

Presented at the FIG Working Week 2016,
May 2-6, 2016 in Christchurch, New Zealand



FIG Working Week 2016

CHRISTCHURCH, NEW ZEALAND 2-6 MAY 2016

Recovery

from disaster

Organised by



Platinum Partners



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Recovery

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EQ Response

- Mark Christison
- David Heiler
- Amber Murphy
- Greg Offer



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Recovery

from disaster

Brutality of 22-2-2012 Earthquake

From this



45
seconds
later



To this



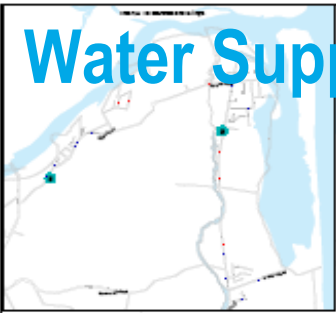


FIG Working Week 2016

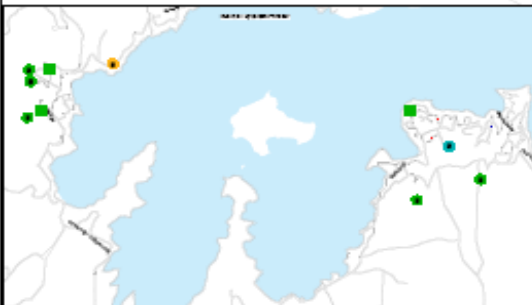
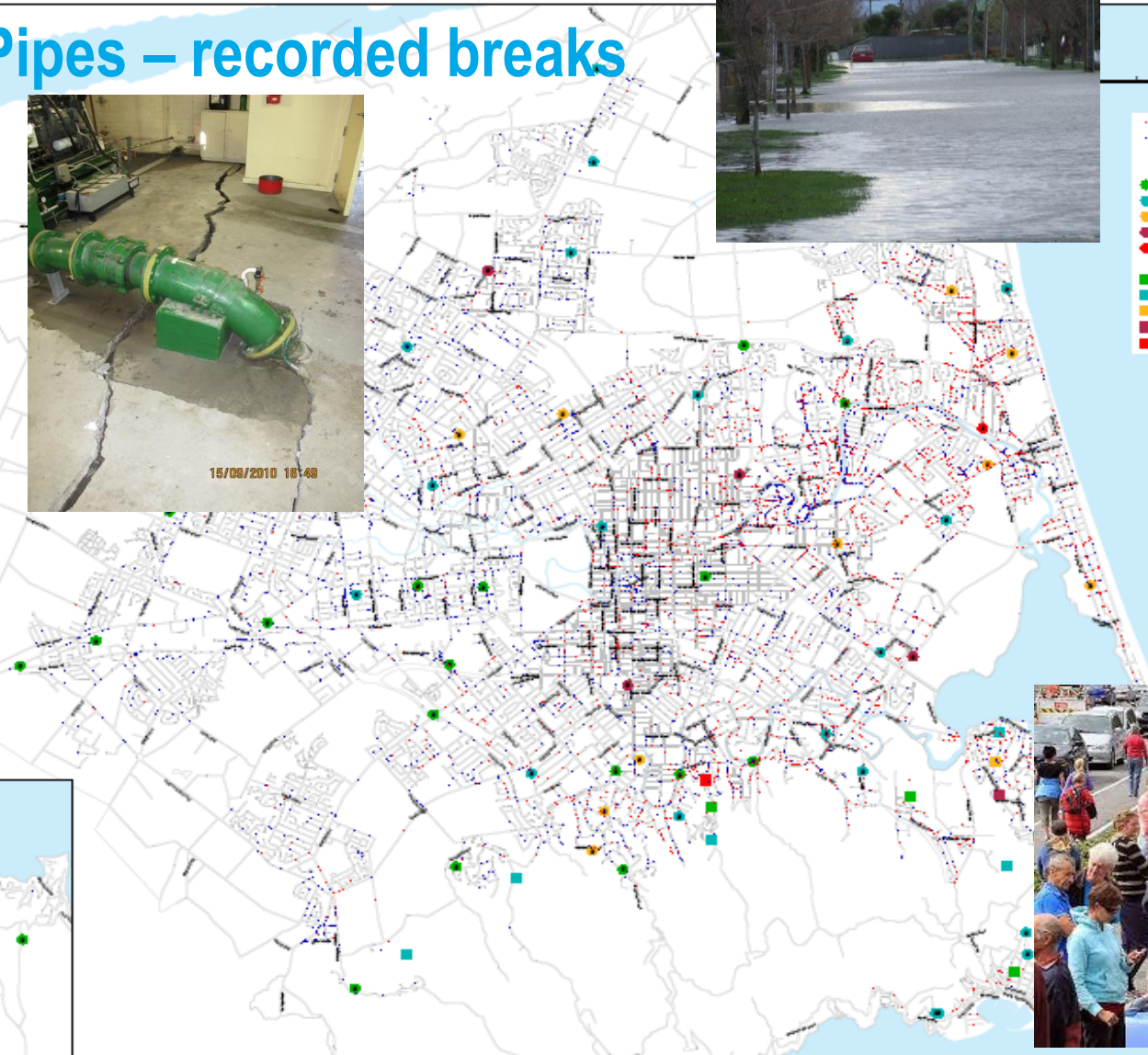
CHRISTCHURCH, NEW ZEALAND 2-6 MAY 2016

Recovery

Water Supply Pipes – recorded breaks



- Mainline water main
- Mainline water main
- Mainline water main
- Mainline water main
- Mainline water main
- Mainline water main
- Mainline water main
- Mainline water main
- Mainline water main
- Mainline water main
- Mainline water main



WATER SUPPLY - MAINS BREAKS
NOT FOR PUBLIC USE

Drawn by: _____
 Checked by: _____
 Date: 10/08/10

Project: Christchurch Water
 Location: Christchurch City
 Date: 10/08/10



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Recovery

Loss of Service - Wastewater Network





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Wastewater Treatment Plant & Network Damage



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Est. Total Volume of Overflows (m³/day)

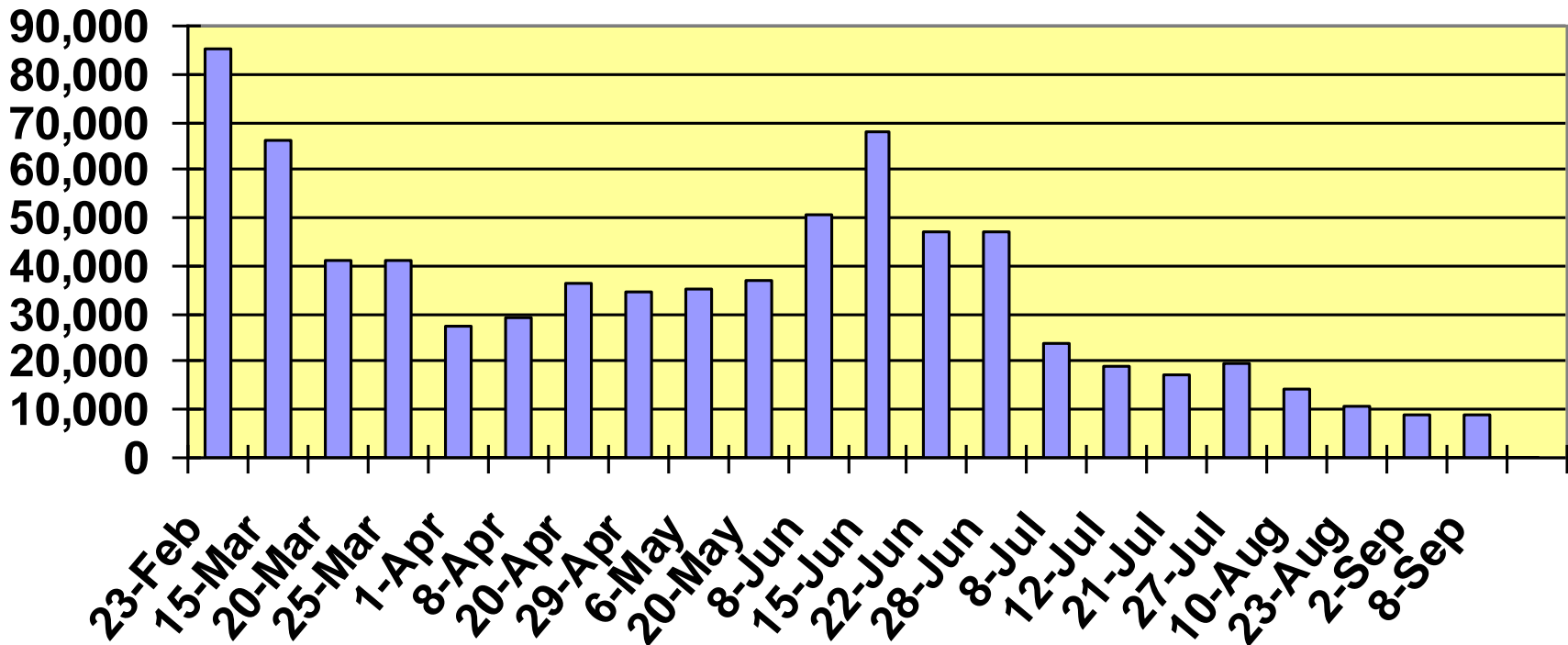




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Emergency Chlorination – 50% of the City

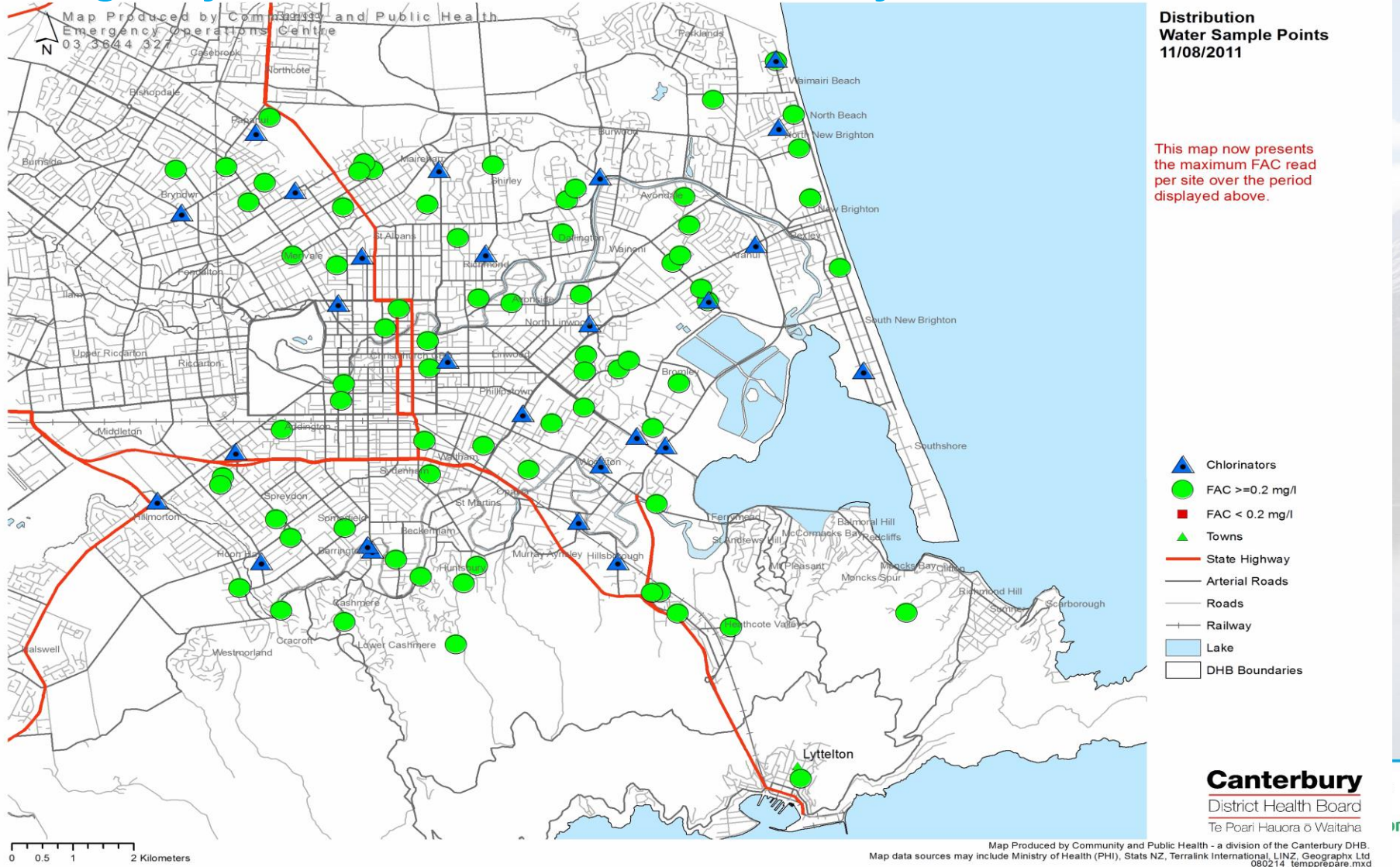




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Immediate Land Drainage Issues





