China African Precious Metals (Pty) Ltd.

Orkney Gold Mine

Storm Water Management Plan

Project No: CAP-ORK-14-10-30

SHANGONI
Management Services (Pty) Ltd

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China African Precious Metals (Pty) Ltd

Orkney Gold Mine

Storm Water Management Plan

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PROJECT DETAILS

Project Title: **Storm Water Management Plan for China African Precious Metals (Pty) Ltd. – Orkney Gold Mine**

Project Number: CAP-ORK-14-10-30

Compiled by: **Dawie Maree**

Date: March 2015

Technical Reviewer: Brian Hayes

RB Hayes (Pr.Eng.)

EXECUTIVE SUMMARY

China African Precious Metals (Pty) Ltd. appointed Shangoni Management Services (Pty) Ltd. to conduct an assessment of the current storm water management infrastructure at the seven shaft locations and compile a storm water management plan with recommendations for improvements to aid in addressing shortcomings in clean/affected water management and improvements with regards to storm water management measures.

The objective of the storm water management plan (SWMP) is to improve the clean and dirty water separation so as to meet the requirements in accordance with the best practice guidelines (DWAF, 2006), Section 19 of the National Water Act and Regulation 704 (No. 704 of 4 June 1999) of the National Water Act (Act 36 of 1998). The SWMP is a high level strategic document presenting a combination of existing and proposed practises with focus on storm water control measures to be implemented.

The main storm water control philosophy for the China African Precious Metals (CAPM) operations is to isolate the potential contamination of clean storm water runoff from the dirty areas. Dirty areas include all facilities and activities that have the potential to pollute clean water resources. The outcome from this assessment includes recommendations in respect to storm water management as well as identification of potential risk of affected water release.

Each of the focus areas is provided with a map indicating the main draining philosophies, catchment areas, areas with the potential to pollute storm water runoff and existing and proposed runoff control strategies. This SWMP includes a conceptual strategy on recommendations to address the separation of clean/affected water and recommendations with regards to storm water measures (berms, channels and containment facilities). Monitoring and maintenance of storm water control infrastructure are included as part of the recommended implementation strategy. The key storm water measures identified for the seven shaft locations for CAPM includes the following:

- Implement a maintenance schedule for the clean water conveyance networks at the shaft locations, especially Shaft #6, #7, #1 and #4, during the operational phase to maintain the integrity of the diversion channels.
- Implement good housekeeping practises to [prevent and minimise dirty areas within the intended operational shafts. It includes the storage and handling of chemicals and hydrocarbon containers. This strategy aims to avoid the need to construct dirty water containment facilities to comply with GN 704, Regulation 7(a).
- Implement a maintenance schedule during the operational phase of the shafts to ensure the integrity of sumps and cooling ponds (dirty water containment facilities). Pumping infrastructure should be in working order at all times to prevent any overflow of affected water into the shaft- and surrounding area – GN 704, Regulation 7(a).

- Divert surface runoff away and prevent surface runoff from flowing into the shafts, especially the shafts were operations are not to be continued – GN 704, Regulation 7(c). This strategy aims to reduce impact on the catchment yield.
- Implement a maintenance schedule to ensure that storm water conveyance channels are free draining. Areas where ponding of storm water takes place should be minimised – GN 704, Regulation 7(g).
- Ensure that rehabilitated areas in progress, such as the Shaft #3 area, are free draining in terms of storm water management. No materials with leaching potential should be left at the site. Vegetation growth should be encouraged on exposed areas to limit erosion.
- It is recommended, as an additional measure, to construct a berm between the sewage sump and the clean runoff diversion channel at the Shaft #5 area. This strategy aims to prevent sewage from flowing into the clean runoff diversion trench during possible overflow – GN 704, Regulation 7(a).
- Of concern is the absence of an oil separator at the wash bay at the Shaft #6 area, to prevent hydrocarbon contaminated wash water discharge into the surrounding clean water environment. It is recommended to install an oil separator as soon as the shaft is operational and conduct regular inspections to ensure that the oil separator is in working order at all times. Monitoring of discharge water should take place and verified against the discharge limits as required by the Department of Water Affairs and Sanitation. If wash water is found to be inadequate for discharge, it is recommended to implement a containment and evaporation facility. This strategy aims to comply with GN 704, Schedule 7(a).

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ABBREVIATIONS

ARM:	Alternative Rational Method
DWA:	Department of Water Affairs
DWS	Department of Water and Sanitation
GN704:	Government Notice Regulation 704 of 4 June 1999
MAMSL:	Meters Above Mean Sea Level
MAR:	Mean Annual Runoff
NWA:	National Water Act (Act 36 of 1998)
RM:	Rational Method
SAWS:	South African Weather Service
SDF:	Standard Design Flood Method
SWMP:	Storm Water Management Plan
WRD:	Waste Rock Dump
WULA:	Water Use License Application

TERMINOLOGY

Berm: A wall usually constructed using raw material (e.g. gravel, soil or rock) with the purpose to divert the natural flow path of surface water.

Catchment: The area from which any rainfall will drain through surface flow to a common point or points.

Clean water: Water that complies with a negotiated standard or natural runoff that has not been contaminated with known pollutants.

Design storm: A particular combination of rainfall conditions generally expressed as a total quantity of precipitation, expressed as mm of rainfall, or a short term intensity, expressed as mm per hour, in combination with a defined recurrence interval.

Dirty water: Water that has been exposed, or could potentially be exposed, to known pollutants.

Drainage area: The total land area that drains to a specified point comprises the drainage area for that point.

Dirty water system: Any system designed to collect, convey or contain dirty water.

Drainage trench: An artificial flow path designed to convey water.

Life of mine: The life of mine includes all the phases of the mine's existence from the conceptual and planning phases, through design, construction, operation and decommissioning to the post-closure and aftercare phases.

Peak flow runoff: Runoff from an area following a hydrograph curve during a storm event. A maximum runoff rate is experienced during the storm event and this rate is referred to as the peak flow runoff.

Surface runoff: Water falling as rainfall and is not lost through evaporation, transpiration or infiltration thereby flowing above the ground surface after deposition.

Watercourse: Defined as a river or spring; a natural channel in which water flows regularly or intermittently; a wetland, lake or dam into which, or from which, water flows; and any collection of water which the *Minister* may, by notice in the *Gazette,* declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

1. Introduction

Shangoni Management Services was appointed by China African Precious Metals (Pty) Ltd. to conduct an assessment of the current storm water management infrastructure at the seven shaft locations and compile a storm water management plan with recommendations for improvements to aid in addressing shortcomings in clean/affected water management and improvements with regards to storm water management measures.

Storm water management is essential to reduce impact on the environment through the resulting erosion, siltation and pollution as it is widely recognised that mining activities and developments impact negatively on drainage systems. By taking greater cognisance of natural hydrological patterns and processes it is possible to develop storm water management systems in a manner that reduces these potentially negative impacts and mimic nature. Storm water management is the science of limiting these negative impacts on the environment and enhancing the positive impacts or catering for the hydrological needs of a development while minimising the associated negative environmental impacts.

This storm water management plan is required to meet legal obligations, describing the storm water management requirements at the seven shaft locations and proposed strategies (including existing measures) for the separation of clean and affected runoff water. The report is prepared as part of additional work to be undertaken to aid CAPM in obtaining the necessary environmental authorisations in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) and the National Water Act, 1998 (Act No. 36 of 1998). The report is based on information provided by CAPM, the Best Practise Guidelines G1 for Storm Water Management (DWAF, 2006), the National Water Act (Act No. 36 of 1998) and Regulation 704 of the National Water Act (Act 36 of 1998).

One of the objectives of the storm water management plan (SWMP) is to manage the risk of the mining activities being exposed to extreme weather conditions. Key steps required within a SWMP include the following (of which this document addresses points 1 to 3, and provides recommendations towards 5 and 6):

1. Identify clean and dirty catchment areas;
2. Assess effectiveness of existing infrastructure;
3. Conceptualise measures to keep these clean and dirty areas separate;
4. Implementation;
5. Monitoring and maintenance; and
6. Review effectiveness of measures implemented.

1.1 Assumptions and limitations

- Whilst every endeavour has been made by Shangoni to ensure that information provided is correct and relevant, this technical report is, of necessity, based on information that could reasonably have been sourced within the time period allocated to the assessment, and is, furthermore, of necessity, dependent on information provided by management and/or its representatives during the course of the project.
- It is assumed that the Client provided all information to Shangoni that is relevant to the scope of work included in this technical report and that no important information has been withheld. Should additional information become available, Shangoni reserves the right to amend this technical report.
- The relevant information received from the Client during the course of this project will be deemed true and correct. If such information reflected in any documentation relevant to this project is discovered to be misleading, Shangoni does not take any responsibility for the implications of such misrepresentations made by the Client.
- Any reference to legislation in this technical report should not be perceived as a substitute for the provisions of such legislation. In the event of any inconsistency between this document and such legislation, the latter would prevail.
- Shangoni is under no obligation to the Client and others to conduct work not specified in the scope of work as agreed in the relevant proposal.
- Flood peak calculations assume rainfall intensity is uniform throughout the duration of the storm. Analysis does not account for runoff retention or artificial acceleration within the catchment.
- Calculations are done for complete catchment areas and should be distributed where there is more than one drainage point within the same built up catchment.
- Storm water control recommendations are based on industry experience and best practice. Final designs for construction should be authorised by an approved engineer.
- Contour and elevation data as provided during the analysis are assumed to be accurate and representative of the site and catchment areas.
- Upstream catchment activities are interpreted according to common practices and no detailed insight is available on possible storm water measures beyond the site. The assessment does not guarantee the integrity of downstream infrastructure in the event of release or discharge from site.
- The SWMP does not impose preference over existing or proposed measures as this is an operational document to assist in the complete management of all storm water measures.
- This storm water management plan does not specifically cover considerations relevant to storm water management for the purpose of safety, like mine flooding and loss of life, the primary focus being environmental management.
- Recommendations represented in this report apply to the site conditions and features as they existed at the time of Shangoni's investigations, and those reasonable foreseeable. The recommendations do not necessarily apply to conditions and features that may arise after the date of this SWMP, for which Shangoni had no prior knowledge nor had the opportunity to evaluate.

1.2 Legal framework

1.2.1 National Water Act (No. 36 of 1998)

Surface water management for the seven shaft operations for CAPM falls under legislation contained in, amongst others, the National Water Act (No. 36 of 1998). Part 4 deals with prevention and contamination, and in particular the situation where pollution occurs or might occur as a result of activities on land: *The person who owns, controls, occupies or uses the land in question is responsible for taking measures to prevent pollution of water resources. If these measures are not taken, the catchment management agency concerned may itself do whatever is necessary to prevent the pollution or to remedy its effects, and to recover all reasonable costs from the persons responsible for the pollution. This can be summarised as follows:*

- *Separate "clean" and "dirty water";*
- *Water contaminated by activities / infrastructure may not be discharged to surface or groundwater resources; and*
- *Prevention of erosion.*

1.2.2 Extracts from the National Water Act (No. 36 of 1998), Part 4

(1) An owner of land, a person in control of land or a person who occupies or uses the land on which *(a) any activity or process is or was performed or undertaken; or* *(b) any other situation exists, which causes, has caused or is likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring.* *(2) The measures referred to (above) may include measures to –* *(a) cease, modify or control any act or process causing the pollution;* (b) *comply with any prescribed waste standard or management practise;* (c) *contain or prevent the movement of pollutants;* (d) *eliminate any source of pollution;* (e) *remedy the effects of pollution;* (f) *remedy the effects of any disturbance to the bed and banks of a watercourse.*

1.2.3 Regulations relating to capacity requirements of "clean" and "dirty" water systems

Every person in control of an activity must – *(a) confine any unpolluted water to a clean water system, away from any dirty area;* *(b) collect the water arising within any dirty area, into a dirty water system;* (c) design, construct, maintain and operate any dirty water system so that it is not likely to spill into any clean water system more than once in 50 years.

Regulation 6 and 7 of GN 704 in terms of the National Water Act regulates the capacity requirements of clean and dirty water systems and the protection of water resources on and around mining and related operations respectively and requires that: "*Every person in control of a mine or activity must confine any unpolluted water to a clean water system, away from any dirty area; and design, construct, maintain and operate any dirty water system at the mine or activity so that it is not likely to spill into any clean water system more than once in 50 years" and "Every person in control of a Mine or activity must take reasonable measures to prevent water containing waste or any substance which causes or is likely to cause pollution of a water resource from entering any water resource, either by natural flow or by seepage, and must retain or collect such substance or water containing waste for use, re-use, evaporation or purification and disposal in terms of the Act.*

2. Description of the environment

2.1 Regional location and surrounding vegetation

The seven CAPM shafts are located in the North-West province, in close proximity of the town Orkney within the jurisdiction of the Dr. Kenneth Kaunda district municipality and the City of Matlosana local municipality. As a result of the distribution of the shafts and the localities of residential areas situated in between the shaft areas, the neighbouring towns and settlements have been provided in relation with No. 7 Shaft. Distances were measured by drawing a straight line from No. 7 Shaft:

- Orkney – 2.6 km south-west;
- Kanana – 3.8 km west;
- Klerksdorp – 10 km north-west;
- Stilfontein – 16.2 km north-east;
- Viljoenskroon – 15.5 km south-east; and
- Hartbeesfontein – 32 km north-west.

The seven shafts within the mining right area are accessed via the N12 national highway connecting Johannesburg, Potchefstroom, Klerksdorp and Kimberley. The R30 provincial road connects Klerksdorp and Orkney. Shaft No. 7, the first shaft to commence with operations) is accessed via Chesterton road (that runs through the town Orkney) and/or an unnamed road to the south which intersects with the R502 provincial road.

The general areas surrounding the seven shaft areas has been modified to a large extend by residential, industrial, mining and agricultural activities. The area that comprises the Klerksdorp Gold fields (in which the shafts are located) has low relief with no depressions. Surface drainage (taking all seven shaft into account) is expected in a south to south-western direction towards natural drainage lines. Due to the flat topography of the area, surface runoff will be as a result of development and modifications at each shaft area. The majority of the shafts are located within the Vaal Reefs Dolomite Sinkhole Woodland vegetation type and the Vaal-Vet Sandy Grassland vegetation type. The general soils in the area are classified as undifferentiated shallow soils and shallow soils on hard or weathering rock. Most of the soils have restricted soil depth and restricted land use options.

The figures below indicate the locality of the CAPM shafts, the master plan for the various shafts and the quaternary catchment in which the shafts are located:

