

THE WATER NEW ZEALAND INFILTRATION AND INFLOW CONTROL MANUAL, 2ND EDITION

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ABSTRACT

The New Zealand Water and Wastes Association published the original New Zealand Inflow and Infiltration (I/I) Control Manual in 1996. As part of its renewed focus to provide its membership with improved access to the latest technical knowledge and skills, Water New Zealand has recently developed and published the Inflow and Infiltration Control Manual 2nd edition (The Manual) to provide new information, methods, and technologies related to the management and reduction of wastewater system I/I. The Manual is intended for wastewater managers, planners, engineers, and operations and maintenance staff who are currently undertaking I/I management, or who are interested in doing so in the future. By drawing upon current good practices and project experience from sources around the world, the Manual is considered the single source of current global best practice. By providing prediction tools and good practice methodologies, the Manual facilitates the reduction of risk and uncertainty in I/I projects and programmes. As a document that includes information applicable to both asset managers and practitioners, it is a comprehensive guide for I/I management in New Zealand.

KEYWORDS

Inflow and Infiltration, I/I, sewer overflow, peak wet weather flows, groundwater infiltration, seawater ingress, saline intrusion

1 INTRODUCTION

Inflow and Infiltration (I/I) is the process in which unwanted water, mainly stormwater and groundwater, enters the wastewater system. I/I can cause surcharging of sewer systems and sewer overflows. Overflows cause economic, environmental, social, and cultural damage, and are therefore a key concern for wastewater managers. As traditional augmentation options can be expensive, the pursuit of I/I reduction projects can be a cost-effective solution to reducing peak wet weather flows and overflows.

The New Zealand Water and Wastes Association published the original New Zealand Inflow and Infiltration Control Manual in 1996. As part of its renewed focus to provide its membership with improved access to the latest technical knowledge and skills, Water New Zealand commissioned GHD Limited to develop the Inflow and Infiltration Control Manual 2nd edition (The Manual) to provide new information, methods, and technologies related to the management and reduction of wastewater system I/I. The Manual is intended for wastewater managers, planners, engineers, and operations and maintenance staff who are currently undertaking I/I management, or who are interested pursuing it in the future.

For the manual development process, a Working Group was formed, consisting of seven councils/council-controlled-organisations from across New Zealand. The Working Group provided direction on the structure and content of the new manual, and also provided assistance to make the Manual applicable to the intended users. The resulting Manual is a two volume document that includes the following key attributes:

- Provides guidelines and tools for reducing risk and uncertainty in I/I management
- Incorporates into the content, lessons learnt and case studies from New Zealand councils as well as overseas utilities, and
- Is a comprehensive I/I management guideline document that contains information for both managers and practitioners.

2 REDUCTION OF UNCERTAINTY

The Manual provides tools and guidance to reduce risk and uncertainty that have historically plagued I/I projects, as described in the following sections.

2.1 KEY PERFORMANCE INDICATORS AND THRESHOLD VALUES

The Key Performance Indicators (KPIs) section in the Manual outlines KPIs to benchmark and measure the performance of a wastewater system, as well as threshold values that indicate when I/I is a significant problem. The KPIs listed are:

- Groundwater Infiltration (GWI)
- Rainfall Dependent Inflow and Infiltration (RDII), and
- Wet weather peaking factor or Stormwater Inflow (SWI).

The Manual includes the typical ranges of the KPIs as well as threshold values. Exceeding these threshold values indicates a catchment that is more likely to have greater success in I/I reduction.

Table 1: KPI Threshold Values

Key Performance Indicator	Threshold Value
RDII	10%
GWI ₁	20%
GWI ₂	350 l/p/d
SWI	8

To increase the chances of success, the initial (pre-rehabilitation) catchment RDII% should be 10% or greater. Past projects that shown that typically, the greater the initial RDII, the greater the I/I reduction. GWI₁ greater than 20%, and GWI₂ greater than 280 l/p/d, indicate a moderate to high level of groundwater infiltration.