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Managing Liquefaction Silt





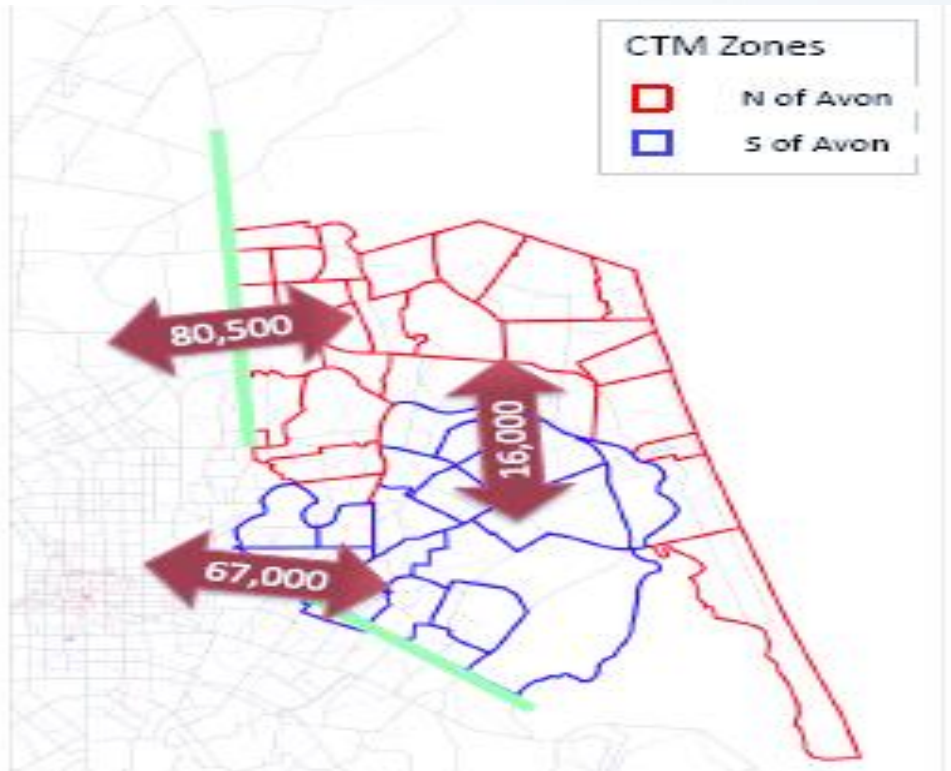
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Transportation Issues



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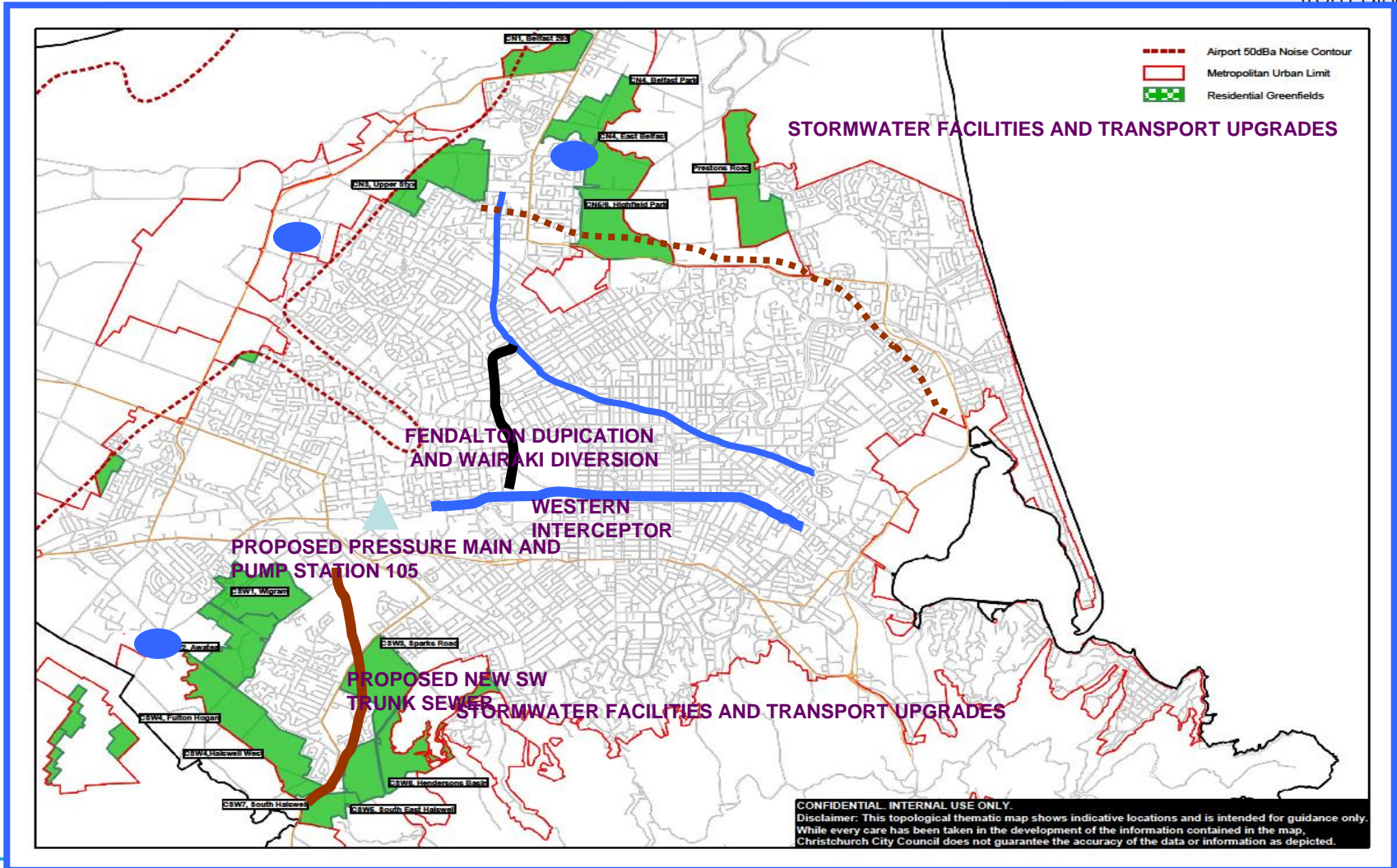


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Growth and Repair needed at same time!

