

Management Plan

Groundwater

Risk Statement: High

This document will be reviewed on a two yearly basis, unless a process change occurs earlier than this period.

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Revision Summary

First Issue	Issue Date	Implementation Requirements	Approved By
1	10 Oct 14	Development of document following granting of PA 11_0060.	

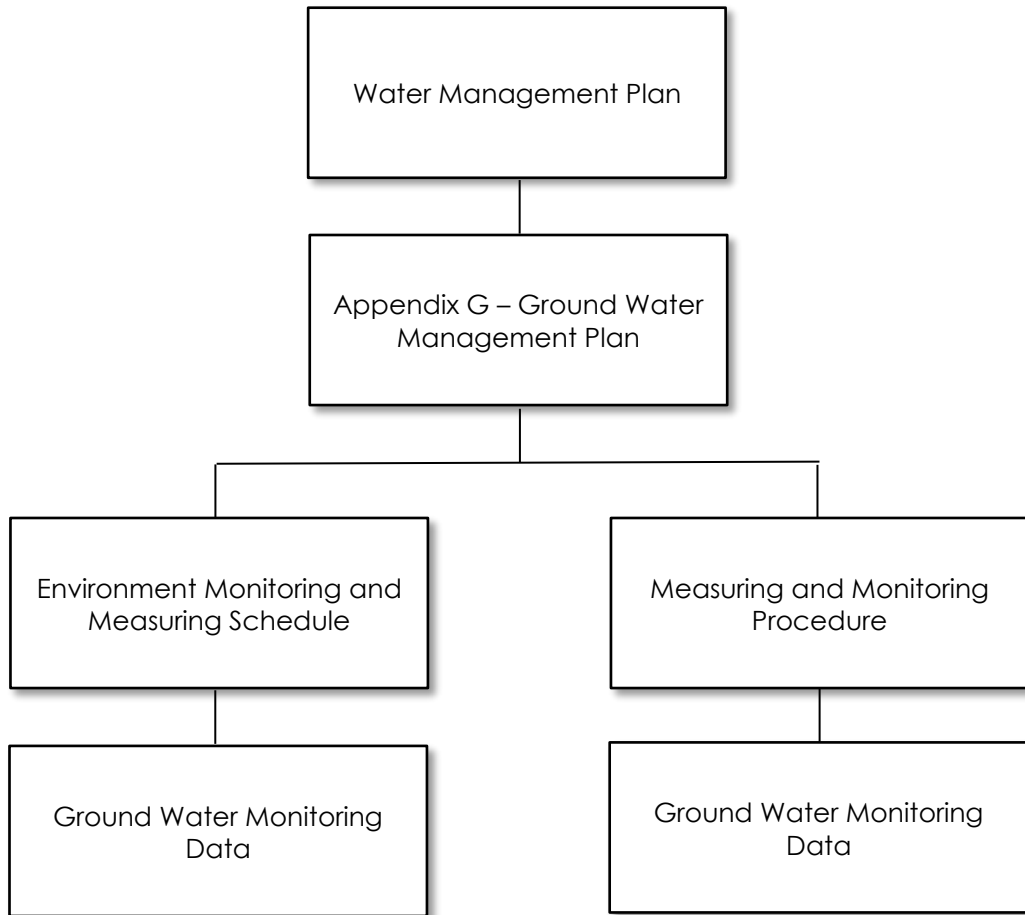
Version No.	Revision Date	Clause No.	Revision Details	Approved By
2	03 Oct 16		Review of document following completion of trigger level values being assessed by SRK. Convert to Northparkes template.	
3	10 Oct 17		Updated references to NSW Department of Industry and replaced "AEMR" with the current report "AR"	
4	31 May 18		Minor updates	

Approval Position	Automatic Notifications

Hard Copy Locations	Associated Documents to be reviewed
Northparkes website	

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Document Hierarchy



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1. OVERVIEW

The Ground Water Management Plan (GWMP) forms Appendix G of the Northparkes Mines Water Management Plan.

The GWMP has been developed to comply with Project Approval 11_0060 as per Section 5 of this document.

2. PURPOSE / OBJECTIVES

This management plan has been developed to address the following requirements from the PA 11_0060;

- Provide background data on the groundwater levels and quality relating to the Project Area
- Management practices for groundwater resources
- Describe trigger levels for investigating potential groundwater impacts
- Describe groundwater monitoring programs
- Methods of response to exceedance in groundwater trigger levels and
- Provide information on reporting and reviewing requirements.

3. SCOPE

This Management Plan applies to all activities relating to activities as approval under PA 11_0060.