Figure 1: Locality

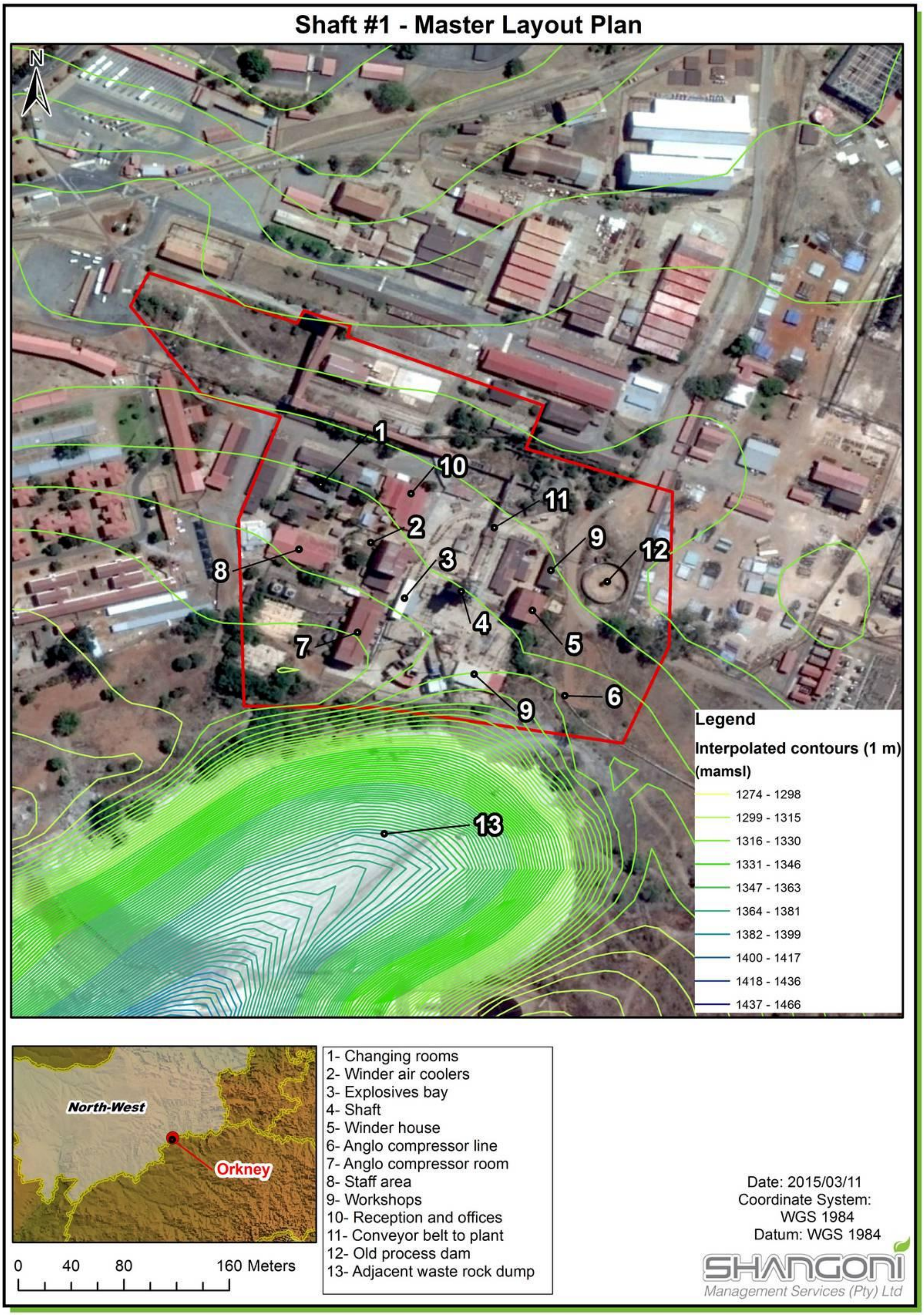


Figure 2: Master Layout Plan – Shaft #1

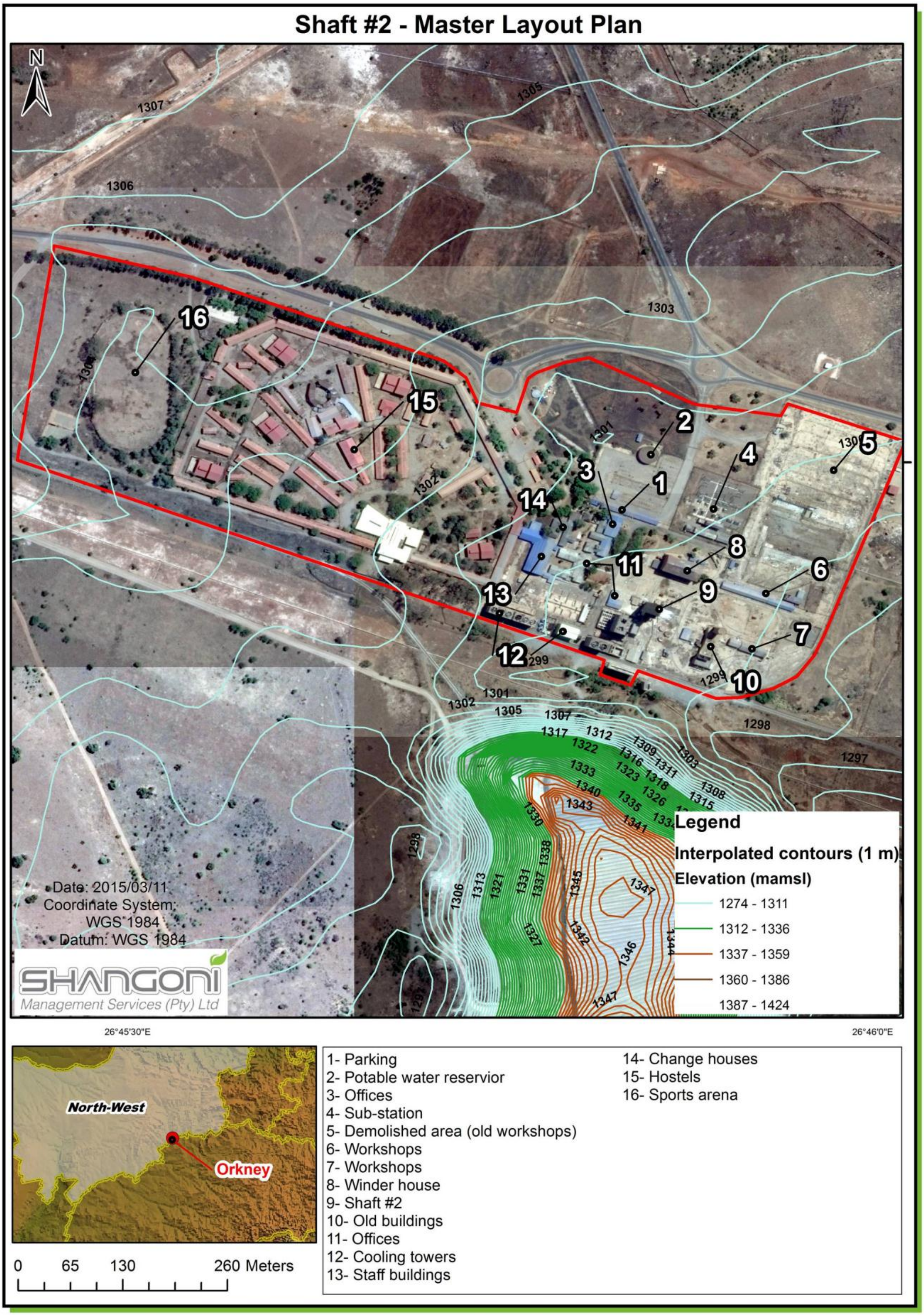


Figure 3: Master Layout Plan – Shaft #2

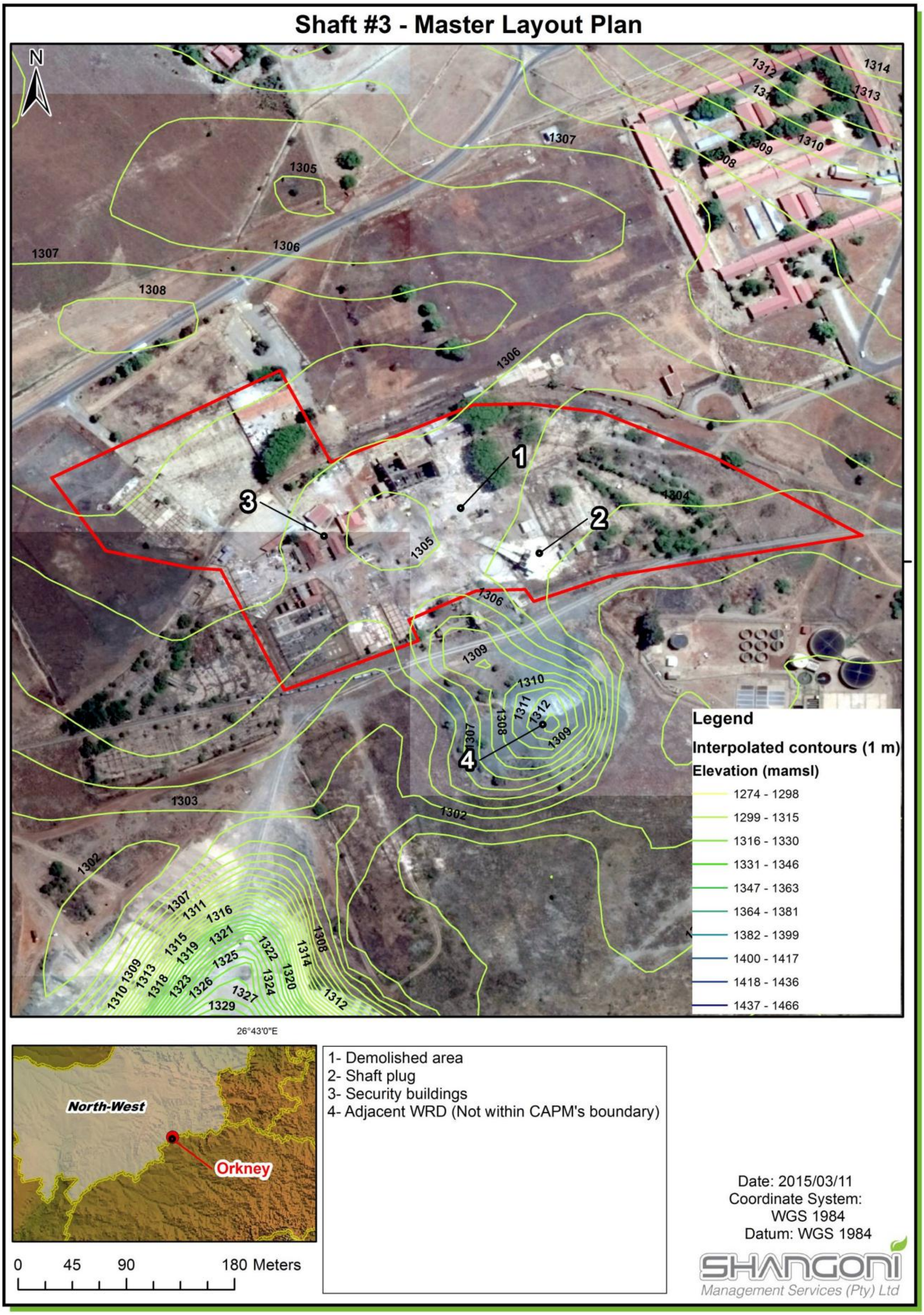


Figure 4: Master Layout Plan - Shaft #3

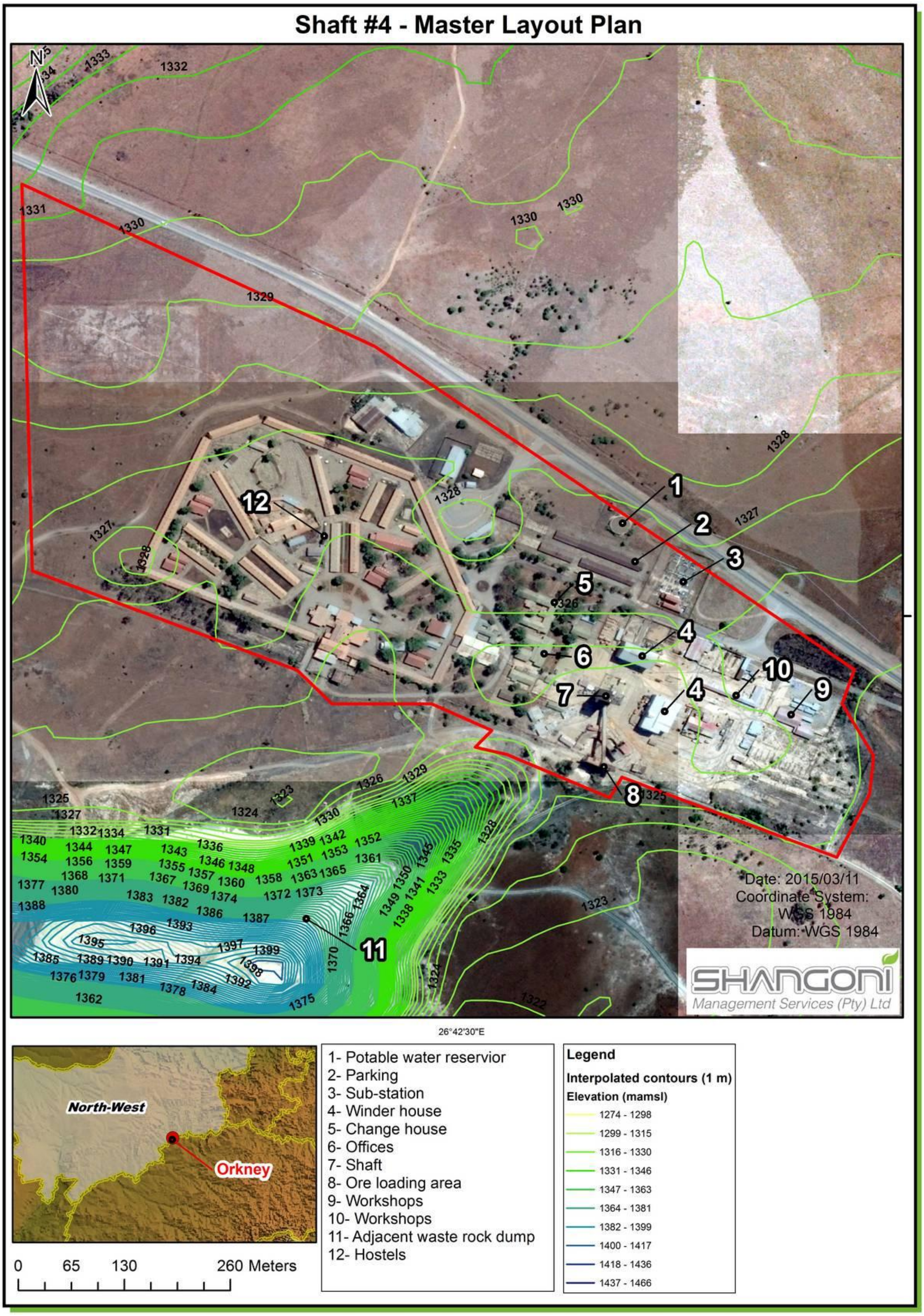


Figure 5: Master Layout Plan – Shaft #4

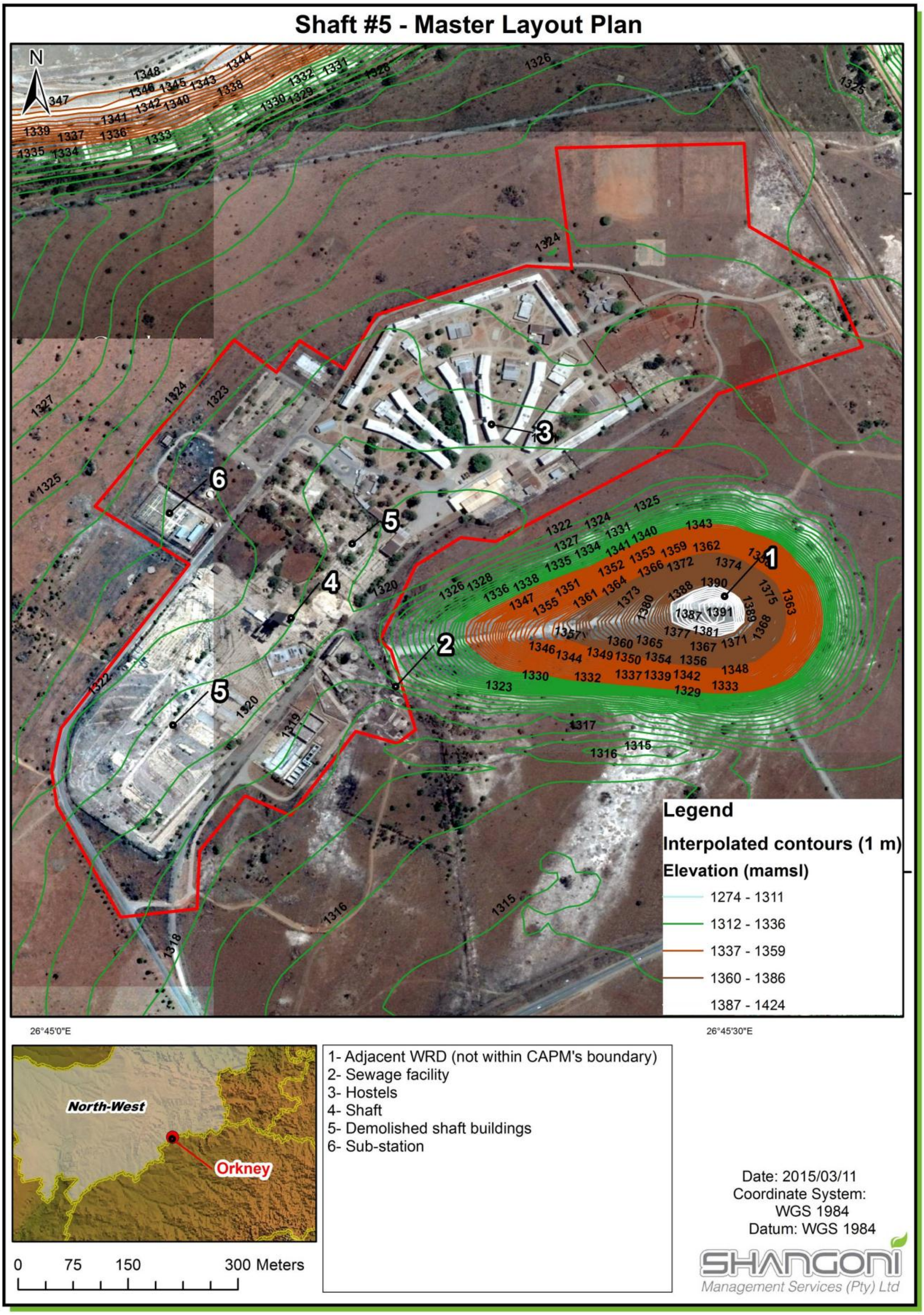


Figure 6: Master Layout Plan – Shaft #5

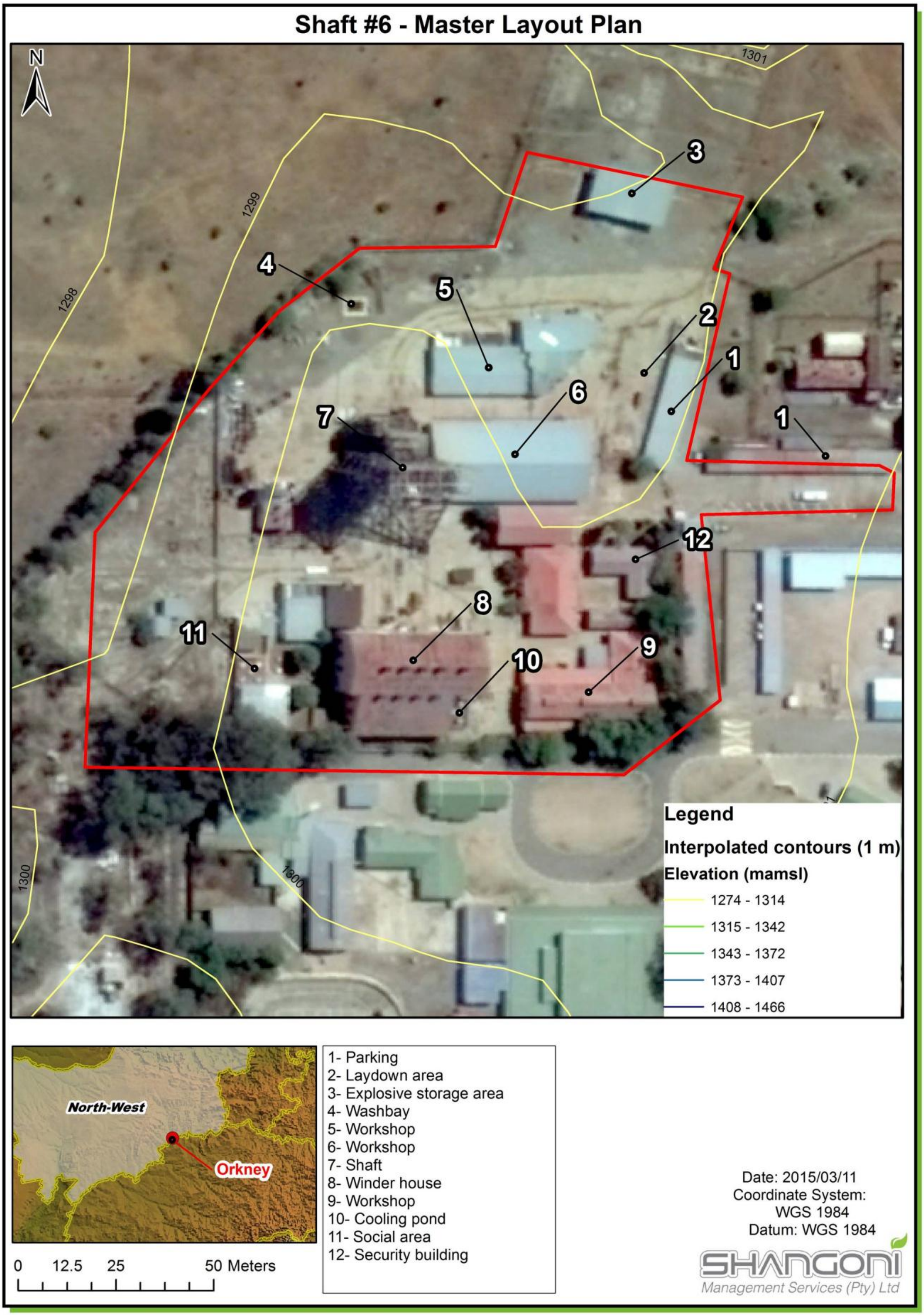


Figure 7: Master Layout Plan – Shaft #6

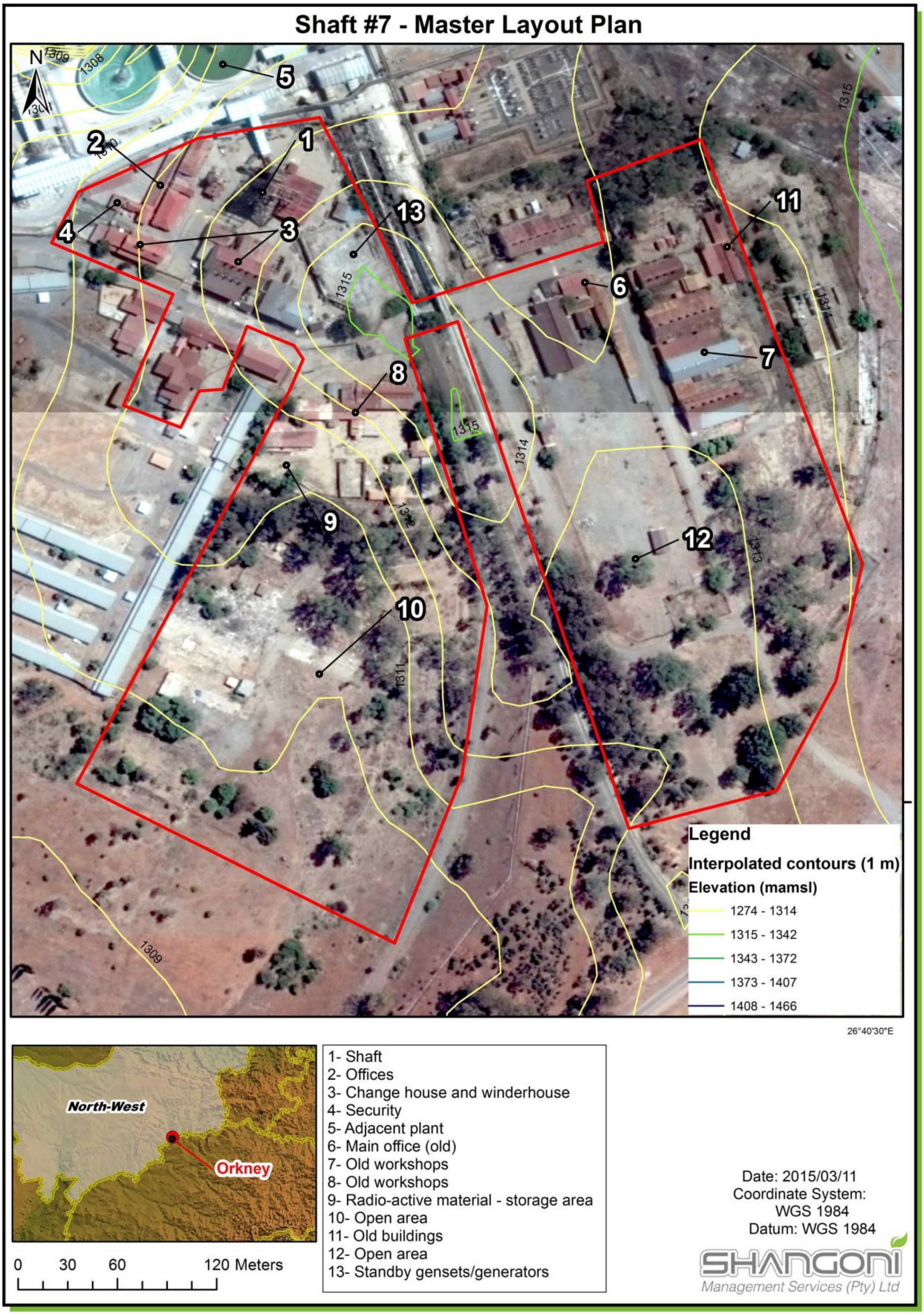


Figure 8: Master Layout Plan - Shaft #7

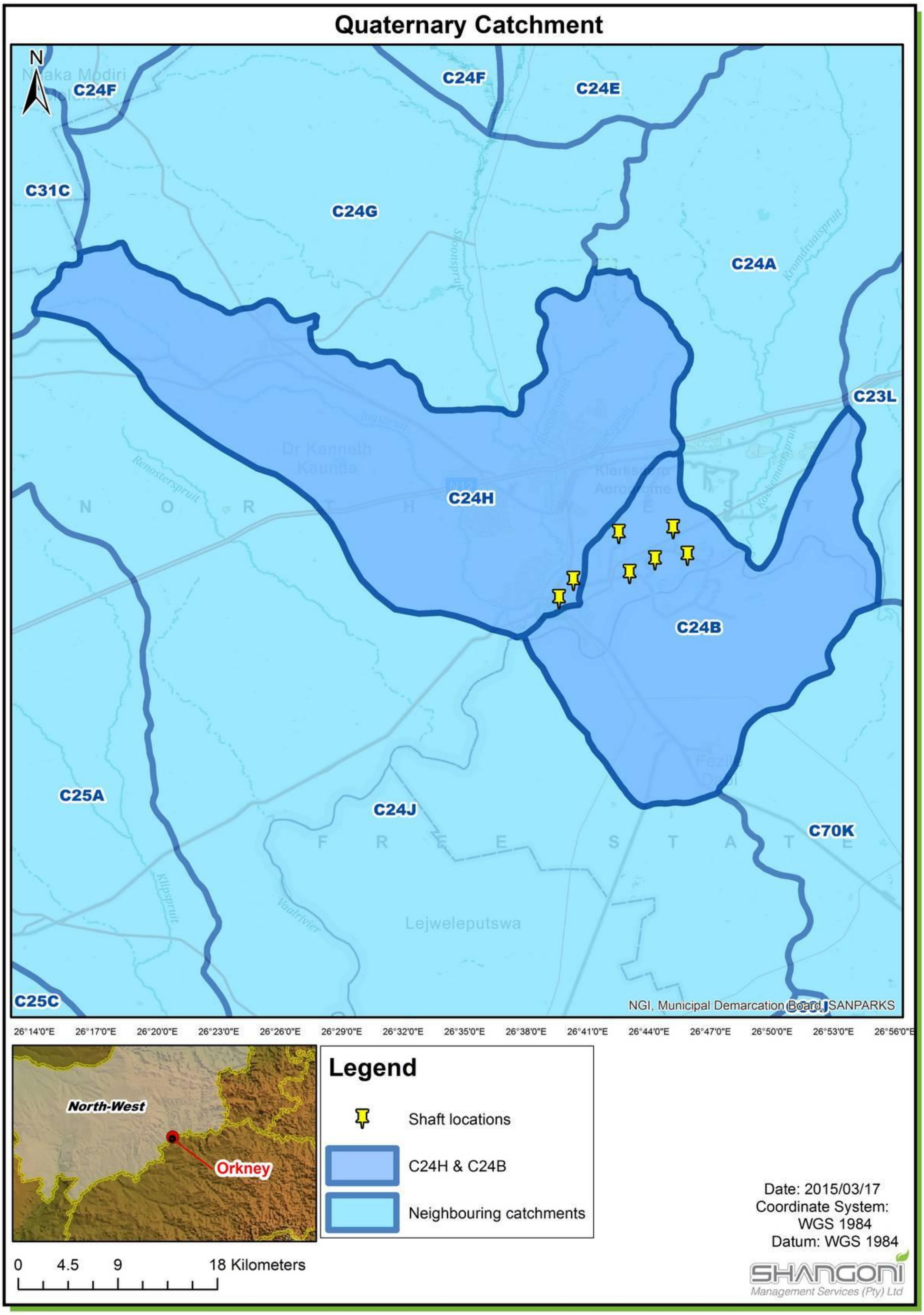


Figure 9: Quaternary catchment

2.2 Topography and regional drainage

Topography is a key feature in the assessment and design of a SWMP as it contains the critical direction and speed of surface water runoff. Interpolated surface contours (1 m) were derived from a Digital Elevation Model (DEM) and used in the assessment of surface water runoff.

The CAPM shafts are situated in the primary catchments of the Vaal River and are located in the quaternary catchments referred to as the C24H and C24B as defined by the DWS. The applicable water management area is referred to as the Middle Vaal management area and the responsibility of the Gauteng regional DWS.

The Vaal River flows south of the CAPM shaft locations from an eastern to western direction towards its confluence with the Orange River approximately 12 km west of the town of Douglas in the Northern Cape. Shaft #2 is closest to the Vaal River at an approximate distance of 1.3 km. The Schoonspruit flows west of the CAPM shaft locations (closest to Shaft #6 at distance of 1.38 km) past the town of Orkney into the Vaal River. The general drainage at the CAPM operations, taking into account all the shaft locations, is in a south-south western direction towards the Vaal River and Schoonspruit depression.

Apart from modifications by mine infrastructure, the general topography in the vicinity of the seven shaft locations is considered flat with an average slope of 1V:72H towards the south and west. Artificial sloping has been done within each shaft footprint as well as hostels to aid with surface drainage into adjacent veldt areas.

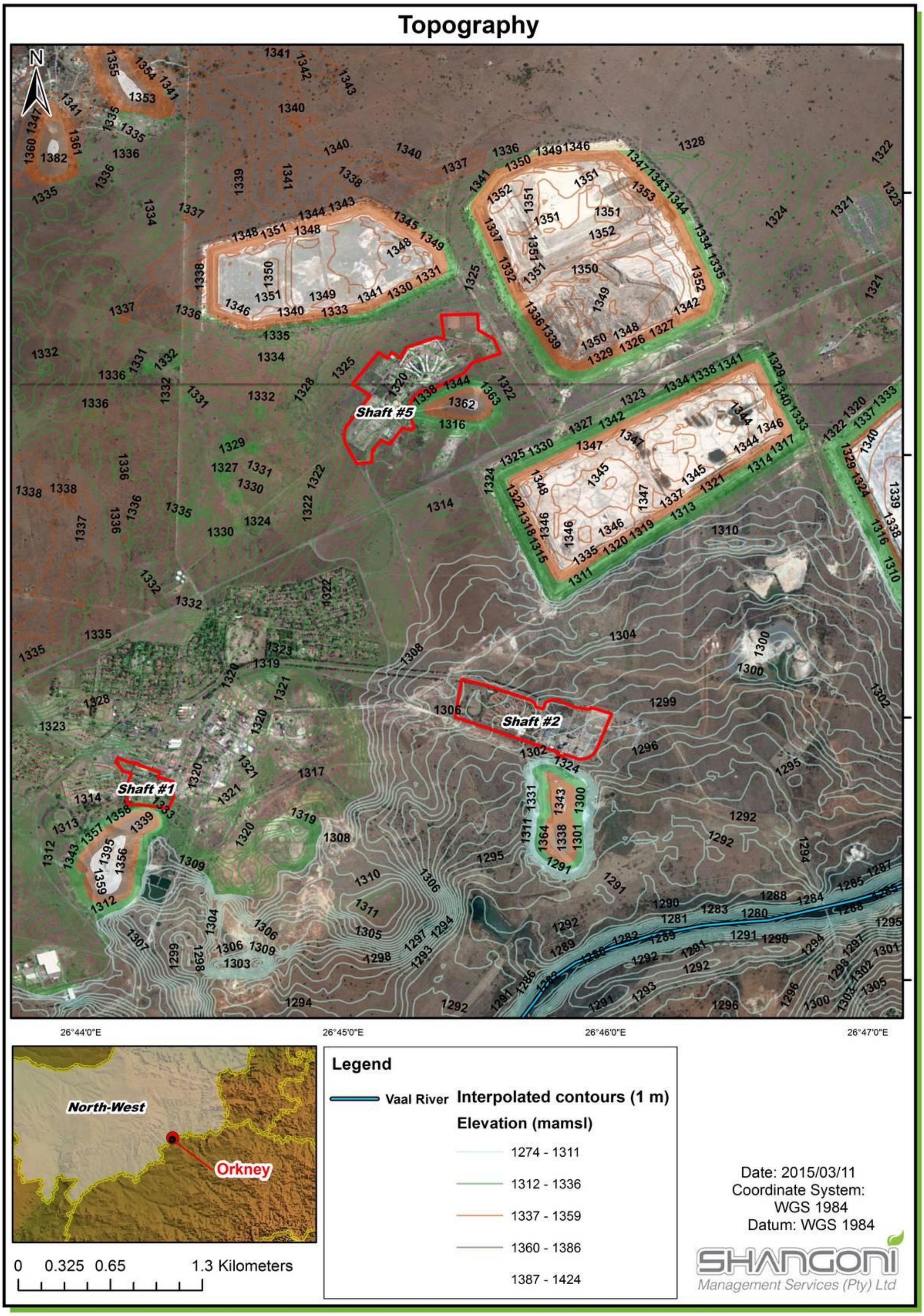


Figure 10: Topography – Shaft #1, Shaft #2 and Shaft #5

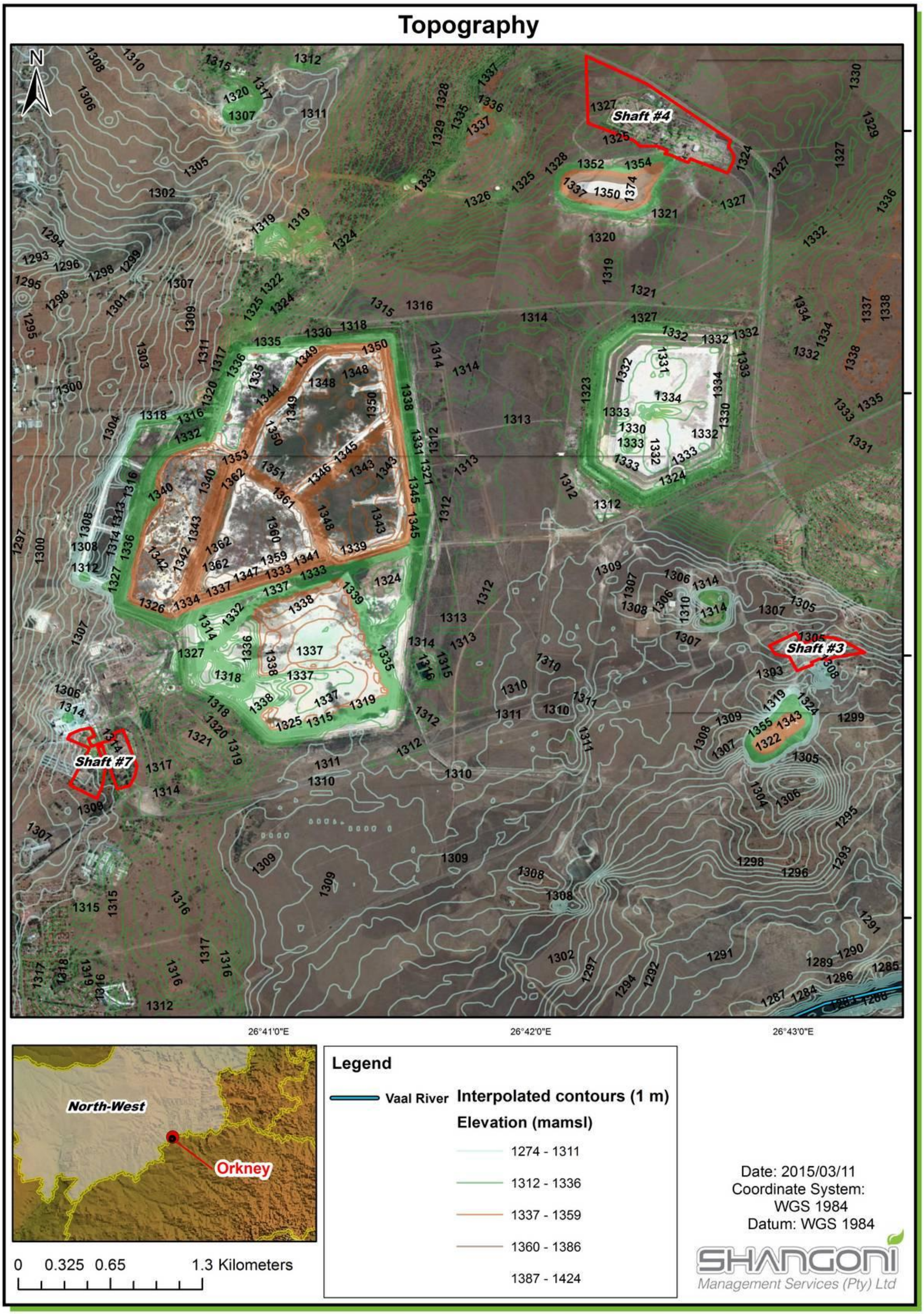


Figure 11: Topography – Shaft #7, Shaft #3 and Shaft #4

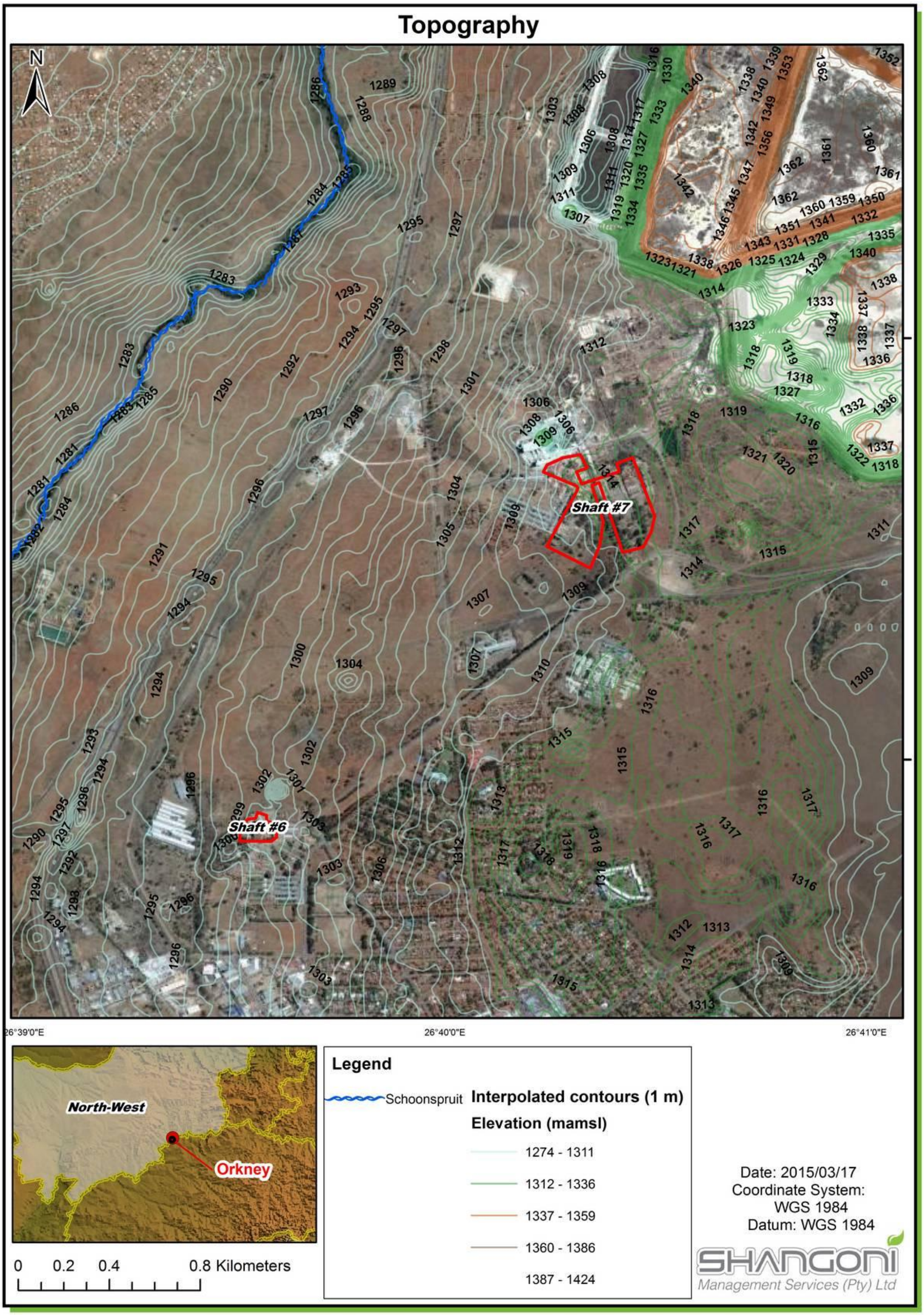


Figure 12: Topography - Shaft #6 and Shaft #7

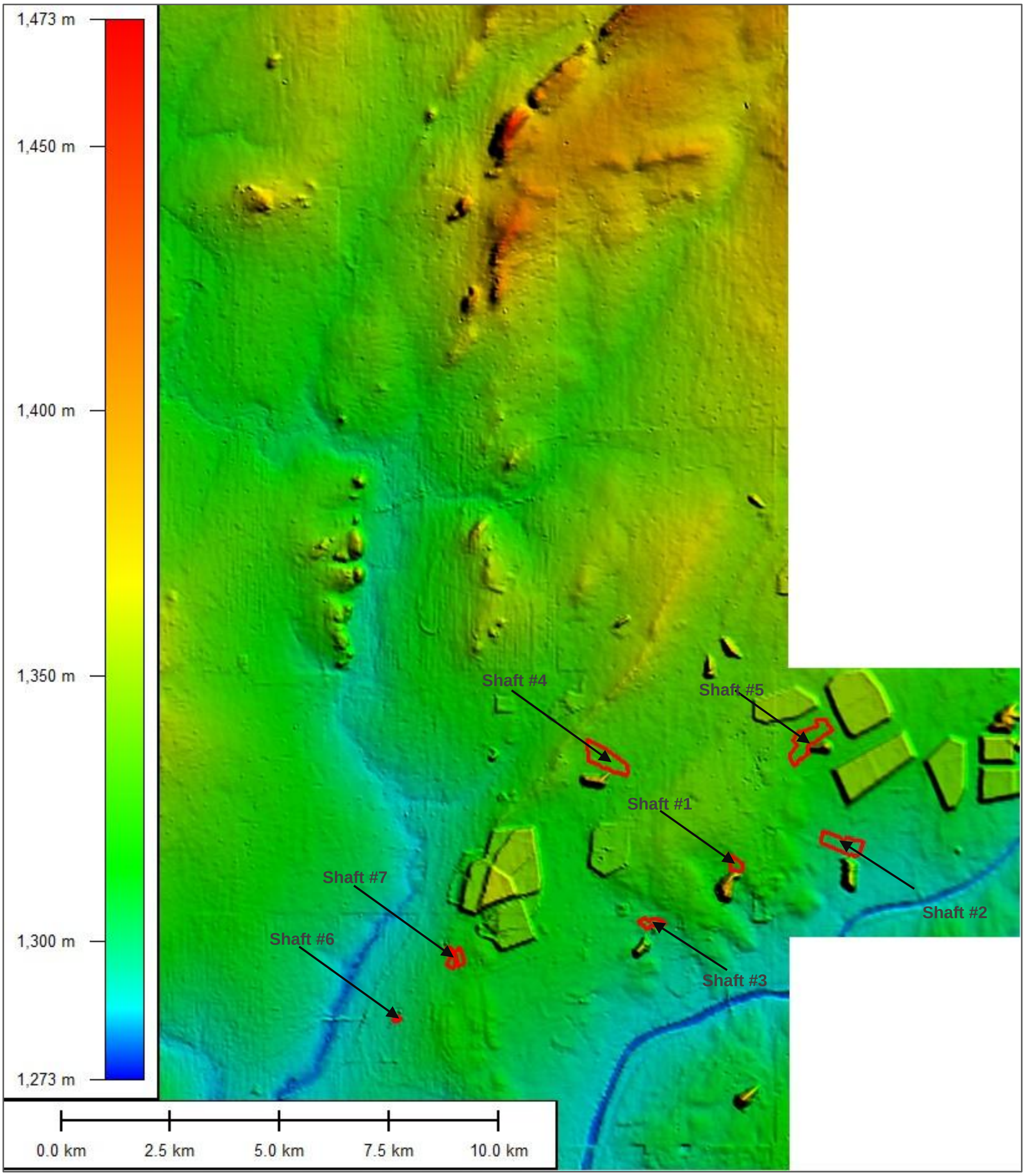


Figure 13: Digital Elevation Model - CAPM Shafts

2.3 Description of the activities to be undertaken

2.3.1 History and prior ownership

The seven (7) shafts that constitutes CAPM Orkney Gold Mine, initially formed part of the Anglo American Vaal Reef Operation and were named No.'s 1 to 7 shafts. The ownership of the shafts then changed to Arfican Rainbow Minerals (Pty) Ltd. (ARMgold) and consisted of ARMgold 1 (No.1, No.2 and No.5 shaft) and ARMgold 2 (No.3, No.4, No.6 and No.7 Shaft). In October 2003, ARMgold merged with Harmony Gold and the mines name changed to the Harmony Orkney Operation No.1 to No.7 shafts.

