

CARTWRIGHT ROAD EMERGENCY STORMWATER WORKS

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ABSTRACT (200 WORDS MAXIMUM)

On Saturday the 18th of February 2012 a section of spiral wound galvanized steel "ARMCO" pipe catastrophically failed, blocking the stormwater network and causing significant flooding of residential and commercial premises. The resultant emergency response was the first major Stormwater emergency event encountered post transition to the new single Auckland Council.

Emergency stormwater works were initiated as a result of the catastrophic failure of a section of "ARMCO" pipe that was then dislodged and forced through the downstream pipe to the outlet. This created a sinkhole approximately 10 m in diameter and 6 m deep in a Waitakere commercial property at 3 Cartwright Road, Kelston. Investigations showed that 60 m of ARMCO pipe remained and was in such a state of disrepair that emergency works were required to remove this pipe and restore the network.

Several departments of Council were required to work together on this project: Stormwater Operations and Civil Defense handled the initial response; Stormwater Projects managed the pipe remediation; and the Council Legal Team provided on-going support for access requirements, consent issues, and emergency management advice.

This paper focuses on the Council's response to the issue, and how this response weighed against the benefit of hindsight.

KEYWORDS

Emergency, response, communication, Armco pipe, contamination, contingency, environmental plan, procurement

1 INTRODUCTION

Localised heavy rainfall in West Auckland on February the 18th 2012 was compounded by a section of "ARMCO" pipe failing and partially collapsing at 3 Cartwright Road, Kelston. This resulted in the flooding of 16 residential properties and a number of commercial premises. Emergency remediation works were required, which included:

- Emergency response and temporary works undertaken immediately after the pipe collapse to restore stormwater conveyance;
- Ground Penetrating Radar (GPR) investigations to ascertain other areas of potential failure; and
- The removal of a 60 m length of the 1680 mm diameter "ARMCO" stormwater pipe from an invert of approximately 6 m, and its replacement with a 2.0 m x 2.5 m concrete box culvert.

This paper reviews the response to the incident by Auckland Council and weighs up the decisions made under emergency conditions with the benefit of hindsight.

2 THE EVENT

On Saturday 18th February 2012, a significant amount of rainfall fell within the Whau River catchment over a short duration¹. This, coupled with the partially collapsed pipe, led to stormwater heading up around the upstream inlet located behind 4116 Great North Road. As the hydraulic pressure increased, the partially collapsed pipe was dislodged and stormwater began running through and around the damaged section creating a large sinkhole in the property at 3 Cartwright Road.

Around this time, the fence at 4116 Great North Rd collapsed due to the damming effect it was having on the overland flow path. Once released, the flow continued downstream; across Great North Road, through several commercial properties, across Cartwright Road, and re-entered the network near the stormwater outfall located at 2 Cartwright Road.

As a result of this event, there were two key issues that Auckland Council had to urgently address; the localised flooding and making safe a large sinkhole. A total of 16 residential properties and several commercial properties had been flooded. The owners of these properties were distressed and were seeking guidance from the Council as to what to do then and into the future. The second issue, was managing the large sinkhole that had opened up above the collapsed Armco pipe. Initial investigations showed that the entire length of the pipe was suffering from significant structural failures. However, Council's immediate attention was on making the site safe for the public and minimising any further loss of property.



Photograph 1: Sinkhole formed within 3 Cartwright Road

¹ 30mm of rain fell over a 45 minute period with a 1.5 km radius.
8th South Pacific Stormwater Conference & Expo 2013

3 THE RESPONSE

A call was made to the Council Call Centre on the morning of the 18th to report a large sinkhole had formed within the property of 3 Cartwright Road and that stormwater could be seen at the bottom of the sinkhole. The network maintenance contractor, Lend Lease, as well as council staff arrived on site to assess the situation (Figure 1). It was quickly realised that there was the potential for the situation to escalate quickly and actions were taken to ensure public safety and reduce the risk of further damage to private property.

