Watercare
An Auckland Council Organisation

Safety in Design

Risk management applied effectively across the entire life cycle of an asset

Disclaimer

Watercare has endeavoured to ensure material in this document is technically accurate and reflects legal requirements. The Designer is responsible for the material and management of the Safety in Design process. The document does not override governing legislation.

Contents

1. Introduction

Project development is an iterative and inclusive process that should consider the lifecycle of a project; from concept to detailed design, construction and then go onto consider the future use; maintenance, refurbishment and demolition of their project.

The Safety in Design process should not stifle innovative design in fact it is an opportunity for designers to stretch the boundaries of the industry to create a practical pragmatic design solution.

This Safety in Design Guide requirements supports the Asset Lifecycle Safety component of the Watercare Health and Safety Toolkit.

1.1 Health and Safety at Work Act 2015

The Health and Safety at Work Act 2015 (HSWA) was enacted to protect workers and other persons from harm and requires everyone in the workplace to be responsible for health and safety. The HSWA is intended to provide for fair and effective workplace representation, consultation co-operation and resolution of issues, and promotes the giving of advice, information, education and training. WorkSafe New Zealand is the health and safety regulator for land-based workplaces.

A guiding principle of HSWA is that workers and others in the workplace should be given the highest level of protection against harm to their health, safety, and welfare from work risks so far as is reasonably practicable. Safe workplaces and healthy workers benefit everyone. Workers have a duty to take reasonable care of their own health and safety and ensure that their actions (or inactions) don't put others at risk when carrying out work.

People with the most influence or control are best placed to manage health and safety risks and under the HSWA there are defined duties and responsibilities. The HSWA sets out a framework of duties, including duties on designers, and project teams must take appropriate steps to manage health and safety risks.

1.2 Duties and Responsibilities

A person conducting a business or undertaking (PCBU) has a primary duty of care not only to their own organisation and workers, but also workers whose activities in carrying out work are influenced or directed by the PCBU and all other people put at risk by work being carried out. Despite its name, in many cases, a PCBU is not an individual, but an organisation. Watercare is a PCBU. To support Watercare to discharge its PCBU responsibilities, project teams must also, therefore, consider what actions they can take that are "reasonably practicable" to eliminate or reduce health and safety risk.

There are additional responsibilities under the HSWA that cover the design, manufacture, import or supply of plant, substances and structures. PCBUs who are designers, manufacturers, importers or suppliers must, so far as is "reasonably practicable", make sure that the plant, substances, and structures designed, manufactured, imported or supplied (as relevant) are without health and safety risks when they are used for their intended purpose in a workplace.

Any PCBU may have more than one duty. Duties cannot be transferred or contracted out to others, but given PCBUs may have the same overlapping duties, those PCBUs must consult, co-operate and co-ordinate activities with those other PCBUs and make reasonable arrangements to make sure that duties are met. The HSWA does not replace any duties under other legislation.

Officers of a PCBU, (in practical terms, directors and certain senior executives) have an obligation to exercise care, diligence and skill to ensure that the PCBU is meeting its obligations. Officers will, therefore, need to satisfy themselves that Watercare is carrying out its obligations, including by carrying out adequate safety in design.

1.2.1 Reasonably practicable

Under previous legislation, the obligation was on persons to take all practical steps, but under the HSWA the obligation is so far as “reasonably practicable”.

Reasonably practicable is defined as something which is, or was, at a particular time, reasonably able to be done in relation to ensuring health and safety, taking into account and weighing up all relevant matters including:

- The likelihood of the hazard or the risk concerned occurring; and
- The degree of harm that might result from the hazard or risk; and
- What the person concerned knows, or ought reasonably to know, about the hazard or the risk; and the ways of eliminating or minimising the risk; and
- The availability and suitability of ways to eliminate or minimise the risk; and
- After assessing the extent of the risk and the available ways of eliminating or minimising the risk, the cost associated with available ways of eliminating or minimising the risk, including whether the cost is grossly disproportionate to the risk.

Safety in Design aims to address the above matters by using the design to eliminate health and safety risks where it is reasonably practicable to do so and minimising them so far as is reasonably practicable if elimination cannot be achieved.

A robust Safety in Design process incorporates a test for whether a proposed risk reduction method is reasonably practicable. This should take into account the factors described above. Multi Criteria Decision Analysis and Whole of Life costing may help with prioritisation of potential risk mitigation options.

1.3 Who is a designer and who should be involved

The Project Team generally includes anyone who has control or influence over, contributes to, modifies, or has input into the design, construction and use of the infrastructure asset. As such, a person representing the asset owner, designer or contractor could be considered to be part of the Project Team, including people from operations, maintenance, engineering, communications, planning, commercial and financial teams.

Representatives from people involved in the whole lifecycle of the plant, substance or structure should be included in Safety in Design. This includes architects, designers, engineers, operators and maintainers from both Watercare and contracted parties who may contribute to the design.

It should be recognised that Safety in Design concepts apply not only at at the outset for a new asset, but also at later stages of the lifecycle, for example redesign or modification of existing plant.

Other groups who make design decisions which can affect health or safety include:

- Project managers
- Financiers and purchasers
- Occupational health and safety professionals
- Importers, suppliers and manufacturers
- Plant-hirers, builders, constructors and installers
- Trade and maintenance personnel
- Clients and property developers
- Owners and insurers.

People who have responsibility for designing work processes and systems also have a role in Safety in Design. They include, for example, health and safety officers, managers, human resources personnel, information technology designers and systems engineers and those responsible for designing shift rosters, organisational structures, computer systems, work layout and configuration.

1.4 Who are we protecting?

In undertaking work we must demonstrate that we have taken all reasonably practicable steps to minimise risks that could affect the health and safety of those who may be affected by the investigation, construction, operation, maintenance, modification, decommissioning and demolition of the project works.

People who may be affected include those who;

- Undertake physical work including site investigations, fabrication, installation and construction;
- Are involved in testing and commissioning;
- Supply equipment or materials;
- Are involved in inspections, operations and maintenance;
- Are involved in the modification, alteration, dismantling, decommissioning or demolition of any part of the installed works;
- Are not directly involved with the project but who (as third parties) may be exposed to project-related activities during construction, operation, maintenance, decommissioning; and demolition activities. These may include adjacent landowners and tenants, road users, pedestrians and members of the public.

1.5 What are we protecting people from?

We need to protect the individuals and groups listed above from risks that are reasonably foreseeable. We need to incorporate measures that are reasonably practicable to protect their health and safety.

