

Euromax Resources

Ilovica Gold-Copper Project

**Feasibility Study
Technical Report**

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Glossary

Units of Measure	
Ampere	A
annum (year)	a
atmosphere	atm
bank cubic metres	BCM
bank cubic metres per hour per cubic metre	bcm/h/m ³
barometric pressure	bar
billion	B
centimetre	cm
cubic metre	m ³
cubic metres per hour	m ³ /h
cubic metres per hour per cubic metre of bucket capacity	m ³ /h/m ³ _{bc}
cubic metres per tonne	m ³ /t
cubic metres per annum	m ³ /a
days per annum	d/a
degrees Centigrade	°C
degrees Fahrenheit	°F
dry metric tonne	dmt
gram	g
gram per tonne	g/t
hectare	ha
horsepower	hp
hours	h
hours per day	h/d
hours per week	h/wk
hours per year	h/a
joule	J
kilo (thousand)	k
kilocalorie	kcal
kilogram	kg
kilojoule	kJ
kilojoule per square metre	kJ/m ²
kilolitre	kL
kilometre	km
kilometres/hour	km/h
kilo-Newton	kN
kilo ounces	koz
kilopascal	kPa
kilopascal absolute	kPa(a)
kilopascal gauge	kPa(g)
kilo pounds	klb
kilotonne	kt

Units of Measure	
kilotonne per annum	kt/a
kilovolt	kV
kilovolt-amperes	kVA
kilowatt	kW
kilowatt hour	kWh
kilowatt hour per tonne (metric tonne)	kWh/t
litre	L
litre per day	L/d
litre per day per hectare	L/d/ha
litre per minute	L/min
litre per second	L/s
loose cubic metres	LCM
Macedonian Denar	MKD
mega cubes	Mm ³
mega cube per annum	Mm ³ /a
megajoules per square metre	MJ/m ²
megapascal	MPa
megawatt	MW
megawatt hour	MWh
metre	m
metres per second	m/s
metres per year	m/y
micron	µm
microsiemens (electrical)	µS
milliampere	mA
millilitre	mL
millimetre	mm
million	M
million ounces	Moz
million pounds	Mlb
million tonnes	Mt
millions of tonnes per annum	Mt/a
minute (time)	min
nano Tesla	nT
Newton metre	Nm
ounces (troy)	oz
parts per billion	ppb
parts per million	ppm
pascal	Pa
percent	%
percentage solids	% ss
pounds	lb
revolutions per minute	rpm
second	s

Units of Measure	
square metres	m ²
square metres per year	m ² /y
square kilometre	km ²
tonne (metric)	t
tonnes per annum	t/a
tonnes per cubic metre	t/m ³
tonnes per day	t/d
tonnes per hour	t/h
United States Dollar	US\$
volt	V
volume by volume	v/v
watt	W
week	wk
weeks per annum	wk/a
weight by volume	w/v
weight by weight	w/w
wet metric tonne	wmt
year	yr

Abbreviations and Acronyms	
80% feed passing size	F ₈₀
100% feed passing size	F ₁₀₀
80% product passing size	P ₈₀
100% product passing size	P ₁₀₀
80% mass passing size	T ₈₀
above mean sea level	AMSL
abrasion index	A _i
acid rock drainage	ARD
acid-base accounting	ABA
all injury frequency rate	AIFR
ALS Environmental Ltd in the UK	ALS
ammonium nitrate fuel oil	ANFO
atomic absorption spectroscopy	AAS
average	ave
best available techniques	BAT
bill of materials	BOM
bill of quantities	BOQ
Biological Monitoring Working Party	BMWP
Bond ball mill work index	BW _i
Bond rod mill work index	RW _i
Brazilian strength test	BST
business management systems	BMS
Canadian Institute of Mining, Metallurgy and Petroleum	CIM
capital cost estimate	Capex
carbon-in-leach	CIL
client satisfaction survey	CSS
closed circuit television	CCTV
compact fluorescent lamps	CFL
construction work package	CWP
control and instrumentation	C&I
critical path method	CPM
Cyril and Methodius University	CMU
design base earthquake	DBE
digital elevation model	DEM
digital terrain model	DTM
direct shear test	DST
discounted cash flow	DCF
down the hole	DTH
drop-weight index	DW _i
electrical load list	ELL
electrical overhead traveling	EOT
engineering, procurement and construction management	EPCM
engineering work package	EWP
environmental design criteria	EDC

Abbreviations and Acronyms	
environmental, health and safety	EHS
environmental impact assessment	EIA
environmental and social impact assessment	ESIA
environmental and social management system	ESMS
environmental impact statement	EIS
equivalent	Eq
et cetera	etc.
European Bank for Reconstruction and Development	EBRD
European Environment Agency	EEA
European Nature Information System	EUNIS
Eurotest Control AD	Eurotest
evaporation	Eo
evapotranspiration	ETo
evaporation (pan)	Epan
exempli gratia (for example)	e.g.
factor of safety	FOS
feasibility study	FS
Fédération Internationale Des Ingénieurs-Conseils	FIDIC
four wheel drive	4WD
front end engineering design	FEED
front end loader	FEL
general and administration	G&A
geological strength index	GSI
Geoscience Australia	GA
global positioning system	GPS
Golder Associates (UK) Ltd	Golder
gravity recoverable gold	GRG
greater than	>
hazard and operability study	HAZOP
hazards of construction	HAZCON
health, safety, security and environment	HSSE
heating ventilation and air conditioning	HVAC
high density polyethylene	HDPE
high grade	HG
high pressure sodium	HPS
high	H
highway addressable remote transducer	HART
hydrogen ion exponent	pH
hydrologic modeling system	HEC-HMS
id est (that is)	i.e.
induced polarisation	IP
inductively coupled plasma	ICP
inductively coupled plasma optical emission spectroscopy (ICP-OES)	ICP-OES
information technology	IT

Abbreviations and Acronyms	
intensity-duration-frequency	IDF
Internal rate of return	IRR
International Commission on Large Dams	ICOLD
International Electrotechnical Commission	IEC
International Finance Corporation	IFC
International Organisation for Standardisation	ISO
International Union for Conservation of Nature	IUCN
laboratory information management system	LIMS
less than	<
life of mine	LOM
light duty vehicle	LDV
local area network	LAN
local study area	LSA
locked cycle test	LCT
logarithmic	log
lost time incident frequency rate	LTIFR
low grade	LG
lower failure limit	LFL
Macedonian Electricity Transmission System Operator	MEPSO
main mining project	MMP
manufacturing information system	MIS
manufacturing execution system	MES
master composite	MC
maximum	max
maximum design earthquake	MDE
mechanical equipment list	MEL
median particle size	D ₅₀
medium voltage	MV
mesh of grind	MOG
metal accounting system	MAS
methyl isobutyl carbinol	MIBC
minimum	min
Ministry of Environment and Physical Planning	MOEPP
motor control centre	MCC
National Fire Protection Association	NFPA
natural period	T _s
National Instrument 43-101	NI 43-101
Natural Resources Conservation Service	NRCS
net present value	NPV
normal	N
not applicable	N/A
number/numbers	No./Nos.
operating base earthquake	OBE
operating cost estimate	Opex

Abbreviations and Acronyms	
peak ground acceleration	PGA
phase II	PII
phase II residual	PIIR
phase III	PIII
Phelps Dodge Exploration Corporation	PDX
pipng and instrumentation diagram	P&ID
point load test	PLT
polyvinyl chloride	PVC
portable document format	PDF
potassium amyl xanthate	PAX
potential acid generation	PAG
power factor correction	PFC
prefeasibility study	PFS
preliminary and general	P&G
preliminary economic assessment	PEA
prime butterfly area	PBA
private automatic branch exchange	PABX
probable maximum flood	PMF
probable maximum precipitation	PMP
procedures, instructions and forms	PIF
process control system	PCS
process flow diagram	PFD
program logic controller	PLC
project labour agreement	PLA
project management plan	PMP
Public Utility Enterprise	PUE
qualified persons	QP
quality assurance/quality control	QA/QC
request for information	RFI
request for quotation	RFQ
revenue factor	RF
reverse circulation (drilling)	RC
river diversion dam	RDD
rock mass rating	RMR
rock quality designation	RQD
run of mine (ore)	ROM
SAG mill comminution	SMC
Schlumberger Water Services	SWS
seismic source zone	SSZ
semi-autogenous grinding	SAG
semi-autogenous mill/ball mill	SAB
semi-autogenous mill/ball mill/pebble crusher	SABC
site acceptance testing	SAT
site security access control	SSAC

Abbreviations and Acronyms	
site variation request	SVR
South African National Standard	SANS
specific gravity (density)	SG
spectral acceleration	Sa
standard reference materials	SRM
strategic project delivery objectives	SPDO
structural, mechanical, piping and platework	SMPP
Strumichko Pole Water Management Company	SPWMC
supervisory control and data acquisition	SCADA
tailings management facility	TMF
terrestrial trunked mobile radio system	TETRA
three dimensional	3D
to be confirmed	TBC
Toronto Stock Exchange	TSX
total dissolved solids	TDS
transitional	T
two dimensional	2D
unconfined compressive strength	UCS
uninterruptible power supply	UPS
United States Bureau of Reclamation	USBR
United States Geological Survey	USGS
upper failure limit	UFL
value added tax	VAT
variable speed drive	VSD
voice over internet protocol	VOIP
water treatment works	WTW
wide area network	WAN
work breakdown structure	WBS
work index	Wi
World Meteorological Organisation	WMO
X-ray diffraction	XRD
X-ray fluorescence	XRF

1. SUMMARY

This technical report comprises a feasibility study (FS) concerning the Ilovica copper-gold deposit which lies within the Ilovica property in Eastern Macedonia owned by Euromax Resources.

The FS was prepared for Euromax Resources, a public company incorporated in British Columbia, Canada that is listed on the TSX Venture Exchange.

This report has been prepared in accordance with National Instrument 43-101 (NI 43-101) and Form 43-101F1.

The FS supports the economic robustness of the Project previously indicated by the prefeasibility study (Pre-Feasibility Study Technical Report for the Ilovitza Gold-Copper Project in Southeast Macedonia, effective date of December 19, 2014) (PFS) and, through the optimisation of the processing flow sheet and a more precise level of costing, demonstrates significant reductions in both capital and operating costs, and a consequential increase in the IRR.

An economic analysis of the Project using discounted cash flow was prepared on a pre-tax and a post-tax basis. For the 20-year mine life, processing 198 Mt total throughput, operating at 10 Mt/a the financial results are:

- Pre-tax NPV of €466.4 M (US\$513.0 M) and post-tax NPV of €400.1 M (US\$440.1 M) at 5% discounted rate
- Pre-tax IRR of 19.8% and post-tax IRR of 17.8%
- Initial Capex €431.2 M (US\$474.3 M) including contingency
- After tax payback period of 4.3 years
- World Gold Council defined Adjusted Operating Cash Costs of €181 /oz (US\$200 /oz) and All-In Costs of €338 /oz (US\$ 372 /oz)¹.

¹ Adjusted Operating Cash Costs and All-In Costs as defined by the World Gold Council, which assumes copper as a by-product and includes US\$1.8 M corporate G&A per annum.

1.1 PROPERTY DESCRIPTION LOCATION

1.1.1 Location

The Ilovica property is located in the southeast of Macedonia, approximately 15 km to the west of the border with Bulgaria, as shown in Figure 1.1. The centre of the mineralised zone is located at coordinates 7 654 000 E, 4 595 500 N Hermannskogel Projection. The project lies within the municipality of Bosilovo, approximately 20 km to the east of the town of Strumica and is situated on the western slopes of the Maleševske mountain range. The project area is part of Mount Ograzhden and ranges from 450 m above mean sea level (AMSL) to a maximum elevation of approximately 860 m AMSL. The overall site layout is presented in Figure 1.2.

Figure 1.1
Regional Location Map



Source: Nations Online Project

[illegible]

1.1.2 Mineral Tenure

1.1.2.1 Property Details

The two contiguous concession agreements, held in the name of Euromax Resources DOO Skopje (concessionaire), covering the locality of “Ilovica”, municipality Bosilovo and municipality Novo Selo in Macedonia, known as Ilovica 6 and Ilovica 11, are:

- Concession Agreement for exploitation of minerals – ores of copper and gold at the locality “Ilovica”, municipality Bosilovo, registered with the Ministry of Economy of the Republic of Macedonia (“Ministry”) under the archive number 24-4563/1 from 23/09/2014 and Euromax Resources DOO Skopje’s archive number 09-10/14 from 10/10/2014, as amended and supplemented with Annex to the Concession Agreement registered with the Ministry under the archive number 24-4170/1 from 22/06/2015 and Euromax Resources DOO Skopje’s archive number 0302-256/15 from 22/06/2015 (“Concession Agreement” or “Ilovica 6”);
- Concession Agreement for exploitation of minerals – ores of copper and gold at the locality “Ilovica”, municipality Bosilovo and municipality Novo Selo, registered with the Ministry under the archive number 24-40/2 from 13/01/2016 and Euromax Resources DOO Skopje’s archive number 0402-09/16 from 13/01/2016 (“New Concession Agreement” or “Ilovica 11”);

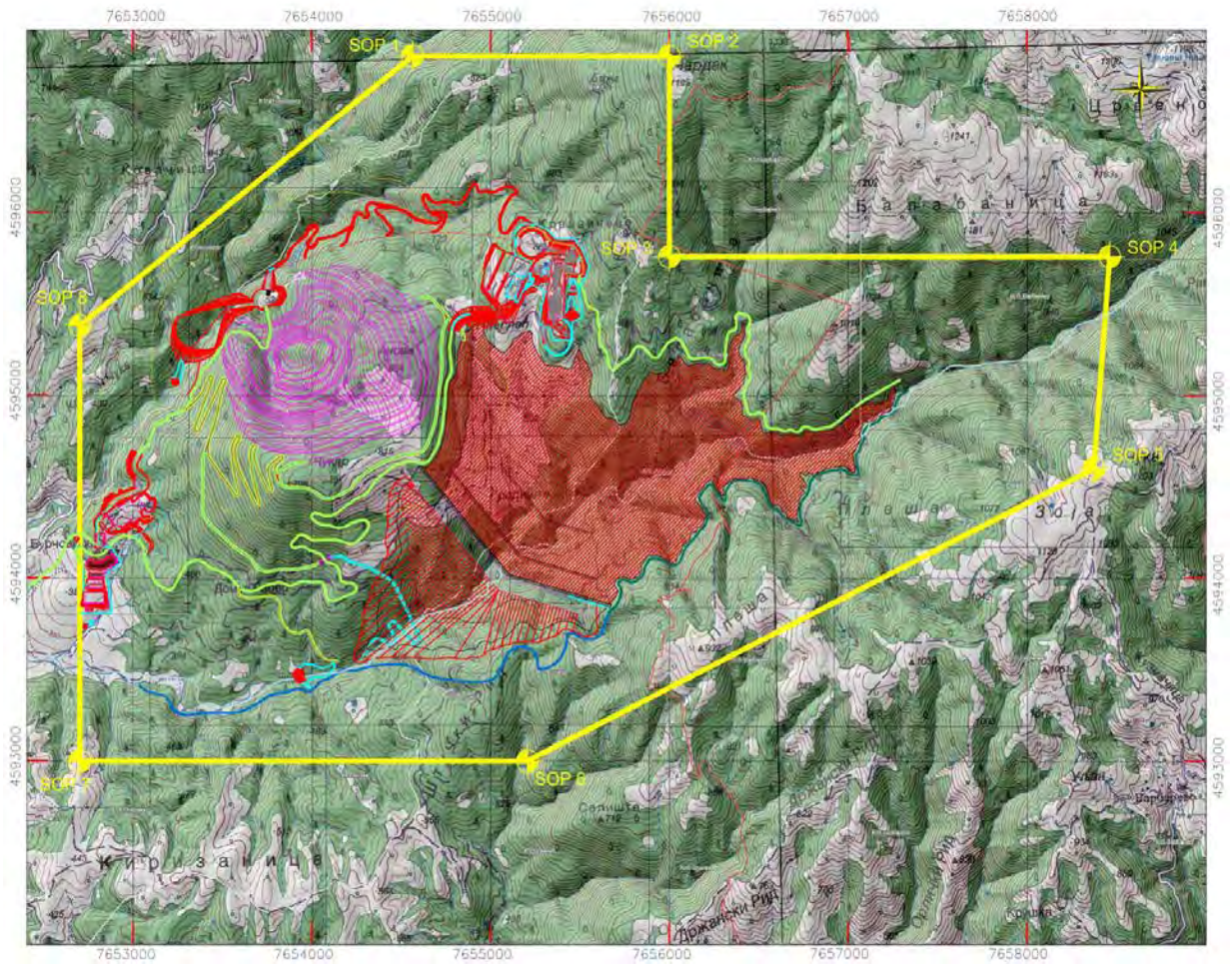
The Concession Agreement is valid until 24 July 2042. The New Concession Agreement is valid for 30 years as of the day of signing, i.e. until 13 January 2046.

The Concession Agreement and the New Concession Agreement have been certified as being in good standing by Mens Legis Law Firm based in Skopje.

The concession coordinates and concession area are presented in Table 1.1 and Figure 1.3, respectively.

Table 1.1 Concession Coordinates		
Point No.	Easting	Northing
SOP 1	4 596 857.126	7 654 562.840
SOP 2	4 596 857.126	7 656 000.000
SOP 3	4 595 759.035	7 656 000.000
SOP 4	4 595 759.035	7 658 463.118
SOP 5	4 594 599.830	7 658 374.874
SOP 6	4 593 000.000	7 655 205.397
SOP 7	4 593 000.000	7 652 701.593
SOP 8	4 595 383.880	7 652 701.593

Figure 1.3
Concession Area



1.1.2.2 Surface Rights

The area (land) that is granted for exploitation of minerals – ores of copper and gold, amounts to some 17.1 km² and it is located in the locality of Ilovica, municipality Bosilovo and municipality Novo Selo, Macedonia. The concessionaire does not establish ownership over the state owned land on which the exploitation shall be performed and the land remains state property. Therefore the right to develop the property is granted through a construction permit and urbanisation process.

1.1.2.3 Taxes and Royalties

The compensation for the concession for exploitation of minerals (concession fee) is consisted of:

- An annual fee for use of the location, i.e. the area granted with the exploitation concession, depending on the type of the mineral that is subject to the concession,
- Compensation for exploitation of the minerals – ores of copper and gold, that are subject to the concession.

The annual fee for use of the location or the surface amounts to 180 000 Denar/km² (2 926.83 €/km²) for surface and/or underground exploitation of metallic minerals.

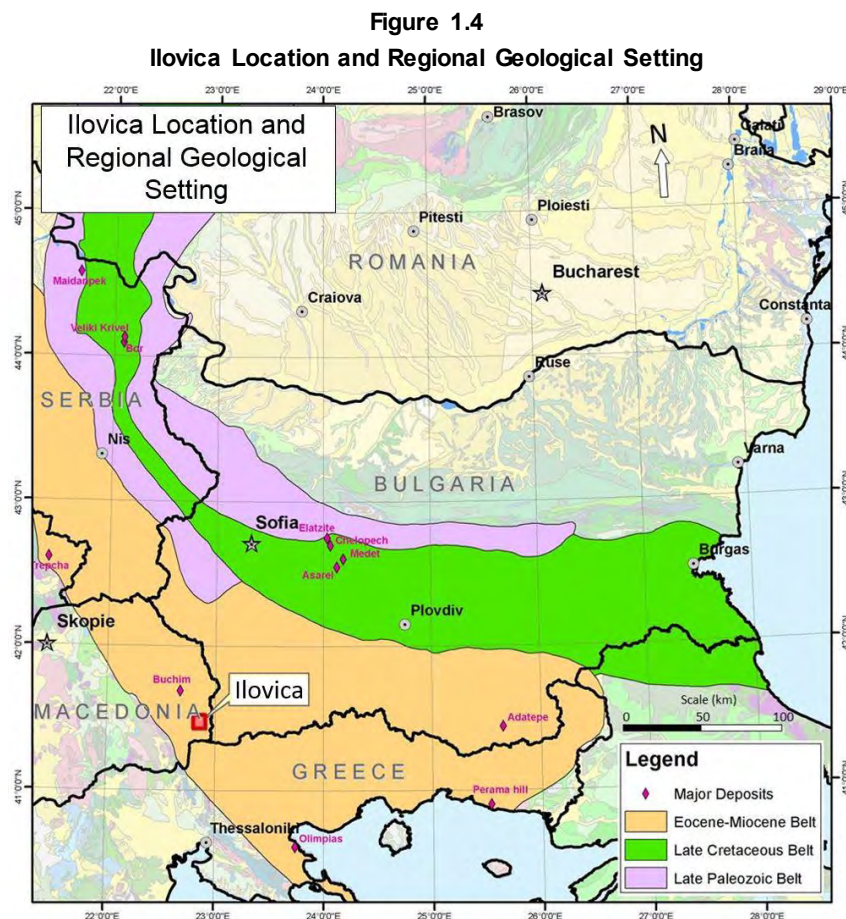
The compensation for exploitation of the minerals amounts to:

- 2% of the market value of the metal of copper per ton in each ton of copper concentrate produced.
- 2% of the market value of the gold produced in each ton of gold concentrate produced.

1.2 GEOLOGICAL SETTING AND MINERALISATION

1.2.1 Regional Geology

Ilovica is a porphyry copper-gold deposit, located in a northwest-southeast striking Cenozoic magmatic arc, that covers large areas of Central Romania, Serbia, Macedonia, Southern Bulgaria, Northern Greece and Eastern Turkey (Figure 1.4).

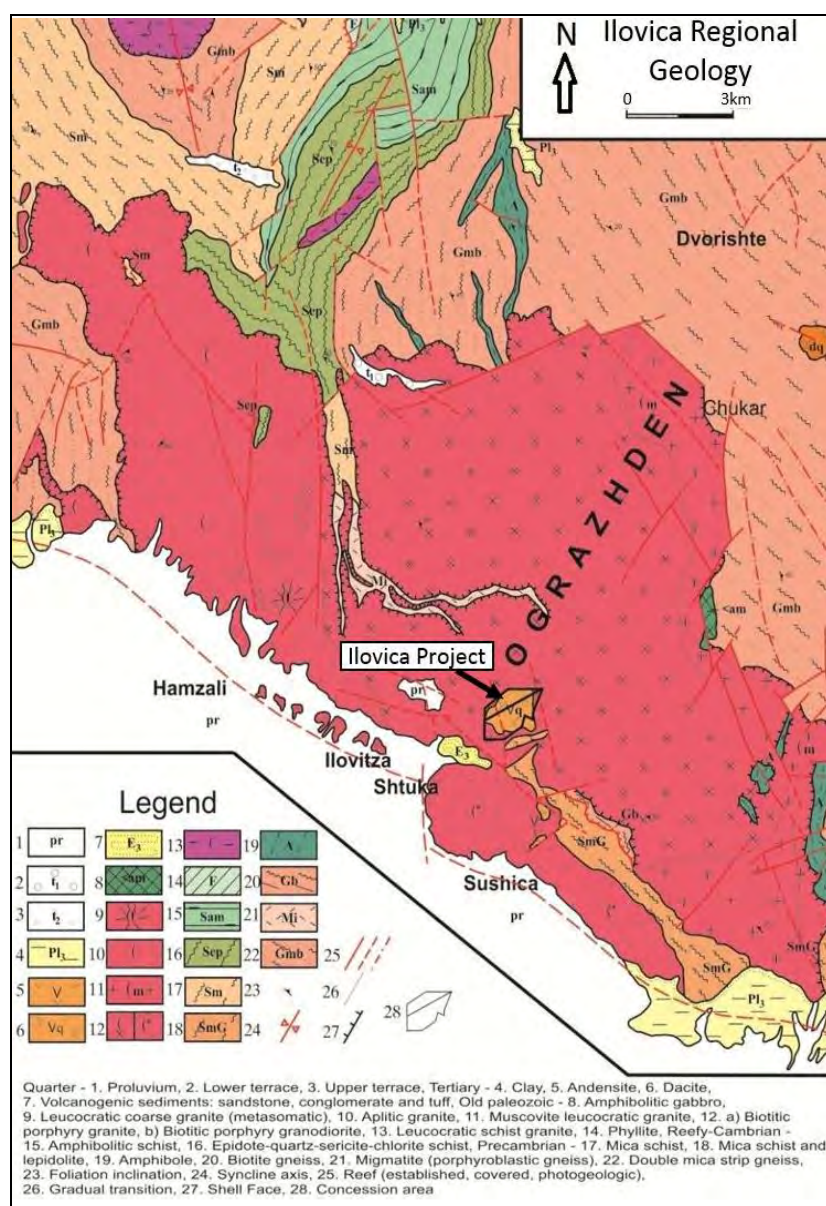


Source: Euromax Resources

1.2.2 Property Geology

The Ilovica porphyry system is approximately 1.5 km in diameter and is associated with a poorly exposed dacite-granodiorite plug, emplaced along the north-eastern border of the northwest-southeast elongate Strumica graben (Figure 1.5). The exact location of the deposit is controlled by major north-south cross cutting faults and minor northwest-southeast faulting, parallel to the faulted border of the graben.

Figure 1.5
Local Geological Setting



Source: Euromax Resources

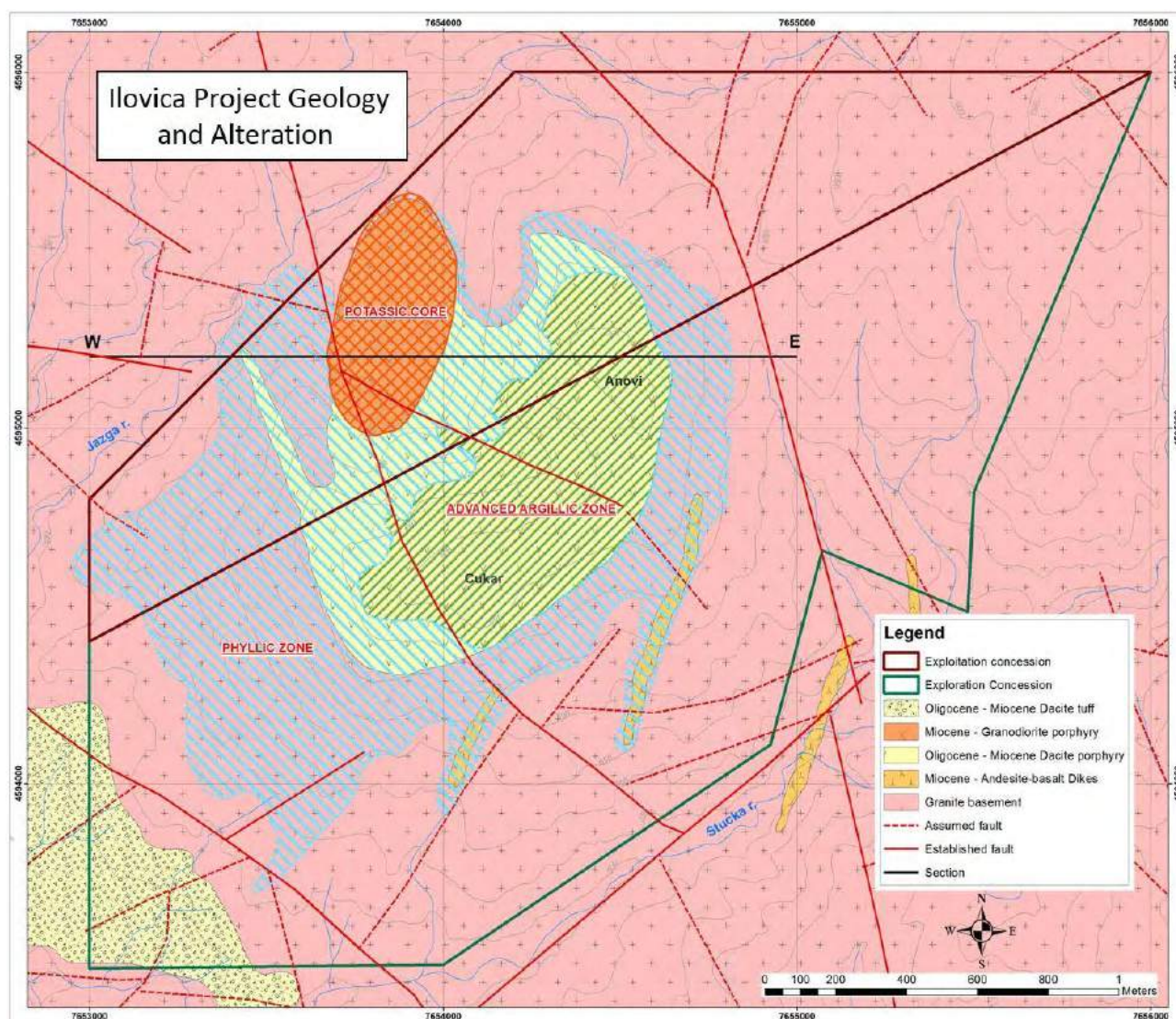
The Strumica graben is a typical post-collision extension structure, approximately 30 km by 10 km in size, and up to more than 1 km in depth. The graben has been filled with terrigenous clastic sediments and felsic volcanic rocks over the last 40 million years.

At surface, the Ilovica intrusive complex consists of a central dacitic breccia diatreme, approximately 1.3 km in diameter. The diatreme is intruded by at least one dacite and two granodiorite porphyry stocks that have generated several hydrothermal pulses, resulting in widespread, multi-phase veining within a mineralised stockwork.

1.2.3 Alteration

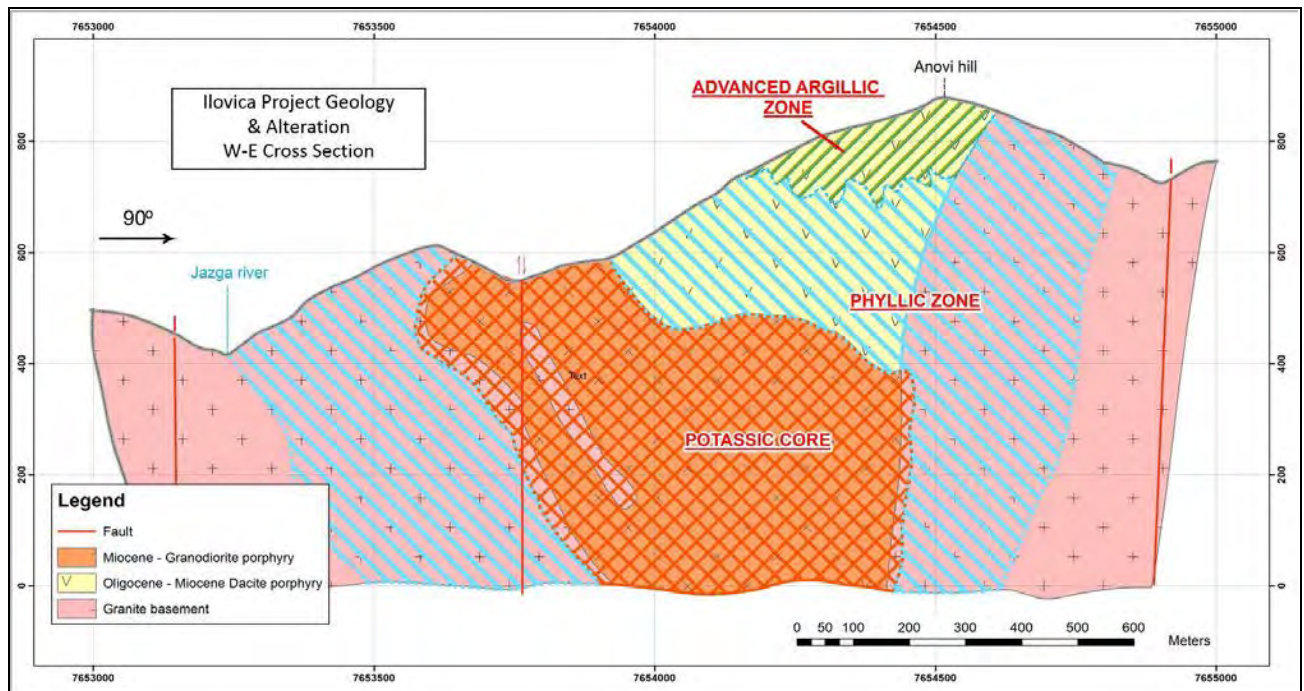
Alteration related to Tertiary magmatic activity at Ilovica is variably present over an area of approximately 8 km² (Figure 1.6 and Figure 1.7). Pervasive alteration is largely confined to a roughly 1.5 km² area in and adjacent to the main intrusive complex. Smaller areas of pervasive and structurally-controlled alteration extend somewhat asymmetrically to the south and east of the intrusive complex.

Figure 1.6
Property Geology and Alteration Plan



Source: Euromax Resources

Figure 1.7
Property Geology and Alteration (West-East Cross Section)



Source: Euromax Resources

1.2.4 Mineralisation

The main sulphide mineral at Ilovica is chalcopyrite, followed by pyrite, and secondary copper sulphides such as chalcocite, covellite, and bornite. Molybdenite, galena, and sphalerite are present in minor amounts, and occasional traces of sulphosalt minerals such as tetrahedrite-tennantite and tellurides of gold and silver are observed.

High temperature oxide mineralisation, such as magnetite, dominates at depth associated with pyrrhotite and chalcopyrrhotite in what is interpreted as the core of the system.

A variety of iron hydroxide group minerals are largely developed within the oxidation and cementation zones. Very occasionally gold nuggets are observed at the base of the oxidation zone.

Ilovica was known historically for minor lead-zinc (and minor copper) and gold occurrences (Cifliganec 1993), confined to distal and peripheral silica-iron oxide and silica-alunite bodies outside of the pervasively-altered intrusive complex. Deep oxidation and leaching (up to 150 m) of the topographically-elevated intrusive complex obscured its sulphide content.

The only visible evidence of copper mineralisation at surface includes: traces of enargite found in one ledge; very rare green copper oxides; and thin chalcocite coatings on sparse un-oxidised pyrite deposits exposed in a creek below the leached cap to the west of the porphyry. Since the start of detailed exploration on the Property, copper mineralisation has become more obvious on surface, on newly bulldozed drill-roads.

Sub-surface porphyry copper-gold mineralisation is expressed at surface by a limonitic, leached stockwork zone approximately 900 m by 600 m in size, containing 0.08 to 0.70 ppm Au, 50 to 450 ppm Cu and 10 to 128 ppm Mo.

At the highest elevations, central portions of this leached cap contain up to 50 to 100 quartz and limonite-quartz veins per metre, comprising up to 25% of the rock volume, within a sericitised and intensely (supergene) clay-altered matrix.

1.3 EXPLORATION

Geological mapping, rock chip sampling, soil geochemistry sampling, induced polarisation (IP)/resistivity and magnetic geophysical surveys were completed between 2004 and 2015.

Mapping was completed on 1:2 000 and 1:5 000 scales and comprised observations with respect to petrology, style of alteration, and mineralisation.

In total, three phases of soil sampling have been undertaken on the property, resulting in a total of 540 sampling points arranged on a 100 m by 100 m grid covering an area of circa 5 000 m².

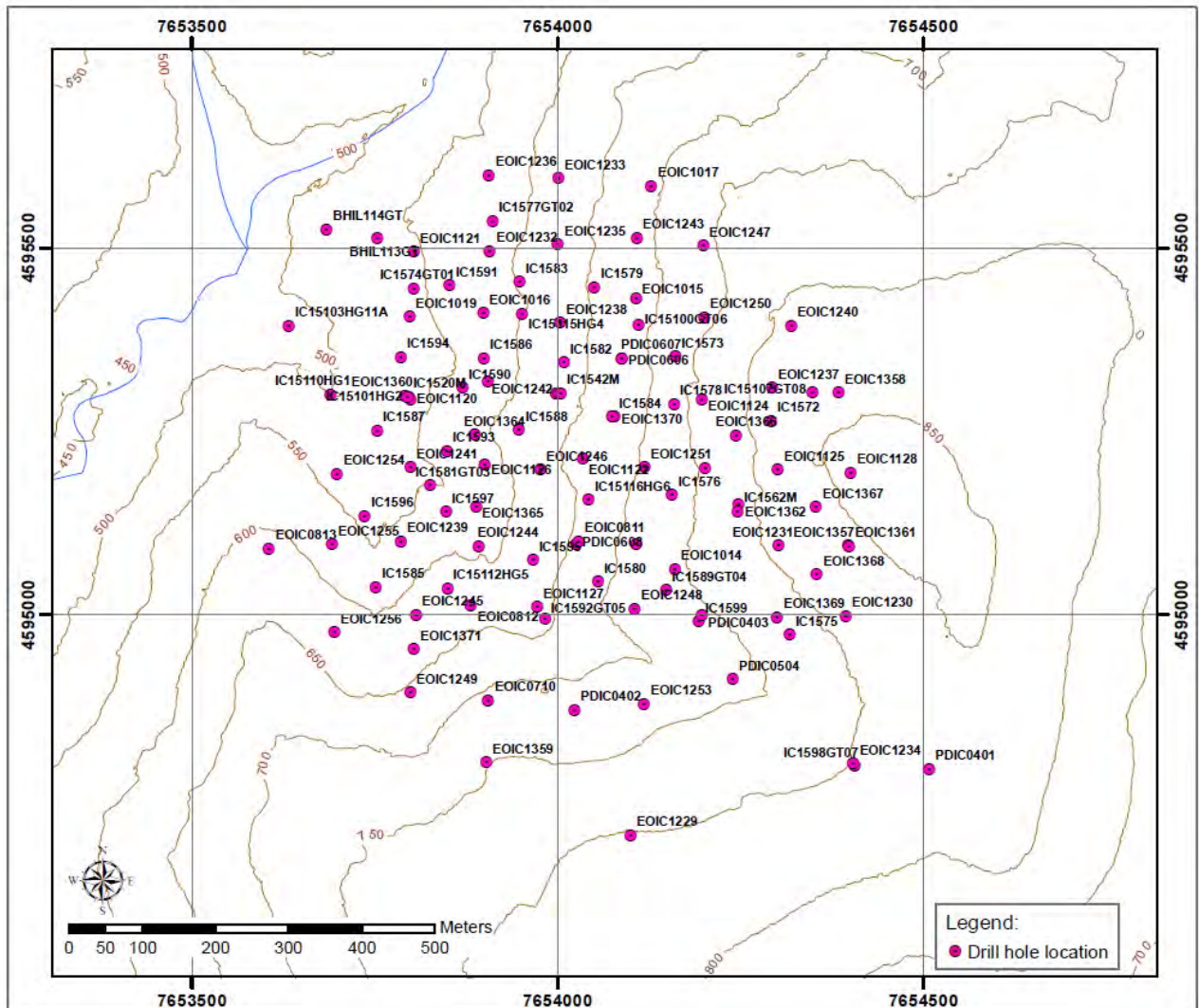
1.4 DRILLING

A total 130 holes have been drilled over 10 campaigns between 2004 and July 2015. Of the 130 holes, 20 were drilled for geotechnical investigation, 15 were drilled for hydrogeological investigation, and 95 were drilled for mineral resource determination. In total, 42 032 m have been drilled. Table 1.2 summarises the scope of the campaign completed on the Property.

Table 1.2 Summary of Drilling Campaigns				
Year	Drilling Technique	No. of Holes	Total Length Drilled (m)	Company
2004	Diamond Core	3	1 178	PDX
2005	Diamond Core	1	385	PDX
2006	Diamond Core	3	1 238	PDX
2007	Diamond Core	2	999	Euromax Resources
2008	Diamond Core	3	1 600	Euromax Resources
2010	Diamond Core	6	3 016	Euromax Resources
2011	Diamond Core	9	4 387	Euromax Resources
2012	Diamond Core	28	12 081	Euromax Resources
2013	Diamond Core	15	5 778	Euromax Resources
2014	No drilling this year	-	-	-
2015	Diamond Core	60	11 371	Euromax Resources
Total	Diamond Core	130	42 032	-

The drill holes are generally vertical or steeply dipping; with 95 of the drill holes vertical and the remainder between 55° and 75°. The drill locations are illustrated in Figure 1.8.

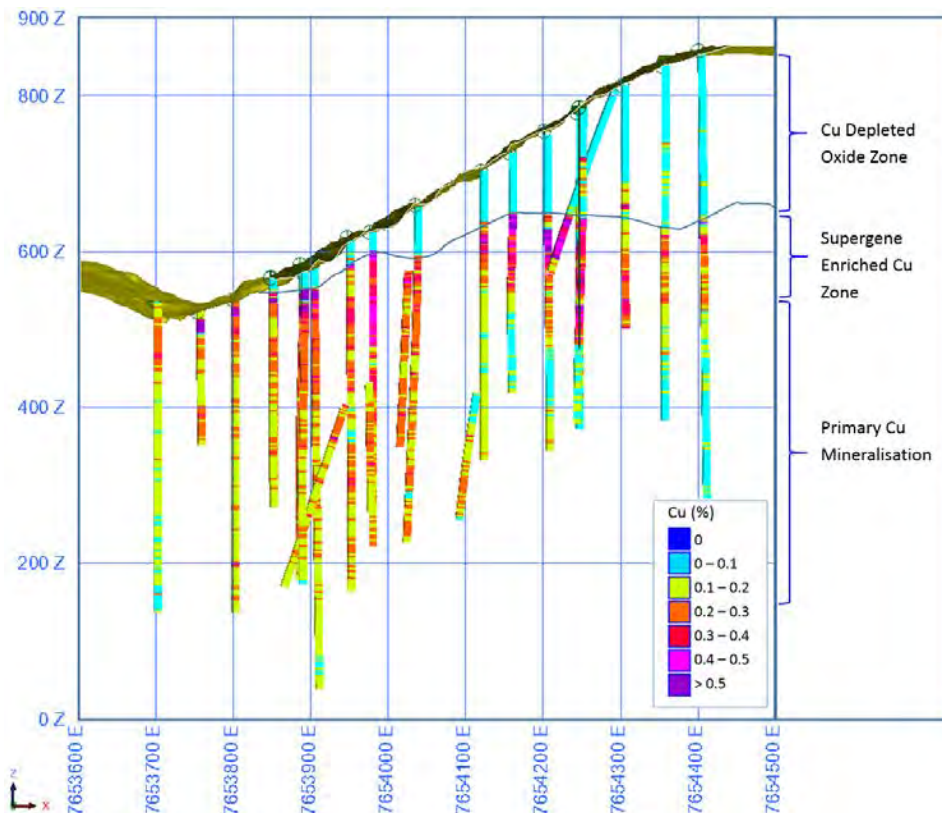
Figure 1.8
Drill Hole Locations on the Ilovica Property



Source: Euromax Resources

The cross section presented in Figure 1.9 illustrates the interpretation of the drilling results in relation to copper depletion in the oxide materials and supergene enrichment beneath. The gold assays show a similar but less pronounced distribution.

Figure 1.9
Typical Section – Copper Assays (%)



Source: Tetra Tech

Note: West-east section at 4 595 200 N

The quality assurance/quality control (QA/QC) programme conducted by Euromax Resources was appropriate and meets industry standards. In Tetra Tech's opinion, the sample preparation and security procedures are acceptable and the data can be relied upon for resource estimation.

1.5 MINERAL PROCESSING AND METALLURGICAL TESTING

Metallurgical tests are reported from the Phase II (PII) samples. The work was undertaken on two drill holes which were used to generate an overall master composite (MC) sample. The PII work was extended as Phase II Residual (PIIR), using the PII MC and supplemented by two additional samples covering higher grade domains designated High (H) and Transitional (T), the latter so named because of the presence of secondary sulphides such as chalcocite and bornite. The PIIR work was essentially to evaluate and confirm the results obtained from the PII work to the level of locked cycle test (LCT), especially in the higher grade material which is encountered in the early years of production. The Phase III (PIII) work has to date focussed on the comminution, with flotation work to optimise reagents and flotation variability work in order to assess recoveries in the early years. PIII test work will continue in to the front end engineering design (FEED) phase in particular to investigate future optimisations of the leaching circuit.

1.5.1 Mineralogy

The main mineralisation was chalcopyrite and pyrite. Both minerals were of a fine grain size, with chalcopyrite, D_{50} of 30 μm , being finer than pyrite, D_{50} of 45 μm . The distribution of Au was mainly in the mineral grains, with a lesser amount in the silicate gangue. No free Au was visible, which would be expected if recovery by gravity were to be considered.

1.5.2 Flotation

A variety of flow sheets were simulated in the laboratory as individual open-circuit flotation tests during the PII and PIIR stages. Initially, the work concentrated on differential flotation, i.e. the production of a separate Cu concentrate to maximise Cu recovery at a saleable grade of Cu, followed by the recovery of a pyrite concentrate which would then be cyanide leached with Au recovery by carbon-in-leach (CIL). The alternative, which appeared to be more successful, was by bulk flotation, i.e. for the production of a single concentrate to maximise / optimise the recovery of both Cu and Au into the one concentrate. The objective was that the concentrate contained Cu of a saleable grade and that the rougher tails were at a relatively low grade for direct disposal to the tailings management facility (TMF). A relatively high Au grade was found in the cleaner scavenger tailing which will be treated by cyanide leaching and CIL. This flow sheet configuration reduced the capital cost estimate (Capex) for the CIL section and appears to be the optimum recovery route.

Inter alia, the tests were to evaluate the optimum mesh of grind and the optimum reagent suite. The initial PII results defined a promising processing route (bulk flotation as referred to above) to achieve a saleable concentrate. Further confirmatory work was done during the PIIR which terminated in three LCTs to simulate the results that could be achieved during actual plant operations. This test, whilst it cannot directly simulate plant operations, can achieve results that are sufficiently close to plant operations to be able to accept with confidence.

The LCT results indicated a concentrate containing 24% Cu and 34 g/t Au at recoveries of 82% Cu and 65% Au. The latest PIII variability results indicate that during the initial years of production recoveries for oxide ore are marginally lower.

1.5.3 Gravity Concentration

A mineralogical examination indicated that the Au particles were generally small with an average liberated particle size of 6.2 μm , which accounted for approximately one third of the total Au content. The remaining Au is in mineral and gangue particles. The general conclusion from this is that a separate recovery of Au as a gravity concentrate is not viable. These results were confirmed by PIIR test work and mineralogical examination.

1.5.4 Cyanide Leaching and CIL

Tests were undertaken in both PII and PIIR. The results were promising and recoveries of Au into solution of approximately 90% for PII samples and 85% to 89% for PIIR samples were obtained. A recovery of 60% of the contained Ag was also indicated, however the silver content of the feed cannot be established yet. Euromax Resources plan to reassay existing coarse rejects from the entire drilling database in order to map the silver in to the geological block model using sufficiently low detection limits which will enable the value of silver reporting to the doré bars to be assessed. Regrinding of the material to 20 μm showed

a small improvement from the 75 µm feed material. However the economic viability of regrinding cannot, as yet, be confirmed. This is to be re-examined in PIII.

The results also indicated that the presence of Cu, S and possibly Fe contributed to higher than expected consumptions of cyanide and oxygen. These figures will be finalised following further test work.

1.5.5 Phase III Test Work

New drill cores have been taken for a new MC. These include 40 additional samples for variability test work. The flotation test work programme was in progress at the time of writing and the first results have been received. These included establishment of the optimum reagent suite for roughing and cleaning. These conditions were applied to the variability samples.

The comminution test work, including the variability samples, has been completed and the results showed wide ranging ore hardness, from hard to very soft. The need to maintain a consistent particle size distribution (one of the metallurgical criteria for the feed to flotation) requires that the feed rate to the mills will be changed by increasing the rate of the soft / very soft ore up to a cap of 20% above the nominal rate (1 250 t/h). The converse is applied for the harder ore. Simulations were run and confirm that the circuit will operate to treat an average annual rate of 1 250 t/h within a range of 1 076 t/h to 1 500 t/h.

The impact of these variations during grinding on the downstream processing is expected to be minimal and allowance for this has been made in the design.

This has allowed the comminution design to proceed to finalise the circuit and establish the parameters for the expected operating envelope.

The results from the flotation work have generally confirmed the previous work in PIIR. Some anomalies have been noted, which will be checked during the FEED phase. The effects of oxide Cu in the resource have given variable results. This is not seen as a major problem but there is a need for this to be confirmed during the FEED phase.

The completion of the test work will include CIL, full leach and absorption characteristics, and concentrate and tailings de-watering. This will be done during the FEED phase when the PIII test work has been completed.

1.6 MINERAL RESOURCE ESTIMATES

Tetra Tech has adopted the definition of Mineral Resource as outlined within the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards on Mineral Resources and Mineral Reserves (CIM 2010).

Tetra Tech has estimated the mineral resources for the Project, with an effective date of 7 July 2015. The last data included in the estimate was also received on 7 July 2015. The resources have been estimated by Mr. Robert Davies, BSc, CGeol, EurGeol, and reviewed by Mr. Joe Hirst, BSc, MSc, EurGeol, CGeol, FGS.

Statistical and grade continuity analyses were completed to characterise the mineralisation and subsequently used to develop grade interpolation parameters for the deposit. Exploratory data analysis

highlighted a number of statistically differentiated grade populations, which were interpreted to be controlled by the following:

- stockwork intensity
- oxidation state
- supergene leaching and enrichment.

Wireframe models were used to isolate grade populations into domains for the purpose of sample selection and to constrain the grade interpolation. Grade estimation was completed using ordinary kriging. The search ellipsoid dimensions and orientations were chosen to reflect the continuity revealed by geostatistical studies and optimised using quantitative kriging neighbourhood analysis.

Estimates for silver and molybdenum were not undertaken as the silver assays are not made with a sufficiently low detection limit in the majority of the deposit and Tetra Tech considers that the potential for incremental value to be added by molybdenum is limited.

The wireframe models were used within the sample selection and compositing routine and subsequently as a constraint to the grade estimation. Euromax Resources provided the geological and analytical data in Microsoft® Excel spread sheets and Microsoft® Access databases. Modelling and estimation was completed using Geovia Surpac Version 6.6.2.

Euromax Resources also provided a topographic survey in drawing exchange format file (.dxf) and consisted of a satellite radar digital elevation model (DEM).

A Mineral Resource Classification scheme consistent with the CIM guidelines (2010) was applied. The estimates are categorised in the Measured and Indicated Mineral Resource categories, reported above a cut-off grade that defines the Resource as potentially mineable by open pit mining methods.

In calculating dollar equivalent block values Tetra Tech considered forecast metal prices from Energy & Metals Consensus Forecasts published by Consensus Economics Incorporated on 12 July 2015. The forecast for September 2016 was US\$1 244 /t oz Au and US\$2.87 /lb (6 333 /t) Cu, with a long-term forecast of US\$1 271 /t oz Au and US\$2.99 /lb (6 590 /t) Cu. For the purpose of assigning a dollar value to blocks, so that a cut-off can be applied to show reasonable prospects of economic extraction, Tetra Tech adopted US\$1 250 /t oz Au and US\$3.00 /lb Cu (6 612 /t):

The dollar equivalent is calculated using the following formula:

$$\text{Dollar Eq} = [\text{Au} * \text{Recovery} * \text{Au Price}] + [\text{Cu} * \text{Recovery} * \text{Cu Price}]$$

A constraining pit shell has been applied to the 3D block model to ensure reasonable prospects of economic extraction for the above reported Resources. This does not represent a formal pit optimisation. The pit was generated using the Lerchs & Grossman algorithm as implemented in Vulcan.

Resource grade/tonnage sensitivity tables were created based upon a range of dollar equivalent cut-offs for blocks within the overall Resource pit shell. A base case cut-off of US\$16 /t was chosen for sulphide materials and US\$8 /t for oxide materials.

For the purpose of Mineral Resource reporting, the transitional material has been grouped with either the oxidised or fresh material based upon the copper content. Where the transitional material has less than

0.2% Cu, it is grouped with the oxide material, where the copper content is greater than 0.2%, it is grouped with fresh material. This approach reflects the fact that there would not be a separate process route for transitional material.

The Mineral Resource for fresh material is summarised in Table 1.3.

Table 1.3 Measured and Indicated Fresh Mineral Resource Based upon a Dollar Equivalent cut-off of US\$16 /t					
Classification	Tonnage	Grade		Contained Metal	
		Au (g/t)	Cu (%)	Au (koz)	Cu (klb)
Measured	147 100 000	0.31	0.23	1500	729 500
Indicated	109 700 000	0.33	0.20	1100	479 000
Total M & I	256 800 000	0.32	0.21	2600	1 208 500

The oxide mineral resources within the constraining pit shell are summarised within Table 1.4.

Table 1.4 Measured and Indicated Oxide Mineral Resource based upon a Dollar Equivalent cut-off of US\$8 /t			
Classification	Tonnage	Grade Au (g/t)	Contained Metal Au (koz)
Measured	12 500 000	0.41	160
Indicated	9 600 000	0.37	110
Total M & I	22 100 000	0.39	280

Notes:

- To define the blocks with reasonable prospects of economic extraction a dollar equivalent has been applied based upon the following calculation:

$$\text{Dollar Eq} = (\text{Au} * \text{recovery} * \text{Au price}) + (\text{Cu} * \text{recovery} * \text{Cu price})$$
- The following assumptions were adopted for the calculation of the dollar equivalent:
 - Au recovery in oxide of 74%
 - Cu recovery in oxide of 0%
 - Au recovery in fresh 88%
 - Cu recovery in fresh 84%
- Forecast metal prices of US\$1 250 /oz Au and US\$3.00 /lb Cu.
- Numbers may not add exactly due to rounding.
- Recoveries are based on those quoted by Euromax Resources in the PFS (effective date of December 19, 2014). Numbers may not add exactly due to rounding.
- Tonnages calculated interpolated density values, as outlined in Section 14.8.
- Mineral Resources that are not mineral reserves do not have demonstrated economic viability. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

1.7 MINERAL RESERVES

A mining plan and schedule were developed for mining the mineral resources that have been estimated for the project.

The Proven and Probable mineral reserves, as shown in Table 1.5, have been estimated to CIM standards from the final pit design.

Table 1.5 Reserves				
Description	Units	Proven	Probable	Total
Sulphide Ore	Mt	112.6	85.5	198.1
Waste	Mt	-	-	199.9
Total	Mt			398
Strip Ratio	t : t	-	-	1.01
Gold Grade	g/t	0.32	0.30	0.32
Gold Content	Moz	1.17	0.84	2.01
Copper Grade	%	0.22	0.19	0.21
Copper Content	Mlb	543.9	355.0	898.9

Note: There may be minor differences in the totals due to rounding of figures.

Mineral reserves are reported to a cut-off grade of 0.22 g/t Au and 0.17% Cu based on a gold price of US\$1 200 /oz less US\$59.52 /oz selling costs and copper of US\$2.50 /lb less US\$0.282 /lb selling costs.

The reserve estimate assumes the construction of a process plant with 10 Mt/a capacity.

Oxide ore is not included and is considered waste for the purposes of pit optimisation.

The mineral reserve estimate (Table 1.5) is classified in accordance with CIM Definition Standards on Mineral Resources and Mineral Reserves incorporated by reference into National Instrument 43-101 “Standards of Disclosure for Mineral Projects”.

1.8 MINING METHODS

The mining method will use conventional drilling and blasting together with shovel and trucks supported by a fleet of ancillary equipment.

Drilling will be done by tracked drills with 127 mm diameter bits to a depth of 11 m. Blasting will be done by contractors using ammonium nitrate and fuel oil (ANFO), slurry and non-electric detonation.

Two 300 t hydraulic face shovels with bucket capacities of 16.5 m³ will be used on ore and waste. These will load a fleet of 90 t nominal payload rigid dump trucks. The number of trucks will vary between 9 at the start of operations and 19 at its peak. Haul routes, distances and speeds will vary depending on the location of the operation. When hauling from the top of the mine the haul roads will follow the contours to intersect with a permanent perimeter haul road with switchbacks. When hauling from the lower part of the mine in the open pit the trucks will haul along a switchback ramp. Haul road gradients vary from 1:10 to 1:12.

Ancillary equipment will include tracked and wheeled bulldozers for earthmoving, graders for road maintenance and water bowsers for dust suppression. A fleet of service vehicles will maintain the mobile mining fleet. There will also be a complement of utility excavators, lights, pumps and pick-up trucks. The total mining fleet will vary from 47 at the start of operations to 74 at its peak.

1.8.1 Production schedule

The production schedule (Figure 1.10) has been developed in Geovia Minesched™ v.9.0.1 Software. The objective of the schedule is to produce only as much ore, as is required by the processing plant without the need for any major stockpiling. Some short term stockpiling will be required. In addition, the aim is to produce an even amount of waste as possible to maintain truck numbers.

Figure 1.10
Production Schedule

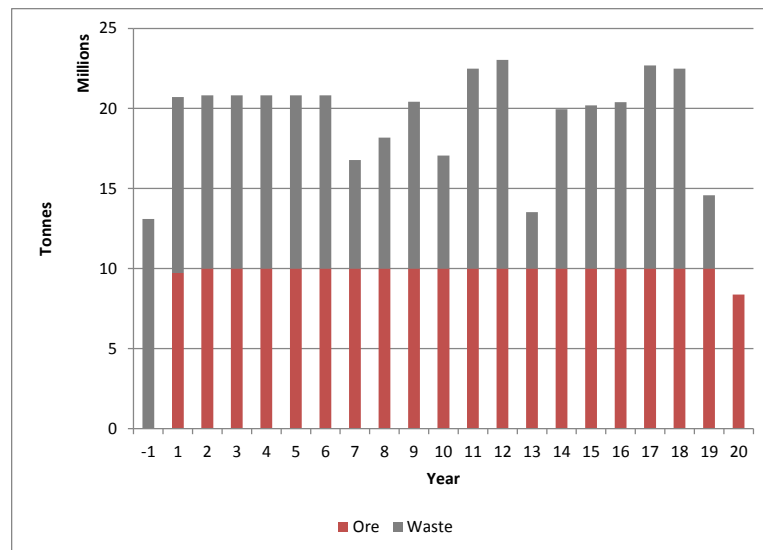
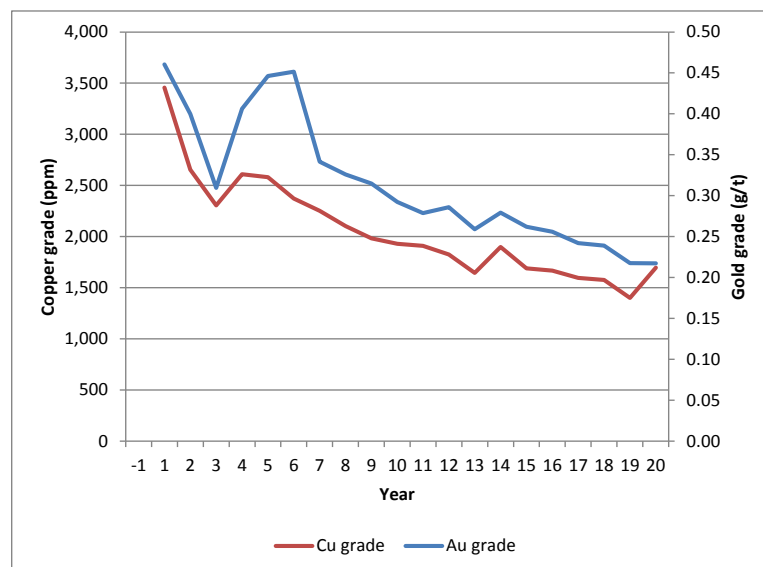


Figure 1.11 shows the head grades for gold and copper that are delivered to the processing plant. This shows higher grades at the beginning with decreasing grades as the mine develops. This profile is essential to ensure the highest net present value (NPV) by providing higher grade ore in the early years.

Figure 1.11
Head Grades for Gold and Copper



1.8.2 Labour Compliment

Labour has been split into Machine Operators, Maintenance, Management and Technical. The number of machine operators is dependent on the number of machines. The labour force will be mostly local, although some expatriot staff have been allowed for in the early years to allow for start-up and training.

The initial compliment of machine operators is estimated to be 108 growing to a peak of 183. Management, Technical and Operations staff are estimated to be 45. Maintenance personnel are estimated to be 60.

1.9 RECOVERY METHODS

The process plant will be constructed for a 10 Mt/a capacity. The design is based on a flow sheet that produces a saleable copper concentrate (78.8 kt/a (dry)) and maximises the overall copper and gold recoveries. The Ilovica ore is derived from a porphyry copper-gold deposit that is amenable to both flotation and cyanidation.

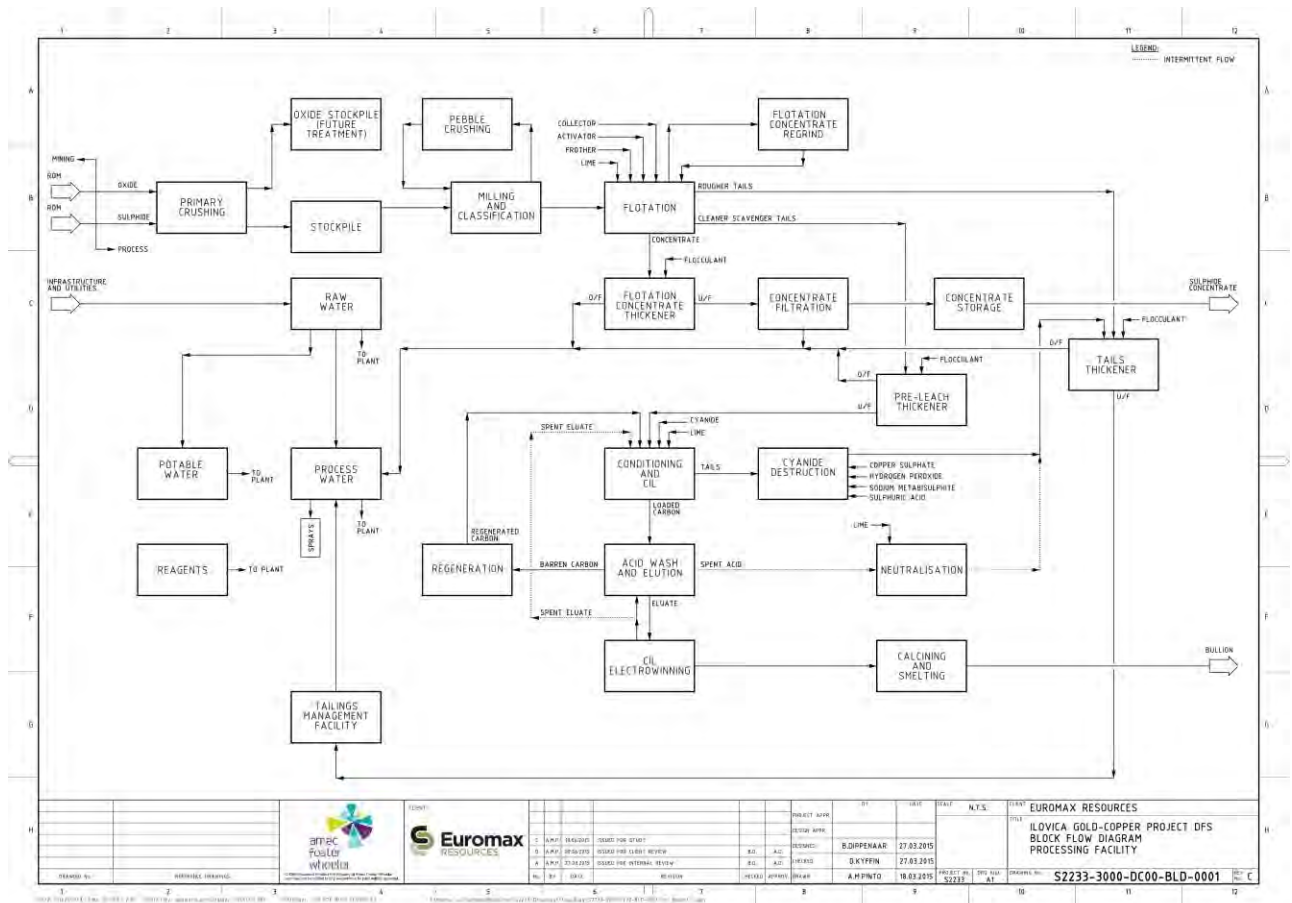
The ROM ore is crushed to a product particle size P_{100} of 318 mm. The crushed ore size is further reduced in a semi-autogenous mill/ball mill/crusher circuit (SABC) configuration. The milling circuit is designed to target a rougher flotation feed F_{80} of 75 μm .

The milled slurry is fed to the rougher/scavenger flotation circuit. The rougher scavenger tails are discharged into the tails thickener for disposal to the TMF. Rougher and rougher scavenger concentrate is collected and feeds into the regrind circuit. The regrind circuit is designed to target a mill product P_{80} of 25 μm . Milled slurry feeds into the cleaner flotation circuit consisting of cleaner, cleaner scavenger and recleaner cells. Recleaner concentrate is dewatered and stored as concentrate. The cleaner tails feeds the cleaner scavenger cells. Cleaner scavenger tails feeds into the leach and CIL circuit for further processing.

Slurry from the cleaner scavenger tails is thickened and pumped through the counter-current CIL circuit for gold adsorption. Slurry from the last CIL tank is thickened. The thickened slurry is passed through a cyanide detoxification step before discharging the tails to the TMF. The loaded carbon is removed from CIL tank 1 and transferred to the elution circuit. During elution, the metals are removed that have then been adsorbed onto the carbon in the CIL. The metal rich solution is passed through an electro-winning circuit. The metal "sludge" plated on the cathodes is washed off the electrodes and filtered to remove excess water. Filter cake is calcined and smelted to produce doré bars.

The block flow diagram in Figure 1.12 graphically represents the selected flow sheet with a summarised mass balance.

Figure 1.12
Block Flow Diagram



1.10 PROJECT INFRASTRUCTURE

1.10.1 Plant and Mining Infrastructure

The infrastructure design was done in accordance with the infrastructure engineering and design, design criteria and is based on South African Standards with due consideration given to site specific conditions likely to be encountered at the mine site in Macedonia.

The Ilovica site exhibits steep longitudinal gradients and steep crossfalls, impacting on the design of roads, terraces and other features that require earthworks.

A geotechnical site investigation was managed by Amec Foster Wheeler to determine, inter alia, foundation conditions and material quality.

Plant and other terraces have been designed to best fit in with topography and functional requirements. The tops of the terraces are finished at slopes of up to 7%.

The main access road from the M6 highway to the plant, provided with bitumen wearing course, was designed with a maximum centre line gradient of 8%.

Roads for the plant and mine infrastructure areas have been classed as primary and secondary, provided with bitumen wearing course, and designed with a maximum centre line gradient of 7%.

Single lane gravel access tracks with passing bays were designed to provide vehicle access to certain areas for operational and maintenance activities. These tracks were designed with a maximum centre line gradient of 14%.

The principal of separating clean storm water from mine affected storm water has been applied to the design of the storm water management system. Diversion channels and containment structures (storm water dams) have been provided. Clean storm water is diverted around the process plant, mining services complex and administrative complex, including diversion of the Jazga River underneath the oxide ore stockpile by means of a culvert. Water collected in the dams is ultimately pumped into the process dam for use in the process. The storm water dams are lined and provided with silt traps and configured for periodic desludging.

Bulk power shall be provided by the Macedonian parastatal power utility company Macedonian Electricity Transmission System Operator (MEPSO) via new 110 kV overhead transmission lines from existing substations at Berovo and Sushica. MEPSO have confirmed that adequate capacity is available for the project. Main medium voltage power is radially distributed within plant areas from the 10 kV main switchboard using above ground cables to the transformers and large motors.

Architectural buildings have been provided for and it is planned to use a local architect to design these light framed steel structures.

Although blasting for mining operations will be done by a blasting contractor, provision has been made for an explosives magazine.

The final disposal of industrial and domestic waste will be off site at a licensed facility; however allowance has been made under civil infrastructure for the costs of an on site storage and sorting facility.

1.10.2 Tailings Management Facility

The proposed Ilovica TMF site is located approximately 3 km east-northeast of the villages of Ilovica and Shtuka, in the Shtuka valley, and southeast of the proposed open pit. The facility has been designed for the storage of 10 Mt of tailings per annum for 21 years, thus a total of 210 Mt of tailings, which based on an average deposited tailings density of 1.5 t/m³ represents a tailings volume of 140 Mm³.

The TMF comprises a valley impoundment and involves the construction of a main embankment (6.5 Mm³ starter wall) across the valley to the south of the process plant. The tailings in the facility will be contained along the northern, eastern and southern sides by the natural contours of the valley, and on the western side by the starter wall and future downstream wall raises to be constructed above the wall. Construction of the wall raises will be a continuous process over a 21 year period. At closure the TMF wall (including the starter wall) will have a volume of approximately 91 Mm³. Details of the heights and geometry of the TMF starter wall and future downstream wall raises are presented in Table 1.6 and Table 1.7, respectively.

Table 1.6 TMF Starter Wall Geometry					
Crest Width (m)	Average Slope (Upstream/Downstream)	Inter-bench Slope (Upstream/Downstream)	Inter-bench Height (m)	Inter-bench Width (m)	Maximum Height (m)
9.05*	1V : 2.5H / 1V : 2.5H	1V : 2H / 1V : 2H	10	5	45

* Approx. 5 m wide crest + 4.05 m wide drainage system.

Table 1.7 TMF Wall Raises Geometry					
Crest Width (m)	Average Slope (Upstream/Downstream)	Inter-bench Slope (Upstream/Downstream)	Inter-bench Height (m)	Inter-bench Width (m)	Maximum Height (m)
10	1V : 2.25H / 1V : 2.5H	1V : 1.85H / 1V : 2H	10 (6 final)	5	276

The TMF will be constructed as an engineered embankment to retaining tailings, and due to its classification as a high risk/consequence facility, has been designed based on the 1 in 10 000 year MDE event, and not based on the requirements of an OBE (during the operating phase).

Static stability results indicate a factor of safety (FOS) >1.3 and therefore indicate the embankment will remain stable in the static condition. Additional seismic stability modelling indicates average settlements of 1.3 m during a maximum design earthquake (MDE) event and therefore a minimum operational freeboard of 2.0 m has been adopted in order to comply with the recommendations of International Commission on Large Dams (ICOLD) 98, (1995) with reference to seismic activity to manage the associated risk, should such an event occur.

Based on the results of a Goldsim model there will be periods in which the supernatant pond cannot meet the plant water demand. The data indicates seasonally varying process water makeup water rates in the order of 0 m³/h - 330 m³/h will be required to meet plant demand. The demand for makeup water is anticipated to decrease as the tailings permeability decreases and the extent of tailings area on the footprint increases, leading to greater run-off and reduced seepage. The model indicates makeup water may not be required during the final years of operations.

Surface run-off entering the TMF facility from the northeast, will be minimised by construction of a river diversion dam (RDD) and river diversion channel. The river diversion will convey flow from the Shtuka River around the southern perimeter of the TMF, capturing run-off from the south and discharging downstream of the storm water dam. A diversion channel will be constructed to keep clean and dirty water separate. Supernatant water from the TMF will be returned to the process plant via a barge pumping system where it will be used as process water makeup. Process water will be supplemented by water from the Ilovica municipal reservoir as required.

At closure a concrete lined spillway and dissipator will be installed. The closure surface of the TMF will be shaped to direct water towards the south of the facility, from where it will be discharging via the spillway to the valley below. Depending on water quality, this system may be combined with the river diversion channel. The TMF will be capped with a system comprising of a minimum 500 mm thick mine waste layer and a minimum 150 mm thick topsoil layer, to promote vegetative growth.

The TMF design relies on a number of assumptions relating to the geotechnical and geophysical site investigations, as well as on the engineering characteristics of TMF wall construction materials and tailings to be deposited on the facility. In addition, a seismic assessment has recently been completed for the TMF site by the Cyril and Methodius University (CMU) in Skopje.

1.10.3 Hydrology and Hydrogeology

1.10.3.1 Hydrology

The project is situated in the steep Jazga and Shtuka catchments, both flowing into the Strumica River. The Strumica River is gauged by the Hydrometeorological Service. To provide flow data in the project catchments a total of 10 project gauging stations were established in the Jazga and Shtuka catchments, stage-discharge relationships were measured and flow records at 5 and 15 minute time steps were recorded. A bathymetric survey was carried out of Ilovica reservoir in April 2015, establishing its capacity to be 356 000 m³. Potential water storage sites were identified at the RDD on the Shtuka River and on the Mala Shtuka tributary of the TMF. The hydrologic modeling system (HEC-HMS) rainfall-run-off (soil moisture accounting) model was calibrated at the project gauging stations close to these locations and, using the daily areal rainfall records calculated for the catchments (above), daily flow records were generated at the storage sites. Analyses of reservoir storage, yield and reliability were carried out for the potential storage sites.

Flood studies were carried out to estimate the 100 yr flood lines around Ilovica reservoir (for the positioning of water supply abstraction works) and to estimate the 100 yr and 500 yr peak flows at the entrance to the proposed culvert underneath the oxide stockpile on the Jazga River.

Estimates were made using the US Natural Resources Conservation Service (NRCS) run-off curve method of run-off volumes in the evolving pit through mine life.

1.10.3.2 Hydrogeology

A hydrogeological site investigation carried out in the deposit area for dewatering design and, along with other investigations, in the TMF basin has shown the following:

- The gold-copper porphyry deposit can be separated into two main groundwater zones: an upper oxidised zone that has sufficient fracture porosity to enable it to be reasonably well drained, and a lower, un-oxidised (sulphide) zone with low to negligible porosity or permeability.
- 3-dimensional numerical groundwater flow modelling suggests that excavation of the open pit will result in annual groundwater inflow volumes estimated to range from around 0.40 Mm³ in years 1 - 2 to 0.98 Mm³ at end of mine life. Most of this inflow is expected to come from the mid to upper levels of the pit (i.e. from around the bottom of the oxide zone).
- Dewatering of the deposit in advance of mine excavation is not considered necessary or practical. Assessment is currently being given to the potential benefits of shallow dewatering wells in the area of the upper plant site to reduce inflows through the higher elevations of the north/north-eastern sections of the pit wall.
- The upper surface of the granite onto which the tailings and the tailings embankment will be emplaced is highly fractured. The thickness of the unsaturated zone below the TMF varies from 0 m along the Shtuka River (i.e. the river is in continuity with groundwater) to around 70 m – 100 m at the ends of the embankment.

- Current conceptual thinking (by Schlumberger Water Services (SWS)) is that emplacement of low permeability tailings within the Shtuka valley could cause groundwater to impound or back up against the upstream side of the TMF. This may result in emergence of groundwater seepage at the upstream edges of the tailings deposit with consequent flow over the upper surface of the deposited tailings. There may be potential for seepage of groundwater along the outside edges of, or into, the TMF impoundment area. This water will be used in preference to fresh makeup water during operation.

1.10.3.3 Site Water Balance

A site wide water balance model with a daily time step was developed in GoldSim in order to estimate water demand, water quantities that can be reclaimed from the TMF and quantities of makeup water that will be necessary to obtain from an external source over the life of the mine. At the time of writing, the GoldSim model comprised the process plant, the pit, the TMF and Ilovica reservoir, the basic components of the mine water supply system as defined in the PFS, each of which was individually modelled.

The total water requirement is 1.017 m³/t, which is equivalent to 10.17 Mm³/a. The minimum fresh water requirement (for gland seals and spray water) is 2.25 Mm³/a. Potable water demand is 0.23 Mm³/a.

Multiple runs of the GoldSim model were made, each with different synthetic daily rainfall and evaporation series, to develop statistical distributions of model outputs. Reclaim water from the TMF is the main source of process water. The model suggests that 7.5 Mm³/a can be obtained from the TMF in Year 1 and that this amount reduces from Year 2 to Year 10 as seepage losses are high, but then increases as hydraulic conductivity of the tailings reduces, reducing seepage losses. Results indicate that the mine demand for water can be satisfied by reclaim operations in the winter months of the final years of mine life. Demand for water is never satisfied by reclaim operations in summer months, requiring a fresh water source to make up the difference.

The pit also provides a source of water for the process plant contributed by run-off and groundwater inflow. The pit contribution is expected to increase from about 0.1 Mm³/a in Year 1 to about 1.1 Mm³/a (at the 50th percentile) in the final year of operations.

The demand for makeup water varies over mine life from 2.5 Mm³/a to about 5.5 Mm³/a. The Ilovica reservoir is planned to be the main source of makeup water. Storage yield studies of the Ilovica reservoir assume that Euromax Resources would share this water resource with other users (public domestic and agricultural supplies). These studies show that Euromax Resources would need to supplement the Ilovica reservoir from an external source such as the Turija reservoir and/or groundwater from the Strumica valley. The amount of supplementary water required will vary seasonally from zero in winter, to the monthly equivalent of about 5 Mm³/a (at the 50th percentile) in summer. This assumes that augmentation is initiated when storage in the reservoir drops to the equivalent of 7 days supply remaining.

1.10.3.4 Water Supply Options

Water resources are scarce in the project catchments and in the project area generally, necessitating the following water management strategy:

- Use of available and unutilised water resources nearby
- Conservation of site run-off and recycling of wastewater

- Maintaining the reliability and water quality of existing public domestic and agricultural water supplies.

Several water resource/supply options are currently under appraisal for servicing the mine scheme. The currently preferred options for supplying the majority of additional requirements, subject to more detailed evaluation, entail development of local groundwater (from the Strumica plain) and/or connection to and utilisation of available supplies from Turija reservoir.

1.10.3.5 Water Quality

Water quality was surveyed across the site at quarterly or monthly intervals from September 2013. At each survey a series of field parameters were recorded and water samples were sent for a range of laboratory analyses at ALS Environmental Ltd in the UK (ALS).

Most of the waters monitored in the upper Jazga and Shtuka catchments are relatively clean, unimpacted waters, dominated by calcium, magnesium and bicarbonate ions. A small number of spring and stream monitoring points located close to the planned open pit and mineralised zone presented higher concentrations of sulphate, iron and copper than elsewhere. These waters also showed depressed alkalinities and pH.

The water quality of water supply options is characterised as two main chemical types:

1. Clean water, with a water chemistry dominated by calcium, magnesium and bicarbonate ions (the major water sources, the RDD and Mala Shtuka dam).
2. Recycled contact water from the mine operations comprises water reclaimed from the pit sump, TMF and minor site sources. Contact water will be characterised by higher concentrations of sulphate, iron and copper and lower alkalinities and pH than elsewhere.

1.10.3.6 Geochemistry

Geochemical work performed to date has included the use of industry-standard static and kinetic geochemical testing to characterize the acid production and metal leaching propensity of each of the major rock types which will be mined and/or exposed in the walls of the proposed open pit.

Results of acid-base accounting (ABA) testing indicate that approximately 5% of the sample population is classifiable as net-acid consuming, with 49% classified as of 'low-reactivity', 13% classifiable as of weak potential acid generation (PAG) character and 38% classifiable as strong PAG.

A series of 16 field 'test pads' were established at Ilovica in 2013 to assess the long-term weathering behaviour of the waste rock stream (most of which is currently proposed for use in the construction of the TMF embankment). Most un-oxidised material shows evidence of strong net acid production, with un-oxidised hydrothermally altered granodiorite and dacite yielding leachate with a pH of below 3.

Further kinetic tests were initiated in July 2015 to assess the leachate chemistry likely to emanate from material to be placed on the oxide stockpile. Euromax Resources has confirmed that 'transitional' (sulphide bearing) rock will now not be stockpiled.

Results of preliminary static and kinetic leach tests on available rougher and cleaner scavenger tails generated from flotation test work suggest that the tailings will not generate low pH contact water due to the high residual alkalinity present within the slurry. Further confirmatory tests are being completed to verify this.

Based on results of the static and kinetic testing, acid rock drainage (ARD) risk codes have been incorporated into the Ilovica block model. The codes have then been applied to predict the proportions of PAG and non-PAG material to be exposed in the pit walls or contained in the waste rock stream throughout mine life.

The proportion of high risk material in both the pit walls and the waste stream increases through mine life, with greater pit extension into un-oxidised rock units. A significant proportion of PAG material is projected to be exposed on the highwall above the level of water inundation within the pit following closure. This may impact the long-term quality of water within any future pit lake and therefore any outflow from the pit lake will have to be managed. Further work is planned for during the detailed design phase.

Most of the initial waste produced corresponds to sterile material and will be used for the initial TMF construction. Highly acid generative waste material begins to be produced from year 3 onwards, which is after the starter TMF embankment (end of life of mine (LOM) year 2). Acid generative material is mostly produced in LOM years 7 to 18. The carbonate bearing material is located at depth within the pit and is mined later in mine life, from LOM year 6 to year 18. Acid generative material will therefore be effectively capped within the embankment and downstream buttress.

1.11 ENVIRONMENTAL AND SOCIAL STUDIES

The objective of the environmental and social impact assessment (ESIA) is to identify and quantify impacts that the Project may have on the biophysical and socio-economic environments by comparison with the ESIA baseline and project environmental design criteria. The ESIA identifies potential mitigation and management processes to minimise negative impacts and maximise positive impacts.

The following basic elements make up the methodology adopted in the ESIA:

- Establish study areas for baseline data collection and establish baseline conditions;
- Establish the project description to be assessed, including the incorporated environmental and social measures;
- Evaluate stakeholder engagement information;
- Confirm the key receptors and their sensitivity or importance;
- Characterise the potential effects on receptors (effects analysis);
- Determine the nature and scale of impact, combined with the importance/sensitivity of receptor (impact assessment);
- Consider the need for mitigation measures should impacts be considered unacceptable;
- Assess the significance of residual impact (after mitigation);
- Consider other operating or planned projects in the region (cumulative impact assessment); and
- Develop monitoring and management plans.

The technical standards to be applied in the ESIA are a combination of Macedonian regulation and international standards, including European Bank for Reconstruction and Development (EBRD) Environmental & Social Policy and Performance Requirements (2014).

ESIA baseline data gathering was completed in August 2015 and will inform the effects analysis and the assessment of impacts. Secondary (literature) and primary (in situ) data gathering has been completed for the following technical areas:

- Air Quality and Climate;
- Noise;
- Geomorphology Soils and Land Use Capability;
- Groundwater and Surface Water;
- Geochemistry;
- Ecology and Biodiversity;
- Ecosystem Services;
- Archaeology and Cultural Heritage;
- Social (including Socio-economics, Agriculture and Forestry); and
- Landscape and Visual Assessment.

Key findings from the baseline include:

- Ambient air quality within the study area is good and sources of local atmospheric pollution are limited.
- The area has a mildly continental climate with typical seasonality.
- Measured noise levels are predominantly influenced by natural noise sources, except where communities are close to the regional highway (M6).
- Topsoil is very limited across the project footprint.
- The study area is prone to geohazards due to a mountainous landscape.
- Local surface and groundwater quality is good.
- Local communities are reliant on the Jazga and Shtuka watercourses for potable and non-potable water. Local communities also rely on spring water for potable supply.
- Presence of the Large blue butterfly triggers critical habitat under the definition in IFC Performance Standard 6 due to the endangered (EN, IUCN) status of the species. The concession sits within the prime butterfly area (PBA) designated by Butterfly Conservation Europe. Large blue butterflies were not found within the mine footprint and the ESIA baseline identified that the likely Large blue butterfly habitat which is a subset of the PBA will not be directly impacted by the mine footprint. Nevertheless, the Euromax Resources is committed to working with the regulator to preserve and enhance the PBA where they do occur.
- There are no fish in the upper reaches of the Shtuka and Jazga, but decapods and macro invertebrates are present.
- The local communities are heavily reliant on agriculture for income.

Based on these findings the ESIA addressed the following key environmental and social issues:

- Security of water supply to Ilovica, Shtuka, plus other villages currently reliant on Ilovica reservoir.
- Security of water supply for irrigation in Strumica basin.
- Water quality of potable water supply to Ilovica and Shtuka.
- Water quality of agricultural water supply to Ilovica and Shtuka.
- Land acquisition for the new project access road.
- Archaeological sites located within the local study area (LSA).
- Sensitive cultural sites and rituals in local communities.
- Population changes during construction and operations and following closure.
- Prime Butterfly Area and associated critical habitat management.
- Species of conservation concern in the LSA.
- Rehabilitation of the TMF.
- Nuisance, noise and air quality due to changes in traffic.
- Sediment control.

No fatal flaws have been identified within the impact assessment and an international ESIA for financing is currently being finalised in parallel with a local environmental impact assessment (EIA) that will accompany submissions for a construction permit in 2016.

1.12 MARKET STUDIES AND CONTRACTS

1.12.1 Market

The commodity prices used for economic analysis are US\$1 220 /oz Au, US\$18 /oz Ag and US\$2.90 /lb Cu. These metal prices are supported by Amec Foster Wheeler Long-term guideline prices for use in cash flow models and mining studies for Q4 2015.

1.12.2 Contracts

The term sheets for copper concentrate and doré bars are:

- Aurubis Bulgaria AD for an offtake agreement for the planned Ilovica copper-gold concentrate.
- MKS (Switzerland) SA for an offtake agreement for the planned Ilovica doré bars.

1.13 CAPITAL AND OPERATING COSTS

1.13.1 Capital Costs

The capital cost estimate includes engineering, procurement, construction, start-up and cold commissioning for the process plant, infrastructure, TMF and mining. Provision is also made for owner's costs.

The base date for pricing is September 2015, with some contractors amending rates subsequent to tender clarifications.

The estimate is within the required accuracy range of $\pm 10\%$ and is slightly lower than that produced in the PFS estimate by Tetra Tech.

The estimate covers the direct field costs of executing the project, the indirect costs associated with the design, construction and commissioning of the new facilities and owner's support costs for items such as management teams, operational staff, environmental, permitting, insurance and utilities such as water supply, bulk power and construction power.

The estimate is calculated in Euros since all costs will be incurred in Euros and all costs have been calculated using the Euromax Resources approved study exchange rates as per Table 1.8.

Table 1.8 Foreign Currency Rates		
Euro	Currency	Value
€1.00	Macedonia Denar	ден 61.50
€1.00	United States Dollar	\$ 1.10
€1.00	Australian Dollar	\$ 1.45
€1.00	South African Rand	R 13.50
€1.00	Canadian Dollar	\$ 1.35
€1.00	Japanese Yen	¥ 135.00
€1.00	Chinese Yuan	¥ 7.10
€1.00	United Kingdom Pound	£0.75
€1.00	Indian Rupee	₹ 70.00
€1.00	Turkish Lira	₺ 3.20
€1.00	Swiss Franc	CHF 1.11

The method of project execution applied to the estimate calculation assumes an engineering, procurement and construction management (EPCM) contract. A summary of the capital cost estimate is presented in Table 1.9 (Euro) and Table 1.10 (US\$).

Table 1.9 Capex Summary (Euro)					
Description	Total Project Cost	Growth and Project Risk	Contingency	Total (€)	Total %
Process Plant and Infrastructure	€ 286 999 947	€ 8 371 142.48	€ 16 939 563.16	€ 312 310 652	72.4%
TMF	€ 39 039 380	€ 1 138 690.85	€ 2 304 216.61	€ 42 482 287	9.9%
Mining	€ 68 430 324	€ 2 629 424	€ 5 320 814	€ 76 380 563	17.7%
Total	€ 394 469 651	€ 12 139 257	€ 24 564 594	€ 431 173 503	100.0%

Table 1.10 Capex Summary (US\$)					
Description	Total Project Cost	Growth and Project Risk	Contingency	Total (US\$)	Total %
Process Plant and Infrastructure	\$315 699 942	\$9 208 257	\$18 633 519	\$343 541 717	72.4%
TMF	\$42 943 318	\$1 252 560	\$2 534 638	\$46 730 516	9.9%
Mining	\$75 273 356	\$2 892 366	\$5 852 895	\$84 018 619	17.7%
Total	\$433 916 616	\$13 353 183	\$27 021 053	\$474 290 852	100.0%

1.13.2 Operating Costs

The operating cost estimate base date is September 2015, and is presented in Euro. The cost estimate was developed with a level of accuracy of $\pm 10\%$ of estimated final costs and is based on the following cost centres as per Table 1.11 (Euro) and Table 1.12 (US\$)

Table 1.11 Operating Cost Estimate Summary (Euro)					
Cost Centre	Total		Fixed Cost	Variable Cost	
	€/y	€/t	€/y	€/y	€/t
Mining (average - including labour)	€ 32 148 842	€ 3.21	€ 7 614 183	€ 24 534 659	€ 2.45
Labour	€ 7 995 685	€ 0.80	€ 7 995 685		
Reagents	€ 15 989 686	€ 1.60	€ 320 375	€ 15 669 311	€ 1.57
Operating Consumables	€ 9 836 519	€ 0.98	€ 807 638	€ 9 028 880	€ 0.90
Power	€ 20 843 710	€ 2.08	€ 140 988	€ 20 702 722	€ 2.07
Maintenance Materials	€ 5 917 460	€ 0.59	€ 5 326 000	€ 591 460	€ 0.06
Mobile Equipment	€ 130 170	€ 0.01	€ 130 170		
Laboratory	€ 424 632	€ 0.04	€ 424 632		
Subtotal	€ 93 286 703	€ 9.33	€ 22 759 671	€ 70 527 032	€ 7.05
General & Administration	€ 3 415 453	€ 0.34	€ 3 415 453		
Subtotal	€ 3 415 453	€ 0.34	€ 3 415 453		
Total	€ 96 702 156	€ 9.67	€ 26 175 125	€ 70 527 032	€ 7.05

Table 1.12 Operating Cost Estimate Summary (US\$)					
Cost Centre	Total		Fixed Cost	Variable Cost	
	US\$ /y	US\$ /t	US\$ /y	US\$ /y	US\$ /t
Mining (average - including labour)	\$35 363 726	\$3.54	\$8 375 601	\$26 988 125	\$2.70
Labour	\$8 795 254	\$0.88	\$8 795 254		
Reagents	\$17 588 655	\$1.76	\$352 413	\$17 236 242	\$1.72
Operating Consumables	\$10 820 171	\$1.08	\$888 402	\$9 931 769	\$0.99
Power	\$22 928 081	\$2.29	\$155 087	\$22 772 994	\$2.28
Maintenance Materials	\$6 509 206	\$0.65	\$5 858 600	\$650 606	\$0.07
Mobile Equipment	\$143 187	\$0.01	\$143 187		
Laboratory	\$467 095	\$0.05	\$467 095		
Subtotal	\$102 615 374	\$10.26	\$25 035 638	\$77 579 736	\$7.76
General & Administration	\$3 756 998	\$0.34	\$3 756 998		
Subtotal	\$3 756 998	\$0.34	\$3 756 998		
Total	\$106 372 373	\$10.64	\$28 792 636	\$77 579 736	\$7.76

1.14 ECONOMIC ANALYSIS

A discounted cash flow (DCF) analysis was developed to evaluate the project based on agreed estimates for Capital, Operating costs and defined Mining plan.

The FS demonstrates a robust NPV at a 5% discount of €466.4 M (US\$ 513.0 M) with an IRR of 19.8% before tax and an after tax NPV at a 5% discount of €400.1 M (US\$440.1 M) and IRR 17.8%.

All figures are expressed in 2015 constant Euro or real terms. No allowance was made for inflation or real cost escalation. All monetary figures are expressed in Euro.

The project value is determined on the cash flow after tax basis and discounting was performed starting from the first year of Capex outflow i.e. 2016. A simplistic tax model was included in the analysis to provide an estimate of the after tax project value.

The mine plan is developed for 20 years and this was the basis for the analysis.

The DCF analysis is based on the underlying economic assumptions as per Table 1.13.

Table 1.13 Economic Inputs		
Item	Unit	Value
Price Forecast		
Gold price	\$ /oz	1220
Silver Price	\$ /oz	18
Copper price	\$ /lb	2.9

Table 1.13 Economic Inputs		
Item	Unit	Value
Overall Metal Recovery		
Cu	%	82
Au	%	84
Royalties (Government tax)	%	2
Percentage of NSR		
Discount rate	%	5
As per EuromaxResources instruction		
Taxation	%	10
Concentrate		
Copper treatment charge	US\$ /wmt	85
Copper refining charge	US\$ /payable lb Cu	0.085
Gold refining charge	US\$ /oz Au	5
Silver refining charge	US\$ /oz Ag	0.4
Transport charge (Pirdop)	US\$ /wmt	26.4
% Payable Copper (based on a 24% grade)	%	95.83
% Payable Gold	%	97
Doré Bars		
Gold refining charge	US\$ /oz Au	0.4
Insurance and transport charge	US\$ /oz Au	4
Gold Payability	%	99.9

Sensitivity analysis was performed on the project to gauge its robustness against favourable and unfavourable changes to project variables taking into account variations in the metal price, operating cost, capital cost, copper and gold recovery. The analysis shows that the project is most sensitive to changes in metal recovery followed by metal price, operating cost and finally capital cost. The results indicate that the project is robust enough to remain viable in the ranges tested for the analysed variables. Economic results of these sensitivities are summarised in Table 1.14 (Euro) and Table 1.15 (US\$) and presented in Figure 1.13.

Table 1.14 Selective Sensitivities, After-tax NPV at 5% Discount Rate (Euro)								
	Factor	Change in Factor (€ M)						
		-30%	-20%	-10%	0%	10%	20%	30%
Capital expenditure	1	€ 565	€ 510	€ 455	€ 400	€ 345	€ 290	€ 235
Total Operating expenditure	2	€ 706	€ 604	€ 502	€ 400	€ 297	€ 193	€ 89
Gold Price	3	€ 98	€ 199	€ 300	€ 400	€ 500	€ 600	€ 699
Recovery	4	€ 318	€ 346	€ 373	€ 400	€ 427	€ 454	€ 481
Copper Price	5	€ 90	€ 194	€ 297	€ 400	€ 503	€ 605	€ 707

Table 1.15 Selective Sensitivities, After-tax NPV at 5% Discount Rate (US\$)								
	Factor	Change in Factor (US\$ M)						
		-30%	-20%	-10%	0%	10%	20%	30%
Capital expenditure	1	\$622	\$561	\$501	\$440	\$380	\$319	\$259
Total Operating expenditure	2	\$777	\$664	\$552	\$440	\$327	\$212	\$98
Gold Price	3	\$108	\$219	\$330	\$440	\$550	\$660	\$769
Recovery	4	\$350	\$381	\$410	\$440	\$470	\$499	\$529
Copper Price	5	\$99	\$213	\$327	\$440	\$553	\$666	\$778

Figure 1.13
Sensitivity of NPV 5% (Tornado Chart)

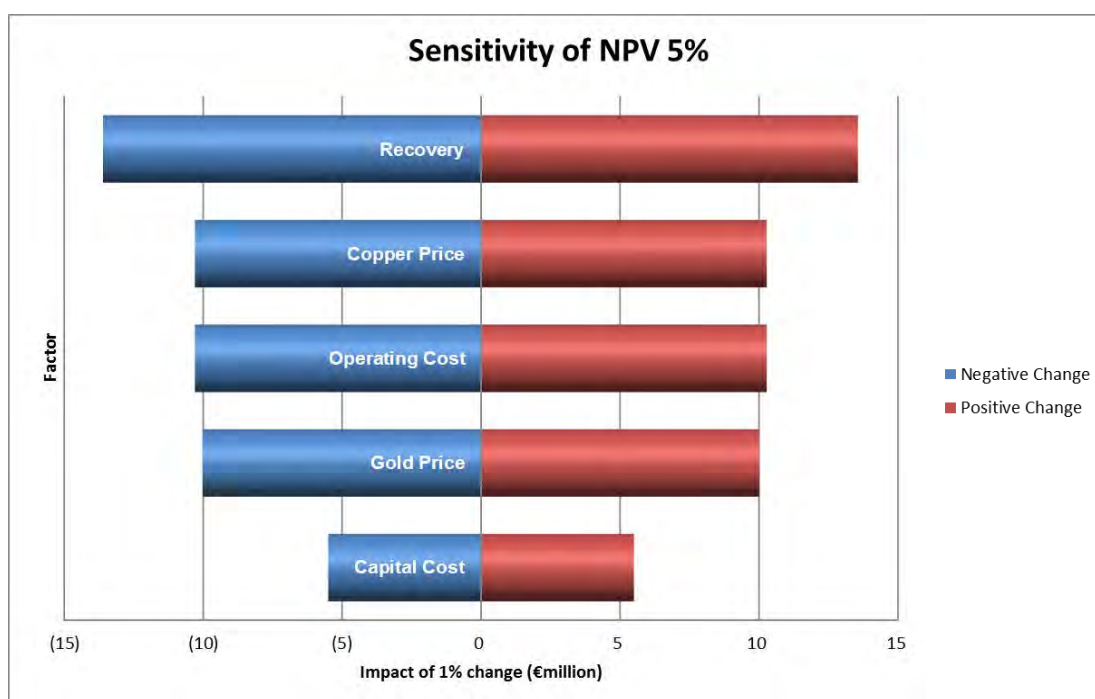


Table 1.16 (Euro) and Table 1.17 (US\$) illustrate the sensitivity to changes to the calculated IRR and NPV at 0%, 5% and 10% discount rates at various gold and copper prices. No assurance or guarantee is provided that the calculated IRR or NPV values will be achieved.

Table 1.16 NPV and IRR Sensitivity to Metal Prices (Euro)									
Gold Price (US\$ /oz)	Copper Price (US\$ /lb)	NPV at 0% discount (€ M)		NPV at 5% discount (€ M)		NPV at 10% discount (€ M)		IRR	
		Pre-tax	Post-tax	Pre-tax	Post-tax	Pre-tax	Post-tax	Pre-tax	Post-tax
1 100	2.50	€ 431	€ 374	€ 201	€ 159	€ 56	€ 22	12.7%	11.1%
1 220	2.90	€ 854	€ 762	€ 466	€ 400	€ 237	€ 187	19.8%	17.8%
1 400	3.50	€ 1 488	€ 1 335	€ 864	€ 759	€ 508	€ 431	28.6%	25.9%

Note: Silver price fixed at US\$18 /oz

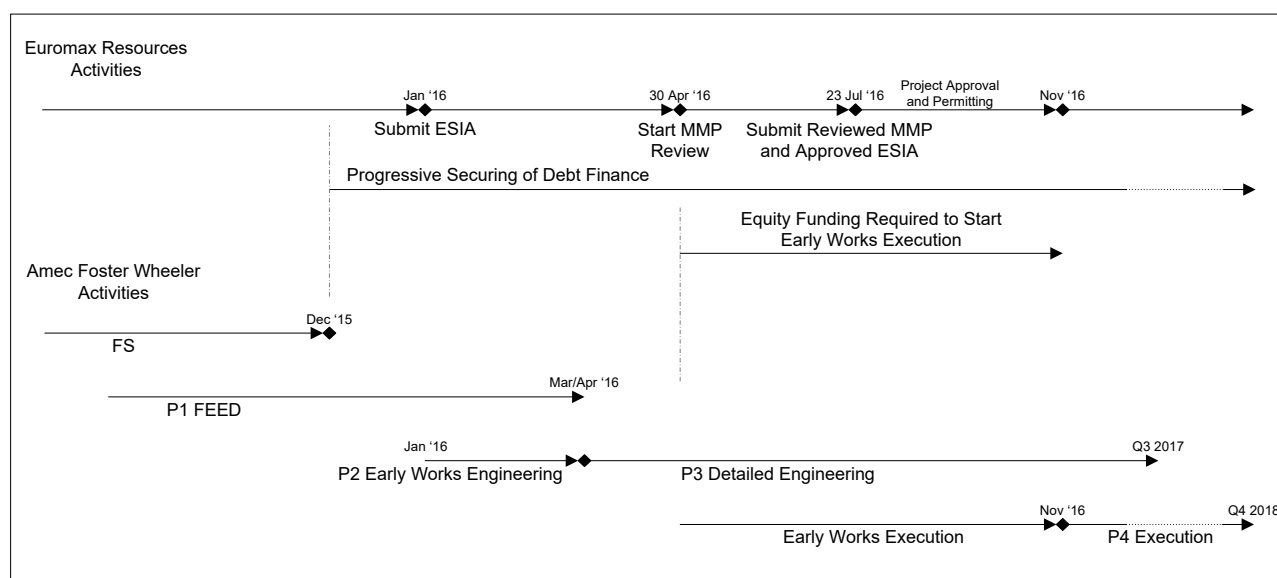
Table 1.17 NPV and IRR Sensitivity to Metal Prices (US\$)									
Gold Price (US\$ /oz)	Copper Price (US\$ /lb)	NPV at 0% discount (US\$ M)		NPV at 5% discount (US\$ M)		NPV at 10% discount (US\$ M)		IRR	
		Pre-tax	Post-tax	Pre-tax	Post-tax	Pre-tax	Post-tax	Pre-tax	Post-tax
1 100	2.50	\$474	\$412	\$221	\$174	\$61	\$25	12.7%	11.1%
1 220	2.90	\$939	\$839	\$513	\$440	\$260	\$205	19.8%	17.8%
1 400	3.50	\$1 637	\$1 469	\$951	\$835	\$559	\$474	28.6%	25.9%

Note: Silver price fixed at US\$18 /oz

1.15 PROJECT IMPLEMENTATION PLAN

An implementation strategy for the next phases of the project has been developed, as part of the FS. The FS was based on South African engineering standards and was priced utilising quotes from internationally suited vendors and local Macedonian based contractor's quotes. The next phase, FEED, will normalise the project against Macedonian/European technical standards. There will be three further phases of project development, the early works engineering and execution phase, detailed engineering phase and the execution phase. Figure 1.14 shows the project delivery phases and forms the basis of the agreed way forward.

Figure 1.14
Project Delivery Phases



1.15.1 Phase 1 FEED

The engineering associated with the FEED is based on localising the design in conformance with local standards and norms. It will not require a change to the level of engineering required, nor will any further procurement or estimating be produced.

Amec Foster Wheeler will specify all packages in accordance with the Regulations on the Content of Mining Projects as adopted by the Minister of Economy.

The preparation, presentation and translation of the engineering work packages (EWP) to meet the Macedonian regulations and submission for approval, will be carried out by the University of Shtip in Macedonia. This submission is described as the main mining project (MMP). The MMP will be based on the FS and extracts from the FEED.

The MMP is reviewed and approved by a multi-disciplined team appointed by the minerals department at the Ministry of Economy.

Euromax Resources will facilitate this process with their in-country management and technical team. The EWPs will be issued to the University of Shtip on a progressive basis and will also be submitted to the Ministry of Economy technical committee on the same progressive basis for their review, to expedite the approval process.

The MMP is presented in two main categories, i.e. Mining and Metallurgy (Processing), the scope of work of each main package has been agreed with the University of Shtip against the Engineering work breakdown structure (WBS).

1.15.2 Phase 2 Early Works Engineering and Execution

The early works phase will have two main focus points. The first will be to confirm package data. The second will be to further the detailed design and finalise the following pre-determined contracts:

- Access Road
- Site Security and Fencing
- Laydown Areas
- Temporary Construction Power
- Water Supply

1.15.3 Phase 3 Detailed Engineering

The detailed engineering phase will initially focus on procurement of equipment and then on the finalisation of the detailed design and 3D model based on certified vendor information to produce construction drawings.

1.15.4 Phase 4 Construction and Commissioning

Construction will commence on finalisation of the environmental and mining permits. Construction will be done by locally sourced contractors with equipment being sourced from vendors of international standing.

1.15.5 Key Milestones

The key milestones for the project are presented in Table 1.18.

Table 1.18
Key Milestones

ID	Description	Date
1	FS Complete	2015/12/15
2	FEED Complete	2016/03/31
3	Process Design Complete	2016/03/31
4	Off Site Access Road Phase 1 Design Complete	2016/03/31
5	Signed Order for Access Road Contractor (By Euromax Resources)	2016/04/29
6	Submit MMP & ESIA	2016/07/22
7	Signed Order for Mills	2016/08/01
8	Signed Order for Bulk Earthworks Contractor	2016/08/02
9	Construction Permit Granted	2016/10/31
10	Construction Power Available	2016/10/31
11	Construction Water Available	2016/10/31
12	Signed Order for Thickeners	2016/11/07
13	Signed Order for Primary Gyratory Crusher	2016/12/07
14	Signed Order for Civil Contractor	2017/01/17
15	Signed Order for Flotation Cells	2017/01/27
16	Signed Order for Regrind Mill	2017/05/05
17	Detailed Engineering Complete	2017/08/01
18	Required On Site Date - Mills	2017/12/01
19	Required On Site Date - Flotation Cells	2018/01/10
20	Required On Site Date - Regrind Mill	2018/01/22
21	Required On Site Date - Thickeners	2018/01/29
22	Required On Site Date - Primary Gyratory Crusher	2018/02/28
23	TMF Starter Wall Complete	2018/09/28
24	Plant Construction Complete	2018/10/31
25	Mining Pre Strip Complete	2018/12/14
26	Commissioning Complete	2018/12/31

1.15.6 Contract Terms

For the purposes of this write-up the project execution strategy is EPCM. As such, the contract to be placed between Euromax Resources and Amec Foster Wheeler would be the Fédération Internationale Des Ingénieurs-Conseils (FIDIC) White Book (Client/Consultant Model Services Agreement).

Amec Foster Wheeler's role will be three-fold:

- Responsible engineer
- Placing contracts for and on behalf of Euromax Resources
- Supervising the work carried out by the contractors

On signing of contracts with contractors the Civil Contractor will be specifically named the "Main Contractor" to fulfil the role as single point of contact to the government of Macedonia. To this end the Civil Contractor will accompany the appointed committee on the final site inspection, hand over all certificates of completion and apply for the operating license.

1.16 INTERPRETATION AND CONCLUSIONS

The current Ilovica Gold-Copper Project FS justifies continuing development through FEED and detailed engineering to project execution. Overall the study complies with industry standard practices for FS level and is considered to have an accuracy of plus or minus 10% or better. The scope of the project including mine design, mine schedule, process flow sheet and process plant design and engineering, waste management and TMF have been assessed and viable solutions defined in each case.

Based on the supplied data and application of appropriate methods, a combination of open pit and hillside quarry type mining, a project was outlined that could be profitably mined and based on the results of a positive economic analysis of the proposed mine, mineral reserves were identified. The detailed production schedule is based on Proven and Probable Reserves.

Processing of the ore using a flow sheet comprising crushing, milling in a SABC circuit, flotation of a copper concentrate and treatment of the cleaner scavenger flotation tails for additional recovery of gold has been defined as a viable process route. The process route has been sufficiently defined in order to establish process operating and capital costs to the required level of detail for a FS level study. Costs have been established for a 10 Mt/a operation. The process will produce a copper concentrate with payable gold credits as well as doré bars.

Existing infrastructure has been examined and the required additional infrastructure designed to a level appropriate for the study. This comprises a system of roads and power lines to connect to the local networks, a water pumping network to ensure sufficient makeup water for the plant, a series of buildings and workshops to house the various parts of the project and accommodate the required support for this and a TMF in the Shtuka valley, adjacent to the mine. The footprint is as compact as possible and has the advantage of impacting only the drainage systems, which pass directly by the deposit.

No fatal flaws have been identified within the impact assessment and an international ESIA for financing is currently being finalised in parallel with a local EIA that will accompany submissions for a construction permit in 2016.

Financial analysis of the parameters defined by the FS demonstrates a viable project. The mine schedule taken forward for the economic analysis delivers higher than average grade in the first eight years. The project is most sensitive to changes in metal recovery but still presents a positive return within the range of sensitivities tested for metal recoveries, price, discount rate, operating costs and capital costs.

1.17 RECOMMENDATIONS

Specific recommendations have been made in the various sections of this report. In general terms the definition of a viable project from the positive results of this FS leads to the recommendation that the project should be advanced to the next phases through FEED and detailed engineering to project execution. Key aspects of this are listed below.

1.17.1 Metallurgical Test Work and Mineral Processing

Test work is continuing in order to confirm the assumptions made, the test results of the previous test work (PII and PIIR), the current test work (PIII) and to allow the detailed process design phase to proceed to completion during the FEED. The programme will include:

- Repeat tests of any anomalous results where unexpected differences in both recoveries and grades of Cu and Au are experienced. Included in this, duplicate tests to confirm the optimum regrind size of the rougher concentrate, which should also be evaluated with respect to leach recovery.
- Oxide Cu analyses undertaken on the residual core samples to assist in the oxide investigation and to provide additional information relative to metallurgical response. These results will then be interpolated into the resource model. Cu oxide analyses will also be carried out on the various flotation products. These various Cu oxide analyses will allow a less conservative evaluation of the CIL metallurgical response.
- Ag assays on selected tests for balances and recoveries to be calculated. Ag assays are also necessary on core samples for inclusion in the geological block model. Euromax Resources has initiated a re-sampling of coarse rejects from the core drilling over the entire deposit to provide 9 m composites. These will be analysed for oxide Cu using a citric acid method. Ag assays will be included in this exercise.
- Additional LCTs on different domain samples to those carried out in PIIR to confirm the open circuit variability tests. Assessments for plant operations have been done using mathematical techniques to include the effect of stream recycles which is suitable but should be verified with the LCTs.
- Leaching, CIL and de-watering tests on bulk flotation test material.
- CIL test work to confirm leach parameters, adsorption parameters and reagent consumptions, including oxygen requirements. The latter is considered essential since the resource material is relatively high in soluble Cu and S, which are oxygen consumers.
- Adsorption and elution test to establish the behaviour of Cu and Ag. It is known that the leach parameters can be varied to reduce adsorption of Cu onto carbon. A cold elution prior to the hot Au elution can also be effective in removal of Cu. This is to be used for the CIL modelling and prediction of the doré analysis.
- Settling tests of the concentrate and final tailings slurry streams for optimisation of the thickening design requirements.
- Filtration tests to confirm the design parameters for de-watering the concentrate and subsequent transport moisture content.
- Bulk solids tests on ore and concentrate to confirm the parameters of bulk density, angle of repose and valley angle for confirmation of the design characteristics for the transport and storage of the ore and concentrate.

1.17.2 Primary Crusher Location

The primary crusher location at the egress to the open pit has resulted in a pillar of payable material being used to provide a site for the crusher. It is therefore recommended that more detailed work should be undertaken as part of the FEED phase and a trade-off be conducted to evaluate the economics of trucking versus conveying and offset against the loss of revenue from the reduced mine resources.

1.17.3 Oxide Ore

The treatment of the oxide ore and hence the need for the stockpile should be reviewed. If this is done in conjunction with the crusher location then access to the crusher via the oxide stockpile would not be required.

1.17.4 Utilities

Based on the power and water supply requirements it is recommended that Euromax Resources:

- Keep in contact with the local utility, EVN, to explore other feasible solutions for the provision of construction power.
- Maintain ongoing communication with MEPSO regarding the application for bulk power supply.
- Conclude the agreement with SPWMC for supply of water.

1.17.5 General

Facilitate continuous interaction with the local population and expedite and monitor the permit approvals processes.

2. INTRODUCTION

This technical report comprises a FS concerning the Ilovica copper-gold deposit which lies within the Ilovica property in Eastern Macedonia owned by Euromax Resources.

The FS was prepared for Euromax Resources, a public company incorporated in British Columbia, Canada that is listed on the TSX Venture Exchange.

The maps and tables for this report were produced or derived from existing documents relating to the Property or produced specifically for the report as indicated and, except where otherwise indicated the map dates are as per the effective date of this report.

Various authors have contributed to this report and a summary of the qualified persons (QP) responsible for each section of this report is provided in Table 2.1.

Table 2.1 Summary of QPs			
Section	Title	Company	Signee
1	Summary		
1.1	Property Description	Amec Foster Wheeler	Hugh Browner, PrEng, MA, MBA, FSAIMM
1.2	Geological Setting and Mineralisation	Tetra Tech	Robert Davies, BSc, CGeol, EurGeol
1.3	Exploration	Tetra Tech	Robert Davies, BSc, CGeol, EurGeol
1.4	Drilling	Tetra Tech	Robert Davies, BSc, CGeol, EurGeol
1.5	Mineral Processing and Metallurgical Testing	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
1.6	Mineral Resource Estimates	Tetra Tech	Robert Davies, BSc, CGeol, EurGeol
1.7	Mineral Reserves	DMT	Richard Hope, BSc, CEng MIMMM
1.8	Mining Methods	DMT	Richard Hope, BSc, CEng MIMMM
1.9	Recovery Methods	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
1.10	Project Infrastructure		
1.10.1	Plant and Mining Infrastructure	Amec Foster Wheeler	Pieter Zietsman, PrEng, BSc(Eng)
1.10.2	Tailings Management Facility	Golder Associates (UK) Ltd (Golder)	Roger White, ARSM, BSc, MSc, CEng MIMMM
1.10.3	Hydrology and Hydrogeology	SWS	Angelo Papaioannou, BA, MCIWEM, FGS, CGeol
1.11	Environmental and Social Studies	Golder	Gareth Digges La Touche, MSc, FGS, CGeol, EurGeol
1.12	Market Studies and Contracts	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
1.13	Capital and Operating Costs		
1.13.1	Capital Costs	Amec Foster Wheeler	Peter Critcher, PrEng, BEng
1.13.2	Operating Costs	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
1.14	Economic Analysis	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
1.15	Project Implementation Plan	Amec Foster Wheeler	Gavin Chamberlain, PrEng, BSc(Eng)
1.16	Interpretation and Conclusions	Amec Foster Wheeler	Hugh Browner, PrEng, MA, MBA, FSAIMM

Table 2.1
Summary of QPs

Section	Title	Company	Signee
1.17	Recommendations	Amec Foster Wheeler	Hugh Browner, PrEng, MA, MBA, FSAIMM
2	Introduction	Amec Foster Wheeler	Hugh Browner, PrEng, MA, MBA, FSAIMM
3	Reliance on Other Experts	Amec Foster Wheeler	Hugh Browner, PrEng, MA, MBA, FSAIMM
4	Property Description and Location	Amec Foster Wheeler	Hugh Browner, PrEng, MA, MBA, FSAIMM
5	Accessibility, Climate, Local Resources, Infrastructure and Physiography		
5.1	Site Topography, Elevation and Vegetation	Amec Foster Wheeler	Hugh Browner, PrEng, MA, MBA, FSAIMM
5.2	Meteorology	SWS	Angelo Papaioannou, BA, MCIWEM, FGS, CGeol
5.3	Local Population	Amec Foster Wheeler	Hugh Browner, PrEng, MA, MBA, FSAIMM
5.4	Regional Infrastructure	Amec Foster Wheeler	Hugh Browner, PrEng, MA, MBA, FSAIMM
6	History	Tetra Tech	Robert Davies, BSc, CGeol, EurGeol
7	Geological Setting and Mineralisation	Tetra Tech	Robert Davies, BSc, CGeol, EurGeol
8	Deposit Types	Tetra Tech	Robert Davies, BSc, CGeol, EurGeol
9	Exploration	Tetra Tech	Robert Davies, BSc, CGeol, EurGeol
10	Drilling	Tetra Tech	Robert Davies, BSc, CGeol, EurGeol
11	Sample Preparation, Analyses and Security	Tetra Tech	Robert Davies, BSc, CGeol, EurGeol
12	Data Verification	Tetra Tech	Robert Davies, BSc, CGeol, EurGeol
13	Mineral Processing and Metallurgical Testing		
13.1	Metallurgical Test Samples	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
13.2	Mineralogical Test Work	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
13.3	Phase II and Phase II Residual Test Work Review		
13.3.1	Comminution Test Work	Amec Foster Wheeler	Dean David, FAusIMM, CP(Met)
13.3.2	Flotation Test Work	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
13.3.3	Gravity Recoverable Gold	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
13.3.4	Cyanide Leaching Tests	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
13.4	Phase III Metallurgical Test Work Review		
13.4.1	Planned Test Work	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
13.4.2	Comminution Test Work	Amec Foster Wheeler	Dean David, FAusIMM, CP(Met)
13.4.3	Flotation Test Work	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
13.4.4	Estimated Metal Distributions	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
13.4.5	Comments	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
13.4.6	Future Test Work Requirements	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng

Table 2.1
Summary of QPs

Section	Title	Company	Signee
14	Mineral Resource Estimates	Tetra Tech	Robert Davies, BSc, CGeol, EurGeol
15	Mineral Reserve Estimates	DMT	Richard Hope, BSc, CEng MIMMM
16	Mining Methods	DMT	Richard Hope, BSc, CEng MIMMM
17	Recovery Methods		
17.1	Flow Sheet Development	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
17.2	Flow Sheet Selection		
17.2.1	General	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
17.2.2	Grinding Circuit Design	Amec Foster Wheeler	Dean David, FAusIMM, CP(Met)
17.2.3	Gravity Recoverable Gold	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
17.2.4	Flotation Circuit Design	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
17.2.5	Cyanide Leaching and Adsorption Tests	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
17.2.6	Design Criteria	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
17.2.7	Process Description	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
17.2.8	Mass and Water Balance	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
17.2.9	Process Control Philosophy	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
17.2.10	Metallurgical and Assay Laboratory	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
17.3	Engineering		
17.3.1	Engineering Development	Amec Foster Wheeler	Hugh Browner, PrEng, MA, MBA, FSAIMM
17.3.2	Civil	Amec Foster Wheeler	Pieter Zietsman, PrEng, BSc(Eng)
17.3.3	Structural	Amec Foster Wheeler	Pieter Zietsman, PrEng, BSc(Eng)
17.3.4	Mechanical	Amec Foster Wheeler	Peter Critcher, PrEng, BEng
17.3.5	Piping	Amec Foster Wheeler	Peter Critcher, PrEng, BEng
17.3.6	Electrical	Amec Foster Wheeler	Jeff White, CEng, PrEng, BEng
17.3.7	Control and Instrumentation	Amec Foster Wheeler	Jeff White, CEng, PrEng, BEng
18	Project Infrastructure		
18.1	Plant and Mining Infrastructure	Amec Foster Wheeler	Pieter Zietsman, PrEng, BSc(Eng)
18.2	Tailings Management Facility	Golder	Roger White, ARSM, BSc, MSc, CEng MIMMM
18.3	Hydrology and Hydrogeology	SWS	Angelo Papaioannou, BA, MCIWEM, FGS, CGeol
19	Market Studies and Contracts	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
20	Environmental Studies, Permitting and Social or Community Impact	Golder	Gareth Digges La Touche, MSc, FGS, CGeol, EurGeol
21	Capital and Operating Costs		
21.1	Capital Costs		
21.1.1	Overall Capital Costs Summary	Amec Foster Wheeler	Peter Critcher, PrEng, BEng
21.1.2	Mining (1000)	DMT	Richard Hope, BSc, CEng MIMMM
21.1.3	Process Plant (3000)	Amec Foster Wheeler	Peter Critcher, PrEng, BEng
21.1.4	Tailings Management Facility (4000)	Golder	Roger White, ARSM, BSc, MSc, CEng MIMMM
21.1.5	Off Site Infrastructure (5000)	Amec Foster Wheeler	Peter Critcher, PrEng, BEng

Table 2.1 Summary of QPs			
Section	Title	Company	Signee
21.1.6	On Site Infrastructure (7000)	Amec Foster Wheeler	Peter Critcher, PrEng, BEng
21.1.7	EPCM Indirects (8000)	Amec Foster Wheeler	Peter Critcher, PrEng, BEng
21.1.8	Temporary Facilities (9000)	Amec Foster Wheeler	Peter Critcher, PrEng, BEng
21.2	Operating Costs		
21.2.1	Overall Operating Costs Summary	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
21.2.2	Mining (1000)	DMT	Richard Hope, BSc, CEng MIMMM
21.2.3	Process Plant (3000)	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
21.2.4	Tailings Management Facility (4000)	Golder	Roger White, ARSM, BSc, MSc, CEng MIMMM
21.2.5	Off Site Infrastructure (5000)	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
21.2.6	On Site Infrastructure (7000)	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
22	Economic Analysis	Amec Foster Wheeler	Berno Dippenaar, PrEng, BEng
23	Adjacent Properties	N/A	
24	Other Relevant Data and Information	Amec Foster Wheeler	Gavin Chamberlain, PrEng, BSc(Eng)
25	Interpretation and Conclusions	Amec Foster Wheeler	Hugh Browner, PrEng, MA, MBA, FSAIMM
26	Recommendations	Amec Foster Wheeler	Hugh Browner, PrEng, MA, MBA, FSAIMM
27	References	N/A	

Mr. Robert Davies of Tetra Tech conducted a site visit between the 16th and 20th of June 2015. Mr. Davies is a BSc, CGeol, EurGeol and a QP as defined by NI 43-101.

Mr. Richard Hope of DMT conducted a site visit between the 27th and 29th of May 2015. Mr. Hope is a BSc, CEng MIMMM and a QP as defined by NI 43-101.

Mr. Hugh Browner of Amec Foster Wheeler conducted a site visit between the 15th and 19th of February 2015. Mr. Browner is a PrEng, MA, MBA, FSAIMM and a QP as defined by NI 43-101.

Mr. Berno Dippenaar of Amec Foster Wheeler conducted a site visit between the 15th and 19th of February 2015. Mr. Dippenaar is a PrEng, BEng and a QP as defined by NI 43-101.

Mr. Pieter Zietsman of Amec Foster Wheeler conducted a site visit between the 15th and 19th of February 2015. Mr. Zietsman is a PrEng, BSc(Eng) and a QP as defined by NI 43-101.

Mr. Gavin Chamberlain of Amec Foster Wheeler conducted a site visit between the 12th and 14th of June 2015. Mr. Chamberlain is a PrEng, BSc(Eng) and a QP as defined by NI 43-101.

Mr. Dean David of Amec Foster Wheeler conducted a site visit between the 13th and 14th of June 2015. Mr. David is a FAusIMM, CP(Met) and a QP as defined by NI 43-101.

3. RELIANCE ON OTHER EXPERTS

For legal aspects of the exploration licences, mining concessions, royalties and rights granted by the Government of Macedonia, along with environmental and political issues, the authors are relying on information provided by Euromax Resources and its legal representatives, Mens Legis of Skopje, Macedonia. This is disclosed in Section 4.2.

Work done by Amec Foster Wheeler has been used by the authors for Sections 13, 17, 18, 21, 22 and 24.

Work done by Tetra Tech has been used by the authors for Sections 6, 7, 8, 9, 10, 11, 12 and 14.

Work done by DMT has been used by the authors for Sections 15, 16 and 21.

Work done by Golder has been used by the authors for Sections 18, 20 and 21.

Work done by SWS has been used by the authors for Section 5 and 18.

4. PROPERTY DESCRIPTION AND LOCATION

4.1 LOCATION

The Ilovica property is located in the southeast of Macedonia, approximately 15 km to the west of the border with Bulgaria, as shown in Figure 4.1. The centre of the mineralised zone is located at coordinates 7 654 000 E, 4 595 500 N Hermannskogel Projection.

Figure 4.1
Regional Location Map



Source: Nations Online Project

The project lies within the municipality of Bosilovo, approximately 20 km to the east of the town of Strumica (Figure 4.2) and is situated on the western slopes of the Maleševske mountain range. The project area is part of Mount Ograzhden and ranges from 450 m AMSL to a maximum elevation of approximately 860 m AMSL. The main valley where the village of Ilovica is located, is at approximately 260 m AMSL.

Figure 4.2
Local Location Map



Source: Google Maps

4.2 MINERAL TENURE

4.2.1 Mineral Rights

Mining is mainly regulated by the Law on Mineral Resources (“Official Gazette of the Republic of Macedonia” Nos. 136/12, 25/13, 93/13, 44/14, 160/14, 129/2015 and 192/2015) and respective bylaws passed by the Ministry of Economy. The right to conduct the exploitation of mineral resources is acquired by receiving a concession for exploitation by the Government. Any legal entity, including foreign legal entities with branch offices registered within the Central Register, is entitled to such right on obtaining exploitation concession, under the terms prescribed by the Law.

4.2.2 Property Details

The two contiguous concession agreements, held in the name of Euromax Resources DOO Skopje (concessionaire), covering the locality of “Ilovica”, municipality Bosilovo and municipality Novo Selo in Macedonia, known as Ilovica 6 and Ilovica 11, are:

- Concession Agreement for exploitation of minerals – ores of copper and gold at the locality “Ilovica”, municipality Bosilovo, registered with the Ministry of Economy of the Republic of Macedonia (“Ministry”) under the archive number 24-4563/1 from 23/09/2014 and Euromax Resources DOO Skopje’s archive number 09-10/14 from 10/10/2014, as amended and supplemented with Annex to the Concession Agreement registered with the Ministry under the archive number 24-4170/1 from

22/06/2015 and Euromax Resources DOO Skopje's archive number 0302-256/15 from 22/06/2015 ("Concession Agreement" or "Ilovica 6");

- Concession Agreement for exploitation of minerals – ores of copper and gold at the locality "Ilovica", municipality Bosilovo and municipality Novo Selo, registered with the Ministry under the archive number 24-40/2 from 13/01/2016 and Euromax Resources DOO Skopje's archive number 0402-09/16 from 13/01/2016 ("New Concession Agreement" or "Ilovica 11");

The Concession Agreement is valid until 24 July 2042. The New Concession Agreement is valid for 30 years as of the day of signing, i.e. until 13 January 2046.

The Concession Agreement and the New Concession Agreement have been certified as being in good standing by Mens Legis Law Firm based in Skopje.

The concession area and concession coordinates are presented in Figure 4.3 and Table 4.1, respectively.

Figure 4.3
Concession Area

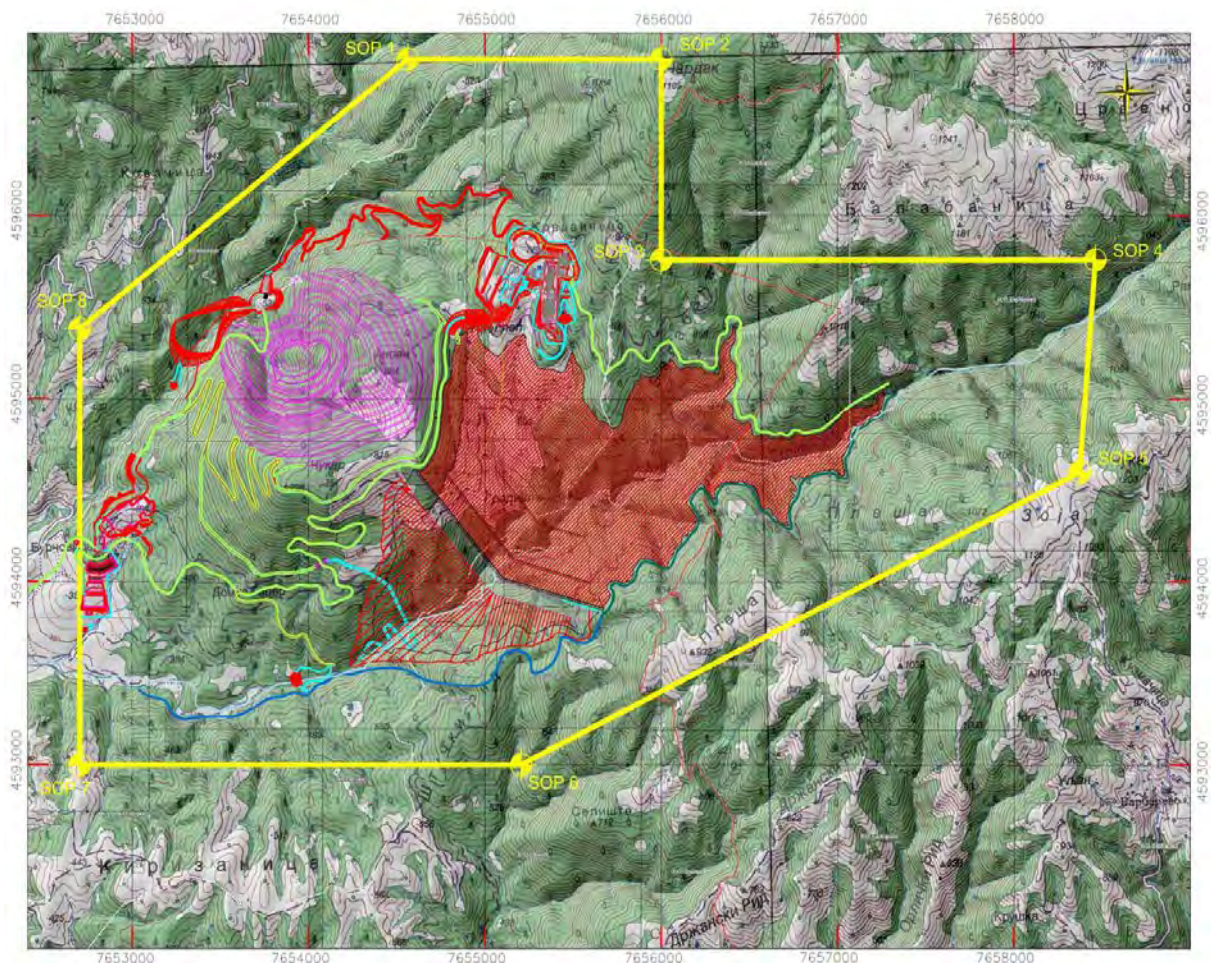


Table 4.1 Concession Coordinates		
Point No.	Easting	Northing
SOP 1	4596857.126	7654562.840
SOP 2	4596857.126	7656000.000
SOP 3	4595759.035	7656000.000
SOP 4	4595759.035	7658463.118
SOP 5	4594599.830	7658374.874
SOP 6	4593000.000	7655205.397
SOP 7	4593000.000	7652701.593
SOP 8	4595383.880	7652701.593

4.2.3 Surface Rights

Mineral resources are owned by the Republic of Macedonia, irrespective of the ownership of the land they are located on.

The area (land) that is granted for exploitation of minerals – ores of copper and gold, amounts to some 17.1 km² and it is located in the locality of Ilovica, municipality Bosilovo and municipality Novo Selo, Macedonia. The concessionaire does not establish ownership over the state owned land on which the exploitation shall be performed and the land remains state property. Therefore the right to develop the property is granted through a construction permit and urbanisation process.

The Expropriation Law (“Official Gazette of Republic of Macedonia” Nos. 95/2012, 131/2012, 24/2013, 27/2014, 104/2015 and 192/2015) prescribes that the right of ownership, inter alia, could be restricted due to temporary seizure of the land for the purpose of performing detailed geological explorations.

4.2.4 Taxes and Royalties

There are no special rules applicable to the taxation of exploration mining entities. The only exception is prescribed in that the turnover of gold and other precious metals towards the central bank is exempted from value added tax (VAT).

The concessionaire performing detailed geological explorations of mineral resources is obliged to pay a one-part fee for the use of an area, in an amount determined depending on the type of mineral resource.

The compensation for the concession for exploitation of minerals (concession fee) is consisted of:

- An annual fee for use of the location, i.e. the area granted with the exploitation concession, depending on the type of the mineral that is subject to the concession,
- Compensation for exploitation of the minerals – ores of copper and gold, that are subject to the concession.

The amount and manner of payment of the concession fee is specified in the Tariff Book for determination of the amount of the compensation for issuing permits and concessions for detailed geological explorations and concessions for exploitation of minerals.

The annual fee for use of the location or the surface amounts to 180 000 Denar/km² (2 926.83 €/km²) for surface and/or underground exploitation of metallic minerals.

The compensation for exploitation of the minerals amounts to:

- 2% of the market value of the metal of copper per ton in each ton of copper concentrate produced.
- 2% of the market value of the gold produced in each ton of gold concentrate produced.

The grounds for calculation of the compensation for exploitation of the minerals that the concessionaire is obliged to pay for the produced quantities of minerals is the Official Report on the average price of metals on the London Metal Stock Exchange for the period of 3 (three) months backwards (market value). Based on the Official Report on the average price of metals, the Ministry of Economy quarterly publishes the average price of the metals in the Official Gazette of the Republic of Macedonia.

4.2.5 Property Maintenance and “Close-out Costs”

The concessionaire is obliged to implement at its own expense measures for environmental protection and protection of nature and cultural heritage, as well as measures for re-cultivation of the land in accordance with the law.

The concessionaire is obliged to compensate in whole the damage caused to third persons during the exploitation of minerals and the damage caused to the environment.

After finishing the exploitation and the mining works, the concessionaire is obliged to perform reparation of the area and re-cultivation of the land. In case the concessionaire does not perform this activity, the grantor will perform the reparation at the expense of the concessionaire. All costs for reparation of eventually occurred deformations on the road and road zone, during the exploitation or from motion and operation of the mechanisation on the road infrastructure shall be covered by the concessionaire.

5. ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 SITE TOPOGRAPHY, ELEVATION AND VEGETATION

The project is situated on the western slopes of the Maleševske mountain range (Figure 5.1). The project area is part of Mount Ograzhden and ranges from 450 m AMSL to a maximum elevation of approximately 860 m AMSL. The main valley where the village of Ilovica is located is at approximately 260 m AMSL.

Figure 5.1
View of the Ilovica Project Area Looking West



Source: Tetra Tech

The area comprises an undulating mountainous topography, with moderately rugged steep slopes up to 30° and generally rounded mountain tops, Figure 5.2. The Strumica valley floor is flat, Figure 5.3.

Figure 5.2
View of the Mountainous Topography Looking West from the Project Area



Source: Tetra Tech

Figure 5.3
View of the Flat Valley Floor Looking East from the Project Area



Source: Tetra Tech

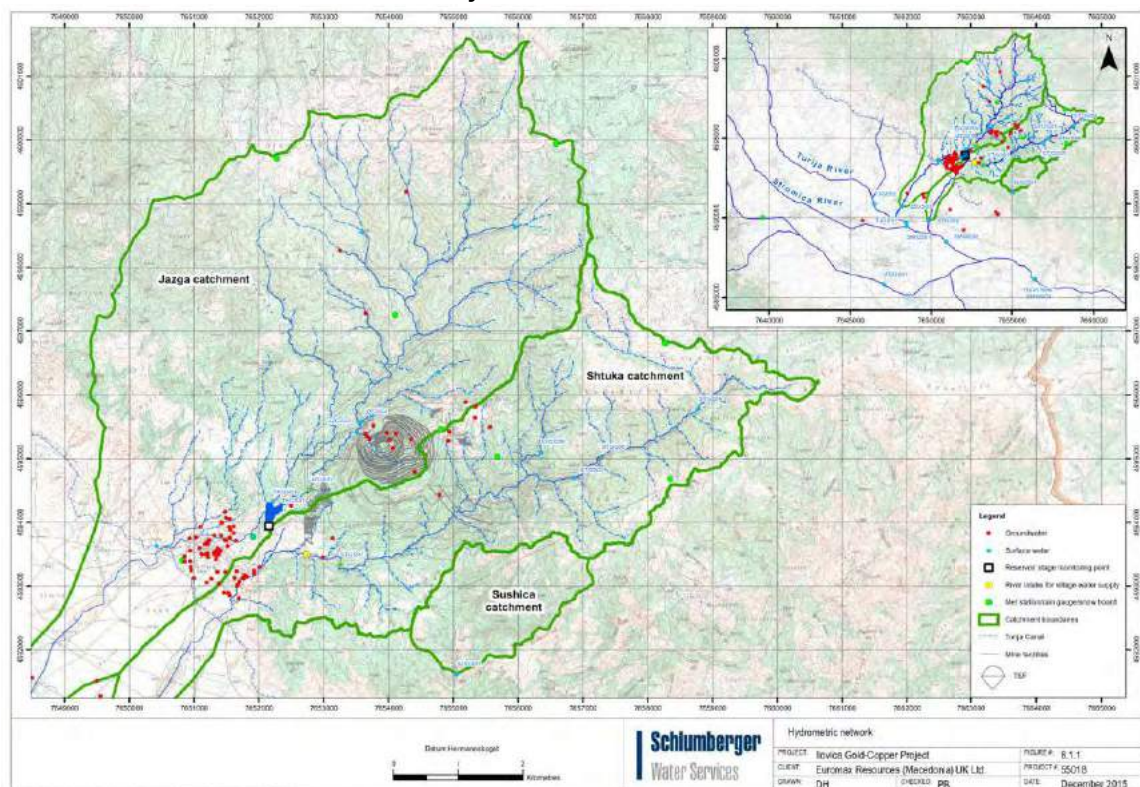
The mountains of the area are relatively unspoiled and contain a combination of Sub- Mediterranean Balkan forests and Balkan Mid-European forests. The forests are natural and include oak, beech, chestnut, black and white pine and walnut trees, with Sessile Oak forests dominating. Clearing of the forest for livestock pasture has occurred creating steppes on the less steep saddles and lower slopes. Where this has occurred, meadow grassland now predominates.

5.2 METEOROLOGY

5.2.1 Approach

Establishing the meteorology of the project site was undertaken by SWS and Golder. Long term meteorological records for Strumica meteorological station and Ilovica village rain gauge were obtained from the national Hydrometeorological Service in Skopje. In May 2013 Euromax Resources established an automatic weather station at 850 m AMSL in the vicinity of the proposed plant site which has recorded rainfall, temperature, humidity, solar radiation and wind speed and direction at various sub-daily time intervals. The meteorological station was supplemented by a network of rain gauges and snow boards established by SWS in the Jazga and Shtuka catchments in early 2014 as shown in Figure 5.4. Details of the rain gauges, snow boards and QA/QC procedures used on rain gauge data are presented in the ESIA Baseline Report (Golder and SWS, in prep.)²

Figure 5.4
Hydrometric Network



² Golder and SWS. In prep. Ilovica Gold-Copper Project Environmental and Social Impact Assessment. Environmental Baseline Report.

As rainfall records at elevation in the project catchments were short and inadequate for engineering design, the daily rainfall records at Ilovica and Strumica, the nearest long term stations to the project site, were transposed to synthesise a 54 yr daily rainfall record at each of the project rain gauges including the plant site. This was done by applying adjustment factors to the Euromax Resources met station record. The adjustment factors were derived between the overlapping Euromax Resources met station and daily rainfall records from both Strumica and Ilovica. The synthesised rainfall record for the plant site was analysed to obtain design rainfalls.

SWS and the UK Met Office were commissioned by Euromax Resources to estimate the probable maximum precipitation (PMP) for input to the design of the TMF.

5.2.2 Regional Meteorology

Owing to its southerly, landlocked situation, Macedonia's regional meteorology is characterised by a combination of Mediterranean and continental-style climates. The typical Mediterranean climate of warm, dry summers and mild, wet winters is modified by the proximity of continental Eurasia so that summers are hot with generally cold, but variable winters and a double peak in rainfall in late spring and autumn/winter.

5.2.3 Project Site Meteorology

5.2.3.1 Rainfall

Table 5.1 presents annual statistics for the historical daily rainfall records at Strumica, Ilovica village and the synthesised rainfall record at the plant site. The rainfall record for the plant site may also be considered representative of rainfall on the deposit area. Note that data are presented by hydrological year, which starts in October. The hydrological year starts when the hydrological system is on average at its driest.

Table 5.1 Annual rainfall statistics for Strumica, Ilovica village and plant site										
	Elev. (m AMSL)	Start	End	Length of record (years)	Mean (mm)	Min (mm)	Max (mm)	Variance (mm ²)	Standard Deviation (mm)	Coefficient of Variation (%)
Strumica	232	Oct 1960	Sep 2014	54	580	311	800	11432	107	18
Ilovica	292	Oct 1960	Sep 2011	51	546	297	835	12659	113	21
Plant site	850	Oct 1960	Sep 2014	54	715	406	1039	18738	137	19

Data sources: Hydrometeorological Service, Skopje; Euromax Resources

Figure 5.5 shows the time series of synthesised annual rainfalls for the plant site. Drought conditions occurred in 1991/92 and 1992/93 and again in 1999/2000 and 2000/01.

Figure 5.5
Estimated annual rainfall series, plant site, hydrological years 1960/61-2013/14

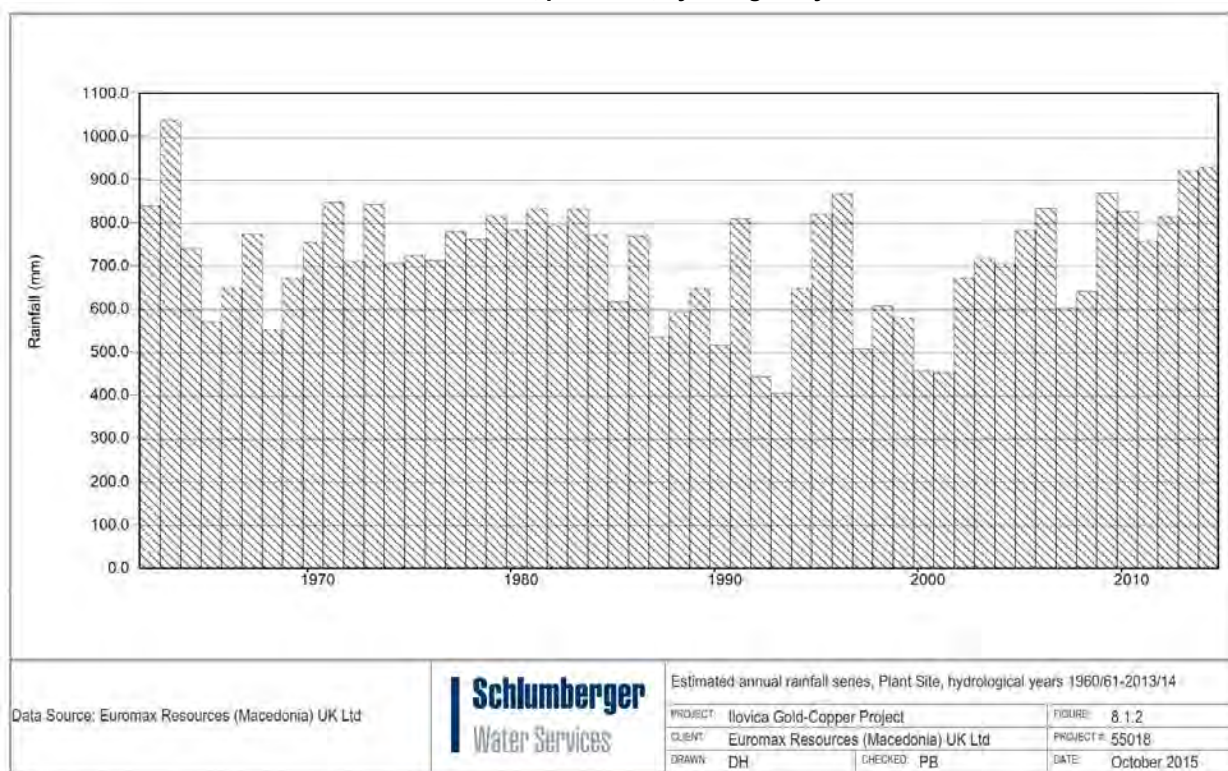
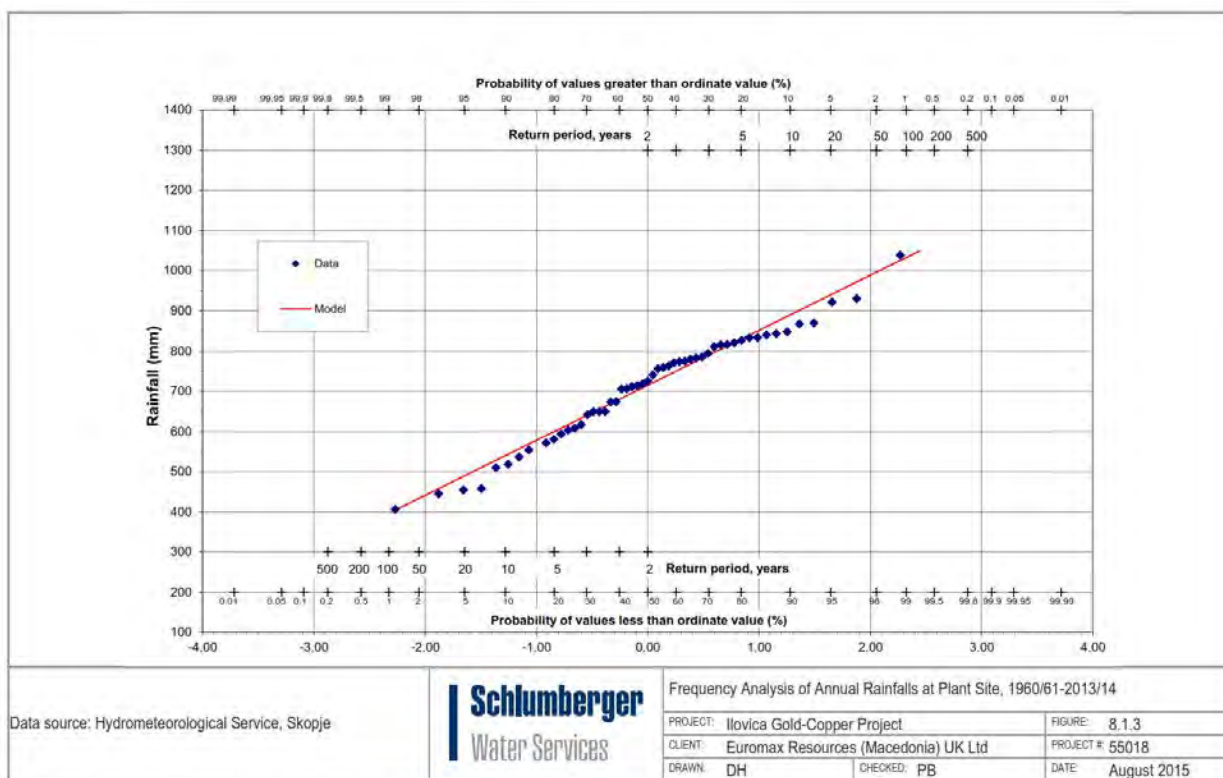


Figure 5.6
Frequency analysis of annual rainfalls at plant site, 1960/61-2013/14



The results of a frequency analysis of synthesised annual rainfall totals at the plant site are shown in Figure 5.6 and presented in Table 5.2.

Table 5.2 Estimates of annual rainfall (mm) in dry, average and wet years at the plant site based on synthesised data 1960/61 - 2013/14										
Dry Years					Mean	Wet Years				
Return Period (years)										
100	50	25	10	5	2	5	10	25	50	100
Annual Exceedance Probability										
0.99	0.98	0.96	0.90	0.80	0.5	0.2	0.1	0.04	0.02	0.01
396	433	475	539	600	715	830	891	955	997	1034

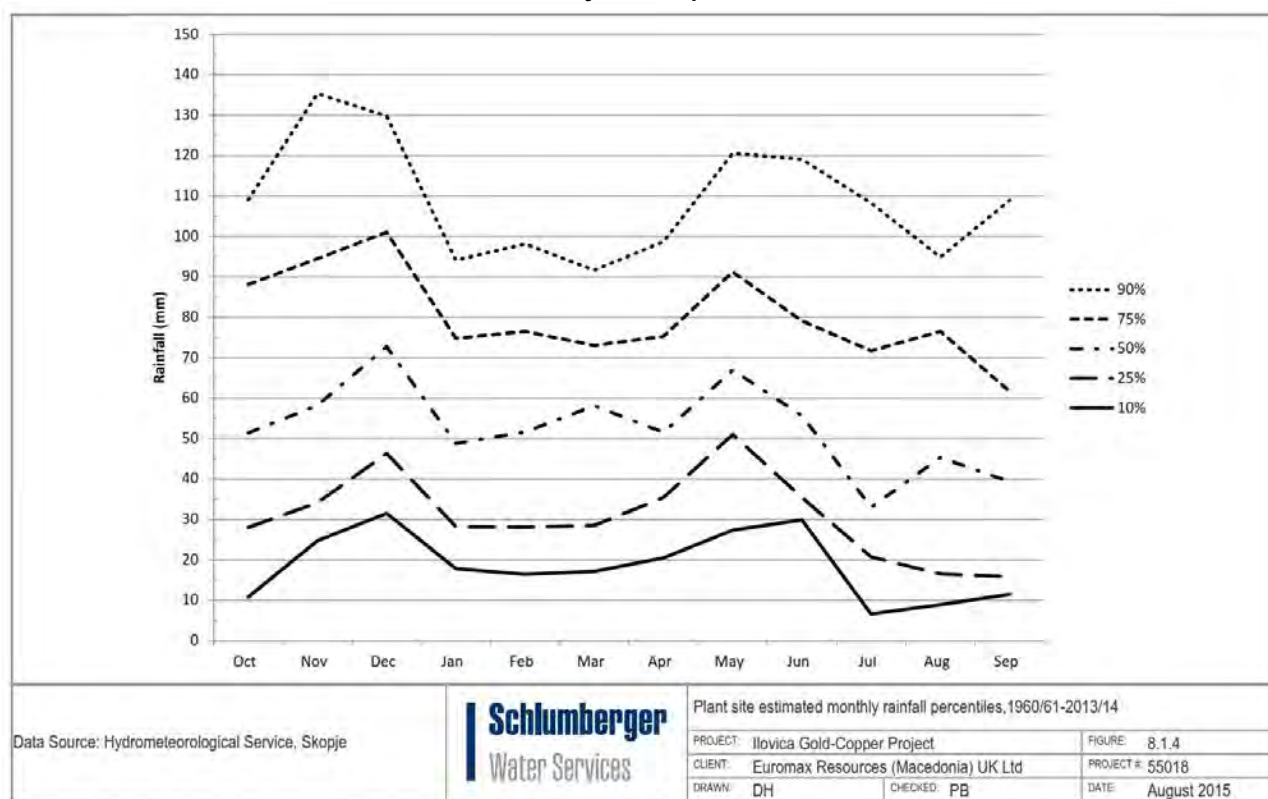
Table 5.3 presents mean monthly rainfalls at the plant site and the percentage contribution of each month to the annual mean total.

Table 5.3 Estimates of monthly rainfalls (mm) and their percentage contribution to mean annual rainfall, plant site, 1960/61 - 2013/14													
	O	N	D	J	F	M	A	M	J	J	A	S	Ann
Mean	60.9	69.1	77.3	54.1	57.6	55.8	58.1	73.6	64.7	46.9	47.9	49.1	715
%	8.5	9.7	10.8	7.6	8.1	7.8	8.1	10.3	9.0	6.6	6.7	6.9	

Percentiles of monthly rainfall were calculated from the plant site monthly record and are presented in Table 5.4 and Figure 5.7.

Table 5.4 Estimated percentile monthly rainfall (mm) at the plant site, 1960/61 - 2013/14												
	O	N	D	J	F	M	A	M	J	J	A	S
90%	109.1	135.3	129.8	94.1	98.1	91.6	98.7	120.6	119.0	108.2	94.9	108.9
75%	88.1	94.5	101.0	74.8	76.5	73.0	75.3	91.2	79.1	71.7	76.5	61.7
50%	51.4	58.2	72.7	48.8	51.6	58.1	51.5	66.9	55.7	33.0	45.3	39.4
25%	28.0	34.1	46.3	28.2	28.1	28.5	35.4	51.0	35.4	20.7	16.5	15.8
10%	10.8	24.7	31.5	17.8	16.4	17.1	20.5	27.3	29.9	6.6	8.9	11.4

Figure 5.7
Plant site estimated monthly rainfall percentiles, 1960/61-2013/14



The average number of non-precipitation days for each month has been estimated for the plant site using the synthesised daily rainfall data set for the plant site and the observed daily snowfall data set for Berovo and is presented in Table 5.5.

Table 5.5													
Estimated average, maximum and minimum number of non-precipitation days at the plant site													
	O	N	D	J	F	M	A	M	J	J	A	S	Average
Mean	15.7	12.5	9.9	10.7	8.7	12.3	12.8	13.3	14.4	16.9	16.2	15.4	159
Max	23	20	24	18	19	19	22	23	19	23	23	22	183
Min	9	4	3	0	0	0	6	3	4	11	5	5	112

5.2.4 Extreme Rainfall Analysis

An extreme rainfall analysis was carried out of plant site daily rainfalls in order to provide information for hydrological design. Annual maximum daily rainfalls were extracted from the plant site synthetic record. Prior to analysis the annual maxima daily data were converted to 24 h rainfall equivalents by multiplying them by 1.13 as recommended in WMO (1986)³ and a standard graphical frequency analysis was carried out.

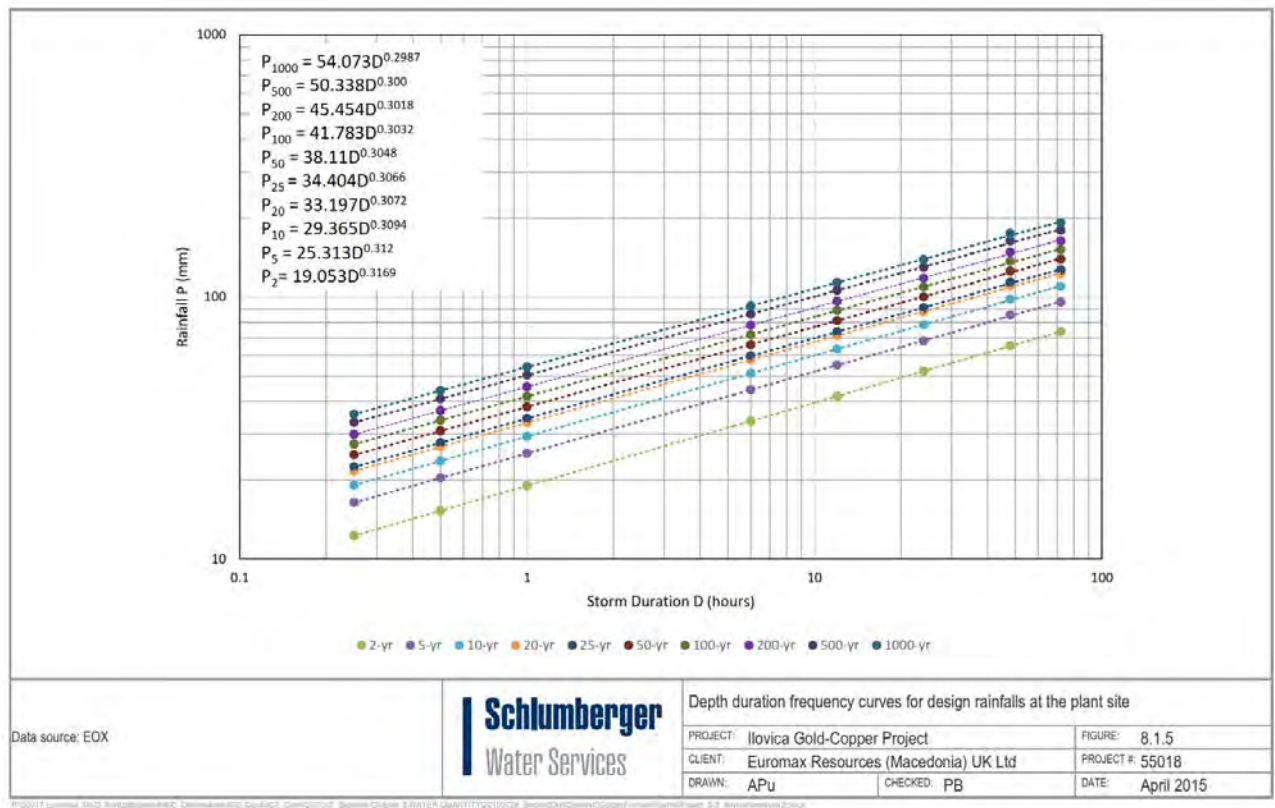
³ Daily rainfalls are measured in a fixed observational interval, e.g. a day starting at 09:00 hrs. In preparation for frequency analysis they need to be converted to an equivalent 24 h interval that can start at any time. WMO. 1986. Manual on estimation of Probable Maximum Precipitation (PMP). WMO Report No. 332, World Meteorological Organisation, Geneva.

Annual maximum 48 h and 72 h rainfall totals were also derived. A number of distributions were fitted to the data. The Log-Normal distribution was found to give the best fit. The resulting rainfall depths for 24 h, 48 h and 72 h durations were plotted against storm duration and regression 'lines of best fit' were extrapolated to shorter storm durations. This process was repeated for a range of return periods.

Table 5.6 and Figure 5.8 present depth-duration-frequency (DDF) results for the plant site. These curves are considered to also be representative of the wider project site. Equations for the lines of best fit for each return period are presented in Figure 5.8. The tabulated and plotted values should be used for hydrological analysis. The equations should only be used to estimate rainfall depths for storm durations which are not presented.

Table 5.6							
Rainfall depth-duration-frequency results (mm) for the project site							
Return period (years)	Storm Duration (hours)						
	0.5	1	6	12	24	48	72
2	15.3	19.1	33.6	41.9	52.1	65.2	73.8
5	20.4	25.3	44.3	55.0	68.1	85.3	95.7
10	23.7	29.4	51.1	63.3	78.2	98.1	109.7
20	26.8	33.2	57.6	71.2	87.8	110.2	122.7
25	27.8	34.4	59.6	73.7	90.8	114.0	126.8
50	30.9	38.1	65.8	81.3	100.0	125.6	139.3
100	33.9	41.8	71.9	88.8	109.0	137.0	151.5
500	40.9	50.3	86.2	106.1	129.8	163.4	179.7
1000	44.0	54.1	92.3	113.6	138.8	174.8	191.9

Figure 5.8
Depth duration frequency curves for design rainfalls at the plant site



Bell (1969)⁴ developed generalised worldwide DDF relationships and showed that for a 1 h duration, the 100 yr amount is normally about 2.3 times the 2 yr amount and this ratio is reasonably consistent from stations around the world. The range of the 'Bell ratio' is from about 1.9 to 2.9. The 'Bell ratio' for the project site is 2.2, falling within the normal range expected and therefore lending some confidence to these results. Further confidence is provided with a check on the plant site derivations using the appropriate r term given in the UK Flood Studies Report (NERC, 1975)⁵. The corresponding values obtained were very similar to the estimated values in Table 5.6.

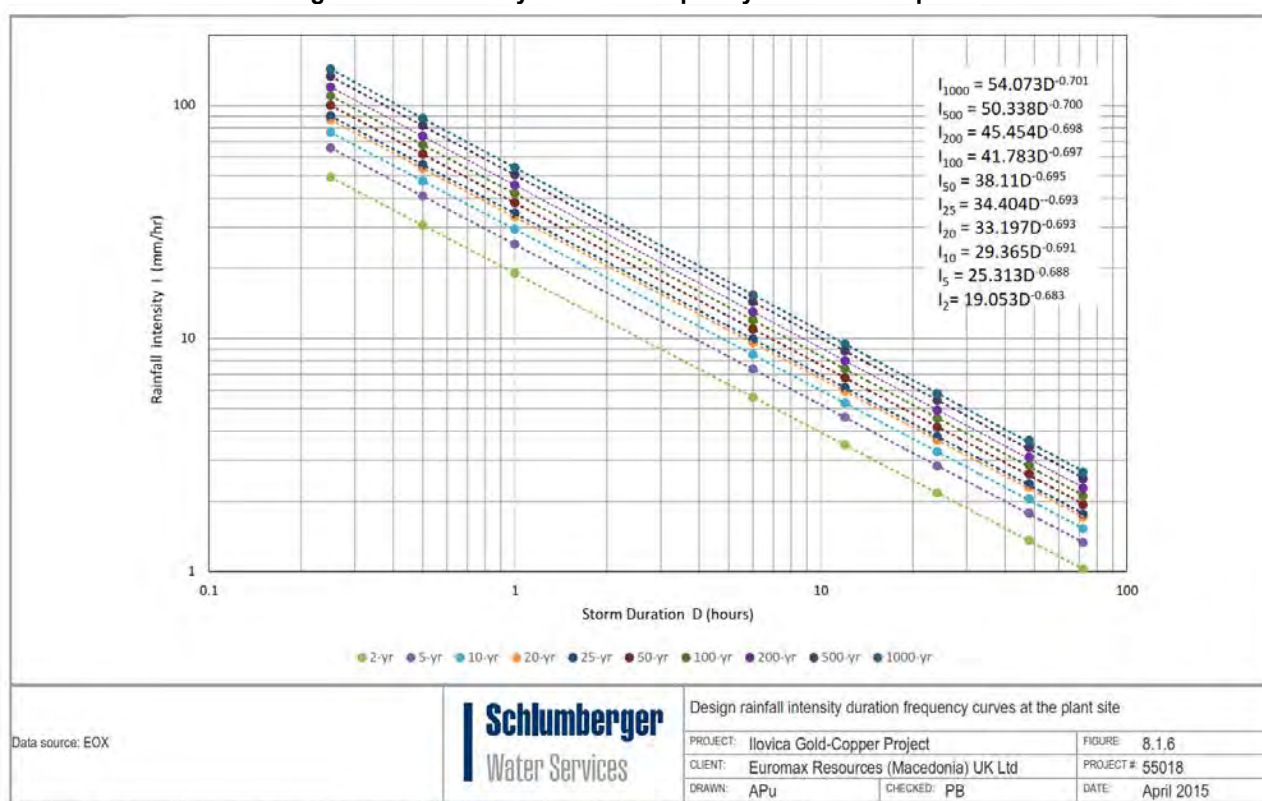
Table 5.7 and Figure 5.9 present the DDF results in terms of rainfall intensity-duration-frequency (IDF) for the project site.

⁴ Bell F C. 1969. Generalised rainfall-duration-frequency relationships. Journal of the Hydraulics Division, ASCE, HY1 January.

⁵ NERC, 1975. Section 3.3.3 (Table 3.7) of Volume II (Meteorological Studies)– Flood Studies Report; Natural Environment Research Council (UK Institute of Hydrology), 1975.

Table 5.7							
Rainfall intensity-duration-frequency results (mm/h) for the project site							
Return period (years)	Storm Duration (hours)						
	0.5	1	6	12	24	48	72
2	30.6	19.1	5.6	3.5	2.2	1.4	1.0
5	40.8	25.3	7.4	4.6	2.8	1.8	1.3
10	47.4	29.4	8.5	5.3	3.3	2.0	1.5
20	53.7	33.2	9.6	5.9	3.7	2.3	1.7
25	55.6	34.4	9.9	6.1	3.8	2.4	1.8
50	61.7	38.1	11.0	6.8	4.2	2.6	1.9
100	67.7	41.8	12.0	7.4	4.5	2.9	2.1
500	81.8	50.3	14.4	8.8	5.4	3.4	2.5
1000	87.9	54.1	15.4	9.5	5.8	3.6	2.7

Figure 5.9
 Design rainfall intensity duration frequency curves at the plant site



The results in Table 5.6 and Table 5.7 are considered to be representative of the project site and may be used for hydrological design until at least 4 years of detailed rainfall records have been recorded by the project rain gauges whereupon analysis of those data should be undertaken to possibly provide alternative design curves to those presented here.

5.2.5 Probable Maximum Precipitation

PMP was estimated for the project site by the UK Met Office using the guidance and methods provided in the WMO Manual No. 1045 (2009)⁶ on PMP estimation and specifically Chapter 3, Section 3.4, PMP estimation with modification of non-orographic PMP for orography using the indirect Generalised Estimation Method.

SWS recommended that the Met Office's base estimate of PMP of 278 mm should be adopted for hydrological designs which require use of the PMP. An alternative estimate of PMP of 347 mm made by SWS using Hershfield's rapid statistical method (Golder and SWS, 2015)⁷ was considered to be an overestimate.

Although heavy rainfall events can occur at any time throughout the year, it was deduced that it is most likely that the PMP will occur during summer. Evidence was also found of heavy rainfall caused by slow moving frontal systems in late autumn. However, the rainfall produced through summer convection is considered the dominant mechanism most likely to cause PMP.

5.2.6 Snow

In order to estimate snow fall at the project site snow depth data were obtained for Berovo meteorological station at 850 m AMSL some 40 km to the north of the project site. Table 5.8 summarises monthly snowfall data recorded at Berovo over the period Oct 1961 to September 2014.

