

PROJECT
**GROUNDWATER
MANAGEMENT PLAN
KINGS FOREST STAGE 1
PROJECT APPLICATION
KINGS FOREST
NEW SOUTH WALES**

PREPARED FOR
PROJECT 28 PTY LTD

DATE
FEBRUARY 2011

DOCUMENT CONTROL

DOCUMENT 10468_GMP_RMH1F.docx

TITLE Groundwater Management Plan, Kings Forest Stage 1 Project Application, Kings Forest, New South Wales

PROJECT MANAGER N. Sutherland

AUTHOR(S) M. Hancock

CLIENT Project 28 Pty Ltd

CLIENT CONTACT Reg van Rij

CLIENT REFERENCE –

SYNOPSIS This report constitutes a Groundwater Management Plan (GMP) for the entirety of the Kings Forest Stage 1 Project Application, including the golf course within precincts 12 and 13. This report should be read in conjunction with the Groundwater Assessment. The GMP establishes responsibilities and procedures for the management of groundwater during the pre-bulk earthworks, bulk earthworks, landform stabilisation phase, civil construction, on maintenance and operational life of the project. The implementation of the GMP provisions will help to ensure work is conducted in an environmentally responsible manner.

REVISION HISTORY

REVISION #	DATE	EDITION BY	APPROVED BY
1	2/11	M. Hancock	P. Mathew / L. Varcoe

DISTRIBUTION

	REVISION NUMBER									
Distribution	1	2	3	4	5	6	7	8	9	10
Project 28 Pty Ltd	1									
JBA Planning	1									
G&S file	1									

BRISBANE

CAIRNS

KAWANA

ROBINA

5/232 Robina Town Centre Dr.
PO Box 4115
Robina Q4230

Phone 07 5578 9944

Fax 07 5578 9945

robina@access.gs

Gilbert and Sutherland Pty Ltd
ABN 56 077 310 840

www.access.gs

SUMMARY

Project 28 Pty Ltd commissioned Gilbert & Sutherland Pty Ltd (G&S) to prepare a Groundwater Management Plan (GMP) in support of the Kings Forest Stage 1 Project Application at Kings Forest, Cudgen, New South Wales.

The GMP should be read in conjunction with the Groundwater Assessment. The GMP identifies and describes strategies for the management of site constraints and their likely impacts during the pre-bulk earthworks, bulk earthworks, landform stabilisation phase, civil construction, on-maintenance and operational phases of the proposed development of Stage 1, in accordance with the project application.

CONTENTS

1	Groundwater Management Plan	6
1.1	Aims and objectives	6
1.2	Scope of this document	6
1.3	Implementation	6
1.4	GMP structure	7
1.5	General commitments	8
1.6	Definitions	8
1.7	Contact details	9
2	Baseline data collection phase	10
2.1	Intent	10
2.2	Background water quality monitoring	10
3	Management of potential impacts – bulk earthworks phase	12
3.1	Intent	12
3.2	Groundwater monitoring	12
3.3	Groundwater seepage monitoring	15
4	Management of potential impacts – landform stabilisation phase	18
4.1	Intent	18
4.2	Groundwater monitoring	18
5	Management of potential impacts – Civil construction	21
5.1	Intent	21
5.2	Groundwater monitoring	21
5.3	Groundwater seepage monitoring	24
5.4	Golf course water conservation	27
5.5	Water management (golf course irrigation)	29
5.6	Golf course nutrient management	32
6	Management of potential impacts – On maintenance phase ...	36
6.1	Intent	36
6.2	Implementation	Error! Bookmark not defined.
6.3	Groundwater monitoring	37
6.4	Golf course water conservation	39
6.5	Water management (golf course irrigation)	41
6.6	Golf course nutrient management	44

7	Management of potential impacts – operational phase	48
7.1	Intent	48
7.2	Groundwater monitoring	48
7.3	Golf course water conservation	51
7.4	Water management (golf course irrigation)	53
7.5	Golf course nutrient management	56
8	Administration of the GMP	60
8.1	Amendment of the GMP	60
8.2	Incident management	60

1 Groundwater Management Plan

1.1 Aims and objectives

This Groundwater Management Plan (GMP) provides a framework to ensure that any impacts to groundwater from the on-site activities are managed, treated, monitored, reported and, if necessary, mitigated.

The GMP aims to achieve the following:

- Provide evidence of practical and achievable plans for the management of site activities.
- To ensure that legislative and environmental requirements are complied with by producing an integrated planning framework for comprehensive monitoring and control of operational impacts. Specific commitments on strategies and design standards to be employed are also given.
- A framework for regulatory authorities and the proponent to confirm compliance with policies and conditions.
- Evidence to the community that the operation is being managed in an environmentally acceptable manner.

The objectives of this GMP are to ensure the following:

- All reasonable and practical measures are taken to prevent and/or minimise the likelihood of environmental harm being caused.
- On-site activities occur without adverse environmental impact or causing nuisance to nearby sensitive receptors.
- Operation of the golf course within precincts 12 and 13 will provide an effective buffer separating the urban development from SEPP 14 wetlands and environmental protection zones that are adjacent to the site.

1.2 Scope of this document

This document constitutes an overarching GMP for the activities involved with the development works to be undertaken for the Stage 1 Project Application for the Kings Forest development area. As such, it is the intent of the document to address the environmental issues relating to groundwater that may arise onsite with regard to the proposed activities involved in completing the bulk earthworks and civil works, on-maintenance and operations of the site.

Although addressing the issues, it is not within the scope of this document to detail the full extent of each issue, but rather to link and integrate the range of management issues governing each individual aspect. The reports specific to the development of the GMP include:

- Kings Forest Stage 1 Project Application and associated documentation.
- Site Based Management Plan (Gilbert & Sutherland, February 2011).
- Acid Sulfate Soils Assessment and Management Plan (Gilbert & Sutherland, February 2011).
- Integrated Water Cycle Management Plan (Gilbert & Sutherland, February 2011).
- Groundwater Assessment and Management Plan (Gilbert & Sutherland, February 2011).
- Review of Environmental Management Plan (ePar 2009).

1.3 Implementation

The GMP requires the Proponent to mitigate the potential environmental impacts related to groundwater associated with the construction of the development works during the baseline data

collection phase, bulk earthworks, landform stabilisation phase, civil construction, on-maintenance and operational phases.

1.4 GMP structure

This GMP acknowledges the environmental impacts to groundwater associated with the construction and operations of the proposed development and details strategies to mitigate them. Each control strategy is based upon proven environmental management methods and is presented as a commitment.

The GMP is based on a series of tables for the baseline data collection phase, bulk earthworks, landform stabilisation phase, civil construction, on-maintenance and operational phases of the development. The person responsible for the implementation of the measures detailed is written on the table itself. The tables then detail the issue, the performance criteria, the implementation strategy, monitoring, auditing, reporting, failure identification and the corrective action. The detachable pages within each section detail the provisions of the GMP. The format is presented below for reference purposes.

Title

Applies to	The relevant construction stages to which the issue detailed on this page applies.
Person responsible	This is the person(s) who has accepted the responsibility of implementing the GMP provisions detailed on this page.

Issue	The issue with which the table deals.
Operational policy	The operational policy or management objective that applies to the element.
Performance criteria	Performance criteria (outcomes) for each element of the operation.
Implementation strategy	The strategies or tasks (to nominated operational design standards) that will be implemented to achieve the performance criteria.
Monitoring	The monitoring requirements which will measure actual performance (i.e. specified limits to pre-selected indicators of change).
Auditing	The auditing requirements, which will verify implementation of, agreed construction and operation phase environmental management strategies and compliance with agreed performance criteria.
Reporting	Content, timing and responsibility for reporting and auditing of monitoring results.

Identification of incident or failure	The circumstances under which the agreed performance criteria are unlikely to be met and environmental harm is likely to result.
Corrective action	The action to be implemented in case a performance requirement is not reached and the company(s) responsible for action.

Commitment

What the management has committed the company to.

An objective of the tabular format is to allow for change and allow the GMP to be a working document. If items need altering, changes may be made to the individual tables after appropriate consultation with the statutory authorities.

1.5 General commitments

Commitment 1

The development shall proceed in accordance with the construction staging detailed in any approved engineering drawings. The Proponents undertake to comply with the environmental implementation strategy relating to groundwater as contained within the approved final GMP at all times throughout the baseline data collection phase, bulk earthworks, site stabilisation phase, civil construction, on-maintenance and operational phases.

Commitment 2

The Proponents undertake to fulfil all commitments made in the approved GMP and to carry out their activities on the project site in accordance with relevant current statutory requirements and approved amendments.

Commitment 3

The principal golf course management operating the golf course within precincts 12 and 13 shall comply with the environmental implementation strategy relating to groundwater as contained within the approved GMP during the operational phase.

1.6 Definitions

In this GMP these terms have the following meanings;

- GMP means the approved Groundwater Management Plan and includes any amendments that may be approved from time to time.
- Development means the development of the site in accordance with the Kings Forest Stage 1 Project Application.
- TSC means Tweed Shire Council.
- Proponent means the person undertaking the construction of the proposed Kings Forest Stage 1 and includes the person nominated by the Proponent as having the responsibility for implementing the provisions of the GMP.
- DECCW means the Department of Environment, Climate Change and Water.

1.7 Contact details

The following persons are responsible for the implementation of the management measures described in the individual tables of the GMP.

Contractor's Site Manager

The name and address of the Contractor and its representative will be notified to TSC by the Consulting Engineer prior to the commencement of each contract/stage of the project.