Pamodzi Gold bought the operations from Harmony Gold in March of 2008, however Pamodzi was provisionally liquidated in March of 2009 and final liquidation granted in October 2009. In late 2009, Aurora Empowerment Systems took over management of the Orkney Operations. Pamodzi Gold then entered into a sales agreement with CAPM with the Section 11 application being submitted in August 2011. The sales agreement with CAPM included the full acquisition of all assets of the Orkney Gold Mine. CAPM however, only took legal ownership of the assets in June 2014.

2.3.2 Mineral to be mined

The CAPM Orkney Gold Mine is an existing mine situated on a portion of the Klerksdorp Gold Fields. It exploits gold bearing conglomerates of the Central Rand and Ventersdorp Groups that are some of the several major gold fields situated on the northern and western margins of the 320 km by 160 km area of preservation of Central Rand Sediments. Gold is produced as the primary product with uranium as a potential by-product.

2.3.3 Description of the main mining activities and processes

The operation has been in under care and maintenance since 2009 and CAPM Orkney Gold Mine intends to commence with operations at the No.7 and No.6 shafts. Approximately two (2) years after the commencemnt of operation at the No.7 and No. 6 shaft CAPM intends to begin operation at the No. 4 and No. 1 Shaft whereafter the commencment of operations at the No.2 Shaft will be investigated.

The mining method to be employed at the CAPM Orkney Gold Mine is conventional scatterred breast mining consisting of the standard deep level underground stoping layout, for extraction of narrow generally flat dipping gold reefs occurring deeper than 500 m below surface.

No ore processing activities will be undertaken at the CAPM Orkney Gold Mine. All ore mined at the CAPM Orkney Gold Mine will be transported to the surface where it will be temporarily stockpiled at the shaft area. The ore will then be transported via haulage trucks to the Nicolor South Plant, located at the Buffelsfontein Gold Mine for processing. As a result, the mine does not have and will not have any mine or plant residue stockpiles.

2.4 Precipitation and evaporation

Precipitation in the area is highly seasonal with a mean annual rainfall of 548.3 mm according to the rainfall data from the DWA hydrological datasets collected at station C2E010. Most of the rainfall occurs during the summer months with the majority of rain events between October and April. The region receives the highest rainfall in January and the lowest in July. Evaporation is measured at station C2E010 for an S-class pan located approximately 53 km from the site. Table 1 below lists the rainfall and evaporation recordings.

Table 1: Average annual precipitation and evaporation

Date	Rainfall (mm)	Evaporation (mm)
January	91.5	207.8
February	74.2	166.5
March	67.1	155.0
April	44.6	118.0
May	14.6	94.4
June	7.0	72.9
July	4.4	81.3
August	8.7	113.5
September	19.2	115.5
October	56.4	185.5
November	73.9	198.4
December	84.7	214.4
Annual	**548.3**	**1784.7**

The design rainfall depths were determined using a method developed by Smithers & Schulze (2000) who undertook a study funded by the Water Research Commission to revise the medium to long duration rainfall Depth-Duration Frequency (DDF) relationships of South Africa. The results of the analysis are presented in Table 2 below. The nearest storm rainfall station to the CAPM shafts is Station 0436297 W with rainfall data collected over a period of 57 years.

Table 2: Design rainfall depths (mm) at 0436297 W West.Reefs Exp./Dev."VR W"

Duration (days)	Return Period (years)						
	2	**5**	**10**	**20**	**50**	**100**	**200**
1	57	76	89	101	117	129	142
2	73	95	110	124	142	156	169
3	83	110	127	144	166	182	198
4	89	118	137	155	179	198	216
5	93	123	143	162	188	207	227
6	98	129	150	171	198	219	240
7	103	136	158	179	207	229	250

3. Design Flood Modelling

Key storm water management areas at the seven CAPM shaft locations are identified where flow rates and volumes during heavy rainfall events may cause damage to infrastructure and/or result in mine affected water spilling into the clean downstream environment and/or result in clean runoff flowing into dirty areas. These areas are modelled to determine the flood peaks and volumes that either has to be diverted or contained during different return periods.

3.1 Design criteria

Potential flood peak flows for the identified catchments were determined using the Utility Programs for Drainage software. The program is specifically designed and developed for South African conditions and contains hydrological variables such as roughness coefficients (Manning's values) and rainfall records from available measuring stations from the South African Weather Service (SAWS).

Each catchment at each focus area was delineated according to distinctive catchment boundaries caused by developments in the area. The catchments were determined that will contribute runoff to the respective storm water measures such as canals and containment facilities that will convey surface runoff either to the clean downstream environment or to the dirty water system.

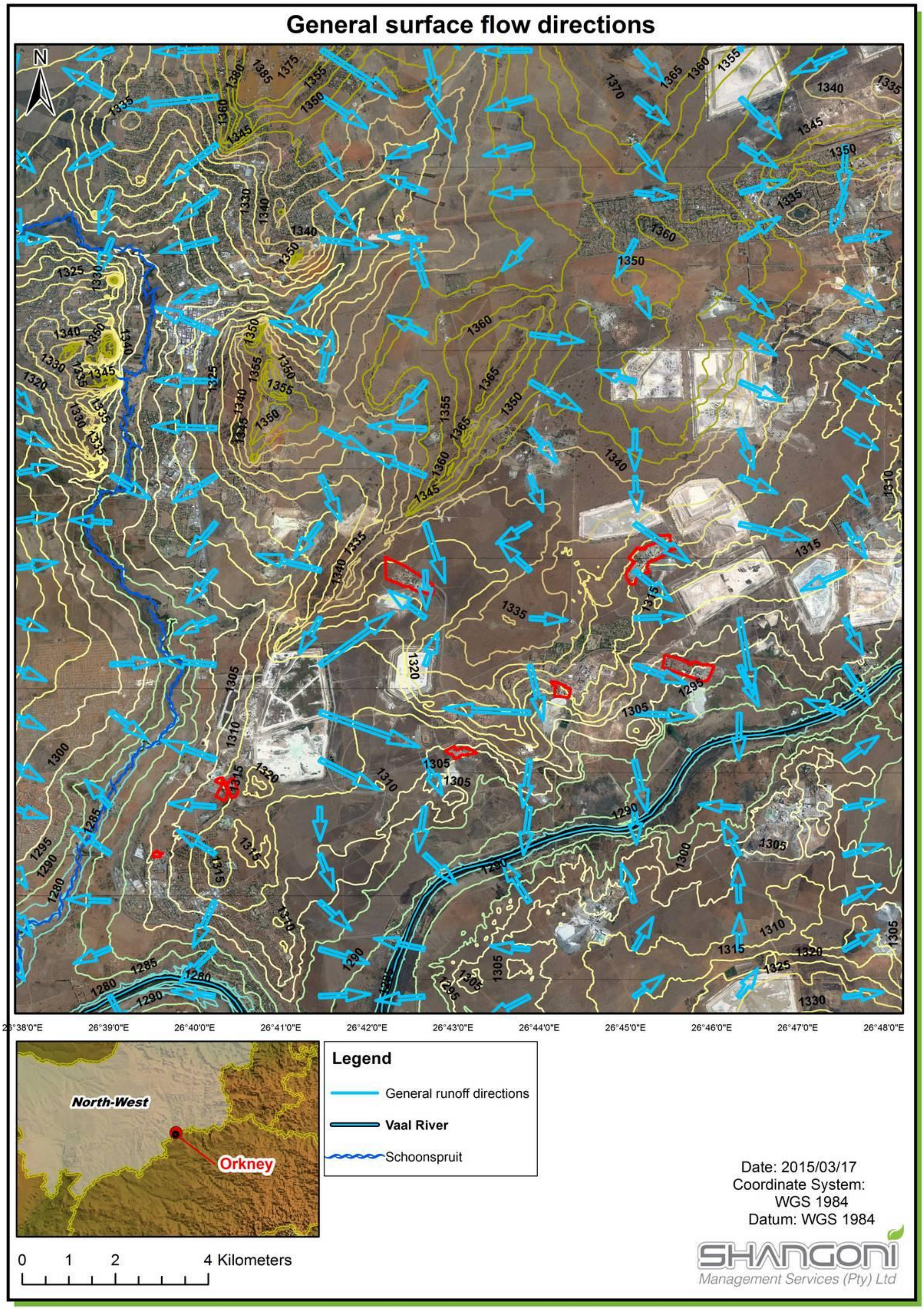


Figure 14: General runoff directions for 2626DC and 2626DD

3.2 Flood peaks and volumes

Flood peaks are essential for storm water management to ensure that infrastructure has sufficient capacity to withstand a design flood during peak runoff flow. Flood peaks provide insight specifically to sizing of diversion and conveying infrastructure, as well as capacity requirements for retention facilities designed to reduce flood peaks.

The following provides a short description of the three methods used to determine flood peaks and volumes for each of the study areas:

3.2.1 Rational Method (RM)

The rational method is based on a simplified representation of the law of conservation of mass. Rainfall intensity is an important input for calculations. It is one of the best-known and the most widely used methods for determining peak flows from small catchments (< 15 km^2). The peak flow is obtained from the formula that indicates that Q = CIA, where Q is the peak flow, C the runoff coefficient, I the rainfall intensity and A the effective area of the catchment.

3.2.2 Alternative Rational Method (ARM)

This method is an adaptation of the rational method. Where the rational method uses the depth-duration-return period diagram to determine the point precipitation, the alternative method uses the modified recalibrated Hershfield equation for storm durations up to 6 hours, and the DWA's technical report TR102 for durations from 1 to 7 days. This method takes local South African conditions into account.

3.2.3 Standard Design Flood Method (SDF)

The SDF is a numerically regionally calibrated version of the rational method. This method provides a uniform approach to flood calculations. The method is based on a calibrated discharge coefficient for a recurrence period of 2 and 100 years. Calibrated discharge parameters are based on historical data and were determined for 29 homogeneous drainage basins in South Africa.

3.2.2 Runoff volumes

Storm runoff volumes are calculated since the flood peak is assumed to occur when flow from the remotest point of the catchment arrives at the exit (point of interest), at time t_c when the design storm is assumed to cease and where after runoff decreases to zero over the period t_c. Storm runoff volumes are usually calculated for containment facilities to obtain a better understanding of the total expected m^3 of runoff generated by a design storm. During the site inspection, no storm water containment facilities were observed at the seven shaft locations. Therefore, only peak flows (overland flow) are calculated for runoff diversion purposes.

4. Storm Water Management Plan and Risk Assessment

4.1 – Storm Water Management Plan

The storm water management plan for the seven CAPM shafts aims to address concerns that have been identified in terms of existing infrastructure as well as proposed changes. The plan attempts to provide management measures that should be in place to prevent flood damage proactively and contribute to effective channelling of surface water. The report is compiled in line with the Best Practise Guidelines G1 for Storm Water Management (DWAF, 2006), the National Water Act (Act No. 36 of 1998) and Regulation 704 (No. 704 of 4 June 1999) in terms of the National Water Act (Act No. 36 of 1998).

The management areas are determined using the geographic location of infrastructure and distinct catchment boundaries (either natural or altered). Regional interpolated contours (1 m) were derived from a digital elevation model (DEM 2626DC, 2626DD) and used to define the drainage regime associated with each focus area. Each focus area is described by indicating the general runoff directions in the vicinity towards the natural watercourses and do not indicate if the directions are controlled or not. Reference should be made to the discussions with regards to existing and proposed storm water control measures.

Each management area at the CAPM operations is discussed by indicating the main drainage philosophy anticipated using contour data and the current / proposed runoff control strategies. Blue and red arrows indicate the location of clean and affected runoff respectively as well as direction. A more detailed description of the storm water environment as well as the measures to control clean runoff and retain affected runoff is also provided in the discussion tables using the maps as reference.

Efficiency and practicality is a key aspect to a successful storm water management plan. Good management is based on separating clean and dirty water and therefore incorporates the fundamental principle of pollution prevention. All proposed measures prioritise the use of gravity and natural drainage lines to provide cost-effective solutions with minimum maintenance requirements. Where such measures are not possible and the use of mechanical equipment is required (e.g. pumping infrastructure in sumps), it is the responsibility of the operation to do a risk assessment with regards to control, maintenance and standby equipment in case of down time.

4.2 Risk Assessment / Best Practice Assessment

4.2.1 Risk Assessment Procedure

The environmental risk of any aspect is determined by a combination of parameters associated with the impact. Each parameter connects the physical characteristics of an impact to a quantifiable value to rate the environmental risk.

Impact assessments should be conducted based on a methodology that includes the following:

- Clear processes for impact identification, prediction and evaluation,
- Specification of the impact identification techniques,
- Criteria to evaluate the significance of impacts,
- Design of mitigation measures to lessen impacts,
- Definition of the different types of impacts (indirect, direct or cumulative), and
- Specification of uncertainties.

After all impacts have been identified, the nature of each impact can be predicted. The impact prediction will take into account physical, biological, socio-economic and cultural information and will then estimate the likely parameters and characteristics of the impacts. The impact prediction will aim to provide a basis from which the significance of each impact can be determined and appropriate mitigation measures can be developed.

The risk assessment methodology is based on defining and understanding the three basic components of the risk, i.e. the source of the risk, the pathway and the target that experiences the risk (receptor). Refer to Figure 15 below for a model representing the above principle (as contained in the DWS's Best Practice Guideline: *G4 – Impact Prediction*).

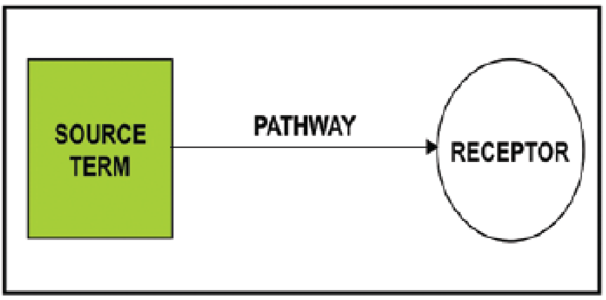


Figure 15: DWS's model for impact prediction (risk assessments)

Table 3 and Table 4 below indicate the methodology to be used in order to assess the Probability and Magnitude of the impact, respectively, and Table 5 provides the Risk Matrix that will be used to plot the Probability against the Magnitude in order to determine the Severity of the impact.

Table 3: Determination of Probability of Impact

Frequency of Aspect / Unwanted Event	Score	Availability of pathway from the source to the receptor	Score	Availability of receptor	Score
Never known to have happened, but may happen	1	A pathway to allow for the impact to occur is never available	1	The receptor is never available	1
Known to happen in industry	2	A pathway to allow for the impact to occur is almost never available	2	The receptor is almost never available	2
< once a year	3	A pathway to allow for the impact to occur is sometimes available	3	The receptor is sometimes available	3
Once per year to up to once per month	4	A pathway to allow for the impact to occur is almost always available	4	The receptor is almost always available	4
Once a month - Continuous	5	A pathway to allow for the impact to occur is always available	5	The receptor is always available	5

Step 1: *Determine the* ***PROBABILITY*** *of the impact by calculating the average between the Frequency of the Aspect, the Availability of a pathway to the receptor and the availability of the receptor.*

Table 4: Environmental impact assessment: Surface Water

Source								Receptor			
Duration of impact	**Score**	**Extent**	**Score**	**Volume / Quantity / Intensity**	**Score**	**Toxicity / Destruction Effect**	**Score**	**Reversibility**	**Score**	**Sensitivity of environmental component**	**Score**
Lasting days to a month	1	Effect limited to the site. (metres);	1	Very small quantities / volumes / intensity (e.g. < 50L or < 1Ha)	1	Non-toxic (e.g. water) / Very low potential to create damage or destruction to the environment	1	Bio-physical and/or social functions and/or processes will remain unaltered.	1	Current environmental component(s) are largely disturbed from the natural state. Receptor of low significance / sensitivity	1
Lasting 1 month to 1 year	2	Effect limited to the activity and its immediate surroundings. (tens of metres)	2	Small quantities / volumes / intensity (e.g. 50L to 210L or 1Ha to 5Ha)	2	Slightly toxic / Harmful (e.g. diluted brine) / Low potential to create damage or destruction to the environment	2	Bio-physical and/or social functions and/or processes might be negligibly altered or enhanced / Still reversible	2	Current environmental component(s) are moderately disturbed from the natural state. No environmentally sensitive components.	2
Lasting 1 – 5 years	3	Impacts on extended area beyond site boundary (hundreds of metres)	3	Moderate quantities / volumes / intensity (e.g. > 210 L < 5000L or 5 – 8Ha)	3	Moderately toxic (e.g. slimes) Potential to create damage or destruction to the environment	3	Bio-physical and/or social functions and/or processes might be notably altered or enhanced / Partially reversible	3	Current environmental component(s) are a mix of disturbed and undisturbed areas. Area with some environmental sensitivity (scarce / valuable environment etc.).	3
Lasting 5 years to Life of Organisation	4	Impact on local scale / adjacent sites (km's)	4	Very large quantities / volumes / intensity (e.g. 5000 L – 10 000L or 8Ha– 12Ha)	4	Toxic (e.g. diesel & Sodium Hydroxide)	4	Bio-physical and/or social functions and/or processes might be considerably altered or enhanced / potentially irreversible	4	Current environmental component(s) are in a natural state. Environmentally sensitive environment / receptor (endangered species / habitats etc.).	4
Beyond life of Organization / Permanent impacts	5	Extends widely (nationally or globally)	5	Very large quantities / volumes / intensity (e.g. > 10 000 L or > 12Ha)	5	Highly toxic (e.g. arsenic or TCE)	5	Bio-physical and/or social functions and/or processes might be severely/substantially altered or enhanced / Irreversible	5	Current environmental component(s) are in a pristine natural state. Highly Sensitive area (endangered species, wetlands, protected habitats etc.)	5

Step 2: *Determine the* ***MAGNITUDE*** *of the impact by calculating the average of the factors above***.**

Table 5: Determination of Severity of impact

ENVIRONMENTAL IMPACT RATING / PRIORITY					
	MAGNITUDE				
PROBABILITY	**1 Minor**	**2 Low**	**3 Medium**	**4 High**	**5 Major**
5 Almost Certain	Low	Medium	High	High	High
4 Likely	Low	Medium	High	High	High
3 Possible	Low	Medium	Medium	High	High
2 Unlikely	Low	Low	Medium	Medium	High
1 Rare	Low	Low	Low	Medium	Medium

Step 3: *Determine the* ***SEVERITY*** *of the impact by plotting the averages that were obtained above for Probability and Magnitude in the table below.*