Table 5.8 Mean monthly snow depth (cm) at Berovo (850 m AMSL), 1960/61 - 2013/14													
	O	N	D	J	F	M	A	M	J	J	A	S	Annual
Mean	1	7	20	20	15	9	2	1	0	0	0	0	74
Max	25	66	78	81	53	32	18	28	0	0	0	0	81
Min	0	0	0	0	0	0	0	0	0	0	0	0	0

Data Source: Hydrometeorological Service, Skopje

A daily record of snow water equivalent was estimated for Berovo by assuming a snow density of 0.1. Table 5.9 summarises monthly snow water equivalent at Berovo.

Table 5.9 Mean monthly snow water equivalent (mm) at Berovo meteorological station (850 m AMSL), 1960/61 - 2013/14													
	O	N	D	J	F	M	A	M	J	J	A	S	Average
Mean	0.8	6.7	19.7	19.6	15.3	9.5	2.2	0.5	0	0	0	0	74.3
Max	25	66	78	81	53	32	18	28	0	0	0	0	81
Min	0	0	0	0	0	0	0	0	0	0	0	0	0

Data Source: Hydrometeorological Service, Skopje

⁶ WMO. 2009. Manual on estimation of Probable Maximum Precipitation (PMP). WMO Report No. 1045, World Meteorological Organisation, Geneva.

⁷ Golder and SWS (2015) Environmental and Social Engineering Considerations. Golder Report No. 135141503363.526/A.0, June and July editions.

In Table 5.10 and Figure 5.10 average monthly snow water equivalent for Berovo (Table 5.9) is added to average monthly rainfall for the plant site (Table 5.3) to estimate the average total monthly precipitation at the plant site. Table 5.10 suggests that on average snow water equivalent may form up to about 26% of precipitation on a monthly basis and 9% of precipitation on an annual basis at the plant site. Berovo is situated in a valley surrounded by mountains and is likely to experience greater snowfall than at the project site which is situated on a south-facing mountain slopes. Nevertheless the Berovo data likely provide an indication of the maximum contribution of snowfall to precipitation at the project site.

Table 5.10													
Mean monthly precipitation (mm) at plant site using Berovo data for snow water													
	O	N	D	J	F	M	A	M	J	J	A	S	Total
Rain ^a	60.9	69.1	77.3	54.1	57.6	55.8	58.1	73.6	64.7	46.9	47.9	49.1	715
SWE ^b	0.8	6.7	19.7	19.6	15.3	9.5	2.2	0.5	0	0	0	0	74
Total	61.7	75.8	97	73.7	72.9	65.3	60.3	74.1	64.7	46.9	47.9	49.1	789
SWE% ^c	1.3	8.8	20.3	26.6	21.0	14.5	3.6	0.7	0.0	0.0	0.0	0.0	9.4

Data source: Hydrometeorological Service, Skopje.

Notes: a. Rainfall for Ilovica plant site (Table 5.3). b. Berovo snow water equivalent (Table 5.9). c. Snow water equivalent as a percentage of total monthly precipitation.

Figure 5.10
 Plant site average monthly precipitation and evaporation

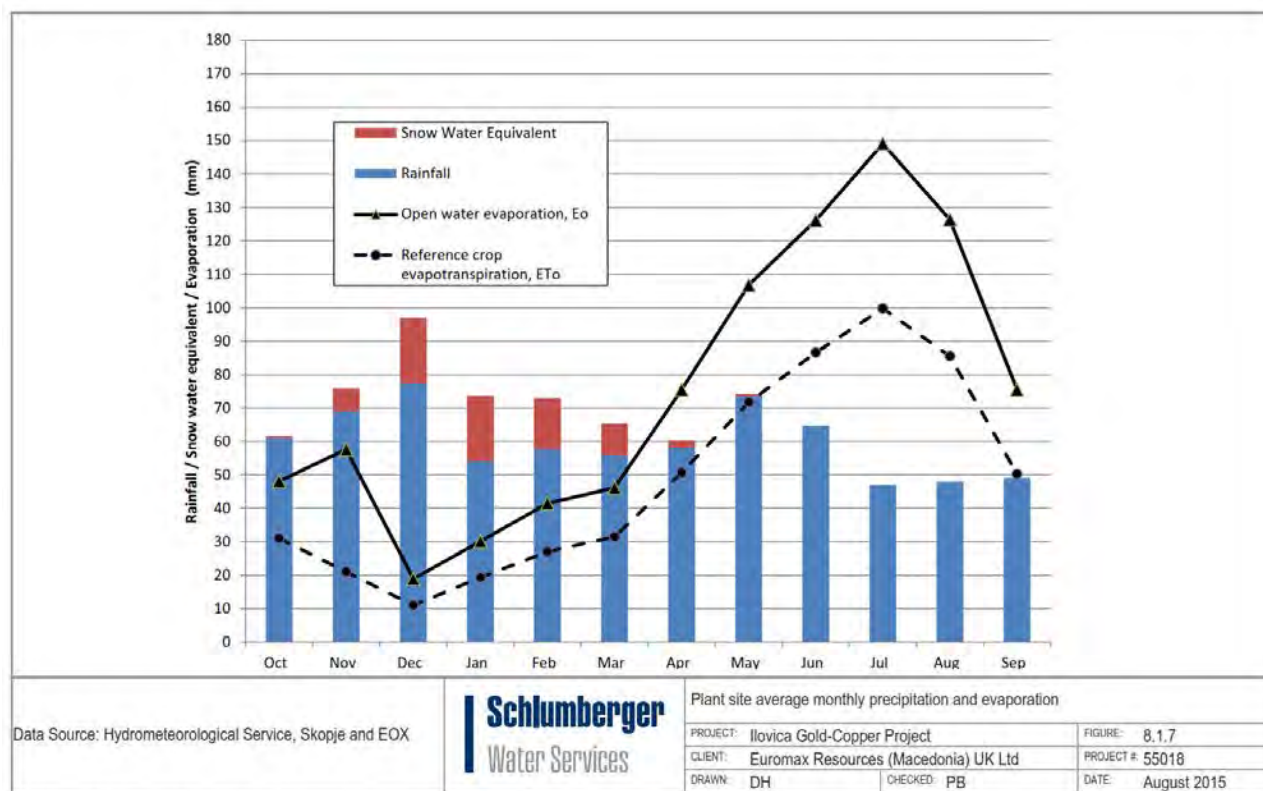


Table 5.11 summarises the number of days per month that snow lies on the ground at Berovo. These data probably represent the maximum upper limit for the Ilovica project site.

Table 5.11 Average, maximum and minimum number of days per month of lying snow at Berovo (850 m AMSL), 1960/61 - 2013/14													
	O	N	D	J	F	M	A	M	J	J	A	S	Average
Mean	0.2	2.9	11.2	14.3	10.6	4.3	0.6	0	0	0	0	0	6.3
Max	4	28	25	31	28	21	5	2	0	0	0	0	31
Min	0	0	0	0	0	0	0	0	0	0	0	0	0

Data source: Hydrometeorological Service, Skopje

5.2.7 Evaporation

Penman-Monteith reference crop evapotranspiration (ET_o) (Allen et al, 1998)⁸ and Penman open water evaporation (E_o) (Penman, 1948)⁹ were calculated for the following two locations:

- Strumica meteorological station
- The Euromax Resources meteorological station.

Meteorological data (temperature, humidity, wind speed and solar radiation) from the respective stations were used in the calculations. Evaporation calculations at the Strumica meteorological station are based on monthly data provided by the Macedonian Hydrometeorological Service. Evaporation values calculated for the Euromax Resources met station are based on daily data.

Table 5.12, Table 5.13 and Table 5.14 summarise (measured) mean monthly pan evaporation, Penman open water evaporation and Penman-Monteith reference crop evapotranspiration respectively at Strumica. All data were provided by the Macedonian Hydrometeorological Service.

Table 5.12 Mean monthly Class A pan evaporation (Epan) at Strumica, 1979/80 - 2010/11													
	O	N	D	J	F	M	A	M	J	J	A	S	Ann
Total, mm	71.7	N/M	N/M	N/M	N/M	N/M	103.7	143.3	179.3	208.6	184.7	127.4	1019
Average, mm/d	2.3	-	-	-	-	-	3.5	4.6	6.0	6.7	6.0	4.2	

N/M – not measured

Table 5.13 Mean monthly Penman open water evaporation (E_o) at Strumica, 1981/82 - 2011/12													
	O	N	D	J	F	M	A	M	J	J	A	S	Ann
Total, mm	49.8	22.5	11.9	11.1	23.8	56.7	90.5	130.8	162.9	178.4	155.7	99.9	994
Average, mm/d	1.6	0.8	0.4	0.4	0.8	1.9	2.9	4.2	5.4	5.8	5.2	3.2	

⁸ Allen RG, Pereira LS, Raes D and Smith M. 1998. Crop evapotranspiration. Guidelines for computing crop water requirements. FAO Irrigation and Drainage Paper 56, The Food and Agriculture Organization of the United Nations, Rome.

⁹ Penman H L. 1948. Natural evaporation from open water, bare soil and grass. Proc. Roy. Soc. London, A193, 120-146.

Table 5.14 Mean monthly Penman-Monteith reference crop evapotranspiration (ETo) at Strumica													
	O	N	D	J	F	M	A	M	J	J	A	S	Ann
Total, mm	35.5	15.4	7.4	6.2	15.9	40.7	65.9	96.7	122.6	135.8	118.4	75.4	736
Average, mm/d	1.1	0.6	0.2	0.2	0.5	1.4	2.1	3.1	4.1	4.4	3.9	2.4	

Table 5.15 and Table 5.16 summarise monthly open water evaporation and reference crop evapotranspiration respectively at the Euromax Resources meteorological station for the period December 2013 to April 2015.

Table 5.15 Monthly open water evaporation (Eo) at Euromax Resources meteorological Station^A													
	O	N	D	J	F	M	A	M	J	J	A	S	Ann
Total, mm	48.1	33.5 ^C	18.9 ^B	30.1	41.5	46.1	75.5	106.8	126.2	149.1	126.4	75.5	902
Average, mm/d	1.6	1.1	0.6	1.0	1.5	1.5	2.5	3.4	4.2	4.8	4.1	2.5	

A Calculations are based on data from the period Dec 2013 to Apr 2015.

B Calculated from daily data.

C Estimated by linear interpolation between values for Oct 2014 and Dec 2013.

Table 5.16 Monthly Penman-Monteith reference crop evapotranspiration (ETo) at Euromax Resources meteorological Station^A													
	O	N	D	J	F	M	A	M	J	J	A	S	Ann
Total, mm	31.0	21.0 ^C	11.0 ^B	19.3	27.0	31.5	50.7	71.7	86.6	99.8	85.5	50.3	585
Average, mm/d	1.0	0.7	0.4	0.6	1.0	1.0	1.7	2.3	2.9	3.2	2.8	1.7	

A Calculations are based on data from the period Dec 2013 to Apr 2015.

B Calculated from daily data.

C Estimated by linear interpolation between values for Oct 2014 and Dec 2013.

Figure 5.10 shows the seasonal variation in calculated evaporation at the Euromax Resources met station. Effective rainfall can be calculated by comparing monthly rainfall and evaporation/evapotranspiration. Average monthly rainfall at the plant site (1960/61 – 2013/14) is presented alongside Eo and ETo calculated at the Euromax Resources meteorological station (December 2013 - April 2015) in Table 5.17 and Figure 5.10.

Table 5.17 Plant site mean monthly rainfalls (mm) 1960/61 - 2010/11, monthly open water evaporation (Eo) and reference crop evapotranspiration (ETo) at Euromax Resources meteorological station^A and effective rainfall													
	O	N	D	J	F	M	A	M	J	J	A	S	Ann
Rain, mm	60.9	69.1	77.3	54.1	57.6	55.8	58.1	73.6	64.7	46.9	47.9	49.1	715
ETo, mm	31.0	21.0 ^C	11.0 ^B	19.3	27.0	31.5	50.7	71.7	86.6	99.8	85.5	50.3	585
Eo, mm	48.1	33.5 ^C	18.9 ^B	30.1	41.5	46.1	75.5	106.8	126.2	149.1	126.4	75.5	902
Eff. Rain, mm^D	29.9	48.1	66.3	34.8	30.6	24.3	7.4	1.9	-	-	-	-	

A Calculations are based on data from the period Dec 2013 to Apr 2015.

B Calculated from daily data.

C Estimated by linear interpolation between values for Oct 2014 and Dec 2013.

D Effective rainfall = Rain – ETo (mm).

Table 5.17 indicates on average a surplus of rainfall over evapotranspiration occurs during the period October to May. This is the period when most run-off might be expected to occur.

5.2.8 Thunder and Lightning

The occurrence of thunder and lightning is not monitored at the Euromax Resources meteorological station. Data for thunder and lightning were obtained for Strumica (232 m AMSL) and Berovo (850 m AMSL). Table 5.18 summarises the number of days per month of thunder and lightning at Strumica meteorological station. It is assumed that the incidence of thunder and lightning will be similar at the project site.

Table 5.18 Number of days with thunder and lightning at Strumica (232 m AMSL), 2008/9 - 2013/14													
	O	N	D	J	F	M	A	M	J	J	A	S	Ann
Mean	1	0	1	0	1	1	2	8	9	8	4	3	39
Max	2	1	1	1	3	2	7	14	13	12	6	5	14
Min	1	0	0	0	0	0	0	3	5	6	1	2	0

Data source: Hydrometeorological Service, Skopje

Data for Berovo are presented in Table 5.19.

Table 5.19 Number of days with thunder and lightning at Berova (850 m AMSL), 2009/10 - 2013/14													
	O	N	D	J	F	M	A	M	J	J	A	S	Ann
Mean	1	1	0	0	0	0	1	5	7	7	3	3	29
Max	2	2	1	1	1	1	4	10	9	8	5	6	10
Min	0	0	0	0	0	0	0	1	3	4	1	1	0

Data source: Hydrometeorological Service, Skopje

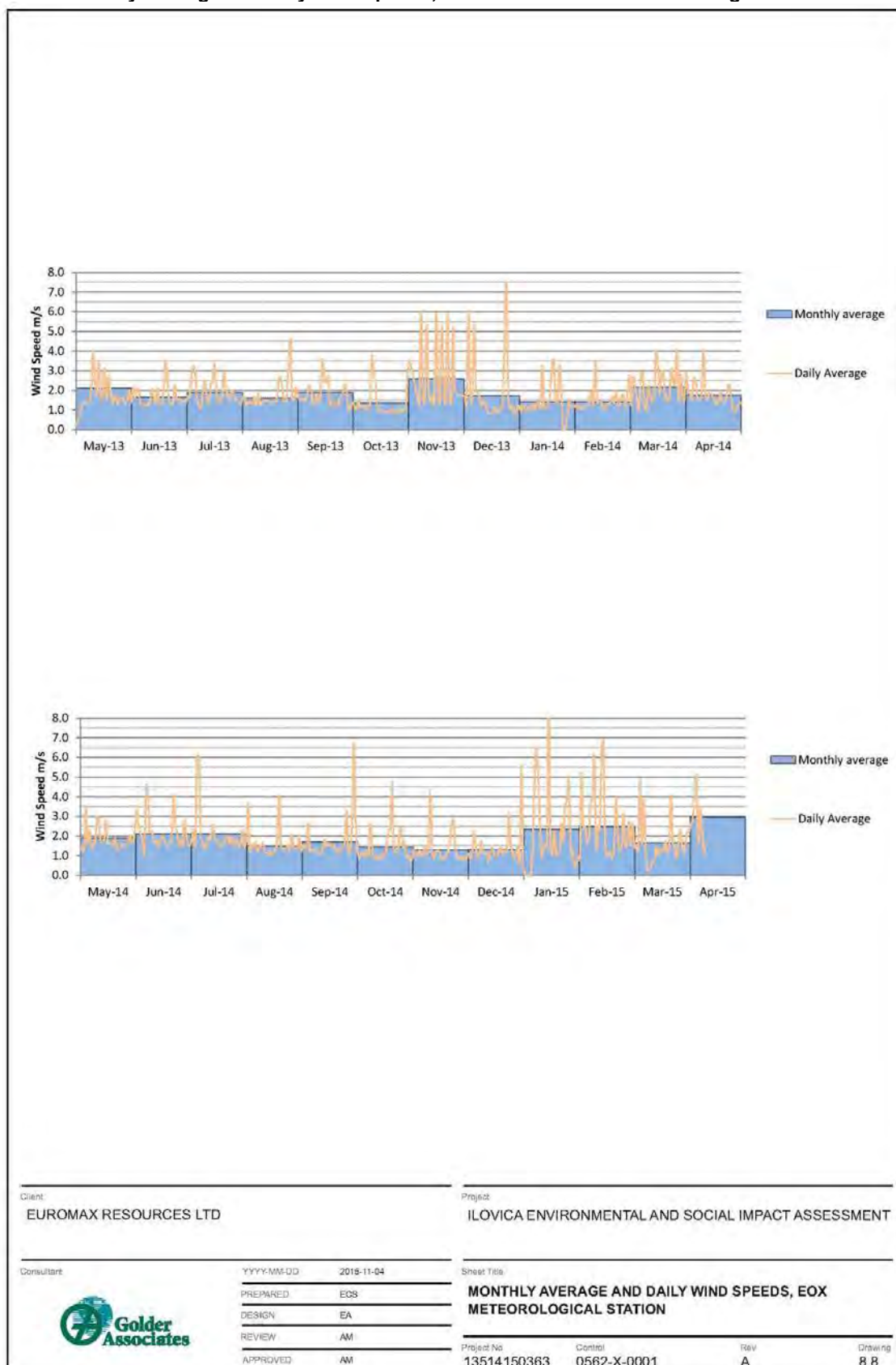
The lower occurrence of thunder and lightning at Berovo than at Strumica may be due to local meteorological conditions at both locations. Reduced convective activity at elevation could account for the difference observed. The Berovo data probably provide an indication of the frequency of days with thunder and lightning at the elevation of the plant site. A small scale map for the whole of Europe published by Anderson and Klugmann (2014)¹⁰ shows mean annual lightning flash density detected between 2008 and 2012. Flash density is the number of lightning flashes per unit area. The map suggests between 1.6 and 4 lightning flashes per square kilometre per year for eastern Macedonia.

5.2.9 Wind

Wind speed data from the Euromax Resources meteorological station from 14 May 2013 to 8 April 2015 have been used to generate the monthly average data in Table 5.20. The monthly averages are plotted with the daily average in Figure 5.11.

¹⁰ Anderson G and Klugmann D. 2014. A European lightning density analysis using 5 years of ATDnet data. Nat. Hazards and Earth Sys. Sci., 14, 815-829.

Figure 5.11
Monthly average and daily wind speeds, Euromax Resources meteorological station



Wind data were gathered with an hourly frequency from May 2013 until 12 December 2013 and with a ten minute frequency thereafter.

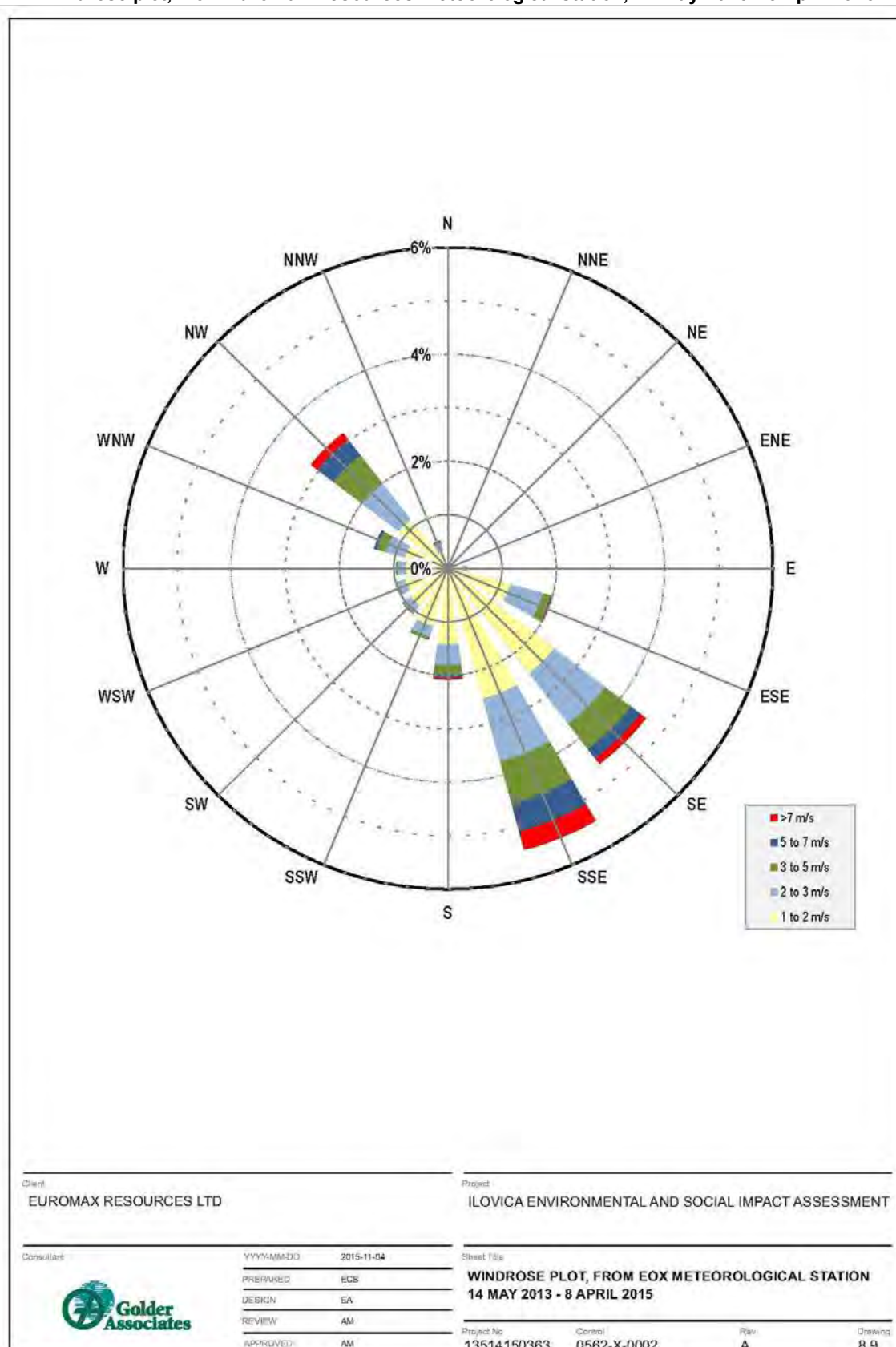
Table 5.20 Monthly average wind speed, Euromax Resources meteorological station								
Month	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
Average Speed m/s	2.11	1.65	1.90	1.61	1.89	1.36	2.56	1.72
Month	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14
Average Speed, m/s	1.40	1.42	2.17	1.76	1.89	2.10	2.12	1.50
Month	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15
Average Speed, m/s	1.71	1.43	1.29	1.31	2.34	2.47	1.64	2.96

Wind direction was also monitored at the Euromax Resources meteorological station though there was a gap in these data between 25 July 2014 and 22 December 2014.

A wind rose, presented in Figure 5.12 was plotted from hourly data where possible or from an hourly average of the ten minute data. Wind speed averages 1.79 m/s overall. Ilovica appears to experience consistent low to moderate wind speeds throughout the data period with some fluctuation between the winter/summer seasons. Wind direction generally prevails from southeast.

Figure 5.12

Windrose plot, from Euromax Resources meteorological station, 14 May 2013 - 8 April 2015



5.2.10 Temperature

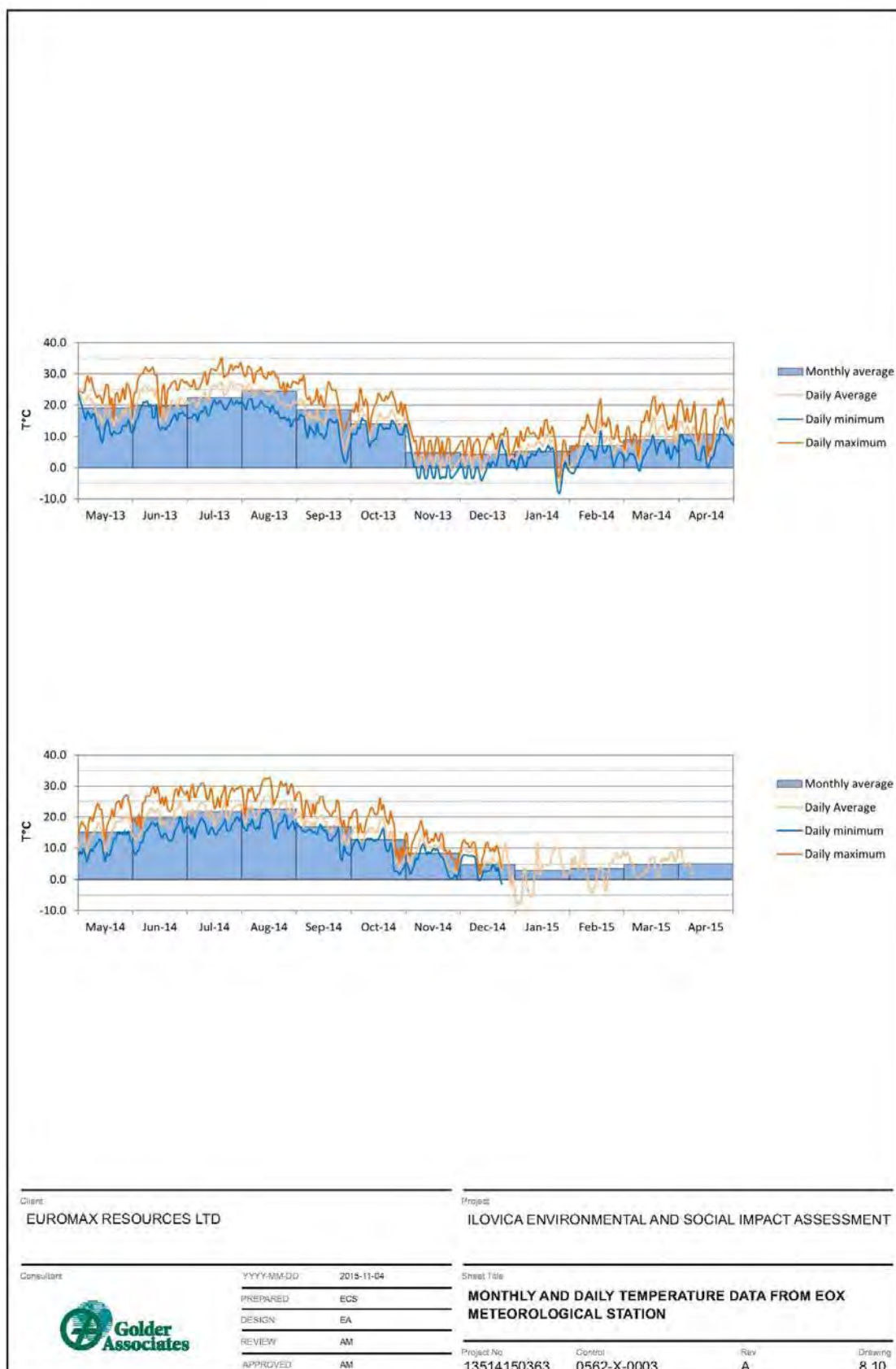
Air temperature data from the Euromax Resources meteorological station from 14 May 2013 to 8 April 2015 were used to generate a data summary table (Table 5.21) of the monthly average, minimum and maximum temperature. The monthly average data is plotted with the daily average, minimum and maximum data in Figure 5.13.

Data were analysed from a series of hourly data records until 12 December 2013 and then ten minute records thereafter. During the period 6 November 2013 to 10 November 2013 no temperature data were available. It should be noted that there was also a coincidental reduction in temperature at this time. Minimum and maximum data were not available for 2015.

Table 5.21 Summary of temperature data, Euromax Resources meteorological station												
Month	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14
Average	19.0	19.6	22.3	24.5	18.5	14.1	4.8	4.3	5.2	7.1	9.0	10.7
Min	8.0	10.3	13.3	15.8	9.5	1.5	-3.6	-4.2	-8.3	-1.9	-1.0	-0.1
Max	29.3	32.1	35.1	33.6	29.5	25.2	20.8	12.7	15.5	21.5	22.6	21.0
Month	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15
Average	15.2	19.5	21.8	22.6	16.9	12.7	8.2	4.8	3.0	3.6	4.9	10.4
Minimum	5.9	7.9	13.1	13.0	6.2	1.5	0.2	-10.3	-12.1	-8.8	-1.6	-0.4
Maximum	27.1	30.1	31.0	32.7	27.7	26.1	18.8	12.6	16.2	13.9	14.4	21.5

Annual temperature averages 11°C with a maximum of 34°C and a minimum of -8°C. The data indicates that the project area experiences consistently warm summers (May to October) and cold winters (October to April). There is a distinct change in temperature seasonally.

Figure 5.13
Monthly and daily temperature data from Euromax Resources meteorological station



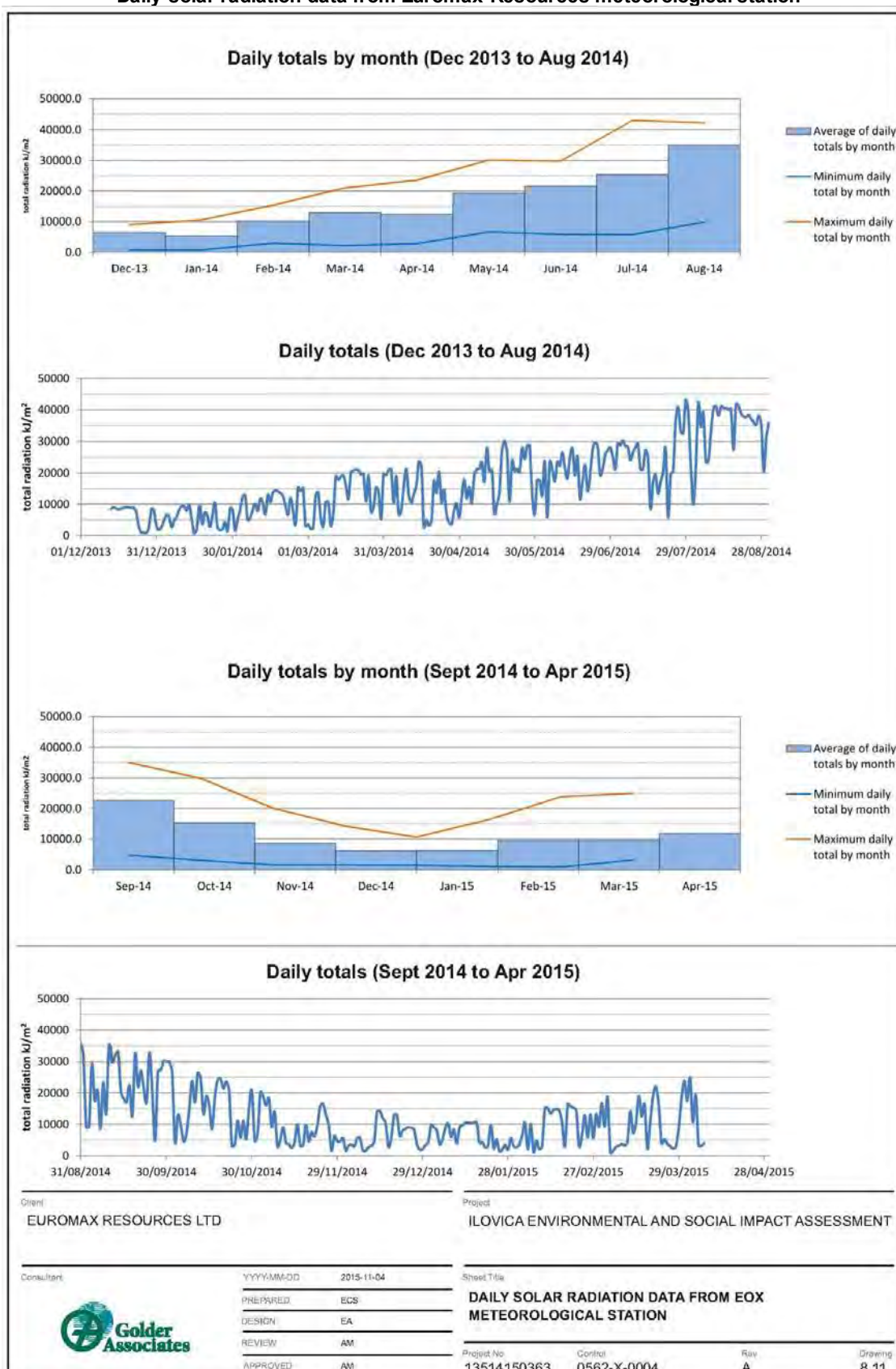
5.2.11 Solar Radiation

Solar radiation data from the Euromax Resources meteorological station from 12 December 2013 to 8 April 2015 was used to generate a data summary table (Table 5.22) of the monthly average, minimum and maximum for daily total radiation. The monthly data is plotted with the daily totals in Figure 5.14. Data were analysed from a series of ten minute data records for total radiation.

Table 5.22 Summary of solar radiation data, daily totals (kJ/m²)									
Month	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14
Minimum	796	736	2953	2177	2792	6592	5843	5779	9848
Maximum	9001	10526	15325	21014	23600	30130	29755	43119	42320
Average	6440	5319	10132	12897	12401	19309	21639	25364	34891
Month	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	
Minimum	4768	3069	1587	1548	1522	1111	914	3160	
Maximum	34982	29832	20153	14235	10669	16362	23809	24921	
Average	22571	15225	8691	6165	6325	9553	9535	11857	

Total solar radiation per day averages 14 299 kJ/m². The data indicates that the project area experiences a consistent trend of increased radiation in the summer and less radiation in the winter. The trend is consistent with that for temperature with the greater amounts of radiation occurring in the months May to October.

Figure 5.14
Daily solar radiation data from Euromax Resources meteorological station



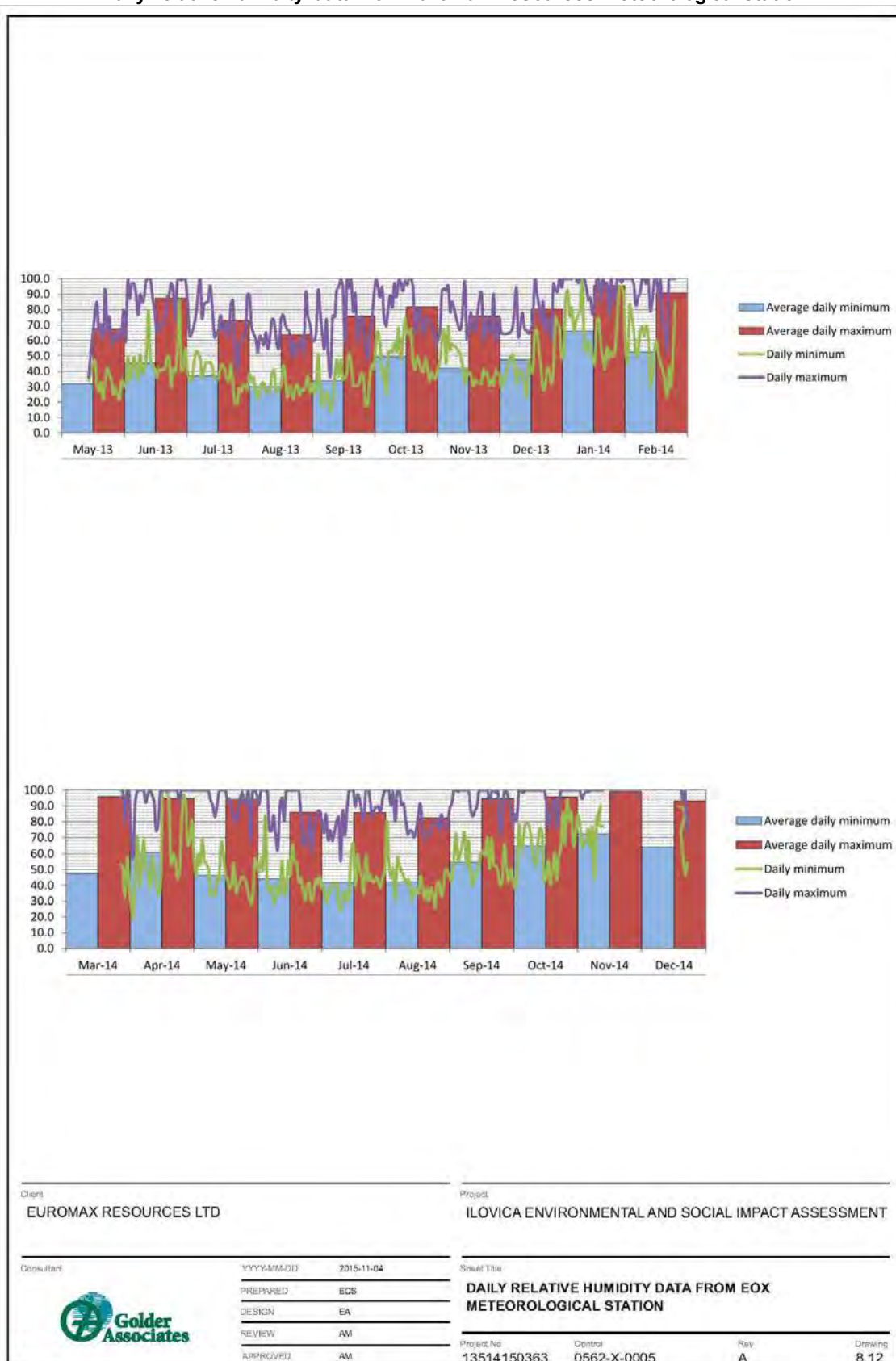
5.2.12 Humidity

Solar radiation data from the Euromax Resources meteorological station from 14 May 2013 to 22 December 2014 were used to generate a data summary table (Table 5.23) of the monthly average for the daily minimum and maximum values. The monthly averages are plotted with the daily minimum and maximum values in Figure 5.15. Data were analysed from a series of records for minimum and maximum humidity.

Data was analysed from a series of hourly data records until 12 December 2013 and then ten minute records thereafter. It should be noted that for the period 22 February 2014 to 27 March 2014, the data were disregarded due to erroneous values. Other data values were also considered erroneous and these were removed from the series and analyses.

Table 5.23 Summary Of Humidity Data										
Month	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14
Avg daily min	31.80	45.40	36.85	30.17	34.00	49.20	42.11	47.33	66.33	52.58
Avg daily max	67.63	87.43	73.00	63.64	75.71	81.65	75.90	80.31	95.52	90.83
Month	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
Avg daily min	47.48	60.70	46.46	44.19	41.85	42.37	54.79	64.86	72.20	64.10
Avg daily max	96.06	94.91	94.22	86.23	85.84	82.41	94.93	95.77	99.18	93.10

Figure 5.15
Daily relative humidity data from Euromax Resources meteorological station



5.3 LOCAL POPULATION

The Maleševske mountain range in which the project is situated is largely unpopulated; with the majority of inhabitants residing within the Strumica valley to the west of the mountains.

The total population of the Strumica valley region is approximately 100 000 inhabitants. The villages of Shtuka and Ilovica have 1 500 to 2 000 inhabitants each and they belong to the municipality of Bosilovo. Table 5.24 presents the statistics collected within the 2002 Census (the Census) regarding the municipality of Bosilovo.

Table 5.24 Population Statistics for Bosilovo Municipality				
Total Population	Economically Active			Economically Non-active
	All	Employed	Unemployed	
5 741	4 208	3 190	1 018	1 533

Note: Economically non-active are defined by the Census as follows: Housewives (engaged on duties within the household in their own house), persons that are serving a sentence in a prison or are in military service, those permanently incapable of work, children under 15 years of age, students and pensioners.

The Census states that the majority of the population (70.7%) work in agriculture; 12.6% work in industry and 16.7% work in the services.

5.4 REGIONAL INFRASTRUCTURE

Local infrastructure relating to the proposed Ilovica project is described in detail in Section 18 of this report.

5.4.1 Roads

The property is well served by asphalt paved roads. The site is located in the hills approximately 3 km northeast of the village of Ilovica. The village of Ilovica is located 3 km to the north of road number M6, which is a two lane asphalt paved road that leaves Strumica to the east. To reach the village of Ilovica, a good quality 3 km single carriage asphalt paved road is taken from the M6.

Access to the interior of the property is by gravel roads that have been constructed to provide access for the drilling equipment. These tracks are generally cut into the weathered bed rock and are uneven and steep in places, but passable by four wheel drive vehicles.

The travelling distances and times from International Airports to Strumica (via car) are as follows:

- Alexander the Great Airport, Skopje: 1 hour 55 minutes, 151 km
- Thessaloniki International Airport, Greece: 1 hour 50 minutes, 146 km
- Sofia Airport, Bulgaria: 3 hours 18 minutes, 237 km.

The site is well linked to the road network in southern Europe. The E-75 International Road passes south through central Europe and Macedonia to the Port of Thessaloniki. The E-75 passes some 50 km west of the site and is linked to the M6 Highway, which passes to the south of Ilovica, by Route 604 over the Belasic mountains.

The M6 Highway also passes east to the border with Bulgaria and links with the town of Petrich (40 km away) and the Bulgarian road and rail networks.

5.4.2 Rail

The railway infrastructure in the Republic of Macedonia has been in place since 1873, when the first railway track from Skopje to Thessaloniki in Greece was constructed. Today the railways network comprises about 925 km of single track standard gauge lines. The Macedonian railway network system is connected north-south with the railway network systems of Serbia and Greece. A further line is under construction to the north to Bulgaria. The railway transport system is managed by the publicly owned Macedonian Railways (Makedonski Železnici, MŽ) and at present, the only provider of railway services in the country.

The main station in Skopje is approximately 160 km from Ilovica, although the railway follows the E-75 corridor, with loading sidings in Gevgelija, on the Greek border, approximately 70 km from the town of Ilovica, Figure 5.16.

Figure 5.16
Macedonian Railway Network



Source: Wikipedia

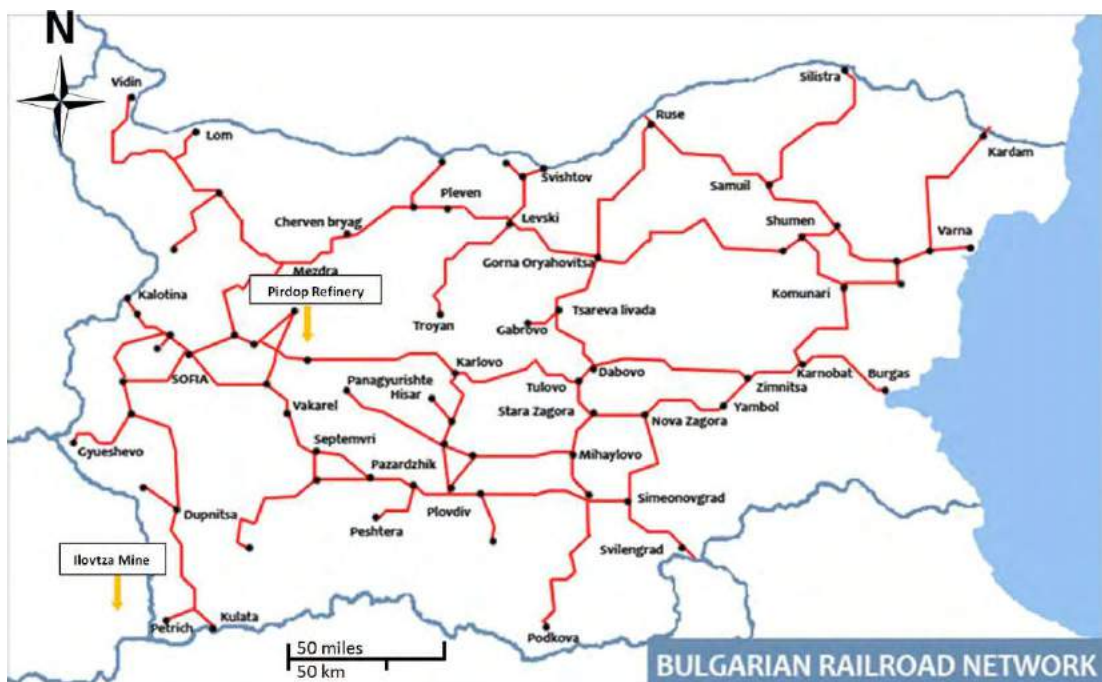
Alternatively the Bulgarian rail network extends as far as Petrich, in south-western Bulgaria, approximately 45 km from site, Figure 5.17. Petrich is not shown on Figure 5.17, but on Figure 5.18. This also links to the Pirdorp smelter at Chelopech, the Black Sea ports and the Mediterranean Port of Thessaloniki.

Figure 5.17
Bulgarian Railway Network



Source: Wikipedia

Figure 5.18
Bulgarian Railway Network



5.4.3 Port

The Thessaloniki Port is located 145 km away from the property and has been recommended as the most cost-effective and operationally optimal option for all modes of shipping (containerised, break bulk, charter) based on the logistics study performed by Multimodal DOO.

5.4.4 Water Dams

There is an existing water reservoir on the edge of the site, which is used for agricultural purposes. Hydrological and hydrogeological studies conducted for the proposed Ilovica project is described in detail in Section 18.3 of this report. There is a larger water reservoir at Turija, some 15 km to the West-Northwest which links to the area via a canal.

5.4.5 Power

Macedonia is connected to the European power grid via the National Grids of Bulgaria, Greece and Serbia as illustrated by Figure 5.19.

Figure 5.19
Macedonian Power Distribution Network



Source: Macedonian Transmission System Operator

Bulk power shall be provided by the Macedonian parastatal power utility company MEPSO via new 110 kV overhead transmission lines from existing substations at Beroovo and Sushica. MEPSO have confirmed that adequate capacity is available for the project.

6. HISTORY

In 1958, T. Ivanovski and P. Chedomil mapped the southwestern slopes of the Ograzhen Mountain. They concluded that there were indicators of an orebody that included a deep sulphide deposit (Ivanovski and Chedomil 1957).

Mineralisation was discovered in 1973 by the Skopje Bureau of Geology team, headed by D. Denkovski. Copper, lead and zinc mineralisation was linked to the dacite intrusions at Ilovica (Denkovski 1971).

Prior to Euromax Resources, the Property was held and explored by Phelps Dodge Exploration Corporation (PDX), who completed drilling campaigns between 2004 and 2006. Euromax Resources has integrated the results of the PDX drilling into the drill hole database that was provided to Tetra Tech. Between 2004 and 2006, PDX completed the drilling shown in Table 6.1.

Table 6.1 Summary of Main Intercepts from the 2004 to 2006 Drilling Campaigns			
Drill hole	Cu (%)	Au (g/t)	Mineralised Intercepts
PDIC-04-01	-	-	Very low values
PDIC-04-02	0.15	0.20	288 m (98 to 386 m) at a cut-off 0.1% Cu
PDIC-04-03	0.24	0.27	147.7 m (393 to 540.7 m) at a cut-off 0.1% Cu
PDIC-05-04	-	0.29	132 m (165 to 297 m) at a 0.1 g/t Au cut-off
PDIC-06-06	0.23	0.30	450 m (54 to 504 m) without a cut-off
PDIC-06-07	0.28	0.45	93 m (132 to 225 m) without a cut-off
PDIC-06-08	0.25	0.36	393 m (57 to 450 m) without a cut-off

Source: Euromax Resources

In 2008, Euromax Resources signed an option agreement with PDX to acquire 100% of the Property.

6.1 HISTORICAL MINERAL RESOURCES

The maiden mineral resource for the Property was estimated by Geoffrey S. Carter, Professional Engineer (P.Eng.), of Broad Oak Associates, Toronto, on behalf of Euromax Resources. The mineral resource was disclosed in a technical report, filed with the Canadian Securities Administrators, on 12 August 2008 (Carter 2008). The mineral resource was classified using CIM Definition Standards for Mineral Resources and Mineral Reserves.

The historical mineral resource estimate was completed using polygonal estimation techniques, based upon eight holes drilled on approximately 200 m centres.

Mr. Carter estimated that there are 303 Mt of Inferred Sulphide Resources at 0.23% Cu, 0.32 g/t Au, 0.005% Mo at a 0.2% Cu cut-off, for a copper equivalency of 0.51%.

The copper equivalent values were calculated using total contained metal and 100% recoveries using: US\$550 /oz for gold, US\$20 /lb for molybdenum, and US\$1.25 /lb for copper. The deposit was estimated to contain 1 560 Mlb of copper, 2.9 Moz of gold, and 34.6 Mlb of molybdenum (Carter 2008).

The 2008 resource estimate was superseded by a mineral resource estimate prepared by Moose Mountain Technical Services (Moose Mountain), with an effective date of 15 February 2012 (Bird and

Morris 2012). The Moose Mountain resource estimate was presented in a technical report released on 17 May 2012 and re-stated in a preliminary economic assessment (PEA) prepared by Tetra Tech and filed with the Canadian Securities Administrators on 22 March 2013.

Tetra Tech prepared two subsequent mineral resource updates for the Project with effective dates of 26 July 2013 and 27 November 2013. The most recent mineral resource estimate was disclosed within a technical report, filed with Canadian Securities Administrators on 17 January 2014. The Tetra Tech mineral resource estimate is discussed in more detail in Section 0, where it is compared to the current estimated mineral resource.

Euromax Resources is not treating the historical mineral resource estimates as current. The previous mineral resource estimates have been entirely superseded by the estimated mineral resource disclosed within this technical report.

6.2 HISTORICAL MINERAL RESERVES

Historical mineral reserves were estimated by ACA Howe in 2014, and were disclosed as part of the PFS technical report filed with Canadian Securities Administrators on 22 December 2014. The mineral reserves have been entirely superseded by the estimates disclosed within this technical report.

For the historical mineral reserves, a mining plan and schedule was developed for mining the mineral resources that were estimated for the Project. The preliminary mine plan was based upon Measured and Indicated Mineral Resources (effective date 27 November 2013). The report's prefeasibility level of detail required that both the Measured and Indicated Mineral Resources be classified as a Probable Mineral Reserve (Table 6.2). No Proven Mineral Reserves were designated.

Table 6.2 Historical Mineral Reserve from PFS filed on 22 December 2014	
Mineral Reserve Category	Value
Probable Reserve, Oxide (Diluted and Recovered) (Mt)	16
Gold Grade (g/t)	0.33
Gold (oz)	172 000
Primary/Transitional Probable Reserve (Diluted and Recovered) (Mt)	209
Gold Grade (g/t)	0.34
Gold (Moz)	2.28
Copper Grade (%)	0.20
Copper (Mlb)	905
Total Probable Reserve (Diluted and Recovered, Rounded) (Mt)	225
Gold Grade (g/t)	0.34
Gold (rounded) (Moz)	2.45
Copper Grade (%)	0.20
Copper (Mlb)	905

For the historical mineral reserve, a pit optimisation was carried out using the parameters outlined in Table 6.3.

Table 6.3 Historical Pit Optimisation Parameters	
Parameter	Value
Gold Price (US\$ /oz)	1 250
Copper Price (US\$ /lb)	3.00
Exchange Rate (US\$:MKD)	1 = 43.50
Non-Mineralised Rock (SG)	2.45
Mining Cost, Ore and Waste (US\$ /t)	1.80
Mining Cost Escalation with Depth (US\$ /m below 400 m AMSL)	0.01
Mining Dilution (%)	5%
Mining Losses (%)	5%
Processing Cost (US\$ /t) – Oxide	6.24
Processing Cost (US\$ /t) – Fresh	9.25
Milling Rate (Mt/a)	10
Milling Recovery – Oxide (Au) (%)	90
Milling Recovery – Oxide (Cu) (%)	0
Milling Recovery – Fresh (Au) (%)	90
Milling Recovery – Fresh (Cu) (%)	85
General and Administrative (US\$ /t)	1.00
Pit Slope (degrees)	39
Reclamation Cost, Ore and Waste (US\$ /t)	0.25
Selling Cost	Gold US\$62.50 /oz Copper US\$0.15 /lb

For the historical mineral reserve, gold equivalency of 1% Cu equivalent to 1.55 g/t Au was calculated using prices of US\$1 250 /oz gold and US\$3 /lb copper and recoveries of 85% copper and 90% gold. A diluting grade equal to the average grade of blocks within the block model and below a cut-off grade of 0.3 g/t gold equivalent were used, namely 0.17 g/t Au and 0.05% Cu.

The in-situ block cut-off grades were calculated for oxide and primary/transitional mill feed as 0.21 and 0.25 g/t of gold or gold equivalent, respectively. Considering the need for some profit to be realised, those grades were increased to 0.23 and 0.27 g/t, respectively. The oxide requires stockpiling and re-handling, so the in situ oxide cut-off was increased to 0.25 g/t. To account for a longer than initially expected mill feed haul distance, the primary/transitional cut-off was increased to 0.30 g/t.

Based on the results of pit optimisation, the calculated cut-off grades were applied to a 10 Mt/a schedule. The waste stripping schedule was brought forward in order to provide sufficient material for constructing the tailings dam, with a total of 10 Mt of material being stripped prior to production. The 21 yr LOM of the resulting pit was subdivided into four phases (Table 6.4).

The phases were designed to balance:

- early capital payback
- operational constraints
- overall profitability
- a reasonable mine life.

Table 6.4
Historical Phases by Year

Phase	Nested Pit	Year(s)	Bottom Elevation (m)	Description
1	1	1-2	480	Starter Pit
2	2	2-3	440	Expansion of Starter Pit
3	6	3-9	400	Pushback and Deepening
4	15	9-21	260	Pushback and Deepening
Oxide Stockpile Mining	-	21-23	-	-

6.3 HISTORICAL PRODUCTION

No historical production has occurred on the Property.

7. GEOLOGICAL SETTING AND MINERALISATION

7.1 REGIONAL GEOLOGY

Ilovica is a porphyry copper-gold deposit, located in a northwest-southeast striking Cenozoic magmatic arc, that covers large areas of Central Romania, Serbia, Macedonia, Southern Bulgaria, Northern Greece and Eastern Turkey (Figure 7.1).

There are five widely recognised deposit types within the belt, of which the porphyry copper-gold, replacement lead-zinc and low sulphidation epithermal gold are economically the most significant.

The major Cenozoic metal deposits, from northwest to southeast are:

- Rosia Montana low sulphidation epithermal gold and Rosia Poeni porphyry copper-gold in Romania
- Trepcha lead-zinc in Kosovo
- Sasa lead-zinc & Ilovica & Buchim porphyry copper-gold deposits in Macedonia
- Olympias porphyry copper-gold and Perama Hill low sulphidation epithermal gold in Greece
- Madan lead-zinc and Ada Tepe low sulphidation epithermal gold in Bulgaria, and Ovacik low sulphidation epithermal gold in Turkey.

A series of significant isolated deposits formed over the last 40 million years within at least 10 discrete metallogenic belts.

Individual metallogenic belts are typically tens to hundreds of kilometres long, dominated by a single deposit type and were active for periods of 5 to 10 million years. The metallogenic belts are generated under post-collision, moderate extensional tectonic conditions, predominantly in back arc settings, over previously thickened crust.

The porphyry deposits in the region are in close spatial and temporal association with intermediate to felsic, medium to high potassium calc-alkaline igneous rocks. The low sulphidation epithermal deposits are related to bimodal volcanic rocks.

The Ilovica deposit, which was emplaced circa 29 million years, is an isolated porphyry copper-gold deposit located about 20 km west of the 33 - 38 million years Osogovo-Besna-Kobila lead-zinc belt and about 30 km east of the 22 to 27 million years Leche-Buchim-Chalkidiki copper-gold belt.

There is a well recorded, systematic thickening of the crust from southwest to northeast across the metallogenic belts, from 34 to 35 km in thickness beneath the Leche-Buchim-Chalkidiki belt, approximately 37 km in thickness below the Ilovica deposit, 41 to 45 km in thickness below the Osogovo-Besna Kobila belt and greater than 50 km in thickness further northeast under the Rodope mountains.

Figure 7.1
Ilovica Location and Regional Geological Setting

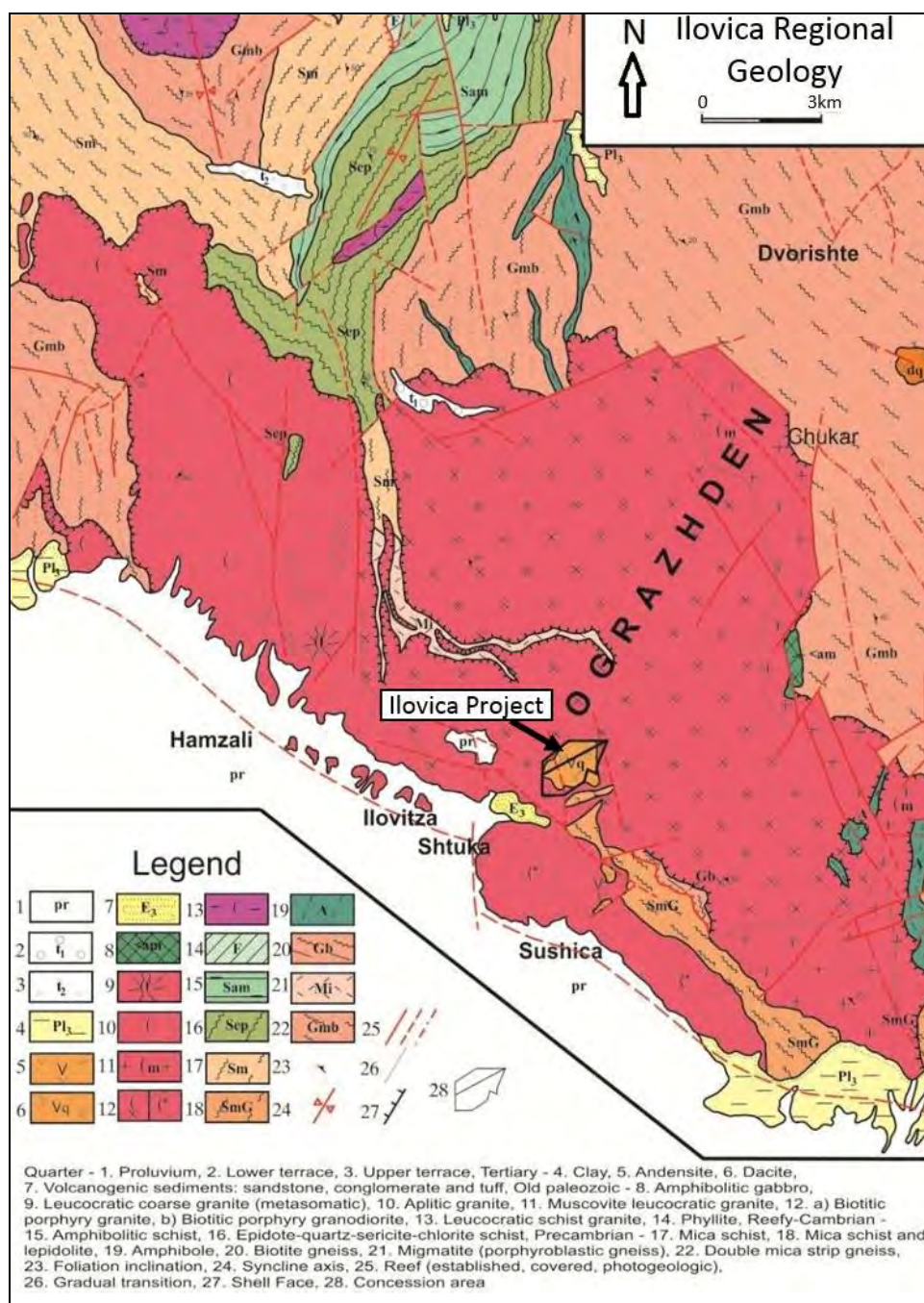


Source: Euromax Resources

7.2 PROPERTY GEOLOGY

The Ilovica porphyry system is about 1.5 km in diameter and is associated with a poorly exposed dacite-granodiorite plug, emplaced along the north-eastern border of the northwest-southeast elongate Strumica graben (Figure 7.2). The exact location of the deposit is controlled by major north-south cross cutting faults and minor northwest-southeast faulting, parallel to the faulted border of the graben.

Figure 7.2
Local Geological Setting



Source: Euromax Resources

The Strumica graben is a typical post-collision extension structure, about 30 km by 10 km in size and up to more than 1 km in depth. The graben has been filled with terrigenous clastic sediments and felsic volcanic rocks over the last 40 million years.

At surface, the Ilovica intrusive complex consists of a central dacitic breccia diatreme, approximately 1.3 km in diameter. The diatreme is intruded by at least one dacite and two granodiorite porphyry stocks

that have generated several hydrothermal pulses, resulting in widespread multi-phase veining within a mineralised stockwork.

The Ilovica porphyry is centred on a hill of more than 400 m of absolute relief, surrounded at lower elevations by numerous small dykes and irregular bodies of dacitic tuff and breccias and intermediate volcanic rocks.

The Ilovica magmatic complex is emplaced into lower Palaeozoic granite. The granite is locally weakly foliated, coarsely porphyroblastic, and forms a roughly northwest-elongate body some 4 by 12 km in size, intruding Precambrian mica schist and gneiss. Portions of the main dacitic diatreme locally contain abundant xenoliths of basement granite near the lithological contact.

Numerous isolated outcrops of dacite porphyry elsewhere within the diatreme breccia commonly have vertical flow laminations but are too small to show as individual mapable units. Drilling demonstrates that dacite and granodiorite porphyries expand at shallow depths into a fairly continuous body.

7.3 ALTERATION

The phyllic alteration is elongated towards the south of the main porphyry and may represent an alteration overprint from a deeper as yet unidentified intrusive that would require deep drilling to confirm. The mineralisation originally identified in the area occurs to the south of the pervasively altered zone and comprised silica alunite and vuggy silica breccias indicative of high sulphidation epithermal veining and may represent high-level mineralisation associated with this concealed intrusion. There is also indication from the IP survey of a deep seated feature with similar characteristics to the main porphyry body developing in the extreme south of the area.

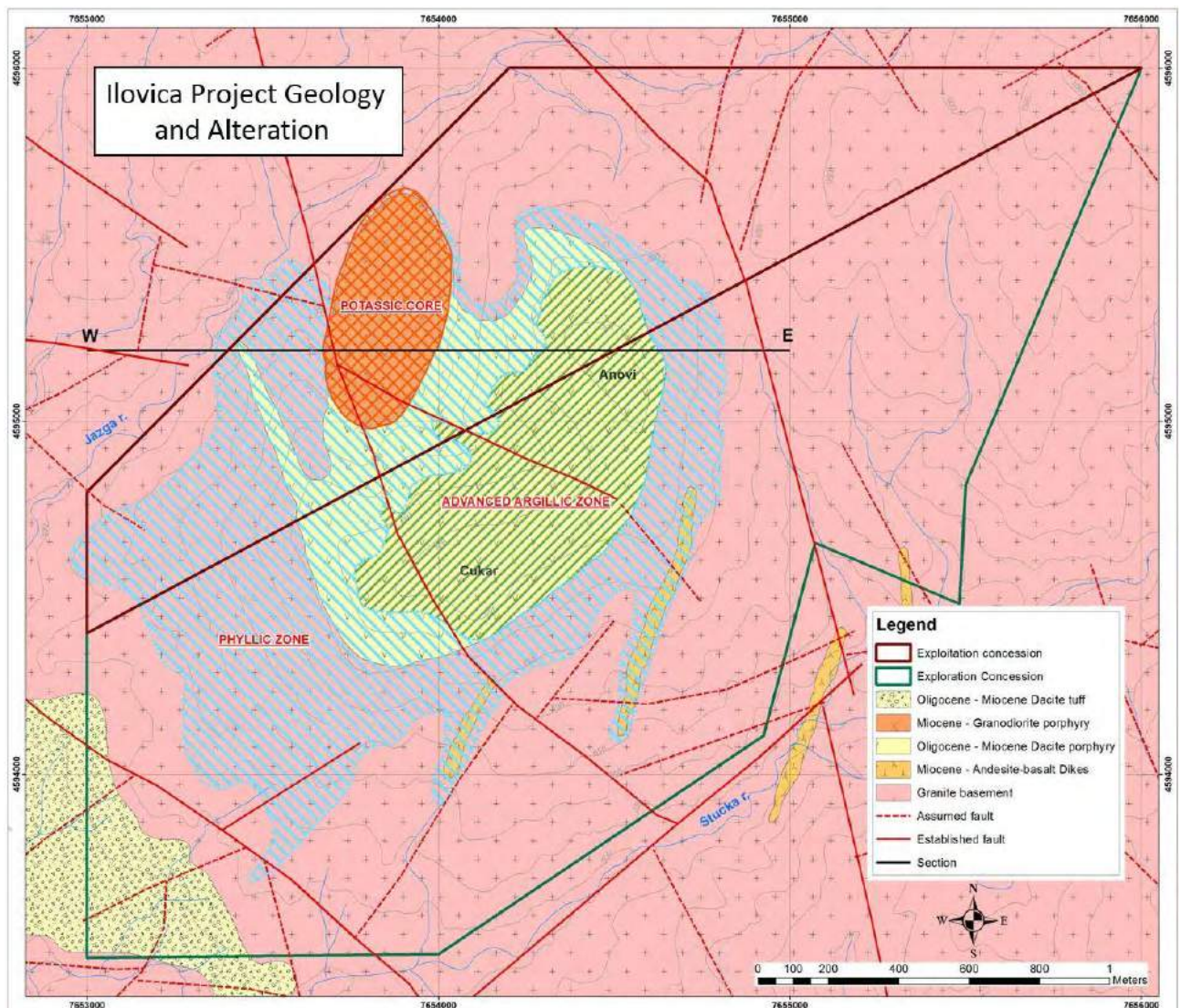
Alteration related to Cenozoic magmatic activity at Ilovica is variably present over an area of about 8 km² (Figure 7.3 and Figure 7.4). Pervasive alteration is largely confined to a roughly 1.5 km² area in and adjacent to the main intrusive complex. Smaller areas of pervasive and structurally-controlled alteration extend somewhat asymmetrically to the south and east of the intrusive complex. Alteration has not been studied in detail, but visual observations document the following zones:

- **Distal:** Structurally-controlled silicification, and silica-or silica-alunite-sulphide/ iron oxide (FeOx) altered rocks ('advanced argillic'), surrounded by narrow zones of clay alteration and bleaching, hosted in both fractured zones within basement granite, or within dykes of Cenozoic tuff-breccia. Such occurrences are present in zones of a few metres up to approximately 100 m in maximum dimension, and occur throughout the entire 8 km² altered area.
- **Proximal:** Pervasive quartz-sericite-clay-iron oxide ('phyllic') alteration, which contains larger bodies of quartz-alunite alteration, hosted in both basement granite and Cenozoic magmatic rocks.
- **Proximal stockwork:** Quartz-pyrite/ iron oxide alteration and intense clay-sericite alteration largely confined to Cenozoic dacitic breccia and dacite-granodiorite intrusive rocks.
- **Central:** Quartz-magnetite-sulphide/ iron oxide stockwork and dissemination, with matrix alteration of illite-sericite, chlorite ('intermediate argillic alteration') containing patches of residual secondary biotite and potassium feldspar, hosted in dacite-granodiorite porphyry, and minor andesite and latite-andesite porphyry dykes.

- **Supergene:** Sulphide oxidation, leaching, and argillisation, locally extending as much as 150 m below surface.

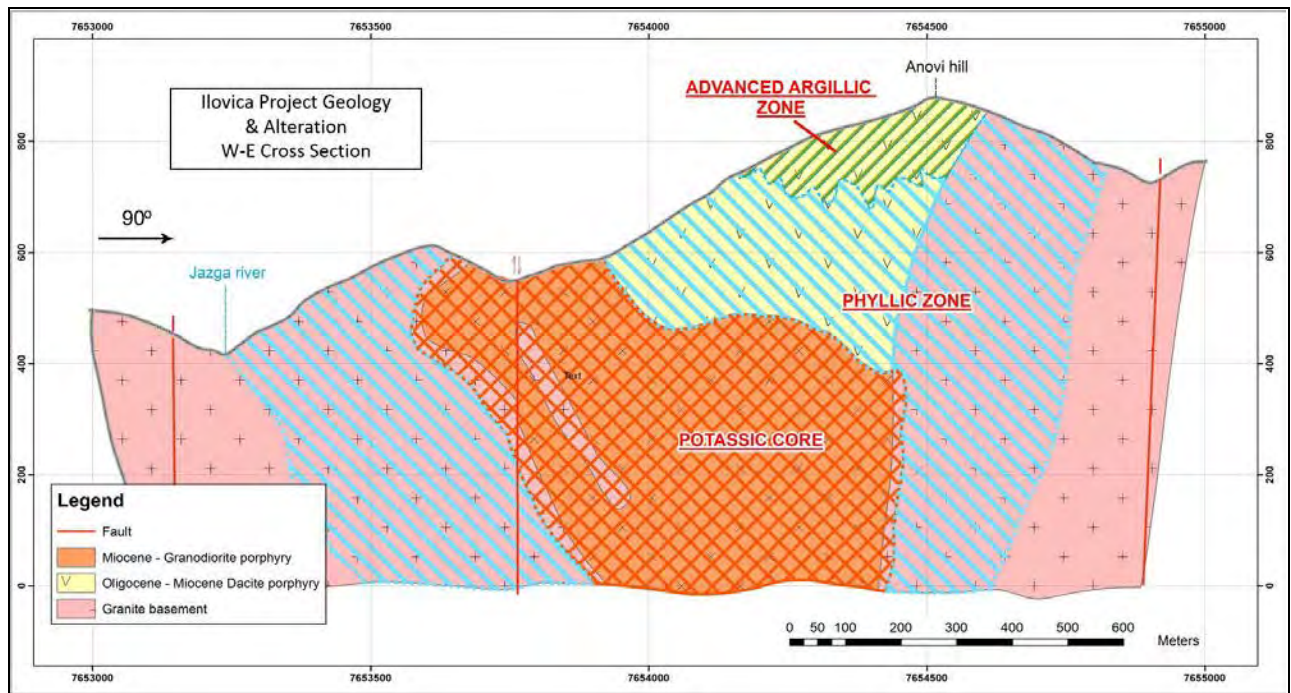
Distinct propylitic alteration is absent at Ilovica. Alunite is typically sugary to coarsely crystalline in texture and locally occurs as mono-mineral, coarsely-crystalline fibrous veins, breccia cement, and phenocryst replacement in pervasive silica-alunite altered dacite breccia. It appears to be hypogene in origin.

Figure 7.3
Property Geology and Alteration Plan



Source: Euromax Resources

Figure 7.4
Property Geology and Alteration (West-East Cross Section)



Source: Euromax Resources

7.4 MINERALISATION

The main sulphide mineral at Ilovica is chalcopyrite, followed by pyrite and secondary copper sulphides such as chalcocite, covellite and bornite. Molybdenite, galena and sphalerite are present in minor amounts, and occasional traces of sulphosalt minerals such as tetrahedrite-tennantite and tellurides of gold and silver are observed.

High temperature oxide mineralisation such as magnetite, dominates at depth, associated with pyrrhotite and chalcopyrrhotite in what is interpreted as the core of the system.

A variety of iron hydroxide group minerals are largely developed within the oxidation and cementation zones. Very occasionally gold nuggets are observed at the base of the oxidation zone.

Ilovica was known historically for minor lead-zinc (and minor copper) and gold occurrences (Cifliganec, 1993), confined to distal and peripheral silica-iron oxide and silica-alunite bodies outside of the pervasively-altered intrusive complex. Deep oxidation and leaching (up to 150 m) of the topographically-elevated intrusive complex obscured its sulphide content.

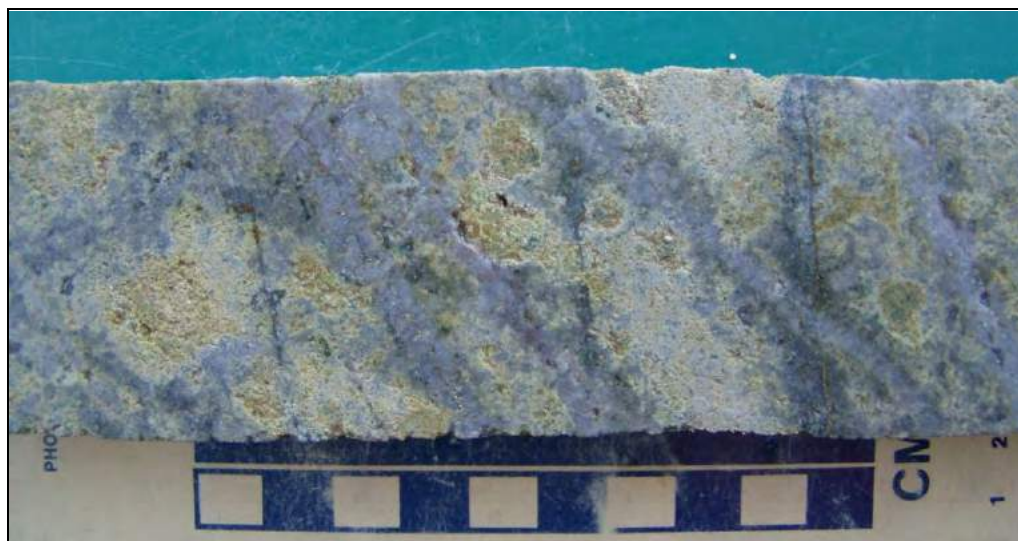
The only visible evidence of copper mineralisation at surface includes: Traces of enargite found in one ledge; very rare green copper oxides, and thin chalcocite coatings on sparse un-oxidised pyrite deposits exposed in a creek below the leached cap to the west of the porphyry. Since the start of detailed exploration on the Property, copper mineralisation has become more obvious on surface, on newly bulldozed drill-roads.

Subsurface porphyry copper-gold mineralisation is expressed at surface by a limonitic, leached stockwork zone approximately 900 m by 600 m in size, containing 0.08 to 0.70 ppm Au, 50 to 450 ppm Cu and 10 to 128 ppm Mo.

At the highest elevations, central portions of this leached cap contain up to 50 to 100 quartz and limonite-quartz veins per metre, comprising up to 25% of the rock volume, within a sericitised and intensely (supergene) clay-altered matrix.

Quartz-dominant veinlets are largely devoid of sulphide cavities and have the texture of both discontinuous A-type (Figure 7.5) veins as well as linear, centre-line B-type veins (Figure 7.6).

Figure 7.5
A-Type Quartz Veins and Superimposed Late Stage Argillisation



Source: Gerhard Westra

Figure 7.6
B-Type Vein (Left side of core) Cutting Earlier Silicification

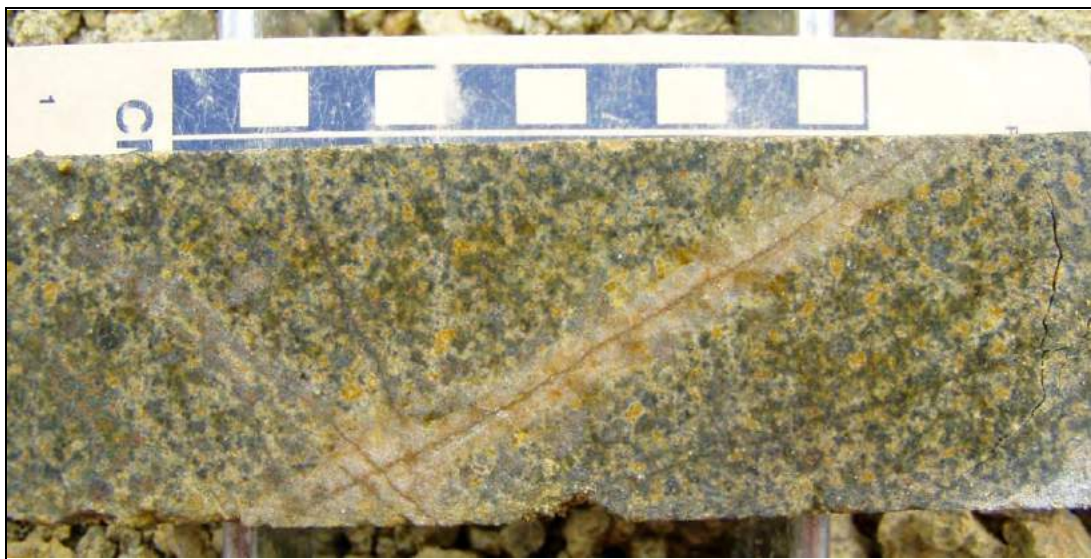


Source: Gerhard Westra

Small exposures at lower elevations (circa 550 m) on the western side of the stockwork zone contain 3 to 7% veinlets and disseminated magnetite, approximately 1% goethitic limonite, and lesser quartz-magnetite veinlets, within a silicified, chloritised matrix, likely representing intermediate argillic overprint of former K-silicate alteration.

Ground magnetic surveys clearly define the subsurface magnetite alteration as a roughly north-northeast elongated, 80 to 1600 nT magnetic high, roughly 800 m long and up to 300 m wide, which appears to plunge to the east and south. Peripheral portions of the overall stockwork zone are characterised by sparse, hairline pyrite fractures with quartz-sericite halos, corresponding to D-type veins (Figure 7.7).

Figure 7.7
Narrow D-Type Vein with Sericite Halo



Source: Gerhard Westra

Surface rock chip sampling, limited drilling, and to a lesser extent soil sampling define a large body containing 0.1 to 1 ppm Au coinciding with the zone of stockwork veining.

Hypogene copper grades greater than 0.15% are largely due to disseminated chalcopyrite, which appears largely confined to the western two-thirds of the stockwork zone. The hypogene copper mineralisation is characterised by the presence of magnetite (+martite), chlorite and a relict biotite-K feldspar groundmass. The pyrite and chalcopyrite are usually present in equal proportions. There is an increase in the proportion of pyrite in the eastern zone of the porphyry at higher elevations, along with more intense phyllic/ argillic alteration, and an absence of magnetite.

A supergene-enriched zone ranging from 9 to 70 m in thickness and containing 0.25 to 0.69% Cu as chalcocite and covellite represents enrichment of about 1.5 to 3 times the hypogene grades.

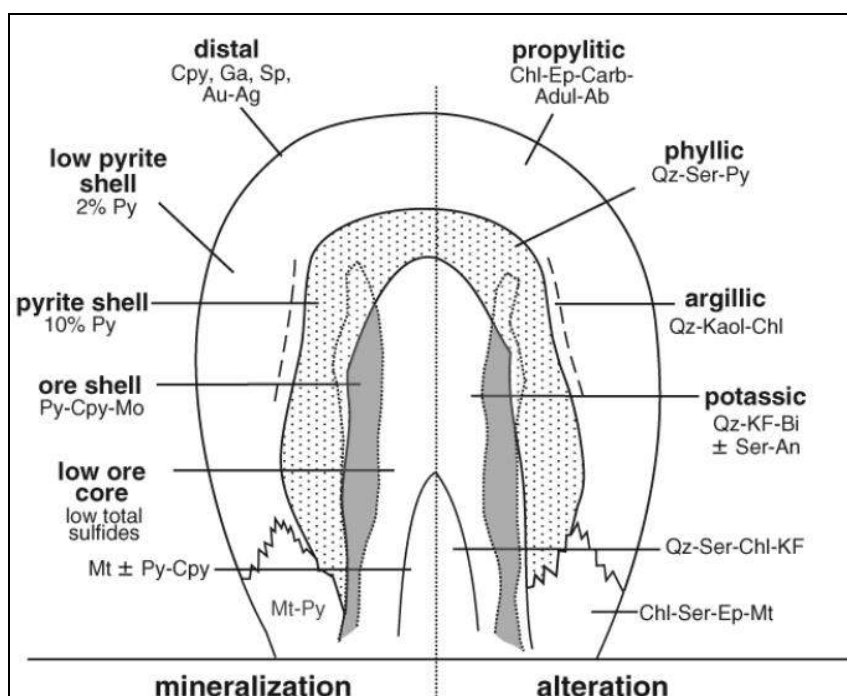
The leached cap generally contains approximately 150 ppm Cu. Molybdenum averages 20 to 80 ppm throughout the copper/ gold mineralised zone and is present largely as molybdenite in quartz veinlets that lack regular distribution.

8. DEPOSIT TYPES

The mineral deposit type at Ilovica is “Alkaline Copper-Gold Porphyry”. The deposit has characteristics which are typical for this deposit type.

The mineralisation is spatially, temporally and genetically associated with hydrothermal alteration of the intrusive bodies and host rocks. Figure 8.1 presents a simplified / idealised section through a porphyry deposit, showing the generally accepted model in relation to alteration and mineralisation.

Figure 8.1
Idealised Hydrothermal Alteration & Typical



Source: Low ell & Guilbert 1970

Notes: Idealised alteration zoning pattern in the Low ell-Guilbert model of porphyry deposits (after Lowell & Guilbert 1970). At Ilovica, supergene leaching and enrichment have overprinted the simple hydrothermal alteration model outlined in Figure 8.1

Key:

±	=	with or without	Ep	=	epidote
Ab	=	albite	Ga	=	galena
Adul	=	adularia	Kaol	=	kaolinite
An	=	anhydrite	KF	=	potassium Feldspar
Bi	=	bismuth	Mo	=	molybdenite
Carb	=	carbonate	Qz	=	quartz
Chl	=	chlorite	Ser	=	sericite

As is typical of this deposit type, stockworks, veinlets and disseminations of pyrite, chalcopyrite, bornite and magnetite occur in large zones of mineralisation in and adjoining porphyritic intrusions of diorite composition.

Subsequent supergene leaching/enrichment and advanced argillic alteration have overprinted the typical hydrothermal alteration and mineralisation pattern in the upper portion of the deposit.

9. EXPLORATION

The following exploration activities have been undertaken on the Property.

9.1 FIELD MAPPING AND ROCK CHIP SAMPLING

Detailed geological mapping was completed on 1:2 000 and 1:5 000 scales and comprised observations with respect to petrology, style of alteration and mineralisation.

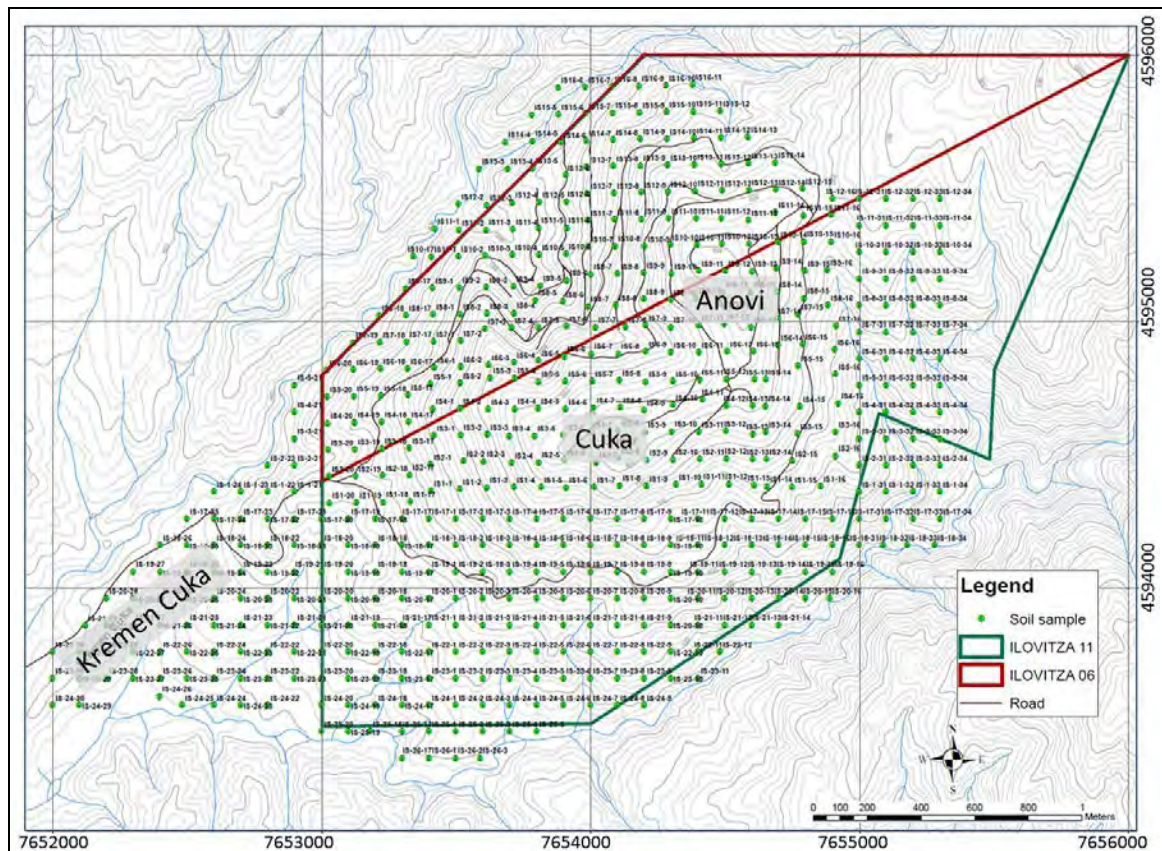
Rock chip samples were collected from the outcrops which were identified as having potential to host mineralisation. The samples were submitted to the assaying laboratory described in Section 11. The laboratory completed multi-element analysis using inductively coupled plasma optical emission spectroscopy (ICP-OES). Outcrops and chip sample locations were delineated using a hand held global positioning system (GPS). In addition, all of the existing roads and trails were GPS tracked.

9.2 SOIL GEOCHEMISTRY SURVEY

In total, three phases of soil sampling have been undertaken on the Property, resulting in a total of 540 sampling points arranged on a 100 m x 100 m grid (Table 9.1 and Figure 9.1).

Table 9.1 Soil Geochemistry Samples			
Soil Sampling Campaign	No. of Sample Points	Company	Area
2004	146	PDX	Anovi & Cukar
2006	111	PDX	Anovi & Cukar
2007	283	PDX & Euromax Resources	Kremen Cukar
Total	540	-	-

Figure 9.1
Soil Geochemistry Sampling Locations



Source: Euromax Resources

The total area covered by the soil geochemistry sampling was approximately 5 000 m².

The soil sampling targeted the subsoil horizon, which is generally at a depth of 20 to 30 cm (the “B” horizon of the soil profile), as this unit generally contains the accumulated minerals.

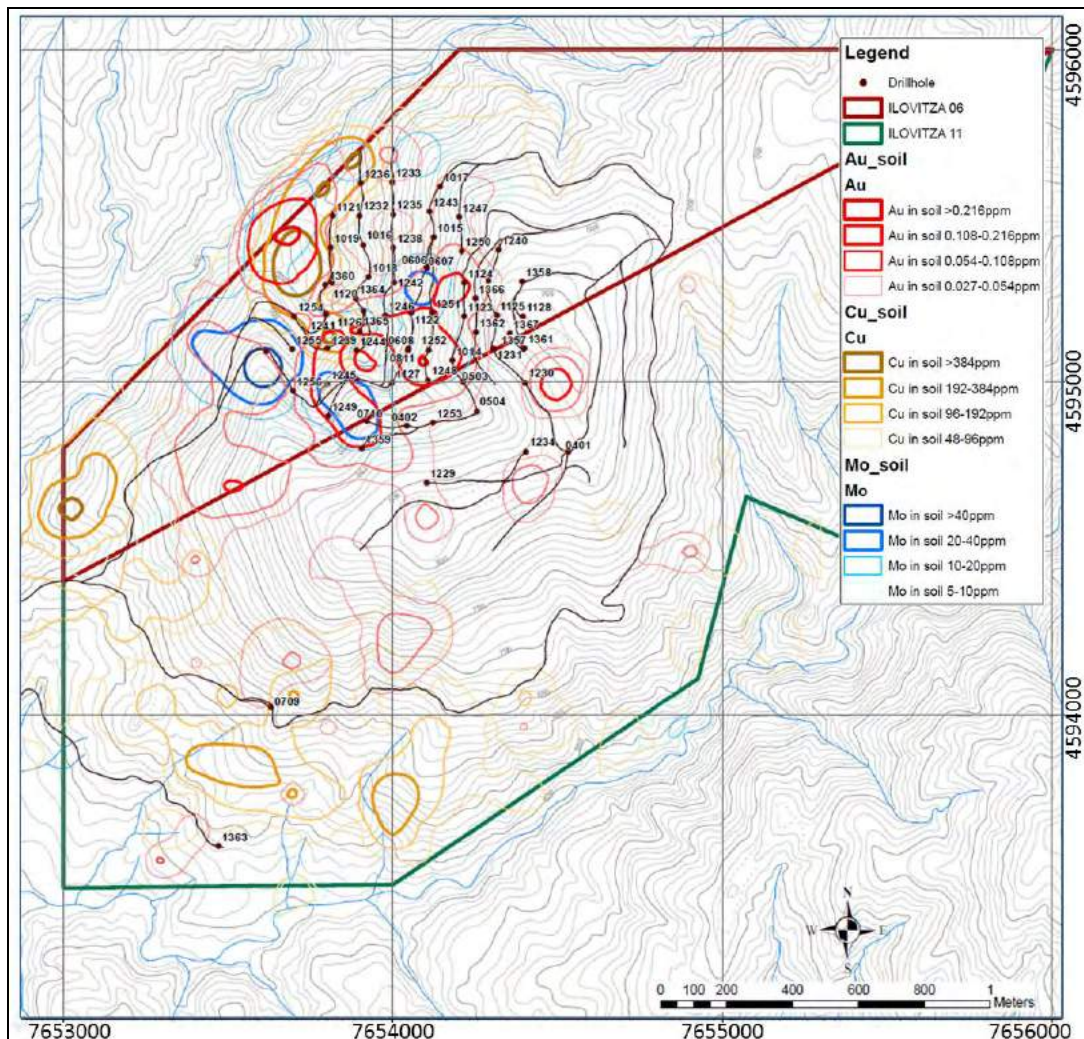
The soil surveys were completed by initially removing the humus topsoil layer with a spade, before taking a 2 to 3 kg sample of the subsoil. The remainder of the soil was restored to the sampling location and rehabilitation of disturbed areas was performed.

The samples were dried at room temperature and sieved using an 80# sieve (0.178 mm mesh sieve). Samples were split via quartering to produce two 150 g representative sub-samples. One of the 150 g sub-samples were sent to the laboratory to be assayed and a duplicate was retained. Pulverisation was completed by the testing laboratory.

Assaying was completed by Eurotest Control AD (Eurotest) in Sofia (described further in Section 11). Assaying was completed using inductively coupled plasma (ICP) analysis, with samples showing elevated gold, copper and molybdenum grades analysed using atomic absorption spectroscopy (AAS).

Results of soil sampling over the property indicate significant copper anomalies (>200 ppm copper) to the northwest, southwest and south of the mineralised intrusive (Figure 9.2). These anomalies are believed to represent down slope dispersion of the copper from the central area of mineralisation. In contrast, significant gold (>0.10 ppm) and to a lesser extent molybdenum (>20 ppm), show less down slope dispersion and more accurately delineate the underlying mineralisation.

Figure 9.2
Soil Geochemistry Anomalies



Source: Euromax Resources

9.3 GEOPHYSICAL SURVEYS

9.3.1 Magnetic Survey

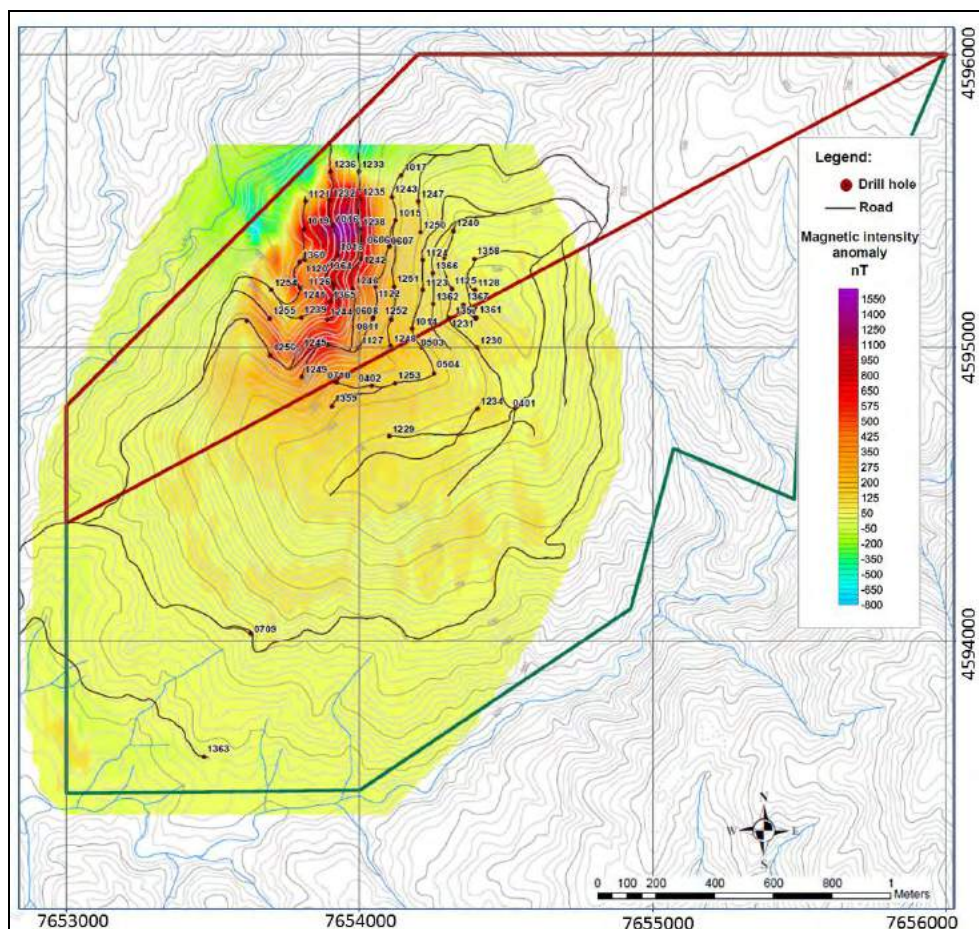
A total magnetic intensity survey was conducted by PDX on behalf of Euromax Resources between 1 April and 6 April 2005. Twenty-four east-west lines spaced 100 m apart were surveyed with readings taken every 10 m. Three proton magnetometers, manufactured in Poland, were used. Their sensitivity was ± 0.1 nT. Two magnetometers were used for traversing while the third was used as a base station.

The aim of the survey was to outline the lateral and vertical extension of stockwork zones with secondary magnetite enrichment intersected in drill holes PDIC-04-03, PDIC-04-02 and PDIC-04-01. The stockworks comprise quartz-sulphide veinlets in illite-sericite-chlorite altered granodioritic host rocks.

Magnetic susceptibility measurements were taken at an average interval of about 10 cm on core from these holes using an electromagnetic inductance bridge. The sensitivity of the bridge was in the order of 0.0001 SI.

A high amplitude magnetic anomaly was outlined; the magnetic susceptibility measurements demonstrated that the only magnetic rocks in the area are the secondary magnetite enrichment stockwork zones that are the source of the magnetic anomaly. The data was modelled using Geosoft's 2D and 3D inversion programme "Potent". The magnetic models indicated that the magnetic stockwork zone trends north-northeast along an 800 m strike length and is approximately 300 m wide, though inherent ambiguities in the interpretation process may have underestimated the width of the body. Figure 9.3 shows the survey results.

Figure 9.3
Ground Magnetic Survey



9.3.2 Induced Polarisation/Resistivity Survey

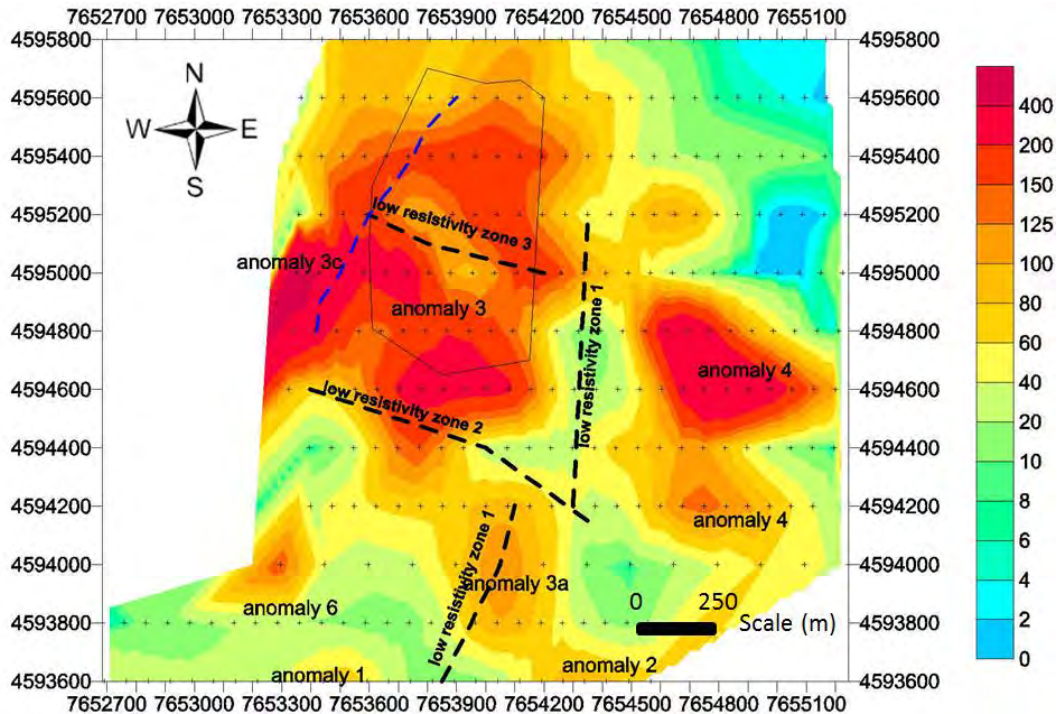
A high resolution pole dipole array survey was conducted by Euromax Resources at Ilovica in July/August 2008 using dipole lengths of 300 m and 150 m and n spacings of 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5 and 5.5 for the array with dipole length of 300 m and $n = 1, 2, 3, 4, 5, 6, 7$ for the 150 m dipole length. The raw data was processed using the Zonge Datpro software package and interpreted using the GEOTOMO software package. Simultaneous inversion modelling of data measured with different electrode configurations was conducted.

The IP or resistivity survey identified a number of intense IP anomalies, interpreted to be related to sulphide and magnetite mineralisation previously intersected in drill holes (Figure 9.4 and Figure 9.5).

The resistivity models revealed the presence of linear, almost vertical low resistivity features, interpreted as fault zones. A specific feature of the resistivity models is the presence of almost horizontal low resistivity layers probably associated with more intensive fracturing of the rocks above silicified granodiorite. The most prominent IP anomaly coincided spatially with the magnetic stockwork zone defined previously by the magnetic survey and tested by several drill holes. Compared to typical low grade porphyry systems, the IP values measured at Ilovica were significantly elevated. The high IP intervals correlated with high total sulphide values of up to 3 to 5%, though while the copper mineralisation in drill holes coincides with high sulphide concentrations it was not possible to distinguish between anomalies related to a barren pyrite halo and IP anomalies associated with porphyry copper mineralisation.

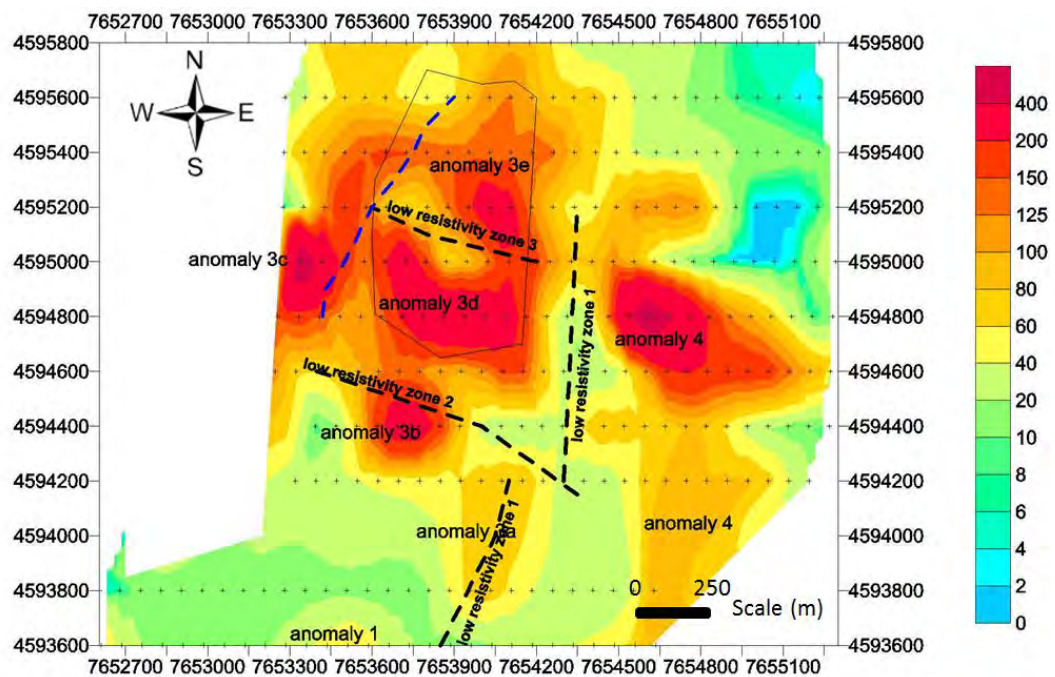
The IP survey indicated that the porphyry system could extend to a depth of at least 550 m from surface. The core of the hydrothermal system as defined by the IP and magnetic surveys trends north-northeast and extends to about 800 to 1 200 m along strike. To the east the interpreted body is truncated by a north-south trending, near vertical resistivity low, most probably a large fault zone. Recent drilling suggests that this fault has a downthrow to the east and that further mineralisation occurs within dacitic rocks east of the fault. The western margin of the IP high extends beyond the bounding magnetic lineament and may represent a pyritic halo continuing beyond the area of magnetite mineralisation in the core of the system. The southern margin of the porphyry as interpreted from the IP coincides with a west-northwest-trending, near vertical, low resistivity feature, interpreted as a fault. The latter appears to offset to the west-northwest the prominent north-south fault that bounds the eastern part of the main porphyry. A parallel west-northwest-trending vertical fault 600 m to the north is also interpreted to be truncated to the east by the north-trending fault. These interpreted faults are shown on Figure 9.4, Figure 9.5, Figure 9.6 and Figure 9.7.

Figure 9.4
2D IP Inversion Model on Level 350 m from Surface



Source: Euromax Resources

Figure 9.5
2D IP Inversion Model on Level 350 m from Surface



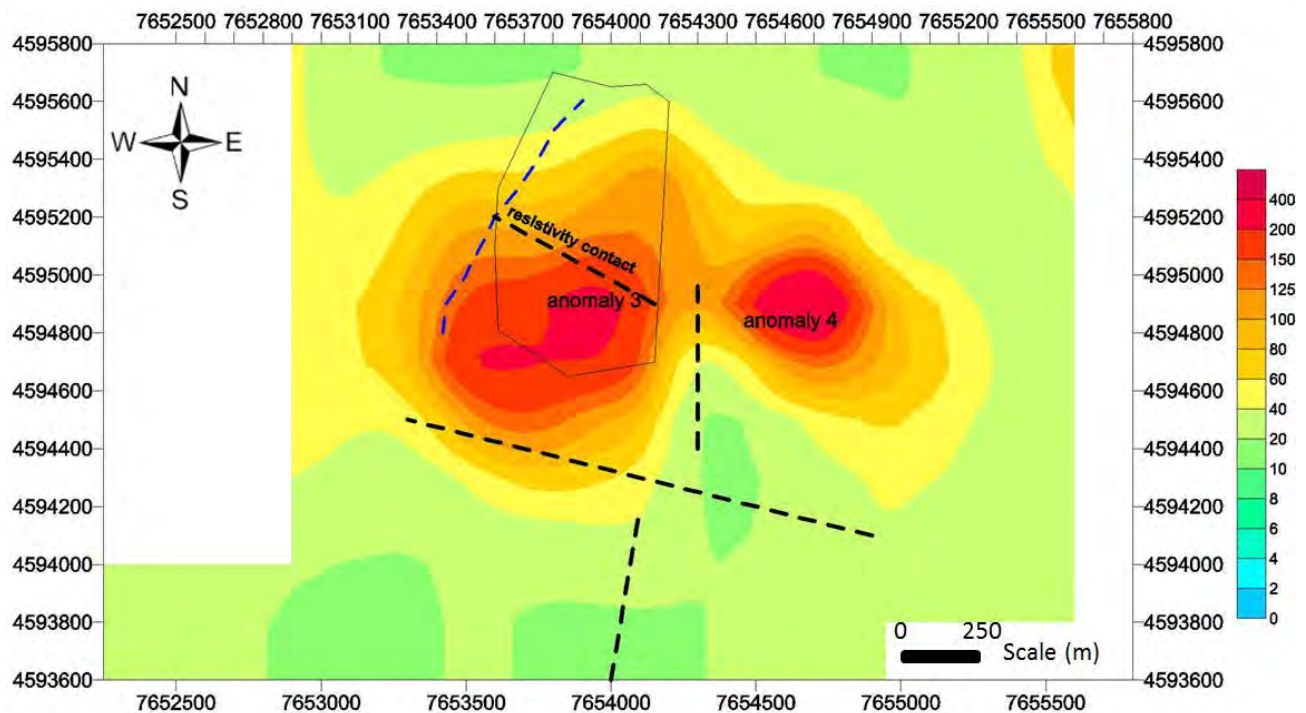
Source: Euromax Resources

Several IP anomalies form a discontinuous annular zone around the interpreted core of the system, probably related to the pyrite halo.

The resistivity models presented in Figure 9.6 and Figure 9.7 indicate the presence of near to horizontal low resistivity layers to the west of the core of the system interpreted to reflect the presence of intensive stockwork zones with copper mineralisation. Initial examination of the more recent drilling conducted on the property has not established conclusive lithological or mineralogical causes of the horizontal IP anomaly. The geological log of drill hole EOIC-07-10 indicates that, as suggested above, silicification increases in the high resistivity zone. However, it seems that this increase in silicification is not a major feature as chlorite-sericite is logged as the dominant alteration in this zone.

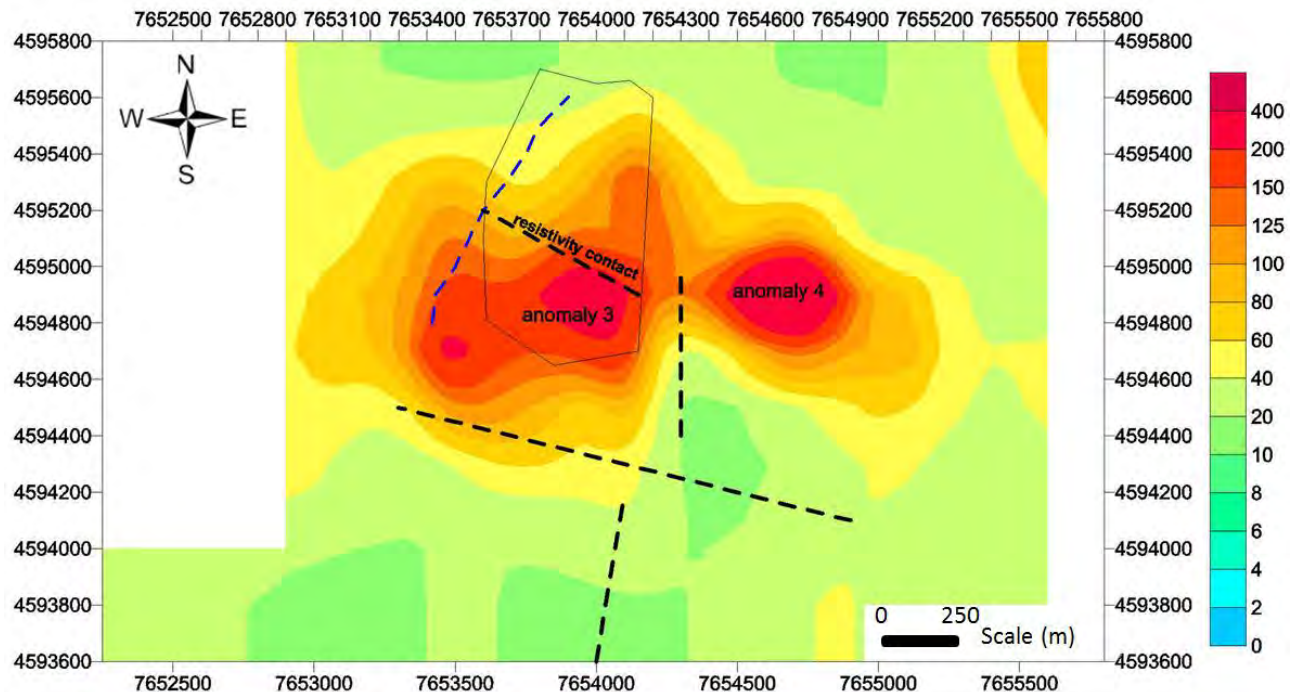
The beginning of the horizontal low resistivity zone appears to coincide with the intercept of fresh, unweathered dacite, although a lithological change from dacite to granodiorite further down the hole does not seem to affect the resistivity model. In drill hole PDIC-04-02, magnetite is logged in the transition from low to high resistivity. A further observation is that the area of low resistivity correlates with low grade copper and gold in the Ilovica block model and, in fact, grade appears to increase as the higher resistivity zone is intersected.

Figure 9.6
3D Resistivity Inversion Model on Level 350 m from Surface



Source: Euromax Resources

Figure 9.7
3D Resistivity Inversion Model on Level 260 m from Surface



Source: Euromax Resources

The enriched stockwork appears to be structurally controlled and, as mentioned above, downthrown to the east by a fault originating at surface at approximately 7 654 200 E on section 4 595 200 N.

It is concluded that additional drilling should be conducted to delineate the structures interpreted from the IP survey and to test IP anomalies beyond the core of the deposit both laterally and to depth. In addition, existing core should be re-logged with specific attention to the contacts between low and high resistivity zones and faults. If possible, attempts should be made to orientate core in future drill programmes.

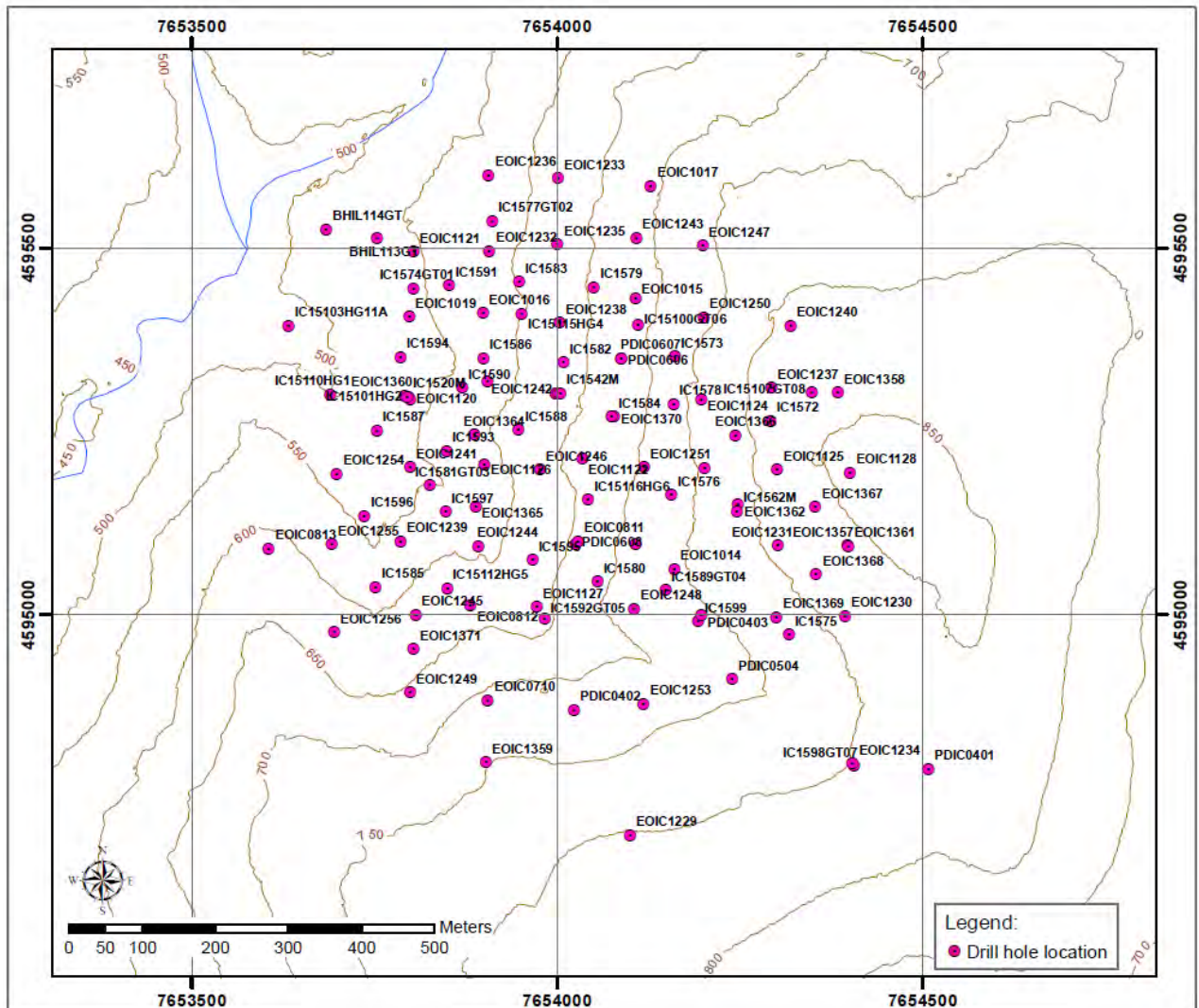
10. DRILLING

A total 130 holes have been drilled over 10 campaigns between 2004 and July 2015. Of the 130 holes, 20 were drilled for geotechnical investigation, 15 were drilled for hydrogeological investigation and 95 were drilled for mineral resource determination. In total, 42 032 m have been drilled. Table 10.1 summarises the scope of the campaign completed on the Property.

Table 10.1 Summary of Drilling Campaigns				
Year	Drilling Technique	No. of Holes	Total Length Drilled (m)	Company
2004	Diamond Core	3	1 178	PDX
2005	Diamond Core	1	385	PDX
2006	Diamond Core	3	1 238	PDX
2007	Diamond Core	2	999	Euromax Resources
2008	Diamond Core	3	1 600	Euromax Resources
2010	Diamond Core	6	3 016	Euromax Resources
2011	Diamond Core	9	4 387	Euromax Resources
2012	Diamond Core	28	12 081	Euromax Resources
2013	Diamond Core	15	5 778	Euromax Resources
2014	No drilling this year	-	-	-
2015	Diamond Core	60	11 371	Euromax Resources
Total	Diamond Core	130	42 032	-

The drill holes are generally vertical or steeply dipping; with 95 of the drill holes being vertical and the remainder being between 55° and 75°. The drill locations are illustrated in Figure 10.1.

Figure 10.1



Source: Euromax Resources

All of the holes were drilled using rotary diamond coring techniques. Drillholes were collared with PQ diameter (85 mm core) and then advanced with HQ (61.1 mm core) and then occasionally NQ (45.1 mm core) diameters. Occasionally, difficult ground conditions were encountered around the base of oxidation. Where this occurred, these sections were cemented and re-drilled.

A wireline system was used to hoist the core tube to surface to allow the drill core to be extracted. The drill core was placed into 1 m long aluminium core boxes, with the core laid out so that the order of drilling is retained. The core was placed with the top of the hole in the top left hand corner of the core box and the deepest core located in the bottom right hand corner of the core box.

10.1 CORE LOGGING AND SAMPLING

Once the core had been collected and transported to the logging facilities in Strumica, the core boxes were laid out on the logging racks for inspection by the exploration geologist.

Core blocks were checked for consistency and core boxes were marked with the drill hole number and interval depths. High quality digital photographs of the core were taken both wet and dry.

Logging included observations relating to lithology, alteration, mineralisation, structure, recovery and rock quality designation (RQD). Geologists initially logged the holes onto paper logging forms before entering the logs into Microsoft Excel® (Excel) on a daily basis.

Drill core recovery is very good, generally greater than 95%, throughout the deposit. Within the oxide zone the core is general highly fractured and as such the RQD is low, however the overall core recoveries remain high.

Once logged, the core was marked for cutting. Core was cut with a diamond blade circular table saw. Samples were taken over variable intervals based upon lithology and alteration observations, collected during detailed logging of the core. Where there are no pertinent changes in lithology or alteration, the samples have generally been collected on the basis of 3 m intervals.

Generally half of the core samples were taken and processed for analysis. Where density samples were taken, one quarter of the core was collected for density determination and one quarter was taken for assaying. Half core samples have been retained and are stored in the facilities at Strumica. The sample preparation process is described in Section 11.3.

10.2 COLLAR AND DOWNHOLE SURVEYS

10.2.1 Collar Surveys

In October 2011 Euromax Resources engaged an independent company (DGU Geo Prem of Strumica) to complete collar survey for drill holes 1 to 27. The survey was completed using a Topcon global positioning system (model reference: Hiper Pro RTK Base and Rover device). The measurements were collected using real time kinematics from a known trigonometric point with loaded parameters for the local site. The accuracy of measurements was 2 to 5 cm.

Collar surveys for drill holes 28 to 70 have been completed using a handheld GPS (Garmin GPS map 62s). The manufacturer specification states that the device accuracy is less than 10 m.

The 2015 campaign drill holes from 70 to 130 have been completed using a Garmin GPS map 62s, specified as above.

10.2.2 Downhole Surveys

Downhole surveys were completed by the drilling contractor as the drill string was extracted from the holes. Downhole surveys were completed using a digital survey instrument (JKH-R magnetic single shot inclinometer) with readings taken every 50 m. Generally the drill holes show very low deviation from the planned hole paths, deeper holes show up to five degrees variance from design for both dip and azimuth.

10.3 HISTORIC DRILLING

Between 2004 and 2006 PDX drilled seven holes on the property totalling 2 800 m. A full quality assurance (QA)/quality control (QC) programme was undertaken, which included: blanks, duplicates and standards, as discussed in Section 11.6.

The 2004 to 2006 drilling has also been validated by Euromax Resources through the twinning of three of the holes drilled by PDX. The grades and core recoveries observed for the PDX drill holes are generally in line with those subsequently recorded within the Euromax Resources drilling. Table 10.2 presents the significant intercepts (>0.7 g/t gold equivalent) associated with the 2004 to 2006 drilling campaigns.

Table 10.2 Significant Intercepts from 2004 to 2006 Campaigns					
Drill hole No.	From (m)	To (m)	Length (m)	Au (g/t)	Cu (%)
PDIC 402	240.0	386.0	146.0	0.25	0.20
PDIC 403	417.0	537.0	120.0	0.29	0.26
PDIC 504	210.0	264.0	54.0	0.32	0.14
PDIC 606	54.0	405.0	351.0	0.36	0.25
PDIC 607	132.0	225.5	93.5	0.45	0.28
PDIC 608	57.0	450.0	393.0	0.36	0.25

10.4 EUROMAX RESOURCES DRILLING 2007 TO 2013

Between 2007 and the 11th of July 2013, Euromax Resources drilled a further 63 holes, with a total length of 27 860 m. Table 10.3 presents the significant intercepts (> 0.7 g/t gold equivalent).

Table 10.3 Notable Intercepts from 2007 to 2013 Campaigns					
Drill Hole No.	From (m)	To (m)	Length (m)	Au (g/t)	Cu (%)
EOIC 810	140.0	182.0	42.0	0.26	0.36
EOIC 811	265.0	323.0	58.0	0.35	0.25
EOIC 812	49.0	121.0	72.0	0.29	0.36
EOIC 814	105.0	153.0	48.0	0.35	0.49
and	207.0	235.0	28.0	0.50	0.47
EOIC 815	123.0	408.0	285.0	0.44	0.27
EOIC 1016	3.6	30.0	26.40	0.69	0.87
and	278.5	314.0	35.5	0.37	0.27
and	332.0	389.0	57.0	0.32	0.32
EOIC 1018	4.5	18.0	13.5	0.41	0.66
and	33.0	171.0	138.0	0.47	0.36
and	195.0	232.2	37.2	0.35	0.29
and	253.0	277.0	24.0	0.35	0.28
and	308.0	332.0	24.0	0.40	0.25
EOIC 1019	109.0	120.5	11.5	0.45	0.26
and	205.5	227.0	21.5	0.43	0.23

Table 10.3
Notable Intercepts from 2007 to 2013 Campaigns

Drill Hole No.	From (m)	To (m)	Length (m)	Au (g/t)	Cu (%)
EOIC 1020	13.1	61.0	47.9	0.44	0.45
<i>and</i>	77.8	117.0	39.2	0.34	0.30
EOIC 1021	254.0	269.0	15.0	0.37	0.26
<i>and</i>	472.0	514.1	42.1	0.59	0.56
EOIC 1022	66.5	192.9	126.4	0.47	0.26
<i>and</i>	334.0	355.0	21.0	0.37	0.25
EOIC 1023	126.0	254.0	128.0	0.55	0.34
EOIC 1024	127.0	151.0	24.0	0.32	0.29
EOIC 1025	216.0	312.4	96.4	0.55	0.29
EOIC 1026	29.0	167.0	138.0	0.48	0.30
EOIC 1027	279.0	297.0	18.0	0.26	0.30
EOIC 1028	235.0	334.4	99.4	0.57	0.23
EOIC 1230	117.0	192.1	75.1	0.38	0.30
EOIC 1231	161.0	258.0	97.0	0.33	0.28
EOIC 1233	38.5	50.0	11.5	0.44	0.26
<i>and</i>	253.0	271.0	18.0	0.56	0.16
EOIC 1235	7.0	38.0	31.0	0.26	0.31
<i>and</i>	349.4	398.0	48.6	0.34	0.28
EOIC 1237	270.9	370.0	99.1	0.52	0.25
EOIC 1238	18.0	75.0	57.0	0.46	0.29
<i>and</i>	87.5	120.0	32.5	0.50	0.38
EOIC 1239	10.0	96.0	86.0	0.39	0.28
<i>and</i>	129.0	184.0	55.0	0.45	0.28
EOIC 1241	2.4	64.0	61.6	0.35	0.30
EOIC 1242	40.0	111.0	71.0	0.66	0.38
EOIC 1244	34.0	107.0	73.0	0.32	0.30
<i>and</i>	173.0	268.0	95.0	0.42	0.28
EOIC 1245	47.0	68.0	21.0	0.19	0.54
<i>and</i>	149.0	170.0	21.0	0.46	0.29
EOIC 1246	15.0	248.0	233.0	0.64	0.32
EOIC 1251	81.5	126.5	45.0	0.36	0.33
EOIC 1357	181.5	338.0	156.5	0.99	0.37
EOIC 1360	0.0	62.5	62.5	0.31	0.44
EOIC 1361	180.0	203.0	23.0	0.35	0.34
EOIC 1362	143.0	305.3	162.3	0.90	0.35
EOIC 1364	26.0	240.0	214.0	0.45	0.28
EOIC 1365	57.0	177.0	120.0	0.39	0.25
EOIC 1366	172.5	228.0	55.5	0.45	0.29
EOIC 1367	214.0	305.0	91.0	0.52	0.23

10.5 EUROMAX RESOURCES DRILLING 2015

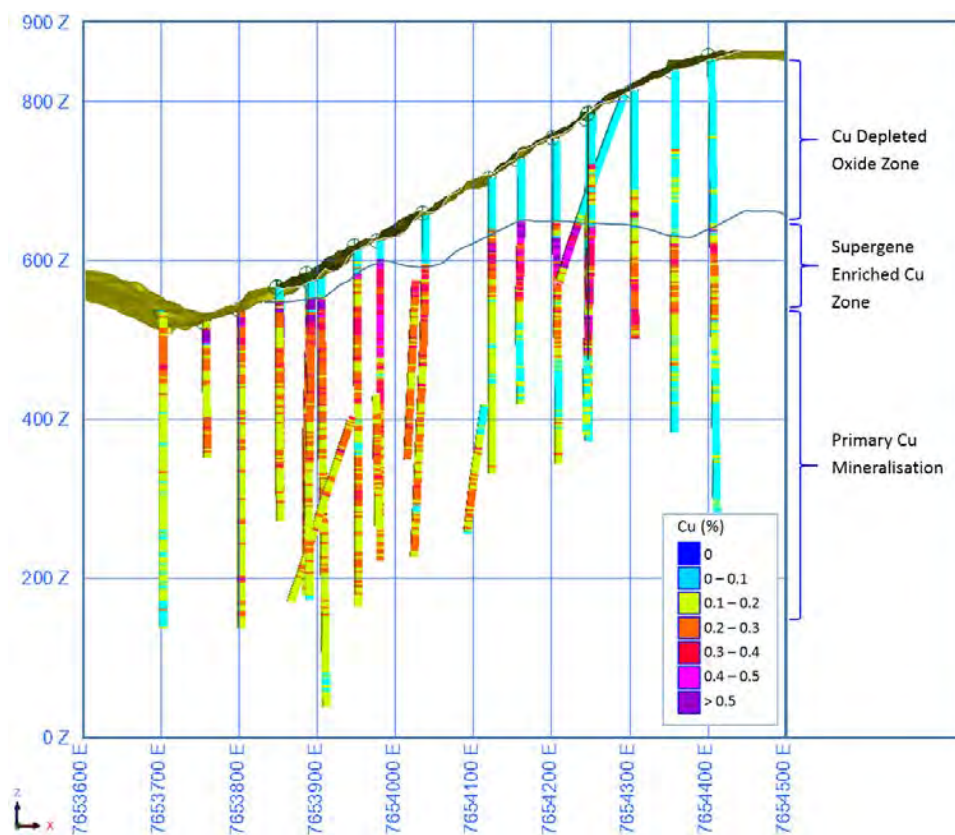
During 2015, Euromax Resources drilled a further 60 holes, 25 of which were assayed for mineral resource definition. A total length of 11 371 m was recorded. Table 10.4 presents the significant intercepts (> US\$16 equivalent recovered grades).

Table 10.4 Notable Intercepts from 2015 Campaign					
Drill Hole No.	From (m)	To (m)	Length (m)	Au (g/t)	Cu (%)
IC1572	60	108	48	0.16	0.0023
and	164.6	206	41.4	0.51	0.1012
IC1576	3.5	78	74.5	0.64	0.0202
IC1578	93	98	5	0.39	0.0976
IC1580	51	53.6	2.6	0.32	0.1018
IC1582	7.7	41.5	33.8	0.45	0.0946
IC1583	18	47.1	29.1	0.89	0.2362
IC1585	11.9	27	15.1	0.28	0.2485
IC1586	29	50.1	21.1	0.71	0.686
IC1587	5.3	25	19.7	0.31	0.7681
IC1588	20.5	35	14.5	0.71	0.1018
IC1590	4	57.1	53.1	0.48	0.7153
IC1591	14.1	38	23.9	0.44	0.0994
IC1593	35	68	33	0.4	0.6899
IC1594	15.3	22.6	7.3	0.26	0.1687
IC1596	15.9	37.4	21.5	0.08	0.1083
IC1597	16.8	31.9	15.1	0.35	0.4551
IC1599	45	67.1	22.1	0.35	0.1063

The mineralisation is generally dispersed throughout the porphyry, but with a broadly sub-horizontal higher grade zone associated with the leaching and supergene enrichment beneath the oxidised material (Figure 10.2). Sectional interpretations have been developed which eliminate any apparent thickening of the enriched zone associated with the inclined drill holes.

The cross section presented in Figure 10.2 illustrates the interpretation of the drilling results in relation to copper depletion in the oxide materials and supergene enrichment beneath. The gold assays show a similar but less pronounced distribution.

Figure 10.2
Typical Section – Copper Assays (%)



Source: Tetra Tech

Note: West-east section at 4 595 200 N

11. SAMPLE PREPARATION, ANALYSES AND SECURITY

11.1 SUMMARY

Euromax Resources undertakes the bulk of the sample preparation activities in its facilities in Strumica. The activities include: sample selection, core cutting, sample drying and crushing. Milling of the samples is undertaken by the testing laboratories.

All assaying was completed by Eurotest, a laboratory with International Organisation for Standardisation (ISO) 9000 accreditation in Sofia, Bulgaria. Eurotest does not have any previous relationship with Euromax Resources or its management.

11.2 GENERAL SAMPLING METHODOLOGY

The mineralised zones at Ilovica have been sampled on the basis of the lithological and alteration observations collected during detailed logging of the core. Where there are no pertinent changes in lithology or alteration, the samples have generally been collected on the basis of 3 m intervals.

As of 7 July 2015, the drill hole database for the Project contained 12 695 samples, 11 847 of which are 3 m in length or less. The remaining 848 samples were between 3 and 6.5 m in length, with 759 being between 3 and 4 m in length. There is no correlation between grade and sample length.

11.3 SAMPLE PREPARATION

After being logged, the sample intervals are marked and the core is sawn in half. The core is photographed after splitting. Tetra Tech was provided with the complete photographic database, which contains a high definition photograph of every box of drill core associated the Project.

The following sample preparation procedure is followed:

- half core samples are crushed to <2 mm grain size
- two 200 g representative sub-samples are split from the whole via several stages of quartering
- one 200 g sample is sent to Eurotest, where it is pulverised and assayed
- the second 200 g sample is retained and stored at Strumica
- pulp rejects (100 to 150 g) are returned to Euromax Resources and stored at Strumica
- coarse rejects of (4 to 10 kg bags) are stored at Strumica

All samples are securely stored in the core storage facility prior to transport by Euromax Resources personnel to the Eurotest Laboratory in Sofia, Bulgaria.

Figure 11.1
Core Cutting Equipment in Euromax Resources' Facilities at Strumica



Source: Tetra Tech

Samples of half core (Figure 11.1) are placed into plastic bags and sealed with single use ties under the supervision of Euromax Resources' geologists. Bags are labelled with a unique sample number, as well as a sample interval and drill hole reference.

The samples are then dried in the drying units at Strumica (Figure 11.2).

Figure 11.2
Sample Drying Equipment in Euromax Resources' Facilities at Strumica



Source: Tetra Tech

Once fully dried, the samples are crushed to 2 mm using a jaw crusher (Figure 11.3).

Figure 11.3
Jaw Crusher Equipment at Euromax Resources' Facilities in Strumica



Source: Tetra Tech

Once crushed and split to 200 g, the samples are sent to the laboratory with associated chain of custody documentation. The duplicate sample is retained by Euromax Resources and stored in Strumica (Figure 11.4).

Figure 11.4
Duplicate 200g Samples Stored at Strumica



Source: Tetra Tech

11.4 CONFIDENTIALITY AND SECURITY OF DATA

The results of the laboratory analysis are strictly confidential and the sole property of Euromax Resources. All information stored on computer systems is accessible via a password protected network drive, accessible only to a limited number of Euromax Resources staff. One member of staff is responsible for the transfer of assay results to the drill hole database.

11.5 ASSAYING

All assaying was completed by Eurotest. Assaying is undertaken on a pulverised 30 g sub-sample of the 200 g sample sent to the laboratory. Gold is assayed by Fire assay with an AAS finish. Unusually high values are checked by metallic screen assay.

All other elements including copper, molybdenum and silver are assayed by inductively coupled plasma atomic spectroscopy. Any over limit samples (>10 000 ppm for copper and molybdenum and >10 ppm for silver) are re-assayed by AAS.

11.6 QUALITY ASSURANCE / QUALITY CONTROL PROGRAMME

QA/QC samples, including crush duplicates, standard reference materials (SRM), and blanks were inserted approximately every 20th sample. This ensured that at least one set of QA/QC samples were included in every batch of samples issued to the testing laboratory.

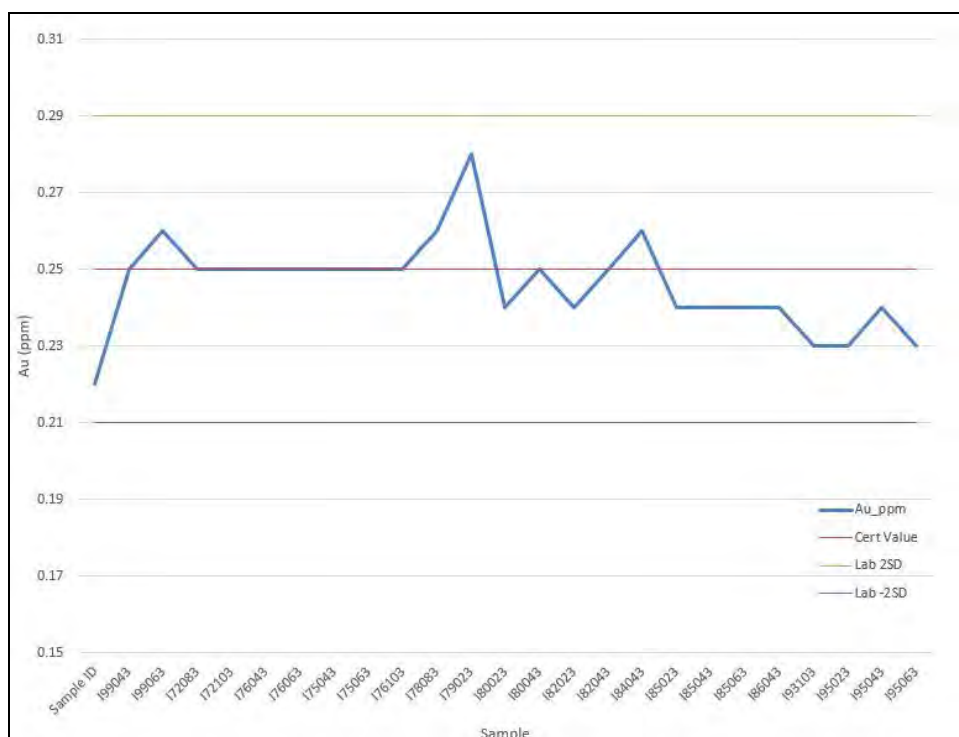
11.6.1 Standards

The QA/QC programme included inserting standard reference materials into the sample stream. A standard was included approximately every 20 samples. This represents approximately 5% of the samples issued to the laboratory.

Table 11.1 Standard Reference Material Conformance													
SRM	Au (ppm)						Cu (ppm)						
	Accepted Value	UFL	LFL	Mean Result	Count	Failure Count	Accepted Value	UFL	LFL	Mean Result	Count	Failure Count	Overall Failure (%)
IS 2	0.25	0.21	0.29	0.246	25	0	2250	2500	2000	2247	25	0	0
IS 3	0.34	0.4	0.28	0.34	65	0	2090	2310	1870	2118	65	0	0

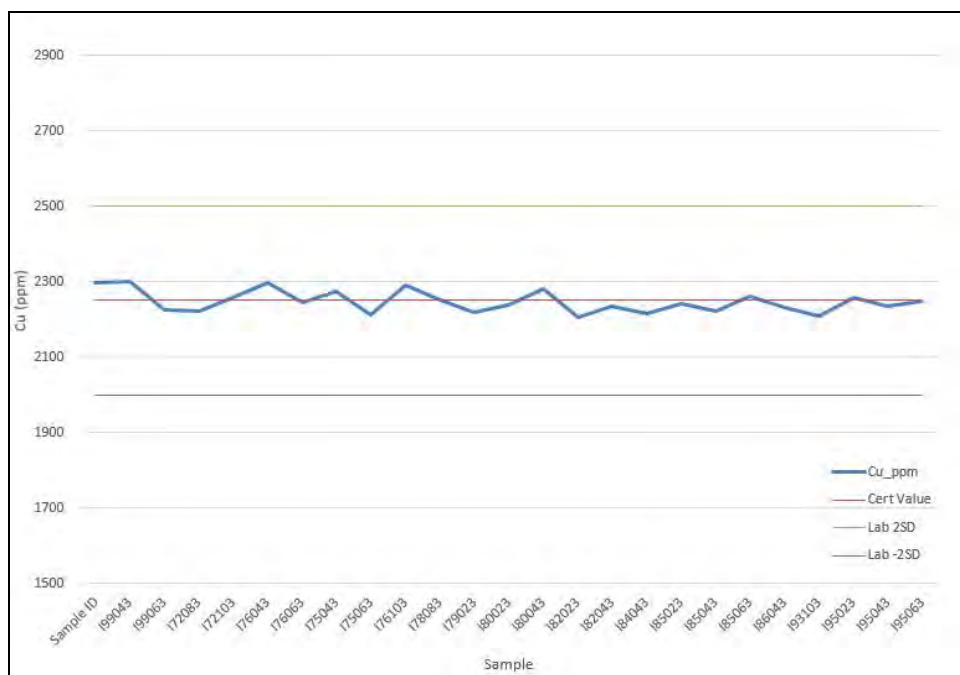
For the 2015 drilling campaign four standard reference materials have been used. Two of the standards were used less than 10 times and therefore statistical inference cannot be derived from this data, however visual inspection shows satisfactory performance. The two standards presented in Table 11.1 are those currently used at the project, Figure 11.5 to Figure 11.8 illustrate the performance of the standards in relation to the accepted values.

Figure 11.5
Standard IS 2 Performance Chart - Gold



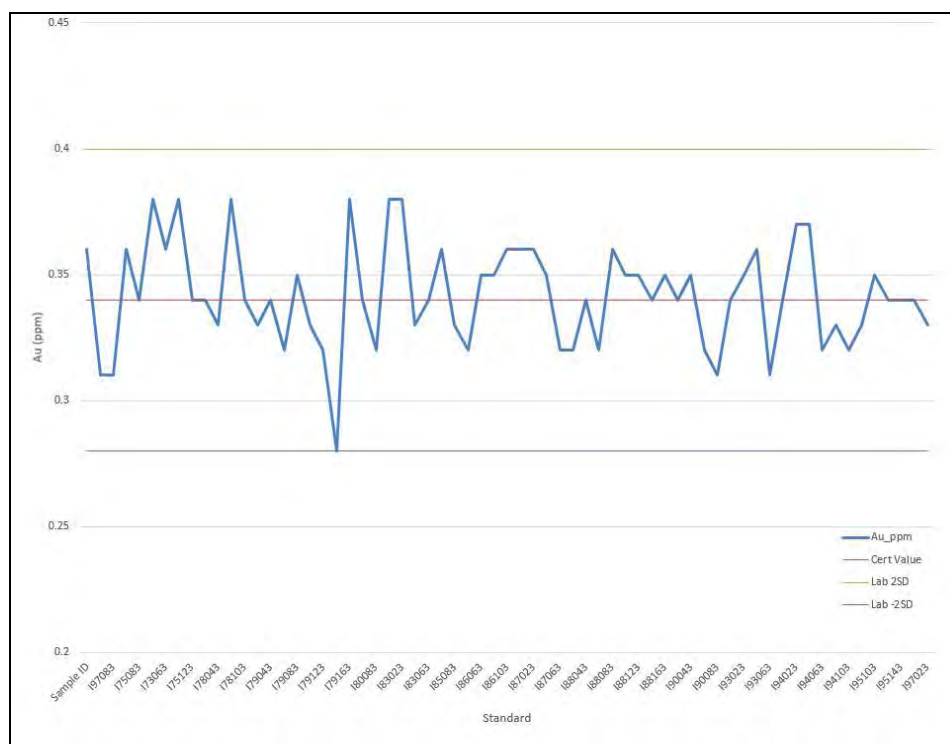
Source: Tetra Tech

Figure 11.6
Standard IS 2 Performance Chart - Copper



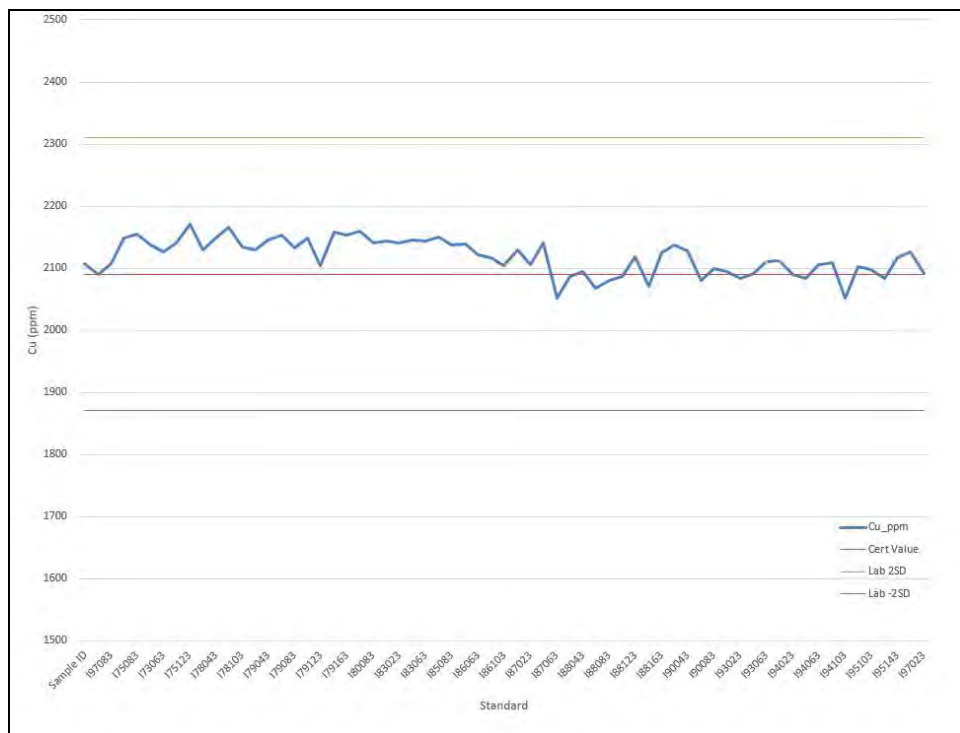
Source: Tetra Tech

Figure 11.7
Standard IS 3 Performance Chart - Gold



Source: Tetra Tech

Figure 11.8
Standard IS 3 Performance Chart - Copper



Source: Tetra Tech

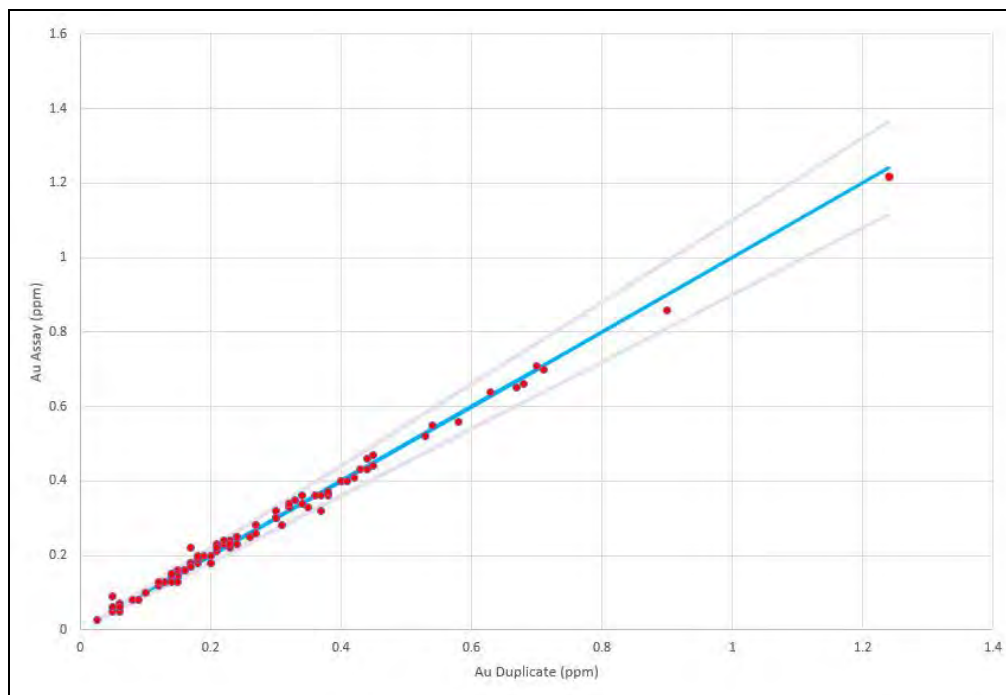
Standards were prepared from core from the Ilovica drilling. The standards were independently prepared for Euromax Resources by Eurotest control laboratory.

The compliance of the results in relation to the accepted values for the standards is generally excellent, with no reported failures. The Au variance can be attributed to the low values being detected, whilst Cu performs very strongly.

Course duplicates were submitted to the laboratory approximately every 20th sample. The duplicates were created when the samples were crushed and split in the facilities in Strumica. To prevent the duplicate from being recognised by the laboratory, these samples were not identified as such when submitted.

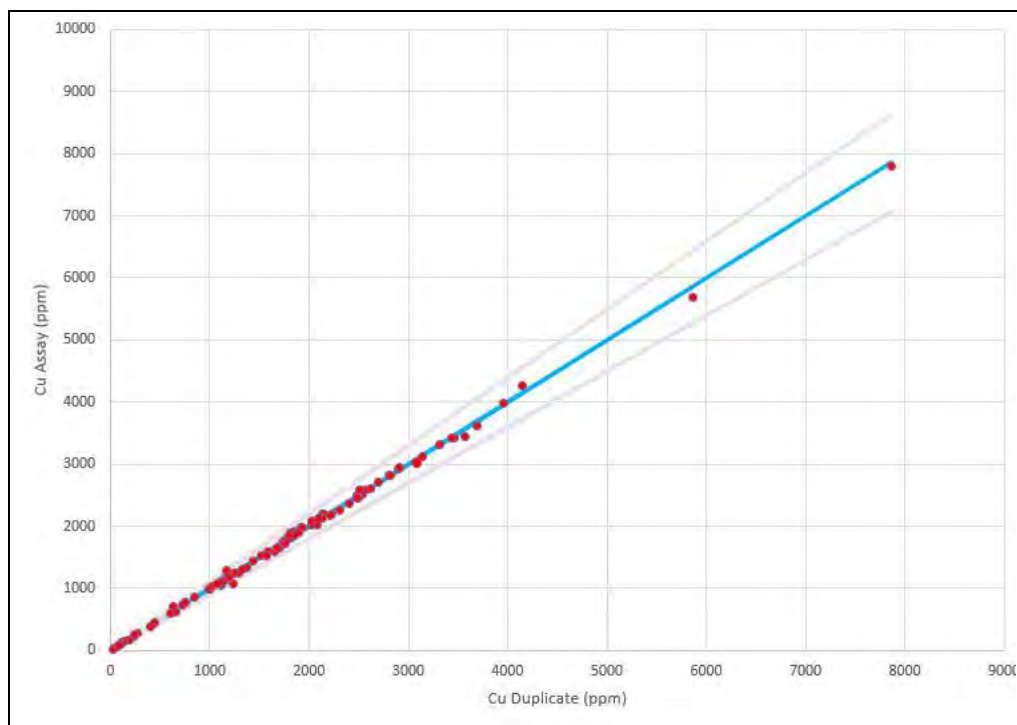
In total 99 duplicate samples were submitted, of which 11 failures occurred for gold and 3 failures occurred for Copper. Failures were defined by the difference between the original and the duplicate assay being >10%. Therefore, the total failure rate was 11% for gold and 3% for copper, which is well within acceptable limits for coarse duplicate analysis. The failures occurred typically at low detection values where there are greater precision errors. No failures occurred at higher values. Correspondingly the slope of regression value of $R^2 = 0.9948$ for gold and 0.9986 for copper indicates an extremely good correlation between the original and the duplicates (Figure 11.9 and Figure 11.10).

Figure 11.9
Coarse Reject Duplicates (Au ppm)



Source: Tetra Tech

Figure 11.10
Coarse Reject Duplicates (Cu ppm)



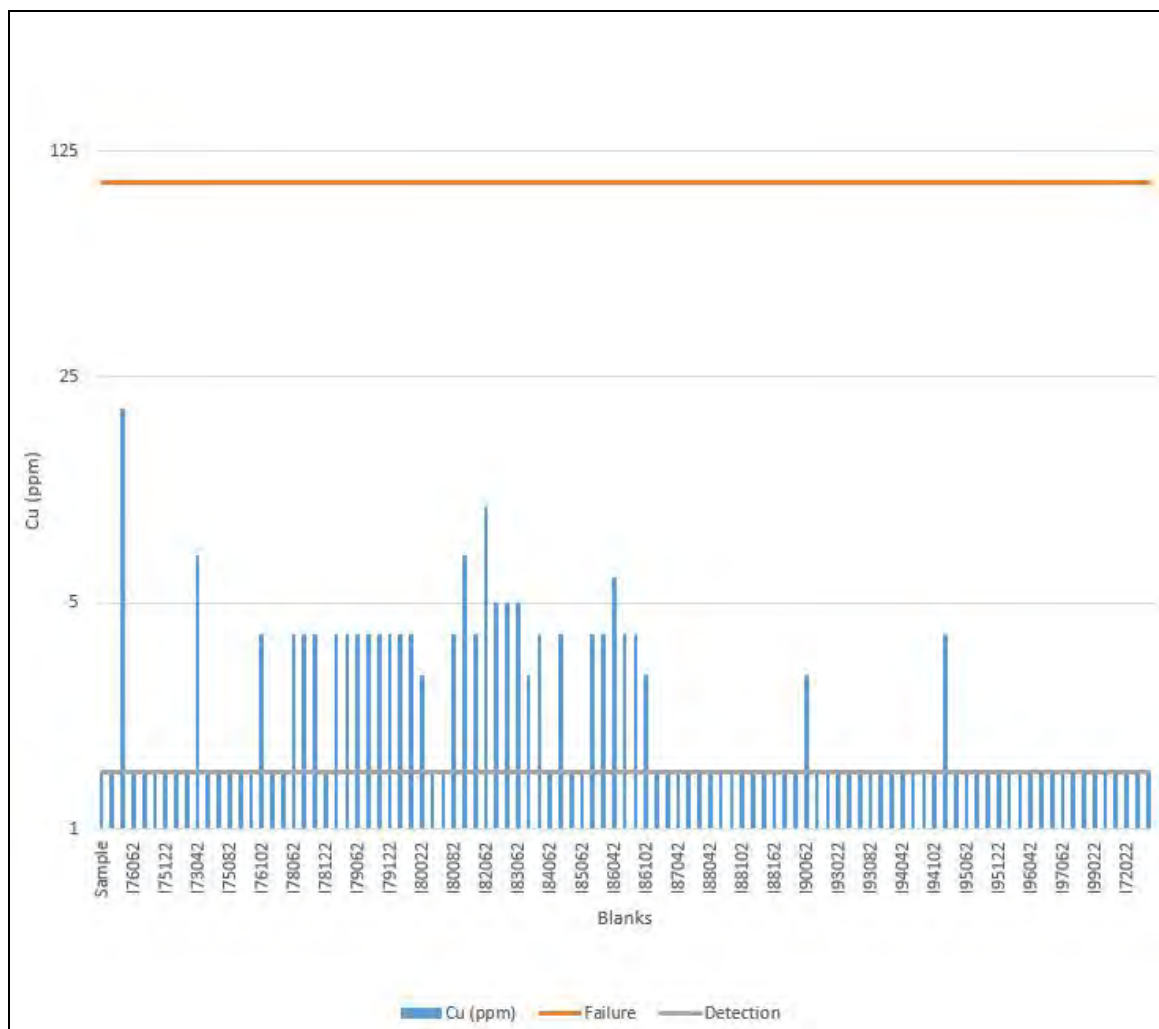
Source: Tetra Tech

11.6.2 Blanks

Euromax Resources has created blank materials out of construction limestone. The limestone is processed through the crushing and splitting procedure using the same techniques as those adopted for the genuine samples. By putting the material through the same process as the genuine samples, the blanks act as a verification of the sample preparation process, indicating the presence of any contamination.

A total of 99 blank samples were inserted for the 2015 campaign. No failures were reported for gold or copper. Gold reported at detection limit for each sample and can be interpreted as completely barren of gold. Copper results are shown in Figure 11.11, which shows minor copper values, well within acceptable limits for blank material.

Figure 11.11
Blank Compliance Chart (Cu %)



11.7 TETRA TECH OPINION

Whilst there are minor failures associated with certain aspects of the QA/QC programme, they are well within acceptable limits and do not show any particular trends or patterns which would suggest any systematic or procedural issues. The QA/QC programme conducted by Euromax Resources was appropriate and meets industry standards.

In Tetra Tech's opinion, the sample preparation and security procedures are acceptable and the data can be relied upon for resource estimation.

12. DATA VERIFICATION

12.1 SUMMARY

The following steps have been taken to verify the data used to estimate the resource and prepare the technical report:

- A site visit was completed to review collar locations, geological outcrops, suitability and accuracy of the core logging and other relevant activities, as well as the suitability of the facilities and equipment.
- An office based verification of assay records against original certificates and validation of drill hole database was completed.

12.2 SITE VISIT

A site visit to the Ilovica project was carried out by Mr. Robert Davies, CGeol, EurGeol., Senior Resource Geologist for Tetra Tech, between the 16th and 20th of June 2015. Mr. Davies was accompanied on the site visit by:

- Mitko Ligovski – Project Geologist
- Dragi Peltechki – Mining Engineer
- Joe Crummy – Independent Geologist
- Ivan Alexiev – Independent Database/ Geographic Information System Consultant
- Euromax Resources' Geology/ Mining Team.

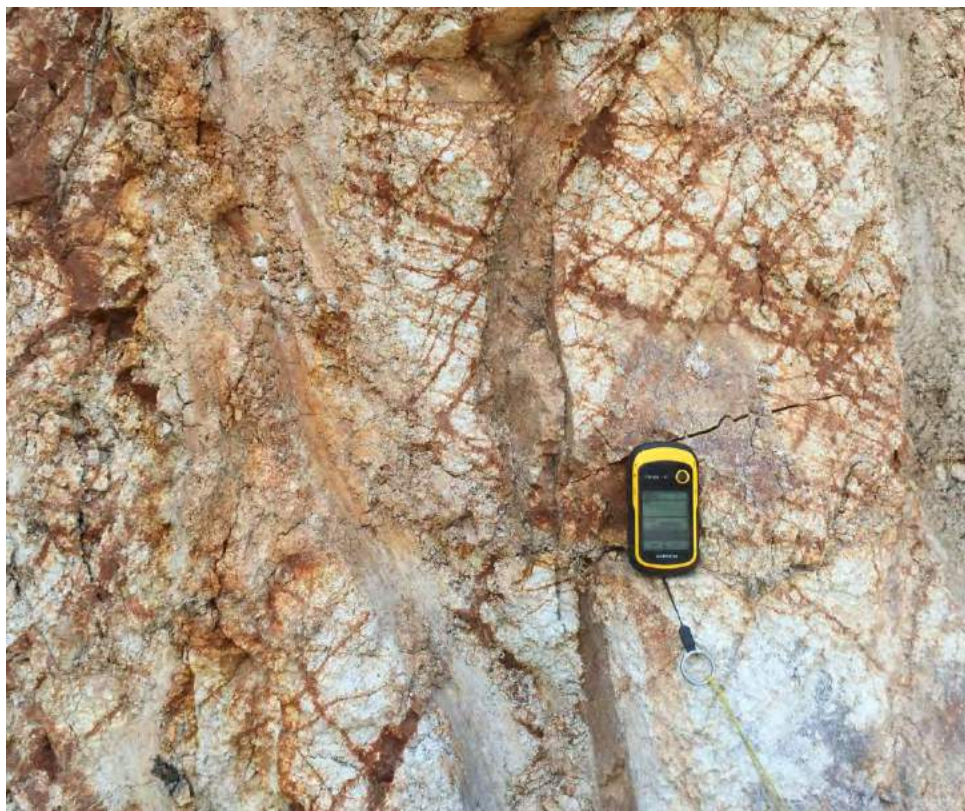
The site visit included an inspection of the following aspects of the Project:

- sampled drill core from a selection of holes associated with recent and historic campaigns
- sample cutting, preparation and storage facilities
- coarse rejects and sample pulps
- drill hole collar locations and Geological outcrops representing all of the major lithologies, oxidation states and alteration facies.

12.2.1 Project Site and Drill hole Locations

Geological outcrops (Figure 12.1) and drilling locations were inspected during the site visit. Drill hole collars are marked with concrete markers (Figure 12.2).

Figure 12.1
Outcrop of Oxidised Granodiorite with Intense Stockwork



Source: Tetra Tech

Figure 12.2
Example Drill hole Collar Marker



Source: Tetra Tech

12.2.2 Core Logging and Sampling Facilities

The lithologies and alteration observed in outcrop correspond to those recorded on Euromax Resources' geological maps and sections.

Where collars were not visible, earthworks associated with the drilling platforms were recognisable. Several drilling locations were checked in the field and compared to the database records. Drilling platform locations and collars (where visible) were verified using a hand-held Garmin Etrex™ GPS. The locations were found to be within an acceptable tolerance of GPS unit accuracy (average of ± 10 m) and consistent with the database. The location of the drill holes listed in Table 12.1 were verified.

Table 12.1 Drill hole Location Verification						
Drill hole ID	Euromax Resources Location		Tetra Tech Location		Difference m	
	X	Y	X	Y	X	Y
EOIC0813	7653614	4595093	7653605	4595092	-9	-1
EOIC1371	7653801	4594947	7653800	4594953	-1	6
EOIC0811	7654045	4595097	7654030	4595097	-15	0
EOIC15107	7654353	4595302	7654347	4595299	-6	-3
EOIC1358	7654391	4595303	7654387	4595303	-4	0
EOIC1361	7654398	4595103	7654403	4595094	5	-9
EOIC1362	7654251	4595149	7654258	4595148	7	-1
EOIC1573	7654162	4595354	7654163	4595354	1	0
EOIC1578	7654159	4595291	7654161	4595291	2	0
EOIC15112	7653847	4595037	7653843	4595032	-4	-5
EOIC15101	7653801	4595322	7653791	4595298	-10	-24
EOIC1120	7653813	4595299	7653800	4595297	-13	-2
Average					-4	-3

The majority of the drill hole locations were well within acceptable limits, with the exception of drill holes EOIC0811 and EOIC15101. As a result of these discrepancies, Euromax Resources re-survey the holes using a hand held GPS and waypoint averaging routine. Following re-surveying the EOIC0811 and EOIC15101 were within acceptable limits.

Tetra Tech inspected the drill rig setup and observed the drilling crew retrieving, handling and recording the drill core samples. Tetra Tech is satisfied that the drilling and core handling is appropriate for the Project.

The core logging and sampling facility is located at Strumica, 20 km to the west of the Property. The facilities are located in a secure, clean, dry and well equipped permanent building (Figure 12.3). Logging is completed on well-lit sturdy benches.

Figure 12.3
Core Logging and Storage Facilities in Strumica



Source: Tetra Tech

12.2.3 Core Storage

The core is permanently stored in stacked aluminium trays within Euromax Resources' facility at Strumica. The core storage facilities were inspected and found to be clean, dry and secure (Figure 12.4).

Figure 12.4
Core Storage Facilities in Strumica



Source: Tetra Tech

The aluminium core trays are clearly labelled with indelible pen. The labels defined the drill hole number, the core box number and the 'from' and 'to' depth intervals (Figure 12.5).

Figure 12.5
Labelled Aluminium Core Boxes



Source: Tetra Tech

Wooden markers, labelled with depth intervals are inserted within the core boxes to identify the end of individual core runs. Core boxes are sealed on the bottom, but do not have lids and are, therefore, exposed to potential contamination from above.

Sample preparation is carried out by Euromax Resources on site before being sent to the assay laboratories. Both coarse rejects and sample duplicates are stored in the facilities at Strumica (Figure 12.6 and Figure 12.7).

Figure 12.6
Duplicate Samples Stored at Strumica



Source: Tetra Tech

Figure 12.7
Coarse Reject Storage in Strumica



Source: Tetra Tech

12.3 DRILL CORE CHECK

The following drill holes were selected by Tetra Tech to be brought out of storage for inspection: IC1357, IC15100, IC15110, IC1008, PDIC0608, IC1572.

The geological interpretation and logging of lithology and alteration has been reviewed against the core samples and discussed with Euromax Resources' senior project geologist. In addition, several core runs were reviewed to ascertain the accuracy of the recovery records.

The reviewed drill cores and logs provided good examples of all oxidation levels, lithologies, alteration facies, stockwork intensities and brecciation. Sulphides, including secondary copper minerals were observed. Chalcocite was tested with hydrochloric acid and clearly demonstrated the presence of copper.

Whilst on site, Tetra Tech also reviewed the Euromax Resources procedures in relation to logging, data transcription, database input and data security.

12.4 OFFICE-BASED DATA VERIFICATION

12.4.1 Assay Certificates

Euromax Resources provided Tetra Tech with signed portable document format (PDF) assay certificates for all of the assays contained within the database.

Tetra Tech checked 10% of the assay certificates against the values contained within the database. The certificates checked were chosen to provide examples from each drilling campaign. In total, 1 321 assay results have been checked against the certificates by Tetra Tech.

12.4.2 Database Validation

The drill hole database was provided to Tetra Tech in Excel and Microsoft Access™ (Access) database format. On import of the records into Surpac, Tetra Tech validated the database to identify incorrectly entered or inconsistent data. Any errors were communicated to Euromax Resources for review and correction.

12.5 LIMITATIONS OF DATA VERIFICATION

Check samples were not taken during the site visit because of the difficulty of exporting representative samples.

12.6 TETRA TECH OPINION

In the opinion of Tetra Tech's QP, the exploration, drilling and sampling activities completed by Euromax Resources on the Property meet or exceed industry norms and form an appropriate basis for Resource estimation.

13. MINERAL PROCESSING AND METALLURGICAL TESTING

The historical investigations have been conducted by two organisations: Institute of Metallurgy ITMNS in Belgrade, Serbia and SGS, UK. This review covers only the most recent mineralogical and metallurgical test work, namely PII (done during the PFS) and PIIR, both completed under the supervision of Euromax Resources and carried out by SGS (Lakefield, Canada and Cornwall, UK). The PIIR programme focused on flotation and was designed to test the PII results within three domains, identified in the PII programme, and to test the possibility of using just a flotation cleaner scavenger tail as a Carbon in Leach (CIL) feed rather than all of the flotation tailings, as was the case in the PFS flow sheet.

The work carried out prior to and during the PFS was accepted as sufficiently positive to continue the test work to provide the data necessary for the FS. This was initiated in the second half of 2014 as PIIR and continued in to PIII.

The comminution test work, which covered the new MC and variability samples (40) has been completed at a PIII level. The results confirmed the PII results and ensured that the design was able to cope with treatment of the fairly wide variability (in terms of material hardness and competence) across the resource.

The PIII work has to date focussed on comminution testing, with flotation work to optimise reagents used in the flow sheet and flotation variability work in order to assess recoveries, particularly in the early years but also including samples representative of later years. PIII test work will continue in to the FEED phase, in particular to investigate CIL, full leach and absorption characteristics, concentrate and tailings de-watering and, inter alia, evaluation of the anomalies found in the PIII results together with an evaluation of the metallurgical response of the Cu oxide mineral content of the resource.

For the entire FS design, the PIIR results have been accepted, and the PIII results were viewed as confirmatory only with no impact on the overall flow sheet and design of the plant. Flotation variability work has been incorporated to confirm that the flexibility of the plant design can cope with the variations in metallurgical response across the resource. This also includes the behaviour of the mixed oxide material found to form part of the plant feed in the first four years.

Section 13.1 describes results of the PIIR tests. The comminution results from PIII are covered in Section 13.4.

Details of the work are presented in the relevant SGS Reports^{11,12}.