Consulting Engineer

Unless advised otherwise the Consulting Engineer is:

Company: TBA

Address:

Contact Details:

Phone:

Facsimile:

2 Baseline data collection phase

2.1 Intent

This part of the GMP specifies those matters which must be complied with by the Proponent during the baseline data collection phase, being the period prior to bulk earthworks when baseline monitoring is being undertaken.

2.2 Background water quality monitoring

Applies to	Baseline data collection phase
Person responsible	Nominated Environmental Consultant

Issue	Establishing appropriate discharge criteria for the construction phase. To determine the existing water quality conditions at the site (levels and quality) and examine any seasonal variations that may result from increased precipitation. This would serve as 'baseline' data and allow comparison with level and quality results recovered during the bulk earthworks and civil construction phase of works at the site.
Operational policy	To determine existing water quality parameters for the proposed Kings Forest Stage 1 area, prior to construction.
Performance criteria	The performance criteria shall be set by background monitoring of pre-construction water quality conditions. The following parameters shall be monitored for a minimum of eight (8) rounds of monitoring: • pH (field measurement); • electrical conductivity (field measurement); • turbidity (field measurement); • dissolved oxygen (field measurement); • temperature (field measurement); • suspended solids (mg L^{-1}); • total and nitrate, nitrite and ammonium (mg L^{-1}); • total and soluble phosphorus (mg L^{-1}); • total and soluble iron and filtered aluminium; and • oil and grease (visual inspection). • calcium; • magnesium; • potassium • sodium • dissolved manganese; • bicarbonate; • carbonate;

	• chloride; • sulfate; and • colour. Laboratory analysis for total acidity (titratable) should also be undertaken on a monthly basis by a NATA accredited laboratory to determine the total potential acidity hazard that may be associated with groundwater at the site.
Implementation strategy	Surface water quality and groundwater level and quality monitoring on a monthly basis from established monitoring locations prior to commencement of bulk earthworks. Following the completion of background monitoring, a water quality report, including results and interpretation would be prepared and submitted to TSC for review.
Monitoring	Background monitoring shall be conducted by a qualified Environmental Scientist for the parameters listed above to allow the interpretation of data for statistical analysis and groundwater modelling purposes.
Auditing	The consultant will audit the results and submit a background groundwater quality report to TSC prior to the commencement of construction works.
Reporting	A background report to TSC including raw data, a results summary and a discussion comparing results with ANZECC guidelines.
Identification of incident or failure	Failure to collect adequate rounds of data prior to commencement of bulk earthworks.
Corrective action	• Cease works until data is available. • Increase frequency of monitoring until sufficient data is available.

Commitment

The Proponent will undertake background water quality monitoring to ascertain existing conditions at the site prior to bulk earthworks commencing.

3 Management of potential impacts – bulk earthworks phase

3.1 Intent

This part of the GMP specifies those matters which must be complied with by the Proponent during the bulk earthworks phase, being the period during which cut and fill works are being undertaken. The obligations in this section of the GMP must be complied with by the Proponent until each precinct is at final grade and stabilised.

3.2 Groundwater monitoring

Applies to:	Bulk earthworks phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Groundwater monitoring.
Operational policy	To establish the stable groundwater conditions and verify by monitoring that development management is appropriate.
Performance criteria	Water quality objectives for the bulk earthworks phase of works would be devised using DECCW guidelines for groundwater monitoring. These proposed objectives would be submitted to TSC for review and approval prior to implementation. Groundwater monitoring will be undertaken for the following parameters: • pH (field measurement); • electrical conductivity (field measurement); • turbidity (field measurement); • dissolved oxygen (field measurement); • temperature (field measurement); • suspended solids (mg L^{-1}); • total and nitrate, nitrite and ammonium (mg L^{-1}); • total and soluble phosphorus (mg L^{-1}); • total and soluble iron and filtered aluminium; and • oil and grease (visual inspection). • calcium; • magnesium; • potassium • sodium • dissolved manganese; • bicarbonate; • carbonate; • chloride;

Implementation strategy	• sulfate; and • colour. Laboratory analysis for total acidity (titratable) and total alkalinity should also be undertaken.
	Monitoring of groundwater levels should be undertaken fortnightly during the construction phase to determine any effect excavation and dewatering activities may have on groundwater levels. Groundwater samples are to be collected monthly and analysed for the parameters specified above.
Monitoring	Carry out fortnightly groundwater level monitoring and monthly groundwater quality monitoring at locations to be specified. Sample recovery and in-situ analysis will be performed by onsite staff and, when required, samples will be forwarded to a NATA accredited laboratory.
Auditing	The environmental consultant is to audit water quality to ensure that no deleterious effects are resulting from any excavation, filling and dewatering operations at the site. The data from the water level measurement shall be collated quarterly and evaluated against the background monitoring data. It will also be used to verify the predictive model for groundwater behaviour.
Reporting	Quarterly reports are to be submitted to TSC within one (1) month of the collection of water quality data. The quarterly reports to TSC shall include raw data, a results summary and a discussion comparing results with baseline values and ANZECC guidelines. Result sheets to be compiled for monitoring results. All results shall be made available for inspection by local and state government officers when requested.
Identification of incident or failure	Degradation of groundwater quality at the monitoring points to below the "Performance Criteria" levels (to be derived following baseline monitoring). Variations in groundwater levels beyond typical seasonal fluctuations.
Corrective action	If the test results for any parameter fails to meet the performance criteria (to be determined based on background monitoring), further investigations will be conducted. This will involve fortnightly groundwater quality monitoring (or more frequent if deemed necessary by the environmental consultant) of the subject parameter(s). The results of the investigation should ascertain if the incident/failure is an anomaly or if a sustained decline in groundwater quality is present. If a trend exists for declining groundwater quality, the likely source(s) of contamination will be identified. Should the investigation indicate that site activities are triggering the

incident/failure, the following will be implemented:

- Locate the source of the contamination/level variation and take all possible actions to contain and control the contaminant/level variation. Investigate the cause of the contamination/level variation and take action to prevent a recurrence.
- All development activities taking place at the time of incident/failure shall be reviewed to verify compliance with the GMP provisions and, if necessary, construction methods and procedures shall be adjusted.

The quality of the dewatered groundwater being discharged to recharge trenches shall be reviewed to confirm compliance with the performance criteria detailed below.

Water Quality Parameter	Release Criteria	Criteria Type
pH	As developed from background monitoring	Range
Oil and grease	No visible film, no detectable odour	-

Commitment

The contractor will seek to establish stable groundwater conditions and verify by monitoring that development management is appropriate.

3.3 Groundwater seepage monitoring

Applies to:	Bulk earthworks phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Groundwater seepage monitoring.																																							
	Management of groundwater seepage quality entering excavation areas.																																							
Operational policy	To minimise and manage the generation of acidic waters entering the onsite excavation areas through seepage. To provide for monitoring and treatment of these waters prior to disposal.																																							
Performance criteria	Daily pH monitoring of any seepage within the excavation areas is to be undertaken prior to the disposal of these waters via dewatering. All waters discharged from the excavation areas to the recharge trenches during the construction phase should comply with the following criteria: <table><tr><th>Water Quality Parameter</th><th>Release Criteria</th><th>Criteria Type</th></tr><tr><td>pH</td><td>As developed from background monitoring</td><td>Range</td></tr><tr><td>Oil and grease</td><td>No visible film or detectable odour</td><td>--</td></tr></table> Where the discharge of dewatered groundwater to on-site or nearby drains and waterways is intended, water quality will satisfy the following performance criteria prior to release at the controlled discharge locations: <table><tr><th>Water Quality Parameter</th><th>Release Criteria</th><th>Criteria Type</th></tr><tr><td>pH*</td><td>As developed from background monitoring</td><td>Range</td></tr><tr><td>Electrical conductivity</td><td><1.5mS cm⁻¹</td><td>Maximum</td></tr><tr><td>Suspended solids</td><td><50mg L⁻¹</td><td>Maximum</td></tr><tr><td>Turbidity</td><td>As developed from background monitoring</td><td>Maximum</td></tr><tr><td>Dissolved oxygen</td><td>60-105% saturation</td><td>Minimum</td></tr><tr><td>Total and dissolved Iron</td><td><0.3mg L⁻¹</td><td>Maximum</td></tr><tr><td>Total and dissolved Aluminium</td><td>As developed from background monitoring</td><td>Maximum</td></tr><tr><td>Litter and gross pollutants</td><td>No man made material >5mm in any dimension</td><td>-</td></tr><tr><td>Oil and grease</td><td>No visible film, no detectable odour</td><td>-</td></tr></table>	Water Quality Parameter	Release Criteria	Criteria Type	pH	As developed from background monitoring	Range	Oil and grease	No visible film or detectable odour	--	Water Quality Parameter	Release Criteria	Criteria Type	pH*	As developed from background monitoring	Range	Electrical conductivity	<1.5mS cm ⁻¹	Maximum	Suspended solids	<50mg L ⁻¹	Maximum	Turbidity	As developed from background monitoring	Maximum	Dissolved oxygen	60-105% saturation	Minimum	Total and dissolved Iron	<0.3mg L ⁻¹	Maximum	Total and dissolved Aluminium	As developed from background monitoring	Maximum	Litter and gross pollutants	No man made material >5mm in any dimension	-	Oil and grease	No visible film, no detectable odour	-
Water Quality Parameter	Release Criteria	Criteria Type																																						
pH	As developed from background monitoring	Range																																						
Oil and grease	No visible film or detectable odour	--																																						
Water Quality Parameter	Release Criteria	Criteria Type																																						
pH*	As developed from background monitoring	Range																																						
Electrical conductivity	<1.5mS cm ⁻¹	Maximum																																						
Suspended solids	<50mg L ⁻¹	Maximum																																						
Turbidity	As developed from background monitoring	Maximum																																						
Dissolved oxygen	60-105% saturation	Minimum																																						
Total and dissolved Iron	<0.3mg L ⁻¹	Maximum																																						
Total and dissolved Aluminium	As developed from background monitoring	Maximum																																						
Litter and gross pollutants	No man made material >5mm in any dimension	-																																						
Oil and grease	No visible film, no detectable odour	-																																						

