extreme climate events, we have had significant uncontrolled discharge due to system damage during these events, but we have had few other loss of service events. NRSBU believes its services fared reasonably well, however while our infrastructure is reasonably robust from a resilience perspective, we clearly have room to improve.

Our infrastructure has generally coped well with the capacity related events, but NRSBU (and our contributors) have had overflows to the environment as a result of these events. The storm surge event in Feb 2018 resulted in significant damage, but temporary repairs brought our services back online within 12 hours.

It is now clear that NRSBU could have had measures on hand that might have avoided the significant damage experienced, and these measures would not have cost much to have available. It is therefore concluded that NRSBU could have been better prepared for events of the scale that occurred.

What has also been learned is that the secondary effects of these events were not effectively identified in advance. Secondary effects are effects on aspects on our facilities and operations, not directly in contact with the issues. These secondary effects are discussed below.

3.2 SECONDARY EFFECTS OF STORM SURGE EVENT

There were numerous secondary effects associated with the storm surge event that NRSBU had not thought about in any detail. These effects for NRSBU largely related to salt toxicity issues.

Some of the effects were:

1. Direct inflow of seawater into the network and elevated salinity of the wastewater
2. Odour events from high sulphide production in the reticulation system.
3. Sulphide toxicity on the algae in NRSBUs facultative ponds
4. Odour events associated with algal die-off in our facultative ponds
5. Ongoing adverse effects for a few months on the pond performance as salinity reduced.
6. Death of pine trees on Rabbit Island immersed in seawater.
7. Inundation of parts of Bell Island close to our treatment facilities.
8. Restricted access to Bell Island WWTP and other assets.

Secondary effects from the storm surge were the cause of a significant odour event associated with our facultative ponds, and it led to poor performance and instability in the ponds for several months while the salinity was diluted by incoming wastewater.

The death of significant area of the pine forest on the shoreline of Rabbit Island affected the area where NRSBU has its biosolids reuse system. The death of the trees resulted in a reduction of land available for biosolids reuse, and significantly altered the reuse regime, as the trees that were killed needed to be removed for safety and economic reasons.

Fortunately, the reduced available area was still sufficient for biosolids reuse, but a storm surge event with a higher magnitude would result in increased area of planted forest being killed, and potentially to land availability issues.

3.3 SECONDARY EFFECTS OF DROUGHT AND FIRE

The drought during summer 2018/2019 resulted in high temperatures and closure and stand down of forest workers.

During the drought NRSBU modified its biosolids operations to limit our activities during the heat of the day, contingency plans were in place for equipment with firefighting equipment on hand, and fire risks were minimized. However, due to a lack of alternative disposal options for biosolids, discharge to the forest could not be stopped. When the forestry industry shut down the forests in the region, NRSBU was not able to shut off its operations, as we have insufficient storage for biosolids and we currently have no mechanical equipment or resource consents in place that would allow disposal of the biosolid elsewhere.

The fires in Tasman District, and subsequently the fire that was lit in the Rabbit Island forest identified in a very real way the fact that we had no contingency plan for biosolids management should the forest burn down.

The fact that there were around 20 helicopters fighting the Pigeon Valley fire when the Rabbit Island fire was started, meant that the response to the Rabbit Island fire was exceedingly fast. If there had been no Pigeon valley fire, then we may have lost a significant portion of the Rabbit Island forest, and therefore we may have been without biosolids reuse for a considerable time. This would have resulted in significant additional nitrogen loading the estuary, and the loss of our assets on Rabbit island, in addition to the loss of the timber value.

Another secondary effect for NRSBU of the drought and water restrictions was the significant (~30%) reduction in inflow to our facility during the peak of the drought. NRSBU charge our customers based on their discharge, and a significant portion of our income comes from flow charges. The reduced flows associated with the drought lead to a significant budget change for our business unit.

4 IS THIS CLIMATE CHANGE – OUR RESPONSE

There is still quite a bit of uncertainty around what the real effects of climate change are going to be for our region, and there are no clear trends at this time. Whether these events are typical of what we should expect in future or whether we have experienced an unusually high number of events in a short time isn't clear. However, given that NRSBU has experienced a number of significant events over the last eight years and particularly over the last two years, it is important for us to think about what can be done, and what can be learned from our experiences.

At present it is not easy to be sure how NRSBU should respond. We can read the latest information from IPCC, MFE, NIWA and other sources about sea level rise allowances, and climate change effects. But if investment is made in new infrastructure now to mitigate these issues it is possible that (like our new pump station) the new assets may not accommodate future events due to the uncertainty associated with the science at present.

Our response needs to be managed in relation to costs, consequences, and based on our expectations of the future. But at present the uncertainty around the future severity and frequency leaves us second guessing our planning.

In 2008 when planning our new pump station to allow for 300mm sea level rise, NRSBU certainly didn't expect that this pump station would be close to failure in 2018 as the result of a storm surge event.

4.1 HAVE A CONTINGENCY PLAN.

What has been a surprise was the extent to which the secondary effects lingered, and how significant these could have been, if we had been less fortunate. It highlighted that for some events NRSBU didn't have contingency plans, and it showed that we can implement more measures in advance (some of which are low cost) to have mitigation measures available at short notice.

While contractors acted quickly to get temporary facilities in place to restore service, it would have been more efficient, safer and less expensive, if the prearranged solutions were available in advance to limit the damage.