13.1 METALLURGICAL TEST SAMPLES

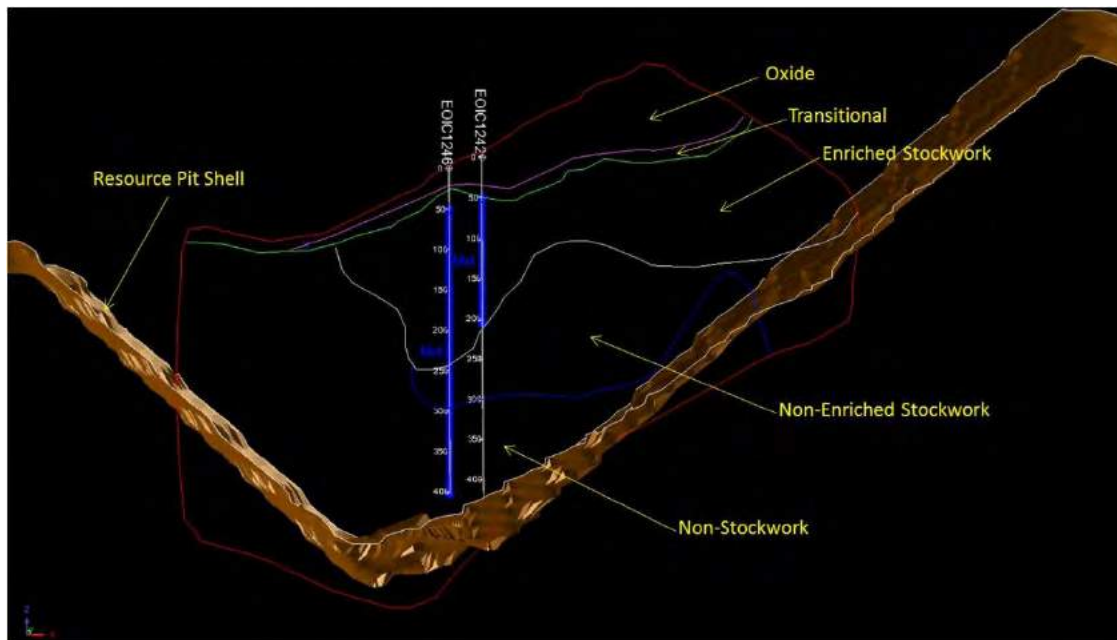
13.1.1 Phase II

A MC was prepared from two drill holes within the mineralised zones. The locations of these holes are shown in Figure 13.1. The drill holes passed through various domains and were expected to generate a composite which should be representative of the ROM feed to the plant.

¹¹ Phase II Metallurgical Testing on the Ilovitza Deposit, dated 23 May 2014

¹² Intermediate Phase Metallurgical Test work on the Ilovitza Copper/Gold Porphyry, FYR Project, dated 29 December 2014

Figure 13.1
Metallurgical Samples Locations



Source: Euromax Resources

The two drill holes were used for the original MC for the PII test work.

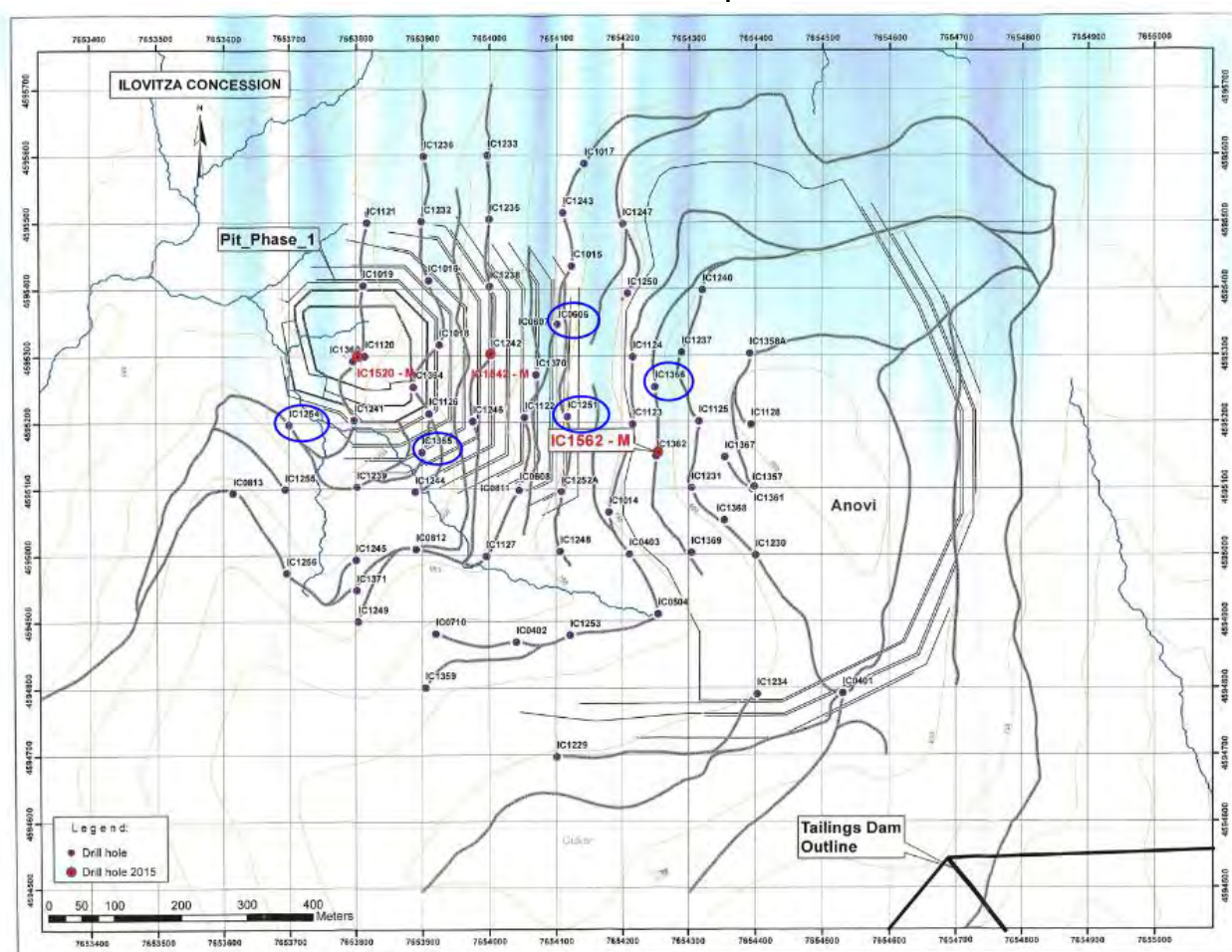
13.1.2 Phase II Residual

Proceeding to the PIIR test work, a residual portion of the PII MC was utilised to confirm and optimise some of the PII conditions and results. Two additional samples were drilled through the high grade and transitional zones and tested under the established optimum conditions. This nomenclature refers to:

- High (H) – refers to slightly higher Cu and Au head grade granodiorite from the potassic core of the porphyry. It is assessed as a part of the probable feed for the early years of mining.
- Transitional (T) – refers to dacite material from the potassic core of the porphyry with above average grade and the presence of secondary sulphide minerals such as chalcopyrite and bornite. These secondary sulphides represent supergene mineralisation in the transition zone below the oxide cap. This material comprises some of the material that will be treated in approximately years 3 to 8 of mining, according to the PFS mining schedule. It is currently estimated to comprise a minor portion of the total resource mass.
- Normal (N) – refers to granodiorite material from the potassic core of the porphyry with a weak phyllic over-print. The PFS mine schedule indicates this to be a major portion of the ROM feed to the plant during the entire life of mine. It will probably be the sole feed to the plant from year 9. It comprises the majority of the resource mass.

The locations of the high grade and transitional materials are indicated on the following Figure 13.2.

Figure 13.2
Location of PIIR Samples



Source: Euromax Resources

The three red indicators show the locations of the original samples and the blue circled holes were additional cores for sampling.

13.1.3 Phase III

The choice and form of these variability samples are critical to the success of the program and the usability of the test work results. As a guide, the sample selection criteria in the Phase III proposals review document¹³ was used.

Euromax Resources and Amec Foster Wheeler have selected and prepared a full list of intercepts for the new 40 variability samples. For each variability sample at least 60 kg was required. For the new full core PQ it has been decided it was simpler to send two core boxes (~8 m of continuous intervals) for each sample.

The following was used for sample selection and preparation.

¹³ S2233-0000-DC00-RPT-0001, Review of Proposed SGS Phase III Metallurgical Test Program, January 2015

- At Ilovica Core Shed
 - The total number of variability samples (40) was a mixture of new PQ full core (30) and existing ½ core samples (10).
 - Each of the samples represented the head grade (Cu & Au) that is typical for that domain though some variation was required.
 - All the new metallurgical full-core holes (30) were photographed in the core-boxes before despatch to assist with the semi-autogenous grinding (SAG) characterisation tests.
 - The core-boxes covered the intercept numbers (based on the twinning of earlier holes) – as listed in Table 13.1.
 - For the 10 variability samples prepared from the existing ½ core samples, Euromax Resources selected five boreholes that were spatially distributed within the deposit in a 3D orientation. Two samples were taken from each borehole of continuous intercepts – one from the top of the hole and the other near the bottom. The five boreholes were IC1254, IC1365, IC1251, IC0606 and IC1366.
 - For the ½ core samples, at least 60 kg (~11 m) were selected from the available competent material – if the samples selected from the log sheets had a high level of fines on inspection in the core box, or had degraded over recent years, they were not selected. This had the natural effect of biasing sampling to competent ore intersections but SAG testing is not possible on fines.

Table 13.1					
Twinned Drill Hole Intercepts					
Hole 20		Hole 42		Hole 62	
Depth - m	Domain	Depth - m	Domain	Depth - m	Domain
4 & 5	High	17 & 18	High	24 & 25	Transitional
10 & 11	"	22 & 23	"	30 & 31	"
13 & 14	"	25 & 26	"	39 & 40	"
17 & 18	"	29 & 30	"	61 & 62	"
24 & 25	"	33 & 34	"	77 & 78	"
33 & 34	"	36 & 37	"	96 & 97	"
36 & 37	Normal	40 & 41	Normal		
39 & 40	"	43 & 44	"		
43 & 44	"	46 & 47	"		
46 & 47	"	49 & 50	"		
50 & 51	"	54 & 55	"		
57 & 58	"	58 & 59	"		

- At SGS-Cornwall / Lakefield Research the core boxes were received and tested as follows:
 - Coarse core pieces were set aside from each sample and submitted for Bond low-energy impact testing (Crusher Work Index).
 - Coarse core pieces were set aside from each sample, for preparation of the MC (40 kg) and the three domain composites (125 kg each).
 - About 40 kg of -32 mm material from each variability sample were shipped to SGS Lakefield for comminution testing. The rest was used at SGS-Cornwall for metallurgical testing.

- From those 30 samples, the Normal and High ore types comprised 12 samples each, while only 6 samples of Transitional were provided.
- Sample preparation can be summarised as:
 - For each full PQ variability sample, 10 pieces of full core (5 per core box) were randomly selected and broken with a sledge hammer. The rocks were broken in such a way that the core pieces remain as full core. The approximate length of each piece varied depending on the nature of the variability sample (Normal, High or Transitional). For each sample, the broken core pieces, which represented between 11 to 21 kg of material, were put in a bag and shipped to SGS Lakefield, for the domain compositing. The compositing and the rest of the preparation were done directly at SGS Lakefield.
 - Then, 20 pieces of full core (10 per core box) of about 60 mm long were randomly selected and broken with a sledge hammer. The rocks were broken in such a way that the core pieces remain as full core. For each sample, the 20 full core pieces were put in a bag and shipped to SGS Lakefield, for Bond low-energy impact testing.
 - The rest of the sample was crushed to minus 32 mm, blended and 40 kg of material was shipped out to SGS Lakefield, for the SMC, RWI, BWI, AI and Mod Bond tests.
 - The remaining sample was used by SGS Cornwall for further preparation and metallurgical testing.
- 10 variability samples were also provided as half core in bags of 60 kg each. These were crushed to minus 32 mm, blended to a 40 kg and shipped to SGS Lakefield, for the SMC, RWI, BWI, AI and Mod Bond tests. The remaining sample was used by SGS Cornwall for further preparation and metallurgical testing.
- The MC (40 kg) and domain samples (125 kg each) were shipped to SGS Lakefield Canada as a priority. The 40 kg samples for the individual SMC tests were shipped later.
- SGS-Cornwall crushed and sub-sampled each variability sample for head assay analysis that enabled the preparation of domain and MC samples for metallurgical testing. Sufficient sample was retained for the individual flotation/leaching test work on each variability sample.

13.2 MINERALOGICAL TEST WORK

Mineralogical test work was completed by SGS in 2014 using the PII MC sample. A sub-sample of the MC was ground to 100% mass less than 150 µm and submitted for a detailed mineralogical examination by QEMSCAN. The aim of the study was to provide an overview of the minerals present in the sample, to identify the form of copper minerals present and the nature of any additional sulphide minerals. The association and liberation characteristics of the minerals of interest were to be identified.

Chalcopyrite showed as moderately liberated to 66% at this grind size, with a D₅₀ (the mid-point of the size distribution) of 30 µm. Pyrite was better liberated at 83%, at this grind size, with a D₅₀ of 45 µm. It was estimated that approximately 20% of the chalcopyrite and 7% of the pyrite have less than 30% exposed surface or are locked. Thus these are unlikely to be recovered at this grind. Recovery of the minerals improved with reducing particle size.

A study of the Au particle size and size distribution was made. The average liberated size of Au grains was 6.2 µm in an overall range (liberated and locked) of 0.6 µm to 8.9 µm. The distribution of the Au grains was examined at the sizes between 150 µm, and 38 µm. Approximately, 20% mass was in the plus 106 µm fraction and more than 50% mass at less than 38 µm.

Of the 60.2% of gold that is locked or exposed in other minerals, 48% is associated with chalcopyrite and 37% is associated with pyrite (Table 13.2).

Table 13.2 Gold Associations							
Sample ID	Gold Occurrence		No. of Observed Grains	Average size	Size Range	Overall Gold Distribution	Minerals Associated with Exposed and Locked Au-Minerals
				µm	µm	%	
SGS405:0048	Microscopic Au	Liberated	3	62	4.2 – 8.9	33.4	Ccp (48.2%), Py(36.9%), Ccp/Kfs/Chl (6.6%), Sil/Py (4.1%) and Ccp/Qtz (4.1%)
		Exposed	12	2.9	0.6 – 5.8	26.9	
		Locked	28	2.3	0.6 – 7.9	33.3	
	Sub - microscopic Au					6.3	
	Sum					100	

Source: SGS (UK)

13.3 PHASE II AND PHASE II RESIDUAL TEST WORK REVIEW

SGS did test work after receiving approximately 370 kg of material from the Ilovica deposit in 2014.

13.3.1 Comminution Test Work

13.3.1.1 Phase II

SMC test work was carried out. The results are summarised in Table 13.3.

Table 13.3 SMC Test – Summary Results								
SG	A	b	Axb	DWi	M _{ia}	M _{ih}	M _{ic}	t _a
				kWh/m ³	kWh/t	kWh/t	kWh/t	
2.53	58.5	1.19	69.4	3.64	12.7	8.3	4.3	0.71

From the Axb result, the sample can be classified as soft. It is viewed as having competency suited for SAG milling.

The potential wear rates on steel liners and grinding media were estimated using the Bond abrasion index (A_i) test, which gave a result of 0.115. This is considered low and the corresponding wear rates are also low.

Bond grindability tests in a rod mill and ball mill were carried out and the results are summarised in Table 13.4.

Table 13.4 Bond Grindability Tests - Results		
Mill	Work Index	Closing Screen
	kWh/t	µm
Rod - BRWi	15.1	1180
Ball - BBWi	15.9	75

These results are both about average and indicate a moderate amount of ball mill grinding energy will be required.

13.3.1.2 Phase II Residual

The SMC test results are summarised in Table 13.5 and Table 13.6. The results indicated that the material contrasts to the PII material in that it is classed as hard for the MC, normal and high domains but medium for the transitional domain.

Table 13.5										
JK Summary Results for PIIR Samples										
Sample Name	Ore Domain	Relative Density	JK Parameters		MacPhersonTest			Work Indices		Ai (g)
			Axb ²	t _a ³	(kg/h)	(kWh/t)	AWi	RWi	BWi	
MC (1-4) Yr	-	2.50*	36.1*	0.37*	6.8	11.4	15.8	15.6	14.8	0.153
Normal (63%)	Normal	2.52	34.3	0.35	-	-	-	16.4	16.8	0.151
High (22%)	High	2.49	36.6	0.38	-	-	-	13.6	13.2	0.220
Transitional (15%)	Transitional	2.52	64.1	0.66	-	-	-	10.0	13.1	0.115

Notes: 1: Axb from DWT tests.

2: Axb from SMC tests.

3: The t_a value reported as part of the SMC procedure is an estimate.

* SMC Results from the MC (1-4) Year were calculated assuming a blend comprising 82% High and 18% Normal (w/w).

Table 13.6								
SMC Summary Results for PIIR Samples								
Sample Name	Ore Domain	Relative Density	Axb	t _a ¹	DWI	M _{ia}	M _{ih}	M _{ic}
					(kWh/m ³)	(kWh/t)	(kWh/t)	(kWh/t)
MC (1-4) Year	-	2.50*	36.1*	0.37	6.9*	21.6*	16.0*	8.3*
Normal (63%)	Normal	2.52	34.3	0.35	7.5	22.7	17.1	8.9
High (22%)	High	2.49	36.6	0.38	6.8	21.3	15.8	8.2
Transitional (15%)	Transitional	2.52	64.1	0.66	4.3	14.6	9.9	5.1

Notes: 1: The t_a value reported as part of the SMC procedure is an estimate.

* SMC Results from the MC (1-4) Year were calculated assuming a blend comprising 82% High and 18% Normal (w/w).

Some JK results have been repeated for clarity and comparison.

The inconsistency in competency between the PII and PIIR samples provided justification for a comminution testing variability programme in PIII.

13.3.2 Flotation Test Work

13.3.2.1 Phase II

More than 50 scoping, batch and cleaning flotation tests have been carried out at SGS UK. A summary of the flotation test work programme follows:

- Mesh of grind (MOG) scoping tests included 6 test runs and aimed to establish an optimum flotation feed size.
- Reagent scoping tests (five) followed and investigated alternative collectors to MX3601.

- A single test was performed to investigate the viability of producing two separate concentrates: one for copper and one for pyrite.
- This was repeated in five more tests to evaluate the repeatability of a possible differential float scenario to produce a copper concentrate and a separate pyrite concentrate.
- Thirty seven bulk sulphide tests were performed to simulate a mixed copper / pyrite float to produce a single concentrate product. These tests included a regrind stage with MOG tests at natural (tap water) pH. A pyrite collector, potassium amyl xanthate (PAX), was included at different addition rates. Some tests also included collector combinations and different modifiers at different dosage levels and pH.
- LCTs were performed to estimate the probable plant grades and recoveries that could be expected.

After completion of these tests, it was concluded that the flotation has not been fully optimised or understood. It was then recommended that in the first quarter of 2014, prior to commencing with the planned PIII feasibility test work programme, that a short series of rougher scoping tests on various collectors and a combination of collectors, should be carried out, termed as Phase II Residual or PIIR. This would also include a short programme of cleaning tests to produce separate copper and pyrite concentrates.

In terms of overall recovery, there was little difference between the bulk flotation (single concentrate) and the differential (two concentrates). This would also be examined during the cyanide leaching section of PIII, with a view to reducing the mass of material sent to CIL, and a consequent reduction in both Capex and operating cost estimate (Opex).

13.3.2.2 Phase II Residual

A major aim during PIIR was to identify conditions for the planned PIII programme, which should have been defined within the PII programme.

The programme of rougher, cleaner and LCT was established as:

- Test numbers FT1 to FT9: rougher kinetic tests on MC to identify the optimum reagent suite and flow sheet conditions.
- Test numbers FT10 to FT15: cleaner tests on MC to produce a final copper concentrate, cleaner tests on high grade and transitional samples at the optimised MC conditions.
- A LCT on each of MC, high grade and transitional samples.

Rougher Kinetic Tests

The first nine tests confirmed an optimum reagent suite and flotation conditions as natural pH (assumed to be between 8.0 and 8.5), sodium silicate dispersant, A7429 primary collector (designed to maximise the recovery of chalcopyrite), PAX as the pyrite collector with copper sulphate (CuSO_4) as the pyrite activator and a sulphidiser as sodium hydrosulphide (NaHS). Under these conditions, the optimum results were obtained from FT6, with overall recoveries at 91.6% Cu, 93.6% S and 89.1% Au into a rougher concentrate of 12.24% mass of the feed.

The flow sheet was a simple open circuit, with the tailings from the first rougher stage passing to the next flotation stage and thence to the third stage. Table 13.7 summarises the results as cumulative over the three stages.

Table 13.7 Rougher Flotation Summary Results							
Test	Mass	Grade			Recovery		
	% (w/w)	Cu %	S %	Au g/t	Cu %	S %	Au %
FT1	5.15	4.47	16.99	5.57	86.45	93.89	79.08
FT2	7.47	2.95	11.59	3.94	83.53	89.49	79.92
FT3	7.43	3.10	11.87	4.59	88.30	94.07	77.00
FT4	10.07	2.24	8.44	4.21	89.06	91.31	90.42
FT5	9.73	2.04	8.72	3.34	87.29	94.00	85.71
FT6	12.24	1.96	7.41	2.35	91.61	93.66	89.11
FT7	13.16	1.73	6.64	2.17	89.44	91.78	84.59
FT8	12.00	2.07	7.48	2.38	91.86	95.33	86.66
FT9	16.55	1.43	5.24	1.79	91.62	93.69	87.42

A dispersant, sodium silicate, was also used in all of the tests at the same dosage rate (500 g/t). The use of sodium silicate had previously (PII) indicated an improvement in grade by its use. Some tests were performed at natural pH and some (FT4, FT5, FT7, FT8) elevated to pH 9 with lime addition. There was no significant difference in metallurgical response between natural pH and pH 9.

The main collector reagents were added in stages, with A7429 used for the first 15 minutes; PAX was added thereafter for the next two stages for a total of 40 minutes. It was noted that A7429 was effective in floating pyrite as the S recovery in the first 15 minutes was 89%. The overall indications from this work were that there was still potential to further optimise the reagent addition rates with a beneficial effect on Opex by a potential reduction in the dosage rates.

These conditions (FT6) were used to produce the concentrate required for the cleaning tests.

Cleaner Tests

The cleaner tests were undertaken on rougher concentrate produced under the same conditions selected for the rougher kinetics' tests as above. Some of the tests were done on re-ground concentrate, which floated the rougher concentrate after re-grinding to a P_{80} of 20 μm (80% mass less than a particle size of 20 μm). Additions of collector A7429 were made to the first cleaner stage. Some of the tests were also done at increased pH, using either lime ($\text{Ca}(\text{OH})_2$) or sodium carbonate (Na_2CO_3).

It was found that it was not possible to depress the pyrite once it had been activated with CuSO_4 and NaHS in a regrind stage. The pyrite float was therefore kept separate in subsequent tests.

A rougher concentrate of approximately 2% Cu grade was targeted in order to maximise Cu and Au recovery to a rougher concentrate.

In the past it had been surmised that it was not possible to recirculate the first cleaner tailing due to the relatively high clay content in the feed, since this tended to cause a build-up and a very viscous pulp with

lower grades and recoveries. A cleaner scavenger is now employed on the first cleaner tailings with the intention that the concentrate only would be recirculated as long as the Cu grade was high enough and would not cause excessive dilution.

Two stages of cleaning were employed as it was felt that the single stage of cleaning in the FS was not realistic. This produced an improved grade with a slight loss in recovery.

The results showed that Cu grades into final concentrate were in excess of 24% with overall recoveries approaching 80%. The Au grade was more than 24 g/t at recoveries between 56% and 64%. The cleaner flotation recoveries are presented in Table 13.8.

Table 13.8 Cleaner Flotation Summary Results							
Test	Mass	Grade			Recovery		
	% (w/w)	Cu %	S %	Au g/t	Cu %	S %	Au %
FT10	1.62	10.16	39.94	11.04	64.61	70.31	53.22
FT11	2.03	10.28	37.07	11.55	79.36	81.32	68.12
FT12*	3.98	5.34	19.46	7.29	85.93	87.46	84.07
FT13*	5.08	4.04	15.52	5.06	85.97	88.54	82.14
FT14	0.76	24.7	27.40	24.90	78.57	24.13	63.59
FT15	0.58	30.45	31.62	29.54	79.18	21.63	56.40
FT15R**	0.58	30.39	31.50	31.60	77.70	21.00	56.80
FT-PH3***	0.74	26.42	27.15	26.09	79.40	24.03	61.31

Notes: * tests without second cleaner (1 cleaning stage).

** re-grind test.

*** no re-grind and high pH (>12) with lime addition.

In order to estimate the closed circuit recovery, the cleaner tests were modelled with a simple iterative Excel sheet to estimate the final Cu and Au recoveries. This proved to be reasonably accurate and the final LCT results obtained were very close to the modelled recoveries.

The optimum conditions appear to indicate a regrind of the concentrate prior to cleaning, although this is obviously not clear cut, the result being from a singleton test. This should be confirmed in the PIII tests, which should include determination of the optimum mesh of grind.

Three variability tests were done on the H and T samples using the MC sample selected conditions (including re-grind). The tests showed that both samples responded well and gave comparable or better results (Table 13.9).

Table 13.9
Variability Tests Summary Results

Test	Mass	Grade			Recovery		
	% (w/w)	Cu %	S %	Au g/t	Cu %	S %	Au %
IC1239 (H)	0.80	25.03	32.99	24.71	80.46	19.20	67.48
IC1362 (T)	1.27	19.13	41.67	45.19	78.52	9.02	66.27
IC1362 (T)*	1.04	24.81	27.60	63.69	79.87	5.43	68.21

Notes: * three cleaning stages, the other test had only two

All tests were done at pH 12

Locked Cycle Test

Phase II

Two LCTs were undertaken to investigate any variances in results between differential flotation (two concentrates, one for Cu recovery and one for pyrite to improve Au recovery) and bulk flotation (one concentrate for both Cu and pyrite targeting all the Au). There were small differences in grade and recovery. The indications were that a bulk flotation offered satisfactory results with a saleable concentrate but that flotation conditions would need to be optimised.

Phase II Residual

Three LCTs were undertaken to produce a Cu concentrate, a combined pyrite concentrate and Cu cleaner scavenger tailings, which was proposed as the potential feed for a cyanide leach / CIL, and rougher (pyrite flotation) tailings. One test on each of the three samples - MC, H and T - was performed.

There was not a large difference in the flotation behaviour of the MC material and the H material. The concentrate mass reporting to CIL feed increases slightly. For the supergene T material, the mass pull reporting to the CIL feed increases significantly from 16.4% to 22.7%.

It was shown that it was possible to introduce the recirculation of cleaner tailings with the use of a Cu first cleaner tailings scavenger (recycle of the concentrate) and that this scheme worked well in the LCTs. It can be concluded that a standard flotation test circuit has been established for the PIII programme (Figure 13.3). The results are summarised in Table 13.10.

Figure 13.3
PIIR Locked Cycle Tests Flow Sheet

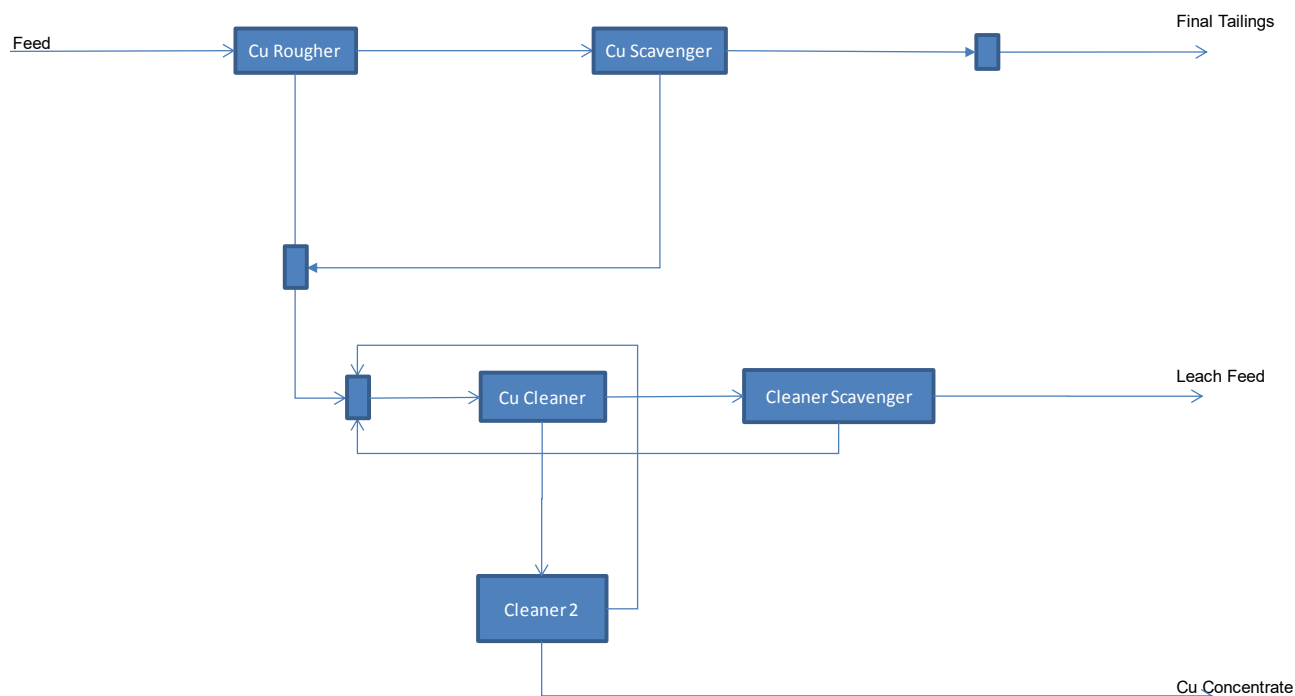


Table 13.10								
Locked Cycle Tests Summary Results								
Test	Product	Mass	Grade			Recovery		
		% (w/w)	Cu %	S %	Au g/t	Cu %	S %	Au %
MC	Cu concentrate	0.68	28.22	33.13	34.26	81.94	25.55	66.40
	Leach feed	16.44	0.13	3.70	0.48	9.39	69.41	22.58
	Rougher tailing	82.89	0.02	0.05	0.05	8.67	5.05	11.01
HC-IC 1239	Cu concentrate	0.95	21.58	32.25	22.95	82.69	22.18	66.94
	Leach feed	17.51	0.13	5.81	0.42	9.10	73.57	22.54
	Rougher tailing	81.54	0.03	0.07	0.04	8.21	4.25	10.53
HC-IC 1362	Cu concentrate	1.02	24.88	38.76	65.88	81.98	6.91	70.16
	Leach feed	25.15	0.12	20.72	0.86	10.07	91.45	22.61
	Rougher tailing	73.84	0.03	0.13	0.09	7.95	1.64	7.23

Netback calculations were also performed by the Euromax Resources to evaluate the optimum grade Cu flotation concentrate where the revenue is maximised. The results indicated that a better Netback value for the Cu concentrate was achieved primarily due to a higher Au recovery into the Cu concentrate.

The supergene T material shows a very high Netback value and it is presumed that the Mine plan will be to target this material as early as possible.

A plot of Netback versus Cu concentrate grade indicated that for the supergene T material, an optimum grade value is approximately 22% Cu and for the MC and H the target value appears to be approximately 25% Cu.

13.3.3 Gravity Recoverable Gold

A standard gravity recoverable gold (GRG) test was carried out which reported a GRG of 15.59. This is comparable to a series of tests carried out on a Cu/Au ore for which the inclusion of gravity concentration had been shown to be economically viable. The inclusion of a gravity recovery circuit was evaluated in a trade-off study and the result was that gravity recovery was excluded from the circuit. Refer to Section 17.1.1.2.

These trade-off study results bear out the comments from the mineralogical examination, which indicated that most of the Au was of a small particle size and associated with chalcopyrite and pyrite minerals. The report also commented that this Au is unlikely to be recovered by gravity means.

13.3.4 Cyanide Leaching Tests

13.3.4.1 Phase II

A diagnostic leach test was performed on the Cu cleaner tailings. The results indicated a potential recovery by cyanidation of 77% of the contained Au.

Individual kinetic cyanide leaching tests, set up as a matrix, were undertaken on whole ore oxide material (6 tests) and sulphide ore rougher flotation tailings (8 tests) from the LCTs. All of the tests were taken to 48 hours. The tests were mainly scoping tests looking at variations in initial cyanide solution strength.

The results showed that Au recoveries were all above 90%, the best being at a low (0.1 g/t) dosage. The reference report commented on decreasing recovery with increasing cyanide strength; this could also be due to insufficient oxygen – oxygen becomes a limiting factor at an adverse Au:CN molar ratio – and may be alleviated by ensuring that the dissolved oxygen in solution is maintained at a reasonable level. The measurement of oxygen consumption is essential (particularly for this type of ore with high oxygen consumers) and must be included in the PIII test work.

Ag recoveries were variable. Apart from mineral association effects, the comments referring to oxygen in the paragraph above may also be relevant.

Generally the sodium cyanide consumptions were low. This is in keeping with the materials being either flotation tailings (low in Cu and S) or oxide material.

13.3.4.2 Phase II Residual

Four kinetic cyanidation tests were carried out on material that was deemed to be CIL feed from the LCTs, this was a mixture of the Cu cleaner scavenger tailings and the pyrite flotation concentrate. There was enough material from the MC CIL feed for two tests and so one leach test was on material with an 'as received' size (approximately at a P_{80} of 75 μm) and the other was milled to minus 20 μm . For the CIL feeds for H and T, both were carried out on material that was milled to a P_{80} of 20 μm .

Table 13.11 summarises the four sets of leach results after 24 hours for the main metals of interest.

Table 13.11 PIIR Cyanidation Test Results Summary												
Leach Time Hours	Recovery of Metal to Solution %											
	20 µm regrind			Flotation Size			H sample IC1239			T sample IC1362		
							20 µm re-grind			20 µm re-grind		
	Cu	Au	Ag	Cu	Au	Ag	Cu	Au	Ag	Cu	Au	Ag
2	23.16	89.43	38.66	19.53	54.07	38.97	15.16	42.16	12.97	34.83	7.43	1.32
4	20.13	73.08	43.94	21.78	66.2	45.04	18.44	45.49	18.75	39.59	12.01	5.29
6	21.78	81.64	43.69	24.35	78.63	45.08	20.78	54.92	25.62	44.86	31.53	29.07
24	27.77	87.23	60.95	31.81	83.9	62.48	25.82	59	35.85	51.39	51.34	42.69
Residue	72.23	12.77	39.05	68.19	16.1	37.52	74.18	41	64.15	48.61	48.66	57.31
Back-calc. head (g/t)	1337.85	0.53	1.76	1309.28	0.56	1.82	1307.9	0.56	1.93	1245.27	1.03	0.58
Reagents	NaCN	CaO		NaCN	CaO		NaCN	CaO		NaCN	CaO	
Addition (kg/t)	1.72	0.86		1.67	0		1.03	1.83		2.11	1.87	
Consumption (kg/t)	1.22	0.86		0.93	0		0.38	1.83		1.29	1.56	

These results show that milling of the pyrite concentrate increased the Au leaching to approximately 87.2% from 83.9% but, the additional energy required and associated potential viscosity issues need to be further evaluated to recommend a re-grind stage.

For the MC material it was shown that overall 65% of the Au could be recovered to a Cu flotation concentrate and 22% to a CIL feed which was amenable to Cyanidation, resulting in an additional 19% Au recovery. The overall potential for Au recovery is thus 84%.

The H and T samples showed disappointing results for Au recovery and this needs further investigation during PIII.

All samples showed an Ag recovery of approximately 60% for the MC sample and 40% for the H and T samples.

The high Cu extraction (and by inference the S and Fe contents) would appear to be a major cause of the high sodium cyanide consumption, with the probable leaching of the contained S (and Fe) (although not recorded). There was no measurement of dissolved oxygen levels nor of oxygen consumption. This is considered to be of critical importance where high oxygen consumers are present in the leach solids.

13.4 PHASE III METALLURGICAL TEST WORK REVIEW

The test work samples were taken from the three previously defined domains (Section 13.1.2).

The baseline conditions have been established in PIIR for the PIII programme and the following will need to be incorporated in the PIII program:

- Further reagent optimisation on new MC sample
- Determine optimum Cu rougher concentrate regrind size

- Determine optimum CIL feed regrind size
- Maximise CIL recoveries for both CIL schemes.

13.4.1 Planned Test Work

The following list summarises the test work planned for PIII prior to its initiation. The work is now in progress. The comminution test work has been completed and is reported and reviewed in the following sections. The remaining work, which is in progress, will be reported and reviewed later. It is doubtful that the work will be completed in time for inclusion in this review report. Results that are available, are included in the report.

- Gravity Recoverable Gold Tests, although previous work has indicated this to be of little, if any, value
- Variability Sample Test work – excluding comminution, which has been completed
- Grind calibrations for flotation (4)
- Rougher kinetic tests on domain samples for reagent optimisation etc. (26)
- Cleaner tests to define regrind sizes etc. (26)
- LCTs on domain samples (10)
- Variability tests. A single standard rougher/cleaner/scavenger test on each (45)
- Standard SMC test on each of the variability and domain samples (44)
- Cleaner tests on selected variability samples to the same format as recent cleaner tests on PIIR (15)
- Cyanidation kinetic test work. This should include measurements for oxygen consumption and pre-oxidation leaching prior to the addition of cyanide
- Carbon adsorption kinetic test work
- Static settling tests on flotation tailings and CIL tailings (6 total)
- Dynamic settling tests on flotation tailings and CIL tailings (2 each). Possibly with Vendor test kit brought to lab for test work
- Filtration tests on Cu concentrate (4)
- ABA/NAP/NAG tests on flotation and CIL tailings (6)
- EN 12457-2 leach tests on flotation and CIL tailings (6).

13.4.2 Comminution Test Work

The comminution test work on the new MC has been completed. The work also included test work on the old MC (PIIR) and associated domain samples which is discussed under the Phase IIR test work review.

The work comprised of the following:

- MacPherson Test
- SMC Tests
- Rod Mill indices
- Ball Mill Indices

- Abrasion Indices
- Drop Weight Indices (4)
- Bond Low Impact tests (4 domains plus selected others)
- Repeat SMC tests on 3 x domain samples
- SMC tests on 40 x Variability samples and 3 domain samples – PIII only.

Table 13.12 JK Summary Results for PIII Samples									
Sample Name	Ore Domain	Relative Density	JK Parameters			Work Indices (kWh/t)			Ai (g)
			Axb ¹	Axb ²	t _a ³	CWi	RWi	BWi	
New MC (1-4) Year	-	2.53**	68.6**	-	0.53**	9.8**	12.4	12.8	0.130
Normal DWT Composite	Normal	2.59	54.6	52.9	0.49	8.8	12.9	13.7	0.088
High DWT Composite	High	2.50	76.6	72.7	0.55	10.3	12.2	12.7	0.107
Transitional DWT Composite	Transitional	2.34	126	111	0.80	9.3	10.6	11.7	0.077

Notes:

1: Axb from DWT tests.

2: Axb from SMC tests.

3: The t_a value reported as part of the SMC procedure is an estimate.

* SMC Results from the MC (1-4) Year were calculated assuming a blend comprising 82% High and 18% Normal (w/w).

** DWT and CWI Results from the new MC (1-4) Year were calculated assuming a blend comprising 71% High and 29% Normal (w/w).

Table 13.13 JK Summary Results for PIII Variability Samples									
Sample Name	Ore Domain	Result Range	Relative Density	JK Parameters		Work Indices (kWh/t)			Ai (g)
				Axb ²	t _a ³	RWi	BWi	M _{ib}	
Drill Holes – Various	High	ave	2.46	57.44	0.61	12.75	13.24	12.56	0.128
		max	2.54	112.20	1.26	14.88	15.08	15.24	0.147
		min	2.30	33.46	0.34	10.61	11.39	9.69	0.109
	Normal	ave	2.48	66.64	0.70	12.60	13.87	13.28	0.119
		max	2.60	181.96	1.94	14.98	14.58	15.04	0.169
		min	2.35	33.97	0.34	11.68	12.89	8.06	0.092
	Transitional	ave	2.51	97.30	1.04	8.39	8.61	11.43	0.059
		max	2.71	238.98	2.81	9.85	10.50	14.37	0.116
		min	2.20	61.80	0.63	6.93	6.71	8.95	0.002

The results in Table 13.12 and Table 13.13 show the variable nature of the resource. The composites (Table 13.12) are taken as representative of the early mine life.

Additional derivations from the SMC tests were also carried out and are summarised in Table 13.14 and Table 13.15.

Sample Name	Ore Domain	Relative Density	Axb	t_a^1	DWI	M_{ia}	M_{ih}	M_{ic}
					(kWh/m ³)	(kWh/t)	(kWh/t)	(kWh/t)
New MC (1-4) Year	-	2.53**	68.6**	0.53**	-	-	-	-
Normal DWT Composite	Normal	2.59	54.6	0.49	-	-	-	-
Normal DWT Composite - SMC test	Normal	2.55	52.9	0.75	4.9	16.1	11.2	5.8
High DWT Composite	High	2.50	76.6	0.55	-	-	-	-
High DWT Composite - SMC test	High	2.50	72.7	0.75	3.5	12.4	8.0	4.1
Transitional DWT Composite	Transitional	2.34	126	0.80	-	-	-	-
Transitional DWT Composite - SMC test	Transitional	2.35	111	1.23	2.3	9.5	5.7	2.9

Sample Name	Ore Domain	Result Range	Relative Density	Axb	t_a^1	DWI	M_{ia}	M_{ih}	M_{ic}
						(kWh/m ³)	(kWh/t)	(kWh/t)	(kWh/t)
Drill Holes - Various	High	ave	2.46	57.44	0.61	4.97	16.54	11.62	6.01
		max	2.54	112.20	1.26	7.61	23.00	17.40	9.00
		min	2.30	33.46	0.34	2.05	8.90	5.20	2.70
	Normal	ave	2.48	66.64	0.70	4.94	16.31	11.49	5.94
		max	2.60	181.96	1.94	7.71	23.10	17.60	9.10
		min	2.35	33.97	0.34	1.36	6.00	3.30	1.70
	Transitional	ave	2.51	97.30	1.04	3.33	11.76	7.63	3.96
		max	2.71	238.98	2.81	4.50	14.90	10.20	5.30
		min	2.20	61.80	0.63	1.00	5.20	2.60	1.40

Notes:

1: The t_a value reported as part of the SMC procedure is an estimate.

* SMC Results from the MC (1-4) Year were calculated assuming a blend comprising 82% High and 18% Normal (w/w).

** DWT Results from the new MC (1-4) Year were calculated assuming a blend comprising 71% High and 29% Normal (w/w).

Some JK results have been repeated for clarity and comparison.

SMC results are presented in *italics*.

The competence (large particle hardness) variability was high variability of hardness, with Axb values ranging from 33 to 240. The new core (PIII) samples were ranked as moderately soft for the normal domain, soft for the high domain and very soft for the transitional domain. It should be noted that within each domain there was also a high degree of variability of hardness.

Similar levels of variability were also evident in the comminution energy measurements such as BW_i, RW_i and DW_i.

The abrasion index in all samples was low, ranked from very mild (0.002 g) to medium (0.220 g). The medium material may be viewed as mildly abrasive.

Two different methods were used for the solids density measurement: the gas pycnometer and water displacement. The standard method, widely used for the SMC tests, is the water displacement method. The gas pycnometer results indicated values approximately 0.2 units higher. For all design calculations, the values from the usual test method (water displacement) have been used.

13.4.3 Flotation Test Work

This programme was in progress at the time of writing and the first results from the PIII test work have been received. The tests used a new composite to confirm the reagent suite and then applied the suite to each of the 40 variability samples. Results were supplied as interim spread sheets¹⁴ made available for early assessment and evaluation before the SGS final report of the PIII test work is issued.

13.4.3.1 Reagent Suite Optimisation

Table 13.16 summarises the rougher test results. At the same time the tests included work on low oxide content material.

These results allowed for the establishment of the reagent suite to be used for the variability samples: 750 g/t sodium silicate, 60 g/t AERO® 7249, 30 g/t MIBC with a further 15 g/t A7249 in the Cleaner Scavenger. Rougher flotation was done at a P_{80} of 75 μm and cleaner flotation was done at a P_{80} of 25 μm .

It was noted that the low oxide content samples tended to show higher Cu and Au recoveries into the rougher concentrate. The use of a sulphidiser had no apparent effect in recovery enhancement.

¹⁴ No reference is made to the interim spread sheets as these considered to be private communications. Reference will be made to the final report when it is issued.

Table 13.16
Summary of Rougher Flotation Tests

Test No	Feed	MOG	Collector	Silicate	Frother	Other	Rougher Recoveries	
			+75gpt PAX				(For min 2% Cu conc)	
			50gpt				Cu	Au
Part A: FT1-12. Initial Rougher Kinetic tests to Optimise MOG and Collector (30 High: 70 Normal)								
Part B: Repeat of FT1-12 on correct Master Composite head sample (70 High: 30 Normal)								
13	70:30 Original Composite	75um	A7249	500	MIBC	CuSO4	81	64
14	"	90um	"	"	"	"	78	66
15	"	63um	"	"	"	"	81	66
16	"	75um	A8761	"	"	"	80	64
17	"	63um	"	"	"	"	80	63
18	"	75um	A7249	"	X133	-	78	65
19	"	"	"	250	"	-	74	60
20	"	"	"	0	"	-	53	45
21	"	"	"	500	MIBC	-	79	59
22	"	63um	"	"	"	-	80	71
23	"	75um	A3302	"	"	-	74	48
24	"	63um	"	"	"	-	69	39
25	"	75um	A7249	750	"	-	82	73
Part C: Kinetic Rougher tests on Different Composites and Higher Silicate								
26	High	"	"	500	"	-	80	65
27	Normal	"	"	500	"	-	91	72
29	High	"	"	750	"	-	83	72
30	High	"	"	1000	"	-	84	75
31	Normal	"	"	750	"	-	91	75
32	Normal	"	"	1000	"	-	92	79
33	High	"	"	500	"	Na2S	82	76
Part D: Kinetic Rougher tests on Low Oxide Intervals and Composites								
34	Low-Oxide High Interval	"	"	"	"	-	93	94
35	Low-Oxide Normal Interval	"	"	"	"	-	84	94
36	Low-Oxide Normal Composite	"	"	"	"	-	88	94
37	Low-Oxide High Composite	"	"	"	"	-	92	95
38	Low-oxide 70:30 Composite	"	"	"	"	-	92	95
Part E: Kinetic Rougher tests to establish benefits of Sulphidiser and Silicate on high Oxide samples								
39	70:30 Original Composite	"	"	500	"	Na2S	87	80
40	"	"	"	750	"	-	87	80
41	"	"	"	1000	"	-	86	77
42	"	"	"	"	"	Na2S	87	80
43	"	"	"	500	"	Na2S + Mild steel rods	88	79
Part A: FT1 -FT13. Scoping tests to verify optimum reagent suite and MOG. Sample incorrectly made up as 30 High: 70 Normal								
Part B: FT 14 - FT25. SGS repeat FT1 - FT13 conditions on 70 High: 30: Normal. A7249 preferred collector and MOG of 75um.MIBCX better as frother. Large drop in recovery with low (250 gpt) or No silica								
Part C: FT26 - FT33. Test individual Domains and with higher Silicate. Improved Cu recovery for Normal. Improvements with additional silicate. Suggestion that								
Part D: Tests on low Cu-Oxide intervals and composites. High Cu & Au recovery for low oxide								
Part E: Tests on Master Composite (70 High: 30 Normal) with sulphidiser and Silicate								

13.4.3.2 Cleaner Test Results

Table 13.17 summarises the rougher test results. The tests used the optimum conditions from the preceding rougher tests, which were applied to the three lithology composites and the MC.

Table 13.17 Summary of Cleaner Test Results						
Test No.	Sample	Feed		Cu Flotation Concentrate		
	Identification	Cu %	Au g/t	Cu Grade	Cu Recovery	Au Recovery to Cu
PIIR FT14	PII MC	0.24	0.30	24.70	82.60	66.30
PIIR LCT1	PII MC	0.23	0.35	28.20	81.90	66.40
FT45	PIII MC	0.27	0.29	19.57	65.02	33.59
FT47	PIII MC	0.28	0.34	23.90	71.17	37.07
FT48	PIII MC	0.29	0.30	16.39	70.24	45.56
FT49	PIII MC	0.28	0.37	21.55	72.24	34.63
FT50	PIII Normal	0.18	0.25	18.11	86.39	44.47
FT51	PIII Normal	0.19	0.22	25.81	81.57	36.69
FT52	PIII MC	0.28	0.32	22.64	76.59	49.03
FT53	PIII MC	0.27	0.30	27.92	77.68	46.52
FT54	PIII High	0.31	0.35	28.52	72.61	48.74
FT55	PIII High	0.32	0.37	32.03	71.39	43.95
FT56	PIII Trans	0.26	0.61	21.09	76.83	59.18

Previous optimum PIIR results are included for comparison. All of the tests used a single rougher concentrate followed by two cleaner stages. The results showed a reasonable response throughout, with the best Au recovery from the Transitional material. Generally, the Cu concentrate achieved the desired grade (above 20% Cu).

13.4.3.3 Variability Sample Results

Table 13.18 summarises the variability sample results.

Table 13.18 Summary of Variability Samples Flotation Tests								
Test No	Lithology	Total Recovery		Concentrate Grade		Head Grade		Cu Oxide
		Cu	Au	Cu	Au	Cu	Au	
		%	%	%	g/t	%	g/t	%
FT57	HIGH	37.5	42.7	43.02	47.87	0.250	0.338	30.8
FT58	HIGH	91.7	70.0	29.45	18.44	0.290	0.295	4.8
FT59	HIGH	89.3	77.5	26.52	20.60	0.370	0.396	2.3
FT60	NORMAL	86.1	73.4	25.57	14.69	0.222	0.186	2.7
FT61	NORMAL	85.4	71.6	25.43	11.26	0.199	0.142	3.0
FT62	HIGH	74.0	82.2	47.14	36.55	0.547	0.532	17.1
FT63	HIGH	91.5	75.6	30.66	35.54	0.293	0.550	17.1
FT64	NORMAL	65.8	63.8	17.60	14.97	0.186	0.220	3.1

Table 13.18
Summary of Variability Samples Flotation Tests

Test No	Lithology	Total Recovery		Concentrate Grade		Head Grade		Cu Oxide
		Cu	Au	Cu	Au	Cu	Au	
		%	%	%	g/t	%	g/t	
FT65	NORMAL	62.8	62.7	19.47	19.87	0.142	0.185	6.4
FT66	NORMAL	64.2	70.4	21.06	20.84	0.253	0.303	1.4
FT67	TRANS	46.0	47.1	8.27	5.37	0.400	0.342	32.4
FT68	TRANS	88.6	88.4	7.81	10.68	0.316	0.498	14.7
FT69	TRANS	88.1	89.7	22.46	69.71	0.410	1.507	7.9
FT70	NORMAL	81.4	86.2	4.51	4.52	0.232	0.246	25.2
FT71	NORMAL	79.1	82.8	17.10	20.48	0.248	0.374	12.3
FT72	NORMAL	82.6	85.0	14.43	11.18	0.161	0.150	4.4
FT73	TRANS	87.0	82.7	8.53	8.96	0.303	0.400	21.1
FT74	HIGH	81.4	73.6	48.70	21.75	0.592	0.306	21.0
FT75	HIGH	85.7	72.6	45.07	10.75	0.514	0.228	13.5
FT76	HIGH	86.2	68.3	21.81	13.06	0.204	0.215	5.2
FT77	HIGH	89.4	75.7	23.45	15.24	0.204	0.202	5.8
FT78	NORMAL	91.9	65.2	29.68	11.08	0.219	0.176	3.8
FT79	NORMAL	86.5	73.8	15.45	7.72	0.189	0.372	5.9
FT80	NORMAL	90.1	68.4	28.07	13.00	0.221	0.179	3.6
FT81	HIGH	30.9	55.1	15.03	79.74	0.091	0.363	56.0
FT82	HIGH	80.4	90.0	33.06	79.63	0.306	0.710	13.8
FT83	HIGH	85.5	80.6	27.46	25.97	0.295	0.416	8.3
FT84	NORMAL	79.4	67.1	16.86	13.37	0.189	0.248	2.9
FT85	NORMAL	80.5	66.7	18.00	13.78	0.178	0.237	2.9
FT86	NORMAL	83.9	68.6	18.29	16.07	0.110	0.155	4.5
FT87	NORMAL	85.9	73.1	18.53	13.44	0.136	0.150	2.9
FT88	TRANS	70.9	72.1	6.35	4.27	0.244	0.220	26.5

These results indicate that:

- There were large differences between the various samples. The reason for the differences is not immediately apparent and will be investigated further.
- In some instances, the calculated head grades showed more than 10% difference to the measured head grades. These results can be considered as anomalous and will be investigated further.
- The oxide Cu content of the samples does not appear to correlate with the Cu grade and recovery and some of the results appear to be counter-intuitive. In general the high oxide samples with better recovery are found to come from the 'Transition' zone as defined in the PIIR programme. By comparison high oxide samples from the 'Higher' zone tend to have low recoveries. However, this has to be confirmed and evaluated with respect to the current plant design.
- Variations in Au recovery into the Cu concentrate and CIL feed are present. In some cases these variations run counter to the Cu results.

- Three cleaner stages were included in the test work to assess whether a third stage was required to achieve an acceptable concentrate Cu grade for smelter feed. The results do not indicate the need to include a third cleaner stage. The results in Table 13.18 are truncated to two cleaner stages.
- A separate rougher scavenger concentrate was recovered to assess the viability of including this in the CIL feed. The concentrate obtained generally showed an additional recovery of less than 2% of Au at a grade significantly less than the cleaner scavenger tails (the current CIL feed material).
- Ag assays have not been done. This is accepted at this stage of the investigation but will have to be included on tests which are close to finalisation of the work, i.e. final test conditions, prior to proceeding to the CIL tests.

13.4.4 Estimated Metal Distributions

The metal distributions and overall recoveries are summarised in Table 13.19. The information contained here is that estimated as applicable to the plant and has been used for the economic analysis (refer to Section 22) and the plant design criteria (refer to Section 17.2.6). The data has been taken from the test work and calculated in the mass balance, done on Metsim. The base data was extracted from the flotation tests FT6 and the LCT done on the MC in PIIR and the PIIR CIL tests on the MC at a regrind PSD of 20 µm.

Table 13.19 Summary of Metal Distribution						
	Grade			Distribution		
	Cu %	Au g/t	Ag g/t	Cu %	Au %	Ag %
Ore feed	0.22	0.34	1.2	100	100	100
Final concentrate	24	28	111	82	65	73
Final Tailings	0.04	0.05	0.15	18	16	17
CIL feed	-	-	-	6	22	27
	Cu %	Au %	Ag %	-	-	-
Doré	24	27	49	0*	19	10
Total overall	-	-	-	82	84	83

Notes: The table reports values to the nearest integer. Actual value is 0.0026%.

From the initial flotation optimisation work of PIII, there was found to be a significant content of oxide Cu in some of the variability samples that were related to the early years of mine production. The flotation recoveries of the individual variability samples were assessed with respect to lithology and oxide Cu content and the ore production schedule from the mine. Some of the results were noted to be anomalous and were ignored, pending re-testing during PIII. By this means it was possible to incorporate an initial indication into the resource model to allow a prediction of weighted average recoveries, including accounting for the oxidised Cu.

Table 13.20 summarises the results for the first four years of operation. The recoveries of year five onwards are taken as those in Table 13.19.

Table 13.20
Summary of Early Year Recoveries

Year	1	2	3	4
Cu recovery into concentrate	77%	80%	81%	81%
Au recovery into concentrate	62%	64%	64%	64%
A recovery to CIL	20%	21%	22%	22%
Year	1	2	3	4

13.4.5 Comments

Based on the foregoing, the following comments are offered as a basis for application of the test results to the existing plant design and the economic analysis, as well as possible influence on plant behaviour from the material received from the mining plan / programme.

The PIII samples were selected by Euromax Resources with the assistance of Amec Foster Wheeler. The basis was to provide material for three composites of different domains, a MC that was applicable to the first few years of operation and samples to evaluate the variability of the resource in 3D spatial. It is considered that the samples selected, prepared and used for this project are representative of the resource.

The estimate for recovery from areas of high oxide Cu content is uncertain at this stage and the results have shown a degree of variability between high and low values. A firm estimate cannot be established until the FEED test work (as described in Section 13.4.6) has been completed.

The test work used a third cleaning stage. At the time this was considered necessary to confirm whether there was a material benefit to be gained in terms of enhanced Cu grade into the concentrate. This did occur but at the expense of recovery. The two stage cleaning generally gave a satisfactory concentrate Cu grade suited for smelter feed stock and thus there does not appear to be justification for the addition of a third cleaning stage. The plant flow sheet will remain as it currently is.

The test work used a rougher scavenger stage to evaluate whether this concentrate could form part of the feed to CIL with the aim of enhanced Au recovery. The results did not confirm this and there is no justification to add the scavenger concentrate as a separate intermediate product. Consideration could be given to including this into the primary Cu rougher concentrate to maximise recovery, without change to the current flow sheet. The very low Cu grade will be upgraded during cleaning; a quick mathematical assessment indicates that there is no significant degradation of grade to final concentrate.

In order to account for these variations the annual plant feed has been subdivided in to mixed material, which contain oxide mineralisation and sulphide material as recorded in the core logging and allocated in to the block model. This sub-division of feed indicated that the first four years of production are impacted. From year 5 on the quantity of oxides is generally only 1-2%. In these years the base case recoveries established in the PIIR test work programme can be applied. In years 1 and 2 the schedule shows a significant portion of mixed oxide granodiorite, corresponding to 'High' metallurgy variability samples and in years 3 and 4 there is a portion of 'Transition' mixed material. In order to obtain weighted average annual recoveries for these first four years variability results from those two categories have been used, weighted by tonnage, combined with the PIIR base case recoveries for the remaining non-oxide portion of that year's recovery.

The work already undertaken in the PII and PIIR phases was reviewed and assessed to be consistent with the level of the study as pre-feasibility. The results were consistent with the aims of the work, as defined previously. The PIII results for comminution were accepted as complete and suitable for detailed design work. The remainder of the scheduled PIII work had been partially completed. The evaluation of the results to date was based on the PII and PIIR results and consolidated with Amec Foster Wheeler knowledge and experience of similar copper / gold sulphide ores. The results and comments presented in this report are considered to be adequate and give a reasonable representation of what may be expected in plant operation.

13.4.6 Future Test Work Requirements

Test work is continuing in order to confirm the assumptions made, the test results of the previous test work (PII and PIIR), the current test work (PIII) and to allow the detailed process design phase to proceed to completion during the FEED. The programme will include:

- Repeat tests of any anomalous results where unexpected differences in both recoveries and grades of Cu and Au are experienced. Included in this, duplicate tests to confirm the optimum regrind size of the rougher concentrate, which should also be evaluated with respect to leach recovery.
- Oxide Cu analyses undertaken on the residual core samples to assist in the oxide investigation and to provide additional information relative to metallurgical response. These results will then be interpolated into the resource model. Cu oxide analyses will also be carried out on the various flotation products. These various Cu oxide analyses will allow a less conservative evaluation of the CIL metallurgical response.
- Ag assays on selected tests for balances and recoveries to be calculated. Ag assays are also necessary on core samples for inclusion in the geological block model. Euromax Resources has initiated a re-sampling of coarse rejects from the core drilling over the entire deposit to provide 9 m composites. These will be analysed for oxide Cu using a citric acid method. Ag assays will be included in this exercise.
- Additional LCTs on different domain samples to those carried out in PIIR to confirm the open circuit variability tests. Assessments for plant operations have been done using mathematical techniques to include the effect of stream recycles which is suitable but should be verified with the LCTs.
- Leaching, CIL and de-watering tests on bulk flotation test material.
- CIL test work to confirm leach parameters, adsorption parameters and reagent consumptions, including oxygen requirements. The latter is considered essential since the resource material is relatively high in soluble Cu and S, which are oxygen consumers.
- Adsorption and elution test to establish the behaviour of Cu and Ag. It is known that the leach parameters can be varied to reduce adsorption of Cu onto carbon. A cold elution prior to the hot Au elution can also be effective in removal of Cu. This is to be used for the CIL modelling and prediction of the doré analysis.
- Settling tests of the concentrate and final tailings slurry streams for optimisation of the thickening design requirements.
- Filtration tests to confirm the design parameters for de-watering the concentrate and subsequent transport moisture content.
- Bulk solids tests on ore and concentrate to confirm the parameters of bulk density, angle of repose and valley angle for confirmation of the design characteristics for the transport and storage of the ore and concentrate.

14. MINERAL RESOURCE ESTIMATES

14.1 SUMMARY

Tetra Tech has adopted the definition of Mineral Resource as outlined within the CIM Definition Standards on Mineral Resources and Mineral Reserves (CIM 2010).

Tetra Tech has estimated the mineral resources for the project, with an effective date of 7 July 2015. The last data included in the estimate was also received on 7 July 2015. The resources have been estimated by Mr. Robert Davies, BSc, CGeol, EurGeol, and reviewed by Mr. Joe Hirst, BSc, MSc, EurGeol, CGeol, FGS.

Statistical and grade continuity analyses were completed to characterise the mineralisation and subsequently used to develop grade interpolation parameters for the deposit. Exploratory data analysis highlighted a number of statistically differentiated grade populations, which were interpreted to be controlled by the following:

- Stockwork intensity
- Oxidation state
- Supergene leaching and enrichment.

Wireframe models were used to isolate grade populations into domains for the purpose of sample selection and to constrain the grade interpolation. Grade estimation was completed using ordinary kriging. The search ellipsoid dimensions and orientations were chosen to reflect the continuity revealed by geostatistical studies and optimised using quantitative kriging neighbourhood analysis.

Estimates for silver and molybdenum were not undertaken as the silver assays are not made with a sufficiently low detection limit in the majority of the deposit and Tetra Tech considers that the potential for incremental value to be added by molybdenum is limited.

The wireframe models were used within the sample selection and compositing routine and subsequently as a constraint to the grade estimation. Euromax Resources provided the geological and analytical data in Excel spread sheets and Access databases. Modelling and estimation was completed using Geovia Surpac Version 6.6.2.

Euromax Resources also provided a topographic survey in drawing exchange format file (.dxf) and consisted of a satellite radar DEM.

A Mineral Resource Classification scheme consistent with the CIM guidelines (2010) was applied. The estimates are categorised in the Measured and Indicated mineral Resource categories, reported above a cut-off grade that defines the Resource as potentially mineable by open pit mining methods.

In calculating dollar equivalent block values Tetra Tech considered forecast metal prices from Energy & Metals Consensus Forecasts published by Consensus Economics Incorporated on 12 July 2015. The forecast for September 2016 was US\$1244 /oz Au and US\$2.87 /lb (6333 /t) Cu, with a long term forecast of US\$1271 /oz Au and US\$2.99 /lb (6 590 /t) Cu. For the purpose of assigning a dollar value to blocks so that a cut-off can be applied to show reasonable prospects of economic extraction, Tetra Tech adopted US\$1 250 /oz Au and US\$3.00 /lb Cu (6 612 /t):

The dollar equivalent is calculated using the following formula:

$$\text{Dollar eq} = [\text{Au} * \text{Recovery} * \text{Au Price}] + [\text{Cu} * \text{Recovery} * \text{Cu Price}]$$

A pit optimisation was performed using the Lerchs & Grossman algorithm as implemented in Vulcan. The pit shell was generated to define blocks within the model that have reasonable prospects for economic extraction.

Resource grade/ tonnage sensitivity tables were created based upon a range of dollar equivalent cut-offs for blocks within the overall Resource pit shell. A base case cut-off of US\$16 /t was chosen for sulphide materials and US\$8 /t for oxide materials.

14.2 GEOLOGICAL INTERPRETATION

The Ilovica porphyry system is approximately 1.5 km in diameter and is associated with a poorly exposed dacite-granodiorite plug, emplaced along the northeastern border of the northwest-southeast elongate Strumica graben. The exact location of the deposit is controlled by major north-south cross cutting faults and minor northwest faults, parallel to the tectonised border of the graben (Figure 7.3 and Figure 7.4).

At surface, the Ilovica intrusive complex consists of a central dacitic breccia diatreme, approximately 1.3 km in diameter. The diatreme is intruded by at least one dacite and two granodiorite porphyry stocks that have generated several hydrothermal pulses, resulting in widespread multi-phase veining within a mineralised stockwork.

The Ilovica porphyry is centred on a hill of more than 400 m of absolute relief, surrounded at lower elevations by numerous small dikes and irregular bodies of dacitic tuff/ breccias and intermediate volcanic rocks.

Alteration related to Tertiary magmatic activity at Ilovica is variably present over an area of about 8 km². Pervasive alteration is largely confined to a roughly 1.5 km² area in and adjacent to the main intrusive complex. Smaller areas of pervasive and structurally-controlled alteration extend asymmetrically to the south and east of the intrusive complex. Interpreted alteration zones are illustrated in Figure 7.3 and Figure 7.4.

Subsequent supergene activity is understood to have re-mobilised metal from the higher elevations within the deposit, resulting in a leached and copper depleted cap. The metal appears to have been deposited beneath the depleted cap, resulting in an enriched layer of between 150 m and 180 m in thickness, located at an elevation of between 325 m and 754 m.

14.3 WIREFRAME MODELS

A three dimensional (3D) wireframe model defining the limit of mineralisation was created for the deposit. The mineralised volume was sub-divided using further wireframe models representing stockwork intensity, oxidation level and enrichment zones. A comprehensive set of lithological models have also been developed for the deposit.

Digital terrain model (DTM) surfaces were created for the “base of complete oxidation” and “base of Mix” oxide logging codes. Enrichment zones were defined on an in-situ dollar equivalent basis, as follows:

$$\text{In-situ Dollar Equivalent} = [\text{Au grade} * \text{Au price}] + [\text{Cu grade} * \text{Cu price}]$$

Where the mineralisation is still open laterally, outside of the main stockwork or enrichment zones the mineralisation has been constrained by a 50 m distance constraint beyond the drill holes.

Wireframes representing stockwork intensity were defined by a numeric index established from the logging of vein percentages. Within the database, a column was created to sum the VeinQtzSulf, VeinSulf, VeinMtSulf and VeinQtzSulphMt logging codes. The index was then used to implicitly model stockwork intensity shells in Leapfrog Geo 3D. A series of shells were assessed against the grade population histograms and box and whisker plots to identify what level of stockwork index was most effective in differentiating the grade populations.

Combinations of the various controls were assessed using a statistical assessment of the grade populations to define the main controls on the gold and copper distribution. The wireframes were used in conjunction with block maths to define the estimation domains summarised in Table 14.1.

Table 14.1 Estimation Domains				
Domain	Stockwork Index	Enrichment wireframe	Mineralisation limit wireframe	Oxidation State
Au Domain 1	<2	Outside	Inside	Any
Au Domain 2	=>2	Inside	Inside	Any
Cu Domain 1	Any	Any	Inside	Oxide
Cu Domain 2	0	Outside	Inside	Mixed and Fresh
Cu Domain 3	>0	Inside	Inside	Mixed and Fresh

The dimensions of the domains are outlined in Table 14.2.

Table 14.2 Estimation Domain Volumes	
Domain	Volume m³
Total Mineralised Volume	305 710 814
Au Domain 1	115 911 688
Au Domain 2	189 799 126
Cu Domain 1	14 997 063
Cu Domain 2	173 251 625
Cu Domain 3	117 462 126

Note: Domain volumes do not sum as they are not mutually exclusive and volume can be Au or Cu mineralised, or both.

14.4 EXPLORATORY DATA ANALYSIS

Euromax Resources provided Tetra Tech with drill hole data in Excel and Access database format on the 7 July 2015. The data consisted of collar, assay, density, lithology, downhole survey, alteration structural and sample recovery information. Euromax Resources is responsible for the database management of the drill programmes.

Tetra Tech linked the supplied data to Surpac via the database utility. Validation checks were made following connection and any errors noted and communicated to Euromax Resources for correction.

Only diamond core drilling data was used for the Resource estimation.

Descriptive statistics for all of the raw samples from within the mineralised wireframes are presented in Table 14.3.

Table 14.3 Descriptive Statistics for Raw Assays		
Measure	Au (ppm)	Cu (ppm)
Count	12 789	12 798
Min	0	4
Max	22.2	28 567
Mean	0.24	1 445
Standard Deviation	0.33	1 335
Skewness	32.96	3.56
Kurtosis	1 849	32.88
Variance	0.11	1 782 707
Coefficient Of Variation	1.37	0.92
Geometric Mean	0.15	824
25%	0.11	525
Median	0.2	1 258
75%	0.31	2 044

There is no relationship noted between sampled length and grade, as illustrated in Figure 14.1 and Figure 14.2.

Figure 14.1
Raw Sample Length Plotted Against Gold Grade

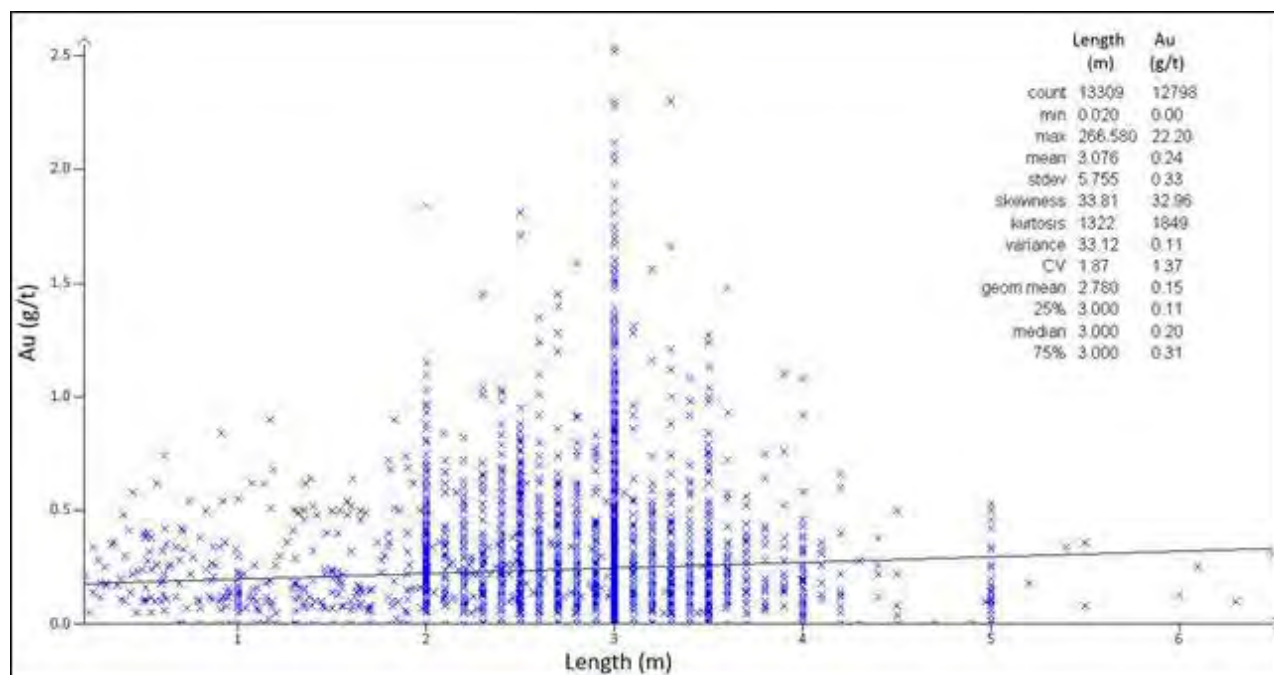
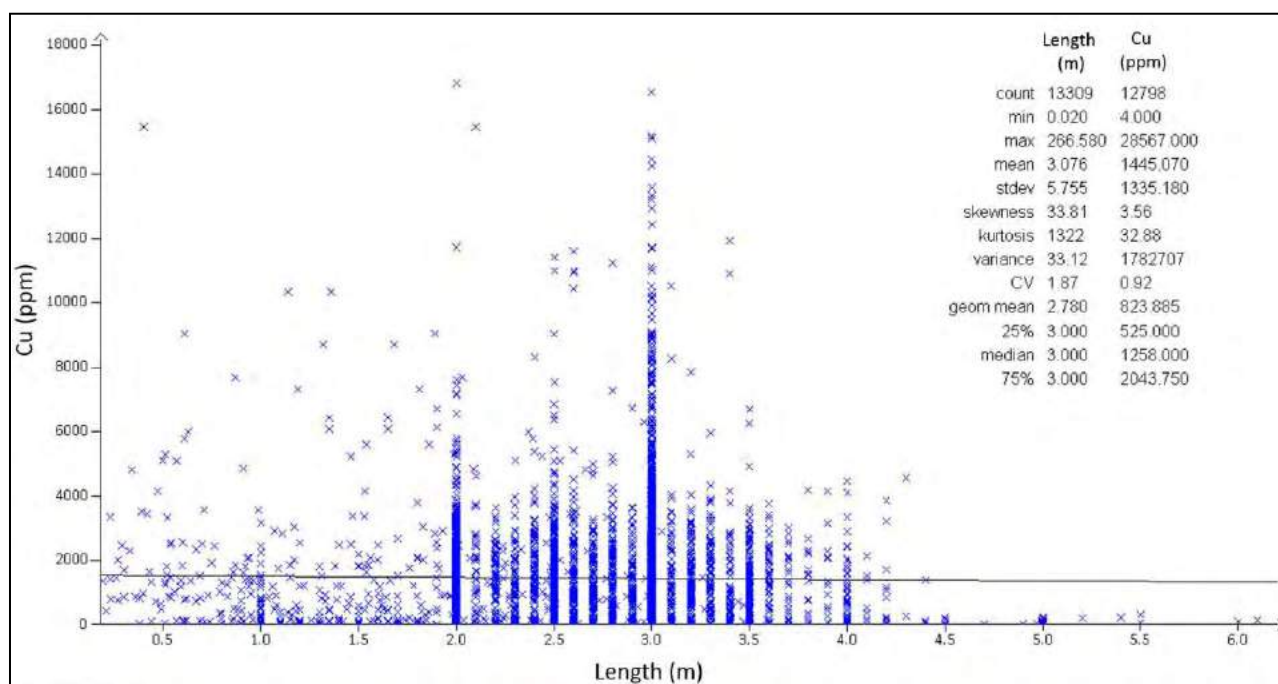


Figure 14.2
Raw Sample Length Plotted Against Copper Grade



14.5 COMPOSITING

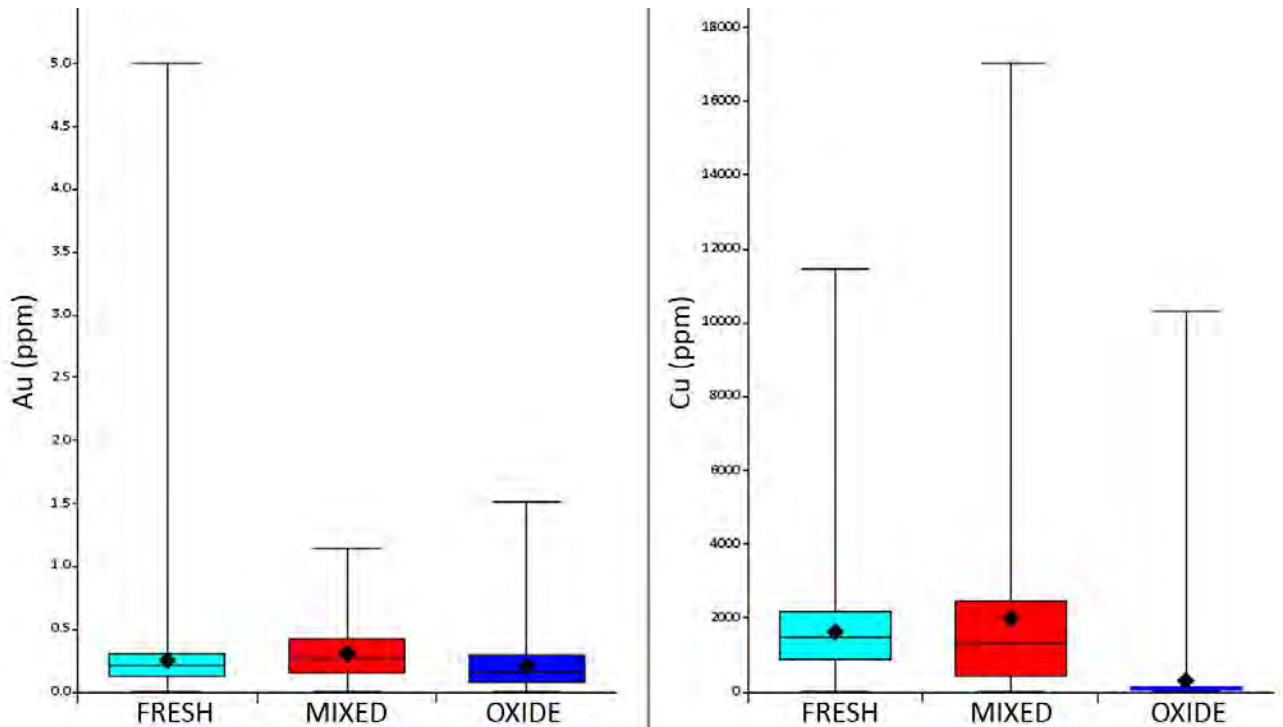
Lithology and alteration observations dictated sample interval selection for all drilling campaigns at Ilovica. The mean sample length for all raw samples 2.055 m. A 3 m best fit routine was utilised to produce composites within hard domain boundaries. The compositing was completed in Surpac. Descriptive statistics associated with all of the composited samples within the mineralised wireframe are given in Table 14.4.

Table 14.4 Descriptive Statistics for All Estimation Domain Composites					
Measure	Au 1 (ppm)	Au 2 (ppm)	Cu 1 (ppm)	Cu 2 (ppm)	Cu 3 (ppm)
Count	2334	7314	602	3631	5416
Min	0	0	22	42	58
Max	1.48	5.00	10 000	4000	10 000
Mean	0.21	0.30	609	1284	2125
Variance	0.02	0.06	2 087 210	499 032	1 509 309
Standard Deviation	0.15	0.25	1445	706	1229
CV	0.69	0.82	2.37	0.55	0.58
Skew	2.94	7.18	4.65	0.99	2.56
Kurtosis	14.26	109.10	24.19	1.19	11.54
Geo Mean	0	0	210.56	1081.43	1834.06
Median	0.17	0.25	153	1151	1949
25%	0.12	0.17	93	778	1405
50%	0.17	0.25	153	1151	1949
90%	0.36	0.52	1580	2232	3292

14.6 POPULATION ANALYSIS AND DOMAINING

Multiple statistical grade populations were noted in the samples contained within the overall mineralisation wireframe. The box and whisker plot presented in Figure 14.3 demonstrates that the oxide material is depleted with respect to copper, with a slight increase in copper concentration within the mixed zone. This distribution is interpreted to be associated with leaching of copper from the oxide zone and supergene enrichment within the transitional zone. The gold distribution is not controlled by the oxidation state.

Figure 14.3
Box and Whisker Plot of Gold and Copper against Oxidation State



Separating the samples into the fresh, transitional and oxide domains resulted in mixed log normal grade populations for gold and copper. The mineralisation was further separated into discrete domains for estimation, based on achieving log normal distribution in each.

The stacked log histogram presented in Figure 14.4 shows the distribution of the gold grade populations. Overall the gold population approximates to a log normal distribution, however differentiation based upon the estimation domains outlined in Table 14.4 results in better defined log normal populations (Figure 14.5).

Figure 14.4
Stacked Log Histogram Illustrating Gold Populations from Composites within Estimation Domains 1 and 2

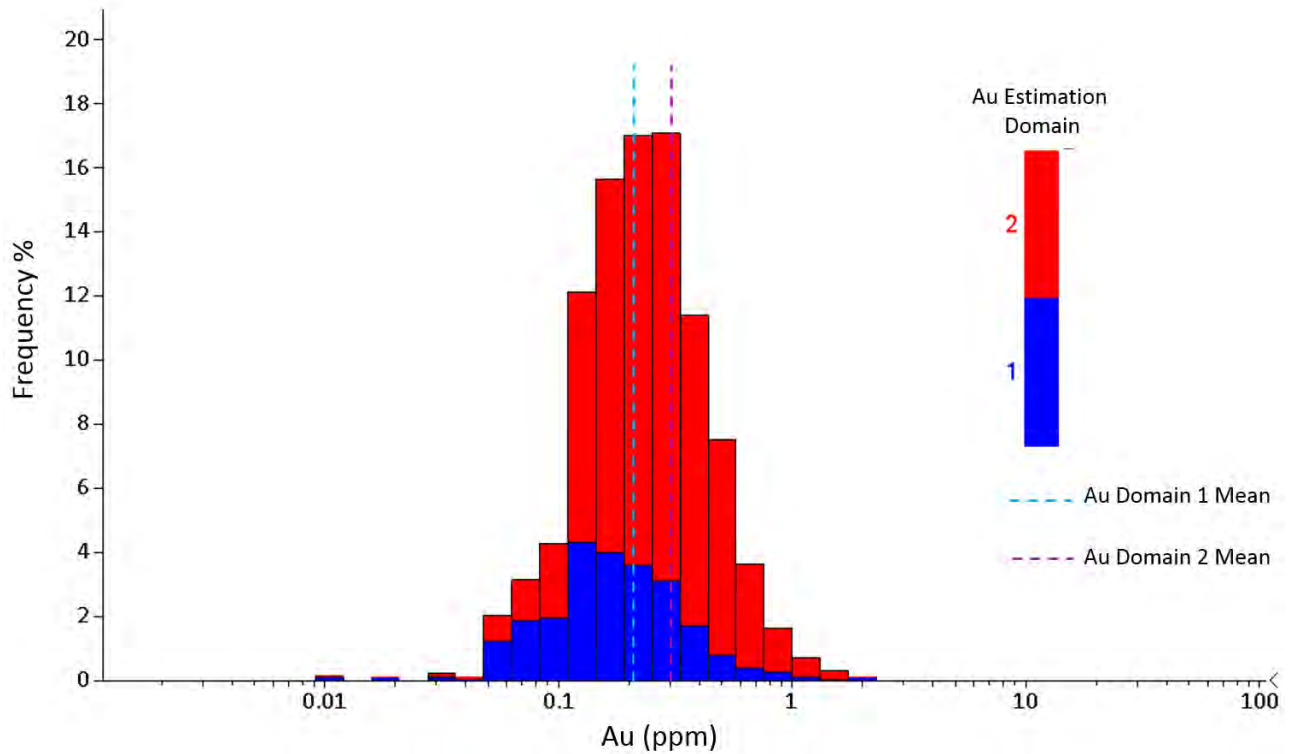
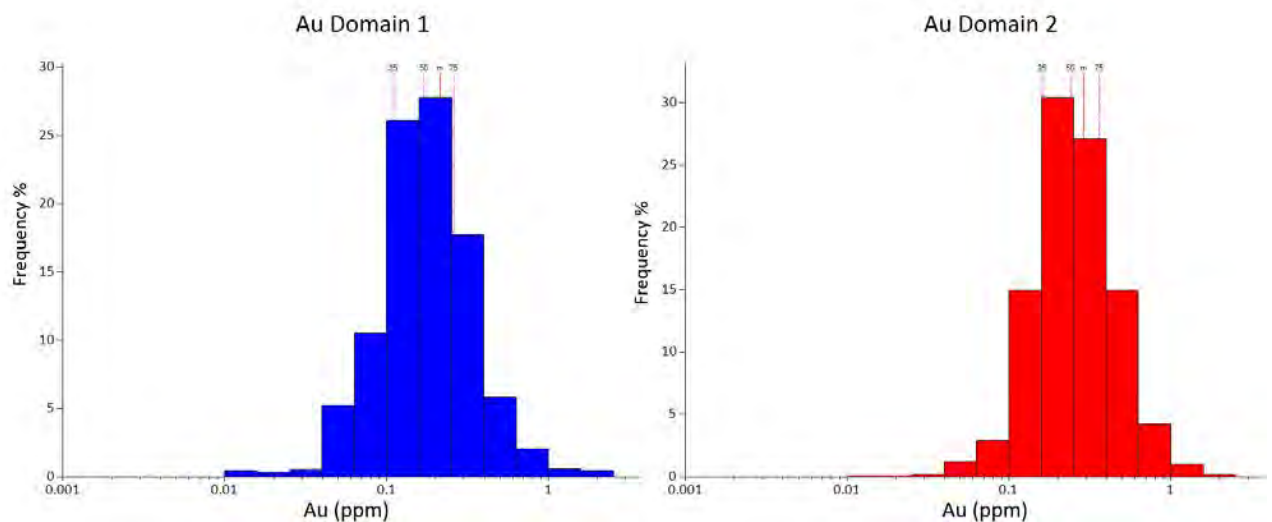


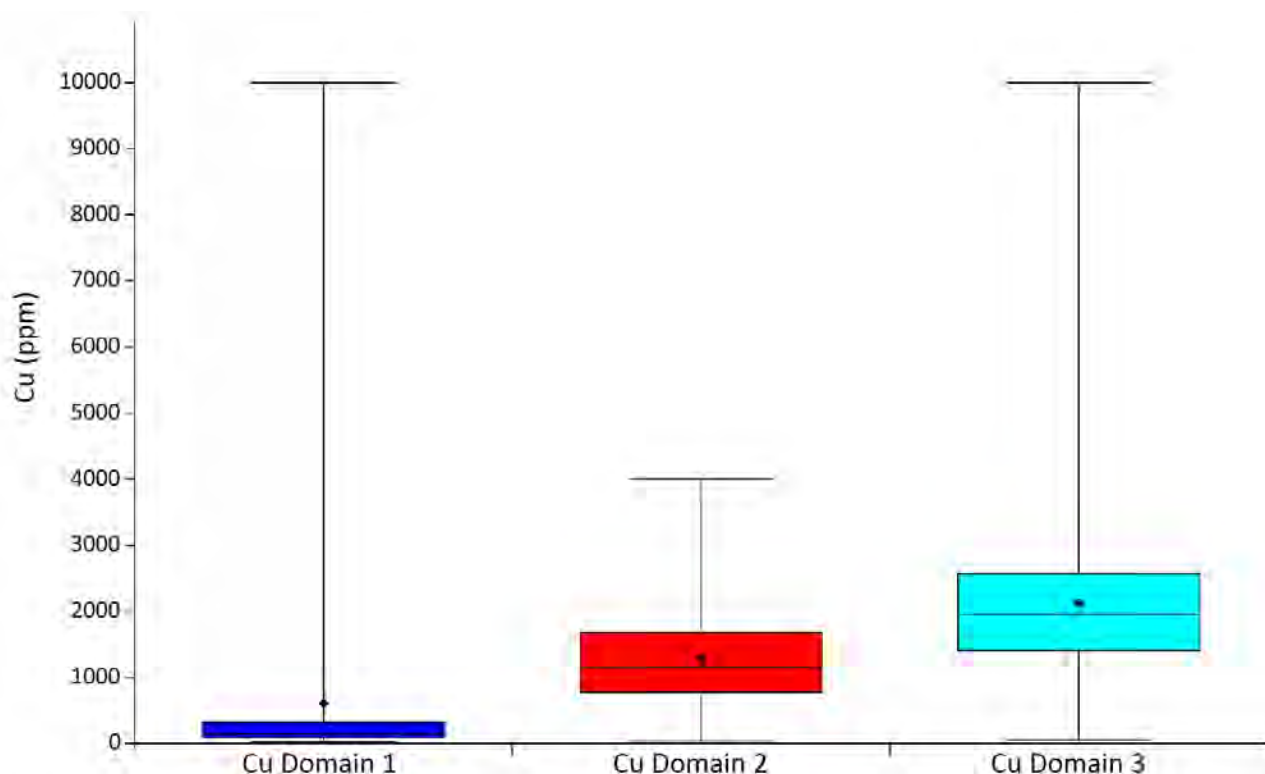
Figure 14.5
Log Histograms for Composites from Differentiated Au Estimation Domains



Justification for gold domaining is not overwhelming, but the differentiation during the estimation results in a more robust local estimation, avoiding over smoothing.

The copper domaining requirement is more distinct than for gold. The oxide zone is clearly depleted, with much of the copper assumed to be leached and deposited into the enriched zone (Cu domain 3). Figure 14.6 illustrates change in copper values for the three domains.

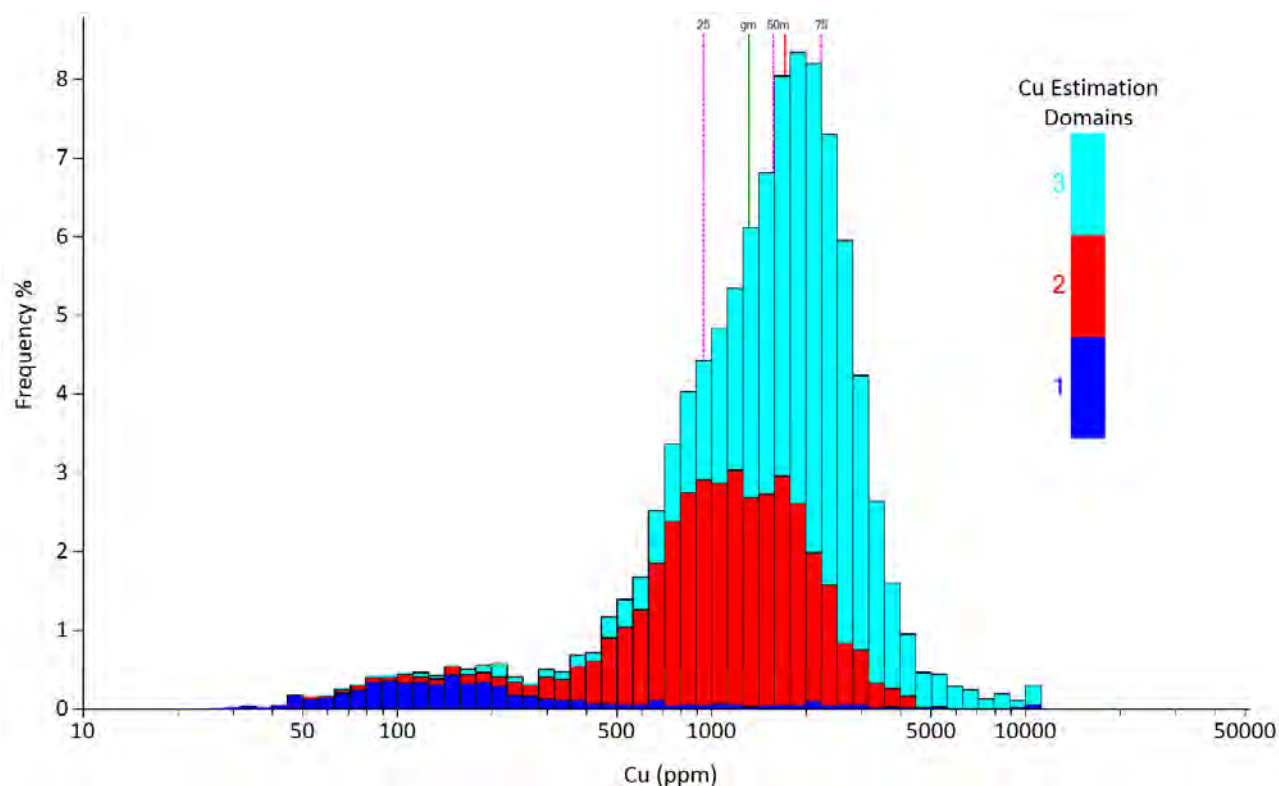
Figure 14.6
Box and Whisker Plot of Showing Copper within the Estimation Domains



The stacked log histogram presented in Figure 14.7 shows the distribution of the copper grade populations. The log histogram presents a mixed population.

Figure 14.7

Stacked Log Histogram Illustrating Copper Populations from Composites within Estimation Domains 1, 2 and 3



Separating the composites into the three estimation domains results in log normal populations for Cu Domains 2 and 3 and a slightly mixed population for Cu domain 1 (Figure 14.8 and Figure 14.9).

Figure 14.8
Log Histograms for Composites from Cu Estimation Domains 1

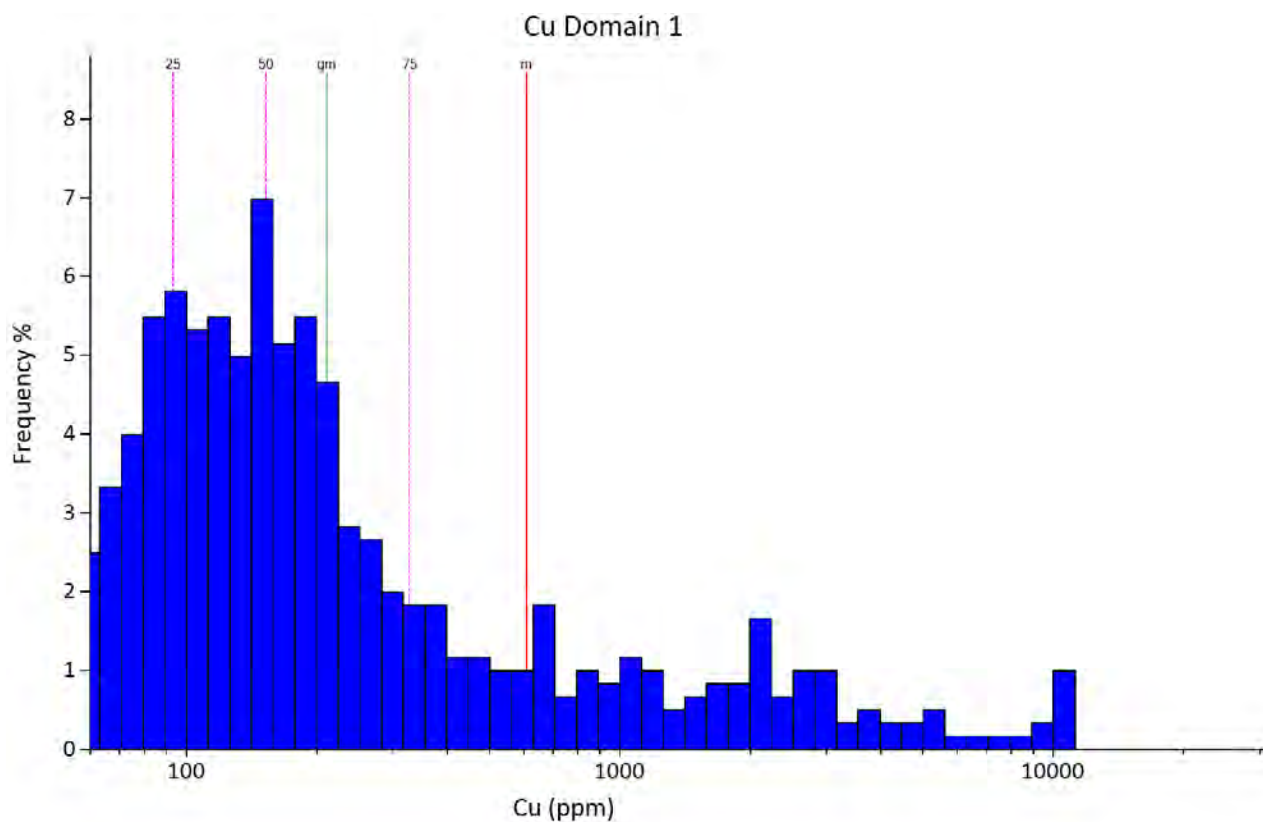
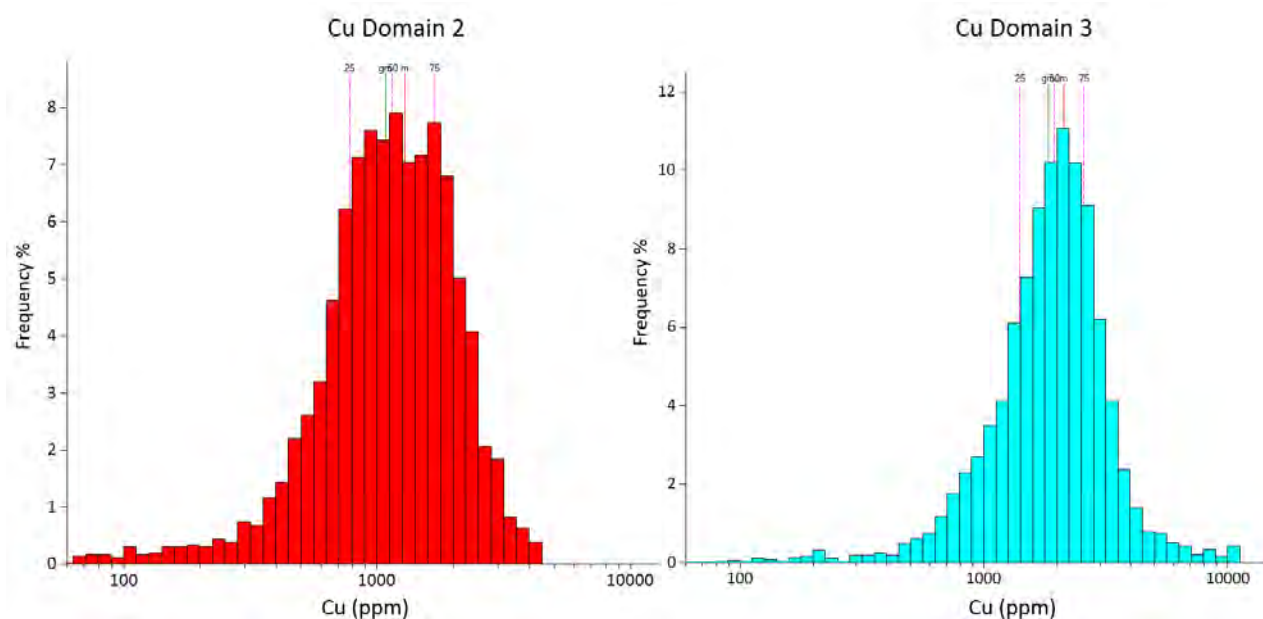


Figure 14.9
Log Histograms for Composites from Cu Estimation Domains 2 and 3



Further domaining using both lithology and alteration were investigated. Neither were shown to be effective in isolating grade populations. Domains based upon a combination of lithology and oxidation state provided no benefit in isolating grade populations compared to oxidation state alone, and subdividing the domains based upon lithology and alteration resulted in a decrease in the number of composites available for each interpolation. Therefore, lithology and alteration style were not used for domaining.

The existence of multiple copper grade populations within Cu domain 1 (oxide) has no effect on the resource, due to the overall grades being very low and it is assumed that no attempt will be made to recover copper from this material. It is also noted that the mixed zone is thin and therefore the effect of mixed copper populations is likely to have negligible impact on the overall resource.

14.7 CAPPING

Capping analysis was completed for copper and gold in each domain using the 3 m composites. Decile analysis (Parrish, 1997) was completed and the grade distributions were plotted as histograms and probability plots on normal and log scales.

Capping requirements were based upon the need to exclude outlier results and to avoid having a significant concentration of metal within the final deciles/ centiles in the Parrish analysis. The capping applied to the composites prior to estimation are presented in Table 14.5.

Table 14.5 Summary of Grade Capping		
Domain	Cap (ppm)	Number of Composites Changed
Au 1	Not required	0
Au 2	5	7
Cu 1	10 000	6
Cu 2	4000	14
Cu 3	10 000	23

14.8 BULK DENSITY

Euromax Resources provided density results for 8283 samples. The samples included granite, granodiorite and dacite, and were taken from the oxide transitional and fresh zones.

The density values were estimated per gold estimation domains using an Inverse Distance Weighting method. The mean density for the rock types reported from the drill hole database are presented per oxide state and lithology in Table 14.6 and Table 14.7.

Table 14.6 Density Values by Oxide State	
Oxide State	Density (t/m ³)
Mix	2.40
Oxide	2.31
Fresh	2.52
Grand Total	2.49

Table 14.7 Density Values by Rock Type	
Rock Type	Density (t/m ³)
Dacite	2.40
Dacite Bcc	2.39
Diluv	2.32
Granite	2.55
Gr-Dior	2.50
Qtz vein	2.79
Grand Total	2.49

Sixty-two of the samples, taken from 2008, 2010, 2011, 2012 and 2013 were tested by the faculty of civil engineering, Sts. Cyril and Methodius University, Skopje, Macedonia. The remaining 8221 samples were tested by Euromax Resources in the facilities in Strumica. There is a good correlation between the density results from the faculty of civil engineering and those collected by Euromax Resources.

14.9 VARIOGRAPHY

Variography was completed in Snowden Supervisor software V.8.1. Experimental semi-variograms were produced in a plan view initially, with the strike, dip and plunge established independently thereafter. The nugget value has been established from a downhole variogram.

The modelled variogram parameters establish the variogram structures to be utilised within the ordinary kriging estimation. Weak to moderate directional control has been established in the majority of the domains for both copper and gold. Table 14.8 presents the variogram parameters used for the estimation.

Table 14.8 Variogram Parameters										
Domain	Azimuth (°)	Dip (°)	Plunge (°)	Nugget	Structure 1			Structure 2		
					Range (m)	Semi-major Ratio	Minor Ratio	Range (m)	Semi-major Ratio	Minor Ratio
Au 1	6.0	48.00	-15.0	0.48	900	5.74	0.80	1800	0.82	1.00
Au 2	357.0	28.00	-29.0	0.12	119	0.65	2.28	297	1.61	5.60
Cu 1	41.3	29.62	-5.0	0.05	25	1.00	6.60	100	2.47	4.75
Cu 2	36.5	69.90	-9.3	0.08	97	0.40	1.22	1800	7.60	22.80
Cu 3	202.0	-39.50	6.4	0.12	135	5.62	3.29	350	1.46	4.93

14.10 RESOURCE BLOCK MODELS

A single block model has been constructed in Surpac for the Project. The block model parameters are given in Table 14.9.

Table 14.9 Block Model Parameters and Extents			
Measure	Y	X	Z
Minimum Coordinates	4594500	7653000	-200
Maximum Coordinates	4596500	7655000	1000
Parent Block Size (m)	20	20	10
Minimum Block Size (m)	5	5	2.5
Rotation (°)	0	0	0

Sub-blocks were used to accurately differentiate domains within the block model. The block model volume for a given zone was found to match well with its corresponding wireframe. A comparison of the overall mineralisation wireframe and block model volumes is given in Table 14.10.

Table 14.10 Comparison of Block Model and Wireframe Volumes		
Description	Unit	Volume
Mineralisation Wireframe	m ³	307 048 879
Block model	m ³	305 710 813
Difference	%	0.44

14.10.1 Interpolation Strategy

Grades were estimated using ordinary kriging, adopting a multi-pass methodology. The kriging employed variogram parameters as presented in Section 14.9.

As previously described the estimation was controlled by five domains, defined by the level of enrichment, stockwork, and oxide state.

Quantitative kriging neighbourhood analysis was undertaken to optimise the block size, number of informing samples, discretisation and search distances used in the estimation. Quantitative measures of the kriging performance (e.g. slope of regression, kriging efficiency, kriging variance, block variance, proportion of negative weights) were used to test the appropriateness and optimise the kriging parameters. The analysis was undertaken on large representative portions of the block model as well as on isolated test blocks. Where test blocks were used, these were chosen as examples of one well informed block and one poorly informed block.

A summary of the estimation strategy is shown in Table 14.11.

Table 14.11 Estimation Parameters									
Domain	Pass 1			Pass 2			Pass 3		
	Samples		Search	Samples		Search	Samples		Search
	Min	Max	Distance	Min	Max	Distance	Min	Max	Distance
Au 1	12	32	200	12	32	400	12	32	900
Au 2	12	32	75	12	32	150	12	32	300
Cu 1	12	32	50	12	32	75	12	32	150
Cu 2	12	32	100	12	32	300	12	32	600
Cu 3	12	32	100	12	32	200	12	32	400

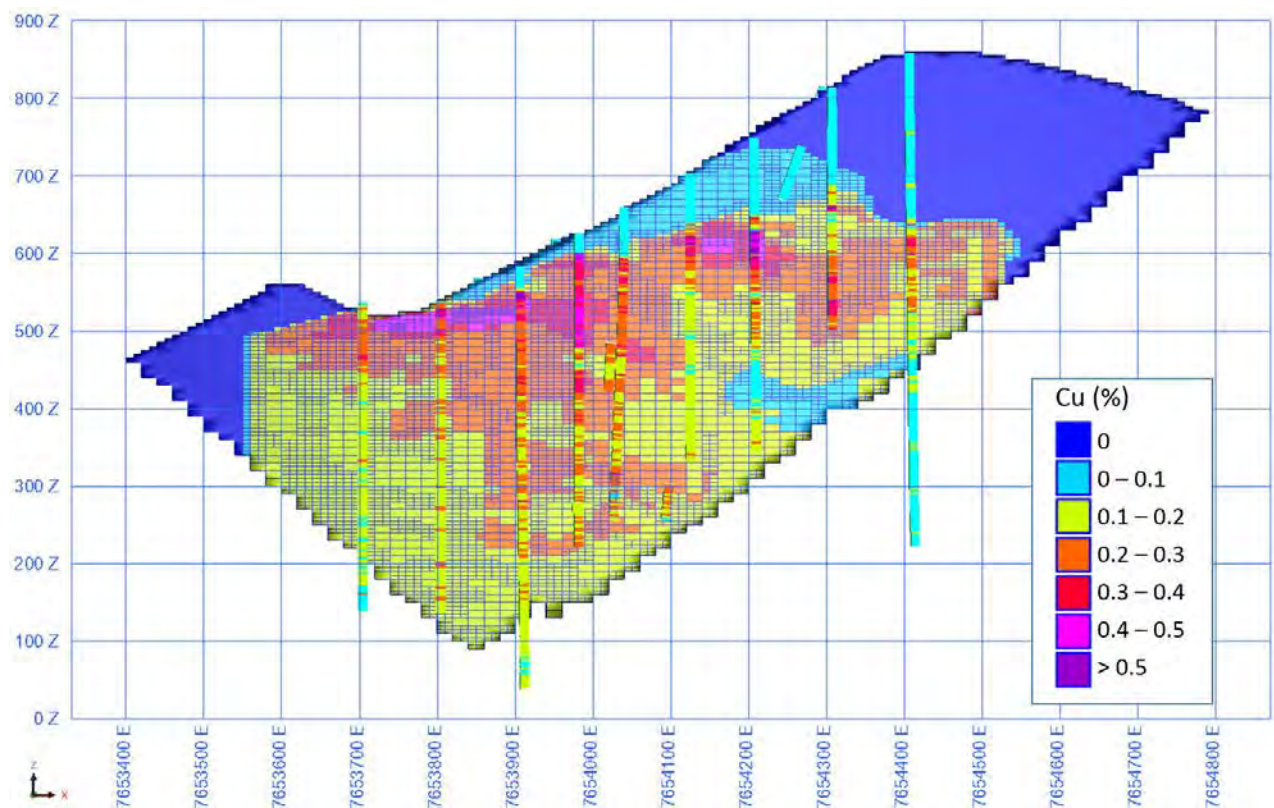
The discretisation of $X = 3$, $Y = 3$ and $Z = 2$ was found to be optimal for all zones. A maximum of four samples per drill hole were allowed to inform the estimation of any one block.

14.11 BLOCK MODEL VALIDATION

Block model validation was completed using graphical and statistical methods, to confirm that the estimated block model grades appropriately reflect the local composite grades.

Graphical analysis of the informing samples versus estimated block grades was undertaken using horizontal and vertical sections (selected vertical sections are presented in Figure 14.10 and Figure 14.11).

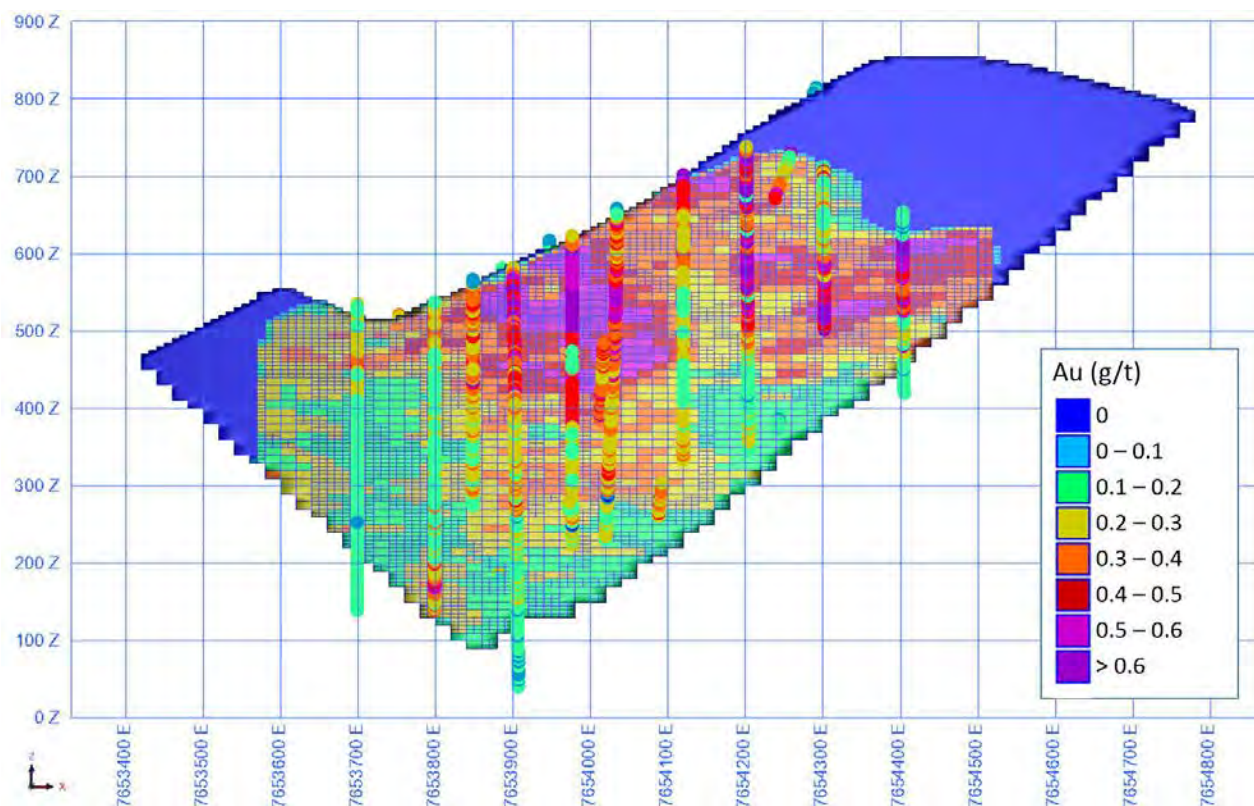
Figure 14.10
East-West Section through Block Model and Local Drill holes with Copper Grades Presented



Note: Section taken along west-east at 4 595 200 N

The visual inspection demonstrated excellent correlation between composite and block grades, with the anisotropic directionality noted in the variography reflected in the grade distribution.

Figure 14.11
East-West Section through Block Model and Local Drill holes with Gold Grades Presented



Note: Section taken along west-east at 4 595 200 N

Figure 14.12 illustrates the correlation between the block gold grades estimated by ordinary kriging, and the informing composites. The plot illustrates a good correlation, with some smoothing within the block grades as would be expected during estimation.

Figure 14.12
Swath Plot for Gold by Elevation

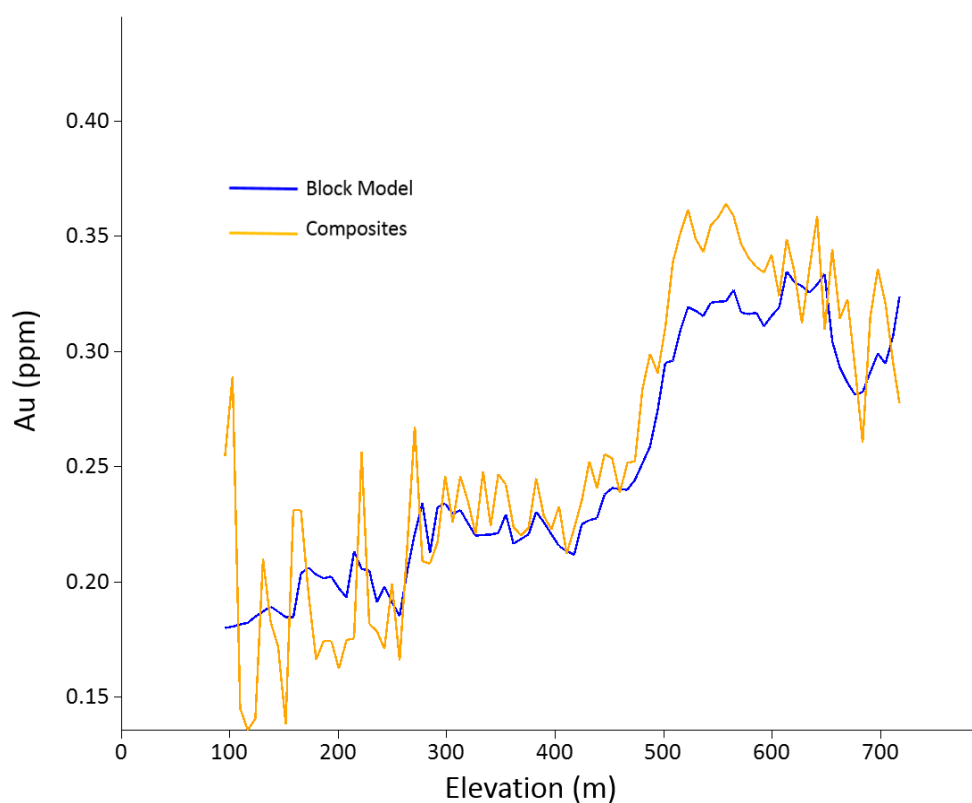
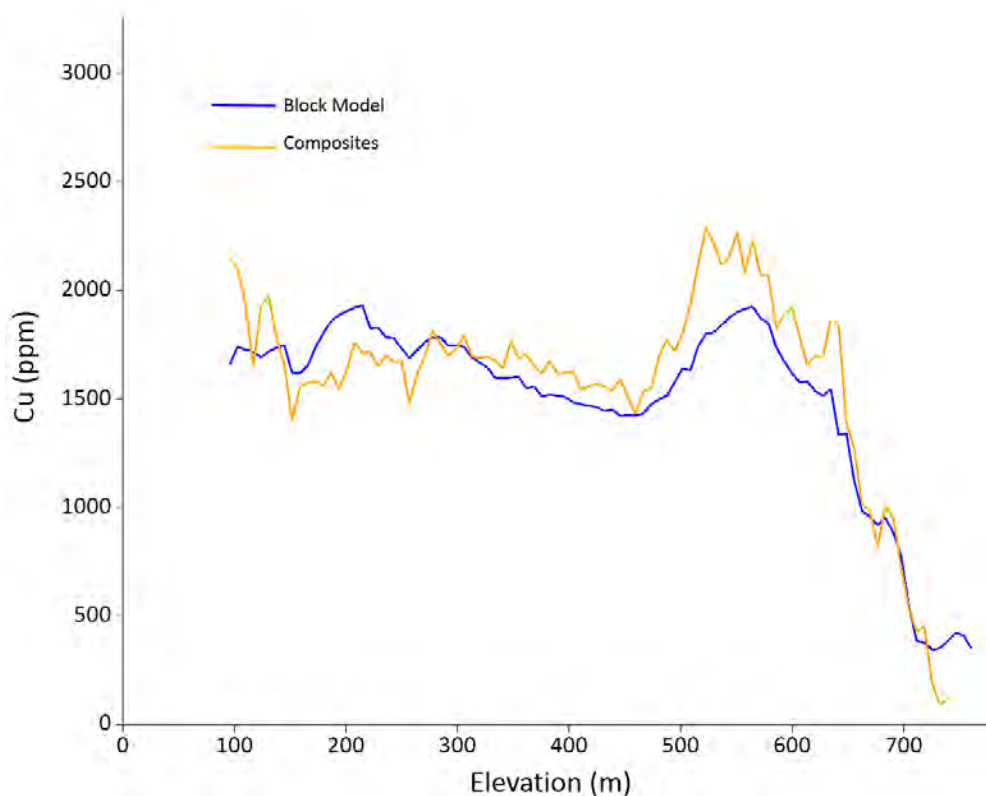


Figure 14.13 illustrates the correlation between the kriged copper grades, and the informing composites. The plot illustrates a good correlation, with the composite trends being reflected in the block model. There is a reduction in variance shown in the block model, which is also reflected in the descriptive statistics presented in Table 14.12.

Figure 14.13
Swath Plot for Cu by Elevation



A comparison was made between the overall estimated block grades and the entire informing composite populations for each domain and metal. This was undertaken through the use of a range of statistical measures, Table 14.12.

A number of the measures indicate a reduction in variance. This is as a result of the change of support associated with the estimation process and the kriging interpolation. Overall, the statistics present excellent conformance.

14.11.1 Conclusion

The various comparators described in the foregoing sub sections serve to illustrate that the block model estimate is robust and satisfactorily models the distribution and variability of the informing sample grades without undue bias or smoothing. It is suitable to support a feasibility study.

Table 14.12
Statistics Comparing Estimated Block Grades and Composite Grades for each Domain

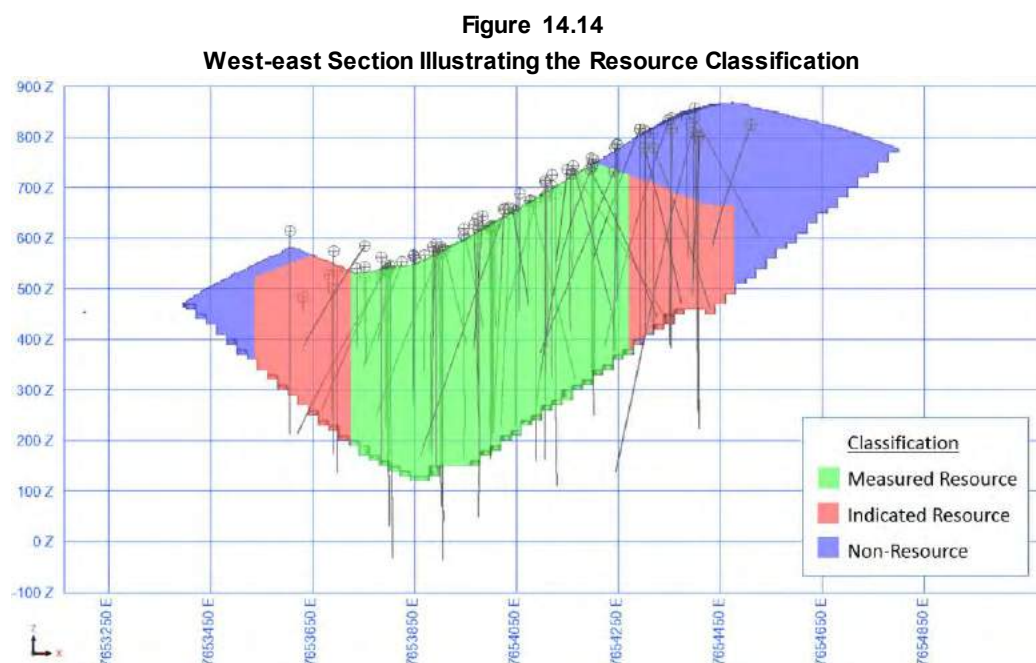
	Composite Statistics					Model Statistics				
	Au (ppm)	Au (ppm)	Cu (ppm)	Cu (ppm)	Cu (ppm)	Au (ppm)	Au (ppm)	Cu (ppm)	Cu (ppm)	Cu (ppm)
Domain	Au 1	Au 2	Cu 1	Cu 2	Cu 3	Au 1	Au 2	Cu 1	Cu 2	Cu 3
Samples	2334	7314	602	3631	5416	890 508	2 330 155	100 200	1 619 632	1 402 094
Minimum	0	0	22	42.37	58.14	0.02	0.04	64.69	290.81	293.82
Maximum	1.48	5	10 000	4000	10 000	1.02	1.77	7432.25	3081.95	9082.68
Mean	0.21	0.3	609.2	1283.72	2124.94	0.19	0.27	734.78	1209.57	1967.43
Variance	0.02	0.06	2 083 743	498 894.9	1 509 031	0.01	0.01	980 196.1	149 826.9	438 645.3
Standard Deviation	0.15	0.25	1443.52	706.32	1228.43	0.08	0.12	990.05	387.07	662.3
Standard Error	0	0	58.83	11.72	16.69	0	0	3.13	0.3	0.56
Skewness	2.94	7.19	4.63	0.98	2.56	1.94	1.81	2.55	0.55	1.69
Kurtosis	14.24	109.15	23.9	1.19	11.53	6.32	5.73	6.9	-0.27	7.2
GEOMEAN	0.18	0.24	210.56	1081.43	1834.06	0.18	0.25	395.21	1148.99	1870
Log Estimate Mean	0.22	0.32	445.35	1328.26	2162.52	0.19	0.27	692.58	1210.63	1966.2

14.12 MINERAL RESOURCE CLASSIFICATION AND TABULATION

The model was classified according to CIM Definition Standards on Mineral Resources and Mineral Reserves (CIM 2010). The Resource Classification at Ilovica considers the following criteria:

- Confidence in the sampling data and geological interpretation
- Analysis of variogram parameters
- The data distribution (based upon graphical analysis and average distance to informing composites)
- Kriging Efficiency
- Slope of Regression.

The block model was constrained based upon the kriging efficiency, slope of regression and average distance to informing composites. Whilst taking into account the confidence in the sampling and geological interpretation, along with the knowledge of the variogram parameters, three wireframe models were generated to define the Measured, Indicated and Inferred resources. The models reflected the trends in the classification parameters, whilst ensuring that the classification resulted in appropriately coherent units. Figure 14.14 presents a west-east section illustrating the adopted Resource Classification.



Note: Section taken along west-east at 4 595 250 N

In order to statistically validate the adopted classification, the weighted average block values within each classification domain were reported (Table 14.13).

Classification	Average Distance to Informing Composites (m)	Kriging Efficiency	Slope of Regression
Measured	54	73	89
Indicated	73	52	78

14.13 MINERAL RESOURCE

For the purpose of Mineral Resource reporting, the transitional material has been grouped with either the oxidised or fresh material based upon the copper content. Where the transitional material has less than 0.2% copper, it is grouped with the oxide material where the copper content is greater than 0.2% it is grouped with fresh material. This approach reflects the fact that there would not be a separate process route for transitional material.

The Mineral Resource for fresh material is summarised in Table 14.14.

Table 14.14 Measured and Indicated Fresh Mineral Resource Based upon a Dollar Equivalent cut-off of US\$16 /t					
Classification	Tonnage	Grade		Contained Metal	
		Au (g/t)	Cu (%)	Au (koz)	Cu (klb)
Measured	147 100 000	0.31	0.23	1500	729 500
Indicated	109 700 000	0.33	0.20	1100	479 000
Total M & I	256 800 000	0.32	0.21	2600	1 208 500

The oxide mineral resources within the constraining pit shell are summarised within Table 14.15.

Table 14.15 Measured and Indicated Oxide Mineral Resource based upon a Dollar Equivalent cut-off of US\$8 /t			
Classification	Tonnage	Grade Au (g/t)	Contained Metal Au (koz)
Measured	12 500 000	0.41	160
Indicated	9 600 000	0.37	110
Total M & I	22 100 000	0.39	280

Notes:

- To define the blocks with reasonable prospects of economic extraction a dollar equivalent have been applied based upon the following calculation:
Dollar Eq = (Au * recovery * Au price) + (Cu * recovery * Cu price)
- The following assumptions were adopted for the calculation of the dollar equivalent:
 - Au recovery in oxide of 74%
 - Cu recovery in oxide of 0%
 - Au recovery in fresh 88%
 - Cu recovery in fresh 84%
- Forecast metal prices of US\$1250 /oz Au and US\$3.00 /lb Cu.
- Numbers may not add exactly due to rounding.
- Recoveries are based on those quoted by Euromax Resources in the PFS (effective date of December 19, 2014). Numbers may not add exactly due to rounding.
- Tonnages calculated interpolated density values, as outlined in Section 14.8.
- Mineral Resources that are not mineral reserves do not have demonstrated economic viability. The estimate of Mineral Resources may be materially affected by environmental, permitting, legal, title, taxation, socio-political, marketing, or other relevant issues.

In addition to the dollar cut-off, in order to ensure that the Resource has reasonable prospects of economic extraction, the block model was constrained to a Resource pit shell. This does not represent a formal pit optimisation, as long term forecast metal prices have been adopted. The pit was generated using the Lerchs & Grossman algorithm as implemented in Maptek Vulcan™ 3D software (Version 8.2 64 bit). The economic value of the blocks was calculated by the multi-element pit optimiser module of Vulcan based on the following financial and technical parameters outlined in Table 14.16.

Table 14.16 Resource Pit Shell Technical & Financial Parameters	
Item	Value
Copper price	US\$3.2 /pound
Gold price	US\$1400 /oz
Copper selling cost	US\$0.15 /pound
Gold selling cost	US\$62.5 /oz
Oxide processing cost	US\$6.24 /t
Mixed/ fresh processing cost	US\$9.25 /t
Copper oxide recovery	0%
Gold oxide recovery	74%
Copper mixed/ fresh recovery	84%
Gold mixed/ fresh recovery	87.80%
Mining dilution	5%
Mining recovery	95%
Mining cost	US\$1.8 down to Z400 m, +US\$0.01 /m further down
Pit slope	40 degrees

A dollar equivalent cut-off of US\$16 and US\$8 was applied to blocks within the overall resource pit shell to define the mineral resource presented within Table 14.14 and Table 14.15. Base case dollar equivalent cut-offs have been chosen based upon assumed processing and General and Administration (G&A) costs of US\$14 /t for sulphide/ mixed materials and US\$6 /t for oxide materials. The assumed mining cost for both mineralised material and waste is US\$2 /t.

14.14 GRADE TONNAGE SENSITIVITY ANALYSIS

The block model has been reported at a range of dollar equivalent cut-offs, as presented in Table 14.17 and Table 14.18. It should be noted that the figures presented in Table 14.17 and Table 14.18 do not constitute a Mineral Resource statement. The figures are only presented to show the sensitivity of the block model estimates to the selection of cut-off grades.

Table 14.17 Grade Tonnage Sensitivity for Fresh Materials							
Classification	Material	Dollar Equivalent Cut-off (US\$)	Tonnage	Grade	Grade	Contained Metal	
				Au (ppm)	Cu (%)	Au (koz)	Cu (klb)
Measured	Fresh	12	182 100 000	0.29	0.21	1700	838 800
		16	147 100 000	0.32	0.23	1500	729 500
		24	51 900 000	0.43	0.28	700	321 600
		36	9 900 000	0.61	0.38	200	83 800
Indicated	Fresh	12	188 500 000	0.28	0.17	1700	688 300
		16	109 700 000	0.33	0.20	1100	479 000
		24	30 600 000	0.48	0.26	500	176 900
		36	6 000 000	0.74	0.31	100	41 400

Table 14.18 Grade Tonnage Sensitivity for Oxide Materials					
Classification	Material	Dollar Equivalent Cut-off (US\$)	Tonnage	Grade	Contained Metal
				Au (ppm)	Au (koz)
Measured	Oxide	4	14 700 000	0.38	180
		6	14 000 000	0.39	170
		8	12 500 000	0.41	160
		10	9 000 000	0.44	130
		12	5 200 000	0.50	80
Indicated	Oxide	4	29 600 000	0.26	250
		6	22 200 000	0.29	210
		8	9 600 000	0.37	110
		10	3 900 000	0.47	60
		12	2 100 000	0.56	40

It is noted that even with higher dollar equivalent cut-offs, the resource remains spatially coherent and relatively close to surface. This presents options with regard to the scale of the potential mining operation and offers a number of opportunities with regard to mine scheduling.

14.15 PREVIOUS MINERAL RESOURCE ESTIMATES

This report presents an updated Mineral Resource for the Project with an effective date of 7 July 2015. The previous Mineral Resource was estimated by Tetra Tech, with an effective date of 27 November 2013. The previous resource estimate was presented in the Prefeasibility Technical Report released on the 22 December 2014. The previous Mineral Resource statement is summarised in Table 14.19 and Table 14.20.

Table 14.19 Summary of Previous Fresh Mineral Resource - Effective Date 27 th November 2013					
Classification	Tonnage (kt)	Grade		Contained Metal	
		Au (g/t)	Cu (%)	Au (koz)	Cu (klb)
Measured	18 440	0.34	0.22	200	88 677
Indicated	218 640	0.33	0.22	2 341	1 036 427
Inferred	19 850	0.36	0.22	226	96 942

Table 14.20 Summary of Previous Oxide Mineral Resource - Effective Date 27 th November 2013			
Classification	Tonnage	Grade	Contained Metal
	(kt)	Au (g/t)	Au (koz)
Measured	1 340	0.38	16
Indicated	34 540	0.33	365
Inferred	6 750	0.25	55

Table 14.21 presents a summary comparison between the 2013 sulphide Resource and the 2015 sulphide Resource, both of which are based upon a US\$16 dollar cut-off.

Table 14.21 Comparison between the 2013 and 2015 Sulphide Resources							
Classification	2013 Resource			2015 Resource			Tonnage Difference (kt)
	Tonnage	Au (ppm)	Cu (%)	Tonnage	Au (ppm)	Cu (%)	
Measured	18 440 000	0.34	0.22	147 100 000	0.31	0.23	128 660 000
Indicated	218 640 000	0.33	0.22	109 700 000	0.32	0.20	-108 940 000
Inferred	19 850 000	0.36	0.22	0	-	-	-19 850 000

Approximately 110 Mt of material has received an upgraded Resource Classification as part of the 2015 update, being upgraded from Indicated to Measured. The copper and gold grades have remained relatively constant. All of the Inferred Resource from the 2013 Resource has now been upgraded to Indicated or Measured.

The increase in the proportion of the resource classified as Indicated and Measured is a result of the infill drilling campaigns completed in 2014 and 2015. The additional drill hole data provides improved confidence in relation to the geological and grade continuity. The additional drilling undertaken during 2014 and 2015 also aided the definition of the lateral extent, by proving the limit of the mineralisation in certain directions.

The oxide Resource tonnage has reduced from approximately 35 Mt to approximately 22 Mt, at similar equivalent cut-offs. The overall reduction in oxide tonnage is due to the 2014 and 2015 drilling campaigns providing additional data which has allowed the base of oxide to be better defined. In addition, the lower metal prices adopted for the dollar equivalent calculation will have omitted some blocks that were previously included. The improved grade interpolation within the mixed zone with respect to copper has also allowed some additional blocks within the mixed zone to be grouped with the fresh material for Resource reporting.

15. MINERAL RESERVE ESTIMATES

15.1 STATEMENT OF RESERVES

The following quantities have been estimated to CIM standards. These have been converted from measured and indicated resources with the appropriate level of engineering work for this level of study. Resources are reported in Section 0 of this report.

Table 15.1 Diluted and Recoverable Reserves				
Description	Units	Proven	Probable	Total
Sulphide ore	Mt	112.6	85.5	198.1
Waste	Mt	-	-	199.9
Total	Mt			398
Strip ratio	t : t	-	-	1.01
Gold grade	g/t	0.32	0.30	0.32
Gold content	Moz	1.17	0.84	2.01
Copper grade	%	0.22	0.19	0.21
Copper content	Mlb	543.9	355.0	898.9

Note: There may be minor differences in the totals due to rounding of figures.

Mineral reserves are reported to a cut-off grade of 0.22 g/t Au and 0.17% Cu based on a gold price of US\$1 200 /oz less US\$59.52 /oz selling costs and copper of US\$2.50 /lb less US\$0.282 /lb selling costs.

The reserve estimate assumes the construction of a process plant with 10 Mt/a capacity.

The mineral reserve estimate (Table 15.1) is classified in accordance with CIM Definition Standards on Mineral Resources and Mineral Reserves incorporated by reference into National Instrument 43-101 "Standards of Disclosure for Mineral Projects".

Oxide ore is not included in Table 15.1 and is considered waste for the purposes of pit optimisation. However, it does have good grade on the contacts with the sulphide ore which enhances the sulphide ore grade in places when diluted. The waste, where it contacts with the sulphide ore, also has some grade as does the sulphide ore outside the pit limits, which reduces the sulphide ore grade but to a lesser extent than it would if it had zero grade. There is no viable copper content in the oxide ore. The combination of these effects means that although more tonnage is added the grades are not affected to the same degree.

However, although the oxide is treated as waste for optimisation, approximately 4.5 Mt of oxide ore with an average gold grade of 0.5 g/t will be stockpiled adjacent to the crusher and run of mine (ROM) pad. While it is envisaged that this material will be processed at the end of the LOM it is currently not included in the economic analysis and hence does not contribute to the economics of the project.

The above quantities allow for dilution and mining recovery (Table 15.2). The method of estimation for this is discussed below.

Table 15.2 Dilution estimation			
Description	Mt	Au (g/t)	Cu (%)
Undiluted ore	197.7		
Diluted ore	206.4		
Dilution	4.4%	1.9%	0.9
Recovery	96%		
Recovered ore	198.1		

To estimate the dilution the following procedure was adopted;

The orebody solid was expanded by 2.5 m all round using adilution module in Geovia Surpac™ v.6.6.2. The 2.5 m criteria was based on the minimum block size on the contacts.

The results of this expansion are then used as the basis for estimating the grade dilution for the reserve quantity, which is estimated more accurately using the block model attributes and the results of the optimisation.

The rationale behind this approach is that it is only the outermost blocks that will be diluted with the surrounding rock, which also has grade. The oxide ore only has gold grades and these are higher than the sulphide ore grades in places. The waste rock and sulphide ore in the pit walls have a lower grade. The combination of this enhancement and reduction in grade gives an overall dilution for the gold.

The oxide ore does not contain copper so the dilution factor for copper is different to that of the gold.

15.2 PIT OPTIMISATION

The open pit has been optimised using industry standard methods based on the criteria that are discussed in the sections below.

15.2.1 Method

The method of optimisation uses the Lerchs-Grossman algorithm in the Geovia Whittle-4D™ v.4.6 Software. It is a two part procedure based on the block model and using mining, processing and G&A costs, selling prices and costs, pit slopes, process and mining recoveries, mining dilution, financial information such as discount rates and Capex values and other criteria. These are input at different stages of the optimisation.

In the first part, the mining, processing and G&A costs, selling price and cost, pit slopes, process and mining recoveries and mining dilution are input in the form of rates, percentages and angles. A series of economic pitshells are generated by the software, based on varying revenue factors (RF), typically from 0.3 to 2, which represent different commodity prices.

Waste and mineral quantities, strip ratios, grades and processing cut-offs are produced for each pitshell. The pitshells can then be used as a template for design purposes.

The pitshells with the lower RFs target the high grade (HG), as they represent the pits that could be mined economically at lower commodity prices, conversely the pitshells with higher RFs allow low grade (LG) to be mined economically.

The second part of the optimisation requires the setting up of an operational scenario that simulates a practical mining situation with a starter pit and pushbacks to keep the stripping ratio reasonably constant to enable equipment selection. Production and financial information is entered at this time. This procedure is iterative, as the input of this information is undertaken in stages based on the output of each iteration. The information that is input at this stage is the discount rate, processing throughput, mining production limit, starter pit, pushbacks, benching strategy and other criteria.

The software generates a pit by pit graph that shows a series of stacked bars representing the mineral and waste tonnages against the pit numbers, based on the pitshells generated in the first stage described above. It is possible to identify change points from this graph that show a marked step up in quantities from one pit to the next. These change points represent the points at which a starter pit and pushbacks can be identified.

The pit by pit graph also shows three lines that represent the best, specified and worst cases. The purpose of these lines is to show how the discounted value of the pit changes with increasing pitshell size and different scheduling strategies.

The best case assumes that each pitshell is worked successively to give the best theoretical value, even though it may be impractical to do so. The worst case assumes that the pit is worked in benches from top to bottom to give the worst theoretical value because the upper benches have a very high strip ratio of waste to mineral. The specified case assumes that the pit is mined in a practical way using a starter pit and pushbacks to maintain a reasonably even strip ratio. The results depend on which of several algorithms are chosen to schedule the pit, to give a compromised value that lies somewhere in between the best and worst cases.

Details of the optimisation procedure are given below.

15.2.2 Criteria, Parameters and Inputs

Table 15.3 shows the input values used for the initial run for gold and copper. Only sulphide ore has been optimised, the oxide ore has been treated as waste.

Table 15.3 Whittle Input Values		
Description	Unit	Values
<u>Gold</u>		
Slopes	Degrees	45&60
Selling price (Au)	US\$ /oz	1 200
Selling cost (Au)	US\$ /oz	59.52
Mining Opex (mined)	US\$ /t	1.67
Stockpile re-handling Opex	US\$ /t ore	0.5

Table 15.3 Whittle Input Values		
Description	Unit	Values
Processing Opex	US\$ /t ore	6
G&A Opex	US\$ /t ore	1
Rehab	US\$ /t ore	0.25
Processing recovery (Au)	%	88%
Stockpile recovery	%	100%
Mining recovery	%	95%
Mining dilution	%	5%
Default SG (waste)		2.45
Processing method limit	Mt/a mineral	10
Mining limit	Mt/a mined	50
Discount rate	%	10
<u>Copper</u>		
Slopes	Degrees	45&60
Selling price (Cu)	US\$ /lb	2.5
Selling cost (Cu)	US\$ /lb	0.282
Mining Opex (mined)	US\$ /t	1.67
Stockpile re-handling Opex	US\$ /t ore	0.5
Processing Opex	US\$ /t ore	6
G&A Opex	US\$ /t ore	1
Rehab	US\$ /t ore	0.25
Processing recovery (Cu)	%	84%
Stockpile recovery	%	100%
Mining recovery	%	95%
Mining dilution	%	5%
Default SG (waste)		2.45
Processing method limit	Mt/a mineral	10
Mining limit	Mt/a mined	35
Discount rate	%	10

The dilution and mining recovery factors are initial estimates for the purposes of optimisation. The final figures are discussed in the statement of reserves (Section 15.1).

15.2.3 Selling Price and Off Site Costs

Table 15.4 shows the calculation for the selling costs based on known and assumed data.

Table 15.4 Calculation of Selling Costs			
Description	Units	Factor	Values
<u>Gold</u>			
Refining	US\$ /oz	0.08%	0.96
Payable deduction	US\$ /oz	1%	12
Insurance & freight	US\$ /oz	0.4%	4.8
Total	US\$ /oz		17.76
Royalty	US\$ /oz	2%	24
Total	US\$ /oz		59.52
<u>Copper</u>			
Treatment	US\$ /dmt concentrate		75
	US\$ /lb Cu metal	24%	0.008
Refining	US\$ /lb Cu metal		0.075
Payable deduction	US\$ /lb Cu metal	4.17%	0.104
Insurance	US\$ /lb Cu metal	0.1%	0.0025
Freight	US\$ /wmt concentrate		45
	US\$ /dmt concentrate	10%	40.5
	US\$ /lb Cu metal	24%	0.004
Total	US\$ /lb Cu metal		0.194
Royalty	US\$ /lb Cu metal	3.5%	0.088
Total	US\$ /lb Cu metal		0.282

15.2.4 Results

15.2.4.1 Cut-off Grade

The unconstrained cut-off grade calculated by Geovia Whittle-4D™ v.4.6 Software is 0.22 g/t Au and 0.17% Cu. This is the grade that determines whether the ore is processed or sent to the waste dump (or LG stockpile). It is sometimes called the pit rim cut-off, as it is at this point that the decision is made.

The cut-off grade calculated by Geovia Whittle-4D™ v.4.6 Software excludes the mining cost, because a block may be economical to mine, even if it is not economical to process, on the basis that the blocks below or adjacent may be economical to both mine and process.

15.2.4.2 Waste, Ore, Strip Ratio and Grade

Table 15.5 shows the standard Geovia Whittle-4D™ v.4.6 output for RFs 0.3 to 2 for 80 fixed factors. The RFs are multiples of the selling price.

Table 15.5
Standard Whittle Output

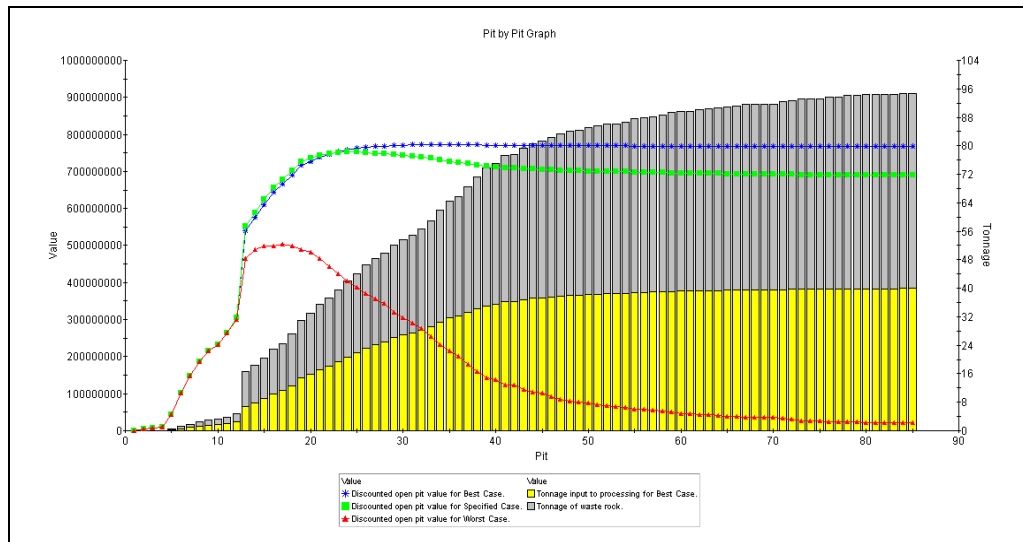
Pitshell	Revenue Factor	Total Tonnes	Ore Tonnes	Waste Tonnes	Strip Ratio	Au Grade (g/t)	Cu Grade (%)
1	0.32	27 854	10 500	17 354	1.65	0.575	0.65
2	0.34	283 380	126 503	156 877	1.24	0.503	0.58
3	0.36	540 071	231 921	308 150	1.33	0.497	0.58
4	0.38	748 561	308 135	440 426	1.43	0.49	0.56
5	0.40	4 522 103	2 085 932	2 436 171	1.17	0.445	0.44
6	0.42	11 656 158	5 394 919	6 261 239	1.16	0.469	0.38
7	0.44	17 219 246	8 551 162	8 668 084	1.01	0.461	0.34
8	0.46	23 005 718	11 462 101	11 543 617	1.01	0.456	0.33
9	0.48	27 973 277	14 064 055	13 909 222	0.99	0.447	0.31
10	0.50	30 639 336	15 614 096	15 025 240	0.96	0.439	0.31
11	0.52	37 285 974	19 119 682	18 166 292	0.95	0.425	0.30
12	0.54	46 765 900	23 828 962	22 936 938	0.96	0.411	0.29
13	0.56	160 944 864	61 593 330	99 351 534	1.61	0.409	0.26
14	0.58	177 452 948	70 631 252	106 821 696	1.51	0.397	0.25
15	0.60	195 812 119	80 784 648	115 027 471	1.42	0.385	0.25
16	0.62	219 140 663	93 304 930	125 835 733	1.35	0.373	0.24
17	0.64	235 918 016	103 356 886	132 561 130	1.28	0.363	0.24
18	0.66	260 767 502	116 263 842	144 503 660	1.24	0.354	0.23
19	0.68	297 554 882	135 210 499	162 344 383	1.2	0.342	0.22
20	0.70	316 335 832	144 612 928	171 722 904	1.19	0.337	0.22
21	0.72	340 228 438	157 119 719	183 108 719	1.17	0.33	0.21
22	0.74	359 177 069	167 177 538	191 999 531	1.15	0.325	0.21
23	0.76	379 648 625	178 531 757	201 116 868	1.13	0.319	0.21
24	0.78	403 864 708	191 041 630	212 823 078	1.11	0.314	0.20
25	0.80	424 780 516	202 795 935	221 984 581	1.09	0.308	0.20
26	0.82	447 864 217	215 219 094	232 645 123	1.08	0.303	0.20
27	0.84	465 992 760	225 468 403	240 524 357	1.07	0.299	0.19
28	0.86	479 233 160	232 826 400	246 406 760	1.06	0.296	0.19
29	0.88	501 985 124	245 085 185	256 899 939	1.05	0.291	0.19
30	0.90	516 852 627	253 646 980	263 205 647	1.04	0.288	0.19
31	0.92	528 194 952	260 462 937	267 732 015	1.03	0.285	0.18
32	0.94	544 355 681	268 616 420	275 739 261	1.03	0.282	0.18
33	0.96	567 537 164	280 189 062	287 348 102	1.03	0.278	0.18
34	0.98	594 967 698	292 714 440	302 253 258	1.03	0.274	0.18
35	1.00	619 978 421	304 795 573	315 182 848	1.03	0.27	0.18
36	1.02	633 163 983	310 687 231	322 476 752	1.04	0.268	0.17
37	1.04	659 329 278	321 213 497	338 115 781	1.05	0.265	0.17
38	1.06	685 738 895	331 399 991	354 338 904	1.07	0.262	0.17
39	1.08	708 335 511	339 992 536	368 342 975	1.08	0.259	0.17
40	1.10	721 656 650	345 140 077	376 516 573	1.09	0.258	0.17
41	1.12	742 571 101	352 529 530	390 041 571	1.11	0.256	0.17
42	1.14	744 957 029	353 873 159	391 083 870	1.11	0.256	0.17
43	1.16	763 177 573	359 480 923	403 696 650	1.12	0.255	0.17
44	1.18	775 358 981	363 188 106	412 170 875	1.13	0.254	0.17

Table 15.5
Standard Whittle Output

Pitshell	Revenue Factor	Total Tonnes	Ore Tonnes	Waste Tonnes	Strip Ratio	Au Grade (g/t)	Cu Grade (%)
45	1.20	781 580 957	365 196 026	416 384 931	1.14	0.253	0.17
46	1.22	791 618 821	367 916 083	423 702 738	1.15	0.253	0.17
47	1.24	800 733 139	370 526 946	430 206 193	1.16	0.252	0.17
48	1.26	807 865 640	372 691 892	435 173 748	1.17	0.252	0.17
49	1.28	811 529 933	373 859 819	437 670 114	1.17	0.251	0.17
50	1.30	818 632 549	375 846 455	442 786 094	1.18	0.251	0.17
51	1.32	823 131 860	376 791 400	446 340 460	1.18	0.251	0.16
52	1.34	827 500 024	377 936 471	449 563 553	1.19	0.25	0.16
53	1.36	827 916 652	378 178 819	449 737 833	1.19	0.25	0.16
54	1.38	832 986 039	379 628 444	453 357 595	1.19	0.25	0.16
55	1.40	843 225 145	381 979 736	461 245 409	1.21	0.249	0.16
56	1.42	845 226 680	382 437 604	462 789 076	1.21	0.249	0.16
57	1.44	848 002 604	383 124 904	464 877 700	1.21	0.249	0.16
58	1.46	853 284 184	384 314 094	468 970 090	1.22	0.249	0.16
59	1.48	858 451 747	385 402 518	473 049 229	1.23	0.249	0.16
60	1.50	861 701 654	386 009 654	475 692 000	1.23	0.248	0.16
61	1.52	862 198 714	386 207 110	475 991 604	1.23	0.248	0.16
62	1.54	865 982 361	386 921 276	479 061 085	1.24	0.248	0.16
63	1.56	869 215 010	387 549 193	481 665 817	1.24	0.248	0.16
64	1.58	872 363 137	388 254 166	484 108 971	1.25	0.248	0.16
65	1.60	874 943 724	388 741 240	486 202 484	1.25	0.248	0.16
66	1.62	877 526 818	389 202 626	488 324 192	1.25	0.248	0.16
67	1.64	880 307 272	389 834 843	490 472 429	1.26	0.248	0.16
68	1.66	881 722 036	390 082 624	491 639 412	1.26	0.247	0.16
69	1.68	881 742 074	390 127 690	491 614 384	1.26	0.247	0.16
70	1.70	882 231 997	390 217 185	492 014 812	1.26	0.247	0.16
71	1.72	889 070 619	391 293 313	497 777 306	1.27	0.247	0.16
72	1.74	891 657 721	391 648 511	500 009 210	1.28	0.247	0.16
73	1.76	896 671 504	392 354 450	504 317 054	1.29	0.247	0.16
74	1.78	896 851 307	392 385 940	504 465 367	1.29	0.247	0.16
75	1.80	897 081 580	392 438 561	504 643 019	1.29	0.247	0.16
76	1.82	901 362 646	393 133 664	508 228 982	1.29	0.247	0.16
77	1.84	901 686 547	393 194 455	508 492 092	1.29	0.247	0.16
78	1.86	904 542 227	393 519 696	511 022 531	1.3	0.247	0.16
79	1.88	904 972 742	393 593 410	511 379 332	1.3	0.247	0.16
80	1.90	907 213 998	393 854 846	513 359 152	1.3	0.247	0.16
81	1.92	908 183 659	394 010 668	514 172 991	1.3	0.247	0.16
82	1.94	908 809 703	394 108 701	514 701 002	1.31	0.247	0.16
83	1.96	909 089 349	394 146 540	514 942 809	1.31	0.247	0.16
84	1.98	909 329 728	394 185 075	515 144 653	1.31	0.247	0.16
85	2.00	909 509 320	394 228 437	515 280 883	1.31	0.247	0.16

RF 1 is the pit shell for the base selling price. It shows that the ore tonnage would be approximately 304 Mt. However, this assumes that the pit can be mined pit shell by pit shell. It is not normally possible to do this and it is conventional practice to set up an operational scenario that aims to simulate a practical mining situation. This usually leads to a reduction in the ore tonnage but an increase in the overall grades. A pit by pit graph is generated, the results for this are shown in Figure 15.1.

Figure 15.1
Pit by Pit Graph for Waste and Ore for RF 0.3 to 2



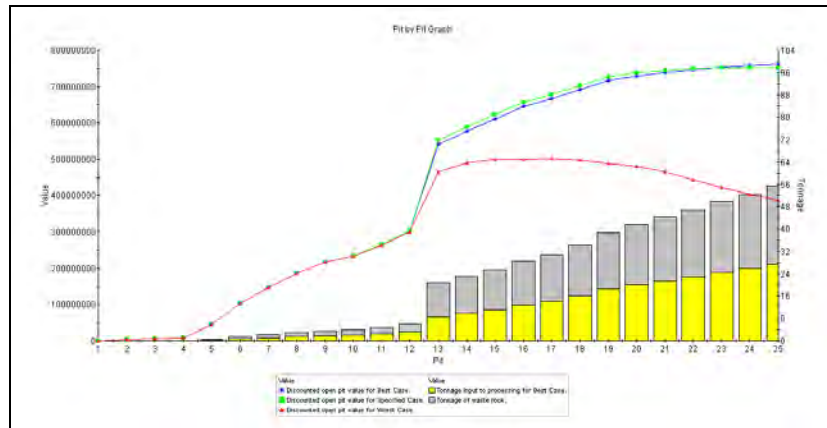
The three scenarios depicted in Figure 15.1 are for best (blue), specified (green) and worst case (red). The best case assumes that each pitshell is worked successively to give the best theoretical value, even though it may be impractical to do so. The worst case assumes that the pit is worked in benches from top to bottom to give the worst theoretical value because the upper benches have a very high strip ratio of waste to ore. The specified case assumes that the pit is mined in a practical way using pushbacks to maintain a reasonably even strip ratio, according to the Milawa Balanced algorithm, to give a most likely value.

15.2.5 Pitshell Selection

Pitshell selection is based on the specified case. This is derived from the basic input criteria, production limits and discount rate quoted in Table 15.3.

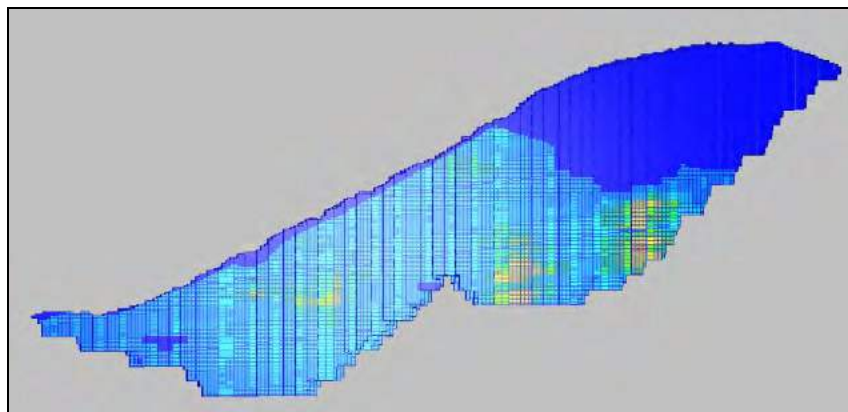
Inspection of the pit by pit graph in Figure 15.1 indicates that pit shell 25 would be the optimum pit shell for the specified case. This is supported by the output table (not shown). To enable a more precise inspection of the change points and likely pushbacks another run was performed with RFs from 0.3 to 0.8. The results for this are shown in Figure 15.2.

Figure 15.2
Pit by Pit Graph for Waste and Ore for RF 0.3 to 0.8



The pushback chooser enables the optimum starter pit and primary pushbacks to be selected. In this case pit shells 11, 13 and 17 were selected. Pit shell 11 is the starter pit and pit shells 13 and 17 are further pushbacks. It is evident from Figure 15.2 that there is a marked change at pit shell 13. This comes about as a consequence of a concentration of higher grade ore towards the bottom of the pit shell that makes the mining of the considerable quantity of waste above it economic. This is illustrated in Figure 15.3.

Figure 15.3
Section through block model showing blocks of higher grade in pitshell 13



Dark blue blocks = waste. Light blue blocks = lower grade ore.

Yellow, orange and red blocks = higher grade ore.

It is also evident that there is a considerable quantity of waste in the upper sections of the pit. There is also a strip of waste above the fresh ore, much of which is actually oxide ore that has been treated as waste for optimisation purposes. There is also some waste that is fresh ore below the cut-off grades.

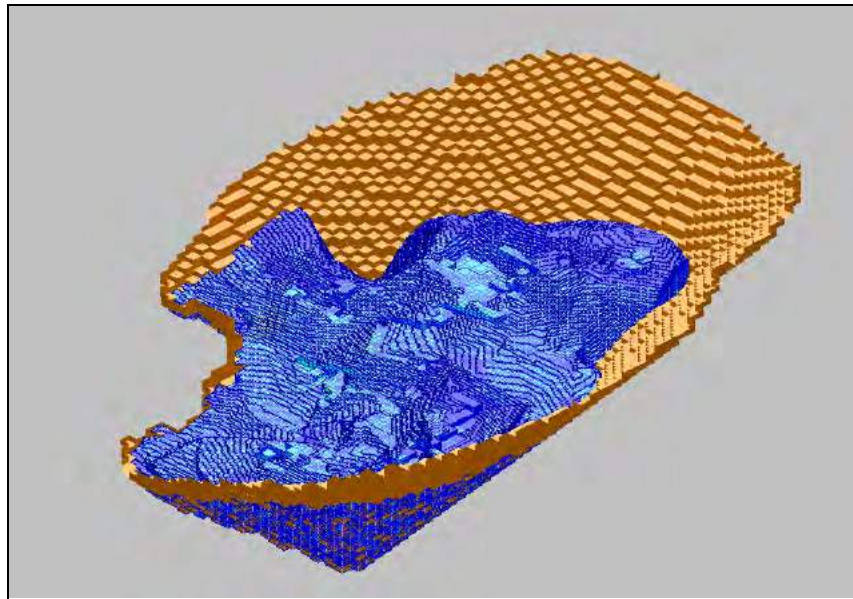
15.2.5.1 Pitshell Dimensions

The pit is a combination of open pit and hillside quarry type mining. The surface dimensions of the final pitshell are approximately 1 250 m by 1 100 m, a roughly circular shape. The pitshell bottom is at an elevation of 200 m and the highest pit rim elevation on the east side is 830 m, resulting in a highwall of approximately 630 m. The lowest pit rim elevation on the west side is 470 m.

15.2.5.2 Pitshell Illustration

Figure 15.4 shows a roughly circular final pitshell with a cut away for a crusher and ROM pad (at bottom left hand side of image).

Figure 15.4
Final pit shell and fresh ore



15.3 DESIGN

15.3.1 Design Criteria

Having established that pitshell 25 produces the optimum result, it is necessary to design a pit with ramps, batters and berms. It was established that in order to maintain approximately 200 Mt of fresh ore and to accommodate the crusher at an elevation of 520 m, an overall slope of 45° is required for the majority of the pit and 60° below the crusher. To achieve this it was established that a switchback ramp design would be required and that it should exit the pit close to the lower pit rim elevation in order to access the ROM pad. It also needed to be contained within a narrow arc to the east of the crusher to keep the 60° portion of the slope to a minimum.

From analysis of the pitshell it was established that a pit base at a level of 240 m would satisfy the minimum mining width of 100 m. This compares with the pitshell pit base of 200 m. The required ramp width was calculated to be 23 m for 90 t trucks. To satisfy these criteria it was calculated that a batter height of 10 m at an angle of 75° and berm widths that alternate between 5 m and 15 m would be required.

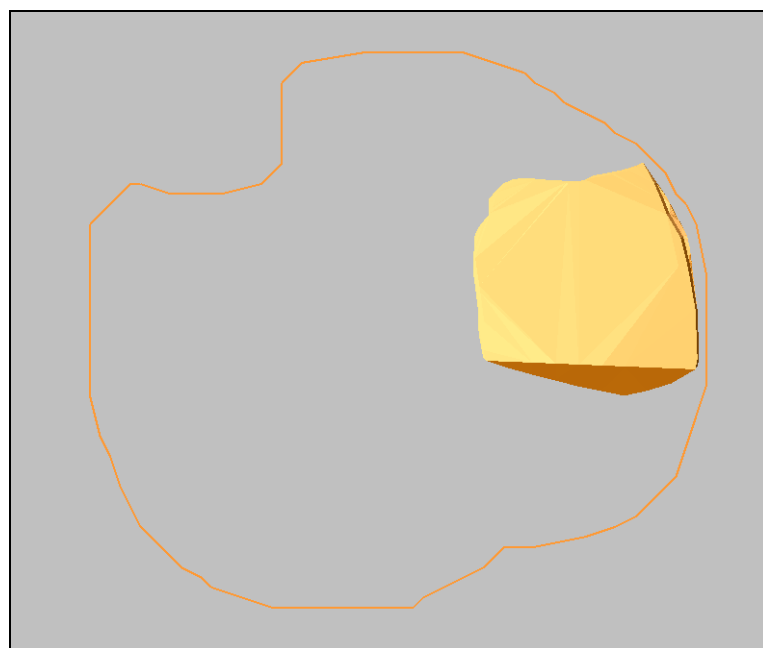
The dimensions of the shovel and rate of vertical advance were also taken into consideration.

15.3.2 Pit Designs

Three full designs based on the pit shells were undertaken in Geovia Surpac™ v.6.6.2., a starter pit, a primary pushback and the final pit. A simple pre-strip design was also done. Pit shells were used for the

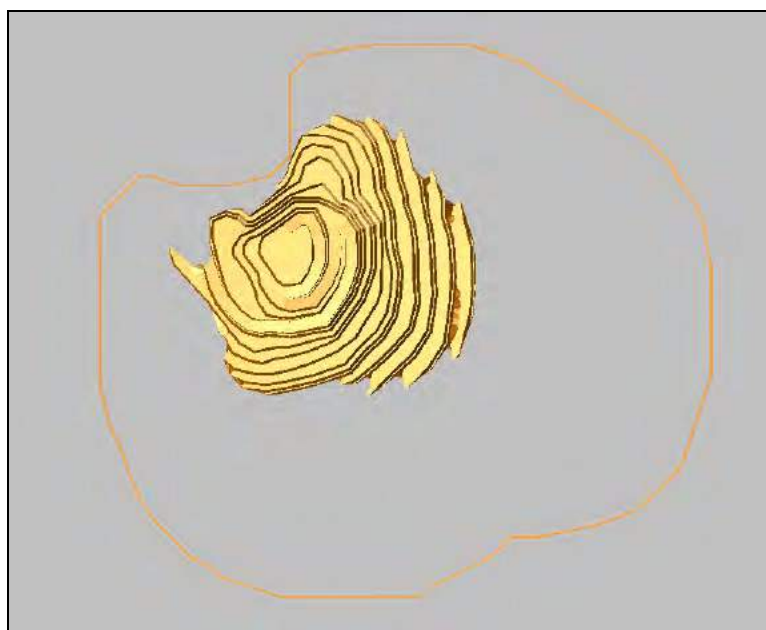
intermediate pushbacks, all of which were used to guide the scheduling process. Figure 15.5, Figure 15.6, Figure 15.7 and Figure 15.8 show the various pit designs.

Figure 15.5
Pre-strip pit design (365 mx420 m, base at 800 m elevation.)