	*Note that pH will be consistent with receiving water quality. If receiving waters are estuarine, pH should be 6.5 – 8.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the <i>Threatened Species Management Plan</i> (JWA 2011) for habitat requirements for Wallum Froglet (<i>Crinia signifera</i>) and Olongburra Frog (<i>Litoria olongburensis</i>).
Implementation strategy	The site contractor shall be equipped with reliable pH monitoring equipment that will be calibrated on a weekly basis (at least). Dewatered groundwater will undergo appropriate treatment to ensure compliance with the above criteria prior to release into recharge trenches. Where disposal to surface water bodies is intended monitoring will be undertaken at the controlled discharge points by the environmental consultant monthly and during rainfall events (defined as >25mm in any 24 hour period). Records of the measured pH, time of monitoring, calibration records and treatment measures employed are to be kept on site for inspection by the environmental consultant and TSC. The total acid risk of seepage waters shall be determined from the total acidity (titratable) results measured during the background monitoring program. These results will be considered during the preparation of a treatment program for any dewatered acidic groundwater. Outside the construction area of each stage existing surface water conditions shall be maintained with reference to background monitoring in accordance with the Site Based Management Plan (Gilbert & Sutherland 2011) provisions. If acidic seepage waters are encountered, the batter slopes of the excavation face should be subject to blanket liming as required at a predetermined rate in accordance with the Acid Sulfate Soil Management Plan (Gilbert & Sutherland 2011) provisions. The addition of liquid lime to acidic seepage waters may also be required. The environmental consultant should be consulted to determine the need for this treatment and the required addition rate in accordance with the Acid Sulfate Soil Management Plan (Gilbert & Sutherland 2011) provisions. Where recharge trenches are required, the base and sides of the trench should also be blanket limed at a predetermined rate prior to the disposal of dewatered groundwater in accordance with the Acid Sulfate Soil Management Plan (Gilbert & Sutherland 2011) provisions.. Before undertaking any earthworks in drains or watercourses, the drain or watercourse will be bunded and contained in a staged manner, with water tested and treated prior to discharge. Particular attention will be given to watercourses containing high levels of organic matter that may also have the potential to form monosulfidic black oozes (MBOs). Existing MBOs will be managed, with organic material within the drain kept to a minimum and dissolved oxygen concentrations within water-bodies monitored and increased if necessary (in accordance with the recommendations outlined

Monitoring	in Tulau (2007). Titratable Actual Acidity contents and water pH levels of water-bodies will also be monitored and adjusted as necessary.
	Carry out daily pH monitoring of seepage waters entering excavations during the construction phase prior to disposal into recharge trenches.
	Where disposal to surface water bodies is intended, all waters leaving the site at the controlled discharge points will be monitored for pH, electrical conductivity, suspended solids, dissolved oxygen, oil and grease monthly and during rainfall events. Analysis for total algae numbers will also be conducted monthly and during rainfall events once the waterbody(ies) have been brought online and are operational.
	Monitoring for aluminium and total and dissolved iron will occur on a monthly basis at water holding locations prior to discharge off site. Samples will be forwarded to a NATA registered laboratory for analysis when required.
Auditing	A visual inspection of the contractor's monitoring and treatment records shall be undertaken to verify sufficient monitoring and treatment is being undertaken.
	Management to audit water quality results monthly to verify that discharges comply with the performance criteria.
Reporting	Recording of monitoring results and treatment procedures is required. Results are to be available onsite at all times.
Identification of incident or failure	Discharge of ground waters to recharge trenches that do not satisfy the nominated pH range for this site.
Corrective action	Take necessary steps to address the problem and apply remedial measures to prevent the generation of excessive acid seepage waters (i.e. blanket liming of excavated faces and recharge trenches).

Commitment

The contractor will minimise and manage the generation of acidic waters entering the onsite excavation areas through seepage and to monitor and treat these waters prior to disposal.

4 Management of potential impacts – landform stabilisation phase

4.1 Intent

This part of the GMP specifies those matters which must be complied with by the Proponent during the landform stabilisation phase, being the period following completion of bulk earthworks when each precinct is at final grade and stabilised, but prior to the commencement of civil construction.

4.2 Groundwater monitoring

Applies to:	Landform stabilisation phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Groundwater monitoring.
Operational policy	To establish the stable groundwater conditions and verify by monitoring that development management is appropriate.
Performance criteria	Water quality objectives for the construction phase of works would be devised using DECCW guidelines for groundwater monitoring. These proposed objectives would be submitted to TSC for review and approval prior to implementation. Groundwater monitoring will be undertaken for the following parameters: • pH (field measurement); • electrical conductivity (field measurement); • turbidity (field measurement); • dissolved oxygen (field measurement); • temperature (field measurement); • suspended solids (mg L^{-1}); • total and nitrate, nitrite and ammonium (mg L^{-1}); • total and soluble phosphorus (mg L^{-1}); • total and soluble iron and filtered aluminium; and • oil and grease (visual inspection). • calcium; • magnesium; • potassium • sodium • dissolved manganese; • bicarbonate; • carbonate; • chloride; • sulfate; and

Implementation strategy	• colour. Laboratory analysis for total acidity (titratable) and total alkalinity should also be undertaken.
	Monitoring of groundwater levels should be undertaken quarterly during the landform stabilisation phase. Groundwater samples are to be collected quarterly and analysed for the parameters specified above.
	Carry out quarterly groundwater level and quality monitoring at locations to be specified. Sample recovery and in-situ analysis will be performed by onsite staff and, when required, samples will be forwarded to a NATA accredited laboratory.
Auditing	The environmental consultant is to audit water quality annually to ensure that no deleterious effects are resulting from any excavation, filling and dewatering operations at the site.
Reporting	Annual reports are to be submitted to TSC. The annual reports to TSC shall include raw data, a results summary and a discussion comparing results with baseline values and ANZECC guidelines. Result sheets to be compiled for monitoring results. All results shall be made available for inspection by local and state government officers when requested.
Identification of incident or failure	Degradation of groundwater quality at the monitoring points to below the "Performance Criteria" levels (to be derived following baseline monitoring). Variations in groundwater levels beyond typical seasonal fluctuations.
Corrective action	If the test results for any parameter fails to meet the performance criteria (to be determined based on background monitoring), further investigations will be conducted. This will involve fortnightly groundwater quality monitoring (or more frequent if deemed necessary by the environmental consultant) of the subject parameter(s). The results of the investigation should ascertain if the incident/failure is an anomaly or if a sustained decline in groundwater quality is present. If a trend exists for declining groundwater quality, the likely source(s) of contamination will be identified. Should the investigation indicate that site activities are triggering the incident/failure, the following will be implemented: • Locate the source of the contamination/level variation and take all possible actions to contain and control the contaminant/level variation. Investigate the cause of the contamination/level variation and take action to prevent a recurrence.

- All development activities taking place at the time of incident/failure shall be reviewed to verify compliance with the GMP provisions and, if necessary, construction methods and procedures shall be adjusted.

The quality of the dewatered groundwater being discharged to recharge trenches shall be reviewed to confirm compliance with the performance criteria detailed below.

Water Quality Parameter	Release Criteria	Criteria Type
pH	As per background monitoring	Range
Oil and grease	No visible film, no detectable odour	-

Commitment

The contractor will seek to establish stable groundwater conditions and verify by monitoring that development management is appropriate.

5 Management of potential impacts – Civil construction

5.1 Intent

This part of the GMP specifies those matters which must be complied with by the Proponent during the civil construction phase, being the period after the landform stabilisation phase but before the on-maintenance phase commences in each stage.

5.2 Groundwater monitoring

Applies to:	Civil construction phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Groundwater monitoring.
Operational policy	To establish the stable groundwater conditions and verify by monitoring that development management is appropriate.
Performance criteria	Water quality objectives for the construction phase of works would be devised using DECCW guidelines for groundwater monitoring. These proposed objectives would be submitted to TSC for review and approval prior to implementation. Groundwater monitoring will be undertaken for the following parameters: • pH (field measurement); • electrical conductivity (field measurement); • turbidity (field measurement); • dissolved oxygen (field measurement); • temperature (field measurement); • suspended solids (mg L^{-1}); • total and nitrate, nitrite and ammonium (mg L^{-1}); • total and soluble phosphorus (mg L^{-1}); • total and soluble iron and filtered aluminium; and • oil and grease (visual inspection). • calcium; • magnesium; • potassium • sodium • dissolved manganese; • bicarbonate; • carbonate; • chloride; • sulfate; and

Implementation strategy	• colour. Laboratory analysis for total acidity (titratable) and total alkalinity should also be undertaken.
	Monitoring of groundwater levels should be undertaken monthly during the civil construction phase. Groundwater samples are to be collected monthly and analysed for the parameters specified above.
	Carry out monthly groundwater level and quality monitoring at locations to be specified. Sample recovery and in-situ analysis will be performed by onsite staff and, when required, samples will be forwarded to a NATA accredited laboratory.
Auditing	The environmental consultant is to audit water quality annually to ensure that no deleterious effects are resulting from any excavation, filling and dewatering operations at the site.
Reporting	• Annual reports are to be submitted to TSC. • The annual reports to TSC shall include raw data, a results summary and a discussion comparing results with baseline values and ANZECC guidelines. • Result sheets to be compiled for monitoring results. All results shall be made available for inspection by local and state government officers when requested.
Identification of incident or failure	• Degradation of groundwater quality at the monitoring points to below the "Performance Criteria" levels (to be derived following baseline monitoring). • Variations in groundwater levels beyond typical seasonal fluctuations.
Corrective action	If the test results for any parameter fails to meet the performance criteria (to be determined based on background monitoring), further investigations will be conducted. This will involve fortnightly groundwater quality monitoring (or more frequent if deemed necessary by the environmental consultant) of the subject parameter(s). The results of the investigation should ascertain if the incident/failure is an anomaly or if a sustained decline in groundwater quality is present. If a trend exists for declining groundwater quality, the likely source(s) of contamination will be identified. Should the investigation indicate that site activities are triggering the incident/failure, the following will be implemented: • Locate the source of the contamination/level variation and take all possible actions to contain and control the contaminant/level variation. Investigate the cause of the contamination/level variation and take action to prevent a recurrence.