from disaster



The Alliance Infrastructure Rebuild Model

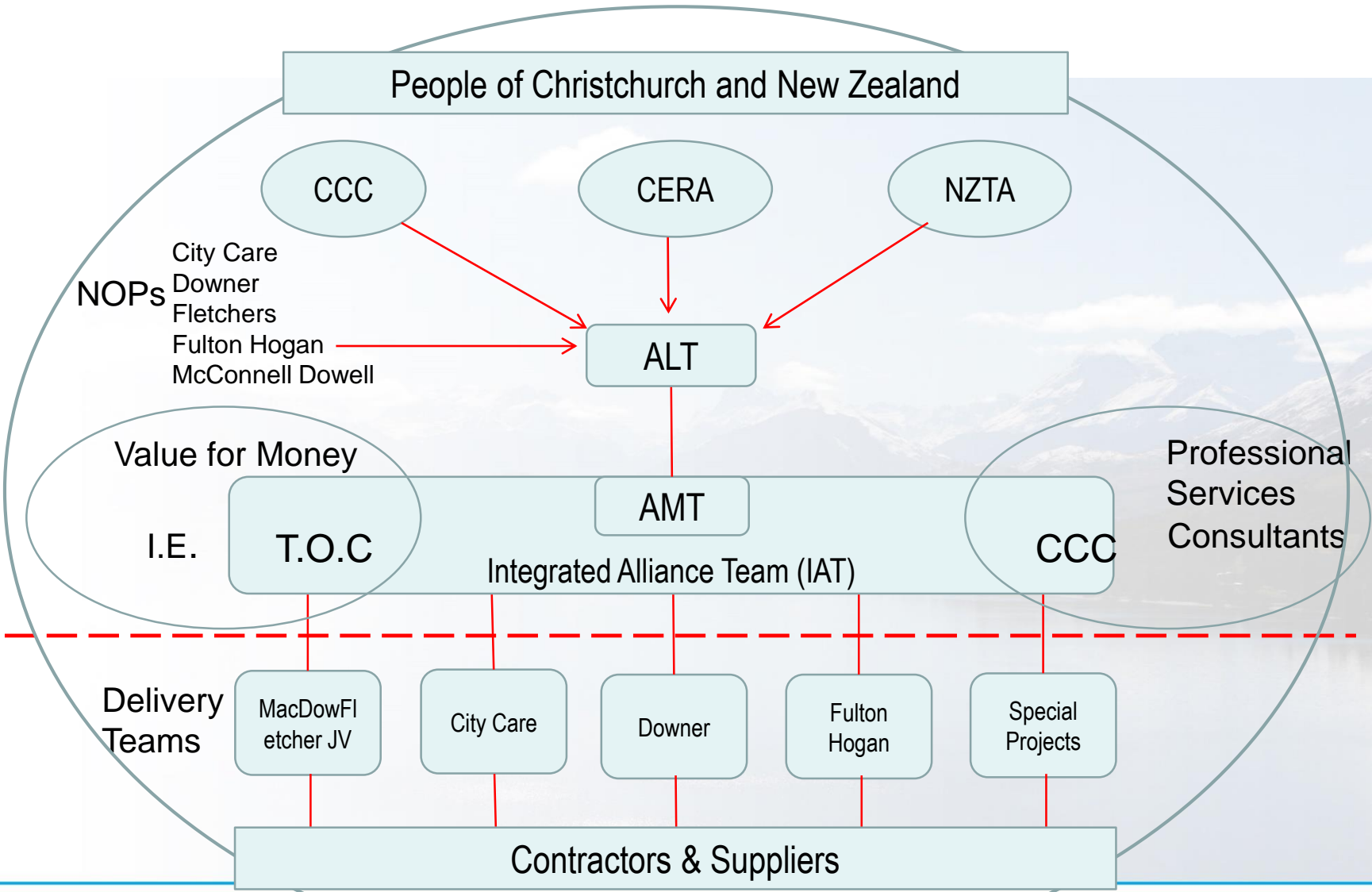




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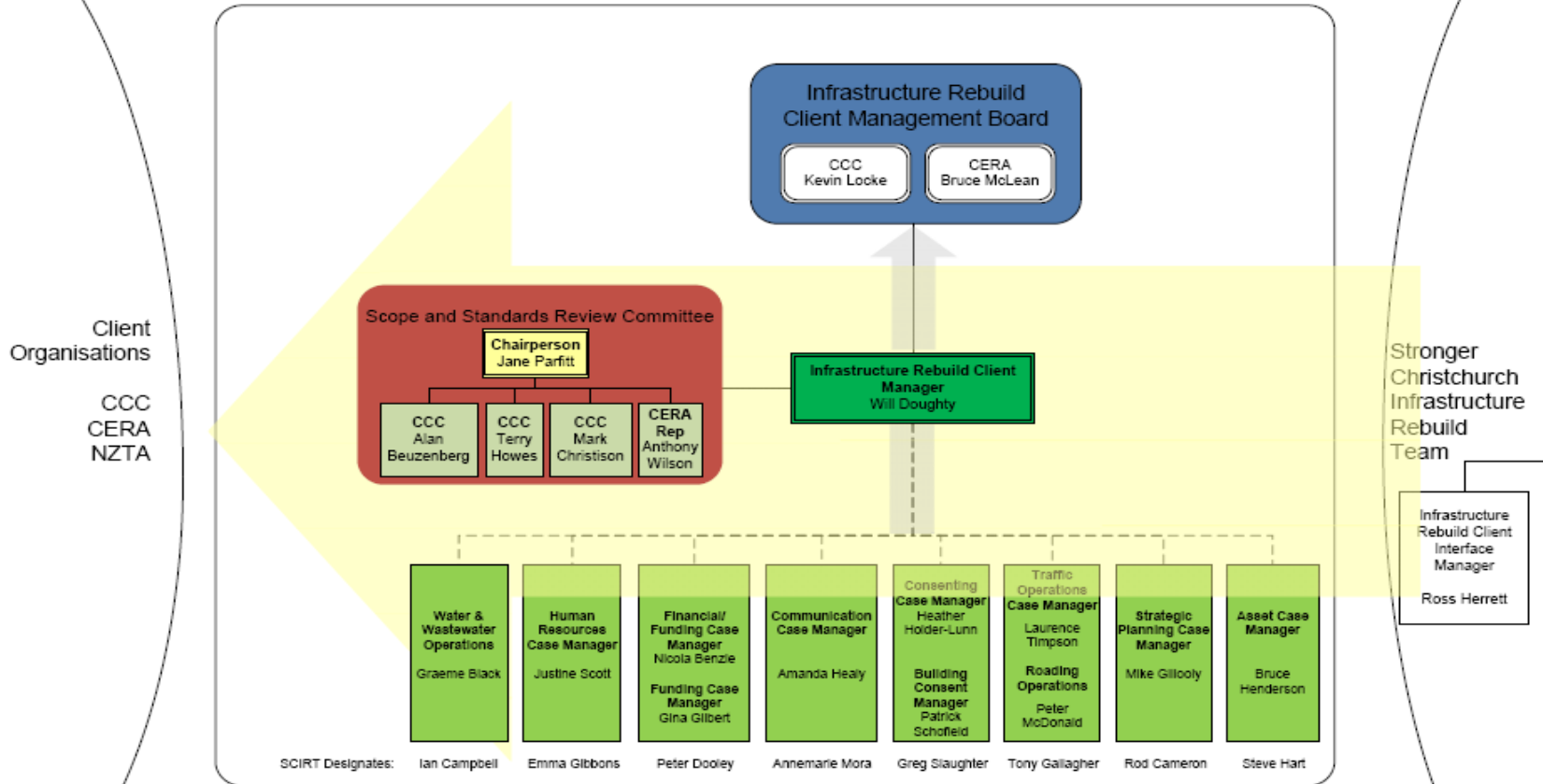
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Recovery

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The Client Interface Model for the Rebuild

Infrastructure Rebuild Client Team



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Recovery Project Prioritisation Process

The prioritisation process is shown below:



Operational Prioritisation has been calculated by using a Multi-Criteria Analysis tool (MCA) considering damage levels, asset Criticality, operational service levels and on-going cost of maintenance. These scores have been calculated at an asset level.



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Capturing Earthquake Operating Costs

Figure 4 CCC Water & Waste Jobs Logged for Water Reticulation Maintenance

CCC Water Job Progress - Running sum of (Daily Logged - Completed)

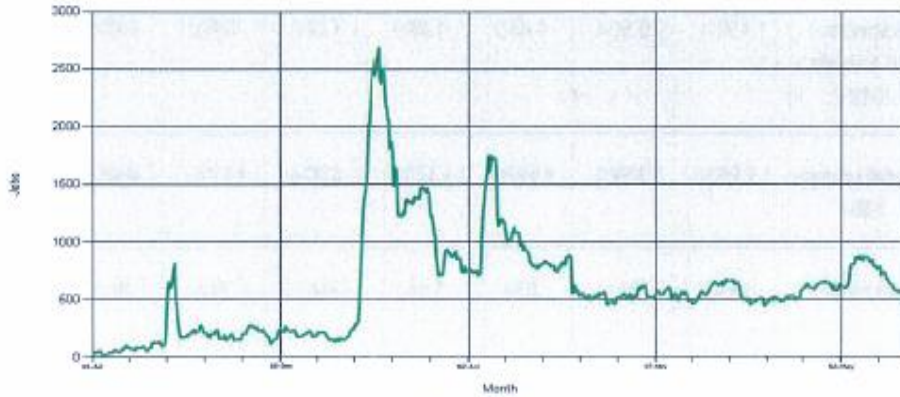


Figure 3 - CCC Water and Waste repair Jobs Logged for Stormwater Contract

CCC Water Job Progress - Running sum of (Daily Logged - Completed)

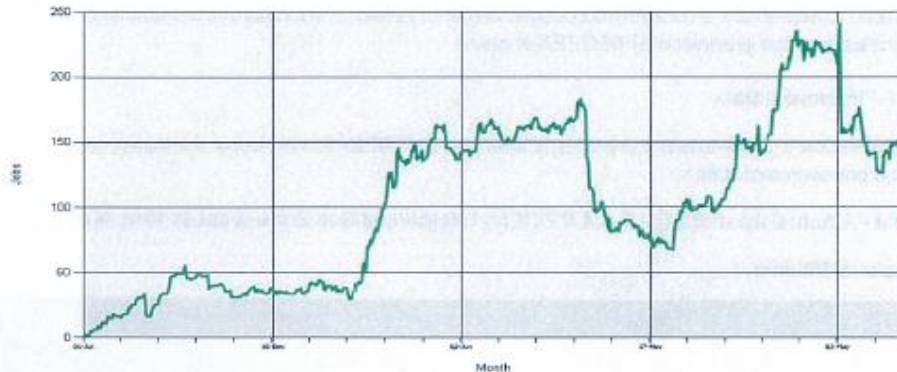


Figure 2 - CCC Water and Waste repair Jobs Logged for Wastewater Reticulation

CCC Water Job Progress - Running sum of (Daily Logged - Completed)