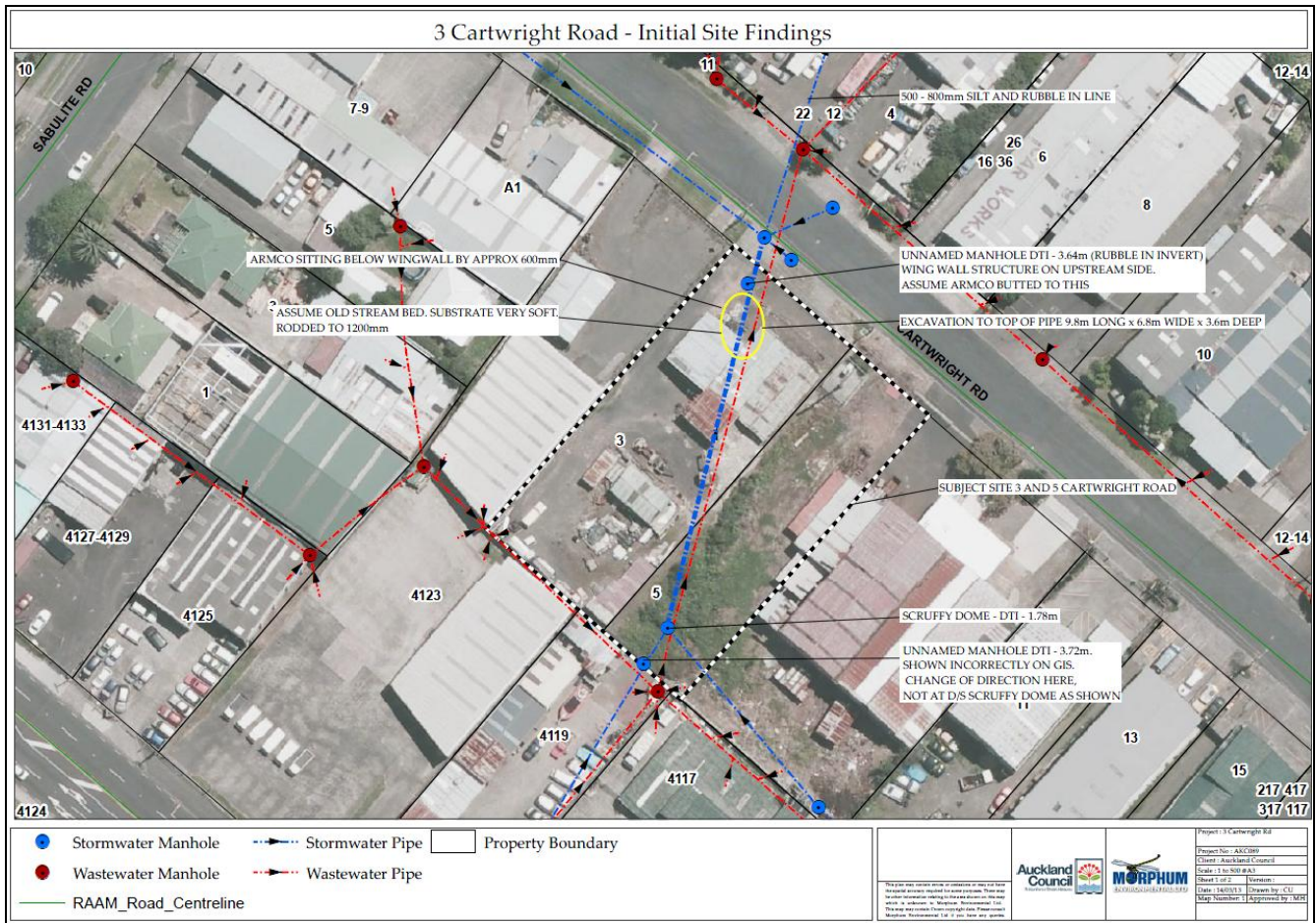


Figure 1: Plan showing initial site findings

3.1 EXTENT OF ISSUE

As the sinkhole within 3 Cartwright Road was fenced off, assessments were made to establish just how much damage had occurred and to try to build a picture of what had happened and what needed to be undertaken to limit damage.

It was established that a catastrophic pipe failure had occurred creating a blockage within the section of "ARMCO" pipe causing stormwater to head up at the inlet located upstream on the other side of Great North Road.

As the stormwater rose higher and built up against the wooden fence around the inlet, the fence collapsed and released a torrent of water downstream. This flowed through 4116 Great North Road, across the road down, through 4119 Great North Road,

overturning the wooden fence and flowing through 3 & 5 Cartwright Road, across Cartwright Road through 4 Cartwright Road, and into the stream.

At some point during this event, a section of the failed "ARMCO" pipe was forced into and through the downstream concrete pipe some 100 m to the outlet.

3.1.1 THE SITE

The catchment upstream of the site can be described as a predominately urban catchment with little in the way of stormwater detention. This lack of stormwater detention promotes a rapid time of concentration for stormwater flows through the stormwater network.

3 Cartwright Road is located in Kelston, West Auckland and the District Plan zones the area as a Working Environment. This property (Photograph 1) and the surrounding properties cater for a wide range of warehousing, manufacturing, and automotive based activities. This is a relatively small pocket of industrial properties with residential properties nearby. The Wairau Creek historically ran through the site and has subsequently been piped by the property owner in an effort to increase usable land area.