Orange line = final pit rim

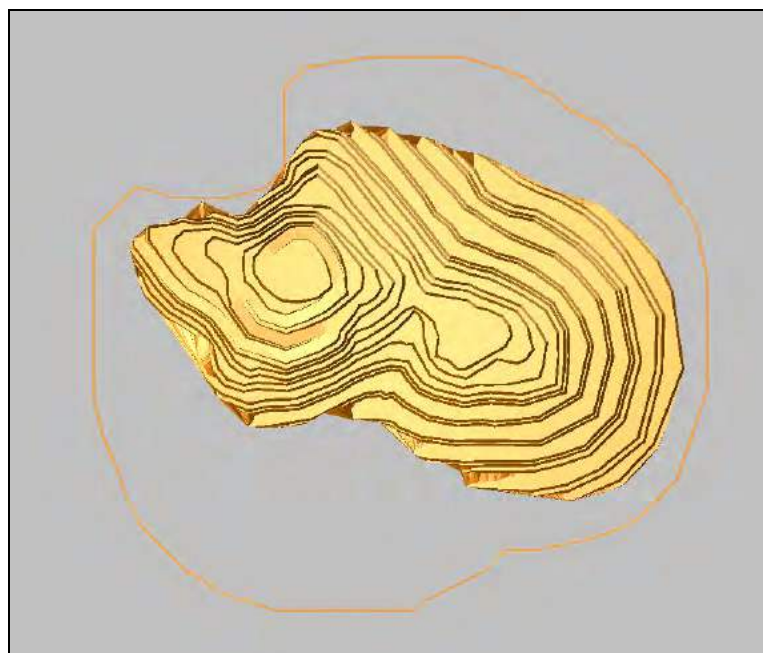
Figure 15.6
Starter Pit Design Based on Pit-Shell 11 (500 m x 530 m, 420 m to 780 m elevation)



Orange line = final pit rim

Figure 15.7

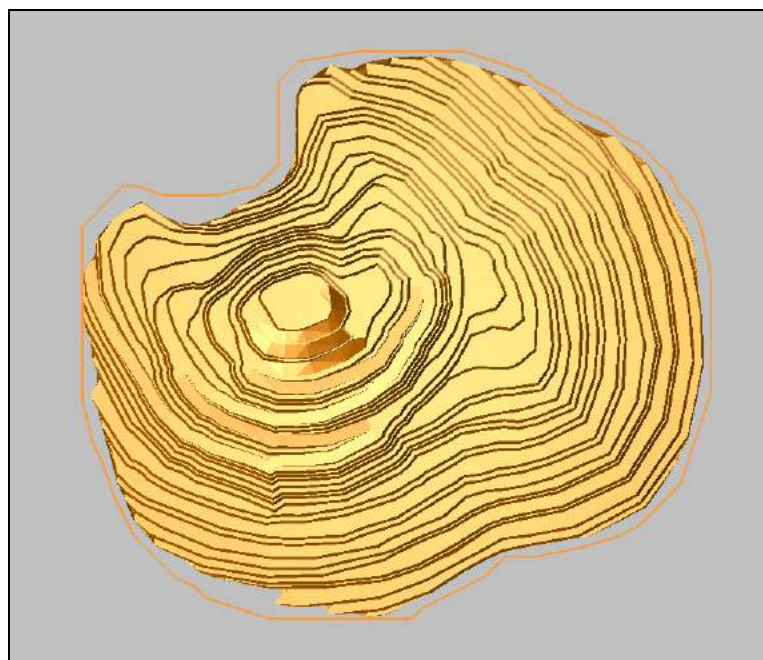
Primary Pushback Pit Design Based on Pit-Shell 13 (1 120 m x 560 m, 390 m to 830 m elevation)



Orange line = final pit rim

Figure 15.8

Final Pit Design Based on Pit-Shell 25 (1 200 m x 1 240 m, 240 m to 820 m elevation)



Orange line = final pit rim

15.3.3 Final Pit Design Quantities

The final pit design quantities are shown in Table 15.1. These are for proven and probable categories. This is quantified separately in accordance to CIM standards.

The design quantities are necessarily different from the pitshell quantities due to the ramps, pit base, batter angle and berms but should normally be within 5% to 10%. The total design quantities for the final pit are within 6% of pitshell 25.

16. MINING METHODS

16.1 INTRODUCTION

16.1.1 Background

Ilovica is a combination of open pit and hillside quarry type mining, with an elevation range of 830 m to 240 m, the split between the two occurring at 480 m. The open pit portion will require an internal switchback ramp that starts at 240 m and exits at 515 m. The hillside portion requires a system of internal ramps, working bench haul routes and temporary haul roads that connect with an external system of haul roads that follow the contours and switchbacks that meet the pit rim at intervals.

A crusher and ROM pad are located on the western side of the open pit at an elevation of 520 m. Access to this in the early years is via haul roads running along the topography. Later, an oxide stockpile adjacent to the ROM pad will allow access as the open pit is extended. A conveyor runs from the crusher to the processing plant at the top of the hill.

The mining infrastructure is located on the downhill side of the open pit with an access haul road that connects it with the crusher, ROM pad and principal haul roads.

The site layout is illustrated in Figure 16.1.

16.1.2 Site Access

Site access is by means of a paved road, which will be improved once the project is underway; this is described in more detail in Section 18.1.6.

16.1.3 Topography

The topography of the area is very hilly with many small streams converging at various critical points. This requires careful planning of mining infrastructure, stockpiling, haul roads, drainage and other items, as there are considerable space restrictions and changes of elevation. The changes in elevation mean that the haul roads have to be carefully considered, multiple switchbacks are required in places to enable the gradients to be maintained.

16.1.4 Method

The proposed method of mining is by conventional open pit methods using drilling and blasting, loading shovels and hauling with rigid dump trucks.

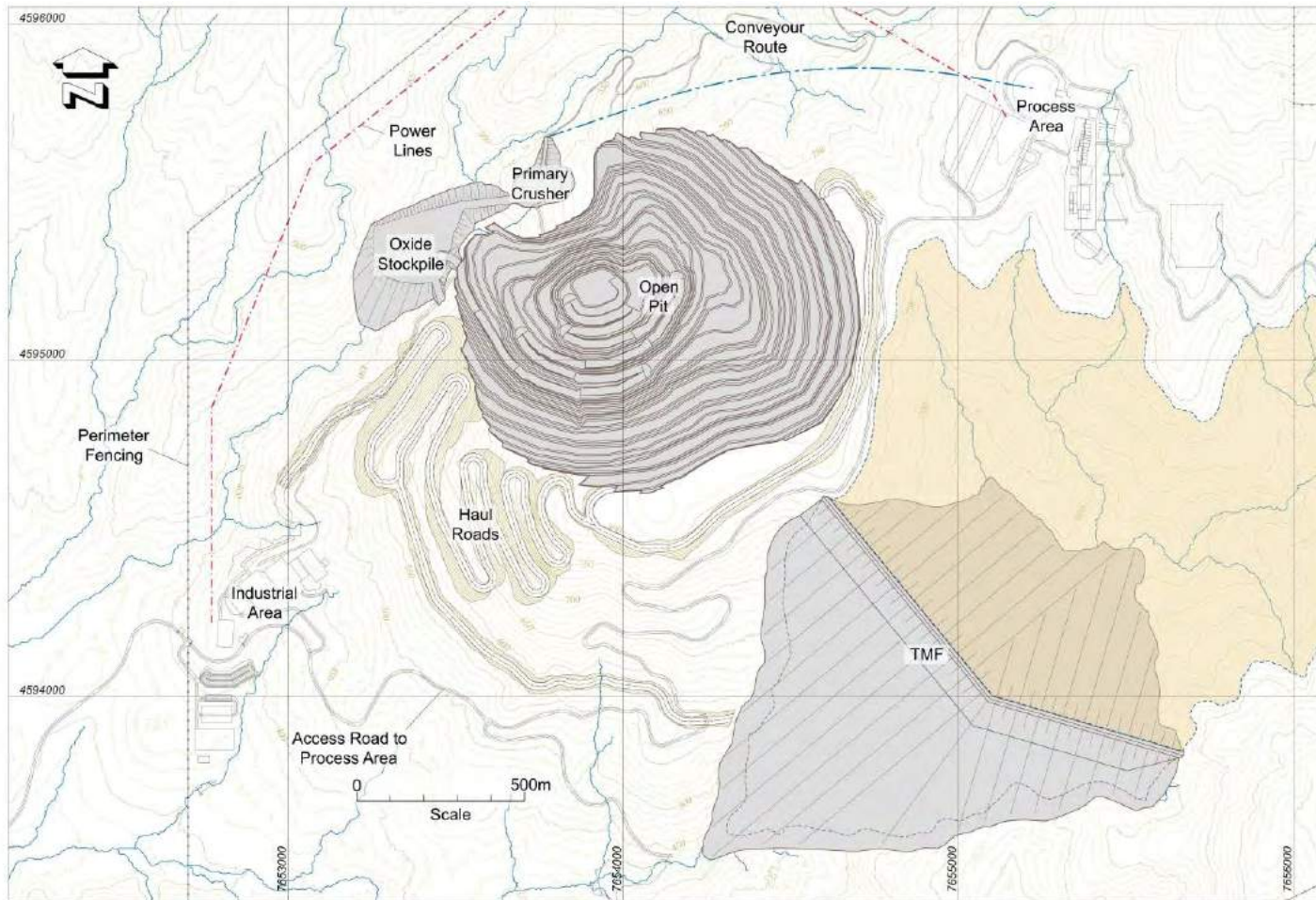
16.1.5 Contractor vs. Owner Operated

Currently it is envisaged that mining will be undertaken by owner operated equipment and labour. The practicality of involving a mining contractor will be investigated in more detail in the next phase of engineering design.

16.1.6 Trade-Off Studies

Two trade-off studies were considered for the mining operation. These were the method of estimation of the oxide ore and the location of the crusher and ROM pad.

Figure 16.1
Site Layout



16.2 GEOTECHNICAL INVESTIGATION

16.2.1 Geotechnical Programme

The geotechnical investigation programme, consisting of drilling, logging and sampling, was conducted between March and October 2015. Eight diamond oriented boreholes (DH15-74, DH15-77, DH15-81, DH15-89, DH15-92, DH15-98, DH15-100, and DH15-107) were drilled, with a total meterage of approximately 2 000 m.

The geotechnical boreholes were inclined so that geomechanical and structural information was collected. Euromax Resources geologists supervised the geotechnical drill program, completed downhole surveys, collar location surveys and supervised the use of the core orientation tool at the drill rig.

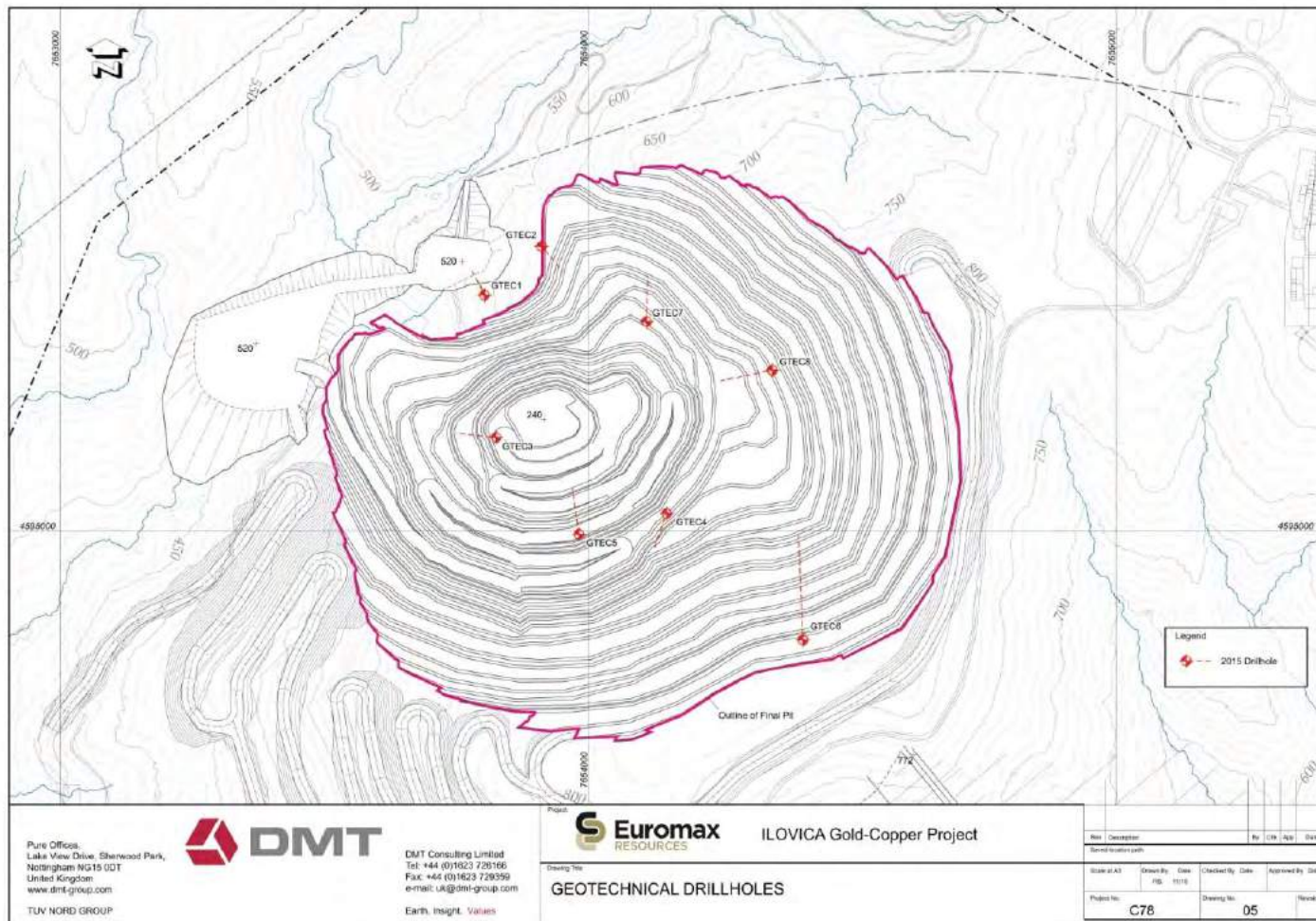
The locations of the 2015 geotechnical boreholes are shown in Figure 16.2. Representative core samples were collected for laboratory testing for determination of rock strength and other geotechnical characteristics.

The geotechnical drilling was conducted by Geops Bolkan Drilling Services Ltd using an Atlas Copco/RIG # CRISTENSEN CS-14 with wire line equipment and triple tube core barrel (HQ3 61.1 mm core diameter).

The collar data for each of the boreholes is summarised in Table 16.1.

Table 16.1							
Collar Data for each Geotechnical Borehole							
hole_id	hole_path	max_depth (m)	Easting (x)	Northing (y)	Elevation (z)	Inclination (degrees)	Azimuth
IC 1575	curved	150.2	7653803	4595450	550	-70	335
IC 1577	curved	194.0	7653908	4595541	576	-70	135
IC 1581	curved	222.6	7653824	4595175	546	-70	270
IC1589	curved	194.3	7654155	4595033	750	-70	195
ICI 1592	curved	275.8	7654008	4594989	668	-70	355
IC1598	curved	350.1	7654404	4594792	811	-55	350
IC 15100	curved	313.0	7654135	4595397	702	-70	355
IC 15107	curved	466.0	7654353	4595302	832	-70	250

Figure 16.2
Location of Geotechnical Boreholes drilled in Ilovica project in 2015 (coordinates are in local system)



16.2.1.1 Geotechnical Logging

Euromax Resources geologists geotechnically logged the drill core from the eight boreholes, according to logging procedures established and audited by DMT.

The information recorded in the geotechnical core logs included:

- percent total recovery,
- rock strength,
- weathering,
- RQD (values were measured at the location of the borehole, so as to discount to mechanical fractures induced during transportation of the core)
- the number of natural and mechanical fractures,
- Characterisation and orientation of structural discontinuities. The descriptions follow those set out in the ISRM guide on rock characterisation (Brown 1980).

Parameters for characterisation of joints and discontinuities were collected based on two widely used empirical rock classification systems. The NGI Q-System (after Barton et. al. 1974) and the rock mass rating (RMR) system (after Bieniawski 1989).

The downhole surveys were done with a BZM-R/JKH-R magnetic single shot instrument by the drillers and Euromax Resources after each borehole was completed. Euromax Resources staff surveyed the borehole collars at the completion of the program.

Drill core from the geotechnical boreholes were oriented using the EzyMark system tool.

The alpha and beta angles are measured and recorded for the dominant and subdominant joint sets for each core run.

Oriented core data was processed using Rocscience DIPS™ software. Each alpha and beta angle pair, in conjunction with downhole survey data, was used to determine a true dip and dip direction for dominant and subdominant joint surfaces observed in core logging.

16.2.1.2 Laboratory Testing

During core logging, samples of the core were collected by the Euromax Resources geologists, using protocols agreed with DMT, to provide specimens for geotechnical laboratory and in-situ testing.

Each sample was sealed and safely stored at the time of collection. Selected samples were geotechnically tested at the rock mechanics laboratory, the Faculty of Civil Engineering of the Sts. Cyril and Methodius University, located in Skopje in accordance with ISRM methodology (Brown 1980) or generally accepted geotechnical laboratory procedures and specifications. The testing consisted of:

- Unconfined compressive strength (UCS) (50 Tests) including Young's modulus and Poisson ratio
- Brazilian strength test (BST) (70 Tests)
- Direct shear test (DST) for natural joints (40 Tests)
- Porosity and specific gravity (50 Tests).

Apart from the laboratory tests in-situ point load test (PLT) tests were carried out on the drilled core. More than 1500 PLT tests were carried out approximately one PLT per core run. UCS samples were collected adjacent to PLT samples to correlate UCS lab tests back to field PLT.

16.2.1.3 Field and Laboratory Test Results

Laboratory testing was conducted to determine strength characteristics of the in situ materials. The overall laboratory program consisted of PLT, UCS, BST and DST tests conducted on rock core samples selected to represent the range of rock conditions observed in the 2015 boreholes and expected throughout the pit area.

The average geotechnical test values for each rock type encountered during the 2015 geotechnical investigations are presented in the Table 16.2 below.

Table 16.2 Average Geotechnical Test Values for each Lithology								
Rock Type	Phase	UCS Intact (MPa)	Unit Weight (kN/m ³)	Tensile strength (MPa)	Young's Modulus (MPa)	Poisson Ratio	Discontinuity Friction Angle	Discontinuity Cohesion (MPa)
Granodiorite	Oxidised	20.5	23	0.96	25,314	0.215	28	0.199
Granodiorite	Unoxidised	80.19	23	0.97	26,904	0.185	28	0.647
Dacite	Oxidised	21.3	20	0.35	8,731	0.208	34	0.256
Dacite	Unoxidised	40.3	22	0.56	13,994	0.265	30	0.558
Granite	Oxidised	8.5	20	0.33	-	-	38	0.23
Granite	Unoxidised	44.8	22	0.93	12,669	0.24	29	1

16.2.2 Rock Mass Classification

Rock mass classification systems to estimate rock mass properties (rock quality) constitute an integral part of the assessment of slope angles for open pits. These systems are used to group areas of similar geomechanical characteristics, based on ratings of three principal properties: the intact rock strength, the frictional properties of the discontinuities, and the geometry of intact blocks of rock defined by the discontinuities.

Using the 2015 geotechnical data, DMT assessed the quality of the rock mass of the pit areas using two commonly applied systems, these being the RMR system (Bieniawski 1989) and the Norwegian Geotechnical Institute's NGI Q-System (after Barton et al. 1974) and the Hoek-Brown geological strength index (GSI) rock mass classification system (Marinos and Hoek 2000).

Table 16.3 provides comparison of RMR, Q and GSI ratings for each rock formation encountered during the 2015 geotechnical investigation.

Table 16.3 Rock Mass Classification Values for each Lithology				
Rock Type	Phase	GSI	RMR	Q
Granodiorite	Oxidised	50	53	6
Granodiorite	Unoxidised	44	53	6
Dacite	Oxidised	43	46	8
Dacite	Unoxidised	40	46	5
Granite	Oxidised	45	44	8
Granite	Unoxidised	41	46	4

16.2.3 Rock Slope Assessment

Geotechnical characteristics of the rock mass, the height of the slopes and blasting practice can impact the stability of the overall pit wall. Estimates of rock mass strength are used to evaluate the stability of the overall slope angles.

The likelihood of generating large-scale (deep-seated) circular failure through the rock mass is also assessed. The slope stability analyses can be conducted with a 2D limit equilibrium software programme such as Rocscience Slide and with the two-dimensional explicit finite difference program such as FLAC sold by ITASCA. For the geotechnical study of the Ilovica pit, DMT has applied both techniques.

16.2.3.1 Pit Design Parameters

The working and final pits designed by DMT are based on the following design parameters:

- Typical bench height: 10 m and 20 m; worked as two 10 m flitches
- Bench face angle: 75 degrees
- Berm width: 5 m and 10 m
- Haul road width: 26 m
- Overall final pit slope angle: 45 degrees and 60 degrees.

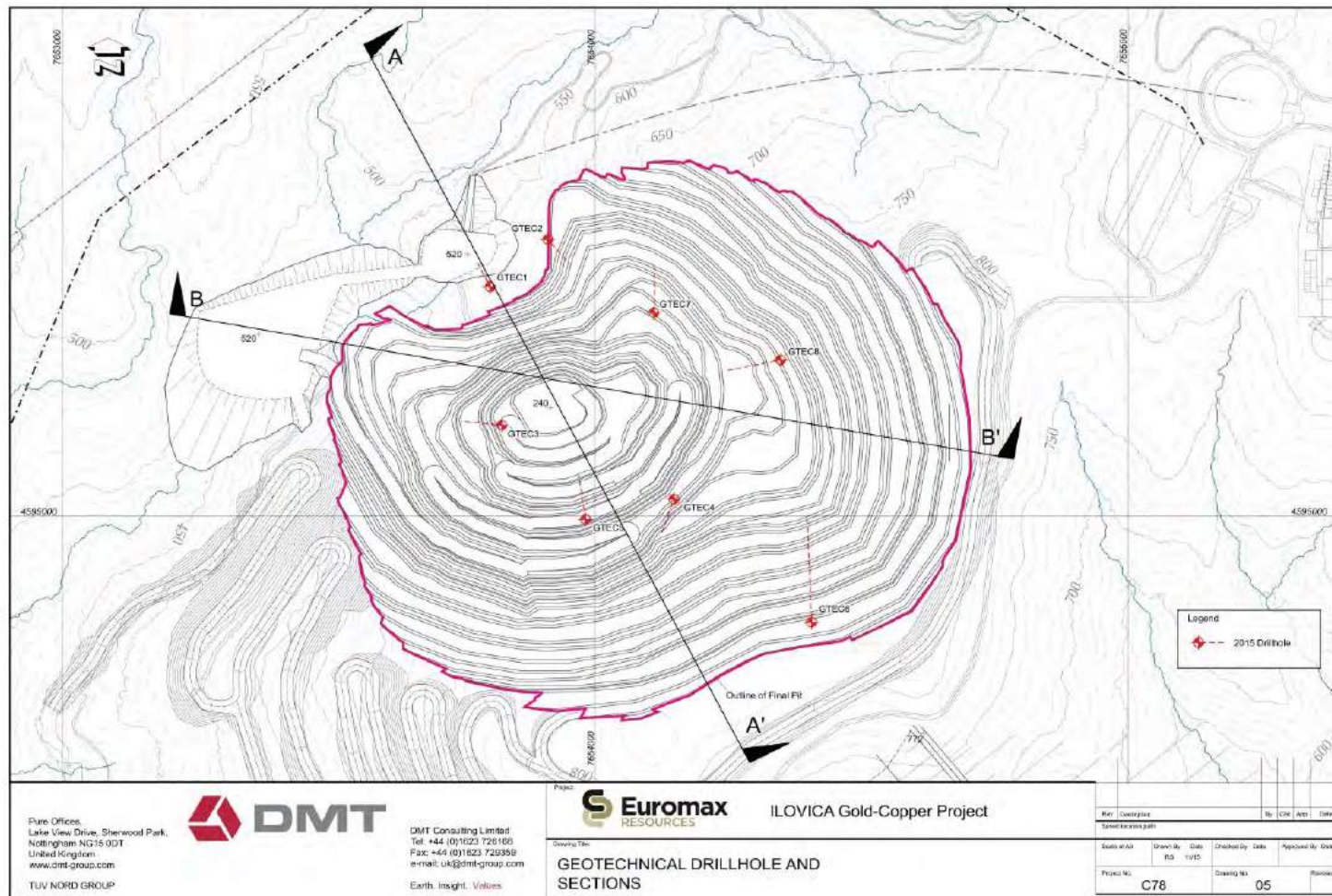
16.2.3.2 Stability Analysis

DMT used the following procedure to model the potential instability:

- Pit wall slopes were assessed for the expected pit heights for each pit.
- The rock strength was assigned a Hoek-Brown shear strength envelope (Hoek et al. 2002), taken from an analysis carried out in the Rocscience software RocLab. A software program for determining rock mass strength parameters, based on the latest version of the generalised Hoek-Brown failure criterion.
- An acceptable level for the factor of safety was set at 1.2 (static conditions) and 1.05 for dynamic conditions (seismic load).

Slope stability analysis is being carried out on 4 slopes with 4 different orientations. The location of the cross sections in relation to the final pit design is presented in Figure 16.3.

Figure 16.3
Location of cross sections A-A' and B-B' in relation to the final pit design



The slopes included in the cross section A-A' are the most critical for the pit design. The reason is that the left slope of the section A-A' (located in the NW sector of the pit) is the steepest slope (60 degrees angle) included in the final pit design. The right slope of the section A-A' (located in the SE sector of the pit) is one of the highest 45 degree slopes (approximately 600 m) incorporated in the pit design. These cross sections are perpendicular to the planned pit walls. The strength parameters adopted in the analysis considered six main types of rocks (Granodiorite Oxidised and Unoxidised, Dacite Oxidised and Unoxidised and Granite Oxidised and Unoxidised).

For the analysis, it has been assumed that controlled blasting techniques (pre-splitting) will be employed for the formation of the final pit slopes. In this way, the blast damage zone beyond the final face will be minimised.

A detailed hydrogeological study has been carried out by SWS in parallel with the geotechnical work and based on the results of their hydrogeological study standing water behind the pit slopes is not envisaged. As a result, water pressure within the slope has been ignored in the slope analysis.

Two overall pit angles have been used in the pit design produced by DMT, these being 45 degrees and 60 degrees. The majority of the final slope has been designed at 45 degrees.

Graphical representation of the slope stability analyses is presented in Figure 16.4 to Figure 16.11 for cross sections A-A'. Table 16.4 summarises the both the limit equilibrium and finite element analyses.

Table 16.4 Slope stability analysis Results for Section A-A'					
Cross Section	Type of Analysis	Slope Height (m)	Overall Angle (°)	FOS (Static)	FOS (Dynamic)
A-A' Left	Limit Equilibrium	200	60	2.04	
A-A' Left	Limit Equilibrium	200	60		-
A-A' Right	Limit Equilibrium	≈600	45	2.38	
A-A' Right	Limit Equilibrium	≈600	45		-
A-A' Left	Numerical Modelling	200	60	2.79	
A-A' Left	Numerical Modelling	200	60		1.59
A-A' Right	Numerical Modelling	≈600	45	4.38	
A-A' Right	Numerical Modelling	≈600	45		2.44

It can be seen that for the results of the static case in both limit equilibrium and numerical analysis, the predicted factor of safety considerably exceeds that set as the target for a stable pit wall. The same can be said for the dynamic state of the numerical analysis.

For the dynamic state of the limit equilibrium analysis there is no global instability issues in either of the slopes examined. However, some minor instability limited at the crest of the benches and restricted at bench slope level can be identified.

Such failures can be addressed with some local support measures, such as rock bolt and mesh but more often they can be addressed with scaling of the crest and small adjustment of the bench slope, without affecting overall slope angle.

Figure 16.4

Result of the static state Limit Equilibrium analysis of the Right slope of the A-A' section

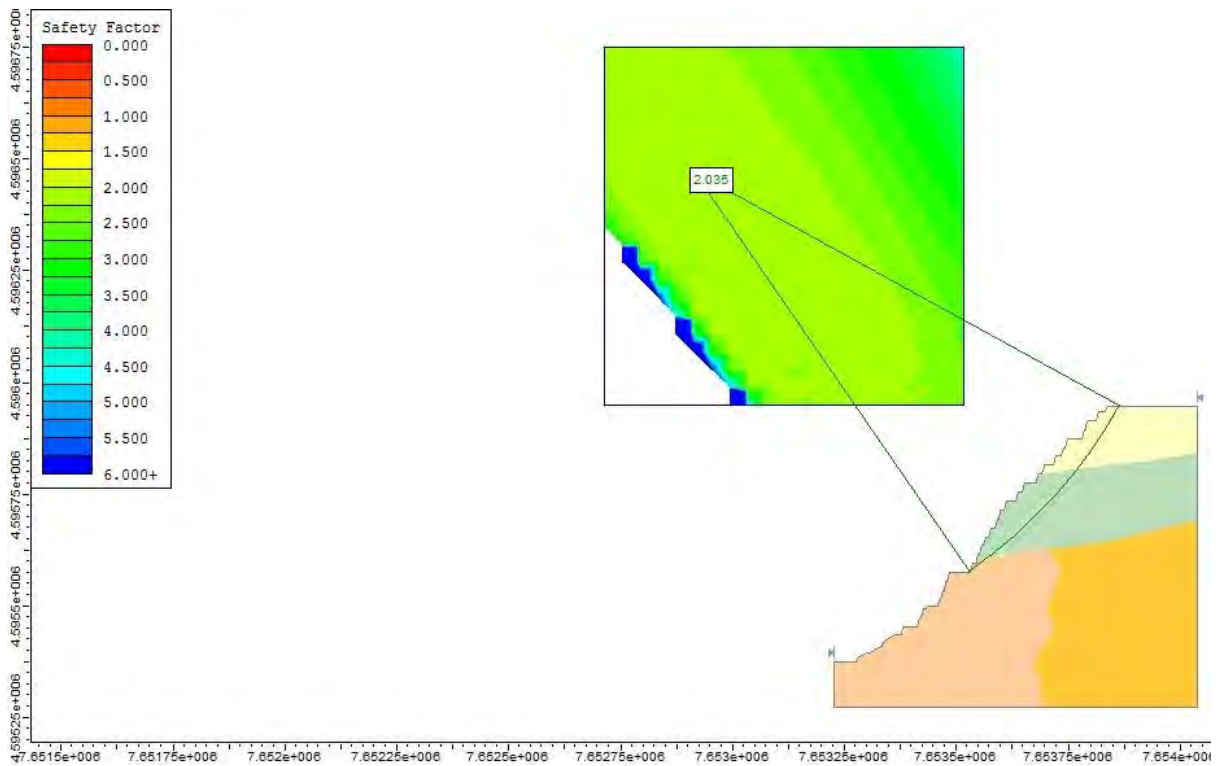


Figure 16.5

Result of the dynamic state Limit Equilibrium analysis of the Right slope of the A-A' section
(Some localised instability i.e. FOS lower than 1.05 (circled in red) can be identified)

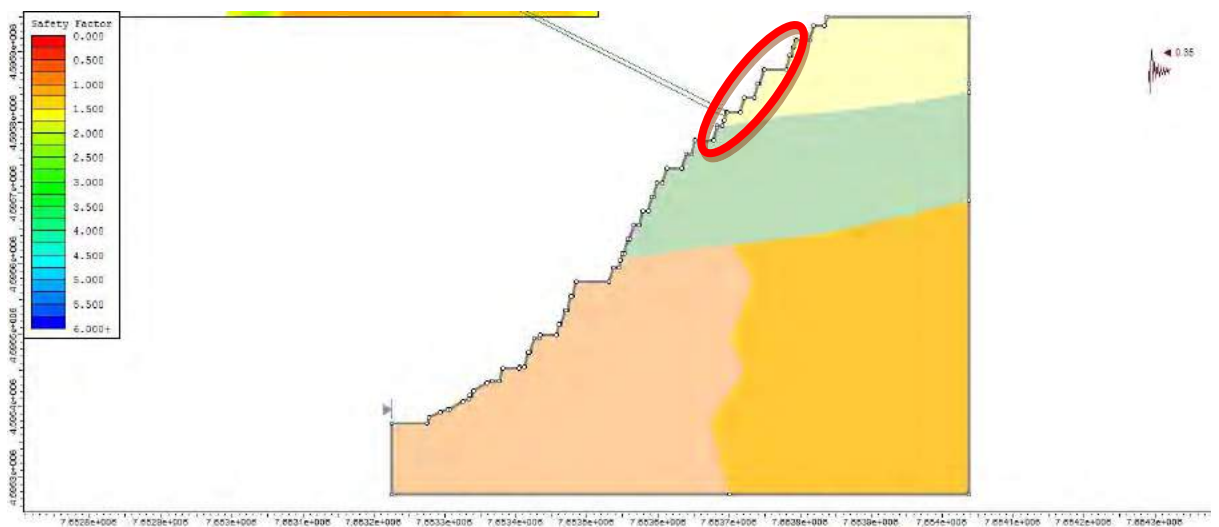


Figure 16.6

Result of the static state Limit Equilibrium analysis of the Left slope of the A-A' section

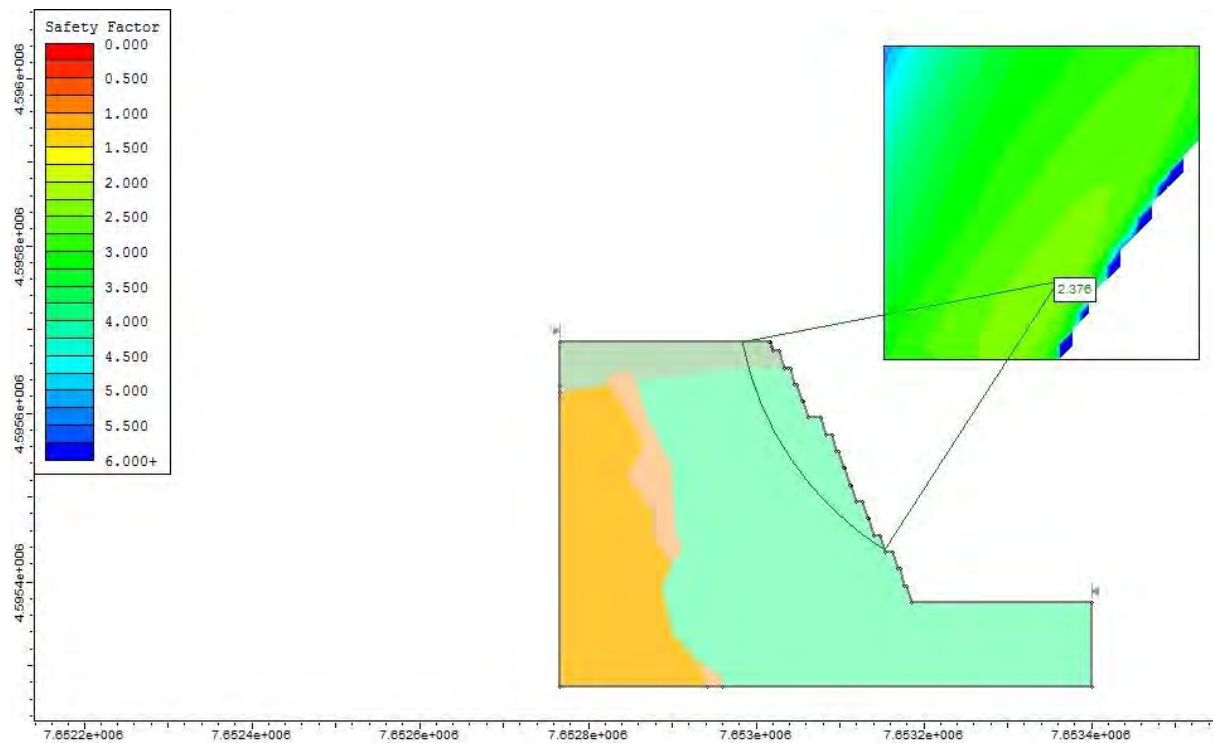


Figure 16.7

Result of the dynamic state Limit Equilibrium analysis of the Right slope of the A-A' section
(Some localised instability i.e. FOS lower than 1.05 (circled in red) can be identified)

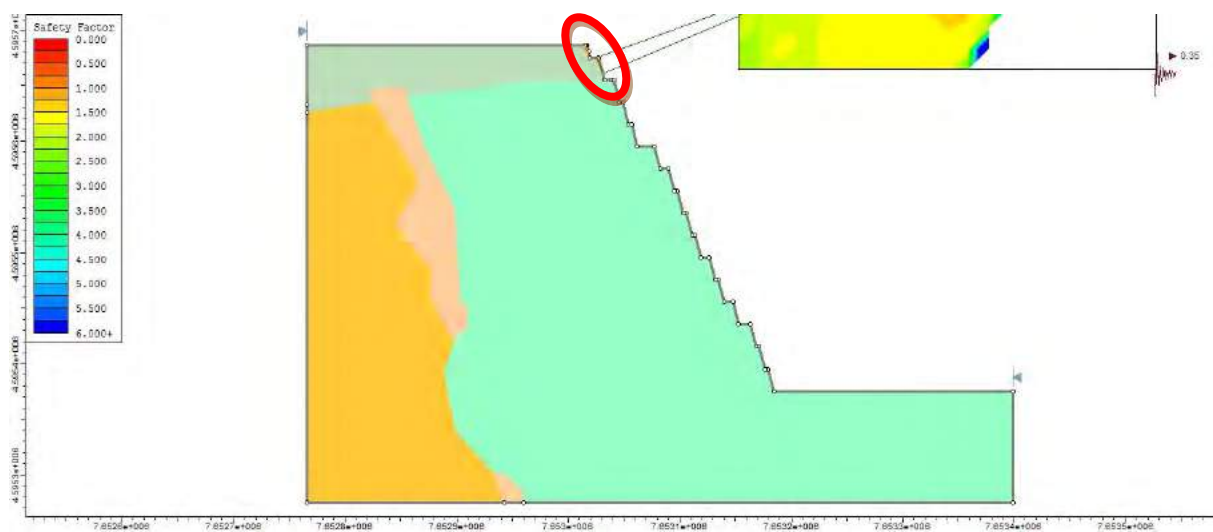


Figure 16.8

Result of the static state Numerical Modelling analysis of the Right slope of the A-A' section (FOS 2.79)

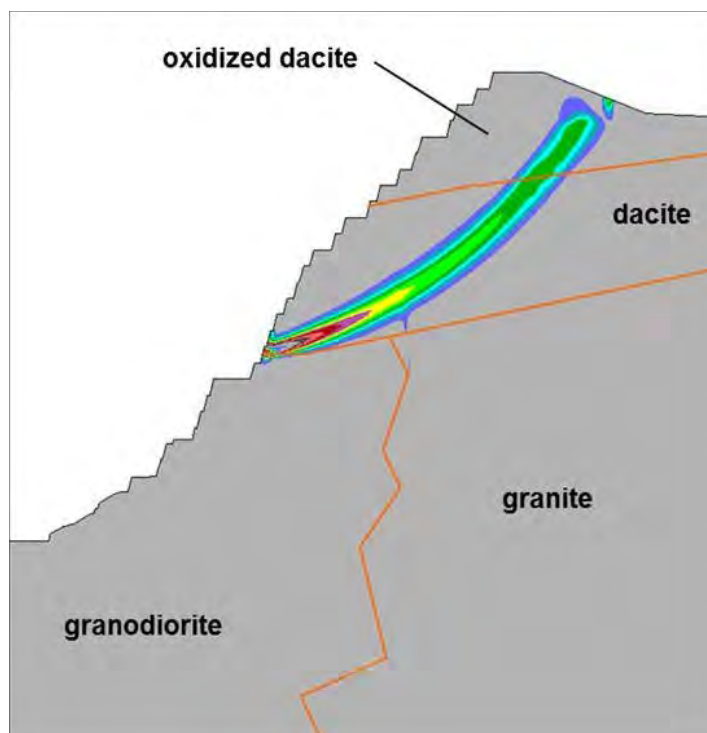


Figure 16.9

Result of the dynamic state Numerical Modelling analysis of the Right slope of the A-A' section (FOS 1.59)

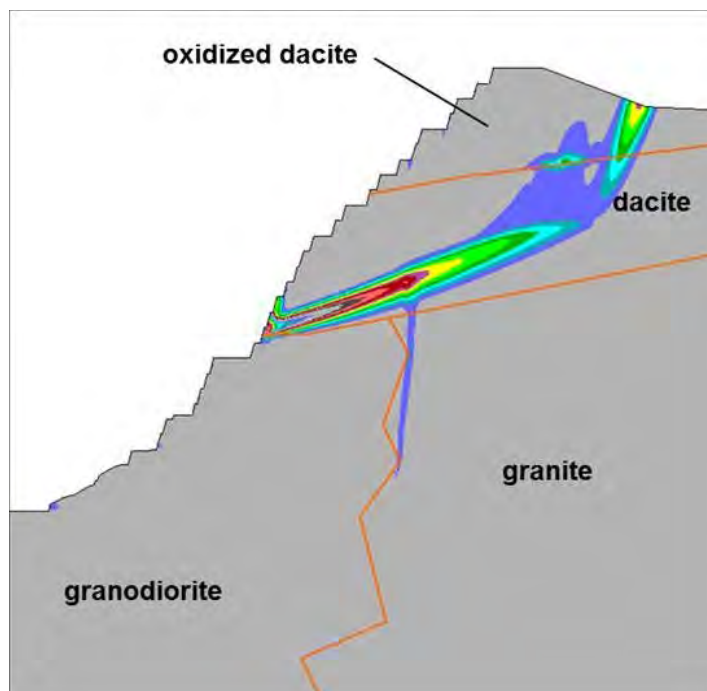


Figure 16.10

Result of the static state Numerical Modelling analysis of the Left slope of the A-A' section (FOS 4.38)

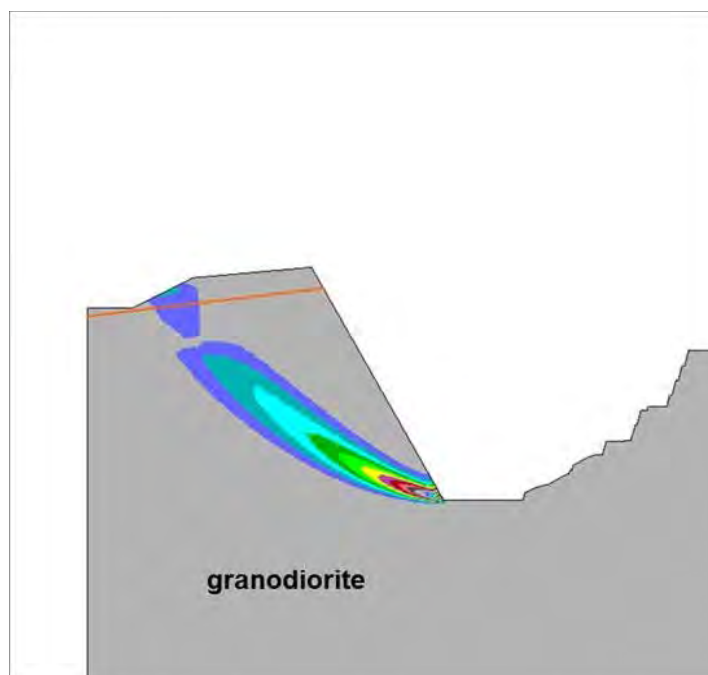
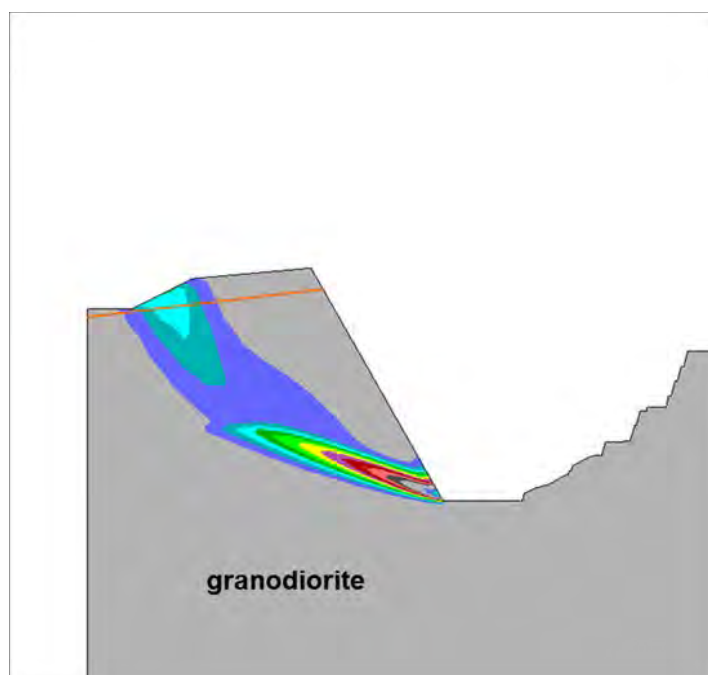


Figure 16.11

Result of the dynamic state Numerical Modelling analysis of the Right slope of the A-A' section (FOS 2.44)



16.2.4 Conclusions and Recommendations

As a result of the pit slope analysis carried out by DMT, based on the field and laboratory data acquired from the geotechnical investigation programme, DMT has reached the following conclusions:

1. The most critical slope in the pit is the SE slope.
2. A number of different final pit slopes have been subjected to analysis by 2D limit equilibrium and found the overall slope to be stable at pit design slope of 45 degrees. At the dynamic state the overall slope is stable, however it has been indicated that the some minor instability at bench height can occur; some additional support measures may be necessary.
3. The critical slope below the crusher location on the NW side of the pit has been designed at 60 degrees. This slope has been analysed by both 2D limit equilibrium and 2D finite element analysis using FLAC 2d software.
4. This slope is also found to be stable at the final overall slope design inclination of 60 degrees with FOS ranging between 2.376 and 4.38 for the static state and 2.44 for the dynamic state in the numerical modelling analysis. Based on the limit equilibrium and numerical analysis carried out by DMT the overall slope both in static as well as dynamic conditions are stable.
5. The overall pit slope analysis undertaken by DMT demonstrates the final pit slopes used in the pit design and for determining the Ore Reserve are stable.
6. Although DMT's analysis demonstrates overall stable final slopes, the mining costs used in the project economic evaluation include an allowance of US\$5.6 M for rock support measures as and when required.
7. It is envisaged that controlled blasting techniques (pre-splitting) will be employed for the formation of the final slopes.
8. An experience geotechnical team will be on site during the operation of the mine in order to monitor the stability of the slopes, address any issues that may arise and advise in the development of the pit.
9. Slope monitoring systems will have to be installed to pre-worn for any potential slope instability.

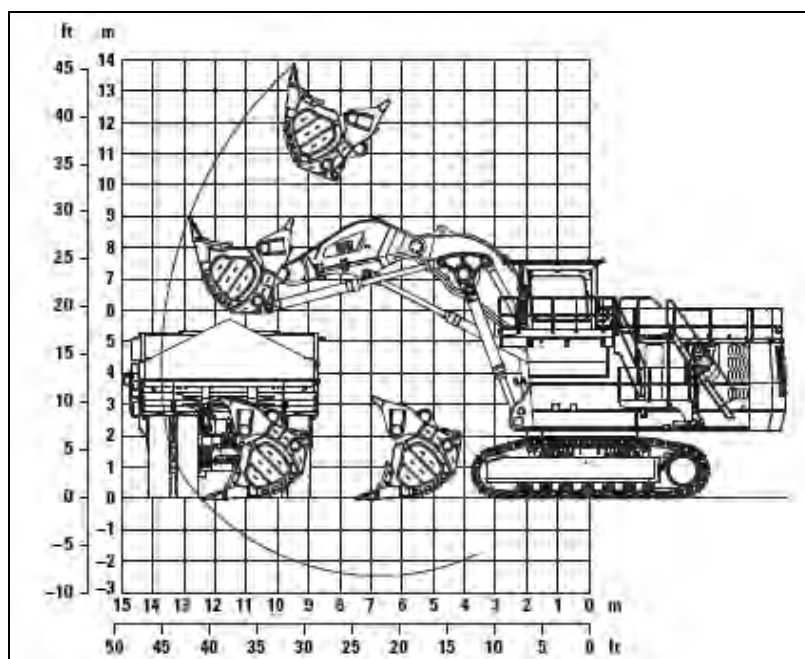
16.3 PIT DESIGN

16.3.1 Criteria, Parameters and Inputs

16.3.1.1 Bench Height

The bench height must be optimised for the shovel and truck match. In this case it has been established that a 300 t machine with a bucket capacity of 16.5 m³ will be able to meet the production requirements and that a 10 m bench height is suitable. Figure 16.12 shows the range diagram for a 300 t machine with a bucket capacity of 16.5 m³ face shovel matched with a 90 t truck.

Figure 16.12
Range Diagram for a 300 t Shovel

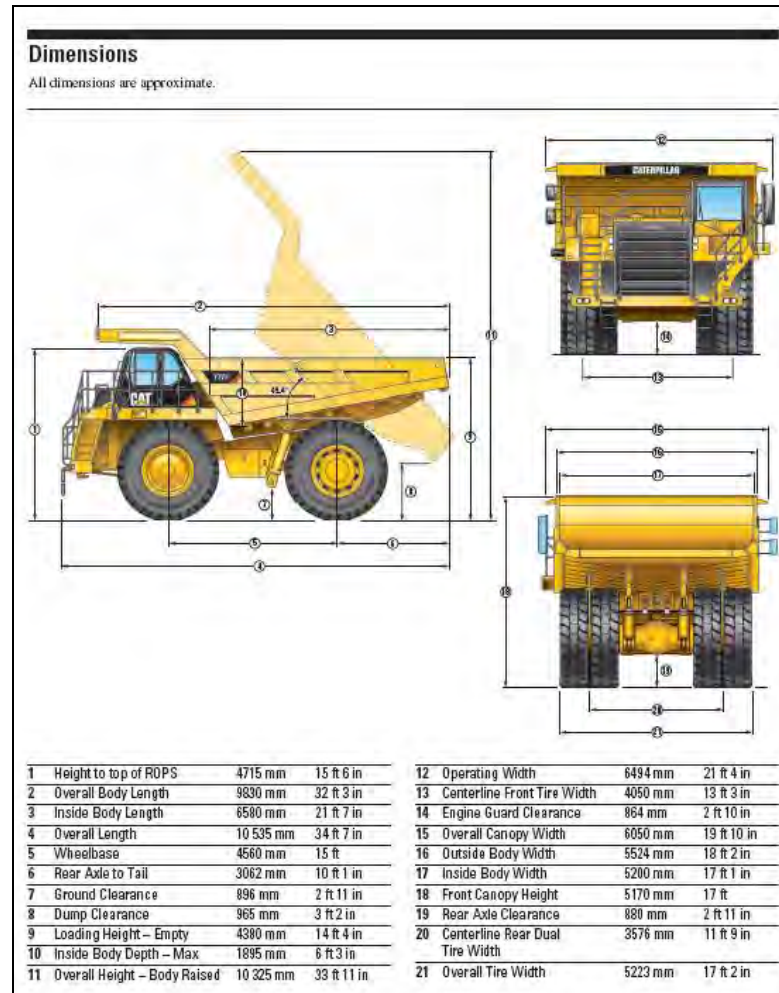


Source: Caterpillar Brochure AEHQ6967 (05-2013)

16.3.1.2 Haul Roads and Ramps

To meet the production requirements and to match the selected loading machines a 90 t truck has been selected. This truck has an overall operating width of 6.5 m (dimension 12 in Figure 16.13).

Figure 16.13
Principal Dimensions of a 90 t Truck



Source: Caterpillar Brochure AEHQ5749-01 (5-07)

The normal convention is to use three times the truck width for two way traffic to allow for safe passing in all conditions for this class of truck. This gives a total width of 19.5 m. This may be reduced to a single truck width plus passing places towards the bottom of the pit to avoid unnecessary waste as the pit bottom narrows.

In addition, it is necessary to have a safety bund equivalent to at least half the tyre height on the open side and an allowance for a drainage ditch on the slope side. The tyre height is 2 m and with an angle of repose of 45° this will require a width of 2 m. The drainage ditch needs to be 0.5 m deep so at a slope angle of 45° this will require a width of 1 m. An allowance of 0.5 m either side of the berm and ditch is required.

Taking all these dimensions into account it will be necessary to allow for a ramp width of 23 m at a gradient of 1:10. The external haul roads have been designed at a maximum gradient of 1:12 to allow for the cut and fill and switchback requirements.

16.3.1.3 Slopes, Batters and Berms

This is discussed in Section 16.2.

16.3.1.4 Phasing

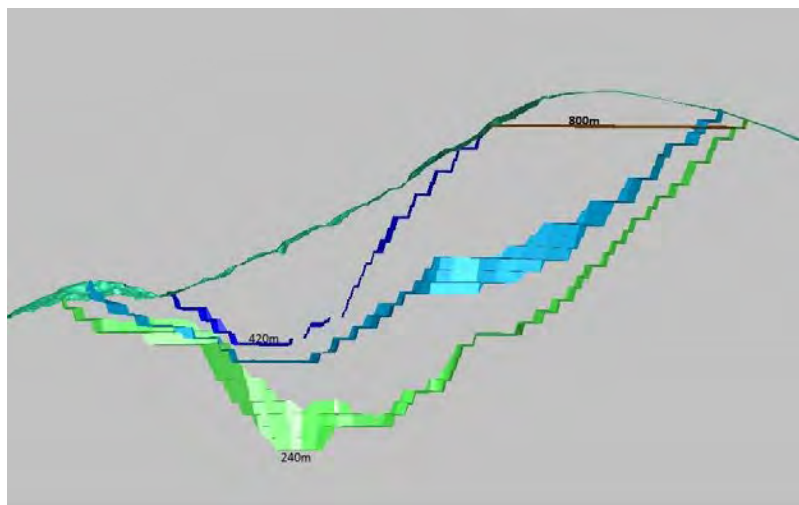
There will be a need to phase the open pit in order to keep the stripping ratio as even as possible.

Prior to production of fresh ore there is a requirement for a pre-strip period of one year to provide waste material for the construction of the starter TMF. This material will come from the top of the hill which has the benefit of easy access. It also helps to reduce the strip ratio during subsequent pushbacks.

A starter pit in higher grade material is envisaged, with a series of pushbacks out to the final pit. The nature of the mineralisation and grade is such that it lends itself well to a starter pit on the lower eastern side. This will allow easy access to the crusher and ROM pad area in the early years.

Figure 16.14 shows the relationship between the phases in an east to west section through the centre of the pit.

Figure 16.14
East to west cross section through the centre of the pit showing the phases



Dark green=topography. Brown=pre-strip. Dark blue=starter pit.
Light blue=primary pushback. Light green=final pit.

16.3.2 Cut-Off Grade

This is discussed in Section 15.2.4.1.

16.3.2.1 Soils, Waste, Mineral, Strip Ratio and Grade

A thin layer of soil covers some of the area which is mainly forested. An estimate has been made that there is a thickness of 0.30 m of soil over the surface area of the pit which equates to 338 000 m³.

This will be stripped off wherever possible and either stored in a separate bund around the perimeter of the pit to act as an environmental barrier for later reuse or re-spread directly over adjacent land for agriculture.

16.3.3 Sensitivity

The design quantities are sensitive to the ramp width and the pit bottom dimensions, as changes to these affect how closely the design matches the pitshell. A small change in the pit bottom width can have a dramatic effect on the waste quantity, especially with such a deep pit, as the wall is carried up to surface. This can be compounded by changes in ramp width and switchbacks, so keeping these as tight as possible will minimise the waste quantity.

16.3.4 Design Selection

Designs have been done for the starter, primary pushback and final pits based on the criteria discussed in Section 15.3.

16.4 WASTE DUMP DESIGN

All the waste, including most of the oxide ore and the fresh ore below cut-off grade will go to the TMF embankment construction and any surplus will be placed against the TMF embankment.

16.5 PRODUCTION SCHEDULE

16.5.1 Method

A detailed production schedule has been produced in Geovia MineSched™ v.9.0.1 software. This programme uses block model information, together with pit locations, mining strategy, constraints, production data and targets to produce a schedule in graph and data form of quantities and qualities, which can then be animated to show how it is mining the pit.

Key data are material codes for each type of rock that will be mined. This has to be prepared in the block model prior to import to Geovia MineSched™.

Production data in the form of daily rates must be input, as well as the locations of where and in what sequence mining is to take place. Quality and material ratio targets can be specified to guide the programme to achieve the best schedule. The Geovia Whittle™ pitshells can also be used to guide the schedule and this has been done.

The advantage of this programme is that it enables many scenarios to be evaluated in a short space of time and the most optimum schedule produced for economic analysis.

16.5.2 Criteria, Parameters and Inputs

The material codes are waste and sulphide ore.

Locations were constrained to the pre-strip, starter pit, primary pushback and final pit designs. Intermediate pit shells were also used. The mining strategy was set to work in 10 m benches from top down in an easterly direction and working radially within each phase. The direction means that the pit will

generally be worked in a particular direction but subject to the other constraints, such as strip ratio, quality and locations. In the case of Ilovica it is essential to mine the pit in a carefully controlled sequence in order to keep the waste quantity under control and to produce the necessary sulphide ore for processing without the need for any major stockpiling.

The production rate was set at 9.75 Mt/a for the first year to allow for a build-up in processing, followed by 10 Mt/a. The waste quantity is not limited but is controlled by the pit designs and pit shells. This means that there is some variation in the annual production of waste but it is kept as even as possible.

A strip ratio target of 1.0, based on the maximum waste and mineral production rates was set.

16.5.3 Waste, Mineral, Strip Ratio and Grade Schedule

The objective of the schedule is to produce only as much ore as is required by the processing plant without the need for any major stockpiling. Some short term stockpiling will be required however. In addition, the aim is to produce an even amount of waste if possible. Given that there is a considerable quantity of waste near surface this aim requires carefully controlled scheduling with some advance waste production at times. This is particularly evident in year three when the primary pushback comes into play.

Figure 16.15 shows the production schedule for ore and waste. It shows a steady production of ore but some variation in the waste. The waste production is closely related to the haul distances as the hilly terrain means there are many switchbacks to achieve an even gradient over the considerable elevation differences. The target is to have a reasonably even number of trucks over a period of time that can be split between ore and waste.

Figure 16.15
Geovia MineSched™ Production Schedule

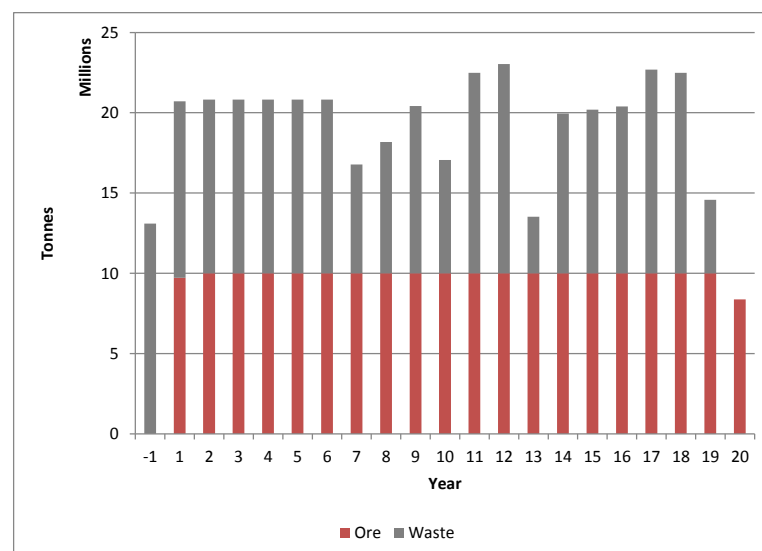


Figure 16.16 shows the head grades for gold and copper that are delivered to the processing plant. This shows higher grades at the beginning with decreasing grades as the mine develops. This is a natural attribute of the orebody of diminishing grade with depth. Table 16.5 details the quantities associated with Figure 16.16.

Figure 16.16
Geovia MineSched™ Head Grade Schedule

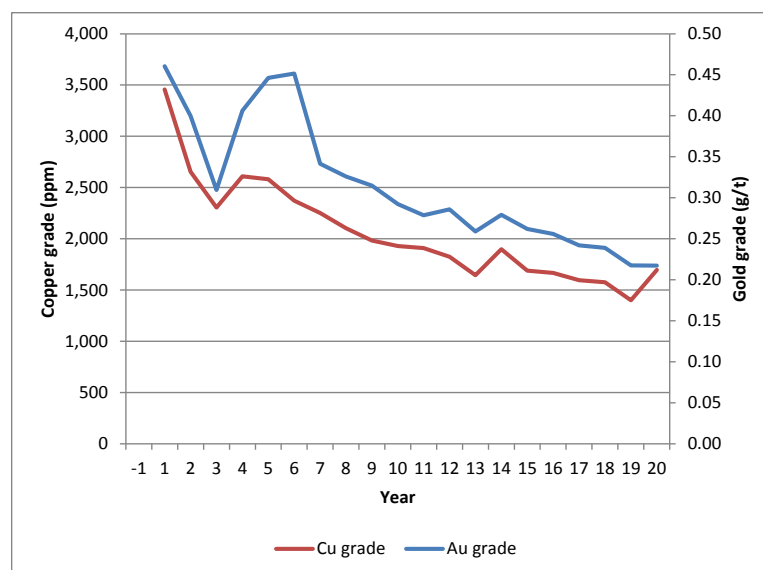


Table 16.5
Head Grades

Year	Ore	Waste	Diluted Au grade (g/t)	Diluted Cu grade (%)	Strip Ratio t:t
-1	0	13 091 350			
1	9 725 000	10 993 947	0.460	0.35	1.13
2	10 000 000	10 818 271	0.400	0.27	1.08
3	10 000 000	10 818 271	0.310	0.23	1.08
4	10 000 000	10 818 271	0.406	0.26	1.08
5	10 000 000	10 818 271	0.446	0.26	1.08
6	10 000 000	10 818 271	0.452	0.24	1.08
7	10 000 000	6 784 488	0.341	0.23	0.68
8	10 000 000	8 182 297	0.326	0.21	0.82
9	10 000 000	10 413 727	0.315	0.20	1.04
10	10 000 000	7 059 139	0.292	0.19	0.71
11	10 000 000	12 489 577	0.279	0.19	1.25
12	10 000 000	13 033 665	0.286	0.18	1.31
13	10 000 000	3 528 820	0.259	0.16	0.35
14	10 000 000	9 945 738	0.279	0.19	1
15	10 000 000	10 186 430	0.262	0.17	1.02
16	10 000 000	10 386 375	0.256	0.17	1.04
17	10 000 000	12 691 015	0.242	0.16	1.27
18	10 000 000	12 479 911	0.239	0.16	1.25
19	10 000 000	4 573 788	0.218	0.14	0.46
20	8 380 837		0.217	0.17	
Total	198 105 837	199 931 624	0.315	0.21	1.01

16.5.4 Sensitivity

The schedule is sensitive to the mining direction and starting locations for each phase.

The schedule was based on a starter pit, the primary pushback and final pit design plus intermediate pitshells. This was done to provide even annualised ore production from the pit while reducing the requirement for a large waste pre-strip.

The phases are illustrated in Figure 16.17, Figure 16.18, Figure 16.19 and Figure 16.20. They show the pre-strip, starter, intermediate and final pits. The pre-strip occurs in year -1 prior to ore production to enable sufficient waste to be excavated to build the TMF starter wall. The starter pit is mined during years 1 to 2 of production in a higher grade area, the intermediate pit covers the years 3 to 9 and the final pit occurs during years 10 to 20.

The principal haul roads are shown in a solid red line and the access roads in a dashed blue line.

Figure 16.17
Mine Plan – Pre-strip

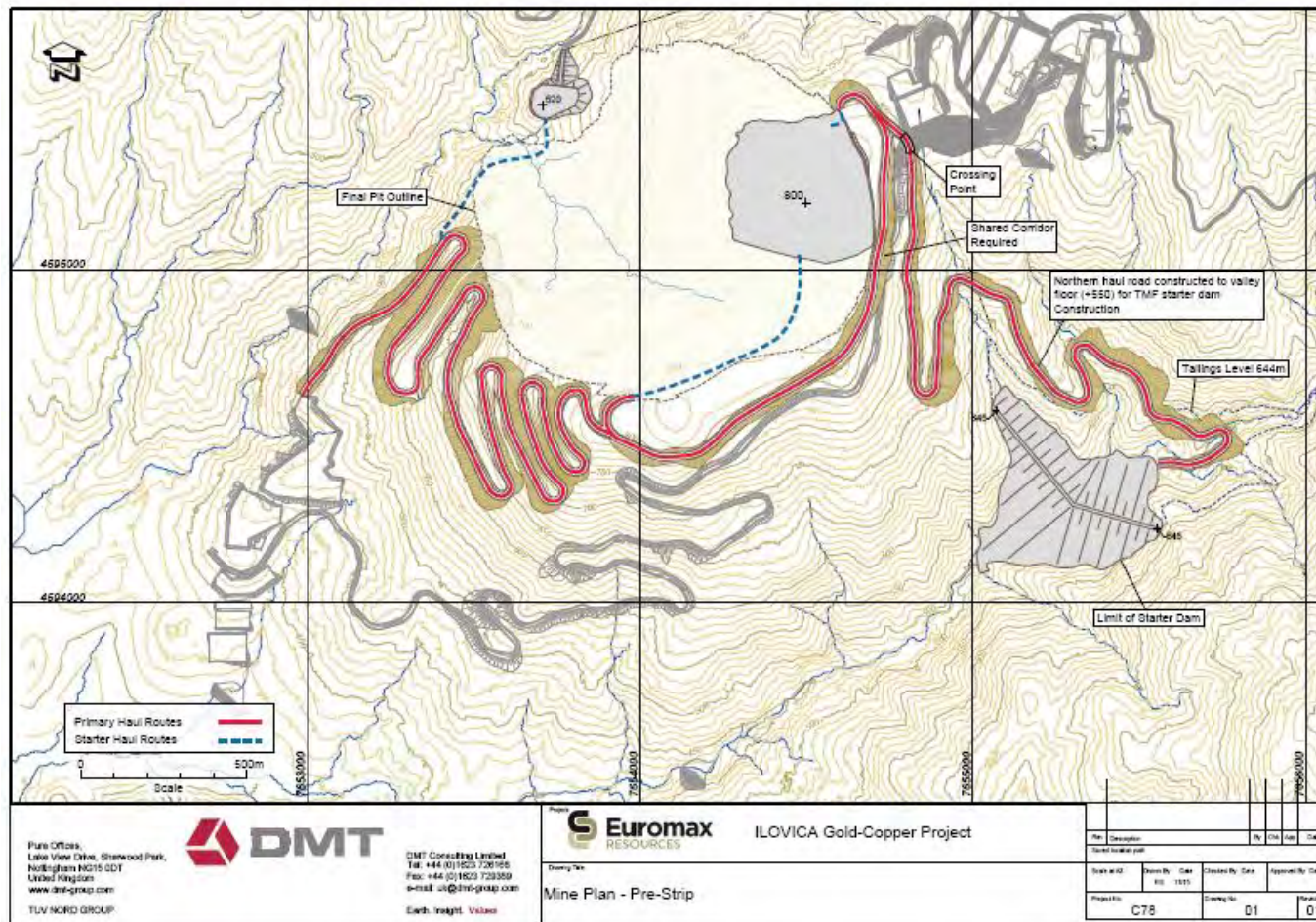


Figure 16.18
Mine Plan – Starter Pit

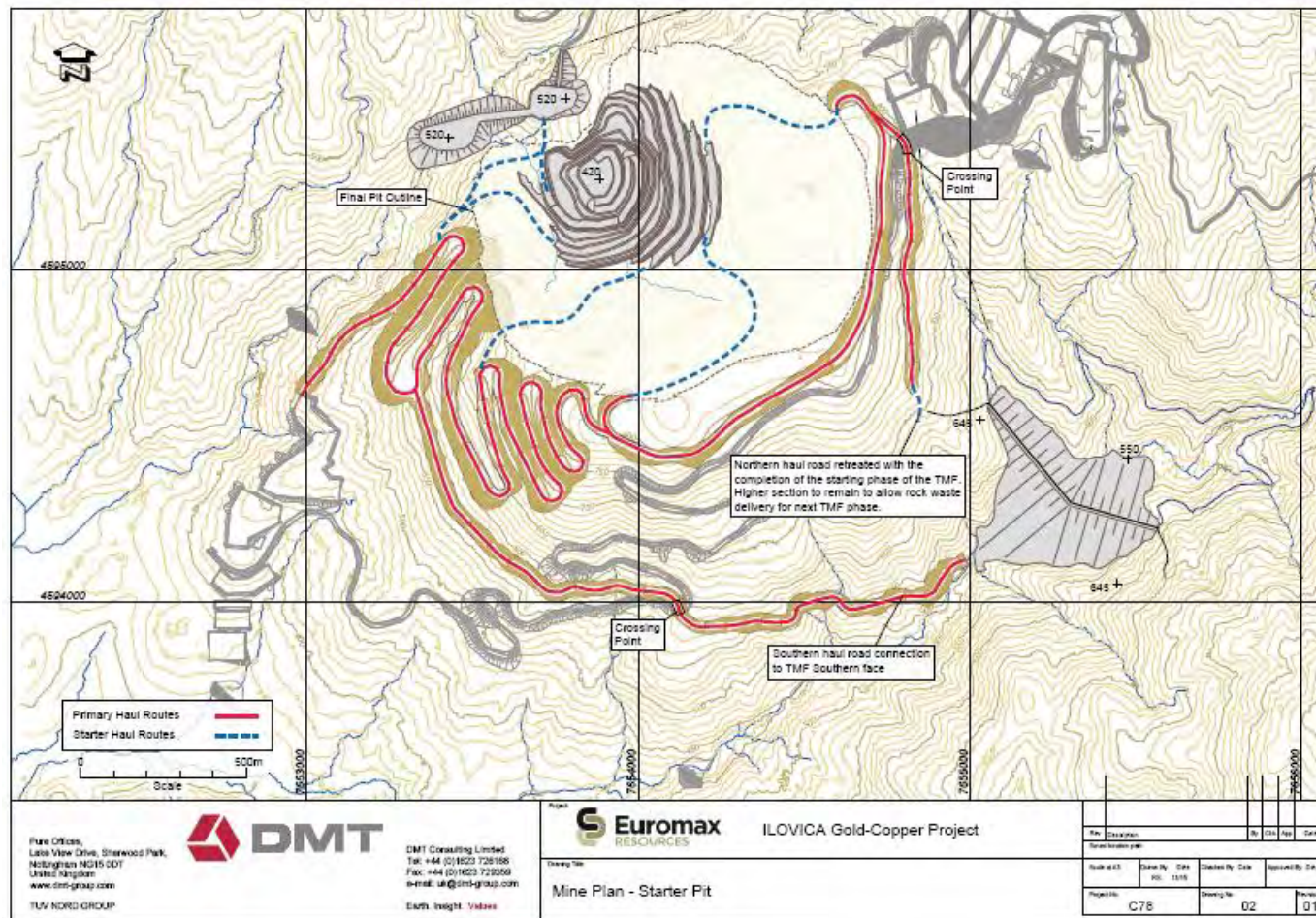


Figure 16.19
Mine Plan – Intermediate Plan

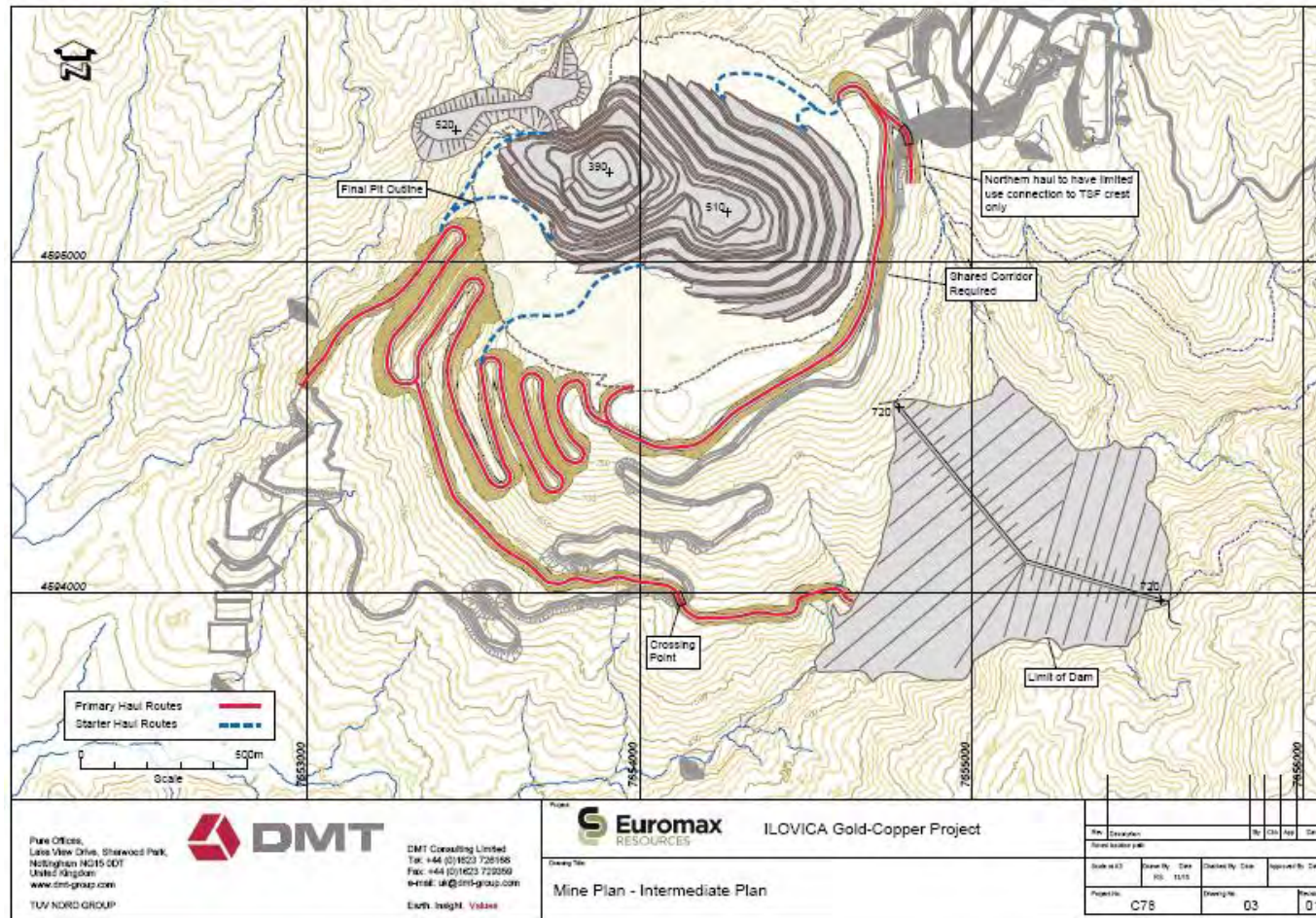
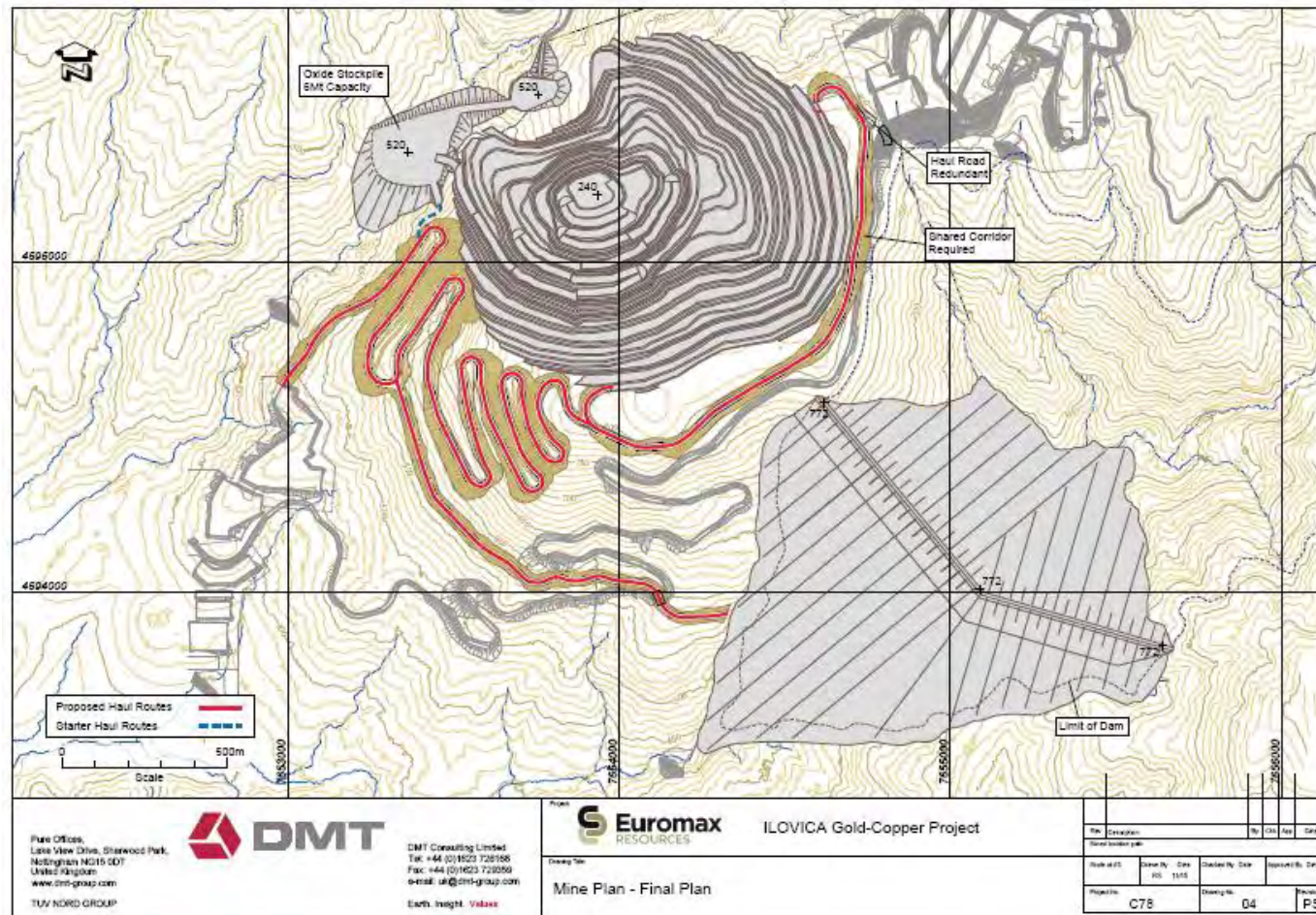


Figure 16.20
Mine Plan – Final Plan



16.6 MINING OPERATION

16.6.1 Drilling

Drilling will be performed by three down the hole (DTH) drills using 127 mm (5 inch) diameter bits with rods of 12 m length. Each hole will be drilled to a depth of 11 m to allow for 1 m of sub-drill to break out the toes. A 2.8 x 3.9 m burden and spacing has been calculated to give the required fragmentation. An instantaneous drilling rate of 0.75 m/min has been assumed and an allowance for setting up and moving, resulting in an overall rate of 0.5 m/min or 30 m/h. Each machine will require an operator and a shared assistant. An example of such a drill is the Caterpillar MD 6290. Table 16.6 shows the principal drilling data.

Table 16.6 Principal Drilling Data			
Blasthole Drill Productivity	Units	Mineral	Waste
Hole Diameter	mm	127	127
Bench Height	m	10	10
Sub-drill	m	1	1
Bank Density	t/m ³	2.5	2.5
Rock Mass per Hole	t	273	273
Burden	m	2.8	2.8
Spacing	m	3.9	3.9
Drilling Rate (overall)	m/h	30	30

16.6.2 Blasting

Blasting will be done using ANFO and slurry explosives delivered ready mixed to site and dispensed using one ANFO truck, together with a base charge and initiated using non electric detonators. It has been assumed that 25% of the holes will require slurry explosives. A team consisting of a shotfirer, an assistant shotfirer and two labourers will be required to charge and connect up the holes. There will be one blast per day, consisting of 220 holes per blast split between ore and waste. A powder factor of 0.74 kg/t is envisaged for this rock to enable good fragmentation and easy loading of the mineral and waste for good productivity.

16.6.2.1 Blasting Specifications

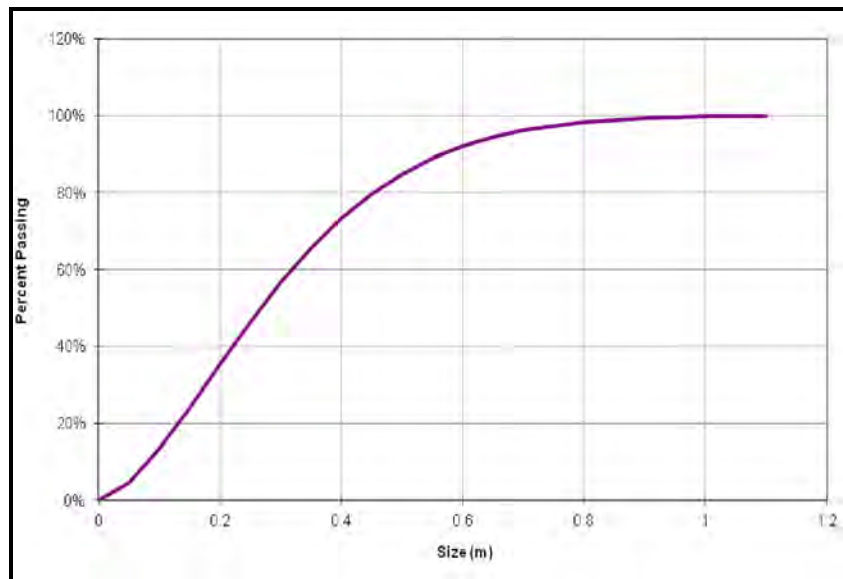
Table 16.7 shows the principal blasting specifications.

Table 16.7 Principal Blasting Specifications			
Blasting Parameters	Unit	Mineral	Waste
Explosive Density	g/m ³ *	0.80-0.98	0.80-0.98
Powder Factor	kg/t	0.74	0.74
Powder Height	m	8	8
Powder per Hole	kg	81.1	81.1
Stemming Height	m	3	3

16.6.2.2 Kuz-Ram Fragmentation Analysis

A Kuz-Ram fragmentation analysis was done (Figure 16.21) to ensure that a high percentage of the blasted rock would pass through the primary screens and crushers.

Figure 16.21
Fragmentation Analysis Results



It can be seen from this graph that 92% of the blasted rock will pass a 0.6 m standard primary screen. The predicted fragmentation ranges are shown in Table 16.8. Any oversize material will be broken up with a hydraulic hammer.

Table 16.8 Fragmentation Sizes	
Predicted Fragmentation	Percentage
Percent Oversize	1.8
Percent In Range	93.6
Percent Undersize	4.6

16.6.3 Loading

To calculate the required size and number of loading machines it is first necessary to establish their productivity and then using this with the productive hours and production requirements to establish what size and how many are required for ore and waste.

16.6.3.1 Calculation of Productivity

This is done by calculating the production in bank cubic metres per hour per cubic metre (bcm/h/m³) of bucket capacity. The benefit of doing this is to eliminate the effect of density, which allows a direct comparison between machines of different bucket capacities. Analysis of many operations has enabled DMT to build up a database of results for different types of machines in different settings. It is also the

case that the larger the machine, the better its productivity, so benefitting from economies of scale. Figure 16.22 shows the results of an analysis of many projects.

Figure 16.22
Bucket Capacity vs. Productivity

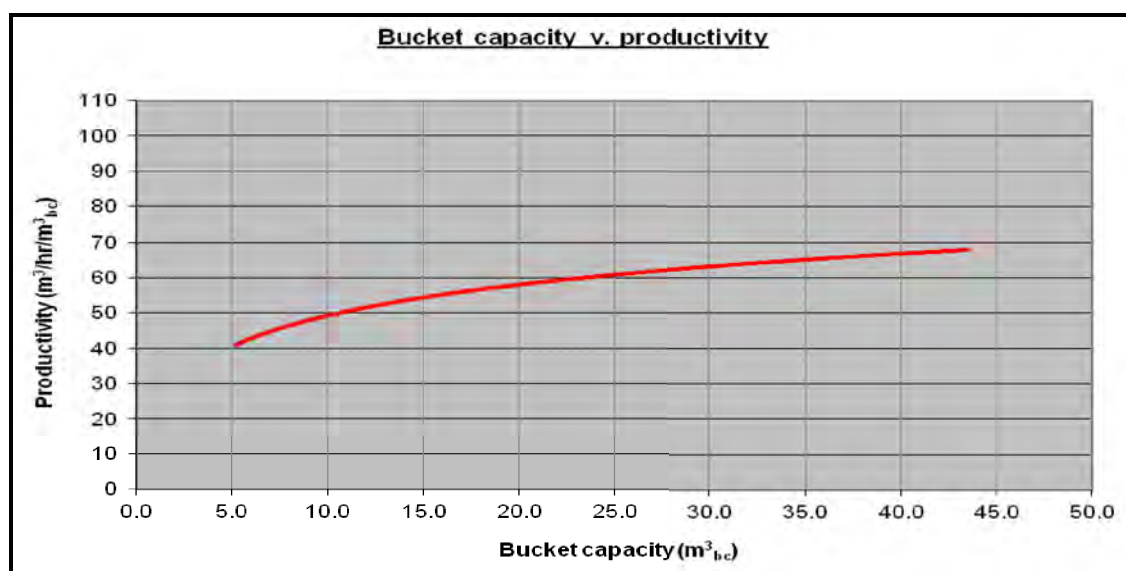


Table 16.9 shows the calculation of productivity for the project, assuming shovels for waste and ore.

Description	Unit	Waste	Ore
Rated bucket capacity	LCM	1	1
Bucket fill factor	%	95	95
Instantaneous swell factor	%	63	63
Moisture	%	2.5	2.5
Effective dry bucket capacity	BCM	0.57	0.57
Cycle time (see below)	min	0.53	0.57
Maximum buckets /h	No.	112.5	105.9
Total utilisation (see below)	%	72	72
Productive buckets /h	No.	81.2	76.4
BCM/h/m³ rated bucket capacity	-	46	43

There may be some minor rounding errors

These figures are slightly conservative in comparison with DMT's database of figures for these types of machines, but allow for local conditions and any peaks in stripping ratio.

The calculation of the cycle time and total utilisation is given in the Table 16.10 and Table 16.11. It should be noted that there are different ways of calculating utilisation and care should be taken in evaluating it. In this case, total utilisation means the productive hours as a percentage of the scheduled hours. Productive hours represent the hours that the machine actually does productive work, having allowed for mechanical availability, shift utilisation and operational efficiency. Scheduled hours represents the

working hours based on the hours per shift, the number of shifts per day, the days per week and the weeks per annum. In this case, it will be working 24 h/d, 350 d/a, which yields a maximum possible hours of 8 400 h/a.

Table 16.10 Calculation of Cycle Time and Total Utilisation			
Cycle Time for Hydraulic Excavator/ Shovel	Unit	Waste shovel	Ore Shovel
Dig	s	15	18
Swing over truck	s	5	5.5
Spot	s	2	2.5
Tip	s	6	3.5
Swing back	s	4	4.5
Total	s	32	34
	min	0.53	0.57
<u>Total Utilisation</u>			
Hours per shift	h	12	12
Shifts per day	/d	2	2
Days	d	7	7
Weeks	wk	50	50
Scheduled hours	h	8 400	8 400
Availability due to mechanical breakdown	%	90	90
Available hours	h	7 560	7 560
Shift Utilisation (see below)	%	84	84
Utilised hours	h	6 379	6 379
Operational efficiency (see below)	%	95	95
Productive hours	h	6 060	6 060
Total Utilisation	%	72	72

There may be some minor rounding errors

To calculate the shift utilisation it is necessary to consider all of the aspects that will contribute to downtime. It is assumed that the fuelling and servicing of the machines will be undertaken at break times, where possible, to minimise the disruption to production.

Table 16.11 Calculation of Shift Utilisation		
Utilisation	Waste (h)	Ore (h)
Shift hours	12	12
Shift change	0.25	0.25
Meal	0.50	0.50
Break	0.25	0.25
Fuelling & servicing	0	0
Clear up	0.25	0.25
Blasting	0.37	0.37
Weather	0.25	0.25

Table 16.11 Calculation of Shift Utilisation		
Utilisation	Waste (h)	Ore (h)
Other	0	0
Total hours lost	1.88	1.88
Utilised hours	10.13	10.13
Utilisation	84%	84%

Operational efficiency represents the loss in time due to operational disruptions such as the necessary moving of the machine across the face, blasting and routine clear up. Spillages from trucks will be dealt with by a rubber tyred dozer.

From Table 16.10 and Table 16.11 it can be seen that a total utilisation of 72% has been calculated. It should be noted that this is particularly dependant on the mechanical availability. This has been set at a high average rate, based on the premise that the equipment will be well maintained and have major overhauls at regular intervals. Costs for major overhauls have been included in the sustaining Capex, described in Section 21.

16.6.3.2 Calculation of Size and Number of Machines

The size and number of machines required to meet the production requirements is calculated by using the productive hours and the productivity of the machine.

For the waste production it has been calculated that a total bucket capacity of approximately 16 m³ would be required and 15.5 m³ for ore. Consequently machines of 15 to 17 m³ would suit the requirements. A total of two would be required. The benefit of having two shovels of the same capacity is that they are inter-changeable between waste and ore.

The calculation for this is shown in Table 16.12.

Table 16.12 Calculation of bucket required capacity			
Item	Units	Waste	Ore
Shovel	Mt/a	11	10
Productive hours	Hours	6 060	6 060
Tonnes per hour required	t/h	1 815	1 650
SG		2.47	2.47
BCM per hour	bcm/h	735	668
Productivity	bcm/h/m ³ _{bc}	46	43
Total bucket capacity required	m ³	16	15.5

Based on average production rates

16.6.4 Hauling

16.6.4.1 Haulage Routes

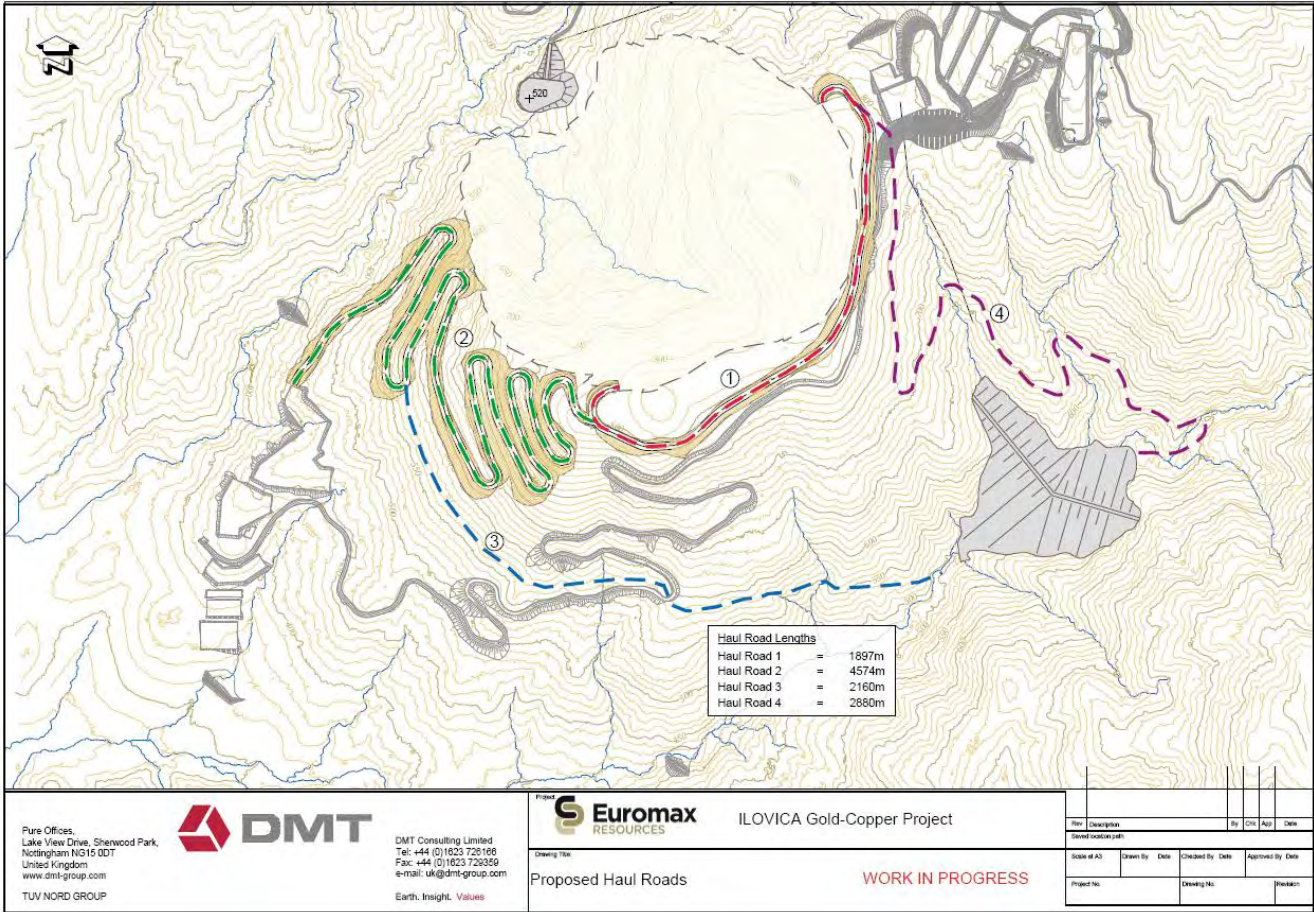
The haulage routes at Ilovica are complex, due to the terrain and the combination of open pit and hillside quarry type mining. Some material will be hauled downhill loaded and some uphill, the proportion of each varying on whether it is waste or ore and pit phasing. Conversely for the empty haul.

There will be a system of haul roads outside the final pit limits to enable waste to be hauled to the TMF embankment and ore to the crusher. The principal haul roads will follow the contours where possible in combination with a series of switchbacks where required. To access these haul roads it will be necessary to have in-pit ramps and haul routes along the working benches at different elevations to the pit rim. From the pit rim temporary haul roads will follow the contours to connect with the principal haul roads.

Figure 16.23 shows the four principal haul roads outside the pit rim. Haul road No.1 follows the contours around the pit rim and has a flat to gentle gradient. Haul road number 2 is a switchback design that connects haul road No. 1 with the workshop and changeover area at a gradient of 1:12. The switchback bends are flat and connect with the pit rim at or close to the pit benches so that several benches may be served from one bend. Haul road No. 3 comes off haul road No. 2 to serve the TMF embankment on the south side. Haul road No. 4 connects the TMF embankment from the pre-strip area.

Access to the pre-strip area uses the main access road with temporary maintenance facilities adjacent to the pre-strip. Haul road number 4 will need to be constructed first, to allow access to the initial TMF dam. Thereafter haul roads 2 and 1 will need to be constructed followed by haul road number 3.

Figure 16.23
Principal haul roads



16.6.4.2 Shovel and Truck Matching

It is necessary to match the shovels to a truck size. It is based on the selected shovel size and the need to fill a truck in three to five passes. The best match for a 300 t machine with a 16.5 m³ bucket is a 90 t truck (Table 16.13).

Table 16.13 Shovel and Truck Matching			
	Unit	Waste	Ore
<u>Loader</u>			
Bucket capacity	m ³	16.5	16.5
Bucket fill factor	%	95	95
Moisture	%	2.5	2.5
Effective bucket capacity	m ³	15.3	15.3
Solid SG		2.47	2.45
Load factor	%	74	74
Loose SG		1.83	1.81
Effective dry bucket capacity	t	28	27.7
<u>Truck</u>			
Max payload	t	90	90
Skip fill factor	%	95	95
Moisture	%	2.5	2.50
Effective dry truck capacity	t	83.4	83.8
<u>Cycle</u>			
Number of passes		3	3
Minutes per pass		0.53	0.57
Minutes to load		1.6	1.7
Suggested machine		90 t	90 t

16.6.4.3 Haulage Cycles

The haulage cycle is made up of four principal components; loading, exchange, dump and travel time. The loading time is dependent on the shovel. The exchange time is dependent on the shovel and truck. The travel and dump times are dependent on the truck.

Loading time is largely fixed, although will vary a little from load to load. Exchange time is the time it takes for one truck to pull away and the next to reverse into position. This should be largely fixed, although it may vary if there are any delays due to bunching. Dump time should be largely fixed. Travel time is by far the largest component of the cycle time and has been calculated to be approximately 21 minutes on average, representing about 85% of the total cycle time.

The travel time is made up of several principal components:

- In the case of the highwall it is the shovel to the in-pit ramp, the in-pit ramp(s), the in-pit haul on the working benches, the pit rim to the principal haul roads and the principal haul roads. The return journey is the reverse of this.

- In the case of the open pit it is the shovel to the ramp bottom, the ramp itself, the ramp top to the principal haul roads and the principal haul roads. The return journey is the reverse of this.

The haul times depend on a number of factors, including the length and grade of the segment, the rolling resistance, the truck speed and the load. The speeds vary depending on the segment of the route. A minimum speed of 15 km/h and a maximum site speed limit of 30 km/h have been used.

Average distances for each segment have been used:

- In the case of the highwall the in-pit components vary depending on the phasing, whereas the principal haul road distances are fixed.
- In the case of the open pit, the ramp length varies as the depth increases, so an estimate has been made of the depth and hence length of ramp, on an annual basis. As the length of the route increases and the proportion of that length that can be used at a given speed, so the number of trucks increases.

Estimates have been done for the waste and ore routes separately:

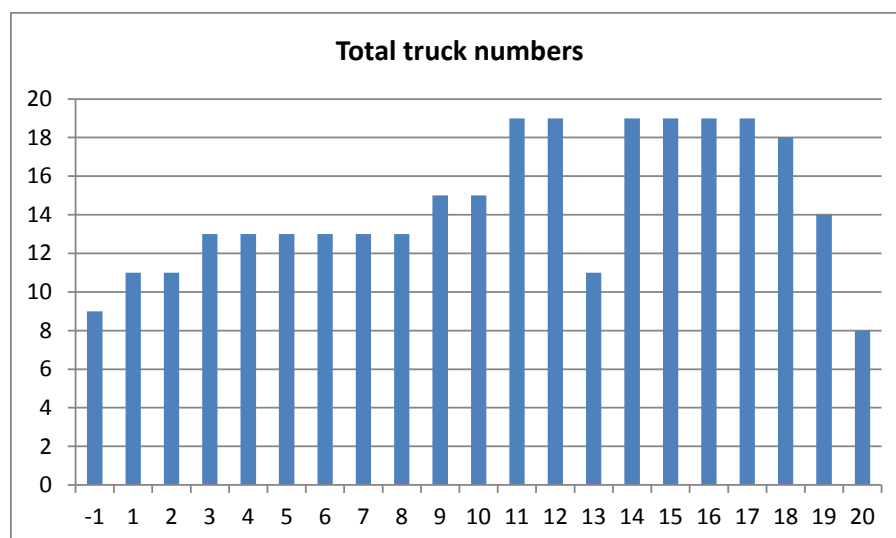
- The return waste haul ranges from 5.6 km to 10.7 km with an average of 8.7 km.
- The return ore haul ranges from 2.6 km to 9.4 km with an average of 6.2 km.

There is considerable variation from one period to another and for waste and ore so many haul profiles have been created to estimate the truck numbers.

16.6.4.4 Haulage Truck Numbers

From the cycle times, speeds and other data it is possible to calculate the truck numbers. These have been estimated for each year according to the haul distances and combined into an annual chart (Figure 16.24) based on the discussions presented above.

Figure 16.24
Number of Trucks Required Annually



By having the same size shovel and trucks for both waste and ore the objective is to try to have a relatively even number of trucks for periods at a time. This has to tie in with the production schedule and it is evident from the above chart that there are one or two periods when this is difficult to achieve. Careful planning of the haul routes during operations will be necessary.

16.6.4.5 Dust Suppression

Dust suppression will be accomplished by using one 91 t converted truck. These trucks have water tanks of 90 000 L capacity and a spray bar at the rear of the truck which is operated from the cab. Water is sprayed over the width of the haul road to allay the dust during dry periods. This machine may also be used to transport water to other locations.

The number of water trucks required has been based on the surface area of the haul roads, a discharge rate of 2 850 L/min and a spreading rate of 4 m² L/d.

16.6.4.6 Ancillary

Ancillary equipment includes two 66 t tracked bulldozers, one 47 t wheeled dozer for cleaning up around the shovels and other areas and two 36 t graders with 4.9 m moldboards. A utility excavator with a 2.8 m³ back-hoe bucket has been allowed for and a small backhoe loader.

16.6.4.7 Stockpiling

Whilst it is not planned to have any major stockpiling an allowance of 10% of production has been allowed for. The ROM stockpiles will require a front end loader (FEL) to re-handle the mineral into the crusher. An oversized machine of 12 m³ bucket capacity will be used, as this can also serve as a standby loading machine in the pit in the event of major breakdown of one of the main fleet.

16.6.4.8 Pumping and Lighting

In pit pumping will be required from sumps. An allowance for eight submersible pumps has been made. The pit will require lighting during the night shift and 14 mobile self-contained generator sets with lighting gantries have been allowed for. These are mounted on sleds that can be pulled by a dozer.

16.6.4.9 Service Vehicles

Service vehicles will be required to maintain the mobile fleet. One fuel and lube truck such as a converted 30 t articulated truck and two tandem boom service and tyre trucks have been allowed for. Twelve double cab pickups have been allowed for.

16.6.4.10 General

The equipment schedules are presented in Table 16.14 and Table 16.15.

Table 16.14 Equipment Schedule – Initial	
Machine Type	No.
Waste Shovel	1
Ore shovel	1
Rigid dump truck	9
FEL (Stocks)	1
Track Dozer	1
Wheeled dozer	1
Grader	1
Water bowser	1
Drill	3
ANFO truck	1
Fuel & lube truck	1
Service & tyre truck	1
Utility excavator	1
Pick up	8
Lights	10
Pumps	8
Total Equipment	47

Table 16.15 Equipment Schedule – Maximum	
Machine Type	No.
Waste Shovel	1
Ore shovel	1
Rigid dump truck	19
FEL (Stocks)	1
Track dozer	2
Wheeled dozer	1
Grader	2
Water bowser	2
Drill	5
ANFO truck	1
Fuel & lube truck	1
Service & tyre truck	2
Utility excavator	2
Pick up	12
Lights	14
Pumps	8
Total Equipment	74

Not all items may be required at any one time so the actual compliment may be less than 74.

16.7 LABOUR REQUIREMENTS

Labour has been split into Machine Operators, Maintenance, Management and Technical. The number of machine operators is dependent on the number of machines. These are largely fixed except for the trucks, which build up and tail off as discussed above. A complement of four machine operators have been allocated per machine to allow for the 12 hour shift rota. An absenteeism allowance of 14% of the primary earthmoving machines (shown in italics below) has been made. Labour requirements are presented in Table 16.16 and Table 16.17.

Table 16.16 Machine Operators – Initial	
Machine Type	No.
<i>Waste shovel</i>	4
<i>Ore shovel</i>	0
<i>Rigid dump truck</i>	36
<i>FEL (Stocks)</i>	4
<i>Track dozer</i>	4
<i>Wheeled dozer</i>	4
<i>Grader</i>	4
Water bowser	4
Drill	12
ANFO truck	4
Fuel & lube truck	4
Service & tyre truck	4
Utility excavator	4
Pick up	4
Lights	4
Pumps	4
Absenteeism	8
Total Operators	108

Table 16.17 Machine Operators – Maximum	
Machine Type	No.
<i>Waste shovel</i>	4
<i>Ore shovel</i>	4
<i>Rigid dump truck</i>	76
<i>FEL (Stocks)</i>	4
<i>Track dozer</i>	8
<i>Wheeled dozer</i>	4
<i>Grader</i>	8
Water bowser	4
Drill	20
Fuel & lube truck	4
Service & tyre truck	8
Utility excavator	8

Table 16.17 Machine Operators – Maximum	
Machine Type	No.
Pick up	4
Lights	4
Pumps	4
Absenteeism	15
Total Operators	183

Not all labour may be required at any one time so the actual compliment may be less than 183.

16.7.1 Management, Technical, Operations and Maintenance

The management section consists of both managers and technical personnel. Operations consist of pit supervisors, general labour and blasting crews. The maintenance section consists of foremen, mechanics, electricians, welders, stores and service vehicle crews.

Initially there will be some expatriate staff to assist with start-up operations. There will be a transition period during the first five years of operation when the expatriate staff will be replaced by local staff. Table 16.18 and Table 16.19 show the initial and the maximum staff, the latter occurring in year 6 at the time when all staff are local.

Table 16.18 Management, Technical and Operations Staff		
Description	Pre-Strip	Maximum
<u>Management & Technical - Expat</u>		
Mine Manager	1	0
Mining Technical Services Manager	1	0
Mobile Mining Plant Maintenance Manager	1	0
Mobile Mining Plant Operator Trainer	2	0
Mobile Mining Plant Mechanical Supervisor	1	0
Mobile Mining Plant Planner	1	0
All Expat Staff	7	0
<u>Management & Technical - Macedonia</u>		
Mine Manager	0	1
Mining Technical Services Manager	0	1
Mobile Mining Plant Maintenance Manager	0	1
Mobile Mining Plant Operator Trainer	0	1
Mobile Mining Plant Mechanical Supervisor	0	1
Mobile Mining Plant Planner	0	1
Manager - Deputy Mine Manager	1	1
Superintendent - Mine Operations	1	1
Superintendent - Senior Geologist	1	1
Superintendent - Senior Mining Engineer	0	1
Superintendent - Chief Surveyor	1	1
Professionals - Mining Engineer	1	2

Table 16.18 Management, Technical and Operations Staff		
Description	Pre-Strip	Maximum
Professionals - D&B Engineer	1	1
Professionals - Geology/Geotech	2	2
Professionals - M&E Supervisors	2	2
Professionals - Surveyors	1	2
Professionals - Mine Foreman	2	2
Professionals - Maintenance Superintendent	1	1
Semi Pro - Maintenance Supervisor	2	2
Semi Pro - Shift Supervisor	4	4
Semi Pro - Accounts Admin	1	1
Admin/PA/Secretary/Office staff	2	4
Trainee Mining Engineer	0	2
Trainee Geologist	0	2
Assistant Geotech Eng/Tech	0	2
Survey Technicians	2	2
Pit Technicians/Database Clerk	1	3
All Management & Technical Staff - Local	26	45
Total MTOM Staff	32	45

Table 16.19 Maintenance Staff	
Description	Total
Maintenance Foreman	4
HD Mechanic	16
Electrician	8
Welder	8
Fuel and Lube Farm Operator	8
Maintenance and Tyre Fitter	8
Stores	8
Total Maintenance Staff	60

16.8 CONCLUSIONS

The project is a conventional open pit combined with hillside quarry type mining that utilises large sized mining equipment that will facilitate economies of scale and flexibility in production. The mineralisation shape is conducive to incorporation of a starter pit with higher grade ore to be exploited first. Water is not regarded as a major issue but there will be sufficient ingress to require normal in pit pumping. Production scheduling will play an important role in obtaining the optimum results. Faulting is not considered a major threat.

16.9 RECOMMENDATIONS

It is recommended that various aspects of the project would benefit from some more detailed value engineering studies which would include:

- Hauling of ore directly to the processing plant location rather than hauling and conveying
- Alternative crusher locations
- Drilling and blasting optimisation
- Oxide ore optimisation

16.10 OPERATIONS MANAGEMENT

The operation of the open pit will be by owner's employees. There will be a compliment of machine operators that will work on a rotational basis, supported by a team of management, operations supervision and maintenance personnel.

To achieve high productivity it is important that the prime earthmovers (shovels and trucks) operate at maximum utilisation. This may include "Hot Seat" changeovers at change of shift, truck dispatching systems, break time fuelling and servicing, in-situ maintenance and regular clean-up of working areas.

16.11 HEALTH AND SAFETY

Health and safety is an important issue for the wellbeing of employees but also provides a sound base for efficient operations. A safety department would provide training and information on a regular basis.

16.12 TECHNICAL RISKS AND OPPORTUNITIES

16.12.1 Risks

The 60 degree overall slopes require support and regular monitoring.

The principal haul roads require switchbacks and these require geotechnical assessment and possible support to ensure stability.

The haul road adjacent to the pit rim on the east side coincides with the access road to the plant and is close to the pit rim. This will require regular monitoring to ensure stability of the pit and the haul road cuttings. Support may be required.

Access to the crusher may be compromised if the stability of the "oxide" stockpile is not maintained.

16.12.2 Opportunities

If the crusher is relocated to the plant then there is the potential of increasing the reserve, if the current pit slopes are maintained.

If all the ore is hauled to the plant then the need for the conveyor will be negated.

17. RECOVERY METHODS

17.1 FLOW SHEET DEVELOPMENT

17.1.1 Trade-off Studies

Trade-off studies were completed to motivate the final selection of the process flow sheet. Two main process considerations were reviewed:

- Firstly looking at treating the entire copper flotation tailings through a CIL circuit.
- Secondly using a differential flotation method and rejecting the pyrite flotation tails, which makeup three quarters of the original feed stream. This option also includes looking at the benefit of regrind on the CIL feed material.
- There was also a focus on the viability of including a gravity recovery system into the current milling circuit.

17.1.1.1 Flotation, leach circuit and regrind inclusion

For the flotation/leach trade-off the following three main systems were looked at with some variations to illustrate the options robustness:

- Option 1A - Selective copper and gold flotation with a pre-leach regrind step
- Option 1B - Bulk flotation and CIL on flotation tails
- Option 1C - Selective copper and gold flotation without a pre-leach regrind step.

The flotation leach trade-off study indicates that treating the bulk of the flotation tails in a large CIL circuit out performs the original differential flotation alternatives mainly due to the high costs of Pyrite flotation reagents. Developed from the PIIIR test work, an additional scenario (Option 1Ba) where only the cleaner scavenger tails are treated in a reduced CIL circuit, shows a high degree of promise with NPV and IRR outcomes. This option requires the bulk flotation control and monitoring to minimise gold losses to tails.

Thus the recommendation is to go forward with Option 1Ba. Simplistically the flowsheet consists of bulk copper/Pyrite/Au flotation followed by CIL treating the cleaner scavenger tails only and sending the flotation tails unleached to the tailings management facility. The design should also make provision to retrofit 2 or 3 additional flotation cells to enhance pyrite flotation if required.

Further confirmatory and variability test work defining stage recoveries and optimisation of flotation reagent consumptions are ongoing.

17.1.1.2 Gravity Separation

For the gravity trade-off, two system options were reviewed:

- Option 2A – This is the best case presented in the first trade-off, which was Option 1B (Bulk flotation and CIL on flotation tails)
- Option 2B – Option 2A including gravity

The inclusion of the gravity separation in the milling circuit is not warranted, merely due to the fact that the principle reason for including a gravity circuit would be to recover coarse, free nugget Au in a small

mass of 0.05 to 0.1%. Up to this stage, no free gold nor any nuggets have been observed by studying drills cores or reported by SGS mineralogical studies. The metallurgical test work also indicates very low figures of gravity recoverable gold, which is backed up by mineralogical studies indicating average gold grains of 6.2 microns associated with sulphides and other minerals making it not viable for gravity separation.

Gravity separation shows an insignificant improvement in gold recovery with no significant economic advantage. This option has therefore not been pursued and has been excluded from the final flow sheet.

17.2 FLOW SHEET SELECTION

17.2.1 General

The following sections apply to the test work undertaken for Euromax Resources on the Ilovica Project.

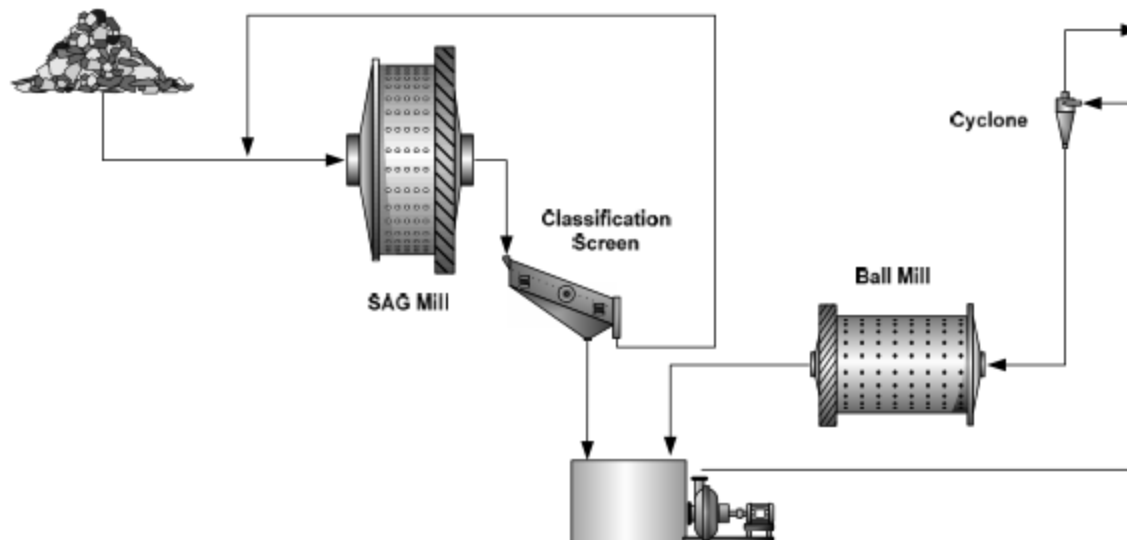
For the evaluation of test results and their application to flow sheet selection, design, equipment sizing and power requirements, the techniques used are generally best engineering practice that are modified according to each project to arrive at the best suited methods for that project, the individual unit operations and the resource material being investigated.

17.2.2 Grinding Circuit Design

17.2.2.1 SGS Canada Design

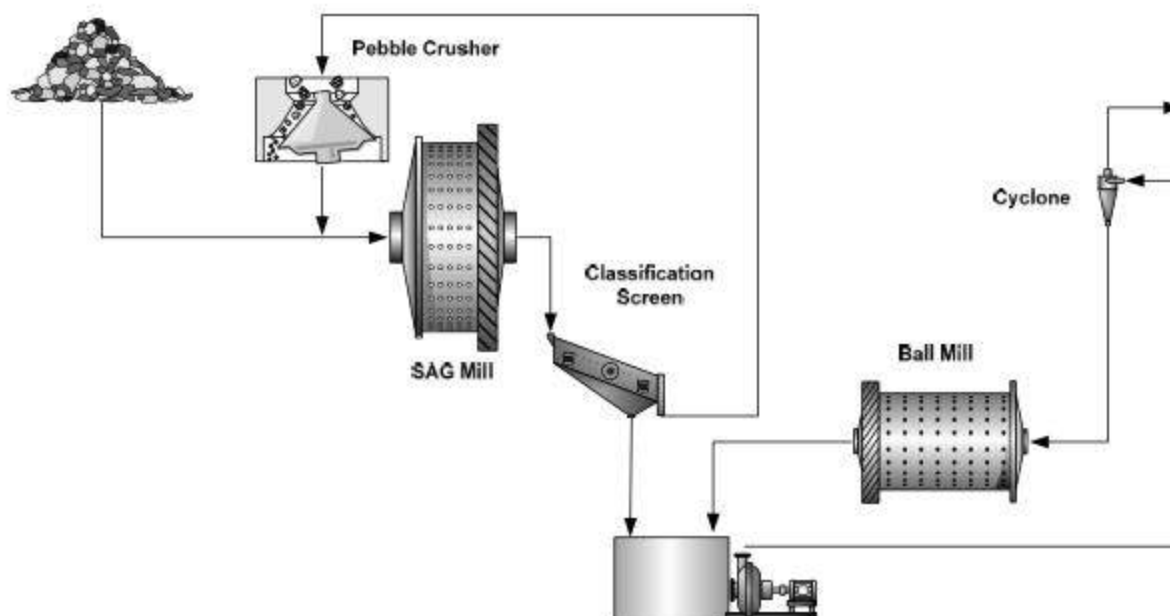
Simulations using JKSimMet software and the test results, were undertaken by SGS Canada on two circuits, each capable of processing 10 Mt/a of ore: semi-autogenous mill/ball mill circuit (SAB) and pebble crushing (SABC) configurations. Typical circuit configurations are shown in Figure 17.1 and Figure 17.2.

Figure 17.1
Typical SAB Flow Sheet



Source: SGS Canada

Figure 17.2
Typical SABC Flow Sheet



Source: SGS Canada

Initially the simulations utilised the SAB circuit. A pebble crusher was then added to make it a SABC circuit. This gave an improved performance and indicated a slightly lower overall power consumption.

The simulations were all based on fixed T_{80} values (particle sizes, at 80% mass passing the indicated sieve size, for transfer from one item of equipment to the next) and a fixed feed rate of ore.

The SGS recommendations resulted in a SABC circuit with a 36.0' x 19.0' SAG mill and 14.6 MW installed power and two ball mills in parallel of 21.5' x 33.0', each with an 8.36 MW motor. The SAG mill was designed to operate with a variable speed drive to cater for hardness variations whilst maintaining a feed rate between acceptable limits. The specific power requirements were simulated as between 8.0 and 10.1 kWh/t for the SAG mill and 9.1 to 13.1 kWh/t for the ball mills.

Assessment for the variability sample data was presented as power consumptions for the above sized mills at the fixed feed rate of 1 250 t/h. The SAG mill required 9.0 MW to 12.7 MW and the ball mills varied from 6.0 MW to 15.9 MW. This results in a variation of total power requirements ranging from 15.0 MW to 28.7 MW, which equates to a specific power range as 12.0 MWh/t to 22.9 MWh/t. The ball mill power variations suggest that with some ores only one ball mill will be required rather than two.

17.2.2.2 Amec Foster Wheeler Design

Simulations were carried out by Amec Foster Wheeler using the Morrell Power methodology, which are summarised in this section. The simulations were applied to the three domain samples as well as the 40 variability samples.

This method does not use a fixed feed rate but allows the feed rate to fluctuate with an upper limit cap of 20%, according to ore hardness. For Ilovica, this puts the upper feed rate limit at 1 500 t/h. Each throughput simulation on the variability samples was run to identify the limiting factor for that particular combination of ore properties: limitations were either the SAG mill, the ball mill stage or the maximum plant flow rate limit of 1 500 t/h. Note that this does not necessarily preclude that the feed rate can be maintained at an annual average of better than 1 250 t/h.

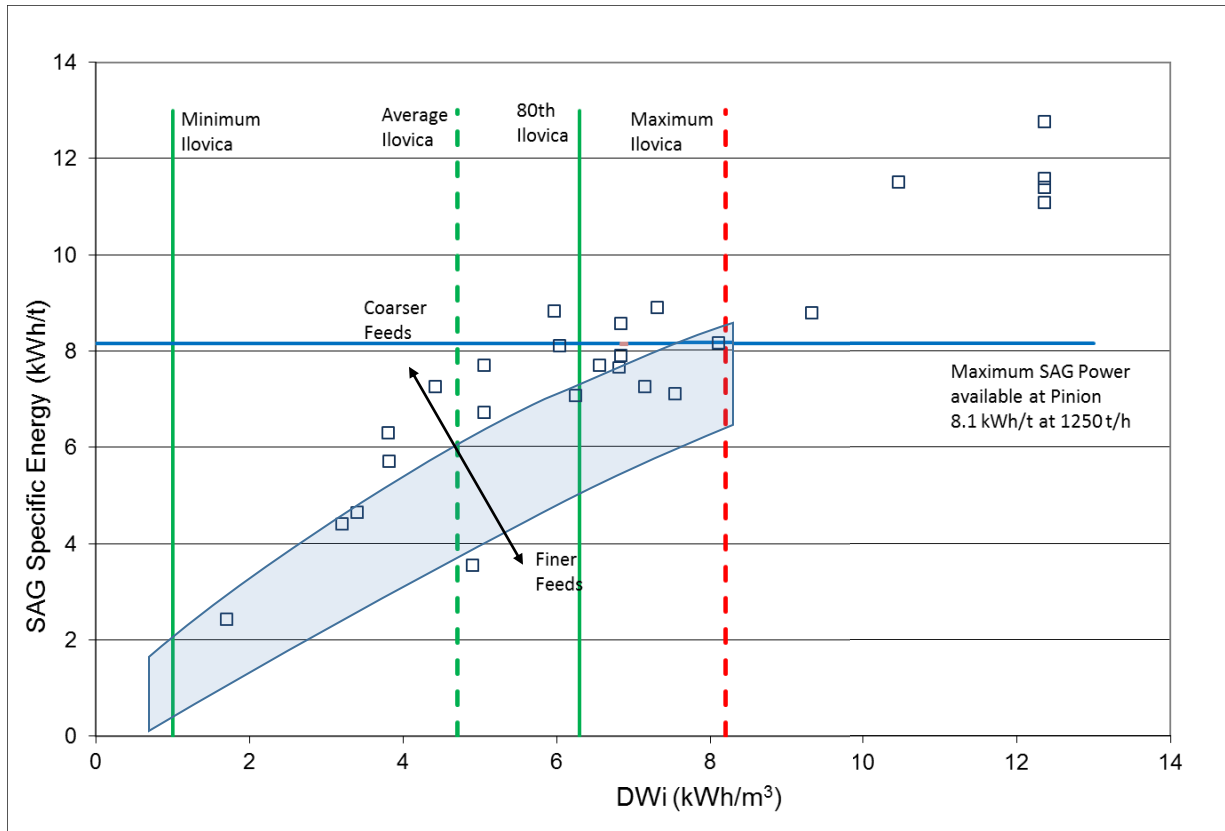
The SAG mill feed particle size distribution, as defined by the F_{80} , is calculated according to ore properties, rather than selecting a fixed value as was the case in the SGS simulations. This ensures that better estimates of the throughput rate and T_{80} (transfer size from SAG to Ball Mill) are achieved. It is expected that the SAG mill F_{80} for this ore will only achieve 150mm if the ore competence (A_{xb}), is < 35. Estimates were made (using two relationships, JK and Morrell) for each variability sample, which indicated SAG mill feed F_{80} values of 89 mm at $A_{xb} = 54.2$ (average ore value) and 109 mm at $A_{xb} = 40.2$ (80th percentile). For this ore, it is estimated that the T_{80} will vary from 2.5 mm for average ore, rising to 5 mm when the A_{xb} value is incompetent with A_{xb} values of more than 150. A full description of the F_{80} and T_{80} estimation techniques are given in the Mill Design report¹⁵.

Mill speed was kept constant in the variability simulations but is available to operators for control purposes.

The approach to the simulations used Morrell's power method based on the SMC test results of M_{ia} , M_{ih} and M_{ic} and the M_{ib} derived from the Bond grindability tests. The SAG mill design was bench marked against the Amec Foster Wheeler data base as shown in Figure 17.3. The simulations were completed by utilising a statistical approach and a JKSimMet simulation.

¹⁵ S2233-0000-DC00-RPT-0006, Mill Design Calculations - Reworked Calculations with full Comminution Data Set, October 2015.

Figure 17.3
SAG Mill Bench Mark Analysis



Notes:

"The vertical green lines show the extent of the design range for Ilovica in terms of competence as measured by the DWI or Drop Weight Index across the 40 variability samples. The upper point for design is generally accepted as being the 80th percentile. The red line shows the most competent sample out of the 40 and is above the required design point.

At a given competence (DWI) some plants have high power requirements and some are low. High power requirements are associated with coarse feed size distributions and low power requirements are associated with fine feeds. This is indicated on the graph by the double headed arrow. Observations of Ilovica ore strongly suggest it will occupy the fine feed part of the design space.

The blue horizontal line represents the specific energy the selected mill (11 MW SAG able to deliver 10.2 MW maximum at the pinion) can deliver to 1250 t/h of feed.

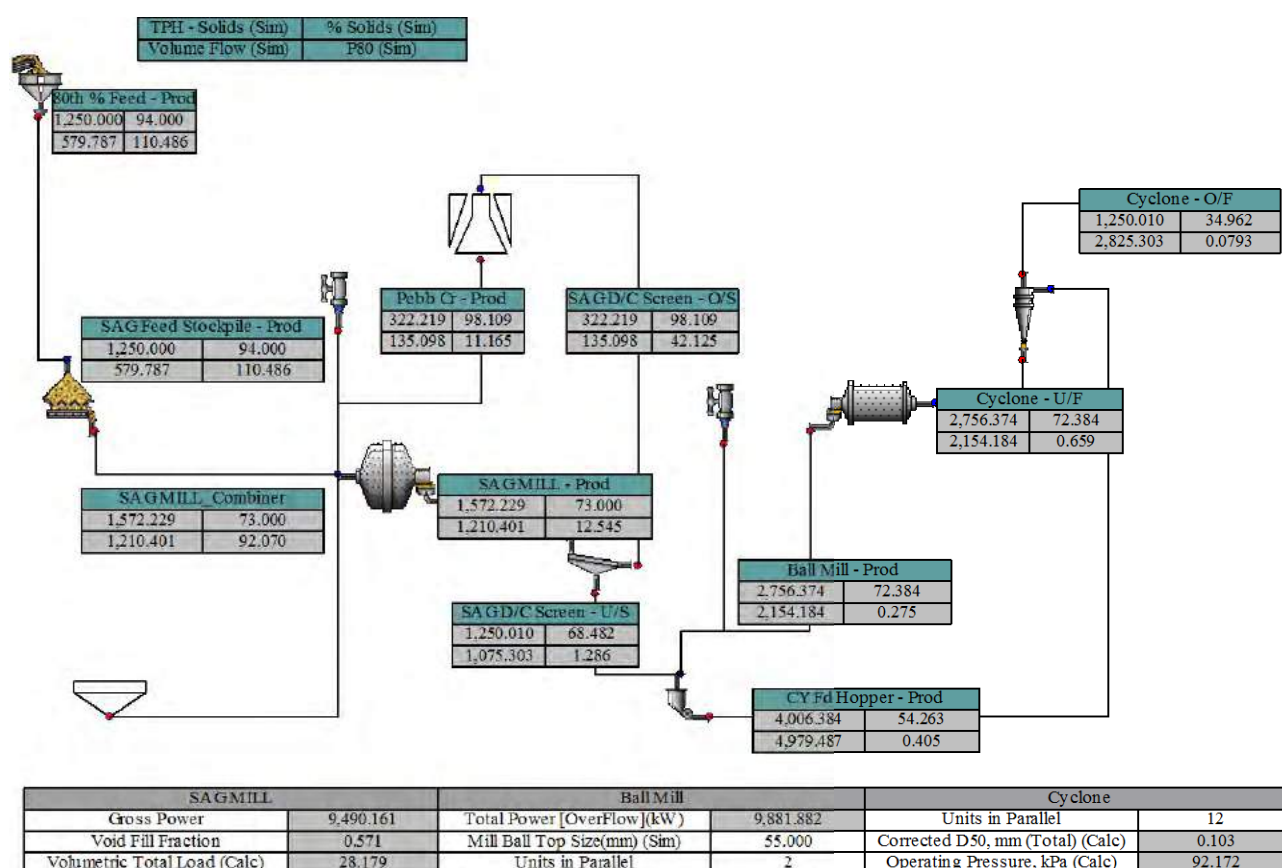
The blue shaded area represents where Amec Foster Wheeler expects the Ilovica SAG mill to operate. This is called the design envelope. The upper boundary of the design envelope crosses the 80th percent vertical green line well below the blue SAG power limit line. This means that the 80th percentile ore should be able to be treated at greater than 1250 t/h in this mill.

The small portion of the design envelope that is above the blue SAG power limit line represents conditions under which the circuit will not be able to treat ore at 1250 t/h due to SAG power limitation. This small amount of restricted operation will not prevent the mill providing at least 1250 t/h of feed in a typical year."

This benchmark analysis shows that the Amec Foster Wheeler specified SAG mill will deliver the required 1250 t/h average rate (or greater).

The Amec Foster Wheeler recommendations resulted in a SABC circuit with a 34.0' x 18.0' SAG mill and 11.0 MW motor power and two ball mills in parallel of 22.0' x 38.0', each with a 10.0 MW motor. The annotated flow sheet under equilibrium conditions is depicted in Figure 17.4.

Figure 17.4
Annotated SABC Flow Sheet



17.2.2.3 Grinding Circuit Selection

The results from the simulations on MC samples and the variability samples were compared. The results showed that with the average and 80th percentile ores, the selected mills were operating at less than their maximum loadings. There is predicted to be SAG mill power available for even higher competence ores.

The Amec Foster Wheeler mills are appropriate selections based on the simulation method used.

17.2.3 Gravity Recoverable Gold

GRG tests were carried out as part of PIIR. The results, including mineralogical examinations, were considered as part of a trade-off study as described in Section 17.1.1.2. The results did not show any advantage in including this and consequently this has been excluded from the design.

17.2.4 Flotation Circuit Design

The flow sheet was selected based on PIIR test work and should be confirmed by the ongoing PIII test work as described below.

17.2.4.1 PII Test Work

Initially from the PII work, it had been indicated that there was no advantage to producing a rougher scavenger concentrate as a separate pyrite concentrate when compared to a single bulk flotation concentrate. The majority of the work in PII was aimed at establishing the optimum PSD for flotation and the reagent suite, as well as kinetic tests to optimise the required cell retention time for best recoveries and grades. The relevant tests, selection of reagent suite and cell residence times are clearly given in Section 13.3.2, centred on rougher flotation to a large extent. LCTs were undertaken to give a closer indication of grades and recoveries that could be expected in plant operations.

It was concluded at the end of the PII tests that the work had not been fully optimised and that further work would be needed to achieve a basic circuit design.

17.2.4.2 PIIR Test Work

This work continued the PII test work on a residual MC sample and also added two variability samples from an area which was proposed to be part of the early mining production.

Tests extended the PII basis to rougher kinetics, reagent suite confirmation, cleaner flotation conditions including the PSD required for optimum production of grade and recovery into the final concentrate. The work culminated in LCTs on the MC, high and transitional composites. A re-grind of the rougher concentrate prior to cleaning was initially indicated to show some advantage but was not considered to be definitive at that stage. However the lack of clear definition justified the retention of a concentrate re-grind until disproven.

The flow sheet design was established at this point and is based on the LCT results presented in Figure 13.3 and Table 13.10.

17.2.4.3 PIII Test Work

The results obtained in PIIR were judged to require confirmation, particularly on composite metallurgical samples representing the first few years of operation and on a set of variability samples covering extended portions of the resource. These were initiated as PIII, which is in progress.

Initial results have been received and are presented in Section 13.4.3. There are no indications, as yet, that the flow sheet design established from the PIIR work requires any changes. This comment also applies to the variability samples.

The test did indicate a larger extent of oxide Cu in the samples that appeared to have an influence on flotation recoveries. However it is necessary to wait for completion of the test work before a full evaluation can be done.

17.2.5 Cyanide Leaching and Adsorption Tests

The flow sheet was selected based on PIIR test work and should be confirmed by the ongoing PIII test work as described below.

17.2.5.1 PII Test Work

A diagnostic leach was undertaken on the Cu cleaner tails. This confirmed that the material was amenable to cyanide leaching. Individual kinetic leach tests were undertaken on oxide ore and flotation rougher tailings, reported in Section 13.3.4.1. The results were all positive, confirming that cyanide leaching was an acceptable Au recovery method. There were indications that the presence of Cu and sulphides may require attention to ensure the selection of optimum leach conditions.

17.2.5.2 PIIR Test Work

Limited leaching kinetics shown in tests were undertaken on three samples chosen to be close to the material expected to be used for the plant operations. These were a combination of cleaner scavenger tailings and pyrite (rougher scavenger) concentrate. The results are presented in Table 13.11. The extraction of Au by cyanide into solution was taken as 87%, this being the value after a 20 µm re-grind. The sample without a re-grind showed a lower extraction of approximately 84%. The H and T samples were known to be a minor constituent of the plant feed and did not show any need to modify the circuit design indicated by the first two samples in terms of volume capacity and retention time. The results also indicated the need to extend the leach work for confirmation.

Until adsorption tests are done, the loss of Au to the CIL tailings is assumed to be minimal and this is reflected in the recovery of Au being taken as equal to the extraction.

Very little adsorption work was undertaken, insufficient to do any modelling. Consequently Amec Foster Wheeler used data similar to the Ilovica material to model the leach test work into a CIL plant and take it forward to a design for the circuit.

It was obvious, during both this work and some of the previous PII work, that there were leach interferences, apparently arising from the Cu, S and Fe contents in the leach head material. This would effectively reduce recovery and increase reagent consumption. Hence part of the PIII work would concentrate on establishing quantitative data for minimisation of these effects.

A trade-off study (Section 17.1.1.1) indicated that it would be advantageous to utilise the cleaner scavenger tailings only for the CIL circuit rather than a combined cleaner scavenger tailings and pyrite concentrate. This material would be examined during the PIII test work.

17.2.5.3 PIII Test Work

PIII test work is in progress and no results are available as yet.

The final design confirmation will take the test results and model them for the full CIL circuit. This will not only confirm the circuit size but also define the reagent usage, concentration in solution and the carbon movement and loading.

17.2.5.4 Elution and Electro-winning

PIIR test results indicates potential high Cu content on the activated carbon. This could impact through to the doré and as such tests were included in PIII to examine options for reducing the carry through of Cu to the doré.

In terms of overall recovery there is no significant loss from this final operation since all streams exiting this circuit are recycled to the CIL circuit.

17.2.6 Design Criteria

The main plant design criteria have been based on data from various sources as referenced and is summarised in Table 17.2. The individual reference codes are presented in Table 17.1.

Since the data was based on the PII and PIIR test work, a number of assumptions have been made in the criteria for the current design. It is of particular importance to note that these assumptions will be confirmed when the ongoing PIII test results have been received and evaluated.

Table 17.1 Design Criteria References	
Reference Key	Source of Information
1	Euromax Resources advice/correspondence
2	Agreement between Euromax Resources and Amec Foster Wheeler
3	Test work data
4	Amec Foster Wheeler recommendation
5	Amec Foster Wheeler experience/database
6	Calculated data
7	Estimated data
8	Vendor data
9	Site conditions and details
10	Industry standard specification
11	Literature
12	Assumed

Table 17.2 Plant Design Criteria				
	Units	Value	Comments	Ref
Site Data				
Location		Macedonia		1
Site Elevation	m AMSL	850		9
Rainfall				
· Maximum (1 hour period)	mm	15.3	2yr return period	9
· Maximum (24 hour period)	mm	52.1	2yr return period	9

Table 17.2 Plant Design Criteria				
	Units	Value	Comments	Ref
General Operating Parameters, Availability and Utilisation				
Operating Schedule				
· Operating Days / Year	#	365		4
· Operating Hours / Day	#	24		4
· Shifts / Day	#	3		7
· Hours / Shift	#	8		6
Availability and Utilisation				
Crusher Operating Time	%	70.2		4
Crusher Operating Time – Hours	h/a	6 150		6
Processing Plant Operating Time	%	91.3		4
Processing Plant Operating Time – Hours	h/a	8 000		6
Throughput				
Plant Throughput	t/a	10 000 000		1
Crusher Throughput	t/h	1 626		6
Processing Plant Throughput	t/h	1 250		6
ROM Ore Physical & Chemical Characteristics				
Type of Deposit		Porphyry copper-gold		3
Bulk Density	t/m ³	1.75		3
Solids SG		2.75		3
Moisture	% m/m	2		3
Maximum Feed Size (F ₁₀₀)	mm	1 000		1
Plant Feed Grade, Design	% Cu	0.22		1
	g/t Au	0.34		1
	g/t Ag	0.5		1
Comminution Indices				
Average Abrasion Index	g	0.162		3
Bond Crushing Work Index (Design)	kWh/t	10.3		3
Pebble Bond Crushing Work Index (Design)	kWh/t	17.5		6
Axb (SMC Test) Average		54.2		6
DWI Average	kWh/m ³	4.71		6
SAG Specific Energy (using Recommended Design DWI) Granodiorite	kWh/t	7.85		6
Bond Ball Mill Work Index (BWi) Design	kWh/t	16.8	Max value	3
Bond Rod Mill Work Index (RWi) Design	kWh/t	16.4	Max value	3
Metallurgical Recovery & Metal Production				
Plant Recovery, Design	% Cu	82	In concentrate	3

Table 17.2
Plant Design Criteria

	Units	Value	Comments	Ref
	% Au	86	Total into concentrate and doré bars	3
	% Ag	60	Total into concentrate and doré bars	8
Final Concentrate				
-Production	t/a (dry)	78 800		6
-Grades	% Cu	24		3
	g/t Au	28		3
	g/t Ag	111		7
Doré Bars				
-Production	t/a (dry)	2.46		6
-Grades	% Cu	24.4		3
	% Au	26.7		3
	% Ag	48.8		7
Water and Process Materials				
Water	m ³ /h	723.2	Total requirement (1)	6
	MI/a	5.8		
	m ³ /t ROM	0.57		6
Sodium cyanide	t/a	1 092		6
Lime (CaO)	t/a	1 932		6
Lead nitrate	t/a	252		6
Flocculant	t/a	588		6
Sodium hydroxide	t/a	59		6
Hydrochloric acid	t/a	840		6
Sulphuric acid	t/a	4 368		6
Sulphamic acid	t/a	274		6
Sodium metabisulphite	t/a	1 848		6
Activator	t/a	3		6
Sodium silicate	t/a	7 875		6
Frother – MiBC	t/a	368		6
Collector – Aero 7249	t/a	1 050		6
Collector – PAX	t/a	0		6
Hydrogen peroxide	t/a	8		5
Activated carbon	t/a	151		5
Oxygen	t/a	38		5

Notes: Excludes rain and run-off captured in the TMF.

17.2.7 Process Description

The below process description can be read in conjunction with the schematic flow sheet in Figure 17.5.

17.2.7.1 Comminution

ROM ore with a feed size F_{80} of 416 mm is transferred via haul trucks to the process plant and dumped directly into the ROM bin. Material is drawn from the ROM ore bin by gravity into the crusher. A primary crusher product with a product particle size P_{100} of 318 mm is produced. The crush product is discharged to the coarse ore stockpile.

Grinding is carried out in a two-stage milling circuit with pebble crushing. The primary mill duty is performed with a SAG mill and the secondary mill duty is split between two parallel ball mills. Crushed ore feeds into the SAG mill where it is pulped with water. The SAG mill is sized to operate with a ball charge of 12% by volume and a total charge of 30% by volume. Trommel screen undersize discharges into the mill discharge hopper and screen oversize with a top size of 75 mm feeds into the pebble crusher.

The pebble crusher product with a P_{80} of 13.2 mm is recycled to the SAG mill.

The mill discharge slurry is diluted in the common mill discharge sump with water for density control. The slurry is pumped to two separate ball mills via cyclone clusters for classification in a closed ball mill circuit. The milling circuit is designed to target a flotation feed F_{80} of 75 microns.

The pulp is discharged from each ball mill via a ball mill trommel screen into the mill discharge hopper. Ball mill trommel screen undersize is discharged into the mill discharge hopper for cyclone classification. The oversized scats are discharged into the separate ball mill scats bunkers. The ball mills are sized to operate with 29% ball charge by volume.

17.2.7.2 Flotation

Cyclone overflow discharges into the flotation conditioning tanks via trash screens. Each flotation bank has a conditioning tank used for reagent dosing and pH adjustment where required.

Rougher and rougher scavenger concentrate is collected and feeds into the regrind circuit. The rougher scavenger tails are discharged into the tails thickener for tailings disposal. The regrind circuit is designed to target a mill product P_{80} of 25 microns. Milled slurry feeds into the cleaner flotation circuit. The cleaner flotation circuit consists of cleaner, cleaner scavenger and recleaner cells. Cleaner concentrate feeds into the recleaner cells. Recleaner concentrate is dewatered and stored as concentrate. The cleaner tails feeds the cleaner scavenger cells. Cleaner scavenger concentrate and recleaner tails are recycled to the cleaner circuit conditioning tank. Cleaner scavenger tails feeds into the leach and CIL circuit for further processing.

17.2.7.3 Final Concentrate

Recleaner concentrate is thickened in the concentrate thickener with an underflow slurry solids concentration of 55%. The slurry is pumped to a plate and frame membrane squeeze filter for final dewatering. The filter cake is stored on the concentrate stockpile.

17.2.7.4 Leach and Adsorption, Elution, Electro-winning and Gold Room

Slurry from the cleaner scavenger tails is thickened in the pre-leach thickener to a slurry solids concentration of 55% solids by mass. The slurry is pumped to the leach circuit and is contacted with lime solution and lead nitrate. Lead nitrate is used to enhance gold recovery and lower cyanide consumption by inhibiting the dissolution of metallic sulphides. Lime is used to control the pH above 10.5. Oxygen is sparged into the leach tank to promote an oxidising environment.

The slurry from the leach tank overflows into the counter-current CIL circuit for gold adsorption. The carbon is contacted with leach slurry for where it adsorbs the gold and other metals that are in solution. Slurry from the last CIL tank is transferred to the post CIL leach thickener. The thickened slurry is passed through a cyanide detoxification step before discharging the tails to the TMF.

The carbon slurry is pumped from the last CIL tank counter current to the leach slurry up the series to CIL tank 1 allowing metal loading onto the carbon. The loaded carbon is removed from CIL tank 1 and transferred to the acid wash column.

The acid wash step is used to remove any calcium on the carbon. Once acid washed, the carbon moves to the elution stage. During elution, the metals are removed that have then been adsorbed onto the carbon in the CIL. The solution that has stripped the metals from the carbon is plated onto electrodes in the electro-winning cells. The metal "sludge" is washed off the electrodes and filtered to remove excess water. Filter cake is calcined and smelted to produce doré bars.

Eluted carbon from the elution column is transferred to the eluted carbon screen. Screen oversize is washed into the eluted carbon hopper, where it is regenerated in a rotary kiln at 650°C. The kiln discharges into the regen carbon transfer tank. The regenerated carbon is diluted and pumped to the CIL circuit. New carbon is transferred with water to the CIL circuit as required in the same way.

17.2.7.5 Tails Management Facility

Tails streams from the process circuit are combined and thickened to an underflow slurry solids concentration of 50% solids by mass. The thickened u/f is pumped to the tails disposal feed box together with cyanide destruction tails. From the TMF feed tank slurry is pumped to the tailings management facility. Water is reclaimed from the TMF returned to the process water dam. TMF seepage water is drained into the TMF embankment storm water dam.

17.2.7.6 Water Circuit

The majority of the off site water is stored in the Ilovica reservoir. From the reservoir, water is pumped to the process plant for potable, fire and process water consumption. Raw water is distributed from the raw water dam.

Raw water from the raw water dam is filtered and chlorinated in a potable water system to be utilised for domestic purposes at the offices, the change houses and for drinking water.

The process water dam receives water from the concentrate thickener overflow, the pre-leach thickener overflow, the tails thickener overflow, pit dewatering tank as well as reclaim and storm water from the TMF embankment and mine infrastructure storm water dams. Raw water is used to make up for process water losses. There are two water distributions that draw water off the process water dam. The first

process water distribution supplies process water to the mills for dilution and to the lime slaker as well as flushing and hosing water. The second process water distribution supplies spray water to the mill, SAG mill and ball mills' trommel screens.

Storm water dams across the mining complex collect run-off for return to the process water dam for re-use within the plant, reducing the fresh water makeup requirement.

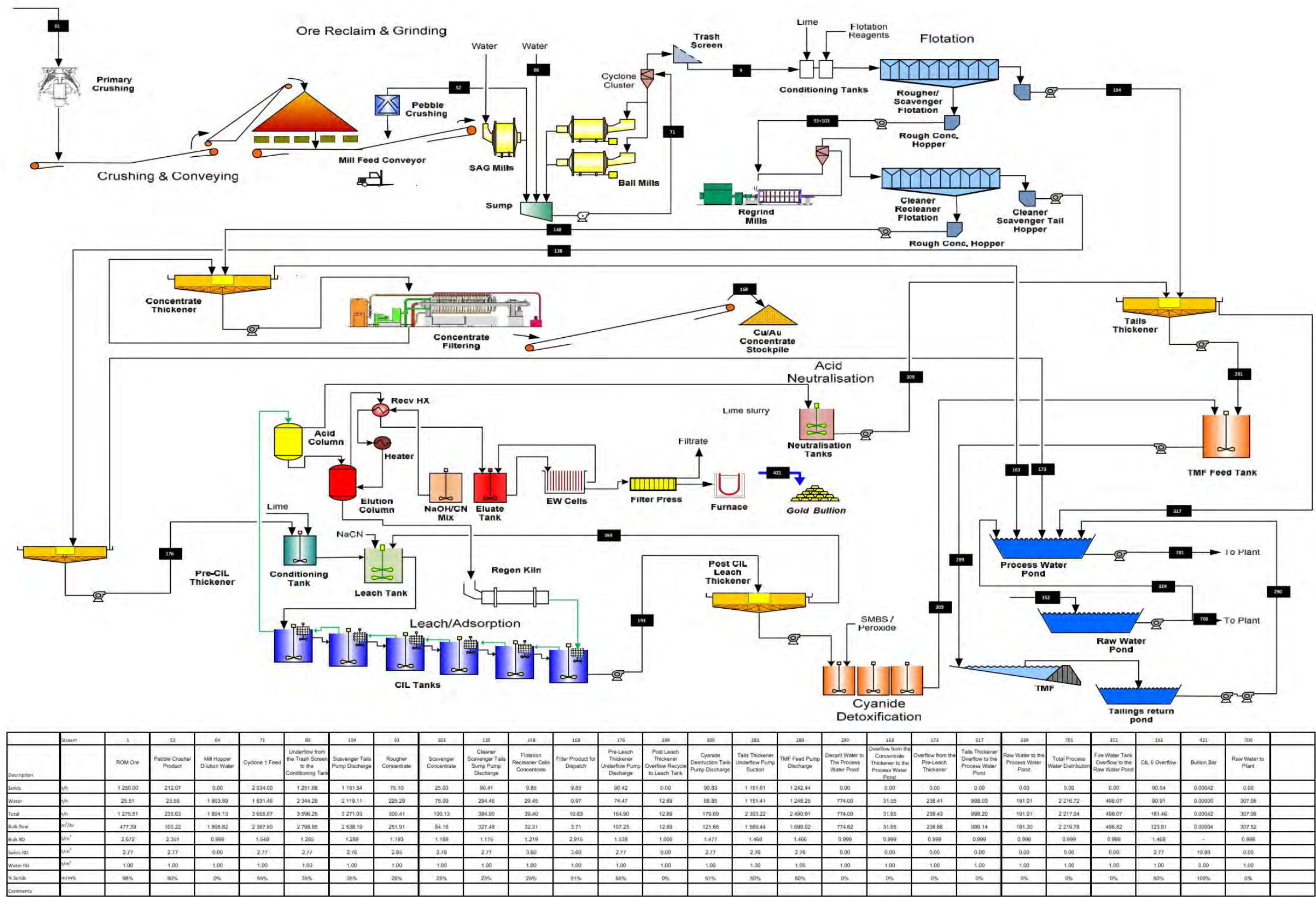
17.2.8 Mass and Water Balance

The mass and water balance is limited to the processing plant only. The material and water balances external to the process plant have not been included in the process related sections of this document, except for the inclusion of return of supernatant water from the TMF and the raw water feed as makeup water for plant and TMF losses.

The process mass and water balances have been reported for the design tonnage and head grade case of 10 Mt/a and with a 0.2% Cu and 0.34 g/t Au head grade respectively.

The typical head grade used is based on the long term average of the mine plan. The high level mass and water balance is presented along with the schematic flow sheet Figure 17.5.

Figure 17.5
Schematic Flow Sheet



17.2.9 Process Control Philosophy

The Ilovica processing plant facility will be automated and controlled to ensure a safe, stable and efficient operation. A control centre is provided for control room operators to monitor the status and control the operation of the process plant via a programmable logic controllers (PLC) and supervisory control and data acquisition (SCADA) system. All measurement and control signals are sent to the centralised control centre where programmed algorithms maintain the process plant in a controlled and stable state. The control room operators monitor the state of the process and will take overriding action where such action is required due to changing requirements in the plant, or to correct deviations from the desired state. These actions will include selecting standby equipment, bypassing failed equipment, changing control set-points, and reporting production figures, equipment failures and process deviations to the appropriate personnel so that corrective actions may be initiated. It is through the control centre that the overall performance and effectiveness of the process plant is monitored and controlled. Some plant areas will be managed in field units or local control panels with inputs into the main plant control room for monitoring purposes only.

The control room operators are in contact with operations and maintenance personnel on the plant in order to communicate when manual interventions are required. A detailed functional specification will be developed in the next phase of engineering.

17.2.10 Metallurgical and Assay Laboratory

The metallurgy and assay laboratory provides for the receipt, processing, preparation and assay of a daily number of samples as solid, slurry, solution and carbon. The samples will, generally, be analysed for Au, Cu, Fe, S. Physical attributes, such as particle size analysis, solids content of slurries, moisture content of final concentrate, will also be determined.

These samples and their associated analysis are required to monitor and control process operations: grinding and flotation circuit efficiency, carbon adsorption, elution, regeneration and electro-winning circuit efficiency and performance. Monthly composites will be prepared for accounting samples as well as shipment samples of final concentrate. The accounting samples and analyses will be to a significantly higher standard than the routine plant control samples.

17.3 ENGINEERING

17.3.1 Engineering Development

During the FS, engineering and supporting documentation were produced that formed the basis of the enquiry documentation. This documentation included:

- Project Basis of Design
- Document and Engineering Numbering Procedure
- Supplier Documentation and Data Requirements
- Supplier Quality Requirements
- QA/QC Inspection Procedure
- Transport, Packaging and Handling Procedure
- Health, Safety, Security and Environment (HSSE) Specification and Requirements for Contractors

- Spill Prevention and Control Procedure.
- Waste Management Plan and Facility Specification
- Emergency Response and Crises Management Plan
- Employee Relations Policy
- Employee Project Requirements
- Procurement Operating Plan
- Procurement and Contracting Strategy
- Procurement Risk Plan
- Procurement Process Plan
- Concept Closure Plan

Following site visits and layout reviews the site and plant layouts (Figure 18.1 and Figure 18.2) and the 3D model were developed and optimised from initial historical data and further refined as additional information became available during the FS. Engineering development, based on the initial layout for the plant and infrastructure, allowed for the constraints of the ROM pad location and site topography.

The above deliverables together with the process design was utilised by each of the engineering disciplines to produce discipline specific engineering documentation.

17.3.2 Civil

17.3.2.1 General

This section of the report covers work associated with reinforced concrete. Other elements of the civil engineering as listed below are covered in Section 18.1 of this report.

- Earthworks
- Roads
- Storm Water Management
- Earth Dams
- Buried Services
 - Water
 - Sewers
- Site Fencing
- Sewage Treatment Plants
- Architectural Buildings

17.3.2.2 FS Execution Methodology

Concrete design is in accordance with the civil design criteria and is based on South African Standards with consideration to conditions likely to be encountered in Macedonia including:

- Seismic Loading
- Wind Loadings
- Snow Loadings
- Founding requirements based on the geotechnical site investigation undertaken for the site.

The following documentation was prepared for contractors to tender on:

- Civil specifications including:
 - Civil Specification – Concrete Work
 - Civil Specification – Holding Down Bolts
 - Civil Specification – Bolt Tightening Procedure
 - Specification – Grout Materials and Placement
- Civil scope of works for reinforced concrete
- Concrete bill of quantities (BOQ)
- Concrete drawings

The drawings and quantities were continuously revised to align with the latest mechanical layout.

Telephonic conferences were held with the contractors to clarify and confirm the rates and prices received and to confirm that the work would be undertaken as envisaged.

The rates received from the contractors were applied to revised quantities and were used as a basis to determine a preliminary cost estimate for Euromax Resources review. Based on Euromax Resources' review of the preliminary cost estimate the design was modified and quantities updated for use in the final FS cost estimate.

A concrete commercial adjudication was completed based on tenders received from contractors.

17.3.2.3 Major Concrete Structures

The estimated quantity of concrete required is approximately 55 000 m³. The following areas have been identified as major contributors.

• Foundations for the SAG Mill, Ball Mill and Screening building	7 400 m ³
• Coarse ore stockpile tunnel	7 000 m ³
• Process plant - pipe and cable racks	4 000 m ³
• Culvert under oxide ore stockpile	3 750 m ³
• ROM conveyor	3 100 m ³
• ROM crusher concrete work	3 000 m ³
• Tailings thickener	2 150 m ³

17.3.2.4 Future Considerations for Design Phase

The following items will be taken into account in the future design phase:

- Ensure that concrete construction is not scheduled before certified mechanical layouts and loads are received.
- Finalise civil design criteria and Specifications to Macedonian/European standards and norms.
- Confirm dimensions of local Macedonian reinforcing.
- Ensure that each concrete contractor has his own batch plant on site.
- Establish mechanism for contractors to produce reinforcing bending schedules and to review the bending schedules.

17.3.3 Structural

17.3.3.1 General

This section of the report covers work associated with structural steel that is part of the structural, mechanical, piping and platework (SMPP) package.

17.3.3.2 FS Execution Methodology

The design of structural steel was undertaken in accordance with the structural steel design criteria based on South African Standards with consideration to conditions likely to be encountered in Macedonia including:

- Seismic loading
- Wind loading
- Snow loading

The following documentation was prepared for contractors to tender on:

- Scope of works - Structural steel erection which has been included in the SMPP tender
- Structural steel specifications including:
 - Specifications - Structural Steelwork
 - Specifications - Sheet Steel Cladding
 - Specifications - Grout material Placement
 - Civil Specification - Bolt Tightening Procedure
- Steelwork BOQ
- Structural steel drawings

Throughout the project the drawings and quantities have been internally revised, to match the latest mechanical layouts.

Telephonic conferences were held with the contractors to clarify and confirm the rates and prices received and to confirm that the work would be undertaken as envisaged.

The rates received from the contractors were applied to revised quantities and were used as a basis to determine a preliminary cost estimate for Euromax Resources review. Based on Euromax Resources' review of the preliminary cost estimate the design was modified and quantities updated for use in the final FS cost estimate.

17.3.3.3 Major Structural Steel Items

The estimated quantity of structural steel required is 2 300 t. The following areas have been identified as major contributors:

• Haul Truck Workshop & Boiler Shop	400 t
• Plant Site Pipes and Cable Racks	350 t
• SAG mill, ball mill and screening building structure	270 t
• CIL Section Supports and walkways	140 t
• Float Section supports and walkways	120 t

17.3.3.4 Future Considerations for Design Phase

The following items will be taken into account in the future design phase

- Ensure that structural steel fabrication is not scheduled before certified mechanical layouts and loads are received.
- Finalise structural design criteria and Specifications to Macedonian/European standards and norms.
- Install Macedonian Structural Steel Section Tables into the projects modelling package and structural steel design packages.
- Establish mechanism for review of contractor's shop detailing drawings prior to the fabrication.

17.3.4 Mechanical

17.3.4.1 FS Execution Methodology

The mechanical design criteria and mechanical equipment list (MEL) was developed from the process flow diagrams and updated throughout the FS.

Mechanical specification's for all major equipment along with General Project Specifications were produced based on individual technical requirements of the equipment, the process design and hazard and operability study (HAZOP) requirements. Data sheets and specific schedules for pumps, agitators, platework (including chute sketches) and electric overhead traveling (EOT) cranes/hoists were produced for the tender documentation.

Individual equipment models were developed considering catalogue information and models supplied by vendors together with historical data, as required. The site topography, earthworks designs and the equipment models were imported in NavisWorks to develop a site 3D model. Model reviews were undertaken to refine the site layout, plot plans and area general arrangements as extracted from the 3D Model.

The scope of work for the SMPP contractor was compiled and issued for enquiry to the selected contractors identified during the FS.

The equipment requisition documentation was produced and issued by procurement using an agreed vendors list. The vendors list required, wherever possible that the suppliers have European aftermarket support and fabrication to ensure cost savings.

Upon receipt of proposals from the various equipment suppliers and SMPP contractors, short form technical and commercial adjudications were undertaken. Clarifications were requested, when required, to develop a priced MEL for the capital estimate.

The indicated lead time for the manufacture and supply of equipment from the various suppliers were included in a detailed implementation schedule to identify long lead items.

17.3.4.2 Materials Handling

The undulating terrain is the driving factor behind the selection of the selected conveying method for the overland conveying system. Various options including conventional, pipe and HAC® conveyors were investigated. The conventional conveyor was found to be too costly to terrace a suitable inclination, whilst the pipe conveyor was considered high risk as neither the suppliers of the belt nor the vendor had installed suitable sized belts on a similar installation. The sharp inclination of the terrain at various points on the selected routing gave rise to final selection of a combination of two HAC® conveyors and a conventional conveyor to complete the overland conveying system. The HAC® conveyor decision was supported with back up documentation of existing installation and two competitive bids were adjudicated as part of the technical recommendation process.

17.3.4.3 Tanks and Platework

Process sections requiring major tankage are:

- Flotation – Carbon steel selected based on process commodities.
- CIL – Carbon steel selected based on process commodities.
- Elution – Carbon steel/rubber lined (Acid Wash Column) & Stainless Steel (Elution Column) selected based on process commodities. Hastelloy strainers have been selected for both elution and acid wash columns.
- Carbon steel was specified for general chute work and wherever high wear areas were identified VRN liners were specified.
- Steel tankage and chute work above 4.2 m diameter wide will be site fabricated, wherever possible platework is shop fabricated.

Sizing of tanks was based on the process live volume and freeboard of 300 to 500 mm to accommodate standard plate usage for the determination of the number of strakes.

17.3.4.4 Plant Layout

As mentioned above the complex terrain was the key driver for location and orientation of equipment on the various terraces. The use of a 3D model developed throughout the FS proved to be a valuable asset

in visualising the complexity of access for construction, reagent deliveries, operational personnel access and interface between and to operations as listed below:

- Mine services complex
- Administrative complex
- ROM pad
- Coarse ore stockpile
- Milling
- Flotation
- Concentrate
- CIL
- Elution
- Gold recovery
- TMF
- Reagents storage makeup and dosing

17.3.4.5 Future Considerations for Design Phase

The following items will be taken into account in the future design phase:

- Finalise mechanical design criteria and Specifications to Macedonian/European standards and norms.
- Optimisation of the process areas using the certified supplier equipment information to effect value engineering across all engineering disciplines. The status of the 3D model that has been developed by Amec Foster Wheeler will assist with this optimisation.
- The reagent supply chain requires further definition to confirm layout requirements.

17.3.5 Piping

17.3.5.1 FS Methodology

Piping design criteria and piping specifications were developed for the FS.

From the piping and instrumentation diagrams (P&IDs) the piping line list and valve list was developed together with the general arrangement drawings and the plot plan. A piping BOQ was produced and sent out together with the mechanical scope of work to the SMPP contractors for quotation.

Upon receipt of the SMPP proposal, a priced BOQ for the piping and valves was incorporated into the SMPP recommendation following technical clarifications with the contractor.

The indicated lead times for the manufacture and delivery received from the SMPP contractor were included into the implementation schedule.

17.3.5.2 Plant Piping

The piping line class was developed in line with the P&IDs considering the commodities transferred in the pipelines.

The plant piping was routed on the central pipe rack and secondary pipe racks throughout the process plant. Pipe spacing layout was aligned with Amec Foster Wheeler standards with an allowance for cable racking and a further 20% spacing allowance for possible future pipes.

Major pipe routings and pipe racks within the process plant were modelled within the 3D model to produce piping general arrangements to ensure process flow and mechanical layout configuration compatibility.

17.3.5.3 Overland Pipelines

Overland pipes including the main raw water supply line from the Ilovica dam and the TMF slurry delivery and decant water lines have been suitably routed on sleepers/sandbags.

Key design considerations were:

- Carbon steel for the raw water lines due to the pressure and
- High density polyethylene (HDPE) for the TMF slurry delivery line

17.3.5.4 Future Considerations for Design Phase

The following items will be taken into account in the future design phase:

- Finalise piping design criteria and specifications to Macedonian/European standards and norms.

17.3.6 Electrical

This section of the report covers work associated with electrical systems for the plant and infrastructure distribution system.

17.3.6.1 FS Execution Methodology

The electrical design was done in accordance with the electrical design criteria. The design was based on South African Standards (SANS) with the exception of the electrical installation which was based on International Electrotechnical Commission (IEC) standards. In many cases the SANS standards are identical to IEC standards.

17.3.6.2 Electrical Load List

The electrical load list (ELL) for permanent facilities was developed from the MEL for all electrical loads within the site boundary and includes the following areas and infrastructure:

- Process plant
- Crusher
- TMF
- Offices, workshops and other buildings

- Non-process loads e.g. lighting and small power
- Raw and storm water pumping. Note that the in-pit pumps are diesel engine powered.

Absorbed (motor shaft) power, where not known, was assumed to be 85% of the installed power. For the FS all low voltage motors use standard values for efficiency and power factor for a 4-pole IE2 (high efficiency) motor operating at 75% load. This approach provides a safety margin over the IE3 (premium efficiency) motors specified in the design documents. Additionally it was assumed that power factor correction (PFC) units are disconnected to give the worst-case reactive load conditions. Non-process loads such as distribution boards and uninterrupted power supplies (UPS) were assumed to have efficiency and power factor values of 90% and 0.80 respectively.

17.3.6.3 Plant and Mining Infrastructure

The estimated plant and mining infrastructure total load is as presented in Table 17.3.

Table 17.3 Estimated plant and mining infrastructure total load							
	Without PFC				With 10 MVar PFC		
	kW	kVAr	kVA	Power Factor	kVAr	kVA	Power Factor
Nominal Continuous Operating Load	49 857	25 336	55 925	0.89	15 336	52 162	0.96
Nominal Maximum Demand	54 804	29 025	62 016	0.88	19 025	58 012	0.94
Theoretical Peak Load	57 498	31 069	65 355	0.88	21 069	61 237	0.94

The total load is based on two 5 MVar PFC banks. The optimum rating for power factor correction taking into account capital cost, reactive power charges, and voltage levels will be determined during the detailed design.

Euromax Resources has applied for the bulk electrical power supply from MEPSO for the permanent operations phase based on the load estimates together with a safety margin for design development and future expansion.

The power and energy consumption estimates will continue to be refined as certified information becomes available during the detailed design phase.

Nominal maximum demand is a measure of electrical power consumption taking into account individual load diversities. It is the maximum load expected on an “average” day. The peak load assumes worst case condition with all possible electrical loads operating simultaneously. Generally this excludes standby motors and selected motors which are part of a controlled sequence.

17.3.6.4 Bulk Power Supply

Bulk power shall be provided by the Macedonian power utility MEPSO via new 110 kV overhead transmission lines from existing substations at BeroVo and Sushica. The detailed feasibility connection study has been prepared by Timel. The plant shall normally be connected using two step down transformers in redundant configuration such that full plant operation is maintained with one transformer not available.

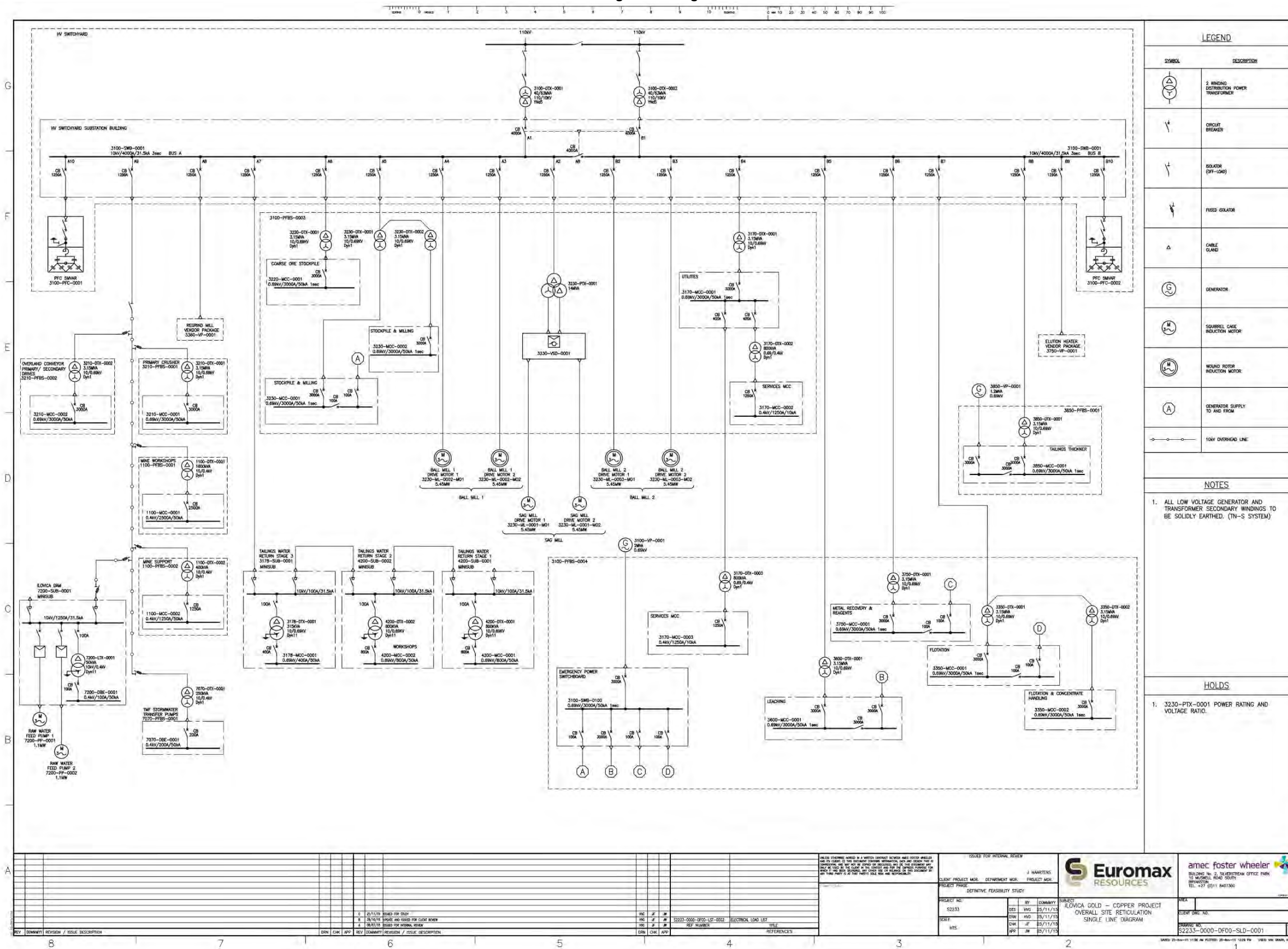
The MEPSO network is interconnected to neighbouring countries and is reported to be stable. Availability shall be further increased due to the dual supply to the plant from different substations.