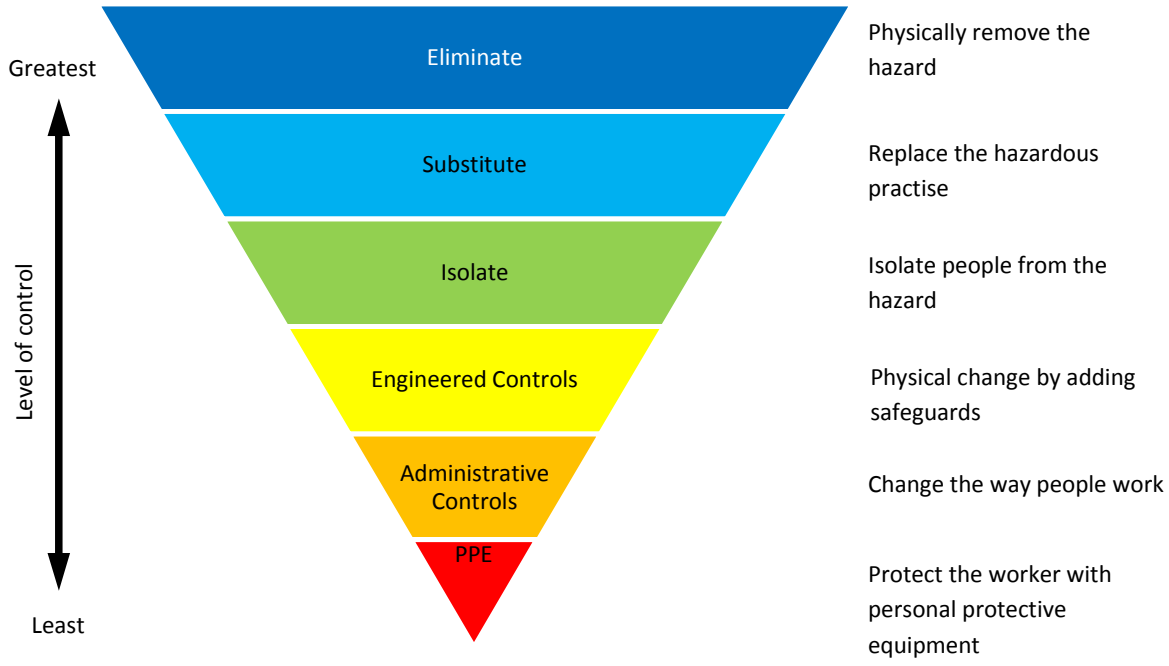
2. Safety in Design Overview

Safety in Design is a process that integrates hazard identification and risk assessment methods early in the design. The process considers how to eliminate, isolate or minimise the risks of death, injury and ill health to those who construct, operate, maintain, decommission or demolish an asset.

Safety in Design begins at the conceptual and planning phases of a project. The emphasis is on making the right design choices as early as possible to enhance the safety of the project. These choices may include appropriate equipment selection, methods of construction, on-going maintenance provisions, or materials used.

Most construction safety risk mitigation is aimed at isolating, informing or controlling the hazard. The opportunity to consider the life cycle of the project and involve decision makers in the early design stages to eliminate a hazard is valuable. The earlier you can begin this process in design, the easier it is to make changes that benefit everyone. Design development offers the greatest opportunity to incorporate improvements that can produce time and cost savings over the life of the asset.

The hierarchy of control sets out the prioritised approaches that can be adopted to managing hazards. The key principle is that *prevention is better than protection*. This means that it is better to eliminate hazards than to try to manage or control them. The hierarchy of hazard control should be consistent with Sections 5-8 of the Health and Safety at Work (General Risk and Workplace Management) Regulations 2016.



The Safety in Design process helps designers fulfil their obligations by :

- Providing a method to reduce the safety risk throughout the lifecycle of an asset
- Presenting an opportunity to challenge and improve designs through an open discussion
- Enabling changes to be made early in the design stage that are more cost effective than retrofitted solutions made during operation and maintenance
- Achieving better health and safety outcomes by considering and reconciling the interests of different parties involved with an asset
- Outlining the key safety in design documentation requirements for each phase of the asset lifecycle
- Continual improvement and knowledge sharing

2.1 Scope

The Safety in Design process applys to all those involved in the Watercare project delivery process. As part of project development consideration must be given to safety and health throughout the life cycle of the asset. This includes reviewing how the asset can be constructed, operated, maintained, decommissioned or demolished safely.

The benefits of embedding Safety in Design principles into the project life cycle include:

A. Taking every opportunity to proactively reduce the health and safety risk during the life of an asset
B. Committing to designing out health and safety risk
C. Understanding the environment, identifying stakeholders and planning how SiD will be executed
D. Documenting the design context and intended purpose, risk process and consultation undertaken, remaining risks and required actions / controls
E. Creating an environment for honest and open discussion amongst the wider design team
F. Committing to continual improvement and knowledge sharing

2.2 Principles

The key principles that impact achieving Safety in Design are:

- **Coordinate, communicate and cooperate**

  Use effective team collaboration to identify project health and safety risks so that all those involved with the asset are safeguarded; understanding the implications of decisions on others.

- **Project Influence**

  People who make decisions that influence the design of project can promote health and safety at the source.

- **Project lifecycle**

  Safe design applies to every stage in the project lifecycle - from concept through to disposal. It involves eliminating hazards and/or minimising risks as early as possible through design solutions.

- **Systematic approach**

  The application of hazard identification, risk assessment and risk control processes to achieve safe design.

- **Safe design knowledge and capability**

  People involved in design should demonstrate the necessary safe design knowledge and capability.

- **Information transfer**

  Essential to safe design is effective communication and documentation of design and risk control information, between those involved in the phases of the asset lifecycle.

2.3 Responsibility of the Project Team

The project team must integrate Safety in Design requirements into their project. The team must also encourage collaboration to improve planning and management and the early identification of hazards. This helps the team focus their efforts on where they can have the most significant impact on health and safety.

Designers have a responsibility to cooperate, communicate and coordinate with others to ensure the health and safety of all those who may be affected by the asset. This includes positively influencing a project through the effective planning and management of risks. The design team must integrate the Safety in Design process into projects. The team must also encourage collaboration to improve planning and management and the early identification of hazards. This will help the team focus their efforts on where they can have the most significant impact on health and safety. It is of particular importance to properly collaborate with and involve those teams who will operate and maintain the asset so that designs are practical and usable and do not introduce unintended additional hazards or operational difficulties.