The Wairau Creek enters the publicly owned stormwater network through an inlet at 4116 Great North Road. This leads to a 1680 mm diameter concrete pipe that runs beneath Great North Road and through to the subject site. Inside the subject site was a section of "ARMCO" pipe that connected to a manufactured bend within 5 Cartwright Road (upstream) and a manhole in the north eastern corner of 3 Cartwright Road (downstream). It appears that the downstream connection was to a historic inlet structure. From this point the pipe construction reverts to a 1680 mm concrete pipe that flows to the outlet within 4 Cartwright Road. Refer to figure 1.

3.1.2 SECURING THE SITE

A cordon was set up around the ground void and access to the site was restricted to authorised personnel only. An inspection of the sinkhole revealed that stormwater was flowing out of the "ARMCO" pipe through a section of approximately 6 m of bare ground, where the failed section of pipe had been, and into the concrete pipe downstream. The waters flowing over the section of exposed ground raised the risk of further erosion and the sinkhole being enlarged.

A number of vehicles and a building were located near to the sinkhole and plans were made to remove these from the immediate area. A mobile crane was used to move the building and vehicles to the rear of the site.

Large trench shields were used to shore the sides and the base of the ground void and to provide a conduit for the stormwater to flow through.

3.1.3 GROUND PENETRATING RADAR (GPR)

As a significant sized sinkhole had formed over the section of failed pipe, there was a question over the state of the rest of the pipe alignment. The remainder of the alignment was scanned using ground penetrating radar (GPR) to determine if there were other areas of less dense fill or ground voids that had formed.

A scan was undertaken and the risk of additional ground voids forming was regarded as low.

3.1.4 OVERLAND FLOW PATH

The overland flow path was inspected and found to have numerous obstructions mostly in the form of fences. Some of these fences had been overturned during the event but others remained.

Work was undertaken to remove these obstructions; in the case of perimeter fencing care was required to maintain the security of the properties. In some instances wire fences were cut and then tied back in place with low strength wire. This ensured that the fence would give way if pressure from overland flow built up.

As the stormwater pipe was severally constricted, the upstream line was unearthed and a relief point cut into the pipe to allow any back water to exit the network at this point and follow the newly created overland flow path (Photograph 3).

3.1.5 COMMUNICATIONS

When the extent of the incident and the damage to the pipeline became known there were a number of communication protocols established; senior Council managers, Local Board Members and Local Councilors were notified in the first instance. The Council Communication Team, Legal, and Risk & Assurance Team were also notified. All of these 'council' stakeholder were kept updated throughout the day by the Stormwater Response Engineer. Furthermore, there was a need to respond to TV and newspaper media requests throughout the emergency management phase.



Photograph 3: Clearance of overland flow path and relief points cut into SW network

3.2 EMERGENCY WORKS

Once the site had been secured, initial investigations undertaken, and the scale of the problem had been identified, Council made the decision to designate the subsequent works as "Emergency Works". This enabled the Council to undertake works as a priority and accelerate certain aspects of the project.

3.2.1 AFFECTED LANDOWNERS

Immediately after the event there were a significant number of landowners who had been directly or indirectly affected by the flooding incident and a smaller number of landowners who would be affected by the initiation of the emergency works. The Council's Legal Team provided a notice to the landowners affected by the flood, explaining how any issues arising from the flood at their properties would be resolved.

For the landowners directly affected by the emergency works, a meeting was held at the local community hall where representatives from the Council's Stormwater Unit and Legal Team met with the affected landowners to discuss the emergency works, how these would affect them, and what process they could follow to obtain compensation for any loss of business directly arising from the emergency works.

The mood of the landowners ranged from mildly inconvenienced to extremely disgruntled; this related directly to the level of disturbance the works were having or were likely to have to their business. The management of the relationship between the landowners and the "Council" (Stormwater Unit, Legal Team, lead consultant, and contractor) would prove to be a critical component of this project.

3.2.2 SITE ACCESS

A stormwater easement runs through the property following the approximate alignment of the stormwater culvert, as such, Council had the right to enter the property to carry out works to modify and or maintain not only the stormwater culvert but also the overland flow path that runs along the surface of the property. Notwithstanding this, access to the site was negotiated and granted by the landowner which, given the extent of the issue on his site and the sites history, was obtained without difficulty. However, access was required to adjacent, apparently unaffected sites to undertake property inspections, vibration monitoring, and investigatory works to help inform the design of the replacement pipe. A warrant was issued by the Council's Legal Team to enable designated persons to access identified properties to undertake works.