4.3 CAPM operations – Shaft #1

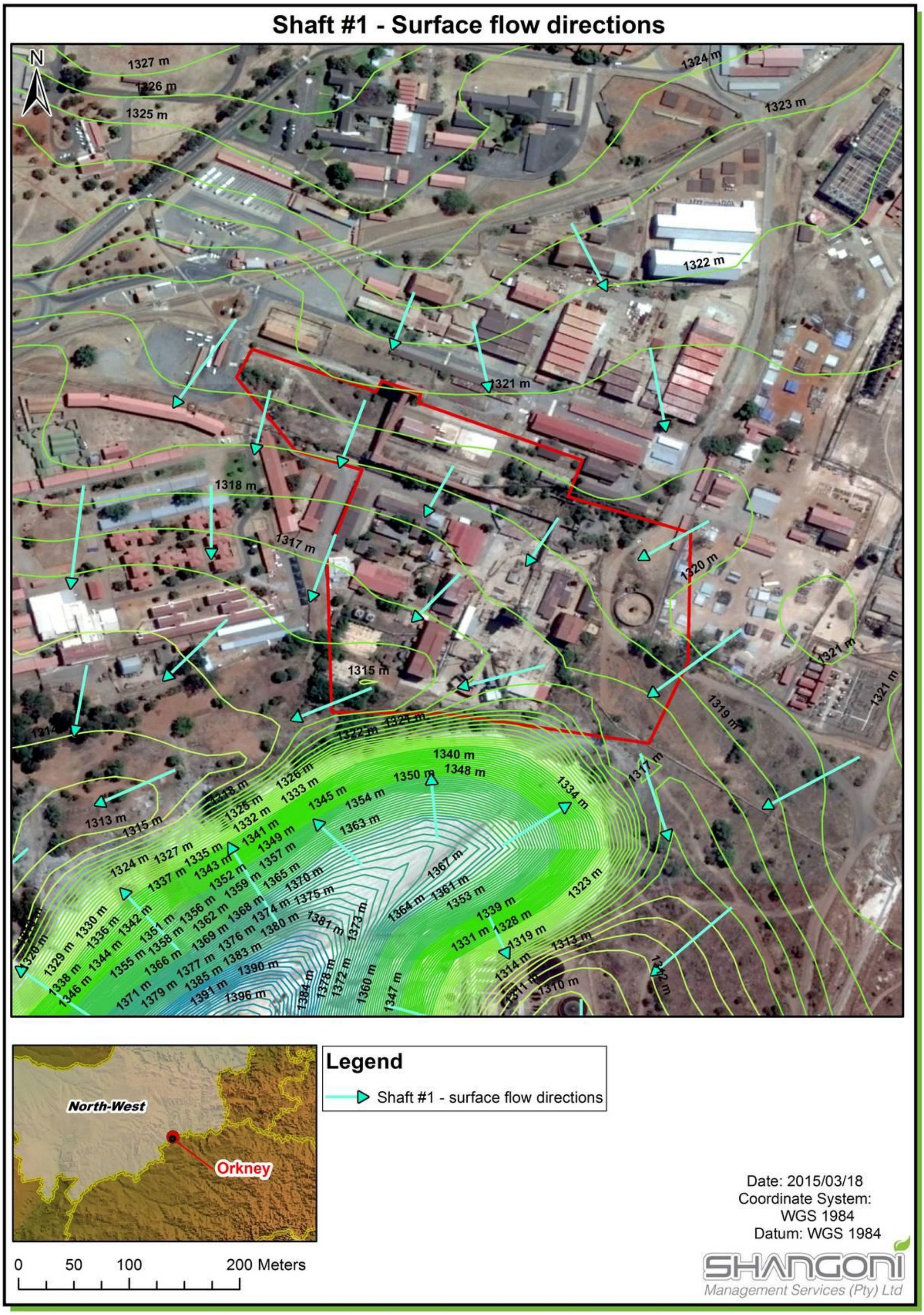


Figure 16: Shaft #1 - Surface flow directions

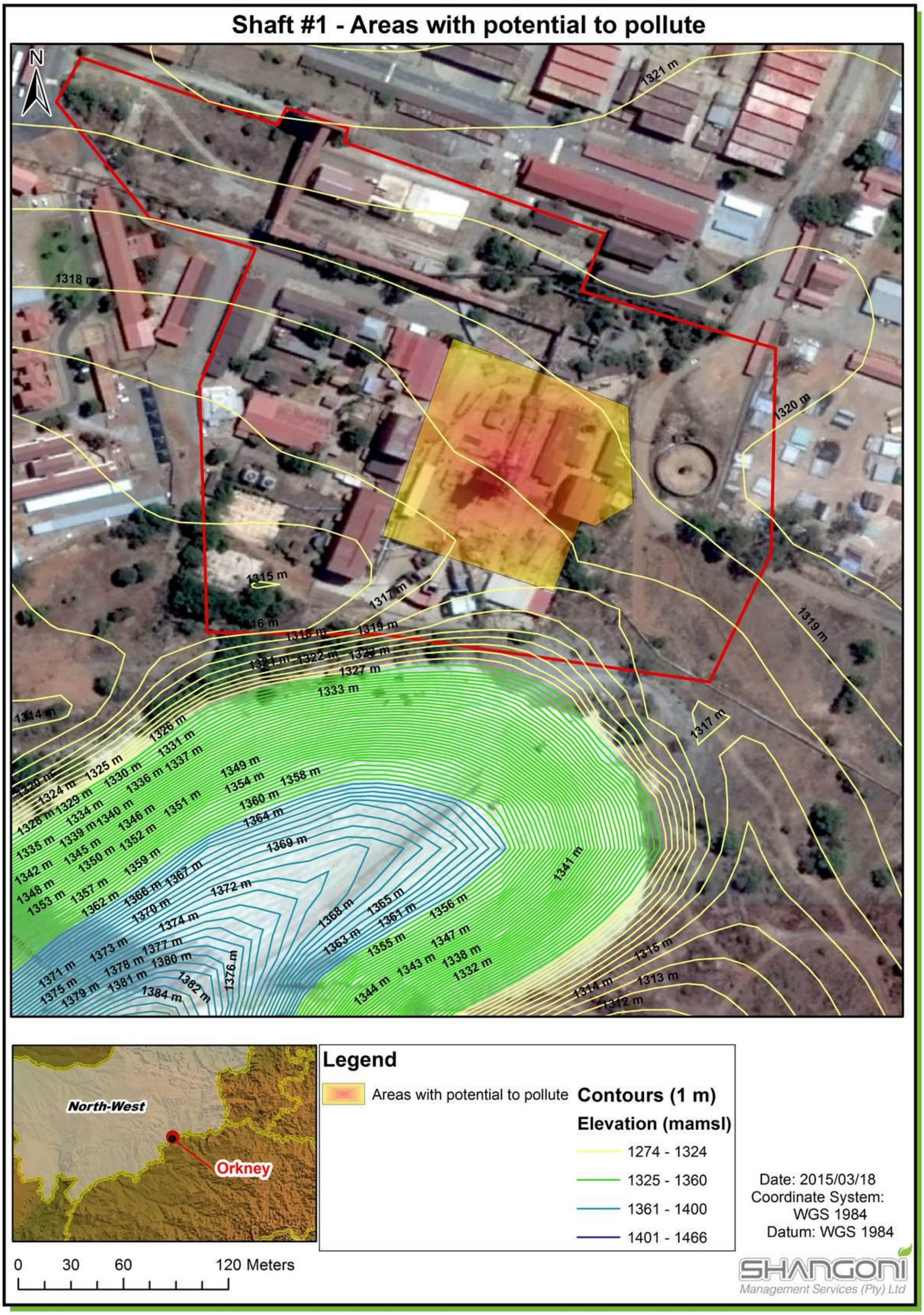


Figure 17: Shaft #1 – Areas with potential to pollute

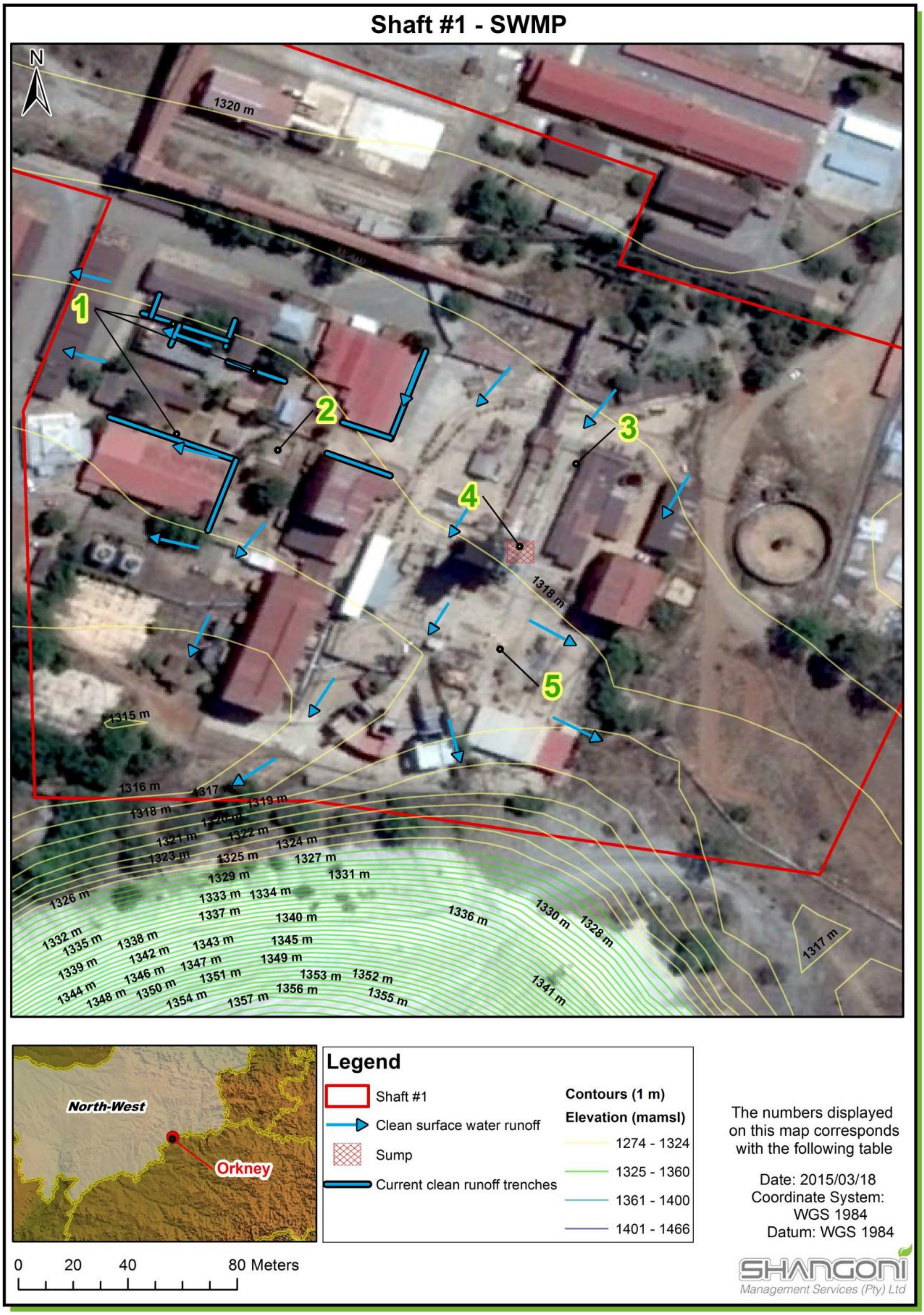
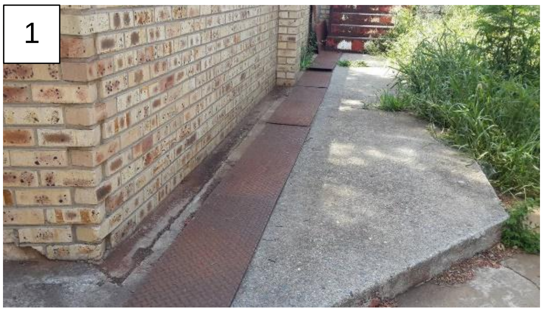
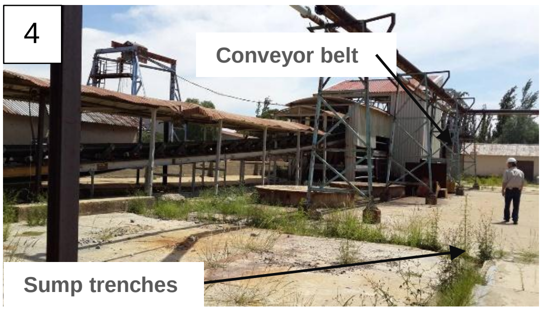


Figure 18: SWMP at Shaft #1

Table 6: Shaft #1 – Storm water measures

Number and picture corresponding to Figure 18	Description and recommendations
    	1 – The current clean storm water network at the Shaft #1 area is lined channels as illustrated. The shaft operations have been under care and maintenance since 2009 and no mining activities has taken place since. The majority of the current clean storm water trenches are located on the eastern side of Shaft #1 consisting of buildings such as offices, change houses, canteen etc. These channels are covered with metal plates in some areas to prevent blockages and to maintain the integrity of the channels to convey clean surface runoff away from the shaft area. These channels drain surface water to the west from where runoff will follow the natural gradient towards the south past the adjacent waste rock dump. Recommendation: It is recommended to implement a maintenance schedule for the clean water conveyance network during the operational phase of Shaft #1 to maintain the integrity of the diversion channels.

 	2 – During shaft operation, these ponds serve as the cooling mechanisms for water used by the winders. These ponds are seen as process water containment facilities. Recommendations: The cooling ponds are located between clean water conveyance channels and should be operated with a sufficient free-board (during the operational phase) in order to limit spillages into the clean surface water network – GN 704, Regulation 7(a) and 6(e).
 	3 – Effort has been made at the Shaft #1 area to isolate all areas with a high possibility of hydrocarbon spillages that will lead to contamination of the surrounding clean water environment. Recommendation: During the site assessment it was noted that there are general housekeeping issues that need to be adressed. There are leaking hydrocarbon containers (oil drums) not stored in demarcated areas and may lead to pollution of surface runoff during rainfall events. This strategy aims to comply with GN 704, Regulation 7(a).
	4 – A sump has been constructed next to the conveyor belt and the shaft. An affected water channel have also been constructed next to the conveyor demarcating an area previously used for cleaning conveyor belts and temporary storage of ore material. Affected water was channelled towards the sump and pumped back to the process water system. Due to ceased activities and no maintenance, the sump is overgrown with vegetation and silted up. The pump has also been removed. Recommendation: Implement a maintenance schedule during the operational phase of the shaft to

	ensure the integrity of the sump. Pumping infrastructure should be in working order at all times to prevent any overflow of affected water into the shaft and surrounding area – GN 704, Regulation 7(a).
  	5 – Most of the shaft area is constructed on an impermeable cement surface and will limit seepage of affected water (if any) into groundwater resources. The shaft area is under care and maintenance with no current activites with potential to pollute clean surface runoff. Once operations at Shaft #1 is reinstated, good house-keeping practices should be conducted to limit the possibility of generating dirty areas and subsequently the need to construct dirty water containment areas – GN 704, Regulation 7(c).

5.1.2 Shaft #1

The Shaft #1 area is surrounded by a plant area on the northern and eastern side, a waste rock dump on the southern side and a hostel on the western side. Some of the buildings within the Shaft #1 area, such as the compressor room are operated by another mining company. It is therefore difficult to determine the exact risks to surface water quality from the Shaft #1 area that will be operated by CAPM as possible impacts from the surrounding activities should also be taken into account.

Table 7: Risks associated with Shaft #1

Environmental impact, extent, duration, significance and degree to which impact will cause irreplaceable loss	Risk rating (before mitigation)			Environmental objective	Degree to which impact can be reversed and the supporting mitigatory action plan	Timeframe	Responsibility	Risk rating (after mitigation)		
	Probability	Magnitude	Severity					Probability	Magnitude	Severity
ENVIRONMENTAL COMPONENT: Surface water										
ACTIVITY: Operation of winder cooling ponds										
PROJECT PHASE APPLICABILITY: Construction ; Operation X ; Closure										
Impact description: The winder cooling ponds are concrete ponds situated next to one of the winder houses and in close proximity of the clean runoff channels. These ponds contain process water used for cooling purposes. Surface water quality: Overflow of winder cooling ponds may lead to affected water discharge into the clean surface runoff channels situated next to the cooling ponds and may result in deterioration in quality of surface water runoff from the Shaft #1 area. Extent: Affect limited to the site Duration: Operational phase Degree to which impact may cause irreplaceable loss: Not applicable, due to low significance.	4	1	L	To prevent quality deterioration of surface runoff generated and within the Shaft #1 area.	Mitigation: • An operational procedure should be implemented to maintain sufficient free-board and limit process water spillages into the clean water system.	Operational phase.	Environmental manager.	2	1	L
ENVIRONMENTAL COMPONENT: Surface water										
ACTIVITY: Storage and handling of hydrocarbon containers										
PROJECT PHASE APPLICABILITY: Construction ; Operation X ; Closure										
Impact description: Reference No. 3, Table 6, Figure 18 Surface water quality: Surface water contamination may take place as a result of leaking hydrocarbon containers stored outside of designated areas. Extent: Affect limited to site Duration: Operational phase	2	2	L		Mitigation: • Implement good house-keeping practises and implement a procedure for the storage and handling of hydrocarbon containers and spillages. • Hydrocarbon containers should be stored within designated areas, preferably bunded and roofed.	Care and maintenance until operational phase.	Environmental manager.	2	1	L

Environmental impact, extent, duration, significance and degree to which impact will cause irreplaceable loss	Risk rating (before mitigation)			Environmental objective	Degree to which impact can be reversed and the supporting mitigatory action plan	Timeframe	Responsibility	Risk rating (after mitigation)		
	Probability	Magnitude	Severity					Probability	Magnitude	Severity
Degree to which impact may cause irreplaceable loss: Not applicable, due to low significance.										
ENVIRONMENTAL COMPONENT: Surface water										
ACTIVITY: Containment of affected water										
PROJECT PHASE APPLICABILITY: Construction; Operation X; Closure										
Impact description – Reference No: 4, Table 6, Figure 18 Surface water quality: Overflow from the containment sump underneath the conveyor system may lead to deterioration of clean surface water quality in the immediate vicinity of the Shaft #1 area. Extent: Affect limited to site Duration: Operational phase Degree to which impact may cause irreplaceable loss: Not applicable, due to low significance	2	2	L		Mitigation: • Implement regular inspections and a maintenance schedule to ensure pumping infrastructure is functional at all times to limit possible sump overflow.	Operational phase	Environmental manager	1	1	L

4.3.1 Shaft #1 – Flood peaks and volumes

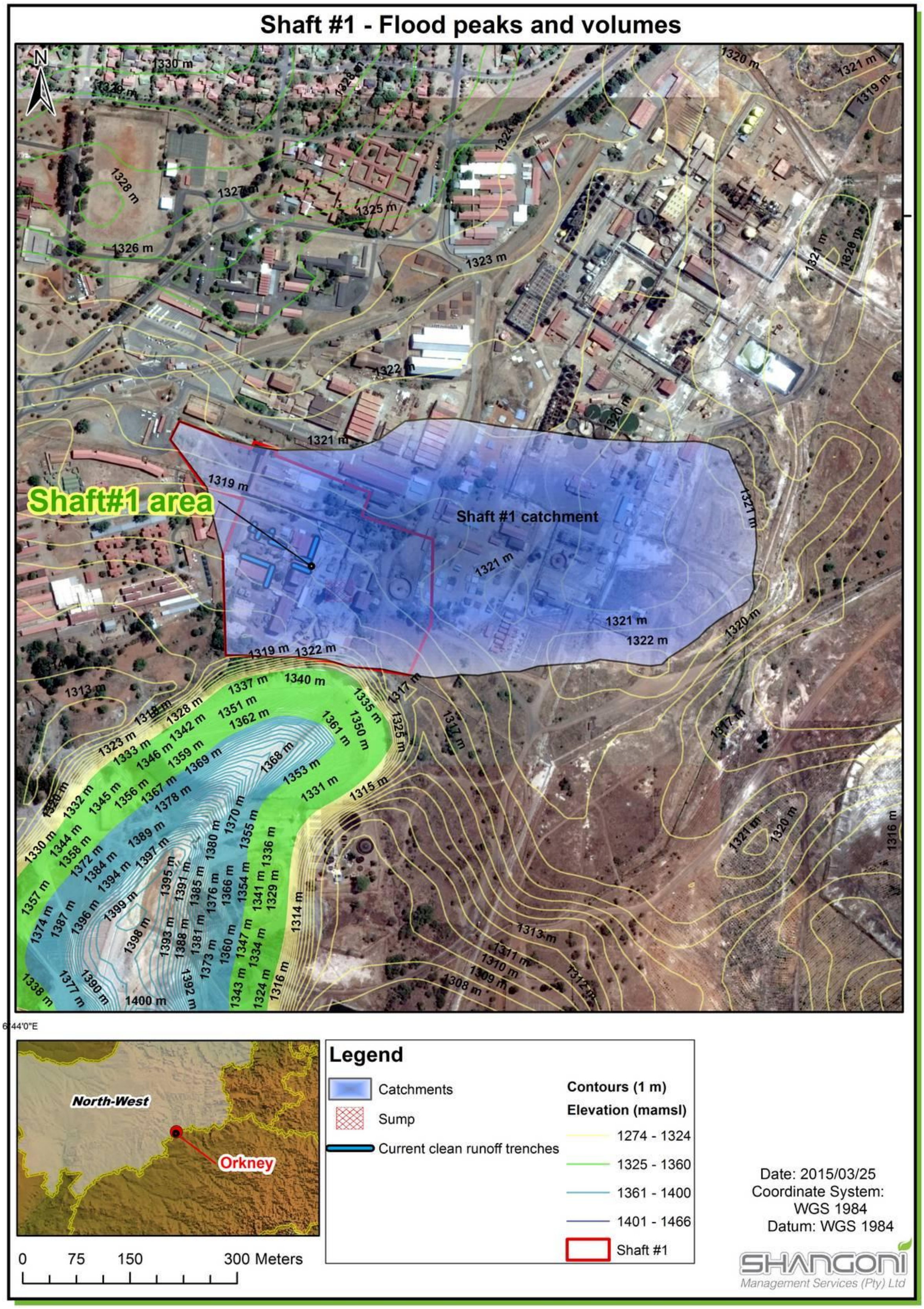


Figure 19: Flood peaks & volumes

Table 8: Catchment characteristics

	Shaft #1
MAP	548.3
Catchment size (km^2)	0.234
Length of longest watercourse (km)	0.769
Height difference (m)	5

Table 9: Peak runoff for different return periods

Peak runoff (m^3/s)	**Return period (year)**											
	1:5			**1:10**			**1:50**			**1:100**		
	RM	**ARM**	**SDF**	**RM**	**ARM**	**SDF**	**RM**	**ARM**	**SDF**	**RM**	**ARM**	**SDF**
Shaft #1	4.096	5.920	1.664	5.213	7.790	2.769	8.462	12.19	5.886	10.47	14.13	7.454

The calculations for the Shaft #1 area should be interpreted with care as there are a number of factors not taken into account. Calculations are done for the complete catchment area towards Shaft #1 and should be distributed where there is more than one drainage point within the same built up catchment. Upstream catchment activities are interpreted according to common practices and no detailed insight is available on possible storm water measures upstream of the site. The topography of the area has a slight gradient towards the west. The catchment consist of hardened surfaces as a result of the constructed plant areas as well as the Shaft #1 operations area. The aforementioned surfaces will limit infiltration into soil and result in larger surface water volumes reporting to the point of interest. Peak runoff volumes towards the Shaft #1 area has been calculated as overflow contribution. Existing diversion measures on the Shaft #1 area convey runoff generated on site away from the area. There are no containment facilities on site and therefore no runoff volumes were calculated for containment activities.

4.4 CAPM operations – Shaft #2

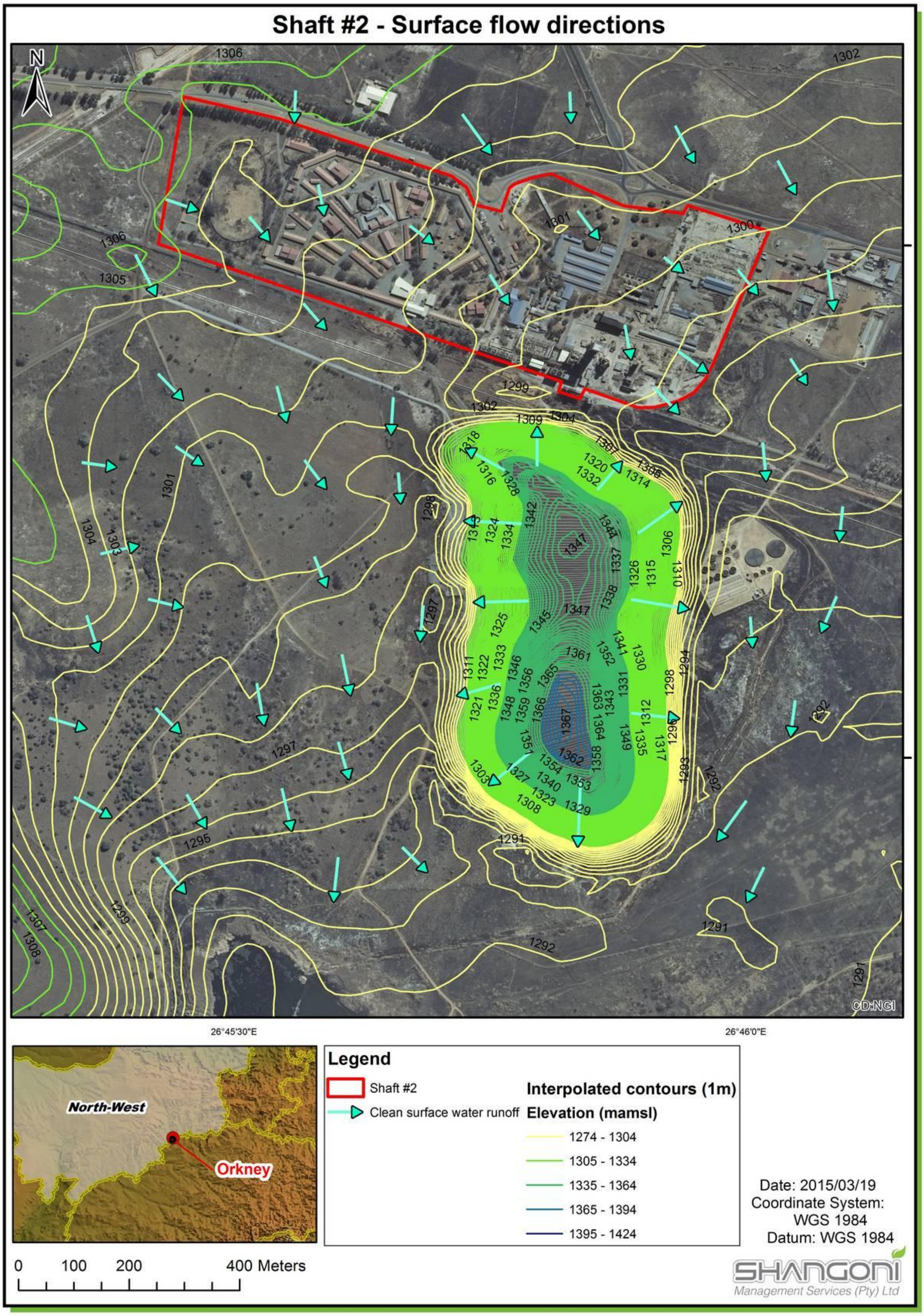


Figure 20: Surface flow directions – Shaft #2

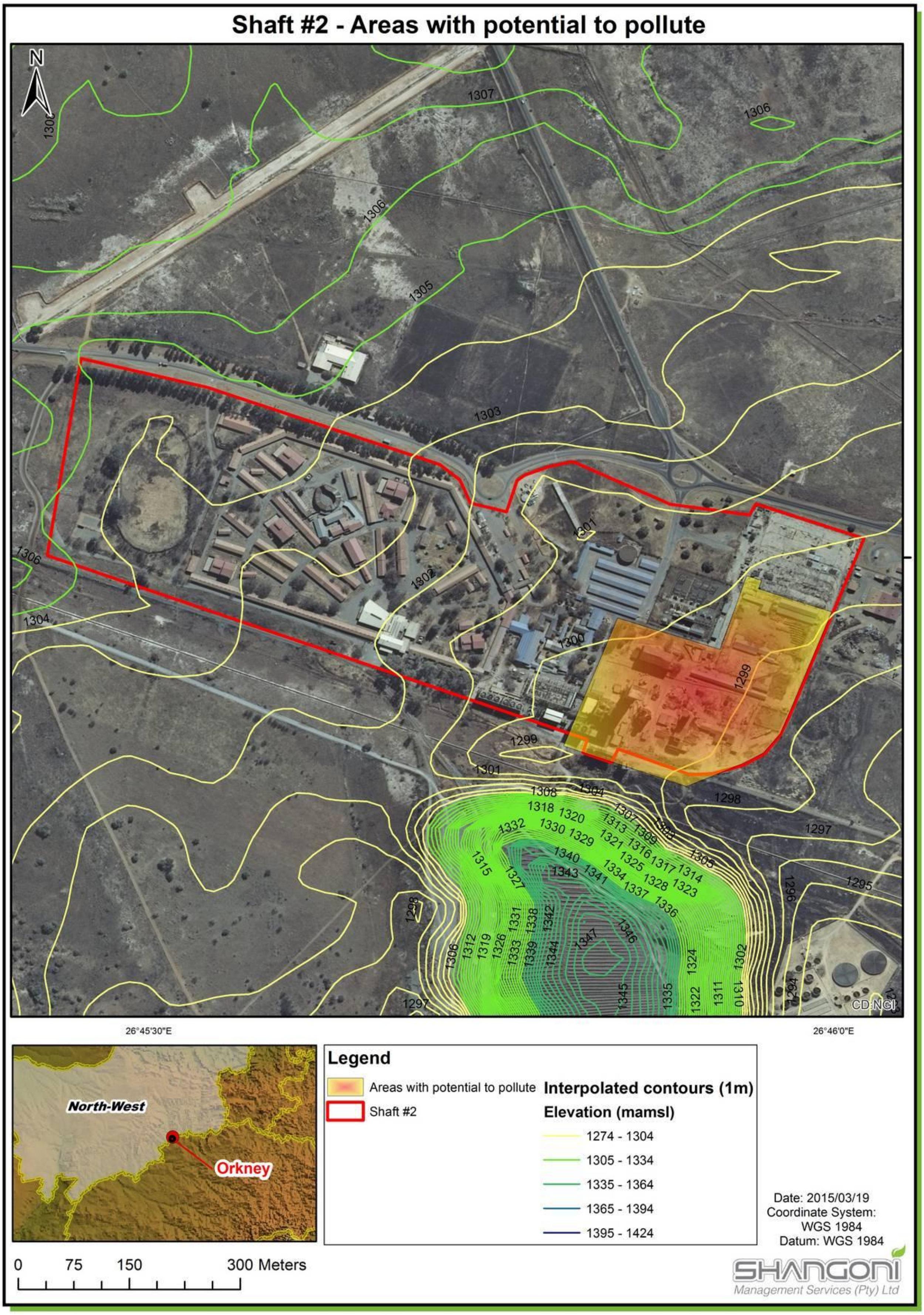


Figure 21: Shaft #2 – Areas with potential to pollute

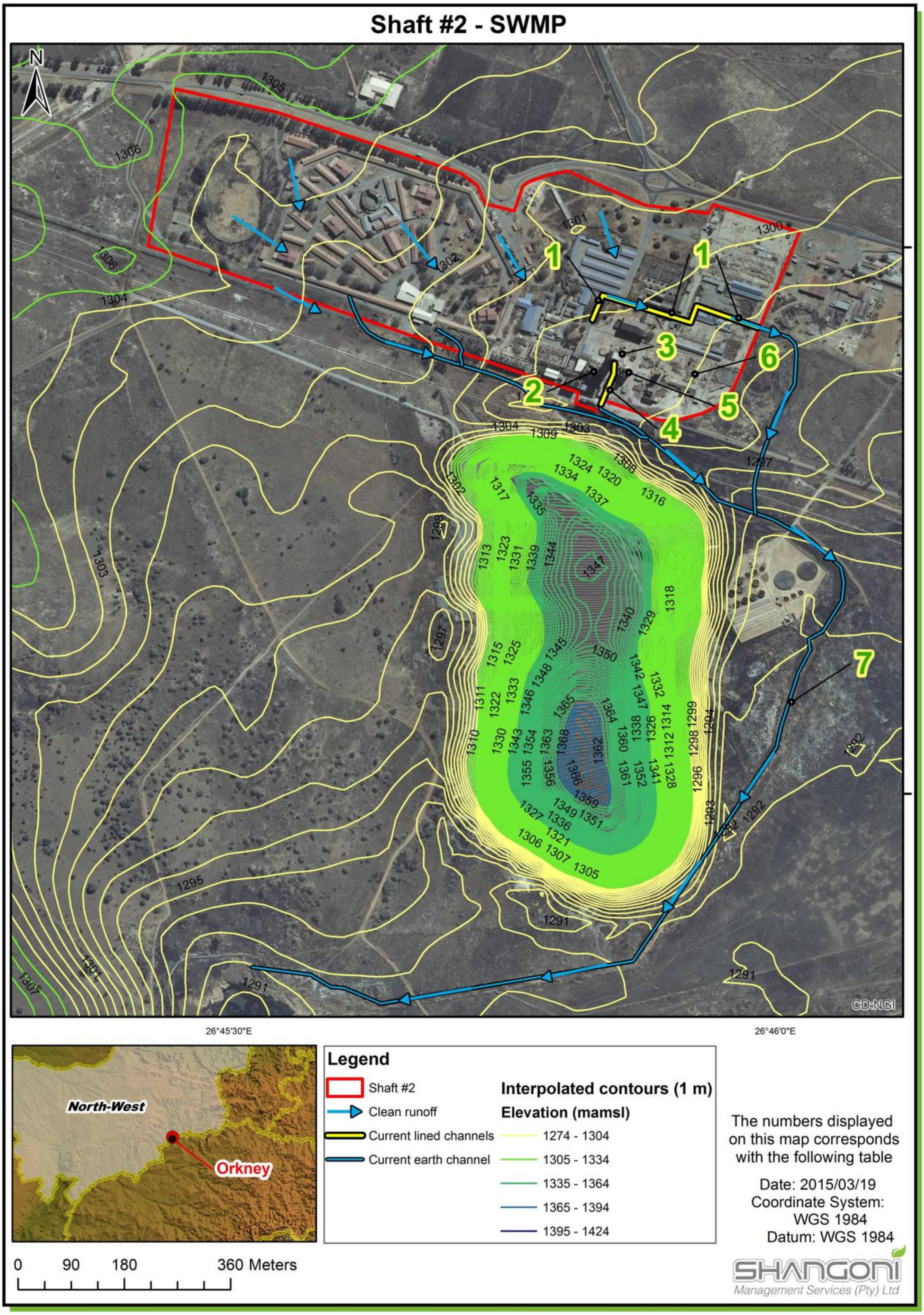


Figure 22: Shaft #2 - SWMP

Table 10: Shaft #2 – Storm water measures

Number and picture corresponding to Figure 22	Description and recommendations
   	1 – A current storm water channel (lined) conveys upstream surface water runoff towards the eastern boundary of the Shaft #2 area. All upstream runoff is discharged in an earth channel that gradually drains past the waste rock dump towards a dam located in close proximity of the Vaal River. Surface runoff within the network of channels from the adjacent buildings (offices, change houses, canteen etc.) connects to the aforementioned channel. Recommendations: It was indicated by mine personnel that CAPM does not intend to reinstate operations at Shaft #2. Further investigations will determine the feasibility of conducting operations at this shaft. At this stage no polluted surface water will be discharged from this channel.
	2 – Sumps have been constructed on both sides of the bulk cooling towers at Shaft #2. These sumps were fitted with pumping infrastructure and process water within the sumps were pumped to the dirty water system. Currently, clean surface water accumulate within these sumps and evaporate over time.