Vendors and suppliers of equipment and materials also have particular obligations relating to the provision of information about risks associated with their products, and control measures required to keep people safe during the storage, installation, testing, commissioning and use of their product

It is Watercare's responsibility to provide information on existing hazards associated with a project, make decisions relating to potential risks, hazards, and the mitigation measures identified by the Safety in Design process (e.g. endorse and accept), and if required, rule on what is reasonably practicable.

Where design work is outsourced, the project team must ensure they are adequately involved to contribute to the safety in design process and put in place assurance that the contractors' own processes are adequate and being followed.

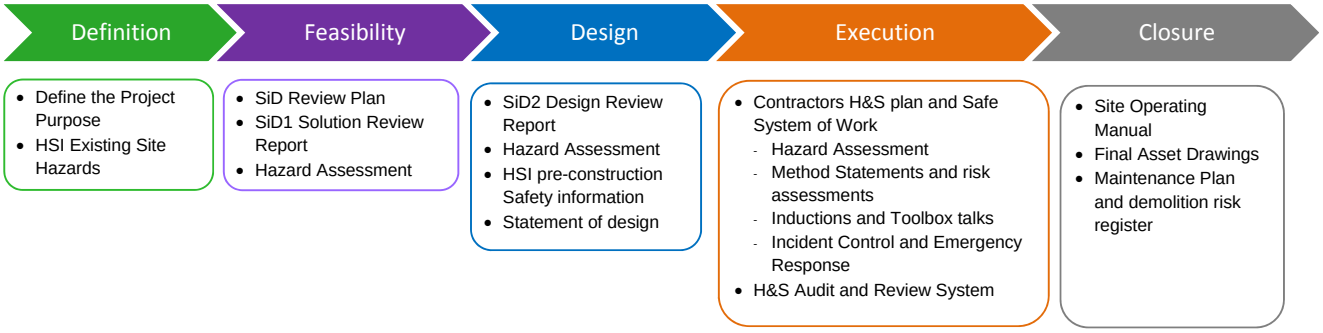
The tables found in **Appendix B** sets out the various team responsibilities through the project lifecycle. All parties must recognise the need to consider operation, maintenance, decommissioning and demolition requirements.

3. Project Management Framework

Infrastructure projects at Watercare are implemented through the Project Management Framework. Projects progress though a sequence of process stages from definition, feasibility, design, construction and ultimately closure. Once complete the responsibility for new infrastructure is transferred to Watercare Service Delivery.

The Project Management Framework sets out the process of creating new or managing changes to an asset from concept, through design and construction, to operation, maintenance and decommission or disposal. There are various points through this cycle where the design team can influence the safety outcomes of the project e.g. providing investigation information to end user specifications.

Gateway approval is required to transition between project stages. Safety in Design documentation is required for a project to progress. The hierarchy of Safety in Design documents for each stage is outlined below:



The **definition** stage details the drivers and objectives that initiate a project. Within water and wastewater infrastructure delivery this can be varied and include; reactive or planned works, routine to complex engineering and specialist engineering or diverse planning workshops. As part of Project Definition it is necessary to outline the *Project Purpose* and detail the *Existing Site Hazards.*

The **feasibility** stage details potential solutions. The *SiD Review Plan* details roles, responsibilities and outlines the Safety in Design required under the project. The *SiD1 Solution Review* documents the key safety hazards assessed for each option or technology. The existing site hazards and solution safety assessment go on to inform the Design Stage hazard control process.

The **design** develops the preferred solution that best meets the project objectives. The *SiD2 Design Review* is required to cover all aspects of the design and utilize standard review procedures. Projects with process pant shall include a hazard and operability study (HAZOP) and projects with control systems shall include a Control Hazard and Operability Study (CHAZOP). Large network, transmission or plant facilities shall include a *Safety in Facility Design* review.

The *Statement of Design* is an engineering document. To cover the requirements of Safety in Design the Statement of Design shall include the design purpose, key design parameters, the standards and codes applied.

Pre-construction Safety Information conveys safety information to enable the Contractor to plan their *Safe System of Work*. Typically this includes a project and organisation description, outline project programme, site location details and emergency procedures, a description of the extent of asset records and the requirements for permits and security.

The Project Management Framework details the **Execution** stage safety management and review system requirements during construction.

The acceptance of hand-over documentation is key to the process of **closure**. The Site Operating Manual includes details on the asset's functional purpose, operating and maintenance instructions along with the safety risks and the hazard control process. The Site Operating Manual shall outline the asset safety hazards and the hazard control associated with refurbishment, upgrades or demolition.

4. Safety in Design Process

Not all projects will follow the same development path or procurement strategy, and some projects may skip some of the development steps. Safety in Design review stages should not be seen as rigid.

The requirements of Safety in Design applies to all procurement models; Design, Design and Construct, Alliancing, Joint Venture Partnerships, Early Contractor Involvement and Entrusted Works Agreements. Under some procurement models a complex Safety in Design requirement may apply to the specimen design, pre-tender, tender design(s) to review and post-award stages. The Watercare project manager shall outline the specific process to be followed for a project at the start of the projects development cycle.

4.1 Concept Design Review

During the definition stage, a project development process is underway. This typically includes an investigation that defines the project drivers and objective. To enable the concept design to proceed it is necessary to detail both the project purpose and the existing site hazards. When considering very early stage safety in design, it is important that the purpose is clearly defined. There may be alternative solutions that have significantly different risk profiles which can be missed if the purpose is too rigidly defined. For example, when supporting a new sub-division, one purpose should be 'supply safe water to the location', which allows more alternatives compared to a purpose of 'extend the water supply network to the location'. The latter pre-supposes a solution.

4.2 Review Plan

The earlier a review is undertaken, the easier it is to build safety into the design and adopt changes.

The Project Manager should review the project brief and agree the Safety in Design process from the onset of the project with the project initiator and asset owner. Together they should establish the number of reviews required and agree appropriate timings for reviews for the *Safety in Design Review Plan*. This is undertaken at the beginning of the feasibility phase.

At commencement the project brief is reviewed and the preliminary health and safety hazards of the project defined. The lead design engineer must ensure they have the right documents, standards, procedures and people to undertake the Safety in Design process. **Appendix C** contains a checklist that can be used to help manage this process.

The number of review meetings undertaken and supporting documentation at each stage will depend on the project's complexity. Large multi-disciplinary projects that are complex (e.g. significant structures, treatment plants, tunnels, etc.) may need to be broken into a number of discipline or area specific reviews. Simple projects that involve common construction and maintenance techniques may only require a simple set of documents and a brief review.

