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Feedback on Draft Guidance on Resilience Principles

Urban Intelligence welcomes the Commission's *Resilience Principles: Decision-making framework for critical infrastructure providers* and the accompanying ResOrgs report. We support the overall direction: an evidence-based, proportionate and systems-level approach to resilience investment. In particular, the guidance usefully distinguishes resilience from reliability, recognises that willingness to pay may not reflect need or risk-bearing capacity, cautions against treating community self-provisioning as evidence of network resilience, and explicitly recognises infrastructure and regulatory interdependencies.

Our main recommendations are intended to make the framework more decision-useful without creating unnecessary analytical burden. We suggest that, for material resilience investments, the guidance:

- make residual risk visible against the relevant tolerance or threshold;
- make consequence measurement explicit, including the period over which consequences are counted and, where relevant, the duration of service disruption;
- account for material cascading and functional consequences;
- assess material distributional effects across those actually affected;
- include a simple maladaptation screening test;
- clarify how cross-sector benefits can be recognised in expenditure assessment;
- describe increasing resilience maturity in terms of practical analytical capability; and
- improve the tools guidance to include interdependency and restoration modelling.

These recommendations are supported by published New Zealand and international evidence showing that the way consequences are defined and measured can change the relative ranking of risks and investment options, rather than simply changing the estimated magnitude of impact. We also make additional comments on how iwi and hapū perspectives can be represented within consequence assessment, alignment with wider adaptation planning, and several specific drafting points.

Urban Intelligence develops Resilience Explorer, a platform that turns natural-hazard and climate data into shared, continuously updated risk intelligence to support decisions. It brings together hazard, infrastructure and community evidence and supports analysis of exposure, vulnerability, direct and cascading consequences, service disruption, and social and economic impacts. Resilience Explorer is named in Table 4.2 of the draft guidance and in the ResOrgs report. Our recommendation on Table 4.2 concerns the distinction between analytical tool classes and the functions they perform, rather than seeking preferential treatment for Resilience Explorer. Several authors cited in this submission hold interests in Urban Intelligence; these are declared in the relevant publications.

Recommendations

1. Make residual risk visible in material investment cases

Suggested change: Include an indicator in Table 3.1 that, for material resilience investments, providers state the residual service risk after investment and compare it with the relevant risk tolerance or threshold.

Table 3.1 asks providers to apply a common framework for risk tolerance and determine risk thresholds for significant investments, but it does not explicitly ask them to state the risk remaining after the proposed investment. Without this information, it is difficult to judge consistently whether the proposed expenditure is proportionate to the level of risk that remains.

There is a strong evidence base for making this explicit. Brown (2025) identifies the absence of a defined level of risk management as a barrier to assessing whether adaptation actions achieve their intended outcome. The Climate Change Commission (2026) similarly emphasises that residual climate risk remains even where effective adaptation is undertaken. Lawrence et al. (2025) also show why this should not imply a single universal threshold: tolerability is context-dependent and can vary between communities and over time.

We therefore suggest that, for material investments, providers state the tolerance or threshold being applied, the residual risk after investment, and whether that threshold is met. This would improve transparency and comparability without prescribing a single national standard.

Suggested Table 3.1 indicator:

"For material resilience investments, residual service risk following implementation is stated and compared with the relevant risk tolerance or threshold."

2. Make consequence measurement explicit, including outage duration

Suggested change: Clarify that, for material resilience investments, providers should state the period over which consequences are counted and, where relevant, use measures that reflect the scale and duration of service disruption.

The guidance addresses hazard likelihoods and investment timing, but it does not specify the time window over which consequences should be measured or the units in which they should be expressed. These choices can materially affect which investments appear most beneficial. Logan et al. (2021) distinguish between the period over which events are considered and the period following an event over which consequences accumulate, and show that the latter can change the ranking of interventions.

Brunner et al. (2026) demonstrate the practical significance for Christchurch electricity, water and wastewater networks under a 1% AEP coastal flood. For the same event, 4,509 properties were directly exposed, 13,827 were without at least one service at the point of impact once cascading failures were included, and 94,474 property-days of outage accumulated over the 38-day restoration period. The ranking of affected properties also changed when restoration was included. Thompson et al. (2024) similarly found that including higher-order consequences changed the relative ranking of impacts at national scale.

For material investments, we therefore suggest that the guidance encourage whole-of-event measures such as consumer-days without service, the number of consumers experiencing outages beyond defined durations, and time to restore service to a defined proportion of consumers. Where different reasonable consequence measures produce different option rankings, that sensitivity should also be disclosed.

Suggested Table 3.1 indicator:

"For material resilience investments, the consequence assessment states the time period over which



impacts are counted, uses measures that reflect the duration of service disruption where relevant, and identifies where alternative reasonable measures materially change the ranking of options."