In most cases, affected parties were consulted as part of the project planning stage, with potential adverse effects discussed and appropriate mitigation measures built into the subsequent access agreement. However, given the situation, it was not always possible to undertake these discussions in a timely manner. The warrant allowed immediate access to the adjacent sites to undertake the required investigations. Over time, as the effects of the works were understood, the required mitigation measures were implemented.

3.2.3 SITE CONSTRAINTS

The site had several constraints that required mitigation to facilitate the removal the damaged stormwater pipe and the installation of sheet piles and subsequent installation of the new concrete box culvert.

3.2.4 STORMWATER

Due to the potential stormwater volumes and rates of flow (0.2 m³/s at base flow to in excess of 12 m³/s) and the necessity to maintain flows under all conditions, by-pass pumping around the work area was not an option.

The solution was to allow a partial diversion of the stormwater. Base flow conditions were examined and understood to be in the region of 0.2 m³/s. A weir was installed in the upstream pipe, sized to allow the base flow to be detained and diverted around the site while allowing events greater than this to overtop the weir and flow through the concrete lined channel to the downstream network. The weir was designed in such a way that if rainfall reached a level that required the full capacity of the pipe, it could be removed from the pipe immediately.

The operation of the dam and diversion was later be incorporated into the Environmental Management Plan.

3.2.5 WASTEWATER

A 300 mm diameter asbestos cement wastewater line was located through the site and parallel to the "ARMCO" stormwater line. An assessment of the line was undertaken, including a CCTV inspection and a high level catchment calculation, to determine potential flows through this pipe.

The catchment calculations showed that this line could potentially convey 110 L/s of wastewater during peak flow conditions.

CCTV inspection showed that aside from a minor dip in the line, the line was in relatively good condition. Both the area to be excavated to remove the Armco pipe and the wastewater line were surveyed and this indicated that, at certain points, the two alignments were within 1 m of each other.

Given the high probability the asbestos cement wastewater line would likely crack or burst when disturbed, the risk of a wastewater overflow was unacceptably high. A number of mitigation measures were developed and options included:

1. Onsite contingency plan involving high capacity pumps and enough flexible pipe available on site to divert wastewater around the site;
2. Installation of a new portion of wastewater network to reroute the line away from the works; and
3. Relining the pipe and monitoring its condition in conjunction with the contingency plan.

Options 3 was considered the most appropriate solution given the time constraints. The contingency plan was developed further and implemented on site so that works to restore stormwater conveyance could continue (Figure 2). Once consent from Watercare Services was granted contractors were engaged to install a Cured In Place Pipe (CIPP) liner through the length of the wastewater line and sheet piling works were started.

3.2.6 RETAINING WALL

A timber palisade retaining wall along the property boundary of 1 and 3 Cartwright Road was inspected and deemed to be within the zone of influence of the sinkhole that had formed during the initial pipe failure. The risk of the wall subsiding or collapsing was assessed as being high and mitigation measures were required to reduce this risk.

Several options were identified and the installation of soil anchors chosen as the most preferred. Structural engineering design was undertaken to determine the additional support the wall required. A suitable sub-contractor was engaged and the anchors installed once access consent was granted by the property owner.

