1.0 Introduction

1.1 The Stream Depletion Issue

The management of water resources has often focussed on groundwater and surface water as if they were separate resources. However, nearly all surface water features (streams, lakes, springs, wetlands, estuaries and the sea-coast) interact with groundwater. Consequently, effective water management requires a good understanding of the way in which interaction between groundwater and surface water takes place.

The interactions between groundwater and surface water take many forms, which affect both the quantity and the quality of water in both resources. These interactions are often difficult to observe and measure, which creates uncertainty regarding their magnitude, their effect and an appropriate form of management. One of the potentially most significant forms of interaction is the effect of groundwater pumping on surface waterways. This is commonly referred to as the stream depletion effect. Understanding this particular form of interaction is becoming increasingly important as greater abstraction demands are placed on both surface and ground waters.

1.2 Purpose of the Guidelines

This technical guideline has been prepared to help the recognition of situations where significant stream depletion effects may occur and to provide tools that quantify the effects of groundwater abstraction on surface waterways. These tools apply to the assessment of single pumping wells, or small groups of wells by using the superposition of single well effects. The cumulative effects of large numbers of wells is best dealt with through the preparation of regional groundwater flow models, which is beyond the scope of this guideline document.

The quantification of the stream depletion effect caused by groundwater abstractions is a necessary component of the Assessment of Environmental Effects which is required by the Resource Management Act when applying for a resource consent to take groundwater.

The purpose of the guideline is to assist both resource consent applicants and the Regional Councils and Unitary Authorities who assess these applications. It is also expected that the quantification of these effects will be a necessary first step to allow the development of effective water management policies to deal with stream depletion effects.

Natural groundwater systems are inherently complex and it is well recognised that any attempts to quantify their behaviour requires gross simplification of the natural variability. The effect of groundwater pumping on surface waterways is no exception.

This guideline presents a pragmatic approach to assessing the effect, while also recognising the approximate nature of the assessment methods.

1.3 Structure of the Guidelines

The guideline has been structured in the following way:

Section 2: General Concepts of Stream-Aquifer Interaction

A stand-alone section which outlines the typical settings where groundwater and surface water interact.

Section 3: Initial Screening of Sites

Definition of some general hydrogeologic criteria which define whether or not groundwater pumping is likely to create a depleting effect on surface waterways.

Section 4: Assessment Methods

A description of tools that are available to quantify the effect of groundwater pumping on surface waterways.

Section 5: Non-uniform Hydrogeological Settings

A description of some common hydrogeological settings that do not match the analytical assessment methods.

Section 6: Field Measurements to Assist Assessments

A description of field measurements that can be made to define the parameters needed for the assessment methods presented in Section 4.

Section 7: Management Implications

This section discusses an approach for assessing the stream depletion effect in resource consent applications and provides some preliminary comments on how quantification of these stream depletion effects can contribute to the development of effective water management policies.

Appendices: Typical Examples

Actual field measurements of groundwater pumping effects are presented and assessed in Appendices A – D. Appendix E presents a summary brochure of the guidelines.

This technical guideline provides a detailed assessment of the stream depletion issue. It is accompanied by a simpler introductory note which summarises the key information in a more user friendly format.

1.4 Summary of Symbols

A	a cross-sectional area perpendicular to the direction of water flow [L^2]
b	the thickness of the aquifer [L]
D	the depth of water in the stream [L]
H	the depth to the water table below the stream water surface [L]
$h_{aquifer}$	the elevation of water in the aquifer [L]
h_{stream}	the elevation of the stream water surface [L]
Δh	the difference in elevation between the water surface in the stream and the groundwater in the aquifer [L]
i	the hydraulic gradient between the stream water and the groundwater [dimensionless]
I	the seepage per unit area of streambed [L/T]
K	the hydraulic conductivity of the aquifer underneath and/or adjacent to the streambed [L/T]
K'	the vertical hydraulic conductivity of the streambed [L/T]
L	the length of a stream reach over which seepage is assessed [L]
ℓ	the perpendicular separation distance between a well and a stream which is approximated by a straight line [L]
lambda = λ	the streambed conductance (a measure of the hydraulic conductivity and dimensions of the streambed) [L/T]
M	the thickness of the streambed which has a hydraulic conductivity of K' [L]
Q	the abstraction rate from a well [L^3/T]
q	the flow of water between the stream and the aquifer, i.e. the stream depletion flow rate [L^3/T]
S	the storage coefficient of the aquifer (a measure of how much water is released from the pore space of the aquifer as water pressures fall) [dimensionless]
T	the transmissivity of an aquifer (a measure of how permeable the aquifer is) [L^2/T]
t	the length of time over which abstraction from a well takes place [T]
W	the width of a stream reach over which seepage is assessed [L]

1.5 Summary of Unit Symbols

[unit symbols are shown in square brackets]

L length (e.g. metres)

T time (e.g. days)

e.g. terms with units of [L^3/T] could be defined as m^3/day or litres/second (L/s).

NB consistent units must be used for all calculations.