3. Account for material cascading and functional consequences

Suggested change: Clarify that, where material, consequence assessments should consider loss of access to essential services and loss of functionality arising from dependencies on other infrastructure, using information available from relevant providers and agencies.

Consumers can be affected even where their own property or service connection is intact. Two relevant mechanisms are **isolation**, where access to essential destinations is lost because transport links fail (Logan et al., 2023; Anderson et al., 2022), and **functional isolation**, where the destination remains accessible but cannot operate because another infrastructure service has failed (Anderson et al., 2025).

The scale can be material. Anderson et al. (2025) found that, for Christchurch under a 1-in-100-year flood with one metre of sea level rise, accounting for cascading utility failures increased the number of non-functional supermarkets, hospitals and schools by 114%, 178% and 142%, respectively, while residential isolation increased from 11,572 to 39,192 people. Brunner et al. (2024) similarly found that only about one-third of end users losing at least one utility service were themselves directly exposed to flooding.

This is relevant to both Principle 4 and Principle 6. A critical facility may remain undamaged and accessible but still be unable to function because a supporting service has failed. We therefore suggest that, where material, consequence assessments include consumers who lose access to essential destinations and those whose essential destinations lose functionality because of infrastructure dependencies.

Suggested Table 3.1 indicator:

"Where material, consequence assessments consider loss of access to essential services and loss of functionality arising from dependencies on other infrastructure."

4. Assess material distributional effects across those actually affected

Suggested change: Clarify that, where distributional impacts are material, analysis should consider the population affected by both direct and indirect consequences, rather than only those directly exposed to the hazard.

The number and composition of people affected can change substantially once indirect impacts are included. Anderson et al. (2024) found that, for a present-day 1-in-100-year coastal flood, the estimated population at risk increased from 61,993 based on direct exposure to 217,002 once isolation from essential services was included. The impacted Māori population increased from 13,010 to 30,387.

Distributional analysis therefore needs to identify who is actually affected, at sufficient spatial resolution to distinguish meaningful differences between communities. This remains a weakness in current practice: Anderson and Logan (2026) found spatially explicit vulnerability to be the weakest dimension across 86 city and regional climate risk assessments internationally.

We suggest that Principle 4 clarify that, where material, distributional analysis should cover those affected through service disruption, isolation and other indirect consequences, using spatial disaggregation where needed to identify differences between affected communities.

Suggested Table 3.1 indicator: "Where distributional impacts are material, analysis considers populations affected by both direct and indirect consequences, with sufficient spatial disaggregation to identify material differences between communities."

5. Add a simple maladaptation test

Suggested change: Add a short maladaptation test under Principle 7 or 9 for shortlisted options.



The guidance considers Avoid, Control, Transfer and Accept, but does not explicitly address whether an intervention could increase risk elsewhere or over time. This matters particularly for hardening measures, which can induce additional exposure, concentrate consequences when protection is exceeded, or reduce one hazard while increasing another (Logan et al., 2018; Anderson et al., 2022; Logan et al., 2026). The Climate Change Commission (2026) similarly identifies infrastructure renewal as a potential source of maladaptation where current decisions lock in inappropriate infrastructure or inequitable outcomes.

We suggest including a simple screening test for material options: does the option increase exposure or consequence for another hazard, create future lock-in, or foreclose more adaptable options?

Suggested indicator:

"Shortlisted options are tested for maladaptation, including whether they increase future or cross-hazard risk or constrain future adaptation choices."

6. Clarify how cross-sector benefits can be recognised in expenditure cases

Suggested change: Clarify how cross-sector resilience benefits should be treated when they accrue outside the provider's own network or consumer base.

Principles 3 and 10 ask providers to consider interdependencies and broader system benefits. The draft also expects providers to include impacts on other essential services and communities in commercial assessment. However, the provider bearing the cost may not be the organisation whose consumers receive the benefit.

This creates a practical gap between identifying a system-wide benefit and being able to justify or fund the investment that delivers it. The Climate Change Commission (2026) identifies a similar issue, highlighting gaps in sector-wide coordination and the need for clearer cost-sharing arrangements.

We suggest the Commission acknowledge this boundary and provide guidance on how cross-sector benefits may be recognised in expenditure assessment. This could include jointly evidenced benefit cases with affected providers, or consideration of demonstrated cross-sector coordination when assessing the reasonableness of expenditure.

Suggested clarification:

"Where material resilience benefits accrue across infrastructure sectors, providers should identify these benefits and relevant dependencies, and the Commission should consider how jointly evidenced cross-sector benefits can be reflected in expenditure assessment."

7. Align maturity with demonstrated analytical capability

Suggested change: Define maturity in terms of the analytical capabilities providers can demonstrate, rather than primarily by how many principles are considered or the level of detail applied.