- All development activities taking place at the time of incident/failure shall be reviewed to verify compliance with the GMP provisions and, if necessary, construction methods and procedures shall be adjusted.

The quality of the dewatered groundwater being discharged to recharge trenches shall be reviewed to confirm compliance with the performance criteria detailed below.

Water Quality Parameter	Release Criteria	Criteria Type
pH	As developed from background monitoring	Range
Oil and grease	No visible film, no detectable odour	-

Commitment

The contractor will seek to establish stable groundwater conditions and verify by monitoring that development management is appropriate.

5.3 Groundwater seepage monitoring

Applies to:	Civil construction phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Groundwater seepage monitoring. Management of groundwater seepage quality entering excavation areas.																																	
Operational policy	To minimise and manage the generation of acidic waters entering the onsite excavation areas through seepage. To provide for monitoring and treatment of these waters prior to disposal.																																	
Performance criteria	Daily pH monitoring of any seepage within the excavation areas is to be undertaken prior to the disposal of these waters via dewatering. All waters discharged from the excavation areas to the recharge trenches during the construction phase should comply with the following criteria: <table><tr><th>Water Quality Parameter</th><th>Release Criteria</th><th>Criteria Type</th></tr><tr><td>pH</td><td>As developed from background monitoring</td><td>Range</td></tr><tr><td>Oil and grease</td><td>No visible film or detectable odour</td><td>--</td></tr></table> Where the discharge of dewatered groundwater to on-site or nearby drains and waterways is intended, water quality will satisfy the following performance criteria prior to release at the controlled discharge locations: <table><tr><th>Water Quality Parameter</th><th>Release Criteria</th><th>Criteria Type</th></tr><tr><td>pH</td><td>As developed from background monitoring</td><td>Range</td></tr><tr><td>Electrical conductivity</td><td><1.5mS/cm</td><td>Maximum</td></tr><tr><td>Suspended solids</td><td><50mg L⁻¹</td><td>Maximum</td></tr><tr><td>Turbidity</td><td>As developed from background monitoring</td><td>Maximum</td></tr><tr><td>Dissolved oxygen</td><td>60-105% saturation</td><td>Minimum</td></tr><tr><td>Total and dissolved Iron</td><td><0.3mg L⁻¹</td><td>Maximum</td></tr><tr><td>Total and dissolved</td><td>As developed from</td><td>Maximum</td></tr></table>	Water Quality Parameter	Release Criteria	Criteria Type	pH	As developed from background monitoring	Range	Oil and grease	No visible film or detectable odour	--	Water Quality Parameter	Release Criteria	Criteria Type	pH	As developed from background monitoring	Range	Electrical conductivity	<1.5mS/cm	Maximum	Suspended solids	<50mg L ⁻¹	Maximum	Turbidity	As developed from background monitoring	Maximum	Dissolved oxygen	60-105% saturation	Minimum	Total and dissolved Iron	<0.3mg L ⁻¹	Maximum	Total and dissolved	As developed from	Maximum
Water Quality Parameter	Release Criteria	Criteria Type																																
pH	As developed from background monitoring	Range																																
Oil and grease	No visible film or detectable odour	--																																
Water Quality Parameter	Release Criteria	Criteria Type																																
pH	As developed from background monitoring	Range																																
Electrical conductivity	<1.5mS/cm	Maximum																																
Suspended solids	<50mg L ⁻¹	Maximum																																
Turbidity	As developed from background monitoring	Maximum																																
Dissolved oxygen	60-105% saturation	Minimum																																
Total and dissolved Iron	<0.3mg L ⁻¹	Maximum																																
Total and dissolved	As developed from	Maximum																																

Implementation strategy	Aluminium	background monitoring	
	Litter and gross pollutants	No man made material >5mm in any dimension	--
	Oil and grease	No visible film, no detectable odour	-
	*Note that pH will be consistent with receiving water quality. If receiving waters are estuarine, pH should be 6.5 – 8.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the Threatened Species Management Plan (JWA 2011) for habitat requirements for Wallum Froglet (<i>Crinia signifera</i>) and Olongburra Frog (<i>Litoria olongburensis</i>).		
	The release criteria for aluminium and total and dissolved iron concentrations will be consistent with the receiving water quality.		
	The site contractor shall be equipped with reliable pH monitoring equipment that will be calibrated on a weekly basis (at least).		
	Dewatered groundwater will undergo appropriate treatment to ensure compliance with the above criteria prior to release into recharge trenches.		
	Where disposal to surface water bodies is intended monitoring will be undertaken at the controlled discharge points by the environmental consultant monthly and during rainfall events (defined as >25mm in any 24 hour period).		
	Records of the measured pH, time of monitoring, calibration records and treatment measures employed are to be kept on site for inspection by the environmental consultant and TSC.		
	The total acid risk of seepage waters shall be determined from the total acidity (titratable) results measured during the background monitoring program. These results will be considered during the preparation of a treatment program for any dewatered acidic groundwater.		
	Outside the construction area of each stage existing surface water conditions shall be maintained with reference to background monitoring.		
	If acidic seepage waters are encountered, the batter slopes of the excavation face should be subject to blanket liming as required at a predetermined rate in accordance with an acid sulfate management plan provisions.		
	The addition of liquid lime to acidic seepage waters may also be required. The environmental consultant should be consulted to determine the need for this treatment and the required addition rate in accordance with the Acid Sulfate Soil Management Plan (Gilbert & Sutherland 2011) provisions.		
	Where recharge trenches are required, the base and sides of the trench should also be blanket limed at a predetermined rate prior to the disposal of dewatered groundwater in accordance with the Acid Sulfate Soil Management Plan (Gilbert & Sutherland 2011) provisions.		
	Before undertaking any earthworks in drains or watercourses, the drain or		

Monitoring	watercourse will be bunded and contained in a staged manner, with water tested and treated prior to discharge. Particular attention will be given to watercourses containing high levels of organic matter that may also have the potential to form monosulfidic black oozes (MBOs). Existing MBOs will be managed, with organic material within the drain kept to a minimum and dissolved oxygen concentrations within water-bodies monitored and increased if necessary (in accordance with the recommendations outlined in Tulau (2007). Titratable Actual Acidity contents and water pH levels of water-bodies will also be monitored and adjusted as necessary.
	Carry out daily pH monitoring of seepage waters entering excavations during the construction phase prior to disposal into recharge trenches.
	Where disposal to surface water bodies is intended, all waters leaving the site at the controlled discharge points will be monitored for pH, electrical conductivity, suspended solids, dissolved oxygen, oil and grease monthly and during rainfall events. Analysis for total algae numbers will also be conducted monthly and during rainfall events once the waterbody(ies) have been brought online and are operational.
	Monitoring for aluminium and total and dissolved iron will occur on a monthly basis at water holding locations prior to discharge off site. Samples will be forwarded to a NATA registered laboratory for analysis when required.
Auditing	A visual inspection of the contractor's monitoring and treatment records shall be undertaken to verify sufficient monitoring and treatment is being undertaken. Management to audit water quality results monthly to verify that discharges comply with the performance criteria.
Reporting	Recording of monitoring results and treatment procedures is required. Results are to be available onsite at all times.
Identification of incident or failure	Discharge of ground waters to recharge trenches that do not satisfy the nominated pH range for this site.
Corrective action	Take necessary steps to address the problem and apply remedial measures to prevent the generation of excessive acid seepage waters (i.e. blanket liming of excavated faces and recharge trenches).

Commitment

The contractor will minimise and manage the generation of acidic waters entering the onsite excavation areas through seepage and to monitor and treat these waters prior to disposal.