The intake substation is positioned at the west side of the plant to provide access for the incoming transmission lines. The main plant 10 kV switchboard 3100-SWB-0001 shall be installed in a substation building at the intake switchyard in line with local practice. Authorised mine personnel shall have access to the intake substation.

17.3.6.5 Medium Voltage and Low Voltage Electrical Distribution

Main medium voltage (MV) power is radially distributed within plant areas from the 10 kV main switchboard using above ground cables to the transformers in accordance with the Single Line Diagram shown in Figure 17.6. Large motors 1 MW and above shall be rated 10 kV and transformers are not required.

Figure 17.6



Transformers at the plant step down to 690 V for low voltage (LV) process loads and then to 400 V for utility (small power) services. For LV motors in main process areas 690 V was selected in preference to the regionally more common 400 V to reduce conductor resistive losses and therefore reduce electrical energy costs.

A basic load flow and short circuit study was carried out to establish minimum equipment ratings for switchgear and transformers.

In the mine services complex and administrative complex only 400 V is used since this area has only a limited number of directly connected motors but has multiple buildings which require 400/230 V and proprietary workshop equipment which is not normally available at other voltages.

A 10 kV overhead line shall be installed from the plant to the mine complex (generally following the pit blast radius) and extending as far as the TMF storm water transfer pumps to provide permanent power to the crusher area, reservoir raw water pumps, mine services complex, administrative complex and storm water handling from the main plant switchboard.

The TMF return water is pumped in 3 stages (pontoon to pontoon to a land based tank and pump system) and a mini-substation will be installed near each set of pumps, interconnected using 10 kV cables and supplied from a single circuit breaker at the main switchboard. The mini-substations and cables can be relocated as required.

There is no conventional electrical power system redundancy provided for the process plant units except safety functions.

Electrical loads for each process unit are generally connected to the same motor control centre (MCC), except for small units which are combined with others onto one MCC. Large units (for example flotation), where the total load is in excess of standard equipment ratings, are supplied from two MCCs with transformers looped from a single 10 kV circuit breaker.

Electrical cables, including control cables, are listed on the Electrical Cable Schedule. Cables to motors and motor control stations are generally assumed to be 150 m in length. Cables within transformer yards are assumed to be 30 m. Distribution 10 kV cables to transformers have been individually measured and have been standardised as a single size 3 core 120 mm² with XLPE insulation.

17.3.6.6 Construction Power

Allowance has been made for a 600 kW baseload diesel generator plant to provide construction power for the full duration of construction, or until the MEPSO mains power is available. The generator plant shall be located adjacent to the contractors' laydown area west of the plant.

The 10 kV overhead distribution line installed from the plant to the mine complex shall initially provide construction power to all major load centres to limit the number of stand-alone generators. Step-down connections to the line shall be made at the mine services complex, administrative complex, crusher area and at the main laydown area near the plant (and any other points along the line servitude) and distributed locally at 400/230V. Generally any electrical loads within 400 m of these points would be covered by the construction supply. The generator plant, overhead line and other infrastructure will be available from

November 2016, prior to this date and in remote locations it shall be necessary to use small local generators.

Euromax Resources remains in contact with the local utility (EVN) to explore other feasible solutions for the provision of construction power.

17.3.6.7 Substations

The process plant area is quite compact and in addition to the MEPSO intake switchyard there are two raised concrete / brick substations providing power to the north and south of the process plant respectively. MV equipment, LV equipment and process control system (PCS) equipment shall each be located in a separate room within the building.

There are also several containerised smaller substations in off site areas at the tailings thickener, overland conveyor transfer point, primary crusher, mine services complex and administrative complex.

17.3.6.8 Mini-substations

Mini-substations containing MV switchgear, transformer and LV switchgear in a single enclosure are defined in specifications and datasheets. Mini-substations are used in remote areas where there are only a small number of loads (including lighting and small power), for example TMF decant pumping.

17.3.6.9 Transformers

Free-standing and mini-substation transformer requirements are defined in specifications and datasheets. Power transformers shall be oil filled type manufactured in accordance with IEC60076. Sizes have been standardised (in particular 3.15 MVA) to reduce the quantity of spares required.

17.3.6.10 MV Switchgear

MV switchgear requirements are defined in specifications and datasheets. There is one conventional indoor, metal enclosed, withdrawable, single busbar, double section 10 kV air insulated switchboard with vacuum or SF6 (to be agreed during detailed design) circuit breakers installed at the intake substation. Gas insulated switchgear is not considered necessary in this application since space is not a concern.

MV switchgear shall be certified internal arc tested and equipped with earth switches, interlocking and other safety features for personnel protection. There is an intentional safety factor applied between the short circuit rating and the actual short circuit level.

17.3.6.11 LV Switchgear / MCC

LV switchgear / MCC requirements are defined in specifications and datasheets. All LV switchgear shall be indoor, metal enclosed, air insulated, and installed indoors. Air circuit breakers are used for overcurrent protection and isolation. Variable speed drives (VSD) up to and including 55 kW are installed inside the MCC, units in excess of this rating are mounted externally to the MCC (in the same substation) due to physical size, access for maintenance and heat dissipation.

Functional units up to and including 55 kW are withdrawable type. Functional units above 55 kW are fixed type since these units are generally too heavy for one person to lift manually.

Plant LV MCCs shall have a normal supply busbar and where required an additional emergency busbar to provide power to essential process loads during mains power failure. Emergency busbars are connected to diesel generators which shall automatically start when loss of mains power is detected. Under normal operating conditions the emergency busbar (and therefore the essential loads) are powered using normal power and the generators are not running.

Typical essential loads include agitators, underflow pumps and barring gear motors. Generator ratings are estimated at 2000 kVA for the plant and 1200 kVA for the tailings thickener.

17.3.6.12 Electrical Motors

LV (690 V or 400 V) and MV (10 kV) motors are defined in the specifications and datasheets. Small and medium sized LV motors are generally squirrel cage induction motor type with efficiency level IE3. Large LV motors driving high torque mechanical loads are assumed to be wound rotor slip-ring type, for example the primary crusher motor. Large LV motors driving low initial (quadratic) torque mechanical loads such as centrifugal pumps are standard induction motors using soft starters or VSDs as necessary.

There are an estimated 385 LV motors, and 8 MV motors.

The ball mills and SAG mills have dual pinion drives. The two fixed speed ball mills shall use wound rotor 10 kV, 5.45 MW motors with rotor resistance starters for acceleration. The SAG mill is variable speed using 10 kV, 5.45 MW induction motors controlled from an MV VSD with dedicated convertor transformer.

17.3.6.13 Plant Lighting

Lighting shall be designed to provide sufficient illumination in accordance with local requirements. Industrial white LED fittings are now proven in existing industrial applications and are the preferred choice in most plant areas due to increased efficiency when compared to other types of lamp, slow rate of light output deterioration (3% per year) and extended lifetime (claimed 10 years by some manufacturers compared to 3 years typical for high pressure sodium (HPS)).

High mast lighting with HPS fittings shall be used in open areas where possible, in particular where there is high traffic volume. Environmental factors shall be considered in the placement of high mast lights.

17.3.6.14 Electrical Tenders and Budget Quotations

Budget quotations were received for the following equipment and installation works:

- Permanent electrical installation works – based on the scope of works and bill of materials (BOM), in accordance with referenced drawings and specifications
- Early works electrical installation – based on the scope of works and BOM, in accordance with referenced drawings and specifications
- MV switchgear – based on the scope of works, in accordance with referenced drawings, specifications and datasheets
- LV switchgear / MCCs (including VSDs and containerised substations) – based on the scope of works, in accordance with referenced drawings including typical schematics, specifications and datasheets

- Transformers - based on the scope of works, in accordance with referenced drawings, specifications and datasheets
- Minisubs - based on the scope of works, in accordance with referenced drawings, specifications and datasheets
- Emergency power diesel generators - based on the scope of works, in accordance with referenced drawings, specifications and datasheets

Technical and commercial adjudications were prepared for all quotations received.

17.3.6.15 Electrical Energy Efficiency

It is a requirement that the plant and infrastructure is designed and operated in order to maximise electrical efficiency.

The following energy saving devices or measures have been considered in the design:

- Use of “Premium efficiency” IE3 rated induction motors: Current legislation in Europe requires minimum of IE2 for new installations but IE3 minimum is expected to be introduced within the next few years.
- PFC: Assumed 2 x 5 MVar which increases the nominal maximum demand power factor from 0.88 to 0.95, resulting in lower current drawn from the utility (MEPSO) and lower conductor losses. The 10 MVar was selected to bring the pf to 0.95 which is typical for a plant of this size. MEPSO charges for reactive power in addition to active power (kW) and the cost / benefit trade-off shall be done in the next phase to determine the optimum capacitor bank rating.
- Harmonic distortion filtering: This is similar to PFC in that it reduces losses due to non contributing harmonic currents. No allowance has been made at this stage since large VSD details are not known. The harmonic filtering is usually combined as part of the PFC package.
- Variable speed control of motors (including air conditioning units): VSDs have been implemented in accordance with process requirements. There are an estimated 131 LV VSDs of all ratings and 1 MV VSD for the SAG mill.
- Use of oversized cables to reduce resistive losses: Not implemented at this present time due to increase in capital cost
- Compact fluorescent lamps (CFL), HPS or LEDs: There is no incandescent lighting specified. LED lights use less than half the energy of a HPS fitting for the same light output and for the same capital cost.
- Building orientation, design, materials and insulation: Containerised substations shall be thermally insulated using polystyrene (or similar). At Ilovica, the building orientation is determined more by contours and facing south is less of a consideration.
- Use of 690 V (instead of the more familiar 400 V) on the low voltage system for process plant loads: This reduces motor current and therefore resistive losses in the conductors including cables, busbars and transformer windings.

17.3.6.16 Future Considerations for Next Phase

The following electrical issues shall be considered for the next stage:

- Finalisation of the Electrical Load List, Single Line Diagram and other engineering documentation based on certified supplier equipment information
- Power Factor Correction bank ratings
- Position of MEPSO intake substation to reduce 10 kV cable lengths to the plant substation
- Combining of emergency diesel generators in to a single plant
- Emergency diesel generator plant(s) rating
- Neutral earthing at 10 kV level
- Occupation sensor lighting in offices: To be implemented as part of detailed design
- Solar water geysers: To be implemented as part of detailed design.

17.3.7 Control and Instrumentation

17.3.7.1 Process Control, Manufacturing Information, and Business Management Systems

The Process Control, Manufacturing Information and Business Management Systems architecture that would have traditionally been adopted for the operation is based on an integrated layered model consisting of five conceptual levels (Figure 17.7).

These five levels are:

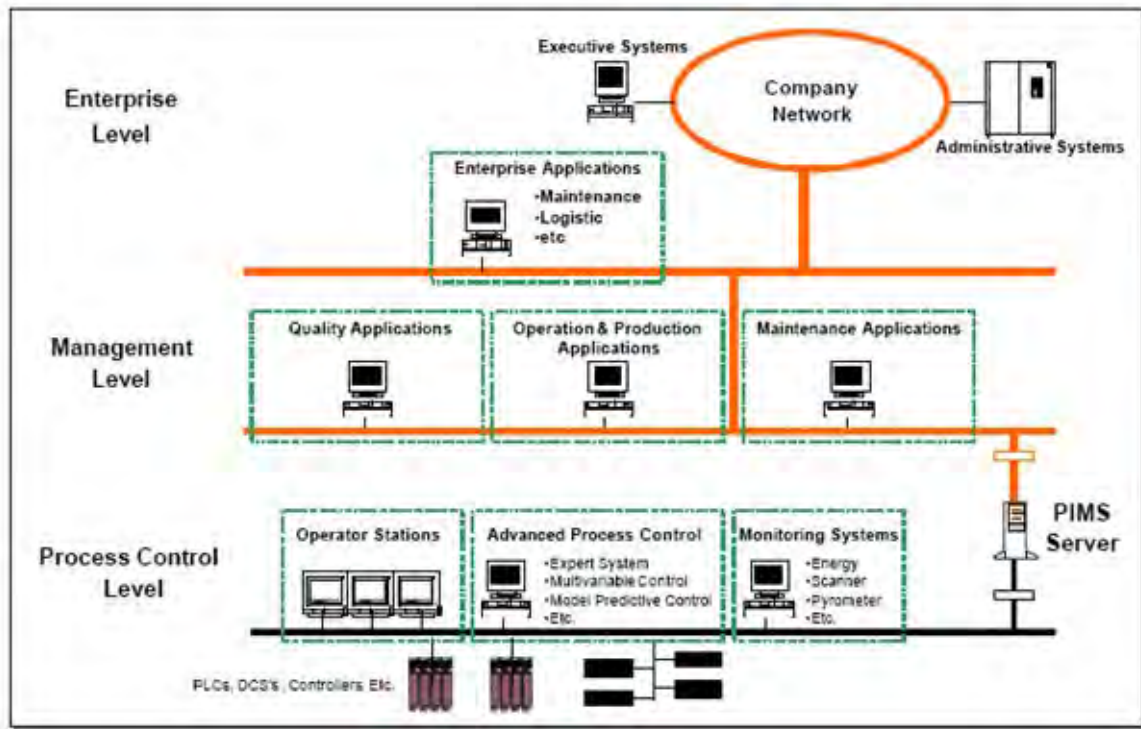
- Level 0: Plant Instrumentation, consisting of all field sensor instruments and actuators that measure the process variables and directly manipulate the process.
- Level 1: Controller level, PLC which are used to perform the interlocking, sequencing and run the control algorithms for the plant.
- Level 2: Supervisory level, SCADA systems, generally located in centralised control rooms, and used by the operators to control the plant.
- Level 3: Manufacturing information system (MIS), which provides the computational and information needs to run the process efficiently. The discrete functional components of the system are responsible for facilitating operation and production management to maintain high productivity, efficiency and product quality.
- Level 4: Business management systems (BMS), which provide all the commercial business data processing. This processing includes the financial, human resources, logistics and asset management needs of the plant.

The system is currently limited to Level 2. Levels 3 and 4 will be considered as future additions when the mine operations are sufficiently stable and full functionality has been established.

Initially the functionality provided by a Level 3 system will be performed manually, i.e. production scheduling, material flow of data, down time analysis, equipment efficiency, production quality management, production reports on a shift, daily, weekly, monthly and yearly schedule basis, etc. The proposed specification for the MIS and the corresponding user requirements specification are used purely and solely as a reference to the functional and technical role this system will fulfil in the future when installed.

Figure 17.7 indicates the services and functionality (highlighted in orange) which will be installed at a later stage.

Figure 17.7
Process control, Manufacturing Information and Business Management Systems



17.3.7.2 Laboratory Information Management System

An on site analytical and metallurgical laboratory shall be supplied as part of the Euromax Resources Ilovica Mine within the scope of other disciplines. A laboratory information management system (LIMS) is required to support the operation of this laboratory. The scope of the software and service requirements to achieve this are in the LIMS Specification.

The LIMS user requirements specification shall be used as an input into the design. The successful approval of the functional requirements specification shall be the basis of the system build.

17.3.7.3 Telecommunications

Telephone Systems

At present the area is covered by the Makedonski Telekom (ex T-Mobile) cellular network with a repeater station mast positioned on top of Ilovica Mine. This system will be used in the early stages of construction, however due to its high user cost establishment of a connection to the national Makedonski Telekom grid will be a priority.

Makedonski Telekom grid

Makedonski Telekom will connect the site to their national grid via a digital leased line which will accommodate both computer and voice communications. The Telekom connection to site will be

terminated in a digital leased unit, this link will be temporarily housed in a container during the construction period. For the permanent installation the digital leased unit will become the main exchange and will be relocated in a dedicated communications room in the main Ilovica Mine offices. From the construction exchange, lines will run to separate contractor and project management team private automatic branch exchange (PABX) units as well as to a number of pay phones in the contractor's village.

Plant Communications

The telephone system will be linked to all areas containing offices via fibre optic networked telephone exchanges. Telephones will be installed in both plant and main work areas. Areas not covered by the land-based telephone systems, will be covered by 2-way radio communications, ensuring that digital and analogue voice and data information can be transferred seamlessly between stakeholders and outside parties, both during the construction and operational phases of the project.

Mobile Voice Communications

A terrestrial trunked mobile radio system (TETRA) is to be provided for both the construction and operational phases of the project. The operational requirements have been costed, but delivery shall be prior to the start of construction. The system to be utilised is modular in nature and expandable as needs change. The handsets may be loaned out to the relevant contractors during the construction phase and will be distributed to the appointed parties on an as needed basis during the operational phase.

System Requirements

System requirements include:

- Provide mobile radio coverage across the entire mining operation area
- Provide basic radio services to enable point to point communications between people and vehicles
- Interface with plant PABX (telephone system).

System Equipment

The type of communication equipment required are:

- Vehicle mount radios
- Desk top radio units
- Mobile hand portable radios and ancillary equipment (holders, charges and spare batteries).

Base Station Location

A single mobile radio base station will be provided as a main communication site, with two 30 metre masts installed at a high site. Three dispatch consoles have been included for the Central Control room, Admin and Mining Admin.

This will provide coverage at the following locations:

- Main Site
- Plant control room
- Main site security office

- Main administration building
- Mine services complex
- Administrative complex

Radios will either be hand held units or will be fixed units in plant vehicles, especially all large vehicles used in the mining area, i.e. haul trucks, face shovels and front end loaders.

Due to the dynamic nature of the mine, especially with the ongoing development of waste dumps, it may be necessary to have an additional mobile repeater in the mining area in order to maintain contact between the mining area, plant and main offices. This option has been removed from the study Capex and may need to be assessed and costed at some future stage of operation.

PABX

Provision has been made for a site PABX, which will connect to the public network and has been specified to provide both data and voice communication functionality.

Functionality includes, but is not limited to:

- Interface to public telephone network (digital and analogue)
- Interface to user devices (video conference equipment etc.)
- Interface to other systems (public address system, mobile radio communications, etc.).

Equipment included:

- PABX main exchange
- Attendant consoles in two locations
- Handsets (site wide supply) internet protocol touch phones as basic, advanced and secretary handsets
- Internet protocol phone conference station
- Paging system.

Network Communication System

Two local area network (LAN) communication systems will be provided for the project, i.e.

- Process Control System Network, which includes:
 - Plant wide automation and control system for peer to peer networking of control processors at Level 1
 - SCADA with historian servers at Level 2. This shall have a distribution switch and firewall to enable future connection to a Level 3 manufacturing execution system (MES) or MIS, and perhaps a metal accounting system (MAS).
- Information technology (IT) Communications Network, which includes:
 - A campus network wide area network (WAN) or LAN platform for enabling Euromax Resources to implement Level 4 Production Management and Business Management Systems. Note that

as there is no Level 3 MIS layer to process and integrate data then no information exchange shall be available between the Process Control System Network Level 2 and any Level 4 BMS implemented by Euromax Resources.

- Access Control System
- PABX System
- Fire Detection System
- General admin and office IT Networking Systems

The two networks are independent and isolated from each other with intelligent network firewalls. The networks proposed are based on intelligent network distribution switches – totally configurable in order to manage the relevant network segments.

The IT communications network will be capable of interconnecting to the WAN in order to facilitate Internet data exchange, by means of suitable industrial security gateway switches and firmware protocol procedures.

17.3.7.4 Site Security and Access Control System

A site security access control (SSAC) vehicle control barrier, turnstiles and time monitoring system shall provide access control and monitoring facilities for the following:

- Zone 0: General Mine Entrance & Induction and Training area
- Zone 1: Administrative Complex
- Zone 2: Mining area
- Zone 2: Process Plant – General area
- Zone 3: Process Plant – Gold Room Electrowinning and Smelter area.

The majority of the buildings in the complex will be covered, selected on the basis of their criticality and occupancy. This will also include strategic service facilities such as the substations and fuel area building.

Some portions of the security system shall be required for the construction phase of the project (i.e. general mine entrance). The security specialist company selected shall advise according to his experience in terms of phasing in of certain areas, in this regard.

A modular and flexible architecture shall be used, allowing the system to be easily expandable and upgradeable to cater for the different phases of the plant lifecycle.

The core of this system will be located in the Security Control Centre and thus be controlled and monitored from a centralised secure location.

The system will consist of bi-directional turnstile gates and vehicle access boom gates. Single entry and exit lanes with vehicle boom and turnstile equipment will be installed at entrances to the various locations with card readers recording vehicle / personnel movement (total in & out) per day. Proximity card technology will be used for access control authorisation.

An interphone system associated with the turnstiles and vehicle barriers will permit communication between the Security personnel and users of the access points.

Security Lighting

Security lighting requirements shall be assessed during the detailed engineering phase, and if determined to be required, designed and installed within the Electrical scope of the project. An outdoor illumination level of at least 15 lux is recommended, with a high degree of uniformity, thus avoiding zones with shadows.

Closed Circuit Television

A closed circuit television (CCTV) system will be included to cater for basic surveillance requirements in strategic plant areas. This consists of day-night colour static cameras being the majority of the fixed installations, and PTZ colour cameras for indoor or outdoor areas requiring motion for variable area of coverage of zones of interest.

A single digital video management equipment station with data base and camera servers shall service the camera network, with digital video recorders connected in a secure network. CCTV surveillance data shall be integrated into the security system described above.

17.3.7.5 Fire Detection System

A fire detection system will be provided to monitor and alarm fire and smoke dangers within the following office areas:

- Mining area administration offices
- Pump House – Plant area
- Pump House – Mining area
- Process Plant Area administration offices
- Offices within Engineering and Maintenance workshops.

The fire system shall consist of an addressable fire detection system. All the fire detection and suppression systems shall be designed to conform to IEC or National Fire Protection Association (NFPA) standards. Monitoring of the fire system and coordination of fire and rescue operations shall be from the mine services complex fire protection facility, building 1090-PABS-0003, control room.

The master control unit installed inside the fire protection building shall serve as the operational master with the back-up located within the Process Plant Control Room.

All the other sub-control units shall be connected to this master unit by using fibre optic cable using peer-to-peer communication.

A separate system installed at the process plant's control room shall communicate with the master system via a fibre optic link.

The sub-control units shall be programmable to serve as master for their own area. Each building or substation shall be provided with a local fire indicator zone panel, smoke detectors and alarm bell or as a sub circuit of a nearby main building's fire zone panel.

Control units shall comply with the following description (as shown for one unit):

- The fire detection system shall comprise of a central unit, connected to field devices, including fire detection devices, alarm devices and control devices, located throughout the protected area.
- The control unit shall continuously monitor the status of all sensing devices, and initiate action when a fire or smoke condition is present.
- The system shall be designed to provide an early warning utilising the most effective detection methods appropriate to the protected areas.

Fire detection sensors shall be installed in the substations, control rooms and plant buildings. In high flammability risk areas thermal probes, infra-red detectors and fusible loops shall be installed. All zones shall have break glass units mounted internally and externally to the buildings as required.

Central Control Room Suppression

The 200 Bar IG541 Inergen inert gas system as per NFPA shall be used for fire suppression in the central control room.

Conveyor Protection

Conveyor deluge systems will be in accordance with NFPA 15. The activation of an ember detector will stop the conveyor, and the deluge water valve will be electrically operated by a linear heat detection cable which interfaces to the main fire detection system via addressable interfaces.

Hydrant Reticulation and Hose Reel Reticulation – both Plant and Mine Complexes

All fire hose reels will be 30 metre hose length on a wall mounted drum. Interconnecting pipework shall be medium weight galvanised steel.

Hand fire appliance system and extinguishers complete with backboards shall be supplied.

Fire Water Pump Sets

The system includes for two separate fire water pump sets:

- Duplicate automatic fire pumps – Plant complex
- Duplicate automatic fire pumps – Mine services complex and administrative complex.

The calculated fire pump duties are based on estimated requirements and as such are subject to the results of a detailed hydraulic calculation during design phase and as per the risk assessment findings.

17.3.7.6 Communications, Control and Instrumentation

The control and instrumentation (C&I) design criteria was developed with respect to communications, control and instrumentation.

Process Control System

The plant is provided with a PCS to control the activities of the production plant. The plant is of moderate level of control complexity with the crushing circuits forming an automatic sequence unit, regulatory control on primary control loops, cascade/ratio as required and batch operations of certain process equipment. Alarms from all devices and trending from all analogues is all stored online for a minimum 3 months.

The PCS system will provide a very high availability with minimal maintenance. Power supplies and communications are designed to be fault tolerant. Un-interruptible power supplies and redundant Ethernet based networks ensure any single point failure has no detrimental effect on the operations. The topology is defined in the Process Control System Concept Architecture drawing.

A site wide fibre optic backbone is to be installed that will accommodate the flow of process and communications data between buildings, process/plant areas and mining infrastructure. The project system scope and size information is illustrated in the Process Control System Contract Specification.

The drives and valves are provided with three primary modes of control, automatic, manual and local. In local mode process interlocks are disabled (i.e. belt drifts, under-speed, downstream conveyor running). Safety interlocks can never be overridden.

All devices display run/stopped or open/closed status and fault indication on the PCS. Interlocks for all devices are displayed on the PCS with their current status to assist operations management of the process. Critical and safety interlocks are either programmed or hard-wired and are not affected by mode selection. Drives are able to operate either as individual drives in manual mode or grouped in automatic mode.

The process control system is defined in the Equipment Specification and operational functionality in the Software Development Specification.

Process Control

The instrumentation and control system design of the plant shall provide for a high level of safety and reliability of the plant, minimising maintenance and providing for an ease of system fault finding during the life of the project. A coordinated and integrated approach has been taken for all electrical, instrumentation and process control design.

The field PLCs are mounted in dedicated cubicles within the related substation. Typical general panel construction requirements are covered in the Panel Specification. Additional cubicles house the network functions from the associated areas of the plant.

Third party communications to the PCS, such as the crusher and mills, variable speed drives, motor protection relays and power system telemetry, are connected to the PCS via an industrial standard communications link. Where the volume of information to be transferred is small, hard-wired signals are used. The controls for mechanical packaged plants are provided by the vendor and mounted in a control panel located on the package, with supervisory control and data presented to the plant operators at the central control room.

Control Locations

Control and monitoring of operations will be from the following locations:

- Central control room: Located in building 3090-PABS-0002, centrally within the processing plant area. The central control room will accommodate the PCS operator workstations, printers and other complementary equipment such as fire indicator panels and CCTV monitors. This building will also have a dedicated equipment room housing the PCS engineering workstations, servers, network communication equipment, security and fire systems hardware.
- Crusher control room: Located in the ROM area adjacent to the crusher in building 3090-PABS-0001. The crusher control room will house an operator workstation to control the crusher, associated conveyors and equipment and will be able to monitor other associated plant operations.
- Mine control room: Located in the in building 1090-PABS-0010. The mining control room will not be permanently manned for process operations as it is primarily for the mining fleet control and as such will only provide basic facilities.

Central Control Room

The plant will be primarily operated from the central control room located in the plant control room & metallurgical laboratory building. The central control room shall contain four process control operating stations and an engineering workstation. Local field operator stations contained in equipment vendor proprietary packages shall present complete control room type information to the operators but allowing interaction from the field operators on a secured basis. As a minimum, the central control room shall:

- Be sized to accommodate the specified number of operator and engineering workstations, printers, CCTV monitors and other auxiliary control equipment and provision for installation of future equipment
- Be designed to enable easy access of people to equipment
- Provided with a restricted access control door
- Be fitted with ergonomic furniture
- Have an elevated false floor with anti-static coverings
- Be air conditioned and pressured to avoid ingress of dust
- Be fitted with suitable lighting for normal and emergency situations in accordance with codes and regulations
- Provide cable tray, trunking and conduits for electrical and communication cables.

Field Instrumentation

The General Instrumentation Specification details the field instrumentation technical requirements. Instruments are specified and selected in accordance with the process requirements to provide uniformity of supply to the extent practical and with a view of minimising the spare parts inventory. All instruments are provided if available with local displays.

Where practical, field instruments are mounted in areas that offer easy access for maintenance, are free of vibration and do not block walkways or prevent maintenance of other equipment. Field-mounted

instruments are of a design suitable for the area in which they are located. All instruments and control equipment have corrosion resistant, weatherproof cases and are suitable for outdoor mounting.

The minimum protection rating is IP65. Instruments shall use ethernet / internet protocol as the communication protocol when available with this technology from the field instrumentation vendor. Otherwise two-wire 4-20 mA conventional analogue transmitters with highway addressable remote transducer (HART) protocol shall be the preferred choice.

A set of typical data sheets for study purposes is available. This should be read in conjunction with the Instrumentation Schedule.

In general, the equipment types shall be as follows.

- Flow Instruments
 - For the measurement of the flowrate of slurries, liquids and gases, the basis of the design is to provide non-intrusive in-line flow measurement devices. Magnetic flow meters are used for measurement of conductive slurries and liquids, whereas vortex type flow meters are employed for low conductivity liquids, air, gas and vapours. For low pressure air flowrate measurement in large ducts or pipes, Pitot tube or annubar type devices are used.
- Pressure Instruments
 - All pressure transmitters and gauges are installed with block and drain/vent valves for process isolation and calibration, except for diaphragm seal applications. For slurries and where the process conditions require, silicon filled flanged diaphragm seals are used to protect the pressure gauges and transmitters. These incorporate a flushing ring with a ball valve facilitating a water connection to clear sediment and minimise blockage. Pressure transmitters are capacitance type devices of stainless steel element construction. Local pressure gauges are 316 stainless case 100 mm diameter glycerine filled 316 stainless steel bourdon tube type instruments.
- Level Instruments
 - Instruments such as ultrasonic and radar transmitters have been selected for continuous level measurement. Vibration/tuning fork level probes are used for point level measurement in tanks and silos. Solid build-up in such as chutes for blockage detection shall be microwave emitter/receiver switches for closed chutes, and mechanical tilt switches (non-mercury) for open accessible chutes such as at conveyor head chutes.
- Temperature Instruments
 - All process temperature transmitters and gauges are to be installed with stainless steel thermowells enabling maintenance and replacement of elements during operation. The exception is bearing temperature monitoring which shall be direct inserted elements. In more severe applications, the instrument wetted parts are constructed of material suitable for the process fluid compatible with the pipe or vessel. Temperature element types are PT100 RTD devices and temperature gauges are stainless steel bimetallic type with 125 mm “every angle” type dials.

- Analytical Instruments
 - Conductivity probes are selected based on the applications. Generally toroidal type probes are used in environments subject to fouling such as the mixer tanks and leach tanks. Electrode based probes are used on clean circuits such as the water heater circuits.
- Signal and Power Levels
 - Wherever possible, analogue field devices shall be two-wire, powered over the same wires used for signal communication. Where available and cost effective ethernet / internet protocol shall be the fieldbus protocol; voltage and current levels will be specified during detailed design. Equipment requiring AC power shall be connected to the 115VAC UPS system. Digital field signals are 24 VDC , with process sensing switches preferably 2 wire induction type having a minimum rating of 1 A at 24 V DC.
- Hazardous Area Instrumentation
 - The location of all instrumentation equipment, which may be a source of ignition, shall be determined after the plant hazardous areas have been classified in detail design phase. Where possible such equipment shall be located outside of the classified area, or in the zone of least hazard. All equipment, which must be installed in a hazardous area, shall be selected in accordance with all the applicable statutory codes, standards and procedures. For field-mounted instruments, Intrinsic Safety Ex 'ib' using electronic isolators will be the preferred protection technique.
- Automated Valves
 - Pneumatic actuated on/off and modulating control valve types are selected according to the process conditions, piping integrity and the required controllability. Individual air filter/regulator units are provided for all of the air actuated modulating control valves and are mounted directly on the valve assembly. Actuators are sized for the process conditions, piping integrity and based on a minimum plant air pressure of 450 kPa. Calculations for required actuator torque shall be provided for all valve types and the sized actuators in the applicable duty are considered in the overall instrument air consumption calculations. Actuated On/Off valves are provided with open and closed limit switches for confirmation of operation. Intelligent modulating positioners are provided on all continuous control applications. Position feedback from modulating positioners may be extrapolated where required over the fieldbus or HART protocol. The project specification for automated valves, both modulating and on/off, details the requirements.
- UPS
 - Instrument transformers will be positioned in the substations at grade level for maintenance, and these will supply power to the main UPS boards. All instrument transformers will be suitably rated for the system load. The main UPS boards will feed plant area UPS boards. These will in turn feed the instrument intelligence production data bases, PLCs and field instruments as required.

Field Installation

The field installation is based on a number of documents. The primary document issued for tender is the Control & instrumentation BOM.

This contains the accumulated materials and quantities from other source documents as follows:

- Instrument Cable Schedule

- The Cable Schedule is produced primarily from the Instrumentation Schedule and the overall Cable and Rack Routing Layout Drawing. This also forms the basis for the take-off of size and quantities for the cable racking.
- The specific cable utilised is detailed in the C&I Cable Specification
- The materials proposed for the plant are defined in the C&I Materials of Construction Specification
- An Equipment Specification C&I Installation is intended to describe the instrument installation works for the Ilovica Gold-Copper project.
- The contractor shall provide the specified equipment or materials in accordance with the intent and the provisions of this specification and all other documents, codes, standards and requirements referred to or included therein.

The control and instrumentation installation scope of work provides a common, standardised basis for the control and instrumentation supplied and installed for the entire project. The quantities for the various components for the C&I were established from the P&IDs.

17.3.7.7 Engineering and Cost Basis

Vendor Selection

The vendors list established for the C&I components of the study was drawn up with due regard to well established, experienced vendors with a proven track record. Enquiries were issued for the LIMS, MIS, Fire System, Automated Valves, C&I Field Installation, the Instrumentation supply package and the Process Control System equipment and software development packages.

Pricing

The method of pricing equipment and packages is detailed below.

With the exception of the communication package which was costed using recent project information, all prices utilised in the C&I component of the estimate were based on bids received (either returned formal enquiry or using recent project order/tender information). The prices received represent complete turnkey solutions from delivery to final handover on site, inclusive of spares, ex works, site and field testing where relevant, vendor representation, training, operating and maintenance manuals. Bids/tenders received were broken down, such that items can be added or deleted as required.

The site IT and LAN package is priced using standard software prices, typically Microsoft, and standard hardware prices, typically HP, for the hardware. Network cable and installation costs were obtained using the local contractor's rates.

The mobile radio and telecommunication prices are based on known costs obtained on a similar recent project using internationally accepted Motorola and Alcatel-Lucent telecommunication equipment.

The site security and access control prices are based on known costs obtained on a similar recent project suitably scaled to suit the Ilovica site and infrastructure.

18. PROJECT INFRASTRUCTURE

18.1 PLANT AND MINING INFRASTRUCTURE

18.1.1 Methodology

The design for infrastructure is in accordance with the infrastructure engineering and design, design criteria and is based on South African Standards with consideration of conditions likely to be encountered in Macedonia. The following were prepared for contractors to tender on:

- Infrastructure scope of works
 - Earthworks and infrastructure
 - Sewage treatment
 - Architectural
- Infrastructure specifications
 - Earthworks and infrastructure
 - Fencing
 - Waste management
- Infrastructure BOQs
 - Earthworks and infrastructure
 - Sewage treatment
 - Architectural
- Infrastructure drawings

The drawings and quantities were continuously revised to align with the latest mechanical layout.

Telephonic conferences were held with the contractors to clarify and confirm the rates and prices received and to confirm that the work would be undertaken as envisaged.

The rates received from the contractors were applied to revised quantities and were used as a basis to determine a preliminary cost estimate for Euromax Resources review. Based on Euromax Resources' review of the preliminary cost estimate the design was modified and quantities updated for use in the final FS cost estimate.

A commercial adjudication was completed based on tenders received from contractors.

18.1.2 Site Selection

18.1.2.1 Process Plant

General

The current site layout was selected following a review of several options. Initially the siting of the process plant was considered at a location below the open pit with the advantage of a downhill truck haul. However further work determined that the power required to pump tailings up to the TMF deposition area would be greater than that required to convey the ore to feed the process plant at a location above the open pit.

The selected process plant location above the open pit also has the advantages of having less visible and noise impact. The natural ground conditions are favourable as the plant civil works will be founded on bedrock, minimising excavation and ground stabilisation works.

A nominal distance of 400 m for the blast radius has been applied in the development of the site layout.

Primary Crusher

Two possible sites were considered during the early development of the study; at the open pit and alternatively at the process plant. Locating the crusher at the process plant will necessitate an increase in the number of haul trucks due to the increased distance and an attendant increase in haul time. This was considered to increase the Capex and Opex, in comparison with the transfer of ore by belt conveyors.

The ROM pad location at the egress to the open pit has resulted in a pillar of payable material being used to provide a site for the crusher. It is therefore recommended that more detailed work should be undertaken as part of the FEED package and the economics of Capex and Opex of trucking versus conveying should be considered in conjunction with the loss of revenue from the reduced mine resources.

Blast radius limitations will not apply to the primary crusher, since the crusher only operates when ore is being hauled from the pit. This stops during blasting in the pit. The crusher will require flyrock protection.

Conveying Systems

The first option with the process plant situated below the open pit, determines that the conveyor will be operating downhill. This location is adjacent to the mine services area at an elevation of approximately 450 m. The estimated horizontal distance is 1.3 km and can be achieved in a single run. This is potentially a power generating system.

The second option entails a conveyor that will be operating uphill from the primary crusher to the plant. The location is at a sloping saddle area between two ridges at an elevation between 800 m and 850 m. The estimated conveying horizontal distance is 1.8 km and requires transfer points to avoid crossing the open pit. The crossing distance is estimated at 800 m. The estimated power installation is 1.5 MW.

The power estimate made was a high level calculation using a standard conveyor system. The power used was assumed to be relevant irrespective of the system used in the options consideration.

The transfer distance and elevations determine that the conveyor, over certain sections, is outside to the normal angular limits and will involve the use of pocket conveyors. The system designs, including the crusher and stockpile elevations and heights, must endeavour to minimise the lift angle.

The second option also considered a cable conveyor. Whilst this has advantages for crossing the rough terrain, it is approximately 2.5 to 3 times the supplied cost when compared to a conventional conveying system. Accessibility and maintenance must also be considered for the winter months, when weather may disrupt access to an elevated cable conveyor. The cable conveyor method has not been pursued and only conventional conveyor systems have been included in the ongoing design work.

The above mentioned options were the ones selected at the time of the initial assessment and the selection holds true. Since then other designs have been considered as a result of the design review process and currently the selected design for the FS utilises a sandwich conveying system.

Tailings Pumping

The first option shows that the tailings slurry must be pumped up hill against a head of approximately 250 m to 300 m and a horizontal distance of 1.9 km. The estimated installed power is 4 MW.

The second option shows that the tailings are pumped downhill against a negative head of approximately 80 m over a distance of 1.9 km. The power requirement shows a potential for generation.

Return water from the TMF to the plant is thus by gravity flow for the first option and by pumping for the second option at an estimated installed power of 0.5 MW.

Selected Process Plant Location

An economic analysis confirms that the optimum location for the plant is above the pit. The additional operating costs (US\$0.19 /t) for pumping tailings uphill outweighs the extra capital requirement for the 3.7 km access road which needs to be allowed for (Table 18.1).

Table 18.1 Trade-off Study Economic Analysis Summary						
Option	Process Plant Capex	Total Capex	Plant Opex	NPV	IRR	Payback
	(MUS\$)	(MUS\$)	(US\$ /t)	(MUS\$)	(%)	(yr)
1	240	724	7.21	463	15.1	5.19
2	236	723	7.02	484	15.5	5.09

The optimum location for the plant is as indicated on the plot plan; above the pit. The prime factor influencing this is the relative power requirements for conveying uphill and the associated return water pumping against the power for pumping tailings uphill.

Location at the lower, downhill site also puts the process plant in the potential blasting zone and in a position nearer to the local community and increases the noise and visible impacts.

18.1.2.2 Mining Services Complex and Administrative Complex

Consolidated areas of land were required for the following:

- Mining Services Complex
 - Daily Service Bay for Mining haul trucks
 - Fuel and Lube Storage for the mine operations
 - Workshops for the mine operations maintenance
 - Warehouses and storage areas for spares and maintenance equipment
 - Offices for mining operations
 - Change rooms, ablution facilities and canteen facilities for the mining operations
- Administrative Complex
 - Offices for services such as managers of human resources, accountants, surveyors, etc.

- Parking for all mining operation and reduction works personnel. (Due to the steep nature of site access to the process plant will be restricted to vehicles required for plant operations only).
- Geological support area to examine, record and store cores obtained during the geotechnical investigation.
- Sewage plant for the treatment of all waste water.

The following were taken into consideration when selecting sites for the mining services and administrative complexes:

- Topography. Vehicular access is required to all the sites. A ridge was chosen and a number of terraces designed where road access is available to each terrace.
- The need to separate heavy mining equipment from light vehicles for safety reasons.

18.1.3 Topography

The general steepness of the site is reflected in the following indicators:

- Lowest point on concession: AMSL 350 m
- Highest point on concession: AMSL +1040 m
- Total ascent from main gate to process plant: 420 m

The natural ground profile exhibits both steep longitudinal gradients and steep crossfalls – in severe cases up to 50%, or 27 degrees on road cross sections. This impacts on the design of roads, terraces and other features that require earthworks. Significant lengths of the roads are placed at maximum gradients. The finished terraces are similarly placed at maximum falls to minimise cut and fill volumes.

18.1.4 Geotechnical Site Investigation

An investigation was carried out by Amec Foster Wheeler to determine, inter alia, foundation conditions and material quality. The fieldwork led into the Geotechnical Interpretative Report for Process Plant and Infrastructure covering the following topics:

- Borehole data
- Test pit data
- Laboratory tests
- Incidence of rock
- Maximum cut and fill slopes
- Permissible foundation bearing pressures
- Borrow material
- Aggregates
- Groundwater

Centre line subgrade investigations for access roads and test pitting still needs to be carried out for the oxide ore stockpile and tunnel.

18.1.5 Terracing

18.1.5.1 Process Plant Site

The process plant was laid out with the following considerations in mind:

- Process functional requirements
- Reagent delivery and shipping of product
- Topography
- Limiting gradients on internal roads
- Alignment and levels of incoming access road

These considerations have led to the overall and plant site layouts (Figure 18.1 and Figure 18.2), with the plant approximately in a horseshoe shape occupying the higher ground around a central valley.

The overall earthworks quantities, including the crushed ore conveyor, are as follows:

- Overall footprint: 27 ha
- Cut volume: 606 000 m³ - including 150 000 m³ for the crushed ore conveyor
- Fill volume: 118 000 m³

The estimated volume of rock in cut is 362 000 m³ based on the findings of the geotechnical report. Cut and fill volumes can be optimised for execution phase by further fine-tuning the specified terrace levels, within the limits of the constraints listed above.

The tops of the terraces are finished at slopes of up to 7%.

18.1.5.2 Mine Services and Administrative Complex

This area consists of two terraces. The upper Mining Services terraces, in closer proximity to the pit, includes the wash bay, heavy vehicle and other workshops, offices, stores and change house. The lower Administrative Complex terraces includes the training room, parking area, mining offices, medical facility and facilities for geology (Figure 18.3).

Both terraces have been designed to best fit in with topography and functional requirements. The overall earthworks parameters are as follows:

- Overall footprint: 9 ha
- Cut volume: 376 000 m³
- Fill volume: 141 000 m³

The estimated volume of rock in cut is 314 000 m³ based on the findings of the geotechnical report. As for the process plant terraces, cut and fill balances can be optimised for execution phase by further fine-tuning the specified terrace levels.

The tops of the terraces are finished at slopes of up to 7%.

Figure 18.1
Overall Site Layout

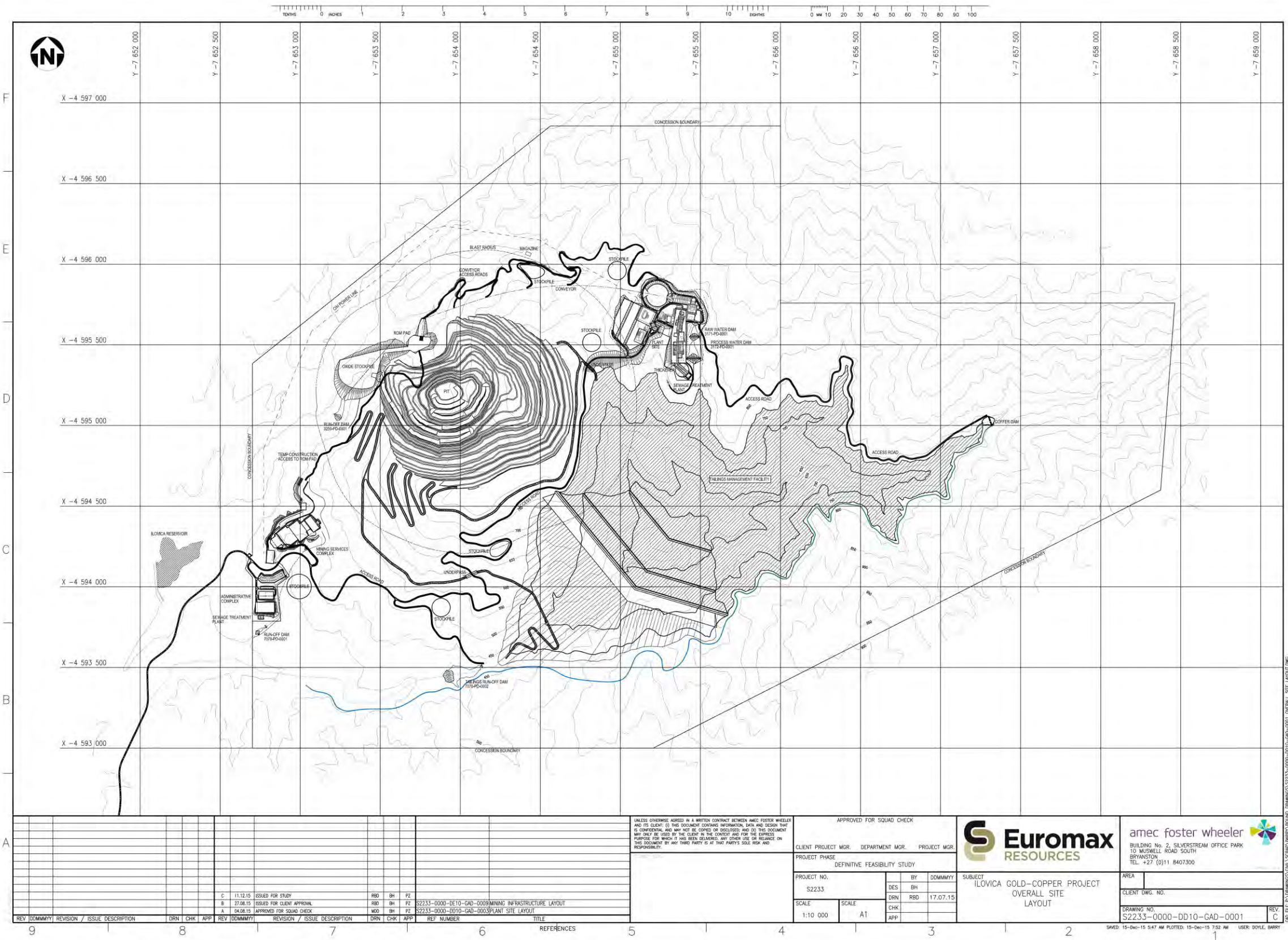


Figure 18.2
Plant Site Layout

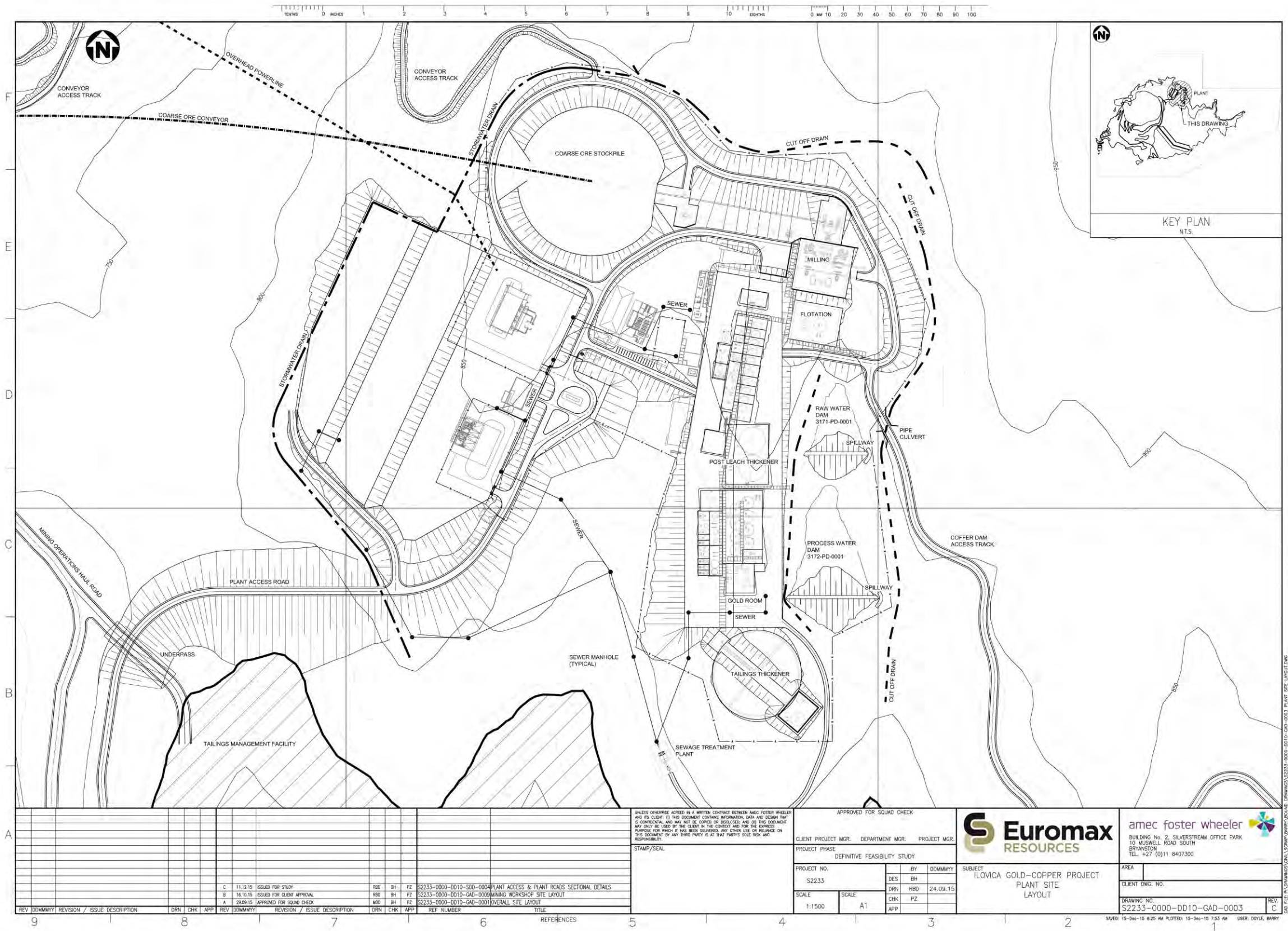
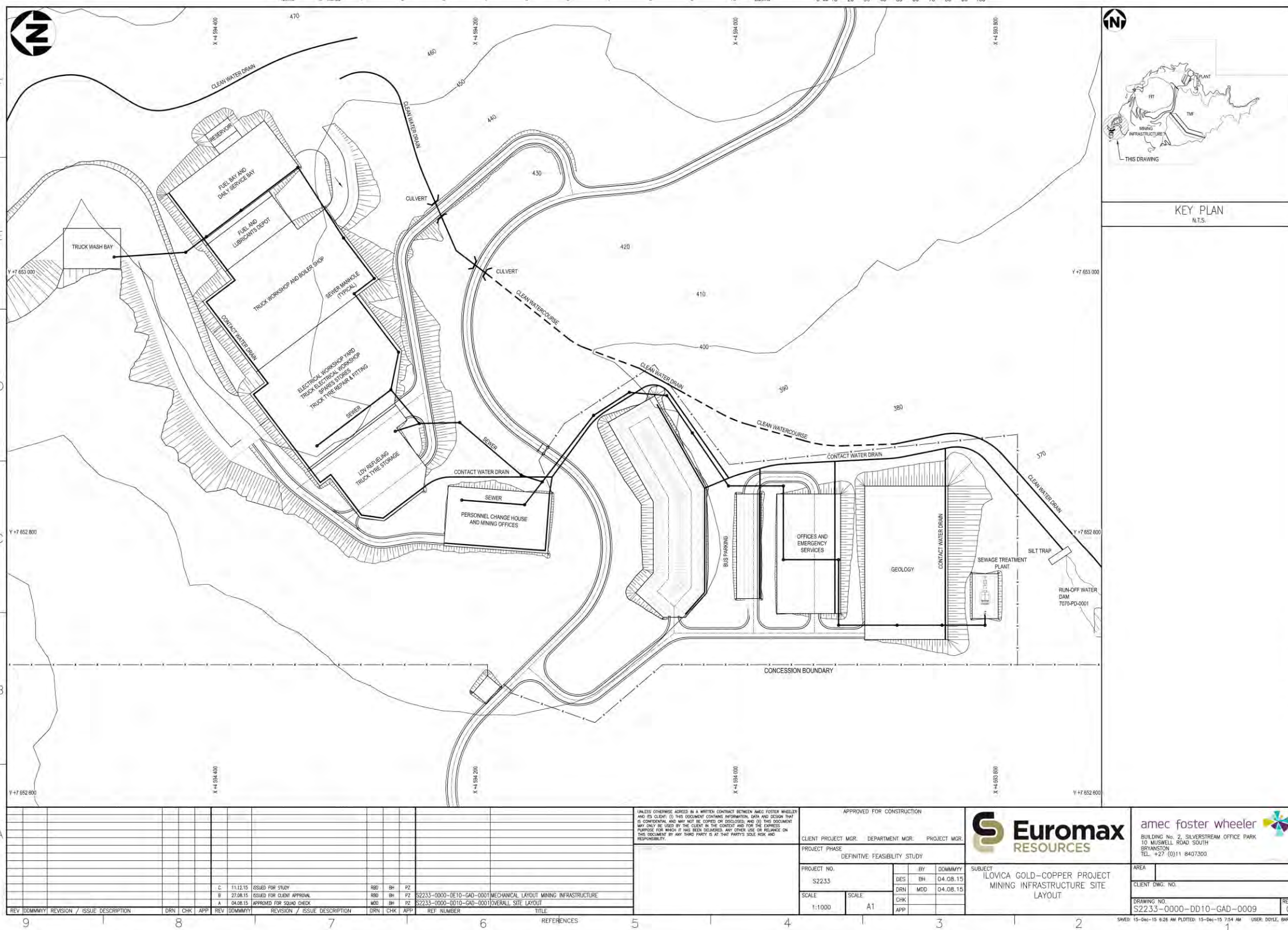


Figure 18.3



18.1.5.3 Measurement of Quantities

Bulk quantities were extracted from Autocad drawings of the terraces with use of the Technocad suite of software. The bulk quantities were used to calculate volumes and areas for the standard items listed in the BOQ.

18.1.6 Roads

18.1.6.1 Main Access Road

The main access road includes an off site section from the main gate to the concession boundary and an on site section from the gate to the process plant. This road will be used by loaded trucks in both directions therefore allowance was made for a bitumen wearing course. This is preferred to a gravel wearing course out of considerations of vehicle safety in wet conditions.

First-pass design on the main access road was carried out on the basis of the following criteria:

- Lane widths of 3.7 m
- 1.5 m wide gravel shoulders
- Maximum centre line gradient 7%

After the first-pass design, the criteria were changed in order to cut down on earthworks volumes and costs. The design used for the cost estimate was based on the following:

- Lane widths of 3.1 m
- 1.2 m wide gravel shoulders
- Maximum centre line gradient 8%

This design is at the permissible limits for low-volume rural highways. It will allow maximum speeds of 60 km/h, with further speed reductions at hairpin bends and, where necessary, lane widening to accommodate larger vehicles. The design references, based on TRH 17 – Geometric Design of Rural Roads, will be reviewed during the FEED phase against the applicable European guidelines.

The main access road includes two underpasses for mining vehicles to tip material at the TMF.

18.1.6.2 Roads for Process Plant and Mine Infrastructure

There are two classes of roads for these facilities, i.e.:

- Primary roads, which are on-terrace extensions of the access roads and are used by vehicles that deliver consumables (reagents, fuel, spares, etc.) and collect product for shipment.
- Secondary roads, which are low-volume roads used mainly by lighter delivery vehicles with occasional access required for lowbed trailers and possibly mobile cranes.

As noted above, the terraces for both mining and process are finished to steep slopes and thus the maximum centre line gradient for these roads is 7%. For considerations of vehicle safety, the on-terrace roads are also provided with bitumen wearing course.

The primary roads have the same geometry as the main access road with a 6.2 m carriageway and 1.2 m gravel shoulders.

On the secondary roads, the carriageway is narrowed to 6 m (being a reasonable practical minimum). The shoulder width of 1.2 m is retained for these roads.

18.1.6.3 Access Tracks

Access tracks provide vehicle access to the following features:

- Overland conveyor
- Tailings slurry delivery lines and TMF RDD
- TMF embankment storm water dam
- ROM pad – construction access

These tracks are designed for access by means of four wheel drive vehicles. The access tracks were initially designed based on the following:

- Gravel surface width of 8.4 m, carriageway and shoulders combined plus side allowances for a drain and guardrail
- Maximum centre line gradient 7%

The above basis was modified in order to cut down on costs. The design used for the estimate was based on the following:

- Gravel surface width of 3.5 m plus side allowances for a drain and guardrail
- Passing bays at intervals along the track
- Maximum centre line gradient 14%

The running surface will be mostly in cut rather than in fill and some allowance was made for gravel surfacing to smooth over the blasted rock profile and provide an even surface for vehicles. These tracks will be used by competent drivers operating suitable off-road vehicles.

18.1.6.4 Measurement of Quantities

As for the terraces, bulk quantities for the roads were extracted from Autocad drawings of the terraces with use of the Technocad suite of software. The quantities were used to calculate volumes and areas for the standard items listed in the BOQ.

18.1.7 Storm Water Control

18.1.7.1 General Principles

This part of the report covers the storm water management for mining and process facilities. It also includes the routing of storm water on the downstream face of the TMF excluding tailings water recovery which forms part of the TMF design carried out by Golder. Pit dewatering and storm water on haul roads are managed by Mining.

In the context of this section, contact water is water that runs off from developed areas i.e. the process plant, mining infrastructure areas, haul roads, oxide ore stockpile and the face of the TMF.

Storm water control is provided to:

- Protect roads, terraces and other assets from being damaged by run-off
- Capture contact run-off and contain it on the property for use in the process
- Prevent, as far as practicable, the contact water from being mixed with clean water from outside the footprint of the contact areas.

Storm water control is managed through a system of drains and containment structures (storm water dams). Water collected in the dams is ultimately pumped into the process dam for use in the process.

The storm water control systems are designed for the 1:100 year flood specific to:

- Drainage systems have capacity for the 1:100 year peak flow according to the critical duration for any catchment.
- The storm water dams are sized for the run-off associated with the 1:100 year X 24 hour rainfall event.

Where possible, to facilitate maintenance, storm water is conveyed in open drains rather than in underground pipes. Underground pipes will be installed where necessary, for instance where culverts are required to collect water on the uphill side of a road and discharge it on the downhill side.

Run-off is estimated using the Rational Method with application of the design rainfall events.

18.1.7.2 Plant Site Run-off

Run-off from the plant site is carried directly to the TMF via open drains. The TMF itself functions as a containment system for plant run-off.

Cut-off drains are provided to the North and East of the plant site, however the function of these is to reduce load on the on-terrace drains rather than to serve an environmental purpose.

18.1.7.3 Storm Water Dams

There are three storm water dams as described in Sections 18.1.7.4, 18.1.7.5 and 18.1.7.6.

The storm water dams are lined and are provided with a silt trap on the upstream side. The silt traps take out the coarse fraction of the sediment and the remaining suspended solids carry over into the dam. The suspended solids can be expected to build up in the dam over time, with augmentation by wind-blown sediment. The dams are therefore configured with a suitable low point for periodic desludging by means of a sludge pump.

The pumping systems that are required to pump water from the storm water dam to the process dam are sized to empty the dam in seven days.

18.1.7.4 Mining Infrastructure Storm Water Dam

This area is provided with a storm water dam to collect contact water from the terraces. Non-contact water from upstream of the terraces is diverted to a point downstream of the dam through surface drains. The operating parameters of the dam are as follows:

- Catchment area: 10 ha
- Estimated 1:100 year X 24 h inflow (design capacity): 7.3 Megalitres

18.1.7.5 Oxide Stockpile Storm Water Dam

The top of the oxide ore stockpile is graded to drain into the pit. Clean water from upstream of the stockpile is collected below the stockpile in a culvert which discharges into the Jazga River at a point downstream of the storm water dam. The dam therefore collects water only from the face of the South embankment of the stockpile. The operating parameters of the dam are as follows:

- Catchment area: 2.5 ha
- Estimated 1:100 year X 24 h inflow (design capacity): 1.4 Megalitres

A preliminary design was completed for the culvert required under the Oxide stockpile. Detailed design will be required for this culvert taking into account the geological conditions, hydrology of the area and Macedonian regulations for this type of work.

18.1.7.6 TMF Embankment Storm Water Dam

The catchment area of the dam includes the face of the wall of the TMF and approximately 1.6 km of haul road. The dam also collects seepage which is piped into the dam from below the wall of the TMF. The seepage discharge pipe is continuous from the seepage collection point to a terminal point within the lined portion of the TMF embankment storm water dam. The operating parameters of the dam are as follows:

- Catchment area: 95.9 ha
- Estimated 1:100 year X 24 h inflow (design capacity): 53.3 Megalitres

The TMF diversion canal and other non-contact diversion drains discharge into the Shtuka River at a point downstream of this storm water dam.

18.1.7.7 Access Roads

Rainwater landing on access roads will run off from paved surfaces, compacted gravel shoulders, grassed banks and bare rock surfaces, therefore there is no significant generation of sediment. Water from upstream of the access roads is passed through to the downhill side via culverts.

18.1.8 Water Systems

18.1.8.1 General

The water system infrastructure for the following sections is described in Section 18.3 of this report:

- Process Plant;

- Potable Water System; and
- Fire Water System.

18.1.8.2 Dams

Besides the storm water dams, covered above, there are two earth dams, both at the process plant, these are:

- The raw water dam, which has a capacity of 15 Megalitres
- The process water dam, which has a capacity of 25 Megalitres

As for the storm water dams, these dams are lined with a polyethylene liner and are provided with a spillway sized for the probable maximum flood.

Due to the height of some of the plant dams and storm water dams (up to around 10 m), it is recommended that specialist design recommendations be obtained from the geotechnical team for execution. For the purpose of the study, the quantities for the dam walls were assessed on the basis of a 1:2 downstream slope and a 1:3 upstream slope. These are typical proportions used previously on such dams and provide for a stable wall while facilitating the placement of the liner.

18.1.8.3 Sewerage Reticulation and Sewage Treatment

Allowance is made for main underground sewers at both the process plant and mining infrastructure site. These sewers are placed to collect discharges from all buildings that have wet fittings such as showers, sinks, wash basins, laundry equipment and similar. They are typically 160 mm diameter pipes and the branches to the buildings are 110 mm diameter. The step up in diameter at the junction to the main sewer is to contain blockages in the local pipework and prevent blockages from occurring in part of the main system. Distances between manholes are within 80 m to allow for rodding from one manhole to the next.

The following manning figures were used:

- Process Plant: total staff over all shifts in a 24 h cycle – 204, of whom 95 will be showering on site
- Mining: total staff over all shifts in a 24 h cycle – 223, of whom 56 will be showering on site

Applying these figures to per capita discharge rates experienced at mines in South Africa, the hydraulic loads were estimated as shown in Table 18.2

Table 18.2 Sewage Volumes				
	A	B	C	Units
	Total staff	Staff using showers	A-B = other staff ⁽¹⁾	
Mine Infrastructure Area	223	56	167	
Q each		120	45	l/d
Total Q		6.7	7.5	kl/d
Total, all categories			14.2	kl/d
Process Plant	204	95	109	
Q each		120	45	l/d

Table 18.2 Sewage Volumes				
	A	B	C	Units
	Total staff	Staff using showers	A-B = other staff ⁽¹⁾	
Total Q		11.4	4.9	kl/d
Total, all categories			16.3	kl/d

⁽¹⁾ Clerical, administration and support

The above population figures were included in the scope of work for the enquiry for the sewage treatment plants.

18.1.9 Power Distribution

Bulk power shall be provided by the Macedonian parastatal power utility company MEPSO via new 110 kV overhead transmission lines from existing substations at Berovo and Sushica. MEPSO have confirmed that adequate capacity is available for the project.

MEPSO considered various connection options, however the two lines from Berovo and Sushica was the only option that satisfied the national network stability criteria used by MEPSO.

As dictated by the MEPSO connection procedure, Euromax Resources commissioned a local licenced electrical consultancy 'TIMEL Projekat' to provide a study to identify possible OHL routes, existing sub-station extensions and modifications and the design of the 110 kV main switchyard at the process plant site. This included a capital cost estimate for the equipment necessary to make the connections to the existing network.

Figure 18.4
Connection of Substation Ilovitza to Substation Sushica with Double-Circuit OHL

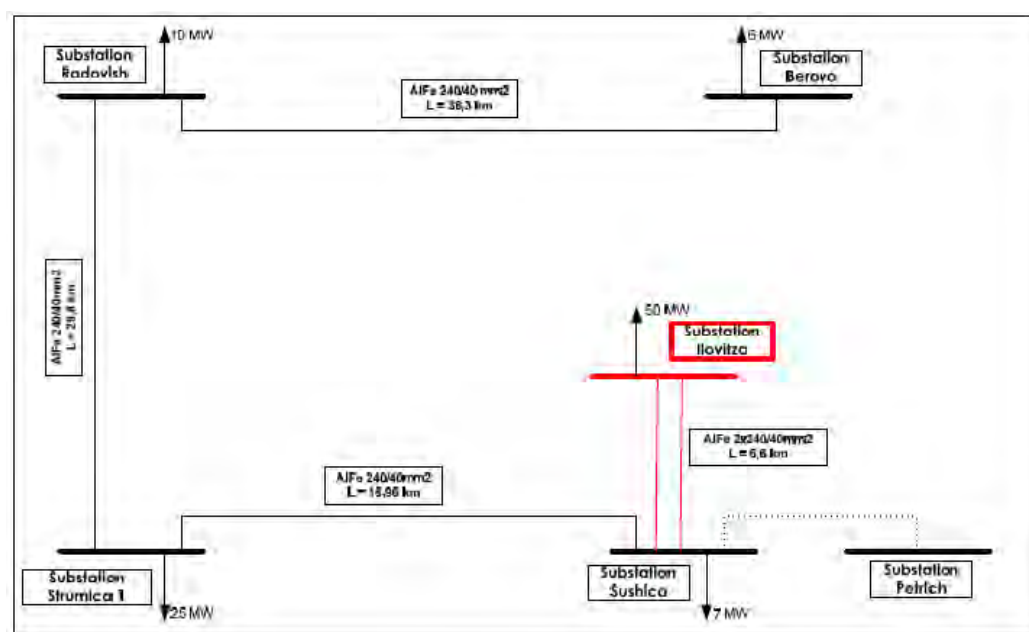


Figure 18.4 shows the connection of Substation Ilovitza to the transmission network with a 110 kV OHL along the route SS Sushica – SS Ilovitza – SS Berovo.

The intake substation is positioned at the west side of the plant to provide access for the incoming transmission lines.

The main plant 10 kV switchboard 3100-SWB-0001 shall be installed in a substation building at the intake switchyard in line with local practice.

Main medium voltage power is radially distributed within plant areas from the 10 kV main switchboard using above ground cables to the transformers and large motors.

A 10 kV overhead line shall be installed from the plant to the mine complex (generally following the pit blast radius) and extending as far as the TMF storm water transfer pumps to provide permanent power to the crusher area, reservoir raw water pumps, mine services complex, administrative complex and storm water handling from the main plant switchboard. It is proposed that the same line shall initially provide construction power to all major load centres to limit the number of stand-alone generators until the MEPSO mains power is available.

18.1.10 Architectural

18.1.10.1 General

Habitable buildings have been deemed to be architectural buildings. Other buildings (warehouses, workshops pump houses etc.) have been designed as structural steel buildings with steel cladding. This section addresses the architectural buildings required.

18.1.10.2 FS Execution Methodology

A scope of work was prepared requiring that the contractors provide a square meter price for the following:

- Architectural design
- Structural design
- Fabrication
- Supply and delivery to site
- Erection
- Completion and testing of all trades including all plumbing, lighting, light current electrical and glazing
- All finishes, permanent fittings and fixtures required for the buildings to be fully functional inclusive of water heaters, heating ventilation and air conditioning (HVAC) installation and other fixtures as stated below
- All concrete work including surface beds, drip aprons, steps and ramps

Tenders were invited from a selected group of contractors. An architectural comparative pricing schedule was drawn up followed by selection of the preferred contractor.

- A telephonic conference was held with the preferred contractor that indicated:

- The price included for the full scope indicated in the tender document
- A lump sum was included for the appointment of an architect and engineer
- The proposed use of light framed steel structure buildings
- Variations in the building requirements could be assessed by applying the square meter rate quoted

The rates received from the contractor were applied to revised quantities and were used as a basis to determine a preliminary cost estimate for Euromax Resources review. Based on Euromax Resources' review of the preliminary cost estimate the design was modified and quantities updated for use in the final FS cost estimate.

Architectural layout drawings were prepared for four typical buildings. These were forwarded to the preferred contractor for information.

18.1.10.3 Architectural Structures

Table 18.3 Architectural Structures			
Title	Approximate Footprint (m²)	Number of Storeys	Active Floor Area (m²)
Mine production and technical office building	480	2	960
Mining complex medical facility	160	1	160
Mining complex fire protection facility	100	1	100
Mining change house	860	1	860
ROM daily service bay offices	240	1	240
Mining fleet control room	50	1	50
Operators crib room (rom complex)	460	1	460
Mining Workshop Offices	240	1	240
Support Section Offices	480	2	960
Gatehouse and access control building no. 2 (mining complex)	150	1	150
Mining workshop & warehouse central offices	260	1	260
High explosive facility plant offices	160	1	160
Core logging building	375	1	375
Crusher control room	30	1	30
Plant control room & metallurgical laboratory	546	1	546
Plant production and technical office building	216	2	432
Plant central workshop & warehouse offices	270	2	540
Plant medical facility	150	1	150
Plant change house	288	1	288
Gatehouse and access control building no. 3 (plant complex vehicle control)	128	1	128
Gatehouse and access control building no. 4 (plant complex)	45	1	45
Security and access control building no. 5 (plant complex gold room)	45	1	45
Administration complex central office building	480	2	960

Table 18.3
Architectural Structures

Title	Approximate Footprint (m ²)	Number of Storeys	Active Floor Area (m ²)
Waste Management Building	500	1	500
Gatehouse and access control building no. 1 (main access road)	45	2	90
EPCM Construction Safety and Induction offices	216	1	275
EPCM Construction Management offices	768	1	1050

18.1.10.4 Future Considerations for Design Phase

The following items need to be taken into account in the future design phase

- Appoint Macedonian Architect to do the architectural layout and design work
- Agree a Euromax Resources standard for building work to ensure consistent building design and construction on the mine
- Finalise architectural design criteria based on Euromax Resources' requirements and Macedonian/European standards and norms
- Prepare manpower schedules so that architectural building requirements can be developed and building designs can be finalised.

18.1.11 Reagents

18.1.11.1 General

Process plant reagents have been identified and provision for the storage, mixing and dosing of the reagents was made. In this phase of the project reagent suppliers have not been contacted to confirm:

- Method and bulk of delivery
- Packaging
- Classification (flammable/poisonous etc.)
- Shelf life

18.1.11.2 FS Execution Methodology

The mixing and storage of process plant reagents have been incorporated into the model and each discipline has estimated costs associated with these requirements.

18.1.11.3 Reagents Storage Facilities

The following major facilities have been provided for in the handling of reagents:

- Tank farm adjacent to the flotation area
- Tank farm adjacent to the elution area
- Warehouse at the entrance to the main plant for the storage of dry reagents

- Silos and mixing facility at the entrance of the plant for the storage and slaking of lime.

18.1.11.4 Future Considerations for Design Phase

The following items need to be taken into account in the future design phase of the project:

- Obtain Macedonian/European regulations for handling each reagent
- Reagent specific information in terms of:
 - delivery method
 - storage requirements
 - method of off loading
 - classification (flammable/poisonous etc.)
 - shelf life(Suppliers need to be engaged to obtain the above information)
- Reagent storage design taking the above considerations into account.

18.1.12 Security

18.1.12.1 Monitoring and Detection

Refer to Section 17.3 of this report.

18.1.12.2 Fencing

General site fencing was included with the earthworks scope of work. The fencing is 2.4 m high, medium security fencing for the overall concession, mining infrastructure and plant site. It also covers the sewage plants and storm water dams, where controlled access is required for safety reasons.

18.1.13 Fuel Storage and Distribution

18.1.13.1 General

The fuel storage infrastructure, with the exception of civil foundations will be installed by the fuel vendor. The fuel vendor will be contacted during the FEED phase to confirm their requirements.

The requirements for terrace, roads and concrete work for the fuel storage and distribution system have been incorporated into the 3D model and each discipline estimated costs associated with these requirements.

18.1.13.2 Fuel Storage and Distribution Infrastructure

Provision has been made for the following:

- Tanker off-loading facility on the light vehicle access to the Mining Workshop area. It is planned that this facility will be able to off-load both diesel tankers and tankers carrying lubes.
- A fuel and lube storage area adjacent to the mining daily service bay. This facility should have sufficient storage capacity to store 7 days fuel and lube.
- A light vehicle refuelling facility in the mining workshop area.

- A light vehicle refuelling facility at the main plant site. Fuel will need to be brought to this facility by tanker.

18.1.13.3 Future Considerations for Design Phase

The following needs to be taken into consideration in the future design phase of the project

- The vendor's requirements for fuel off-loading, storage and distribution systems. The vendor must take into consideration the restricted nature of the site.
- Ensure the civil construction is not scheduled to be done before the vendor's mechanical layout and loads are obtained.

18.1.14 Explosives Magazine

18.1.14.1 General

Blasting for mining operations will be done by a blasting contractor who will be responsible for the infrastructure required to store ANFO and detonators.

Provision was made in the Bulk Earthworks, Concrete, Structural Steel and Architectural estimates for the requirements of the blasting infrastructure.

18.1.14.2 Explosive Magazine Infrastructure

The following items were allowed for in the cost estimate

- Terrace for explosives magazine situated out of the blast area on the track serving the ROM conveyor access
- Architectural building with kitchen and ablution facilities at the high explosives facility
- Structural steel building for the storage of ANFO
- Explosive magazine

18.1.14.3 Future considerations for Design Phase

The following items need to be taken into account in the future design phase of the project

- Macedonian blasting regulations
- Battery limits of the blasting contractors responsibilities
- Ensure that civil layouts and loadings are available before civil design is scheduled

18.1.15 Waste Management

The final disposal of industrial and domestic waste will be off site at a licensed facility, however allowance has been made under Civil Infrastructure for the costs of an on site storage and sorting facility. The requirements will include the following facilities:

- Waste transition yard
- Waste management facility storage yard

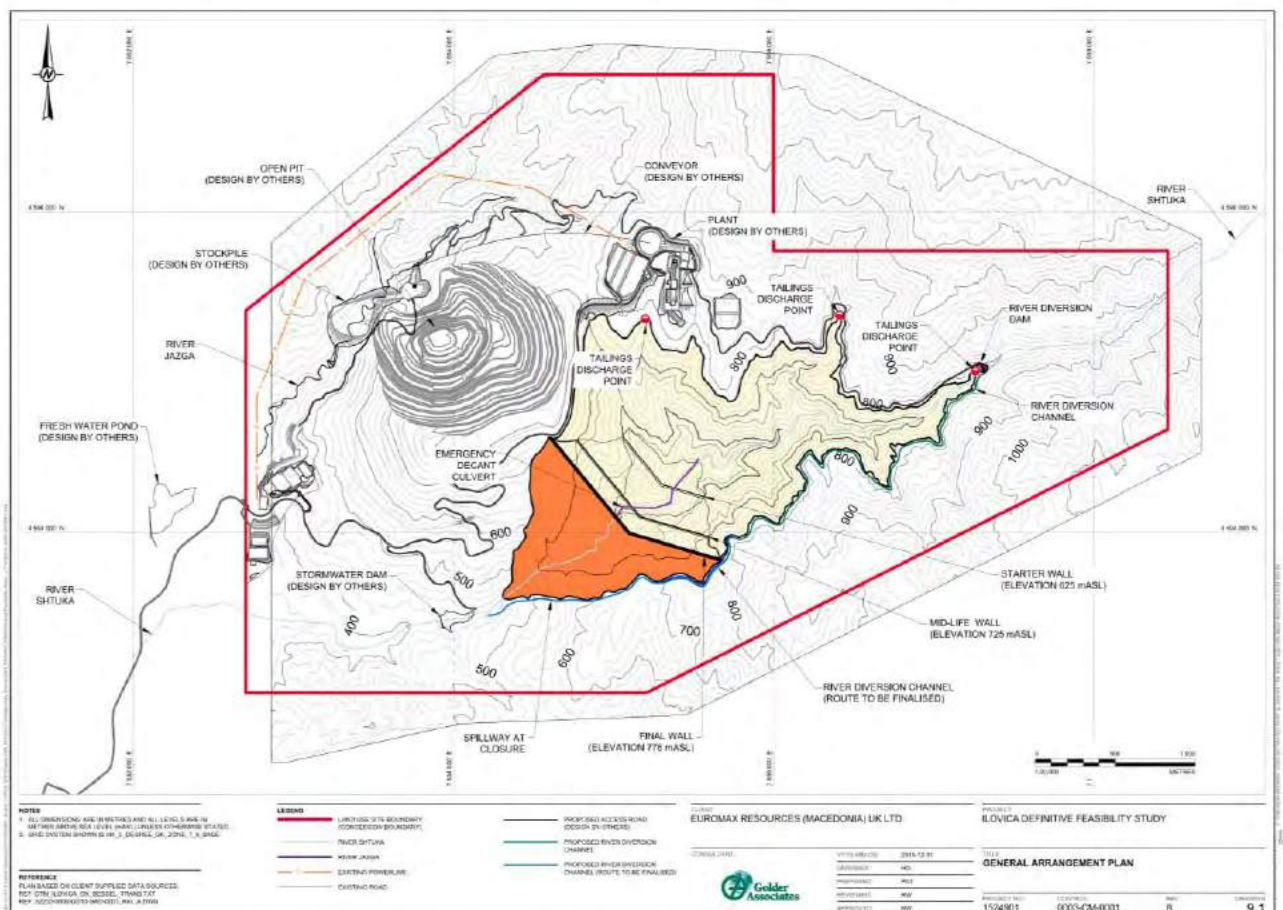
- Salvage yard
- Perimeter fencing
- Drainage
- Building for monitoring and control of activities

18.2 TAILINGS MANAGEMENT FACILITY

18.2.1 Introduction

The proposed Ilovica mining project is located in rugged mountainous terrain in an area marked by high hills and steep valleys. The elevation of the proposed mine site area varies between 350 m and 950 m AMSL. The lower areas are located at the south-southwestern end of two relatively narrow valleys while the high ground is predominantly located in the north-northeastern part of the site (Figure 18.5).

Figure 18.5
TMF General Arrangement Plan



The proposed site for the TMF is located approximately 3 km east-northeast of the villages of Ilovica and Shtuka, in the Shtuka valley, directly southeast of the proposed open pit area. From the photographs taken of the site, the valleys are steeply-sided and densely vegetated with medium size/height (5 m to 10 m) trees.

No site selection study was carried out as part of the PFS for the project because of the mountainous terrain and the need for a facility close to the open pit. However, different TMF configurations situated in the Shtuka valley were evaluated, with the TMF location selected for development as part of the FS.

18.2.2 Geotechnical site investigation

The geotechnical site investigation for the Ilovica TMF is currently being undertaken by the Department of Civil Engineering of the Cyril and Methodius University in Skopje. Following ongoing consultation between Golder and CMU, the programme has been designed with the principal aim of determining the potential geological/hydrogeological nature of the area and the in situ rock which will act as the foundation material for the proposed embankment. In addition the works will aim to identify any potential geo-hazards (springs, landslides, faults, land erosion etc.).

Proposed geophysical techniques will also aim to gather data on both the solid and drift geological units within the valley which will be required to complete a site specific seismic assessment as part of future works. Trial pitting of the area will establish the depth of superficial materials and therefore enable estimations as to the volume of material which will require removal during TMF construction.

It is understood that the final geotechnical site investigation works will comprise the following:

- Engineering, geological and hydrogeological mapping of the TMF area;
- Drilling of geotechnical boreholes along with rock core logging and in situ hydrogeological (packer) testing;
- Excavation and geotechnical logging of trial pits;
- Geophysical survey of the TMF area using refraction seismic and electrical resistivity imaging techniques;
- Collection of geotechnical samples for laboratory testing including materials from the open pit which will be used as embankment construction materials.

As works are currently ongoing, not all information was available as part of the current study, a summary of which is provided below. As such, it is recommended that the results and conclusions of this study, in relation to the TMF, are validated during detailed design, following receipt and interpretation of the collected site investigation data.

18.2.2.1 Lugeon Packer Testing

Based on data received from CMU, Golder has analysed the results the Lugeon packer tests carried out at varying depths within 14 boreholes within the TMF area (Figure 18.6). A summary of these tests is provided in Table 18.4.

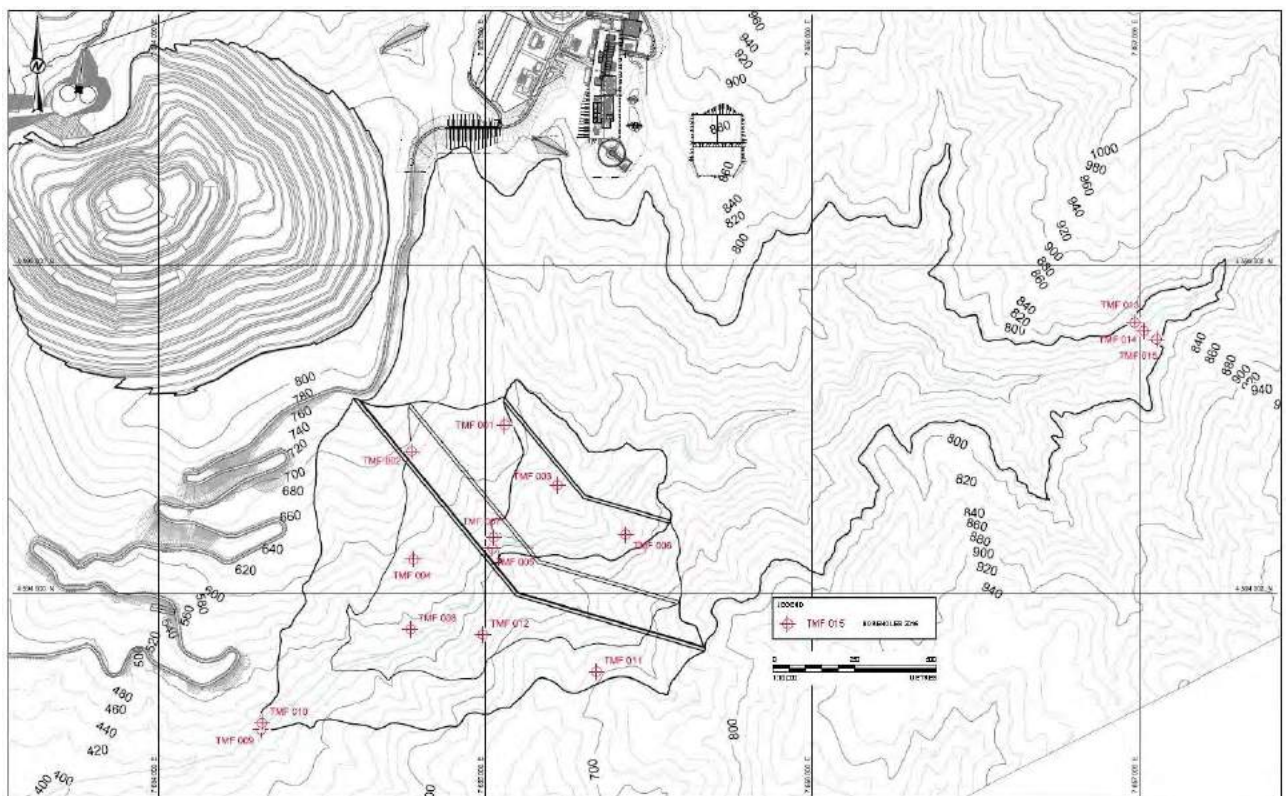
Table 18.4 Summary of Lugeon Testing by CMU			
Borehole	Depth from (m)	Depth to (m)	Permeability (m/s)
TMF 001	20.00	31.00	3.7×10^{-7}
	31.00	41.10	5.5×10^{-7}
	41.00	51.30	1.1×10^{-6}
	51.00	60.00	4.4×10^{-7}
TMF 002	17.00	29.90	9.8×10^{-7}
	44.00	55.80	6.4×10^{-7}
	89.10	100.40	1.5×10^{-7}
	100.00	110.10	5.0×10^{-7}
	110.00	120.00	4.7×10^{-7}
TMF 003	20.30	31.30	8.1×10^{-8}
	31.00	42.30	1.1×10^{-7}
	49.00	60.00	1.6×10^{-7}
TMF 004	11.00	22.00	2.4×10^{-7}
	22.00	32.00	1.3×10^{-6}
	46.00	60.00	1.6×10^{-7}
TMF 005	29.00	40.20	1.1×10^{-8}
	40.00	52.00	2.5×10^{-8}
	52.00	62.80	9.1×10^{-7}
	62.00	73.20	7.0×10^{-8}
	73.20	83.80	3.4×10^{-7}
TMF 006	20.00	30.00	2.3×10^{-6}
	30.00	40.90	7.6×10^{-7}
	41.50	49.80	1.1×10^{-6}
	59.00	60.00	3.4×10^{-7}
TMF 007	23.00	30.00	3.4×10^{-6}
	27.50	41.30	1.0×10^{-7}
	39.40	52.00	1.7×10^{-7}
	52.00	62.30	9.8×10^{-8}
	62.00	70.00	9.2×10^{-8}
	70.00	77.00	6.3×10^{-8}
TMF 008	19.60	24.40	2.1×10^{-7}
	20.40	34.40	8.7×10^{-7}
	31.00	44.30	6.6×10^{-7}
	43.60	60.50	6.2×10^{-7}
TMF 009	29.40	37.00	4.5×10^{-7}
	38.10	47.00	1.5×10^{-6}
	48.00	60.00	3.5×10^{-7}
TMF 011	11.00	20.50	2.1×10^{-7}
	31.00	41.50	1.0×10^{-6}
	41.70	51.90	1.9×10^{-7}
	48.10	62.50	7.2×10^{-8}
	62.00	73.00	3.9×10^{-8}

Table 18.4 Summary of Lugeon Testing by CMU			
Borehole	Depth from (m)	Depth to (m)	Permeability (m/s)
	82.90	93.90	9.6×10^{-8}
	101.00	112.00	5.3×10^{-7}
	109.90	120.30	5.3×10^{-7}
TMF 012	21.00	31.00	2.9×10^{-7}
TMF 013	21.00	31.70	4.3×10^{-7}
TMF 014	16.80	30.00	9.0×10^{-7}

Based on the data provided by CMU it can be seen that, in general, there is no relationship between depth and permeability within the granite rock underlying the TMF. This would appear to support the conclusion that the permeability of the granite basement is controlled by fractures opposed to rock porosity. It can also be seen that, on average, the permeabilities obtained were in the order of 5.4×10^{-7} m/s with a range between 1.1×10^{-6} and 9.2×10^{-8} .

Based on the values obtain it is estimated that the permeability of the rock is approximately 1 to 2 orders of magnitude higher than the tailings which will be deposited on top of the rock (Table 18.11). As a result, it is expected that seepage rates from the TMF will be controlled by the lower permeability tailings. These values will however need to be re-validated when the relevant tailings laboratory test data become available, and the implications thereof with regards to seepage rates, evaluated.

Figure 18.6
TMF Boreholes – 2015 Site Investigation



18.2.3 Tailings Management Facility Design Parameters

The following sections which cover the site Geology, Geomorphology and Climate of the TMF site were extracted from the Ilovica Copper-Gold Project Tailings Dam Design Review report prepared by Phoenix Mining Consultants (submitted to Euromax Resources in December 2014). These sections have subsequently been updated by Golder for the FS, based on the data currently available.

18.2.3.1 Geology

The solid geology on the mine site generally consists of massive granite with local fractures up to a few centimetres. Alluvium is present in the base of the valley but only thin superficial deposits higher up the slopes.

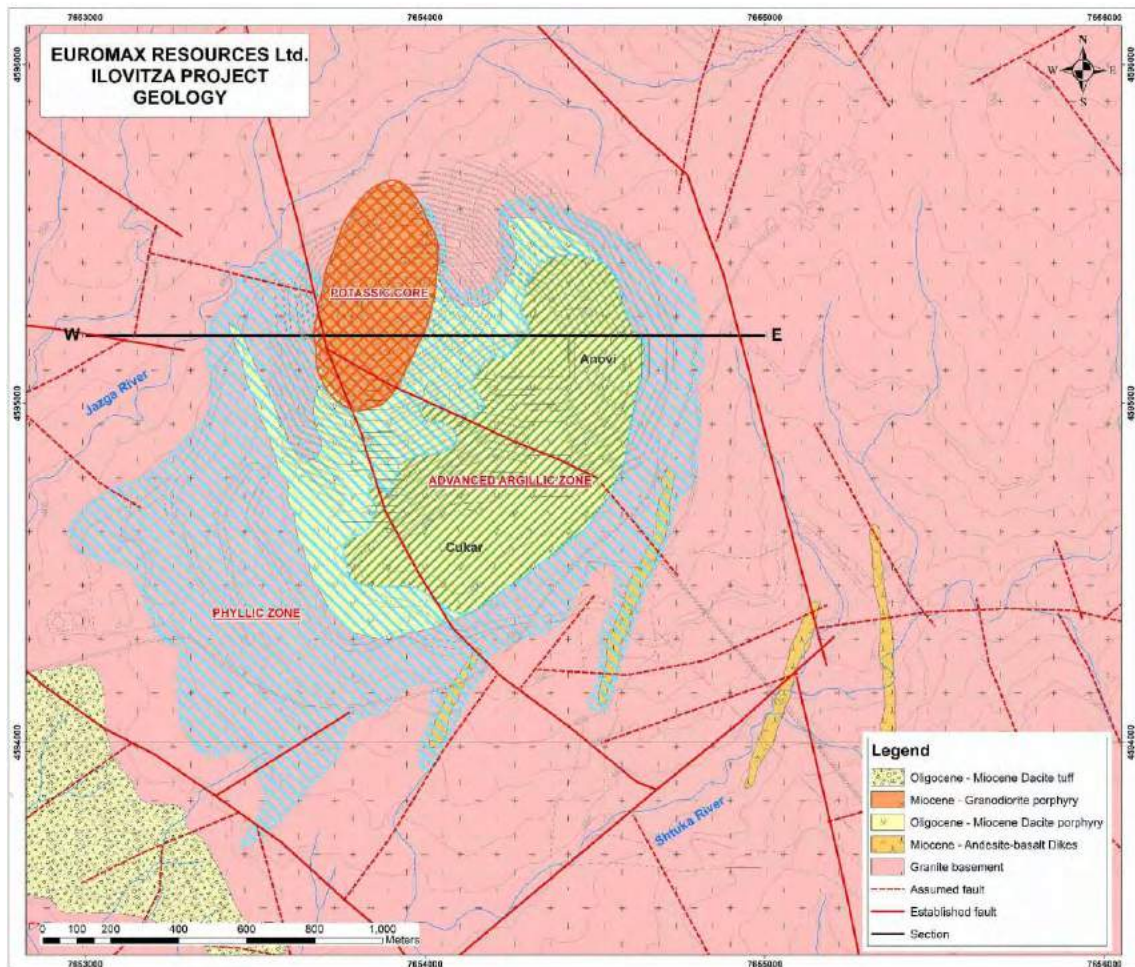
The presence of faults and springs are currently being investigated as part of the geotechnical investigation carried out as part of the FS. These investigations involve detailed engineering-geological mapping of the TMF site including the proposed route of the river diversion channel, as well as geophysical investigations in the zone of the TMF starter wall and final wall. If these investigations confirm the presence of faults and/or springs beneath the footprint of the dam, the design of the facility will be modified (drainage blanket and/or slush grouting etc.) accordingly during the next phase of the project.

The TMF is located within the Shtuka valley immediately to the southeast of the proposed open pit and processing plant (Figure 18.5). Figure 18.7 presents the general solid geology of the immediate study area and indicates that the TMF location is generally underlain by the granite basement unit, although a number of basalt dykes, which run perpendicular to the valley, are also present. Visual observations of the site made during the PFS study describe the bedrock geology within the TMF as massive granites with some fracturing.

A number of faults have been identified within the TMF area including one running roughly parallel along the base of the Shtuka valley in a north-easterly direction. A number of other faults have also been identified running approximately perpendicular to the valley within a number of small side valleys which feed into the main Shtuka Valley.

Drift geology is generally limited to the valley sides and comprises of a thin layer of colluvial and residual soils.

Figure 18.7
Geology and alteration zones - plan view



18.2.3.2 Geomorphology

The Ilovica TMF will be located within the Shtuka valley immediately southeast of the proposed open pit and process plant. The valley base rises from approximately 435 m AMSL at the toe of the final TMF embankment to 776 m AMSL at the upstream side of the RDD over a plan distance of approximately 3 900 m, equivalent to an average slope of 1 Vertical (V): 10 Horizontal (H).

The valley has steep sides which rise to elevations of 800 and 950 m AMSL on the northern and southern slopes respectively. In general the slopes are steeper on the southern side, at 1V:2.5H, than the northern side at 1V:3.5H. In addition to the main valley, a small side valley is located on the northeastern side of the TMF, approximately 1 km to the east of the process plant. The base of this smaller valley rises from 675 m AMSL to 775 m AMSL at an average slope of 1V:3H although the side slopes are as steep as 1V:1.5H. An overview of the TMF is provided in Figure 18.5.

The valley generally comprises of a thin layer of colluvial and residual soils (>0.5 m thick) on the sides and base of the valley, although the riverbed is generally bare as a result of loose sediment having been removed by seasonal flows.

The valley is densely vegetated with medium trees located within both the base and on the sides of the valley. During preliminary clearance works some trees will need to be removed to assist in construction of the starter wall and associated infrastructure.

Based on observations made during the site visit, only one small area with landslide scarring was noticed on the southern side of the valley. Due to the heavily vegetated nature of the site and time restrictions, a more detailed investigation to assess the presence of geo-hazards on the site was not possible. The results of the ongoing site investigation works will however be evaluated when available to identify any potential geo-hazards which may exist within the TMF area.

18.2.3.3 Climate

The climatic data is presented in The Environmental and Social Engineering Considerations document, Golder Report No 13514150363.526/A.0, dated July 2015.

18.2.3.4 Seismicity

Introduction

The seismic design criteria for the Ilovica mine site have been evaluated using seismic data of the region to derive the operating base earthquake (OBE) also known as the design base earthquake (DBE) and the MDE. The results of the seismic assessment were reported to Euromax Resources in Golder Report 1524901.500/B.0, dated 8 June 2015, which includes full details of the assessment as well as relevant references.

These are equated to peak ground accelerations (PGA) at the site and are used in the analysis of the stability of the TMF and associated infrastructure. The procedure used international guidelines as set out by the International Commission on Large Dams Bulletin 52, 1986 (ICOLD).

The DBE equates to the largest anticipated earthquake event that is likely to occur during the life of the structure. The MDE relates to the largest earthquake that could possibly occur at the site). For reporting the MDE it is generally accepted to use the 1 in 10 000 year event. Using the associated PGA value in slope stability calculations will reduce the factor of safety for the facility, although it should be noted that “some damage may be accepted, but safety must be persevered”

The TMF will be constructed as an engineered embankment to retaining tailings, and due to its classification as a high risk/consequence facility, has been designed based on the 1 in 10 000 year MDE event, and not based on the requirements of an OBE (during the operating phase).

Regional Seismicity

The eastern Mediterranean region is one of the world's most seismically active areas. Earthquakes in this area are related to large scale tectonic movements resulting from the Arabian plate moving northward with respect to the Eurasian plate. The majority of the movement is taken up by shortening of the Caucasus (Figure 18.8 and Figure 18.9) with the remainder of the relative movement taken up in a series of strike slip faulting and east west trending thrusts. The main fault is the North Anatolian fault and the closest fault is the VFZ strike slip fault approximately 50 km west of the Ilovica mine site running in a northsouth direction, as shown in Figure 18.8.

As part of the site seismic analysis a search window of earthquakes occurring within latitude 45° to 38° and longitude 20° to 26° was used which returned in excess of 18 000 recorded earthquakes with a magnitude of 3 or greater and from the year 1867 AD until 22 April 2015. Data from the United States Geological Survey (USGS), and Geoscience Australia (GA), for the last 148 years in the abovementioned search area was selected. These data were used in a probabilistic determination of the PGA for the MDE.

Figure 18.8

**Active faults and approximate Ilovica Mine Site location
(USGS open source website, Earthquake Hazard Program)**

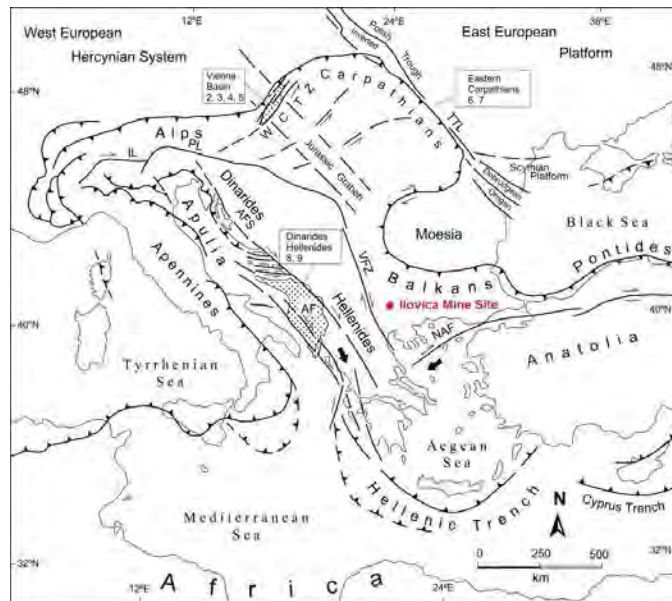
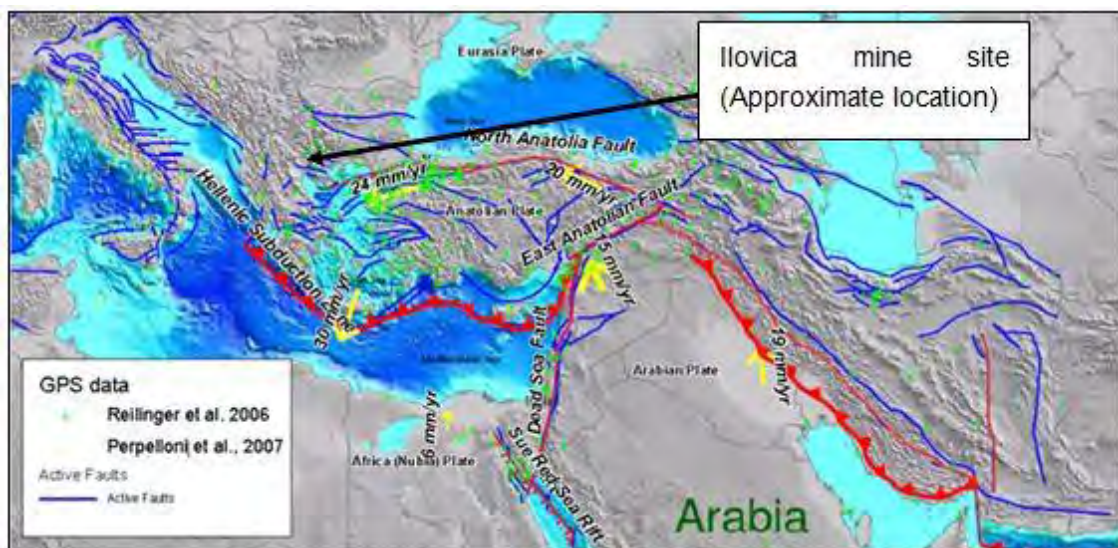


Figure 18.9

**Active plate boundaries and active faults
(Galasso, C., Gomez, I., Gupta, A. & Shen-Tu, B. Probabilistic Seismic Hazard Assessment for Albania, Macedonia and Serbia).**



Peak Ground Acceleration Determination

The catalogue of earthquake data was limited to only include earthquakes in the abovementioned search area, an approximate 600 km radius around the Ilovica mine site. These seismic data have been used to determine the PGA based on the magnitude, depth and distance from the mine site. Two attenuation formulae were used to determine the PGA for the mine site, the Ambraseys-Douglas, (2000) Formula and the Boore-Joyner Formula.

For each attenuation formula, the highest values of PGA derived for each individual year across the data timeline were then used. These values were ranked in relation to the PGA value and plotted on a semi-log scale creating a Gumbel plot. For the most accurate results an unbroken set of values across the timeline is preferable. The trend of the data is extrapolated to determine probabilistic return events.

The USGS data covers a time span of 148 years. The last 148 years was the longest time period of results obtained from the USGS and GA without too many extended gaps for the recorded earthquakes.

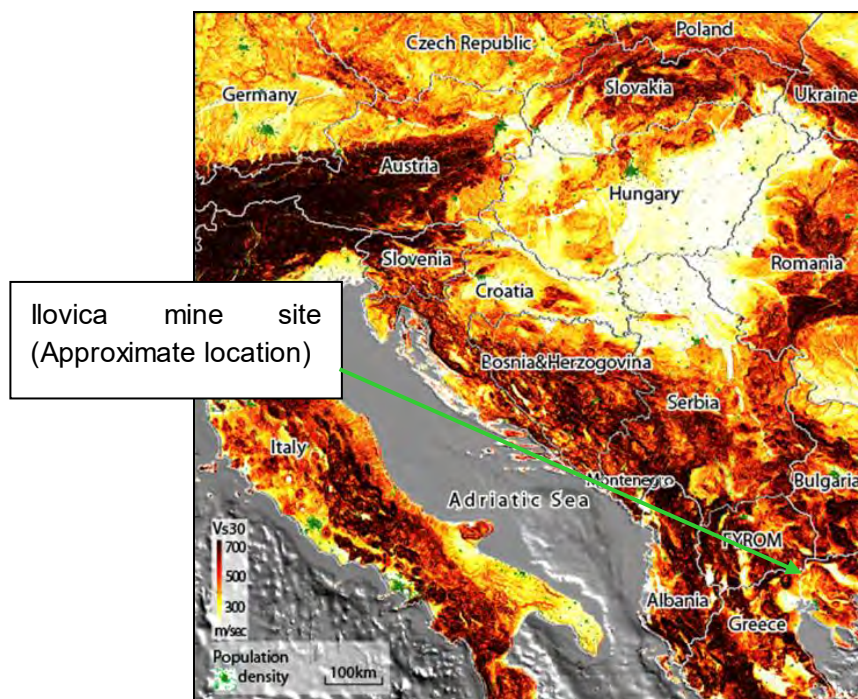
Table 18.5 tabulates the extrapolated values of PGA (g) for the required return events. The early data are based on historical records and are subject to interpretation. The peak ground accelerations derived from the data have been assigned a probability of occurrence/exceedance. This means that within a defined time period, a given event will have a certain probability of occurring or being exceeded.

Based on the USGS and GA data and averaging the results from the two methods, the derived values are 0.14g for the 1 in 500 year event, 0.20g to 0.23g for the 1 in 1 000 year event and 0.28g to 0.32g for the 1 in 10 000 year event.

Table 18.5 Summary of PGA for Given Return Events		
Return Event Years	Peak Ground Acceleration (g)	
	USGS & GA Data Ambraseys-Douglas (2000) Formula and Gumbel Plot	USGS & GA Data Boore-Joyner Formula and Gumbel Plot
1 in 100	0.130	0.130
1 in 500	0.140	0.140
1 in 1 000	0.230	0.200
1 in 10 000	0.320	0.280

The average shear-wave velocity in the top 30 m (V_{s30}) used in the calculation was 609 m/s, for a Tertiary volcanic unit. This value is also confirmed in Figure 18.10.

Figure 18.10
Ilovica Mine Site falling in a V_s30 area of between 500 - 700 m/s
(USGS open source website, Earthquake Hazard Program)



The Boore-Joyner and Ambraseys-Douglas formula are both traditional quadratic functions characterised by the distance and magnitude of the event from an individual seismic source zone (SSZ). The Boore-Joyner analysis is applicable only in an area of multiple SSZ if every earthquake originating from each separate SSZ is grouped together and analysed separately. The Ambraseys-Douglas attenuation model is distance and magnitude dependant. The formula used assumes conditions where the magnitude (M_s) is greater than or equal to 5.8 and distance is less than or equal to 15 km.

A sensitivity analysis was undertaken to assess the effect of distance and magnitude on the PGA values. The measured earthquakes from site were sub divided into three categories based on distance. These categories are events occurring between 0 km to 20 km from site, between 20 km to 50 km from site and between 50 km to 100 km from site. The strongest magnitude was selected for each year and plotted as a Gumble graph. The extrapolated magnitudes for the required events, 1:100, 1:500 (OBE), 1:1 000 and 1:10 000 (MDE) are presented in Table 18.6.

Table 18.6				
Extrapolated magnitude for required events				
Distance (km)	1:100 Year event Extrapolated M	1:500 Year event Extrapolated M	1:1 000 Year event Extrapolated M	1:10 000 Year event Extrapolated M
0 – 20	3.8	4.0	4.8	5.8
20 – 50	5.8	6.2	7.5	9.2*
50 – 100	6.1	6.4	7.6	9.2*

*These extrapolated values are likely to be too high as such a massive event would only occur on a plate boundary, not a secondary structure.

The nearest large fault zone from site is approximately 40 km to 60 km as can be seen in Figure 18.8, the VFZ strike slip. There are minor fault zones closer to site, but have not recorded significant magnitude values and according to the Gumble plot are unlikely to produce significant motions.

The extrapolated ranges of magnitudes were used in conjunction with the average distance of earthquakes occurring from site. The average distances used were 16 km, 45 km and 78 km. The results are presented in Table 18.7.

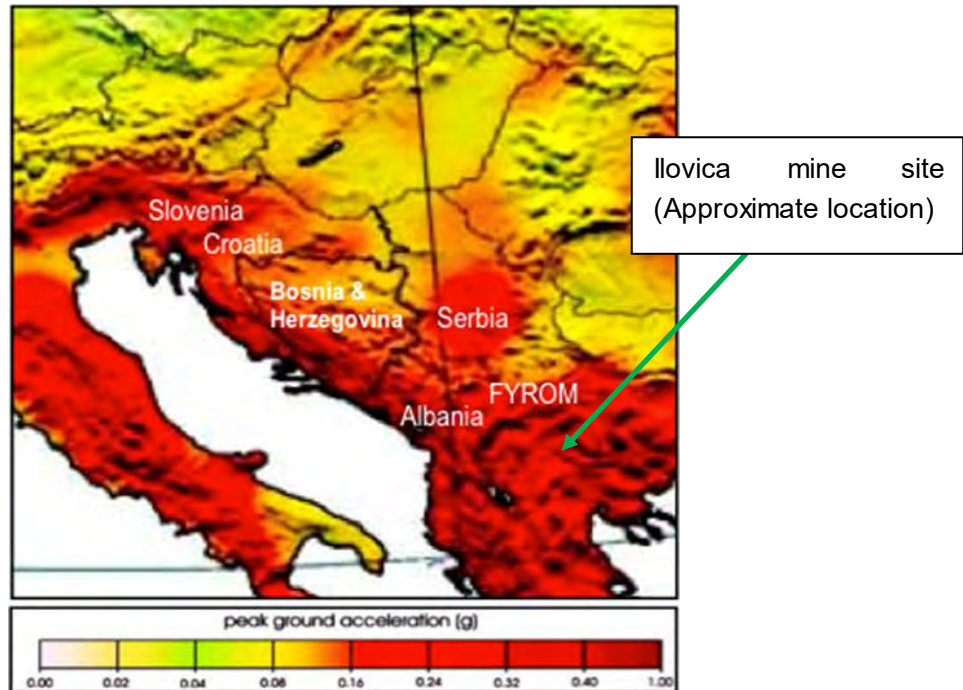
Table 18.7 Seismic Sensitivity Analyses												
Distance from site (km)	16	16	16	16	45	45	45	45	78	78	78	78
Earthquake magnitude	3.8	4.0	4.8	5.8	5.8	6.2	7.5	9.2	6.1	6.4	7.6	9.2
PGA (g) Boore-Joyner Attenuation Model	0.055	0.061	0.093	0.157	0.047	0.058	0.115	0.283	0.026	0.030	0.057	0.133
PGA (g) Ambraseys- Douglas (2000) Attenuation Model	0.057	0.063	0.091	0.145	0.029	0.036	0.065	0.143	0.006	0.006	0.011	0.024

The Ambraseys-Douglas (2000) attenuation model is not ideal for determining PGA for events occurring greater than 15 km from a selected location, therefore for the range of distances analysed the Boore-Joyner model provides more realistic values. Table 18.7 shows that an extrapolated 1:10 000 year event earthquake occurring 16 km from site gives a PGA of 0.157 g which is only marginally higher than the calculated OBE event.

The crucial distance range is the 20 km to 50 km band, as the active “VFZ” fault zone falls within this range from site. The extrapolated 1:10 000 year event at a distance of 45 km from site gives a PGA value of 0.283 g which is similar to the probabilistic MDE PGA value calculated of between 0.28 g to 0.32 g.

On a probabilistic seismic map for Macedonia, the area in Figure 18.11 shows that the mine falls into the PGA zone of between 0.24g and 0.32g. From the data in Table 18.6, a magnitude larger than 8.1 and/or closer than 30 km from site with a depth of 10 km equates to an approximate return period of 1 in 10 000 years (MDE). An earthquake of magnitude 7.1 only 30 km from the project site with a depth to the epicentre of 10 km, is comparable to a 1 in 500 year event (OBE).

Figure 18.11
Peak ground acceleration (g)
(USGS open source website, Earthquake Hazard Program)



Recommendation

Based on the above seismic analysis, the OBE calculated for input to the stability of the embankment wall has been taken as 0.14 g. The MDE has been calculated as 0.32 g. These values were therefore selected to be used for design purposes for the Ilovica project as well as in the calculation of potential wall settlements (and thus the minimum freeboard requirements on the TMF) for pseudo-static (earthquake) conditions.

18.2.3.5 Potential Construction Materials Overview

As part of work completed by Golder, TMF rockfill construction materials have been classified based on the eleven lithology units identified by Euromax Resources and others as part of the current mine waste plan.

As a result of discussions with Euromax Resources, a review of the recovered core and site leach tests 6 material types have been identified and are based on the observed geochemical and physical degradation of samples both from exposure to weathering conditions and in their recovery (excavation, transportation, placement and compaction). These 6 material types are presented in Table 18.8.

Table 18.8 Identified Waste Rock Units				
Waste Rock Unit Name	Lithologies Covered*	Physical Condition on Recovery	Physical Degradation with Weathering	Geochemistry with Weathering
Sterile	DACOX, GRTALOX	Fresh to Highly Weathered	No physical degradation	No chemical degradation
Lithocap/Starter	DACOXBR	Fresh to Weathered	No physical degradation	No chemical degradation
Carbonate Bearing	GNDIOCA	Fresh	No physical degradation	Some chemical degradation (Alkaline)
Intermediate	GNDIO, GNDIONON, GRTNON	Fresh to Weathered	Limited physical degradation	Some chemical degradation (Acidic)
Acid Generating	DACUNOXBR, GRTAL, GRTALHS	Fresh to Slightly Weathered	Some physical degradation	Some chemical degradation (Acidic)
Highly Acid Generating	DACUNOXUD, GDUNOXUD	Fresh to Slightly Weathered	Significant physical degradation	Significant chemical degradation (Acidic)

Based on the materials above a total of 13 samples have been selected for geotechnical testing. These tests are ongoing and as such results are not available at this time.

In order to develop geotechnical properties for the identified rockfill materials use has been made of the rock core testing undertaken by DMT as well as the empirical relationships established by Barton and Kjaernsli, (1981).

These relationships enable the estimation of the drained shear strength for rockfill materials based on a reduction in the angle of friction with increasing depth within large rockfill structures, as a result of particle crushing. The values adopted for each of the units above are presented in Table 18.9. To take account of the highly weathered, soil like behaviour of a proportion of the sterile (oxide materials) and highly acid generating units, separate geotechnical parameters have been derived from Golder's experience in similar materials and are also presented in Table 18.9.

In addition, it is anticipated that both gravel and sand materials will be required for the construction of the proposed embankment filters and under embankment drain. Sources and potential availability of these materials should be identified within the next phase of the project.

Table 18.9 TMF Construction Rockfill Criteria						
	Sterile ²	Carbonate Bearing ²	Intermediate ²	Acid Generating ²	Highly Acid Generating ²	Completely Weathered Rock (Soil) ²
Average Unconfined Compressive Strength (MPa) ^Δ	17.44	92.63	69.87	37.85	32.25	N/A
Average Density (kN/m ³)	19.42 ^Δ	23.57 ^Δ	22.85 ^Δ	21.52 ^Δ	21.39 ^Δ	18.0*
Rockfill Porosity (after compaction) (%)	25*	25*	25*	25*	25*	N/A

Table 18.9 TMF Construction Rockfill Criteria						
	Sterile ²	Carbonate Bearing ²	Intermediate ²	Acid Generating ²	Highly Acid Generating ²	Completely Weathered Rock (Soil) ²
Material Origin [□]	Overburden	Open Pit	Open Pit	Open Pit	Open Pit	Overburden/ Open Pit
Equivalent Roughness*	6.5	8.3	8.3	8.3	6.5	N/A
D ₅₀ of Rockfill (mm)*	15	35	35	35	15	N/A
Max Effective Shear Friction Angle (°)	34.7 ¹	41.4 ¹	40.7 ¹	39.0 ¹	36.0 ¹	33*
Min Effective Shear Friction Angle (°)	25.5 ¹	29.7 ¹	28.9 ¹	27.2 ¹	26.8 ¹	25*

Δ Average data calculated from values in "Combined Tensile and Uniaxial Compression Strength", received from DMT

* Estimated/calculated values based on experience with similar materials. To be confirmed by results of geotechnical laboratory testing

1 Based on empirical data from Barton and Klaernsil (1981), based on a maximum embankment height of 250 m. Values include a 1.2 Factor of Safety

2 Groupings based on site observations and discussions in relation to physical and geochemical behaviour

18.2.3.6 Tailings Production

The proposed TMF production design criteria are presented in Table 18.10 and are based on relevant information provided by Euromax Resources and others as part of the PFS study and subsequent works. In addition, where criteria has yet to be determined preliminary values have been adopted for design purposes based on Golder's engineering judgement and experience with similar materials.

Table 18.10 TMF Production Design Criteria	
Ratio of CIL to Flotation Tailings [°]	0.006:1
Mill Throughput (t/a) ^Δ	10 000 000
LOM (Years) [□]	21
LOM Solids Mass (t)*	210 000 000
Slurry Solids Content by mass (%) ^Δ	50
Solids SG ^Δ	2.75
LOM Solids Volume (m ³)*	140 000 000
Tailings Production (m ³ /a)*	6 666 667

[°] Discussed in the meeting between Golder and Euromax Resources 14/7/15

^Δ Data from Amec Foster Wheeler "Process Design Criteria", S2233-0000-DC00-DSC-0002, dated 1st July 2015

* Estimated/calculated values based on experience with similar materials. To be confirmed by results of geotechnical laboratory testing

[□] Data from PFS study

18.2.3.7 Tailings Characteristics

Tailings characteristics have been adopted based on data obtained from others as part of the PFS study as well as subsequent work.

As part of the tailings test work, undertaken by SGS, a sample of tailings was subjected to consolidation testing in a Rowe Cell to determine the potential void ratios, dry densities and permeabilities of the tailings under increasing levels of loading. The results of this testing have been assessed by Golder however, at this stage there is significant variations between the values and behaviour suggested by the testing (which does not appear to have correctly measured the sample void ratio at each loading stage) and based on Golder's experience with similar tailings materials from projects around the world.

As a result, the tailings characteristics adopted as part of this study, as shown in Table 18.11, have been determined based on Golder's engineering judgement and experience with similar materials. Further tailings test work, which will include additional consolidation testing (comprising of slurry consolidometer testing) is therefore planned for the next phase of the project.

Table 18.11 Tailings Geotechnical Design Criteria	
D ₈₀ (µm) ^Δ	75
D ₁₀₀ (µm) [*]	150
Range of Void Ratio [*]	1.60 – 0.6
Adopted Settled Void Ratio [*]	0.8
Average Settled Dry Density (t/m ³) [*]	1.5
Permeability Range (m/s) [*]	1E-9 – 1E-8
Range of Coefficient of Volume Compressibility (m ² /kN) [*]	2.12E-4 – 3.19E-4
Range of Coefficient of Consolidation (m ² /y) [*]	10 – 75.8
Range of Compression Index [*]	0.2 – 0.3
Effective Friction Angle (°) [*]	32
Effective Cohesion (kPa) [*]	0

Δ Data from Amec Foster Wheeler "Process Design Criteria", S2233-0000-DC00-DSC-0002, dated 1st July 2015

* Estimated/calculated values based on experience with similar materials. To be confirmed by results of geotechnical laboratory testing.

No geochemical laboratory test results are available at present for the tailings, but these results, which did not form part of Golder's scope of work, will be included when they become available.

18.2.3.8 Socio-economics

For the socio-economics aspects of the TMF site, refer to the Golder ESIA report for the Ilovica Project.

18.2.3.9 Land Use

The site for the TMF is located approximately 3 km east northeast of the villages of Ilovica and Shtuka, in the Shtuka valley, directly southeast of the proposed open pit area. Land use in the area consist primarily of forestry, but is in addition also used for the grazing of livestock and agricultural activities, especially lower down in the flatter sections of the Shtuka valley.

18.2.4 TMF Design

Tailings from the plant, situated above and approximately 1 km to the North, will gravitate via the tailings transportation system to the TMF. Due to longer pumping distances, higher friction losses, and the reduction in static head between the plant and the TMF, tailings will be pumped to the furthest deposition points on the facility during the middle and later stages of the project.

It is expected that upon deposition the tailings materials will segregate into a coarse fraction (settling out on the beach) and a fine fraction (running off into the impoundment area). Due to the fine nature of the tailings, the very high rates of rise on the facility, and the high seismicity of the site, upstream raising of the TMF is not deemed to be a viable option. As it is likely that the tailings will take some time to consolidate, the facility has been designed using the downstream method of construction and dam wall raising to safeguard the long term structural integrity of the facility. The TMF's starter wall embankment and future wall raises will be constructed from rockfill from the development of the open pit.

Based on the LOM plan for the project, the Ilovica TMF has been designed for the storage of 10 Mt of tailings per annum for 21 years, thus a total of 210 Mt of tailings, or based on an average deposited tailings density of 1.5 t/m³, a total tailings volume of 140 Mm³, as per Table 18.10.

18.2.4.1 General Layout

The TMF (Figure 18.12, Figure 18.13 and Figure 18.14) comprises a valley impoundment and involves the construction of a main embankment (starter wall) across the valley to the south of the process plant. The tailings in the facility will be contained along the northern, eastern and southern sides by the natural contours of the valley, and on the western side by the starter wall and future wall raises to be constructed above the wall. The starter embankment will be approximately 45 m high (measured vertically from the crest of the dam to ground level), and the TMF will have a final height of 276 m at closure of the facility (measured vertically from the crest to ground level). It should be noted that these true heights of the starter and final TMF walls, are higher than the values previously quoted in the PFS, which were measured from the crests of the walls directly vertically to the valley below the walls.

Figure 18.12
TMF End of Year 1

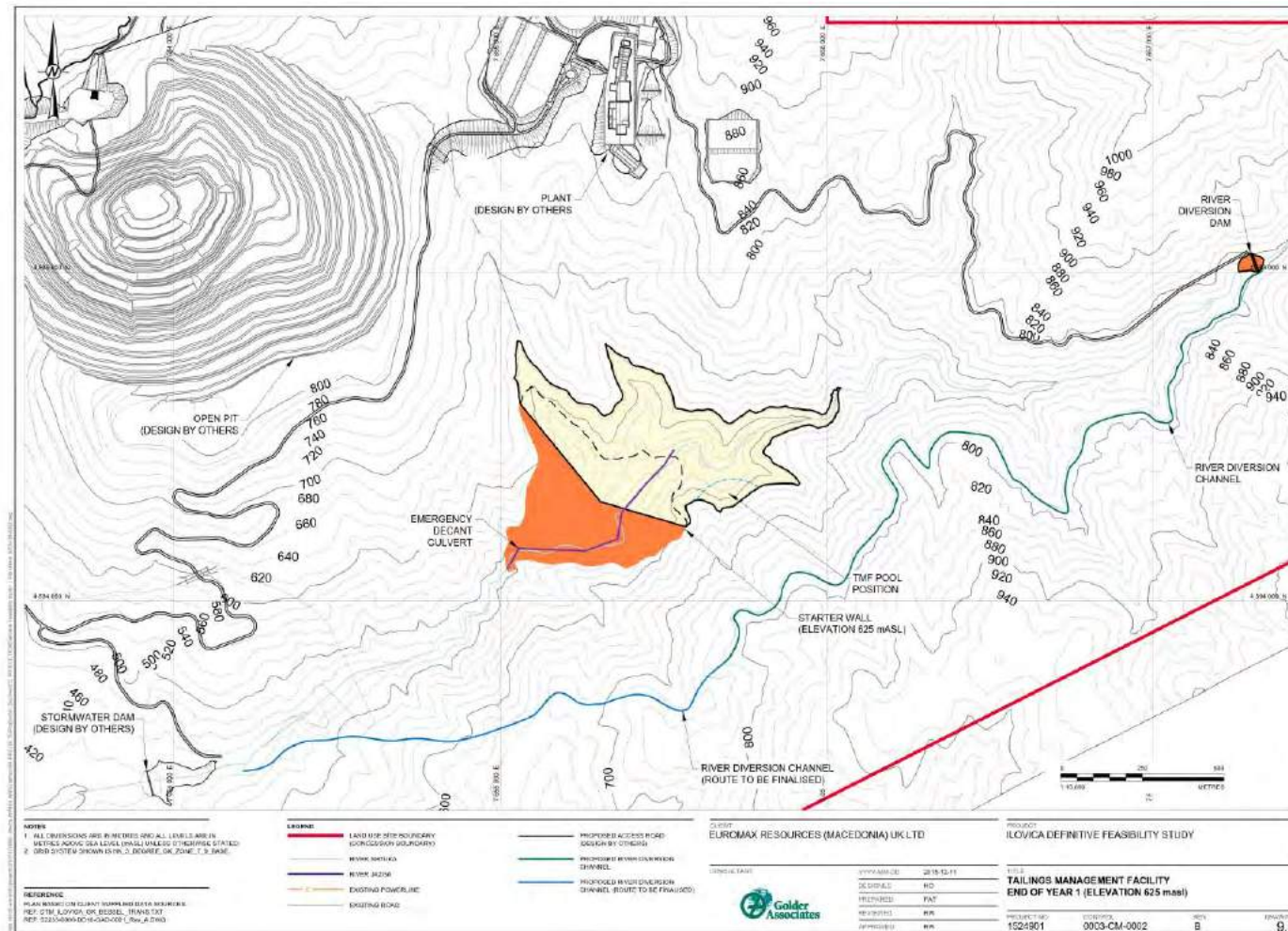


Figure 18.13
TMF Mid-Life

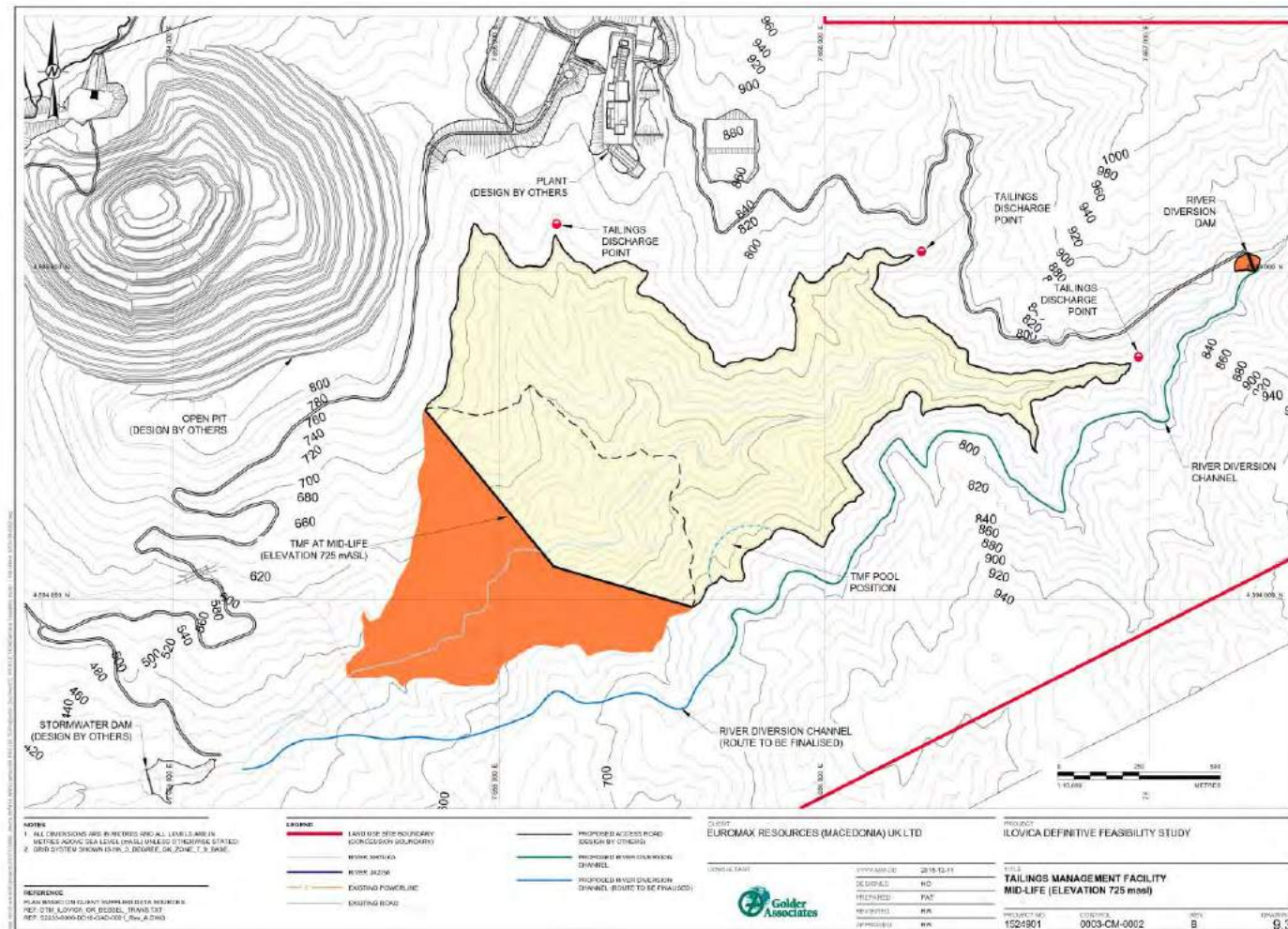


Figure 18.14

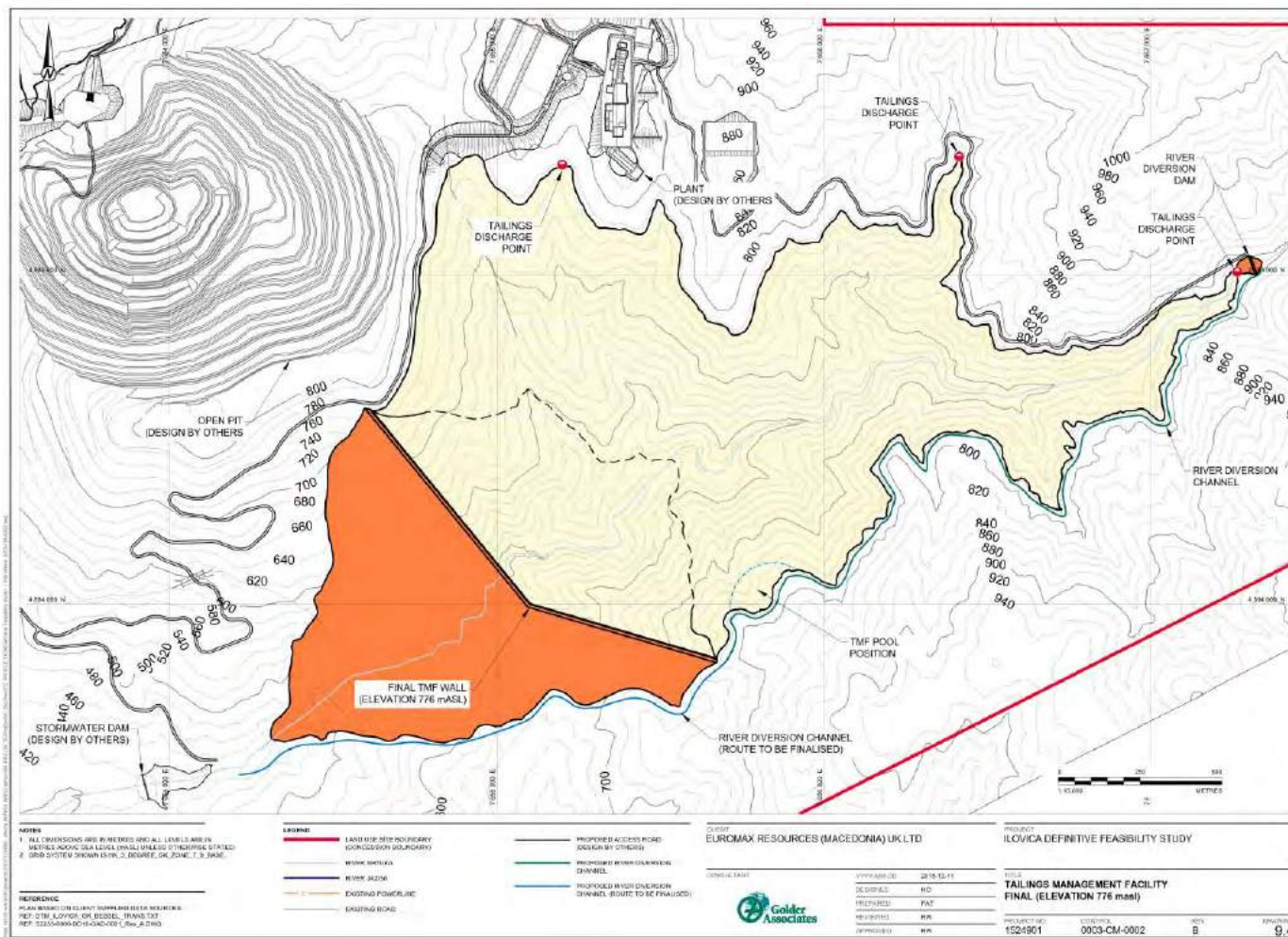
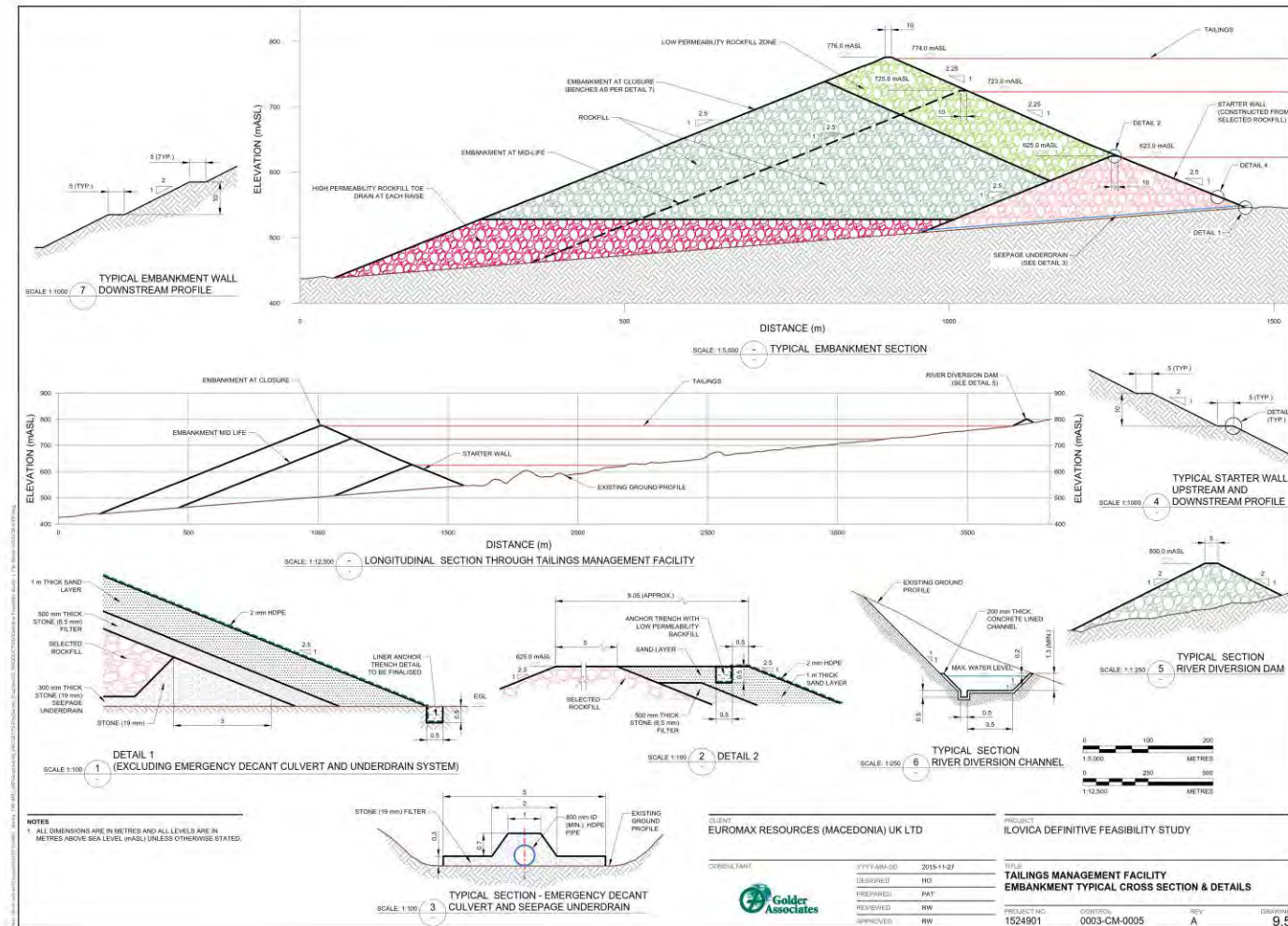


Figure 18.15
TMF Embankment Typical Cross Section and Details



Details of the heights and geometry of the TMF's starter wall and future downstream wall raises are presented in Table 18.12 and Table 18.13 and in Figure 18.15.

Table 18.12 TMF Starter Wall Geometry					
Crest Width (m)	Average Slope (Upstream/Downstream)	Inter-bench Slope (Upstream/Downstream)	Inter-bench Height (m)	Inter-bench Width (m)	Maximum Height (m)
9.05*	1V : 2.5H / 1V : 2.5H	1V : 2H / 1V : 2H	10	5	45

* Approx. 5 m wide crest + 4.05 m wide drainage system.

Table 18.13 TMF Wall Raises Geometry					
Crest Width (m)	Average Slope (Upstream/Downstream)	Inter-bench Slope (Upstream/Downstream)	Inter-bench Height (m)	Inter-bench Width (m)	Maximum Height (m)
10	1V : 2.25H / 1V : 2.5H	1V : 1.85H / 1V : 2H	10 (6 final)	5	276

Based on the LOM plan described above and the geometry presented in Table 18.12 and Table 18.13, the facility will have a storage capacity of approximately 210 Mm³ at a closure elevation of approximately 776 m AMSL, which will be approximately 2 m higher than the top tailing elevation at closure. At closure the TMF will have a top tailings surface area of approximately 191 ha.

The starter wall has been designed for the deposition of tailings during the first year after commissioning of the plant, will be approximately 45 m high with a 5 m wide crest, 1V:2.5H upstream slope and a 1V:2.5H downstream slope. The upstream slope will consist of 1V:2H slopes with 5 m wide benches located at 10 m vertical increments, for an average slope of 1V:2.5H. The starter wall which will be lined with a 2 mm thick HDPE liner, will be equipped with a coarse and fine seepage filter as well as a seepage underdrain below the liner which will convey any seepage under the TMF wall down the central section of the valley to the storm water dam located below the TMF.

Initial tailings deposition will be carried via spigots from the starter wall in an easterly direction to create a beach with a 0.5% to 1% fall towards the rear of the facility. Due to this approach the supernatant pool on the facility will be pushed away from the starter wall, up-valley in an easterly direction. Following tailings deposition during the first two years after commissioning, tailings deposition on the facility will also commence for the northern and eastern sides of the facility, to manage the pool position on the southern side of the facility where the return water barge will be located. Return water from the barge will be pumped across the crest of the TMF to the northern side of the wall from where it will be pumped back for re-use in the plant. During the final few years of the facility's life, tailing deposition will be adjusted to move the position of the supernatant pond to within 200 m of the crest of the TMF to reposition the pool closer to the front of the TMF for closure purposes.

18.2.4.2 Storage Capacity Evaluation and Construction Phasing

The Ilovica TMF has been designed for the storage of 210 Mt of tailings, which based on an average deposited tailings density of 1.5 t/m³, represents a total tailings volume of 140 Mm³. Tailings will be deposited at a rate of 10 Mt/a for a period of 21 years, the life of the mine.

The TMF wall will be raised using the downstream method of wall construction. This method of TMF construction has been selected due to the following combination of factors:

- The TMF, which will be approximately 276 m high, is situated up-valley from the Shtuka village and as such classifies as a high risk facility;
- The TMF is situated in a seismic active area, which also poses a risk to the long term stability of the facility;
- The tailings to be deposited in the TMF is relatively fine; and
- The rate of rise on the facility, especially during the first few years, is very high and remains in excess of 3 m/y throughout the life of the facility. This indicates that consolidation and strength gain is likely to occur slowly.

Due to these factors, it is evident that in order to meet long term performance and safety requirements, downstream raising of the facility presents the only viable option, as both centreline and upstream raising of the facility pose unacceptable risks to the project, the general public and the environment.

As shown in Figure 18.15, the TMF's starter wall will be constructed to an elevation of 625 m AMSL prior to commissioning of the TMF and processing plant, which will be commissioned in Year 0 (the commissioning milestone date), when tailings deposition on the facility will commence. The starter wall will require approximately 6.55 Mm³, or at a density of 2 t/m³, approximately 13.1 Mt of rockfill from the open pit.

Following construction of the starter wall, construction of the downstream wall raises will continue as a continuous operation. During Year 1 approximately 5.28 Mm³ of rockfill will be required for wall construction, followed by approximately 4.84 Mm³ of rockfill during Year 2. This will be followed by an average of approximately 4.00 Mm³ of rockfill for wall construction during Year 3 to (and including) Year 21. More accurate rockfill volume requirements on an annual basis are provided in Table 18.14.

The TMF construction phasing has been carried out to provide adequate freeboard at all times to allow the facility to accommodate a probable maximum flood (PMF) event (based on data provided by SWS), as well as to accommodate wall settlements should a seismic event occur. These two aspects of the TMF design are discussed in more details in the sections which follow.

Table 18.14
Ilovica TMF - Stage Capacity

Start date	End date	Years	Production t/yr	Density (t/m³)	Volume	Cum. Vol.								
2016	2037	21	10,000,000	1.5	6,666,667	140,000,000								
			210,000,000											
CONTOUR	AREA	AVE AREA	HEIGHT	HEIGHT	VOLUME	SUM VOLUME	SUM TONNES	DEPOSITION TIMING	RoR	Embankment Volume	Construction Year	Construction Phase	Volume of Phase	
masl	m²	m²	m	m	m³	m³	t	Yrs	m/yr	m³				
540	-	-	0.0	0	0	0	0	2019.00	-	0	-1.00			
560	24,000	12,000	20.0	20	447,314	447,314	670,971	2019.07	277.78	611,579	-0.93			
580	54,000	39,000	20.0	40	559,142	1,006,456	1,509,685	2019.15	123.46	1,376,054	-0.85			
600	116,374	85,187	20.0	60	1,162,532	2,168,988	3,253,482	2019.33	57.29	2,008,067	-0.67			
620	212,505	164,440	20.0	80	3,146,421	5,315,409	7,973,114	2019.80	31.37	5,415,153	-0.20			
625	243,942	228,224	5.0	85	1,326,542	6,641,951	9,962,926	2020.00	27.33	6,545,675	0.00	-1	6,545,675	
626	250,230	247,086	1.0	86	265,308	6,907,259	10,360,888	2020.04	26.64	6,771,779	0.04			
627	256,517	253,373	1.0	87	265,308	7,172,567	10,758,851	2020.08	25.99	6,997,883	0.08			
628	262,805	259,661	1.0	88	265,308	7,437,875	11,156,813	2020.12	25.37	7,223,988	0.12			
629	269,092	265,948	1.0	89	265,308	7,703,184	11,554,776	2020.16	24.77	7,450,092	0.16			
630	275,380	272,236	1.0	90	265,308	7,968,492	11,952,738	2020.20	24.21	7,676,197	0.20			
635	306,817	291,098	5.0	95.0	1,326,542	9,295,034	13,942,550	2020.39	21.73	8,806,718	0.39			
640	338,254	322,535	5.0	100.0	1,326,542	10,621,575	15,932,363	2020.59	19.71	9,937,240	0.59			
645	371,841	355,048	5.0	105.0	1,718,876	12,340,451	18,510,677	2020.85	17.93	11,221,660	0.85			
646	379,514	375,678	1.0	106.0	417,112	12,757,563	19,136,344	2020.91	17.57	11,523,636	0.91			
647	387,188	383,351	1.0	107.0	417,112	13,174,674	19,762,011	2020.98	17.22	11,825,612	0.98	1	5,279,937	
648	394,861	391,024	1.0	108.0	417,112	13,591,786	20,387,679	2021.04	16.88	12,127,588	1.04			
649	402,534	398,698	1.0	109.0	417,112	14,008,897	21,013,346	2021.10	16.56	12,429,564	1.10			
650	410,208	406,371	1.0	110.0	417,112	14,426,009	21,639,014	2021.16	16.25	12,731,540	1.16			
655	448,574	429,391	5.0	115.0	2,085,558	16,511,567	24,767,351	2021.48	14.86	14,241,421	1.48			
660	486,941	467,758	5.0	120.0	2,085,558	18,597,125	27,895,688	2021.79	13.69	15,751,301	1.79			
662.5	508,376	497,658	2.5	122.5	1,385,492	19,982,617	29,973,926	2022.00	13.11	16,659,701	2.00	2	4,834,089	
665	529,810	519,093	2.5	125.0	1,385,492	21,368,109	32,052,164	2022.21	12.58	17,568,102	2.21			
670	572,679	551,245	5.0	130.0	2,770,984	24,139,094	36,208,640	2022.62	11.64	19,384,902	2.62			
675	615,548	594,114	5.0	135.0	2,770,984	26,910,078	40,365,117	2023.04	10.83	21,201,703	3.04	3	4,542,001	
680	658,417	636,983	5.0	140.0	2,770,984	29,681,062	44,521,593	2023.45	10.13	23,018,503	3.45			
682.5	683,339	670,878	2.5	142.5	1,831,337	31,512,399	47,268,598	2023.73	9.76	24,145,481	3.73			
685	708,260	695,799	2.5	145.0	1,831,337	33,343,736	50,015,604	2024.00	9.41	25,272,460	4.00	4	4,070,757	
687.5	733,182	720,721	2.5	147.5	1,831,337	35,175,073	52,762,609	2024.28	9.09	26,399,438	4.28			
690	758,103	745,642	2.5	150.0	1,831,337	37,006,410	55,509,614	2024.55	8.79	27,526,416	4.55			
692.5	783,025	770,564	2.5	152.5	1,831,337	38,837,746	58,256,620	2024.83	8.51	28,653,394	4.83			
695	807,946	795,485	2.5	155.0	1,831,337	40,669,083	61,003,625	2025.10	8.25	29,780,373	5.10	5	4,507,913	
700	857,789	832,868	5.0	160.0	3,662,674	44,331,757	66,497,636	2025.65	7.77	32,034,329	5.65			
702.5	886,033	871,911	2.5	162.5	2,348,357	46,680,114	70,020,170	2026.00	7.52	33,473,127	6.00	6	3,692,754	
705	914,276	900,154	2.5	165.0	2,348,357	49,028,470	73,542,705	2026.35	7.29	34,911,925	6.35			
710	970,763	942,520	5.0	170.0	4,696,713	53,725,184	80,587,775	2027.06	6.87	37,789,521	7.06	7	4,316,394	
715	1,027,250	999,007	5.0	175.0	4,696,713	58,421,897	87,632,845	2027.76	6.49	40,667,116	7.76			
717.5	1,055,494	1,041,372	2.5	177.5	2,348,357	60,770,253	91,155,380	2028.12	6.32	42,105,914	8.12	8	4,316,394	
720	1,083,737	1,069,615	2.5	180.0	2,348,357	63,118,610	94,677,915	2028.47	6.15	43,544,712	8.47			
722.5	1,117,121	1,100,429	2.5	182.5	2,943,755	66,062,365	99,093,547	2028.91	5.97	45,315,845	8.91	9	3,209,930	
725	1,150,505	1,133,813	2.5	185.0	2,943,755	69,006,119	103,509,179	2029.35	5.79	47,086,977	9.35			
727.5	1,183,889	1,167,197	2.5	187.5	2,943,755	71,949,874	107,924,810	2029.79	5.63	48,858,110	9.79	10	3,542,265	
730	1,217,274	1,200,581	2.5	190.0	2,943,755	74,893,628	112,340,442	2030.23	5.48	50,629,242	10.23			
735	1,284,042	1,250,658	5.0	195.0	5,887,509	80,781,137	121,171,706	2031.12	5.19	54,171,507	11.12	11	5,313,398	
740	1,350,810	1,317,426	5.0	200.0	5,887,509	86,668,646	130,002,969	2032.00	4.94	57,713,772	12.00	12	3,542,265	
745	1,427,817	1,389,313	5.0	205.0	7,274,632	93,943,278	140,914,917	2033.09	4.67	62,072,961	13.09	13	4,359,189	
750	1,504,824	1,466,320	5.0	210.0	7,274,632	101,217,911	151,826,866	2034.18	4.43	66,432,150	14.18	14	4,359,189	
755	1,581,830	1,543,327	5.0	215.0	7,274,632	108,492,543	162,738,814	2035.27	4.21	70,791,339	15.27	15	4,359,189	
760	1,658,837	1,620,334	5.0	220.0	7,274,632	115,767,175	173,650,763	2036.37	4.02	75,150,528	16.37	16	4,359,189	
762.5	1,703,060	1,680,948	2.5	222.5	4,276,469	120,043,644	180,065,467	2037.01	3.91	77,771,469	17.01	17	2,620,941	
765	1,747,283	1,725,171	2.5	225.0	4,276,469	124,320,114	186,480,171	2037.65	3.82	80,392,410	17.65			
767.5	1,791,506	1,769,394	2.5	227.5	4,276,469	128,596,583	192,894,875	2038.29	3.72	83,013,351	18.29	18	5,241,882	
770	1,835,729	1,813,617	2.5	230.0	4,276,469	132,873,053	199,309,579	2038.93	3.63	85,634,292	18.93			
771	1,853,418	1,844,573	1.0	231.0	1,710,588	134,583,640	201,875,460	2039.19	3.60	86,682,669	19.19	19	3,669,317	
772	1,871,107	1,862,262	1.0	232.0	1,710,588	136,294,228	204,441,342	2039.44	3.56	87,731,045	19.44			
773	1,890,400	1,880,754	1.0	233.0	1,889,509	138,183,737	207,275,605	2039.73	3.53	88,854,194	19.73			
774	1,909,694	1,900,047	1.0	234.0	1,889,509	140,073,245	210,109,868	2040.01	3.49	89,977,343	20.01	20	3,294,675	
775	1,928,987	1,919,340	1.0	235.0	1,889,509	141,962,754	212,944,130	2040.29	3.46	91,100,492	20.29			
776	1,948,281	1,938,634	1.0	236.0	1,889,509	143,852,262	215,778,393	2040.58	3.42	92,223,642	20.58	21	2,246,298	

18.2.4.3 Embankment and Liner Design

The starter wall to the Ilovica TMF will be constructed to an elevation of 625 m AMSL, and the upstream face will be lined to its full height with a 2 mm thick HDPE liner, to limit seepage through it during the first year of tailings deposition (Figure 18.15). The liner will be anchored at the crest, base and at each bench, using 500 mm wide by 500 mm deep anchor trenches.

The processing plant will include a cyanide (CN⁻) destruction circuit for the 6% CIL tailings to be produced as part of the process at Ilovica. This combined with the natural degradation of any remaining particles in the tailings stream when exposed to the sun's UV radiation, should assist in lowering CN⁻ to safe levels.

It is not currently a requirement to line TMF's for the disposal of copper-gold porphyry tailings in Macedonia, neither is it common practice in large parts of Europe. This together with the challenging topography of the site and the low permeability of the tailings to be deposited, led to the decision to only line the upstream face of the TMF's Starter Wall. The primary aim of the liner is to reduce seepage through the wall during the first year of tailings deposition, when the supernatant pool on the facility will be close to the starter wall.

The wall will also be equipped with a filter drain behind the liner to collect any seepage which migrates through any defects (pin holes etc.) in the liner. The filter drain has been designed to prevent the penetration of tailings into the rockfill wall, and will consist of a 1 m thick layer of sand, followed by a 500 mm thick layer of 6.5 mm stone. Along the inner toe of the wall, the 6.5 mm stone layer will be connected to a 5 m wide, 300 mm thick 19 mm stone layer, which will function as a seepage collector drain. The drain will have a 5 m wide section which will extend underneath the starter wall and downstream TMF embankment, to convey any seepage down the central section of the valley to the storm water dam situated below the TMF.

Following commissioning of the TMF, construction of the downstream TMF embankment will commence, which will be a continuous construction operation until the end of the life of the facility. To prevent ingress of tailings into the rockfill, the upstream zone of the embankment will be constructed from engineered fill with a suitable grading (weathered material) to prevent the ingress of tailings into the rockfill. This is aimed at preventing the formation of preferential flow paths which could have a detrimental effect on the long term integrity of the embankment.

In order to manage and reduce potential degradation of rockfill material from the open pit with ARD potential, these materials will be incorporated into the inner zones of the TMF embankment. Material with low or very low ARD potential will be used for construction of the outer zones of the TMF embankment.

The TMF will also be equipped with a high permeability rockfill toe on the downstream end of the embankment at each stage, to assist in lowering the phreatic surface within the wall.

The selection of the various types of rockfill material from the open pit to be used in the construction of the TMF, and the placement thereof in specific zones of the wall, will be finalised during the next phase of the project. This will be based on the mining plan, the TMF wall construction requirements, the engineering characteristics as well as the ARD potential of the materials, once all the geotechnical laboratory testing on the materials has been completed.

The TMF starter wall will be equipped with a minimum 800 mm diameter storm water diversion culvert, to convey storm water from the up-valley TMF catchment area during construction of the wall, beneath the dam wall. The culvert which has been designed to safely decant a 1 in 25 year 24 hour storm event during construction of the wall, but will be sealed with non-shrink grout prior to commissioning of the TMF.

18.2.4.4 Slope Stability Analysis

Static and Pseudo-Static Stability

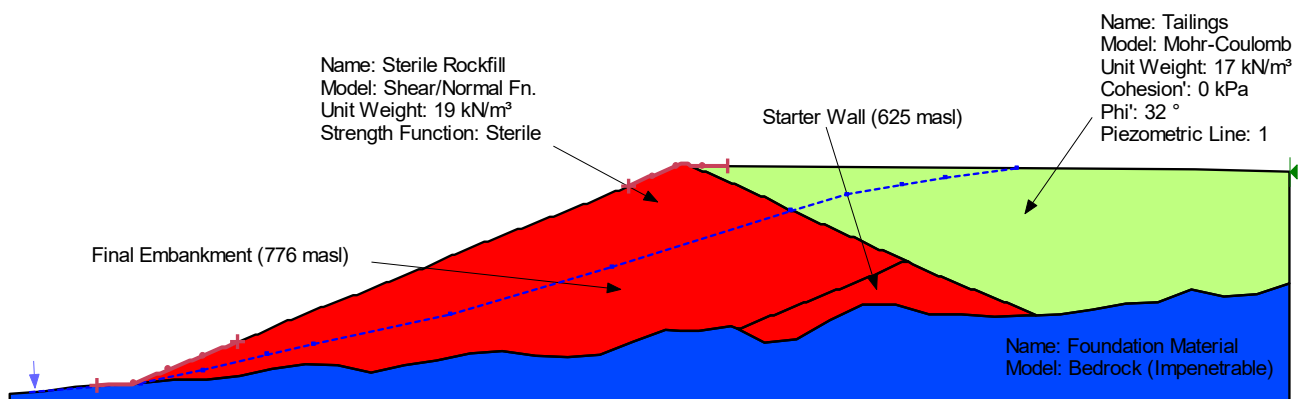
Static and pseudo-static stability of the TMF embankment was determined using Slope/W, a limit equilibrium slope stability software package. The software was used to determine the FOS against failure of the downstream face for the starter and final height facility as well as the upstream face for the starter facility. The Morgenstern-Price method was adopted along with entry and exit slip surfaces for a starter facility raised to 625 m AMSL and a final closure elevation of 776 m AMSL utilising a rockfill embankment raised using the downstream method as shown in Figure 18.16.

A piezometric surface was adopted in starter wall analyses based on a TMF pond situated approximately 500 m away and the piezometric level being drawn down to the seepage underdrain at the toe of the facility. These seepage would enter the TMF wall through the low permeability tailings and above the elevation of the lined starter wall, via the installed filter layers. In addition it has been assumed that the rockfill material used to construct the TMF embankment will be relatively free draining, and that excess pore-water pressures will thus not be present in the TMF embankment. This assumption would be confirmed following the receipt of the laboratory test results on the rockfill materials.

For the final wall analyses a piezometric surface was adopted based on a TMF pond situated approximately 500 m away and the piezometric level being drawn down to the higher permeability rockfill material proposed on the downstream toe of the facility. Due to the adoption of a drained strength model for the TMF wall construction rockfill, the calculation of the critical slip plane on the downstream side of the wall and the exclusion of porewater pressures, the effect of a higher piezometric surface is unlikely to adversely influence the results of the stability carried out at this stage. These assumptions will be verified and additional modelling undertaken as part of the detailed design.

FOS of 1.3 and 1.0 have been adopted for the static and pseudo-static stability respectively due to the high risk classification of the proposed facility.

Figure 18.16
TMF Embankment Geometry Used for Stability Analyses



Material Properties and Seismic Parameters

Material properties have been adopted based on the information presented in Table 18.9. At this stage the availability of the different waste rock units identified is unknown and as such it has not been possible to zone these materials within the embankment structure. As a result a conservative estimate has been made by assuming that the embankment will be constructed from the weakest of the rock units identified ('Sterile'). This represents the most abundant waste rock unit at 57% of the total waste rock. Based on the results of the previous site investigation and information presented above the foundation granite rock has been modelled as impenetrable (from a slope stability perspective). It is important to note that the top layer of the granite at the base of the valley is heavily fractured, and as such is expected to convey seepage below the TMF to the valley below. The design will be optimised during detailed design.

A summary of the material parameters adopted in this assessment is provided in Table 18.15.

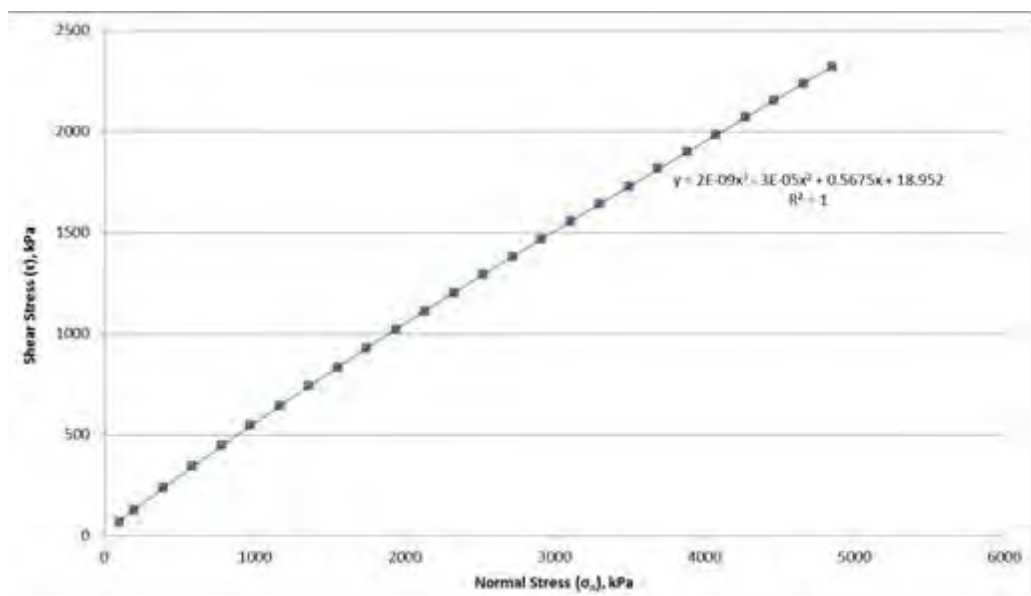
Table 18.15 Material Properties for Stability Analysis				
Material Description	Material Model	Bulk Unit Weight (kN/m³)	Friction Angle (°)	Cohesion (kPa)
Granite Bedrock	Impenetrable ¹	-	-	-
Tailings	Mohr-Coulomb	17	32	0
'Sterile' Rockfill	Shear/Normal Function ² (assuming drained behaviour)	19	34.7 reducing to 25.5 under very high loads ³	0

¹Impenetrable from a slope stability perspective

²As shown in Figure 18.17 assuming drain behaviour

³Based on empirical data from Barton and Klaernsil (1981), based on a maximum embankment height of 250 m. Values include a 1.2 Factor of Safety

Figure 18.17
Shear/Normal Function for Sterile Rockfill



A coefficient of horizontal seismic loading for the MDE of 0.32g has been adopted based on the seismic information presented above.

Static and Pseudo-Static Stability Results

The results of the static and pseudo-static stability modelling are presented in Table 18.16.

Table 18.16 Static and Pseudo-Static Stability Results			
Embankment Analysed	Face Analysed	Conditions	FOS
Starter (625 m AMSL)	Upstream	Static	1.672
Starter (625 m AMSL)	Upstream	Pseudo-Static	0.840
Starter (625 m AMSL)	Downstream	Static	1.640
Starter (625 m AMSL)	Downstream	Pseudo-Static	0.820
Final (776 m AMSL)	Downstream	Static	1.476
Final (776 m AMSL)	Downstream	Pseudo-Static	0.74

All the static stability results indicate FOS > 1.3 and therefore indicate that the embankment will remain stable in the static condition.

However it can also be seen that in each of the pseudo-static analyses the FOS were <1.0 and therefore indicate that vertical movement of the embankment is likely to occur during a MDE earthquake event. To determine the amount of settlement expected, and hence determine the stability of the embankment, deterministic seismic analyses have been carried out and are presented in the following sections.

Deterministic Seismic Stability

In the conventional pseudo-static analysis method, the stability of a facility is determined by its ability to achieve a pre-described FOS, where a FOS of 1 indicates a stable structure under the action of a uniform horizontal acceleration (which is selected to mimic the effect of the design earthquake). As a result no net movement of the facility is allowed to occur.

According to ICOLD bulletin 98, (1995), “damage of the dam is acceptable as long as the integrity and stability of the dam is maintained and the release of the impounded tailings is prevented”, implying that some settlement of the dam is acceptable so long as this is less than the freeboard available on the facility. A limitation of the pseudo-static method is that it applies the effects of an earthquake by the application of a large horizontal load at a single time step, with this simplification of true earthquake behaviour tending to derive conservative estimates of stability.

Various improvements to pseudo-static analysis have been developed, generally tracing back to Newmark (1965), where the dynamic response of the dam is included and the results of the analysis are predicted dam movements, rather than a strength-based factor of safety. The methodology adopted for the present design was a generalisation of Newmark’s approach that was proposed by Bray and Travarasrou, (2007).

It is based on some 600 simulations of dam and slope response during earthquakes from which parametric performance trends were developed in terms of a few key inputs. This methodology enables the design of a rockfill embankment in which some vertical settlement is tolerated, rather than one which would prevent any settlement from occurring but requires the construction of a larger embankment. The two steps involved are determining the level of settlement that may be tolerable (i.e. less than the dam’s freeboard to prevent the release of supernatant water/tailings) and estimating how much settlement might occur.