4.3 Safety in Design 1 Solution Review

As the concept design is developed, thought should be given to any surrounding hazards e.g. working over/near water, at depth or height, land contamination and adjacent construction sites (see **Appendix D** for prompt words). This information, together with any existing information such as historical or general background and design requirements, should form a basis of the first Solution Review (SiD1).The feasibility *SiD1 Solution Review* completes an assessment of the preferred options before the project proceeds into design. This should provide a key contribution to the choice of option to be taken forward for detailed design. The final choice and the reasons for it, with clear inclusion of the safety in design aspects, should be recorded.

4.4 Safety in Design 2 Design Review

Once the detail design stage commences prior Safety in Design documentation should be reviewed to ensure it is complete and understood. The lead design engineer should set out the number of Safety in Design reviews required during the detail design and at what point they should take place. **Appendix F** contains a checklist can be used to help manage this process.

The *SiD2 Design Review* should be held as soon as enough information is available for discussion, and not too far along that it is difficult to make design changes (between 40-60% complete). A Safety in Design review carried out at the very end of detail design should be avoided.

A Safety in Design review focused on construction hazards, maintenance and operational hazards, renewal hazards and demolition hazards should be carried out at least once during the detailed design stage. However, as design is an iterative process, it will usually involve refinement or changes as a result of further discussions and considerations. Therefore it is important to review the risks and hazards identified to ensure items are closed out and ensure any new hazards that are introduced or identified are managed appropriately. For larger projects this may occur though a number of workshops or design meetings.

The lead design engineer should:

A. Ensure the right people are invited to the review.
B. Carry out a site visit where possible, with a constructor (or team member) and a maintenance contractor (or operations team member) with the appropriate experience.
C. Provide the facilitator an appropriate amount of time to prepare.
D. Ensure all the appropriate drawings and design information and previous risk assessments are available to the attendees well in advance of the review.
E. Ensure the Safety in Design review is carried out appropriately using a systematic approach
F. Ensure remaining actions are closed, updated or recorded and managed.
G. Ensure Safety in Design documentation is completed and made available the contractor, the asset owner and the maintenance contractor.
H. Complete handover documentation that is clear and effective.

The people on the ground doing the job every day must be included in this process. These are the people who have to construct, maintain, renew and operate the asset. They have experience and direct contact with the outcome. These resources should be included and used to their full potential.

Designers should take the opportunity to visit similar projects to get an understanding as to what plant may be used during construction, how the site will look once it is operating, and how maintenance activities will be undertaken.

It should be noted that the safest long-term option for operation and maintenance may not be the safest in terms of constructability. In these instances, a balanced decision will need to be made based on the merits of each and the rationale recorded.

4.5 Demolition or decommissioning

Demolition is frequently a hazardous activity. Demolition or decommissioning may be a distant prospect at the start of the concept design stage. Alternatively, it may be more immediate or even the specific reason for the project itself. This will influence the degree to which the design team can viably consider demolition and/or decommissioning aspects.

At the concept design stage, consideration should be given to whether common demolition methods are likely to be adequate. Some projects will have higher risks or complex demolition requirements that need to be taken into account. In those cases, the design considerations need to be more comprehensive and demonstrate that the health and safety hazards have been considered. Decommissioning should also be considered and detail provided if a specific method is required.

Hazards likely to be present during decommissioning and demolition can be mitigated by design modification. For example, decommissioning of a facility that handles hazardous liquids can be made

significantly safer by designing so that all contents can be emptied via an easily accessible, single low point drain.

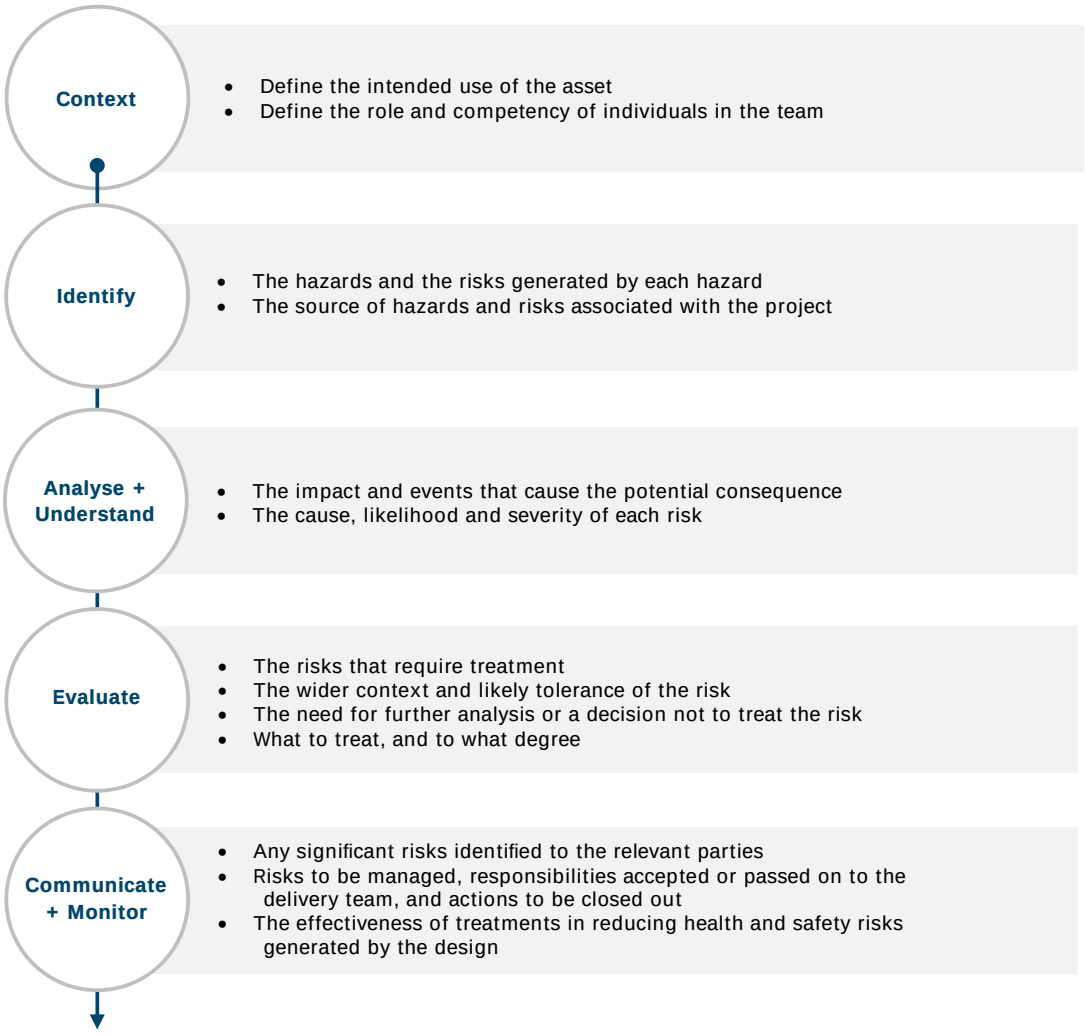
Projects where demolition or decommissioning is the immediate objective will generally be staged or of short duration. In such cases detailed demolition proposals will be required and subject to their own health and safety in design review to determine the safest way to progress the project. Note that, particularly for assets with long life, original design intent for demolition may be superseded by up to date methods and tools.