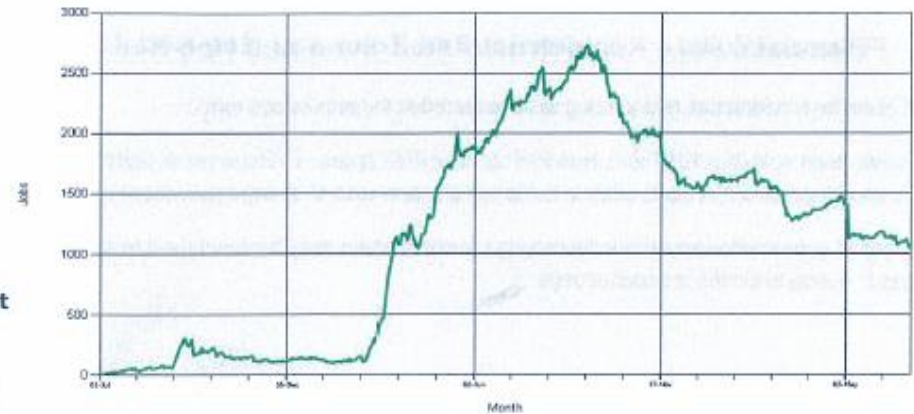




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Operating Cost Modelling

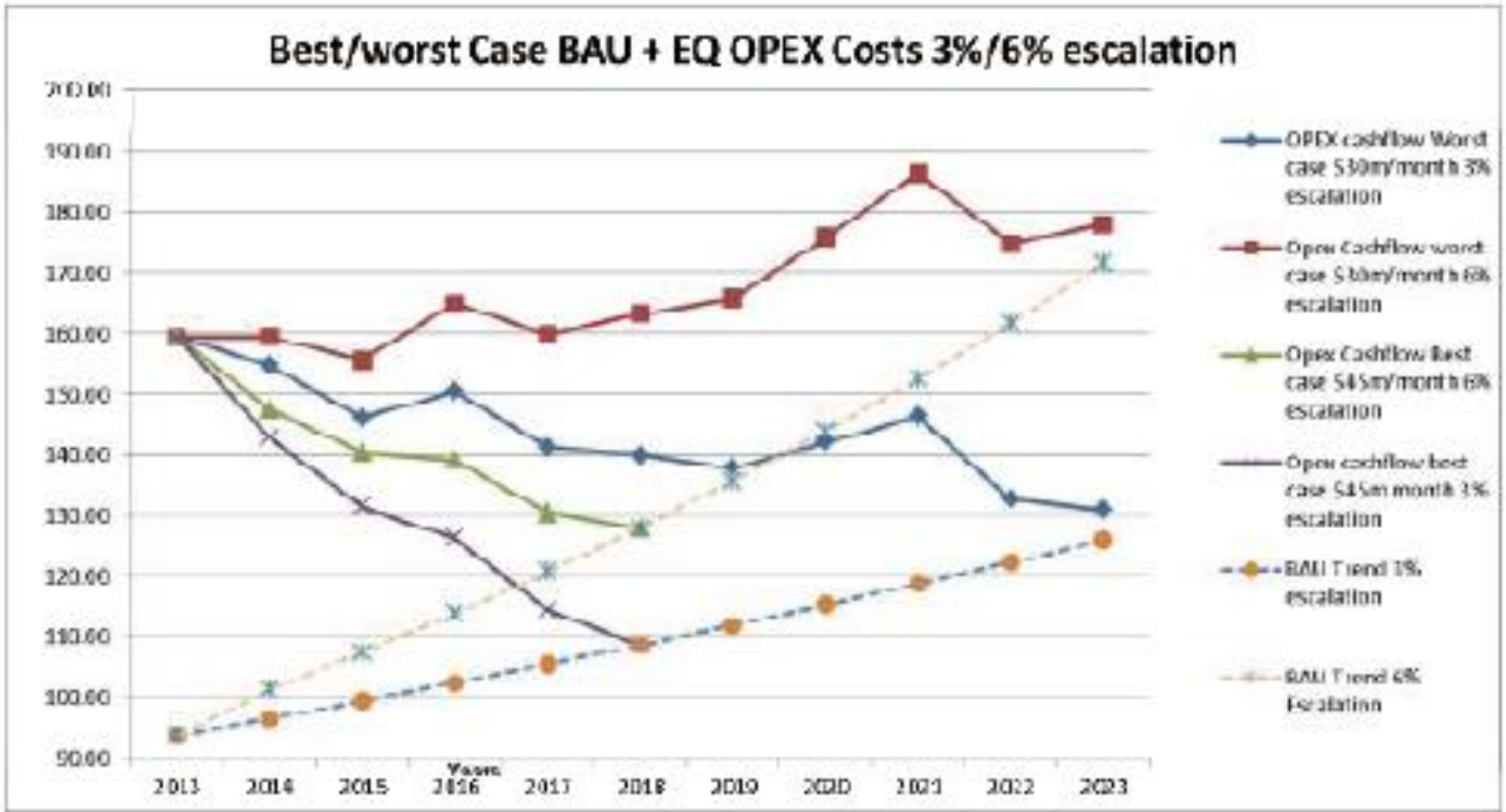




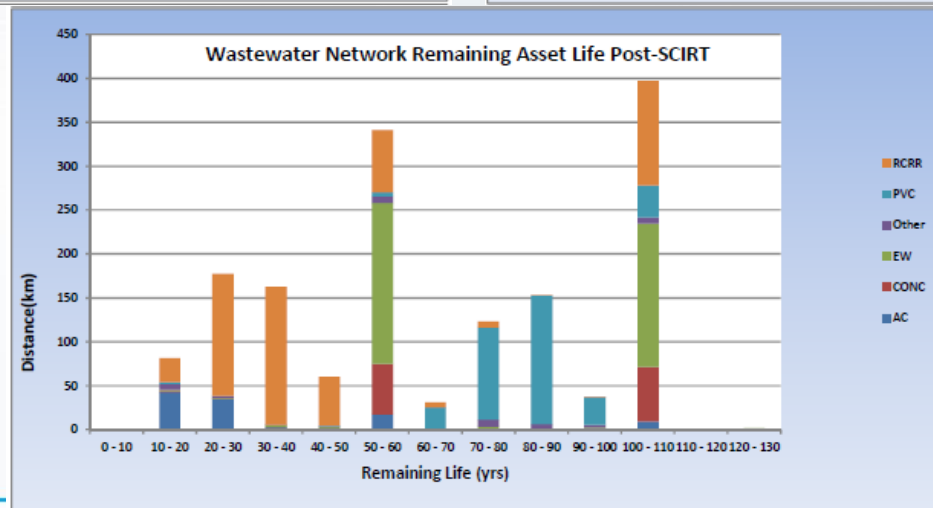
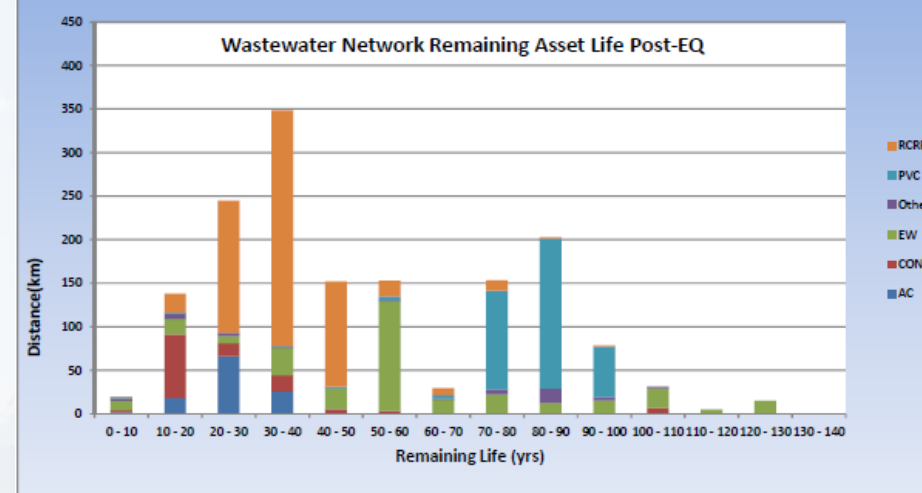
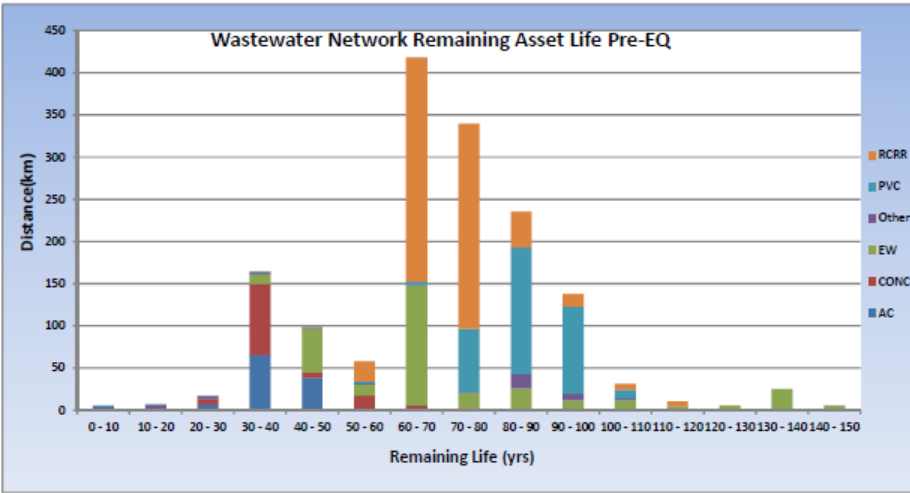
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Contingent Liabilities – Inter-Generational Issue





Key Response and Recovery Establishment Lessons

- Forge strong relationships in BAU times.
- Resilience Planning is good business (not gold plating).
- Risk management is not risk avoidance.
- Communication of risk to the lay person is critical in emergencies – why can't I water my garden?
- Infrastructure needs compete with social needs – MCA tools are needed to inform decision making.
- Need to focus on outputs not inputs - don't micro-manage.



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Acknowledgements

- Staff of Christchurch City Council
- SCIRT Staff
- Beca Colleagues



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Recovery

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Damage Investigation and Analysis

David Heiler

SCIRT Data Assessment Lead in the Asset Assessment Team

Technical Director – Water Infrastructure, Beca Ltd



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The Damage Assessment Challenge

There are *known knowns*; there are things we know we know.

We also know there are *known unknowns*; that is to say we know there are some things we do not know.

But there are also *unknown unknowns* – there are things we do not know we don't know.

Donald Rumsfeld – US Secretary of Defence





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Some Damage Visible





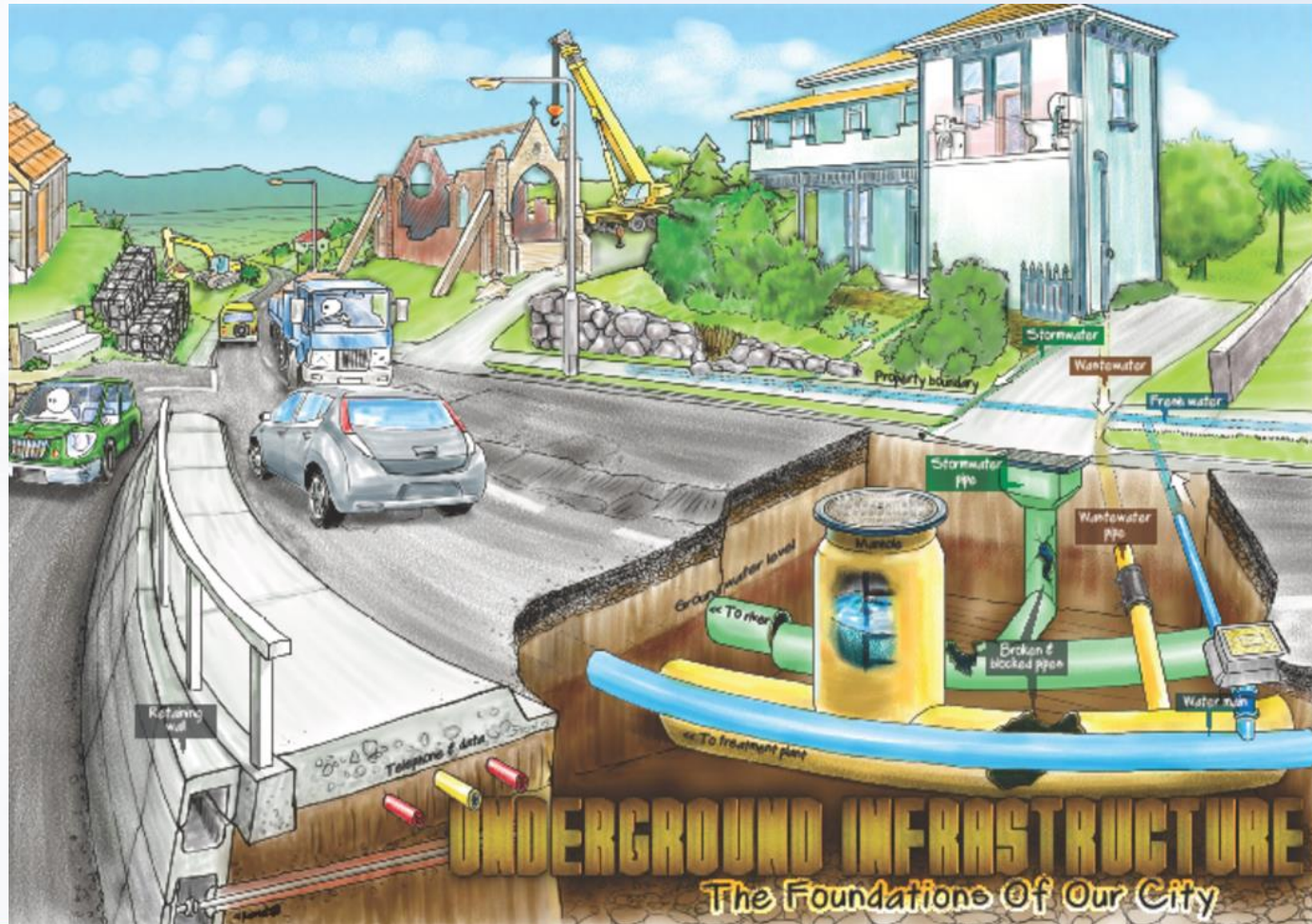
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Other damage harder to assess



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Gravity Pipe Assessment

- 50% of rebuild budget
- Identify immediate service issues
- Assess functional and structural damage
- Assess changes in levels of service from pre-EQ
- 1600km of gravity WW network
- 1000km of gravity SW network





Traditional Inspection Methods

Level Survey – Functional Assessment

- GPS and detailed level survey of MH lids and pipe inverts
- Allowed assessment of post-EQ grade against pre-EQ grade and design grades (for solids movement)
- Also required for network hydraulic modelling





Traditional Inspection Methods

CCTV – Structural Assessment

- 20 combined camera, jetting, and suction crew operating
- 150 FTE = half of NZ CCTV resource
- Productivity ~ 50km/month
- Cost ~ \$50/metre





The Problem

- Structural assessment progress not sufficient to match rebuild programme
 - \$40M/month of deliverable outputs required 100km/month of CCTV
 - Insufficient CCTV resources available and investigation costs high.
- CCTV did not provide all damage information (especially grades and dips)



Alternative Methods – Pole Camera

- Structural Assessment
- Used to make fast structural condition assessments of short pipe lengths (generally SW)
- Used instead of CCTV where defects clearly evident or absent

Haloptic™ targeting
Will change how you see
Pipe infrastructure.

Think zooming can't provide a quality infrastructure assessment at the lowest possible cost? QuickView™ with Haloptic™ targeting technology is here to prove you wrong. With powerful pinpoint illumination and a built-in manhole camera, this new QuickView captures pipeline infrastructure in a single pass. It's all you need to inspect pipe and manhole condition, scope maintenance work, and avoid confined space entry. More than 2000 operators already trust QuickView for fast, comprehensive inspection—if you're not one of them, let the new QuickView show you what you've been missing.

Manhole viewing.
Optional rear wide-angle camera views rear targets.

Wireless viewer/recorder.
Pole-mounted unit stores up to 32 GB.

Complete kit.
Transport camera and viewer/recorder in a single rugged case.

Distance viewing

Common problems found

Sideview & for illumination

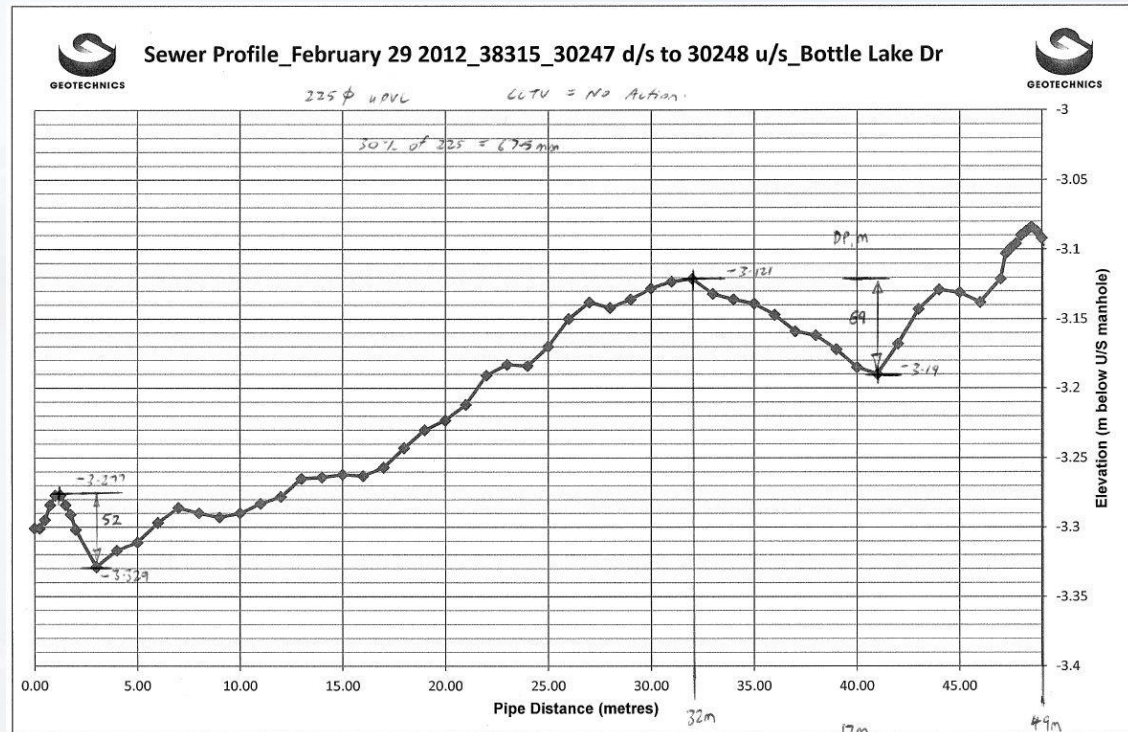
Wide view in manholes

HALOPTIC™
Patent-pending Haloptic technology uses an engineered lens/reflector combo to project a halo of light precisely aligned with the camera view. This concentrated beam floods pipe walls with light, and illuminates distant targets for maximum clarity and detail.