It should be noted that groundwater infiltration reduction projects are generally more costly than other forms of I/I reduction. This is due to the need for comprehensive sealing of pipes within the catchment.

2.2 PREDICTING I/I REDUCTION

The manual provides two key tools to help managers predict the I/I reduction for their projects. The first is a graph with a scatterplot of actual past project RDII reduction results versus percent catchment rehabilitated from New Zealand, Australia and North America.

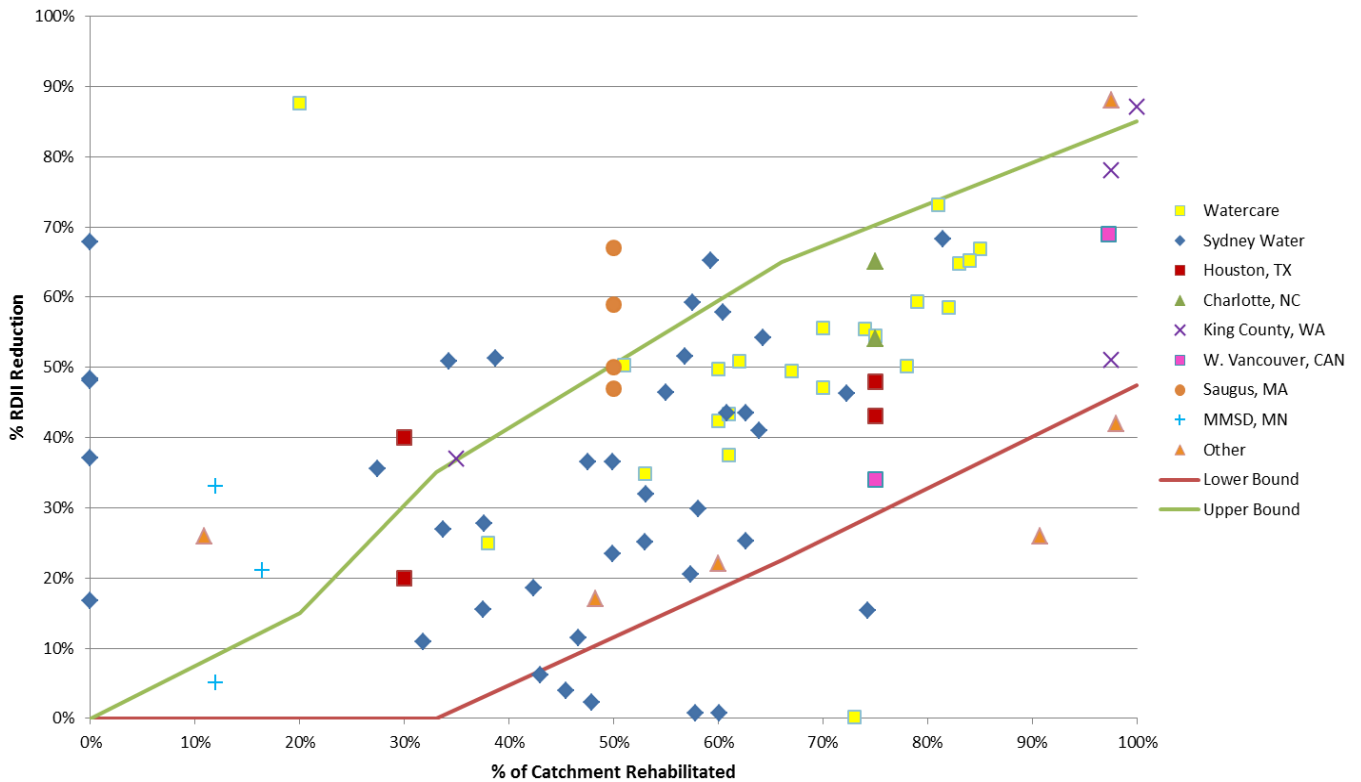


Figure 1: Past Project Results - RDII% Reduction vs. % Catchment Rehabilitated

The graph includes upper and lower bound lines to show the general trend that more catchment rehabilitation generally equates to greater RDII reduction. There is no doubt that there is still band of uncertainty between the two variables. However, this graph could help managers who would previously describe I/I reduction as uncontrollable and entirely unpredictable.