5.4 Golf course water conservation

Applies to:	Civil construction phase of golf course, precincts 12 and 13
Person responsible:	Proponent, golf course manager

Issue	All water flows must be controlled and managed to allow the effective use of the onsite water within a total water cycle. Essential to the ecological stability of the golf course and surrounding wetland and ecological protection zone is the maintenance of water quantities to both golf course and ecosystems.
Operational policy	To manage the rainfall on site to effectively distribute water supply to both the golf course and the surrounding Ecological zones (SEPP14 wetland and Ecological protection zones).
Performance criteria	Ground water levels to be maintained within and adjacent to golf course with critical levels to be in accord with the seasonal variation in ground water height. Monitoring periods to be divided into Summer recharge period and Winter depletion period.
Implementation strategy	Harvesting • All water directed to bio-retention basins. • Held to recharge groundwater. • Golf course graded towards the basins. Volume • Maintain a no change in volumes by maintaining course infiltration rate and fairways runoff directed to swales for detention and infiltration to ground water. Storage • Subsurface storage. • Central dam of surface run-off collection and ground water window. • Habitat storages within landscape plan. Treatment • Bio-detention and filter basins to remove nutrients. • Sediments removed by filtering through rough and percolation through Bio-detention and filter basin floor. Distribution • 30% annual average recharge to ecosystem. • 70 % to landscape in golf course. Maintenance of treatment basins • Basins maintained to ensure nutrient stripping and water infiltration.

Monitoring	Fortnightly monitoring of groundwater height.
Auditing	Environmental consultant will audit the groundwater monitoring procedures and outcomes of the monitoring on a monthly basis.
Reporting	Results of monitoring will be reported quarterly to the Tweed shire council and NSW Department of Planning.
Identification of incident or failure	Ground water heights outside of critical limits to water level.
Corrective action	Groundwater lower than the critical level – Irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 40% to ecosystem 60% to golf course. Continue to monitor. Ground water still outside limits – Irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 60% to ecosystem 40% to golf course. Continue to monitor. Ground water still outside limits – Irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 80% to ecosystem 20% to golf course. Seek alternate sources of water for golf course irrigation and undertake environmental management and plan for the import of water supply to site. Continue to monitor. Ground water still outside limits – implement alternate water supply. Groundwater higher than critical level – determine source of excess water. High rainfall events – do nothing incident is self correcting. Golf course groundwater mounding – alter irrigation regime to decrease irrigation input to site.

Commitment

The land user will ensure the water table heights in the vicinity of the golf course will be maintained within the critical limits identified in the Groundwater Management Plan.

5.5 Water management (golf course irrigation)

Applies to:	Civil construction of golf course, precincts 12 and 13
Person responsible:	Proponent, golf course manager

Issue	All water flows must be controlled and managed to allow the effective use of the onsite water within a total water cycle. Essential to the ecological stability of the golf course and surrounding wetland and ecological protection zone is the maintenance of water quantities to both golf course and ecosystems.
Operational policy	To manage the irrigation applied to the golf course to minimise its impact on the surrounding Ecological zones (SEPP14 wetland and Ecological protection zones).
Performance criteria	Ground water levels to be maintained within and adjacent to golf course with critical levels to be in accord with the seasonal variation in ground water height. Monitoring periods to be divided into Summer recharge period and Winter depletion period.
Implementation strategy	Source of water - Extraction at central point of development which is distant from ground water dependant ecosystems. Distribution - Pipe mains and lateral distribution. - Spray irrigation for distribution efficiency. - Irrigation on tees greens and fairways only (allowing for minor over-spray on adjacent roughs). - Pump stations and associated infrastructure, including sprinkler heads, to be sized and installed in accordance with recommendations in ePar (2009, pp10). Irrigation scheduling - Install weather station and computerised control system to ensure efficient irrigation in accordance with recommendations in ePar (2009, pp9). - Irrigation to occur at dawn or dusk (generally characterised by lower relative humidity, air temperature and wind speed). - Soil water deficit based trigger for irrigation. - Effective soil depth for schedule 0-200mm. - Refill point to be set at 70% plant available soil moisture depletion. - Irrigation applied to 98% of field capacity. Water allocation model - Sustainable yield applied to irrigation set at 70 % recharge potential.

Monitoring	• Recycling. • Fairways constructed with gradient towards bio-detention basins. • Capture of irrigation runoff in detention basins for treatment and groundwater recharge. • Tees and greens captured separately and recycled to fairways. Soil management • Soil amendment to improve moisture holding (zeolite etc). • Maintenance of soil organic matter for soil structure maintenance. • Minimise compaction by machinery selection and operating procedures. • Control traffic. Plant selection and management • Native species and naturalised species endemic to local area. • Species selection dependant on landscape location eg Drought tolerant plants in elevated areas, waterlog tolerant plants in depressions.
	Fortnightly Height monitoring: • Surface water – dams, basins, adjacent ecosystem water bodies. • Ground water transect from detention basins to protection area (e.g. of groundwater monitoring bore transect through golf course and extending into adjacent SEPP 14 wetland). Parameters: • Height (AHD); pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure). Daily • Soil water – Soil water monitoring for refill point - methods to be selected as appropriate to soil and turf management conditions, for instance: tensiometers (150 mm depth), or Penman's estimation etc.
	Auditing Environmental consultant will audit the monitoring procedures and outcomes of the monitoring on a quarterly basis.
	Reporting Results of monitoring will be reported quarterly to the Tweed shire council and other appropriate authorities.
	Identification of incident or failure Ground water heights outside of critical limits to water level.
Corrective action	Groundwater lower than the critical level – Irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 40% to ecosystem 60% to golf course. Continue to monitor. Ground water still outside limits – Irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 60%

	to ecosystem 40% to golf course.
	Continue to monitor.
	Ground water still outside limits – Irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 80% to ecosystem 20% to golf course. Seek alternate sources of water for golf course irrigation and undertake environmental management and plan for the import of water supply to site.
	Continue to monitor.
	Ground water still outside limits – Implement alternate water supply.
	Groundwater higher than critical level – Determine source of excess water.
	High rainfall events – do nothing if incident is self-correcting.
	Golf course groundwater mounding – alter irrigation regime to decrease irrigation input to site.

Commitment

The land user will ensure the water table heights in the vicinity of the golf course will be maintained within the critical limits identified in the Groundwater Management Plan.

5.6 Golf course nutrient management

Applies to:	Civil construction of golf course, precincts 12 and 13
Person responsible:	Golf course manager

Issue	The nutrients applied to maintain the vigour of the golf course must not gain access to the surrounding environment. All nutrients must be controlled and managed to allow the effective use of the onsite water and to ensure to the ecological stability of the golf course and surrounding wetland and ecological protection zone.
Operational policy	To manage the nutrients applied to the golf course to minimise its impact on the surrounding Ecological zones (SEPP14 wetland and Ecological protection zones).
Performance criteria	Ground and surface water nutrient levels to be maintained within and adjacent to golf course within critical levels in accord with the seasonal variation in ground water. Monitoring periods to be divided into Summer recharge period and Winter depletion period. <i>Critical criteria set at:</i> • Critical limits set as per background monitoring. <i>Parameters:</i> • pH (field measurement); • electrical conductivity (field measurement); • turbidity (field measurement); • dissolved oxygen (field measurement); • temperature (field measurement); • suspended solids (mg L⁻¹); • total and nitrate, nitrite and ammonium (mg L⁻¹); • total and soluble phosphorus (mg L⁻¹); • total and soluble iron and filtered aluminium; and • oil and grease (visual inspection). • calcium; • magnesium; • potassium • sodium • dissolved manganese; • bicarbonate; • carbonate; • chloride; • sulfate; and • colour.

Implementation strategy

Tees

- Impervious membrane under green set at 0.6m below NSL, leachate collected in containment well and reused on fairways.
- Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity).
- Fertiliser selection – slow release and specialty fertilisers for tee maintenance.
- Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. Fertiliser rates to be determined in consultation with the recommendations in ePar (2009, pp8) or the site's Fertiliser Management Plan.
- Application method – split application at low rates, timed with other fairway operations that incorporate nutrients into turf (eg, turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off).
- Clippings removed and composted for reuse on landscaping.

Greens

- Impervious membrane under green set at 0.6m below NSL, leachate collected in containment well and reused on fairways.
- Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity).
- Fertiliser selection – slow release and specialty fertilisers for green maintenance.
- Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management.
- Application method – split application at low rates, timed with other fairway operations that incorporate nutrients into turf (eg, turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off).
- Clippings removed and composted for reuse on landscaping.

Fairways

- Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity).
- Fertiliser selection – slow release and specialty fertilisers for tee maintenance.
- Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. In addition,

Monitoring	a mass balance method will be used to identify fertiliser rates – inputs of water nutrients, fertiliser and effluent from tees and greens, output soil store, biomass and percolation. • Application method – split application at low rates, timed with other fairway operations that incorporate nutrients into turf (e.g., turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Irrigation maximum refill set to 98% field capacity to ensure first rainfall infiltrates and not runs off.
	Rough • No fertiliser used. • Rough to act as irrigation, sediment and nutrient buffer. • Biomass mulched back into rough.
	Swales and detention basins • No fertiliser used. • Maintenance removal of biomass to composting and reuse in landscaping.
	Groundwater <i>Monthly</i> • Ground water quality samples (from all height monitoring bores). • Multiple group lysimeters set at 1 m depth in four (4) locations in golf course fairways– leachate samples. • Parameters: pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure); N – Total, NH₄, NO₃ P – Total, Ortho; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. Surface water <i>Monthly</i> • Central irrigation supply. • Surface habitat water bodies. • Parameters: pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure); N – Total, NH₄, NO₃ P – Total, Ortho; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. <i>Monthly</i> • Central irrigation supply. Parameters: • Irrigation water quality, N & P.