The Bray and Travarasrou (2007) method calculates the vertical settlement which can be expected following an earthquake event according to the following equation.

$$\ln(D) = -1.10 - 2.83 \ln(k_y) - 0.333(\ln(k_y))^2 + 0.566 \ln(k_y) \ln(Sa(1.5T_s)) + 3.04 \ln(Sa(1.5T_s)) - 0.244(\ln(Sa(1.5T_s)))^2 + 1.50T_s + 0.278(M - 7) \pm \varepsilon$$

Where:

D = Vertical Displacement (cm)

K_y = Yield acceleration (the seismic coefficient for a FOS of 1) obtained from pseudo-static limit equilibrium modelling using the fully-softened soil strength is used (g)

S_a = Spectral acceleration from earthquake time record (g) at a period of 1.5T_s

M = Earthquake magnitude (which acts as a measure of the earthquake duration)

ε = Standard deviation of 0.66

T_s = Natural period of the dam (s) = 2.6H/V_s

Where:

H = Height of the sliding mass. Taken as the height of the deepest slice from the limit equilibrium modelling (m)

V_s = The shear wave velocity of the material along the critical slip plane (m/s).

Using this method settlement values are determined at a mean and at ± 1 standard deviation (SD) termed lower and upper bound values.

It should be noted that the Bray and Travasarou (2007) method does not include "compaction" strains. However, we do not expect those to be large when compared to the shear-related movements caused by an MDE event.

Determination of Slope Yield Acceleration (K_y)

In order to calculate the yield acceleration of the proposed facility Slope/W, a limit equilibrium slope stability software package was used. The software was used to determine the pseudo-static seismic coefficient which returned a factor of safety of 1 against failure of the embankment. The Morgenstern-Price method was adopted along with entry and exit slip surfaces.

Analyses were carried out using the same material properties presented in Table 18.15.

The results of the limit equilibrium modelling are presented in Table 18.17 and include details of the calculated FOS, yield acceleration and max height at the base of the slip surface. At present the tailings have been modelled in a drained state as per Table 18.15. It is acknowledged that during seismic events the strength of the tailings is likely to reduce to post-seismic values as a result of liquefaction. However, given that the critical slip planes occur wholly within the rockfill embankment the tailings strength does not influence the stability calculations.

Table 18.17 Limit Equilibrium Stability Results for Deterministic Analysis				
Embankment Analysed	Face Analysed	FOS	Yield Acceleration (g)	Max Height of Slip Plane (m)
Starter (645 m AMSL)	Upstream	1.000	0.224	24.086
Starter (645 m AMSL)	Downstream	1.000	0.212	27.303
Final (772 m AMSL)	Downstream	1.001	0.160	87.184

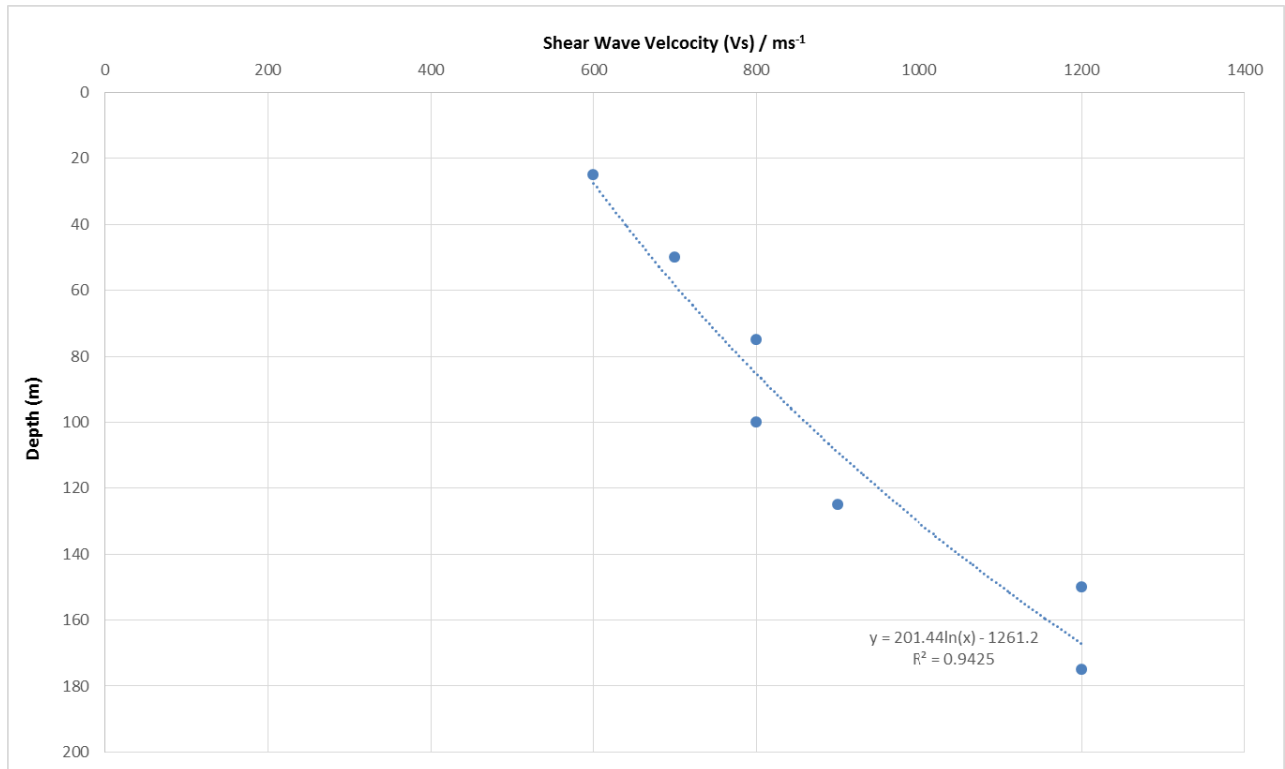
Determination of Shear Wave Velocity

At present no laboratory or in situ measurements have been made to determine the shear wave velocity (V_s) of the rockfill materials which will be used for the construction of the embankment. As a result Golder has utilised data from our database on typical shear wave velocities within large rockfill structures.

The adopted relationship between V_s and depth is shown on Figure 18.18. Based on this relationship the average shear wave velocity at the depths shown in Table 18.17, were determined as shown in Table 18.18.

Table 18.18 Calculated Values of V_s			
Embankment Analysed	Face Analysed	Max Height of Slip Plane (m)	Average V_s (m/s)
Starter (645 m AMSL)	Upstream	24.086	590.22
Starter (645 m AMSL)	Downstream	27.303	599.72
Final (772 m AMSL)	Downstream	87.184	807.32

Figure 18.18
Adopted Relationship between Shear Wave Velocity and Depth



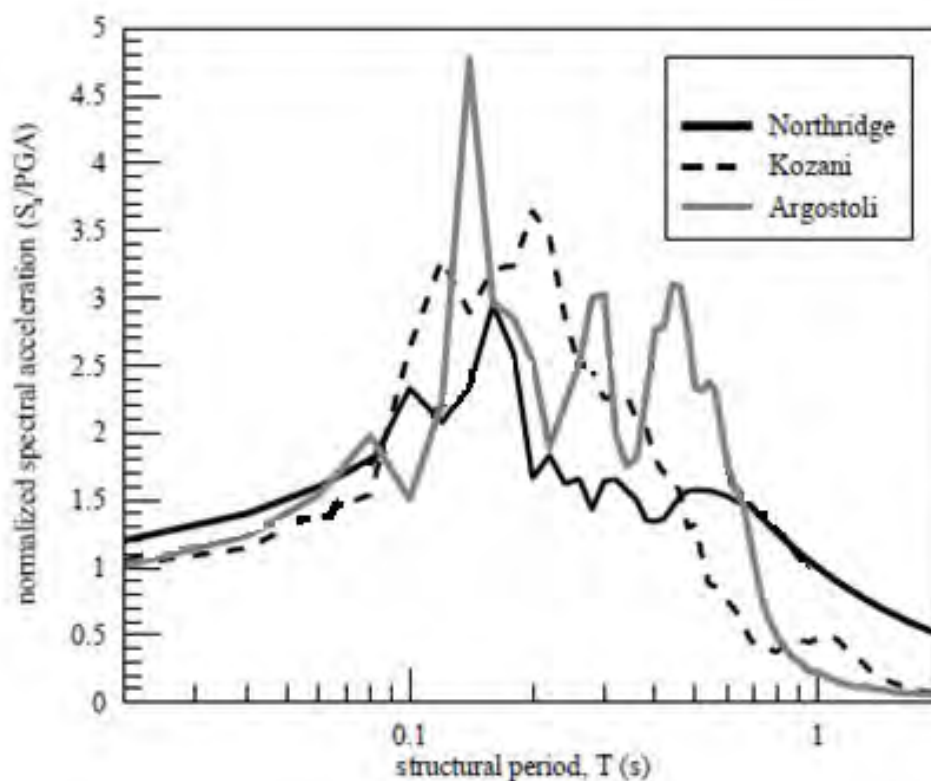
Selection of Seismic Parameters

In order to utilise the Bray and Travasarou (2007) method it is necessary to use time dependent earthquake data so that the variations in acceleration can be incorporated within the stability analyses.

Unfortunately time dependent earthquake data is not currently available for the Ilovica site and as such it was necessary to use substitute earthquakes. Based on Golder's recent involvement in a number of projects in northern Greece, three substitute earthquake spectral acceleration relationships have been used as presented in Figure 18.19.

As part of the next stage of the project it is recommend that a site specific spectral acceleration relationship is determined by the Macedonia Seismic Institute. This data should then be used to update the results of this seismic stability assessment prior to finalising the design of the TMF embankment.

Figure 18.19
Adopted Spectral Acceleration Relationships



Based on parameters determined as part of the limit equilibrium modelling it was possible to determine the natural period (T_s) of the sliding masses, as recommended by Bray and Travasarou, (2007), using equation the following equation.

$$T_s = 2.65 H/V_s$$

The natural period for each of the sliding masses was then used to determine the spectral acceleration (S_a) values at 1.5 times the natural period ($S_a(1.5T_s)$). The calculated T_s and $S_a(1.5T_s)$ are presented in Table 18.19. It should be noted that the Y-axis in Figure 18.19 represents spectral accelerations which have been normalised using the earthquake PGA, as such the S_a values adopted in this analyses have been calculated by multiplying the values obtained from Figure 18.19 by the PGA value representative of an MDE event at the donor site (0.56g).

Table 18.19 Calculated Values T_s and $S_a(1.5T_s)$				
Embankment Analysed	Face Analysed	T_s	Earthquake Record Adopted	$S_a(1.5 T_s)$
Starter (645 m AMSL)	Upstream	0.11	Northridge	1.596
			Kozani	1.792
			Argostoli	1.848
Starter (645 m AMSL)	Downstream	0.12	Northridge	1.512
			Kozani	1.820
			Argostoli	1.624

Table 18.19 Calculated Values Ts and Sa(1.5Ts)				
Embankment Analysed	Face Analysed	Ts	Earthquake Record Adopted	Sa(1.5 Ts)
Final (772 m AMSL)	Downstream	0.28	Northridge	0.784
			Kozani	0.952
			Argostoli	1.624

Results of Deformation Modelling

The results of the deformation modelling following an MDE event are presented in Table 18.20.

Table 18.20 Calculated Embankment Settlements Following an MDE Event					
Embankment Analysed	Face Analysed	Earthquake Record Adopted	Calculated Settlements (mm)		
			Lower Bound	Mean	Upper Bound
Starter (645 m AMSL)	Upstream	Northridge	236.67	457.90	885.95
		Kozani	337.55	653.09	1 263.59
		Argostoli	271.92	526.10	1 017.90
		Average	282.06	545.70	1 055.81
Starter (645 m AMSL)	Downstream	Northridge	237.02	458.59	887.28
		Kozani	296.63	573.92	1 110.43
		Argostoli	314.50	608.50	1 177.32
		Average	282.72	547.00	1 058.34
Final (772 m AMSL)	Downstream	Northridge	125.92	243.62	471.36
		Kozani	188.35	364.42	705.08
		Argostoli	518.62	1 003.43	1 941.42
		Average	832.90	537.16	1 039.30

Based on the results obtained for the starter embankment it can be seen that on average the largest embankment settlements (approximately 1.3 m) were calculated for the upstream face. However, as the starter facility will be filled after 1 year the likelihood of a MDE event occurring in this time is highly unlikely.

For the final height facility the results indicate an average vertical settlement of approximately 1.00 m, with values up to a maximum of 1.95 m during the Argostoli earthquake event.

Given the higher PGA for these earthquakes in Greece (0.56g) opposed to the values obtained from the recent seismic study (0.32g), the adoption of the Northridge, Kozani and Argostoli earthquakes are believed to represent conservative estimates for embankment settlement. However, it should be noted that it is the spectral acceleration relationship and not necessarily the magnitude and PGA which controls the settlement of large rockfill dams following seismic events.

In addition, the current models are based on the embankment being constructed entirely from the sterile waste rock unit, which represents the weakest although most abundant waste rock unit available.

It is therefore recommend that the results of this stability analyses are re-visited following the completion of the final mine waste plan, so that the zonation of material within the embankment can be determined, as well as the determination of a site specific spectral acceleration relationship.

At this stage and based on the information presented above it is recommended that a minimum operational freeboard of 2.0 m should be adopted in order to comply with the recommendations of ICOLD 98, (1995) with reference to seismic activity.

18.2.4.5 Tailings Deposition

During commissioning of the Ilovica TMF tailing deposition on the facility will be via spigots from the crest of the starter wall in an easterly direction to create a beach with a 0.5% to 1% fall towards the rear of the facility. Deposition from the wall TMF wall will continue in this manner for the first two years after commissioning.

Due to the tailings deposition approach the supernatant pool on the facility will be pushed from its initial position against the starter wall up-valley in an easterly direction. Following tailings deposition during the first two years after commissioning, tailings deposition on the facility will also commence for the northern and eastern sides of the facility, to manage the pool position on the southern side of the facility where the return water barge will be located. Return water from the barge will be pumped across the crest of the TMF to the northern side of the wall from where it will be pumped back for re-use in the plant.

The tailings deposition pipeline will have to be raised to a higher bench once the tailings have filled the TMF basin to the top of the existing bench. This will happen on an almost monthly basis during the early stages of tailings deposition due to the small basin area and high rates of rise on the facility.

Raising of the deposition pipeline as well as the northern tailings discharge points to higher benches/positions will continue throughout the life of the facility. Tailings deposition will also be managed carefully throughout the life of the project to ensure that the pool will remain accessible to the pump barge.

During the final few years of the facility's life, tailing deposition will be adjusted to move the position of the supernatant pond to within 200 m of the crest of the TMF, to reposition the pool closer to the front of the TMF for closure purposes (Figure 18.12, Figure 18.13 and Figure 18.14). This will assist in limiting the length and depth of the channel approach required to connect the low position at closure of the TMF, to the closure spillway which will convey any storm water falling on top of the TMF or running onto the TMF, to the Shtuka valley below the main embankment.

18.2.4.6 Water Balance

A GoldSim model was set up to simulate supernatant ponding and return water pumping from to the Plant. The objective was to use the available climatic data and the water requirements of the Plant supplied by SWS, to calculate:

- The likelihood of makeup water being required, whilst maintaining a minimal pumping draft on the facility;
- Estimated rates of makeup water required to meet Plant demand; and
- Supernatant pond management and freeboard requirement;

The GoldSim TMF water balance model feeds into a site wide water balance that provides a holistic representation of the flow into, out of and between the elements of the Ilovica project i.e. the Mine, processing plant, TMF and Storm Water Dams.

The software includes a Monte Carlo simulator which is used to consider the potential for variance in rainfall and evaporation, thereby calculating the probability and magnitude of deficits and surpluses caused by dry or wet spells occurring throughout the LOM. The PFS water balance model has been updated to reflect the FS design and hydrology. The water balance was modelled using the dynamic simulation and probabilistic analysis programme GoldSim.

Data Utilised and Assumptions

A 54 yr synthetic rainfall and evapotranspiration record has been utilised from the SWS site wide water balance.

The TMF design criteria presented in Table 18.10 and Table 18.11 have been adopted in the TMF water balance.

The water balance also includes the following assumptions:

- All Shtuka River flow upstream of the TMF will be diverted along the southern perimeter of the facility (Figure 18.5).
- All run-off from the catchment north of the TMF will enter the TMF.
- The TMF will contain the PMP/PMF, in addition to operating supernatant pond volumes. The 24 h PMP depth adopted for the design is 278 mm, in accordance with the recommendation by SWS.
- Daily tailings production is calculated from the annual rates (10 Mt/a) assuming production is constant throughout each year i.e. the annual value is divided by days in the year.
- Minimum 10 000 m³ supernatant pond volume.
- Only storm water and 50% of tailings water is available for reclaim from the TMF during the first month. It may be possible to return water earlier and at higher flow rates although this water might be high in suspended solids.
- After the first month all water on the TMF apart from the 10 000 m³ cut-off will be available for return to the plant site.
- Seepage is assumed to obey Darcy's empirical law, with a hydraulic gradient of 1 across area the area of the tailings.
- Interstitial water, based on a void ratio of 0.8, is permanently bound within the deposited tailings.

Methodology

The GoldSim TMF water balance model provides a holistic representation of the flow into and out of the TMF. The Monte Carlo simulator also considers the potential for variance in rainfall and evaporation, thereby calculating the probability and magnitude of deficits and surpluses caused by dry or wet years occurring throughout the LOM.

Inflows to the TMF include:

- Tailings makeup water;

- Direct precipitation on the TMF; and
- Run-off from the catchment areas upstream of the TMF within the Shtuka River catchment that are not diverted. Catchment referred to as Mala Shtuka.

Outflows from the TMF include:

- Seepage through the base of the TMF to ground;
- Seepage through the TMF embankment;
- Evaporation from the pond, wet tailings and dry tailings; and
- Pumping from the supernatant pond to the Plant.

The in-built time step feature allows GoldSim to recalculate values at specified intervals throughout the simulation. This accommodates a more accurate calculation of seepage and evaporation from the TMF by defining them as functions of the increasing TMF area. The relationship between these factors was defined by determining the TMF deposition area through 3D modelling and entering the data in GoldSim, which uses a lookup function and linearly interpolates between the given values. Seepage is assumed to obey Darcy's Empirical Law, with a hydraulic gradient of 1. Seepage from the TMF is considered to be controlled by the permeability of the tailings.

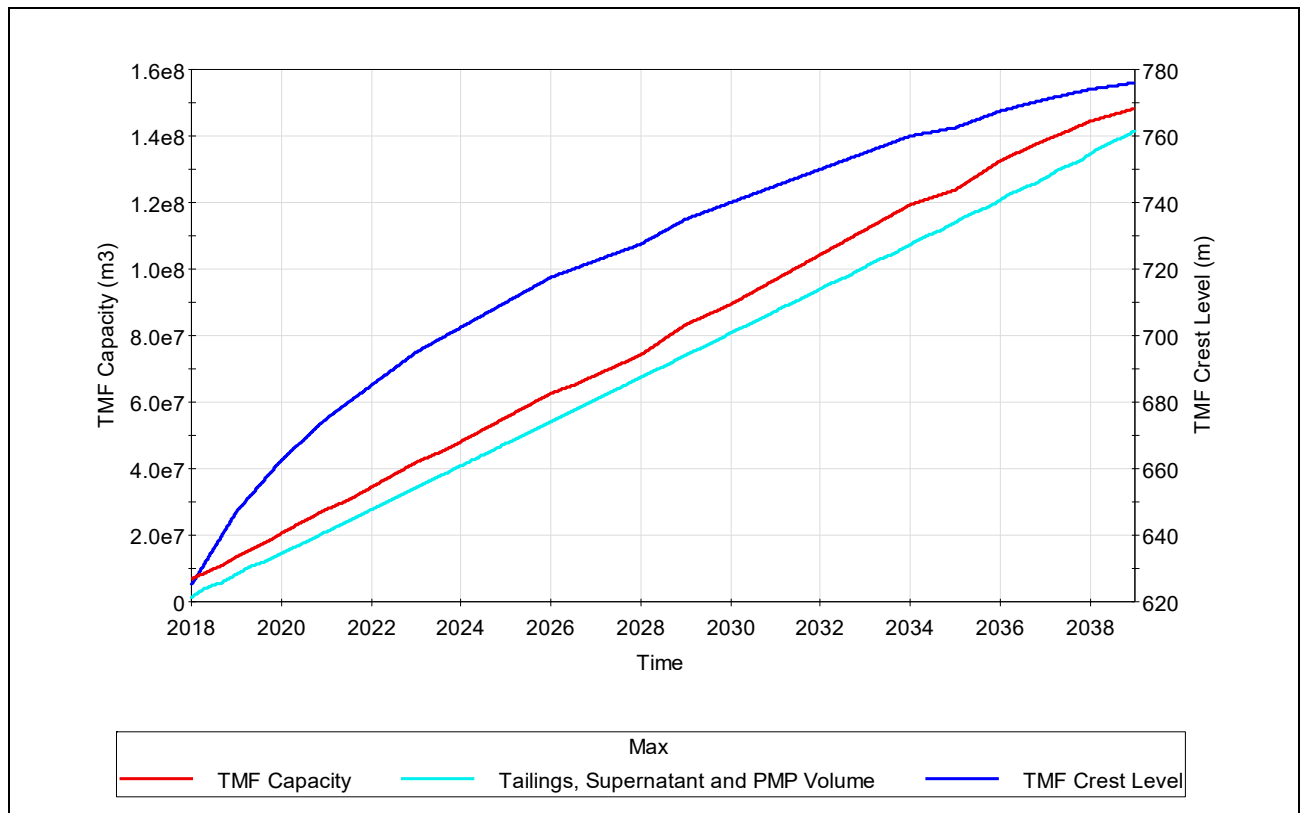
The adopted tailings design criteria for all deposited tailings ranges between 1×10^{-8} m/s to 1×10^{-9} m/s. The tailings are assumed to exhibit an initial higher permeability of 1×10^{-7} m/s, consolidating in a linear fashion to 1×10^{-9} during the LOM. These values will however need to be validated when the relevant tailings laboratory test data become available, and the implications thereof with regards to seepage rates, and the water balance for the TMF, evaluated.

The GoldSim model uses a shifting time series function to repeat the synthetic 1961 to 2014 precipitation evapotranspiration and Mala Shtuka flow record; each model realisation features a randomly selected year to commence the simulation. Evaporation from the TMF varies depending on the extent of dry beach, wet beach and supernatant. Flow from the Mala Shtuka catchment entering the TMF is based on HEC-HMS modelling undertaken by SWS.

Results and Recommendations

Figure 18.20 illustrates how the TMF capacity changes during the life of the mine, based on the maximum model results and rate of rise during operations. Given the rapid rate of rise and large volume of the TMF, significant freeboard above the tailings will be provided to manage extreme rainfall events. The TMF storage capacity available between the dam crest and above the combined tailings level, supernatant water level and an allowance for the PMP averages $8.0 \text{E}6 \text{ m}^3$, with a minimum of $5.9 \text{E}6 \text{ m}^3$ during the life of the mine.

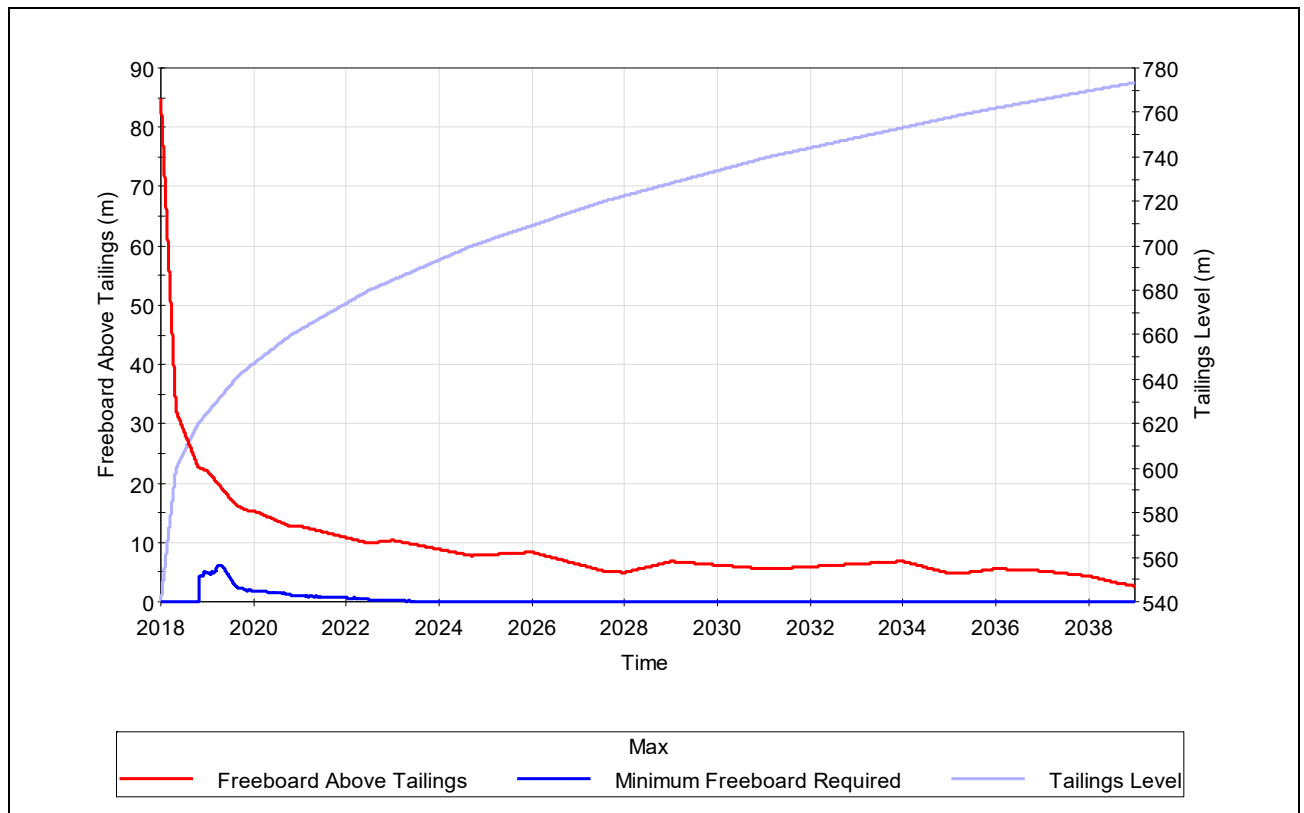
Figure 18.20
TMF Level and Volume



The volume of precipitation on the TMF during a PMP is approximately 500 000 m³ for a 24 hour event. The baseline HEC-HMS rainfall run-off flood model for the project area, constructed by SWS, was adopted for transformation of the PMP to the PMF for the natural catchment draining to the TMF. The total volume of water on the TMF during a PMF is predicted to be approximately 750 000 m³ for a 24 hour event. Given the need to contain the water and the absence of a spillway during operations, a factor of safety of 1.5 was applied, giving a design volume of 1 125 000 m³. The reason for this decision was so that the TMF will be able to store additional water (should adverse conditions ever arise) without over-topping.

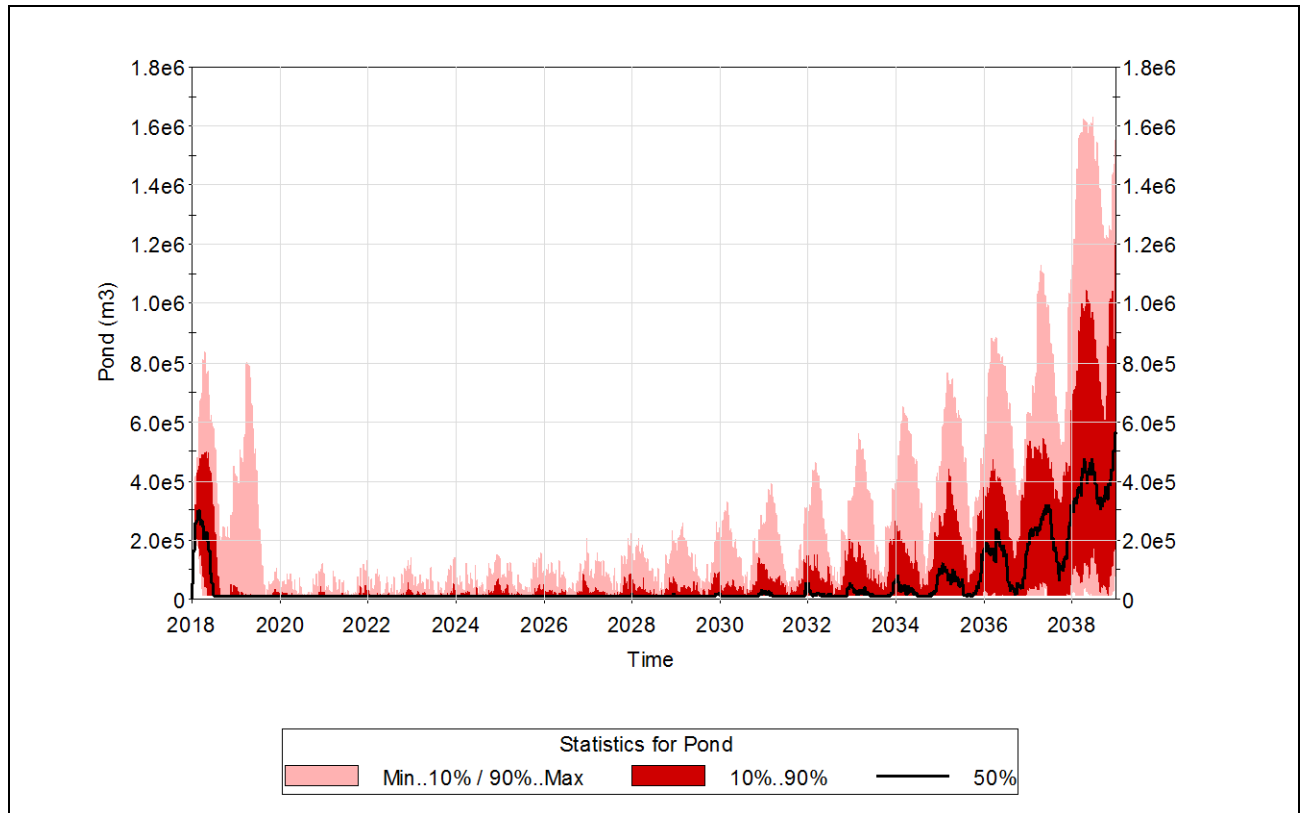
Figure 18.19 illustrates the rate of rise of the facility provides sufficient capacity to manage supernatant water plus an allowance for the PMF. For the majority of the mine life, supernatant and the PMF would be contained within the 0.5% slope of the tailings beach. Based on the starter dam with a crest elevation of 625 m AMSL, a minimum 6.2 m freeboard above the deposited tailings crest level is required to contain the PMF as the tailings level approaches the starter dam crest level (Figure 18.20). The freeboard level requirement decreases as the dam height increases, accommodating significantly greater volumes of supernatant and storm water.

Figure 18.21
Minimum TMF Freeboard



The 50 percentile model output for the volume of supernatant water on the facility, presented in Figure 18.21, indicates the pond volume will be minimal for much of the mine life (following pumping of return water). The outputs do show an increasingly seasonal response to rainfall, which is attributed to the increasing tailings area. The increasing tailings area may create water surplus during the final years of operations, indicated by the 50 percentile model scenario in Figure 18.21. Predicted supernatant pond volume during the life of the mine presented in Figure 18.21 also includes the 90 percentile and maximum model results which also illustrate a clear seasonal pattern, with volumes peaking during the winter months. The initial peak is a function of the lag in tailings deposition and commencement of reclaiming water to the plant.

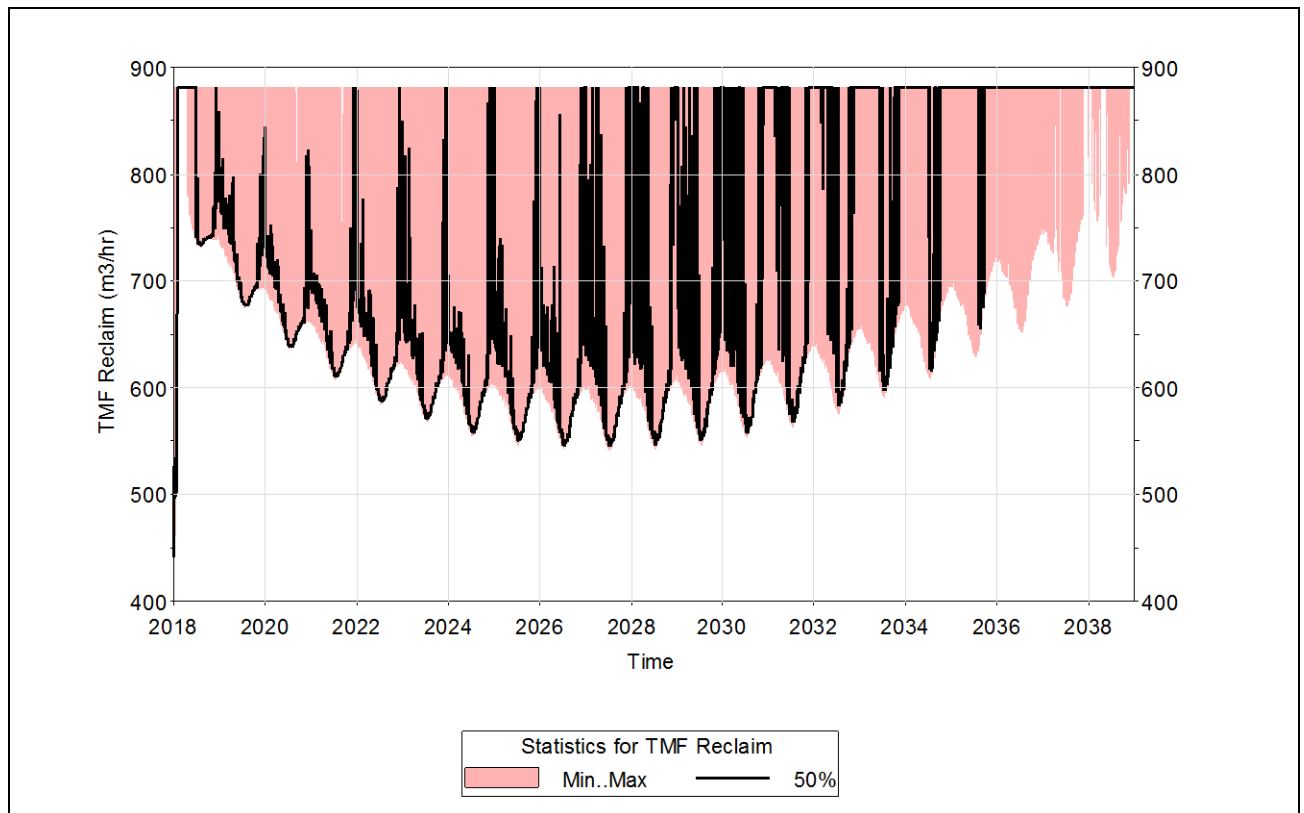
Figure 18.22
Supernatant Pond Volume



The 50 percentile return water values in 50 realisations of the probabilistic model are presented in Figure 18.22. Based on the climatic data used in the model, there will be periods in which the supernatant pond cannot meet the Plant water demand, therefore makeup water will be required. The initial lack of return water followed by peak return water rates is a function of the 1 month lag prior to full commencement of pumping water from the TMF.

Figure 18.22 indicates seasonally varying makeup water rates in the order of 0 m³/h - 330 m³/h will be required to meet plant demand. The demand for makeup water is anticipated to decrease as the tailings permeability decreases and the extent of tailings increases, leading to greater run-off and reduced seepage. The model indicates makeup water may not be required during the final years of operations. The results will be sensitive to the tailings characteristics (permeability, void ratio, interstitial water content), for which detailed laboratory analysis is still required.

Figure 18.23
TMF Water Reclaim



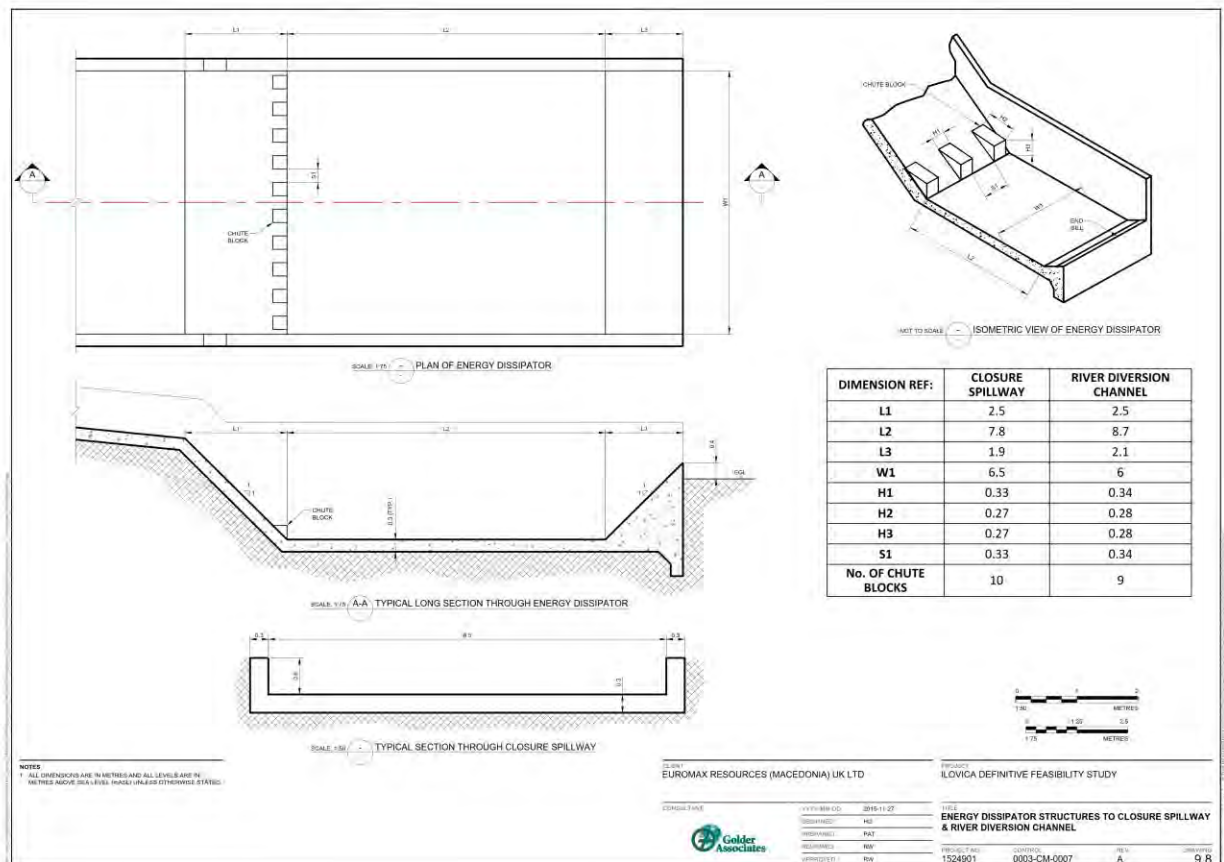
The TMF water balance can be refined and updated as more hydrological, hydrogeological, meteorological and tailings data becomes available. A trade-off study may be considered for increasing the TMF catchment for water supply during the early years of mining, however this needs to be balanced against the imperative need for storage of the PMF and maintaining river flow for downstream water users. Using the Goldsim software package it is possible for charts and graphs of all data inputs and outputs, including the statistical spread of data, to be readily produced.

18.2.4.7 Surface Water Management

The TMF is located in a steep valley with a surrounding catchment area of 11.9 km². Surface run-off entering the TMF facility from the northeast, will be minimised by construction of a RDD and river diversion channel that will reduce the catchment area draining to the TMF by 7.4 km². The river diversion will convey flow from the Shtuka River around the southern perimeter of the TMF, capturing run-off from the south and discharging downstream of storm water dam.

The diversion channel (Figure 18.14) will keep clean and dirty water separate, maintaining a clean source of water for downstream users. The river diversion will be equipped with a dissipator structure (Figure 18.24) before discharging to the Shtuka River downstream of the storm water dam.

Figure 18.24
Energy Dissipator Structures to TMF Closure Spillway and River Diversion Channel



Although it would be possible to divert storm water run-off from the area to the north of the facility, this would have reduced the water available for return to the Plant. As the project is situated in an area with a water deficit, it had been decided to allow water from this catchment to flow onto the facility to supplement water available for the project instead.

A storm water dam will be constructed below the TMF, to collect storm water run-off from the TMF's outer wall and the valley sides below the facility. The dam will be used to collect rain water and sediment from the catchment area, as well as seepage reporting to the downstream toe of the TMF.

Storm water from the remaining catchment flowing to the TMF, an area of approximately 4.5 km², will be managed on the TMF. For closure of the facility the TMF will be equipped with a spillway and dissipator system on the southern side of the valley. At closure the diversion channel will continue to minimise water flowing onto the TMF and the TMF will feature a closure spillway to manage water from the remaining 4.5 km² catchment flowing onto the TMF.

Overview of Design

The river diversion has been designed to divert flow from the Shtuka River, around the TMF, during a PMP event. In addition to the river diversion, a TMF spillway will be installed prior to closure, which has been designed to cope with peak flow during a PMP event.

Methodology

The PMP is defined as the greatest depth of precipitation for a given duration that is possible at a particular location. The 24 h PMP depth adopted for the design is 278 mm, in accordance with the recommendation by SWS.

The PMF is the flood that results from the transformation of the PMP using conservatively low (but reasonable) values for losses and catchment areas. The baseline HEC-HMS rainfall run-off flood model for the project area, constructed by SWS, was adopted for this transformation. HEC-HMS is a modelling package developed by the Hydrologic Engineering Center of the US Corps of Army Engineers and is publically available and used worldwide.

The peak flow along the diversion channel during the PMF is estimated to be 23 m³/s.

The run-off curve number (CN), an empirical parameter used for predicting surface water run-off and adopted in the HEC-HMS model, was increased to 75 for the closure scenario on the TMF, representing pasture/meadow on soils with slow infiltration rates. The peak flow to the TMF embankment during the PMF is also predicted to be 23 m³/s.

Design Approach and Sizing

The diversion structures and closure spillway have been dimensioned based on the estimated PMF with the lining proposed to be constructed of concrete (low maintenance and applicable for closure).

River Diversion

The river diversion will be a trapezoidal shaped channel, with a low flow notch, designed using Manning's equation for open channel flow. The design is based on an average gradient of 0.5% and Manning's n value of 0.015. The basal width of the channel will be 4 m, which will incorporate a 0.5 m x 0.5 m notch for low flow (Figure 18.15). The remaining 3.5 m basal width will also allow for vehicular access for maintenance with channel side slopes of 1V:1H. A small embankment upstream of the TMF will back up water allowing it to weir over into the river diversion channel. The route of the river diversion channel downstream of the TMF is to be finalised and may require drop structures along the final alignment.

The diversion channel will enter a chute, flowing through a dissipator and discharging back to the Shtuka River, downstream of the storm water dam. A United States Bureau of Reclamation (USBR) type III dissipator has been designed with capacity to accommodate the PMF. Figure 18.24 presents details of the proposed dissipator.

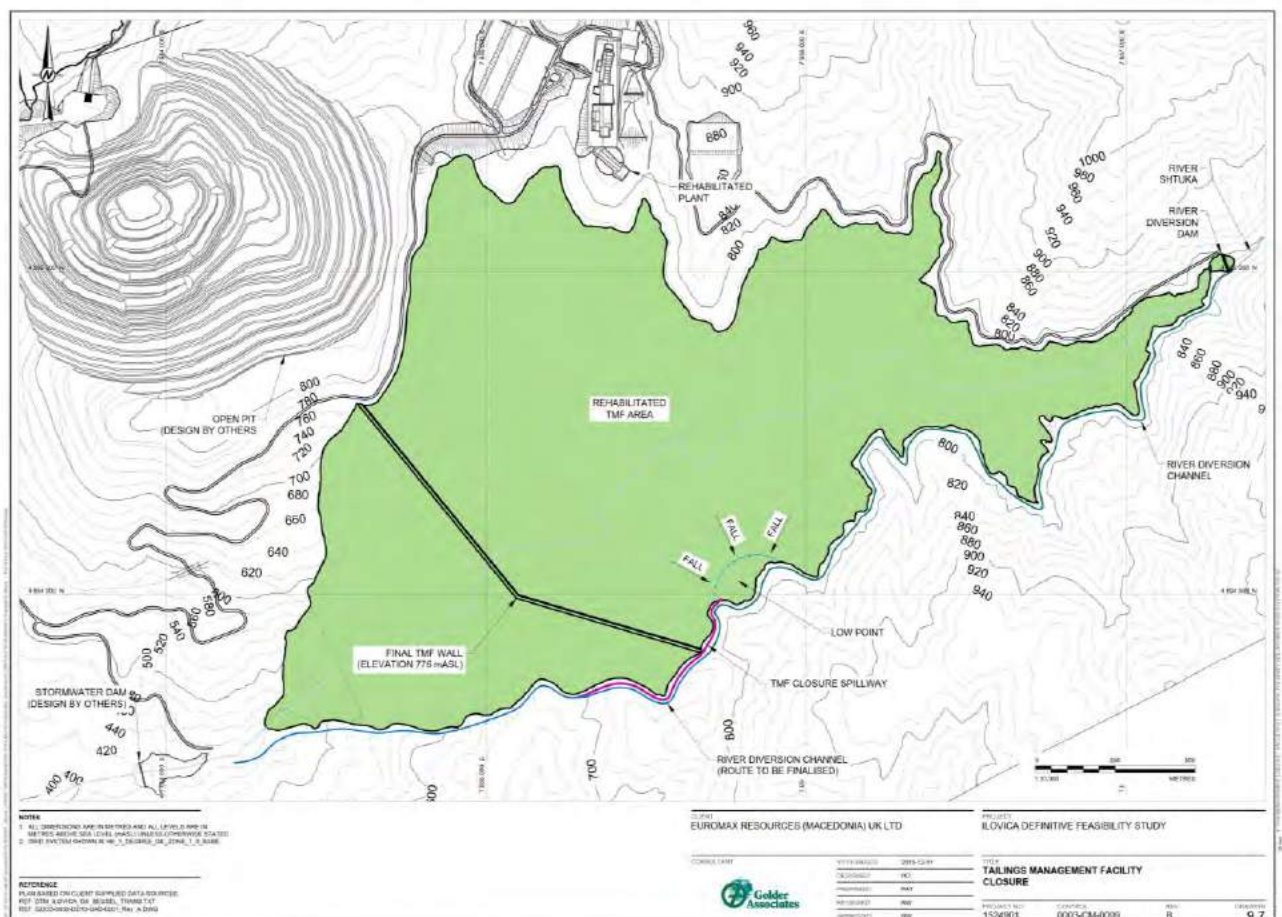
The overall internal length (including inlet and outlet transition to the dissipator) and width of the structure will be 13.3 m and 6 m, respectively. The base of the structure will have a level gradient and will be excavated into the existing topography, which is assumed to be at a grade of 3%. The structure will have vertical side slopes. Nine chute blocks and six baffle blocks are incorporated into the structure to allow for the dissipation of energy. Given the current uncertainties regarding final site layout a trade-off study is recommended to assess the diversion alignment and lining options. One consideration would be for the river diversion channel and spillway downstream of the TMF be sized to accommodate Shtuka River flow plus run-off from the TMF. At closure only a single spillway would be required.

TMF Closure Spillway

At closure a concrete lined spillway and USBR type III dissipator will be installed to manage water on the facility, with the capacity to manage peak PMF flow (23 m³/s). The closure surface of the TMF will be shaped to direct water towards the south of the facility, discharging down the southern side of the valley. The system will be separate to the aforementioned river diversion channel, so as not to mix clean and dirty water, and allowing for treatment (active or passive) should it be required, prior to discharge to the environment.

The proposed location of the spillway is as presented in Figure 18.25. The overall internal length (including inlet and outlet transition to the dissipator) and width of the structure will be 12.2 m and 6.5 m, respectively. The base of the structure will have a level gradient and will be excavated into the existing topography, which is assumed to be at a grade of 5%. The structure will have vertical side slopes. Ten chute blocks and seven baffle blocks are incorporated into the structure to allow for the dissipation of energy.

Figure 18.25
TMF Closure



Given the current uncertainties regarding final site layout a trade-off study is recommended to assess the management of TMF run-off. One consideration for closure would be to manage TMF run-off by tying into

the river diversion channel and spillway. At closure only a single spillway would be required, though the diversion channel and spillway size would need to be increased accordingly.

18.2.4.8 Supernatant Water Management

Supernatant water from the TMF will be returned to the process plant via a barge pumping system where it will be used as process water and makeup water for the pumping of tailings to the TMF. Process water will be supplemented by water from the Ilovica municipal reservoir.

The TMF has been designed to accommodate the run-off from a PMF 24 hour event which equated to approximately 750 000 m³.

For the (highly unlikely) event that the river diversion channel fails and the water from the channel is deposited on the TMF, the total volume of water from a PMF event will be approximately 2 Mm³. Assuming a maximum pump rate of 2 500 m³/h, it will thus take approximately 800 hours or 33.3 days to decant the water off the facility.

As the facility will be developed to have adequate storage capacity to contain such an event with the diversion works operational, and will be developed using the downstream method of construction. Equipping the facility with an emergency spillway will be very expensive and difficult, as the TMF wall will be raised continuously, and therefore the spillway will have to be rebuilt on a continuous basis during the LOM.

The return water pump barge will be equipped with two pumps (one duty, one standby), each with a maximum pump capacity of 1 250 m³/h. From the barge water will be pumped to a tank situated on the side of the TMF. From there water will be pumped along the crest of the TMF wall, and then up in a northerly direction to the process water tank at the Plant.

During normal operating conditions, approximately 500 m³/h of water will be returned to the Plant, although this will depend on the availability of interstitial water on the TMF. Additional water required at the Plant will be provided from the Ilovica reservoir.

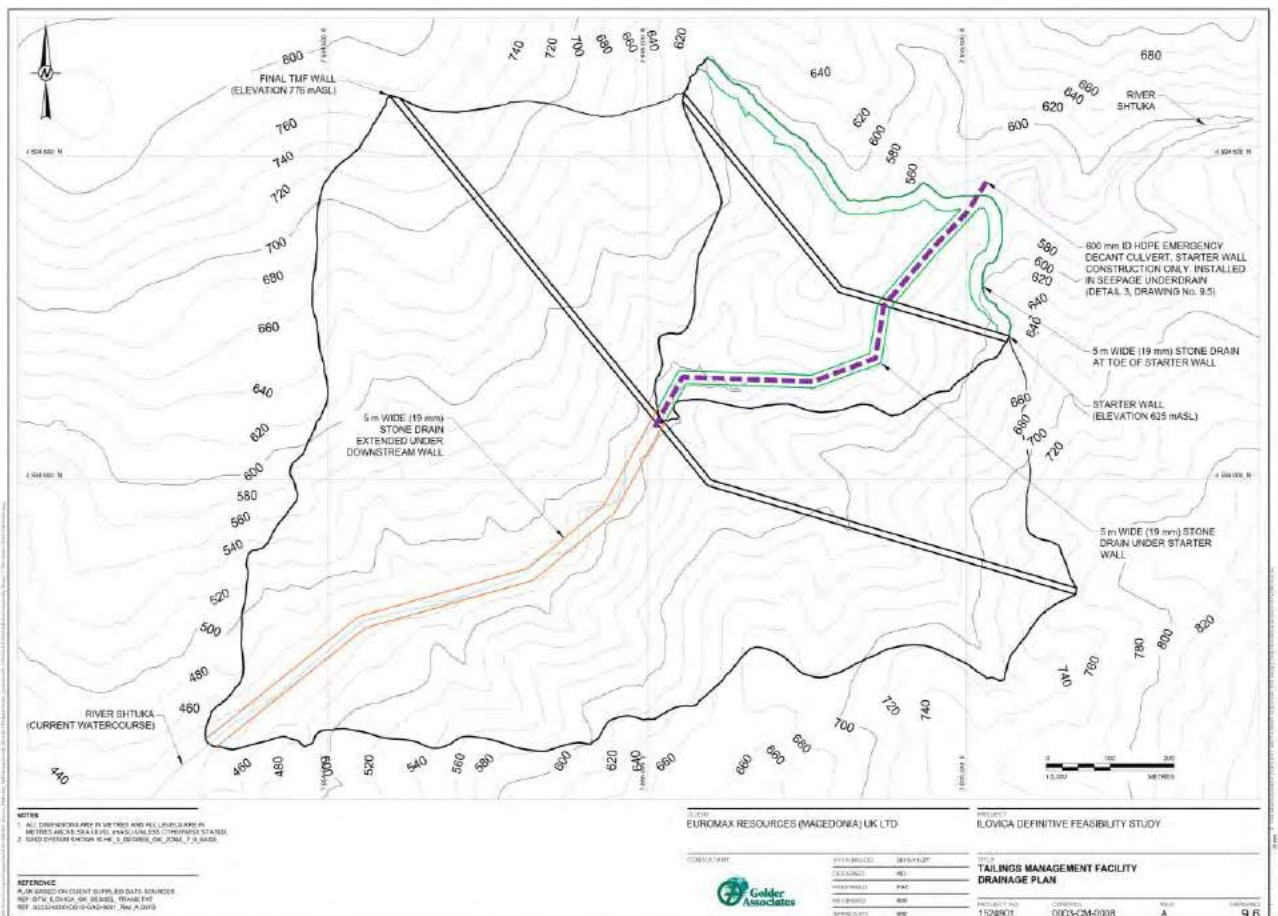
Should a PMF event occur however, the volume of water pumped from the TMF will be increased by 750 m³/h to 1 250 m³/h (of which 750 m³/h will be returned to the Plant), to assist in safeguarding the slope stability of the TMF. At this pumping rate (1 250 m³/h), it will take one pump approximately 25 days to decant 750 000 m³ of water.

To reduce the time required to decant a PMF (or any other large storm) event, the standby pump on the pump barge could also be used. Based on a combined maximum pumping capacity of 2 500 m³/h (for the duty and standby pumps), it will take approximately 12.5 days to decant a PMF event off the TMF.

18.2.4.9 Groundwater Management and Seepage Collection

The TMF will be equipped with a seepage collection system which will be constructed on the upstream face of the starter wall, prior to installation of the 2 mm thick HDPE liner on the wall Figure 18.26. The system will collect any seepage through the liner and will consist of a 1 m thick layer of concrete sand against the liner, with a 500 mm thick layer of 6.5 mm stone between the sand and the starter wall.

Figure 18.26
TMF Drainage Plan



At the bottom of the upstream slope, the 6.5 mm stone layer will be connected to a 5 m wide, 300 mm thick, 19 mm stone drain which will be constructed underneath the upstream toe of the starter wall. Any seepage collected by the sand and 6.5 mm stone layer, will be conveyed by this layer to the lowest point of the valley, from where it will be conveyed via a 10 m wide continuation of the 19 mm stone drain below the TMF wall, to the seepage collection sump.

Standpipe piezometers will be installed in the embankment walls of both the WDD and TMF and in the foundations at several sections and at various depths to detect any piezometric pressures associated with seepage through the structures. The number, location and depth will be defined during the detailed design phase.

Monitoring boreholes will be installed consisting of 100 mm ID perforated pipes installed in a 200 mm borehole backfilled with gravel and plugged with bentonite/concrete near the ground surface. The boreholes will be drilled to 5 m below the expected groundwater level. The number, location and depth will be defined during the detailed design phase.

On a monthly basis a sample should be collected from each piezometer and monitoring borehole and submitted for laboratory analysis of the key total and dissolved metals indicators, together with the basic

parameters. In addition, alkalinity and acidity determinations should be carried out by titration in an environmental laboratory.

18.2.4.10 Access Roads

Besides the haul roads designed by the mining team for TMF wall construction as well as the roads required for the installation and maintenance of the tailings delivery and slurry transportation system design (which will be relocated a number of times during the life of the project as tailings deposition progresses), Golder has allowed for two additional access roads for the TMF. The first road will be located at the bottom of the Shtuka valley and will go up the middle of the valley to the position where the RDD will be located. The road will be used primarily for access during construction of the RDD and the TMF Starter wall.

The second road will be incorporated into the river diversion spillway and will follow the contours up on the southern side of the Shtuka valley, to the position of the RDD wall. The road which will be approximately 4 m wide, will form part of the concrete lined river diversion channel (Figure 18.15) which will also be equipped with a 0.5 m x 0.5 m low flow channel section on the side. The low flow section will accommodate river flow during normal operating conditions to allow for the road to be used. During storm events however, the entire width of the channel will be used to decant the flow, and the road will not be operational during these times. Access to the top of the valley via this road will therefore be limited during the rainy season.

Construction of the combined river diversion channel and access road will not only save money, but also time, as it should provide a durable paved road surface for the LOM.

18.2.4.11 Monitoring

Construction Monitoring

Monitoring during the construction phase should include a construction quality assurance (CQA) program. The CQA program will be designed to:

- Verify the fill characterisation by inspection and laboratory testing;
- Confirm the compaction requirements;
- Monitor the placement and compaction by inspection;
- Confirm the compaction requirements have been met by in situ and laboratory testing;
- Confirm the installation and integrity of the HDPE liner;
- Confirm the installation of hydraulic structures; and
- Verify the characteristics of structural concrete works by inspection and testing.

Operational and Closure Monitoring

Monitoring of the condition of the earthworks structures will be required for both the TMF and TMF embankment storm water dam during the operational and closure phases. This will include:

- Regular inspections of slope condition;
- Regular inspections of drainage systems;

- Installation and regular inspection of monitoring piezometers to confirm groundwater conditions;
- Installation and regular monitoring of survey points on embankments to monitor movements and settlement;
- Installation and inspection of slip indicators; and
- Undertaking and monitoring the timely remediation of identified defects.

Site Laboratory

It is recommended that either an independent site laboratory be mobilised for the initial construction and operational period to undertake soils testing related to earthworks construction requirements or an independent soils company is engaged and samples tested off site or a combination of both. Soils testing required will comprise:

- Moisture content by oven drying;
- Liquid limit, plastic limit and plasticity index;
- Particle size distribution (PSD) by wet sieving;
- Proctor Compaction;
- Concrete compressive strength at 7, 14 and 28 days;
- Permeability/Compaction testing of compacted clay liner as well as drainage materials;
- Tensile strength testing of geosynthetic materials; and
- CBR Compaction.

Field testing equipment would also be recommended to include:

- Hand shear vane;
- Air test equipment for Geomembrane seams;
- Vacuum box or spark test equipment for geomembrane defect testing;
- Core cutters to allow the determination of soil density; and
- Sand replacement and nuclear density testing equipment could also be considered for the determination of in situ density testing.

18.2.4.12 Closure

The objective of the TMF closure or reclamation is to provide long term engineering and chemical stability of the TMF and landscape integration. This can be best achieved promoting run-off and the growth of a vegetation cover to minimise infiltration as far as possible given the local climatic conditions. As part of the detailed design phase a final landform design and re-vegetation strategy should be formulated. This should be aimed at designing the geotechnical stability of the deposited tailings and complemented by the establishment of a vegetated cover. The vegetated cover will minimise the potentially damaging effects that soil erosion could have on the stability of the closed facility.

The primary objectives of the reclamation of the TMF are to:

- Prevent the migration of air borne contaminants (dusting);
- Minimise rainfall infiltration into the TMF;
- Minimise long term seepage and impact on the groundwater;
- Prevent erosion from surface run off;
- Blend with the natural surroundings; and
- Provide some after use.

The closure and rehabilitation of the facility will take into account the following key components:

- Tailings surface profile;
- Surface water run-off and groundwater infiltration into the cap;
- Type of capping;
- Soil enhancement and vegetation trials to investigate the necessity for soil amendments and establish suitability of locally occurring or other species; and
- Monitoring.

Important aspects for closure include implementing measures to minimise the likelihood of the formation of Acid Mine Drainage, and preparation of the facility to control storm water run-off such that the facility will not have a negative impact on the health or safety of the general public or the environment.

With these aims in mind adequate steps should be taken to prepare the TMF for closure. This will include the filling-in, shaping and re-profiling of the facility with mine waste to drain towards the southeast. This will be followed by capping of the facility with a layer of topsoil. The top surface and side slope of the facility would then be vegetated.

Financial provision should be made during the operating life of the Mine to ensure that adequate funds are available to prepare the facility for closure as well as the monitoring and maintenance of the facility during the steady state phase.

Area and Site Setting

Tailings from the Ilovica mine will be deposited on the TMF which will have a final surface area of approximately 191 ha at the top tailings elevation of 774 m AMSL. The footprint area of the TMF (including the downstream raises of the facility) will be approximately 251 ha at closure. The maximum tailings depth is estimated at 224 m and the majority of the tailings impoundment surface is anticipated to have a beach slope of between 0.5% and 1%. The TMF will be located in a valley currently used primarily for forestry but also for the grazing of livestock and agriculture.

Successful rehabilitation of the TMF to a low maintenance land use such as a native ecosystem, which is sustainable in the long term, requires an understanding of the basic concepts of soil development, plant succession and species diversity. Rehabilitation aims to accelerate the natural successional processes so that the plant community develops in the desired way.

Tailings Characteristics

The project will involve open pit mining and the processing of ore by crushing and grinding circuits followed by flotation.

Progressive restoration/re-vegetation has many advantages, such as shorter closure implementation and integration of the closure activities into the daily operational activities. This will however not be possible for the TMF as the facility will be operated as a single unit.

Legal Context

This conceptual closure and rehabilitation plan is taking into consideration the new European Directive 2006/21/EC and associated best available techniques (BAT) reference document for the management of waste from extractive industries, which outlines procedures for closure and post-closure procedures. In addition, for the purposes of minimising water pollution, the discharge of waste into any receiving water body of water should comply with Directive 2000/60/EC.

The TMF must be chemically stable throughout the phases of the life cycle. The consequences of any chemical changes or conditions leading to the leaching of metals, salts or organic compounds should not endanger public health and safety nor result in the deterioration in environmental resources.

It is impossible to restore a site to its original condition although it can be improved in some aspects. However, Euromax Resources, the authorities and the stakeholders involved have to agree on the successive use that takes a balanced consideration of ecological, environmental, recreational and economic aspects.

Objectives of TMF Closure and Rehabilitation

The objective of the closure plans is to ensure long term engineering physical stability, chemical stability and successive land use. It has been assumed, for the purpose of this conceptual closure plan that the TMF should aim to be returned to a similar vegetation cover as possible to the surrounding hillsides.

The engineering design of the conceptual final land form will ensure geotechnical stability of the TMF which will be complimented by the establishment of a vegetated cover. The primary purpose of the cover is to ameliorate the potentially damaging effects of soil erosion upon the stability of the facility and to re-establish self-sustaining flora and fauna. This might not be the original ecosystem that existed on the site, but ecosystems and biotope selected as the most effective and appropriate.

While no major environmental risk is predicted to arise from the rehabilitated TMF area, it is likely that the eventual end use will be determined by the success of rehabilitation research and land use demand at the time of closure.

Designing a re-vegetation plan is inherently complex due to the large number of soil, climatic and biological factors that need to be incorporated to establish viable plant populations, in addition to regulatory and community considerations.

Note the following considerations taken in preparing this section:

- Golder has not provided a fixed, prescriptive methodology for the establishment of vegetation on the TMF at Ilovica. A fixed methodology will not be successful due to the inherent variability within and between substrates, vegetation and climate. Guidance is based on current best practice and Golder's experience in re-vegetation; and
- The closure planning strategy should remain flexible and must evolve through the lifespan of the facility based on regulatory decisions, local requirements, consultations, findings of plot trials and field-scale applications.

Tailings Surface Profile

Tailings deposition on the TMF during the last three years of operation will be adjusted in such a way that the supernatant pool will be repositioned towards the south-eastern side of the TMF (Figure 18.14).

Once the tailings on the TMF have achieved a suitable degree of consolidation to support earthmoving equipment, the tailings deposition will be managed to provide a suitable final land form for closure. The facility will then be capped with a minimum 500 mm thick layer of mine waste, covered with a minimum 150 mm thick layer of topsoil/growing medium to allow for the re-establishment of vegetation on the TMF.

Surface Run Off and Infiltration

Following the establishment of a low point for the final pool position on the south-eastern side of the facility, the facility will be modified as necessary to allow for the drainage of surface run-off from the facility to this point. At this stage due to the modifications carried out to the tailings deposition methodology, the TMF beach will have formed a dish shape with a low point located at the south-eastern side of the facility. The TMF will then be equipped with a spillway to the storm water diversions system situated to the south of the facility to allow for the long term gravity decanting of storm water from the facility.

Water Quality

Water quality monitoring for the TMF and TMF embankment storm water dam carried out during the operating phase of the facilities will have to continue on a six monthly basis following closure of the facilities to determine whether water quality trends are stabilising and whether the water quality complies with Macedonian legal requirements and international best practice guidelines for discharge.

Samples should be collected from each piezometer and monitoring well and submitted for laboratory analysis of the key total and dissolved metals indicators, together with the basic parameters. In addition, alkalinity and acidity determinations should be carried out by titration in an environmental laboratory.

The following monitoring techniques will be used to assess the performance of the TMF during and after operations:

- Piezometric level measurements within the main embankment wall, foundations and base of tailings to monitor the head and any seepages across the geomembrane; and
- pH, conductivity and other water quality measurements in the monitoring wells immediately downstream of the embankment walls.

TMF Capping Layer

A water cover as a closure alternative has not been considered for the TMF due to the climatic considerations associated with the area around Ilovica in Macedonia. It is proposed to place a capping of weathered rockfill on top of the tailings to provide a suitable sub grade for the topsoil. The thickness of the layer will be dependent on the ability of the material to support earth moving equipment during placement. This will be dependent on the strength gain of near surface tailings exposed to desiccation.

For the purpose of vegetation, it should be ensured that the substrate is capable of supporting plant growth.

A capping layer will be provided for the facility and will be composed of:

- A minimum 500 mm thick mine waste layer nominally compacted by construction plant in a single layer; and
- Top soil cover layer of minimum thickness of 150 mm to promote vegetative growth.

Topsoil and Alternative Substrates

Topsoil removed during the construction phase should be retained on site for subsequent rehabilitation. It is preferable to reuse the topsoil immediately rather than storing it in stockpiles. If topsoil must be stockpiled, then it should be for as short a time as possible and be kept as low as possible (2 m high or less) and the stockpiles should be re-vegetated to protect the soil from erosion.

If limited topsoil is available, it can potentially be laid in strips over the tailings and the primary vegetation added to the strips.

If topsoil is unsuitable or absent, alternative substrates (such as subsoil, overburden, waste rock) need to be identified and tested that may be a suitable substitute after addition of soil improving substances. These materials will generally require techniques to increase their organic matter content and nutrient status. Different techniques can be considered and tested in laboratory, pot trials and subsequently at field scale to improve the ability to support plant growth in the long term, including the application of organic matter, chemical amendments or inorganic fertilisers or establishing nitrogen fixing species.

Plant Selection for Re-vegetation

Re-vegetation is an essential part of the rehabilitation process. A vegetation cover on mine tailings can be effective in controlling surface erosion, providing the necessary surface stability prevent wind-blown tailings particles, reducing infiltration by interception of rainfall and improving aesthetics.

Species

Some indigenous species may not thrive in areas where the soil conditions are substantially different. Successful rehabilitation at Ilovica to low maintenance, sustainable vegetation in the long term requires an understanding of the basic concepts of soil development, plant succession, and species diversity. Nutrient demands must be met, in the long term, by nutrient cycling and natural inputs rather than by continued fertilizer application.

The rehabilitation recommendations for the Ilovica TMF proposed here cannot be prescriptive about what species or phytosocial groups should be used. The crucial component of successful re-vegetation will be investigation of local endemic flora and the harnessing of local knowledge. Local botanical knowledge, for example at local universities, botanical gardens, research scientists and local farmers will be vital for selecting the optimal species for re-vegetating the facility, which will have to be tested at pot trial and field trial level.

The species composition must include sufficient smaller species to generate ground cover against erosion whilst the ecosystem becomes established.

Sourcing of Plants

Plant species can be established on rehabilitated areas from:

- Propagules;
- Sowing seeds;
- Planting nursery-raised seedlings;
- Transplants of individual plants from natural areas;
- Habitat transfer – the transfer of substantial amounts of relatively undisturbed soil with its vegetation intact from natural areas; and
- Invasion from surrounding areas through vectors including birds, animals and wind.
- Nursery seedlings are likely to provide the most suitable start for a re-vegetative cover. It is important that the seedlings are not too young when received from the nursery as they then have a smaller chance of survival in poor substrate.
- The availability of vegetation, seeds or propagules from the wild, from on site propagation or from commercial seed suppliers need to be determined.

Irrigation

It is anticipated that irrigation may be required in the initial stages of re-vegetation of the TMF at Ilovica.

Rehabilitation Sequence, Monitoring and Maintenance

General Approach

Trials will have to be undertaken in a step-by-step manner to determine the optimum procedures and methodology for the restoration of the TMF.

The general approach for all stages of investigations will involve:

- When conditions are determined to be suitable for plant establishment, organic amendment of the residues will be carried out and seeds/seedlings sown; and
- In order to develop a monitoring system for assessing sustainable indicators key soil parameters will be determined. The effect of organic amendment and fertilizer application on residue properties will be investigated. Parameters crucial to the promotion of sustainable plant growth will be reported and related to plant performance.
- The main steps of investigation will be discussed in the following section.

Laboratory Test Work

The initial laboratory test work should include the following:

- Sampling of tailings;
- Chemical analysis of the tailings to identify potential plant toxicities and nutrient deficiencies; and
- Analysis of the chemical and physical characteristics of the surrounding native top soil and sub soils (pH, nutrient and metal content) to create a baseline soil chemistry against which the waste substrate can be compared.

Glasshouse Trials

At the glasshouse trial stage a large range of variables for substrate amendment and plant species have to be tested to find regimes most likely to succeed and thus testing further at subsequent field scale trials.

Suggested variables are:

- Different cover systems: single layer soil cover and re-vegetation; and multi-layered (gravel drainage layer and topsoil) soil cover and re-vegetation;
- Topsoil and other potential substrates;
- Organic addition - Organic sources in the Ilovica area needs to be determined and different types assessed;
- Observation of nutrient levels and addition of fertilizers - in particular the following elements should be considered: Mn, Ca, Mg, K, N, P;
- A range of plant species; and
- Irrigation frequency and rate.

Small-scale Field Trials

Small-scale field trials would be carried out to test establishment techniques and the on site response of selected plants to substrate amendments.

Key substrate variables and promising species to be tested at small scale - e.g. triplicate plots of 1 m² for the same variables.

Large-scale Field Trials

Depending on areas that can be isolated early in the TMF area, larger scale field trials will be conducted there for some promising combinations of substrate and plant species observed at the small-scale field trials.

The field trial plots should have the following features:

- Each trial plot should be in the order of 20 m x 20 m;
- Each area will slope down towards a dedicated run-off collection system to allow surface run-off from each area to be collected and then decanted by means of outlet pipes. These should be installed with a valve system allowing both water quality and flow to be assessed and measured; and
- Seepage water quality will be assessed via a seepage collection system installed down gradient of the TMF which will be connected via a pipework system to an outlet pipe situated at the lowest point

of the system. The outlet should take the form of a riser pipe running from the collection unit to a perimeter or divider wall and up the slope, finishing with a valve/end cap suitable for collecting water samples.

Full Scale Establishment of Vegetation

The detailed closure plan for the TMF area should be formalised a minimum of 24 months prior to the planned closure.

Monitoring and Maintenance

The rehabilitated areas need to be monitored and managed until the vegetation is self-sustaining and meets the requirement of Euromax Resources and the authorities or until their management can be integrated into the management of the surrounding area.

Rehabilitation success is often compromised by the invasion of animals, weeds and human activities.

It is essential to monitor the success of the rehabilitation program; maintenance may include:

- Replanting failed or unsatisfactory areas;
- Repairing any erosion problems;
- Pest and weed control;
- Fertiliser and organic matter application;
- Watering plants in drier areas, especially in the establishment phase;
- Scrub planting; and
- Topsoil importation to augment earthworm and soil decomposer communities.

Components of the success criteria could include:

- Physical (stability, resistance to erosion, re-establishment of drainage);
- Biological (species richness, plant density, seed production, weed control, productivity, establishment of nutrient cycles);
- Water quality for drainage water; and
- Public safety issues.

Success of surface re-vegetation will be measured on the basis of vegetation and soil biological surveys. These surveys should be conducted bi-annually (in wet and dry season) until Year 5 post closure when it is anticipated that the re-vegetation programme will be deemed successful. Heavy metal analysis of representative samples of the final TMF surface will be necessary to confirm the status of the surface as not creating a risk to wildlife in terms of heavy metal accumulation. Minimum monitoring requirements are included in Table 18.21.

Table 18.21
Monitoring Requirements for Rehabilitation Success

Sample Type	Parameter	Monitoring Frequency
Erosion	Gully formation	Annually
Sheet erosion		Annually
Vegetation cover	Species diversity	Bi-annually
	Cover density	Bi-annually
	Herbage weight	Bi-annually
	Soil fertility pH	Bi-annually
	Conductivity	Bi-annually
	N, P, K	Bi-annually
	Ca, Mn, Mg	Bi-annually
	Minor elements B, Mo, Zn, Cu, Co Mn	Bi-annually

Spillways

For closure it will be necessary to construct a closure spillway for the TMF. The spillway will be approximately 5.5 m wide at the base and 2 m deep with 1V:1H side slopes. To provide a low maintenance long term option the TMF spillway will be lined with a 0.2 m reinforced concrete lining.

Following closure the reinforced concrete lined river diversion channel will remain in operation to supply clean water to Shtuka village and minimise the catchment reporting to the TMF.

River Diversion Dam

Up-valley of the TMF, a small 10 m high RDD will be constructed to capture run-off from the Shtuka valley above the TMF, prior to diverting the water into the river diversion channel located to the South of the TMF to bypass the facility. The design of the RDD and the diversion channel are aimed at providing a source of clean water to the Shtuka village, located in the valley below the TMF. The dam and channel will have to be constructed first, to allow the TMF basin to be relatively dry during Starter Wall construction. The RDD will have a 5 m wide crest and 1V:2H upstream and downstream slopes, and will be equipped with a 2 mm thick HDPE liner on the upstream side to limit seepage through the wall, as well as a 300 mm thick rip-rap layer, to protect the wall against wave action.

General

Following the closure of the mine it is envisaged that the TMF embankment storm water dam would be utilised for water storage by the local communities. This will however mean that the dam will have to be inspected and maintained to a high standard in accordance with legal requirements in Macedonia and international best practise guidelines.

Closure requirements for the TMF will be required to prepare the facility for closure. This will include the stabilisation of the dam wall, implementation of erosion management measures to protect the TMF embankment storm water dam wall and convey storm water safely away from the dam and past the TMF.

Financial provision should be made during the operating life of the mine to ensure that adequate funds are available to prepare the TMF embankment storm water dam for closure as well as the monitoring and maintenance of the facility during the steady state phase.

18.2.4.13 Quantification and Costing

The TMF and associated infrastructure Capex and Opex, as well as costs for preparing the facility for closure (TMF closure spillway construction, capping and re-vegetation, etc.), have been included in Sections 21.1.4 and 21.2.4, respectively, of this report.

18.2.4.14 Conclusions & Recommendations

The TMF design prepared as part of the FS relies on a number of assumptions relating to the Geotechnical and Geophysical Site Investigations, as well as on the engineering characteristics of TMF wall construction materials and tailings to be deposited on the facility. In addition, the TMF design prepared for the FS had been completed before the seismic assessment, recently completed for the TMF site by the CMU in Skopje, was available.

The findings from the geotechnical and geophysical site investigations, the geotechnical laboratory test work, as well as from the seismic assessment by CMU will be used to validate the current FS design for the TMF and associated infrastructure during the implementation phase. Where necessary the design will be modified accordingly to meet performance and safety requirements.

18.2.5 Tailings Delivery and Deposition

Golder's battery limits for the tailings transportation system design is the discharge flange of the TMF feed tank. Golder was responsible for the sizing of the tailings disposal pumps and design of piping from the pumps to the tailings discharge points. The tailings delivery and deposition system includes the tailings deposition pipelines and associated valves and spigots.

18.2.5.1 Tailings Management

Scavenger tailings from the process plant are dewatered in the tailings thickener and subsequently pumped into the TMF feed tank. Cyanide destruction tailings are also pumped into the TMF feed tank. Both tailings streams are agitated and homogenised into a single tailings stream which is then transported to the TMF for deposition.

The TMF will use a downstream constructed earthen and waste rock dam to provide containment for the tailings. Tailings will be deposited on each side of the TMF to maximise storage volume and for pond water management.

The tailings delivery system will be comprised of two pipelines. One pipeline will be routed to the west and will discharge tailings from the dam crest into the TMF. The second pipeline will be routed to the east and will discharge tailings from the side hill into the north end of the TMF. The combination of both pipelines will allow the distribution of tailings around the TMF in accordance with the deposition plan.

18.2.5.2 Tailings Transportation System

The tailings transportation system begins at the discharge flange of the TMF feed tank located in the tailings pump station. The system consists of two pipelines, the East and the West pipelines, and will comprise of two single 630 mm SDR 9 HDPE pipes.

The West pipeline will transport tailings to the starter dam while the east line will transport tailings to the north side hill. Each pipeline is sized to carry 100% of the tailings throughput. As such, maintenance activities and pipe relocation can be completed on one pipeline without affecting mine production, dam building or tailings deposition. The total length of each pipeline during the initial TMF stage is approximately 3 100 m for the west line and 4 500 m for the east line.

During the initial TMF operation, the tailings transportation pipelines will operate in a combination of open channel and pressurised flow. The pipelines will be equipped with 2-way slurry vent valves after each high point to allow the admission and expulsion of air to facilitate open channel flow and minimize vaporisation and cavitation effects. In order to reduce the areas where the pipe cycles between pressurised and open channel flow and to limit the flow velocity the routing will need to be optimised in later engineering stages to maintain a more constant slope and limit slopes in excess of 10%.

The pipelines will be rotated in a systematic manner to maximise the life of the pipe. As the TMF is raised, the pipelines will be increasingly pressurised until they become fully pressurised.

Initially, the tailings transportation system will not require pumping. The head provided from the TMF feed tank and the elevation difference between to the TMF will be sufficient to transport tailings during the initial years.

Once the TMF reaches an elevation of 710 m AMSL (year 8) a single pump stage (one operating and one standby unit) will need to be installed to provide the necessary head to transport tailings out to the TMF. Each pump will consist of a Weir 300 WBH centrifugal slurry pump with a 375 kW motor and variable frequency drive. When the TMF reaches an elevation of 750 m AMSL (year 15) a second pump stage (in series) will need to be installed on each train, for a total of four pumps (two operating and two standby units).

The head requirements for each system are presented in Table 18.22. As the routing has not been finalised for each pipeline, the pumping requirements may change in the future.

Table 18.22 Tailings Transportation System – Pumping Requirements				
Parameter	Starter TMF – West Line	Starter TMF – East Line	Final TMF – West Line	Final TMF – East Line
<i>Transportation</i>				
Total pipe length (m)	3 100	4 500	2 400	4 100
Pipe specifications	630 mm SDR 9 HDPE	630 mm SDR 9 HDPE	630 mm SDR 9 HDPE	630 mm SDR 9 HDPE
<i>Deposition</i>				
Total pipe length (m)	750	50	1 250	150
Pipe specifications	200 mm SDR 17 HDPE	630 mm SDR 9 HDPE	200 mm SDR 17 HDPE	630 mm SDR 9 HDPE
<i>Pumping</i>				
Total discharge head (m)	-	-	35	63
Total discharge pressure (kPa)	-	-	504	913

Table 18.22
Tailings Transportation System – Pumping Requirements

Parameter	Starter TMF – West Line	Starter TMF – East Line	Final TMF – West Line	Final TMF – East Line
Total power (kW)	N/A	N/A	341	576
Pump type	N/A	N/A	WEIR 300 WBH	WEIR 300 WBH
Number of operating pumps	N/A	N/A	2	2
Number of spare pumps	N/A	N/A	2	2
Motor power (kW)	N/A	N/A	375	375

18.2.5.3 Tailings Deposition

Tailings will be deposited into the TMF from various discharge points. The west pipeline will deposit tailings from the dam crest while the east line will deposit tailings from the side hill on the east side of the TMF. Both tailings transportation pipelines are equipped with 200 mm rupture disks at the beginning of the deposition sections to protect the system against overpressure.

Once on the dam, the west tailings transportation pipeline is equipped with 200 mm discharge points every 50 meters. Each discharge point consists of a 200 mm knife gate valve for isolation, a 200 mm pinch valve for flow throttling and flow adjustment between spigots, and 50 meters of 200 mm SDR 17 HDPE pipe.

A 600 mm knife gate valve will segment the on-dam pipeline every 150 meters, isolating sections of 3 discharge points. Initially the starter dam will contain 15 discharge points, additional discharge points will be added as the dam grows. The 200 mm knife gates and pinch valves will be actuated manually; the 600 mm knife gate valves will be actuated hydraulically using a mobile hydraulic power unit.

Deposition will be continuous and only discharge points located inside two 600 mm sectioning valves will be operated at a time. Deposition of tailings will begin with the upstream discharge points and work its way to the three farthest discharge points on the line. The 600 mm sectional valves will isolate the inoperative areas which will remain drained.

A flush line at the end of the pipeline will allow the pipeline to be flushed at the end of each discharge sequence prior to shutting down. During shutdowns, the pipelines will be drained into the impoundment after flushing. Once the pipeline has fully drained and the discharge valves at the station have been closed, the isolation valves on the dam can be closed.

The east pipeline is equipped with 2 deposition spigots ending with spreader bars to distribute tailings. As tailings will be deposited at precise locations on the east side of the TMF, only one spigot per discharge location has been considered. Each spigot is made from the same material as the main pipeline, 630 mm SDR9 HDPE. Knife gate valves will be installed on spigots for isolation. Knife gate on the transportation pipeline will be installed for segmenting purposes. One additional discharge point will be added as the dam TMF grows.

18.2.5.4 Closure

The tailings transportation and deposition closure will be carried out in accordance with the mine closure plan.

18.2.5.5 Quantification and Costing

A BOQ was produced for quantification of tailings deposition material.

18.2.5.6 Conclusions and Recommendations

The tailings transportation systems have been designed with a 100% availability and will not require pumping during the initial years of the TMF. Single stage pumping will be required starting in year 8 when the TMF reaches elevation 710 m AMSL. Once the TMF reaches an elevation of 750 m AMSL, a second stage of pumps will be required, for a total of four pumps (two operating and two standby units).

During the next phase of engineering, the routing of both the east and west pipelines will need to be optimised to reduce the severe pipeline slope changes. This will reduce unwanted transitions between pressurised and open channel flow as well as limit the flow velocity in the pipeline to prevent premature wear.

In the next phase of engineering a transient analysis will need to be carried out to determine the pressure surge conditions of the pipeline and implement mitigation measures to protect the pipeline. Additionally, a pipe stress analysis must be carried out during the next phase to evaluate the pipeline load capabilities and ensure a safe pipeline configuration.

18.3 HYDROLOGY AND HYDROGEOLOGY

18.3.1 Hydrology

18.3.1.1 Introduction

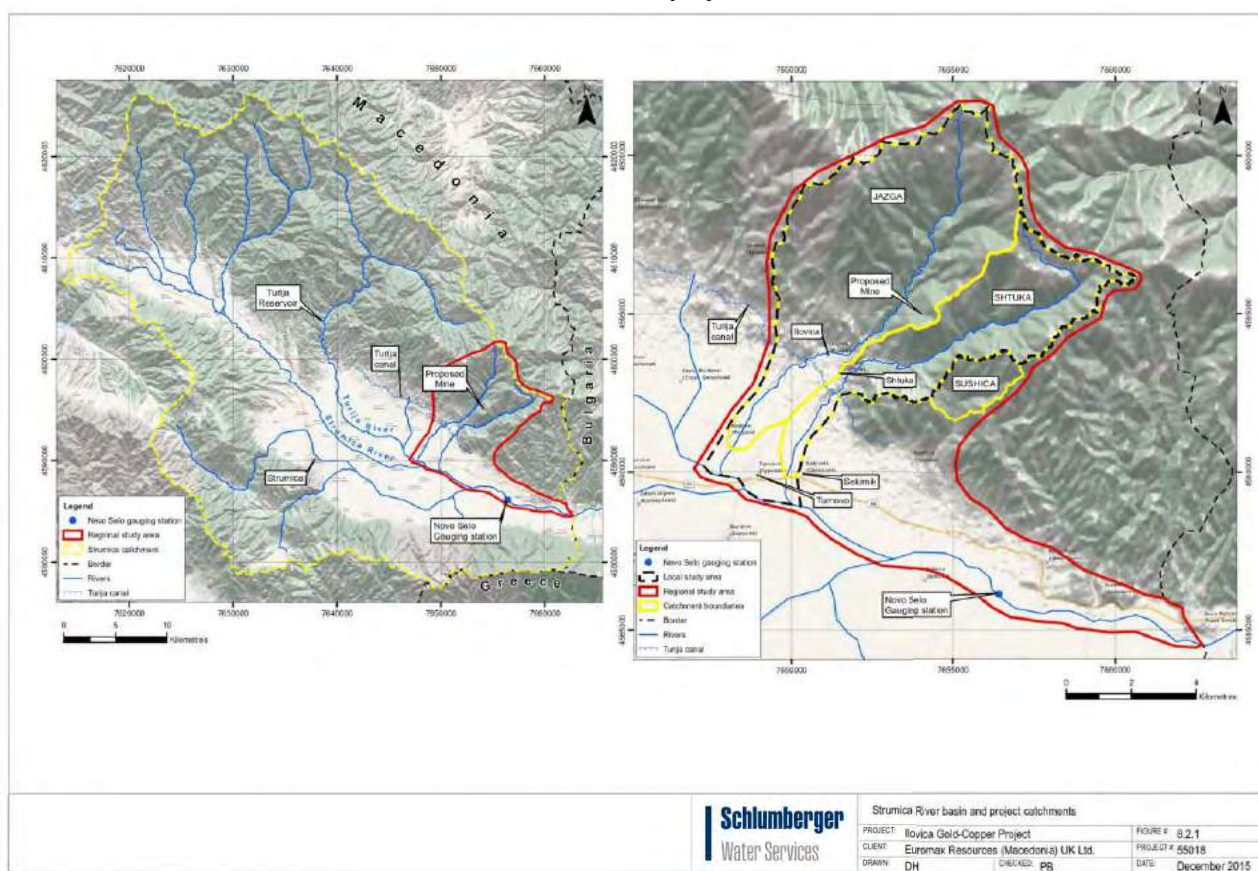
This section focuses on presenting hydrological information and analyses used in the engineering design of the project. Further information on the hydrology of the project area is presented in the ESIA Baseline report (Golder and SWS, in prep.)¹⁶.

18.3.1.2 Regional Hydrology

The project is situated in the catchments of the Jazga and Shtuka rivers shown in Figure 18.27.

¹⁶ Op. cit.

Figure 18.27
Strumica river basin and project catchments



The Jazga and Shtuka catchments, approximately 45 km² and 22 km² in area respectively, are situated on the south-facing slopes of the Ograzhden mountain range on the northern side of the Strumica River basin. The Jazga River flows through the village of Ilovica into the Turija River near Turnovo. Turija River flows are regulated by the Turija reservoir. The Turija River flows into the Strumica River. The Shtuka River flows through the village of Shtuka directly into the Strumica River near Sekirnik.

The length of the Strumica River from the project catchments downstream to the border with Bulgaria is approximately 15 km. The Strumica River basin is largely mountainous and forested, but the floor of the valley (here called the Strumica plain) is relatively flat and is cultivated intensively with horticultural and cereal crops. A significant area of the Strumica plain is covered by the urban area of Strumica and a number of villages.

The Strumica River basin is characterised by scarcity of surface water resources (Government of Macedonia, 2012)¹⁷ and uncontrolled development of alluvial groundwater resources. Surface water resources are used for urban, rural and agricultural supply by public sector owned and operated water resources systems. Owing to a lack of investment in O&M wastage of irrigation water is relatively high and there is considerable scope for improved water resources management. Shallow alluvial groundwater in the project area is used by the private sector for household supply, agriculture, and agribusinesses. Sushica village public water supply is sourced from groundwater in the Strumica plain.

¹⁷ Government of Macedonia (2012) National Water Strategy, 2012-2042.

18.3.1.3 Project Site Hydrology

Hydrometric Network

The project site hydrology is based on the data collected by the surface water hydrometric network established by SWS shown in Figure 5.4. River gauging stations installed in late 2013 and early 2014 consisted of stage gauges and pressure transducer/loggers logging water levels at 5 - 15 minute intervals. Details of the stations are presented in the ESIA Baseline report. Details of stage-discharge rating curves developed at each station and QA/QC procedures are presented in the ESIA Baseline report (Golder and SWS, in prep.)¹⁸.

Bathymetric Survey of Ilovica Reservoir

A bathymetric survey of Ilovica reservoir was carried out by Euromax Resources in April 2015. The present capacity of the reservoir is 356 000 m³. Approximately 59 000 m³ of the original storage of 415 000 m³ has been lost due to sedimentation over the 15 year reservoir life.

Hydrological Studies for Water Supply and TMF Planning

Water supply options are discussed in Section 18.3.5. Hydrological studies for water supply planning comprised the following:

- Identifying potential water storage sites
- Generating long term synthetic daily flow series at the storage sites
- Storage yield analyses of identified sites
- Operational modelling of Turija reservoir for assessment of the reliability of supply to the proposed mine.

The following water storage sites were identified:

- Ilovica water supply reservoir (existing)
- RDD site, upstream of TMF basin, for diversion of the Shtuka River around the TMF
- Mala Shtuka dam on Mala Shtuka tributary to the TMF.

Long term inflow records for Ilovica reservoir, the RDD and the Mala Shtuka dam and the TMF were generated by rainfall run-off modelling. The US Corps of Army Engineers' HEC-HMS rainfall run-off (soil moisture accounting) model was calibrated at the following gauging stations:

- JZGS01 on the Jazga River, for Ilovica reservoir
- STGS03 on the Shtuka River, for the RDD
- STGS05 on the Mala Shtuka tributary, for the Mala Shtuka dam
- STGS01 and STGS03 on the Shtuka River, for the TMF.

Model calibration used the recorded rainfall and flow records. Figure 18.28 and Figure 18.29 show the Jazga and Shtuka catchment model layouts respectively. Figure 18.30 and Figure 18.31 show

¹⁸ Op. cit.

calibrations at the Jazga stations (for the period March 2014 to September 2014) and Shtuka stations (for the period February 2014 to August 2014) respectively. Contiguous results of model validation at the Jazga (for the period September 2014 to April 2015) and Shtuka (for the period October 2014 to May 2015) stations are shown in Figure 18.32 and Figure 18.33 respectively.

For each of the modelled catchments a 54 yr daily areal rainfall dataset was generated from the long term rainfall records at Strumica and Ilovica village. The 54 yr rainfall datasets were used with the calibrated models to generate 54 yr daily inflow series at the dam sites. Figure 18.34 shows the long term inflow series for the Ilovica reservoir.

Figure 18.35 shows the inflow series for the RDD and Mala Shtuka dam sites.

Figure 18.28
HEC-HMS calibrated Jazga catchment model

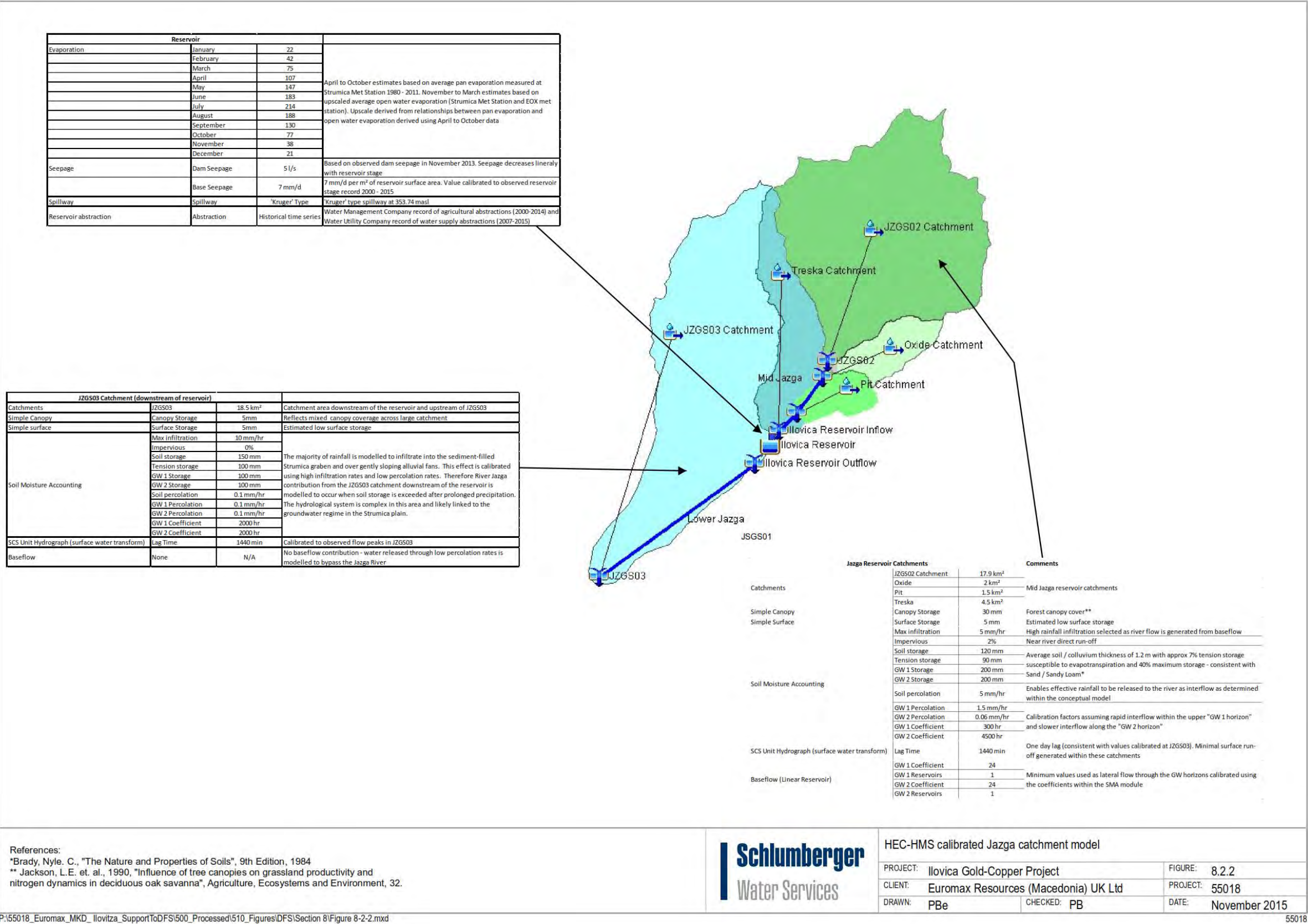


Figure 18.29
HEC-HMS calibrated Shtuka catchment model

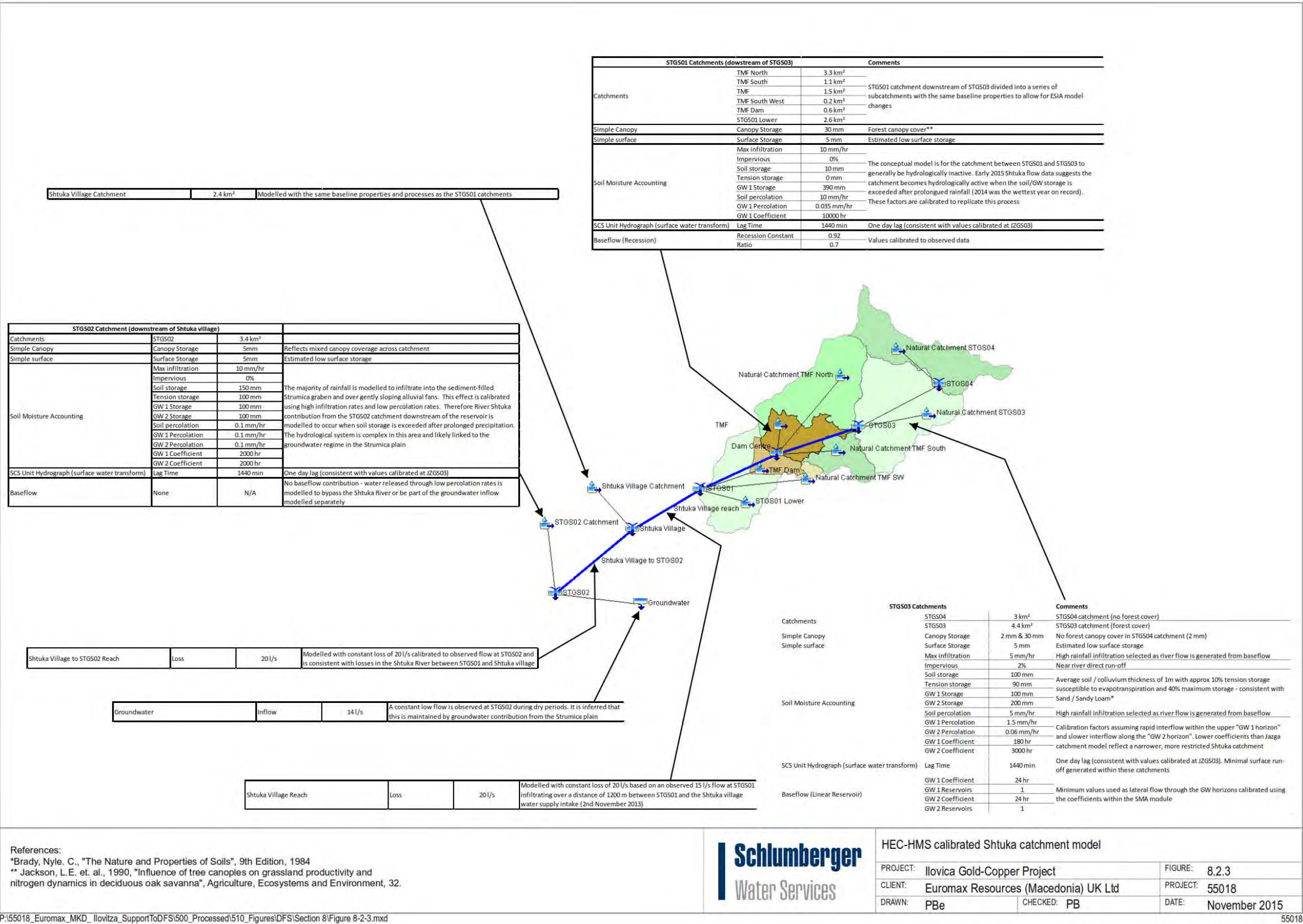


Figure 18.30
Calibration of HEC-HMS at JZGS01, JZGS02 and JZGS03

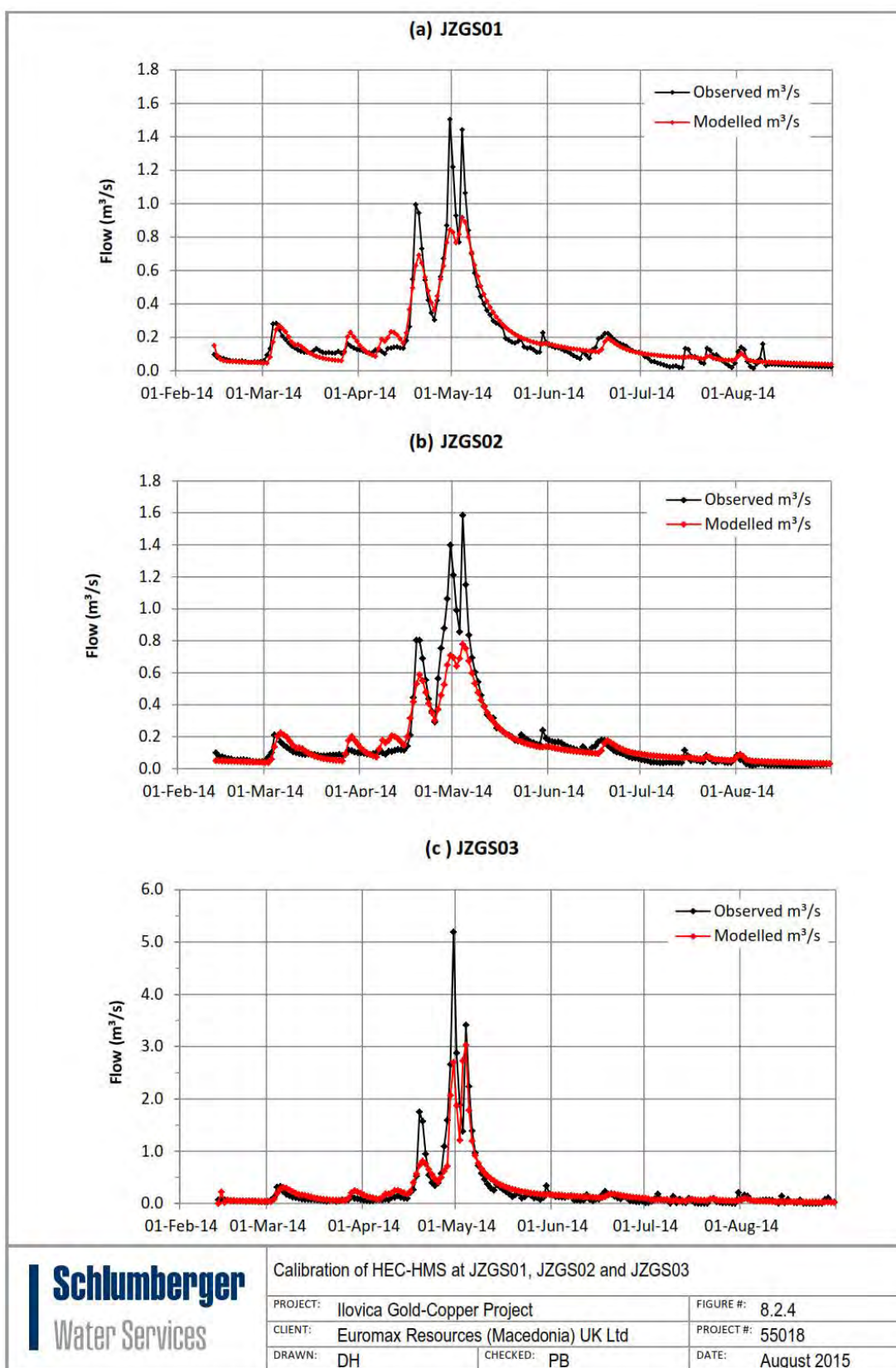


Figure 18.31
Calibration of HEC-HMS at STGS01, STGS02 and STGS03

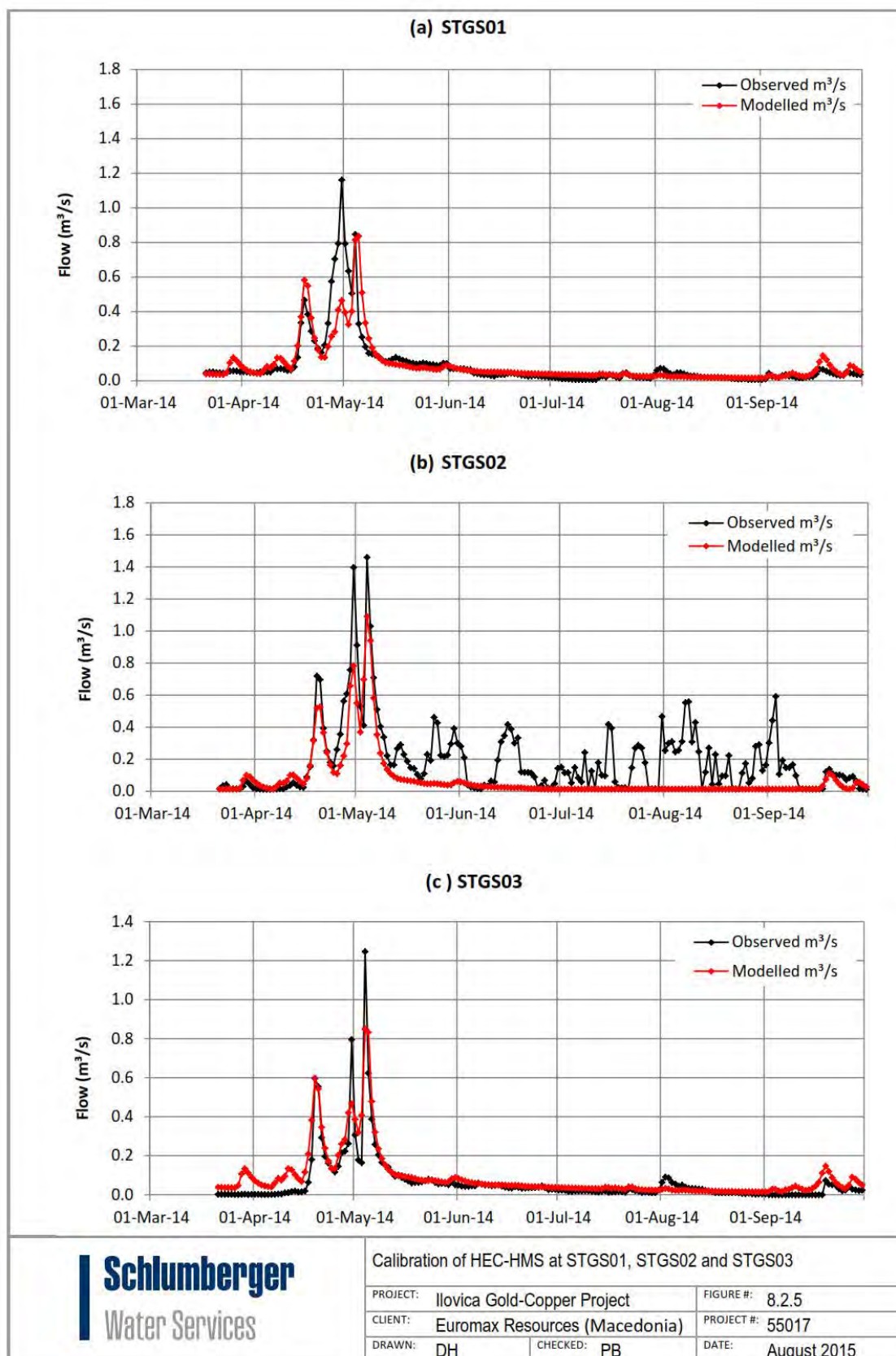
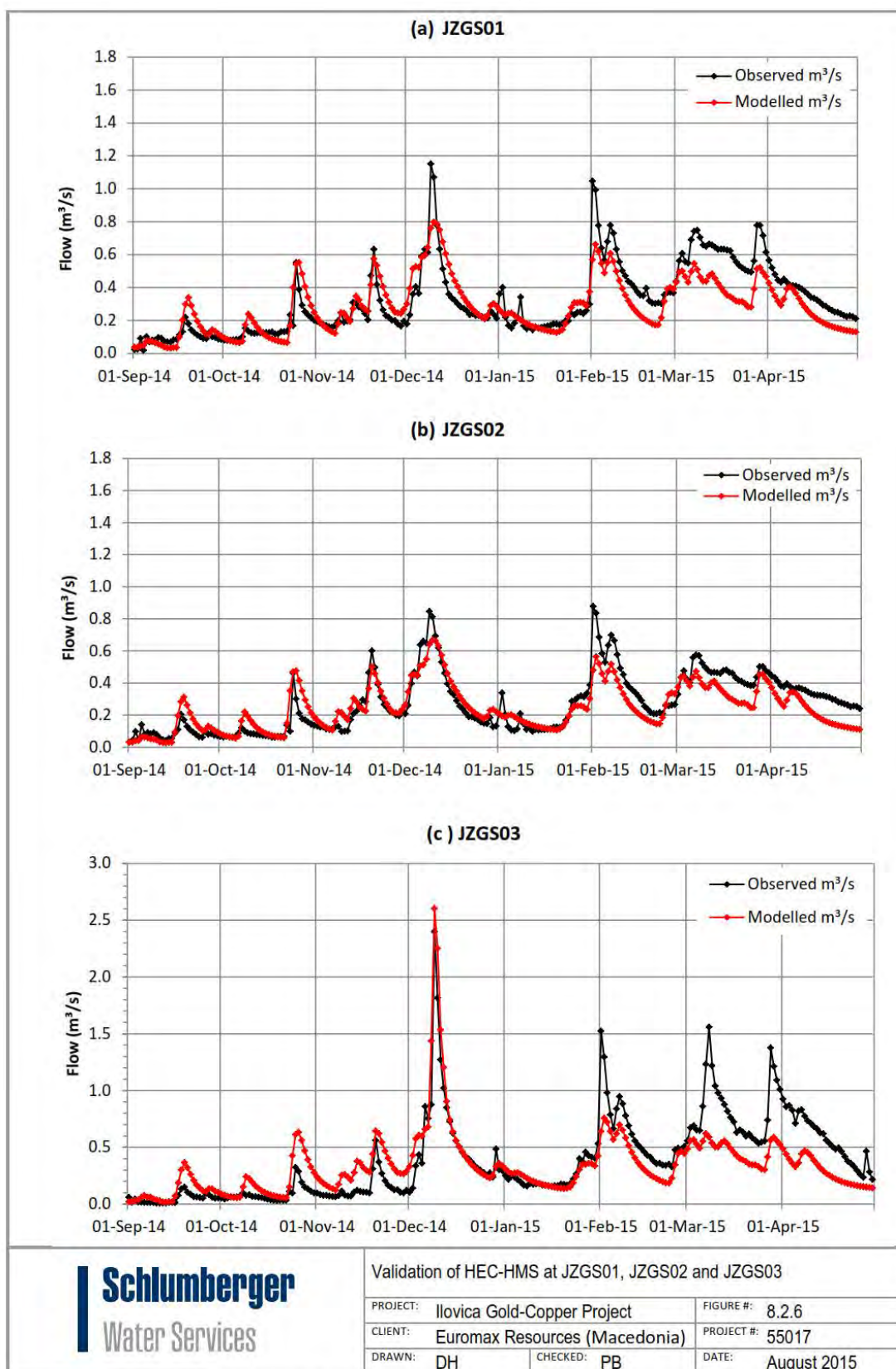


Figure 18.32
Validation of HEC-HMS at JZGS01, JZGS02 and JZGS03



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Figure 18.33
Validation of HEC-HMS at STGS01, STGS02 and STGS03

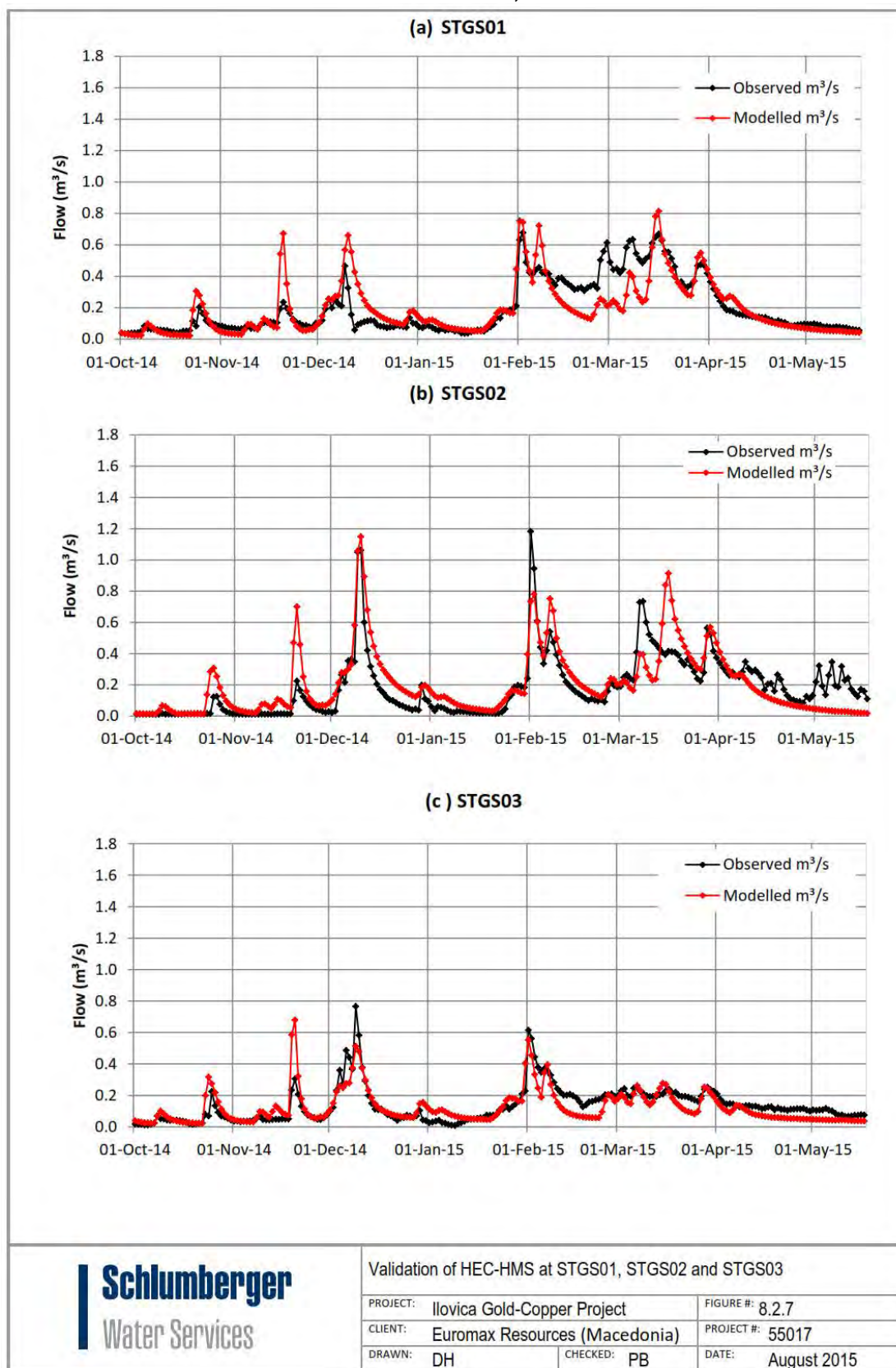


Figure 18.34
Modelled inflows to Ilovica reservoir, 1961-2014

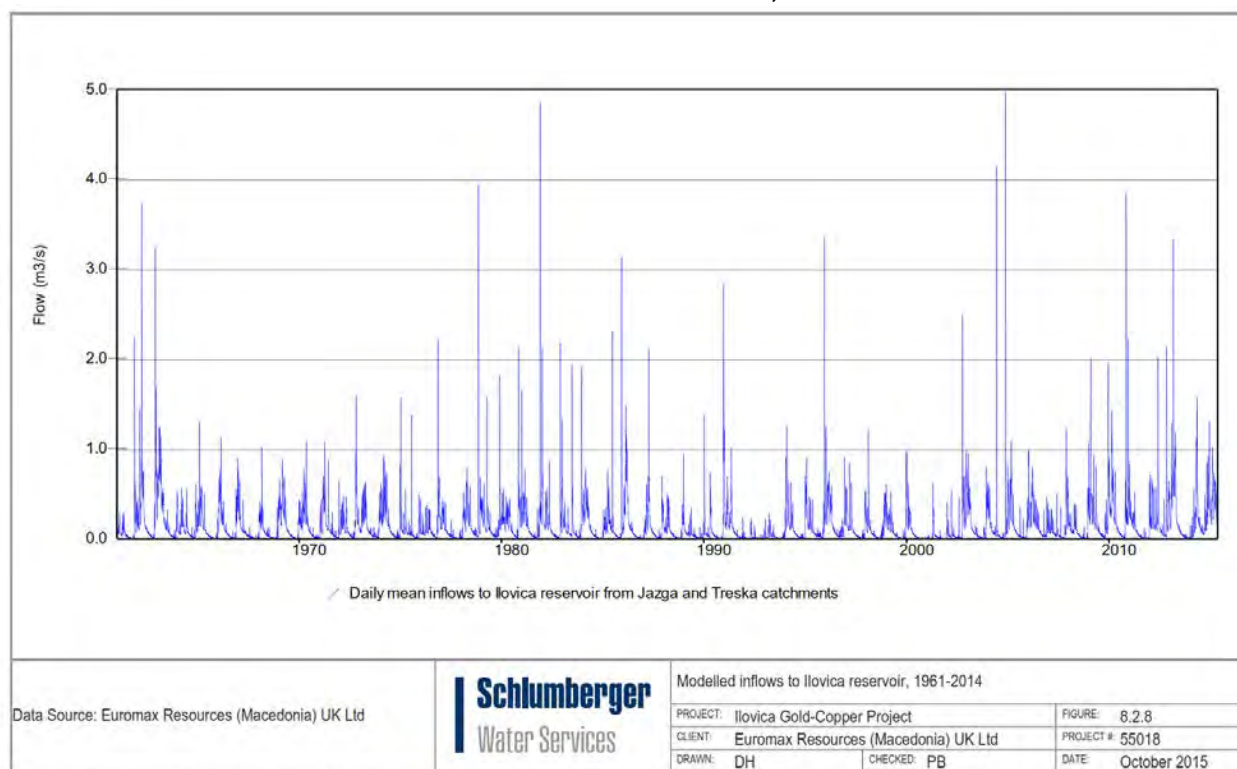
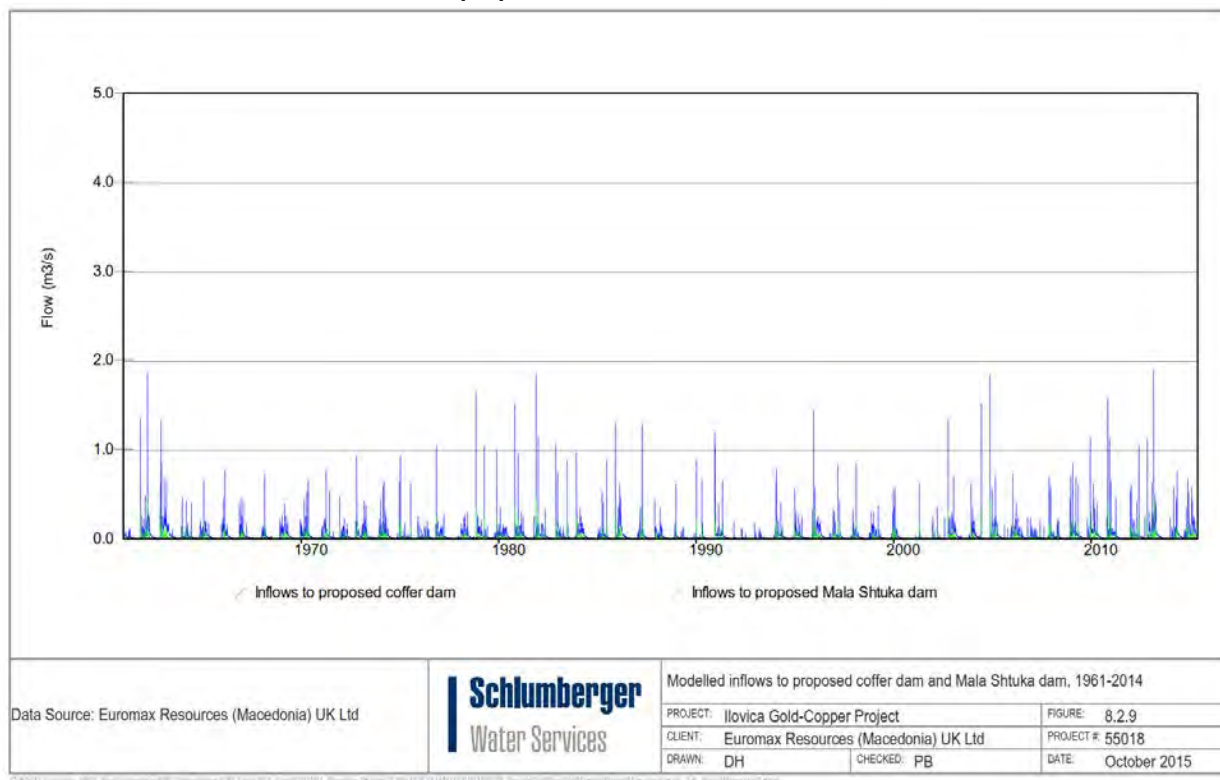


Figure 18.35
Modelled inflows to proposed RDD and Mala Shtuka dam, 1961-2014



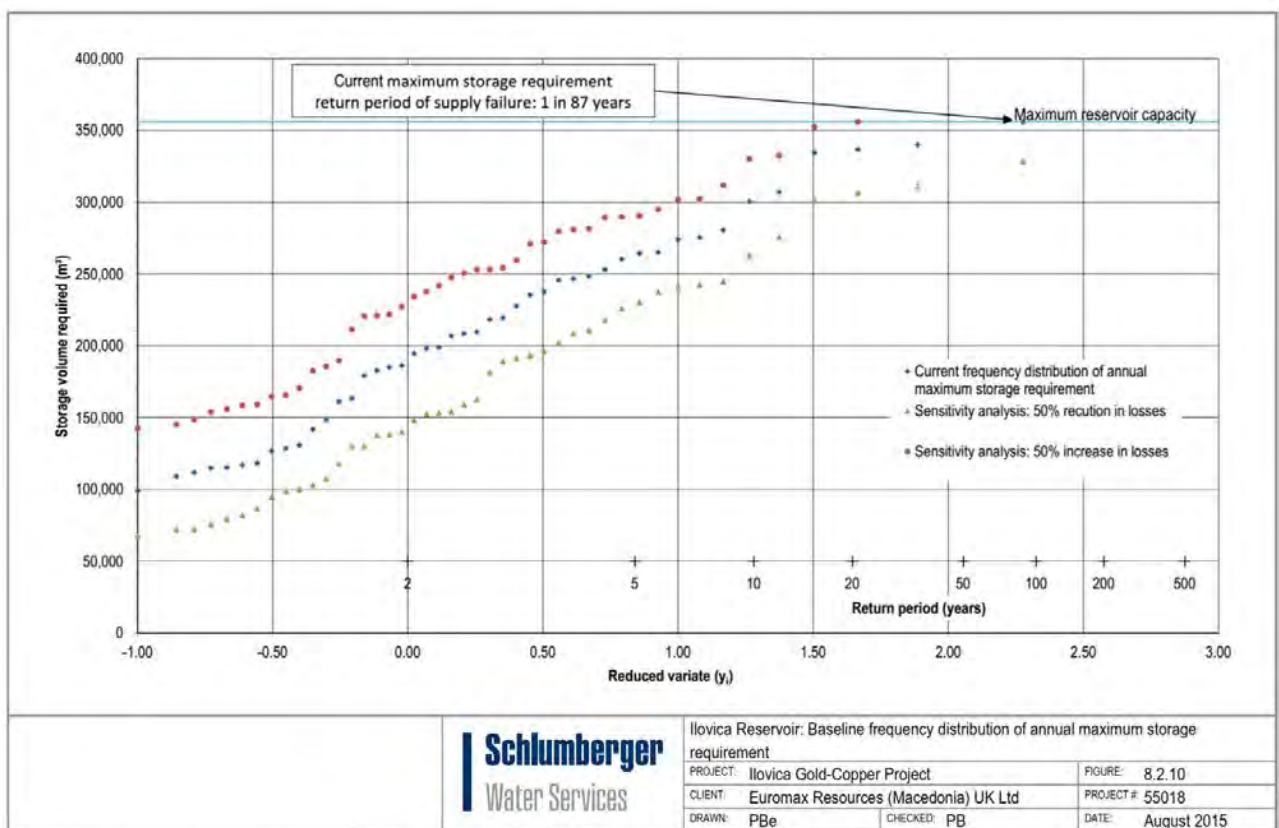
Reservoir Storage Yield Analyses

Reservoir storage yield analyses of the dam sites were carried out using the method of Parks and Gustard (1982)¹⁹. This method involves modelling the behaviour of the reservoir taking into account inflows, direct rainfall, evaporation, spills and releases. A frequency analysis is performed on the annual series of maximum storage requirements.

The analysis for the existing Ilovica reservoir used the present capacity of the reservoir (356,000 m³) and the maximum abstraction for agriculture and potable water supply in the period 2012 to 2014 (465,794 m³ in 2012). The reservoir was modelled using a 54 yr daily inflow series generated using the HEC-HMS rainfall run-off model.

The results for Ilovica reservoir under existing demand conditions (without the proposed mine project) are shown in Figure 18.36. The existing annual probability of failure (the reservoir running dry) is 0.0115. This is equivalent to an average return period of failure of once in 87 years.

Figure 18.36
Ilovica reservoir: Baseline frequency distribution of annual maximum storage requirement



The storage yield analyses for the proposed RDD and Mala Shtuka dam sites shown in Figure 18.37 and Figure 18.38 respectively, allow dam height and corresponding storage volumes to be estimated for given yields and return periods of failure.

¹⁹ Parks YP and Gustard A (1982) A reservoir storage yield analysis for arid and semiarid climates. In: Optimal Allocation of Water Resources (Proceedings of the Exeter Symposium, July 1982), IAHS Publ. No. 135.

Figure 18.37
RDD: Design storage-yield-reliability relationships

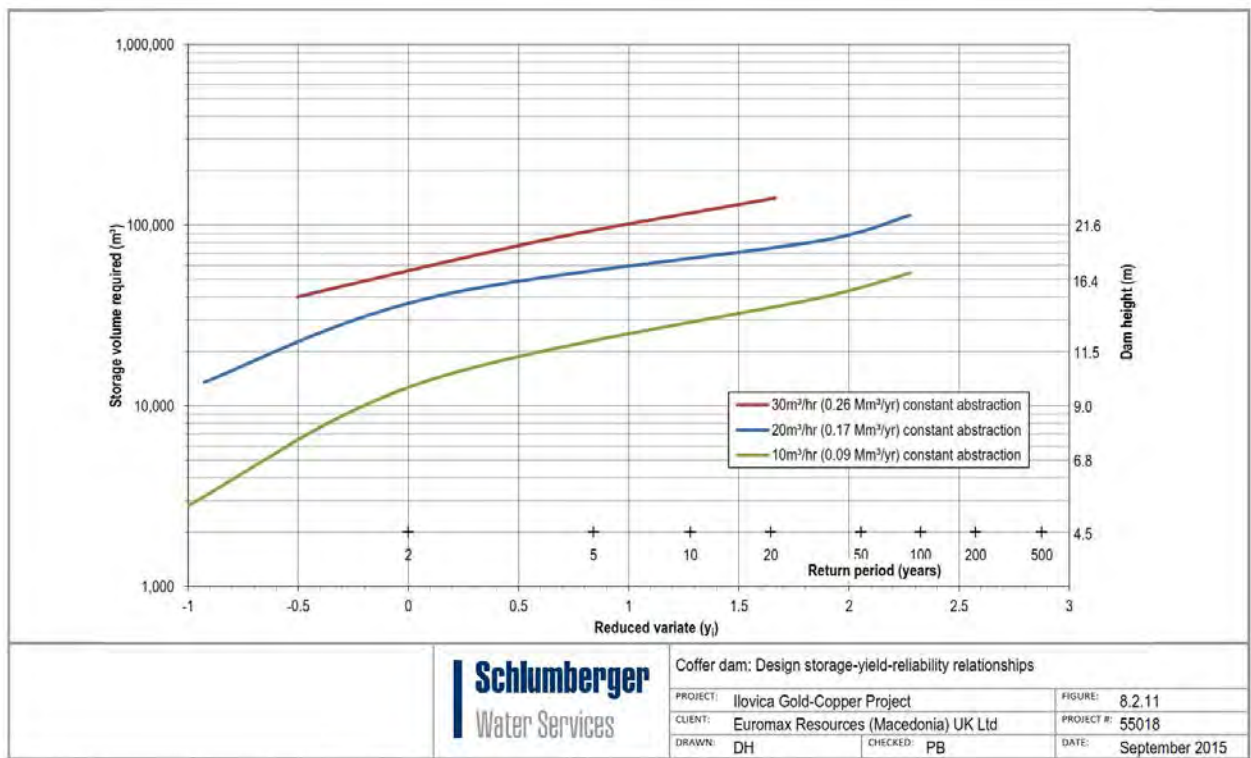
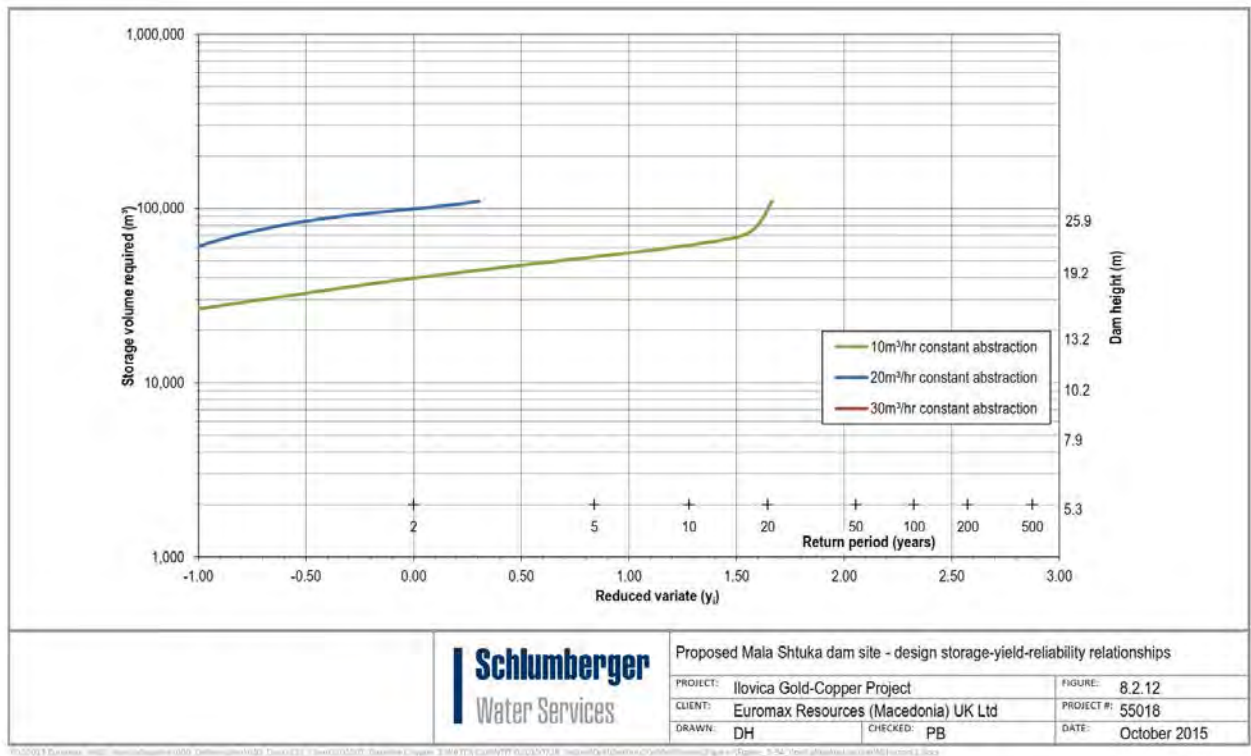


Figure 18.38
Proposed Mala Shtuka dam site – design storage-yield-reliability relationships



Design Flood Estimation

Effects of Snowmelt on Run-off

An assessment was made of the effect of snowmelt on run-off and the degree to which it should be taken into account in drainage design. Historical flood events on the Jazga River were analysed between 2000 and 2014 as recorded by daily spill volumes via Ilovica reservoir spillway estimated as a function of reservoir water level. The following observations were made:

- Snow melt has not played a significant role in causing flooding in the Jazga catchment in the period 2000-2014. Snow melt does however contribute to 'wetting up' the catchment and should a significant storm occur under these conditions then flooding could be significantly enhanced. Allowance should be made for wet antecedent catchment conditions when estimating floods due to rainfall.
- Long duration frontal rainfall events occur leading to saturation of the catchment. Should a significant storm occur under wet antecedent conditions then flooding could be significant.
- Intense summer / late spring storms are relatively common and have resulted in the four largest flood events as estimated by spill volume in the Jazga catchment over the period 2000-2014. The largest event recorded appears to have fallen under moderately wet antecedent conditions, emphasising their importance in affecting run-off generation.

It was concluded that estimation of design floods should assume wet antecedent conditions prior to the design event. Explicit allowance for snow melt in design flood estimation is unnecessary. Details of the assessment are presented in Golder and SWS (2015)²⁰.

100 yr Flood Lines around Ilovica Reservoir

A HEC-HMS single event rainfall run-off model based on the US Natural Resources Conservation Service run-off curve method was set up for the catchment draining to Ilovica reservoir as shown in Figure 18.39. The curve number was calibrated to the largest flood event to have occurred during the reservoir's history (2000-2014) (its causal rainfall was estimated to have a 20 yr return period) with both modelled and observed reservoir levels and spillway outflows shown in Figure 18.40.

The curve number derived from the above model calibration was then adjusted (as indicated in Figure 18.39) taking into account future changes in land cover resulting from the proposed mine development for design flood analysis, using the HEC-HMS model, applicable to the proposed mine scheme.

²⁰ Op cit

Figure 18.39
HEC-HMS model of the Ilovica reservoir catchment

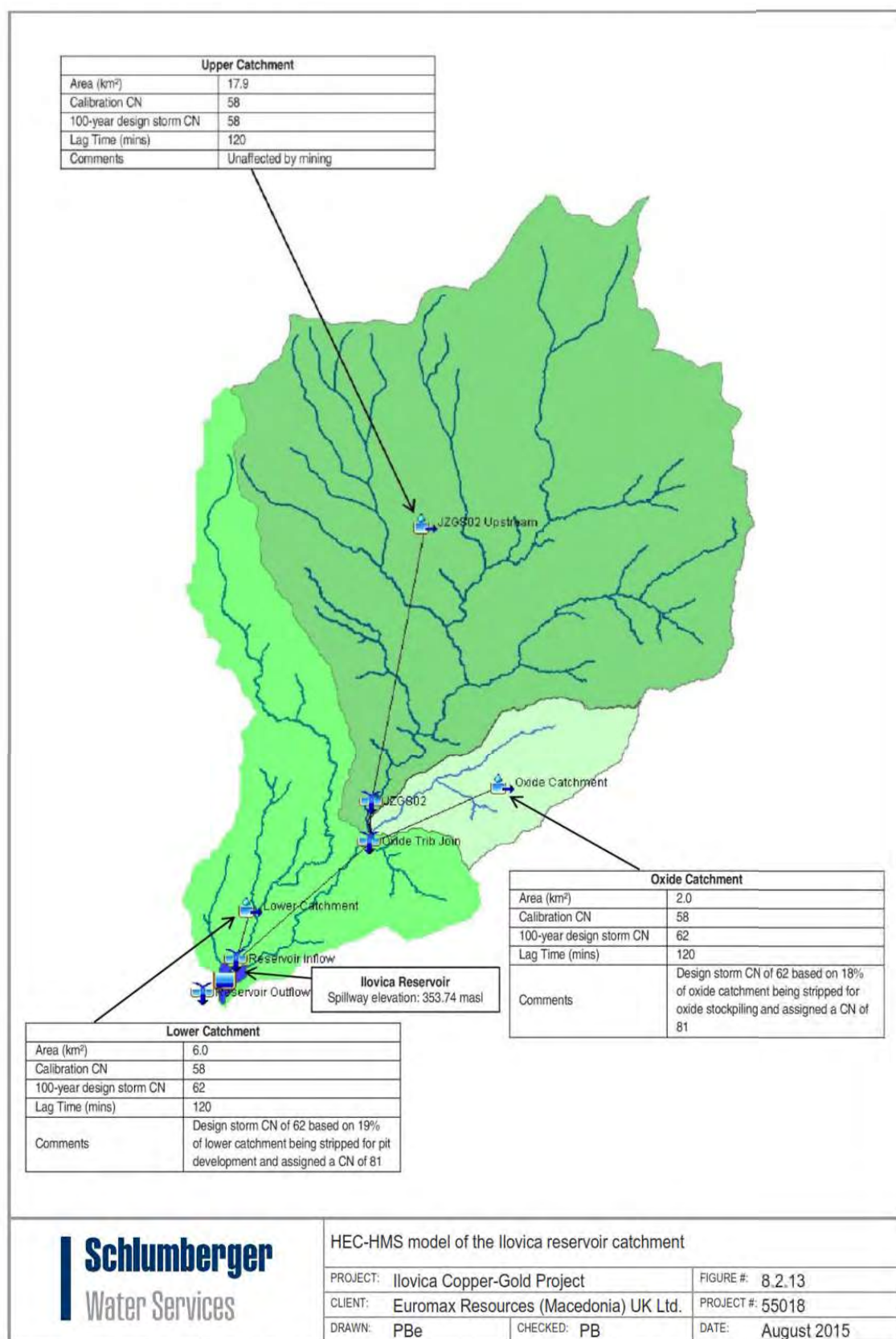
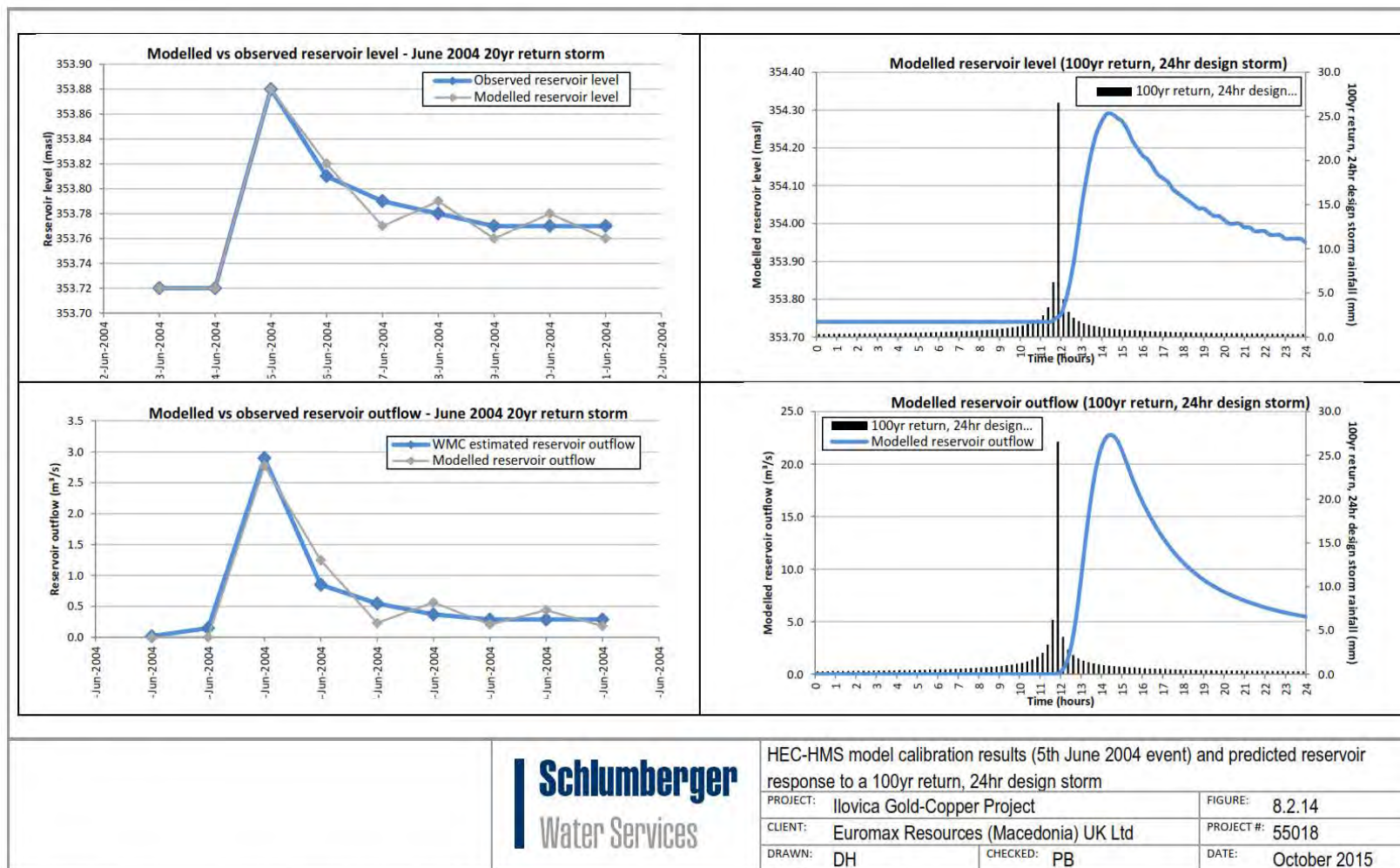


Figure 18.40

HEC-HMS model calibration results (5th June 2004 event) and predicted reservoir response to a 100 yr return, 24 hr design storm



The design (100 yr, 24 h) storm was selected from Table 5.6. The storm depth (109.0 mm) was distributed according to a symmetrical storm profile using the 'depth-duration-frequency method' (Haan, Barfield & Hayes, 1981)²¹. An aerial reduction factor (0.97) was calculated based on the catchment area and duration of the design storm and was applied to convert the point profile to an aerial profile. The model predicted a design inflow hydrograph with a peak flow of 22.8 m³/s. The inflow hydrograph was routed through the reservoir using the following rating for the 'Kruger' type spillway on Ilovica reservoir provided by the SPWMC:

$$Q = 1.86 B H^{(3/2)}$$

Where: Q is discharge (m³/s)
B is spillway length (30 m)
H is head over the spillway crest (m).

The peak 100 yr flood elevation in Ilovica reservoir was estimated to be 354.3 m AMSL. The modelled outflow discharges and levels for the design event at Ilovica reservoir are shown in Figure 18.40. Further details are presented in Golder and SWS (2015)²².

Design Flood Estimates on Jazga River

The HEC-HMS single event flood model described above was used to estimate the 100 yr and 500 yr peak flows at the following locations upstream on the Jazga River to inform the design of a culvert underneath the oxide stockpile:

- Gauging station JZGS02 on the Jazga River at the confluence of the 'oxide tributary'
- Gauging station JZGS04 on the 'oxide tributary' at the confluence of the Jazga River
- The Jazga River downstream of the confluence of the 'oxide tributary'.

Table 18.23 presents the design flood estimates.

Table 18.23 Design flood estimates			
Description	Jazga River at JZGS02	Oxide tributary	Jazga River downstream of the tributary/river confluence
Peak 100 yr flood flow (m ³ /s)	14.3	2.2	16.5
Peak 500 yr flood flow (m ³ /s)	24.3	3.5	27.8

Run-off Estimation in the Open Pit

The SCS Curve Number Method was used to estimate the volume of run-off generated by precipitation falling within the open pit on a daily time step. For a single curve number, the method calculates a unit run-off rate which varies depending upon (i) the depth of precipitation for the day, (ii) the total depth of precipitation for the preceding five days and (iii) the season. The unit run-off rate is then multiplied by the area of the open pit to produce a daily run-off flow.

²¹ Haan CT, Barfield BJ and Hayes JC (1981) Design hydrology and sedimentology for small catchments. Academic Press.

²² Op cit

A curve number of 76 was used for the open pit for LOM. Under 'normal' antecedent conditions, this produces the equivalent run-off coefficients of:

- 0.3 for a 24 h 5 yr storm (68.1 mm)
- 0.35 for a 24 h 10 yr storm (78.2 mm).

The run-off calculations were carried out in GoldSim which was used to extrapolate the open pit area over time based on the inputs defined in Table 18.24. It was assumed that any run-off generated outside of the pit area is routed through diversion channels so does not enter the pit.

The results (Table 18.24) show that annual run-off is likely to range from 25 500 m³/y (70 m³/d) in year -1 up to 131 400 m³/y (360 m³/d) in year 21. Peak run-off volumes for a 24 h, 10 yr storm range from 9 500 m³ to 26 000 m³.

Table 18.24 Open pit areas for run-off estimation and run-off estimates				
Year	Description	Area at end of year (ha)	Run-off 24 h, 10 yr storm (m ³)	Mean annual run-off (m ³ /d)
-1	Pre-strip	34.8	9 515	70
2	Starter pit	56.9	15 584	210
7	Pushback 1	66.9	18 309	270
21	Final pit	94.8	25 944	360

Run-off Estimation for Storm Water and Sediment Control Dam Sizing

The storm water dams are provided with a silt trap on the upstream side. The silt traps take out the coarse fraction of the sediment and the remaining suspended solids carry over into the dam. The suspended solids can be expected to build up in the dam over time, with augmentation by wind-blown sediment. The dams are therefore configured with a suitable low point for periodic desludging by means of a sludge pump.

Mining Infrastructure Terraces Area

This area is provided with a storm water dam to collect contact water from the terraces. Non-contact water from upstream of the terraces is diverted to a point downstream of the dam through surface drains. The operating parameters of the dam are as follows:

Catchment area:	10.0 hectares
Estimated 1:100 year x 24 h inflow (design capacity):	7.3 Megalitres

For further details, refer to Section 18.1 of this report.

Oxide Ore Stockpile Storm Water Dam

The top of the oxide ore stockpile will be graded to drain into the pit. Clean water from upstream of the stockpile will be taken under the stockpile in a culvert, which discharges into the Jazga River at a point downstream of the storm water dam. The dam therefore collects water only from the face of the South embankment of the stockpile. The operating parameters of the dam are as follows:

Catchment area:	2.5 hectares
Estimated 1:100 year x 24 h inflow (design capacity):	1.4 Megalitres

For further details, refer to Section 18.1 of this report.

TMF Embankment Storm Water Dam

The catchment area of the dam includes the face of the wall of the TMF and approximately 1.6 km of haul road. The dam also collects seepage which is piped into the dam from below the wall of the TMF. The operating parameters of the dam are as follows:

Catchment area:	95.9 hectares
Estimated 1:100 year x 24 h inflow (design capacity):	53.3 Megalitres

The TMF diversion canal and other non-contact diversion drains discharge into the Shtuka River at a point downstream of the storm water dam.

For further details, refer to Section 18.1 of this report.

18.3.2 Hydrogeology

18.3.2.1 Introduction

Aims and Objectives

A hydrogeological investigation has been carried out to support the FS and ESIA. This section focuses on presenting hydrogeological information and analyses for use in the engineering design of the project. Further information on the hydrogeology of the project area is presented in the ESIA Baseline Report (Golder and SWS, in prep.)²³.

The aims and objectives of the hydrogeological investigation were as follows:

- To determine the hydrogeological characteristics of the in situ rocks into which the mine and the TMF will be constructed and of the surrounding area which could be potentially affected by mining operations. Specific objectives included:
 - Characterisation of groundwater occurrence, storage and flow
 - Determination of the hydraulic properties of rocks in the mine and TMF areas
- To identify and characterise those aspects of the groundwater environment that need to be taken into account in planning the construction and operation of the mine and the TMF. Specific objectives included:
 - Estimation of groundwater inflows to the open pit
 - Estimation of the effect on groundwater of emplacement of low permeability tailings and the tailings embankment in the Shtuka valley

²³ Op. cit.

- Identification of the presence / distribution of springs and their significance in relation to the mine and TMF
- Assessment of the presence and significance of fractures and faults
- To identify the way in which the mining operation and its associated activities could potentially affect the groundwater environment and to determine the magnitude of potential impacts of mining on key ecological and human receptors. Specific objectives included:
 - Determination of the likelihood and extent of contamination of groundwater from the TMF
 - Determination of the likelihood and extent of contamination of groundwater from the oxide stockpile.

This section describes those aspects of the hydrogeological investigation that are pertinent to the construction, operation and closure of the open pit, TMF and associated mine infrastructure. Reference is made to ESIA studies for further information on potential impacts to key receptors and particularly in respect of potential effects associated with proposed mine closure.

18.3.2.2 Investigation Methodology and Data Sources

Hydrogeological information has been acquired for the three main areas in which mining operations will be undertaken: the open pit, the upper plant site and the TMF. Data were also acquired in locations outside (mainly downgradient) of the main mining areas that could potentially be affected by mining operations.

The scope of the hydrogeological investigation conducted by SWS included:

- ESIA baseline studies conducted by SWS (September 2013 – May 2015);
 - Review of existing groundwater data;
 - Establishment of a groundwater monitoring network;
 - Evaluation of baseline groundwater conditions in and around the proposed open pit, the TMF and the upper plant site, in and around Ilovica and Shtuka villages and in irrigated agricultural areas on the Strumica plain.
- Hydrogeological site investigation of the open pit and adjacent areas (May – July 2015);
 - Drilling (coring at HQ size) and injection packer (Lugeon) testing of investigation drill holes in and around the open pit;
 - Installation of multi-level vibrating wire piezometers in drill holes within the open pit;
 - Installation of standpipe piezometers in the open pit, the upper plant site, and the TMF area.

Hydrogeological assessment of the Ilovica mining project has also drawn on the following associated investigations:

- Geotechnical drilling in the open pit (Euromax Resources, February – July 2015);
- Geotechnical investigation of the upper plant site (Amec Foster Wheeler, June – July 2015);
- Geotechnical investigation of the TMF (Golder and Department of Civil Engineering of the CMU in Shtip, June – September 2015).
- Geophysical survey within the footprint of the TMF embankment (CMU, October – November 2015).

The data acquired from these various investigation programmes are being used by SWS to develop numerical 3D groundwater flow and contaminant transport models of the project area. At the time of writing, modelling work is still in progress. The models are being used to assess likely dewatering requirements for the open pit, and to evaluate the potential effects of development and operation of the mine and TMF on key receptors (as part of ESIA studies).

18.3.2.3 Groundwater Characterisation

Overview

The baseline description of the hydrogeology of the project area has been documented in the ESIA Baseline Report (Golder and SWS, in prep.)²⁴.

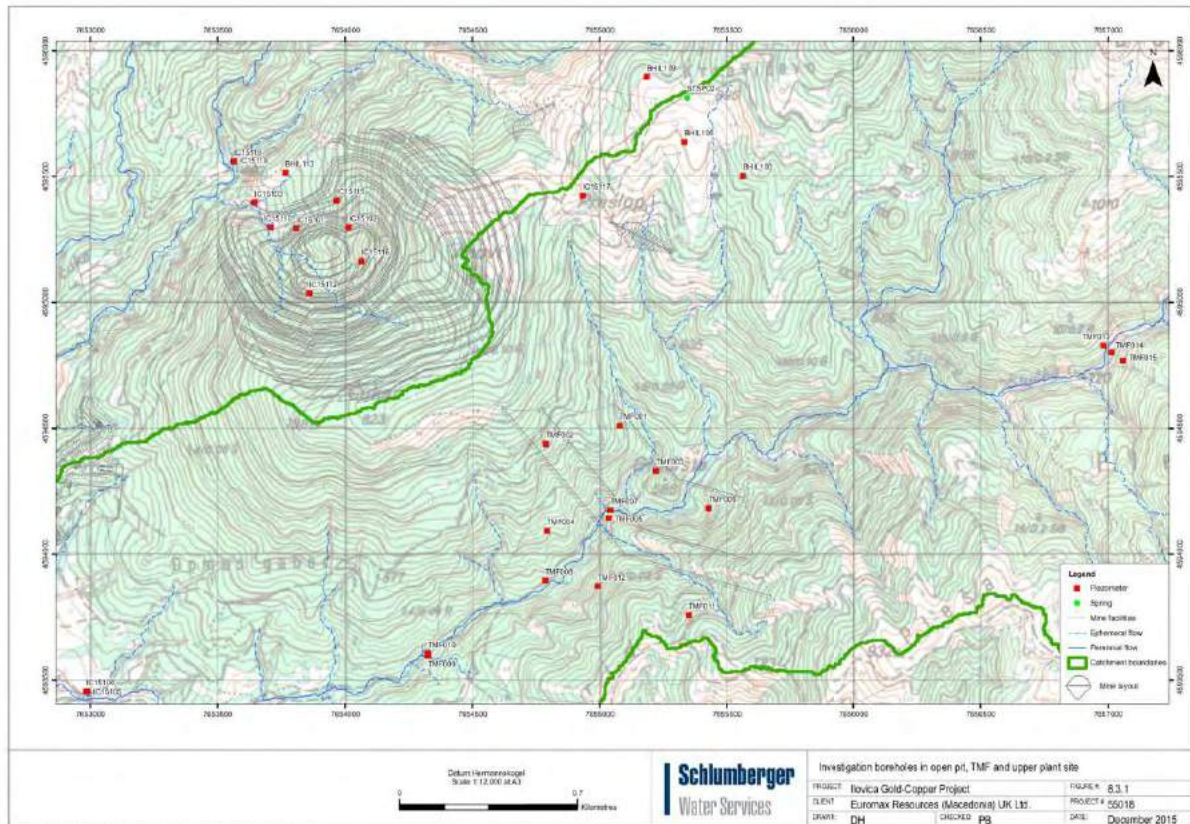
The following section summarises key groundwater-related information that is relevant to planning and operation of the mine and TMF.

Hydraulic Characteristics

Permeability tests (single packer injection – Lugeon – tests) have been conducted under various hydrogeological and geotechnical investigation programmes in boreholes in and around the open pit in the Jazga valley and within the footprint of the TMF embankment and on RDD site in the Shtuka valley. Borehole locations are shown in Figure 18.41.

²⁴ Op. cit.

Figure 18.41
Investigation boreholes in open pit, TMF and upper plant site



The results of tests conducted in 17 drill holes within the open pit including data for tests conducted in drill hole IC15117 between the open pit and the upper plant site, and drill hole IC15118 in the granite adjacent to the pit entrance are presented graphically in Figure 18.42. The same data are also presented as a cross plot in Figure 18.43 showing the relationship between permeability values and depth below ground surface. The main observations are as follows:

- Permeability values are low to very low (or negligible) in each of the three main rock types in which tests have been conducted (dacite, granodiorite, granite).
- The data show a general decrease in value with increasing depth below ground surface.
- Permeability values show a greater correlation to alteration state than to particular rock types. Within the shallower oxide zone, permeability values are generally in the range 1×10^{-6} to 1×10^{-8} m/s. In the underlying sulphide zone, permeability values reduce to around 1×10^{-7} to 1×10^{-9} m/s.
- Permeability values in the granite immediately outside of the deposit (IC15117, IC15118) are consistent with values recorded in the upper, oxidised, layers of the deposit, i.e. around 1×10^{-6} to 1×10^{-7} m/s. This is as expected given the relatively shallow depth of these drill holes.

Figure 18.42
Packer test results in the open pit

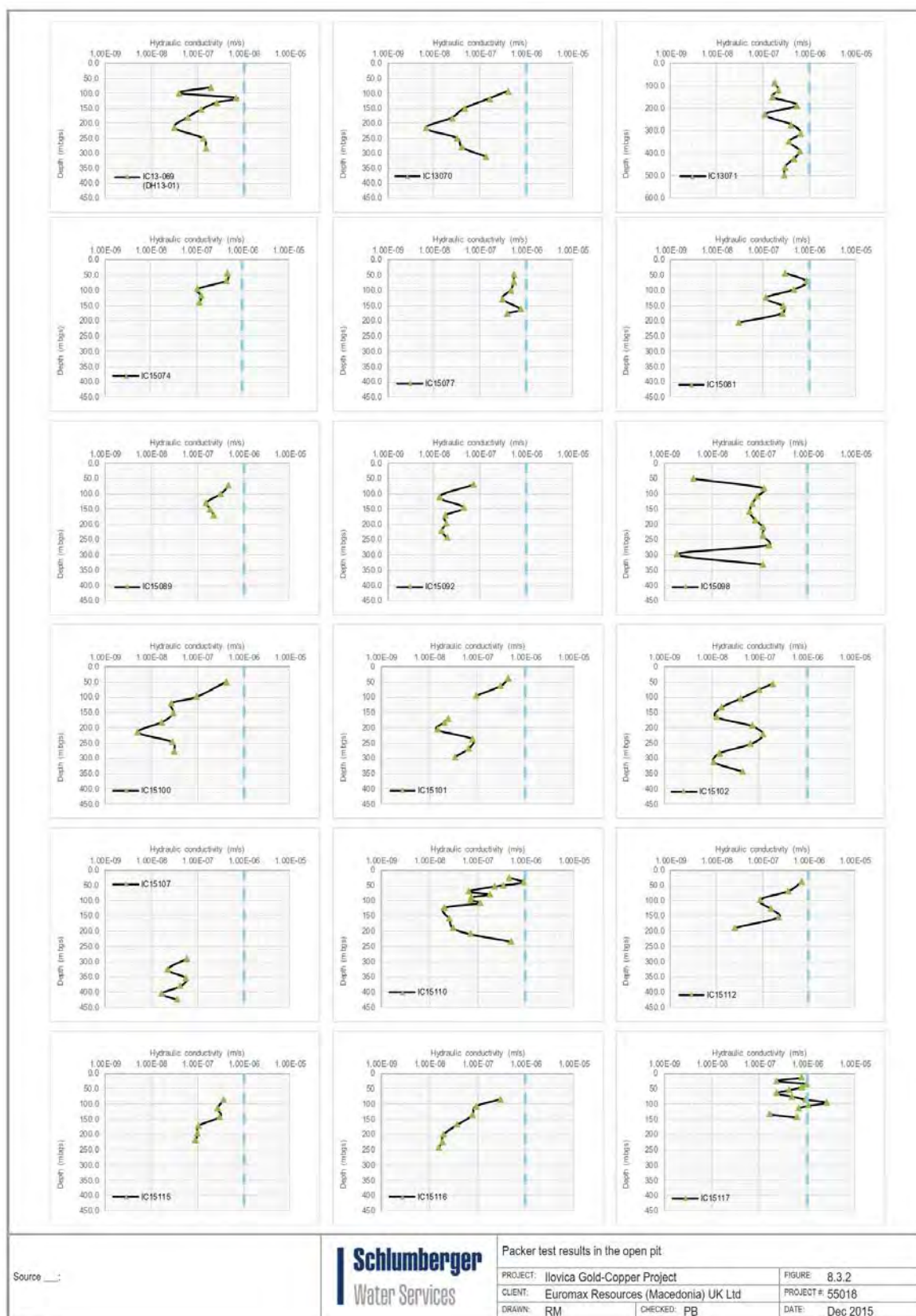
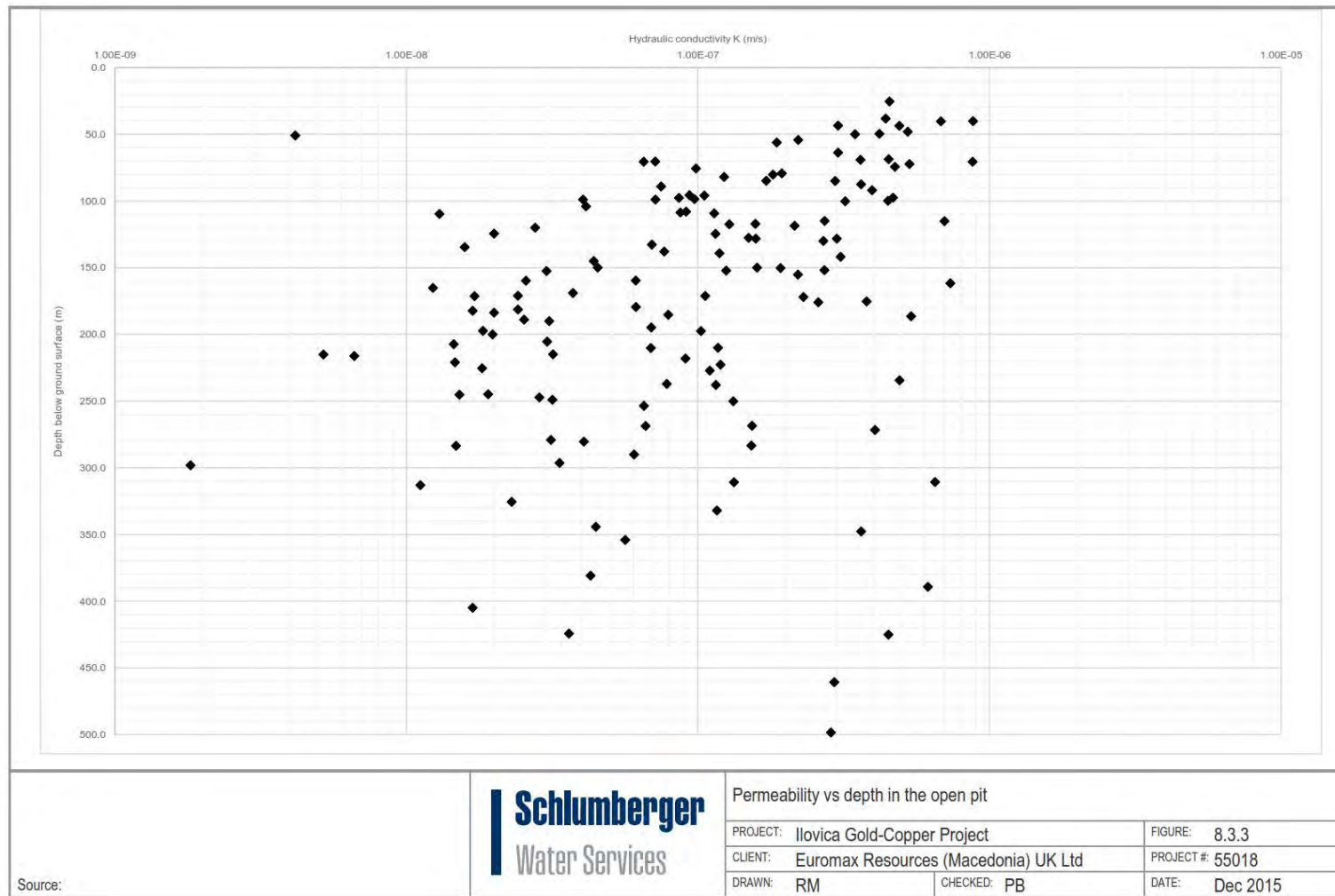


Figure 18.43
Permeability vs depth in the open pit



Analysis of water level measurements taken during packer testing (e.g. IC13069, IC15089, IC15098) indicates the probable existence of preferential flow zones at various depths and locations within the deposit. The significant water level changes recorded are likely to have occurred as boreholes have intersected open and transmissive fractures. Such features are likely to yield water when intersected during mine excavation.

The results of tests conducted in 14 drill holes within the footprint of the TMF are presented graphically in Figure 18.44, and a cross plot showing the relationship between permeability values and depth below ground surface is shown in Figure 18.45. The target depths for TMF investigation boreholes were 30 m, 60 m or 120 m, although TMF005 in the middle of the embankment alignment was extended to 200 m depth. All of the tests were conducted in fractured granite. The results are summarised as follows:

- The permeability values recorded in the granite underlying the TMF are low, generally in the range 1×10^{-6} to 1×10^{-8} m/s; these values are comparable to those recorded in the upper (oxide) layers of the porphyry deposit in the open pit area.
- Figure 18.45 indicates a reduction in permeability with increasing depth below ground surface (as also observed in the open pit). It is noted that the TMF investigation boreholes are relatively shallow and only penetrate the upper 30 m - 120 m (200 m) of the granite.
- Importantly, whilst the reported permeability values appear to be similar to those recorded in the open pit, observations and anecdotal evidence acquired during visits to site during drilling and testing indicate that the recorded values may under estimate the significance of fracture permeability in the near-surface granite:
 - Packer tests were attempted but abandoned in the shallow granite (approx. 0 – 30 m depth) at TMF005, TMF009 and TMF010 due to an inability to properly seat the packer in highly fractured rock.
 - While conducting a test at approx. 40 m depth in TMF005, water was observed to return to surface several metres away from the drill rig, indicating an open, transmissive fracture system in the shallow granite.