4. RESPONSIBILITY

General role responsibilities under this Procedure are outlined in 'HSE Accountabilities' Procedure (3-8950).

Personnel carrying out work under this Management Plan must be familiar with and comply with it in full.

The following persons have specific responsibility as outlined in section 5.0 of this Management Plan

Table 1: Responsibilities

Role	Responsibility
REG Champion	The principal point of contact in relation to the GWMP. Coordinate the Water Team and delegate tasks and water enquiries at Northparkes.
Risk Exposure Group - Environment	Review or arrange review of activities associated with the GWMP on a regular basis. Maintain a record of water monitoring results. Investigate GWMP non-conformances in accordance with relevant TARP's. Determine appropriate management strategies and implement contingency measures in consultation with relevant departments. Complete all internal and external reports required by the GWMP. Investigate and report on all incidents and complaints relevant to the GWMP. Maintain a record of all incidents and complaints relevant to the GWMP.

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Role	Responsibility
Operations and Engineering Managers	Installation, maintenance and operation of water management infrastructure. Consultation with the Water Team to determine appropriate environmental management strategies and contingency measures required by the GWMP. Consult with the Water Team with respect to the management of any contractor activities that may affect the effectiveness of the GWMP.
All employees and contractors	Undertake activities in accordance with relevant Northparkes policies, procedures and management plans and statutory and contract requirements. Implement appropriate environmental management measures in accordance with the GWMP. Report all environmental incidents to the Water Team.

5. LEGAL COMPLIANCE

Northparkes commits to complying with all relevant legal and other requirements. This includes all relevant legislation, licences, Company, Australian and International Standards and other requirements.

This GWMP has been prepared in consultation with the NSW Department of Industry and NSW Environment Protection Authority, as required by conditions provided within the development consent PA 11_0060. The statutory requirements of this management plan are summarised in Table 2. A list of current groundwater licences are provided in Table 3.

5.1 Project Approval

This Water Management Plan has been developed in accordance with Schedule 3 Conditions 20, 21, and 23 and Schedule 6, Condition 3 of the Department of Planning and Environment (DPE) Project Approval (11_0060), as well as the Statement Of Commitments from the EA. Table 2 indicates where each component of the Conditions are addressed within this document.

Table 2: Groundwater Management Plan Statutory Requirements

Condition	Requirement	Section
PA 11_0060 Schedule 3 Condition 20	The proponent shall provide a compensatory water supply to any landowner of privately owned land whose water supply is adversely and directly impacted (other than an impact that is negligible) as a result of the project, in consultation with NOW, and to the satisfaction of the Secretary. The extent of adverse impact on water quality must be investigated in accordance with the procedures outlined in Condition 4, of Schedule 5. The compensatory water supply measures must provide an alternative long term supply of water that is equivalent to the lost attributable to the project. Equivalent water supply should be provided (at least on an interim basis) within 24 hours of the loss being identified, unless otherwise agreed with the landowner. If the proponent and the landowner cannot agree on measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Secretary for resolution. If the Proponent is unable to provide an alternative long-term supply of water, then the Proponent shall provide alternatively compensation to the satisfaction of the Secretary.	11
PA 11_0060 Schedule 3 Condition 21	Unless an EPL authorises otherwise, the Proponent shall comply with Section 120 of the POEO Act.	8.0

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Condition	Requirement	Section
Schedule 3 Condition 23	<p>The Proponent shall prepare and implement a Water Management Plan for the Project to the satisfaction of the Secretary. This plan must:</p> <ul style="list-style-type: none"> a) be prepared in consultation with DPI (Department of Primary Industries) Water and the EPA, by suitably qualified and experienced persons. b) be submitted to the Secretary for approval. c) in addition to the standard requirements for management plans (condition 3 of Schedule 6), this plan must also include a: <ul style="list-style-type: none"> a: 	5.0, entire document
PA 11_0060 Schedule 3 Condition 23	<p>(iii) Groundwater Management Plan, that includes:</p> <ul style="list-style-type: none"> - detailed baseline data on groundwater levels, yield and quality in the region and privately-owned groundwater bores that could be affected by the project; - groundwater assessment criteria, including trigger levels for investigating and potentially adverse groundwater impacts; - a program to monitor and report on: <ul style="list-style-type: none"> o groundwater inflows to the block cave and open cut mining operations o the seepage/leachate from water storages, emplacements and final voids; o background changes in groundwater yield/quality against mine- induced changes; o impacts of the project on: <ul style="list-style-type: none"> ▪ regional and local (including alluvial) aquifers; ▪ groundwater supply of potentially affected landowners; and ▪ riparian vegetation; o A program to validate the groundwater model for the project; and comparison of monitoring results with modelled predictions; and o a plan to respond to any exceedances of the groundwater assessment criteria. 	6.0, 11.0, 10.0, 12.0