4.6 Review Objectives

Design reviews can be carried out in a number of ways including:

A. Design review meetings
B. Conversations with appropriate team members
C. Constructor input/constructability workshops
D. Safety in Design workshops

The objectives of the review are:



4.7 Safety in Design Review

A safety in design review should be structured, systematic and thorough. As with any design record, the scope, purpose and the design basis upon which the review is conducted need to be clearly documented. This is so that the state of knowledge at the time of the review is defined.

An agenda template for a Safety in Design workshop can be found in **Appendix E**. It is recommended that the agenda leads with a review of the options considered during concept design and leads with the design statement and drawings during detained design. It is more meaningful to progress through a safety review when the design demonstrates a good match against the project constraints.

A review should be a systematic process of establishing the context, identifying, analysing, evaluating and communicating the hazards. The reviews are undertaken during design in order to identify, isolate and eliminate where reasonably practicable, or minimise, foreseeable risks which may occur in the construction or subsequent phases of the project life cycle. A guideline to Safety in Design review methodology and guide words can be found in **Appendix H**.

The client project manager, operations and maintenance representatives, design leads and contractors' representative (where available) should be invited to the review. Collaboration with the various team members will likely deliver more successful design reviews.

To achieve a successfully outcome, the design team leader should:

A. Create an honest and open environment to enable coordination, communication and cooperation.
B. Ensure the right people are invited to the review.
C. Visit the site at least once and provide photographs of the site at the review.
D. Engage a facilitator and ensure they are given an appropriate amount of time to prepare.
E. Ensure all the appropriate drawings and design information is available to the attendees well in advance.
F. Ensure the Safety in Design review is carried out appropriately using a systematic approach
G. Record and manage actions.
H. Complete documentation at concept design stage and made it available for the detail design.

Output from the Safety in Design reviews should inform decision making regarding which design option to progress, which materials to use, or which construction methodologies are appropriate.

There are a number of ways to present the outputs from the reviews in a Safety in Design report. These may include:

I. File notes
J. Spread sheets/risk registers
K. Minutes of meetings
L. Hazard identification drawings
M. Designers hazard assessment

4.8 Hazard Review

The Safety in Design hazard and risk assessment should be conducted in accordance with an appropriate methodology and tools for the project. ISO 31010 Risk Management provides guidance on risk assessment techniques. This is to ensure consistency of output and ease of incorporation of handover material in a *Health and Safety Risk Register*.

In a workshop it is not always easy to separate the two, but it should be made clear at the onset of a review that the focus is on safety and health, not project risks. Any general project risks identified should be noted and addressed in a risk workshop/meeting.

4.9 Facilitation

The facilitator should be an independent, suitably experienced person – they may be an employee of the design consultant or someone else. Guidelines for facilitators can be found in Appendix H.

5. Records and communication

The extent of the Safety in Design records/report will depend on the objectives and scope of the review. The review process should be documented together with the results of the assessment. Risks should be expressed in understandable terms.

The results of the review, such as information on any residual risks, should be supplied with the project deliverables in an appropriate form at the end of each design phase.

In order for the project team to understand the risks that have been mitigated and those that remain to be, a copy of the *Safety in Design Report* should be issued to team members following the assessment.

The review documentation can include:

A. The design documentation
B. The objectives of the review
C. The methodology employed
D. The dates, timing and participants
E. A record of all risks identified (even where no further actions or recommendations are made)
F. Responsibility for specific actions and for management of the overall outcomes
G. Identification of specific actions and residual hazards to be managed by various team members.

5.2 Pre-construction handover

Pre-construction Health and Safety Information should be included in the tender documentation. This will allow the contractor to appropriately manage the health and safety risks identified.

A pre-start meeting is a good opportunity to discuss the Safety in Design documentation so that remaining safety risks are managed appropriately, and any design assumptions, specified materials, and methodologies can be understood.

5.3 Operations handover

Following practical completion of the project, safety in design information must be passed to the operations team. This should include at least:

- Documentation of key design decisions made
- Information related to the residual risks posed by the identified hazards
- Key operational and engineering controls that are required to manage residual risks
- Maintenance requirements for safety critical items of equipment
- Safe design and safe operating limits for the asset and how they can be monitored.

6. Project Closure

Any feedback and lessons learned should be carried out and circulated back to the lead design engineer and Watercare Project Manager to ensure that future designs are improved. These learnings should be reviewed and outcomes shared with the organisations involved.

Appendix A: References

The list of industry codes of practice and guides listed below are not comprehensive. Designers need to identify the specific regulations relevant to the work in which their project will be constructed.

- Health and Safety at Work Act 2015 (HSWA)
- The work health and safety regulator WorkSafe New Zealand http://www.worksafe.govt.nz/worksafe
- Electricity Act and Electricity (Safety) Regulations HSNO Regulations
- NZ Utilities Access Act and associated NZUAG Code of Practice
- UK CDM ACoP
- DoL Safe Working in Confined Space
- DoL Best practice guidelines for working at height in New Zealand, April 2012
- AS2685-2009- Safe Working in Confined Spaces
- AS/NZS ISO 31000:2009, Risk Management Principles and Guidelines
- AS/NZS ISO 31010:2009, Risk Management Assessment Techniques
- Design for Safety in Buildings and Other Structures [IPENZ/ACENZ/NZIA 2006]
- Managing Hazards to Prevent Major Industrial Accidents
- Guide to Best Practice for Safer Construction
- Code of practice for temporary traffic management (COPTTM): Part 8 of the Traffic Control Devices Manual (TCD)
- MBIE Approved code of practice for load-lifting rigging 5th edition 2012
- Health and Safety Executive (HSE) – UK www.hse.gov.uk
- Safe Work Australia Code of Practice - Safe Design of Structures www.safeworkaustralia.gov.au
- Crossrail Healthy by Design guide http://www.cbhscheme.com/Documents/Healthy_by_Design_Version_3