	Soils 6 monthly • Soil fertility sampling as per standard practice for turf (agricultural) management.
	Biomass <i>Quarterly</i> • Fairway reference sites set at four locations within golf course. • The reference sites will have the biomass collected (weighed) and analysed for N & P. (Data to be used in estimating mass balance for monitoring purposes). <i>Biannually</i> • SEPP 14 wetland and environmental protection zone to be monitored with two (2) reference transects to outline floristic structure and function.
	Auditing Environmental consultant will audit the monitoring procedures and outcomes of the monitoring on an annual basis.
	Reporting Results of monitoring will be reported annually to the Tweed Shire Council and NSW Department of Planning.
	Identification of incident or failure • Groundwater analyses in excess of critical limits for two consecutive sample events. • Critical limit set considering background monitoring.
	Corrective action Fertiliser regime re-assessed and fertiliser management plan altered by change of fertiliser form, rate or application technology. Continue to monitor.

Commitment

The land user will ensure the water table and surface water areas associated with the golf course does not input excess nutrients into the surrounding SEPP14 wetlands and ecological protection zones.

6 Management of potential impacts – On maintenance phase

6.1 Intent

This part of the GMP specifies those matters relating to groundwater which must be complied with by the Proponent during the 6 month on-maintenance period, being the period after civil construction but before TSC assumes responsibility for the subdivision works or Golf Course Management assumes responsibility for the golf course. The Proponents' obligations in this Section of the GMP conclude at the end of the maintenance period for each stage.

6.2 Groundwater monitoring

Applies to:	On-maintenance phase
Person responsible:	Site manager; Environmental Consultant

Issue	Groundwater monitoring.
Operational policy	To maintain stable groundwater conditions and verify by monitoring that development management is appropriate.
Performance criteria	Water quality objectives for the on-maintenance phase of works would be devised using DECCW guidelines for groundwater monitoring. These proposed objectives would be submitted to TSC for review and approval prior to implementation. Groundwater monitoring will be undertaken for the following parameters: • pH (field measurement); • electrical conductivity (field measurement); • turbidity (field measurement); • dissolved oxygen (field measurement); • temperature (field measurement); • suspended solids (mg L^{-1}); • total and nitrate, nitrite and ammonium (mg L^{-1}); • total and soluble phosphorus (mg L^{-1}); • total and soluble iron and filtered aluminium; and • oil and grease (visual inspection). • calcium; • magnesium; • potassium • sodium • dissolved manganese; • bicarbonate; • carbonate; • chloride; • sulfate; and • colour. Laboratory analysis for total acidity (titratable) and total alkalinity should also be undertaken.
Implementation strategy	Monitoring of groundwater levels should be undertaken monthly during the on-maintenance phase. Groundwater samples are to be collected monthly and analysed for the

	parameters specified above.
Monitoring	Carry out monthly groundwater level and quality monitoring at locations to be specified. Sample recovery and in-situ analysis will be performed by onsite staff and, when required, samples will be forwarded to a NATA accredited laboratory.
Auditing	The environmental consultant is to audit water quality biannually to ensure that no deleterious effects are resulting from any excavation, filling and dewatering operations at the site.
Reporting	Annual reports are to be submitted to TSC. The annual reports to TSC shall include raw data, a results summary and a discussion comparing results with baseline values and DECCW guidelines. Result sheets to be compiled for monitoring results. All results shall be made available for inspection by local and state government officers when requested.
Identification of incident or failure	Degradation of groundwater quality at the monitoring points to below the "Performance Criteria" levels (to be derived following baseline monitoring). Variations in groundwater levels beyond typical seasonal fluctuations.
Corrective action	If the test results for any parameter fails to meet the performance criteria (to be determined based on background monitoring), further investigations will be conducted. This will involve fortnightly groundwater quality monitoring (or more frequent if deemed necessary by the environmental consultant) of the subject parameter(s). The results of the investigation should ascertain if the incident/failure is an anomaly or if a sustained decline in groundwater quality is present. If a trend exists for declining groundwater quality, the likely source(s) of contamination will be identified. Should the investigation indicate that site activities are triggering the incident/failure, the following will be implemented: • Locate the source of the contamination/level variation and take all possible actions to contain and control the contaminant/level variation. Investigate the cause of the contamination/level variation and take action to prevent a recurrence. • All development activities taking place at the time of incident/failure shall be reviewed to verify compliance with the GMP provisions and, if necessary, construction methods and procedures shall be adjusted.

Commitment

The manager will seek to maintain stable groundwater conditions and verify by monitoring that development management is appropriate.

6.3 Golf course water conservation

Applies to:	On-maintenance Phase of golf course, precincts 12 and 13
Person responsible:	Golf course Management

Issue	All water flows must be controlled and managed to allow the effective use of the onsite water within a total water cycle. Essential to the ecological stability of the golf course and surrounding wetland and ecological protection zone is the maintenance of water quantities to both golf course and ecosystems.
Operational policy	To manage the rainfall on site to effectively distribute water supply to both the golf course and the surrounding Ecological zones (SEPP14 wetland and Ecological protection zones).
Performance criteria	Ground water levels to be maintained within and adjacent to golf course with critical levels to be in accord with the seasonal variation in ground water height. Monitoring periods to be divided into Summer recharge period and Winter depletion period.
Implementation strategy	Harvesting • All water directed to bio-retention basins. • Held to recharge groundwater. • Golf course graded towards the basins. Volume • Maintain a no change in volumes by maintaining course infiltration rate and fairways runoff directed to swales for detention and infiltration to ground water. Storage • Subsurface storage. • Central dam of surface run-off collection and ground water window. • Habitat storages within landscape plan. Treatment • Bio-detention and filter basins to remove nutrients. • Sediments removed by filtering through rough and percolation through Bio-detention and filter basin floor. Distribution • 30% annual average recharge to ecosystem. • 70 % to landscape in golf course.

	Maintenance of treatment basins Basins maintained to ensure nutrient stripping and water infiltration. An Environmental Management System (EMS) for the golf course should be developed and implemented to ensure staff and contractors are familiar with the above strategies.
Monitoring	Monthly monitoring of groundwater height.
Auditing	Environmental consultant will audit the groundwater monitoring procedures and outcomes of the monitoring on an annual basis.
Reporting	Results of monitoring will be reported biannually to the Tweed shire council and NSW Department of Planning.
Identification of incident or failure	Ground water heights outside of critical limits to water level.
Corrective action	Groundwater lower than the critical level – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 40% to ecosystem 60% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 60% to ecosystem 40% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 80% to ecosystem 20% to golf course. Seek alternate sources of water for golf course irrigation and undertake environmental management and plan for the import of water supply to site. Continue to monitor. Ground water still outside limits – implement alternate water supply. Groundwater higher than critical level – determine source of excess water. High rainfall events – do nothing incident is self correcting. Golf course groundwater mounding – alter irrigation regime to decrease irrigation input to site.

Commitment

The land user will ensure the water table heights in the vicinity of the golf course will be maintained within the critical limits identified in the Groundwater Management Plan.

6.4 Water management (golf course irrigation)

Applies to:	On-maintenance Phase of golf course, precincts 12 and 13
Person responsible:	Golf course Manager

Issue	All water flows must be controlled and managed to allow the effective use of the onsite water within a total water cycle. Essential to the ecological stability of the golf course and surrounding wetland and ecological protection zone is the maintenance of water quantities to both golf course and ecosystems.
Operational policy	To manage the irrigation applied to the golf course to minimise its impact on the surrounding Ecological zones (SEPP14 wetland and Ecological protection zones).
Performance criteria	Ground water levels to be maintained within and adjacent to golf course with critical levels to be in accord with the seasonal variation in ground water height. Monitoring periods to be divided into Summer recharge period and Winter depletion period.
Implementation strategy	Source of water - Extraction at central point of development which is distant from ground water dependant ecosystems. Distribution - Pipe mains and lateral distribution. - Spray irrigation for distribution efficiency. - Irrigation on tees greens and fairways only (allowing for minor over-spray on adjacent roughs). - Pump stations and associated infrastructure, including sprinkler heads, to be sized and installed in accordance with recommendations in ePar (2009, pp10). Irrigation scheduling - Install weather station and computerised control system to ensure efficient irrigation in accordance with recommendations in ePar (2009, pp9). - Irrigation to occur at dawn or dusk (generally characterised by lower relative humidity, air temperature and wind speed). - Soil water deficit based trigger for irrigation. - Effective soil depth for schedule 0-200mm. - Refill point to be set at 70% plant available soil moisture depletion. - Irrigation applied to 98% of field capacity. Water allocation model - Sustainable yield applied to irrigation set at 70 % recharge potential.

Monitoring	Recycling • Fairways constructed with gradient towards bio-detention basins. • Capture of irrigation runoff in detention basins for treatment and groundwater recharge. • Tees and greens captured separately and recycled to fairways. Soil management • Soil amendment to improve moisture holding (zeolite etc). • Maintenance of soil organic matter for soil structure maintenance. • Minimise compaction by machinery selection and operating procedures. • Control traffic. Plant selection and management • Native species and naturalised species endemic to local area. • Species selection dependant on landscape location eg Drought tolerant plants in elevated areas, waterlog tolerant plants in depressions.
	Monthly <i>Height monitoring:</i> • Surface water – dams, basins, adjacent ecosystem water bodies. • Ground water transect from detention basins to protection area (e.g. of groundwater monitoring bore transect through golf course and extending into adjacent SEPP 14 wetland). <i>Parameters:</i> • Height (AHD); pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure). Daily • Soil water – Soil water monitoring for refill point - methods to be selected as appropriate to soil and turf management conditions, for instance: tensiometers (150 mm depth), or Penman's estimation etc.
	Auditing Environmental consultant will audit the monitoring procedures and outcomes of the monitoring on a biannual basis.
	Reporting Results of monitoring will be reported biannually to the Tweed shire council and NSW Department of Planning.
	Identification of incident or failure Ground water heights outside of critical limits to water level.
Corrective action	Groundwater lower than the critical level – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 40% to ecosystem 60% to golf course. Continue to monitor.

	Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 60% to ecosystem 40% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 80% to ecosystem 20% to golf course. Seek alternate sources of water for golf course irrigation and undertake environmental management and plan for the import of water supply to site. Continue to monitor. Ground water still outside limits – implement alternate water supply. Groundwater higher than critical level – determine source of excess water. High rainfall events – do nothing if incident is self correcting. Golf course groundwater mounding – alter irrigation regime to decrease irrigation input to site.
--	--

Commitment

The land user will ensure the water table heights in the vicinity of the golf course will be maintained within the critical limits identified in the Groundwater Management Plan.

6.5 Golf course nutrient management

Applies to:	On-maintenance Phase of golf course, precincts 12 and 13
Person responsible:	Golf course Manager

Issue	The nutrients applied to maintain the vigour of the golf course must not gain access to the surrounding environment. All nutrients must be controlled and managed to allow the effective use of the onsite water and to ensure to the ecological stability of the golf course and surrounding wetland and ecological protection zone.
Operational policy	To manage the nutrients applied to the golf course to minimise its impact on the surrounding ecological zones (SEPP14 wetland and Ecological protection zones).
Performance criteria	Ground and surface water nutrient levels to be maintained within and adjacent to golf course within critical levels in accord with the seasonal variation in ground water. Monitoring periods to be divided into Summer recharge period and Winter depletion period. Critical criteria set at: • Critical limit set as per background monitoring. Parameters: • pH (field measurement); • electrical conductivity (field measurement); • turbidity (field measurement); • dissolved oxygen (field measurement); • temperature (field measurement); • suspended solids (mg L⁻¹); • total and nitrate, nitrite and ammonium (mg L⁻¹); • total and soluble phosphorus (mg L⁻¹); • total and soluble iron and filtered aluminium; and • oil and grease (visual inspection). • calcium; • magnesium; • potassium • sodium • dissolved manganese; • bicarbonate; • carbonate; • chloride; • sulfate; and

Implementation strategy	• colour. Tees • Impervious membrane under green set at 0.6m below NSL, leachate collected in containment well and reused on fairways. • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for tee maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. Fertiliser rates to be determined in consultation with the recommendations in ePar (2009, pp8) or the site's Fertiliser Management Plan. • Application method – split application at low rates, timed with other fairway operations that incorporate nutrients into turf (eg, turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Clippings removed and composted for reuse on landscaping. Greens • Impervious membrane under green set at 0.6m below NSL, leachate collected in containment well and reused on fairways. • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for green maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. • Application method – split application at low rates, timed with other fairway operations that incorporate nutrients into turf (eg, turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Clippings removed and composted for reuse on landscaping. Fairways • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for tee maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing
-------------------------	--

Monitoring	consistent with standard best practice for turf management. In addition, a mass balance method will be used to identify fertiliser rates – inputs of water nutrients, fertiliser and effluent from tees and greens, output soil store, biomass and percolation. • Application method – split application at low rates, timed with other fairway operations that incorporate nutrients into turf (eg, turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Irrigation maximum refill set to 98% field capacity to ensure first rainfall infiltrates and not runs off. Rough • No fertiliser used. • Rough to act as irrigation, sediment and nutrient buffer. • Biomass mulched back into rough. Swales and detention basins • No fertiliser used. • Maintenance removal of biomass to composting and reuse in landscaping.
	Groundwater Monthly: • Ground water quality samples (from all height monitoring bores). • Multiple group lysimeters set at 1 m depth in four (4) locations in golf course fairways– leachate samples. • Parameters: pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure); N – Total, NH₄, NO₃, P – Total, Ortho; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. Surface water Monthly: • Central irrigation supply. • Surface habitat water bodies. • Parameters: pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure); N – Total, NH₄, NO₃, P – Total, Ortho; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. Quarterly: • Central irrigation supply. • Parameters: irrigation water quality, N & P.

	Soils 6 monthly: Soil fertility sampling as per standard practice for turf (agricultural) management. Biomass Quarterly: • Fairway reference sites set at four locations within golf course. • The reference sites will have the biomass collected (weighed) and analysed for N & P. (Data to be used in estimating mass balance for monitoring purposes). Biannually: • SEPP 14 wetland and environmental protection zone to be monitored with two (2) reference transects to outline floristic structure and function.
	Auditing Environmental consultant will audit the monitoring procedures and outcomes of the monitoring on a biannual basis.
	Reporting Results of monitoring will be reported biannually to the Tweed Shire Council and NSW Department of Planning.
	Identification of incident or failure • Groundwater analyses in excess of critical limits for two consecutive sample events. • Critical limit set considering background monitoring.
	Corrective action Fertiliser regime re-assessed and fertiliser management plan altered by change of fertiliser form, rate or application technology. Continue to monitor.

Commitment

The land user will ensure the water table and surface water areas associated with the golf course does not input excess nutrients into the surrounding SEPP14 wetlands and ecological protection zones.

7 Management of potential impacts – operational phase

7.1 Intent

This part of the GMP specifies those matters which should be complied with by the Golf Course management during the operational phase. It also specifies those matters which need to be addressed by Council following its acceptance off maintenance.

7.2 Groundwater monitoring

Applies to:	Operational phase
Person responsible:	Golf course manager

Issue	Groundwater monitoring.
Operational policy	To maintain stable groundwater conditions and verify by monitoring that development management is appropriate.
Performance criteria	Water quality objectives for the operational phase of works would be devised from DECCW guidelines for groundwater monitoring. These proposed objectives would be submitted to TSC for review and approval prior to implementation. Groundwater monitoring will be undertaken for the following parameters: • pH (field measurement); • EC (field measurement); • dissolved oxygen (field measurement); and • temperature (field measurement). Laboratory analysis for the following parameters will also be performed: • calcium; • magnesium; • total and dissolved iron; • dissolved manganese; • filtered aluminium; • bicarbonate; • carbonate; • chloride; • sulfate; and • colour. Laboratory analysis for total acidity (titratable) and total alkalinity should also be undertaken.
Implementation	Monitoring of groundwater levels should be undertaken quarterly during

strategy	the operational phase. Groundwater samples are to be collected quarterly and analysed for the parameters specified above.
Monitoring	Carry out quarterly groundwater level and quality monitoring at locations to be specified. Sample recovery and in-situ analysis will be performed by onsite staff and, when required, samples will be forwarded to a NATA accredited laboratory.
Auditing	The environmental consultant is to audit water quality biannually to ensure that no deleterious effects are resulting from site activities.
Reporting	Annual reports are to be submitted to TSC. The annual reports to TSC shall include raw data, a results summary and a discussion comparing results with baseline values and DECCW groundwater guidelines. Result sheets to be compiled for monitoring results. All results shall be made available for inspection by local and state government officers when requested.
Identification of incident or failure	Degradation of groundwater quality at the monitoring points to below the “Performance Criteria” levels (to be derived following baseline monitoring). Variations in groundwater levels beyond typical seasonal fluctuations.
Corrective action	If the test results for any parameter fails to meet the performance criteria (to be determined based on background monitoring), further investigations will be conducted. This will involve monthly groundwater quality monitoring (or more frequent if deemed necessary by the environmental consultant) of the subject parameter(s). The results of the investigation should ascertain if the incident/failure is an anomaly or if a sustained decline in groundwater quality is present. If a trend exists for declining groundwater quality, the likely source(s) of contamination will be identified. Should the investigation indicate that site activities are triggering the incident/failure, the following will be implemented: • Locate the source of the contamination/level variation and take all possible actions to contain and control the contaminant/level variation. Investigate the cause of the contamination/level variation and take action to prevent a recurrence. • All activities taking place at the time of incident/failure shall be reviewed to verify compliance with the GMP provisions and, if necessary, construction methods and procedures shall be adjusted.

Commitment

The golf course manager will seek to maintain stable groundwater conditions and verify by monitoring that management is appropriate.

7.3 Golf course water conservation

Applies to:	Operational Phase of golf course, precincts 12 and 13
Person responsible:	Golf course Manager

Issue	All water flows must be controlled and managed to allow the effective use of the onsite water within a total water cycle. Essential to the ecological stability of the golf course and surrounding wetland and ecological protection zone is the maintenance of water quantities to both golf course and ecosystems.
Operational policy	To manage the rainfall on site to effectively distribute water supply to both the golf course and the surrounding Ecological zones (SEPP14 wetland and Ecological protection zones).
Performance criteria	Ground water levels to be maintained within and adjacent to golf course with critical levels to be in accord with the seasonal variation in ground water height. Monitoring periods to be divided into Summer recharge period and Winter depletion period.
Implementation strategy	Harvesting • All water directed to bio-retention basins. • Held to recharge groundwater. • Golf course graded towards the basins. Volume • Maintain a no change in volumes by maintaining course infiltration rate and fairways runoff directed to swales for detention and infiltration to ground water. Storage • Subsurface storage. • Central dam of surface run-off collection and ground water window. • Habitat storages within landscape plan. Treatment • Bio-detention and filter basins to remove nutrients. • Sediments removed by filtering through rough and percolation through Bio-detention and filter basin floor. Distribution • 30% annual average recharge to ecosystem. • 70 % to landscape in golf course. Maintenance of treatment basins • Basins maintained to ensure nutrient stripping and water infiltration.