The second tool is an empirical model between three variables: Initial RDII percentage, percentage of total network that is rehabilitated, and the resultant percent RDII reduction. This model was developed by Watercare and is based on previous North Shore City Council projects results. Figure 2 shows the model graph.

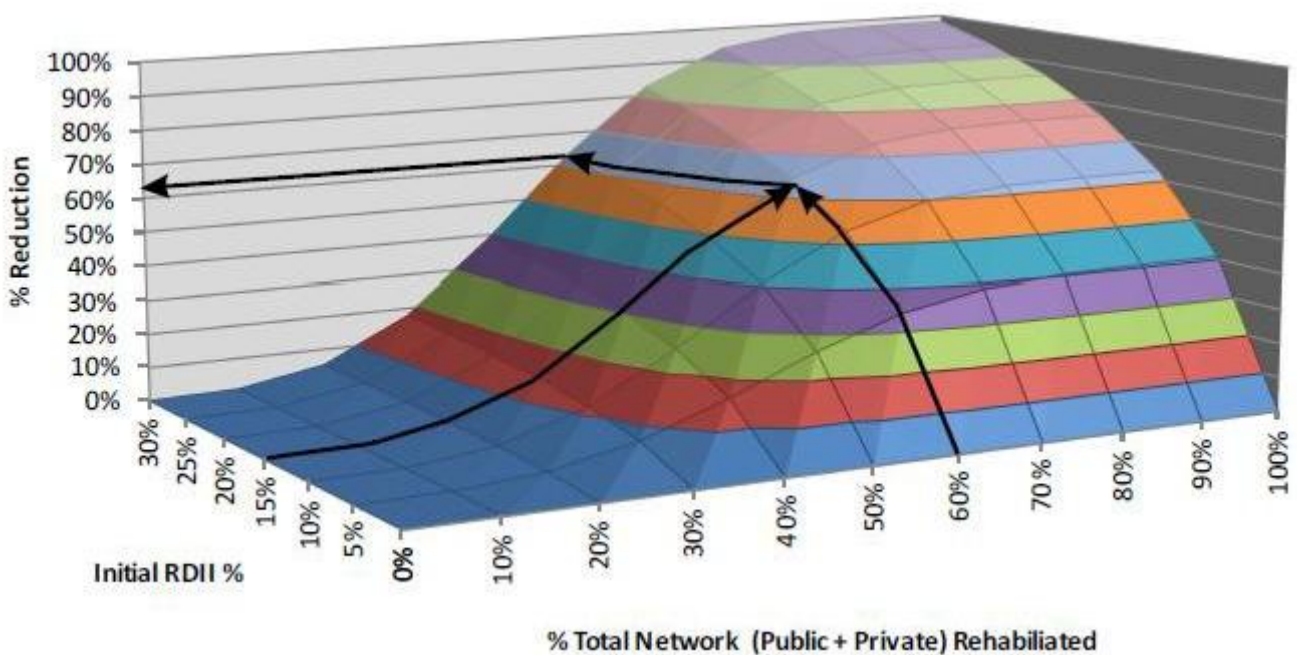


Figure 2: WaterCare I/I Prediction Model

It should be noted that this graph is based on certain catchments in the Auckland region and a specific analysis technique, and therefore should be more a guideline as opposed to being a precise prediction tool.

2.3 FIVE-STEP GOOD PRACTICE METHODOLOGY

The Manual presents a five-step good practice methodology for I/I reduction. Previous I/I projects that have excluded one or more of the steps have encountered obstacles to success. The five steps are:

1. Pre-rehabilitation monitoring and analysis
2. Source detection
3. System Rehabilitation
4. Post-rehabilitation monitoring and analysis, and
5. Effectiveness Assessment.