It is apparent that the TMF will be constructed over highly fractured rock that has a permeability which may be several orders of magnitude greater than the tailings themselves. There will be significant potential for vertical drainage of leachate into the underlying granite. Along the main axis of the Shtuka valley, the base of the tailings will be in direct contact with the fractured granite aquifer.

Figure 18.44
Packer test results in the TMF

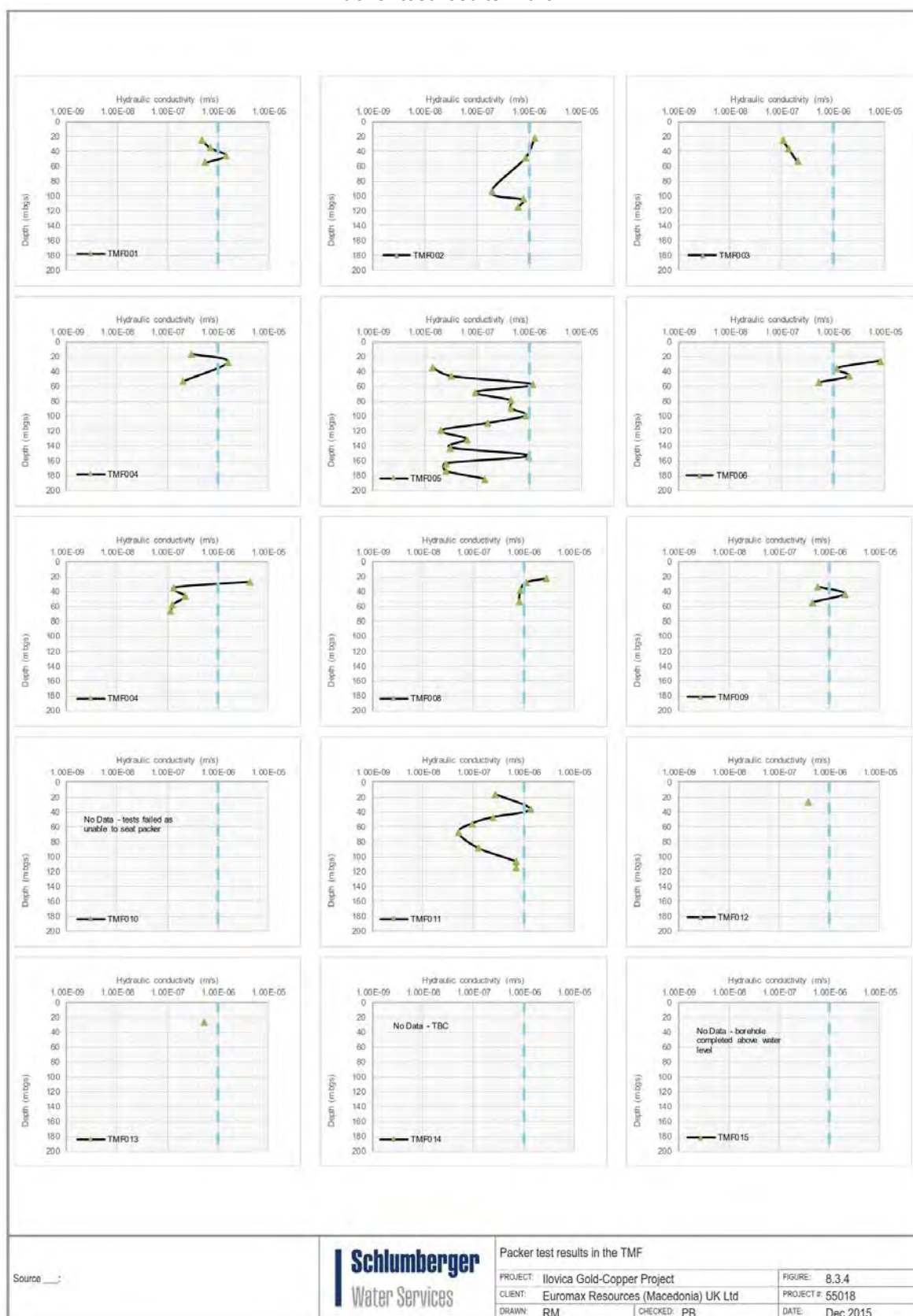
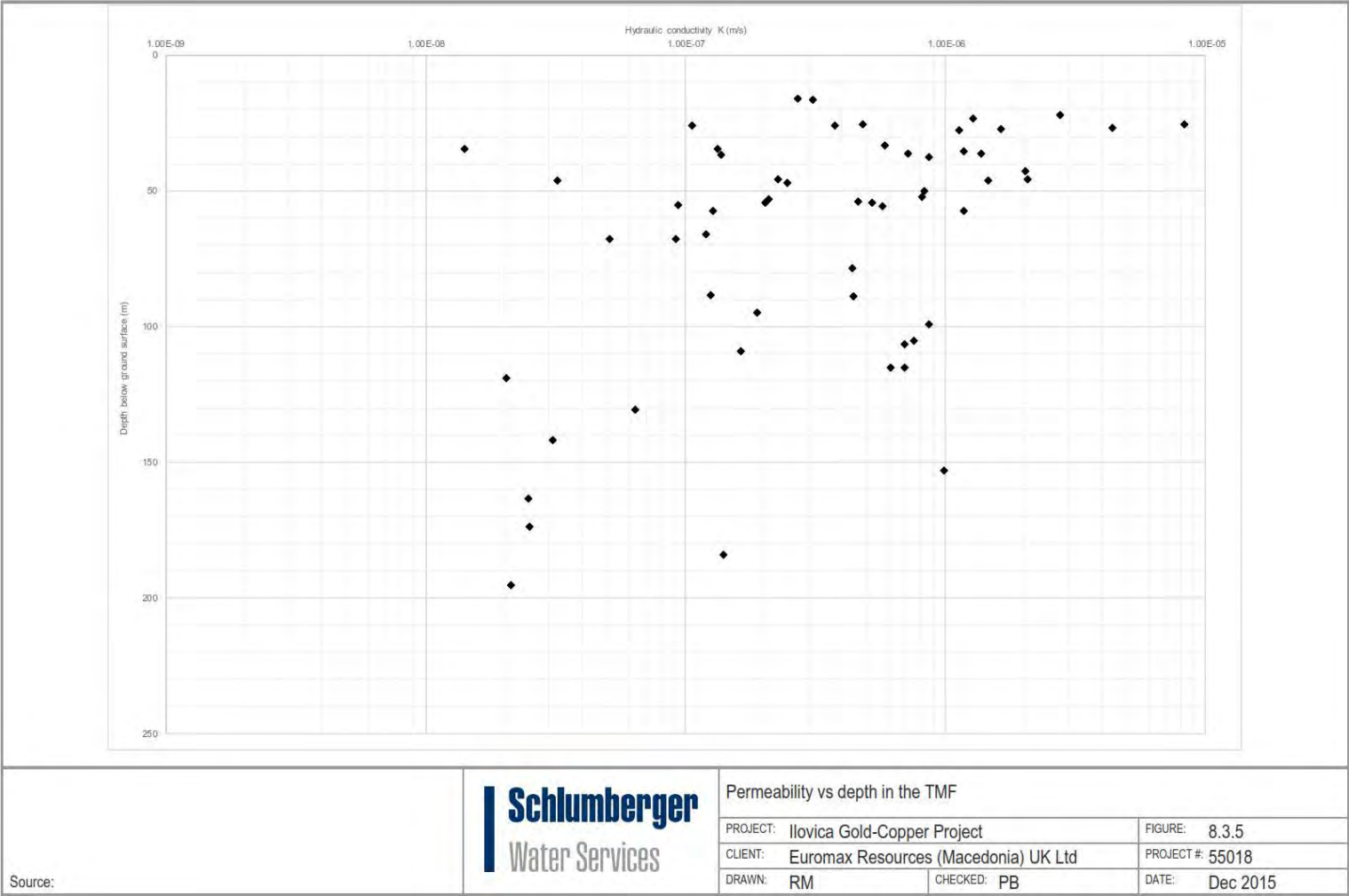


Figure 18.45
Permeability vs depth in the TMF



Groundwater Occurrence, Levels and Flow Directions

The locations of groundwater monitoring points in the open pit, upper plant site and TMF are shown in Figure 5.4. Baseline depth to groundwater and groundwater elevation contours in each of the three locations are shown in Figure 18.46 and Figure 18.47.

Figure 18.46
Contours of depth to groundwater level for village wells, proposed open pit, plant area and TMF boreholes measured in July 2015

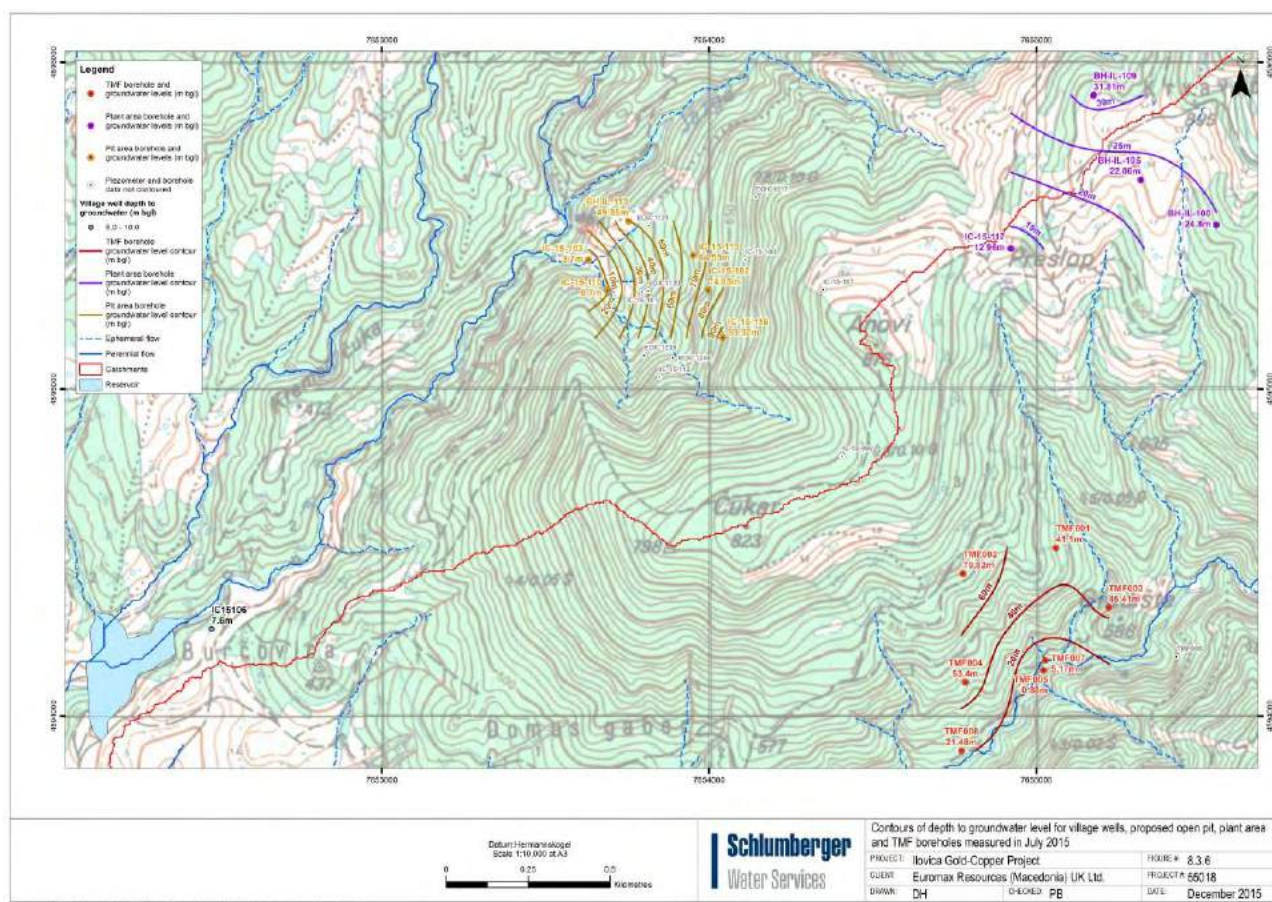
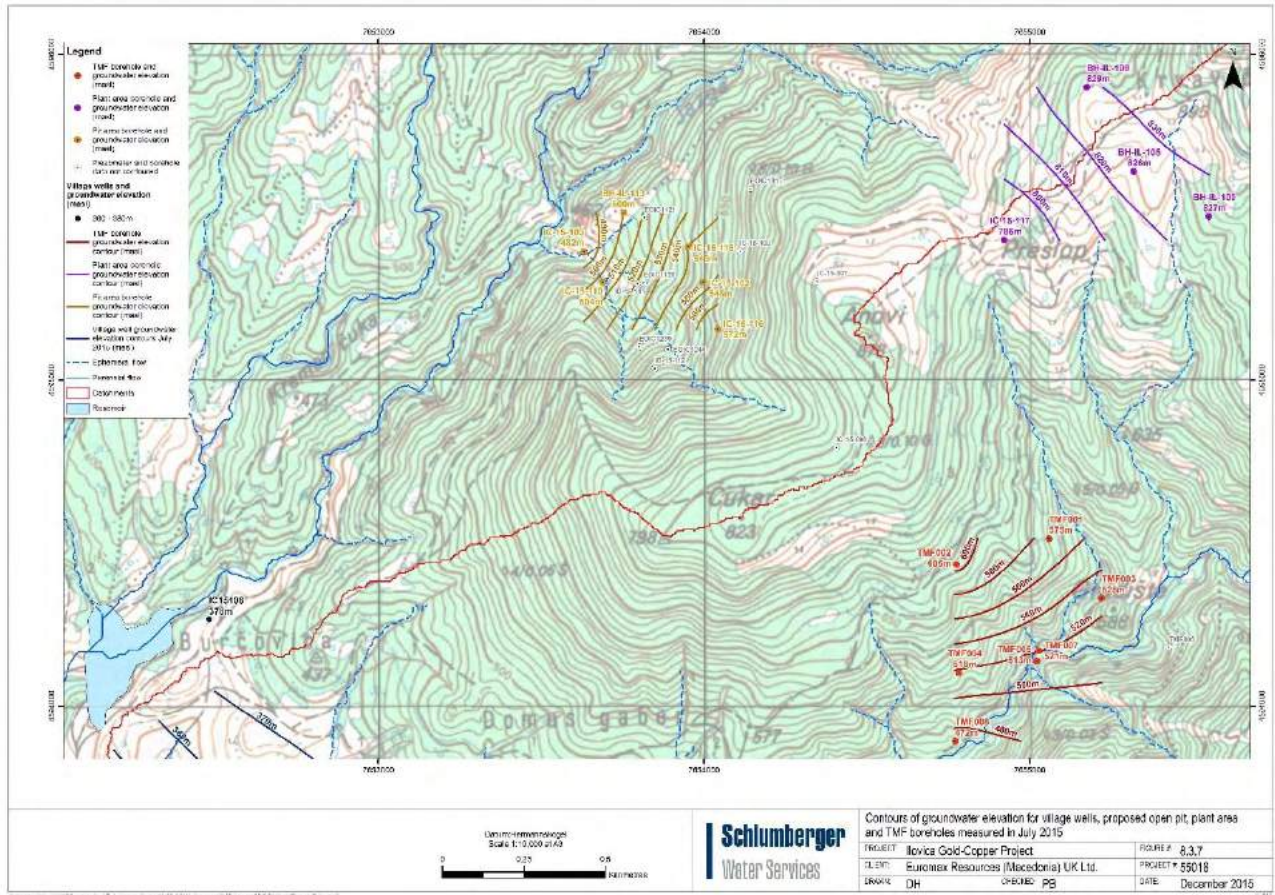


Figure 18.47

Contours of groundwater elevation for village wells, proposed open pit, plant area and TMF boreholes measured in July 2015

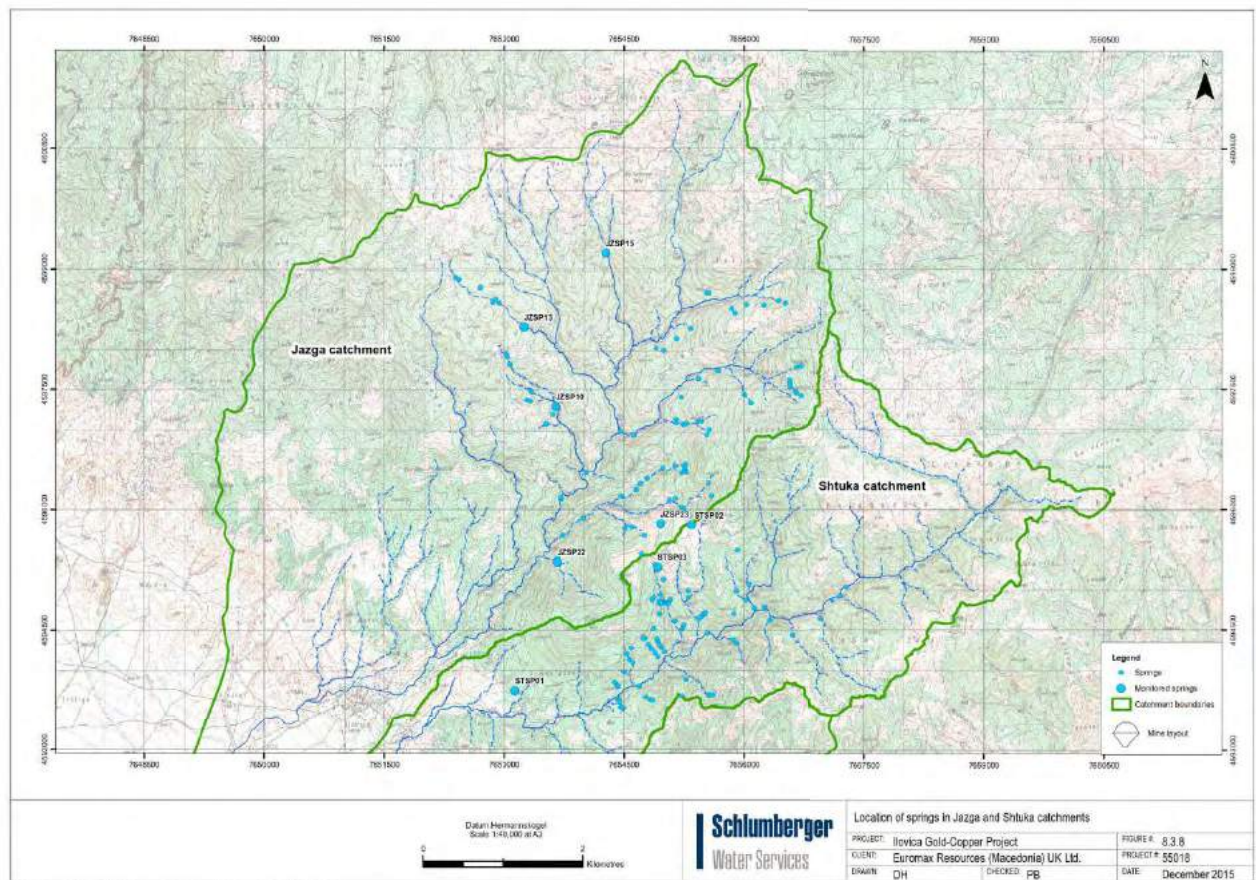


Springs

Springs and seepages have been identified throughout the upper reaches of the Jazga and Shtuka catchments (Figure 18.48).

There is no single geological control on the distribution of springs and seepages. Those that have been identified at or close to the bottom of the main river valleys may represent groundwater discharge from the fractured granite. There are also numerous minor springs and seepages on the valley sides, e.g. as observed along the axis of the TMF embankment, which have shallow origins and within the superficial, weathered regolith above the regional water table.

Figure 18.48
Locations of springs in Jazga and Shtuka catchments



Jazga Catchment and Open Pit

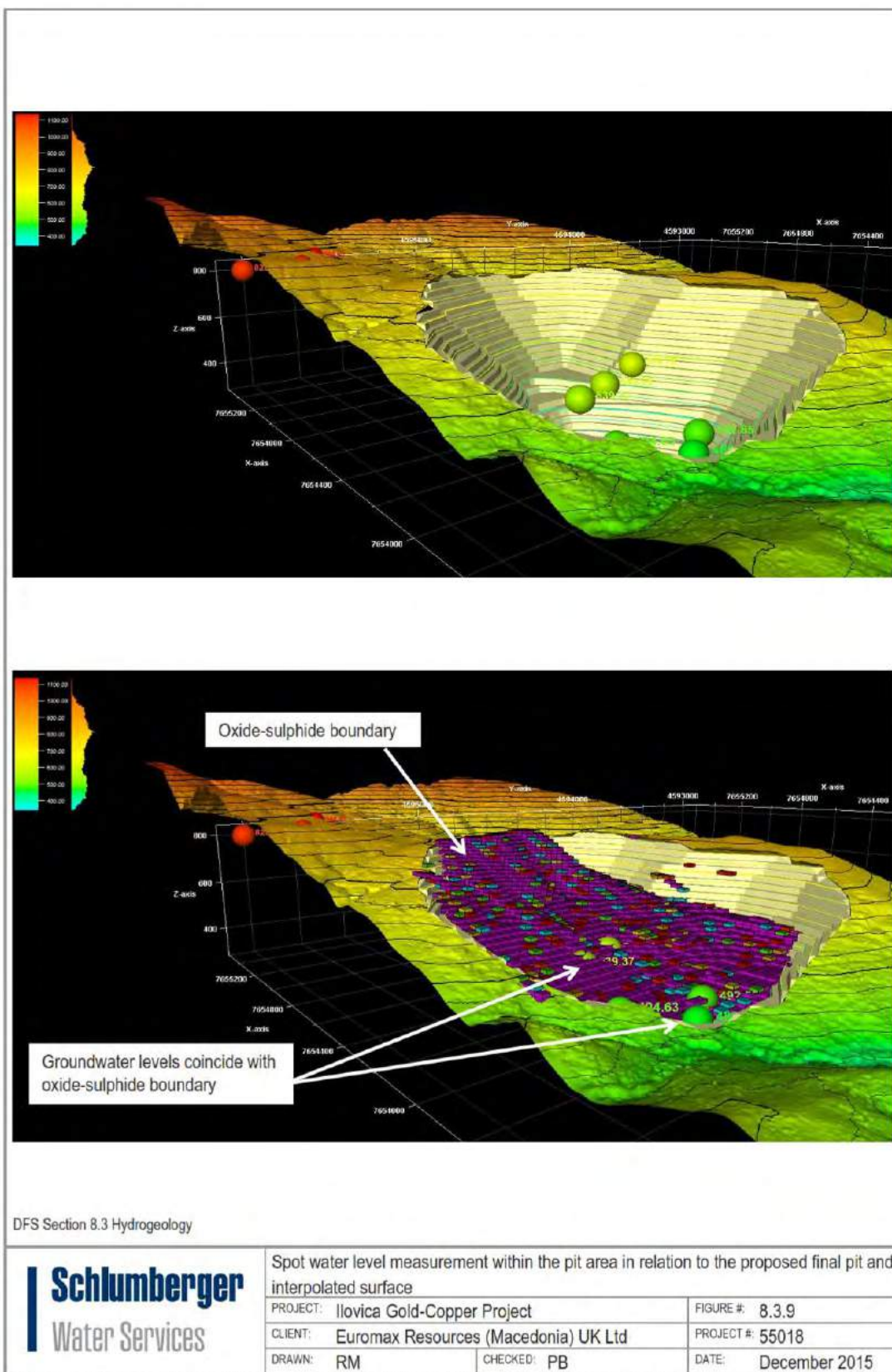
In the absence of any significant intergranular porosity in any of the project rock types, groundwater occurrence and flow are wholly controlled by the degree and distribution of fracturing that occurs within the porphyry deposit or in the surrounding granite host rock. Whilst there is evidence in drill core that most of the deposit rocks are quite highly fractured, most fractures are infilled – with calcite, clay and/or other minerals – and present little or no effective pathway for groundwater flow, which is reflected in the very low permeability values recorded in packer test results.

There is a hydraulic gradient across the open pit, from approximately 620 m - 650 m AMSL under higher ground in the northeast/east to around 475 m - 500 m AMSL in the Jazga river valley on the western edge of the deposit. The observed groundwater levels correspond approximately with the elevation of the boundary between the oxide zone and the sulphide zone as shown in Figure 18.49. This contact zone is believed to be the main horizon in which groundwater occurs and in which groundwater flows occur across the deposit. The unsaturated zone above the oxide-sulphide contact is fractured and open to infiltration of rainfall recharge, whilst below the contact zone open fractures are almost absent and the rock comprises a saturated but mostly inactive groundwater zone.

Shallow piezometers in the granite underlying the upper plant site indicate a NNE to SSW hydraulic gradient, with groundwater flow occurring from higher areas towards the open pit.

Figure 18.49

Spot water level measurement within the pit area in relation to the proposed final pit and interpolated surface



Shtuka Catchment and TMF

In the Shtuka valley, the fractured granite comprises a locally extensive minor aquifer. Groundwater flow is towards the Shtuka River and its main tributaries which form the main ground water discharge zone for the Shtuka catchment. The main axis of the valley is believed to be faulted and forms a highly conductive pathway for groundwater flow. This is a key control on both surface water and groundwater flow through and out of the upland catchment.

The piezometer installed in TMF014 is artesian, with a head above ground level of more than 1.5 m, indicating an upward hydraulic gradient at the RDD site.

A downward gradient is indicated by the pair of piezometers (TMF009/TMF010) at the downstream end of the TMF embankment.

The catchment is characterised by steep slopes and deeply incised stream valleys which means that the depth to the water table is highly variable across the area; groundwater is at or within a few metres of ground surface along the main axis of the Shtuka river valley. Moving away from the river, the depth to water increases rapidly; the depth to water at TMF002 on the north side of the TMF embankment is approximately 70 m, while in the south, at TMF011 near the divide with the neighbouring Sushica catchment, depth to water is close to 100 m. There is clear evidence in all of the TMF geotechnical investigation boreholes of active groundwater movement within the fractured unsaturated zone.

18.3.2.4 Effect of Mining Operations on Groundwater

Pit Dewatering

The potential volumes of groundwater inflow into the open pit at key stages of mine operation have been estimated from the groundwater model. The results are shown in Table 18.25.

Table 18.25 Estimated groundwater inflow to the open pit over pit life			
Pit stage	Year	Mean annual inflow (Mm³)	Mean daily inflow (m³)
Pre-strip	-1	0.31	850
Starter pit	1-2	0.40	1 100
Pushback	3-7	0.60	1 650
Final pit	8-21	0.98	2 700

Groundwater inflows to the open pit are likely to occur as discrete seepages through the pit walls as water bearing fractures are exposed. It will not be possible to reliably predict where such inflows will occur and so control will need to be based on implementation of water control measures during mining.

In-pit water control measures should not be required to manage groundwater inflows. Pit dewatering pumps were sized primarily on the basis of predicted daily storm rainfall run-off volumes given in Table 18.24.

Given the very low permeability of the deposit it is unlikely to be practical to dewater the deposit with boreholes. At the time of writing, consideration is being given to whether there may be benefit in installing

shallow dewatering boreholes in the upper plant site area to partially intercept groundwater flow towards the open pit.

Effect of Mining on Groundwater Levels

Figure 18.50 and Figure 18.51 present modelled groundwater levels before mining (Year -1) and at the end of pit development (Year 21).

By the final year of pit operation (Year 21), groundwater levels will be drawn down by virtue of sump dewatering to just below the pit floor at 260 m AMSL. This is equivalent to ground surface elevation of the Strumica plain just south of Ilovica and Shtuka villages. However, owing to the very low permeability of the surrounding granite host rock, the extent of the cone of depression caused by lowering groundwater levels within the pit is likely to be very limited.

No significant drawdown effects are predicted at receptors in Ilovica or Shtuka villages, or further down gradient in the Strumica valley.

A reduction in stream flow rates is likely to occur in the Jazga River and the 'oxide' tributary stream during mine operation. A similar reduction in flow in the Shtuka River resulting from pit dewatering is not predicted.

Figure 18.50
Modelled groundwater head contours for mine year -1

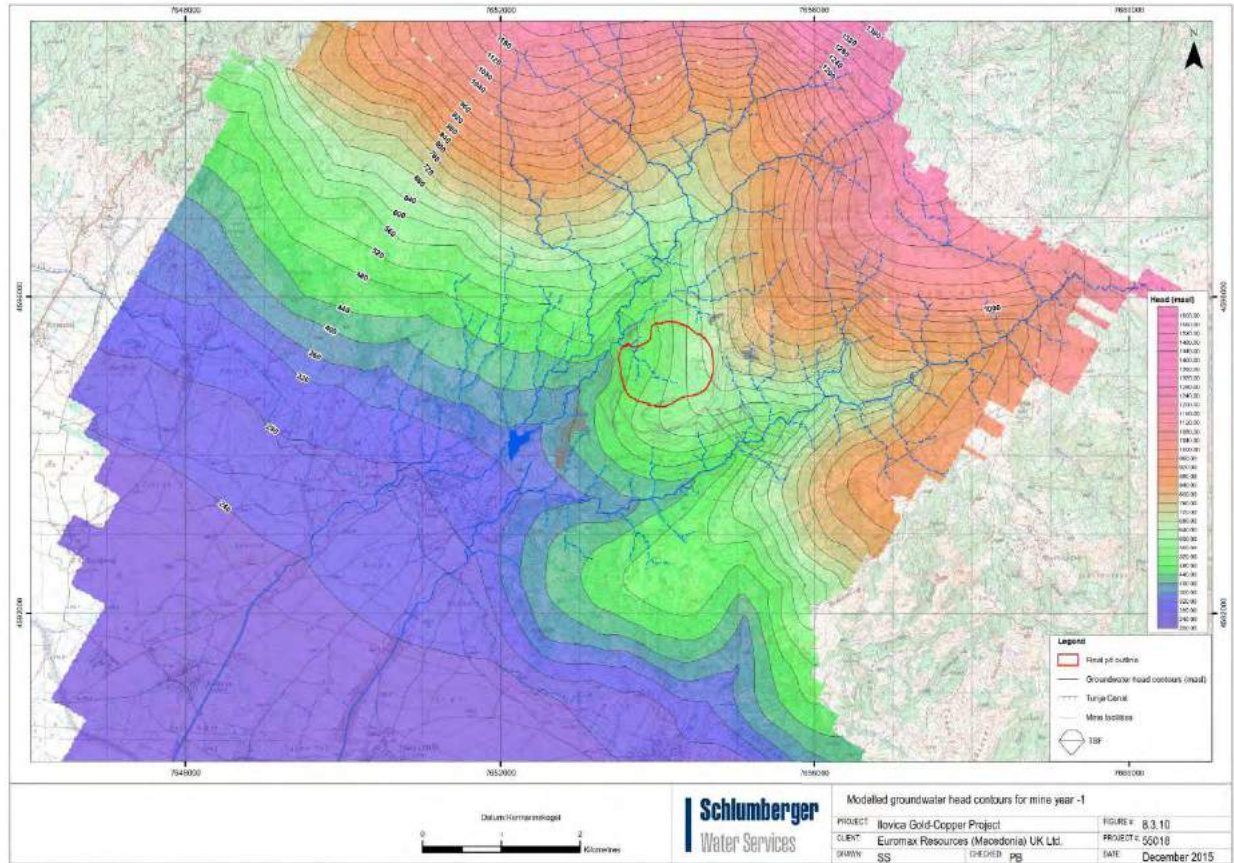
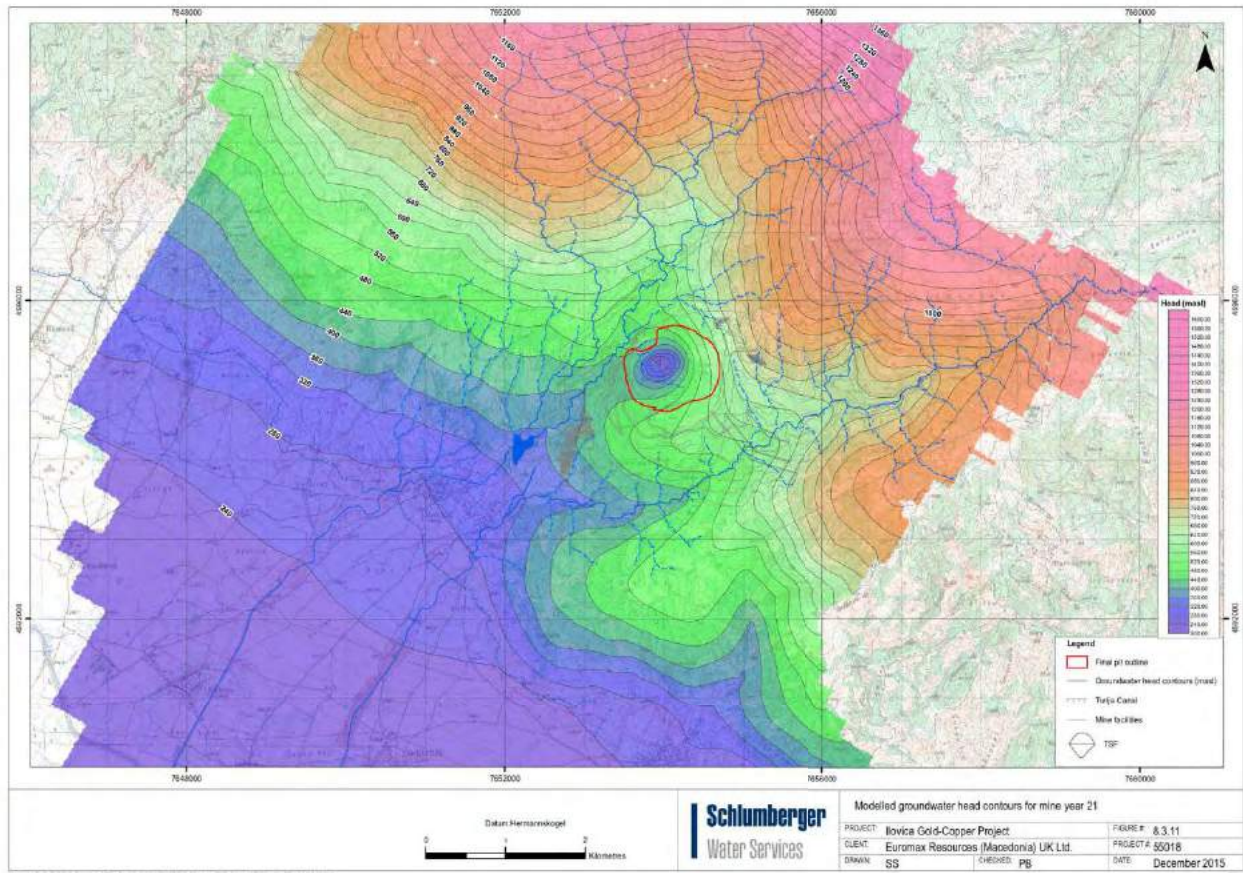


Figure 18.51
Modelled groundwater head contours for mine year 21



Construction and Operation of the TMF

Under current, pre-mining conditions, groundwater discharges as baseflow to the Shtuka River and its main tributaries. Under dry conditions, usually during summer months, the river loses some flow to the highly fractured rock underlying the main stream channel.

Deposition of low permeability tailings material within the river valley, and in the river channel in particular, will remove an important pathway by which groundwater is able to leave the upper Shtuka catchment. Current conceptual thinking suggests that the following may occur due to emplacement of the TMF:

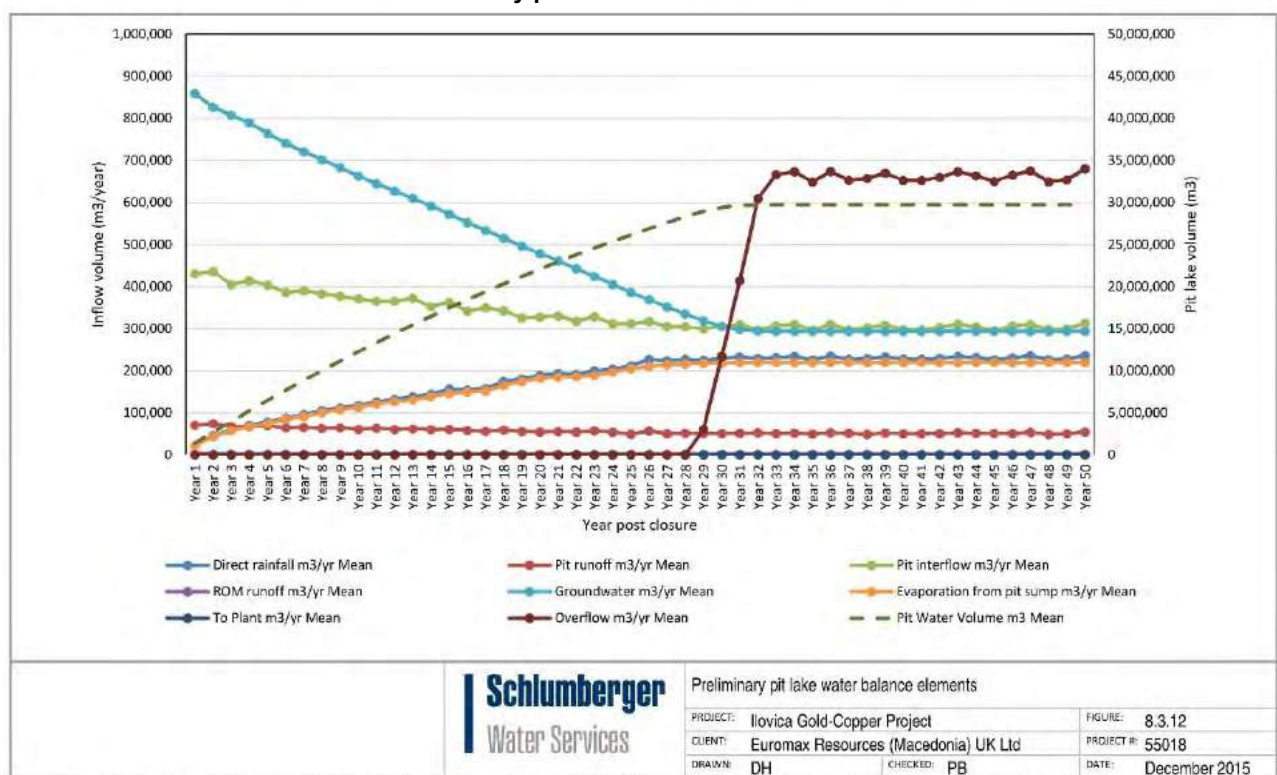
- As the body of tailings grows, groundwater that would otherwise discharge as baseflow in the Shtuka River will become impounded against the upstream sides of the tailings deposit. Groundwater levels may therefore rise within the highly fractured, near-surface layers of the granite.
- During the initial period before the tailings become fully compacted (years 1-2) there is a possibility that upward groundwater flow may occur through the tailings themselves.
- Flow will occur either laterally and/or vertically along the contact between the fractured granite and the underside of the tailings as groundwater tries to find a new discharge point.
- Groundwater may discharge as seepage over the edge of the tailings deposit. This is most likely to occur around the upstream perimeter of the deposit. There may also be potential for groundwater seepage to occur around sides of the tailings embankment.

At the time of writing groundwater modelling and contaminant transport studies are in progress and these preliminary conclusions are still to be confirmed. The resulting assessment of effects by the TMF on groundwater flow and groundwater quality down gradient of the TMF are also not yet available.

Closure and Cessation of Pit Dewatering

Preliminary calculations suggest that a pit lake will start to develop from the time of cessation of pit dewatering and may reach the elevation of the overflow point (elevation assumed: 473 m AMSL) after about 30 years as shown in Figure 18.52.

Figure 18.52
Preliminary pit lake water balance elements



18.3.2.5 Conclusions

The main conclusions, at the time of writing, of the hydrogeological investigation programme are summarised as follows:

Jazga valley and open pit

- Although less information is available regarding the hydrogeology of the granite in the Jazga catchment, compared to the adjacent Shtuka valley, it is likely that the upper horizons of the granite are moderately to highly fractured and comprise an unconfined, fractured aquifer.
- The gold-copper porphyry deposit can be separated into two main groundwater zones: an upper oxidised zone that has sufficient fracture porosity to enable it to be reasonably well drained, and a lower, un-oxidised (sulphide) zone with low to negligible porosity or permeability.

- Excavation of the open pit will result in groundwater inflow that is estimated to range from around 0.40 Mm³/a in years 1 - 2 to 0.98 Mm³/a at end of mine life. Most of this inflow is expected to come from the mid to upper levels of the pit (i.e. from around the bottom of the oxide zone).
- Groundwater inflows to the open pit are likely to occur as discrete seepages as more conductive fractures are intersected during excavation. Water inflows will be intercepted and channelled to the pit sump, from where water will be pumped to the upper plant site.
- Dewatering of the deposit in advance of mine excavation is not considered necessary or practical. Assessment is currently being given to the potential benefits of shallow dewatering wells in the area of the upper plant site to reduce inflows through the higher elevations of the north/northeastern sections of the pit wall.
- Owing to the very low permeability of the surrounding granite host rock, the extent of the cone of depression caused by lowering groundwater levels within the pit should be very limited. No significant drawdown effects are predicted at receptors (water supply wells) in Ilovica or Shtuka villages. A reduction in stream flow rates is likely to occur in the Jazga River and the 'oxide' tributary stream during mine operation.

Shtuka catchment and TMF

- The granite in the Shtuka valley comprises a fractured, minor aquifer that is locally extensive and, whilst not abstracted directly within the upper catchment areas, provides an important water resource on which downstream users (village water supply and irrigated agriculture) are dependent.
- The upper surface of the granite onto which the tailings and the tailings embankment will be emplaced is highly fractured. The thickness of the unsaturated zone below the TMF varies from 0 m along the Shtuka River (i.e. the river is in continuity with groundwater) to around 70 m – 100 m at the ends of the embankment.
- The main axis of the Shtuka valley comprises a fractured, conductive zone that acts as a key conduit for transmission of both surface water and groundwater to lower catchment areas.
- Current conceptual thinking (by SWS) is that emplacement of low permeability tailings within the Shtuka valley could cause groundwater to impound or back up against the upstream side of the TMF. This may result in emergence of groundwater seepage at the upstream edges of the tailings deposit with consequent flow over the upper surface of the deposited tailings. There may be potential for seepage of groundwater along the outside edges of, or into, the TMF impoundment area. This water will be used in preference to fresh makeup water during operation.
- The groundwater modelling and contaminant transport study is in progress at the time of writing and no conclusions are as yet available regarding the potential effect of the TMF on groundwater flow or groundwater quality down gradient of the facility.

18.3.3 Site Water Management

18.3.3.1 Overview

Supply of raw water is from the Ilovica reservoir.

Storm water dams have been incorporated in the design to prevent environmental contamination and to recover water. All mine affected run-off is pumped to the process water dam.

18.3.3.2 Open Pit

The ROM pad run-off together with storm water and seepage collected in the pit is pumped with a movable pontoon pump into the pit dewatering tank.

Surface run-off at the crusher, which does not drain into the mine pit, is collected in the crusher building sump. The sump pumps the run-off into the pit dewatering tank.

18.3.3.3 Mine Infrastructure

The storm water and surface run-off in the mine infrastructure area is collected in the mine infrastructure storm water dam. The collected run-off is transferred to the TMF embankment storm water dam.

18.3.3.4 Oxide Stockpile

The oxide stockpile seepage water is collected in the oxide storm water dam and pumped to the pit dewatering tank.

18.3.3.5 TMF Embankment

Waste rock from the mining operations is buttressed against the TMF embankment. Run-off from the TMF embankment / waste rock buttress together with run-off from the access and haul roads is collected in the TMF embankment storm water dam.

18.3.3.6 Processing Plant

Raw water is pumped from the Ilovica reservoir to the mine infrastructure area fire water tank and the process plant fire water tank. Both fire water tanks are kept in an overflow state to supply raw water to the downstream users.

Raw water overflow from the process plant fire water tank collects in the raw water dam that supplies makeup to the process water dam.

All storm water and run-off from the catchment area north of the TMF, including from the process plant, is collected in the TMF. This water together with supernatant water is pumped to the process water dam.

18.3.3.7 Sewage Treatment

Sewage effluent is pumped to the process water dam.

18.3.4 Water Balance

18.3.4.1 Model Structure

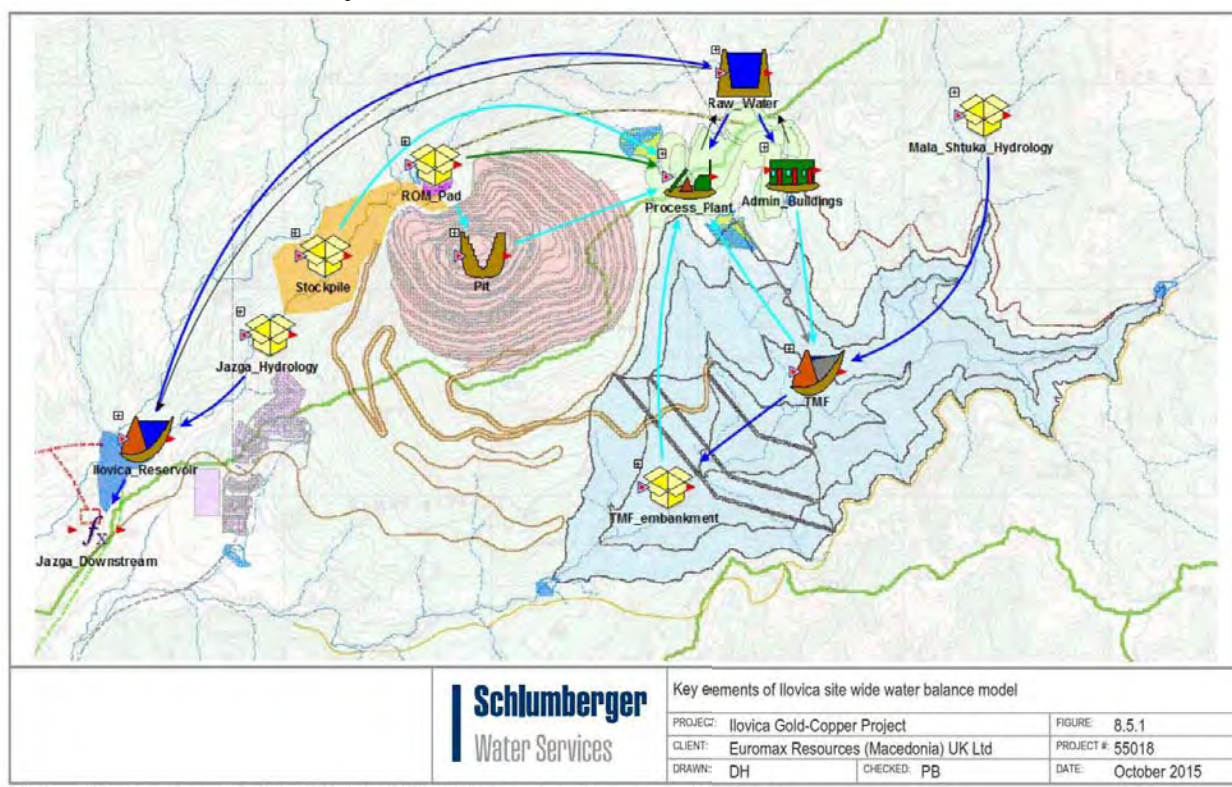
A site-wide water balance model has been developed in GoldSim for the Ilovica FS to quantify reclaim and fresh (raw) water sources through LOM. The model currently comprises four key components shown in Figure 18.53:

- process plant (including ore feed)
- TMF

- pit
- Ilovica Reservoir.

The model runs on a daily timestep for the 21 years of mine life starting arbitrarily on 1st January 2018 (GoldSim uses calendar dates so 2018 has been used to represent year 1 of mine life).

Figure 18.53
Key elements of Ilovica site wide water balance model



18.3.4.2 Time Series Inputs

The model uses external time series inputs of precipitation and surface run-off for a number of locations around the mine site and surface water catchments. The precipitation data has been interpolated from historic datasets from 1961 to 2014. The run-off data has been generated using the precipitation data and HEC-HMS run-off models calibrated with 2014-2015 stream gauging data. The methodologies for both precipitation and surface water time series generation are detailed in the Environmental Baseline Report (Golder and SWS, in prep.)²⁵.

When the model is run, GoldSim randomly selects a 1st January from the historical precipitation and surface run-off time series (e.g. 1st January 1999) and uses the time series data from that point onwards in the model (which, as stated above, actually starts on 1st January 2018 (Year 1)). If the end of the time series datasets (31st December 2014) are reached within the model run, GoldSim loops round to the start of the historical data series (1st January 1961) to continue to the end of the model run (31st December 2038 (Year 21)).

²⁵ Op. cit.

Potential evapotranspiration data were calculated for 2014 using data from the Euromax Resources met station located close to the process plant location. This dataset is repeated for the whole model run.

18.3.4.3 Model Components

Process plant

The ore feed provides the primary driver for water demand in the model. A constant ore feed rate of 10 Mt/a is used for the whole LOM. Water demand in the process plant is defined by four moisture contents or losses:

- ore moisture content of 2% w/w (equivalent of 0.2 Mm³/a for 10 Mt/a)
- product moisture content of 9% w/w for 0.077 Mt/a (0.0076 Mm³/a)
- tailing percent solids of 50% w/w (10 Mm³/a)
- plant losses of 0.016 m³/t of ore (0.16 Mm³/a).

Together these provide a total water requirement of 1.017 m³/t of ore processed, or the equivalent of 10.17 Mm³/a. This is then subdivided into a minimum fresh water requirement and a reclaim water requirement.

The minimum fresh water requirement is defined by processes which cannot use reclaim water such as spray water to the plant and gland seal water. The requirement is 0.225 m³/t or the equivalent of 2.25 Mm³/a. Reclaim water requirement is the remaining processes water requirement (i.e. total process requirement minus minimum fresh water requirement) or as much reclaim that can be pumped from the TMF.

When there is insufficient water in the TMF pond to satisfy the reclaim requirement, the shortfall is added to the fresh water demand. Some scenarios have been included in the model to use pit water, stockpile seepage and TMF embankment run-off to contribute to the reclaim stream. However, for conservative estimates of both reclaim availability and fresh water requirements, these are not included in the results presented in Section 18.3.4.4.

In addition to the fresh water requirements for the plant, there is also a requirement for the potable water system of 0.23 Mm³/a.

TMF

Golder have modified the TMF component of the site wide water balance to include details of construction, tailings properties and pond management. Full details of the TMF component are provided in Section 18.2 of this report (a summary of key inflows, outflows and internal functions is provided in this section).

Inflows to the TMF are:

- tailings slurry water (10 Mm³/a)
- treated sewage water (80% of potable supply: 0.18 Mm³/a)
- direct precipitation falling on the pond and wet tailings (100% of precipitation)
- run-off from dry tailings (60% of precipitation)

- interflow from dry beach (assumed to be zero)
- run-off from the TMF footprint without deposited tailings (calculated using a curve number of 58)
- interflow from the TMF footprint without deposited tailings (assumed to be zero)
- Run-off from the upstream Mala Shtuka catchment (SWS-calibrated HEC-HMS time series).

All water entering the TMF is assumed to be held within the TMF pond with the exception of interstitial water bound up within the tailings mass. The interstitial water is calculated based on the consolidated tailings void ratio (e) of 0.8 and the dry tailings density of 1.5 t/m^3 . Therefore, the tailings have a porosity of 44% and the volume of water held in the pores is $0.3 \text{ m}^3/\text{t}$ of tailings solids or the equivalent of $2.96 \text{ Mm}^3/\text{a}$.

The remaining water within the TMF pond can be removed by one of the following processes:

- evaporation from open water and wet tailings (potential evapotranspiration factored by 1.2)
- evaporation from dry tailings (potential evapotranspiration factored by 0.3)
- seepage to ground (75% of pond area multiplied by tailings permeability)
- seepage through the embankment (25% of pond area multiplied by tailings permeability)
- reclaim to the process plant (reclaim water requirement or volume of available water in the TMF pond).

Any water remaining in the TMF pond at the end of the timestep is combined with the inflow of the next timestep.

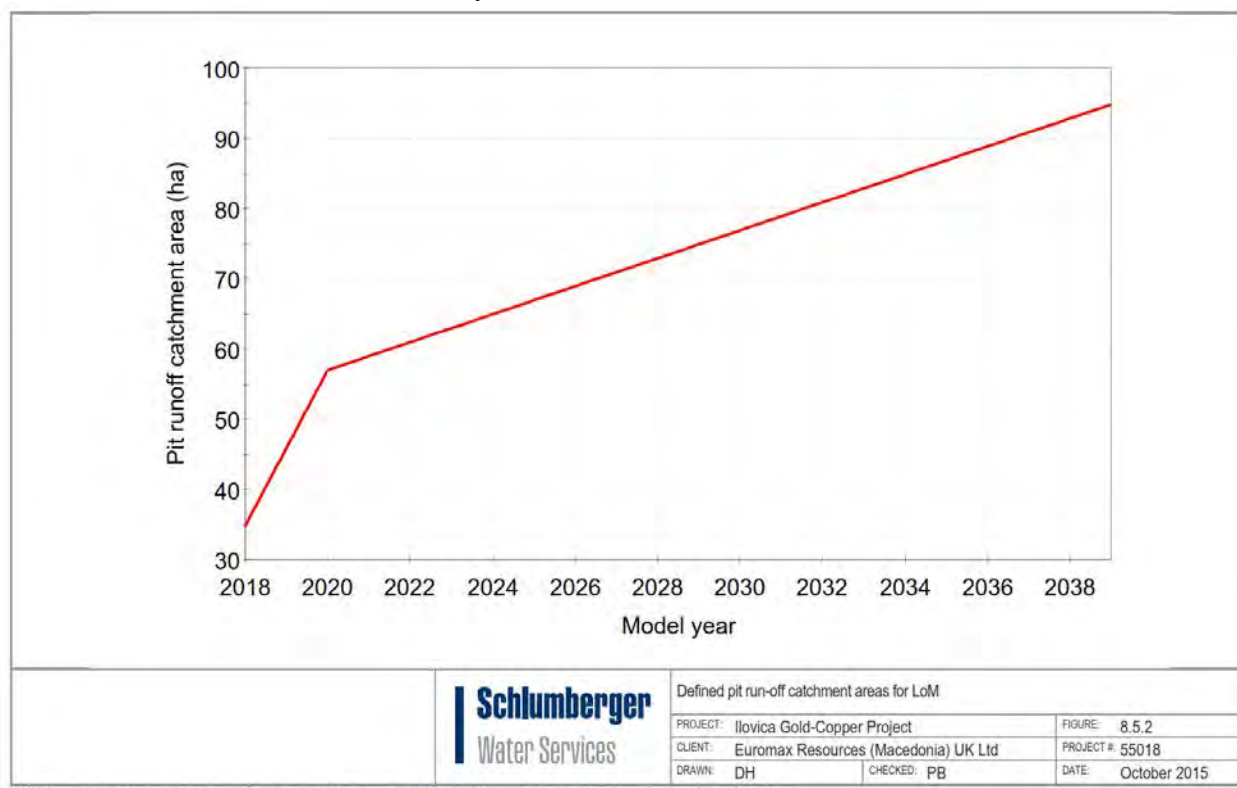
Pit

Run-off from the pit is estimated using a unit run-off value derived from the US SCS curve number method. This ensures that light rainfall events do not register any run-off (and are lost as evaporation) but that larger events are represented. A curve number of 76 has been used which produces the following equivalent run-off coefficients which have been used by Amec Foster Wheeler to size the pit sump:

- Run-off coefficient of 0.3 for a 5 year, 24 hour storm
- Run-off coefficient of 0.35 for a 10 year, 24 hour storm.

The unit run-off from the curve number method is multiplied by the pit area for that timestep to produce a run-off flow. The pit area for that timestep is calculated by linearly interpolating between the defined areas provided in Table 18.26 and illustrated in Figure 18.54. This is based on the assumption that the pit area grows at a constant rate between defined areas and that all run-off generated outside of the pit is diverted to the Jazga River.

Figure 18.54
Defined pit run-off catchment areas for LOM



Groundwater seepage to the pit has been simulated using a 3D numerical groundwater model. The results from the preliminary 3D model have been input directly to the water balance for the first day of every year. The seepage inflows increase at an almost linear rate from 210 m³/d in at the start of year 1 to 2 690 m³/d at the end of year 21.

Evaporation is lost from the pit sump assuming a surface area of 0.01 ha with an evaporation rate equal to potential evapotranspiration factored by 1.2. Scenarios are included which allow water from the pit sump to be pumped to the process plant as reclaim. However, for conservative estimates of both TMF reclaim availability and fresh water requirements, pit sump pumping is not included in the results presented in Section 18.3.4.4.

Table 18.26 Defined pit run-off catchment areas for LOM			
End of year	Model date	Area (ha)	Description
-1	31-Dec-2017	34.76	End of pre-strip
2	31-Dec-2019	56.94	End of starter pit
7	31-Dec-2024	66.90	End of pushback 1
21	31-Dec-2038	94.79	Final pit

Ilovica Reservoir

Ilovica Reservoir has two inflows:

- direct precipitation falling on the water surface (100% of precipitation)
- run-off from the upstream Jazga catchment (as defined by HEC-HMS time series).

The bathymetric survey undertaken in 2015 provides the elevation-volume-area relationship for the reservoir as shown in Figure 18.55. It has been assumed that there is no change to this relationship over LOM and therefore that sedimentation does not occur or that it is regularly dredged.

Outflows from the reservoir are defined as follows:

- evaporation from open water (potential evapotranspiration factored by 1.2)
- seepage to ground (surface area of water multiplied 10^{-7} m/s)
- seepage through the dam (0.1 L/s for every metre of elevation above 338 m AMSL)
- abstractions (further details below).

Total abstraction from Ilovica Reservoir is a combination of any of the following three abstractions depending upon the scenario:

- mine demand (process plant and potable fresh water demand as defined above.)
- irrigation abstractions (30 ha being irrigated with water demand based on crop water requirements for potato (Allen et al, 1998)²⁶ as shown in Table 18.27)
- domestic water abstractions (number of household connections increasing by 33 a year from 2086 in year 1 with each connection having a mean demand of 537 L/d; monthly variations are shown in Table 18.27).

The results presented in Section 18.3.4.4, assume that Ilovica Reservoir continues to supply the irrigation and domestic water supplies while also supplying Euromax Resources.

²⁶ Allen RG, Pereira LS, Raes D and Smith M (1998) Crop evapotranspiration Guidelines for computing crop water requirements. FAO Irrigation and Drainage Paper 56. FAO, Rome.

Figure 18.55
Elevation-volume-area relationships for Ilovica Reservoir

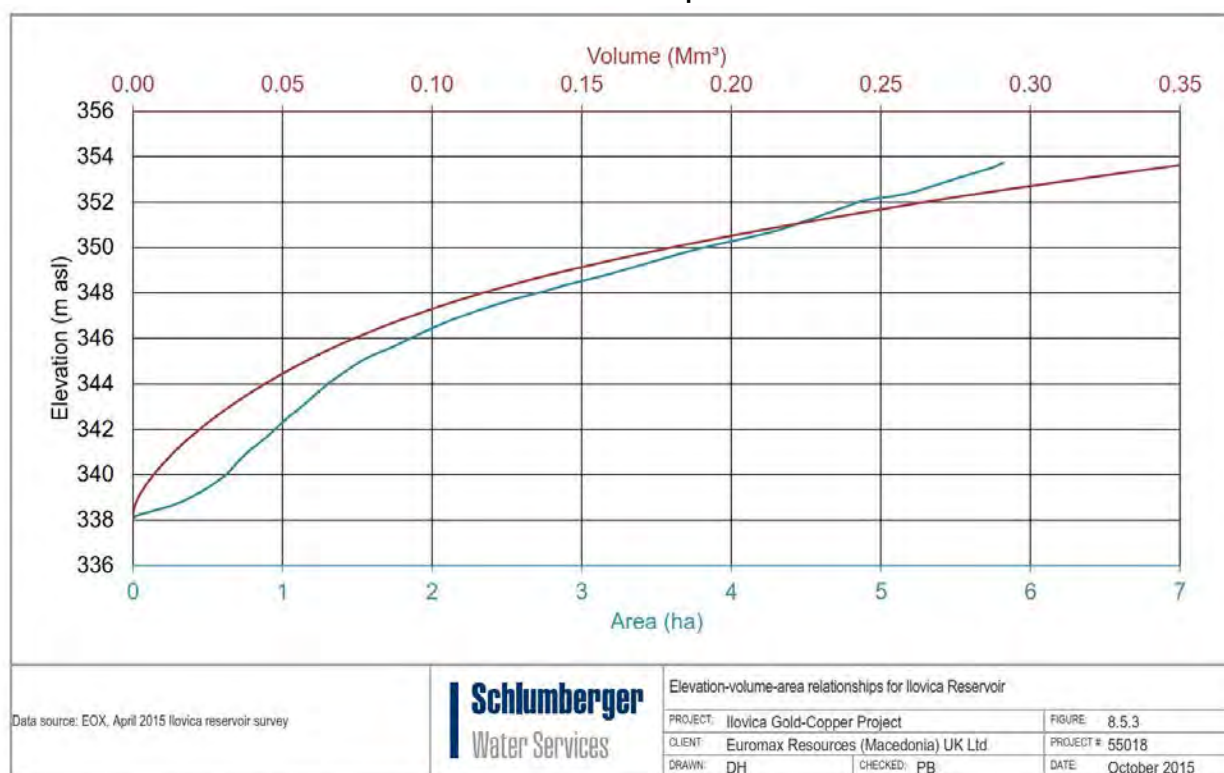


Table 18.27
Ilovica Reservoir unit irrigation and domestic water abstraction demands

Month	Irrigation demand (L/d/ha)	Domestic demand (L/d/connection)
January	0	439
February	0	446
March	1511	434
April	7244	491
May	13111	505
June	43121	569
July	64768	739
August	45758	784
September	14606	645
October	0	493
November	0	432
December	0	461

18.3.4.4 Model Results

GoldSim allows the model to be run using the same model configuration but with different precipitation and evapotranspiration inputs to introduce meteorological uncertainty to the results. Each model run, known as a “realisation”, uses a different starting point in the external time series inputs of precipitation

and surface run-off as described in Section 18.3.4.2. Taken together, the results of the realisations have their own probability distribution.

A total of 50 realisations were run and the results combined to produce time series of probability distributions for select flows within the model as presented in Figure 18.56 to Figure 18.59. Each figure presents the median (50th percentile) result as a black line; the interquartile range (25th to 75th percentile) as a dark red band; and the minimum to maximum range as a light red band.

Figure 18.56 presents the mean monthly TMF reclaim to the process plant. It shows that in year 1 (model year 2018) around 7.5 Mm³/a can be reclaimed (although refinement is required of the TMF pond at the start of mine life). From year 2 to year 10 (model year 2019 to 2028) amount of available reclaim reduces year-on-year due to high seepage rates. From year 10 onwards, the amount of reclaim increases as seepage rates reduce due to decreasing hydraulic conductivity over time. The results indicate that the full reclaim requirement will only be met during winter months in the last three years of mine life. Full reclaim requirement is never met during summer months.

Figure 18.57 presents the mean monthly pit inflow (run-off, groundwater seepage and ROM pad inflows) which increases from 0.1 Mm³/a in year 1 to 1.1 Mm³/a in year 21 at the 50th percentile. Pit run-off is less than 0.1% of the total reclaim requirement so cannot be relied upon as a sustainable water source. Groundwater seepage will be high enough to provide some additional reclaim water to the plant provided that the water can be stored effectively and its geochemistry is suitable. This scenario has not been included in the model results presented here.

Figure 18.56
Mean monthly TMF reclaim to the process plant

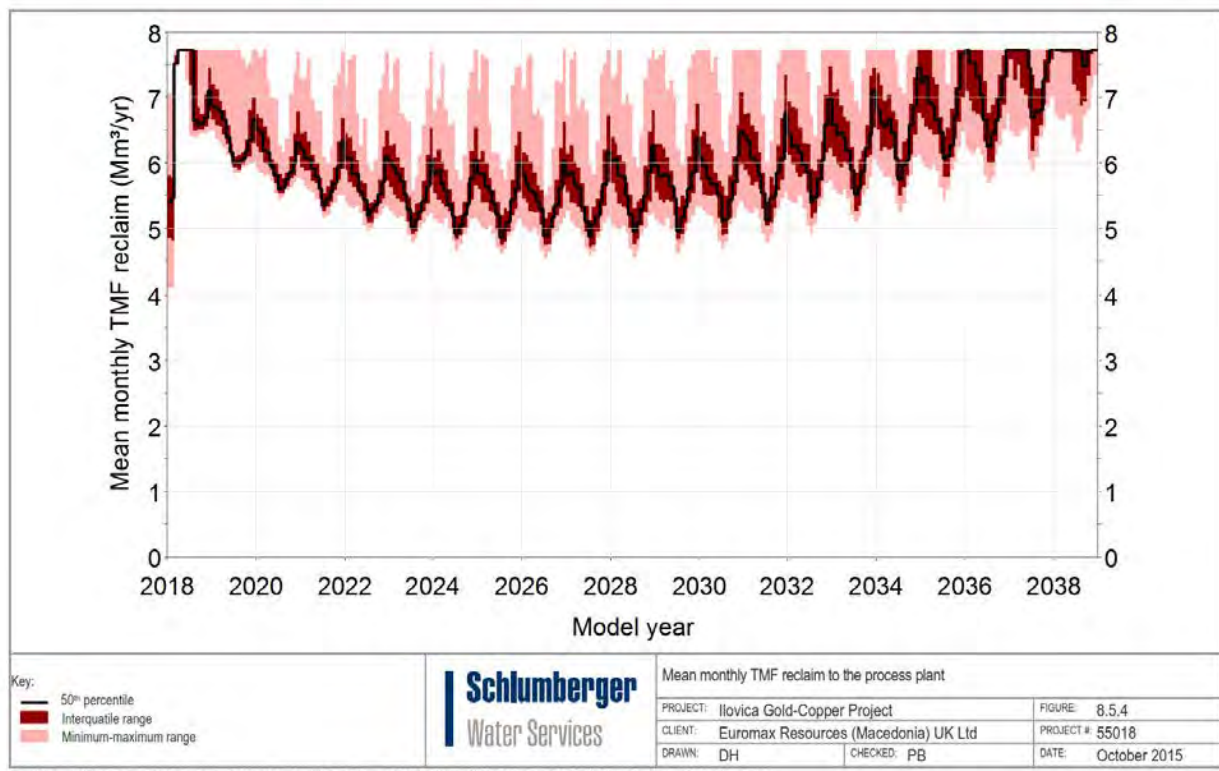


Figure 18.57
Mean monthly pit run-off

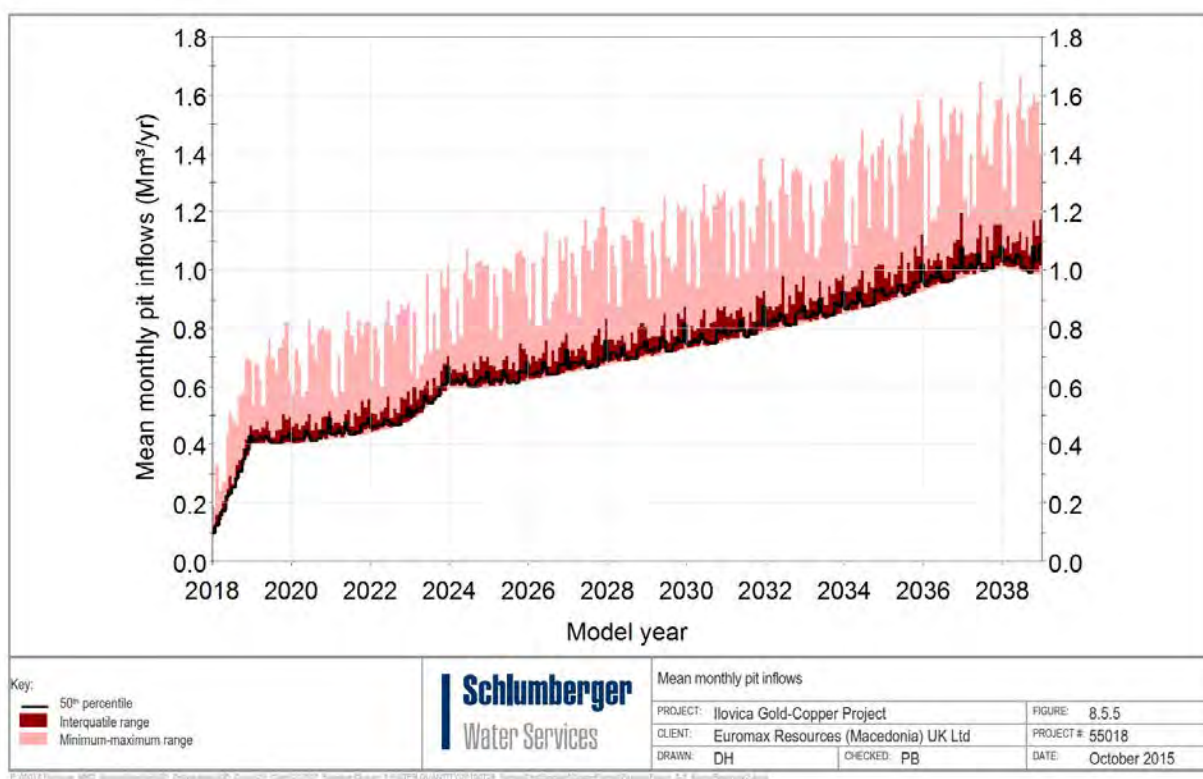


Figure 18.58
Mean monthly mine fresh water requirement

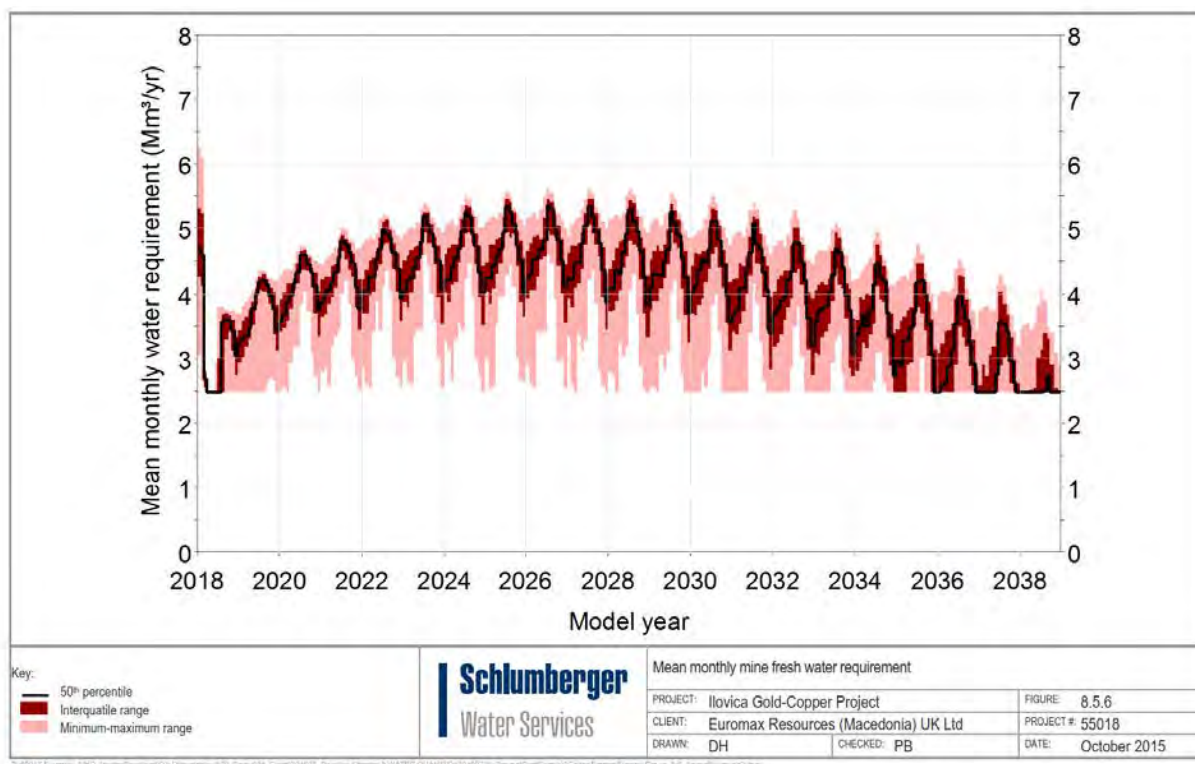


Figure 18.59

Mean monthly fresh water augmentation required to maintain Ilovica Reservoir as a supply for domestic and irrigation supplies and Euromax Resources fresh water requirement

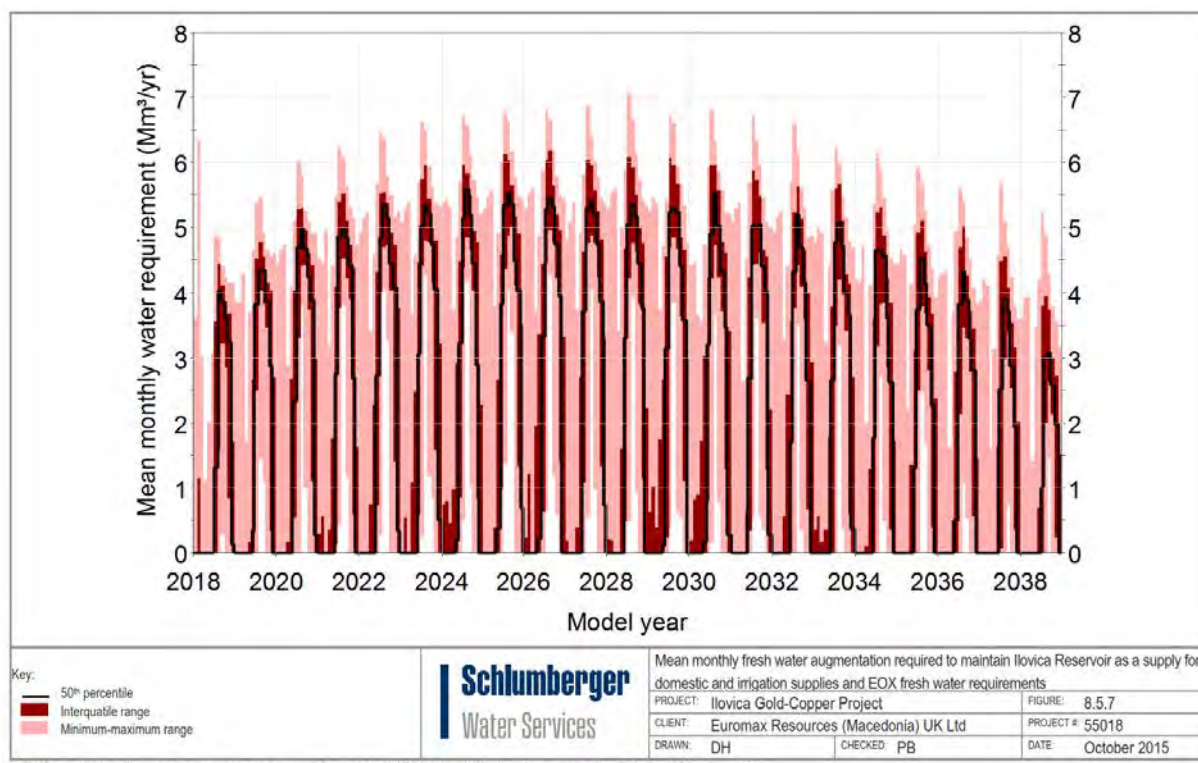


Figure 18.58 presents the mean monthly mine fresh water requirement which includes both process plant requirements and potable supply. The variation reflects the seasonal deficit in reclaim from the TMF with the addition of 2.5 Mm³/a for potable supply. Assuming that Euromax Resources shares use of Ilovica Reservoir with the existing domestic and irrigation supplies (refer to Section 18.3.4.3), the fresh water augmentation from other sources (such as groundwater or Turija reservoir) to maintain the reservoir supply varies seasonally between 0 and 5 Mm³/a at the 50th percentile as shown in Figure 18.59.

This scenario assumes that augmentation only occurs when the volume of water within the reservoir is less than the amount required for 7 days of abstractions. Under these circumstances, in most years, Ilovica Reservoir will not need augmentation through the winter but will during summer. However, if alternative augmentation rules were applied, such as starting augmentation earlier in the year but at a lower rate, the maximum augmentation rate may be reduced. Due to overtopping of the reservoir in winter, the augmentation demand cannot be distributed evenly throughout the year. Further scenarios of fresh water supply options are described in Section 18.3.5.

18.3.4.5 Model Updates

Further updates to the site wide water balance model will be required to include:

- any changes in tailings properties based on further test work analysis
- confirmation of TMF footprint evaporation, run-off and interflow components
- addition of storm water dams as the designs are finalised

- modifications to water use rules for water reclaimed from the pit, stockpile and storm water dams following geochemical modelling and verification that the water can be used in the plant.

18.3.5 Water Supply Options

18.3.5.1 Introduction

Water resources in the project area and in the project catchments are scarce. Accordingly, Euromax Resources' strategy on water for the project is to:

- Use available and unutilised water resources nearby.
- Conserve site run-off and recycle wastewater. The major resource to be drawn upon in this regard is from the proposed TMF including recycled decant water and intercepted run-off.
- Maintain the reliability and protect the water quality of existing public domestic and agricultural water supplies.

The main mine water supply source, for fresh makeup, is planned to be Ilovica reservoir, as was proposed in the PFS²⁷. Water will be pumped from Ilovica reservoir to the water storage facility at the upper plant site. Ilovica reservoir is a source of public domestic and agricultural water supplies. Since Euromax Resources will share the reservoir and since the yield of the reservoir is insufficient to also support Euromax Resources' demand for makeup water it will be necessary to supplement the reservoir resource with water sourced elsewhere.

At present there are major two options for the external sources:

- Groundwater at depth in the Strumica valley
- Turija reservoir.

At the time of writing investigations of the alluvial aquifer in the Strumica valley, of the yield and reliability of Turija reservoir and discussions with regulatory institutions are still underway. Consequently a single scheme cannot yet be defined. However, the potential range of options for mine water supply have been identified and are outlined in Table 18.28 and shown in Figure 18.60. In summary, and subject to feasibility, Strumica valley groundwater would be the preferred major option for supporting water supplies from Ilovica reservoir. If this proved not feasible or not totally sufficient then, subject to additional appraisal, it is envisaged varying degrees of supplementation from Turija reservoir would be incorporated into the mine water supply scheme.

²⁷ Euromax Resources, 2014. Pre-Feasibility Study Technical Report for the Ilovitza Gold-Copper Project in Southeast Macedonia. Euromax Resources Ltd.

Figure 18.60
Ilovica mine water supply options schematic

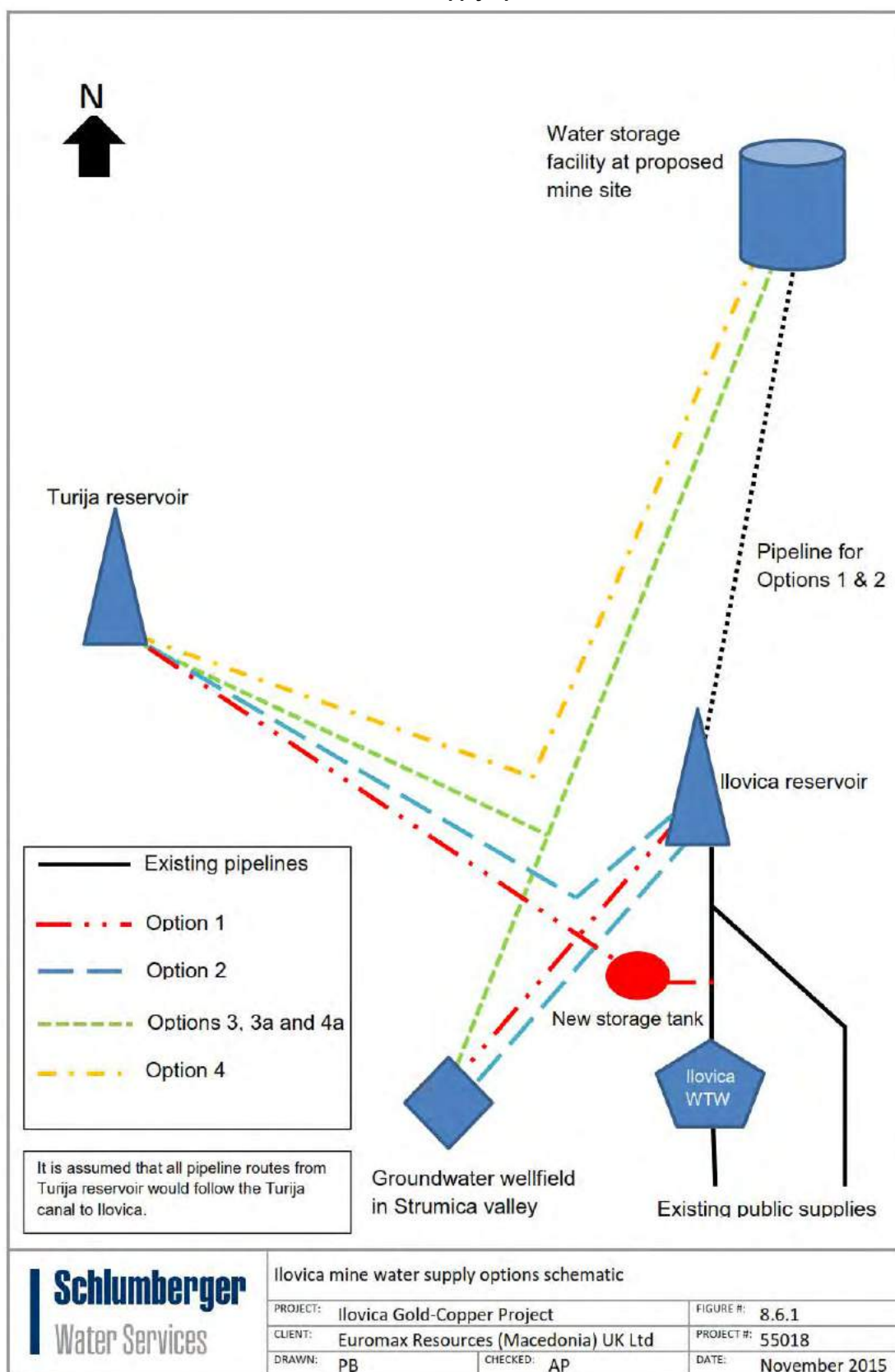


Table 18.28
Summary of mine water supply options

Option		Abstraction source/s			Other key requirements or detail	Additional considerations?		Engineering prefeasibility requisites		
NO.	Brief comment	Primary	Preferred Secondary	Alternative Secondary		First	Second	Cost	Euromax Resources	Drought reliability
1	Euromax Resources joint user of IR with SPWMC	Ilovica Reservoir	Strumica valley GW	Turija water from gravity pipeline	Pipeline from Turija reservoir to Ilovica WTW	Vodocha Res supply to Strumica	Relative cost of Strumica valley GW option	Groundwater wellfield, pumps and pipeline (under appraisal). Gravity pipeline for SPWMC from TR to Ilovica WTW with connection to IR	High, if GW is used	High/Medium
2	Euromax Resources joint user of IR with SPWMC & BWUC	Ilovica Reservoir	Strumica valley GW	Turija water from gravity pipeline	Pipeline from Turija reservoir to Ilovica reservoir	Vodocha Res supply to Strumica	Relative cost of Strumica valley GW option	Groundwater wellfield, pumps and pipeline. Dedicated gravity pipeline for Euromax Resources from TR to IR for aug. purposes	Medium, if GW is used	High/Medium
3	Direct GW (no augmentation)	Strumica valley GW	n/a		GW serves mine directly via pump & pipeline	Depends on reliable yield from GW	Cost of Strumica valley GW option	Groundwater wellfield, pumps and pipeline (under appraisal).	High	Subject to GW assessment
3a	Direct GW (with augmentation)	Strumica valley GW	Turija reservoir via Euromax Resources pipeline		GW (& Res) serves mine directly via pump & pipeline	conjunctive reliability assessment	Cost of Strumica valley GW option	Groundwater wellfield, pumps and pipeline. Pump & pipeline for Euromax Resources from TR to mine plant	Medium	Subject to GW assessment

Table 18.28
Summary of mine water supply options

Option		Abstraction source/s			Other key requirements or detail	Additional considerations?		Engineering prefeasibility requisites		
NO.	Brief comment	Primary	Preferred Secondary	Alternative Secondary		First	Second	Cost	Euromax Resources	Drought reliability
4	Direct Res (no augmentation)	Turiya reservoir	n/a		Res serves mine directly via pump & pipeline	Specific yield reliability from Res		Pump & pipeline for Euromax Resources from TR to mine plant	Low	Medium/Low
4a	Direct Res (with augmentation)	Turiya reservoir	Strumica valley GW		Res (&GW) serves mine directly via pump & pipeline	Conjunctive reliability assessment	Cost of Strumica valley GW option	Pump & pipeline for Euromax Resources from TR to mine plant. Groundwater wellfield, pumps and pipeline.	Low/Medium	Medium

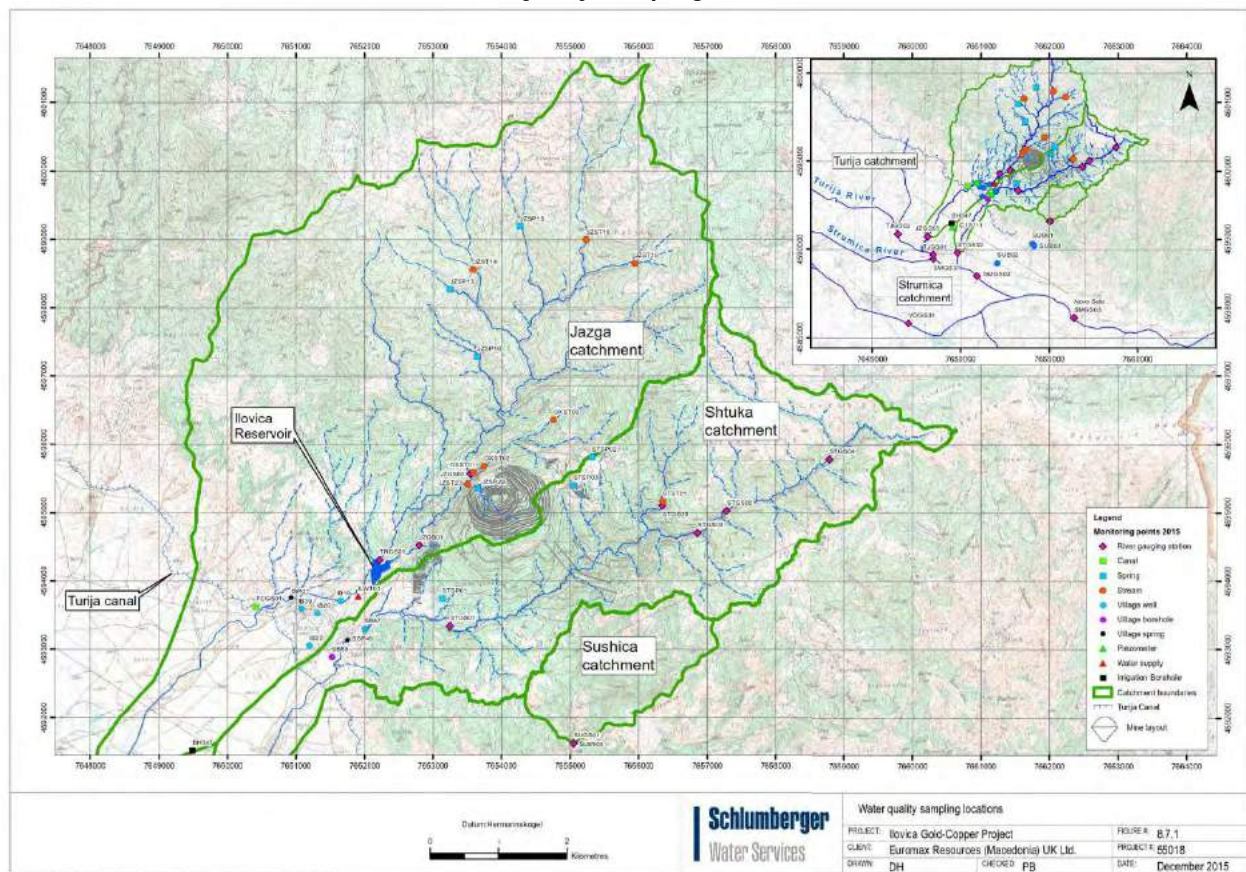
18.3.6 Water Quality

18.3.6.1 Project Site Water Quality

Water quality was surveyed across the site at quarterly or monthly intervals from September 2013. Monitoring points as shown in Figure 18.61 corresponded to selected hydrology and hydrogeology monitoring locations. At each survey a series of field parameters were recorded and water samples were sent for a range of laboratory analyses at ALS.

Most of the waters monitored in the upper Jazga and Shtuka catchments are relatively clean, unimpacted waters, dominated by calcium, magnesium and bicarbonate ions. A small number of spring and stream monitoring points located close to the planned open pit and mineralised zone presented higher concentrations of sulphate, iron and copper than elsewhere. These waters also showed depressed alkalinities and pH. The water chemistries are likely to be controlled by the sulphide mineralisation in the deposit area, and are a useful indicator for the expected drainage from the excavation of a pit and exposure of sulphides on pit surfaces and waste material.

Figure 18.61
Water Quality Sampling Locations



18.3.6.2 Water Quality of Water Supply Options

The water supply options for the project are described in Section 18.3.5. These are broken down into two main water quality types:

1. Clean water, with a water chemistry similar to that described above (the major water sources and the RDD and Mala Shtuka dam).
2. Recycled contact water from the mine operations, mainly including water reclaimed from the pit sump and the TMF (most of the minor, site water sources).

The major clean water supply options considered by the project include a combination of the Ilovica reservoir, Turija reservoir and possibly groundwater from the Strumica valley. The minor clean water supply options include the RDD located on the Shtuka River and a potential small dam on the Mala Shtuka tributary. Generally the water quality of the supply options is good and no concerns are foreseen with use for processing.

Water quality of the Ilovica reservoir is represented by samples taken from the intake at the Ilovica water treatment plant (ILWT01) and the Jazga water quality flowing into the reservoir (JZGS01). The reservoir has a neutral pH with a moderate total dissolved solid load (between 90 and 123 mg/l). The water tends to be dominated by calcium, sodium and bicarbonate ions and is typical of natural surface waters.

The water quality of Turija reservoir is represented by a single sample taken in April 2015 at the Turija Canal gauging station (TCGS01) upstream of Ilovica village. At the time of sampling, water had recently started to be released from the reservoir for irrigation. The water chemistry is dominated by calcium, magnesium and bicarbonate ions, has a similar dissolved solid load to Ilovica reservoir water and is well oxygenated. Water quality in the canal is likely to vary seasonally as a result of the control of flow from the reservoir; in winter the canal may contain more local run-off or stagnant water.

Less information is available for the groundwaters on the Strumica plain. Shallow groundwater is represented by BH347 and deeper groundwater by the recently drilled IC15111. The data from the first sample taken at IC15111 records a higher TDS (720 mg/l) than is found in other groundwater samples across the project area. The water is also dominated by sodium ions. The high TDS and sodium could be a remnant of the drilling fluids used in the recently drilled hole and it is expected that groundwater at depth will have a character that is similar to BH347 with more time to allow the borehole to equilibrate with water from the surrounding aquifer. The total dissolved solids recorded for BH347 is moderate, only 240 mg/l, and the major ions are calcium, magnesium and bicarbonate.

Upland surface water in the Shtuka may be used as minor sources of water supply for the project by the RDD on the main Shtuka River and a second small dam on the Mala Shtuka tributary. Surface waters were sampled on the main Shtuka River at STGS03 and STGS06 and these represent the RDD water quality. Sampling was also undertaken at the sampling points STST01 and STGS05 on the Mala Shtuka. The water is dominated by calcium, magnesium and bicarbonate ions and the total dissolved solid load is on average 100 mg/l, consistent with those described for the other surface water supply options described above.

18.3.7 Geochemistry

18.3.7.1 Introduction

Geochemical investigations focused specifically on the assessment of potential ARD and associated metal leaching risks which may require management throughout the operational life and following final closure of the Ilovica project were initiated in mid-2013 under the supervision of Euromax Resources' environmental specialist in liaison with SWS. These investigations remain ongoing and have formed the basis for much of the water quality impact assessment incorporated into the ESIA for the Ilovica project.

The work performed to date has included the use of industry-standard static and kinetic geochemical testing to characterize the acid production and metal leaching propensity of each of the major rock types which will be mined and/or exposed in the walls of the proposed open pit. Results of testing will be applied in the construction of facility scale geochemical models to predict the life-of-mine chemistry of contact water which may be generated within the pit, areas of waste rock placement and in the future Ilovica TMF.

Geochemical test work was performed on discrete rock types identified within the deposit area during exploration drilling, with individual units classified on the basis of:

- Mineralisation
- Primary lithology
- Degree of hydrothermal alteration
- Degree of supergene oxidation

The methods and results of all testing are described in detail in an SWS technical memorandum (55017_TM11v1.2) of 2015, and will also be published in an Annex to the project ESIA. A breakdown of the material codes used within the geochemistry studies is presented in Table 18.29.

Table 18.29 ARD material classification codes	
Acronym	Characteristic
GRT	Granite
DAC	Dacite
GNDIO or GDIO	Granodiorite
OX	Oxidised zone
UNOX	Unoxidised zone
MIX	Mixed zone (partially oxidised)
BR or SW	Brecciated or stockworked, mineralised and hydrothermally altered
UD or DIST	Hydrothermally unaltered or distal from mineralisation
CA	Contains carbonate
NON	Contains nontronite
FR	Fresh
AL	Altered
HS	High sulphide

18.3.7.2 Geochemical Data Collection

Static tests

Screening level assessment of drill core was initially performed using field-based paste pH and electrical conductivity (EC) tests which provide a measure of readily hydrolysed forms of mineral acidity. The results from this screening were used to guide the selection of samples for ABA tests, completed as part of PFS and FS studies. A total of 61 waste-grade and 10 ore-grade samples were initially subject to ABA testing in 2014 at the Evrotest laboratory in Bulgaria. A further 36 samples were subsequently analysed using a modified Sobek (1979) ABA method at Maxxam laboratories in Canada during 2015. This second group of static tests was performed following the completion of a gap analysis relating to the level of representation of major rock units within the deposit area achieved by the first phase of test work.

Results of ABA testing indicate that approximately 5% of the sample population is classifiable as net-acid consuming, with 49% classified as of 'low-reactivity', 13% classifiable as of weak PAG character and 38% classifiable as strong PAG. Neutralisation potential (NP) versus acid generation potential (AP) ratios for all ABA samples are presented on Figure 18.62.

The sample suite collected for ABA analysis in 2015 was additionally subject to a wider range of static tests. Bulk geochemistry and whole rock analysis were conducted on the entire suite of 36 samples. Mineralogical analysis (by Rietveld X-ray diffraction (XRD)) was completed on 25 of the samples. Net acid generation (NAG) tests and NAG leachate analyses were performed for 7 samples. The results of these tests will be fully described in an annex of the ESIA.

The XRD analysis indicates the presence of natroalunite in a number of samples, as presented in relation to AP and HCl extractable S in Figure 18.63 and Figure 18.64. Where present, natroalunite may result in erroneous over-estimation sulphide-S abundance in conventional ABA tests and thus, in turn, may result in over-conservative estimates of net acid production potential.

Figure 18.62
ABA analyses presented by NP vs. AP for all static test samples

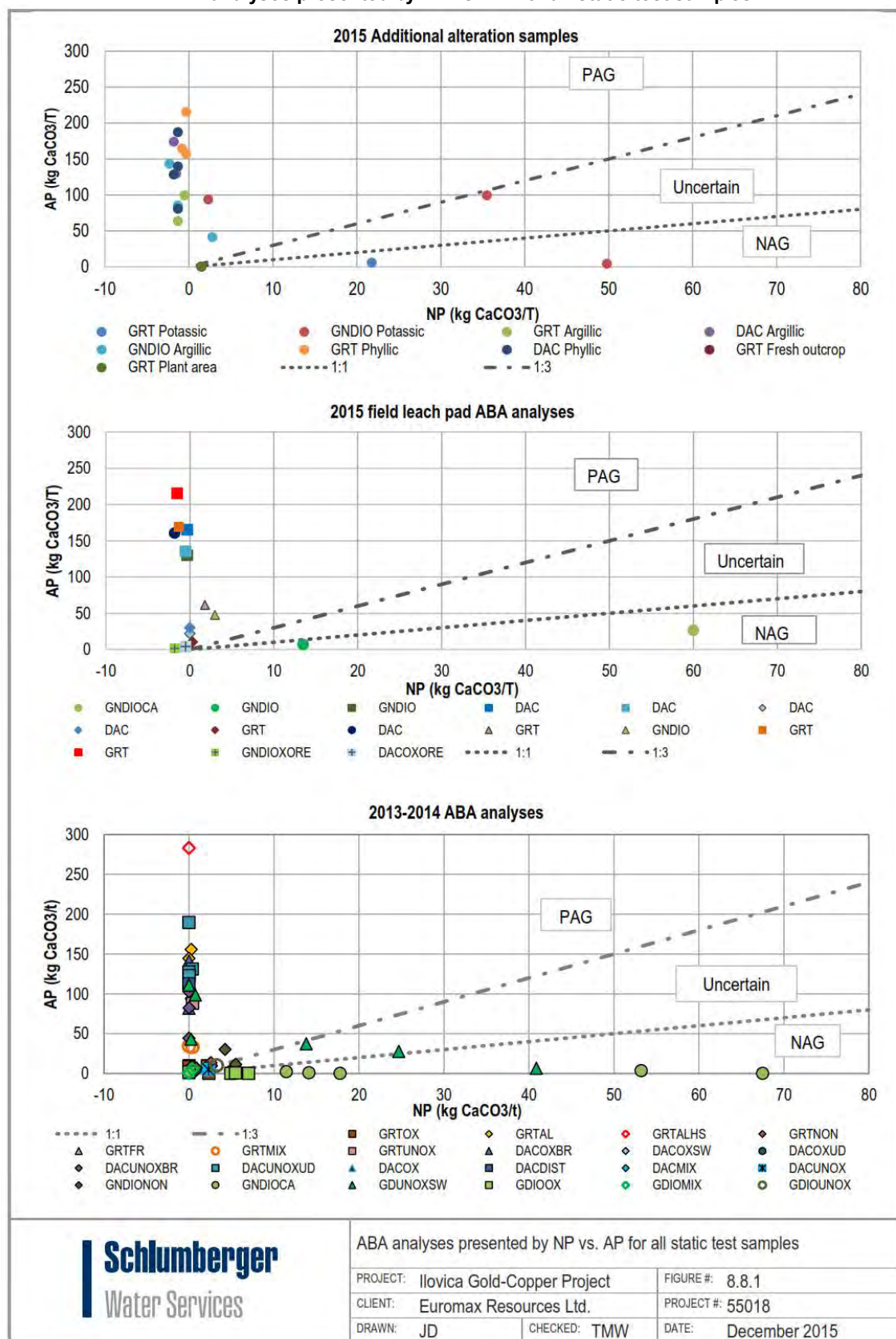


Figure 18.63

Additional alteration samples XRD Natroalunite abundances and AP and HCl extractable S

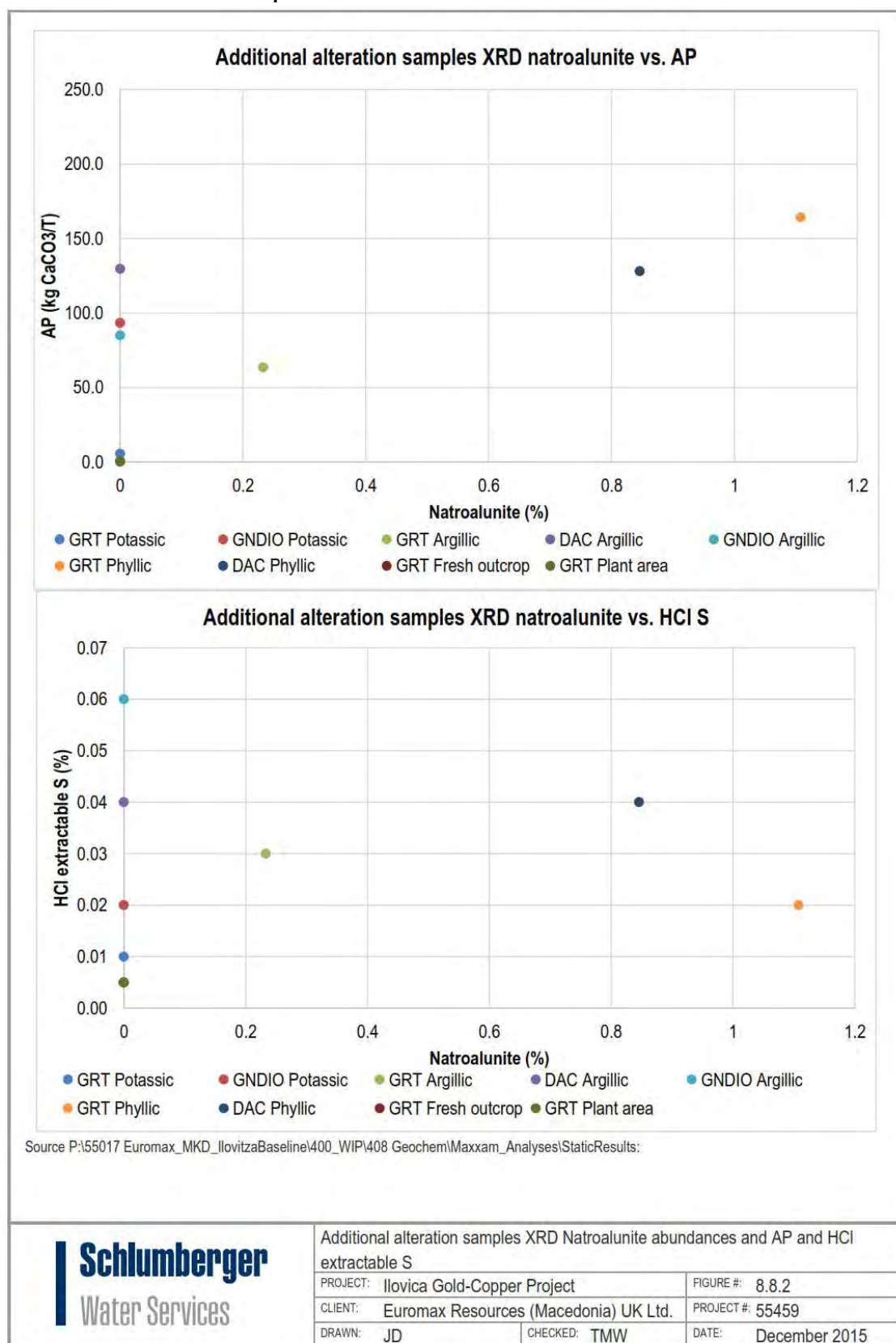
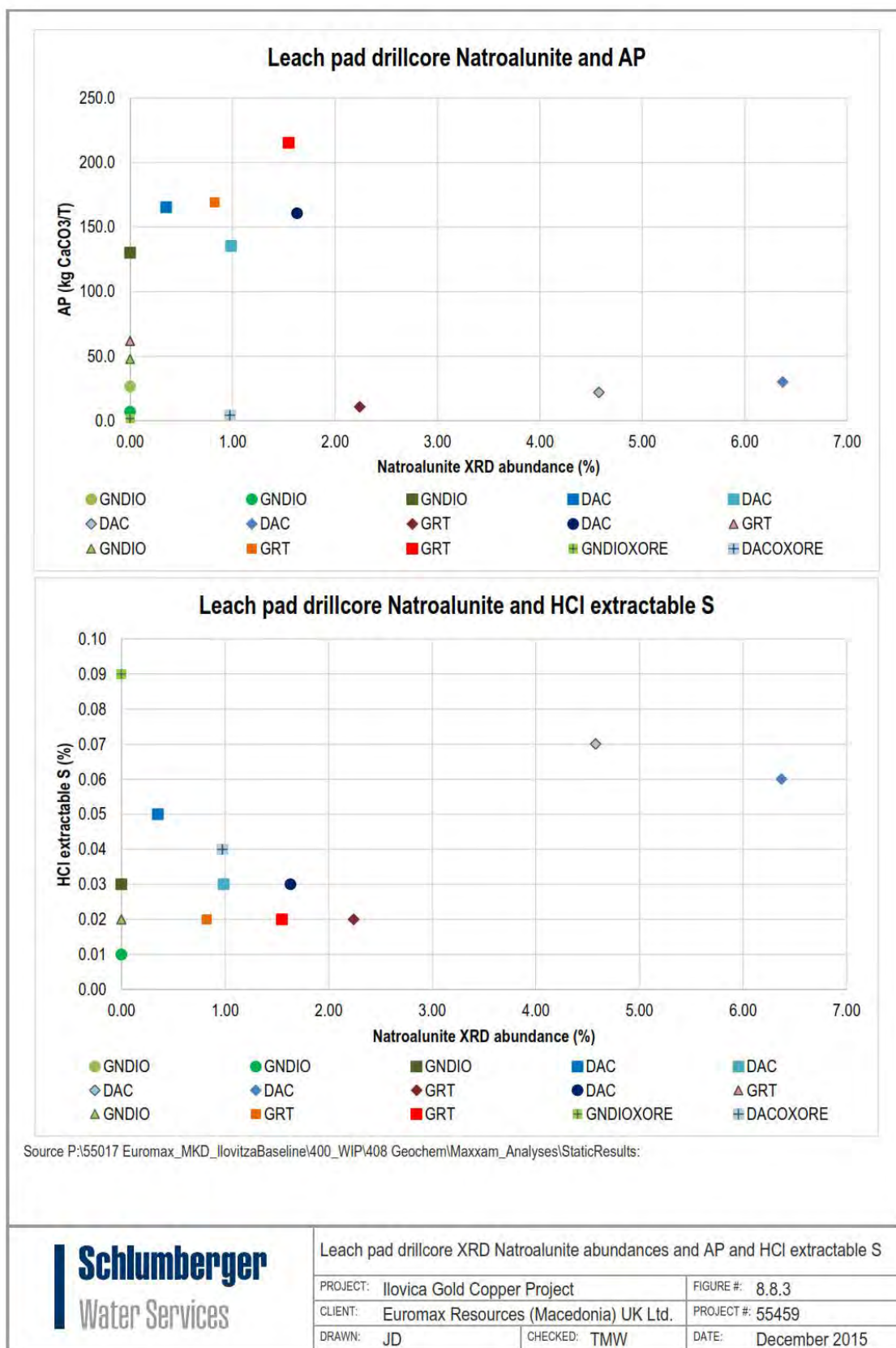


Figure 18.64

Leach pad drill core XRD Natroalunite abundances and AP and HCl extractable S



Kinetic tests

A series of 16 field 'test pads' were established at Ilovica in 2013 to assess the long-term weathering behaviour of the waste rock stream (most of which is currently proposed for use in the construction of the TMF embankment). The material units subject to kinetic testing using the test pads represent the major waste rock types indicated by the initial mine production schedule and geological cross sections.

Drill core for each material type was aggregated and placed in polyvinyl chloride (PVC) containers with no further crushing. The mass of drill core used for each test ranged from 95 kg to 300 kg as dictated by the availability of drill core material. The test pads are located adjacent to the weather station at Ilovica, thus permitting good constraint on precipitation levels influencing the pads. Leachate from each pad reports to a sealed container which is periodically subject to in-field analysis for pH, EC and alkalinity), plus laboratory analysis for a full suite of anions and cations at ALS.

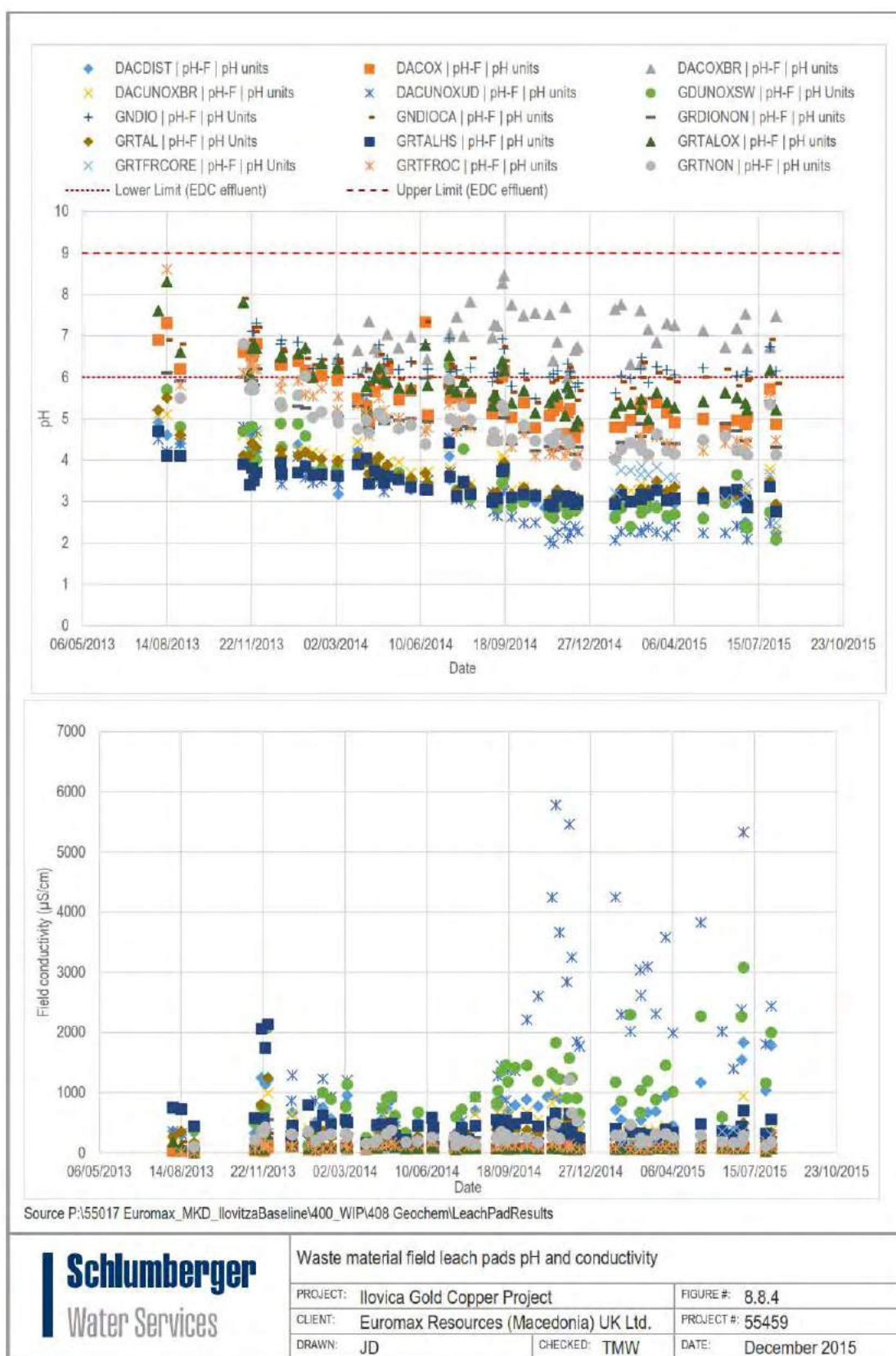
The results for the field leachates have been assessed in association with the rainfall record as recorded at the Ilovica weather station to define volumes of precipitation and weathering periods. The field pH and conductivity results are presented in Figure 18.65. Most un-oxidised material shows evidence of strong net acid production, with un-oxidised hydrothermally altered granodiorite and dacite yielding leachate with a pH of below 3. Oxidised units produce leachates with a higher pH, generally between pH 5 and 6. The carbonate bearing granodiorite mostly produces circum-neutral leachate.

Further kinetic tests were initiated in July 2015 to assess the leachate chemistry likely to emanate from material to be placed on the oxide stockpile. Initially ore-grade oxidised granodiorite and dacite were identified as the primary material types to be stockpiled. Artificially irrigated leach tests were adopted by Euromax Resources to accelerate the rate of data production for these tests and thus to provide key information for use during the period of execution of the FS. All samples were crushed to <3 cm with 30 kg samples then placed into PVC containers.

The tests were irrigated periodically using distilled water. Weathering periods and volumes of irrigation were recorded. Leachate was collected and field parameters were recorded as for earlier generation of tests. To date, only a small number of samples have been subject to full chemical analysis. The pH of leachate from oxidised dacite samples is indicated by these data to range from pH 5.3 to 6.2. Average electrical conductivity is around 300 $\mu\text{S}/\text{cm}$.

The granodiorite oxide ore was observed to produce acidic leachate, as low as pH 2.99. However, subsequent assessment of the source of core used to represent this material type suggests that a significant proportion of 'transitional' (sulphide bearing) rock may be present. Euromax Resources has confirmed that material of this nature will now not be stockpiled. The material has now been re-classified into two distinct zones, upper oxidised granodiorite which is sterile in nature and lower granodiorite which is acid generating.

Figure 18.65
Field Leach Pad



Tailings

Preliminary static and kinetic leach tests have been performed on available rougher and cleaner scavenger tails generated from flotation test work. Results of these tests suggest that the tailings will not generate low pH contact water due to the high residual alkalinity present within the slurry. Further confirmatory tests are being completed to verify this.

Extrapolation of Geochemical Test work Data

Based on results of static and kinetic testing, ARD risk codes have been incorporated into the Ilovica block model. The codes have then been applied to predict the proportions of PAG and non-PAG material to be exposed in the pit walls or contained in the waste rock stream throughout mine life. The codes are shown in Table 18.30.

Table 18.30 ARD material proportions exposed by pit shell surface						
Block Model Codes	Corresponding Leach Pad	Stage	Pre-Strip	Starter Pit	First Pushback	Final Pit
		LOM Year	-1	2	7	21
		Surface Area (2D) (m ²)	257308	474942	589774	941198
DACMIX	DACUNOXUD	%	0.0	1.9	2.5	1.2
DACMIXSW	DACUNOXBR	%	0.0	0.4	1.7	1.4
DACOX	DACOX	%	86.0	47.0	19.2	13.9
DACOXSW	DACOX	%	0.0	0.1	0.2	1.5
DACUNOXSW	DACUNOXBR	%	0.0	4.2	18.4	12.5
DACUNOXUD	DACUNOXUD	%	0.0	0.7	10.7	7.6
GDIONON	GRDIONON	%	0.0	9.6	5.0	5.6
GDUNOXSW	GDUNOXSW	%	0.0	1.1	2.1	2.6
GNDIOCA	GNDIOCA	%	0.0	3.4	6.0	6.8
GNDIOCAMIX	GNDIOCA	%	0.0	0.2	0.2	0.1
GNDIOMIX	GNDIO	%	0.0	1.9	1.1	0.3
GNDIOMIXSW	GDUNOXSW	%	0.0	1.5	1.2	0.1
GNDIONONMIX	GRDIONON	%	0.0	1.6	0.4	0.3
GNDIONONSW	GDUNOXSW	%	0.0	12.1	13.0	17.2
GNDIOOX*	GNDIO*	%	0.0	4.8	2.6	0.4
GNDOUNOX	GNDIO	%	0.0	3.5	2.5	1.3
GRTAL	GRTAL	%	0.0	0.0	3.2	10.6
GRTALOX	GRTALOX	%	13.9	6.0	9.1	8.5
GRTMIX	GRTAL	%	0.1	0.1	0.9	2.9
GRTNON	GRTNON	%	0.0	0.0	0.2	5.5

*This will be updated in the future to reflect the split between granodiorite upper and granodiorite lower, as described in this section.

The relationship between block model material codes, kinetic test work results and the assigned ARD risk class for each rock type is shown in Table 18.31.

Table 18.31 Classification of ARD material into ARD risk category		
Block Model Unit	Corresponding Kinetic Test work	ARD Category
DACMIX	DACUNOXUD	Acid generative
DACMIXSW	DACUNOXBR	Acid generative
DACOX	DACOX	Sterile
DACOXSW	DACOX	Sterile
DACUNOXSW	DACUNOXBR	Acid generative
DACUNOXUD	DACUNOXUD	Highly acid generative
GDIONON	GRDIONON	Intermediate
GDUNOXSW	GDUNOXSW	Highly acid generative
GNDIOCA	GNDIOCA	Acid consumptive
GNDIOCAMIX	GNDIOCA	Sterile
GNDIOMIX	GNDIO	Acid generative
GNDIOMIXSW	GDUNOXSW	Acid generative
GNDIONONMIX	GRDIONON	Acid generative
GNDIONONSW	GDUNOXSW	Acid generative
GNDIOOX_UPPER	GNDIO	Sterile
GNDIOOX_LOWER	GNDIOOXORE	Acid generative
GNDOUNOX	GNDIO	Mildly reactive
GRTAL	GRTAL	Acid generative
GRTALOX	GRTALOX	Sterile
GRTMIX	GRTAL	Acid generative
GRTNON	GRTNON	Intermediate

18.3.7.3 Integration with Mine Plan

The ARD risk potential, as assigned within the block model, for the open pit walls through LOM is presented in Table 18.32.

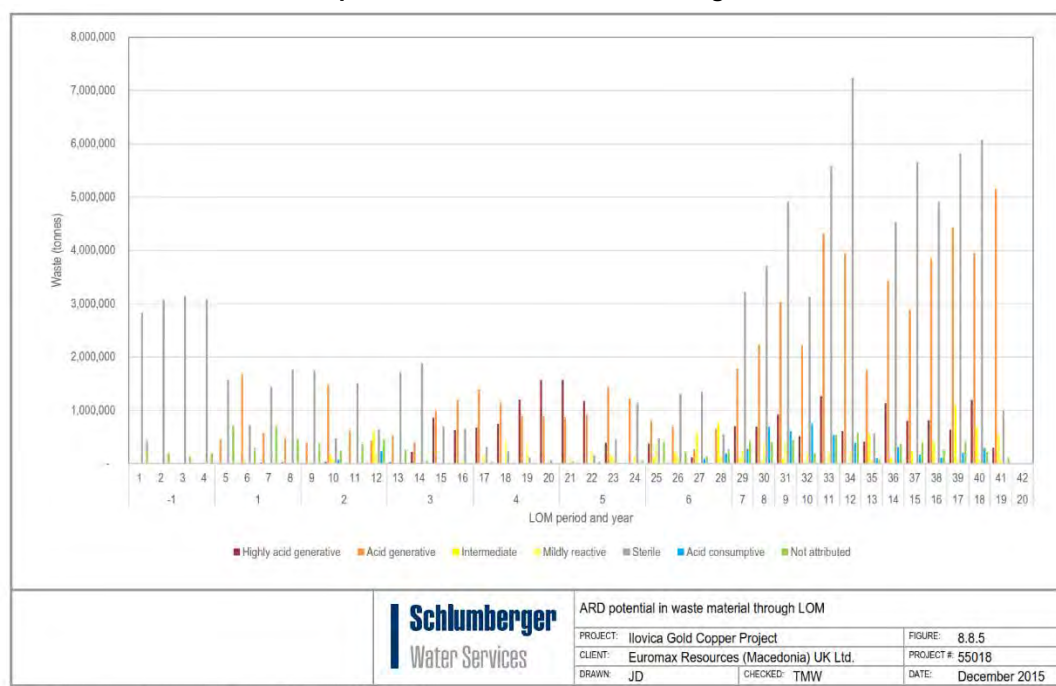
Table 18.32 ARD potential of the pit shell through LOM					
ARD Category*	Stage	Pre-strip	Starter Pit	First pushback	Final pit
	LOM Year	-1	2	7	21
Highly acid generative	%	0	2	13	10
Acid generative	%	0	27	48	53
Intermediate	%	0	10	5	11
Mildly reactive	%	0	4	2	1
Sterile	%	100	58	31	24
Acid consumptive	%	0	3	6	7
Not attributed	%	0	0	0	0

*This will be updated in the future to reflect the split between granodiorite upper and granodiorite lower, as described in this section.

The ARD risk potential of waste material in the LOM schedule is summarised in Table 18.33 and in Figure 18.66. Unsurprisingly, the proportion of high risk material in both the pit walls and the waste stream

increases through mine life, with greater pit extension into un-oxidised rock units. A significant proportion of PAG material is projected to be exposed on the highwall above the level of water inundation within the pit following closure. This may impact the long-term quality of water within any future pit lake and therefore any outflow from the pit lake will have to be managed. Further work is planned for during the detailed design phase.

Figure 18.66
ARD potential in waste material through LOM



The waste schedule indicates that most of the initial waste produced corresponds to sterile material (relating to oxidised dacites), which will be used for the initial TMF construction. The carbonate bearing material is located at depth within the pit and is mined later in mine life, from LOM year 6 to year 18. Highly acidic generative waste material begins to be produced from year 3 onwards, which is after the starter TMF embankment (end of LOM year 2). Acid generative material is mostly produced in LOM years 7 to 18. Further investigation and assessment of potentially acid generative mine waste rock destined for the TMF embankment is ongoing.

Table 18.33		
Overall waste material by ARD potential		
ARD category	Waste (Mt)	Waste%
Highly acid generative	20	10
Acid generative	63	31
Intermediate	7	3
Mildly reactive	5	2
Sterile	85	45
Acid consumptive	5	3
Not attributed	11	5
Totals	195	100

19. MARKET STUDIES AND CONTRACTS

19.1 MARKET

19.1.1 Commodity Price

The commodity prices used for economic analysis are US\$1 220 /oz Au, US\$18 /oz Ag and US\$2.90 /lb Cu.

These metal prices are supported by Amec Foster Wheeler Long-term guideline prices for use in cash flow models and mining studies for Q4 2015 (Table 19.1).

Table 19.1 Amec Foster Wheeler Guideline Long-term Metal Prices							
Mineral	Units	Spot price (30/09/15)	3-year moving average	Analyst Consensus Long Term	SEDAR (last 12 months)	AmecFW Cash Flow Guidelines	AmecFW Resources Guidelines
Gold	US\$ /oz	1 116	1 334	1 227	1 250	1 250	1 440
Silver	US\$ /oz	14.51	15.11	18.15	18.25	18.25	21.00
Copper	US\$ /lb	2.35	3.11	3.00	3.00	3.00	3.50

The commodity guidelines data come from the following sources:

- Spot prices for metals and oil: metalprices.com; for FX Bank of Canada website
- Analyst consensus: Bloomberg, Reuters or Banking sources.
- NI 43-101: SEDAR compiled by internal resources and with the help of DisclosureNet.
- Other sources of credible information.

19.1.2 Product Specification Requirements

19.1.2.1 Flotation Concentrate

The copper-gold concentrate must be free from any deleterious impurities and must have normal physical characteristics and chemical composition and be free of radioactivity. The moisture content shall not be less than 7% to avoid dusting.

19.1.2.2 Doré Bars

The doré bars need to contain at least 70% Au/Ag purity and individual bars not to weigh less than 5 kg. The material also needs to be free of radioactivity, Iodine and Beryllium.

19.1.3 Penalties

The following contaminants in the copper-gold concentrate will be penalised if the threshold is exceeded:

- Fluorine – each 100 ppm above the 300 ppm threshold will lead to a penalty of US\$1.25 per dmt treated.
- Lead – US\$1.9 per dmt of concentrate will be payable for each 0.1% exceeding the upper threshold limit of 300 ppm.

Charges will be applied for deleterious elements contained in the doré bars between the respective free upper limits and maximum level, as specified by MKS in Table 19.2.

Table 19.2 MKS Deleterious Elements Schedules of Charge					
Element	Symbol	Free Upper Limit	Increment	Maximum Level	Increment Charge
		%	%	%	US\$ /t
Arsenic	As	0.01	0.01	1	20
Antimony	Sb	2	1	10	50
Bismuth	Bi	0.01	0.01	1	15
Cadmium	Cd	0.01	0.01	1	30
Mercury	Hg	0.01	0.01	0.05	300
Selenium	Se	0.1	0.05	1	50
Tellurium	Te	0.1	0.05	1	50
Tin	Sn	2.0	1.0	10.0	30
Nickel	Ni	0.1	1	10	50
Zinc	Zn	5	1	15	20
Lead	Pb	1	1	5	50

19.1.4 Contracts

19.1.4.1 Smelting and Refining

The term sheets for copper concentrate and doré bars are:

- Aurubis Bulgaria AD for an offtake agreement for the planned Ilovica copper-gold concentrate.
- MKS (Switzerland) for an offtake agreement for the planned Ilovica doré bars.

20. ENVIRONMENTAL STUDIES, PERMITTING AND SOCIAL OR COMMUNITY IMPACT

20.1 BACKGROUND AND METHODOLOGY

An EIS was approved by the Macedonian Government in November 2011 based on the Conceptual Study. This covered the project area but was submitted in relation to the Ilovica 6 licence area which does not include the whole project footprint.

An ESIA is currently being completed to meet Macedonian requirements and EBRD Performance Requirements and using details of the project defined in this document, based on the Ilovica 11 licence area.

Golder is responsible for the ESIA for the Ilovica project, with SWS providing all input on water topics (surface water, groundwater and geochemistry).

The objective of the ESIA is to identify and quantify impacts that the project may have on the biophysical and socio-economic environments by comparison to the ESIA baseline and project environmental design criteria. The ESIA identifies potential mitigation and management processes to minimise negative impacts and maximise positive impacts.

The following basic elements make up the methodology adopted in the ESIA:

- Establish study areas for baseline data collection and establish baseline conditions;
- Establish the project description to be assessed, including the incorporated environmental and social measures;
- Evaluate stakeholder engagement information;
- Confirm the key receptors and their sensitivity or importance;
- Characterise the potential effects on receptors (effects analysis);
- The effects analysis is the modelling or qualitative analysis used to determine whether there is any change due to the development and to predict the magnitude of the change. Direct, indirect and combined effects will be considered in the ESIA.
- Determine the nature and scale of impact, combined with the importance/sensitivity of receptors (impact assessment);
 - The impact assessment uses the results of the effects analysis to quantify the impact on key receptors (e.g. villages, dwelling, areas of cultural importance, watercourses, land use). The magnitude of the effect will be determined by taking into account the following factors:
 - magnitude of change
 - geographic extent of change;
 - duration of change; and
 - frequency.
- Consider the need for mitigation measures should impacts be considered unacceptable;
 - Should the results of the impact analysis show unacceptable results, mitigation may be identified according to the hierarchy of options:

- Avoid;
 - Minimise;
 - Restore;
 - Compensate; and
 - Improvement measures.
- Assess the significance of residual impacts (after mitigation);
 - Residual impacts are those that remain following the implementation of the proposed mitigation. Residual impacts will be defined based on the same process applied to the evaluation of impacts.
 - Consider other operating or planned projects in the region (cumulative impact assessment); and
 - The assessment of cumulative impacts will consider the effects of other developments in the vicinity of the project which are operating, under construction or have been consented which, when combined with the effects of the project, may have an incremental effect.
 - Develop monitoring and management plans.
 - An environmental and social management system (ESMS) will be prepared, based on the findings in the ESIA. The ESMS will consist of a set of management plans which identify management processes, mitigation and monitoring to be carried out during project construction, operation and maintenance to manage key potential environmental and social impacts identified in the ESIA.

20.2 REGULATORY FRAMEWORK AND PERFORMANCE STANDARDS

The technical standards to be applied in the ESIA are a combination of Macedonian regulation and international standards. Regulatory Macedonian instruments, which will guide the acceptability of effects of the project and which are specific to technical topics, are described further in the ESIA baseline chapters. International standards to be applied have been selected based upon good international practice and the requirements and expectations of investors in the Ilovica project. These include:

- EBRD Environmental & Social Policy and Performance Requirements (2014);
- European Union Directives, Regulations and BAT reference documents;
- ICMM Sustainable Development Framework;
- International Cyanide Management Code;
- Voluntary Principles on Security and Human Rights;
- International Finance Corporation (IFC) Environmental & Social Policy, Performance Standards (2012), and environmental, health and safety (EHS) Guidelines (general and mining); and
- IFC/EBRD Guidance on Workers' Accommodation.

An EIA is required in Macedonia under Article 77 of the Law on Environment and associated regulations. The Law on Environment sets out the procedures, timeframes, content and decision-making process for EIAs. Relevant secondary legislation includes regulations for the projects for which an EIA is required, the requirements for the content of an EIA, and necessary information to be included in notifications and public announcements.

Under Article 83 of the Law, the EIA can be conducted by any individual, expert, or legal entity but must be signed off by one person from the list of experts (as defined under Article 85 of the Law) who takes responsibility for the quality of the study. It has been agreed with Euromax Resources that Dragi Peltechki (In Country Project Manager) will fulfil this role for the Ilovica ESIA.

20.3 BASELINE CONDITIONS

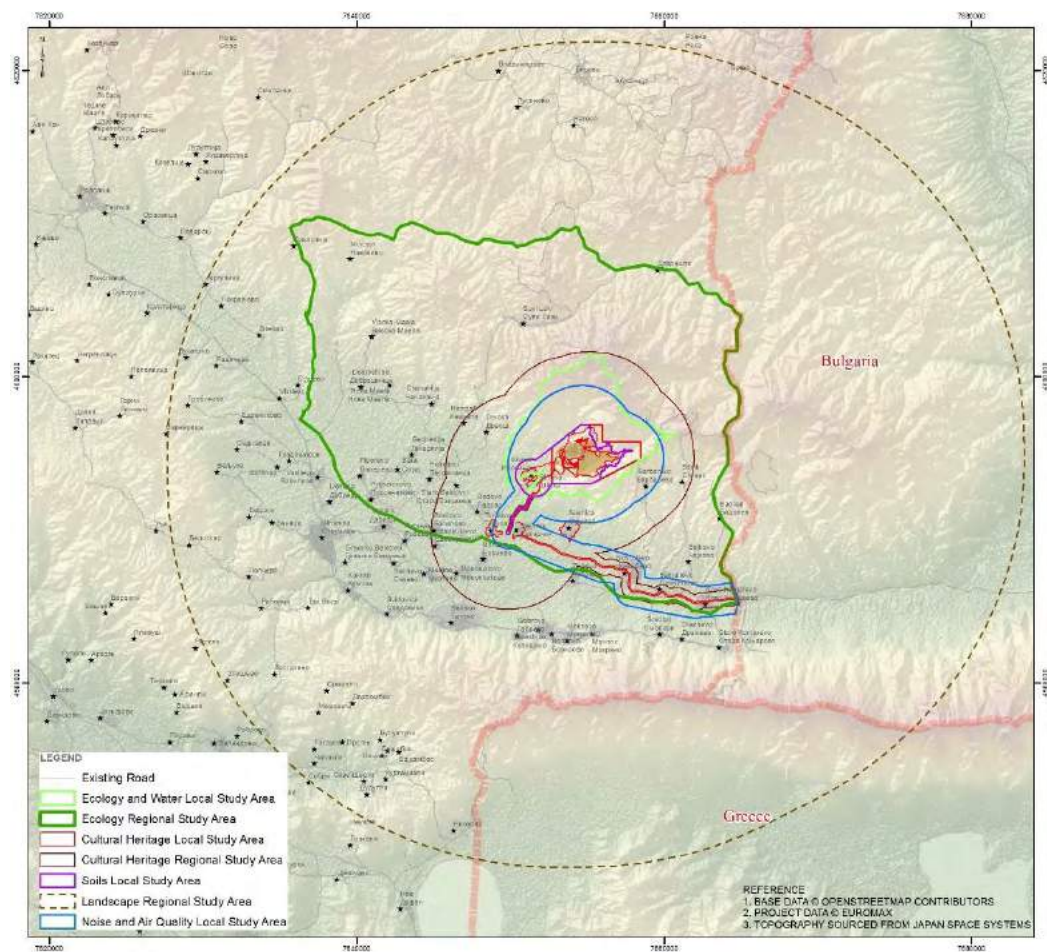
ESIA baseline data gathering was completed in August 2015 and will inform the effects analysis and the assessment of impacts. Secondary (literature) and Primary (in situ) data gathering has been completed for the following technical areas:

- Air Quality and Climate
- Noise
- Geomorphology, Soils and Land Use Capability
- Groundwater and Surface Water
- Geochemistry
- Ecology and Biodiversity
- Ecosystem Services
- Archaeology and Cultural Heritage
- Social (including Socio-economics, Agriculture and Forestry)
- Landscape and Visual Assessment.

Biophysical data was gathered in the study areas specific to the technical topics (Figure 20.1), with a view to characterising the local area which could be subject to effects of the project and to inform the effects analysis and impact assessment.

Data continues to be collected on air quality and climate, groundwater, surface water and geochemistry. Social data was gathered based around communities which could be affected by the project. The regional study area included Bosilovo and Novo Selo municipalities and Strumica. The LSA focused on Ilovica and Shtuka.

Figure 20.1
Biophysical topic study areas



20.3.1 Geographic Setting

The majority of the LSA is dominated by rugged low altitude mountains which protrude prominently in the landscape relative to the lowland zone. The highest peak in the LSA (part of Mount Ograzhden) is located at the summit of Anovi at 878 m AMSL; the lowest elevation is located in the southwest corner of the LSA along the Shtuka River at about 256 m AMSL.

The Jazga and Shtuka catchments, in which the proposed project is located, are approximately 45 km² and 22 km² in area respectively and are situated on the south-facing slopes of the Ograzhden mountain range on the northern side of the Strumica River basin. The Jazga River flows through the village of Ilovica into the Turija River near Turnovo. Upstream Turija River flows are regulated by the Turija reservoir. Downstream of the Jazga confluence, the Turija River flows into the Strumica River. The Shtuka River flows through the village of Shtuka directly into the Strumica River near Sekirnik.

Groundwater occurrence in the Strumica River basin is dominated by the sedimentary aquifer underlying the Strumica plain. In the mountains, including the Ilovica deposit area, the geology is dominated by crystalline granitic rocks and groundwater occurrence is limited to fault zones and fractures and to alluvial

deposits of very limited thickness in the bottoms of steep valleys. Ilovica and Shtuka villages are located on the northern fringe of the Strumica Plain alluvial aquifer system.

There is significant variation in the landscape. The Strumica Valley is predominantly flat agricultural land, which contrasts with the forested mountains which rise steeply either side of the valley. Slope gradients on the mountains range from moderately steep (30% to 60%) to very steep (>60%). Slope gradients of <15% are uncommon on the mountains and only occur in isolated locations such as terraced hillslopes and upland saddles and ridges. In lowland areas, slope gradients are mostly <15%; the notable exception is the hilly topography transitioning up to the highland zone and along some incised fluvial channels. Low gradients (<5%) occur on well-drained plains in the lowlands.

20.3.2 Physical Environment

The physical environment has been defined using a combination of desk based literature research and the following data gathering activities:

- Air Quality (dust, particulates and NO_x, SO_x and ozone data collected by the ESIA team at villages and key receptors in the study area)
- Climate (data from the Euromax Resources meteorological station and historic data from regional stations)
- Noise (data gathered by the ESIA team at villages and key receptors in the study area)
- Geomorphology, Soils and Land Use Capability (data gathered by the ESIA team in the study area)
- Groundwater, Surface Water and Geochemistry (data gathered from surface water and groundwater bodies by the ESIA team in the study area)
- Landscape and Visual Assessment (3D modelling and photographic data collected by the ESIA team at villages and key receptors in the study area)

The following subsections provide a summary of baseline characterisations within each of the topic areas that have been extracted from the ESIA baseline chapters.

20.3.2.1 Air Quality

Overall, the baseline monitoring indicates that ambient air quality within the study area is good and that sources of local atmospheric pollution are limited. The monitoring results indicate the following:

- Ambient NO₂ concentrations are relatively consistent across the study area, although variation is observed between lower concentrations in more rural locations and at locations closer to the roads and combustion sources in villages. Ambient concentrations across the study area are substantially below environmental design criteria (EDC²⁸) limits for the protection of human health. Measured concentrations are also substantially below EDC limits for the protection of ecosystems.
- In the absence of significant local emission sources, ambient SO₂ concentrations are consistent across the study area, with little difference between rural locations and at locations closer to roads

²⁸ The EDC is a Golder and SWS document generated as part of the Engineering Design Considerations document (ref: 13514150363.526/A.0) to guide the engineering teams in their design of the project, providing design guidelines for water discharge, noise, air quality and soils/sediment.

and villages. Ambient concentrations across the study area are substantially below EDC limits for the protection of human health. Measured concentrations are also substantially below EDC limits for the protection of ecosystems.

- Variation in measured O₃ levels is experienced between more rural locations (higher concentrations) and those closer to roads and villages. The high O₃ levels at rural locations are considered to represent concentrations that are experienced on a regional level and are attributable to transboundary pollution (i.e. occurring elsewhere and transported to Ilovica and surrounding region). It is expected that exceedances of the 8 h EDC limit occur in rural locations and is considered probable at village locations.
- Measured levels of deposited dust are typically higher close to roadside locations than in other parts of the villages or in rural locations. The levels of measured deposited dust are influenced by meteorological conditions, with higher concentrations measured during dry summer periods. Measured deposition levels are below EDC limits on an annual and monthly average basis.
- Long term monitoring of PM₁₀ and PM_{2.5} indicates that annual average levels are substantially below the EDC limits, however short term periods of elevated concentrations were observed in the data. Short term monitoring at other locations within the study area indicates the potential for higher ambient concentrations at locations closer to the M6, particularly Sekirnik, reflecting the trend in measured dust deposition levels. However, extrapolation of the measured levels indicates that PM₁₀ and PM_{2.5} concentrations will remain below EDC limits.

20.3.2.2 Climate

Key meteorological parameters were recorded between 2013 and 2015 to characterise local climate conditions. The area has a mildly continental climate with typical seasonality, although some effects on measured conditions, such as higher wind speed, may be attributed to the elevation and position of the monitoring station.

The following key trends were identified from the data:

- Temperature is highest during the months of June to September with peak temperatures generally recorded in August and the lowest temperatures recorded during the winter months, particularly December and January. As expected, the same trends are seen in the solar radiation data.
- Relative humidity displays the same seasonal variation as temperature, but with lower relative humidity during the summer months (approx. May to September) and higher relative humidity during the autumn and winter months (approx. October to March).
- Precipitation data suggests that there are a large number of low intensity rainfall days in the spring and winter, with shorter duration high intensity rainfall days tending to occur during the summer months. Monthly precipitation levels tend to be consistent throughout the year with slight increases in June and towards the end of the year.
- The dominant wind direction at the Euromax Resources meteorological station is bimodal although predominantly south-easterly in direction. The location of the monitoring station within the mountain range is likely to influence this bimodal pattern due to channelling of the wind. The same effect is potentially also observed in the wind speed data where the average monthly wind speeds are greater than those recorded at the Strumica station. Wind speeds are generally greater during the spring and early summer and they reduce slightly for the remainder of the year.

The trends in measured data from the Euromax Resources meteorological station are similar to those observed at the Strumica and Ilovica village stations, located elsewhere in the region, although levels of monthly average precipitation, relative humidity and wind speeds are generally higher at the Euromax Resources meteorological station than at the other locations.

20.3.2.3 Noise

Measured noise levels at the majority of receptors in the study area were found to be predominantly influenced by natural noise sources. These included wildlife, such as birds and insects and also domesticated animals including chickens, cows, dogs and pigs, as well as wind-induced noise from rustling vegetation. This is consistent with the rural nature of the study area, in which industrial and commercial mechanised noise sources are largely absent.

The primary anthropogenic noise source in the study area is the M6 from Strumica to Bulgaria. Traffic flows on the road are typically low, however, there is a significant component of articulated heavy goods vehicles. Villages through which the M6 passes typically exhibited higher period-averaged ambient noise levels and minimum hourly-averaged ambient levels. The highest ambient noise levels were recorded at monitoring locations in Novo Konjarevo, Samuilovo and Novo Selo.

In villages close to the M6 where the monitoring locations were sited away from the road, including Sekirnik and Turnovo, noise levels were comparable with villages remote from major roads. This suggests that traffic noise alone is the dominant factor in the higher noise levels in villages close to the road, rather than additional anthropogenic noise associated with settlements on a major transport route. Additional evidence of this is seen in the measured background noise levels at monitoring locations adjacent to the M6, which are comparable to those measured in villages remote from the road.

20.3.2.4 Geomorphology, Soils and Land Use

The most common soil map units in the LSA are those derived from colluvial deposits (1a to 1c). These soils are located in the highland zone (mountainous regions) and are characterised by moderately well to rapidly drained soils of variable texture and coarse fragment contents (primarily angular to subangular). These soils developed on high relief (i.e., moderately steep to very steep) slopes, dominated by Regosols and Cambisols, occupying about 50 of the total LSA (about 64% of the highland zone).

The majority of the LSA is characterised by steep (>30%) to very steep slope gradients (>60%). During intense or extreme rainfall events, the potential for soil erosion is a function of increases in slope gradient and slope length. Gully, sheet wash, rill erosion, landslides (active, inactive and relic) and rockslides occur in the LSA.

The LSA is prone to geohazards due to a mountainous landscape (steep slopes), climatic variability (including intense rainfalls and aridity), old, deeply, weathered bedrock, and highly erodible soils (coarse-textured). Geohazards can include mass movements (e.g., landslides, debris flows, soil creeps, lateral spreads, mudslides, rockfalls), liquefaction, or seismic events (i.e., earthquakes). Although the majority of geohazards are likely to be natural; anthropogenic activity such as deforestation, unsustainable agriculture, access road construction and alteration of water flow patterns (e.g., surface flow, irrigation, and reservoir drawdown) can increase the geohazard risk.

The land use characterisation in the LSA focused on irrigated soils for agriculture in the lowlands, pastoral agriculture on the highland areas (due to cattle that graze the higher elevations around the planned project area), and forestry.

20.3.2.5 Groundwater, Surface Water and Geochemistry

The water environment setting and characterisation is described in detail in Section 18.3 of this report.

20.3.2.6 Landscape and Visual Assessment

The landscape within and surrounding the concession area is not designated or protected. It is attractive, yet reasonably commonplace within the wider region.

In terms of the direct physical effects, the preliminary project footprint (including the access road and the powerline) extends into the open agricultural plain, transition zone, the mountain forest and the pasture/scrub in the highlands.

The main parts of the mine (the open pit, TMF, stockpiles, lower/upper plant sites, haul roads and conveyor) are located almost entirely within mountain forest which is considered to be of high sensitivity due to the dramatic landform, tranquillity and lack of human intervention.

20.3.3 Biological Environment

The biological environment has been characterised using a combination of the following surveys, which allow a baseline for ecology, biodiversity and ecosystem services to be established in the LSA.

- Large/Medium Mammals
- Small (micro) Mammals
- Bats
- Birds
- Herpetofauna
- Terrestrial Invertebrates
- Fisheries
- Aquatic Invertebrates
- Terrestrial Flora
- Aquatic Flora
- Flora/Fauna Bioaccumulation
- Decapod survey
 - Wetted perimeter survey
 - Habitat Mapping
 - Ecosystem Services

20.3.3.1 Terrestrial Flora

A total of 271 vascular species of plant were recorded within the LSA during baseline survey. Within these findings, there are two grassland communities from Annex I of the Habitat Directive (Balkan montane *Nardus stricta* swards and Helleno-Balkan short grass and therophyte communities). Floral species of conservation concern include bladder campion (*Silene vulgaris*) which is described on the European Corine List of threatened species (endangered at European level). This species appears to be relatively widespread throughout the LSA.

Habitats within the LSA are dominated by sessile oak forest (Orno-Quercetum petraeae) which covers 1447 ha. Grazing pasture of differing biodiversity quality also contributes largely to the overall habitat composition. Much of the oak/hornbeam forest (Querco-Carpinetum orientalis) and sessile oak forest (Orno-Quercetum petraeae) is modified by frequent and extensive clear cut felling through licenced and un-licenced operations.

A total of 138 species of fungi were also recorded within the LSA. From the known species, *Boletus quellingii* is listed on the provisional European red list of threatened fungi and is described as category B 'evidence of steady decline, some national extinctions, medium-level concern'. Furthermore, Caesar's mushroom (*Amanita caesarea*) is considered to be endangered at the National scale.

20.3.3.2 Invertebrates

A total of 82 species of Lepidoptera invertebrates have been identified during baseline surveys within the RSA and LSA. Eleven species of the order Coleoptera invertebrates have been recorded within the RSA and LSA during baseline surveys. Four saproxylic (invertebrates that rely on dead or dying wood) species of conservation concern (SoCC) have been identified. A total of 15 species of odonata invertebrates were recorded within the LSA during baseline surveys. This included two species listed as being near threatened, namely the Eastern Spectre (*Caliaeschna microstigma*) and Downy Emerald (*Cordulia aenea*).

The combined survey area (RSA and LSA) is species-rich for Lepidoptera invertebrates as the number of species identified reflects nearly 40% of Macedonia's total number of butterfly species. A total of seven SoCC have been identified which includes the Large blue (*Phengaris arion*) which is considered to be endangered at the European level by International Union for Conservation of Nature (IUCN). Large blue butterfly larvae initially feed on the flower-heads of wild thyme (*Thymus polytrichus*) but from their fourth instar they feed on ant grubs within the nests of the *Myrmica* red ants.

Much of the LSA is designated by Butterfly Conservation Europe as a PBA. PBAs are designated throughout Europe at a considerable scale. The Ilovica PBA stretches from the village of Ilovica upstream along the Jazga River toward the highest peak of Ograzden (1745 m). The designating butterfly species of the PBA are Large blue and Apollo (*Parnassius apollo*), the latter of which was not observed during surveying.

20.3.3.3 Terrestrial Fauna

A total of ten species of large and medium mammals were identified during surveys in the LSA. Species such as the pine marten (*Martes martes*) and fox (*Vulpes vulpes*) appeared to be relatively widespread and abundant and were frequently observed through the camera trapping surveys. Species such as

golden jackal (*Canis aureus*) and roe deer (*Capreolus capreolus*) were observed less frequently, though these species are considered to be generally common and widespread with large territorial ranges.

A total of 15 species of small or 'micro' mammals were identified during surveys in the LSA. This number represents 40% of the total number of micro-mammals present at the National scale. Of these fifteen species, the forest dormouse and the common dormouse are afforded a level of conservation protection under the EU Habitats and Species Directive. A total of 16 species of bat were recorded within the LSA during baseline surveys. All of the observed species are protected according to the EU Habitat Directive and three of them are classified as "Near Threatened" by the IUCN.

In total, 113 species of bird have been recorded within the LSA during baseline surveys. This represents approximately 36% of the total avifauna present at the national scale (Micevski, 2002/2003). More than 50% of the birds recorded within the LSA are resident species; around 30% were identified only during the breeding season and the remaining ca. 20% are transient or solely over wintering (Biomaster, 2014).

A total of 25 species of herpetofauna have been recorded within the LSA. This represents nearly 50% of the herpetofauna known to exist within Macedonia. Of that number, 19 can be considered to be SoCC, including toads, tortoises, terrapins, frogs, lizards, vipers and snakes.

20.3.3.4 Aquatic Resources

Riparian habitats include:

- Reed beds are represented in the lower Jazga and Shtuka floodplain. This habitat corresponds to European Nature Information System (EUNIS)²⁹ habitat classification D5.1 and provides ecological functionality by hosting nesting and foraging birds, creating linear vegetative connectivity and also lowering nutrient status within an aquatic system.
- Willow woodland within the LSA potentially corresponds with EUNIS Habitats. This habitat generally flourishes in the lower Jazga and Shtuka floodplain where seasonal inundation occurs and sandy alluvial soil is prevalent.
 - Hiporhithral Streams (those < 5 m in width) correspond with EUNIS Habitats. The likely elevated nutrient status of the lower Jazga and Shtuka systems had allowed the development of macrophytes such as *Potamogeton* sp. whilst in the lentic (low or no flow) sections duckweed (*Lemna minor*) often covers the water surface completely

No fish were found in the upper catchments of the Shtuka and Jazga Rivers. Within the lower Jazga and lower Shtuka, barbell were observed. In the Strumica River, eight fish species were caught with barbell (61%) dominating the catches. All of these species are classified as least concern by the IUCN.

A total of 21 families that feature on the Biological Monitoring Working Party (BMWP) index were observed during the aquatic invertebrate survey. The dominant families are crustaceans such as the gammaridae and mayflies from the baetidae and ephemeridae families. Sampling sites provided results that ranged from 'moderate' to 'clean' with the majority of the sites being classified as 'fairly clean'. Aquatic

²⁹ The European Nature Information System (EUNIS) habitat classification is a pan-European system, which was developed by the European Environment Agency (EEA) in collaboration with experts from throughout Europe. It covers all types of natural and artificial habitats, both aquatic and terrestrial

invertebrate assemblages recorded within the LSA are considered to be common and widespread and no family groups of conservation concern were identified.

A total of 22 micro-sites hosted decapods, with stone crayfish at 21 micro-sites in both the Jazga and Shtuka Rivers and freshwater crab at only one micro-site on the Shtuka River. Throughout the RSA and LSA, stone crayfish were observed as juvenile and adult forms at different stages of sexual maturity. The stone crayfish has been assessed as data deficient by the IUCN, but is listed under Annex II of the EU Habitats Directive as a species requiring special conservation measures (Souty-Grosset *et al.* 2006).

20.3.3.5 Bioaccumulation

Bioaccumulation of metals analysis was completed on ungrouped tissue samples from some of the fish, amphibian and plants processed during the assessment. Results for arsenic, mercury, copper, cadmium, lead, antimony, thallium and zinc have been recorded. Baseline results were consistent across the Shtuka and Jazga catchments, except for elevated results for some metals in samples from the middle Shtuka site. This may be attributed to groundwater discharge from the ore deposit discharging via spring to a small tributary which joins the Shtuka just upstream of this monitoring location.

20.3.3.6 Critical Habitat

The approach to critical habitat screening is described in the ecology and biodiversity baseline chapter. Whilst the LSA hosts a number of species of conservation concern, critical habitat has only been triggered by a single species: the Large blue butterfly. Many of the species that may be considered to be of conservation concern are classified as vulnerable or near threatened at the European scale (e.g. Stone crayfish, Common tortoise, Rosalia alpine, Long-horn beetle and Barbastelle bat). Despite this, their extensive geographic ranges (often throughout Europe) preclude the critical habitat trigger. In contrast, the classification of Large blue butterfly as endangered, regardless of its range, triggers critical habitat.

20.3.4 Socio-economic Environment

Socio-economic parameters of study were selected based on an understanding of the project and its potential effects, and discussion with Euromax Resources staff residing in the region and local experts from the Goce Delcev University. At the national level, the following topics are discussed:

- Political environment;
- Economic environment;
- Social environment; and
- Physical infrastructure.

At the regional and local level, the discussion of socio-economic baseline conditions goes into greater detail and addresses the following parameters:

- Population demography;
- Government;
- Economic and land use activity;
- Employment and incomes;

- Education;
- Health and wellbeing; and
- Physical infrastructure.

The socio-economic environment has been characterised using desk based research, household surveys, focus groups and key informant interviews.

A household survey was designed to capture relevant socio-economic information pertaining to demographics, employment and incomes, educational attainment, and agricultural activity in the primary affected communities of Ilovica and Shtuka. There are 464 households in Ilovica and 207 in Shtuka and the target sample size for the survey was 20% of households. In total, 108 households in Ilovica and 48 households in Shtuka were surveyed, representing 23% of the households in each community. The number of individuals captured by the surveys was 784 in Ilovica, and 338 in Shtuka.

A series of focus group discussions were conducted with representatives from various organisations active in the socio-economic LSA to obtain contextual information on relevant socio-economic topics. Key informant interviews were conducted to support and supplement the household surveys and focus groups, and tend to focus on a specific topic areas (e.g., education, business).

20.3.4.1 Economic Environment

In both the municipalities of Bosilovo and Novo Selo, arable land and gardens (i.e., plough land) comprises the majority of agricultural land, accounting for 85% (6 528 ha) of land in Bosilovo and 62% (5 318 ha) in Novo Selo. While Novo Selo maintains less plough land than Bosilovo, the municipality keeps a comparatively large amount of pasture land (2 555 ha or 30% compared to 92 ha, or 1%, in Bosilovo). Vineyards are more prevalent in Bosilovo, accounting for 7% (566 ha) of agricultural land in the municipality compared to 1% (89 ha) in Novo Selo. Meadows and orchards account for less than 5% of the agricultural land in each municipality.

Ilovica and Shtuka generally match the agricultural land use distribution in the municipality of Bosilovo, with the exception of a higher proportion of land devoted to meadows. Most (72%) households maintain plough land for growing vegetables and industrial crops (i.e., tobacco). A smaller, yet still significant, number of households hold meadows (40%) and vineyards (34%). Few households maintain fallow fields (8%), pastures (5%) or greenhouses (4%). Approximately 60% of households gained an average annual gross income of €3 494 from plough land in 2014. Subtracting the average annual cost of upkeep (€804), this represents a net agricultural income of €2 690.

In Ilovica and Shtuka, livestock is raised primarily for home use, with little being sold to market. Nearly half of all households keep cattle, with the average household keeping about five cows. With the exception of several larger (i.e. 50 head) herds raised for sale, most cattle are kept for milk. Approximately 30% of households keep around two pigs per household for meat. A smaller number of households keep goats, mostly for milk (16%) and sheep (4%). Sheep are raised in herds ranging from 6 to 60 head, and are kept primarily for meat, or breeding. Over a third (36%) of households keep poultry, largely for egg production and household consumption. While several households have large flocks (i.e. 20 or more birds), most maintain a smaller number of birds.

A limited amount of forestry activity occurs in the area immediately around Ilovica and Shtuka. Several private forest owners in the area sell wood to local processing companies and as fuel mainly for domestic furnaces. The manufacturing industry in southeast Macedonia is concentrated in Strumica. Textile manufacturing also still occurs, however, in Strumica.

Hunting was not noted as a prevalent activity for residents of Ilovica and Shtuka, where only a small number of residents (i.e., less than 1%) hunt. Fishing also occurs to a limited extent in the region, including in the Ilovica reservoir and in regional rivers (FG, 2015).

20.3.4.2 Social Environment

The population of Strumica, the largest centre in the region, was 54 676 in 2002. Though natural population growth and rural-to-urban migration to the city has occurred over the past decade, so too has out-migration to Skopje and abroad.

The population of Ilovica is younger than that of Shtuka, with a median age of 35 versus 38. This is influenced the fact that 26% of the Shtuka population is aged 60 and over, while the same is true of only 18% of the Ilovica population. The portion of the population under the age of 20 is similar in both Ilovica and Shtuka. Most residents of Ilovica and Shtuka identify as ethnically Macedonian (77% and 99%, respectively). There is also a large Turkish population in Ilovica (20% of the village population), and several Roma, Bulgarian and Albanian households. The population of Ilovica has a gender ratio (male to female) of 51:49, and 54:46 in Shtuka.

In Ilovica and Shtuka, 32% of the population aged 18 and over has not completed primary school, while, for 36% of the population, primary school is the highest level of education completed. Twenty seven percent of the population has completed secondary school as their highest level of education. 3% of the population aged 18 and over possess an academy diploma or a bachelor's degree.

In Ilovica and Shtuka, females engaged in waged employment earned, on average, more than males (i.e., €308/month versus €234/month). This could be explained by the higher representation of women in healthcare, education and manufacturing industries compared to men.

20.3.4.3 Physical Infrastructure

Primary medical clinics (e.g., family doctors and paediatricians) are available in Strumica, and the city's Old City Hospital and General Hospital provide secondary medical care (e.g. gynaecology, psychiatry, surgery) to the Southeast Region. There is an emergency medical department in Strumica that provides ambulatory care services to the Southeast Region. There is a primary healthcare clinic in Ilovica staffed by a doctor, dentist and two nurses.

Public water supplies are obtained from the Jazga and Shtuka Rivers and from groundwater sources.

A description of the sources of potable and non-potable water to the communities is presented in Section 18.3 of this report. The following provides a summary of socio-economic information relating to water supply, which has been acquired as part of household surveys and complements the infrastructure and hydrological data presented in Section 18.3. In summary, the public water supply sources comprise the following:

- One intake on the Jazga River upstream of Ilovica and two intakes on the Shtuka River upstream of Shtuka, treated by sand filter and not considered potable (supplied for MKD10 (€0.16) per cubic metre);
- Ilovica Reservoir, located on the Jazga River upstream of Ilovica, supplies water to seven villages on Strumica plain (Bosilovo, Sekirnik, Turnovo, Radovo, Borievo, Ednokukevo and Robovo) and Shtuka in the summer and Ilovica in particularly dry years (available to local residents at a cost of MKD30 (€0.50) per cubic metre. During dry periods when the Jazga and Shtuka off-takes do not provide water, treated water is offered at a reduced cost; and
- Two spring sources in Ilovica and Shtuka are regarded as important public water supply sources. Both springs have been renovated by Euromax Resources and are understood to be used almost exclusively as potable water supply sources, with the water being used in preference to the supplies piped from the Jazga and Shtuka River intakes. Villagers collect water in bottles and hand-carried containers.

There are a number of wells and boreholes which are used to supply water to households within Ilovica and Shtuka villages. Although they supply multiple households, all of these sources are believed to be privately owned.

Individual settlements have unofficial (i.e., illegal) waste dumping sites, typically located in large pits or river valleys. There is currently approximately 2 000 m³ of illegal dumps in the Municipality of Bosilovo. While municipal utility authorities attempt to concentrate these dumping sites to reduce their prevalence, they recognise that the necessary standards for waste disposal are not being met. In both Ilovica and Shtuka, dumping sites are located in the river valleys on the edges of each community. Waste collection is not available in either Ilovica or Shtuka.

20.3.5 Stakeholder Engagement

The fundamental principle of stakeholder engagement is for stakeholders to have meaningful input in the early stages of the ESIA. The program is designed to address the following three primary goals:

1. Disseminate information to potentially impacted stakeholders and other concerned members of the public regarding the project description, potential environmental and socioeconomic effects, planned mitigation measures and monitoring throughout the various phases of the project;
2. Actively seek comments from stakeholders regarding existing environmental and socioeconomic conditions in the project area, potential environmental and/or socioeconomic effects of the project and possible mitigation measures that could be incorporated to resolve those issues; and
3. Document and respond to all public issues in a timely manner.

The following communities have been identified as forming the outreach area for stakeholder engagement. Communities are grouped according to how they may be affected by the project and project activities:

- Primary Affected Communities
 - Ilovica
 - Shtuka
 - Strumica

- Secondary Affected Communities

- Borievo
- Bosilovo
- Drvosh
- Ednokuvevo
- Novo Konjarevo
- Novo Selo
- Petralinci
- Radovo
- Robovo
- Sekirnik
- Staro Baldovci
- Sushica
- Turnovo

Ilovica and Shtuka are likely to be most affected by the project, (e.g. water, visual, noise, air). However these two villages would also capture project benefits such as direct community investments, employment and perhaps will see some other economic benefits from project procurement and spending.

Categories of stakeholders that have been identified include:

- Business Owner/Contractor
- Elected Official - Mayor's Office
- Elected Official – Other level of government
- Farmer's Association
- Forestry Company (other commercial tenure holders)
- Government dept. – Municipal
- Government dept. – Regional
- Government dept. – National
- Non-elected leaders/administrators (economic, planning and emergency response departments)
- Health services
- Education sector reps
- Youth Council
- Hunting Association (recreational users)
- Land Owners
- Law Enforcement Official
- NGO/ENGO Official (environmental groups); and
- Religious organisation.

Two rounds of stakeholder engagement activities have been completed during the baseline period, each with a broad focus:

- Round one (March/April 2015): Focus groups and key informant interviews during which Golder and Euromax Resources introduced the project and the ESIA process and sought input to refine draft baselines and scope for the ESIA
- Round two (September 2015): Open houses at Ilovica and Novo Selo, where Golder, SWS and Euromax Resources reported back on the results of baseline studies (including the results of the water studies), provided an update on the project description, and described the upcoming impact assessment process.

A further round of stakeholder engagement is planned for 2016 during which the results of the ESIA will be presented.

20.4 POTENTIAL IMPACTS

The ESIA is currently being completed. The information in Table 20.1 presents the initial analysis completed at scoping stage to guide the baseline data gathering and is a guide to some of the key issues being assessed in Section 20.3.4.

Table 20.1 Communities potentially affected by project and project activities					
Communities	Potential project Effects				
	Traffic	Water Quality and Quantity	Air Quality and Noise	Visual	Other Potential Effects (incl. socio-ec)
Shtuka	Yes	Yes	Yes	Yes	Yes
Ilovica	Yes	Yes	Yes	Yes	Yes
Novo Selo	Yes	No	No	No	Yes
Novo Konjarevo	Yes	No	No	No	No
Strumica	Yes	No	No	No	Yes
Radovo	No	Yes	Yes	Yes	No
Turnovo	Yes	Yes	Yes	Yes	No
Sekirnik	Yes	Yes	Yes	Yes	No
Borievo	No	Yes	No	No	No
Bosilovo	No	Yes	No	Yes	No
Robovo	No	Yes	No	Yes	No
Ednokuvevo	No	Yes	No	Yes	No
Staro Baldovci	No	No	No	Yes	No
Drvosh	No	No	No	Yes	No
Sushica	No	No	Yes	No	No
Petralinci	No	No	No	Yes	No

The ESIA assesses the following potential effects of the project during construction:

- Air quality, Noise, Vibrations and deposited dust - due to ground clearance and exposed areas, traffic, generators and Greenhouse gases

- Geomorphology, Soils and Land use - due to clearance of TMF and project infrastructure, and land acquisition
- Water quantity, quality and sediment - due to ground clearance and exposed areas, seepage from waste facilities, diversion of the Shtuka, and construction of sediment control structures
- Visual - due to power line construction, traffic on roads, TMF dam construction and ground clearance
- Tangible and intangible cultural heritage - due to population changes, clearance activities and traffic
- Aquatic Biodiversity - due to changes in water quantity and quality and sediment, plus construction of in-channel structures
- Terrestrial Biodiversity and Ecosystem Services - due to clearance and air quality and soils effects
- Social - due to all of the above, plus changes to local economics, community health and safety, population changes, agriculture, land acquisition and employment.

The ESIA assesses the following potential effects of the project during operations:

- Air quality, Noise, Vibrations and deposited dust - due to blasting, mine operations, traffic and Greenhouse gases
- Geomorphology, Soils and Land use - due to clearance of TMF and project infrastructure
- Water quantity, quality and sediment - due to exposed surfaces, groundwater management in the pit and/or abstraction in the sedimentary basin, changes to drainage, diversion of the Shtuka, seepage from waste facilities, stockpiles, tailings and pit
- Visual - due to power lines, traffic on haul and access roads, TMF dam construction, oxide stockpile and open pit
- Tangible and intangible cultural heritage - due to population changes, air quality, water quality, traffic and physical footprint of mining activities
- Aquatic Biodiversity - due to changes in water quantity and quality and sediment, plus in-channel structures
- Terrestrial Biodiversity and Ecosystem Services - due to clearance and air quality and soils effects
- Social - due to all of the above, plus changes (positive and negative) to local economics, community health and safety, population, agriculture, land use and employment.