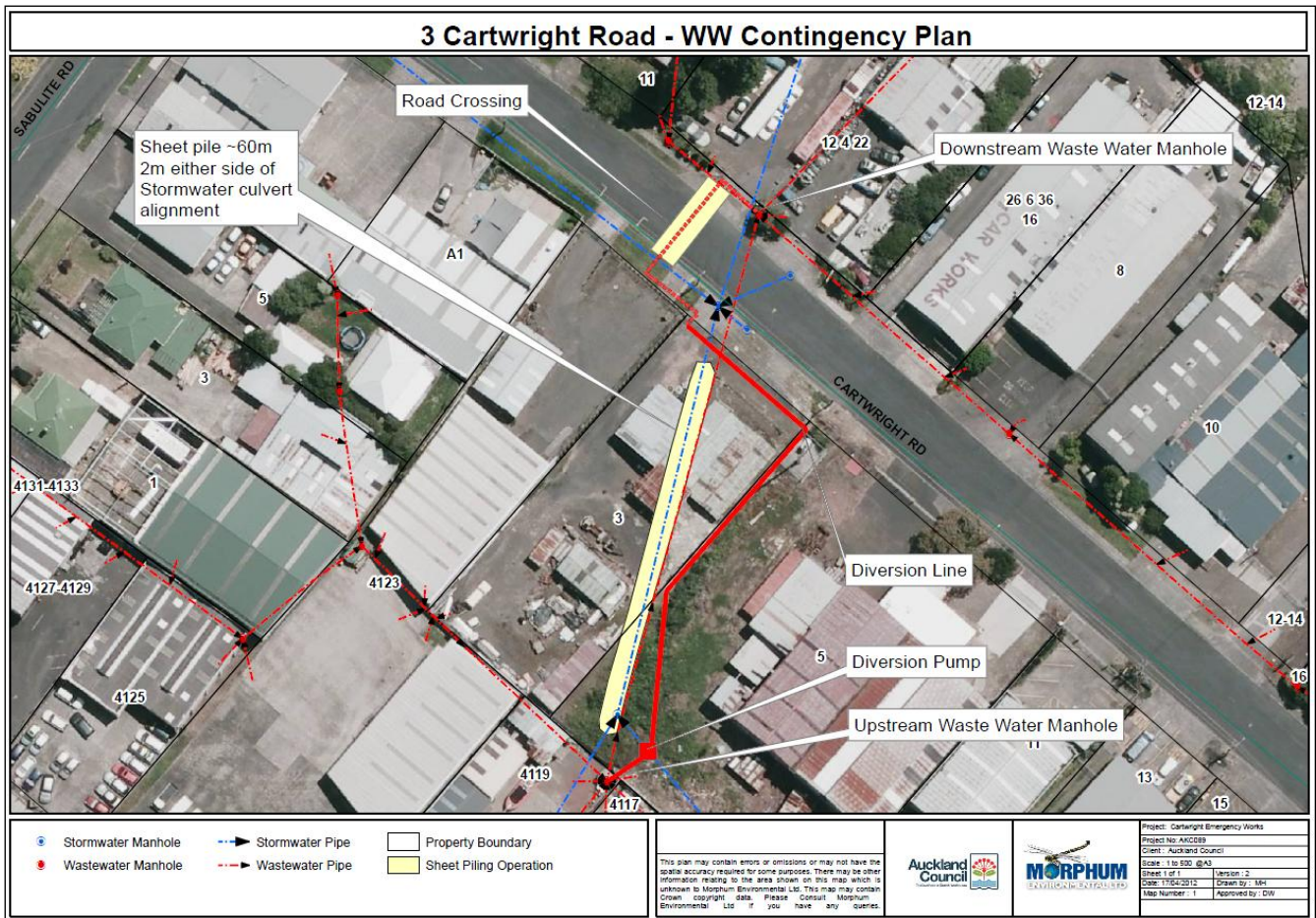


Figure 2: Wastewater diversion plan

3.2.7 GEOTECHNICAL INVESTIGATIONS

Background information and visual inspection of the exposed area quickly determined that further information was required to make informed decisions on the best and most practicable method of removing the damaged sections of pipe. Geotechnical engineers were engaged to undertake investigations along the alignment of the pipe.

The site is underlain by mudstone and graded sandstone of the East Coast Bays Formation and the pumiceous deposits of the Puketoka Formation.

The Geological Map of New Zealand suggests that a stream existed in the vicinity of the works and the previous owner of the property commented that the steel stormwater pipe was laid in the bed of this stream.

These investigations showed that the pipe was indeed in the existing stream bed and that this was saturated and very weak at the downstream end of the alignment. The upstream end of the alignment was similar however, the stiffer East Coast Bays formation was a lot closer to the surface. The entire alignment of the pipe was overlain with uncontrolled fill comprising soil, clay, bricks, concrete blocks and organic material (Photograph 2). Groundwater was near the surface and standing water in the boreholes had a sheen indicating the possible presence of petrochemicals in the fill material.



Photograph 2: Photo showing uncontrolled fill within 3 Cartwright Road

3.2.8 STRUCTURAL DESIGN

The investigations showed that the removal of the pipe would require the trench to be shored or benched. Given the proximity of the alignment to the retaining wall at the boundary of 1 & 3 Cartwright Road, benching the trench was not a viable option. Sheet piling of the trench was recommended.

Structural engineers were engaged to provide a design for the sheet pile installation. A general arrangement of the sheet pile construction was developed and provided to the contractor to allow the sourcing of materials and equipment (Photograph 4). Aspects of the design, in particular the whaler spacings, were made to allow for the excavation of the material and the damaged pipe and the installation of the new pipe. At that stage the new pipe had not been designed so allowance was made for a large box culvert (up to 3 m in width).

An unreinforced concrete base of 150 mm was specified to be poured to form the toe of the sheet piled excavation and provide a surface for stormwater to flow across prior to a new pipe being installed.