Alternative Methods – Pipe Profile

- Functional Assessment
- Provided long section profile of the pipe invert between manholes
- Uses geotech profilometer technology
- Quantitative assessment of dips - not possible with CCTV





Alternative Methods – Predictive Tool

- Pipe Damage Assessment Tool (PDAT)
- Predicts whether pipe requires Renewal, Repair or No Action
- Desktop tool to predict the structural condition of pipes that have not been surveyed using key criteria:
 - Liquefaction index
 - Pipe material type, diameter, depth
 - Geographic location
- Predictive model calibrated against CCTV information (focused on structural condition)
- Used in the rebuild to:
 - Inform concept design and save investigation costs
 - Predict condition of pipes that can't be practically CCTV
 - Assess damage in low damage areas to reduce the amount of CCTV



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LOS indicators to focus rebuild effort

Public Lateral maintenance – post EQ

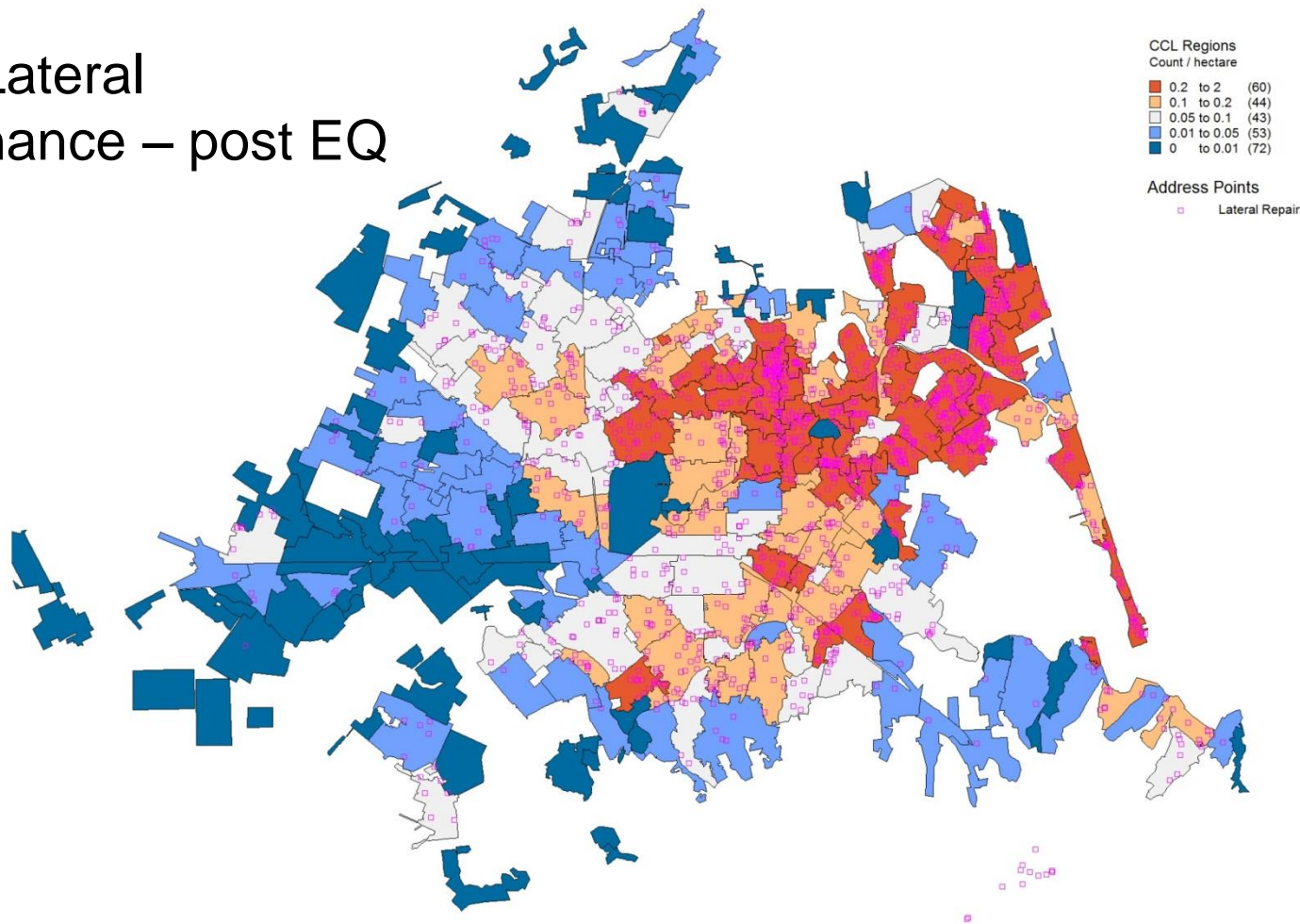




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Recovery

from disaster

On-going Maintenance costs

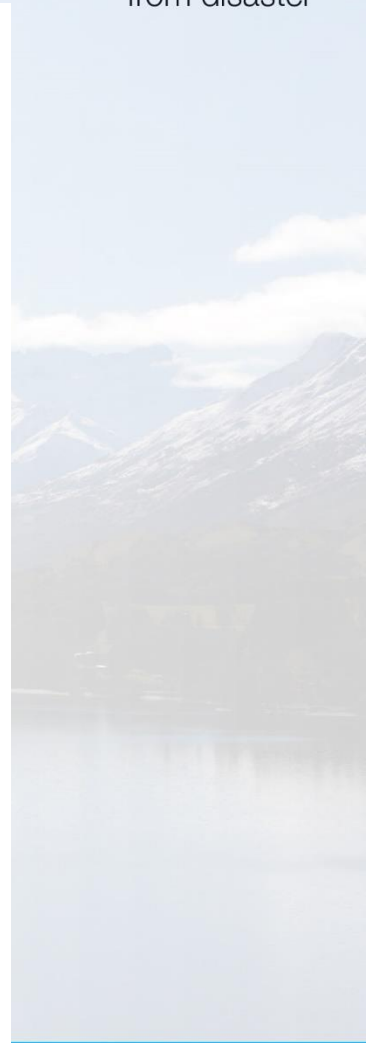
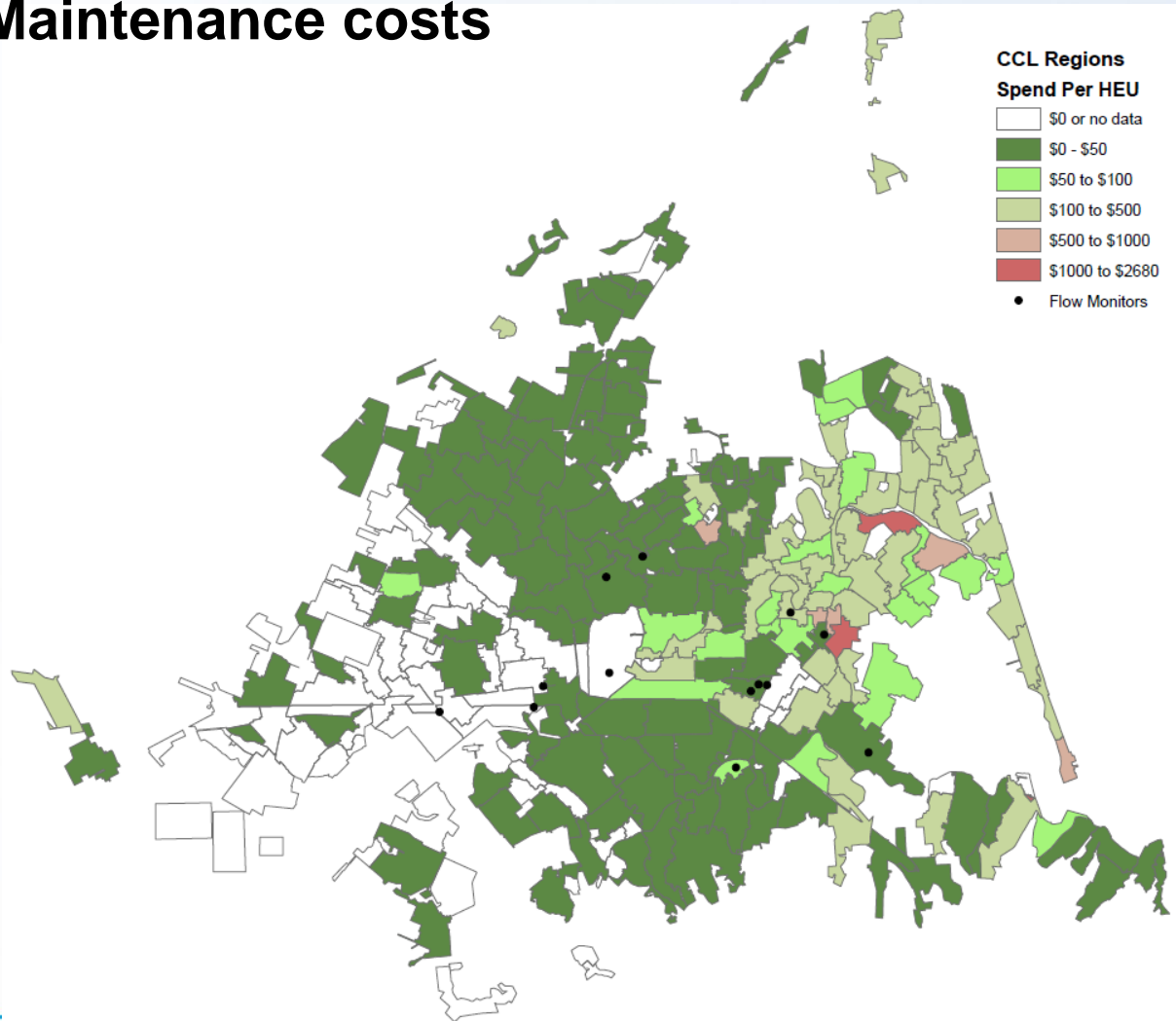




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Recovery

from disaster

Comparison of Infiltration (pre and post EQ)