2 	
3 	3 – The shaft at the Shaft #2 area is currently not sealed off and surface water may flow into the shaft during heavy rainfall events. Recommendation: Investigations should be conducted to implement temporary diversion measures to channel surface runoff away and prevent surface runoff from flowing into the shaft while in care and maintenance – GN 704, Regulation 7(c). This strategy aims to reduce impact on the catchment yield.
4  4  4 	4 – An existing clean surface water diversion channel (lined) conveys surface runoff from the Shaft #2 area towards the downstream clean water environment. Recommendation: A lack of maintenance has compromised the integrity of the trench. It is recommended to implement a maintenance schedule on all surface water conveyance structures to divert runoff away from the shaft area although the operation is under care and maintenance – GN 704, Regulation 7(g).

5 	5 –Effort has been made during the shaft's operational phase to bund all areas that contained process water/liquor as a measure to prevent spillages into the clean environment. Currently, there are no process water containment at the shaft with no associated risk to the surrounding clean water environment.
6  6  6 	6 – Most of the shaft area is constructed on impermeable cement areas. Due to the flat topography of the area, there is no risk of induced velocity of surface runoff that might lead to erosion of adjacent areas.
7 	7 – An earth channel (yellow line) conveys surface water runoff from the Shaft #2 area and the Shaft #2 hostel area past the waste rock dump on its eastern side towards a dam in close proximity of the Vaal River.

5.1.2 Shaft #2

The Shaft #2 area is situated in close proximity (1.3 km) of the Vaal River. The shaft area has been vandalised to such a degree that it is unlikely that CAPM would reinstate operations due to cost implications.

Table 11: Risks associated with Shaft #2

Environmental impact, extent, duration, significance and degree to which impact will cause irreplaceable loss	Risk rating (before mitigation)			Environmental objective	Degree to which impact can be reversed and the supporting mitigatory action plan	Timeframe	Responsibility	Risk rating (after mitigation)		
	Probability	Magnitude	Severity					Probability	Magnitude	Severity
ENVIRONMENTAL COMPONENT: Surface water										
ACTIVITY: Uncontrolled surface water runoff										
PROJECT PHASE APPLICABILITY: Construction: ; Operation: ; Closure: X										
Impact description: There are no current diversion measures to prevent surface runoff from flowing into Shaft #2. Runoff retention also takes place inside previously constructed containment facilities. Surface water quantity: Surface runoff ingress into the shaft and retention inside previously constructed containment facilities may lead to a decrease in catchment yield towards the Vaal River. Extent: Affect limited to the site Duration: During care and maintenance/decommissioning Degree to which impact may cause irreplaceable loss: Not applicable, due to low significance.	4	2	M	To prevent a decrease in catchment yield towards the Vaal River.	Mitigation: • Implement temporary storm water diversion measures at the shaft area to prevent ingress of surface runoff into the shaft during heavy rainfall events while the shaft is under care and maintenance. The temporary measures will be removed when operations commence as it is not practical. • Areas where surface water retention takes place should be minimised to encourage free drainage of surface water towards the downstream environment. • Obstructions within current storm water trenches should be removed to promote free drainage of the Shaft #2 area.	Care and maintenance/ Operational phase.	Environmental manager.	1	1	L

4.4.1 Shaft #2 – Flood peaks and volumes

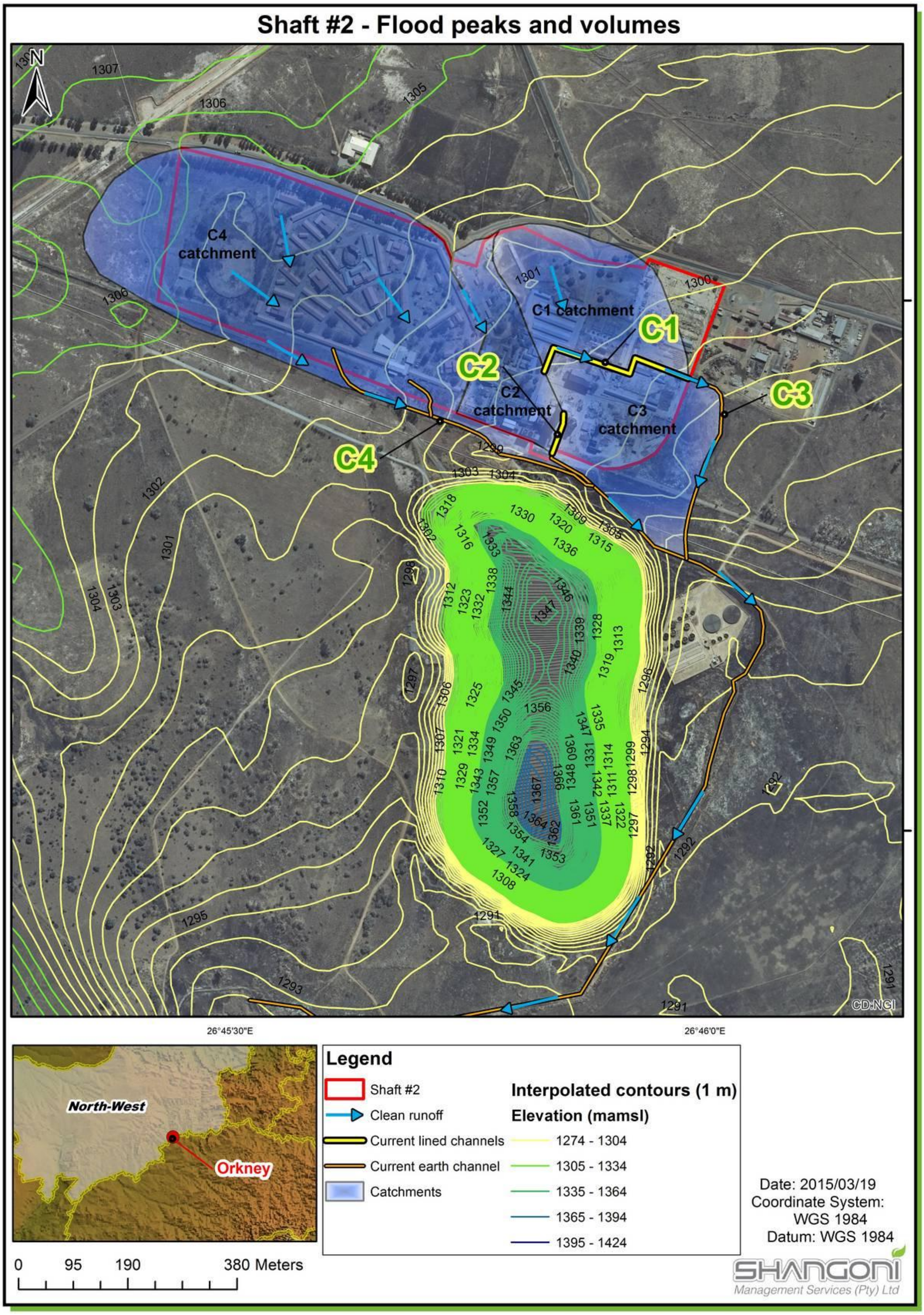


Figure 23: Flood peaks and volumes

Table 12: Catchment characteristics

	C1	C2	C3	C4
MAP	548.3	548.3	548.3	548.3
Catchment size (km^2)	0.059	0.036	0.068	0.205
Length of longest watercourse (km)	0.497	0.423	0.438	0.911
Height difference (m)	3	2	4	8

Table 13: Peak runoff for different return periods

Peak runoff (m^3/s)	**Return period (year)**											
	1:5			**1:10**			**1:50**			**1:100**		
	RM	**ARM**	**SDF**	**RM**	**ARM**	**SDF**	**RM**	**ARM**	**SDF**	**RM**	**ARM**	**SDF**
C 1	0.821	1.212	0.503	1.059	1.616	0.837	1.765	2.595	1.779	2.212	3.046	2.252
C 2	0.664	0.982	0.315	0.843	1.288	0.524	1.360	2.005	1.114	1.679	2.317	1.411
C 3	1.001	1.504	0.668	1.290	2.005	1.111	1.623	2.523	1.613	2.690	3.773	2.991
C 4	2.335	3.372	1.444	2.991	4.464	2.403	4.912	7.068	5.109	6.114	8.238	6.470

C1 – Lined storm water runoff channel conveying surface water towards the eastern boundary of the Shaft #2 area. The lined channel discharges into an earth channel.

C2 – Lined storm water runoff channel conveying surface runoff from the Shaft #2 area towards the southern boundary of the site from where it discharges into an earth channel.

C3 – Earth channel conveying clean surface runoff from the Shaft #2 area downstream into a surface water dam located in close proximity of the Vaal River.

C4 – Earth channel conveying clean surface runoff from the Shaft #2 hostel area and connects with C3 towards the downstream surface water dam.

4.5 CAPM operations – Shaft #3

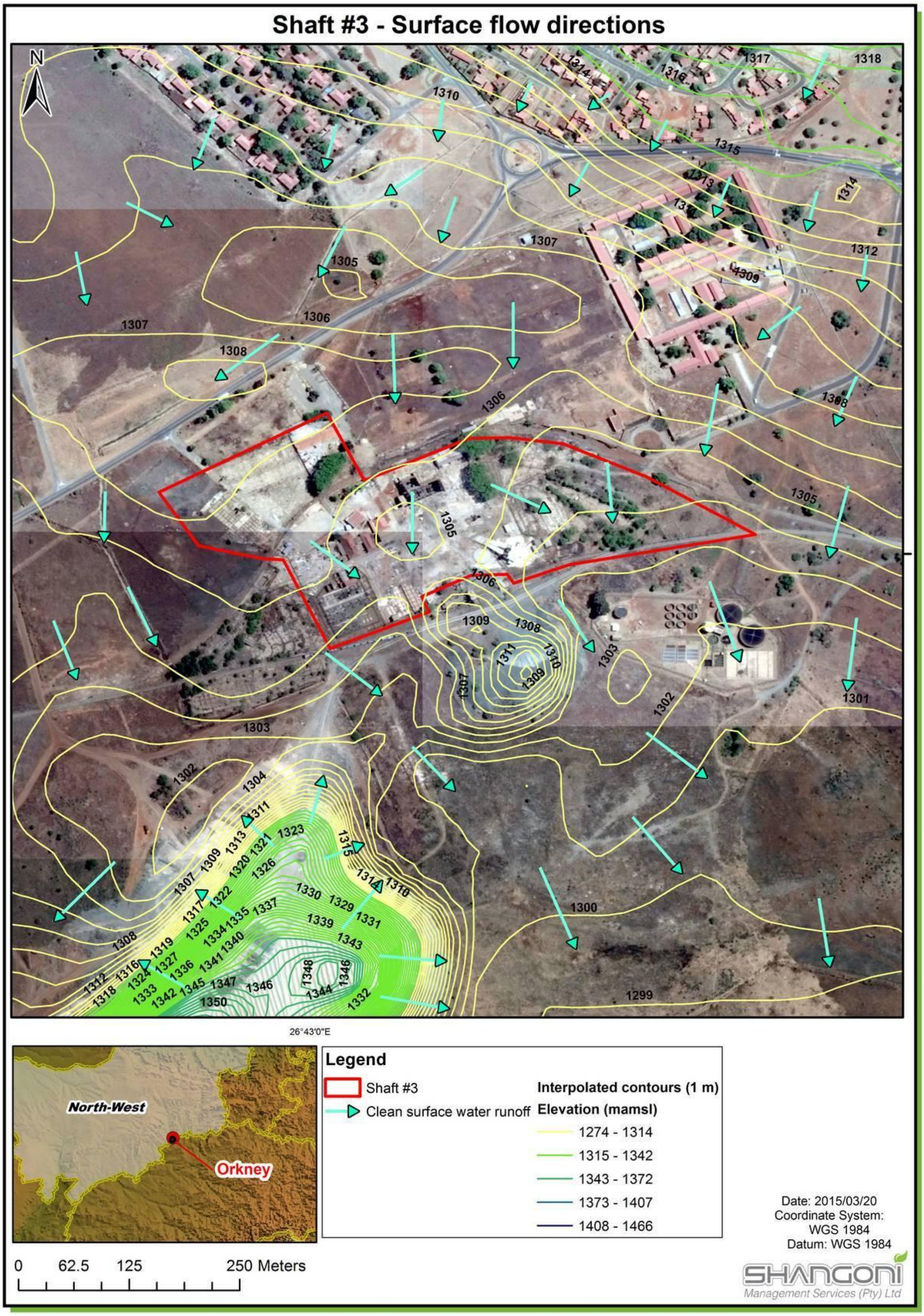


Figure 24: Surface flow directions – Shaft #3

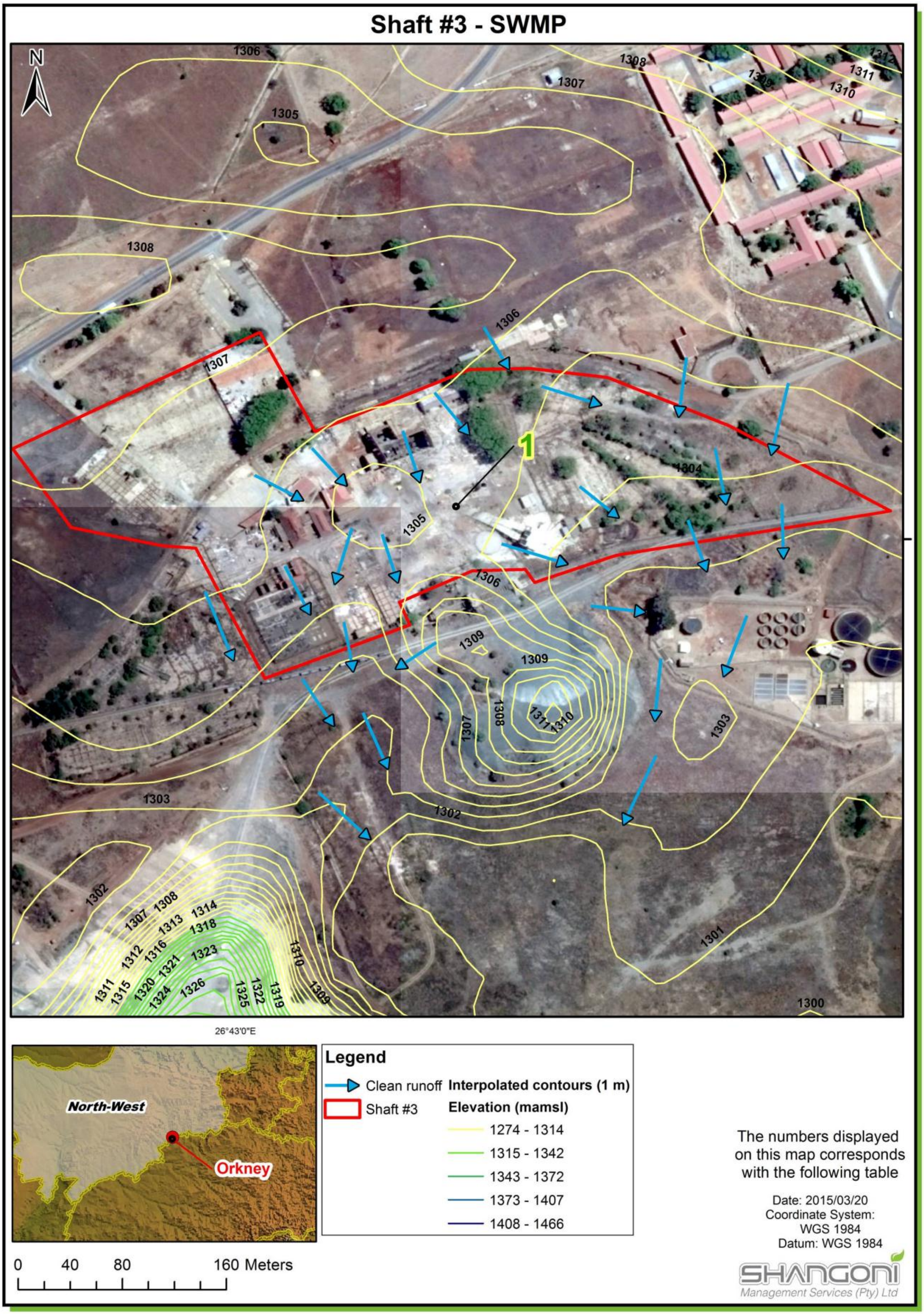


Figure 25: Shaft #3 - SWMP

Table 14: Shaft #3 – Storm water measures

Number and picture corresponding to Figure 25	Description and recommendations
   	1 – The Shaft #3 area is in the process of rehabilitation. The shaft headgear structure has been removed and plugged. Most of the buildings at the Shaft #3 area have been demolished. It was indicated by mine personnel that a tender process has begun and that rehabilitation of the area would commence at a time to be determined. There are currently no process water activities at the Shaft #3 area and no affected water is generated on site. Recommendation: Rehabilitation should be conducted to promote free drainage of surface water runoff towards the downstream clean water environment. Vegetation growth should be encouraged to limit exposed areas and reduce any possibility of erosion during heavy rainfall events. Any possible leaching substances should be removed from the site. No diversion measures or containment facilities are proposed.

5.1.2 Shaft #3

The Shaft #3 area has been completely demolished and is undergoing rehabilitation. The shaft has been plugged and sealed off.

Table 15: Risks associated with Shaft #3

Environmental impact, extent, duration, significance and degree to which impact will cause irreplaceable loss	Risk rating (before mitigation)			Environmental objective	Degree to which impact can be reversed and the supporting mitigatory action plan	Timeframe	Responsibility	Risk rating (after mitigation)		
	Probability	Magnitude	Severity					Probability	Magnitude	Severity
ENVIRONMENTAL COMPONENT: Surface water										
ACTIVITY: Rehabilitation of Shaft #3 area										
PROJECT PHASE APPLICABILITY: Construction [ ]; Operation [ ]; Closure [X]										
Impact description: Closure phase: Incorrect rehabilitation techniques may result in exposed areas and areas that will prevent drainage of storm water runoff towards the downstream environment. Surface water quantity and quality: Exposed areas within the Shaft #3 footprint may result in an increased sediment load that may deteriorate water quality towards the downstream environment. Incorrect rehabilitation techniques may result in ponding of storm water runoff and reduction in the catchment yield. Extent: Affect limited to the site Duration: During care and maintenance/decommissioning Degree to which impact may cause irreplaceable loss: Not applicable, due to low significance.	2	1	L	To prevent a decrease in catchment yield towards the Vaal River.	Mitigation: • It is imperative that the Shaft #3 area be rehabilitated to ensure free drainage of surface flow towards the downstream environment. • Vegetation growth should be promoted to reduce the possibility of erosion of exposed areas.	Decommissioning/ Rehabilitation	Environmental manager.	1	1	L

4.5.1 Shaft #3 – Flood peaks and volumes

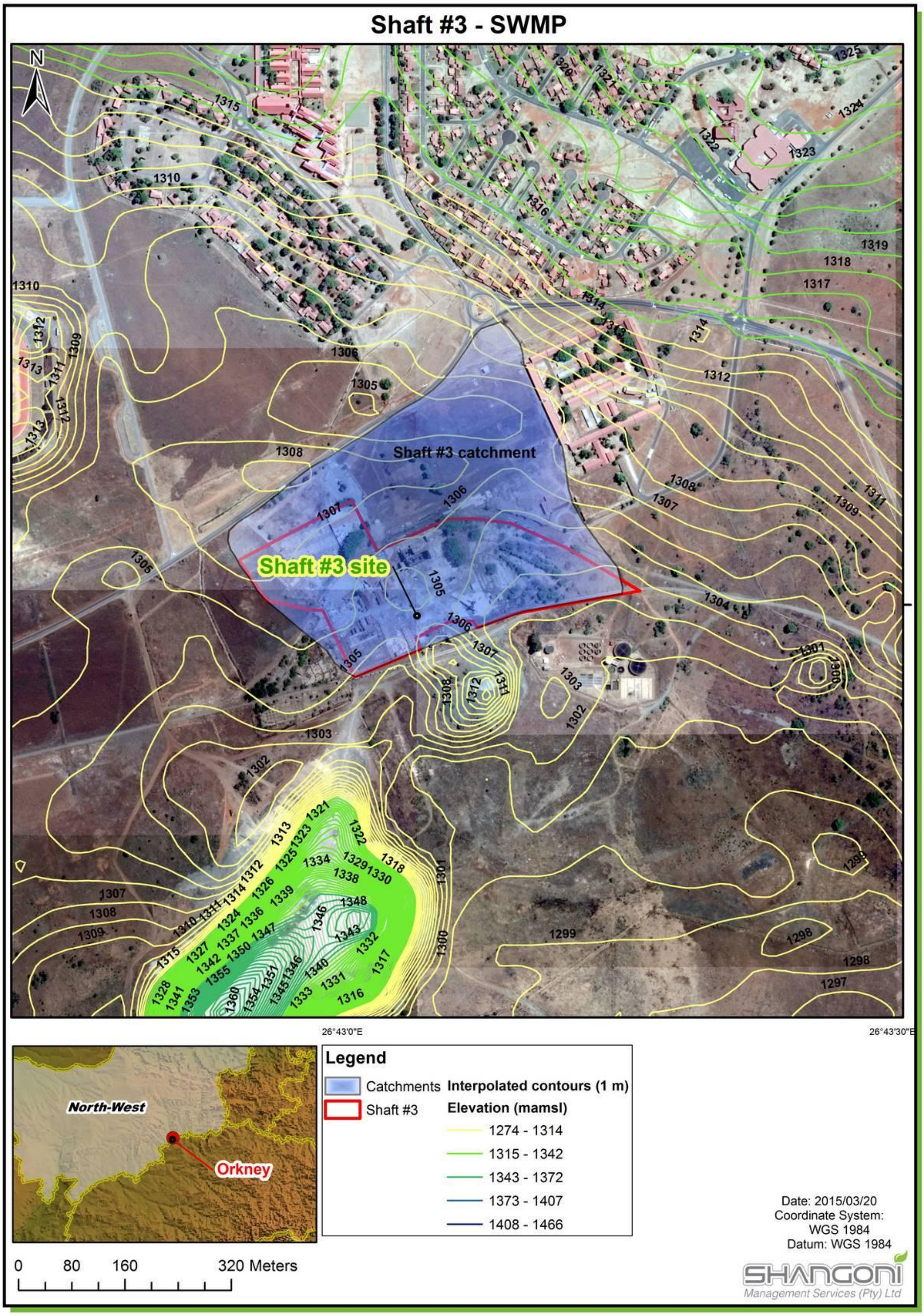


Figure 26: Flood peaks and volumes

Table 16: Catchment characteristics

	C1
MAP	548.3
Catchment size (km^2)	0.166
Length of longest watercourse (km)	0.524
Height difference (m)	7

Table 17: Peak runoff for different return periods

Peak runoff (m^3/s)	Return period (year)											
	1:5			1:10			1:50			1:100		
	RM	ARM	SDF	RM	ARM	SDF	RM	ARM	SDF	RM	ARM	SDF
Shaft #3 area	0.677	0.906	1.128	0.898	1.242	1.878	1.574	2.097	3.992	2.018	2.518	5.055

Shaft #3 – The Shaft #3 area has been temporary demolished due to a high degree of vandalism. Rehabilitation will continue in the near future. The shaft headgear structure has been removed and plugged. The catchment for the Shaft #3 area has been delineated taking existing trenches from the nearby settlement into account. Peak runoff flows were calculated by means of overflow contribution from the upstream areas towards the point where runoff leaves the Shaft #3 site. No dirty water will be generated and therefore no volume calculations were performed for containment purposes.