Photograph 4: Excavated trench showing sheet pile shoring

3.2.9 CONTAMINATED SITE MANAGEMENT

The site was recognised as being potentially contaminated² and an assessment of the site was initiated. Results and analysis of the samples taken were expected to take a week to ten days to process. To enable works to begin, a contaminated site management plan was developed that assumed the material was contaminated.

Disposing of contaminated material can be an expensive exercise and care is required in determining the level of contamination and the requirements of its disposal. A bunded stock pile area was created at the contractor's yard to allow excavation works on site to continue. The stockpile was covered with an impermeable membrane overnight or during rain events, as was the cut face of the excavation on site.

The results of the Contaminated Land Assessment showed that the material tested had elevated levels of the heavy metal copper. This required that any material that was removed from site had to be disposed of at a suitable disposal facility. In this case, the most appropriate facility was Greenmount land fill in East Auckland.

3.2.10 HEALTH & SAFETY, ENVIRONMENTAL MANAGEMENT PLAN, & MONITORING

As with all construction projects health and safety of the work place was of paramount importance. The initial response was handled by the network maintenance contractor, Lend Lease, and health and safety for this component of work was done under their preapproved Health and Safety Plan.

To manage the risks associated with the emergency works, several workshops were held with the project team. Through these workshops, risks and mitigation methods were identified. By including the people actually supervising and undertaking the works, real value was gained and appropriate safety measures put in place. A Safe Work Method Statement (SWMS) was developed for the project and all high risk activities identified. A specific Job Safety Analysis (JSA) was then written for each of the high risk activities. At the time, the pressure was on to have "spades in the ground" on site. By running through each aspect of the project with the project team, a working Health and Safety Plan was produced quickly and works carried out under the guidance of the plan. As a result, no accidents or injuries occurred during this project.

The dig up and removal of the pipe required a significant amount of earthworks and site works. An Environmental Management Plan (EMP) was developed with the contractor to address any works that could have adverse effects on the environment. A workshop was held between the Council, consulting engineers, and the contractor to determine the most practicable solutions to the issues identified. These issues included, but were not limited to:

² The Ministry for the Environment National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health, hereafter NES (MfE, 2011), in force since January 1st 2012, applies to the land at 3 and 5 Cartwright Road because an activity listed in the Hazardous Activities and Industries List (HAIL) is occurring. The metal working and/or car-wrecking activities presently occurring at 3 and 5 Cartwright Road are covered in the HAIL by either: D5-Engineering workshops with metal fabrication, or F4-Motor vehicle workshops. Furthermore, the NES were triggered by the required emergency earthworks activity as a soil disturbance under Regulation 5. Consequently, a detailed site investigation according to the Ministry for the Environment Contaminated Land Guidelines (MfE, 2004; Revised 2011) was required under the NES.

- Sediment discharge;
- Noise;
- Vibration propagation; and
- Diversion of stormwater.

Once the EMP had been developed, an audit program was put in place to ensure that the EMP was adhered to. Results of the audit were discussed at weekly project update meetings and options to remedy any issues were developed.

This process was different to most contract works situations where the contractor develops the EMP and the Council expects them to adhere to the plan and adjust it as necessary. In this situation there was not the time to wait for the contractor to develop the EMP (and cost it into the contract works). The most practicable solution was to develop the EMP in conjunction with all parties. This allowed the best solutions to be implemented and encouraged innovation and collaboration.

3.2.11 PROPERTY INSPECTIONS

Sheet piling was specified as the best solution for shoring the trench and geotechnical investigations had identified the presence of uncontrolled fill. The sheet piles were to be installed by way of excavator mounted vibration hammer. Damage (actual or potential) to surrounding properties from the propagation of vibration from the installation of the sheet piles was identified as a risk. As such, structural engineers were engaged to undertake property inspections at all adjacent properties.

During this process, it was identified that vibration could affect the core business of adjacent landowners. Early identification of this risk allowed mitigation measures to be put in place to limit the effects.

The property inspection reports were called upon throughout the project to provide a picture of the adjacent landowner's properties "pre works". The ability to demonstrate this pre-works condition ensured any claims of works related damage could be verified.

3.2.12 VIBRATION RISK MITIGATION

The risk of damage to property from the propagation of vibrations from construction sites is not a new problem. International standards have been developed to provide a baseline for construction vibrations to be assessed against. In this case, the standard DIN 4150 was recommended and used.

Geophones and seismometers were installed at various locations throughout the works with the locations changing as the trench was extended.

The level of vibration propagating from the site was low throughout the project and works did not exceed the safe working limit outlined in the DIN standard.

During the property inspections, one adjacent business raised concern that the vibration could interfere with delicate sensors on components that were being manufactured on the premises. Options were investigated and anti-vibration pads were utilised at this location to mitigate the risk of damage to the equipment from vibration.