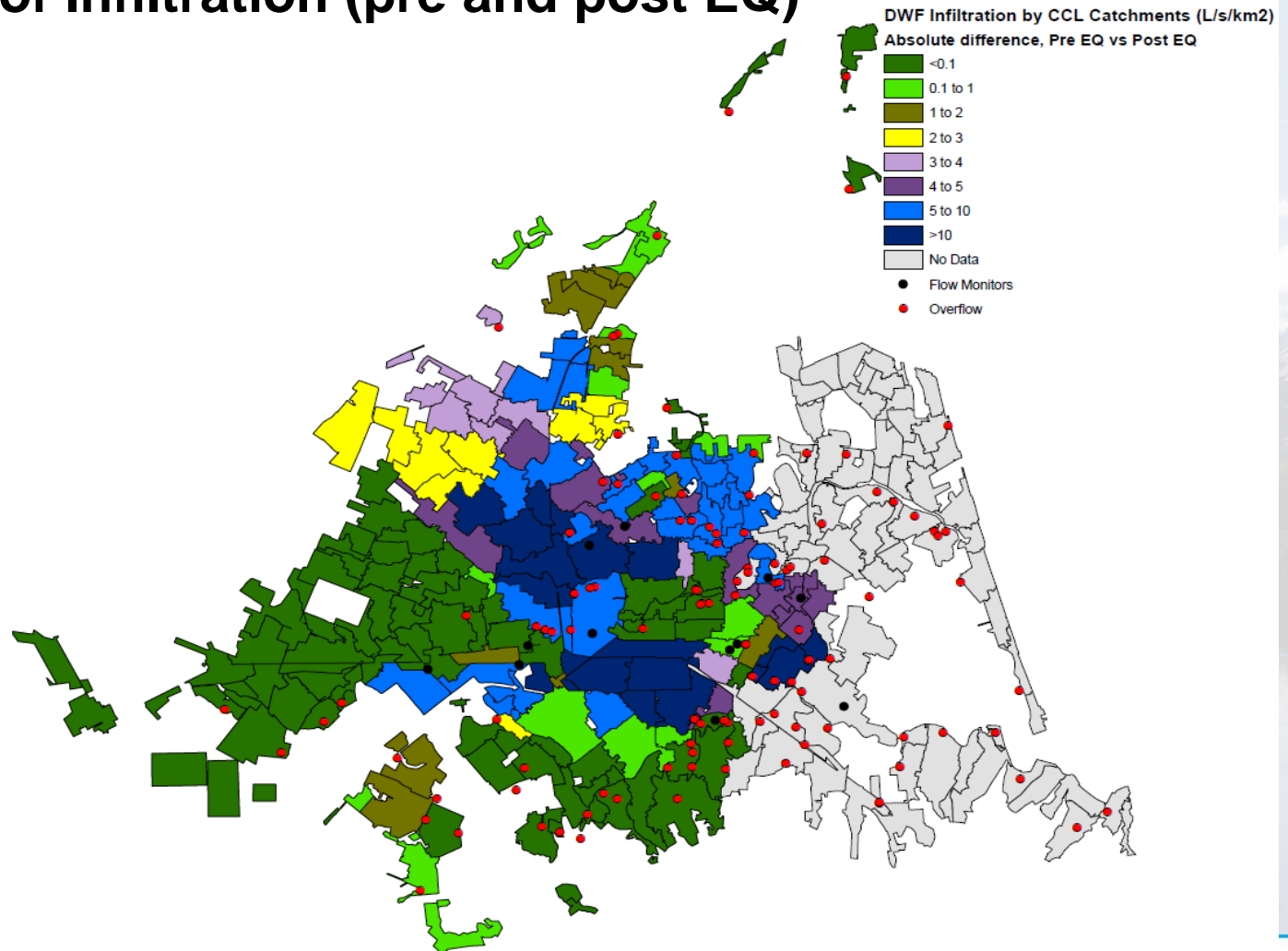


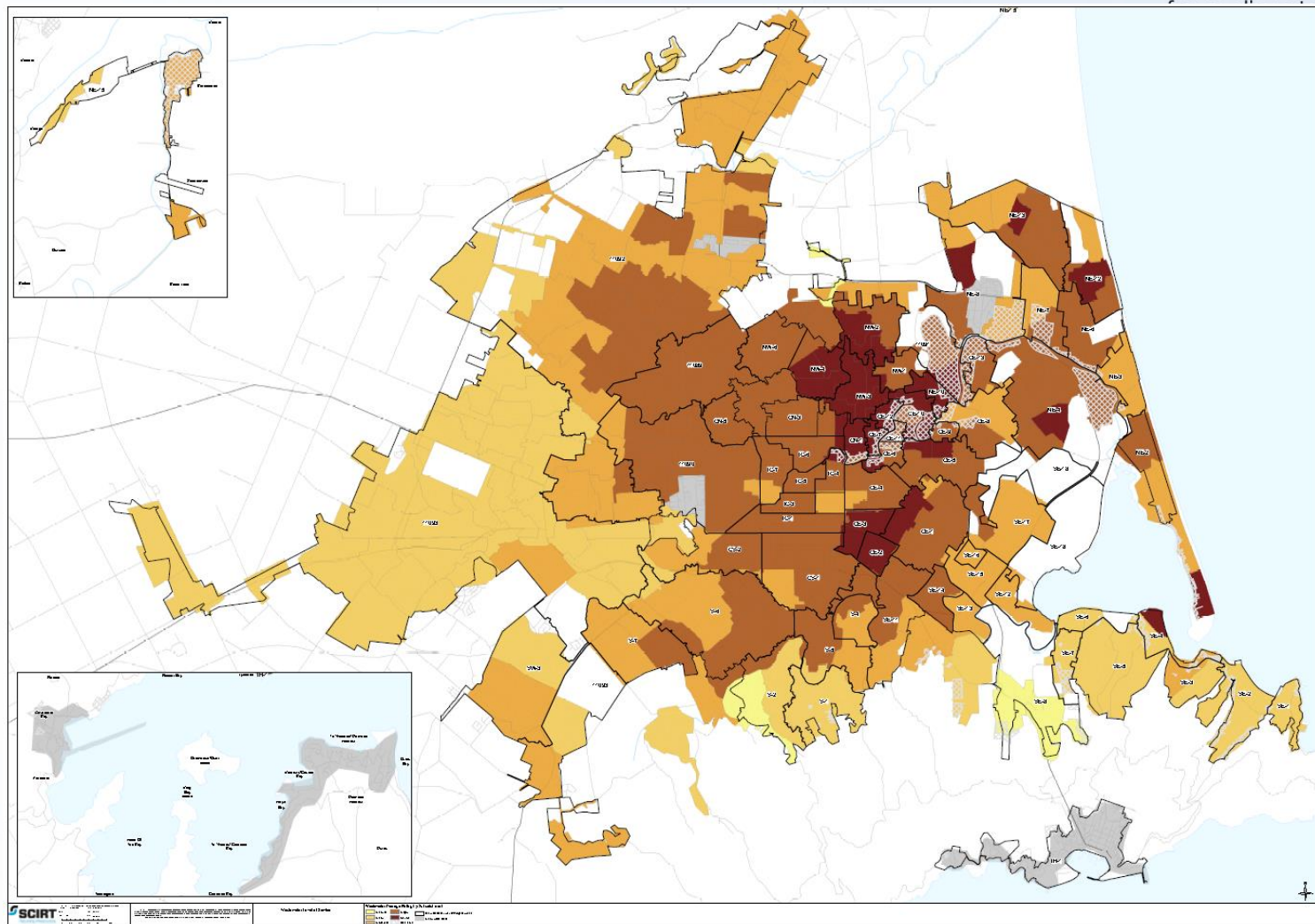


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Recovery

LOS Score



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Recovery

from disaster

Lessons from Damage Investigation and Analysis

- GIS for managing asset data and condition surveys
- Understand Levels of Service and monitoring
- Data management systems
- Skilled workforce – condition assessment and rebuild
- Maintain flexibility in approach and stay abreast of technology
- Risk based predictive tools for focusing investigation effort



Design of network repairs

Amber Murphy

Designer in the SCIRT Red Team, chair of SCIRT's Stormwater and Land Drainage technical group and member of the Water Supply technical group

Civil and Hydraulic designer and project manager for various Christchurch City Council Land Drainage Recovery Programme (LDRP) projects

Environmental Engineer – Christchurch Water, Beca Ltd



Pipe breaks



Lateral spread



Differential settlement



Rotation



Avonhead

Burwood

New Brighton

RL 10.8m
5-YEAR HIGH TIDE

Avon River

RL 10m

Christchurch Central

RL 15m

RL 9.3m
MEAN SEA LEVEL

Heathcote River

Avon-Heathcote Estuary

Redcliffs

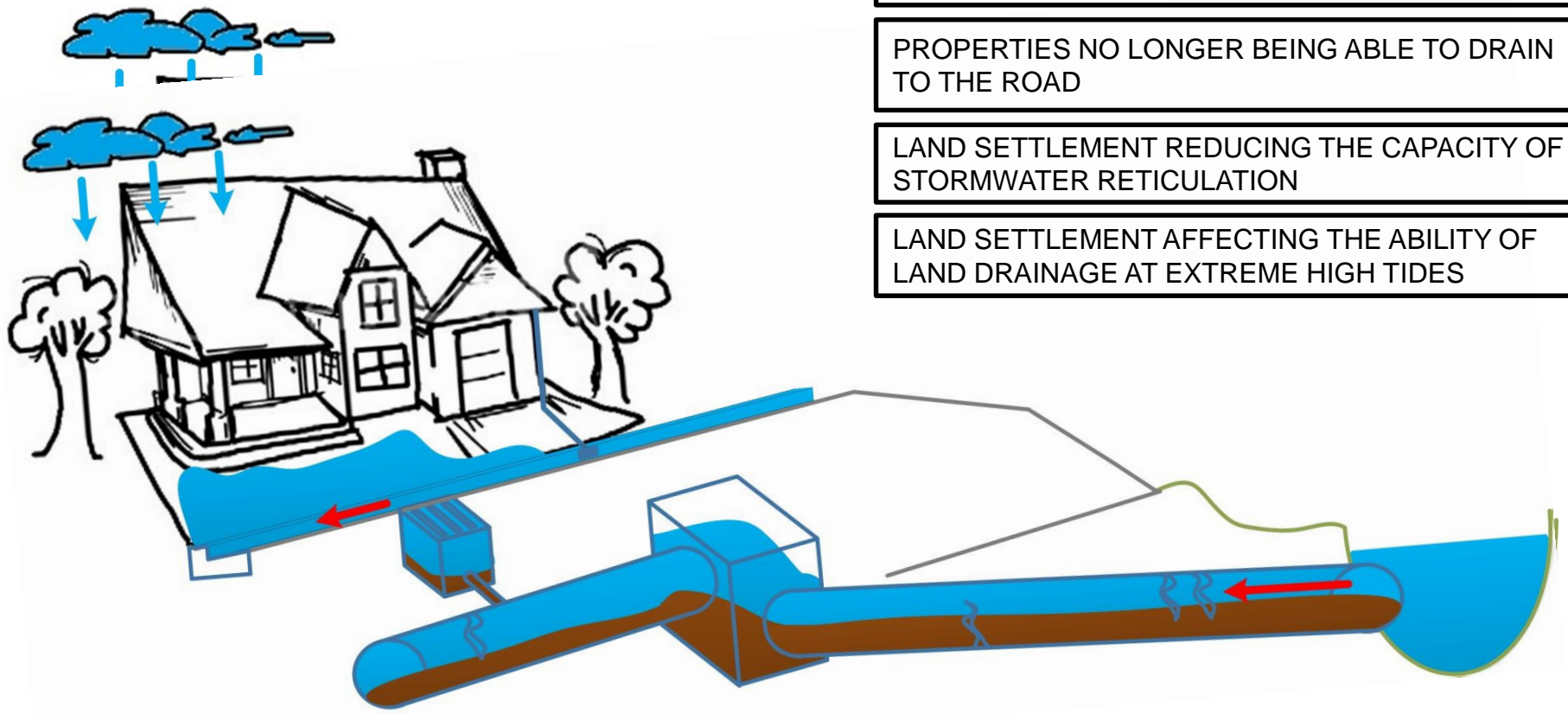
Halswell

Cashmere

RL 500m



SCIRT Project Extent



DAMAGED PIPES, BLOCKED PIPES AND OUTLETS,
MISSING OR BROKEN FLAP VALVES

SILT INGRESS INTO PIPES AND SUMPS, CAUSING
BLOCKAGES AND A REDUCTION IN PIPE CAPACITY

ROAD DRAINAGE BEING IMPEDED, CHANGES TO
SECONDARY FLOW PATHS, AND SUMPS NO
LONGER BEING POSITIONED AT LOW POINTS

PROPERTIES NO LONGER BEING ABLE TO DRAIN
TO THE ROAD

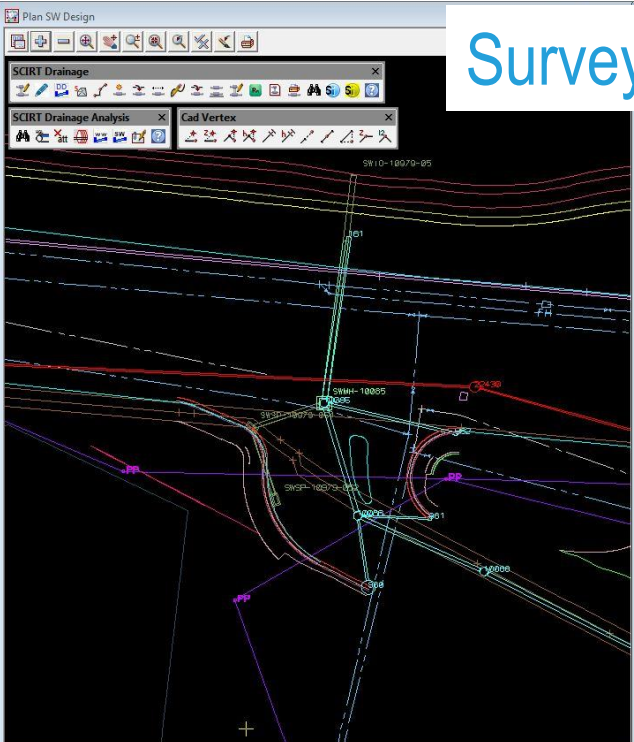
LAND SETTLEMENT REDUCING THE CAPACITY OF
STORMWATER RETICULATION

LAND SETTLEMENT AFFECTING THE ABILITY OF
LAND DRAINAGE AT EXTREME HIGH TIDES

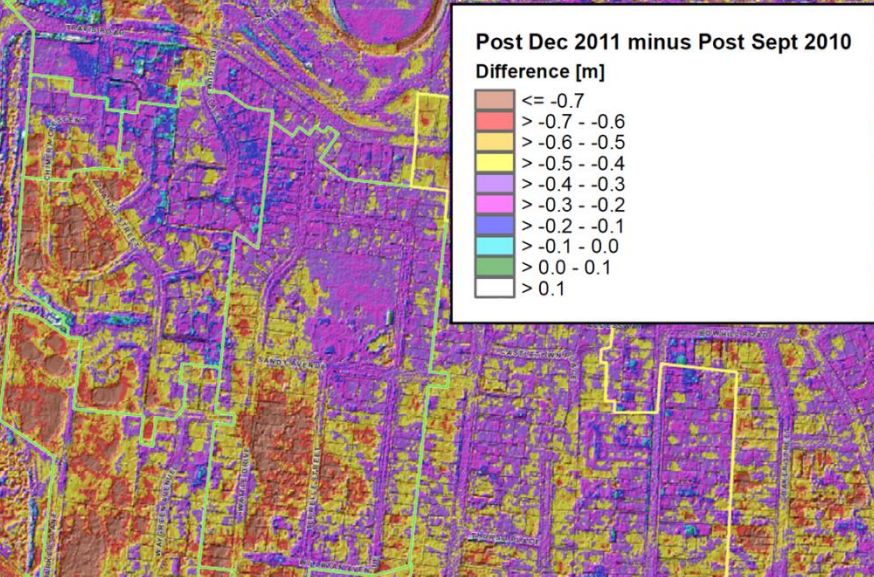
Emergency works



Survey and design software



	0.0% (1 in 200)	0.0% (1 in 200)	1.00% (1 in 60)	1.00% (1 in 60)
H.A.D. (m)	8.000	8.000	8.000	8.000
DESIGN SURFACE	12.00	12.00	12.00	12.00
INVERT LEVEL	12.00	12.00	12.00	12.00
DEPTH TO MAIN INVERT LEVEL	0.00	0.00	0.00	0.00
DISTANCE (m)	8.10	8.17	17.47	7.06