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Condition	Requirement	Section
PA 11_0060 Schedule 6 Condition 3	<p>The proponent shall ensure that the management plans required under this approval are prepared in accordance with the relevant guidelines, and include:</p> <ul style="list-style-type: none"> a) detailed baseline data b) a description of <ul style="list-style-type: none"> • the relevant statutory requirements (include any relevant approval, licence or lease conditions); • any relevant limits or performance measures/criteria • the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the project or any management measures c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria d) a program to monitor and report on the: <ul style="list-style-type: none"> • Impacts and environmental performance of the project; • Effectiveness of any management measures (see c above) e) a contingency plan to manage any unprecedented impacts and their consequences; f) a program to investigate and implement ways to improve environmental performance of the project overtime; g) a protocol for managing and reporting any: <ul style="list-style-type: none"> • incidents; • complaints; • non compliances with statutory requirements; and • exceedances of the impact assessment criteria and/or performance criteria; and h) A protocol for periodic review of the plan 	5.0, 6.0, 9.0, 10.0, 11.0, 12.0
Statement of Commitments 6.9.1	NPM commit to the continuation of the existing approved groundwater monitoring program as part of the project.	11.0
Statement of Commitments 6.9.2	<p>In additions to the continuation of the existing groundwater monitoring program, NPM commit to the following additional groundwater monitoring and management measures:</p> <ul style="list-style-type: none"> • The extent of dewatering, impacts on current users and future resources will be monitored throughout the life of the project in accordance with a revised groundwater monitoring program. • Monitor dewatering volumes to verify that volumes are within licensed allocations. • Trigger levels, regarding declines in groundwater levels and the degradation of groundwater quality, will be reviewed to manage the potential impacts as part of the updated monitoring program. Where monitoring results indicate levels in excess of the trigger values, an investigation appropriate for the situation will be conducted to assess the need to implement management/mitigation/remedial measures. • The existing water monitoring program will be updated for the project in accordance with relevant approval requirements. 	9.0, 10.0, 13.0

Table 3: Northparkes Groundwater Licences

Licence number	Issue date	Expiry date
80BL244990	16 July 2008	Perpetuity
80BL244991	16 July 2008	Perpetuity
80BL244992	17 July 2008	Perpetuity
80BL620200	7 September 2011	Perpetuity
80BL620201	9 September 2011	Perpetuity
80BL620202	9 September 2011	Perpetuity

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Licence number	Issue date	Expiry date
80BL620405	22 May 2014	Perpetuity
80BL620406	22 May 2014	Perpetuity
80BL620407	22 May 2014	Perpetuity
80BL620408	22 May 2014	Perpetuity
80BL620203	9 September 2011	Perpetuity
80BL155192	09 August 1994	Perpetuity
80BL236021	17 April 1994	Perpetuity
80BL236023	17 April 1994	Perpetuity
80BL237290	15 April 1997	Perpetuity
80BL241019	MBPWD1, MBPWD2, MBPWD3, W6, W11, W13, E22, MBOPP1, MBOPP2, MBOPP3, MBOPP4, MBOPP5 are capped due to Estcourt tailings dam. MB13 bore is still in operation.	
80BL241020	E48 bore is capped.	Bore licence will be surrendered in 2016.
80BL241021	E26-P89, E268-P71AS	Bore licence will be surrendered in 2016.
80BL241023	MB08, E27, W7, W5, W1 bores are no longer in existence. These bores are capped. MB10 and W14 are operational.	
80BL241039	W15 is capped and no longer exists. MB11 and MB12 are in operation.	
80BL241042	E26-P147, E26-OPEN CUT MINE, E26-D129W1 are capped. E26-P149 and E26-P139 are in operation.	
80BL241045	E31R-P123 and W12 are capped and no longer exists.	

5.2 Water Act 1912

The *Water Act 1912* (Water Act) is administered by the NSW Department of Industry and has historically been the main legislation for managing water resources in NSW. The Water Act governs access, trading and allocation of licences associated with both surface water and groundwater sources and is currently being progressively phased out and replaced by water sharing plans (WSPs) under the *Water Management Act 2000* (WM Act). The elements to which the *Water Act 1912* applies include extraction of water from a river, extraction of water from groundwater sources, aquifer interference (less than 3 ML/year) and diversion works of surface water runoff for capture (of a capacity less than basic landholder rights).