Another adjacent business, whose main work involved restoration of classic cars, found that dust could be dislodged from the beams of the paint shop during sheet piling

operations. The solution here was simple, the landowner would liaise with the foreman on the site and fit his painting in around the sheet piling schedule.

3.2.13 BUILDING DEMOLITION

During the planning for removing the Armco pipe, it was realised that a building on the site had been built within the easement and over the alignment of the pipe and a portion of the building would have to be demolished to allow the pipe to be removed.

An independent valuer was called in to assess the property as a whole allowing for a portion of the building to be demolished and any compensation able to be determined at a later date.

The requirement of demolition consents was investigated and found not to be required in this instance.

3.2.14 LEGAL

With the scale of the initial flooding incident and the initiation of emergency works on the site, the Auckland Council Legal Team was instrumental in providing legal advice. The team was faced with two situations, the response to the initial flooding incident and the ongoing effect of the emergency works at 3 and 5 Cartwright Road.

Access issues were resolved by the issuing of warrants to key personnel.

3.2.15 PROCUREMENT

Under normal conditions, a project of this scale would be investigated and designed over a period of months, if not years. This process allows for the project to be fully scoped and documented, including items that are not readily obvious on the surface. Once a design has been approved, a detailed costing can be undertaken and this estimate used as a basis for securing the funding and determining the best method of procurement. The investigation, design, and physical works phases would be procured separately and undertaken under separate contracts, all of which would be approved under Council's processes before works could commence.

This project did not have the luxury of time to determine the design and best method of procurement.

A short list of contractors was drawn from contractors that had a long track record of delivering large scale drainage projects for the Council and who were known to have the equipment and manpower to be able to respond quickly to situation. March Cato was selected as the lead contractor as they had successfully dealt with emergency works in the past and had the available resources to begin immediately. In particular, they had over 200 m of 6 m x 0.6 m sheet piles in stock.

Morphum Environmental Ltd were selected to undertake the emergency works management as they have a good track record and the required operational experience to get the project done without compromising Health and Safety and Environmental requirements. Each of the parties involved at this point showed a great amount of goodwill, undertaking the tasks assigned to them as a priority, and focusing on the risks and potential solutions.

4 LEARNINGS

A post event review, combined with the added benefit of hindsight, allowed for the dissemination of key learning's. Some of these are as follows:

4.1.1 THE EASEMENT

In the response to the initial event, it was noted that the easement within the property had been compromised by historical land development. Significant land filling had occurred on the site and a building had been built within the easement. The building had been given consent at the time of construction, as had several subsequent modifications. The importance of maintaining the overland flow path and maintaining the easement had not been recognized by those authorizing these works. As a consequence, considerable effort was required to work around these impediments and, subsequently, increased cost to Council arising from reinstating the site to provide for overland flow and re-site the building outside the easement.

The need to educate the wider Council on the importance of protecting overland flow paths and maintaining formal easements has been recognized as a direct result of this event.

4.1.2 COUNCIL COMMUNICATION

Auckland Council Stormwater had an Incident Response Plan in place at the time of the event. This plan established clear responsibilities and protocols for any response as a function of the number of people affected by any incident, creating 5 levels of response from 50 people through to 20,000 or more people.

On review, it became clear that the Plan did not adequately deal with the communication needs that were actually required during the 'Cartwright Road' incident. Given the number of people affected, the property damage, and the consequential media interest, the effective scale was much greater than defined in the Plan. As a consequence, the Plan was reviewed and amended.

The need for regular and reliable updates on progress was realized in the early days of the emergency response. Initially, daily reports were instigated until the project reached a point where this could be reduced to weekly. These reports became a valuable communication tool that were utilized by Council to keep key stakeholders informed as to progress and any current issues that were being dealt with. These reports were compiled by the lead consultant.

The demand for communication on the event and subsequent progress was significantly underestimated and took valuable resource away from dealing with the issues during the stages of the incident. A dedicated communications person working to a plan is required to manage such demands during events of this nature.

4.1.3 SECURING THE SITE

At the time of the event, 3 Cartwright Road was in the process of being sold. Meetings were held with the interested parties and the decision was made to allow the new owners to occupy part of the site in order to facilitate their ongoing business.

With the benefit of hindsight, it would have been less time consuming and less costly to have insisted on a vacant site, allowing the contractors to focus on the pipe removal. Managing Health and Safety became particularly important as the contractors had to continuously allow for the site to be sectioned off to allow for a work area for the owner's business.