The Manual details the five steps, what is involved in each step, and the reason for including each step into the methodology.

PRE-REHABILITATION MONITORING AND ANALYSIS

Once it has been established that the indicative levels of I/I exceed the benchmark KPIs, or other levels of service are not being met, there are a number of steps to planning an effective detailed investigation which are described in this section in the Manual. These steps will enable the Council to develop an accurate picture of the existing wastewater system, I/I problems, and help to create the informational backbone of the I/I program.

SOURCE DETECTION

Source detection activities are described in this section of the Manual. These activities are aimed at identifying and locating sources of I/I with a view to their subsequent removal by rectification of their causal defect.

SYSTEM REHABILITATION

This section describes the methods and techniques used for the rehabilitation of public and private sewers. The structural condition of the sewer determined from the source detection works is often the main factor in determining what rehabilitation technique should be used to achieve the I/I reduction levels required.

POST-REHABILITATION MONITORING AND ANALYSIS

Post-rehabilitation flow monitoring and analysis should be performed in accordance with the procedures taken during the pre-rehabilitation stage. The quantity and locations of gauges and monitors (flow, rainfall, EC, etc.) should also be similar to the layout established during the pre-rehabilitation phase.

EFFECTIVENESS ASSESSMENT

I/I reduction effectiveness is the quantification of the actual amount of I/I reduction achieved through the rehabilitation works program. This section of the Manual describes I/I reduction effectiveness assessment as well as cost effectiveness assessment. Reduction determination involves calculating the differences in I/I levels for each of the I/I KPIs pre and post-rehabilitation. The Manual describes the different ways to quantify I/I reduction.

3 SOURCE FOR GLOBAL BEST PRACTICE

The Manual combines best practice from Councils and utilities around the world, including from New Zealand, Australia, the United States and Canada. The good practices and lessons learnt by these utilities have helped to bolster the contents of the Manual. In addition, the Case Studies section in the Manual includes many examples from New Zealand, but also a few cases from other countries.

3.1 LESSONS LEARNT

Under Federal EPA requirements, most utility owners in the United States are required by law to have 100% wastewater containment with no overflows at any time. This strict regulation has pushed many US utilities to aggressively pursue I/I reduction, and moreover, private property I/I works. Reduction outcomes have proven that approximately half the removable I/I gets in through private property laterals. The private property I/I section of The Manual takes advantage of lessons learnt from the US as well as those carried out here in New

Zealand. The I/I program management section of the Manual also takes advantage of their lessons learnt. This section of the Manual provides information to help managers avoid the common pitfalls of program management.

The private property I/I section includes a discussion on the advantages and disadvantages of various sewer lateral ownership agreements and their impact on the reduction of I/I. The following table, from the Private Property I/I section of the manual, shows different options for financing lateral rehabilitation, and the advantages and disadvantages of each option. This table draws on the experience of utilities that have experimented with various lateral ownership strategies. These utilities include not only US organisations, but also some from both New Zealand and Australia.

Table 2: Options Comparison for Funding Lateral Rehabilitation

	Option	Advantages	Disadvantages
1	Owner pays full cost	<ul style="list-style-type: none"> • Low funding commitment from agency 	<ul style="list-style-type: none"> • Lower participation rates • Long timeframe for complete rehabilitation • Low-income owners are disadvantaged
2	Agency pays full cost	<ul style="list-style-type: none"> • Higher participation rates • Relatively shorter timeframe for complete rehabilitation 	<ul style="list-style-type: none"> • May be cost-prohibitive • Legal issues with using public funding for private assets.
3	Agency pays partial cost	<ul style="list-style-type: none"> • Higher participation rates than 1 • More affordable than 2 • Increased funding for low-income owners could create more equitable situation 	<ul style="list-style-type: none"> • Legal issues with using public funding for private assets. • Lower participation rates than 2 • Less affordable than 1

3.2 CASE STUDIES

The case studies section of The Manual includes many cases from across New Zealand but also includes some cases from overseas that have unique lessons to be learned. A table is also provided to help the reader determine what issues each case study addresses. These overseas cases were chosen for their unique situation.