4.2 LESSONS LEARNED

For NRSBU our infrastructure was largely undamaged by the rainfall and drought events, however we experienced significant overflows from several of our pump stations because of the inflow and infiltration during the rainfall and storm surge events.

NRSBU did not have a significant issue during the drought but this was more luck rather than good management.

NRSBU is presently looking into ways of mitigating the risk of climate events, and improving the infrastructure to accommodate these types of issues, without investing significantly in new assets.

Some of the actions being implemented are outlined below

4.2.1 IMMEDIATE RESPONSES:

1. We are constructing simple plywood shutters for our pump stations that we can mount over doorways and other openings in advance of a storm surge to seal the structures. We are sealing pipe penetrations, and other water ingress points.
2. We are planning to install well sealed lids on all the facilities to limit the direct ingress of seawater.
3. We have lifted the electrical systems on some stations and will progressively raise them for all pump stations.
4. We are planning to install drainage pumps in dry wells to limit the level water can reach internally, if the shutters and sealing hold the bulk of the water out.

4.2.2 SHORT / MEDIUM TERMS RESPONSES

We propose to implement changes that can manage the short to medium term effects while we take time to reconsider our long-term plans, and while hopefully the scale of the climate change issues becomes clearer. These short to medium term responses include defending low-lying area of our plant by constructing a protection bund, and developing options for conveyance, treatment and disposal that allow more resilience and allow more ready access for maintenance and repair.

For significant rainfall events:

1. We are planning to increase capacity from our Richmond catchment to better accommodate significant rain events, however we expect to still have overflows in extreme events.
2. We are looking to add levels of redundancy, including changing our backup electrical generation in our pump stations to power our stormflow pumps, so that our systems can continue to operate when other infrastructure services have failed.

For our biosolids system:

Post event discussions with our contractors and the forest managers identified that the significance to NRSBU of a fire and the loss of the entire Rabbit island forest, may not have been as significant as NRSBU initially thought. Together we identified that we could potentially access the forest area for biosolids reuse as soon as it was cool enough for it to be safe.

The application of biosolids could be undertaken on the bare land in advance of replanting of the pine trees, and therefore the period we would be out of service for was estimated to be up to two months.

It was considered likely that area where young trees had been located would be bare, and little additional clearance work would be required. Areas with older trees would likely require clearance prior to NRSBU being able to use them.

We identified that we would therefore need to have contingency plans in place that could allow alternative storage, alternative treatment plant operations, or alternative disposal options for around 60 days.

We have since identified that if our contractor's irrigation vehicle was destroyed, then this would form a bottleneck in restarting our facilities, and so obtaining a redundant asset for this is something we have now initiated.

4.2.3 THE LONG TERM

Many of our responses have been immediate or short term, but we have not yet come up with a plan for our long-term future. We have not yet decided whether our facilities are appropriately located.

Historically we have considered relocating our treatment plant, and it was clear at that time that the costs of shifting our facilities was daunting and would place a significant financial burden on the region. Discussion has once again started about whether this may be required.

Due to the level of uncertainty we are currently taking a defend in place approach, with a watching brief on the climate science. Our hope is that the scale and rate that changes are occurring will become clearer, and therefore we will be able to make a more informed and therefore better decisions.

What has helped us since these events is taking a much more focused risk management approach to events, brainstorming the "what could happen" scenarios, and working with these scenarios we can then try to predict what could result from the events.

For us we felt we understood the primary risks quite well, but it is clear that we had not previously thought enough about the secondary consequences.

Hopefully others have a better handle on the effect these secondary consequences will have on their systems than we did on ours.

5 CONCLUSIONS

What we have seen is that our planning even ten years ago wasn't as conservative as we probably needed it to be. Hindsight shows us that it is possible to manage our existing assets better with limited additional cost.

When looking back we can see alternatives, which might have significantly improved performance with limited cost, we have identified that we currently don't have enough levels of redundancy, particularly in our reticulation and biosolids reuse systems

We have increased our use of risk management approaches, brainstorming the "what could happen" scenarios in more detail, and working with these scenarios to predict what could result from the events.

NRSBU felt that there was reasonable understanding regard the primary risks, but we had not thought sufficiently about the secondary consequences.

Our experience shows that focusing on the details a bit more will reduce the impact of these extreme events. Hopefully these temporary responses and our planned increased resilience improvements, will allow us time to get more information and certainty around the scale and speed at which climate changes are likely to occur, so that we can respond to them with more confidence.

Historically we have considered the need for relocating our facilities and have identified that the costs of shifting our facilities if we had to, is daunting, and would place a significant financial burden on the region. As such until more clarity is available, we are taking a defend in place approach, while identifying options that we could implement if we needed to.

Our questions are still; how far should we go to protect our assets? how soon do we do this? and how much do we spend to do this?

Overall, we still need to determine the balance point between significant investment, and the point that we accept that we will have failures, and therefore loss of service in extreme events.

ACKNOWLEDGEMENTS

Nelson Regional Sewerage Business Unit Board- For allowing me to talk about our experiences, and our issues, in a way that I hope will help us all manage climate risks.

Nelmac, our operations and maintenance contractor, for their responses during these events, for the work that their staff have undertaken to keep our systems running, and for the great photographic record of the events that occurred.

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