4.1.4 LEGAL

The Council legal team provided valuable support to the project team throughout the project however, at times, the differing priorities and objectives of the legal team and site team created strained relationships. By necessity, the site team was focused on the day to day issues arising on site, including working with the surrounding property owners to progress the works. The legal team, remote from these day to day issues, was not fully aware of what the site team were dealing with.

A site visit was arranged for the legal team so they could get an appreciation of the drivers and pressures faced onsite. This assisted in making the communication clear and concise for any subsequent meeting as everyone immediately understood what was being talked about including the complexities and logistics when faced with any potential roadblock.

While there is often the want to keep the lawyers and 'support' functions "at arms length" and away from the work site, the sooner they are part of the wider project team and fully informed about the works and any issues, the greater the benefit they will be to a project's success.

4.1.5 PROPERTY INSPECTIONS

A "Worst Case Scenario" analysis identified the need for a information or data on the state of the existing infrastructure and building associated with the site. This included commissioning property/building inspections of the neighbouring properties.

Property inspections were undertaken after the initial stabilisation works but before the pipe excavation phase which included sheet piling. The property inspections were undertaken by structural engineers to establish a benchmark condition assessment and a reference point. These became invaluable as the project progressed and any suspected damage could be compared against the data collected prior to works commencing.

These inspections as well as a "Worse Case Scenario" analysis play an important role in managing an event of this type where the decisions being made are very reactive.

4.1.6 PROCUREMENT

As soon as the incident was declared 'Emergency Works' by the Stormwater Manager, experienced consultants and contractors were approached to immediately start the required works with the intention that Council's procurement processes would "catch up". This was supported through an approval in principle from Council's senior management.

Although the required procurement processes were fast tracked for the entire project envelope there were still complications that caused delays in the payment processes – especially as the pace of the physical works and risk mitigation activities (geotechnical, structural, vibration monitoring, contaminated land management) exceeded the ability of the administration processes to keep up.

Changes in the structure of the Stormwater Unit combined with changes to how such 'projects' would be structured in future will ensure that the administration issues that occurred in this case would either not occur or will be able to be dealt with promptly.

4.1.7 PROJECT STRUCTURE

Setting in place the project structure at the earliest time possible is critical. In this example, a lead consultant was engaged to "manage the site" which included the

functions of Engineer to Contract and Engineers Representative. This worked well in terms of efficiency on site management and completing the emergency works. However, the structure did limit Council's involvement in some of key decision making processes. In future, Council will ensure these key roles would be undertaken by appropriate Council staff.

5 CONCLUSIONS

The initial response of Auckland Council's Stormwater team to the event on the 18th of February 2012 was swift and decisive. Council's emergency contractors, Lend Lease, secured the area and made it safe shortly after the initial report of the event.

Worst case scenarios were developed and action plans formulated around these. Communication plans were quickly put into place and stakeholders were able to be kept informed on a regular basis. Once the incident was deemed to be an Emergency and the extent of the required works known, the engagement of specialist consultants and contractors enabled mitigation measures to be put in place. While the "ARMCO" pipe remained in the ground, there was the risk of ongoing flooding. Dealing with this risk became the priority. What would normally take months, if not a full year, of planning was put into place within weeks.

As is often the case with projects that are highly reactive and carried out under emergency conditions under the public gaze, communication is key to a project's success. Not only did the affected parties, politicians, Council's management, subcontractors, subconsultants, emergency services, lawyers and Civil Defence all wanted to be kept informed, the timing of the communication was critical. Having a clear and practiced Incident Response Plan that can be articulated and actioned immediately ensures that any issues arising from any incident can be effectively managed.

It is also important to have reliable and experienced contractors and consultants who have undertaken works of a similar nature under emergency conditions. Equipment such as large diggers, sheet piles, pipes, and pumps are required along with specialist pipe laying experience, geotechnical, structural and environmental management are required to be available at short notice. The need for diplomacy and strong negotiation skills should not be forgotten.

Continual Health and Safety workshop planning and methodology building meant quality was never compromised throughout the duration of the project. This collaboration encouraged innovation and allowed for decisions to be made quickly.

The project could not have been a success if not for the efforts of many people in many departments within Council. Nor could it have been achieved without the goodwill and hard work of the consultants, engineers, and contractors.

This was a successful project and, as such, the methodologies and tools that were put in place could be replicated and used for any future emergency works. However, there were things that could have been done differently to achieve the same or a better outcome and the learning that Council's Stormwater Unit have gained from this event has been incorporated into its processes and procedures.

The work presented in this paper was funded by the Auckland Council. Views expressed in this paper are those of the authors and do not necessarily represent policy or position of the Auckland Council.

REFERENCES

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