The section includes a case study from East Bay Municipal Utilities District (EBMUD) located in the San Francisco Bay Area in the United States. Beginning in 2009, EBMUD enacted a private sewer lateral programme in which the lateral to a property must be replaced or rehabilitated under one of three triggers. The three triggers are:

1. The sale of a property
2. Renovations in excess of \$100,000, or
3. Changing the water meter size.

The programme places the cost of replacement on the property owners, but work is only required under one of the three conditions. This conditional requirement attempts to create a more equitable situation and avoids a programme that would immediately require all homeowners to spend money regardless of their personal and financial circumstances.

4 COMPREHENSIVE DOCUMENT

The Manual includes a wide range of topics applicable to both practitioners and managers.

4.1 ASSET MANAGERS

The Manual working group provided direction to create a document that addresses their key I/I issues and concerns. Many of their concerns were high-level in nature. As described in the following paragraphs, the Manual includes sections that address these higher-level concerns.

I/I PROGRAMME MANAGEMENT

This section describes good practice I/I Programme Management, discusses some of the typical issues and challenges, and presents some solutions to address those challenges. I/I programmes often require significant funding, staffing resources, proactive engagement campaigns, and close collaboration with external and internal stakeholders. For these reasons, centralised management and leadership are particularly important and will help to define and keep organised, the many and varied aspects of the programme.

RELEVANT NZ LEGISLATION

Section 1 includes information on New Zealand legislation that is relevant to I/I management, including:

- Resource Management Act (RMA)
- Local Government Act (LGA)
- Building Act, Building Code and Building Consents, and
- Health Act.

Some of these pieces of legislation are risks to I/I management, such as how the RMA relates to wastewater overflows. Others, such as the LGA and Building Act, provide a basis for Councils to perform certain activities such as I/I investigations or drainage inspections.

COMMUNITY AND STAKEHOLDER ENGAGEMENT

Community engagement and communication is critical to successful I/I management. The multi-disciplinary nature of I/I management means that a wide range of stakeholders are involved and many parties are affected. Engagement planning should take into account everyone who will or may be affected by the programme. Both external and internal stakeholders should be engaged.

4.2 PRACTITIONERS

The Manual includes information useful to practitioners who are responsible for delivering the works, including engineers and maintenance personnel. The Source Detection and System Rehabilitation sections of the Manual include descriptions of different methods and technologies, the advantages and disadvantages of each method, and indicative unit cost rates for budgeting purposes. Practitioners are able to reference the information in these sections to undertake source detection and rehabilitation. The sections also include guidance on construction performance and quality, which are key to achieving I/I project success.

5 CONCLUSIONS

The Manual provides guidance on the implementation of an I/I programme from conception to implementation and post-project success determination. Sections in the Manual provide guidance on the preliminary evaluation of the I/I problem in the system, determining the drivers and goals of the programme, all the way to system rehabilitation and effectiveness assessment. Two key sections in the Manual include the KPIs section and Predicting I/I Reduction. The prediction section provides tools to help the reader predict the post-rehabilitation I/I reduction. These tools are based on outcomes from projects in New Zealand and around the world.

By drawing upon practices and project experience from sources around the world, the Manual is a single source of global best practice. By providing prediction tools and good practice methodologies, the Manual facilitates the reduction of risk and uncertainty in I/I projects and programmes. As a document that includes information applicable to both asset managers and practitioners, it is a comprehensive guide for I/I management in New

Zealand. The Manual has been published by Water New Zealand and can be accessed for free online at www.waternz.org.nz.

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