As the NSW Murray Darling Basin Fractured Rock Groundwater Sources WSP is in place for the area within the site boundary, the Water Act does not apply for the installation of bores for the extraction of groundwater. Several licences are held by NPM under the Water Act for groundwater monitoring bores, summarised in the Northparkes Licence and Permits Register.

5.3 Water Management Act 2000

The WM Act, also administered by the NSW Department of Industry, is progressively being implemented throughout NSW to manage water resources, superseding the Water Act. The aim of the WM Act is to ensure that water resources are conserved and properly managed for sustainable use benefiting both present and future generations. It is also intended to provide formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses as well as to provide for protection of catchment conditions. Fresh water sources throughout NSW are managed via WSPs under the WM Act.

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Key rules within the WSPs specify when licence holders can access water and how water can be traded.

An amendment to the WM Act (Section 60I) came into effect on 1 March 2013. This amendment provides that it is an offence for a person without an access licence to take, remove or divert water from a water source or relocate water from one part of an aquifer to another part of an aquifer in the course of carrying out a mining activity. Various activities are captured by the provisions of the amendment including mining, mineral exploration and petroleum exploration.

The area within the site boundary is covered by the NSW Murray Darling Basin (MDB) Fractured Rock Groundwater Sources WSP which regulates extractions from the saprock, saprolite and fractured bedrock aquifers. As defined by this WSP the site is within the Lachlan Fold Belt MDB Groundwater Source.

The Lachlan Unregulated and Alluvial Water Sources WSP regulates extraction of alluvial groundwater within the site boundary. As defined under this WSP the site is within the Upper Lachlan Alluvial Groundwater Source. Table 4 of the Surface Water Management Plan identifies the water access licences (WALs) currently held by NPM under the WM Act, the annual extraction limit and the WSP covering the WAL.

It is recommended that NPM review their WALs held under the WM Act. NPM must ensure they have sufficient WALs for the predicted groundwater extractions from both the alluvial and fractured rock groundwater sources.

5.4 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) aims to protect, restore and enhance the quality of the environment in NSW by rationalising, simplifying and strengthening the regulatory framework for environment protection. The POEO Act and associated Regulations are administered by the NSW EPA.

The *Protection of the Environment Operations Act 1997* regulates emissions to air, water pollution, noise pollution and waste management through a single integrated licence.

NPM holds Environment Protection Licences (EPL) No: 4784 under this Act. The conditions of the EPL are further discussed within the WMP and SWMP.

6. BASELINE INFORMATION

6.1 Groundwater Levels

There was a lack of long term pre-mining background data. To determine baseline groundwater levels, bores outside the modelled 2m drawdown contour at the base of the saprock at the end of mining in 2032 were used. The modelled 2m drawdown contour was digitised from data provided in Step Change Project Response to Submissions (Umwelt, 2013b). It was assumed that at these locations groundwater levels have not been greatly impacted by mining activities and that these bores would provide appropriate background data.

Estcourt TSF was approved in October 2009 and was excavated to provide construction material for TSF 1 and TSF 2. Groundwater monitoring bores have had a variable change in water level with W19 being stable, W20 increasing and W21 decreasing according to the SRK report (Water Management Plan Appendix H). Groundwater levels in MB10 had been increasing consistently since monitoring began in 2008.

Groundwater bores up-gradient of Estcourt TSF have shown the same uniform trend as bores located to the north. Monitoring of W23 (to the east of Estcourt TSF) and W22 (adjacent to W23) began in 2012 and since then have shown an increased water level trend. W22 screens fresh bedrock and may be influenced by a range of factors including dewatering of E27 pit or underground workings in the E48 ore body. In W24 and W25 groundwater levels have

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fluctuated since monitoring showing no real trend.

The groundwater impact assessment conducted as part of the Step Change Project indicated that the radius of groundwater depressurisation in the bedrock formation would extend approximately 4.5 km from the pits at cessation of current approved mining operations (Golder Associates, July 2013).

The groundwater impact assessment also identified that subsidence zones will have a localised impact on groundwater levels and quality.

As mining operations cease the underground workings will slowly flood with groundwater and a water level equilibrium will be reached over time (Golder and Associates, July 2013).

For more information regarding background groundwater levels refer to the Step Change Project Environmental Assessment (Umwelt, 2013) Appendix 10.

6.2 Groundwater Quality

The Northparkes Mines Step Change Project Environmental Assessment (Umwelt, 2013), Appendix 10 (Golder Associated, 2013) conducted a groundwater quality assessment. It indicated that;

- pH ranged from 6.5 – 9.6;
- TDS ranged from 169 – 28,440 mg/L (These ranges are also variable according to bore depth); and
- There is a spatial and temporal variation in water quality across the Northparkes site near the ore bodies.