Legend

- Condition Assessment
- Sw CCTV Assessments
 - UNCERTAIN
 - ABANDONED SURVEY
 - NO ACTION
 - REPAIR
 - RENEWAL
- Services
- SW Pipe Labels
- SW Access
- SW Inlet
- SW Outlet
- SW Private Fitting
- SW Pump

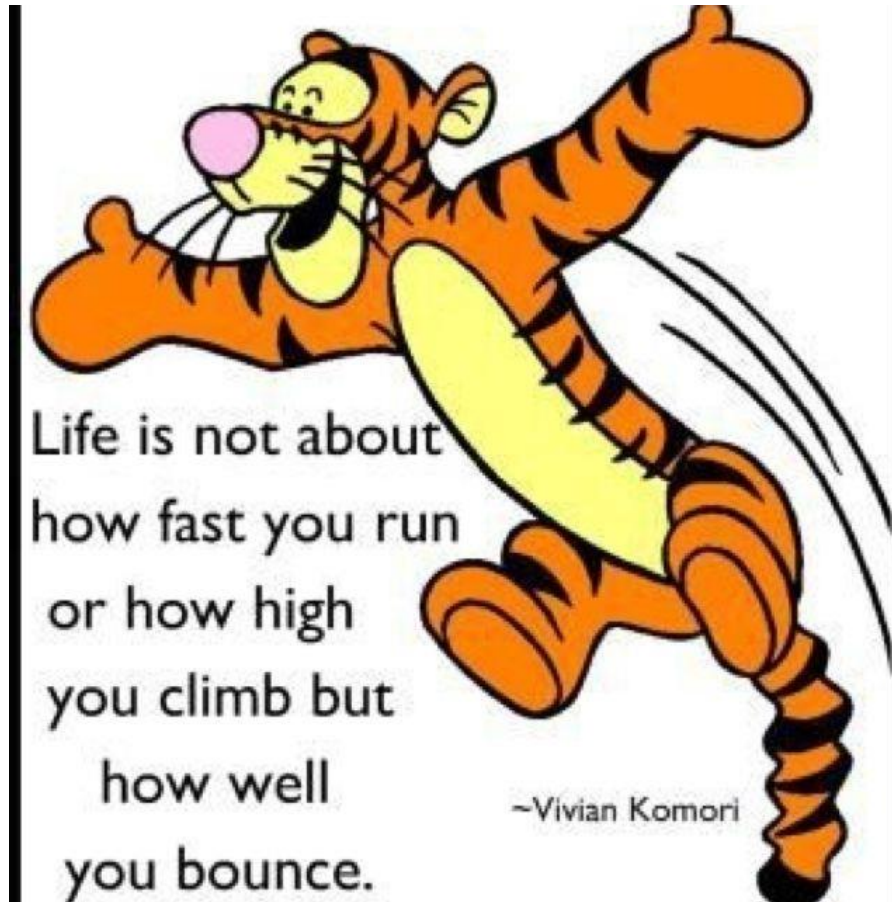
Active Layer List

- Photos
- Condition Assessment
- Ww Assessments
- Sw Assessments
- Wb Assessments
- Roading Assessments
- Citycare Repairs
- Damaged Water Infrastructure
- WW Network O & M
- Building Assessment
- Ground Investigations
- Liquefaction
- 12d Design
- Level Of Service
- Services
 - Existing Services
 - StormWater
 - WasteWater
 - WaterSupply
 - Pump Station/Reservoir Facilities
- Utilities
- Planning
- SCRT Projects
- CCC Building Consents
- RAMM Contractor
- Salesforce

LiDAR and survey analysis

GIS viewer

Design – focus on building back resilience



Gravity network repair initiatives

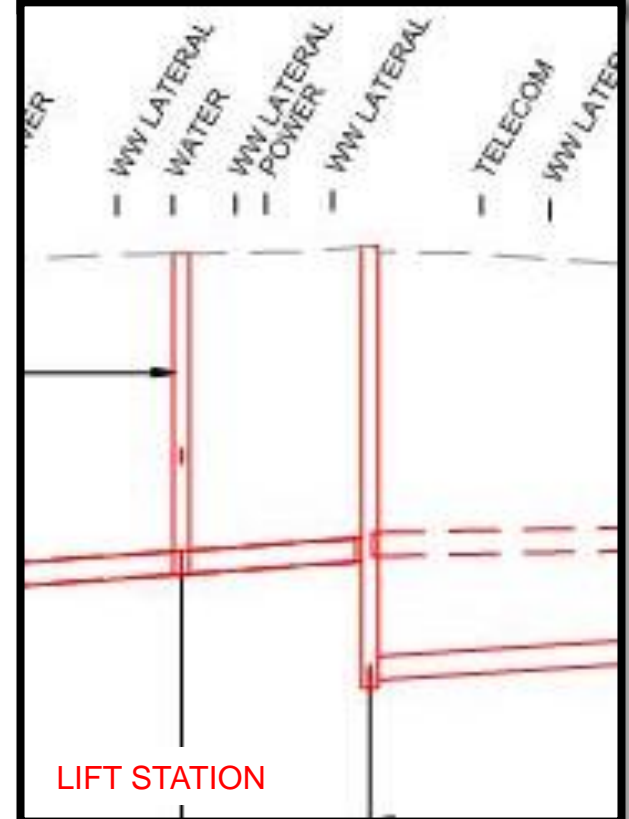
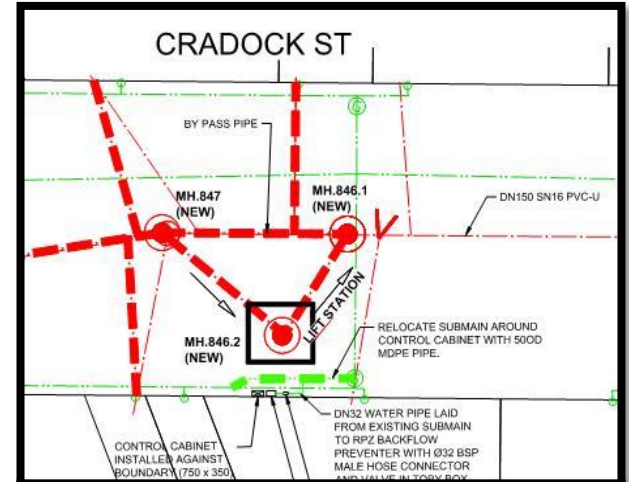


CIPP LINER INSTALL



PE PIPE THROUGH SEAWALL

CONCRETE SLEEVE ON OUTLET



LIFT STATION

Pump Station initiatives

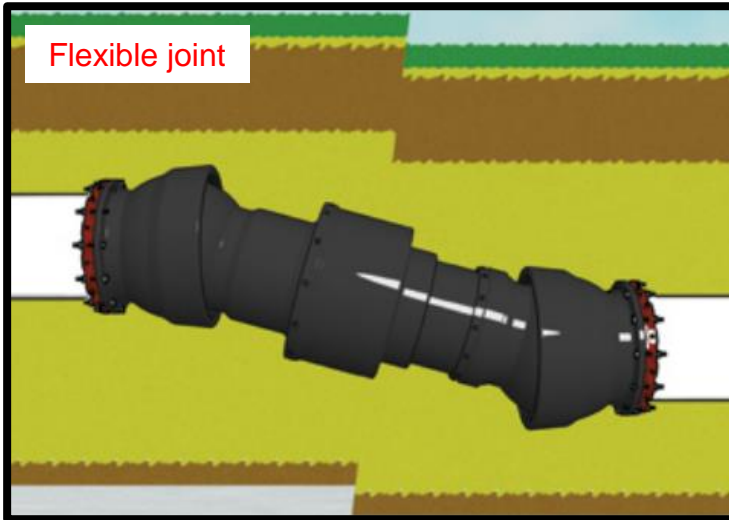
PS136 Foundations



PS136 Typical Cross Section B - B'



Flexible joint



PS229 Intake





General design features

- Efficient asset assessment
- New guidance documents, and standard details; making design and construction simple where we can
- What is best for this specific project? What is the best value to the rebuild and the people of Christchurch
- How do we make this resilient? can we integrate works? think about safety in design, consider the operation and maintenance
- Legacy – sharing knowledge, data, lessons learnt, best practise



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Wastewater Treatment Plant

Greg Offer

Programme manager for earthquake repairs at Christchurch Wastewater Treatment Plant
Technical Director – Environmental Engineering, Beca Ltd



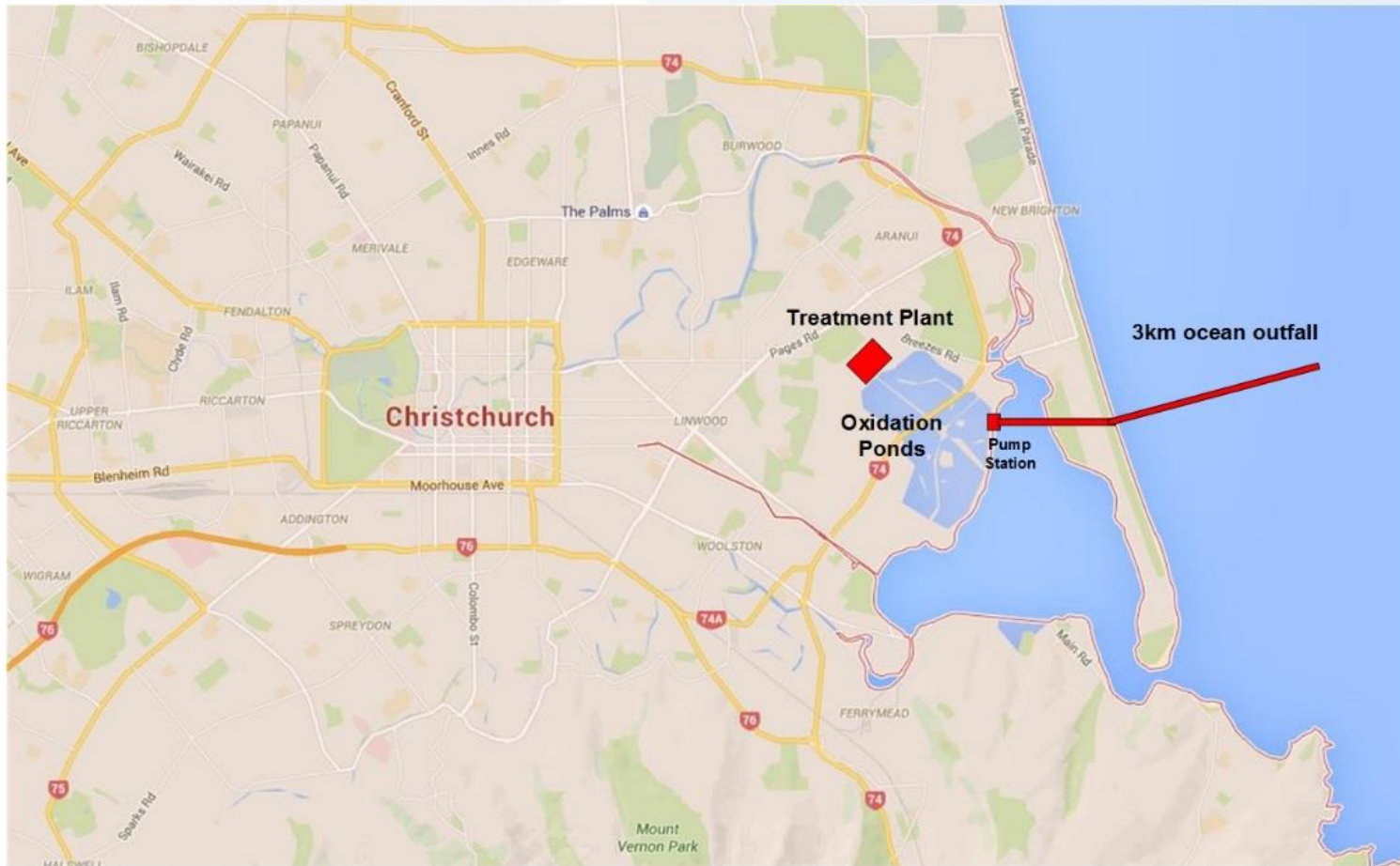
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Recovery

from disaster

Christchurch Wastewater Treatment Plant



Platinum Partners:



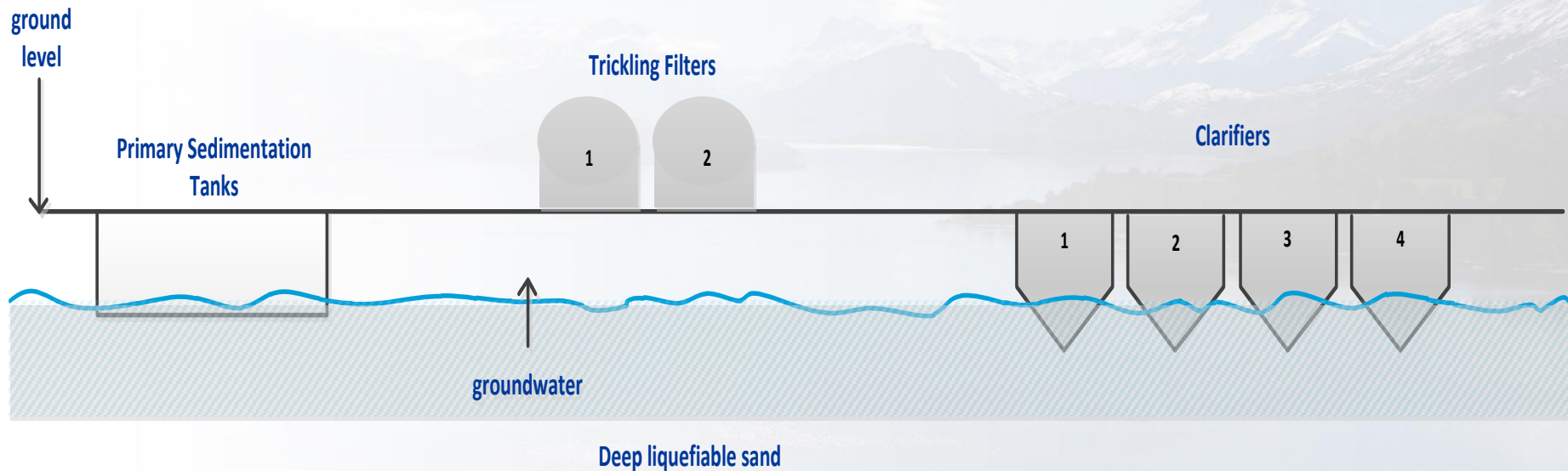
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Christchurch Wastewater Treatment Plant

- Plant built in deep sands
- Shallow groundwater
- High risk of liquefaction during earthquake





Earthquake impacts

- Shallow structures ok
- Deeper structures seriously damaged

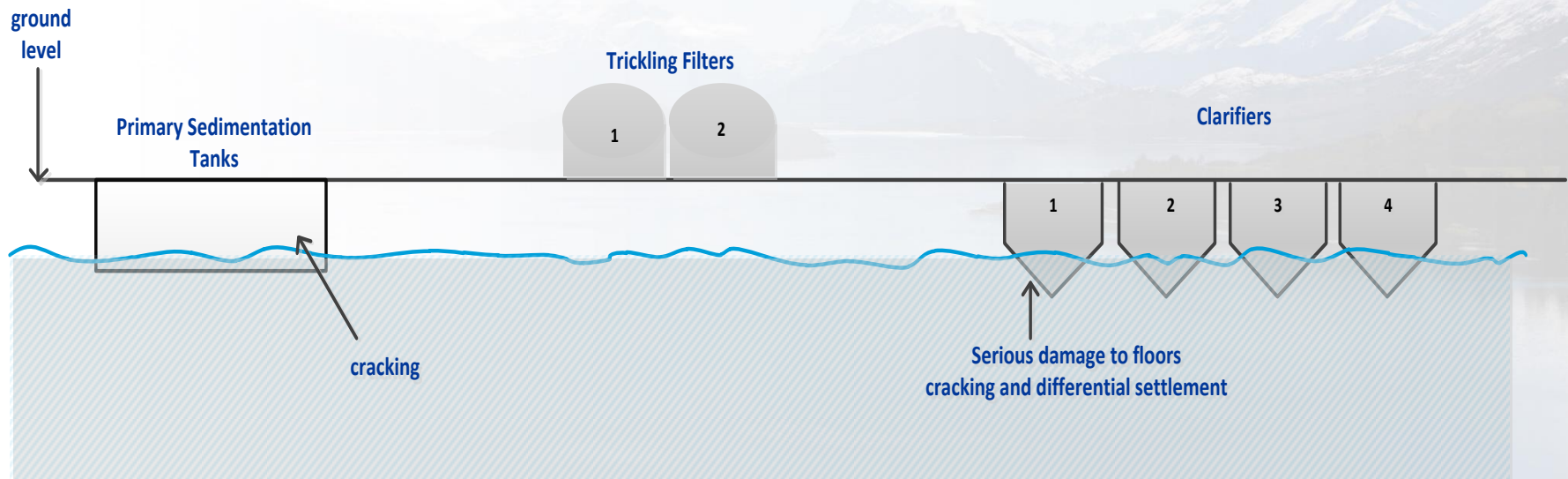




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Recovery

from disaster

Treatment plant & pond damage





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Recovery

from disaster

First Response

Pre-earthquake



Post-earthquake

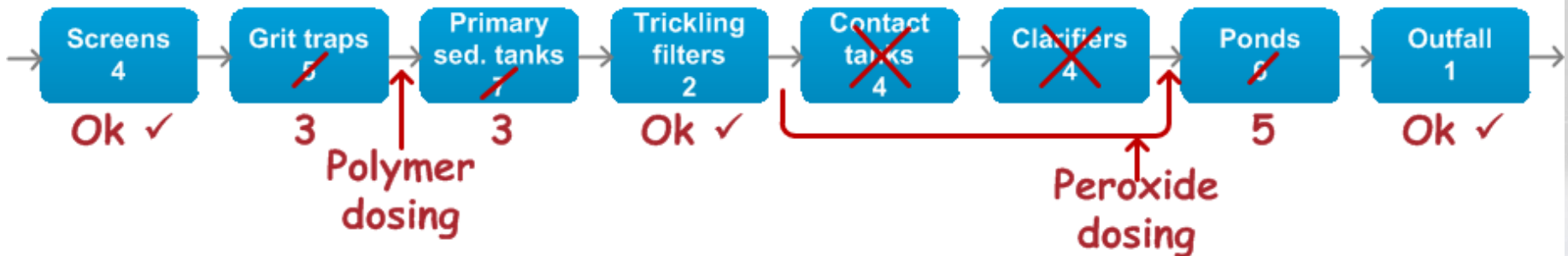




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Sand ingress in grit, primary sedimentation and digesters !





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Trickling filters



- Built at shallow depth so lightly damaged
- Some media and rotating arm damage
- External ring beam to strengthen tank
- Online 24/7 means inspection difficult... insurer wants “whole of site settlement”





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Recovery

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Clarifiers

- Two clarifiers severe damage, two minor damage
- Liquefaction pore pressures caused floor deformation
- Repairs based on reinforced concrete overlay
- Cure-in-place liner installed on inlet pipes





Lesson # 1 - Flexibility

Pre-earthquake



Post-earthquake

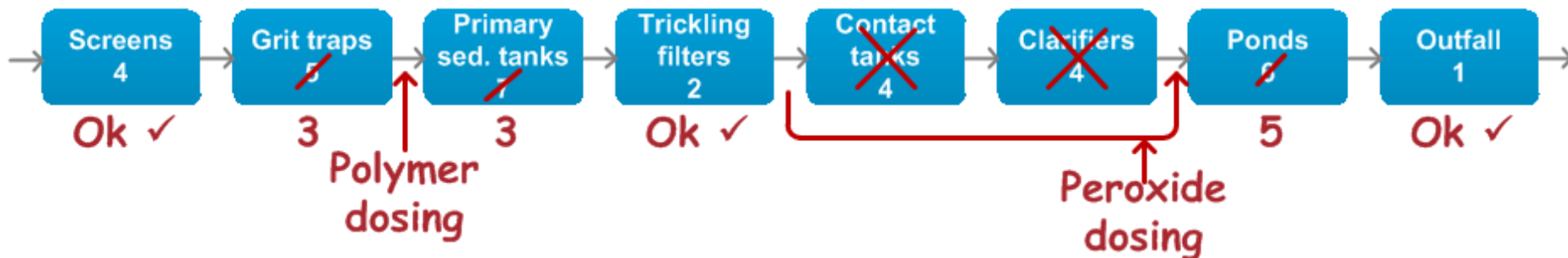




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Recovery

from disaster

Lesson # 2 – Layers of protection

Levels of Protection

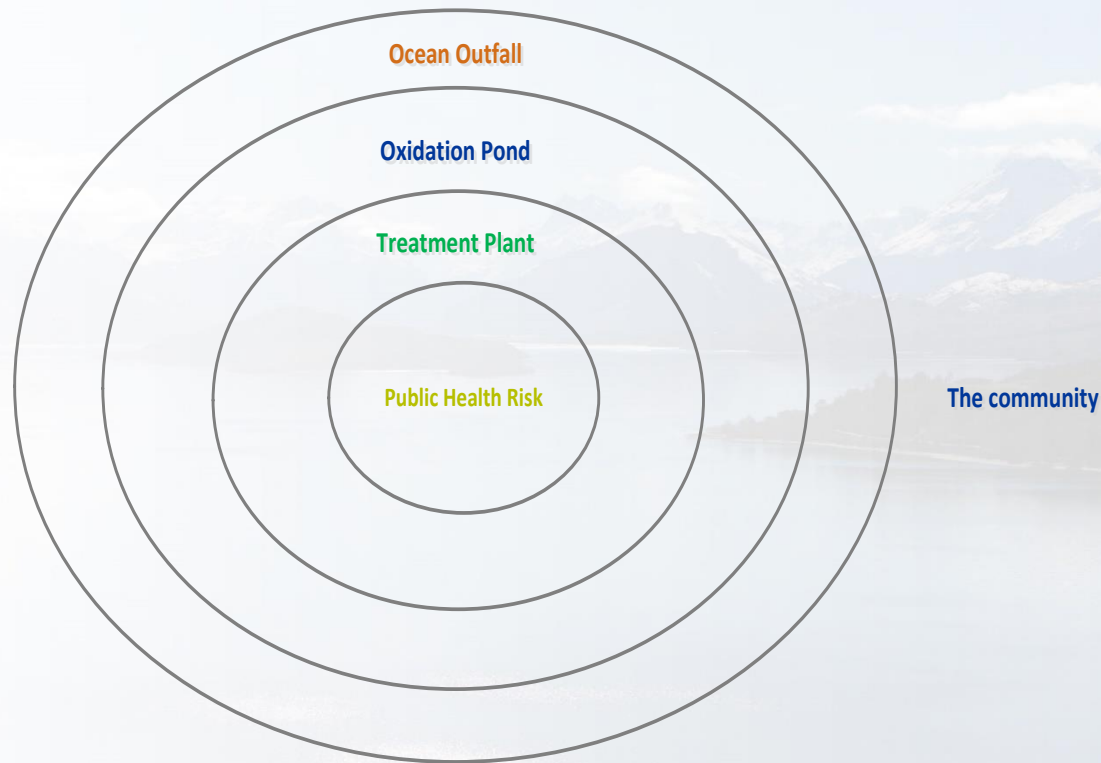




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Recovery

from disaster

Lesson # 3 - Risk management and resilience



- Don't ignore low probability, high consequence events
- Use risk management and renewal funding to improve resilience – know the weak spots.
- Up to date asset management systems very important to help recovery.
- Have clear design statements on major assets.



Lesson # 4 - Insurance



- What is the extent of cover (for example - does it include temporary working ?)
- Assume a litigious approach from day 1
- Don't start fixing things until the damage is properly documented !
- Need a good understanding of asset condition before the event
- Pipes – were they already leaking?
- Cracking – was it pre-existing?
- Decisions needed to keep plant running – could leave you financially exposed