4.6 CAPM operations – Shaft #4

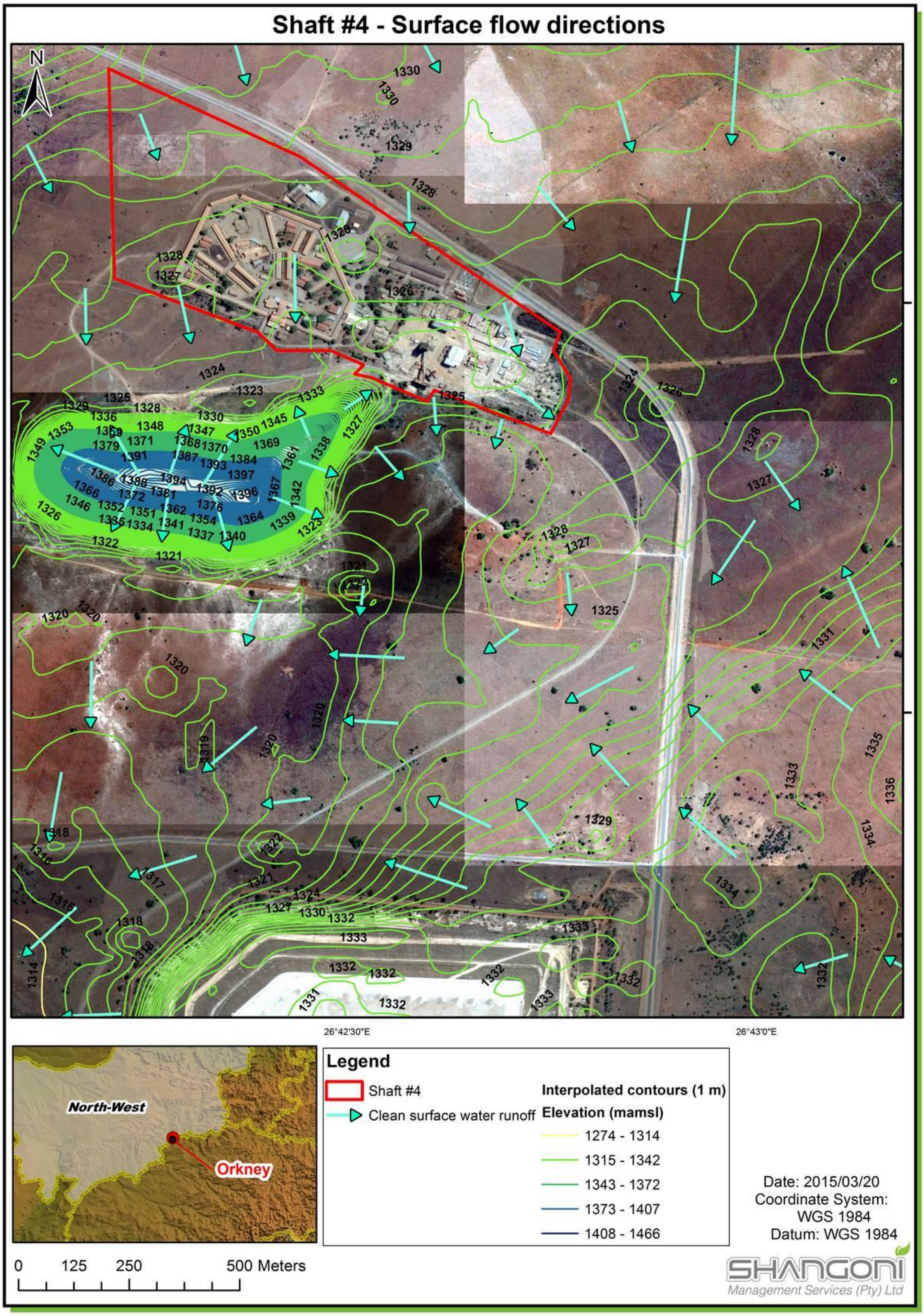


Figure 27: Shaft #4 - Surface flow directions

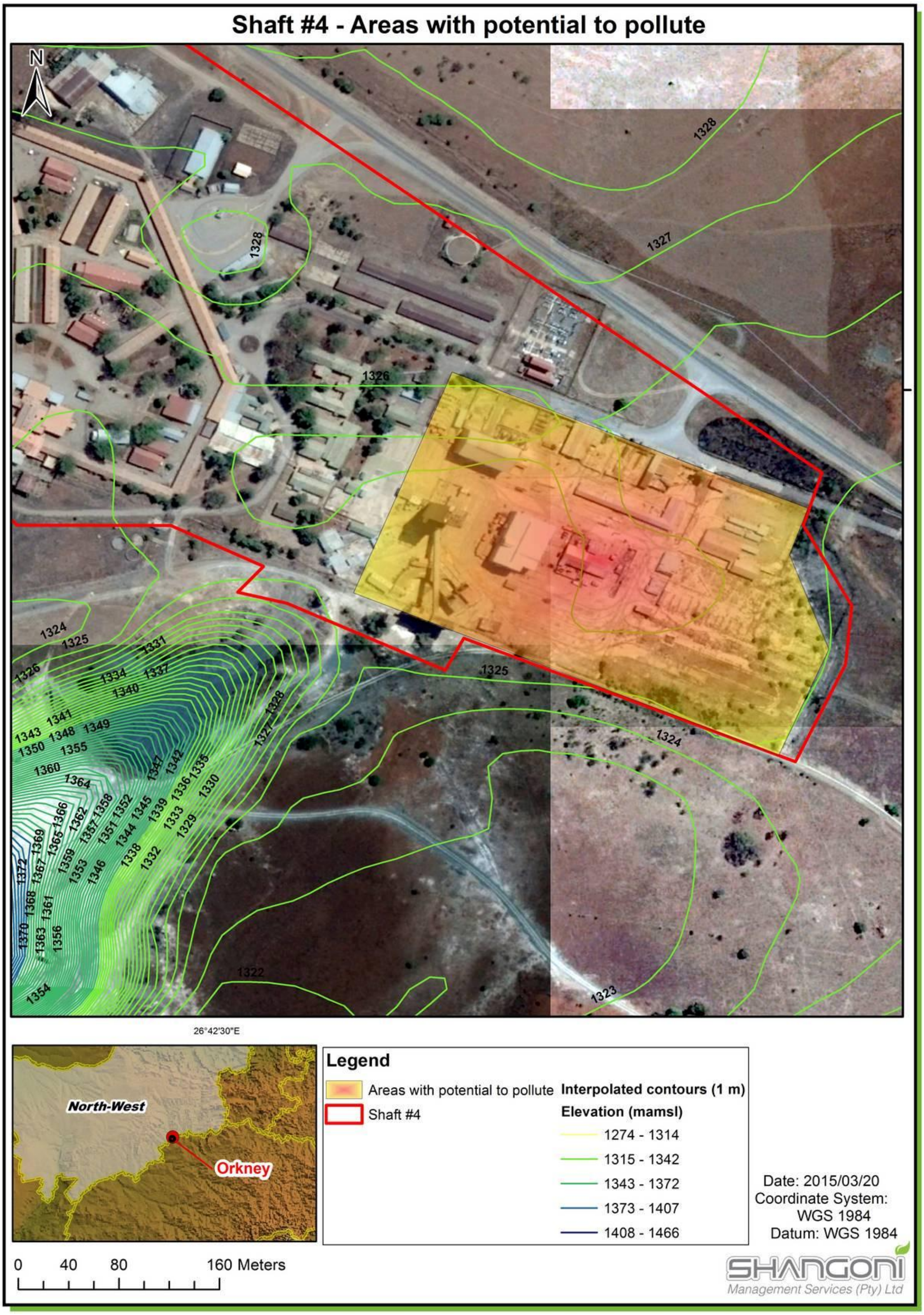


Figure 28: Shaft #4 – Areas with potential to pollute

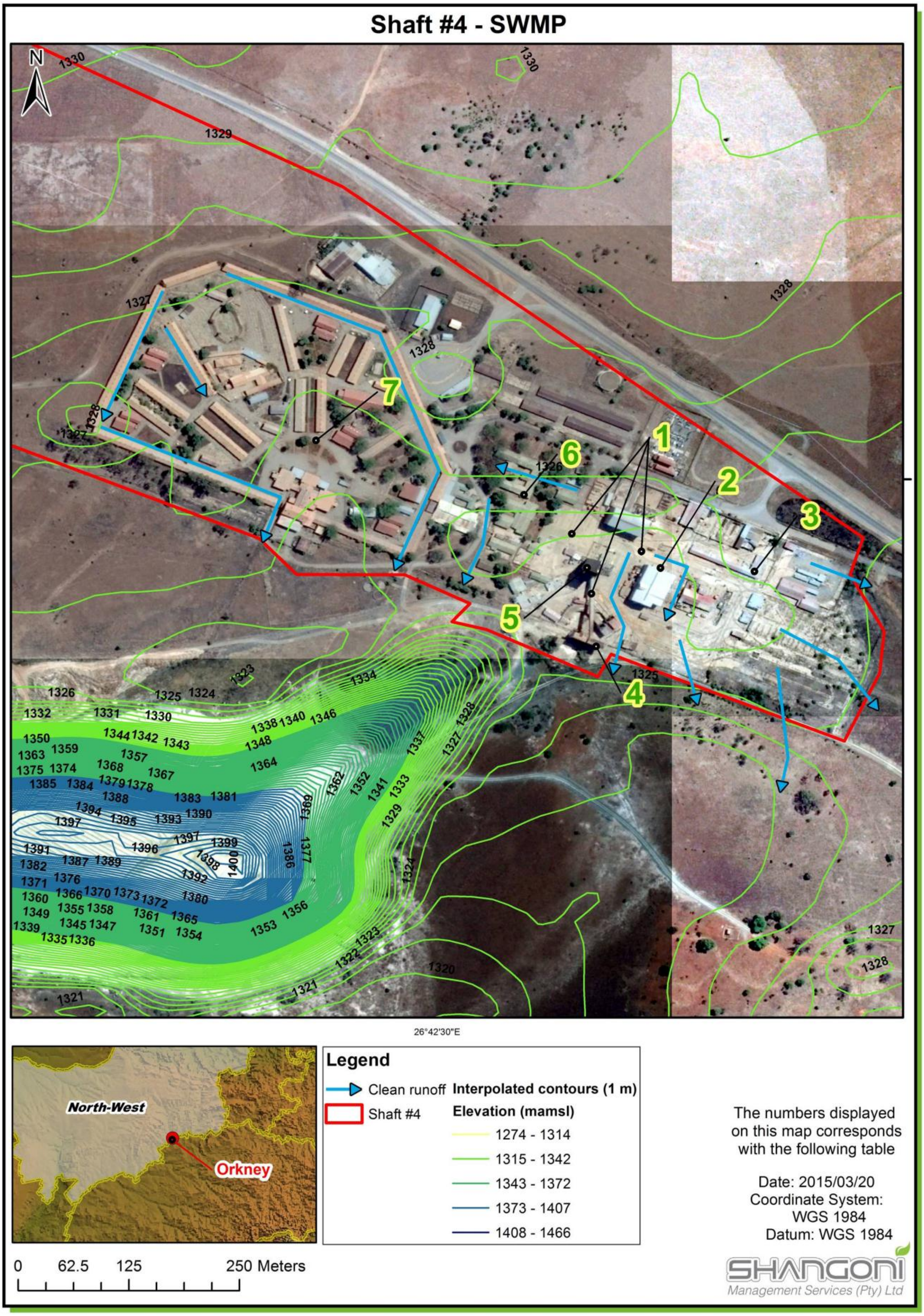
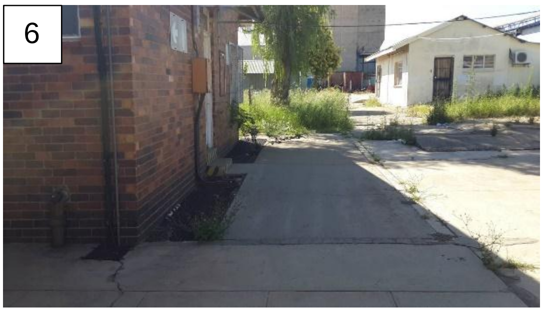


Figure 29: Shaft #4 - SWMP

Table 18: Shaft #4 – Storm water measures

Number and picture corresponding to Figure 29	Description and recommendations
   	1 – Shaft #4 is currently under care and maintenance. It was indicated by mine personnel that CAPM intends to reinstate operations at Shaft #4 approximately two years after operations at Shaft #6 and Shaft #7 has commenced. The topography at Shaft #4 has a slight slope towards the south. No clear storm water diversion measures at the shaft operations area were observed during the site assessment. Currently, storm water runoff flows over the concrete surface and discharges into the adjacent veldt areas. Recommendation: Once operations commence at Shaft #4, good house-keeping practises should be implemented to avoid generation of dirty areas within the shaft operations area. This strategy aims to avoid the need to construct dirty water containment systems as per GN 704, Regulation 6(c).
	2 – Effort has been made during the operational phase of Shaft #4 to store hydrocarbon containers within designated areas. These areas are bunded and roofed to prevent rainwater ingress and possible contamination of clean surface water – GN 704, Regulation 7(a).

3  3  3 	3 – Some of the workshop buildings have been removed at Shaft #4 operations area as the footprints of previous structures are visible. As a result, the total concrete area at Shaft #4 results in a reduced surface water infiltration rate that corresponds with a higher volume of surface water generated during heavy rainfall events. Runoff generated on site will gradually drain along the slope and into the adjacent veldt areas.
4  4 	4 – Bunded areas have been constructed during the operational phase of Shaft #4 at the ore loading area. Any ore spillages and any contaminated water from the spilled ore were contained.

4 	
5  5 	5 – Currently, there is no surface water diversion measures at the open shaft area. Runoff during heavy rainfall events may enter the shaft area into underground water resources. Recommendation: It is proposed to construct temporary storm water diversion measures, during care and maintenance, to prevent clean surface runoff inflow into the shaft – GN 704, Regulation 7(c). Once operations commence at Shaft #4, the temporary diversion measures can be removed and alternative diversion measures should be investigated.
6  6 	6 –Clean storm water diversion measures have been implemented at the Shaft #4 office areas. These storm water measures (channels) convey clean runoff mostly from roofs and impermeable surfaces towards the adjacent veldt areas. Most of these channels are covered with metal grids or cement slabs in order to prevent obstructions in the channels. Recommendation: Once operations at Shaft #4 commence, it is proposed to implement a maintenance schedule to maintain the integrity of the conveyance structures – GN 704, Regulation 7(g).

 	
  	7 – Clean storm water diversion measures have been implemented at the hostel area. These measures consist of open lined channels and underground conveyance pipes diverting clean runoff from roofs and impermeable surfaces to the adjacent veldt areas.

7 	

5.1.2 Shaft #4

Table 19: Risks associated with Shaft #4

Environmental impact, extent, duration, significance and degree to which impact will cause irreplaceable loss	Risk rating (before mitigation)			Environmental objective	Degree to which impact can be reversed and the supporting mitigatory action plan	Timeframe	Responsibility	Risk rating (after mitigation)		
	Probability	Magnitude	Severity					Probability	Magnitude	Severity
ENVIRONMENTAL COMPONENT: Surface water										
ACTIVITY: Uncontrolled surface water runoff										
PROJECT PHASE APPLICABILITY: Construction [ ]; Operation [X]; Closure [ ]										
Impact description: There are no current diversion measures to prevent surface runoff from flowing into Shaft #4. Runoff retention also takes place inside previously constructed containment facilities within the shaft operations area. Surface water quantity: Surface runoff ingress into the shaft and retention inside previously constructed containment facilities may lead to a decrease in catchment yield. Extent: Affect limited to the site Duration: During care and maintenance/ operational phase Degree to which impact may cause irreplaceable loss: Not applicable, due to low significance.	4	2	M	To prevent a decrease in catchment yield towards the Vaal River.	Mitigation: • Implement storm water diversion measures at the shaft area to prevent ingress of surface runoff into the shaft during heavy rainfall events. • Areas where surface water retention takes place should be minimised to encourage free drainage of surface water towards the downstream environment. • Obstructions within current storm water trenches should be removed to promote free drainage of the Shaft #2 area.	Care and maintenance/ Operational phase	Environmental manager.	1	1	L

4.6.1 Shaft #4 – Flood peaks and volumes

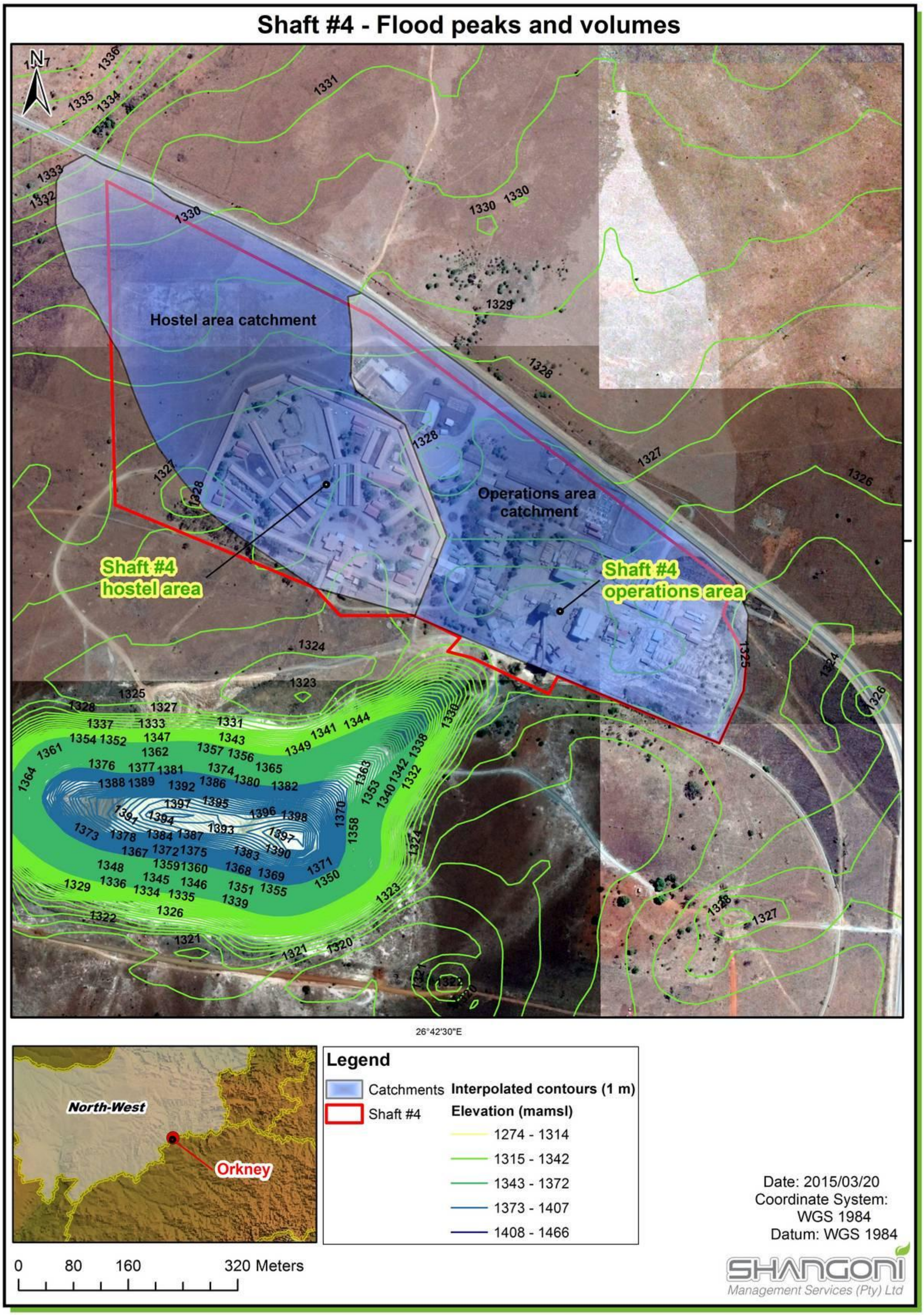


Figure 30: Flood peaks and volumes

Table 20: Catchment characteristics

	Shaft #4 operations area	Shaft #4 hostel area
MAP	548.3	548.3
Catchment size (km^2)	0.167	0.193
Length of longest watercourse (km)	0.843	0.764
Height difference (m)	5	7

Table 21: Peak runoff for different return periods

Peak runoff (m^3/s)	Return period (year)											
	1:5			1:10			1:50			1:100		
	RM	ARM	SDF	RM	ARM	SDF	RM	ARM	SDF	RM	ARM	SDF
Shaft #4 operations area	1.051	1.396	0.769	1.339	1.837	1.279	2.174	2.876	2.719	2.691	3.333	3.443
Shaft #4 hostel area	0.927	1.233	1.031	1.205	1.656	1.716	2.033	2.693	3.647	2.563	3.179	4.619

Shaft #4 operations area – Due to the flat topography of the area, the catchment towards the Shaft #4 operations area is defined from the tar road (boundary) to the south-eastern boundary of the operations area. The total runoff contribution generated within the catchment will be distributed by the various existing storm water channels at the office area while the rest will flow as overland flow across the impervious surface towards the south-eastern boundary and discharge into the adjacent veldt. There are no surface water containment facilities on site and therefore runoff volumes have not been calculated. The relatively low peak runoff volumes indicate a low risk of flood damage to buildings and low risk of scouring and erosion at discharge points.

Shaft #4 hostel – The majority of the Shaft #4 hostel catchment consists of open veldt area towards the hostel buildings. Runoff generated within the hostel area roofs and impervious surfaces will be conveyed via existing lined channels towards the lowest point from where discharge into the adjacent veldt will take place.

4.7 CAPM operations – Shaft #5

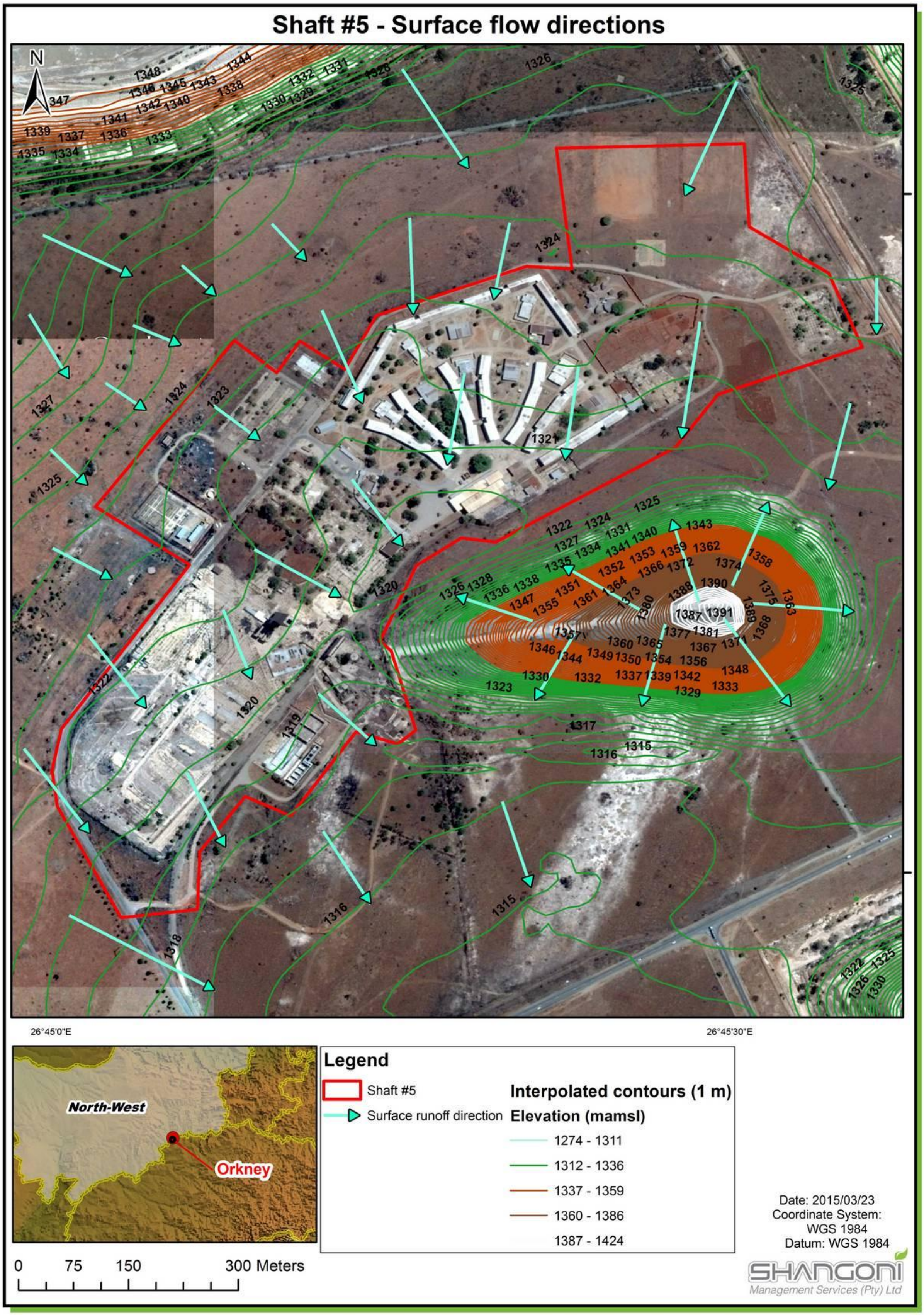


Figure 31: Shaft #5 - Surface flow directions

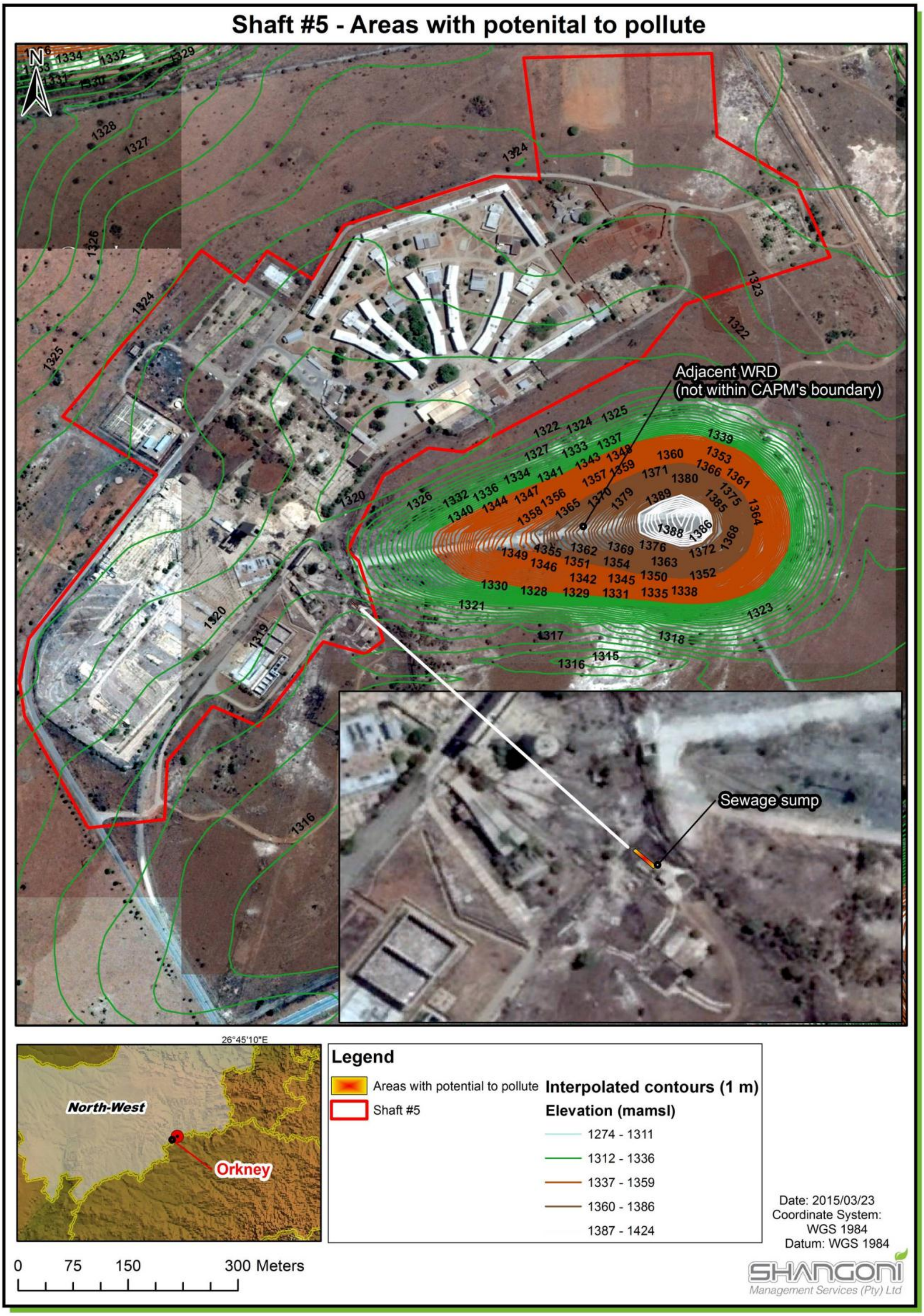


Figure 32: Shaft # 5 – Areas with potential to pollute

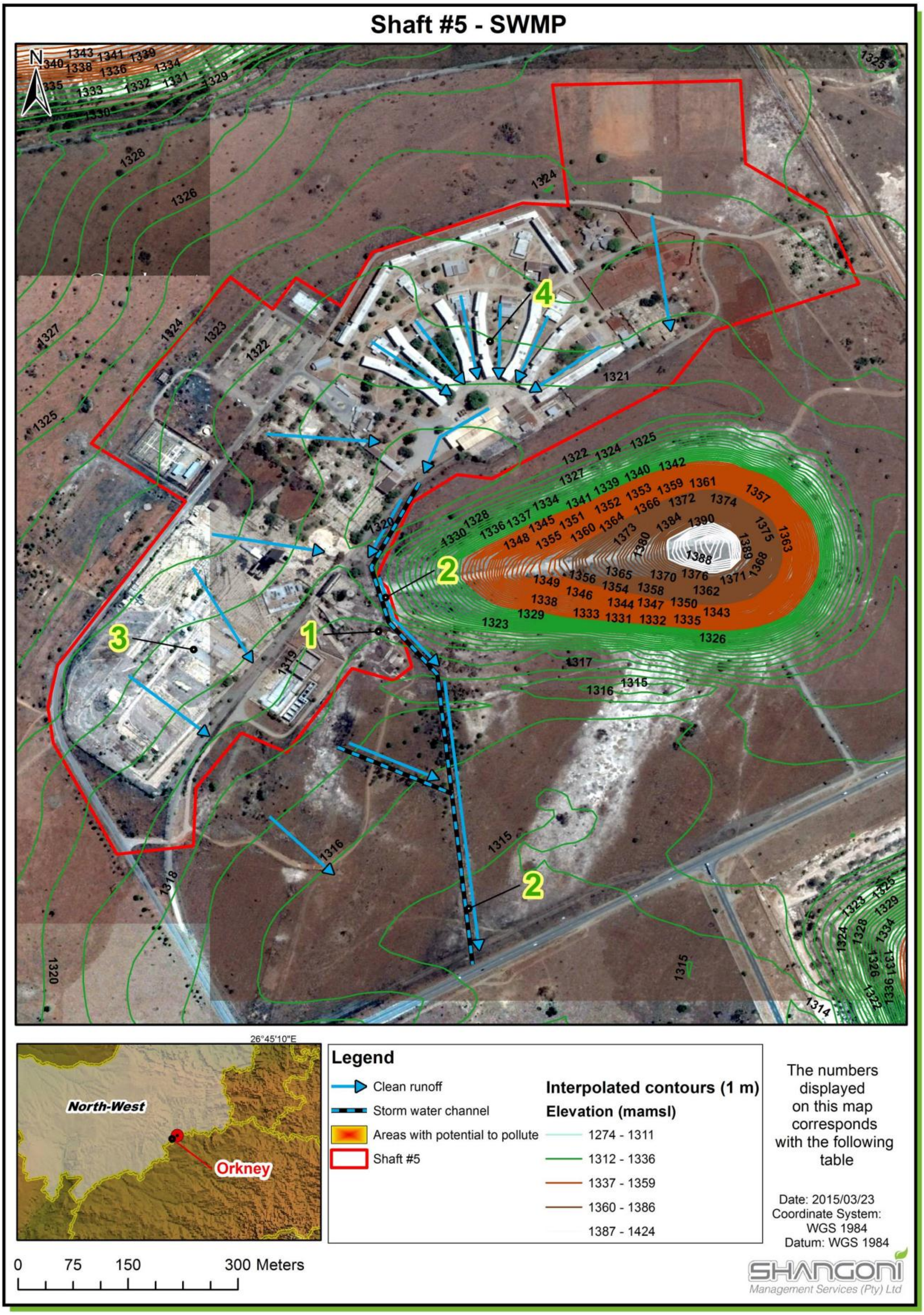


Figure 33: Shaft #5 - SWMP

Table 22: Shaft #5 - Storm water measures

Number and picture corresponding to Figure 33	**Description and recommendations**
 	1 – A sewage sump is located next to the clean storm water diversion channel conveying runoff from the Shaft #5 hostel area towards the downstream clean water environment. The sump is pumped out on a daily basis by a contractor. It was indicated by mine personnel that the sump has overflowed in the past when the operations was not owned by CAPM. Recommendation: It is recommended, as an additional measure, to construct a berm between the sewage sump and the clean runoff diversion channel. This strategy aims to prevent sewage from flowing into the clean runoff diversion trench during possible overflow – GN 704, Regulation 7(a). Contractors has been appointed to drain the sump on a regular basis.
 	2 – A clean runoff diversion channel has been constructed and conveys clean runoff from the Shaft # 5 hostel area, towards the downstream environment. It was observed during the site assessment that domestic waste accumulated within the clean runoff channel. The channel is also overgrown with vegetation. Recommendation: It is proposed to develop and implement a waste management procedure specifying the requirements for the storage and disposal of general waste at the hostel area. Maintenance should be conducted on the conveyance channel to ensure that no impeding structures prevent free passage of clean runoff into the adjacent areas – GN 704, Regulation 7(g).