7. POTENTIAL GROUNDWATER IMPACTS

The following activities have the potential to impact groundwater resources;

- Underground mining
- Open cut mining
- Storage and use of chemicals and hydrocarbons and
- Tailings storage.

7.1 Underground Mining

Underground mining results in drawdown of groundwater levels as the underground workings intercept deeper aquifers and groundwater is pumped to the surface. Continuation of underground mining in E26 and E48 and the commencement of underground mining in E22 will result in a drawdown in groundwater pressure in the vicinity of the workings.

7.2 Open Cut Mining

Open cut mining results in drawdown of groundwater levels as mining intercepts shallow aquifers that are pumped out of the open cut workings. Development of any open cut mining in E28, E28N, E31 and E31N or E26 will likely result in groundwater drawdown in the vicinity of the workings. Drawdown will continue as long as open cut areas continue to be dewatered. As dewatering ceases it is anticipated groundwater levels will slowly re-stabilise.

Open cut mining ceased in 2010 with the completion of the E22 open cut pit.

7.3 Storage and Use of Chemicals and Hydrocarbons

To reduce the risk of contamination from the use and storage of chemicals and hydrocarbons, these products will be stored in bunded areas in accordance with the relevant Australian Standards. These areas will be inspected as part of the site Auditing and Reporting Program.

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7.4 Tailings Storage

Analysis of groundwater level data by SRK showed an increase in groundwater levels at regolith bores MB1 to MB6 inclusive and regolith and or bedrock bores W14 (SRK, 2016).

The EIS for the Project raised a number of potential causes of the observed increase in groundwater levels associated with TSFs. Potential causes were related to enhanced recharge due to thinning or removal of the regolith near the tailings dams, pore squeezing due to the weight of tailings on the ground surface and actual leakage from the tailings dams (Golder Associates, 2013).

8. MANAGEMENT PRACTICES FOR GROUNDWATER RESOURCES

Groundwater quality is protected through the following management practices;

- Preparation of base layers for waste rock emplacements to reduce risk of infiltration from runoff through the waste rock into the groundwater;
- Preparation of base layers for the tailings storage facilities to reduce the risk of infiltration of seepage through the tailings profile into the groundwater; and
- Monitoring of groundwater levels and quality to determine any potential impacts associated with the Projects activities and developing appropriate management options to mitigate impacts.

Given the low conductivity and flow rates it is not anticipated that the subsidence zone will detrimentally impact the regional groundwater flow regime. It is expected according to the studies in the Northparkes Mines Step Change Project Environmental Assessment (Umwelt, 2013) that the anticipated drawdown zone will be confined to within the Project Disturbance Boundary.

The management strategy will include designs which consider the proximity of the subsidence zones to tailing storage facilities and water storages. This will aim to avoid the subsidence zone not encroaching on these areas causing permanent changes in rock hydraulic characteristics and have the potential to cause seepage of water beneath the structures.

9. TRIGGER LEVELS FOR GROUNDWATER MONITORING RESULTS

Northparkes engaged SRK to conduct a review of trigger levels for groundwater levels and quality. The review was conducted to assist in providing more relevant trigger levels for the groundwater monitoring network. These triggers were developed to assist in identifying and appropriately managing potential groundwater impacts based on historical monitoring data available from the groundwater monitoring network. SRK has developed groundwater levels and quality criteria for each bore where there was sufficient data available. Bores have not been grouped together as has been in the past due to the variability in parameters such as EC and Copper concentrations, particularly in those bores which are within close proximity to the ore bodies.

Each bore has been set with Level 1 and 2 trigger levels which correspond to Appendix D of the WMP (Site Specific Trigger Values for Groundwater Bores). Applying individual trigger levels to each of the monitoring bores provides the Environment Team with a more accurate and representative range of the groundwater levels and quality of the bores. This enables more effective and accurate interpretation of monitoring data with respect to the existing activities associated with PA 11_0060.

It should be noted that several bores have been dry or had insufficient flow to make them suitable for sampling and as such trigger levels have not been developed on these bores due to lack of data.

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9.1 Groundwater Levels

Groundwater levels were assessed and triggers developed for individual bores where there was sufficient data available. Analysis indicated that the overall trend was stable to increasing across the site. Groundwater level triggers can be found in Appendix D of the WMP (Site Specific Trigger Values for Groundwater Bores) and Appendix H of the WMP (SRK Report). The previous GWMP trigger levels were specified for 17 bores. The new trigger levels presented in Appendix H of the WMP includes groundwater trigger levels for more than 30 bores.