Paragraph 2.5 describes progression from considering some principles to applying all principles in greater detail. This indicates increasing process maturity, but gives providers limited direction on the capability they should be developing toward.

For example, increasing maturity might mean progressing from assessing direct asset impacts, to understanding service disruption and restoration, and then, where material, accounting for important infrastructure dependencies and cascading consequences. Logan et al. (2026) similarly argue that risk assessment capability should be judged by the consequences and system interactions an assessment can represent.

We suggest the Commission describe maturity through a small number of practical capabilities, with expectations proportionate to the scale and complexity of the investment. This would give providers a clearer direction of travel without prescribing particular tools or modelling approaches.



8. Improve the tools guidance to include interdependency and restoration modelling

Suggested change: Add interdependency and restoration modelling as a distinct tool class in Table 4.2, and clarify that the table is indicative rather than exhaustive.

Principle 3 asks providers to assess infrastructure interdependencies and cascading failures. Table 4.2 does not currently identify the class of tools designed to model network failure, restoration and time-dependent service disruption.

This creates a gap between the analytical expectations in Chapters 2-3 and the tools presented in Chapter 4. Risk and catastrophe models are primarily suited to estimating direct impacts and losses, while interdependency and restoration models can represent cascading failure, recovery and resulting service disruption (Anderson & Logan, 2026; Brunner et al., 2026).

We suggest separating direct risk/loss modelling from interdependency, recovery and consequence modelling in Table 4.2. Some platforms span both categories. Resilience Explorer, for example, supports direct hazard and consequence analysis as well as cascading infrastructure failure, restoration, service disruption, and downstream economic and social impacts. It would therefore be more accurately represented across both categories than solely within the current risk and catastrophe modelling row.

Additional system-level considerations

Allow iwi and hapū perspectives to shape how consequences are framed

The guidance includes several expectations for engagement with iwi and hapū, but generally treats that engagement as an input to an assessment framework defined by the provider. This can constrain which consequences and values are represented.

Scadden et al. (2026) found that across 45 city-level climate risk assessments in New Zealand, Australia, Canada and the United States, Indigenous perspectives were rarely incorporated into the framing of risk itself.

We suggest the guidance recognise that material consequences or values identified by iwi and hapū may sit outside a provider's standard categories. Where this occurs, they should be recorded rather than omitted, and complementary or partner-led assessment approaches should be accepted where appropriate.

Recognise alignment with national and local adaptation planning

The guidance asks providers to consider resilience in a broader system context, but does not explicitly connect resilience assessment with national or local adaptation planning.

This creates a risk of parallel assessments using the same hazard, exposure and consequence information but producing different views of risk and priorities. The Climate Change Commission (2026) also emphasises adaptation as an iterative cycle of assessment, action, monitoring and review.

We suggest Chapter 1 or Chapter 5 briefly clarify how provider resilience assessments can inform, and draw from, wider adaptation planning and how they should be refreshed as material conditions change. This could reduce duplicated analysis without creating a separate planning requirement for providers.



Additional detailed comments

Figure 2.2 should better represent indirect consequences

Figure 2.2 provides a useful risk-assessment pipeline, but several elements could be clarified:

- Replace or supplement **fragility** with **vulnerability**, which more broadly describes how assets respond to hazards.
- Show social impacts separately from economic impacts, or group them explicitly as social and economic impacts.
- Extend the figure beyond the direct impact chain to reflect the indirect consequences discussed elsewhere in the guidance, including access loss, loss of destination functionality and cross-sector cascading effects.

Clarify how scenarios should be used in Table 3.1

Table 3.1 appropriately encourages scenario analysis, but could more clearly discourage reliance on a single planning scenario.

We suggest asking providers to identify which uncertain conditions were varied and, where different credible scenarios produce different option rankings, disclose that sensitivity. This would improve transparency without prescribing a particular scenario method.

Revise the DAPP trigger example

Paragraph 2.37 uses flooding occurring twice a year as an example of a trigger. Event-frequency triggers can be strongly influenced by short-term variability and may therefore give inconsistent signals of longer-term change (Curran et al., 2026).

We suggest replacing this with a measurable driver-based example, such as a defined increment of sea-level rise. The distinction between **signals**, **triggers** and **thresholds** shown in the Auckland Council example should also be carried through into the Principle 11 expectations.

Consider absolute service outcomes in benefit assessment

Benefit measures based only on avoided loss of service can favour consumers starting from higher service levels, because they have more service to lose (Logan and Guikema, 2020). This can reinforce the distributional issue already recognised under Principle 5.

We suggest a short clarification under Principle 8 that benefit assessment should consider the level of service consumers are left with after an event, alongside the change from their pre-event service level.



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