Appendix B: Design team responsibilities

Concept Design

Asset Owner/Project Manager

- Provide H&S knowledge of the project area/asset including all known hazards
- Provide all known investigation information to the designer
- Highlight any operational and maintenance needs of the project
- Clarify the intended use of the asset
- Endorse the mitigation measures identified in the reviews

Design Team Leader

- Understand if the project includes bespoke construction requirements, materials or departures from standard
- Critically assess the design to ensure health and safety issues are identified and solutions integrated into final concept design
- Consider appropriate materials and construction methodologies
- Manage and organise Safety in Design reviews
- Provide full information about any risks associated with the design
- Ensure all Safety in Design information is issued to the design team for the next stage of work
- Ensure all Safety in Design reviews are completed before design progresses to the next stage

Construction Contractor (where available)

- Ensure appropriate resources experienced in the techniques likely to be required to construct the design are made available for Safety in Design reviews
- Proactively highlight all construction hazards and risks of the design
- Share knowledge/experience regarding construction methodology, materials and planning requirements

Detail Design (and/or Demolition)

Asset Owner/Project Manager

- Highlight any operational and maintenance needs of the project
- Highlight any changes to the project/asset requirements, scope and likely usage
- Evaluate the mitigation measures identified in the reviews

Design Team Leader

- Pro-actively address new risks emerging through the design process
- Complete previous in Design actions
- Manage and organise Safety in Design reviews
- Provide full Safety in Design information about any risks associated with the design
- Ensure all Safety in Design information is issued to the relevant party (design team and/or the construction contractor) for the next stage of work including any untreated hazards identified
- Ensure all Safety in Design reviews are completed before proceeding to construction

Construction Contractor (where available)

- Ensure appropriate resources experienced in the techniques required to construct the design (or undertake the demolition) are made available for Safety in Design reviews
- Pro-actively highlight and address new risks emerging through the design process
- Share knowledge/experience regarding construction methodology, materials and planning requirements
- Plan, manage and coordinate construction work to ensure hazards are identified and risks are properly controlled

Everyone

- Cooperate, coordinate and communicate with all other team members
- Ensure you can competently carry out your responsibilities; seek training and advice where required
- Actively participate in Safety in Design reviews
- Complete any actions allocated to you in the Safety in Design reviews

Pre-construction Handover

Asset Owner/Project Manager

Attend the pre-construction meeting, providing input where required

Highlight any operational and maintenance needs of the project including all known hazards related to the project area/asset

Evaluate the mitigation measures identified in the review

Design Team Leader

Attend the pre-construction meeting, providing input where required

Highlight any design assumptions or changes made in relation to Safety in Design

Highlight items to be included in O&M Manual

Ensure all Safety in Design information including any untreated hazards identified are issued to the relevant party (contractor and the asset owner)

Maintenance Contractor

Review the Safety in Design information received regarding for completeness (construction risks) and issue to the appropriate people/parties

Ensure the construction team is competent to carry out the work they are engaged to do in a safe manner and with the correct equipment

Plan, manage and coordinate construction work, and any design work during construction, to ensure hazards are identified and risks are properly controlled

Ensure all relevant information passed on to the construction teams during site meetings/tool box talks etc

Ensure all relevant information is included in H&S plans, As-built and O&M manuals

Maintenance, Renewal and Operation

Asset Owner/Project Manager

Highlight any operational and maintenance needs of the project including all known hazards related to the project area/asset

Agree O&M manual content

Confirm intended use

Evaluate the mitigation measures identified in the review

Design Team Leader

Provide full Safety in Design information about any maintenance and operation risks associated with the design

Ensure all Safety in Design information is issued to the maintenance contractor and the asset owner

Highlight any maintenance and operation assumptions in relation to Safety in Design

Ensure all Safety in Design information is issued to the construction contractor, maintenance contractor and the asset owner

Contractor

Review the Safety in Design information received for completeness (maintenance and operation risks)

Ensure the maintenance work contractors can be done in a safe manner

Ensure all relevant information is identified for inclusion in H&S plans, As-built and O&M manuals

Everyone

Cooperate, coordinate and communicate with all other team members

Ensure you can competently carry out your responsibilities; seek training and advice where required

Actively participate in Safety in Design reviews

Complete any actions allocated to you in the Safety in Design reviews

Appendix C: Concept design checklist

The following checklist can be used on projects as a prompt to manage the Safety in Design process through concept design.

	Key Elements	Y/N	Comments / Justifications
1	Is there a clear scope of works, do you understand the design requirements and intended end use?		
2	Have you reviewed the project brief to understand the preliminary health and safety hazards?		
3	Do you have all the relevant design documents and standards to carry out the design?		
4	Has the frequency of the Safety in Design reviews been determined and at what stages?		
5	Have the key people who should attend the Safety in Design reviews been identified (member from each Team), do you need a facilitator?		
6	Where available, have you included a contractor representative and an operational/maintenance representative in the review team?		
7	Have you carried out a site visit to identify existing hazards?		
8	Have you carried out a Safety in Design Review? Are there construction hazards that need to be addressed? Are there operational hazards that need to be addressed? Are there maintenance hazards that need to be addressed? Are there demolition hazards that need to be addressed?		
9	Have you applied the hierarchy of hazard control? (eliminate, isolate and minimise)		
10	Have all actions been allocated to people and/or closed? Have you recorded risks and who owns them? Is there a process for capturing treatment actions, progress, closure and reporting?		
11	Are there any outstanding unacceptable residual risks?		
12	Are there factors outside of your control? (e.g. risks to be accepted or tolerated)		
13	Have you circulated all the outputs from the Safety in Design review to the project team?		
14	Have you collated all the Safety in Design outputs for the next phase?		
15	Have you agreed the next review date?		