Groundwater drawdown levels will be continually assessed against the groundwater assessment conducted in the Step Change EA.

9.2 Groundwater Quality

Groundwater quality parameters were assessed and triggers developed for individual bores where there was sufficient data available. The water quality in the bores was variable. Particularly EC which indicated higher levels in the bores closer to the ore body.

Groundwater quality trigger levels can be found in Appendix D of the WMP (Site Specific Trigger Values for Groundwater Bores) and Appendix H of the WMP (SRK Report). The updated trigger levels in Appendix H of the WMP are more specific than the previously approved GWMP. The previous trigger levels were only relevant for those bores with excess salinity levels. The trigger levels have been grouped as per the following;

- Open cut bores;
- Tailings storage facility bores;
- Underground bores, and
- Regional bores.

Each of the bores has been allocated with its own relevant trigger levels based on review of monitoring data conducted by SRK.

10. GROUNDWATER MONITORING PROGRAMS

The aim of groundwater monitoring program is to;

- Check that groundwater drawdown is within the predictions of the groundwater modelling undertaken as part of the EIS for the Project (Umwelt, 2013a); and
- To detect any potential impact on surrounding groundwater users and to ensure that requirements of the NSW Aquifer Interference Policy are met.

This section of the GWMP outlines the locations, parameter, frequency and methodology of monitoring.

10.1 Monitoring Methodology

As specified by DIPNR (2003), groundwater monitoring should be undertaken in general accordance with A Practical Guide to Groundwater Sampling (Jiwan and Gates, 1992), although it is recommended that low flow sampling techniques be used for purging and sampling (rather than bailers or submersible pumps) to minimise aquifer disturbance and reduce the volume of groundwater extracted during sampling.

In general, the groundwater monitoring methodology should include the following;

- Gauging of groundwater levels prior to purging for water analysis sample collection;
- Purging of monitoring bores using a low flow peristaltic pump. To limit the disturbance of possible sediments in the base of each bore, the sample tubing at each bore should be lowered to approximately the middle of the screened interval for purging and sample collection;
- Measurement of groundwater field parameters (pH, EC) using a calibrated water quality meter and a flow cell during purging. The pH and EC readings should be recorded in the

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field once they have stabilised;

- If groundwater samples are to be collected, they are to be transferred into suitably preserved laboratory supplied sample containers once field parameters have stabilised.
- Samples to be analysed for dissolved metals are to be filtered in the field using 0.45 µm filters. All sample containers are to be clearly labelled with sample number, sample location and sample date.
- The sample containers are to be transferred to a chilled esky for sample preservation prior to and during shipment to the testing laboratory. A Chain- of-Custody form should be forwarded with the samples to the testing laboratory; and
- Decontamination of all non-dedicated sampling equipment between monitoring locations

10.2 Water Transfer Monitoring

To monitor and assess the operational water cycle at NPM, a number of volumetric meters are positioned around the site. These meters allow for definitive annual reporting of water usage, inputs and outputs of the operational water cycle and provide a point of verification for the water balance representations of the site. These existing volumetric metering locations will continue to be monitored daily for the life of the mine. The locations of the volumetric meters are:

- Transfers from Parkes Shire Council groundwater bores and river supply to the Raw Water Tank;
- Raw Water Tank outflows to the Water Treatment Plant;
- Potable Water Tank to contractor's yard, E26 Underground, truck wash and administration facilities;
- TSF 1 and TSF 2 to the Process Water Dam;
- E26 Underground to the Process Water Dam;
- Transfers from the Return Water Dam to the Process Water Tank, Caloola Dams; and
- Process Water Dam.

The Site Water Balance (GHD, 2014a) considers the historical data of these metering locations as well predicted future annual transfer volumes.

10.3 Monitoring Parameters and Frequency

All groundwater bores are monitored on a quarterly basis as per Table 4: Groundwater Monitoring Parameters and Frequency for all Groundwater Monitoring Bores. All active groundwater monitoring bores are listed in Table 5: Monitoring Bore Names.

Table 4: Groundwater Monitoring Parameters and Frequency for all Groundwater Monitoring Bores

Frequency	Parameter
Quarterly	Water level
Quarterly	pH, EC, total dissolved solids, hydroxide alkalinity, carbonate alkalinity, bicarbonate alkalinity, total alkalinity, sulfate, chloride, calcium, magnesium, sodium, potassium, aluminium, antimony, arsenic, beryllium, barium, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, zinc, nitrate, strontium, thallium, thorium, uranium, iron and mercury.