	
  	3 – Is was indicated by mine personnel that Shaft #5 has been dormant since 1992 as a result of an accident that caused the shaft's steel structure to bend. The shaft has been unsafe to operate since. Most of the buildings at the Shaft #5 operations area have been removed during the past. CAPM intends to rehabilitate the Shaft #5 area. There are no activities at the Shaft #5 operations area that generates contaminated surface water runoff. There is still people living in the Shaft #5 hostel and as a result the sewage system is still operational. Recommendations in terms of the sewage system have been discussed under reference number 1.
	4 – Surface water runoff from the Shaft #5 hostel area gradually flows along the slight gradient and enters a culvert leading to the clean surface runoff diversion channel. This channel flows past the Shaft #5 area and the sewage sump towards the open veldt area.

 4 Storm water conveyance channels at hostel area  4 Culvert leading to the storm water diversion channel	

5.1.2 Shaft #5

The Shaft #5 area has been decommissioned since 1992 as a result of an accident that caused the shaft's steel structure to bend. The shaft has been unsafe to conduct operations since. Most of the buildings at the shaft area has been removed. The hostel at Shaft #5 is still operational.

Table 23: Risks associated with Shaft #5

Environmental impact, extent, duration, significance and degree to which impact will cause irreplaceable loss	**Risk rating (before mitigation)**			**Environmental objective**	**Degree to which impact can be reversed and the supporting mitigatory action plan**	**Timeframe**	**Responsibility**	**Risk rating (after mitigation)**		
	Probability	**Magnitude**	**Severity**					**Probability**	**Magnitude**	**Severity**
ENVIRONMENTAL COMPONENT: Surface water										
ACTIVITY: Sewage management										
PROJECT PHASE APPLICABILITY	Construction									
	Operation	X								
	Closure									
Impact description: A sewage sump is located next to a clean storm water diversion channel downstream of the Shaft #5 hostel area. Mine personnel has indicated that there were previous incidents (before CAPM took over operations) in which the sump's capacity was reached and sewage entered the clean storm water conveyance channel. Surface water quality: Overflow of sewage into the clean storm water conveyance channel will result in significant deterioration of water quality. Extent: Impact may extend beyond site to adjacent sites. Duration: Operational phase of sewage system. Degree to which impact may cause irreplaceable loss: May result in irreplaceable loss to aquatic ecosystems if system not effectively managed.	4	3	H	To prevent a decrease in surface water quality reporting to the downstream clean water environment.	Mitigation: • Implement regular inspections and ensure that the sump is serviced on a daily basis. • As an additional measure, construct a berm between the sewage sump and the clean storm water channel to prevent sewage from entering the channel during possible overflow.	Operational phase of hostel	Environmental manager.	2	2	L

4.7.1 Shaft #5– Flood peaks and volumes

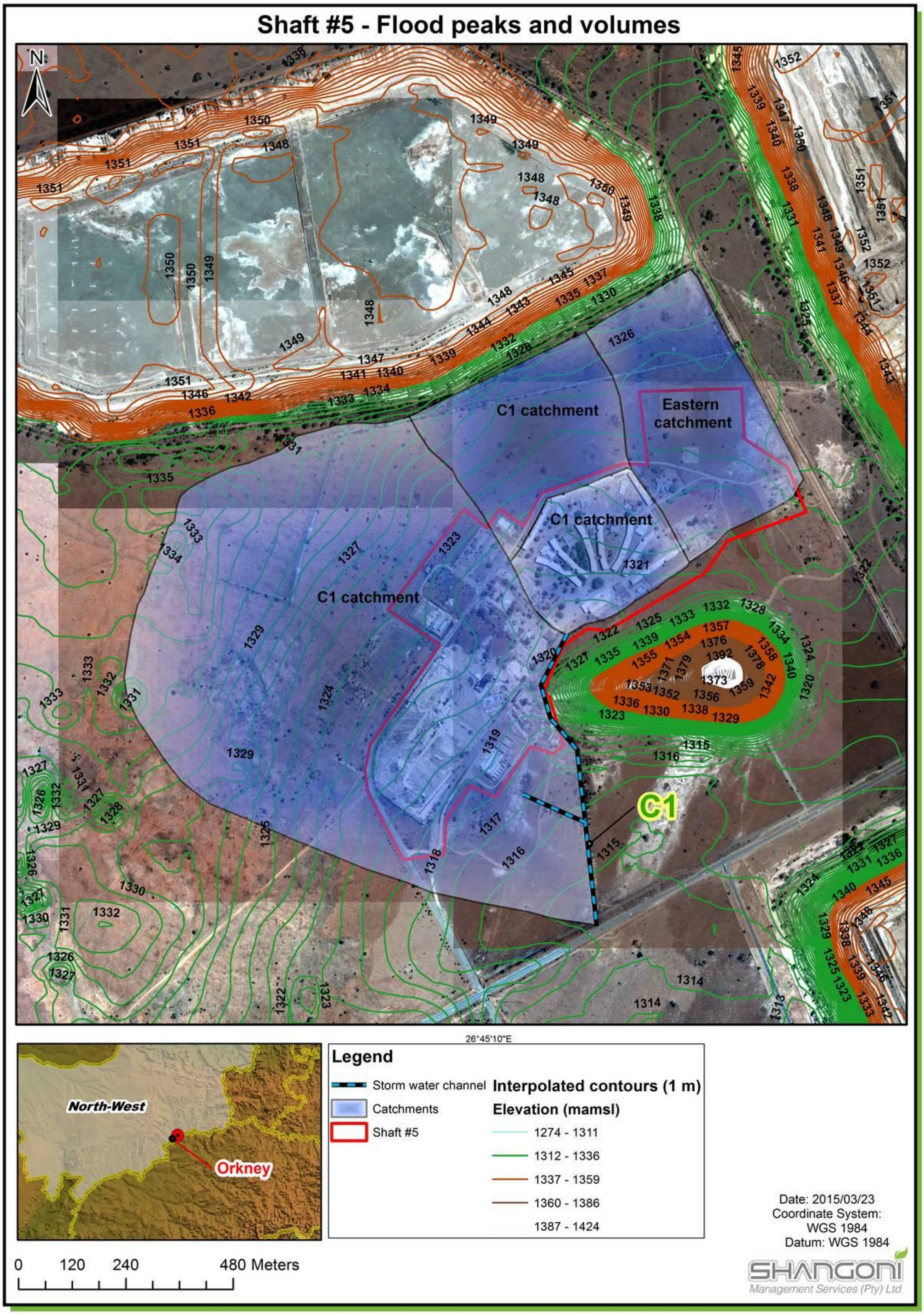


Figure 34: Flood peaks and volumes

Table 24: Catchment characteristics

	Decline
MAP	548.3
Catchment size (km^2)	1.0235
Length of longest watercourse (km)	1.286
Height difference (m)	10

Table 25: Peak runoff for different return periods

Peak runoff (m^3/s)	Return period (year)											
	1:5			1:10			1:50			1:100		
	RM	ARM	SDF	RM	ARM	SDF	RM	ARM	SDF	RM	ARM	SDF
C1	3.103	4.122	5.889	4.076	5.597	9.800	7.018	9.294	20.84	8.930	11.07	26.39

C1 – Lined storm water diversion channel: This channel conveys clean surface water runoff from the Shaft #5 hostel area in a southern direction towards the downstream environment. Runoff from the hostel area will generate from the roofed area and impermeable surfaces. A network of underground pipes and open channels convey runoff towards the start of the C1 channel. This channel may also receive runoff as overland flow from the upper catchment areas. The runoff contribution from these catchments was also taken into account and added as overland flow contribution to determine the peak runoff volumes during different flood scenarios. There are no runoff containment facilities at Shaft #5 and therefore no runoff volumes were calculated for the purpose of containment.

4.8 CAPM operations – Shaft #6

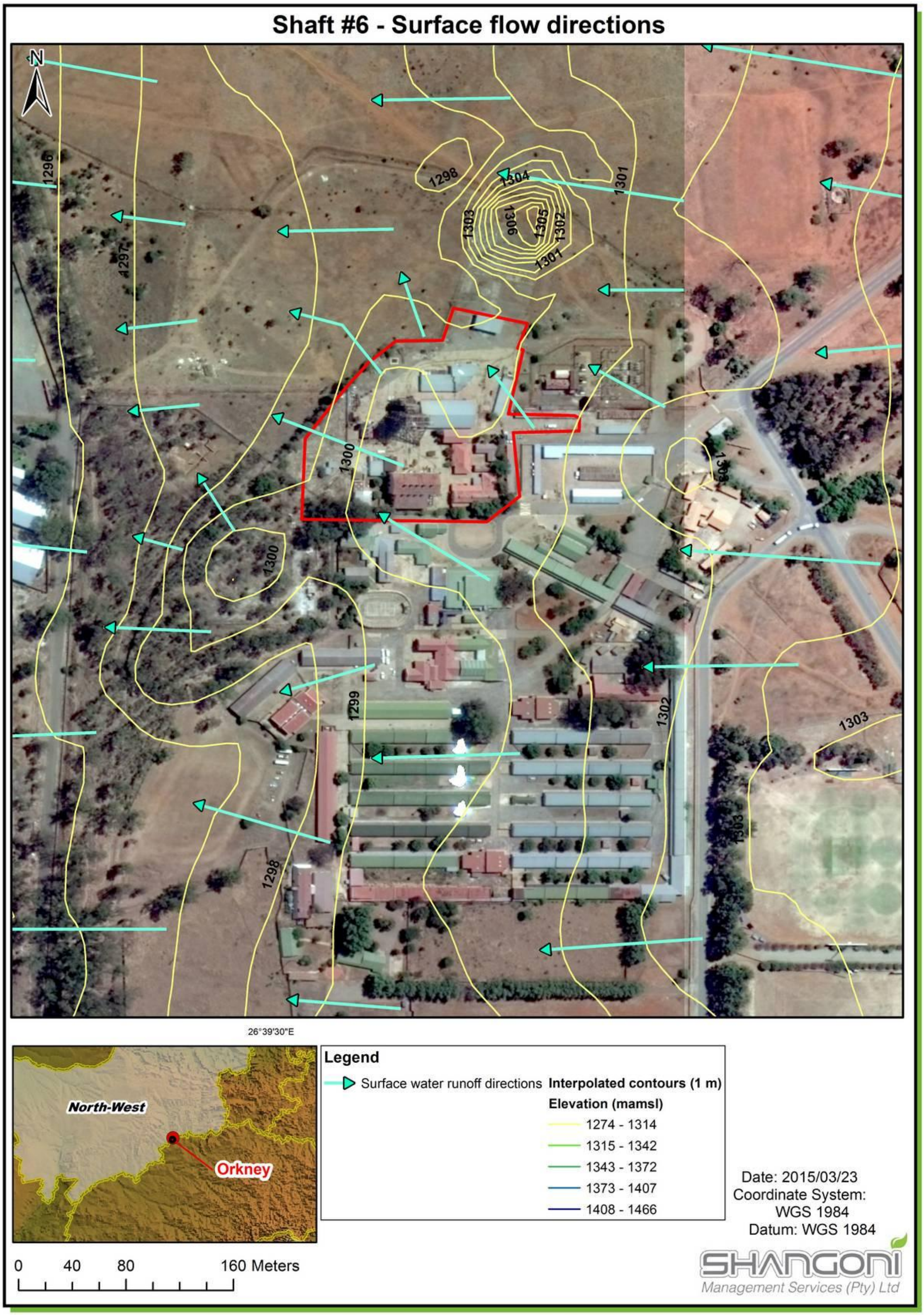


Figure 35: Shaft #6 - Surface flow directions

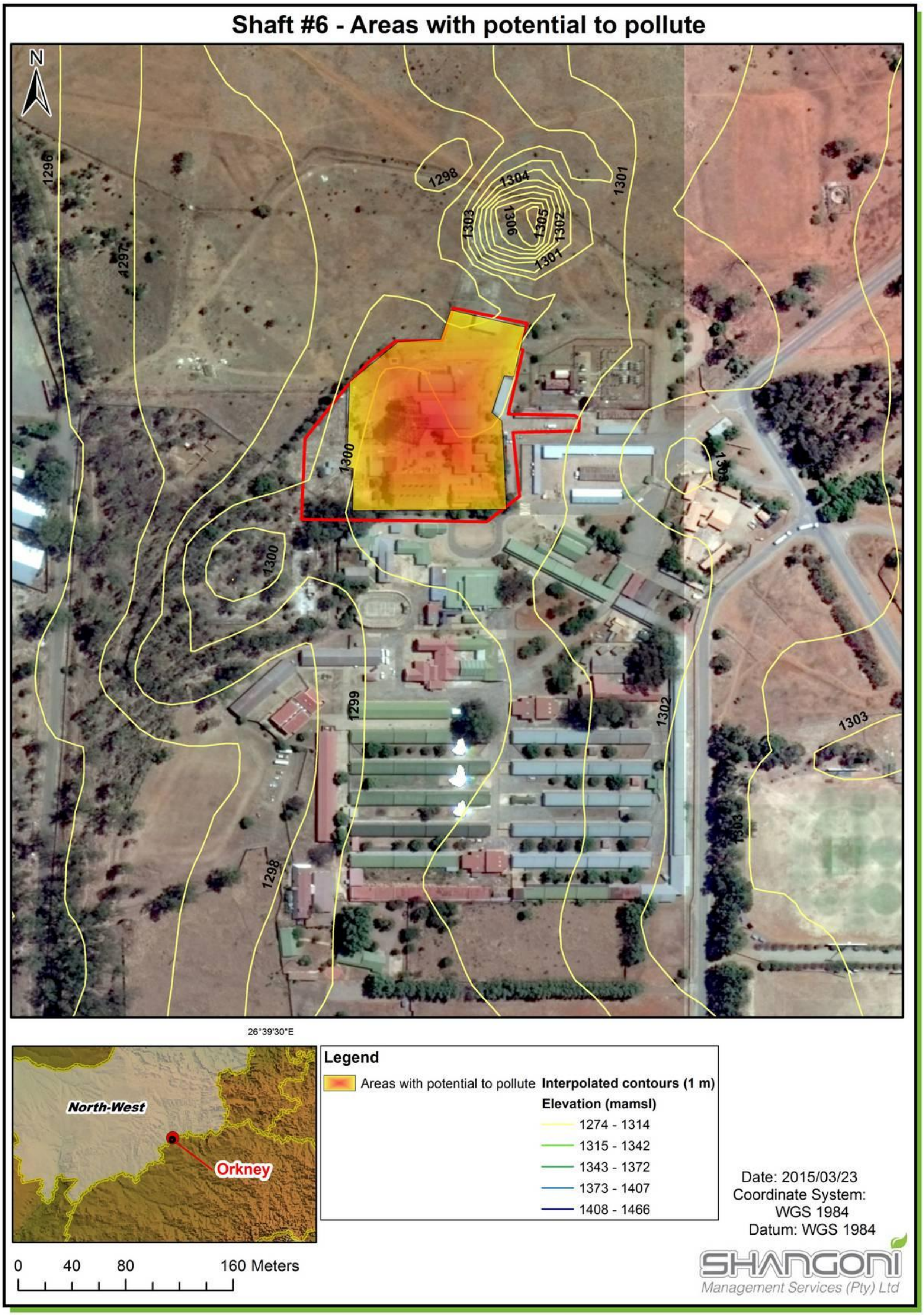


Figure 36: Shaft #6 – Areas with potential to pollute

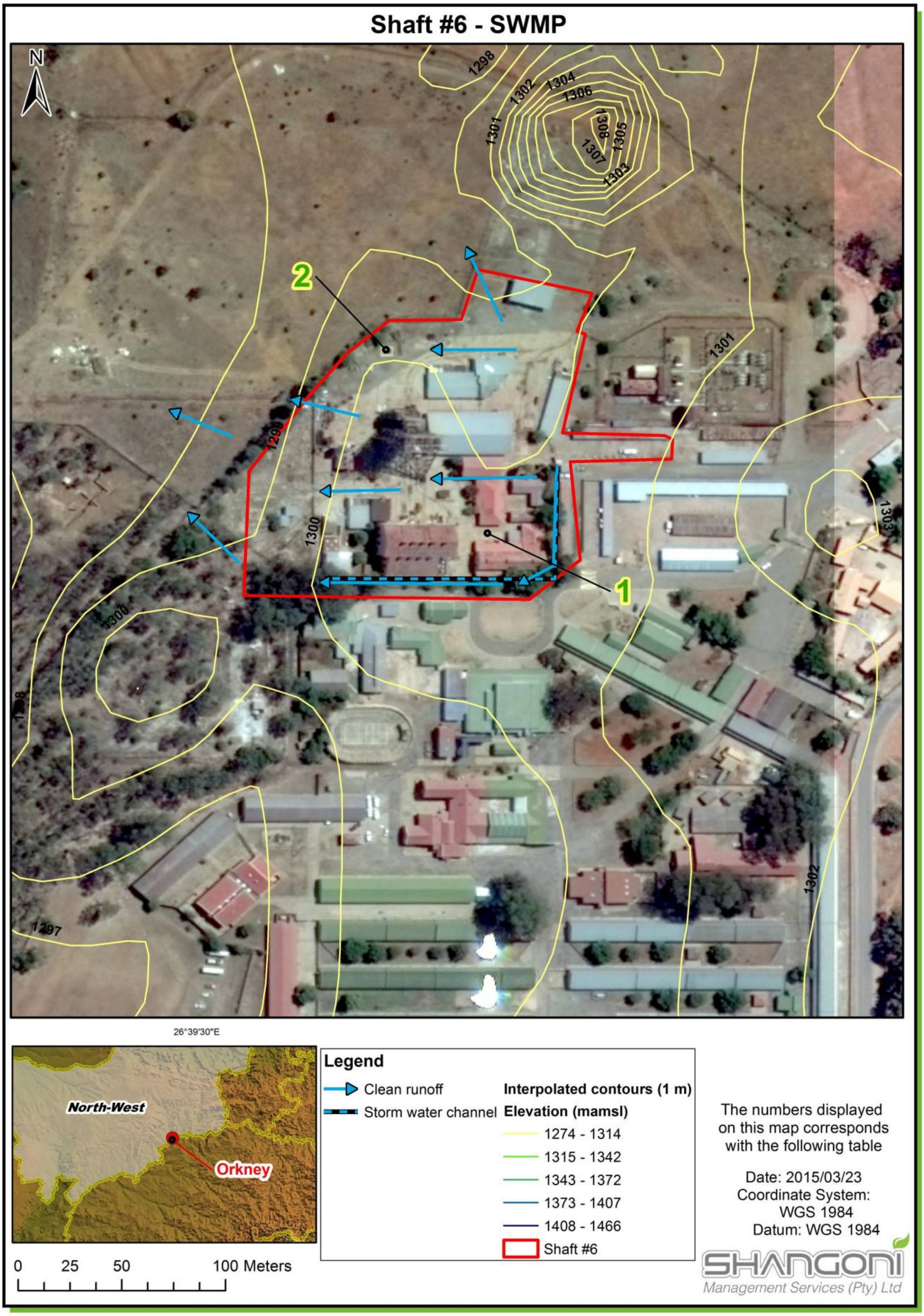


Figure 37: Shaft #6 - SWMP

Table 26: Shaft #6 - Storm water measures

<table>
<tr><th>Number and picture corresponding to Figure 37</th><th>Description and recommendations</th></tr>
<tr><td>


</td><td>
1 – A network of clean storm water conveyance channels (lined) have been constructed at the Shaft #6 operations area. These channels convey clean storm water runoff from the roofs and impermeable surfaces of the operations area towards the adjacent veldt area on the western side of the shaft.

It was indicated by mine personnel that CAPM intends to re-instate operations at Shaft #6.

Recommendation: It is proposed to implement a maintenance schedule on all storm water conveyance infrastructures. This strategy aims to allow for free drainage of surface water runoff from the shaft operations into the surrounding clean water environment - GN 704, Schedule 7(g). Ponding of storm water runoff will also be limited. Measures should be implemented to prevent surface runoff from flowing into the shaft – This strategy aims to comply with GN 704, Schedule 7(c).
</td></tr>
</table>

	
 	2 – The wash bay area at Shaft #6 is constructed on an impermeable cement surface fitted with a bund wall. Wash water will be discharged into the open veldt area. Recommendation: It is proposed to add an oil separator to the wash bay in order to prevent hydrocarbon contaminated wash water discharge into the surrounding clean water environment. Regular inspections should be conducted to ensure that the oil separator is in working order at all times. Monitoring of discharge water should take place and verified against the discharge limits as required by the Department of Water Affairs. If wash water is found to be inadequate for discharge, it is recommended to implement a containment and evaporation facility.. This strategy aims to comply with GN 704, Schedule 7(a).

5.1.2 Shaft #6

CAPM intends to reinstate operations at Shaft #6. The Shaft #6 area is relatively small in comparison with the rest of the shaft areas and has existing clean surface runoff diversion channels within the footprint. The surrounding areas include a residential area towards the east, a hostel area towards the south, open veldt area towards the north and an industrial area on the western side.

Table 27: Risks associated with Shaft #6

Environmental impact, extent, duration, significance and degree to which impact will cause irreplaceable loss	Risk rating (before mitigation)			Environmental objective	Degree to which impact can be reversed and the supporting mitigatory action plan	Timeframe	Responsibility	Risk rating (after mitigation)		
	Probability	Magnitude	Severity					Probability	Magnitude	Severity
ENVIRONMENTAL COMPONENT: Surface water										
ACTIVITY: Uncontrolled storm water runoff										
PROJECT PHASE APPLICABILITY: Construction [ ]; Operation [X]; Closure [ ]										
Impact description: There are no current diversion measures to prevent surface runoff from flowing into Shaft #6. Surface water quantity: Surface runoff ingress into the shaft may lead to a decrease in catchment yield towards the clean water environment. Extent: Affect limited to the site Duration: During care and maintenance / operational phase Degree to which impact may cause irreplaceable loss: Not applicable, due to low significance.	4	2	M	To prevent a decrease in catchment yield towards the downstream clean surface water environment.	Mitigation: • Implement storm water diversion measures at the shaft area to prevent ingress of surface runoff into the shaft during heavy rainfall events. • Areas where surface water retention takes place should be minimised to encourage free drainage of surface water towards the downstream environment. • Obstructions within current storm water trenches should be removed to promote free drainage of the Shaft #6 area.	Operational phase	Environmental manager.	1	1	L
ENVIRONMENTAL COMPONENT: Surface water										
ACTIVITY: Wash bay operation										
PROJECT PHASE APPLICABILITY: Construction [ ]; Operation [X]; Closure [ ]										
Impact description: The wash bay will be used as a designated area to clean equipment and currently not fitted with an oil separator. This facility is not connected to a dirty water system and therefore wash water is pumped out and discharged into the adjacent veldt during operations. Surface water quality: Should any wash water be discharged from the wash bay in its current status, discharge of hydrocarbon contaminated water will take place in the surrounding clean water environment. Extent: Affect limited to the site and immediate surroundings. Duration: During operational phase	5	3	H	To prevent discharge of hydrocarbon contaminated wash water into the clean water environment.	Mitigation: • Implement an oil separator system at the wash bay to lower the hydrocarbon content of wash water to be discharged into the clean environment. • Regular inspections should be conducted to ensure that the oil separator is in working order at all times. • Conduct regular monitoring of discharge of wash water to comply with the DWS general limit standards for discharge.	Operational phase	Environmental manager.	4	2	M

Environmental impact, extent, duration, significance and degree to which impact will cause irreplaceable loss	Risk rating (before mitigation)			Environmental objective	Degree to which impact can be reversed and the supporting mitigatory action plan	Timeframe	Responsibility	Risk rating (after mitigation)		
	Probability	Magnitude	Severity					Probability	Magnitude	Severity
Degree to which impact may cause irreplaceable loss: Hydrocarbon contaminated discharge may pollute the receptor to such a degree that bio-physical and social functions might be considerably altered.										

4.8.1 Shaft #6 – Flood peaks and volumes

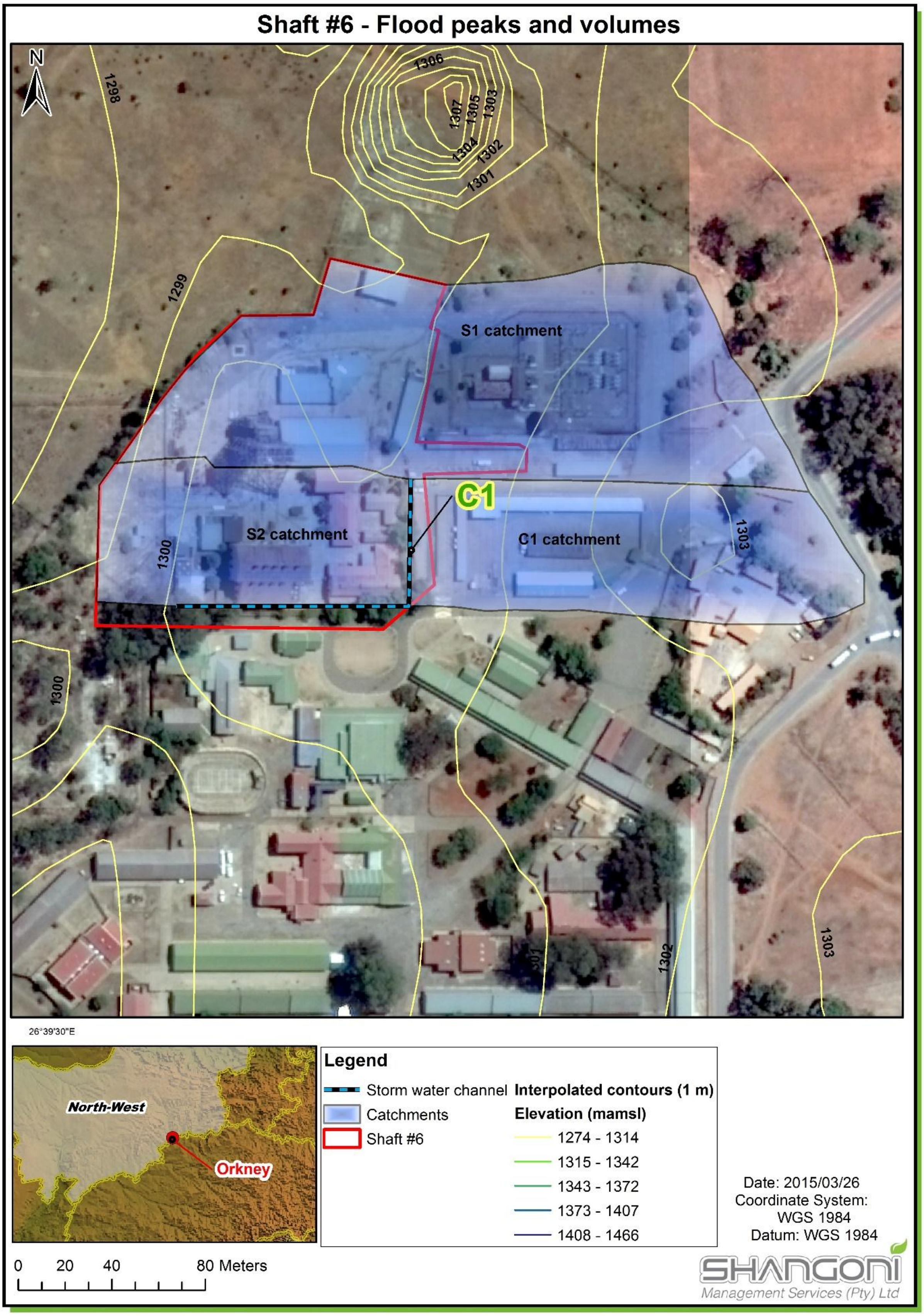


Figure 38: Flood peaks and volumes

Table 28: Catchment characteristics

	S1	S2	C1
MAP	548.3	548.3	548.3
Catchment size (km^2)	0.02	0.007	0.01
Length of longest watercourse (km)	0.256	0.141	0.198
Height difference (m)	3	2	3

Table 29: Peak runoff for different return periods

Peak runoff (m^3/s)	Return period (year)											
	1:5			1:10			1:50			1:100		
	RM	ARM	SDF	RM	ARM	SDF	RM	ARM	SDF	RM	ARM	SDF
S1	0.457	0.711	0.244	0.578	0.929	0.405	0.928	1.438	0.861	1.142	1.657	1.091
S2	0.198	0.315	0.094	0.251	0.413	0.157	0.403	0.638	0.334	0.496	0.735	0.423
C1	0.212	0.334	0.132	0.268	0.437	0.220	0.430	0.676	0.467	0.529	0.779	0.591

C1 – Lined storm water diversion channel: This channel conveys clean surface water runoff around the Shaft #6 workshop area along the southern border towards the western border where discharge takes place into the adjacent veldt area. Although the area is defined by rooftops and impermeable paving and streets, the peak runoff volumes are low due to the flat topography of the area.