Appendix D: Review prompt words

Prompt Words
Noise
Manual Handling
Vibration
Heat
Hyperbaric Atmosphere
Chemical – Cement, silica, dust, solvents, hydrocarbons, asbestos
Biological – Contaminated water or soil
Working at height or depth
Working over/near water
Adjacent construction sites and land use
Underground excavations and works - tunnelling, trenching, etc.
Ground conditions
Services and utilities
Confined spaces
Heavy Lifting - including working under suspended loads
Temporary Works
Working in and around mobile plant - site traffic
Demolition
Emergency requirements
Existing structures
Existing information – as-builts, historical, etc.
Prescribed methods of working/construction
Existing and future operational and maintenance issues
Live Traffic – vehicles/cycles/pedestrians
Natural Hazards - wind, rain, snow, flooding, seismic activity, etc.
Competence

Appendix E: Workshop agenda template

SAFETY IN DESIGN WORKSHOP AGENDA

Date:

Venue:

Attendees:

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1. **Introduction**
   - Setting the scene
2. **The Project**
   - The purpose of the project and project constraints
   - Outline existing site hazards
   - For a concept design, outline the options considered
   - For a detailed design, outline the design statement and discus the drawings and supporting analysis.
3. **The Safety in Design process**
   - Systematic approach Hierarchy of Control
4. **Safety in Design review**
   - Review and discus safety for each element of the design for each stage of the asset lifecycle
5. **Key hazards**
   - Agree and discuss unique project safety hazards and risks for each stage of the asset lifecycle
   - Review the residual medium/high hazards that have been identified during project development
6. **Conclusions and wrap up**
7. **Next meeting**

Appendix F: Detail design checklist

The following checklist can be used on projects as a prompt to manage the Safety in Design process through detail design.

	Key Elements	Y/N	Comments / Justifications
1	Is the scope of works clear, do you understand the design requirements, assumptions made, standards used and intended end use?		
2	Have you received and reviewed the previous Safety in Design documentation? Is it complete?		
3	Has the frequency of the Safety in Design reviews been determined and at what stages?		
4	Have the key people who should attend the Safety in Design reviews been identified (member from each Team)? Do you		
5	Where available, have you included a contractor representative and an operational/maintenance representative in the review team?		
6	Have you carried out a site visit, with the relevant people to review the existing hazards and proposed design?		
7	Have you carried out a Safety in Design Review? Are there construction hazards that need to be addressed? Are there operational hazards that need to be addressed? Are there maintenance hazards that need to be addressed? Are there demolition hazards that need to be addressed?		
8	Have you applied the hierarchy of hazard control? (Eliminate, isolate and minimise)		
9	Have all actions been allocated to people and/or closed? Have you recorded risks and who owns them? Is there a process for capturing treatment actions, progress, closure and reporting?		
10	Are there any outstanding unacceptable residual risks? Have they been communicated?		
11	Are there factors outside of your control? (e.g. risks to be accepted or tolerated)		
12	Have you circulated all the outputs from the Safety in Design review to the project team? How will you check they have been closed before handover?		
13	Have you communicated all the Safety in Design outputs for the tender documentation?		
14	Have you carried out a handover?		

Appendix G: Review methodology and templates

Methodology

A guideline for a successful Safety in Design Reviews methodology is as follows:

- Understand the intended use of the project, including existing hazards and risks. Understand the external and internal parameters of the project to be reviewed.
  - Hazard means the potential for an agent, activity or process to cause injury, illness or damage to people, property, or the environment.
  - Risk is a measure of the severity of the consequence of a hazard and the likelihood of its occurrence.

- Identify the sources of the hazard or risk, areas of impact, events, control measures and their causes and potential consequences.

- Analyse the cause and source of the hazard or risk and likelihood of the consequences that can occur. Determine the likelihood and consequence of the risk to produce a level of risk using the Watercare risk matrix.
  - Likelihood is an assessment of the chance of the risk issue occurring and resulting in the determined potential consequence.
  - Consequence is the worst reasonably foreseeable extent of harm to people, property or the environment, resulting from an incident due to a hazard.

- Evaluate the hazard or risk treatment and the priority of this treatment (e.g. eliminate, substitute, isolate, control) as far as reasonably practicable.

- Reassess the residual risk in terms of severity and likelihood and therefore level of risk.
  - Severity is a quantification of the potential consequence of an incident due to a hazard.
  - Assign responsibility for implementation of proposed treatment option to the appropriate person attending the risk assessment.
  - Document the assessment.
  - Follow up to confirm recommended controls are implemented.
  - Communicate treatment option and any residual risks.

Communication is a key to Safety in Design. Therefore, documentation of any findings or alterations should be made clear to ensure that others can follow the design plans or modifications.

Ensure that all information concerning actions taken to address health and safety is adequately recorded and transferred from the planning/design phases and that those involved at later lifecycle phases have access to information about any residual risks that may affect their health and safety.

A review table/spreadsheet can be used to assess the severity of the risks. Residual level of risks of ‘low’ should be targeted. Where the level of risk is ‘medium’ or ‘high’, control measures need to be implemented, as far as reasonably practicable, to enable the risk to be eliminated or minimised. Where risks cannot be reduced to ‘low’ the end-user should be informed.

Guide words for a Safety in Design review

Site Layout	Surrounding environment, site clearance, access (within and to site), traffic circulation, size, storage space, limitations, contamination, existing infrastructure/structures.
Access/egress	No. of entry/egress points, caught, trapped, emergency egress, obstructions, lighting, external impacts, people and equipment, frequency of movements.
Interfaces external to the project	Public safety, traffic, adjacent property, services, external fire, day/night/ weekend, emergency services, noise, dust, pollution, vibration, departures from standard details or practice.
Natural Hazards	Extreme weather, lightning, dust, temperature, ground, water, snow, ice, noise, earthquake, floods, high wind.
Site Caused Environment	Vapour/dust, effluent/waste, noise, flooding, asbestos.
Position / Location	Too high, too low, too far, misaligned, wrong position.
Heights / Depths	Working at heights/depth, falls, striking by falling objects, scaffolding (space to fit).
Load / Force / Energy	High, excess, low, insufficient, additional loads, dynamics, temporary weakness, fragile, tension, compression, PE, inertia, movement, fluid flows.
Movement Direction	Stability/instability, compression, physical damage, vibration, friction, slip, rotation, up, downwards, reverse, expansion, tension, rollover.
Toxicity / Safety	PPE, chemicals, safety showers, eye wash, barriers/guards, lead/asbestos, oil, handling, precautions, ventilation, gases, pressure venting, overflows (provision), materials.
Utilities/Services	Vapour/dust, effluent/waste, noise, seepage, heat/cold, electricity, flooding, outages, proximity.
Electrical	Underground, overhead, heating, proximity, spacing, clearances, isolation for maintenance access
Eliminate / Combine	Movements, mobile plant, lifting, exertion, sequence, timing, simplify
Ergonomics	Posture, manual handling, RSI, discomfort, fatigue, stress, effect on PPE, visibility, slips, trips
Fire / Explosion	Prevention/detection, suppression/protection, emergency procedures, sparks/ earthing
Moving Plant & Machinery	Internal, external, above, below, reversing, visibility.
Confined Spaces	Access, egress, emergency procedures
Timing	Too late, early, short, long, sequence, extended delays
Demolition	Ease, issues, documentation, asbestos, sequencing.