Table 5: Monitoring Bore Names

Bores	Location
MB10, MB11, MB12, MB13, MB14, MB16, W14, W19, W20, W21, W22, W23, W24, W25	Open Cut Bores
MB01, MB02, MB03, MB04, MB05, MB06B, MB07, MB16, W19, W21, W22, W23, W26, W27, W28, W29, W30, W31, W32	TSF Bores

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Bores	Location
MB17, MB18, MB19, MB20, P71, P100, P101, P102, P103, P104, P139, P145, P149	Underground Bores
Far Hilliers, Moss, Wright, Long Paddock, South Hilliers	Regional Bores

11. RESPONSE TO TRIGGER LEVEL EXCEEDANCE

The appropriate response to a trigger being exceeded is outlined in the Trigger Action Response Plan in Appendix B of the WMP (Groundwater Trigger Action Response Plan). The response to a trigger being exceeded generally involves undertaking analysis to determine if a change in groundwater quality or level is due to natural variation or mining activity and informing the Site Manager that a trigger value has been exceeded.

Five monitoring bores are located on privately owned land surrounding the mine lease. In the event that a complaint is received regarding potential impact on groundwater levels or quality an investigation would be conducted to determine if the activities related to the Project have influenced an impact on the stakeholder's groundwater resources. In addition to this the Northparkes Complaints Management process would be implemented. Compensation would be developed if required in consultation with the private landowner where an investigated has indicated that Northparkes related activities have adversely affected the groundwater level or quality. To date, no complaints have been received in relation to the groundwater supply of private landowners. There is limited use of groundwater resources in the area due to the quality and recharge rates.

12. REPORTING REQUIREMENTS

Upon receipt of monitoring results, the following review processes will be undertaken;

- Data will be compared to the specified trigger values where applicable; and
- If any results do not meet specified trigger values, further investigation will be required at the respective location.

Groundwater levels should be compared to the predicted groundwater modelling on an annual basis. Any large discrepancies or variances from predicted groundwater levels should be investigated. If the cause of the variance is determined to be due to mining-related activities, then the groundwater model will require updating. Northparkes will undertake groundwater modelling on an annual basis in 2019, 2020, 2021 and once every three years after the initial three year period.

12.1 Data Review Requirements

12.1.1 EPL 4784

The monitoring requirements under this GWMP are part of Northparkes Environment Protection Licence (EPL) 4784 and therefore the monitoring results need to be reported in accordance with the requirements of the EPL.

The conditions of EPL 4784 require groundwater monitoring to be undertaken at the following locations: W14, MB21, MB23, MB25, MB27 and MB22. The parameters requiring reporting and the frequency of reporting are shown in Table 6: EPL 4784 Groundwater Quality Monitoring Requirements.

Table 6: EPL 4784 Groundwater Quality Monitoring Requirements

Parameter	Units	Frequency	Sampling Method
Aluminium	mg/L	Yearly	Representative Sample
Arsenic	mg/L	Yearly	Representative Sample
Barium	mg/L	Yearly	Representative Sample

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Parameter	Units	Frequency	Sampling Method
Beryllium	mg/L	Yearly	Representative Sample
Bicarbonate	mg/L	Yearly	Representative Sample
Cadmium	mg/L	Yearly	Representative Sample
Calcium	mg/L	Yearly	Representative Sample
Chloride	mg/L	Yearly	Representative Sample
Chromium	mg/L	Yearly	Representative Sample
Cobalt	mg/L	Yearly	Representative Sample
Conductivity	µS/cm	Quarterly	Representative Sample
Copper	mg/L	Quarterly	Representative Sample
Lead	mg/L	Yearly	Representative Sample
Magnesium	mg/L	Yearly	Representative Sample
Molybdenum	mg/L	Yearly	Representative Sample
Nickel	mg/L	Yearly	Representative Sample
pH	pH units	Quarterly	Representative Sample
Potassium	mg/L	Yearly	Representative Sample
Selenium	mg/L	Yearly	Representative Sample
Sodium	mg/L	Yearly	Representative Sample
Standing water level	m	Quarterly	In Situ
Sulfate	mg/L	Yearly	Representative Sample
Total dissolved solids	mg/L	Yearly	Representative Sample
Zinc	mg/L	Yearly	Representative Sample

12.1.2 Annual Review

Northparkes completes an Annual Review (AR) that reviews the performance of operations against the requirements of the Water Management Plan.