S1 – Northern part of the Shaft #6 area: Runoff is expected to generate as overland flow as well as from the roofs of buildings in the northern part of the Shaft #6 area. Overland flow will be distributed between existing channels situated between shaft buildings and will be conveyed towards the western side of the shaft area. These channels also function as preventative measures to channel runoff away from the shaft tower as required by GN 704, Regulation 7(c).

S2 – Workshop area: Runoff generated within the workshop area at Shaft #6 will be conveyed by the C1 channel along the southern border of the shaft area. Storm water runoff channels along the buildings within the workshop area will also convey runoff towards the western side of the shaft area. Therefore, the peak runoff flow for the S2 catchment may be distributed between the existing channels.

No surface water containment facilities are planned at the Shaft #6 area and therefore no runoff volumes were calculated.

4.9 CAPM operations – Shaft #7

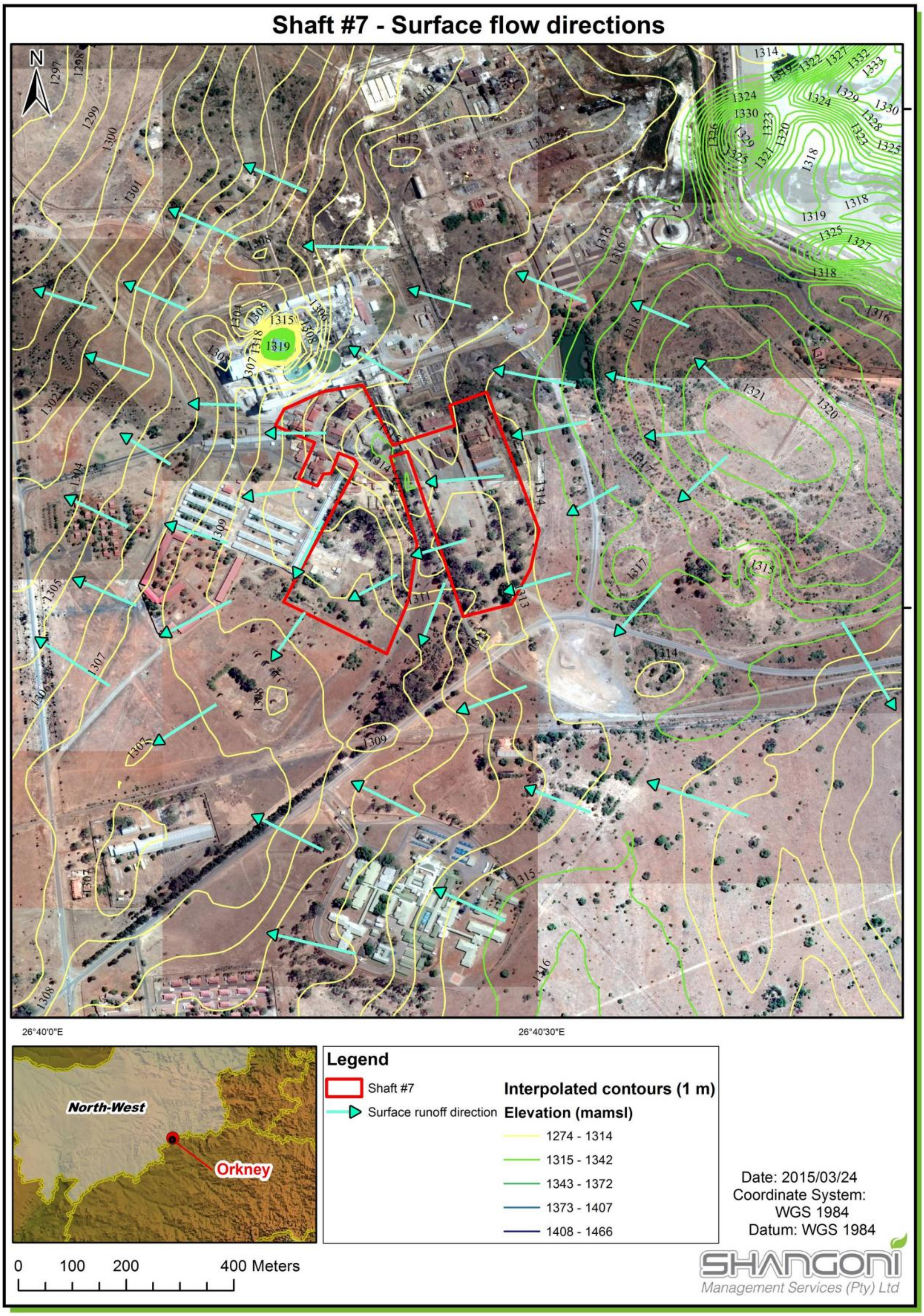


Figure 39: Shaft #7 - Surface flow directions

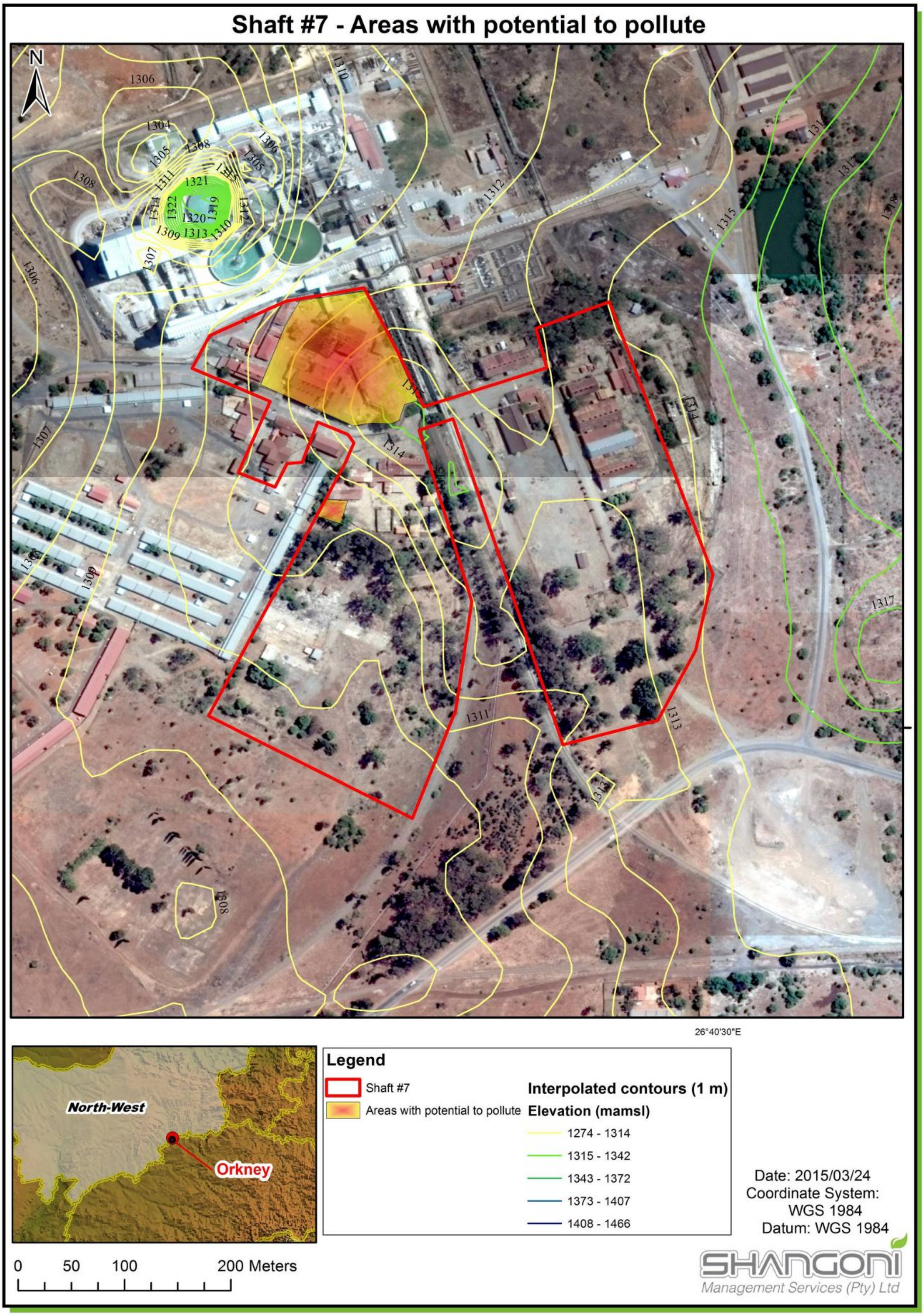


Figure 40: Shaft #7 – Areas with potential to pollute

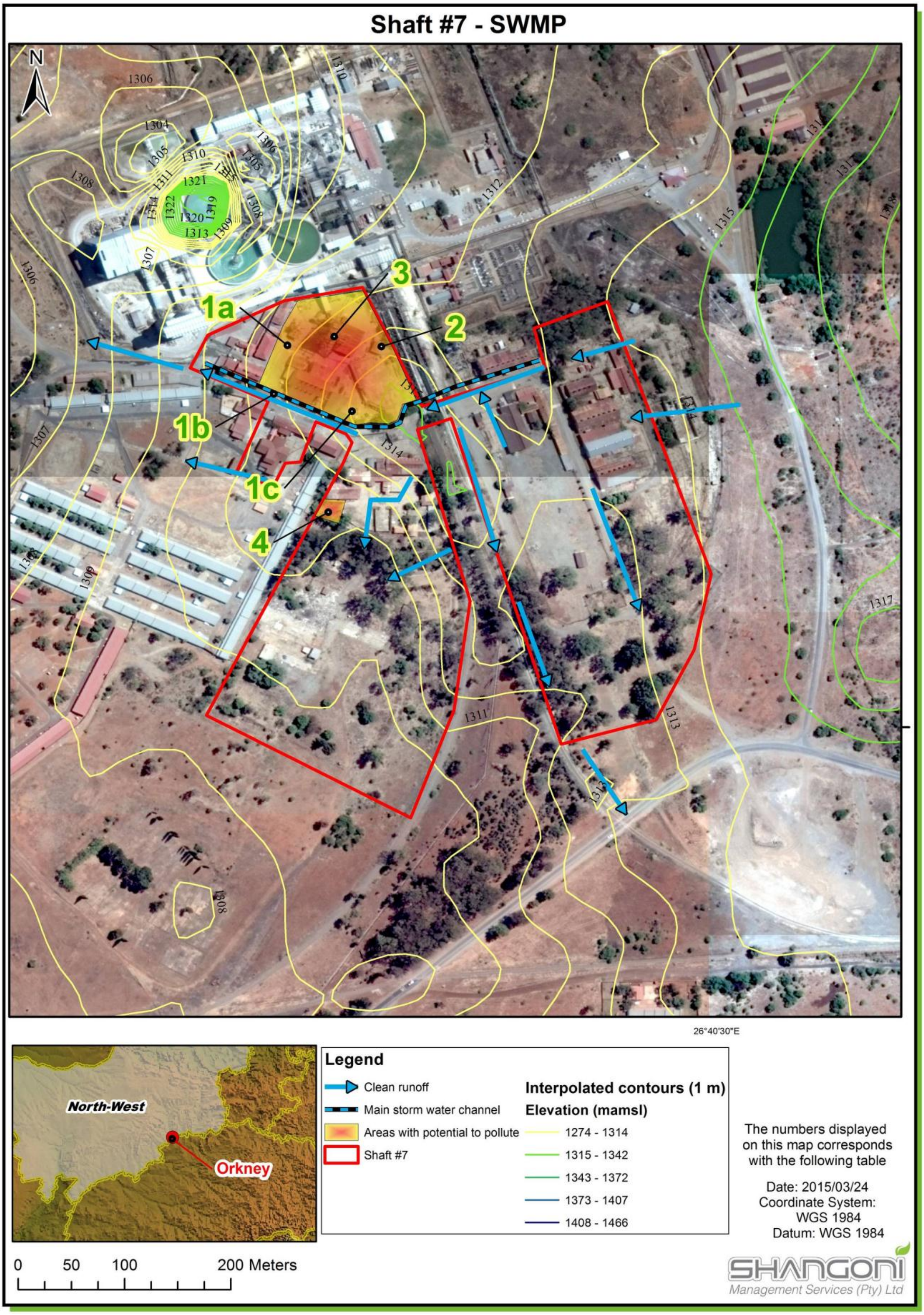


Figure 41: Shaft #7 - SWMP

Table 30: Shaft #7 - Storm water measures

<table>
<tr><th>Number and picture corresponding to Figure 41</th><th>Description and recommendations</th></tr>
<tr><td>


</td><td>
1 – The total Shaft #7 area is constructed on an impermeable concrete surface fitted with lined water channels conveying runoff towards the adjacent clean water environment.

A main clean runoff channel conveys runoff from the eastern side of the shaft area towards the western side. Several small channels are connected to the main channel with most of the runoff flowing towards the main channel via overland flow.

During the site assessment is was noted that oil drums were stored outside of a designated storage area. Several pieces of equipment containing grease are also located near the oil drums. This area poses risk of hydrocarbon contamination of clean surface water runoff from this area. There is a risk of hydrocarbon contaminated runoff entering the main clean storm water channel that will be conveyed outside of the shaft area into the environment.

Recommendation: It is proposed to improve house-keeping practises at Shaft #7 to minimise areas with potential to contaminate clean surface runoff. Any equipment containing hydrocarbons should be stored within designated areas, preferably bunded and roofed. This strategy aims to comply with GN 704, Schedule 7(a) and (f).
</td></tr>
</table>

  	2 – The washbay sump area will be used to clean equipment contaminated by radio-active material. A bund wall was being constructed to prevent any spillages from flowing out of the designated area. This strategy is a preventative measure in case of pump failure and sump overflow. Contaminated water within the washby sump will be contained and pumped to the adjacent plant as part of the process water system. Recommendation: Regular inspections should be conducted to ensure that pumping infrastructure is operational. Repair work should be done if necessary to maintain a sealed area to contain any spillages. This strategy aims to comply with GN 704, Schedule 7(a) and (f).
 	3 – A dirty water containment facility has been constructed under the conveyor system. It was indicated by mine personnel that the ore material hoisted up from the shaft is damp in most cases. The dirty water facility underneath the conveyor belt contains water leaching from the ore material and is pumped to the plant as part of the process water system. Recommendation: Regular inspections and maintenance should be conducted to maintain the dirty water facility's capacity as well as the pump infrastructure. This strategy aims to comply with GN 704, Schedule 7(a) and (f).

4 	4 – The radiation deterioration area is currently used to store equipment contaminated by radio-active material. This area is identified as a dirty area in term of storm water management. Recommendation: Any runoff generated from this area should be contained in a dirty water system. Clean runoff should be diverted away from this area.

5.1.2 Shaft #7

CAPM intends to reinstate operations at Shaft #7. The Shaft #7 area is drained by a main clean storm water runoff channel from the eastern side to the western side where discharge into the adjacent veldt area takes place. Several clean storm water channels contribute runoff into the main channel. The channel also receives runoff via overland flow generated on the impermeable surface on which the Shaft #7 area is built.

Table 31: Risks associated with Shaft #7

Environmental impact, extent, duration, significance and degree to which impact will cause irreplaceable loss	**Risk rating (before mitigation)**			**Environmental objective**	**Degree to which impact can be reversed and the supporting mitigatory action plan**	**Timeframe**	**Responsibility**	**Risk rating (after mitigation)**		
	Probability	**Magnitude**	**Severity**					**Probability**	**Magnitude**	**Severity**
ENVIRONMENTAL COMPONENT: Surface water										
ACTIVITY: Chemical and hydrocarbon management										
PROJECT PHASE APPLICABILITY Construction: Operation: X Closure:										
Impact description: The main storm water channel is located next to a hydrocarbon and chemical storage area. Any chemical and hydrocarbon containers as well as equipment (operated using grease) stored outside of a designated area creates a risk of surface water pollution. Contaminated runoff as a result of poor housekeeping practises will enter the clean storm water diversion trench towards the adjacent veldt area. Surface water quality: The quality of surface runoff generated within the Shaft #7 area may be deteriorated as a result of contact with hydrocarbons such as oil and grease. Extent: Affect limited to the site and immediate surroundings. Duration: During operational phase. Degree to which impact may cause irreplaceable loss: Low significance as a result of receptor of low sensitivity due to disturbed state.	3	2	M	To prevent a decrease in surface water quality generated and discharged from the Shaft #7 area.	Mitigation: • Implement good housekeeping practises to limit the generation of dirty areas with the Shaft #7 area.	Operational phase	Environmental manager.	1	2	L
ENVIRONMENTAL COMPONENT: Surface water										
ACTIVITY: Wash bay operation										
PROJECT PHASE APPLICABILITY Construction: Operation: X Closure:										
Impact description: The wash bay will be used as a designated area to clean radio-active contaminated equipment. This facility is connected to a dirty water system and wash water is pumped to the adjacent plant and used as part of the process water system. Should an incident occur, radio-active wash water may be discharged towards the clean storm water channel.	3	3	M	To prevent discharge of radio-active contaminated wash water into the clean water environment.	Mitigation: • Construct containment walls around the wash bay as a measure to contain possible overflow from the sump. • Implement regular inspections and a maintenance schedule to ensure that pumping infrastructure is in working order during operations.	Operational phase	Environmental manager.	1	3	L

Environmental impact, extent, duration, significance and degree to which impact will cause irreplaceable loss	**Risk rating (before mitigation)**			**Environmental objective**	**Degree to which impact can be reversed and the supporting mitigatory action plan**	**Timeframe**	**Responsibility**	**Risk rating (after mitigation)**		
	Probability	**Magnitude**	**Severity**					**Probability**	**Magnitude**	**Severity**
Surface water quality: Discharge of contaminated water from the wash bay at Shaft #7 may lead to a significant deterioration of surface water quality towards the downstream clean water environment. Extent: Affect limited to the site and immediate surroundings. Duration: During operational phase. Degree to which impact may cause irreplaceable loss: Not applicable, due to low significance of receptor.										
ENVIRONMENTAL COMPONENT: Surface water										
ACTIVITY: Sump operation underneath conveyor										
PROJECT PHASE APPLICABILITY	Construction									
	Operation	X								
	Closure									
Impact description: A sump has been constructed underneath the conveyor system next to Shaft #7. The purpose of this sump is to contain any seepage from the damp ore material hoisted from underground. This sump is fitted with pumping infrastructure towards the adjacent plant as part of the process water system. There is a risk that overflow into the main storm water channel might occur as a result of pump failure. Surface water quality: Discharge of contaminated water from the sump may result in deterioration of clean surface water runoff towards the adjacent clean water environment. Extent: Affect limited to the site and immediate surroundings. Duration: During operational phase. Degree to which impact may cause irreplaceable loss: Not applicable, due to low significance of receptor.	3	2	M	To prevent discharge of contaminated water into the clean water environment.	Mitigation: • Implement regular inspections and a maintenance schedule to ensure that pumping infrastructure is in working order during operations.	Operational phase	Environmental manager	2	2	L

4.9.1 Shaft #7– Flood peaks and volumes

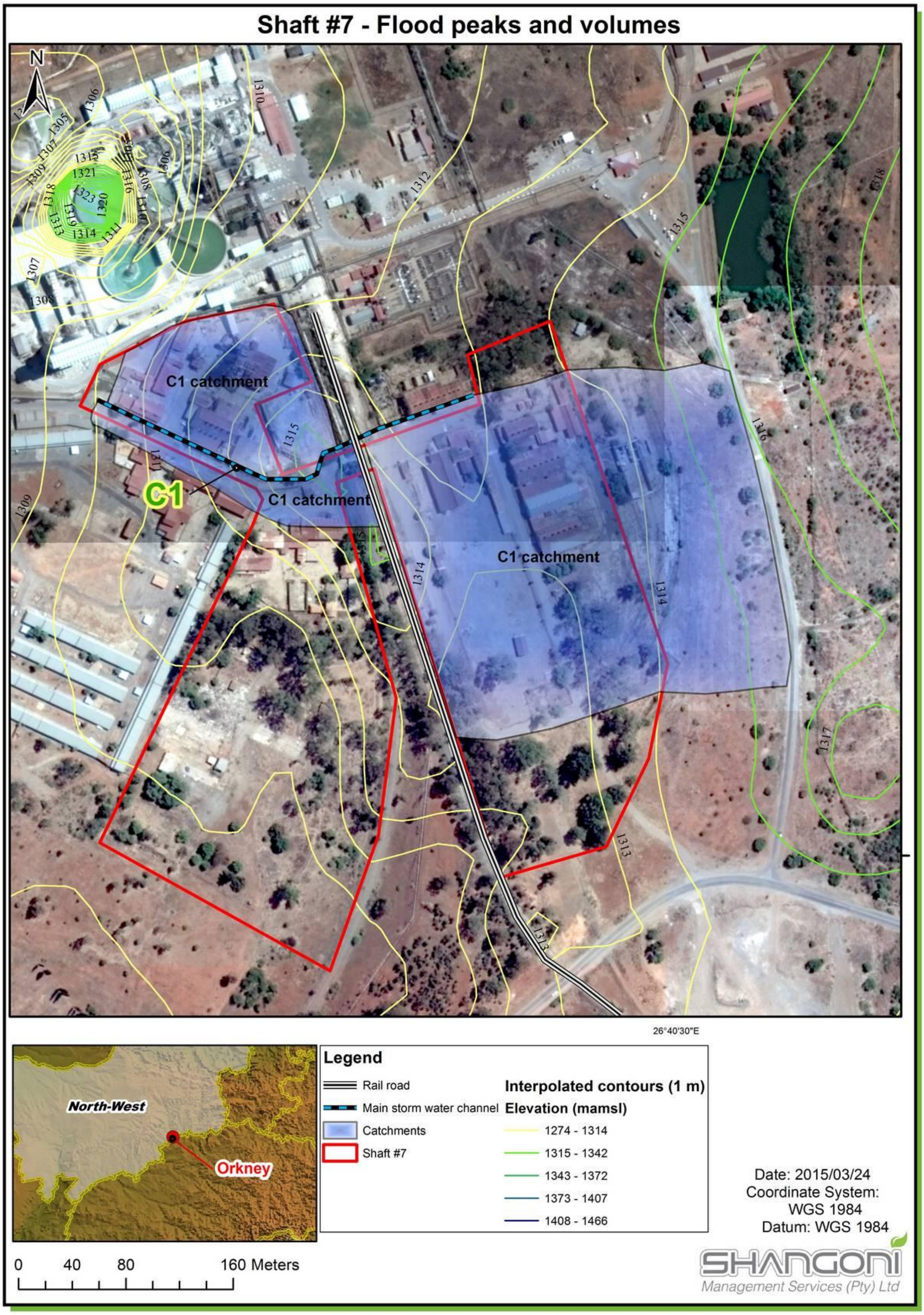


Figure 42: Flood peaks and volumes

Table 32: Catchment characteristics

	Decline
MAP	548.3
Catchment size (km^2)	0.088
Length of longest watercourse (km)	0.504
Height difference (m)	7

Table 33: Peak runoff for different return periods

Peak runoff (m^3/s)	**Return period (year)**											
	1:5			**1:10**			**1:50**			**1:100**		
	RM	**ARM**	**SDF**	**RM**	**ARM**	**SDF**	**RM**	**ARM**	**SDF**	**RM**	**ARM**	**SDF**
C1	1.695	2.557	0.882	2.149	3.353	1.468	3.464	5.208	3.120	4.272	6.014	3.951

C1 – Clean storm water runoff channel: This channel conveys runoff from the upper catchment (old offices and workshops) through a culvert (underneath rail road) past the shaft operations area and discharges into the open veldt area on the north western side of the Shaft #7 area. Three catchment areas have been delineated that will contribute surface runoff towards the C1 channel. No containment of surface water runoff will take place at the Shaft #7 area and therefore no runoff volumes were calculated.

4.10 General storm water management measures

- The capacity of all storm water conveyance structures and containment facilities should accommodate at least a 1:50 year flood event.
- All channels, trenches and sumps should be inspected and serviced regularly to ensure the design capacity and integrity are maintained. Storm water control measures should be kept clear of obstructions by objects as well as siltation especially where the velocity of the runoff is induced.
- Affected runoff water should be controlled and not contaminate the natural clean habitat within the mining vicinity.
- No affected water from the CAPM operations is allowed to spill into the clean water environment. This should be ensured through operational control measures.
- Erosion prevention measures (e.g. grass, cement or rock) should be in place at all concentration points. These areas include roads, trenches, channel outlets and other infrastructure that may increase surface runoff.

Optimisation of water usage

General water saving measures should be in place to minimise the water requirements at the CAPM operations. Awareness strategies should be implemented such as pamphlets describing techniques to minimise water usage. Topics that should be covered include water consumption, waste management, storm water management, incident reporting procedure etc.

The following serves as a guidance to decrease water requirements:

- Optimal use of affected water;
- Regular maintenance and inspection of equipment to prevent leaks;
- Regular site inspections by supervisors to prevent wastage of water;
- Environmental training and awareness of staff; and
- Monitoring of resource consumption at the CAPM operations.

5. Conclusion

The storm water management plan developed for the CAPM operations is conceptual in its design, but should be used as an action strategy by the operation. Principles and storm water measures have been discussed to separate clean and affected water. Infrastructure design recommendations and maintenance requirements should be integrated into the existing operational management.

It is the responsibility of the CAPM operations to ensure that storm water control measures are designed and constructed to be capable of withstanding the maximum design flood (1:50 year flood event). It should be taken into consideration that the potential for erosion increases where the surface runoff is concentrated and should be addressed within the designs. Designs should incorporate gradual drainage to avoid siltation of storm water infrastructure.

The following main recommendations in terms of storm water management were identified for the CAPM operations:

- Clean water conveyance networks at the shaft locations should be serviced on a regular basis, especially Shaft #6, #7, #1 and #4, during the operational phase to maintain the integrity of the diversion channels. It is essential to monitor the outflows from the shaft areas to determine the effectiveness of the conveyance channels to prevent ponding of clean runoff within shaft areas.
- Good housekeeping practises should be implemented to prevent and minimise dirty areas within the intended operational shafts. It includes the storage and handling of chemicals and hydrocarbon containers. This strategy aims to avoid the need to construct dirty water containment facilities to comply with GN 704, Regulation 7(a).
- A maintenance schedule should be implemented during the operational phase of the intended operational shafts to ensure the integrity of sumps and cooling ponds (dirty water containment facilities). Pumping infrastructure should be in working order at all times to prevent any overflow of affected water into the shaft and surrounding area – GN 704, Regulation 7(a).
- Investigations should be conducted to divert surface runoff away and prevent surface runoff from flowing into the shafts, especially the shafts where operations are not to be continued – GN 704, Regulation 7(c). This strategy aims to reduce impact on the catchment yield.
- A maintenance schedule should be implemented to ensure that storm water conveyance channels are free draining, with no impeding structures. Areas where ponding of storm water takes place should be minimised – GN 704, Regulation 7(g).
- Ensure that rehabilitated areas, such as the Shaft #3 area are free draining in terms of storm water management. No materials with leaching potential should be left at the site. Vegetation growth should be encouraged on exposed areas to limit erosion.
- It is recommended, as an additional measure, to construct a berm between the sewage sump and the clean runoff diversion channel at the Shaft #5 area. This strategy aims to prevent sewage from flowing into the clean runoff diversion trench during possible overflow – GN 704, Regulation 7(a).

- Of concern is the absence of an oil separator at the wash bay at the Shaft #6 area to prevent hydrocarbon contaminated wash water discharge into the surrounding clean water environment as soon as operations commence. It is recommended to install an oil separator and conduct regular inspections to ensure that the oil separator is in working order at all times. Monitoring of discharge water should take place and verified against the discharge limits as required by the Department of Water Affairs and Sanitation. If wash water is found to be inadequate for discharge, it is recommended to implement a containment and evaporation facility. This strategy aims to comply with GN 704, Schedule 7(a).

Storm water management measures discussed in this report should be prioritised to address ineffective infrastructure and prevent damage or failures during flood events. After implementation of the storm water management plan, regular inspections and maintenance should be conducted to ensure that all infrastructures are functioning according to design capabilities. Effective management of surface water runoff and clean/affected water separation at the CAPM operations will contribute to conservation of downstream clean water resources.