	An Environmental Management System (EMS) for the golf course should be developed and implemented to ensure staff and contractors are familiar with the above strategies.
Monitoring	Monthly monitoring of groundwater height.
Auditing	Environmental consultant will audit the groundwater monitoring procedures and outcomes of the monitoring on an annual basis.
Reporting	Results of monitoring will be reported biannually to the Tweed shire council and NSW Department of Planning.
Identification of incident or failure	Ground water heights outside of critical limits to water level.
Corrective action	Groundwater lower than the critical level – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 40% to ecosystem 60% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 60% to ecosystem 40% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 80% to ecosystem 20% to golf course. Seek alternate sources of water for golf course irrigation and undertake environmental management and plan for the import of water supply to site. Continue to monitor. Ground water still outside limits – implement alternate water supply. Groundwater higher than critical level – determine source of excess water. High rainfall events – do nothing incident is self correcting. Golf course groundwater mounding – alter irrigation regime to decrease irrigation input to site.

Commitment

The golf course management will ensure the water table heights in the vicinity of the golf course will be maintained within the critical limits identified in the Groundwater Management Plan.

7.4 Water management (golf course irrigation)

Applies to:	Operational Phase of golf course, precincts 12 and 13
Person responsible:	Golf course Manager

Issue	All water flows must be controlled and managed to allow the effective use of the onsite water within a total water cycle. Essential to the ecological stability of the golf course and surrounding wetland and ecological protection zone is the maintenance of water quantities to both golf course and ecosystems.
Operational policy	To manage the irrigation applied to the golf course to minimise its impact on the surrounding Ecological zones (SEPP14 wetland and Ecological protection zones).
Performance criteria	Ground water levels to be maintained within and adjacent to golf course with critical levels to be in accord with the seasonal variation in ground water height. Monitoring periods to be divided into Summer recharge period and Winter depletion period.
Implementation strategy	Source of water - Extraction at central point of development which is distant from ground water dependant ecosystems. Distribution - Pipe mains and lateral distribution. - Spray irrigation for distribution efficiency. - Irrigation on tees greens and fairways only (allowing for minor over-spray on adjacent roughs). - Pump stations and associated infrastructure, including sprinkler heads, to be sized and installed in accordance with recommendations in ePar (2009, pp10). Irrigation scheduling - Install weather station and computerised control system to ensure efficient irrigation in accordance with recommendations in ePar (2009, pp9). - Irrigation to occur at dawn or dusk (generally characterised by lower relative humidity, air temperature and wind speed). - Soil water deficit based trigger for irrigation. - Effective soil depth for schedule 0-200mm. - Refill point to be set at 70% plant available soil moisture depletion. - Irrigation applied to 98% of field capacity.

Monitoring	Water allocation model • Sustainable yield applied to irrigation set at 70 % recharge potential. • Recycling. • Fairways constructed with gradient towards bio-detention basins. • Capture of irrigation runoff in detention basins for treatment and groundwater recharge. • Tees and greens captured separately and recycled to fairways. Soil management • Soil amendment to improve moisture holding (zeolite etc). • Maintenance of soil organic matter for soil structure maintenance. • Minimise compaction by machinery selection and operating procedures. • Control traffic. Plant selection and management • Native species and naturalised species endemic to local area. • Species selection dependant on landscape location eg Drought tolerant plants in elevated areas, waterlog tolerant plants in depressions.
	Biannually <i>Height monitoring:</i> • surface water – dams, basins, adjacent ecosystem water bodies; and • ground water transect from detention basins to protection area (e.g. of groundwater monitoring bore transect through golf course and extending into adjacent SEPP 14 wetland). <i>Parameters:</i> • Height (AHD); pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure). Daily • Soil water – Soil water monitoring for refill point - methods to be selected as appropriate to soil and turf management conditions, for instance: tensiometers (150 mm depth), or Penman's estimation etc.
	Auditing Environmental consultant will audit the monitoring procedures and outcomes of the monitoring on an annual basis.
	Reporting Results of monitoring will be reported annually to the Tweed shire council and NSW Department of Planning.
Identification of incident or failure	Ground water heights outside of critical limits to water level.

Corrective action	Groundwater lower than the critical level – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 40% to ecosystem 60% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 60% to ecosystem 40% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 80% to ecosystem 20% to golf course. Seek alternate sources of water for golf course irrigation and undertake environmental management and plan for the import of water supply to site. Continue to monitor. Ground water still outside limits – implement alternate water supply. Groundwater higher than critical level – determine source of excess water. High rainfall events – do nothing if incident is self-correcting. Golf course groundwater mounding – alter irrigation regime to decrease irrigation input to site.
-------------------	---

Commitment

The golf course management will ensure the water table heights in the vicinity of the golf course will be maintained within the critical limits identified in the Groundwater Management Plan.

7.5 Golf course nutrient management

Applies to:	Operational Phase of golf course, precincts 12 and 13
Person responsible:	Golf course Manager

Issue	The nutrients applied to maintain the vigour of the golf course must not gain access to the surrounding environment. All nutrients must be controlled and managed to allow the effective use of the onsite water and to ensure to the ecological stability of the golf course and surrounding wetland and ecological protection zone.
Operational policy	To manage the nutrients applied to the golf course to minimise its impact on the surrounding Ecological zones (SEPP14 wetland and Ecological protection zones).
Performance criteria	Ground and surface water nutrient levels to be maintained within and adjacent to golf course within critical levels in accord with the seasonal variation in ground water. Monitoring periods to be divided into Summer recharge period and Winter depletion period. Critical criteria set at: • Mean ground water nutrient level considering background monitoring. Parameters: • pH (field measurement); • electrical conductivity (field measurement); • turbidity (field measurement); • dissolved oxygen (field measurement); • temperature (field measurement); • suspended solids (mg L⁻¹); • total and nitrate, nitrite and ammonium (mg L⁻¹); • total and soluble phosphorus (mg L⁻¹); • total and soluble iron and filtered aluminium; and • oil and grease (visual inspection). • calcium; • magnesium; • potassium • sodium • dissolved manganese; • bicarbonate; • carbonate; • chloride; • sulfate; and

Implementation strategy	• colour..
	Tees • Impervious membrane under green set at 0.6m below NSL, leachate collected in containment well and reused on fairways. • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for tee maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. Fertiliser rates to be determined in consultation with the recommendations in ePar (2009, pp8) or the site’s Fertiliser Management Plan. • Application method – split application at low rates, timed with other fairway operations that incorporate nutrients into turf (e.g. turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Clippings removed and composted for reuse on landscaping.
	Greens • Impervious membrane under green set at 0.6m below NSL, leachate collected in containment well and reused on fairways. • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for green maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. • Application method – split application at low rates, timed with other fairway operations that incorporate nutrients into turf (eg, turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off) • Clippings removed and composted for reuse on landscaping.
	Fairways • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for tee maintenance.

Monitoring	• Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. In addition, a mass balance method will be used to identify fertiliser rates – inputs of water nutrients, fertiliser and effluent from tees and greens, output soil store, biomass and percolation. • Application method – split application at low rates, timed with other fairway operations that incorporate nutrients into turf (eg, turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Irrigation maximum refill set to 98% field capacity to ensure first rainfall infiltrates and not runs off.
	Rough • No fertiliser used. • Rough to act as irrigation, sediment and nutrient buffer. • Biomass mulched back into rough.
	Swales and detention basins • No fertiliser used. • Maintenance removal of biomass to composting and reuse in landscaping.
	Groundwater Quarterly • Ground water quality samples (from all height monitoring bores). • Multiple group lysimeters set at 1m depth in four (4) locations in golf course fairways– leachate samples. • Parameters: pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure); N – Total, NH₄, NO₃, P – Total, Ortho; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. Surface water Quarterly • Central irrigation supply. • Surface habitat water bodies. • Parameters: pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure); N – Total, NH₄, NO₃, P – Total, Ortho; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. Quarterly • Central irrigation supply.

	- Parameters: irrigation water quality, N & P. Soils Annually - Soil fertility sampling as per standard practice for turf (agricultural) management. Biomass Annually - Fairway reference sites set at four locations within golf course. - The reference sites will have the biomass collected (weighed) and analysed for N & P. (Data to be used in estimating mass balance for monitoring purposes). SEPP 14 wetlands Annually - SEPP 14 wetland and environmental protection zone to be monitored with two (2) reference transects to outline floristic structure and function.
	Auditing Environmental consultant will audit the monitoring procedures and outcomes of the monitoring on an annual basis.
	Reporting Results of monitoring will be reported annually to the Tweed Shire Council and NSW Department of Planning.
	Identification of incident or failure - Groundwater analyses in excess of critical limits for two consecutive sample events. - Critical limit set at considering background monitoring.
	Corrective action Fertiliser regime re-assessed and fertiliser management plan altered by change of fertiliser form, rate or application technology. Continue to monitor.

Commitment

The golf course management will ensure the water table and surface water areas associated with the golf course does not input excess nutrients into the surrounding SEPP14 wetlands and ecological protection zones.

8 Administration of the GMP

8.1 Amendment of the GMP

The Proponent may make an application to TSC to amend the provisions of this GMP. The application shall:

- be in writing; and
- specify the provisions of the GMP to which the application relates; and
- state how the proposed amendments achieve the objectives of the provisions to which the amendments relate.

TSC shall approve the amendment where TSC is satisfied acting reasonably that the proposed amendments achieve the objective of the provisions to which the amendment relates.

8.2 Incident management

The Proponent and any person appointed by the Proponent as having responsibility for a control strategy set out in this GMP have clearly defined responsibilities under the NSW *Protection of the Environment Operations Act* (1997) to report any incidents likely to cause material or serious environmental harm.