The AR typically includes the following elements specific to water management;

- Any amendments to licensing or statutory approvals;
- A summary of any complaints or incidents relating to the performance of the water management system over the reporting period;
- A summary of the monitoring results collected over the reporting period and assessment against any relevant criteria;
- An evaluation of any trends in the monitoring results occurring across the site over the life of the project;
- Any non-compliance recorded during the reporting period and the actions taken to ensure compliance;
- Identification of any discrepancies between the predicted and actual impacts of the Project and an analysis of the potential cause of any significant discrepancies;
- An evaluation of the site water balance; and
- A summary of management actions to be implemented over the next year to improve the environmental performance of the project.

Northparkes will report annually in the AR the predicted groundwater take of the open cut and underground block caving mining areas for alluvial groundwater and saprock, saprolite and fractured bedrock groundwater sources for the next reporting period. Northparkes will compare the predicted extraction from each of these groundwater sources to the extraction licences held under the WM Act.

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13. REVIEW

NPM will undertake an annual review of hydrogeological groundwater level predictions against the monitored data. A review should also be undertaken if the operations timeline or site development varies from what was predicted as part of the most recent revision of the hydrogeological modelling. Opportunities for hydrogeological model verification exist through using the transfer data metered from E26 Underground to the Process Water Dam. This data is metered daily along with the volume of water transferred into the E26 Underground.

The GWMP will be reviewed and revised every year or as a result of;

- Any regulatory or statutory requirements;
- Any significant change to water management practices;
- Construction of additional surface water storages;
- Development of new open cut or underground mining areas;
- Continual exceedances of any trigger values; and
- Any incident that requires reporting.

A review of the GWMP will be undertaken by a suitably qualified person and also should consider consultation with the appropriate local and state government authorities.

14. RELATED DOCUMENTS

Document Title	Doc ID No.
Water Management Plan	DOCID-3-3756
Environment Monitoring and Measuring Schedule	DOCID-3-3877
Monitoring and Measuring Procedure	DOCID-3-3878
Auditing and Reporting Program	DOCID-3-8532

15. DEFINITIONS / ATTACHMENTS

Word	Definition
Alluvial	Deposition from running waters.
Baseflow	The component of streamflow that originates from groundwater.
Block Cave Mining	A mining method in which an ore body is undercut by drilling and blasting and allowed to fall
Bore	Constructed connection between the surface and a groundwater source that enables groundwater to be transferred to the surface with naturally or through artificial means.
Catchment	The land area draining through the main stream and tributary streams to a particular location.
Dewatering	Transfer of water from underground workings to the surface.
Drawdown	A reduction in piezometric head within an aquifer.
Electricity conductivity	A measure of the concentration of dissolved salts in water.
Groundwater	Water in a saturated zone, stratum or aquifer beneath the surface of the land.
Groundwater dependant ecosystem	Communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater. A GDE may either be entirely dependent on groundwater for survival or it may use groundwater opportunistically or for a supplementary source of water.

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Word	Definition
Groundwater extraction	For the purposes of this study, groundwater extraction has been defined as the removal of groundwater from a groundwater source or aquifer, either via direct removal for use via a production bore or via incidental flow of groundwater from the aquifer into the mine workings during and after mining. Groundwater extraction includes the pumping of underground water from flooded mine workings in equilibrium with the surrounding strata as well as the removal of water from perched aquifers recharged directly from rainfall infiltration.
Guideline	Numerical concentration or narrative statement that provides appropriate guidance for a designated water use or impact.
Hardness	The concentration of multivalent cations present in water. Generally hardness is a measure of the concentration of calcium and magnesium ions in water and is expressed in units of calcium carbonate (CaCO ₃) equivalent. Hardness may influence the toxicity and bioavailability of substances in water.
Hydrogeology	The area of geology that deals with the distribution and movement of groundwater in soils and rocks.
Infiltration	Natural flow of surface water through ground surfaces a result of rainfall events.
Percentile	The value of a variable below which a certain percent of observations fall. For example, the 80th percentile is the value below which 80 percent of values are found.
pH	Value taken to represent the acidity or alkalinity of an aqueous solution. It is defined as the negative logarithm of the hydrogen ion concentration of the solution.
Riparian	Pertaining to, or situated on the bank of a river or other water body.
Runoff	Amount of rainfall that ends up as streamflow.
SILO	An enhanced climate data bank based on historical climate data from 1889 provided by the Bureau of Meteorology. Records are mainly based on observed data, with interpolation where there are data gaps.
Strata	Geological layers below the surface.
Subsidence	Mining-induced movements and deformations at the ground surface.
Surface water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
Tailings	The by-product resulting from the processing of ore.
Trigger value	The concentration or load of physicochemical characteristics of an aquatic ecosystem, below which there exists a low risk that adverse ecological effects will occur. They indicate a risk of impact if exceeded and should 'trigger' action to conduct further investigations or to implement management or remedial processes.