Appendix H: Facilitation guidelines

Preparation

At least two weeks before the Safety in Design review the facilitator should meet with the Design Team Leader or other appropriate person and establish the following:

1. Appropriate attendees – Asset Owners, Designers, Constructors, Maintainers, Operators etc.
2. Project scope – the boundary for the assessment.
3. Basis for review – general arrangement drawings; sections where possible; for brown field sites a site inspection at the start of the session can help to identify hazards.
4. Areas for assessment – break down the scope into discrete items or areas for review. They should be small enough to easily review and discuss.
5. Agenda – plan a logical path through the project; allow a reasonable time for each area; send the agenda to the attendees.
6. Prepare a set of prompt works, phrases and open questions.
7. Recording methodology – refer to Section 6.4.

Review

A guideline to facilitating the Safety in Design Review is as follows:

8. Set the scene of the review, explaining the purpose and objectives.
9. Use a predetermined set of guides or prompts to assist in the identification of hazards associated with each item (similar to those in Appendix E).
10. Optional - brainstorm the list of prompt words to engage participants and create a safe environment.
11. For each area break down the scope into discrete items, activities or areas for review.
12. Invite the group to consider what actions need to be taken in this area during construction, operation, maintenance and demolition.
13. Review these actions and look for any associated hazards.
14. When discussion slows, use a predetermined set of guides, prompts or open questions to assist in the identification of hazards associated with each item (Appendix E).
15. Manage the risk assessment process to ensure all hazards are identified, analysed and evaluated in a systematic approach.
16. Manage the group dynamics by being aware of the participants and ensure everyone has the chance to be heard.
17. Be prepared to take control of a discussion if it starts to go off topic, not all issues will be concluded in the workshop. Ask the individuals to follow up on their discussion outside of the workshop and report back to the group.
18. Take regular breaks if it is a long workshop.
19. Wrap up the workshop by thanking people for their participation, highlight the next steps and ask for any final thoughts.
20. After the workshop the records should be documented and communicated to the teams.

Appendix I: Example Safety in Design Risk Register

Project: Link Sewer

Project Stage: Preliminary Design

Author: Lead Desiger

Date:

Reviewed by:

Date:

Version 2

SAFETY IN DESIGN RISK REGISTER

RISKS ASSOCIATTED WITH DESIGN ELEMENT						STAGE			DESIGN MITIGATION MEASURES AND RESIDUAL RISK							
No.	Activity	Hazard	WHO IS AT RISK: Principal / Contractor	WHO IS AT RISK: Public	Location / Design Element	Construction	Operation and Maintenance	Demolition	Design Mitigation Measures	Residual Hazards and Management	Likihood	Consequence	Residual Risk	Risk Owner	Expected Date to Complete Action	COMMENTS
1.	Work within Residential Property sites	Collision of construction vehicles and and equipment with existing private structures and residents.	y	y	Scorpio Place	y	y	y	Minimise construction in private property where appropriate.	Access agreements with private property owners are currently being negotiated by Watercare. A temporary access shall be constructed through the properties and cordoned off from residents to provide a safe working area.	2	5	3	Principal Contractor		
2.	Work within Commercial Property sites	Collision of construction vehicles and and equipment with existing private structures and residents, delivery vehicles etc.	y	y	Commercial properties between Centorian Reserve and Apollo Dr Commercial properties between Apollo Dr and Ascension Dr	y	y	y	Minimise construction in private property where appropriate. Position pipe to allow maximise access and egress room.	Access agreements with commercial property owners are currently being negotiated by Watercare. Access from Constellation Dr into Centorian Reserve. Egress out from commercial property ointo Apollo Dr. It shall be a one way operation. A temporary access shall be constructed. Access and egress will need to be maintained for both roads Apollo Dr and Ascension Dr. A temporary access shall be constructed. Construction working areas to be fenced of from unauthorized personnel. Gate control to be in place to allow commercial vehicle and pedestrian access onto site as required.	2	5	3	Principal Contractor		
3.	Working in Roads and Public Spaces (parks and reserves etc)	Contractor workers struck by road vehicles.	y	y	All roads and public spaces	y	y	y	Alignment confined to single side of road where possible and away from the heavy traffic Constellation Dr. Trenchless technology to be used for Crossing SH1. Where possible design is to keep chambers out of roads (with preference towards reserves where traffic hazard is eliminated).	Ensure appropriate traffic management plans are in place and adhered to during construction.	2	4	3	Contractor		
3.01		Public collide with warning sign, site fence, etc.		y	All roads and public spaces	y	y	y		Safe vehicle and pedestrian movements to be addressed as part of the Traffic Management Plan by the appointed Contractor	2	3	2	Contractor Principal		
3.02		Public injury by entering into work sites		y	All work sites	y				Long term construction site yards (Windsor Park, Centorian Reserve, Watercare Land) to have construction working area to be fenced off from unauthorized personnel. All pipe trench and chamber excavation works to be undertaken within a fenced area. Unsecured sites for minor works (survey, potholing) to be monitored at all times. When not monitored, shall be tidied and equipment stored in construction site yards.	3	5	4	Contractor		

				CONSEQUENCES				
				Negligible	Minor	Moderate	Severe	Extreme
				Injury requiring shot-term first aid care and no absence from workplace.	Injury requiring short-term medical treatment and workplace absence less than 1 day.	Injury requiring medical treatment or lost time of 1day to 3 weeks.	Serious injuy (injuries) requiring specialist medical treatment of lost time greiter than 3 weeks.	Loss of life, permanent disability, or multiple serious injuries.
				1	2	3	4	5
LIKELIHOOD	Almost Certain	Expected to occur in most circumstances	5	Low	High	High	Critical	Critical
	Likely 55% to 85%	Will probably occur in most circumstances	4	Low	Medium	High	Critical	Critical
	Possible 30% to 55%	Likely to occur at some time	3	Low	Medium	Medium	High	Critical
	Unlikely 5% to 30%	More likely not to occur under normal conditions	2	Low	Low	Medium	Medium	High
	Rare <5%	Will only occur in exceptional circumstances	1	Low	Low	Low	Low	High