The ESIA assesses the following potential effects of the project following closure:

- Air quality, Noise and deposited dust - due to closure activities
- Geomorphology, Soils and Land use - due to effective rehabilitation of mine infrastructure areas, e.g. TMF, plant and pit
- Water quantity, quality and sediment - due to changes to drainage, diversion of the Shtuka, seepage from waste facilities, stockpiles, tailings and pit, decommissioning of in-channel structures and potential formation of pit lake
- Visual - due to effective rehabilitation of mine infrastructure areas
- Tangible and intangible cultural heritage effects - due to closure activities

- Aquatic Biodiversity - due to changes in water quantity and quality and sediment, plus in-channel structures and effective rehabilitation of habitats
- Terrestrial Biodiversity and Ecosystem Services - due to closure activities and effective rehabilitation of habitats
- Social - due to all of the above, plus changes (positive and negative) to local economics, community health and safety, population, agriculture, land use and employment.

20.5 MANAGEMENT AND MONITORING

Management plans will form an essential part of the ESIA, which itself will be an integral part of the FS. The management plans will in turn be incorporated by Euromax Resources into the ESMS that will be developed for the project and will be focussed on construction, operations and closure. Management plans will likely include the following as per Table 20.2.

Table 20.2 Management Plan	
Environmental	Social
Environmental, Social and Health and Safety Management System	Stakeholder Engagement
Pollution Prevention (incl. noise, dust, air emissions, vibrations)	Community Health, Safety and Security
Water resources	Cultural Heritage
Soil	Human Resources
Biodiversity	Workers Occupational Health, Safety and Security
Sediment and erosion control	Community Development
Waste	Transport
Mine waste	Emergency Preparedness and Response
Hazardous Materials	Land Acquisition and Economic Displacement
Spill response	Influx
Cyanide	
Footprint	
Conceptual Closure	

While each plan will contain a section on monitoring requirements, these may also be consolidated into a separate monitoring plan.

At the start of construction, Euromax Resources propose that contractors will be pre-qualified on various aspects including their health, safety and environment capabilities. They will sign off on the relevant management plans to confirm that they understand the standards which Euromax Resources require. Suitable contract clauses will be included by Euromax Resources in the main EPC/EPCM contract, with a requirement for sub-contractors to adhere to the same standards.

20.6 WASTE MANAGEMENT

A waste collection and sorting facility will be maintained at site. Currently, recycling opportunities in Macedonia are limited, as are specialist waste management facilities. As far as possible, waste streams such as packaging and containers will be returned to suppliers. From the collection and storage facility, some waste categories will be disposed of at local licenced municipal landfill sites.

These will be audited and Euromax Resources will ensure waste is recorded, handled and managed appropriately. This may require collaboration with the site operator(s) to ensure that waste streams are disposed of in accordance with international good practice. If necessary, export of small quantities of hazardous waste for specialist disposal will be considered.

Should municipal waste facilities be found non-compliant following the auditing process, Euromax Resources is committed to assisting the upgrade of existing facilities or seeking alternative waste management solutions either within the concession or at alternative municipal waste facilities in or outside of Macedonia.

20.7 REHABILITATION AND CLOSURE

Once the ESIA is complete a closure plan will be developed to incorporate all environmental and social issues including land use management, water management, social management and monitoring at closure.

It is likely that all plant, buildings, structures and associated infrastructure will be removed, and the site restored to grassland and/or woodland, to enhance and encourage habitats, as defined by the biodiversity action plan.

A number of environmental and social aspects are important for consideration at closure and include:

- **Deposit geochemistry:** The geochemistry of the tailings and mineralised waste rock have the potential for acid rock drainage from the tailings, waste rock and the pit lake slopes. It is reported that initial studies have indicated that any acid generative material may be managed by encapsulating with oxidised rocks. In addition, it is important to consider the potential effects from process reagents post closure.
- **Revegetation:** The regular spring and autumn rainfall will encourage re-vegetation of the mine site but it is proposed that this will be enhanced to encourage the development of similar habitats to those there at present, according to the biodiversity action plan.
- **Water:** Many of the local people around the project site require water supply for personal use, irrigation and farming. The ESIA assesses ways to maintain acceptable water supply in quantity and quality at closure and post closure.
- **Biodiversity:** The project will adopt a No Net Loss approach to Biodiversity, in line with IFC Performance Standard 6 (PS6), and will use the mitigation hierarchy to develop the best approach to meet PS6.
- **Presence of the Large blue butterfly triggers critical habitat under the definition in IFC Performance Standard 6** due to the endangered (EN, IUCN) status of the species. The concession sits within the PBA designated by Butterfly Conservation Europe. Large blue butterflies were not found within the mine footprint and the ESIA baseline identified that the likely Large blue butterfly habitat which is a subset of the PBA will not be directly impacted by the mine footprint. Nevertheless, the company is committed to working with the regulator to preserve and enhance the PBA where they do occur.
- **Socio-economic impact on local communities and labour at closure:** The impact of the cessation of the socio-economic benefits the project offers will be evaluated in the ESIA and measures put in place to maintain skills and manage influx/efflux.

20.8 KEY ENVIRONMENTAL AND SOCIAL ISSUES

The ESIA addresses the following key environmental and social issues:

- Security of water supply to Ilovica, Shtuka, plus other villages currently reliant on Ilovica reservoir
- Security of water supply for irrigation in Strumica basin
- Quality of potable water supply to Ilovica and Shtuka
- Quality of agricultural water supply to Ilovica and Shtuka
- Land acquisition for the new project access road
- Archaeological sites located within the LSA
- Culturally sensitive sites and rituals in local communities
- Population changes during construction and operations and following closure
- Prime Butterfly Area and associated critical habitat management
- Species of conservation concern in the LSA
- Closure and rehabilitation of the TMF
- Nuisance, noise and air quality due to changes in traffic
- Sediment control.

No fatal flaws have been identified within the impact assessment and an international ESIA for financing is currently being finalised in parallel with a local EIA that will accompany submissions for a construction permit in 2016.

21. CAPITAL AND OPERATING COSTS

21.1 CAPITAL COSTS

21.1.1 Overall Capital Costs Summary

21.1.1.1 Estimate Description

The Ilovica Gold-Copper Project FS Capex is a Class 3 estimate with an accuracy of $\pm 10\%$.

Sources of information include layout drawings, sketches, equipment schedules, BOQs, preliminary execution schedule and pricing from vendors. This information, together with previous experience of similar studies and projects, allows for contingency and growth allowance calculations. The combination of the aforementioned supports this level of accuracy.

The estimate is made up of sections for mining, process plant, tailings management facility, infrastructure and project indirect costs.

21.1.1.2 Estimate Base Date

September 2015, with some revisions to the contracts following tender clarifications.

21.1.1.3 Estimate Categories

Process plant, infrastructure and tailings management include direct costs, indirect costs, growth provision and contingency.

Mining includes direct costs.

Escalation will not be covered in the FS estimate and will be the responsibility of Euromax Resources to manage. The value of the estimate excludes escalation.

Provision for exchange rate variation or treatment of the perceived risk will not be covered in the FS estimate and will be the responsibility of Euromax Resources to manage. The value of the estimate excludes provision for exchange rate fluctuations.

21.1.1.4 Scope of Work

The scope of work covered by this estimate includes the engineering, procurement, construction and commissioning of the process plant and ancillary systems as described in Section 24.2.

The estimate is based on the engineering documentation mentioned within Section 17.3 of this report. The status of scope definition on which the estimate is based has been categorised as follows.

- Contract and procurement packages
- Take-off from drawings, identified from the mechanical equipment list
- Take-off from general arrangements, plot plans, single line diagrams and P&IDs
- Quantity estimates based on design documentation

21.1.1.5 WBS

The WBS was developed:

- To meet the requirements of the EPCM contractor to control time and money during execution;
- For Euromax Resources to adequately allocate final project costs to correct assets and maintenance planning requirements.

21.1.1.6 Estimate Summary

A summary of the capital cost estimates is presented in Table 21.1. Refer to the respective section numbers for detail of each of the categories.

Table 21.1 Capex Summary					
Section	Categories	Estimated Value (€)		Estimated Value (US\$)	
	Mining		€ 76 380 563		\$84 018 619
21.1.2	Mining (1000)	€ 68 430 324		\$75 273 356	
21.1.7	EPCM Indirects (8000)	€ 7 950 238		\$8 745 262	
	Process Plant, Infrastructure and TMF (incl. Temporary Facilities)		€ 354 792 940		\$390 272 233
21.1.3	Process Plant (3000)	€ 181 454 297		\$199 599 727	
21.1.4	Tailings Management Facility (4000)	€ 39 039 380		\$42 943 318	
21.1.6	On Site Infrastructure (7000)	€ 23 661 579		\$26 027 737	
21.1.7	EPCM Indirects (8000)	€ 107 301 104		\$118 031 214	
21.1.8	Temporary Facilities (9000)	€ 3 336 579		\$3 670 237	
	Estimate Total		€ 431 173 503		\$474 290 852

21.1.1.7 Owner's Costs

Detailed breakdown of Owner's Costs is shown in Table 21.2.

Table 21.2 Owner's Cost Summary			
Description	Base Value	€	US\$
Owners Project Indirects	\$3 250 701	€ 2 955 183	\$3 250 701
Environmental and Permitting	\$225 000	€ 204 545	\$225 000
Owners Procurement Services (Subs)	\$138 000	€ 125 455	\$138 001
Insurance	\$2 562 500	€ 2 329 545	\$2 562 500
Bulk power supply	€ 7 238 074	€ 7 238 074	\$7 961 881
Construction Power	€ 2 147 346	€ 2 147 346	\$2 362 081
Water supply	€ 3 000 000	€ 3 000 000	\$3 300 000
Specialist Training	€ 44 813	€ 44 813	\$49 294
Fleet Management System	€ 225 194	€ 225 194	\$247 713
Tyre Management System	€ 225 194	€ 225 194	\$247 713
Blast Management System	€ 225 194	€ 225 194	\$247 713
Simulator Training	\$377 813	€ 343 466	\$377 813

Table 21.2 Owner's Cost Summary			
Description	Base Value	€	US\$
Waste Management	€ 321 867	€ 321 867	\$354 054
Additional Labour	€ 5 700 814	€ 5 700 814	\$6 270 895
Land Acquisition Costs	€ 5 114 565	€ 5 114 565	\$5 626 022
TOTAL		€ 30 201 254	\$33 221 381

21.1.1.8 Foreign Currency

The base currency of the estimate is Euro (€).

Table 21.3 shows the various foreign currency rates of exchange advised Euromax Resources that have been used in the estimate to convert pricing in different currencies to the base currency.

Table 21.3 Foreign Currency Rates		
Euro	Currency	Value
€1.00	Macedonia Denar	ден 61.50
€1.00	United States Dollar	\$ 1.10
€1.00	Australian Dollar	\$ 1.45
€1.00	South African Rand	R 13.50
€1.00	Canadian Dollar	\$ 1.35
€1.00	Japanese Yen	¥ 135.00
€1.00	Chinese Yuan	¥ 7.10
€1.00	United Kingdom Pound	£0.75
€1.00	Indian Rupee	₹ 70.00
€1.00	Turkish Lira	₺ 3.20
€1.00	Swiss Franc	CHF 1.11

21.1.2 Mining (1000)

21.1.2.1 Basis of Estimate

Source of Data

Sources of information include layout drawings, sketches, equipment schedules, the preliminary execution schedule, database pricing and firm pricing from vendors.

Estimate Qualifications, Exclusions and Assumptions

Table 21.4 identifies some costs included and excluded from the mining portion of the overall capital cost estimate.

Table 21.4 Mining Capex Inclusions and Exclusions				
Description	Included in Capex	Excluded from Capex	Part of Owner's Costs	Part of Contingency
Open pit and hillside quarry type mining	✓			
Owner operated equipment and labour	✓			
Waste removal	✓			
Pre-strip mining (deliver rock to TMF)	✓			

21.1.2.2 Methodology

The initial Capex reflects the need to purchase all the mobile equipment required at the start of operation.

Mobile equipment costs have been obtained from the local Caterpillar agent (Teknoxgroup). Other costs are from DMT database sources.

Delivery, assembly and commissioning costs have been allowed for items where the cost is not included in the supply cost.

Sustaining Capex primarily reflects the need to purchase new trucks as the pit haul increases plus the transition from pre-strip to ore production, the overhaul costs required in maintaining the fleet and replacement of equipment. It has been assumed that the maximum life of any piece of equipment is 60,000 hours with proper repair, maintenance and overhaul. The maximum number of overhauls varies for each piece of equipment, depending on the type and nature of its task. Each piece of equipment has a number of hours of operating before it requires a major overhaul.

Mining Infrastructure

Refer to Sections 21.1.3 and 21.1.6. Generally, the same methodology has been applied. Distinctions are noted below.

Electrical Cabling

Cables to motors and motor control stations are generally assumed to be 150 m in length. Cables within transformer yards are assumed to be 30 m.

21.1.2.3 Capital Costs

The mining capital costs are presented in Table 21.5.

Table 21.5 Capital Cost Estimate Mining				
Description	Total Cost (€)	Total Cost (US\$)	% of Total DFC	% of Total Cost
Direct Field Costs				
Earthworks, Roads and Civil Infrastructure	€ 8 201 251	\$9 021 376	11.99%	11.98%
Reinforced Concrete	€ 1 205 593	\$1 326 152	1.76%	1.76%
Buildings	€ 2 853 125	\$3 138 438	4.17%	4.17%
Structural Steel	€ 1 628 330	\$1 791 163	2.38%	2.38%
Mechanical	€ 2 518 937	\$2 770 831	3.68%	3.68%
Piping and Valves	€ 798 570	\$878 427	1.17%	1.17%
Electrical	€ 278 242	\$306 066	0.41%	0.41%
Instrumentation	€ 7 010 574	\$7 711 631	10.25%	10.24%
Mining Consultant Mobile Equipment	€ 22 124 200	\$24 336 620	32.35%	32.33%
Pre-Strip Mining (deliver rock to TMF)	€ 20 466 071	\$22 512 678	29.93%	29.91%
Transport and Freight	€ 488 443	\$537 287	0.71%	0.71%
1 Year Spares	€ 220 890	\$242 979	0.32%	0.32%
Vendor Assistance	€ 345 593	\$380 152	0.51%	0.51%
Vendor Commissioning	€ 222 482	\$244 730	0.33%	0.33%
First Fill	€ 18 021	\$19 823	0.03%	0.03%
Total Direct Field Costs	€ 68 380 324	\$75 218 356	100.00%	99.93%
Professional Services	€ 50 000	\$55 000	0.07%	0.07%
Total Cost excluding Growth and Contingency	€ 68 430 324	\$75 273 356	100.07%	100.00%
Growth	€ 2 629 424	\$2 892 366	3.84%	3.84%
Contingency	€ 5 320 814	\$5 852 895	7.78%	7.78%
Total Growth and Contingency	€ 7 950 238	\$8 745 262	11.62%	11.62%
Control Budget Estimate	€ 76 380 563	\$84 018 619	111.69%	

21.1.3 Process Plant (3000)

21.1.3.1 Basis of Estimate

Source of Data

Sources of information include layout drawings, sketches, equipment schedules, engineered bills of materials, the preliminary execution schedule and firm pricing from vendors.

This information is supported by the team's collective previous experience of similar studies and projects by the engineering team.

Supporting Documentation

This estimate has stored all tenders received and adjudication documents electronically on the dedicated Ilovica Gold-Copper Project SharePoint site, managed by Amec Foster Wheeler.

Estimate Qualifications, Exclusions and Assumptions

Table 21.6 identifies costs included and excluded from the process plant and infrastructure portion of the overall capital cost estimate.

Table 21.6 Process Plant and Infrastructure Capex Inclusions and Exclusions				
Description	Included in Capex	Excluded from Capex	Part of Owner's Costs	Part of Contingency
Foreign currency fluctuations			✓	
Scope changes		✓		
Changes to design criteria		✓		
Provision for force majeure		✓		
Government duties, taxes, permit fees and the like			✓	
Licence fees			✓	
Spares and maintenance tools	✓			
Salvage value of temporary facilities		✓		
Salvage value of permanent facilities at end of plant life		✓		
Land cost, right of way, royalties			✓	
Project schedule delays, including but not limited to: - Unidentified ground conditions - Labour disputes - Receipt of information beyond the control of the EPCM contractor - Costs due to weather delays and work shutdowns				✓
Project schedule acceleration costs		✓		
Finance and interest during construction		✓		
Capital contributions to any statutory authorities			✓	
Environmental and ecological considerations (statutory approvals)			✓	
Environmental issues external to the plant site			✓	
Insurances – contract works and public liability			✓	
Utilities outside the plant boundaries	✓			
Value added and/or goods and services taxes		✓		
Legal costs			✓	
Project audits, external / independent audits		✓		
Working and sustaining capital			✓	
Research and development			✓	
Capitalised depreciation		✓		
Technical reviews	✓			
Hazard studies	✓			
Borehole development		✓		
Escalation			✓	
Activities of previous phases		✓		
Mine pit and waste dumps	✓			

Table 21.6 Process Plant and Infrastructure Capex Inclusions and Exclusions				
Description	Included in Capex	Excluded from Capex	Part of Owner's Costs	Part of Contingency
Mine haul roads	✓			
Tailings Delivery and Slurry Transportation System	✓			
Supply of water to the Ilovica reservoir			✓	
Overhead lines and grid interconnections	✓			
Access road from the mine concession boundary to the M6 road	✓			

Assumptions:

- All equipment and materials are new.
- Site construction contracts are based on unit price contracts.

21.1.3.2 Methodology

Quotations were obtained from suppliers. The following points were requested and have been included in the estimate where provided by the suppliers. In the event of costs being excluded by the suppliers, allowances have been made.

- Point of manufacture
- Delivery duration
- Cost of estimated spares (commissioning, critical and 1 year spares)
- Supplier assistance costs – installation and commissioning
- Shipping weight and dimensions
- Export packaging
- Freight costs from point of manufacture to site

Mechanical and Platework (including conveyors and tankage)

Mechanical equipment has been taken from process flow diagrams (PFD) and the resultant mechanical equipment list.

Quotations were requested from specified / qualified equipment suppliers (based in South Africa with European representation) for each piece of tagged equipment by issuing specifications based on SANS and datasheets.

Miscellaneous equipment has been priced by using supplier e-mail quotations or data from historical or other recent similar projects.

Tenders received were evaluated using short form technical evaluations. Where tenders were not received, allowances have been made based on historical data or current, similar projects.

All construction materials will generally be supplied from Europe. The pricing for the items listed below have been included in the construction contractors' scope of work:

- Structural steel supply – including light, medium, heavy, stairs, handrails, ladders, specialty items, etc.
- Pre-engineered building supply and installation or appropriate building construction costs for the area
- Fabricated platework supply.

Items of mechanical equipment have been included in the estimate as per the mechanical equipment list.

Pricing of mechanical equipment is based on tenders received. The erection or installation of equipment has been incorporated into the SMPP package. Where appropriate, vendor representation during construction has been included for relevant equipment.

In addition to tenders received and evaluated for both technical and commercial acceptance, installation costs have been assessed based on experience from previous projects and industry estimating norms.

Platework masses have been calculated from basic shapes and profiles. The cost of platework (chute work, bins, splitter boxes, sumps, launders, shop and site fabricated tanks etc.) and applicable lining material (VRN steel, ceramic or rubber) has been valued in accordance with estimated fabricated tonnages calculated by the mechanical discipline. Fabrication and erection rates were received from reputable steel fabricators and applied to estimated tonnages.

Tanks of size greater than 4.5 m diameter will be site-fabricated and constructed to minimise volume on shipments and possible road restrictions.

The pricing for the conveyor package includes design, supply and fabrication, with an allowance for delivery to site.

Request for quotations (RFQ) were issued to the market for equipment. Tenders were received and assessed technically and commercially.

Piping and Manual Valves

Process piping BOM was developed and estimated from general pipe routing drawings and the BOM was issued to the market for pricing as part of the SMPP package, similarly for a manual valve list.

In order to receive accurate pricing, the sizing of materials of construction was indicated in the RFQs. Pricing has been obtained for piping supply, fabrication and installation as a unit rate per metre together with unit costs for pipe fittings.

Costs for typical standard piping supports will be quantified during detailed engineering although an allowance has been made.

Valves were priced according to the issued valve list.

Civil, Earthworks and Infrastructure

For all civil engineering construction on the mine property, enquiry documents were prepared and issued to the market for pricing by contractors. The documentation comprised scopes of work, drawings, specifications and BOQ, as necessary.

Bulk earthworks costs are based on BOQs developed from plant layout drawings and contract rates tendered by competent earthworks contractors.

Rates were applied to bulk earthworks quantities on the basis that fill material will be available on a cut and fill basis.

A provisional sum was included in the BOQs to allow for dam liners and ancillary equipment.

Structural Concrete

Concrete quantities have been estimated by material take-offs based on general arrangement drawings and preliminary designs representative of the types of concrete structures required.

Concrete quantities are categorised by standard “class of concrete” commodity (columns, footings, slabs on grade, etc.).

Prices for the provision of site concrete works were based on BOQs and tendered rates applicable at the time of estimate.

The unit prices are inclusive of formwork, reinforcement, concrete placement and joints required.

Hold down bolts, embedded metalwork, excavation and backfill along with other miscellaneous items are included separately.

An allowance for acid proofing has been included based on previous experience of a similar plant.

Buildings

The footprint of all buildings was sized based on the operational manpower loading per building and facility requirements, the type of storey (single, double etc.) and materials of construction (e.g. the administration complex and the mine complex are light framed steel structures as recommended by the preferred contractor).

Tendered prices were obtained from the market place.

RFQs complete with relevant building schedules and engineering specifications were issued to specialist suppliers.

HVAC pricing includes associated auxiliary equipment and ductwork. Vendors provided a rate per square metre for this type of building.

Structural Steel

Structural steel quantities (per category of fabrication i.e. light, medium and heavy) have been estimated from material take-offs based on preliminary designs, and general arrangement drawings.

Tendered rates were received for the shop detailing, supply, fabrication, surface/corrosion protection, delivery to site and erection of structural steelwork, floor grating, stair treads, handrails, ladders, purlins, girts and structural bolts. (Note: a zero rate was applied to the shop detail drawing item in the BOQ; however, when the preferred contractor was asked for clarity, it was confirmed that the cost had been accounted for elsewhere in the priced BOQ.

Structural steelwork associated with conveyor systems (gantries, trestles, take up steelwork, walkways, skirts, etc) is included in the conveyor package price.

For structural steel, the BOQ, specifications and scope were included with the SMPP enquiry for costing.

The bids were assessed as stated in the adjudication reports for each package. The resulting representative unit costs were applied to the quantities to arrive at the costs stated in the estimate.

Electrical

The electrical battery limit is the 10kV switchboard incoming terminals.

Preliminary engineering specifications, datasheets, scope of work documents, BOM, schedules and supporting drawings were prepared based on process requirements as defined in the flow sheets and mechanical equipment list. Electrical and instrumentation databases were populated using Aveva software.

Enquiry packages were developed from the above information.

All cabling is to be provided by the respective installation contractor.

Electrical field work pricing is based on the tendered bids received for the electrical installation.

RFQs were issued to the market for equipment. Tenders were received and assessed technically and commercially. For the study stage, no clarifications with suppliers or contractors were requested.

Control and Instrumentation

RFQs were issued to the market. Tenders received were adjudicated for commercial and technical acceptance. For the study stage there were no clarifications required by suppliers or contractors.

The MIS for Production Monitoring and Reporting and a MAS have been excluded from the capital cost estimate at the request of Euromax Resources. These systems can be procured at a later stage by Euromax Resources, if deemed necessary.

Contractors' Preliminary and General Costs

Preliminary and General (P&G) costs relate directly to the construction contractors' fixed and time-related costs for such aspects as:

- Supervision / management personnel
- Erection equipment (including cranes) and machines (such as welding machines)
- Construction temporary works
- Site establishment and running costs
- Personnel transport to and from site
- Site vehicles
- Insurances
- Risk allowances and profit

Heavy Lift Cranes

Cost allowances have been included for the hire of cranes necessary for lifting of equipment with excessive mass or requiring a long reach, depending on the construction sequence, access and eventual maintenance requirements. These costs will form part of the contractor scope of work.

First Fills

The estimated cost for first fills of process consumables is based on an estimate of the quantities required, and pricing received from suppliers. First fills includes such items as reagents, lubricants and oils.

Commissioning, Critical and 1 Year Spares

Commissioning, critical and one year spares have been included, where applicable, in equipment supply prices. Where suppliers did not indicate spares, allowances have been made.

The supply of operating and maintenance spares has been excluded from the capital cost estimate.

Freight, Duty and Insurance

RFQs were issued to individual contractors with equipment lists and detailing fabrication dimensions and masses (tonnage) of equipment. The contractors were requested to provide estimates for each piece of equipment on the basis of transport to the closest port to the contractor, shipping to the port closest to site and transport to the site.

Abnormal loads and escorts will be assessed and managed by the selected freight company.

Import duties and taxes will be provided by the owner. It should be noted that these duties and taxes are only applicable to goods procured and delivered from outside the European Union (as advised by KPMG to Euromax Resources).

Transport included as per vendor / contractor quotes. Where tenders excluded transport costs, allowances were made as follows:

- 1% of materials cost from within the region
- 3% of equipment value from within Europe
- 5% of equipment value other than Europe

Euromax Resources will be responsible for overall insurance cover comprising:

- Contractors All Risks
- Public Liability
- Freight

Vendor Representation during Construction and Commissioning

An allowance is included to cater for equipment vendor representation on site during the installation and pre-operational testing of equipment, including mobilisation and demobilisation of the representative and any special tools.

The estimate is based on information provided by the vendors where available, or in-house estimates. The estimate includes the services of a vendor to ensure manufacturer warranty where required. These representatives provide expertise and supervision in construction assembly. Travel time, airfares, lodging and out-of-pocket expenses are included in their daily rate.

Allowances have been made for commissioning assistance. Costs for the EPCM cold commissioning teams are included.

No EPCM allowances are included for costs associated with cold commissioning. Operating and maintenance costs for the commissioning period is not included in the capital cost estimate, except for those specifically included in the first fills.

Laboratory, Laboratory Equipment and LIMS

The laboratory building was included in the architectural BOQ issued to the market, and priced accordingly. Allowances for laboratory equipment and LIMS were included based on historical data.

Growth

The probability of growth was assessed by the study team and applied per package. This allowance is listed separately in the estimate summary.

Contingency

An estimate review was held to ensure the completeness of the estimate. Thereafter, a risk session was held with the study team to determine design and cost risk and any other allowances deemed necessary. This allowance is listed separately in the estimate summary.

21.1.3.3 Capital Costs (including tailings management)

The process plant, infrastructure and TMF capital costs are presented in Table 21.7.

Table 21.7 Capital Cost Estimate Process Plant, Infrastructure and TMF (incl. Temporary Facilities)				
Description	Total Cost (€)	Total Cost (US\$)	% of Total DFC	% of Total Cost
Direct Field Costs				
Earthworks, Roads and Civil Infrastructure	€ 44 776 336	\$49 253 970	18.09%	13.73%
Reinforced Concrete	€ 16 914 585	\$18 606 044	6.83%	5.19%
Buildings	€ 2 687 896	\$2 956 686	1.09%	0.82%
Structural Steel	€ 4 458 345	\$4 904 180	1.80%	1.37%
Mechanical	€ 84 081 322	\$92 489 454	33.97%	25.79%
Platework	€ 8 557 885	\$9 413 674	3.46%	2.62%
Piping and Manual Valves	€ 32 163 104	\$35 379 414	13.00%	9.86%
Electrical	€ 17 271 890	\$18 999 079	6.98%	5.30%
Instrumentation	€ 18 496 351	\$20 345 986	7.47%	5.67%
Laboratory, Laboratory Equipment and Laboratory Information Management System	€ 1 479 427	\$1 627 370	0.60%	0.45%
Transport and Freight	€ 4 247 659	\$4 672 425	1.72%	1.30%
Commissioning Spares	€ 382 652	\$420 917	0.15%	0.12%
Critical Spares	€ 3 575 380	\$3 932 918	1.44%	1.10%
1 Year Spares	€ 2 577 620	\$2 835 382	1.04%	0.79%
Vendor Assistance	€ 3 727 718	\$4 100 490	1.51%	1.14%
Vendor Commissioning	€ 139 785	\$153 764	0.06%	0.04%
First Fill	€ 1 953 879	\$2 149 267	0.79%	0.60%
Total Direct Field Costs	€ 247 491 835	\$272 241 019	100.00%	75.91%
Professional Services Home Office (Amec Foster Wheeler)	€ 25 117 310	\$27 629 041	10.15%	7.70%
Professional Services Site (Amec Foster Wheeler)	€ 15 432 222	\$16 975 444	6.24%	4.73%
Professional Services Consultants (Amec Foster Wheeler)	€ 663 363	\$729 699	0.27%	0.20%
Indirect Field Costs (Amec Foster Wheeler)	€ 6 299 215	\$6 929 137	2.55%	1.93%
Professional Services Home Office (Golder)	€ 481 320	\$529 452	0.19%	0.15%
Professional Services Site (Golder)	€ 284 608	\$313 069	0.11%	0.09%
Professional Services Consultants (Golder)	€ 40 000	\$44 000	0.02%	0.01%
Indirect Field Costs (Golder)	€ 28 200	\$31 020	0.01%	0.01%
Total Net Cost	€ 295 838 073	\$325 421 880	119.53%	90.74%
Owner's Costs	€ 30 201 254	\$33 221 379	12.20%	9.26%
Total Cost excluding Growth and Contingency	€ 326 039 327	\$358 643 260	131.74%	100.00%
Growth	€ 9 509 833	\$10 460 816	3.84%	2.92%
Contingency	€ 19 243 780	\$21 168 158	7.78%	5.90%
Total Growth and Contingency	€ 28 753 613	\$31 628 974	11.62%	8.82%
Control Budget Estimate	€ 354 792 940	\$390 272 234	143.36%	

21.1.3.4 Detailed Priced Mechanical Equipment list (including tailings management facility)

The process plant mechanical equipment capital costs are presented in Table 21.8.

Table 21.8 Process Plant Priced Mechanical Equipment list (incl. TMF)		
Equipment	Average Unit Cost	Total Supply Cost
Services (3100)		
Plant Central Engineering Workshop Overhead Crane	€ 30 000	€ 30 000
Plant Central Store Overhead Crane	€ 30 000	€ 30 000
Plant Tools & Rigging Store Overhead Crane	€ 16 000	€ 16 000
Central Workshops & Offices Overhead Crane	€ 33 000	€ 33 000
Weighbridge	€ 42 465	€ 42 465
Raw Water Distribution Pump 1&2	€ 21 386	€ 42 772
Process Water Distribution Pump 1	€ 70 375	€ 140 750
Spray Water Distribution Pump 1&2	€ 10 309	€ 20 617
Borehole Pump 1-5	€ 15 233	€ 76 165
Raw Water Transfer Pump 1&2	€ 136 645	€ 273 290
Intermediate Raw Water Booster Pump 1&2	€ 81 480	€ 162 960
Pit Dewatering - Diesel Pontoon	€ 452 566	€ 452 566
Pit Dewatering Stage Pump	€ 24 569	€ 24 569
Potable Water Spillage Sump Pump	€ 7 950	€ 7 950
Emergency Safety Showers Plant Wide	€ 11 713	€ 11 713
Potable Water Vendor Package	€ 338 503	€ 338 503
Filtered Water Distribution Pump 1&2	€ 19 853	€ 39 706
Gland Seal Water Distribution Pump 1&2	€ 5 717	€ 11 434
Sand/Carbon Filtration Spillage Sump Pump	€ 7 950	€ 7 950
Filtered Water Storage Tank	€ 236 747	€ 236 747
Sand/Carbon Filtration Vendor Package	€ 114 222	€ 114 222
Oxygen Plant Vendor Package	€ 6 500	€ 6 500
Flotation Air Blower 1	€ 229 745	€ 459 491
Air Compressor 1-4	€ 59 805	€ 239 222
Plant Air Receiver	€ 13 271	€ 13 271
Air Dryer 1	€ 5 885	€ 11 770
Filters 1-6	€ 372	€ 2 234
Instrument Air Receiver	€ 13 271	€ 13 271
Decant Reclaim Water Pump 1&2	€ 126 740	€ 253 480
Pit Dewatering/Oxide Reclaim Water Pump 1&2	€ 126 740	€ 253 480
Fire Water Pump House Hoist	€ 1 450	€ 1 450
Plant Air Compressor House Hoist	€ 3 300	€ 3 300
Blower Shed Hoist	€ 4 400	€ 4 400
Instrument Air Compressor House Hoist	€ 3 300	€ 3 300
Oxygen Plant Hoist	€ 1 200	€ 1 200
Fire Water Tank	€ 22 433	€ 22 433
Fire Water Pump Skid Vendor Package	€ 85 683	€ 85 683

Table 21.8 Process Plant Priced Mechanical Equipment list (incl. TMF)		
Equipment	Average Unit Cost	Total Supply Cost
Subtotal		€ 3 487 865
Ore Receipt And Crushing (3210)		
Primary Crusher Maintenance Crane	€ 238 000	€ 238 000
Primary Crushing Compressor	€ 61 472	€ 61 472
Primary Crusher	€ 2 187 503	€ 2 187 503
Primary Crusher Sacrificial Discharge Conveyor	€ 279 339	€ 279 339
Stockpile Feed Conveyor	€ 13 955 375	€ 13 955 375
Crushing Area Compressor Air Dryer	€ 11 770	€ 11 770
Crusher Building Extraction Fan 1	€ 81 740	€ 81 740
Primary Crusher Discharge Apron Feeder	€ 240 681	€ 240 681
Crushing Area Compressor Filters 1-3	€ 745	€ 2 234
Primary Crusher Sacrificial Tail Pulley Hoist	€ 1 200	€ 1 200
Primary Crusher Sacrificial Head Pulley Hoist	€ 1 200	€ 1 200
Hydraulic Power Pack Hoist	€ 25 100	€ 25 100
Crusher Motor Hoist 1	€ 8 529	€ 8 529
Crusher Motor Hoist 2	€ 8 529	€ 8 529
Primary Crusher Product Metal Detector	€ 21 184	€ 21 184
Primary Crusher Belt Magnet	€ 73 704	€ 73 704
Dust Suppression Water Pump 1&2	€ 4 698	€ 9 397
Primary Crusher Scrubber Pump	€ 3 591	€ 3 591
Primary Crusher Scrubber Tank Drain Pump	€ 2 001	€ 2 001
Crushing Area Compressor Air Receiver	€ 14 940	€ 14 940
Rock Breaker	€ 367 688	€ 367 688
Primary Crusher Building Sump Pump 1&2	€ 8 871	€ 17 742
Dust Suppression Vendor Package	€ 109 848	€ 109 848
Dust Extraction Vendor Package	€ 102 222	€ 102 222
Primary Crusher Discharge Conveyor Weightometer	€ 10 810	€ 10 810
Subtotal		€ 17 835 798
Milling (3220&3230)		
Sag Mill Feed Conveyor	€ 496 843	€ 496 843
Stockpile Reclaim Exhaust Fan 1	€ 23 354	€ 23 354
Stockpile Reclaim Feeder 1-5	€ 146 443	€ 732 213
Apron Feeder Hoist	€ 5 000	€ 5 000
Stockpile Reclaim Feeder Hoist	€ 2 950	€ 2 950
Reclaim Dust Suppression Water Pump 1&2	€ 4 003	€ 8 005
Reclaim Scrubber Recirculation Pump	€ 2 001	€ 2 001
Reclaim Scrubber Tank Drain Pump	€ 2 001	€ 2 001
Stockpile Tunnel Sump Pump 1-3	€ 8 568	€ 25 703
Dust Extraction Vendor Package	€ 132 815	€ 132 815
Dust Suppression Vendor Package	€ 90 369	€ 90 369

Table 21.8 Process Plant Priced Mechanical Equipment list (incl. TMF)		
Equipment	Average Unit Cost	Total Supply Cost
Sag Mill Feed Conveyor Weightometer	€ 10 540	€ 10 540
Ball Mill 1 Ball Feed Chute	€ 56 072	€ 56 072
Mill Tower Crane	€ 191 227	€ 191 227
Pebble Crusher	€ 1 407 828	€ 1 407 828
Pebble Crusher Feed Conveyor	€ 390 576	€ 390 576
Pebble Crusher Product Conveyor	€ 82 379	€ 82 379
Cyclone Cluster 1	€ 462 785	€ 462 785
Pebble Crusher Feeder	€ 12 139	€ 12 139
Sag And Ball Mill Ball Mill Magnet Hoist	€ 5 000	€ 5 000
Ball Mill Kibble Hoist	€ 26 300	€ 26 300
Mill Liner Handler	€ 2 599 030	€ 2 599 030
Sag Mill Electromagnet	€ 37 037	€ 37 037
Mill Ball 1 Electromagnet	€ 37 037	€ 37 037
Pebble Crusher Feed Metal Detector	€ 20 274	€ 20 274
Sag Mill	€ 9 038 329	€ 9 038 329
Ball Mill 1&2	€ 6 550 915	€ 13 101 829
Pebble Crusher Feed Belt Magnet	€ 73 704	€ 73 704
Cyclone Feed Pump 1&2	€ 144 794	€ 289 588
Cyclone Feed Pump 3&4	€ 144 794	€ 289 588
Milling Area Sump Pump 1-4	€ 8 568	€ 34 270
Pebble Crusher Product Conveyor Weightometer	€ 10 540	€ 10 540
Oxide Stockpile Catchment Pump 1&2	€ 12 253	€ 24 505
Subtotal		€ 29 721 828
Flotation (3350)		
Rougher Conditioning Tank 1 Agitator	€ 100 667	€ 100 667
Cleaner Conditioning Tank Agitator	€ 17 800	€ 17 800
Re Cleaner Conditioner Tank Agitator	€ 3 730	€ 3 730
Rougher Cell 1-5	€ 307 113	€ 1 535 564
Rougher Scavenger Cell 1-4	€ 311 727	€ 1 246 909
Cleaner Cell 1-4	€ 139 418	€ 557 673
Scavenger Cleaner Cell 1-2	€ 129 600	€ 259 200
Recleaner Cell 1-2	€ 69 218	€ 138 436
Rougher Feed Pump	€ 480 270	€ 480 270
Rougher Froth Pump 1&2	€ 10 880	€ 21 760
Scavenger Tails Pump 1&2	€ 230 277	€ 460 555
Scavenger Froth Pump 1&2	€ 28 297	€ 56 594
Cleaner Feed Pump 1&2	€ 19 729	€ 39 457
Cleaner Scavenger Tails Pump 1&2	€ 16 438	€ 32 876
Cleaner Froth Pump 1&2	€ 11 543	€ 23 087
Recleaner Feed Pump 1&2	€ 5 392	€ 10 784
Recleaner Tails Pump 1&2	€ 5 284	€ 10 568

Table 21.8 Process Plant Priced Mechanical Equipment list (incl. TMF)		
Equipment	Average Unit Cost	Total Supply Cost
Recleaner Concentrate Froth Pump 1&2	€ 10 170	€ 20 340
Cleaner Scavenger Froth Pump 1&2	€ 11 543	€ 23 087
Rougher Feed Sampler	€ 62 305	€ 62 305
Recleaner Concentrate Sampler	€ 25 674	€ 25 674
Trash Screen 1	€ 232 261	€ 232 261
Pre-Flotation Screening Spillage Sump Pump	€ 8 568	€ 8 568
Scavenger Flotation Spillage Sump Pump	€ 7 950	€ 7 950
Subtotal		€ 5 376 113
Concentrate Regrind (3360)		
Regrind Mill Feed Pump 1&2	€ 20 277	€ 40 553
Sump Pump	€ 7 950	€ 7 950
Regrind Mill Vendor Package	€ 6 178 278	€ 6 178 278
Subtotal		€ 6 226 781
Concentrate Dewatering And Storage (3400)		
Filter Feed Tank Agitator	€ 10 363	€ 10 363
Filter Cake Conveyor	€ 207 007	€ 207 007
Filter Cake Transfer Conveyor	€ 293 551	€ 293 551
FFP Filter	€ 403 704	€ 403 704
Thickener Underflow Pump 1&2	€ 5 325	€ 10 649
Overflow Tank 1 Pump 1&2	€ 5 351	€ 10 702
Filter Feed Pump 1&2	€ 21 931	€ 43 863
Filtrate Pump 1&2	€ 7 477	€ 14 954
Filter Cake Sampler	€ 24 081	€ 24 081
Concentrate Thickener Sump Pump	€ 7 950	€ 7 950
Filter Area Sump Pump	€ 7 950	€ 7 950
Concentrate Thickener	€ 72 101	€ 72 101
Concentrate Load Out Weightometer	€ 9 234	€ 9 234
Concentrate Storage Spillage Sump Pump	€ 7 950	€ 7 950
Subtotal		€ 1 124 058
Leach And Adsorption		
Neutralisation Tank 1 Agitator	€ 4 681	€ 4 681
Pre-Leach Thickener Underflow Pump 1&2	€ 7 855	€ 15 710
Neutralisation Tails Pump 1&2	€ 71 917	€ 143 833
Pre-Leach Thickener Overflow Pump 1	€ 14 404	€ 28 808
Pre-Leach Thickener Spillage Sump Pump	€ 7 950	€ 7 950
Neutralisation Spillage Sump Pump	€ 7 950	€ 7 950
Pre-Leach Thickener	€ 406 625	€ 406 625
Conditioning Tank Agitator	€ 61 393	€ 61 393
Leaching Tank Agitator	€ 61 393	€ 61 393

Table 21.8 Process Plant Priced Mechanical Equipment list (incl. TMF)		
Equipment	Average Unit Cost	Total Supply Cost
CIL Tank 1-6 Agitator	€ 60 481	€ 362 889
CIL Tower Crane	€ 184 427	€ 184 427
CIL Carbon Transfer Pump 1-8	€ 9 171	€ 73 369
Post CIL Thickener Underflow Pump 1&2	€ 7 845	€ 15 691
Post CIL Thickener Overflow Tank Pump 1&2	€ 5 933	€ 11 867
Post CIL Thickener Feed Tank Pump 1&2	€ 7 845	€ 15 691
Leach Feed Prim/Sec Sampler	€ 26 124	€ 26 124
CIL Tails Prim/Sec Sampler	€ 26 124	€ 26 124
Loaded Carbon Screen	€ 31 139	€ 31 139
CIL Pump Interstage Screen 1-7	€ 38 163	€ 267 141
Carbon Sizing Screen	€ 22 061	€ 22 061
CIL Tails Carbon Recovery Screen 1&2	€ 31 139	€ 62 278
Conditioning Tank Spillage Sump Pump	€ 7 950	€ 7 950
CIL Spillage Sump Pump	€ 8 568	€ 8 568
CIL Tails Spillage Sump Pump	€ 8 568	€ 8 568
Post CIL Leach Thickener Spillage Sump Pump	€ 8 568	€ 8 568
Post CIL Leach Thickener	€ 406 625	€ 406 625
CIL Interstage Screen High Pressure Washer	€ 111	€ 111
Subtotal		€ 2 277 532
Acid Wash And Elution (3750)		
Acid Wash Tank Agitator	€ 3 604	€ 3 604
Caustic Cyanide Mixing Tank Agitator	€ 4 896	€ 4 896
Pre-Heat Tank Agitator	€ 3 589	€ 3 589
Acid Wash Column	€ 136 578	€ 136 578
Elution Column	€ 143 943	€ 143 943
Pre-Heat Tank Heater	€ 1 852	€ 1 852
Acid Wash Pump 1&2	€ 5 388	€ 10 775
Caustic Cyanide Mixing Transfer Pump 1	€ 13 073	€ 13 073
Caustic Cyanide Mixing Transfer Pump 1	€ 13 073	€ 13 073
Loaded Carbon Sampler	€ 25 674	€ 25 674
Acid Wash Spillage Sump Pump	€ 8 005	€ 8 005
Elution Spillage Sump Pump	€ 7 730	€ 7 730
Elution Heating Vendor Package	€ 214 585	€ 214 585
Carbon Attritioning Tank Agitator	€ 2 426	€ 2 426
Carbon Hoist	€ 6 100	€ 6 100
Regeneration Kiln	€ 342 407	€ 342 407
Carbon Attritioning Pump	€ 4 029	€ 4 029
Regen Carbon Transfer Pump	€ 4 499	€ 4 499
Transfer Water Pump 1&2	€ 7 545	€ 15 091
Eluted Carbon Sampler	€ 25 674	€ 25 674
Eluted Carbon Screen	€ 22 061	€ 22 061

Table 21.8 Process Plant Priced Mechanical Equipment list (incl. TMF)		
Equipment	Average Unit Cost	Total Supply Cost
Regen Spillage Sump Pump	€ 7 950	€ 7 950
Fine Carbon Spillage Sump Pump	€ 7 950	€ 7 950
Fine Carbon Sump Pump	€ 7 950	€ 7 950
Subtotal		€ 1 033 514
Electrowinning & Gold Room (3760&3770)		
Eluate Tank 1 Agitator	€ 5 126	€ 15 378
Electrowinning Overhead Crane	€ 16 200	€ 16 200
Electrowinning Cell 1-3	€ 194 922	€ 194 922
Gold Room Extraction Fan Unit 1-4	€ 114 898	€ 114 898
Eluate Pump 1	€ 5 388	€ 10 775
Spent Eluate Pump	€ 5 388	€ 5 388
Eluate Tank Spillage Sump Pump	€ 8 468	€ 8 468
High Pressure Cathode Washer 1	€ 111	€ 111
Silica Flux Bin	€ 215	€ 215
Soda Ash Flux Bin	€ 108	€ 108
Borax Flux Bin	€ 108	€ 108
Gold Room Jib Crane	€ 34 800	€ 34 800
Smelt Furnace Dust Extraction	€ 31 028	€ 31 028
Prill Drill	€ 804	€ 804
Calcliner Oven	€ 20 487	€ 20 487
Horizontal Plate Filter Press	€ 51 065	€ 51 065
Smelt Furnace (Electrical)	€ 87 422	€ 87 422
Smelt Furnace Hoist	€ 4 000	€ 4 000
Filter Press Feed Pump	€ 15 042	€ 15 042
Wash Water Transfer Pump 1&2	€ 2 001	€ 4 003
Bullion Vault Door	€ 3 074	€ 3 074
Gold Room Spillage Sump Pump	€ 8 468	€ 8 468
Bullion Wash Table	€ 5 670	€ 5 670
Smelt Furnace Trolley	€ 1 584	€ 1 584
Gold Room Smelting Vendor Package	€ 282	€ 282
Bullion Moulds	€ 1 859	€ 1 859
Subtotal		€ 636 160
Tailings And Cyanide Destruction (3850&3860)		
TMF Feed Tank Agitator	€ 209 037	€ 209 037
Tails Thickener U/F Pump 1&2	€ 56 528	€ 113 056
Tails O/F Tank Pump 1&2	€ 126 740	€ 253 480
Flush Water Pump 1&2	€ 43 033	€ 86 066
Tails Disposal Pump 1&2	€ 56 528	€ 113 056
Tails Thickener Feed Sampler 1	€ 62 305	€ 62 305
Tails Thickener Area Sump Pump	€ 7 950	€ 7 950

Table 21.8 Process Plant Priced Mechanical Equipment list (incl. TMF)		
Equipment	Average Unit Cost	Total Supply Cost
Tails Disposal Area Sump Pump	€ 7 950	€ 7 950
Tails Thickener	€ 965 452	€ 965 452
Cyanide Destruction Tank 1-3 Agitators	€ 5 056	€ 15 167
Cyanide Destruction Tails Pump 1&2	€ 9 031	€ 18 061
Cyanide Destruction Tails Sampler	€ 26 124	€ 26 124
Cyanide Destruction Spillage Sump Pump	€ 6 941	€ 6 941
Subtotal		€ 1 884 646
Reagents (3900)		
Activator Mixing Tank Agitator	€ 3 044	€ 3 044
Frother Dosing Pump 1-3	€ 3 392	€ 10 177
Frother Transfer Drum Pump	€ 2 610	€ 2 610
Activator Dosing Pump 1&2	€ 5 040	€ 10 081
Frother Spillage Sump Pump	€ 8 419	€ 8 419
Activator Spillage Sump Pump	€ 7 410	€ 7 410
Frother Offloading Storage Vendor Package	€ 124 495	€ 124 495
Collector Dosing Tank Agitator	€ 3 215	€ 3 215
Collector Dosing Pump 1-5	€ 3 505.17	€ 17 526
Collector Spillage Sump Pump	€ 8 419	€ 8 419
Collector Makeup Plant Vendor Package	€ 144 142	€ 144 142
Sodium Silicate Dosing Tank Agitator	€ 2 319	€ 2 319
Sodium Silicate Distribution Pump 1	€ 4 234	€ 8 468
Sodium Silicate Spillage Sump Pump	€ 7 410	€ 7 410
Cyanide Transfer Pump 1&2	€ 12 073	€ 24 145
CIL Cyanide Dosing Pump 1&2	€ 4 999	€ 9 998
Caustic Cyanide Dosing Pump 1&2	€ 9 568	€ 19 137
Cyanide Makeup Spillage Sump Pump	€ 7 410	€ 7 410
Cyanide Makeup Vendor Package	€ 200 365	€ 200 365
Lime Dosing Agitator	€ 4 422	€ 4 422
Lime Transfer Pump 1&2	€ 6 528	€ 13 055
Lime Dosing Pump 1&2	€ 6 498	€ 12 996
Lime Mixing Spillage Pump	€ 7 096	€ 7 096
Lime Dosing Spillage Pump	€ 7 096	€ 7 096
Lime Slaking Vendor Package	€ 276 616	€ 276 616
Cyanide Mixing Caustic Soda Dosing Pump 1&2	€ 9 568	€ 19 137
Caustic Soda Mixing Spillage Sump Pump	€ 8 419	€ 8 419
Caustic Soda Makeup Vendor Package	€ 312 854	€ 312 854
Hydrochloric Acid Transfer Drum Pump	€ 1 761	€ 1 761
Hydrochloric Acid Transfer Pump 1	€ 3 650	€ 7 300
Sulphamic Acid Distribution Pump 1	€ 9 133	€ 18 266
Hydrochloric Acid Transfer Spillage Sump Pump	€ 8 827	€ 8 827
Sulphamic Acid Spillage Sump Pump	€ 8 827	€ 8 827

Table 21.8 Process Plant Priced Mechanical Equipment list (incl. TMF)		
Equipment	Average Unit Cost	Total Supply Cost
Hydrochloric Acid Storage Vendor Package	€ 116 872	€ 116 872
Sulphuric Acid Makeup Vendor Package	€ 175 313	€ 175 313
SMBS Mixing Agitator	€ 400 730	€ 400 730
Lead Nitrate Transfer Pump 1&2	€ 5 213	€ 10 427
Lead Nitrate Dosing Pump 1&2	€ 3 995	€ 7 991
Hydrogen Peroxide Dosing Pump 1&2	€ 5 174	€ 10 348
SMBS Spillage Sump Pump	€ 8 419	€ 8 419
Lead Nitrate Spillage Sump Pump	€ 11 319	€ 11 319
Hydrogen Peroxide Spillage Sump Pump	€ 11 319	€ 11 319
Hydrogen Peroxide Storage Vendor Package	€ 139 339	€ 139 339
Flocculant Dosing Transfer Pump 1&2	€ 17 830	€ 35 660
Flocculant Dosing Transfer Pump 3	€ 4 235	€ 4 235
Flocculant Dosing Transfer Pump 4	€ 18 284	€ 18 284
Flocculant Dosing Transfer Pump 5&6	€ 24 254	€ 48 507
Flocculant Spillage Sump Pump 1&2	€ 7 410	€ 14 820
Flocculant Makeup System Vendor Package 1	€ 166 257	€ 166 257
Flocculant Makeup System Vendor Package 2	€ 80 600	€ 80 600
Sulphuric Acid Pump 1&2	€ 6 960	€ 13 921
Subtotal		€ 2 599 814
TMF		
Tailings Dam Workshop Hoist	€ 3 300	€ 3 300
TMF Decant Pump 1a&b - Pontoon	€ 207 438	€ 414 876
TMF Decant Pump 2a&b - Pontoon	€ 207 438	€ 414 876
TMF Seepage Pump 1	€ 25 171	€ 50 342
Subtotal		€ 883 394
Mobile Equipment		€ 1 736 857
Subtotal - Primary Equipment Cost		€ 74 824 360
Associated Erection Costs		€ 5 354 894
Associated P&Gs		€ 3 902 068
Total Mechanical Direct Field Costs		€ 84 081 322

21.1.4 Tailings Management Facility (4000)

21.1.4.1 Basis of Estimate

Source of Data

This information is supported by the team's collective previous experience of similar studies and projects.

Supporting Documentation

Supporting documentation has been stored electronically on the dedicated Ilovica Gold-Copper Project SharePoint site, managed by Amec Foster Wheeler.

Estimate Qualifications, Exclusions and Assumptions

Table 21.9 identifies some costs included and excluded from the estimate.

Table 21.9 TMF Capex Inclusions and Exclusions				
Description	Included in Capex	Excluded from Capex	Part of Owner's Costs	Part of Contingency
Professional Services	✓			
Acquisition of land for the tailings management facility			✓	
Permitting of the facility or risk mitigation measures relating to this			✓	
Return water system (included as part of the process plant and infrastructure)	✓			

The Capex for the TMF includes construction of the TMF starter wall and downstream wall raises (place, spread and compact for bulk earthworks only), river diversion and storm water management systems.

The TMF estimate prepared as part of this FS currently relies on a number of assumptions relating to the geotechnical and geophysical site investigations, as well as on the engineering characteristics of TMF wall construction materials and tailings to be deposited on the facility.

The wall construction volumes are based on the breakdown on the stage capacity curve contained within Section 18.2 of this report:

- The TMF starter wall and downstream wall raises will be constructed with material from the open pit;
- Where additional material is required (i.e. sand for construction of the drainage system), the material will be imported;
- Only the upstream face of the TMF starter wall will be lined with 2 mm HDPE;
- The walls of the TMF and liner will be constructed and installed by suitable qualified contractors.

An allowance (extra over) has been made for blasting of the river diversion channel. This channel will be finished with a 200 mm thick 30 MPa concrete liner.

21.1.4.2 Methodology

Capex costs have been divided into Years -1 (TMF Starter Wall Construction), Years 1-21 (Sustaining Capex) and closure Capex. Only those costs pertaining to Year -1 have been included in the capital cost estimate.

As far as possible rates are based on construction rates received from Amec Foster Wheeler, based on rates from the Pera Construction & Engineering Ltd.

Where necessary Golder also used rates for projects of a similar nature carried out during the last few years in Ireland and Eastern Europe.

All cost estimates have either been obtained or calculated in Euro, or converted to Euro utilising the approved study exchange rates.

Preliminary and General costs were included at 10%, and Construction Supervision costs at 1%, of the cost of the works.

Growth and contingency have been included as part of the growth and contingency calculations in Section 21.1.3.3.

The costs associated with the tailings delivery and slurry transportation system are included in the capital cost estimate included in Section 21.1.3.3.

The costs associated with the acquisition of land for the TMF are included as part of owner's costs.

Costs associated with permitting of the facility or any risk mitigation measures that may be required are included as part of owner's costs.

The costs associated with haulage, haul roads and the return water system are included in Section 21.1.3.3.

Locally available materials will be used as far as possible for construction of the facility to reduce the costs.

Allowances have been made for construction works (earthworks, emergency decant and liner installation) required to construct the TMF (Capex and Sustaining Capex).

Allowance has been made for instrumentation for the TMF.

21.1.4.3 Capital Costs

The Capex developed for the TMF includes P&G costs (10% of the cost of the works), construction site visits (1% of the cost of the works) as well as initial, sustaining and closure costs. These costs are summarised in Table 21.10 (Euro) and Table 21.11 (US\$).

Table 21.10 Capital Cost Estimate TMF (Euro)				
Description	Initial Capex (€)	Sustaining Capex (€)	Closure Capex (€)	Total Capex (€)
	Year -1	Years 1 to 21	Closure	
Preliminary and General Costs	€ 2 448 518		€ 1 460 640	€ 3 909 159
Construction Site Visits	€ 244 852	€ 986 070	€ 146 064	€ 1 376 986
Construction	€ 24 485 186	€ 98 607 008		€ 123 092 194
Closure			€ 14 606 402	€ 14 606 402
Roads	€ 491 269			
Associated Infrastructure	€ 11 369 555			
Total	€ 39 093 380	€ 99 593 078	€ 16 213 107	€ 142 984 741

Table 21.11 Capital Cost Estimate TMF (US\$)				
Description	Initial Capex (US\$)	Sustaining Capex (US\$)	Closure Capex (US\$)	Total Capex (US\$)
	Year -1	Years 1 to 21	Closure	
Preliminary and General Costs	\$2 693 370		\$1 606 704	\$4 300 075
Construction Site Visits	\$269 337	\$1 084 677	\$160 670	\$1 514 685
Construction	\$26 933 704	\$108 467 709		\$135 401 413
Closure			\$16 067 043	\$16 067 043
Roads	\$540 396			
Associated Infrastructure	\$12 506 511			
Total	\$42 943 318	\$109 552 386	\$17 834 417	\$157 283 215

21.1.5 Off Site Infrastructure (5000)

21.1.5.1 Basis of Estimate

No costs included in this section – all infrastructure costs are included in Section 21.1.6.

21.1.6 On Site Infrastructure (7000)

21.1.6.1 Basis of Estimate

Infrastructure comprises bulk earthworks and terracing, restricted earthworks, concrete, non-process buildings, access roads, maintenance roads, fencing and security, sewer reticulation, storm water drainage, dams lining, etc.

21.1.6.2 Methodology

Generally, the same methodology was applied to obtain pricing for both process plant and infrastructure.

21.1.6.3 Capital Costs

Included in Section 21.1.3.3.

21.1.7 EPCM Indirects (8000)

21.1.7.1 Basis of Estimate

Contracting / Project Services Execution Model

The method of project execution applied to the estimate calculation assumes a reimbursable EPCM contract.

Engineering Design and Project Management

EPCM costs include for design, project management, procurement and construction up to the completion of cold commissioning of the process facility.

It includes for the coordination and project management (for and on behalf of Euromax Resources) of third party design consultants.

A project organisation structure has been developed. This has formed the basis of EPCM loading. Uplift of EPCM cost rates for site based resources during implementation has been included.

Engineering Design

Engineering design and drafting costs have been estimated by way of a list of engineering and document deliverables.

This manpower resource loading schedule has composite discipline rates applied to it to derive total manpower cost requirements.

Project Management

Project Management costs are based on a manpower resource loading schedule that is reflective of the implementation strategy and project schedule.

This manpower resource loading schedule has composite discipline rates applied to it to derive total manpower cost requirements.

Construction Management

Construction management costs are based on a detailed staffing plan that is reflective of the implementation strategy and project schedule.

This detailed staffing plan utilising the discipline rates has been used to derive total man-power cost.

Commissioning

Costs for the EPCM commissioning teams are included.

Disbursement Costs

The EPCM estimate includes the following major expenses.

- Uplift for site personnel
- Staff travel (air fares and /or road travel) of a selected key engineering, project management and construction personnel
- Office and site running costs
- Accommodation and meals will be provided at no cost to the EPCM contractor, other than those allowed for in the EPCM estimate.

Technical Services

The following external consultants will either provide design input for the process plant or be managed for and on behalf of Euromax Resources:

- HAZOP and Hazards of construction (HAZCON)
- Foundations and materials investigation
- Dam consultant
- Third party quality inspections
- Blasting consultant
- Fire protection consultant
- Radio signal survey
- Earthing survey
- Electrical protection consultant
- Power factor correction and harmonic suppression consultant
- Acid proofing consultant
- Quality control (laboratory costs during construction)
- Material flow consultant

21.1.8 Temporary Facilities (9000)

21.1.8.1 Basis of Estimate

This section includes all items that will be provided during the construction phase of the project only, such as:

- Euromax Resources and EPCM contractor office accommodation, furnishings, ablutions, crib rooms and storage facilities on site
- Provision of water and sewerage services to site facilities
- Provision of temporary power to the site facilities
- Cleaning and maintenance of site facilities
- Temporary mine maintenance facilities
- Road signage
- Provision of security facilities for the plant construction site

21.2 OPERATING COSTS

21.2.1 Overall Operating Costs Summary

21.2.1.1 Estimate Description

The Ilovica Gold-Copper Project FS Opex has an accuracy of $\pm 10\%$. The estimate is made up of sections for mining, process plant, tailings management facility and infrastructure.

21.2.1.2 Estimate Base Date

September 2015.

21.2.1.3 Estimate Summary

A summary of the LOM operating cost estimates is presented in Table 21.12. Refer to the respective section numbers for detail of each of the categories.

Table 21.12 LOM Opex Summary			
Section	Categories	Estimated Value (€)	Estimated Value (US\$)
21.2.2	Mining (1000)	€ 642 976 831	\$707 274 514
21.2.3	Process Plant (3000)	€ 1 267 082 779	\$1 393 791 057
21.2.4	Tailings Management Facility (4000)	Included in Process Plant	Included in Process Plant
21.2.5	Off Site infrastructure (5000)	Included in Process Plant	Included in Process Plant
21.2.6	On Site Infrastructure (7000)	Included in Process Plant	Included in Process Plant
	Estimate Total	€ 1 910 059 610	\$2 101 065 571

21.2.1.4 Foreign Currency

Refer to Section 21.1.1.8.

21.2.1.5 Definition of Terms

The operating costs are categorised as labour, power, reagents, consumables, maintenance and miscellaneous items. The inputs into the preparation of this estimate are defined in Table 21.13.

Table 21.13 Opex Categories	
Item	Description
Labour	Agreed organisational structure, classifications, rates and overheads. The items included in the labour calculation are: staff numbers; salary rates; shift rosters; allowances for leave; bonuses; taxes; provision for contractors.
Power	Optimised drive list and firm rates. Items included are: on site generation or external supply; power requirements for the equipment list calculated by applying load factors and operating hours; allowance for site lighting and general power consumption, operating and maintenance labour, maintenance consumables.

Table 21.13 Opex Categories	
Item	Description
Reagents and consumables	Reagent use confirmed by test work, quotes (including freight) and shipping package details. Consumables included are: raw water; grinding media; crusher, screen and mill liners; process materials; fuel and lubricants and filter cloths.
Maintenance	Percentage of total direct capital cost by process area; quotes with documented backup for major items; mill relines; major shutdowns, worked up estimates for other areas.
Vehicles / Mobile equipment	Quotes, detailed estimates relating to the plant vehicles and hired equipment and include fuel, maintenance, tyres, lubricants, licensing and insurance. A mobile equipment schedule is generated for the Opex, but it could also be used as input for the capital cost estimate.
Assay / Laboratory	Quotes, detailed estimates relating to the site analytical laboratory and external analyses by third parties for the evaluation of production or metallurgical accounting samples.
Bullion / Concentrate Transport / Refining	Quotes.
General and administration	Quotes, detailed estimates. Costs necessary for sustaining operations but that are not directly associated with the output of the desired product. General and administrative costs may include licensing fees, insurances, contract costs for catering, security, employee transport and medical services, communications costs, legal fees, corporate office / management charges, stationery costs, donations, postage, petty costs and recruitment and relocation.
Pre-production	Estimates for first fill (consumables required for initial fill of storage / mix tanks and initial grinding mill ball charges) based on number of days stockholding. Start-up manning schedule defined.
Commissioning / Vendors	Quotes, detailed estimates.
Miscellaneous	Can include HSSE (safety equipment, housekeeping expenses, training) research and development (allowances for consultants and external test work not associated with the laboratory), transportation of goods to site, residue storage facility (construction materials or audits), product related costs (transport, port, agent fees, smelting, toll refining charges, insurance, and marketing).

21.2.2 Mining (1000)

21.2.2.1 Basis of Estimate

The mine operating costs were estimated based on owner mining operation with blasting, fleet maintenance and tyre management service contracts. The costs have been determined by expense type over the life of the mine. The operating labour complement is based on mine equipment numbers which vary over the mine life.

21.2.2.2 Methodology

Opex costs are summarised by cost centre and activity, it has been built up using a combination of database, quotes and local figures.

21.2.2.3 Operating Costs

The fuel cost is built up using individual average machine fuel consumptions together with a local fuel price of Euro 0.63 /litre. Machine operator costs are built up using the local rates and numbers discussed above.

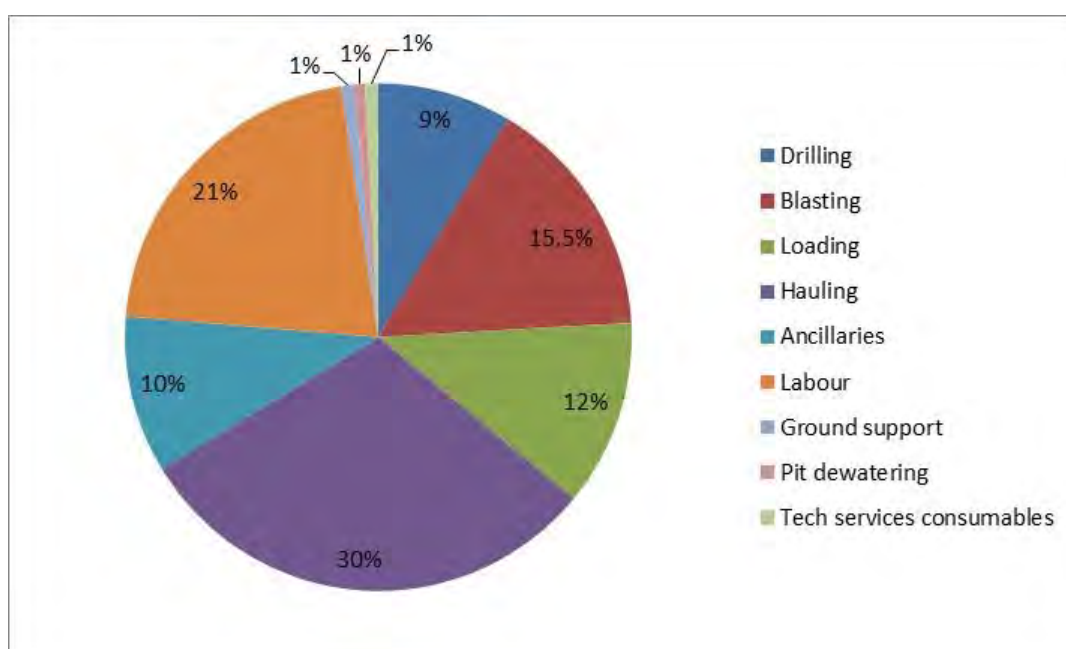
The cost by activity is derived from the costs for each machine and applied to the appropriate activity.

The year -1 of operating costs do not form part of the operating cost breakdown and is reported as initial Capex.

Opex by Activity

Activity	€ M	€ /t mined	US\$ M	US\$ /t mined
Drilling	54.9	0.14	60.4	0.15
Blasting	100.0	0.26	110.0	0.29
Loading	76.5	0.20	84.2	0.22
Hauling	194.9	0.51	214.4	0.56
Ancillaries	64.4	0.17	70.8	0.19
Labour	137.2	0.36	150.9	0.40
Ground support	5.1	0.01	5.6	0.01
Pit dewatering	4.5	0.01	5.0	0.01
Tech services consumables	5.4	0.01	5.9	0.01
Total	642.8	1.67	707.1	1.84

Figure 21.1
Opex by Activity – Average for LOM

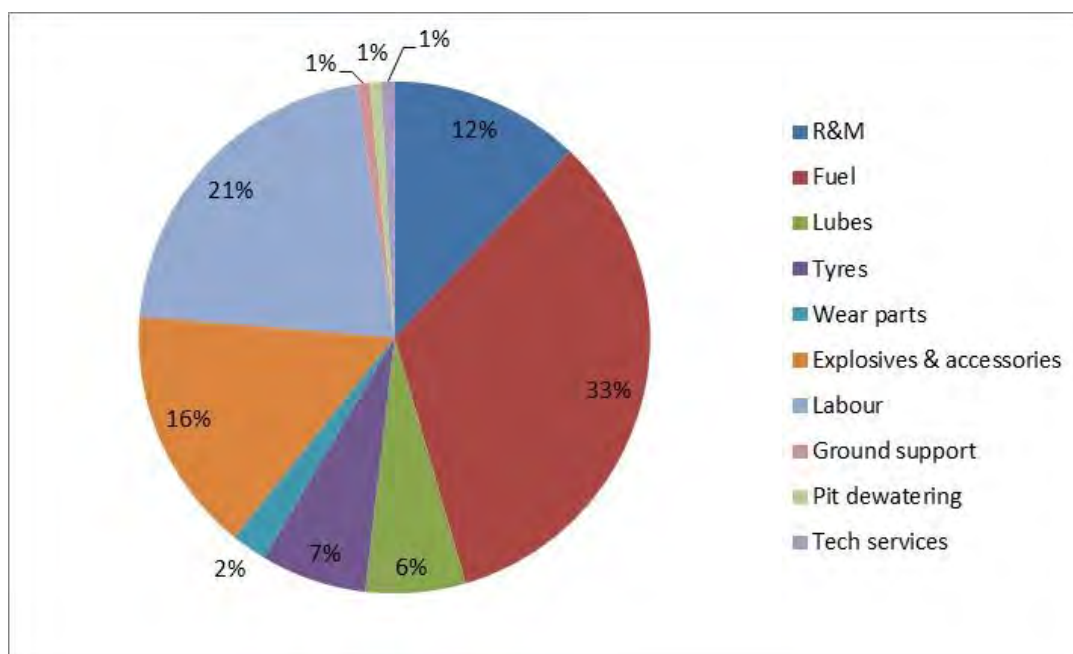


It can be seen from Table 21.14 and Figure 21.1 that hauling represents the highest proportion of the costs. This is typical for an open pit operation, it is heavily influenced by the number of trucks and the complex haul routes.

Opex by Expense

Activity	€ M	€/t mined	US\$ M	US\$ /t mined
R&M	77.39	0.20	85.13	0.22
Fuel	215.15	0.56	236.67	0.62
Lubes	40.67	0.11	44.74	0.12
Tyres	43.11	0.11	47.42	0.12
Wear parts	14.41	0.04	15.85	0.04
Explosives	99.97	0.26	109.97	0.29
Labour	137.20	0.36	150.92	0.40
Ground support	5.14	0.01	5.65	0.01
Pit dewatering	4.55	0.01	5.01	0.01
Tech services	5.40	0.01	5.94	0.01
Total	642.98	1.67	707.28	1.84

Figure 21.2
Opex by Expense – Average for LOM



It can be seen from Table 21.15 and Figure 21.2 that fuel represents the highest proportion of the costs. This is typical for an open pit operation, it is heavily influenced by the number of trucks and the complex haul routes.

21.2.3 Process Plant (3000)

21.2.3.1 Basis of Estimate

The operating philosophy for the plant has been confirmed with Euromax Resources.

As part of the estimating process, the following process and engineering documents have been reviewed: operations plans (mine and process facility); mine operating cost estimate; process flow diagrams; process design criteria (based on test work results); process mass and energy balance (including water consumption); equipment lists or electrical load lists and capital cost estimates.

The process plant operating cost estimate is based on the nominal treatment rate (as ROM) of 10 Mt/a through the plant.

The process plant operating costs are summarised in Table 21.16 (Euro) and Table 21.17 (US\$).

Table 21.16 Operating Cost Summary (Euro)					
COST CENTRE	Total Ore		Fixed Cost	Variable Cost	
	€ /y	€ /t milled	€ /y	€ /y	€ /t milled
Labour	€ 7 995 685	€ 0.80	€ 7 995 685		
Reagents	€ 15 989 686	€ 1.60	€ 320 375	€ 15 669 311	€ 1.57
Operating Consumables	€ 9 836 519	€ 0.98	€ 807 638	€ 9 028 880	€ 0.90
Power	€ 20 843 710	€ 2.08	€ 140 988	€ 20 702 722	€ 2.07
Maintenance Materials	€ 5 917 460	€ 0.59	€ 5 326 000	€ 591 460	€ 0.06
Mobile Equipment	€ 130 170	€ 0.01	€ 130 170		
Laboratory	€ 424 632	€ 0.04	€ 424 632		
TOTAL	€ 61 137 862	€ 6.11	€ 15 145 488	€ 45 992 373	€ 4.60

Table 21.17 Operating Cost Summary (US\$)					
COST CENTRE	Total Ore		Fixed Cost	Variable Cost	
	US\$ /y	US\$ /t milled	US\$ /y	US\$ /y	US\$ /t milled
Labour	\$8 795 254	\$0.88	\$8 795 254		
Reagents	\$17 588 655	\$1.76	\$352 413	\$17 236 242	\$1.72
Operating Consumables	\$10 820 171	\$1.08	\$888 402	\$9 931 768	\$0.99
Power	\$22 928 081	\$2.29	\$155 087	\$22 772 994	\$2.28
Maintenance Materials	\$6 509 206	\$0.65	\$5 858 600	\$650 606	\$0.07
Mobile Equipment	\$143 187	\$0.01	\$143 187		
Laboratory	\$467 095	\$0.05	\$467 095		
TOTAL	\$67 251 648	\$6.73	\$16 660 037	\$50 591 610	\$5.06

Source of Data

Sources of information include metallurgical test work, cost to company data provided by Euromax Resources, database pricing and pricing from suppliers.

Opex Qualifications, Exclusions and Assumptions

The estimate excludes the following:

- All head office and corporate costs
- Environmental monitoring and compliance costs
- Import duties
- Any licence fees or royalties on production sales
- All taxes, including VAT
- Government levies
- Insurance
- Operating cost contingencies
- Foreign exchange variations
- Transportation of the final product
- Site closure and rehabilitation
- Capital, social or any other contribution towards power and water supply to site
- Compensation and purchase costs of land
- Any other cost not specifically stated

21.2.3.2 Methodology

The following methodology was used to estimate the different cost categories:

Plant Labour

Plant labour in terms of the organisational structure and cost to company has been based on market related figures for 2015 provided by Euromax Resources.

Plant Reagents

Reagent consumptions were taken from the Metsim mass balance. Reagent pricing were for 2015 were provided by DGB International Associates. Reagent costs for Nitre was sourced from the Amec Foster Wheeler database. A reasonable estimate for transport was included, as applicable, from Thessaloniki, Greece to site.

Plant Consumables

Water consumption was calculated at 0.57 m³/t (incl. TMF return water) supplied at a budget cost of €0.08 /m³.

Diesel consumption was calculated based on the mobile equipment which includes vehicles, busses and lifting equipment requirements. The budget cost used for diesel was €0.63 /litre.

Plant consumables relating to the primary crusher and Pebble crushers, as well as mill grinding media and mill wear liners were sourced from associated equipment Vendors.

Plant Power

Plant power consumption in kWh per annum is based on installed power, excluding standby equipment, applying the appropriate load factors and annual operating hours.

The budget cost of power, at €0.05 /kWh, as provided by MEPSO for 2015, was used.

Plant Maintenance Materials

Maintenance materials, hired equipment and contractor costs make up the remainder of the cost factored from the total direct capital cost by discipline. Table 21.18 details the standard factors used for a typical plant operation.

Table 21.18 Standard Maintenance Factors	
Discipline	Factor
Earthworks	0.5%
Concrete (civils)	1.0%
Structural steel	1.5%
Platework	5.0%
Mechanical equipment	3.5%
Piping	5.0%
Electrical	5.0%
Instruments	4.5%
Building (architectural)	1.5%
Infrastructure (roads)	1.6%

Mobile Equipment

Mobile equipment quantities were estimated and the associated maintenance costs were sourced from the Amec Foster Wheeler database.

Metallurgy and Assay Laboratory

The amount of process samples to be assayed on a daily, weekly and monthly basis were determined from the process design with the assaying costs being sourced from the Amec Foster Wheeler database.

General and Administration

General and administration costs have been based on figures provided by Euromax Resources and similar sized projects.

21.2.3.3 Operating Costs

Power

The largest cost component of the process operating cost at €20 843 710 per annum. The detailed cost breakdown per area is given in Table 21.19.

Table 21.19 Power Consumption Summary							
Area	Description	Installed Power kW	Average Continuous Draw kWh	Total Annual Power Cost		Fixed Cost € /y	Variable Cost € /t
				€ /y	€ /t		
1000	Mining	1703	5 638 339	285 263	0.029	3 346	0.028
3000	Processing						
3100	Plant Services	3757	13 411 375	677 951	0.068	7 383	0.067
3210	Ore Receipt and Crushing	4620	19 422 852	980 223	0.098	9 080	0.097
3220	Coarse Ore Stockpile	684	3 557 393	179 213	0.018	1 343	0.018
3230	Milling	36917	255 794 712	12 862 287	1.286	72 551	1.279
3250	Oxide Stockpile	60	202 129	10 224	0.001	118	0.001
3350	Flotation	4536	25 300 633	1 273 945	0.127	8 914	0.127
3360	Concentrate Regrind	2433	17 069 112	858 237	0.086	4 781	0.085
3400	Concentrate Thickening and Filtration	214	1 115 304	56 187	0.006	421	0.006
3410	Concentrate Storage	11	6 140	329	0.000	22	0.000
3550	Leach	233	745 639	37 739	0.004	457	0.004
3600	Carbon-in-leach	1107	6 188 616	311 606	0.031	2 175	0.031
3750	Elution and Acid Wash	3792	22 168 098	1 115 857	0.112	7 452	0.111
3760	Electro-winning	134	837 317	42 130	0.004	264	0.004
3770	Gold Room	361	2 573 407	129 380	0.013	709	0.013
3780	Carbon Regeneration	1097	7 704 222	387 367	0.039	2 156	0.039
3850	Tails Thickening	3470	12 504 689	632 054	0.063	6 819	0.063
3860	Cyanide Destruction	98	395 006	19 943	0.002	193	0.002
3900	Reagents	752	1 769 506	89 953	0.009	1 478	0.009
4000	Tailing Management Facility						
4200	Tailings Impoundment and Dams	2417	6 291 811	319 341	0.032	4 750	0.031
7000	On Site Infrastructure	3345	11 358 133	574 480	0.057	6 574	0.057
TOTAL		71 741	414 054 434	20 843 710	2.084	140 988	2.070

Reagents

The flotation and CIL reagent consumption was based on laboratory scale test work conducted by various metallurgical test work service providers. The reagent consumptions for chemicals used in the acid wash and elution / electro-winning process have been determined on industry averages.

The estimated operating costs for reagents are summarised in Table 21.20.

Table 21.20 Reagent Consumption Summary							
Item	Cost		Consumption	Total Annual Cost		Fixed	Variable
	€/Unit	Unit	t/a	€	€/t	€	€/t
Activated Carbon	€ 1 493	t	151	€ 225 748	€ 0.02		€ 0.02
Aero 7249	€ 2 591	t	1050	€ 2 720 455	€ 0.27		€ 0.27
Borax	€ 957	t	1.314	€ 1 257	€ 0.00		€ 0.00
Copper Sulphate	€ 1 902	t	3	€ 4 792	€ 0.00		€ 0.00
Flocculant	€ 2 584	t	588	€ 1 519 365	€ 0.15		€ 0.15
Hydrated Lime	€ 75	t	2625	€ 196 875	€ 0.02		€ 0.02
Hydrochloric Acid	€ 393	t	840	€ 330 158	€ 0.03		€ 0.03
Hydrogen Peroxide	€ 766	t	8	€ 6 290	€ 0.00		€ 0.00
Lead Nitrate	€ 1 970	t	252	€ 496 520	€ 0.05		€ 0.05
MIBC	€ 2 000	t	368	€ 735 000	€ 0.07		€ 0.07
NaHS	€ 898	t	0	€ 0	€ 0.00		€ 0.00
Nitre	€ 502	t	0.493	€ 247	€ 0.00		€ 0.00
Oxygen	€ 650	t	38	€ 24 570	€ 0.00		€ 0.00
PAX	€ 2 039	t	0	€ 0	€ 0.00		€ 0.00
Quick Lime (Finely milled CaO)	€ 302	t	1932	€ 583 376	€ 0.06		€ 0.06
Silica	€ 270	t	0.657	€ 178	€ 0.00		€ 0.00
Soda Ash	€ 502	t	0	€ 0	€ 0.00		€ 0.00
Sodium Cyanide	€ 1 992	t	1092	€ 2 174 718	€ 0.22		€ 0.22
Sodium Hydroxide	€ 539	t	588	€ 316 638	€ 0.03		€ 0.03
Sodium Metabisulphite	€ 518	t	1848	€ 956 340	€ 0.10		€ 0.10
Sodium Silicate	€ 461	t	7875	€ 3 632 165	€ 0.36		€ 0.36
Sulphamic Acid	€ 1 170	t	274	€ 320 375	€ 0.03	€ 320 375	€ 0.00
Sulphuric Acid	€ 399	t	4368	€ 1 744 619	€ 0.17		€ 0.17
TOTALS				€ 15 989 686	€ 1.60	€ 320 375	€ 1.57

Consumables

Grinding media and liner consumption have been developed from wear rates factored from the bond abrasion index using in-house correlations. Operating liner sets have been estimated to last 1-2 years, due to the medium abrasion index of the ore.

The estimated operating costs for consumables are summarised in Table 21.21.

Table 21.21 Plant Consumable Summary						
Operating Consumable	Cost		Total Annual Cost		Fixed	Variable
Item	€/Unit	Unit	€	€/t	€	€/t
Steel Balls, 125 mm	€ 760	t	€ 1 320 895	€ 0.132		€ 0.132
Steel Balls, 75 mm	€ 740	t	€ 3 105 855	€ 0.311		€ 0.311
Steel Balls, 40 mm	€ 740	t	€ 745 920	€ 0.075		€ 0.075
Primary Crusher Liners						
• Lower & Upper Mantle	€ 36 818	ea	€ 73 636	€ 0.007		€ 0.007
• Concave Tiers	€ 54 172	ea	€ 54 172	€ 0.005		€ 0.005
Pebble Crusher Liners						
• Bowl liner	€ 27 170	ea	€ 31 246	€ 0.003		€ 0.003
• Mantle liner	€ 26 235	ea	€ 30 170	€ 0.003		€ 0.003
SAG Mill Wear Liners	€ 858 000	ea	€ 943 800	€ 0.094		€ 0.094
Ball 1 Mill Wear Liners	€ 673 000	ea	€ 740 300	€ 0.074		€ 0.074
Ball 2 Mill Wear Liners	€ 673 000	ea	€ 740 300	€ 0.074		€ 0.074
Regrind Mill Wear Liners						
• Screw Wear Liners	€ 287 800	ea	€ 211 053	€ 0.021		€ 0.021
• Wear liners	€ 519 798	ea	€ 571 778	€ 0.057		€ 0.057
Laboratory Supplies -Fixed	€ 100 000		€ 100 000	€ 0.010	€ 100 000	€ 0.000
General Consumables -Fixed	€ 100 000		€ 100 000	€ 0.010	€ 100 000	€ 0.000
Crucibles	€ 605.0	ea.	€ 7 623	€ 0.001	€ 7 623	€ 0.000
Diesel (Mobile Equipment)	€ 0.63	L	€ 600 015	€ 0.060	€ 600 015	€ 0.000
Raw Water	€ 0.08	m ³	€ 459 756	€ 0.046		€ 0.046
TOTALS			€ 9 836 519	€ 0.984	€ 807 638	€ 0.903

Labour

The labour cost has been based on three shifts per day at 8 hours per shift. The manning numbers were based on the number of personnel required to supervise and conduct the operational activities per section. The total number of personnel for the administration, mining and process plant can be seen in Table 21.22.

Expatriate positions have only been included for the initial years or up and until local personnel can fill the appropriate positions.

Table 21.22 Summary of Labour Costs						
Description	Number of People	Local/ Expat	Base Salary €/y	Overhead Costs €/y	Annual Labour Cost €/y	Total Annual Cost €/y
ADMINISTRATION						
<i>Head Office</i>						
Commercial & Admin Manager	1	L	€ 81 951	€ 8 195	€ 90 146	€ 90 146
Accountant	2	L	€ 36 098	€ 3 610	€ 39 707	€ 79 415
Accounts Clerk	2	L	€ 19 512	€ 6 622	€ 26 134	€ 52 268
Payroll Clerk	2	L	€ 19 512	€ 6 622	€ 26 134	€ 52 268
Secretary / Receptionist	1	L	€ 19 512	€ 6 622	€ 26 134	€ 26 134
Supply & Logistics						
Superintendent	1	L	€ 68 293	€ 6 829	€ 75 122	€ 75 122
Purchasing Officer	2	L	€ 19 512	€ 6 622	€ 26 134	€ 52 268
Expeditor	1	L	€ 19 512	€ 6 622	€ 26 134	€ 26 134
<i>Site</i>						
General Manager	1	E	€ 173 913	€ 81 739	€ 255 652	€ 255 652
Secretary / Receptionist	1	L	€ 19 512	€ 6 622	€ 26 134	€ 26 134
<i>Administration</i>						
Catering Manager	0	L	€ 81 951	€ 8 195	€ 90 146	€ 0
Head Chef	0	L	€ 14 634	€ 1 463	€ 16 098	€ 0
Catering/Cleaning	6	L	€ 7 805	€ 780	€ 8 585	€ 51 512
Village Maintenance Supervisor	1	L	€ 19 512	€ 6 622	€ 26 134	€ 26 134
Bus Drivers	4	L	€ 14 634	€ 1 463	€ 16 098	€ 64 390
<i>Human Resources</i>						
HR Officers	2	L	€ 36 098	€ 3 610	€ 39 707	€ 79 415
IR Officer	1	L	€ 36 098	€ 3 610	€ 39 707	€ 39 707
Clerks	2	L	€ 7 805	€ 780	€ 8 585	€ 17 171
<i>IT</i>						
IT Administrator	1	L	€ 50 732	€ 5 073	€ 55 805	€ 55 805
Information Technician	2	L	€ 36 098	€ 3 610	€ 39 707	€ 79 415
<i>Supply</i>						
Supply Supervisor	1	L	€ 36 098	€ 3 610	€ 39 707	€ 39 707
Procurement Officer	2	L	€ 36 098	€ 3 610	€ 39 707	€ 79 415

Table 21.22 Summary of Labour Costs						
Description	Number of People	Local/ Expat	Base Salary € /y	Overhead Costs € /y	Annual Labour Cost € /y	Total Annual Cost € /y
Expediter Clerk	2	L	€ 7 805	€ 780	€ 8 585	€ 17 171
Warehouse Labour (crane/forklift drivers)	4	L	€ 7 805	€ 780	€ 8 585	€ 34 341
OH&S						
OH&S Officers	2	L	€ 36 098	€ 3 610	€ 39 707	€ 79 415
Doctor	1	L	€ 50 732	€ 5 073	€ 55 805	€ 55 805
Nurses	3	L	€ 14 634	€ 1 463	€ 16 098	€ 48 293
Environment & Community Development						
Environmental & CD Manager	1	E	€ 130 435	€ 76 522	€ 206 957	€ 206 957
Relocation & Resettlement Supervisor	0	L	€ 36 098	€ 3 610	€ 39 707	€ 0
CDMF Officer	0	L	€ 36 098	€ 3 610	€ 39 707	€ 0
Environmental Officer	3	L	€ 36 098	€ 3 610	€ 39 707	€ 119 122
Community Liaison Officers	0	E	€ 36 098	€ 3 610	€ 39 707	€ 0
Nursery Supervisor	1	L	€ 19 512	€ 6 622	€ 26 134	€ 26 134
Labourers	10	L	€ 7 805	€ 780	€ 8 585	€ 85 854
Asset Protection Department						
Security Manager	1	L	€ 152 174	€ 79 130	€ 231 304	€ 231 304
Security Superintendent	1	L	€ 68 293	€ 6 829	€ 75 122	€ 75 122
Supply & Logistics Security Coordinator	1	L	€ 50 732	€ 5 073	€ 55 805	€ 55 805
Rapid Response	4	L	€ 36 098	€ 3 610	€ 39 707	€ 158 829
Shift Supervisors	4	L	€ 36 098	€ 12 250	€ 48 348	€ 193 392
Security Officers/Guards	24	L	€ 7 805	€ 2 649	€ 10 454	€ 250 887
ADMINISTRATION TOTAL	98					€ 2 906 642
PROCESS						
Operations Manager - Processing	1	E	€ 173 913	€ 81 739	€ 255 652	€ 255 652
Secretary / Receptionist	1	L	€ 14 634	€ 1 463	€ 16 098	€ 16 098
Process operations						
Plant Superintendent	1	E	€ 152 174	€ 79 130	€ 231 304	€ 231 304
TMF Superintendent	1	L	€ 84 640	€ 6 829	€ 91 469	€ 91 469
Process Training Officer	1	L	€ 130 435	€ 76 522	€ 206 957	€ 206 957
Shift Supervisor	4	L	€ 36 098	€ 12 250	€ 48 348	€ 193 392
Control Room Operator	4	L	€ 19 512	€ 6 622	€ 26 134	€ 104 536
Mill Operator	8	L	€ 19 512	€ 6 622	€ 26 134	€ 209 072
Crusher Operator	8	L	€ 19 512	€ 6 622	€ 26 134	€ 209 072
CIL Operators	4	L	€ 19 512	€ 6 622	€ 26 134	€ 104 536
Flotation Operators	4	L	€ 19 512	€ 6 622	€ 26 134	€ 104 536
Elution Operators	4	L	€ 19 512	€ 6 622	€ 26 134	€ 104 536

Table 21.22 Summary of Labour Costs						
Description	Number of People	Local/ Expat	Base Salary € /y	Overhead Costs € /y	Annual Labour Cost € /y	Total Annual Cost € /y
<i>TMF Field Operators</i>	3	L	€ 19 512	€ 6 622	€ 26 134	€ 78 402
Day Crew (Utilities, Reagents)	10	L	€ 14 634	€ 1 463	€ 16 098	€ 160 976
<i>TMF Field Crew</i>	4	L	€ 14 634	€ 1 463	€ 16 098	€ 64 390
Goldroom Supervisor	1	L	€ 36 098	€ 3 610	€ 39 707	€ 39 707
Goldroom Operator	3	L	€ 14 634	€ 1 463	€ 16 098	€ 48 293
Subtotal						€ 2 222 929
Process maintenance						
Maintenance Superintendent	1	E	€ 152 174	€ 79 130	€ 231 304	€ 231 304
Maintenance Training Officer	1	E	€ 130 435	€ 76 522	€ 206 957	€ 206 957
Plant Maintenance Planner	1	L	€ 36 098	€ 3 610	€ 39 707	€ 39 707
Electrical Supervisor	1	L	€ 50 732	€ 5 073	€ 55 805	€ 55 805
Mechanical Supervisor	1	L	€ 50 732	€ 5 073	€ 55 805	€ 55 805
Shift Foreman	4	L	€ 50 732	€ 5 073	€ 55 805	€ 223 220
Electrician/Instrument Technicians	8	L	€ 36 098	€ 3 610	€ 39 707	€ 317 659
Fitters / BM	10	L	€ 36 098	€ 3 610	€ 39 707	€ 397 073
<i>TMF Field Maintenance Operators</i>	4	L	€ 19 512	€ 6 622	€ 26 134	€ 104 536
Trades Assistants	10	L	€ 14 634	€ 1 463	€ 16 098	€ 160 976
Subtotal						€ 1 793 041
Metallurgy						
Chief Metallurgist	1	E	€ 130 435	€ 76 522	€ 206 957	€ 206 957
Snr Metallurgist	1	E	€ 121 739	€ 75 478	€ 197 217	
Metallurgist	3	L	€ 50 732	€ 5 073	€ 55 805	€ 167 415
Laboratory Manager	1	E	€ 50 732	€ 5 073	€ 55 805	€ 55 805
Shift Chemist	6	L	€ 36 098	€ 12 250	€ 48 348	€ 290 088
Laboratory Leading Hands	6	L	€ 19 512	€ 6 622	€ 26 134	€ 156 804
Laboratory Assistants	10	L	€ 14 634	€ 4 966	€ 19 601	€ 196 005
Subtotal						€ 1 073 073
PROCESS TOTAL	131					€ 5 089 043
LABOUR TOTAL	487					€ 7 995 685

Plant Maintenance Materials

The maintenance materials and services costs include all materials, contract labour, equipment hire, consumable costs such as mill liners, mill relining costs and pump rebuilds as summarised in Table 21.23.

Table 21.23 Summary of Estimated Maintenance Materials Costs				
Description	Direct Capital Cost	% of Equipment	Annual Maintenance Cost	Maintenance Cost
	€000	Cost	€	€/t
Plant Maintenance				
Earthworks	€ 36 724	0.5%	€ 183 621	€ 0.02
Civils	€ 18 120	1.0%	€ 181 202	€ 0.02
Structural Steel	€ 6 087	1.5%	€ 91 300	€ 0.01
Platework	€ 4 075	5.0%	€ 203 729	€ 0.02
Equipment	€ 77 056	3.5%	€ 2 696 971	€ 0.27
Piping	€ 14 372	5.0%	€ 718 622	€ 0.07
Electrical	€ 13 190	5.0%	€ 659 486	€ 0.07
Instruments	€ 19 925	4.5%	€ 896 609	€ 0.09
Buildings (architectural)	€ 1 355	1.5%	€ 20 322	€ 0.00
Infrastructure (roads)	€ 16 253	1.6%	€ 265 598	€ 0.03
Total - Processing Maintenance	€ 207 157	2.9%	€ 5 917 460	€ 0.59

Mobile Equipment Costs

The mobile equipment costs are presented in Table 21.24.

Table 21.24 Summary of Mobile Equipment Costs		
Equipment	Number of Units	Total Cost €/y
Light Vehicles		
Single Cab Utility 4WD	3	€ 17 710
Double Cab Utility 4WD	4	€ 10 120
4WD Troop Carrier / Ambulance	1	€ 0
*Busses - 52 seaters	5	€ 22 770
Busses - 14 seaters	1	€ 3 010
Subtotal	13	€ 53 610
Medium / Heavy Vehicles		
Bobcat (Skid-Steer loader)	1	€ 2 530
25 t Rough Terrain Crane	1	€ 6 540
*60 t Rough Terrain Crane	1	€ 6 540
*150 t Crane	1	€ 6 540
Cherry-Picker	1	€ 0
*Forklift 2 tonne	2	€ 5 060
Warehouse Forklift (5 t)	2	€ 0
*Forklift - container lift (10 t)	1	€ 0

Table 21.24
Summary of Mobile Equipment Costs

Equipment	Number of Units	Total Cost € /y
*Hiab Truck - 3.5 t (4WD)	1	€ 7 590
TMF Hiab Truck - 10 t (4WD)	1	€ 9 920
Backhoe/FEL	1	€ 2 530
Fire Truck	1	€ 0
Skid-steer loader 3.5 t	1	€ 6 540
FEL 992 (ROM Feeding)	1	2530
Subtotal	16	€ 56 320
Equipment		
Emergency Generator (750 kVA)	1	€ 2 530
Portable Pumps Generator (200 kVA)	1	€ 2 530
Generator (5 kVA)	1	€ 2 530
Portable Compressor	1	€ 2 530
Diesel Welder	2	€ 5 060
Fusion Butt Welder Damos	2	€ 5060
Subtotal	8	€ 20 240
Total	37	€ 130 170

Laboratory

The laboratory costs are based on an assay schedule developed for Ilovica Mine for the handling of metallurgical composites, metallurgical test work, control samples, and environmental samples. Samples will be analysed mainly for gold and copper, while various carbon samples will be analysed for silver, iron, nickel, calcium and magnesium. The manning costs for the laboratory have been included in the main labour costs. The total laboratory costs are € 424 632 per year equivalent of € 0.04 /t milled.

General and Administration Costs

These costs are deemed to be the project site support and project administration costs. The general administration costs include insurances and permitting, telephones, office supplies and stationary, in-plant and light vehicle operation, travel expenses, conferences, consultants, training costs, and miscellaneous hardware costs. An allowance of € 0.34 /t milled has been provided equating to € 3 415 453 per year.

21.2.4 Tailings Management Facility (4000)

21.2.4.1 Basis of Estimate

The TMF operating costs are based on quantities determined by Golder together with rates as provided by Euromax Resources and Amec Foster Wheeler.

The TMF labour and mobile equipment operating costs have been included as part of the process plant operating costs defined in Table 21.22 and Table 21.24 but have been extracted and are presented in Table 21.25 and Table 21.26.

Table 21.25 Summary of TMF Labour Operating Costs						
Description	Number of People	Local/ Expat	Base Salary € /y	Overhead Costs € /y	Annual Labour Cost € /y	Total Annual Cost € /y
TMF Superintendent	1	L	€ 84 640	€ 6 829	€ 91 469	€ 91 469
TMF Field Operators	3	L	€ 19 512	€ 6 622	€ 26 134	€ 78 402
TMF Field Crew	4	L	€ 14 634	€ 1 463	€ 16 098	€ 64 390
TMF Field Maintenance Operators	4	L	€ 19 512	€ 6 622	€ 26 134	€ 104 536
Labour Total - TMF	12		€ 138 298	€ 21 536	€ 159 835	€ 338 797

Note: Four (4) control room operators have been included in the process plant labour compliment (Table 21.22) one of which will also be responsible for the TMF.

Table 21.26 Summary of TMF Mobile Equipment Costs		
Equipment	Number of Units	Total Cost € /y
TMF Hiab Truck - 10 t (4WD)	1	€ 9 920

Note: Light vehicles have been included in the process plant mobile equipment (Table 21.24). A single cab utility 4WD will be available for use by the TMF operators.

21.2.5 Off Site infrastructure (5000)

21.2.5.1 Basis of Estimate

No costs included in this section – all off site infrastructure costs are included in plant operating cost maintenance allowance for infrastructure in Section 21.2.3.

21.2.6 On Site Infrastructure (7000)

21.2.6.1 Basis of Estimate

All associated operating costs have been included in Section 21.2.3.

22. ECONOMIC ANALYSIS

22.1.1 Summary

An economic analysis of the Project using discounted cash flow was prepared on a pre-tax and a post-tax basis. For the 20-year mine life, processing 198 Mt total throughput, operating at 10 Mt/a the financial results are:

- Pre-tax NPV of €466.4 M (US\$513.0 M) and post-tax NPV of €400.1 M (US\$440.1 M) at 5% discounted rate
- Pre-tax IRR of 19.8% and post-tax IRR of 17.8%
- Initial Capex €431.2 M (US\$474.3 M) including contingency
- After tax payback period of 4.3 years
- World Gold Council defined Adjusted Operating Cash Costs of €181 /oz (US\$200 /oz) and All-In Costs of €338 /oz (US\$ 372 /oz)³⁰

The project is most sensitive to changes in metal recovery and less so to changes in operating costs and capital costs changes. Opportunities may lie in reduction of operating costs but most notably in metal recovery.

22.1.2 Basis of Evaluation

The results of this economic analysis depend on inputs that are subject to a number of known and unknown risks, uncertainties, and other factors that may cause actual results to differ from those presented here. All costs, revenues and economic outcomes included in this section are represented in Euro.

22.1.3 Methodology

The project has been evaluated using DCF analysis on an after tax basis. Cash inflows consist of annual revenue projections for the mine. Cash outflows such as capital, operating costs, and royalties are subtracted from the inflows to arrive at the annual cash flow projections.

To reflect the time value of money, annual net cash flow (NCF) projections are discounted back to the project valuation date using several discount rates. The discount rate appropriate to a specific project depends on many factors, including the type of commodity and the level of project risks, such as market risk, technical risk, and political risk. The discounted present values of the cash flows are summed to arrive at the project's NPV.

In addition to NPV, IRR and payback period are also calculated. The IRR is defined as the discount rate that results in an NPV equal to zero. Cash flows are taken to occur at the end of each period.

Capital cost estimates have been prepared for initial development and construction of the project and for ongoing operations (sustaining capital).

³⁰ Op. cit.

22.1.4 Model Parameters

22.1.4.1 Mineral Reserve and Mine Life

The Mineral Reserve and mine life are discussed in Section 15. For the economic analysis it was assumed that the total Mineral Reserve of 198 Mt will be mined through open pit mining methods. The mineralised material is to be processed at an average rate of 10 Mt/a for a 20 year life of mine.

22.1.4.2 Metallurgical Balance

Recovery and grade assumptions based on metallurgical test work results are summarised in Table 22.1.

Table 22.1 Metallurgical Recoveries				
Item	Unit	Value		
Product Type	#	Flotation Concentrate	Doré	Overall Recovery
Cu Recovery	%	82	N/A	82
Cu Grade	%	24	<25	-
Au Recovery	%	65	19	84

The concentrate produced from metallurgical test work was found to have payable quantities of silver in all assays completed. Concentrates from previous test work also all had payable silver in similar quantities. The assay from the most recent work was the lowest of the three available assays at 110 g/t silver (a smelter analysed a concentrate from a different batch of test work and obtained 113 g/t silver and a sample of concentrate produced at the Institute of Mining and Metallurgy at Bor, Serbia was assayed at the same laboratory and returned 145 g/t silver). The lowest of these values, i.e. 110 g/t silver, was adopted for the economic analysis to generate a by-product revenue associated with the copper concentrate.

22.1.4.3 Off Site Charges

The copper-gold ore concentrate and gold doré off site charges include treatment, refining and transport charges as detailed in Table 22.2.

Table 22.2 Concentrate and Doré Off Site Charges		
Item	Unit	Value
Concentrate		
Copper treatment charge	US\$ /wmt	85.00
Copper refining charge	US\$ /payable lb Cu	0.085
Gold refining charge	US\$ /oz Au	5.00
Silver refining charge	US\$ /oz Ag	0.40
Transport charge (Pirdop)	US\$ /wmt	26.40
% Payable Copper (based on a 24% grade)	%	95.83
% Payable Gold	%	97.00
Doré		

Table 22.2
Concentrate and Doré Off Site Charges

Item	Unit	Value
Gold refining charge	US\$ /oz Au	0.40
Insurance and transport charge	US\$ /oz Au	4.00
Gold Payability	%	99.9

22.1.4.4 Operating Costs

The operating costs for the project are discussed in Section 21.2. The project is highly sensitive to changes in operating cost.

22.1.4.5 Capital Costs

The LOM capital costs consist of:

- Initial capital costs for plant, infrastructure, mine fleet and TMF pre-deposition are summarised in Table 21.1.
- Capital cost for opening stocks and strategic spares deferred to the first and second years of operation.
- Sustaining capital of €181 M allowed for which is based on mine fleet replacement and TMF expansions during the life of mine.
- Closure costs only include TMF, Processing Plant and associated infrastructure.

22.1.4.6 Royalties

The LOM royalty is 2.0% on the net smelter and refinery return.

22.1.4.7 Working Capital

Working capital is considered to be a temporary use of funds, incurred at the start-up of operations and intended to fund mining and production operations until the receipt of revenues. As revenues and costs typically vary from year to year, the working capital will also change each year. However, all working capital is theoretically recovered at the end of the project. The formal definition of working capital is current asset value minus current liabilities. For the sake of simplicity, a good approximation to this, for this project, is one month's production revenue.

22.1.4.8 Taxes

The project was evaluated on a 10% corporation tax basis payable on expenses not recognised for tax purposes and understated revenues and mainly profit distribution. Total tax payable for the life of the project is € 91.3 M (US\$100.4 M).

22.1.4.9 Financing

The economic analysis is based on 100% equity financing.

22.1.4.10 Inflation

The economic analysis assumes that no inflationary adjustments are made. Capital and operating costs are based on fourth quarter 2015.

22.1.4.11 Depreciation

Capital expenditure is depreciated by using the units of production method, in which the charge reflects the pattern of production over the asset's useful life.

22.1.5 Results and Sensitivity Analysis

The FS demonstrates a robust NPV at a 5% discount of €466.4 M (US\$ 513.0 M) with an IRR of 19.8% before tax and an after tax NPV at a 5% discount of €400.1 M (US\$440.1 M) and IRR 17.8%.

The discounted cash flow analysis for the base case is presented in Table 22.3

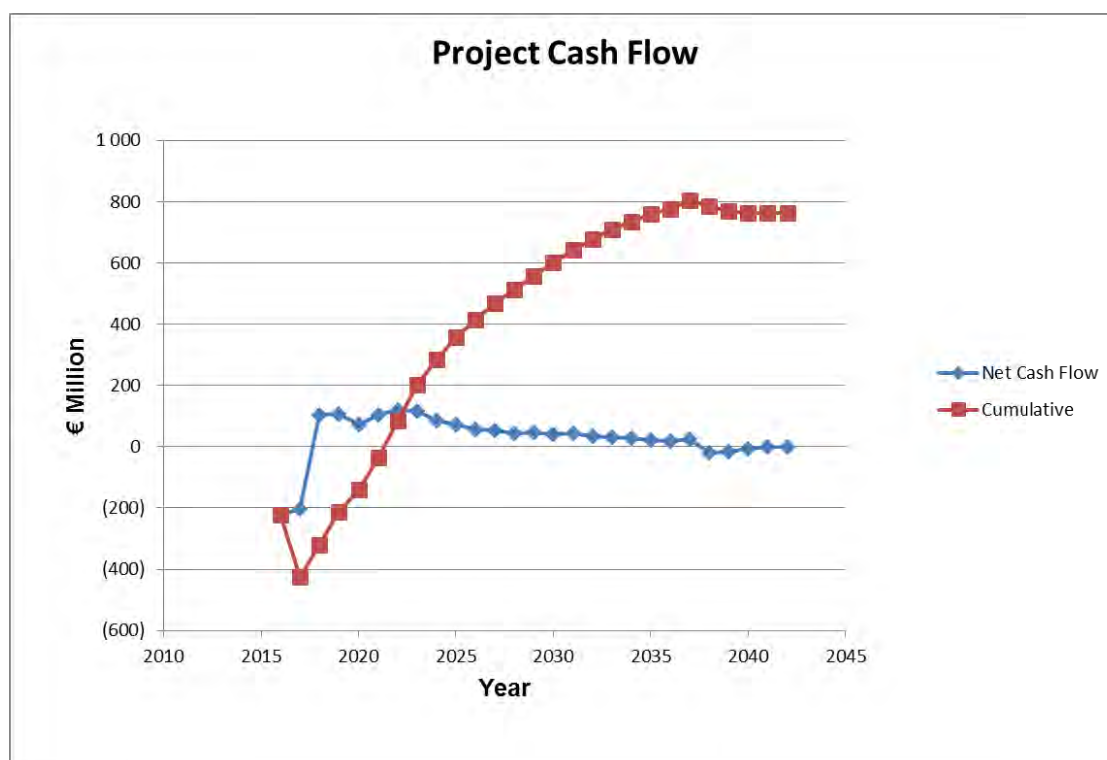
Table 22.3

	Unit	Total	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
Production																													
Sulphide																													
Sulphide Ore Tonnes	t	198 105 837			9 725 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	8 380 837				
Au grade	g/t	0.31			0.46	0.40	0.31	0.41	0.45	0.45	0.34	0.33	0.31	0.29	0.28	0.29	0.26	0.28	0.26	0.26	0.24	0.24	0.22	0.21					
Cu grade	%	0.21%			0.35%	0.27%	0.23%	0.26%	0.26%	0.24%	0.23%	0.21%	0.20%	0.19%	0.19%	0.18%	0.16%	0.19%	0.17%	0.17%	0.16%	0.16%	0.14%	0.17%					
Waste																													
Pre-strip	t	13 091 350		13 091 350																									
Waste	t	186 840 274			10 993 947	10 818 271	10 818 271	10 818 271	10 818 271	10 818 271	6 784 488	8 182 297	10 413 727	7 059 139	12 489 577	13 033 665	3 528 820	9 945 738	10 186 430	10 386 375	12 691 015	12 479 911	4 573 788						
Strip ratio (incl Oxide)	Waste:ore	1.01			1.13	1.08	1.08	1.08	1.08	1.08	0.68	0.82	1.04	0.71	1.25	1.30	0.35	0.99	1.02	1.04	1.27	1.25	0.46						
Total Waste (incl Prestrip)	t	199 931 624	-	13 091 350	10 993 947	10 818 271	10 818 271	10 818 271	10 818 271	10 818 271	6 784 488	8 182 297	10 413 727	7 059 139	12 489 577	13 033 665	3 528 820	9 945 738	10 186 430	10 386 375	12 691 015	12 479 911	4 573 788						
In-Situ Metal Au - Oxide		oz																											
In-Situ Metal Au - Sulphide	oz	2 003 553			143 923	128 635	99 611	130 512	143 467	145 210	109 759	104 807	101 243	93 989	89 636	91 939	83 234	89 731	84 243	82 224	77 809	76 863	69 924	56 794					
In-Situ Metal Au - Total	oz	2 003 553			143 923	128 635	99 611	130 512	143 467	145 210	109 759	104 807	101 243	93 989	89 636	91 939	83 234	89 731	84 243	82 224	77 809	76 863	69 924	56 794					
In-Situ Metal Cu	t	407 547			33 660	26 542	23 048	26 072	25 819	23 719	22 518	21 026	19 826	19 282	19 100	18 246	16 450	18 974	16 893	16 670	15 968	15 748	14 001	13 984					
Flotation Plant Feed																													
Sulphide Ore	t	198 105 837			9 725 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	10 000 000	8 380 837					
Au grade	g/t	0.31			0.46	0.40	0.31	0.41	0.45	0.45	0.34	0.33	0.31	0.29	0.28	0.29	0.26	0.28	0.26	0.26	0.24	0.22	0.21						
Cu grade	%	0.21%			0.35%	0.27%	0.23%	0.26%	0.26%	0.24%	0.23%	0.21%	0.20%	0.19%	0.19%	0.18%	0.16%	0.19%	0.17%	0.17%	0.16%	0.16%	0.14%	0.17%					
Au recovery to Conc	%				61.5%	63.8%	64.2%	64.3%	65.0%	65.0%	65.0%	65.0%	65.0%	65.0%	65.0%	65.0%	65.0%	65.0%	65.0%	65.0%	65.0%	65.0%	65.0%						
Cu recovery to Conc	%				77.1%	80.3%	80.9%	81.1%	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%	82.0%						
Recovered Au to Conc		oz	1 294 113		88 559	82 072	63 961	83 955	93 254	94 386	71 343	68 125	65 808	61 093	58 264	59 760	54 102	58 325	54 758	53 446	50 576	49 961	45 451	36 916					
Recovered Cu to Conc	t	331 622			25 963	21 320	18 652	21 143	21 172	19 450	18 465	17 242	16 257	15 811	15 662	14 961	13 489	15 559	13 852	13 669	13 093	12 913	11 480	11 467					
Concentrate Grade (Cu)	%				24%	24%	24%	24%	24%	24%	24%	24%	24%	24%	24%	24%	24%	24%	24%	24%	24%	24%	24%						
Moisture Content	%				10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%						
Concentrate Produced	wmt	1 400 937			118 998	97 718	85 488	96 905	97 036	89 144	84 631	79 024	74 512	72 468	71 784	68 573	61 826	71 312	63 490	62 650	60 011	59 186	52 619	52 557					
Concentrate Produced	dmt	1 381 759			108 180	88 835	77 716	88 096	88 215	81 040	76 937	71 840	67 738	65 880	65 259	62 339	56 206	64 829	57 718	56 955	54 556	53 806	47 835	47 779					
Calculated Au Conc Grade	g/dmt	29.13			25.46	28.74	25.60	29.64	32.88	36.23	28.84	29.49	30.22	28.84	27.77	29.82	29.94	27.98	29.51	29.19	28.83	28.88	29.55	24.03					
CIL Plant																													
Rom Throughput																													
Sulphide																													
Mass pull to CIL feed	t	14 263 620			700 200	720 000	720 000	720 000	720 000	720 000	720 000	720 000	720 000	720 000	720 000	720 000	720 000	720 000	720 000	720 000	720 000	720 000	720 000	603 420					
					19.8%	21.2%	21.5%	21.6%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%	22.0%					
Overall Au Recovery to CIL																													
Au grade	g/t	0.55			1.27	1.18	0.93	1.22	1.36	1.38	1.04	1.00	0.96	0.89	0.85	0.87	0.79	0.85	0.80	0.78	0.74	0.73	0.66	0.64					
Cu grade	%	0.01%			0.021%	0.016%	0.014%	0.016%	0.015%	0.014%	0.014%	0.013%	0.012%	0.012%	0.011%	0.011%	0.010%	0.011%	0.010%	0.010%	0.010%	0.009%	0.008%	0.010%					
Au recovery to Dore	%				86.1%	86.1%	86.1%	86.1%	86.1%	86.1%	86.1%	86.1%	86.1%	86.1%	86.1%	86.1%	86.1%	86.1%	86.1%	86.1%	86.1%	86.1%	86.1%						
Recovered Au Dore	oz	375 176			24 537	23 532	18 452	24 261	27 185	27 515	20 798	19 859	19 184	17 810	16 985	17 421	15 772	17 003	15 963	15 580	14 744	14 564	13 250	10 762					
Gross Au Recovery		83.5%			79%	82%	83%	83%	84%	84%	84%	84%	84%	84%	84%	84%	84%	84%	84%	84%	84%	84%	84%						
Capital																													
Initial Capital																													
Mining(1000)	EUR	68 380 324	28 104 313	40 276 011																									
Process Plant (3000)	EUR	181 454 298	83 022 936	98 431 362																									
TMF (4000)	EUR	39 039 380	8 687 370	27 093 157	3 258 853																								
Infrastructure offsite (5000)	EUR																												
Infrastructure onsite (7000)	EUR	23 661 578	19 497 140	4 164 438																									
EPCM Contractor (8100)	EUR	48 396 237	32 310 528	13 721 097	2 364 613																								
Owner's Costs (8200)	EUR	30 201 254	22 937 852	7 263 402																									
Growth Provision (8300)	EUR	12 139 257	12 139 257																										
Contingency (8400)	EUR	24 564 594	11 594 488	11 778 723	1 191 383																								
Tempary Works (9000)	EUR	3 336 581	3 336 581																										
Total		431 173 504																											
Defered Capital																													
Strategic and Critical Spares		1 620 868																											
Opening Stocks		5 856 381			5 856 381																								
Total		7 477 249																											
Sustaining Capital																													
TMF	EUR	99 593 078			6 190 417	5 628 381	5 248 016	4 712 565	5 209 283	4 331 538	4 991 673	4 991 673	3 734 453	4 168 626	6 124 519	4 112 066	5 040 295	5 040 295	5 104 935	5 040 295	3 065 211	6 043 259	4 256 433	3 830 744	2 728 402				
Mining Fleet	EUR	80 937 097			13 149 549	1 589 268	3 528 622	2 814 093	1 749 845	1 784 472	1 789 241	1 792 950	7 808 918	6 741 274	6 293 421	4 615 447	2 729 466	6 493 622	3 643 749	5 881 337	3 707 149	2 924 157	1 900 517						
Working Capital	EUR				6																								

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The cash flow analysis shows that the project will generate positive cash flows during the first year of production (Figure 22.1).

Figure 22.1
Project Net Cash Flow (After Tax)



Sensitivity analysis was performed on the project to gauge its robustness against favourable and unfavourable changes to project variables taking into account variations in the metal price, operating cost, capital cost, copper and gold recovery. The analysis shows that the project is most sensitive to changes in metal recovery followed by metal price, operating cost and finally capital cost. The results indicate that the project is robust enough to remain viable in the ranges tested for the analysed variables. Economic results of these sensitivities are summarised in Table 22.4 (Euro) and Table 22.5 (US\$) and presented in Figure 22.2.

Table 22.4								
Selective Sensitivities, After-tax NPV at 5% Discount Rate (Euro)								
	Factor	Change in Factor (€ M)						
		-30%	-20%	-10%	0%	10%	20%	30%
Capital expenditure	1	€ 565	€ 510	€ 455	€ 400	€ 345	€ 290	€ 235
Total Operating expenditure	2	€ 706	€ 604	€ 502	€ 400	€ 297	€ 193	€ 89
Gold Price	3	€ 98	€ 199	€ 300	€ 400	€ 500	€ 600	€ 699
Recovery	4	€ 318	€ 346	€ 373	€ 400	€ 427	€ 454	€ 481
Copper Price	5	€ 90	€ 194	€ 297	€ 400	€ 503	€ 605	€ 707

Table 22.5 Selective Sensitivities, After-tax NPV at 5% Discount Rate (US\$)								
	Factor	Change in Factor (US\$ M)						
		-30%	-20%	-10%	0%	10%	20%	30%
Capital expenditure	1	\$622	\$561	\$501	\$440	\$380	\$319	\$259
Total Operating expenditure	2	\$777	\$664	\$552	\$440	\$327	\$212	\$98
Gold Price	3	\$108	\$219	\$330	\$440	\$550	\$660	\$769
Recovery	4	\$350	\$381	\$410	\$440	\$470	\$499	\$529
Copper Price	5	\$99	\$213	\$327	\$440	\$553	\$666	\$778

Figure 22.2
Sensitivity of NPV 5% (Tornado Chart)

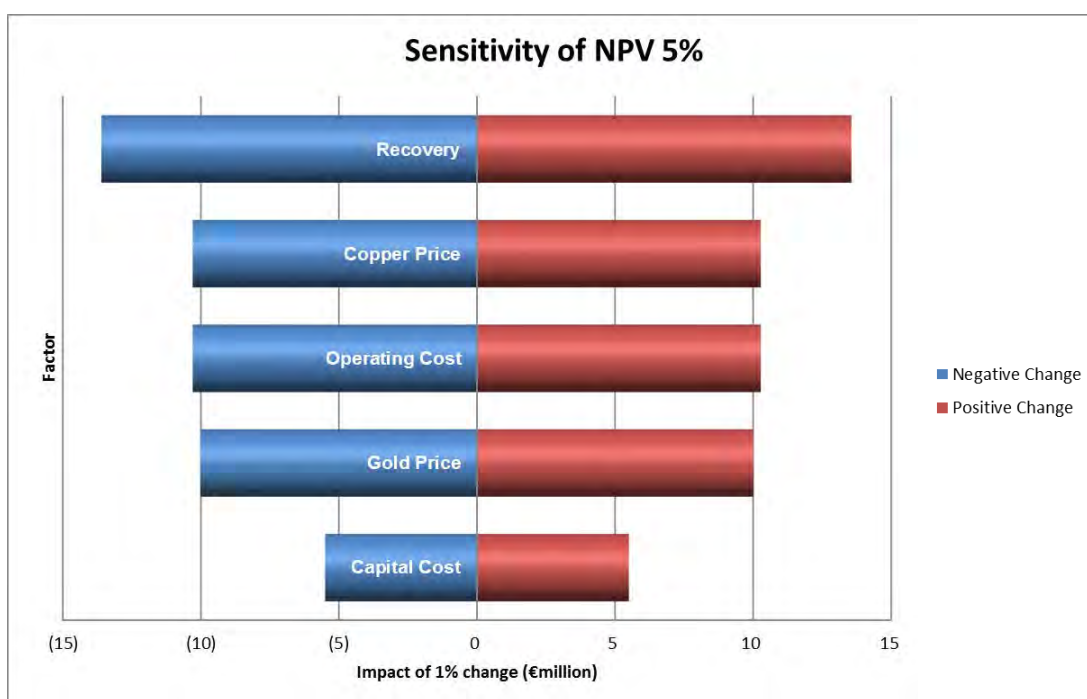


Table 22.6 (Euro) and Table 22.7 (US\$) illustrate the sensitivity to changes to the calculated IRR and NPV at 0%, 5% and 10% discount rates at various gold and copper prices. No assurance or guarantee is provided that the calculated IRR or NPV values will be achieved.

Table 22.6 NPV and IRR Sensitivity to Metal Prices (Euro)									
Gold Price (US\$ /oz)	Copper Price (US\$ /lb)	NPV at 0% discount (€ M)		NPV at 5% discount (€ M)		NPV at 10% discount (€ M)		IRR	
		Pre-tax	Post-tax	Pre-tax	Post-tax	Pre-tax	Post-tax	Pre-tax	Post-tax
1 100	2.50	€ 431	€ 374	€ 201	€ 159	€ 56	€ 22	12.7%	11.1%
1 220	2.90	€ 854	€ 762	€ 466	€ 400	€ 237	€ 187	19.8%	17.8%
1 400	3.50	€ 1 488	€ 1 335	€ 864	€ 759	€ 508	€ 431	28.6%	25.9%

Note: Silver price fixed at US\$18 /oz

Table 22.7 NPV and IRR Sensitivity to Metal Prices (US\$)									
Gold Price (US\$ /oz)	Copper Price (US\$ /lb)	NPV at 0% discount (US\$ M)		NPV at 5% discount (US\$ M)		NPV at 10% discount (US\$ M)		IRR	
		Pre-tax	Post-tax	Pre-tax	Post-tax	Pre-tax	Post-tax	Pre-tax	Post-tax
1 100	2.50	\$474	\$412	\$221	\$174	\$61	\$25	12.7%	11.1%
1 220	2.90	\$939	\$839	\$513	\$440	\$260	\$205	19.8%	17.8%
1 400	3.50	\$1 637	\$1 469	\$951	\$835	\$559	\$474	28.6%	25.9%

Note: Silver price fixed at US\$18 /oz

22.1.6 Project Opportunities

Opportunities may lie in reduction of operating costs but most notably in metal recoveries.

23. ADJACENT PROPERTIES

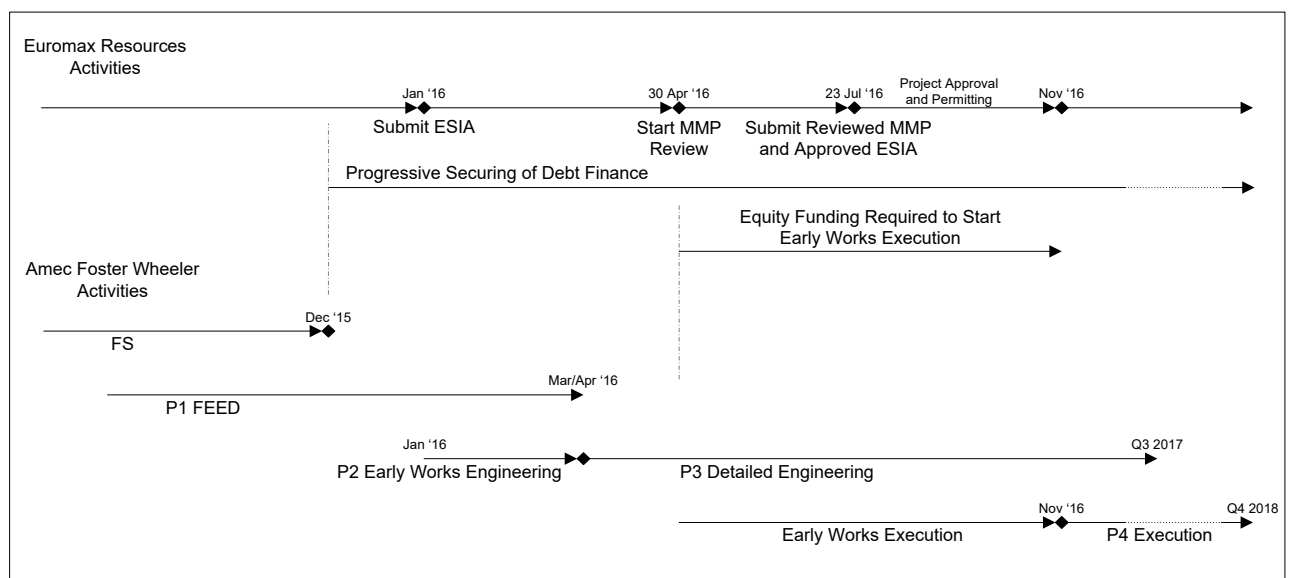
There are no material properties adjacent to the Property.

24. OTHER RELEVANT DATA AND INFORMATION

24.1 PROJECT INFORMATION

The Ilovica Gold-Copper Project FS has been executed by Amec Foster Wheeler on behalf of Euromax Resources. An implementation strategy for the next phases of the project has been developed, as part of the study deliverables. This section details the execution strategy and will be part of initiation documentation for the next phase of the project. The FS was based on South African engineering standards and was priced utilising quotes from internationally suited vendors and local Macedonian based contractor's quotes. The next phase, FEED, will normalise the project against Macedonian/European technical standards. There will be three further phases of project development after the FEED phase, the early works engineering and execution phase, detailed engineering phase and the execution phase. Figure 24.1 shows the project delivery phases and forms the basis of the agreed way forward.

Figure 24.1
Project Delivery Phases



24.1.1 Phase 1 FEED

The engineering associated with the FEED is based on localising the design in conformance with local standards and norms. It will not require a change to the level of engineering required, nor will any further procurement or estimating be produced.

Amec Foster Wheeler will specify all packages in accordance with Article 16 of the Regulations on the Content of Mining Projects as adopted by the Minister of Economy pursuant to article 49, paragraph 4 of the Law on Mineral Raw Materials (Official Gazette of Republic of Macedonia, no. 24/07). Article 16 states:

“The technical solutions for separate mining facilities are developed into technical projects for mining facilities and sections of the technological process and they include the following:

- *Project task with required appropriate design basis;*
- *Solution of the task with technical description of performance, construction selection, static calculation and drawings in adequate scale (clarification of design codes);*
- *Bill of quantities of operations with appropriate economic parameters;*
- *Specific safety measures.*

The technical projects or their sections for facilities and structures of specific (construction, electro-technical, mechanical) character, in addition to the elements provided with mining regulations, also include elements provided with the related type of technique.”

The preparation, presentation and translation of the EWPs to meet the Macedonian regulations and submission for approval, will be carried out by the University of Shtip in Macedonia. This submission is described as the MMP. The MMP will be based on the FS and extracts from the FEED.

The MMP is reviewed and approved by a multi-disciplined team appointed by the minerals department at the Ministry of Economy.

Euromax Resources will facilitate this process with their in-country management and technical team. The EWPs will be issued to the University of Shtip on a progressive basis and will also be submitted to the Ministry of Economy technical committee on the same progressive basis for their review, to expedite the approval process.

The MMP is presented in two main categories, i.e. Mining and Metallurgy (Processing), the scope of work of each main package has been agreed with the University of Shtip against the Engineering WBS.

The list of FEED packages anticipated for the project are defined in Table 24.1.

Table 24.1 List of FEED Packages		
WBS Area	Area Description	Notes
MINING		
1010	Mine (by Independent Mining Consultant)	
1020	Earthworks and Infrastructure	
1030	• Mining Site Preparation	
1040	• Mining Laydown Area	
1050	• Mining Underground Services	
1070	• Mining Access Roads and Bridges	
1080	• Mining Drainage	
	• Environmental Ponds and Monitoring	
1090	Mining Buildings	Design and supply. Civil design by Amec Foster Wheeler and construction by civil contractor. Building design by Amec Foster Wheeler and local architect, erection by main SMPP contractor.
1100	Mining Power Distribution and Control	

Table 24.1
List of FEED Packages

WBS Area	Area Description	Notes
1110	Mining Communications	
1120	Mining Maintenance and Mobile Equipment	
1140	Mining Hardware and Software	
1160	Primary Fuel Storage and Distribution	Design, supply and install.
1170	Mining Utility Facilities	
1180	Spares and First Fill	
1190	Mining Security and Access Control	
1300	Drilling Equipment (by Independent Mining Consultant)	
1350	Loading Equipment (by Independent Mining Consultant)	
1400	Hauling Equipment (by Independent Mining Consultant)	
1500	Haul Truck Workshops and Infrastructure	
1550	Ancillary Workshops and Infrastructure	
1600	Explosive Storage and Manufacturing	
1650	Geology Infrastructure	
PROCESSING		
3020, 4020, 5020, 7020, 9020	Earthworks and Infrastructure • Site Preparation	
4030, 9030	• Laydown Area	
3040, 4040, 7040	• Underground Services	
5050, 7050	• Roads and Bridges	
4070, 7070	• Drainage	
4080, 7080	• Environmental Ponds and Monitoring	
	Laydown Area	
	Underground Services	
	Roads and Bridges	
	Drainage	
	Environmental Ponds and Monitoring	
3090, 4090, 7090, 9090	Buildings (General)	Design and supply. Civil design by Amec Foster Wheeler and construction by civil contractor. Building design by Amec Foster Wheeler and local architect, erection by main SMPP contractor.
3100, 4100, 7100, 9100	Power Supply, Distribution and Control	
7110, 9110	Construction IT and Communications	

Table 24.1
List of FEED Packages

WBS Area	Area Description	Notes
3120, 4120, 7120, 9120	Maintenance and Mobile Equipment	
3130	Process Control System	
7140, 9140	Hardware and Software Computing	
3150, 4150	Pipe Racks and Pipe Bridges	
3160, 7160, 9160	Fuel Storage and Distribution	
3170, 7170, 9170	Utility Services	
3180, 4180, 7180, 9180	Spares and First Fill	
3190, 7190, 9190	Security and Access Control	
3210	Ore Receipt and Crushing	Primary crusher and lubrication system design, supply and install. Crusher civil design by Amec Foster Wheeler and construction by civil contractor. Conveyors design and supply with erection by main SMPP contractor.
3220	Coarse Ore Stockpile	Design and supply. Civil design by Amec Foster Wheeler and civil construction by civil contractor, erection by main SMPP contractor.
3230	Milling and Pebble Crushing	Mills and building design, supply and install. Civil design by Amec Foster Wheeler and civil construction by civil contractor, installation of mills by vendor.
3250	Oxide Ore Stockpile	
3350	Flotation	Flotation circuit design and supply. Civil design by Amec Foster Wheeler and construction by civil contractor. Building design by Amec Foster Wheeler and local architect and erection by main SMPP contractor.
3360	Concentrate Regrind	
3400, 3410	Concentrate Dewatering and Storage	
3550	Pre-leach Thickening	Design and supply. Civil design by Amec Foster Wheeler and civil construction by civil contractor, installation and erection by main SMPP contractor.
3600	Carbon-in-leach	
3600	Post-Leach Thickening	Design and supply. Civil design by Amec Foster Wheeler and civil construction by civil contractor, installation and erection by main SMPP contractor.

Table 24.1
List of FEED Packages

WBS Area	Area Description	Notes
3750	Elution and Acid Wash	Design and supply. Civil design by Amec Foster Wheeler and civil construction by civil contractor, installation and erection by main SMPP contractor.
3760	Electro-winning	
3770	Gold Room	
3780	Carbon Regeneration	
3850	Tails Thickening	Design and supply. Civil design by Amec Foster Wheeler and civil construction by civil contractor, installation and erection by main SMPP contractor.
3860	Cyanide Destruction	
3910	Reagents - Frother and Activator Makeup	
3911	Reagents - Collector Mixing and Dosing	
3920	Reagents - Cyanide Mixing and Makeup	
3921	Reagents - Lime Mixing and Dosing	Design and supply. Civil design by Amec Foster Wheeler and construction by civil contractor. Building design by Amec Foster Wheeler and local architect and erection by main SMPP contractor.
3922	Reagents - Caustic Soda Mixing and Dosing	
3923	Reagents - Hydrochloric Acid Mixing and Dosing	
3924	Reagents - Lead Nitrate, SMBS and Hydrogen Peroxide Mixing and Dosing	
3925	Reagents - Flocculant Mixing and Dosing	Design and supply. Civil design by Amec Foster Wheeler and construction by civil contractor. Building design by Amec Foster Wheeler and local architect, erection by main SMPP contractor.
3926	Reagents - Sulphuric Acid Storage and Dosing	
4200	Tailings Management Facility (by Golder)	
4300	Tailings Slurry Pipelines	
4400	Tailings Booster Pumping	
7200	Water Supply and Treatment	
7250	Sewage Treatment Facility	Modular design and supply. Civil design by Amec Foster Wheeler and construction by civil contractor.
7400	Concentrate or Product Handling and Transportation	
9200	Construction Warehousing and Materials Management	

24.1.2 Phase 2 Early Works Engineering and Execution

The early works phase will have two main focus points. The first will be to confirm package data. The second will be to further the detailed design and finalise the following pre-determined contracts:

- Access Road
- Site Security and Fencing
- Laydown Areas
- Temporary Construction Power
- Water Supply

24.1.3 Phase 3 Detailed Engineering

The detailed engineering phase will initially focus on procurement of equipment and then on the finalisation of the detailed design and 3D model based on certified vendor information to produce construction drawings.

24.1.4 Phase 4 Construction and Commissioning

Construction will commence on finalisation of the environmental and mining permits. Construction will be done by locally sourced contractors with equipment being sourced from vendors of international standing.

24.1.5 Key Stakeholders

24.1.5.1 Key Stakeholders

The major shareholders are:

- European Bank for Reconstruction and Development (EBRD)
- Royal Gold

24.1.5.2 In-country Stakeholders

The generic groups identified in-country are:

- Business owners / contractors
- Elected official – Mayor's office
- Elected official – Other level of government
- Farmer's Association
- Forestry company (other commercial tenure holders)
- Government department – Municipal
- Government department – National
- Non-elected leaders / administrators (economic, planning and emergency response departments)
- Health services
- Hunting Association (recreational users)
- Land owners
- Law enforcement official
- Media official

- NGO / ENGO official (environmental groups)
- Religious organisations

24.2 SCOPES OF WORK

The project has been broken down into three areas of work, i.e. Process Plant and Infrastructure, Mining, and TMF. The definition of work for these areas is detailed below.

24.2.1 Process Plant and Infrastructure

Amec Foster Wheeler Johannesburg will be responsible for the detailed designs of the Gold-Copper Processing Plant and Infrastructure.

The Gold-Copper processing plant includes the following unit processes:

- ROM material handling and Crushing;
- Milling;
- Flotation;
- Copper concentrate dewatering and handling;
- Pre-leach thickening;
- CIL;
- Carbon handling;
- Reagents;
- Elution;
- Carbon regeneration;
- Gold electrowinning and smelting;
- Cyanide destruction; and
- Tailings thickening.

The Infrastructure design includes:

- Commercial buildings and facilities for the process plant and the mine, namely; access and perimeter control and security including gate-houses, control-rooms and offices;
- Industrial buildings for both mine and process plant including warehouses, engineering workshops for heavy and light equipment and mobile machinery, laboratory, explosive storage facilities, fuel and lubrication storage and dispensing facilities and change-houses;
- All on-mine roads, terraces, berms and topsoil stockpiles;
- ROM pad;
- Water diversion and storm water drainage and storage arrangements for the process plant and infrastructure;
- Power distribution, excluding bulk power generation; and

- Water distribution, excluding bulk water supply.

In addition to the above, Amec Foster Wheeler's scope will include:

- ROM handling between the mine and plant;
- On site water reticulation;
- On site power reticulation; and
- On site road design.

24.2.1.1 Battery Limits

The battery limits applicable to Amec Foster Wheeler's scope will be:

- ROM pad
- Discharge flange on the tailings disposal tank.
- Mine security fencing.
- Supply of water from the Ilovica reservoir.
- Incoming terminals of the main plant MV switchboard.

24.2.2 Mining

An independent mining consultant in conjunction with Euromax Resources will be responsible for undertaking the detailed mine open pit design.

24.2.2.1 Pit optimisation and Mine Design

The pit optimisation will consider:

- Modifying factors such as mining losses and dilutions;
- Cut-off grades;
- Value engineering and trade-off studies;
- Production rates – run-of-mine and plant throughput;
- Plant recoveries;
- Mining boundaries (licence area);
- Preliminary pit slope design;
- Operating costs; and
- Revenue assumptions as supplied by Euromax Resources.

The detailed pit design will consider:

- Geotechnical parameters (slope angles, mining bench height, ramp widths, overall bench stack height, berm widths and batter angles);

- The design of the final pit will include batters, berms, safety benches, ramp and haul roads and geotechnical benches based on the optimised pit shells, major equipment types and the geotechnical parameters;
- Ramp entrance and exit strategy;
- Water management – The consultant will provide Amec Foster Wheeler with schedules of potential water quantities from the open pit in order for them to design the site water management facilities accordingly;
- Optimisation of the ROM production profile to meet the processing and product targets;
- Waste production scheduling and dump requirements, including scheduling of ARD potential waste for consideration in construction of the TMF facility retaining dam;
- Estimation of cut-off grade, minimum mining width, mining losses and dilution; and
- Detailed design of haul roads.

24.2.2.2 Battery Limits

The consultant battery limits will be the pit rim of the open pit, haul roads to the tipping point on the ROM stockpile for the primary crusher and up to and including the waste dumps.

24.2.3 Tailings Management Facility

Golder will be responsible for the detailed design of the TMF and associated infrastructure.

The design of the TMF and associated infrastructure will include:

- TMF embankment design;
- River diversion embankment design;
- Tailings deposition planning;
- Lining system design;
- Calculation of TMF water balance;
- Design of surface water management systems including diversion works and closure spillways;
- Design of in-facility water management systems (emergency decant); and
- Conceptual closure planning and design.

The design of the tailings delivery and slurry transportation system will entail the following:

- Sizing of the tailings pumps;
- Design of the tailings delivery pipelines; and
- Design of the tailings deposition system.

Golder's scope relating to the Geotechnical Site Investigation of the TMF area will entail the following:

- Supporting and advising The Cyril and Methodius University in Skopje on the geotechnical site investigation;

- Selection and scheduling of waste rock samples for geotechnical testing; and
- Scheduling of tailings samples for geotechnical testing.

24.2.3.1 Battery Limits

Golder's battery limits for the design of the TMF, including the water balance, will start at the deposition points for the tailings delivery system, to the final downstream toe of the TMF wall. The scope will include water management up-valley of the TMF, the diversion of storm water past the facility, as well as the management of contact water from the downstream slope of the facility.

Golder's battery limits for the tailings transportation system design will be the discharge flange of the TMF feed tank. Golder will be responsible for the sizing of the tailings disposal pumps and design of piping to the tailings discharge points.

Amec Foster Wheeler will be responsible for the ancillary design associated with the tailings disposal pumps that includes the civils, miscellaneous mechanical items, electrical and instrumentation.

The design of the civils, mechanical, electrical and instrumentation for the return water systems from the TMF supernatant pond, as well as access roads to the TMF will be excluded from Golder's scope. This will form part of Amec Foster Wheelers' scope.

The scope associated with water management from the access roads, or the design, management and supervision of geotechnical site investigations will be the responsibility of others.

24.3 PROJECT IMPLEMENTATION

24.3.1 Project Management

24.3.1.1 Objectives

The following strategic project delivery objectives (SPDO) were agreed with Euromax Resources:

- Opportunities to clarify package scope and increase definition, to be sought through early submission of some FEED packages for review by the Faculty of Mining, University of Skopje; thereby reducing cost and schedule risk
- To deliver the project against a defined schedule such that Euromax Resources can meet the obligations in order for financial institutions to initiate their due diligence.
- To transfer skills and expertise to project appointed Macedonian citizens.
- Implementation of measures to minimise impacts on the environment.

24.3.1.2 Project Kick-off

Project kick-off is planned during the month March 2016.

24.3.1.3 Project Implementation Schedule

Basis of Schedule

The basis of schedule describes the methodology used to compile the preliminary execution schedule, taking note of critical inclusions and exclusions, engineering, procurement and contracting strategy, construction philosophy (including early works), equipment delivery times, installation contracts, construction and EWPs, site establishment and dis-establishment.

The calendars used allows for a 40 hour week for home office activities and a 50 hour week for site activities, South African public holidays for home office activities and Macedonian public holidays for construction and commissioning. A duration of 3 wk/a have been allowed for inclement weather over the winter seasons. Allowance has been included each year for an annual break of approximately 2 weeks as well as 1 week in early January and 1 week during Easter to align with the traditional Macedonian breaks. It has been assumed that there will be no resource constraints.

All dealings with the Government of the Republic of Macedonia or any other official body that impedes the works to proceed as per the schedule remain a risk for Euromax Resources to manage. This will be evaluated on an event by event basis and related time and cost claims will be submitted.

All delivery times are indicative and can only be finalised upon contract award.

The schedule assumes that all logistic plans have been determined and agreed, prior to transport to site, to prevent delays of items to site.

Sudden natural disasters, industrial action, violent demonstrations, xenophobic attacks and any event of a force majeure nature are not included as part of the schedule and will cause an impact to the schedule. These will be assessed on an event by event basis as, and when, they occur.

Work permit delays have not been catered for in the schedule. Any delays to work permits to both consultants and the contractor will result in a schedule impact.

Construction durations were based on the following quantities:

- Earthworks - Process Fill and Wearing Coarse 2 500 m³ per day
 - Load and haul 2 500 m³ per day
- Concrete 130 m³ per day
- Steel
 - Light mass steel 5 ton per day
 - Medium mass steel 11 ton per day
 - Heavy mass steel 24 ton per day
- Electrical
 - Rack 280 meters
 - Cable (pulled and strapped) 1 200 meters

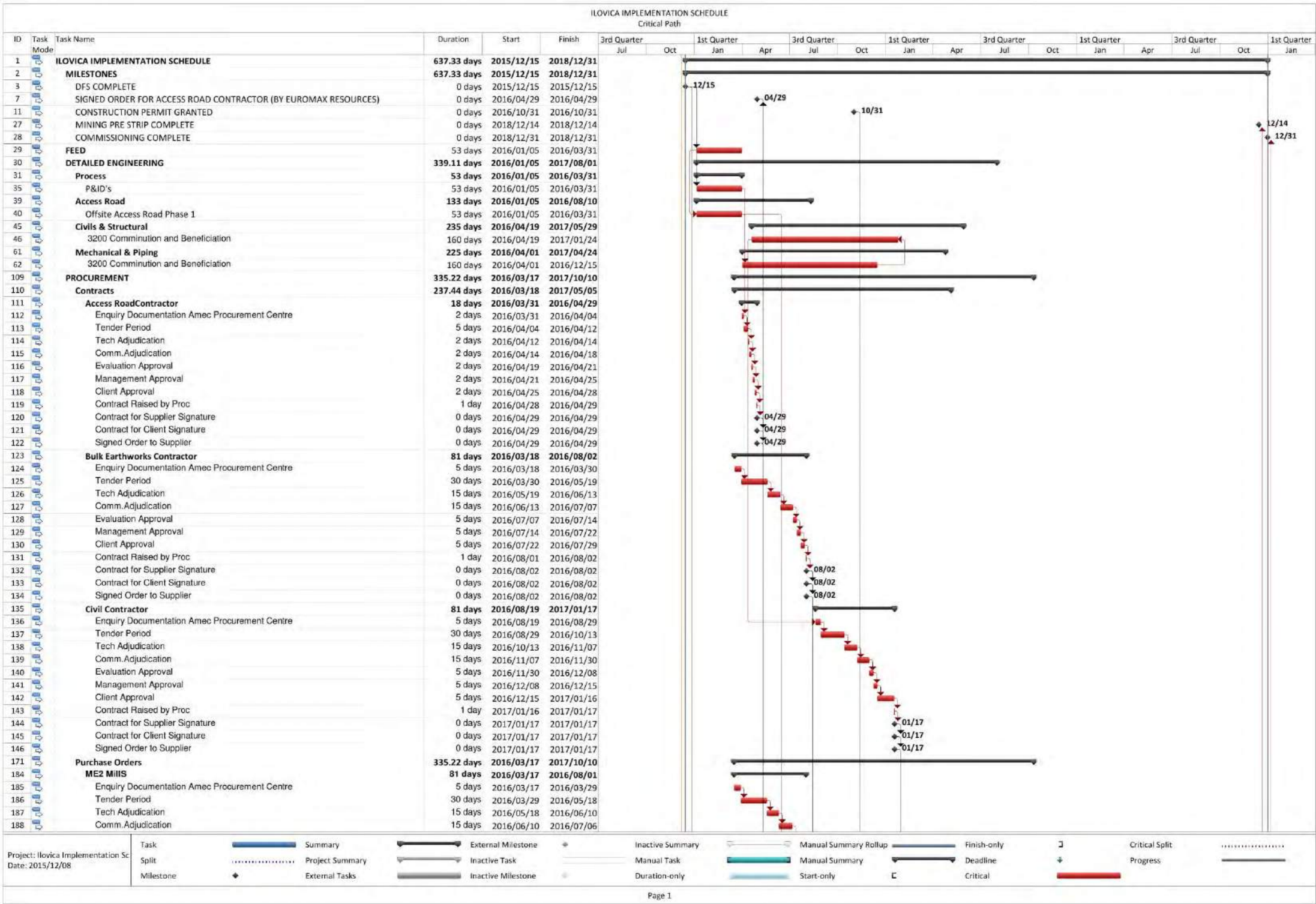
Key Milestones

The key milestones for the project are presented in Table 24.2.

Table 24.2 Key Milestones		
ID	Description	Date
1	FS Complete	2015/12/15
2	FEED Complete	2016/03/31
3	Process Design Complete	2016/03/31
4	Off Site Access Road Phase 1 Design Complete	2016/03/31
5	Signed Order for Access Road Contractor (by Euromax Resources)	2016/04/29
6	Submit MMP & ESIA	2016/07/22
7	Signed Order for Mills	2016/08/01
8	Signed Order for Bulk Earthworks Contractor	2016/08/02
9	Construction Permit Granted	2016/10/31
10	Construction Power Available	2016/10/31
11	Construction Water Available	2016/10/31
12	Signed Order for Thickeners	2016/11/07
13	Signed Order for Primary Gyratory Crusher	2016/12/07
14	Signed Order for Civil Contractor	2017/01/17
15	Signed Order for Flotation Cells	2017/01/27
16	Signed Order for Regrind Mill	2017/05/05
17	Detailed Engineering Complete	2017/08/01
18	Required On Site Date - Mills	2017/12/01
19	Required On Site Date - Flotation Cells	2018/01/10
20	Required On Site Date - Regrind Mill	2018/01/22
21	Required On Site Date - Thickeners	2018/01/29
22	Required On Site Date - Primary Gyratory Crusher	2018/02/28
23	TMF Starter Wall Complete	2018/09/28
24	Plant Construction Complete	2018/10/31
25	Mining Pre Strip Complete	2018/12/14
26	Commissioning Complete	2018/12/31

The project implementation schedule showing the critical path is presented in Figure 24.2.

Figure 24.2
Project Implementation Schedule (Critical Path)





24.3.1.4 Risk Management

Risk management on the project is a core management process and will be performed in accordance Amec Foster Wheeler risk management procedures, instructions and forms (PIF).

Project Risks and Opportunities

Risk is the consequence of things happening that negatively impact the project performance. Risks can arise from events that occur inside and outside the project. The consequence of an event can impact the quality, cost or schedule of the project, or some combination of these effects.

Opportunity can be defined as an uncertainty that could have a positive effect leading to benefits or rewards. In fact, opportunity could be seen as another form of risk. But unlike a risk with negative impacts is a threat, a risk with a positive impact is an opportunity.

Opportunities can be quantified in the same way that a risk is quantified: the probability of a risk or opportunity occurring multiplied by the consequence if the risk or opportunity is realised (measured either in arbitrary units or currency). In this document, where risk is addressed, the reader should remember that it can be viewed as “risk or opportunity”.

The risks to the project will be identified and defined in the risk register. This risk register shall be reviewed on a monthly basis. The top 5 risks in each category shall be reported in project reports and shall have formal documented mitigation plans which are reviewed on a monthly basis. Contingencies associated with the top 5 risks shall be appropriately recognised within the project budget and schedule.

Nominated risk owners will be responsible for proactively managing their risk and shall have auditable action plans in place. The status of all risks shall be reported on a regular basis.

24.3.1.5 Project Organisation

Project Organisation

The proposed Euromax Resources Project Development Organogram is presented in Figure 24.3.

The proposed Amec Foster Wheeler Project Management Organogram is presented in Figure 24.4.

The proposed Amec Foster Wheeler Engineering Organogram is presented in Figure 24.5.

The proposed Amec Foster Wheeler Project Services Organogram is presented in Figure 24.6.

The proposed Amec Foster Wheeler Construction Management Organogram is presented in Figure 24.7.

The proposed Golder TMF Engineering and Construction Supervision Organogram is presented in Figure 24.8.

Figure 24.3
Euromax Resources Project Development Organogram

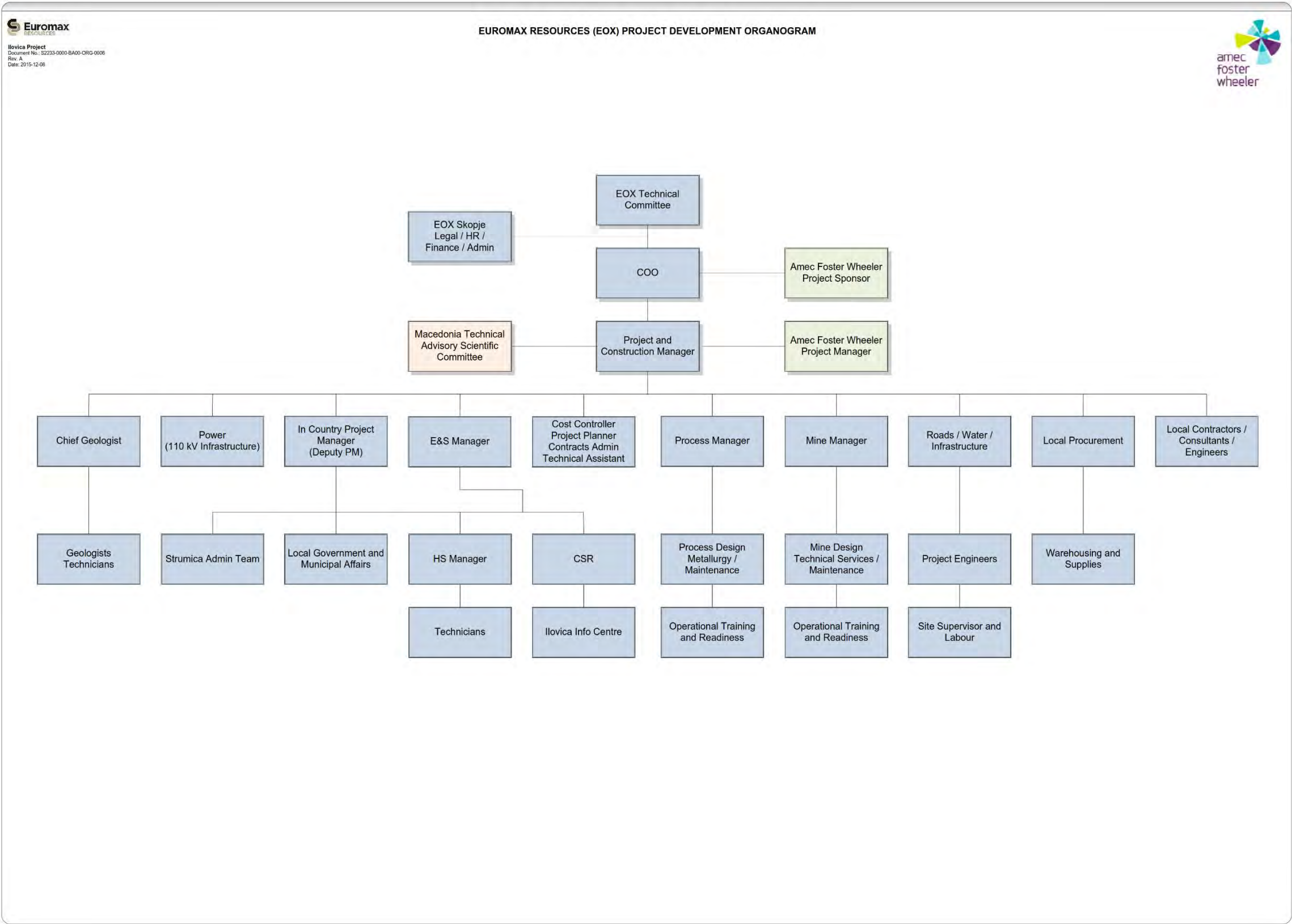


Figure 24.4
Amec Foster Wheeler Project Management Organogram

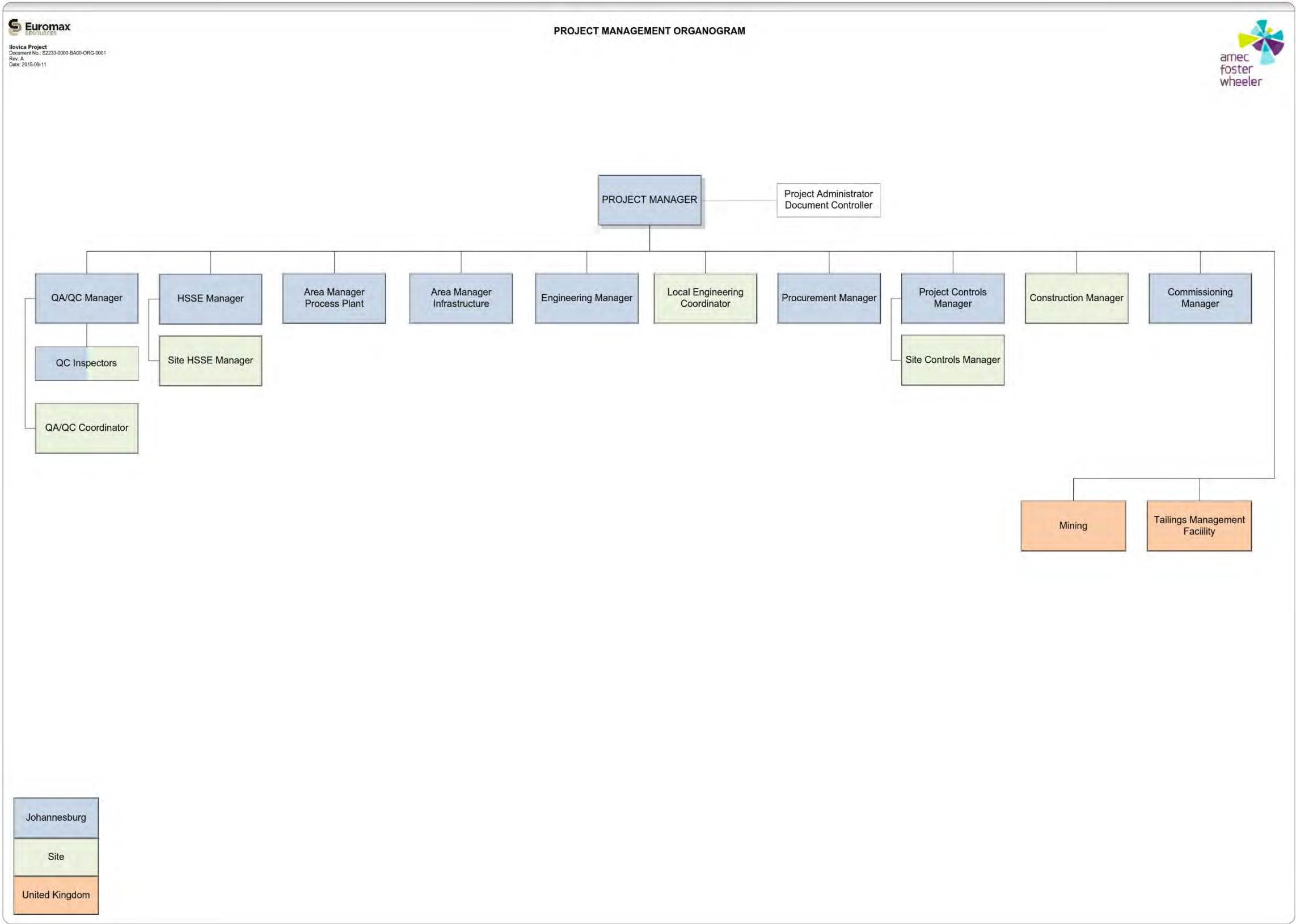


Figure 24.5
Amec Foster Wheeler Engineering Organogram

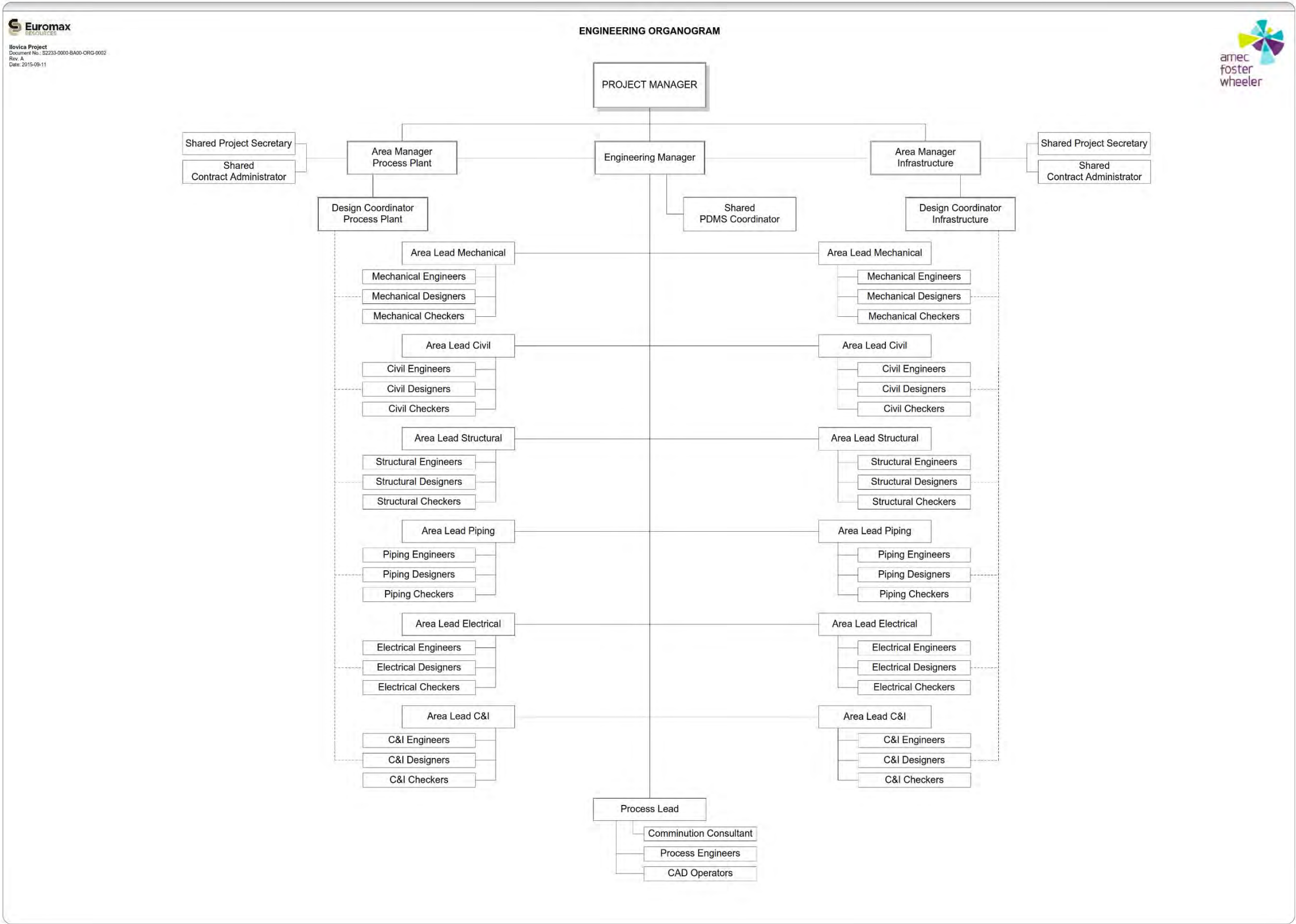


Figure 24.6
Amec Foster Wheeler Project Services Organogram

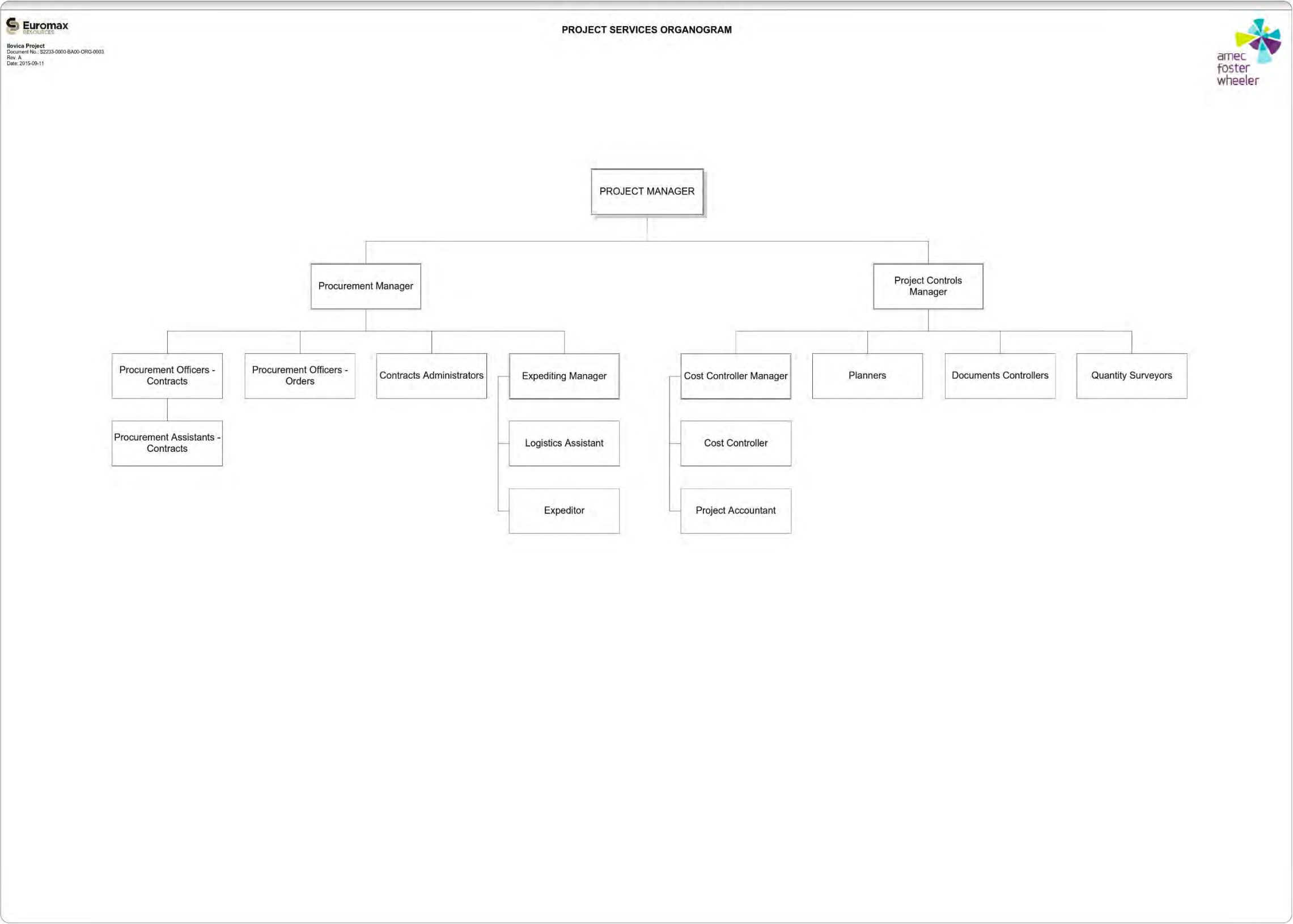


Figure 24.7
Amec Foster Wheeler Construction Management Organogram

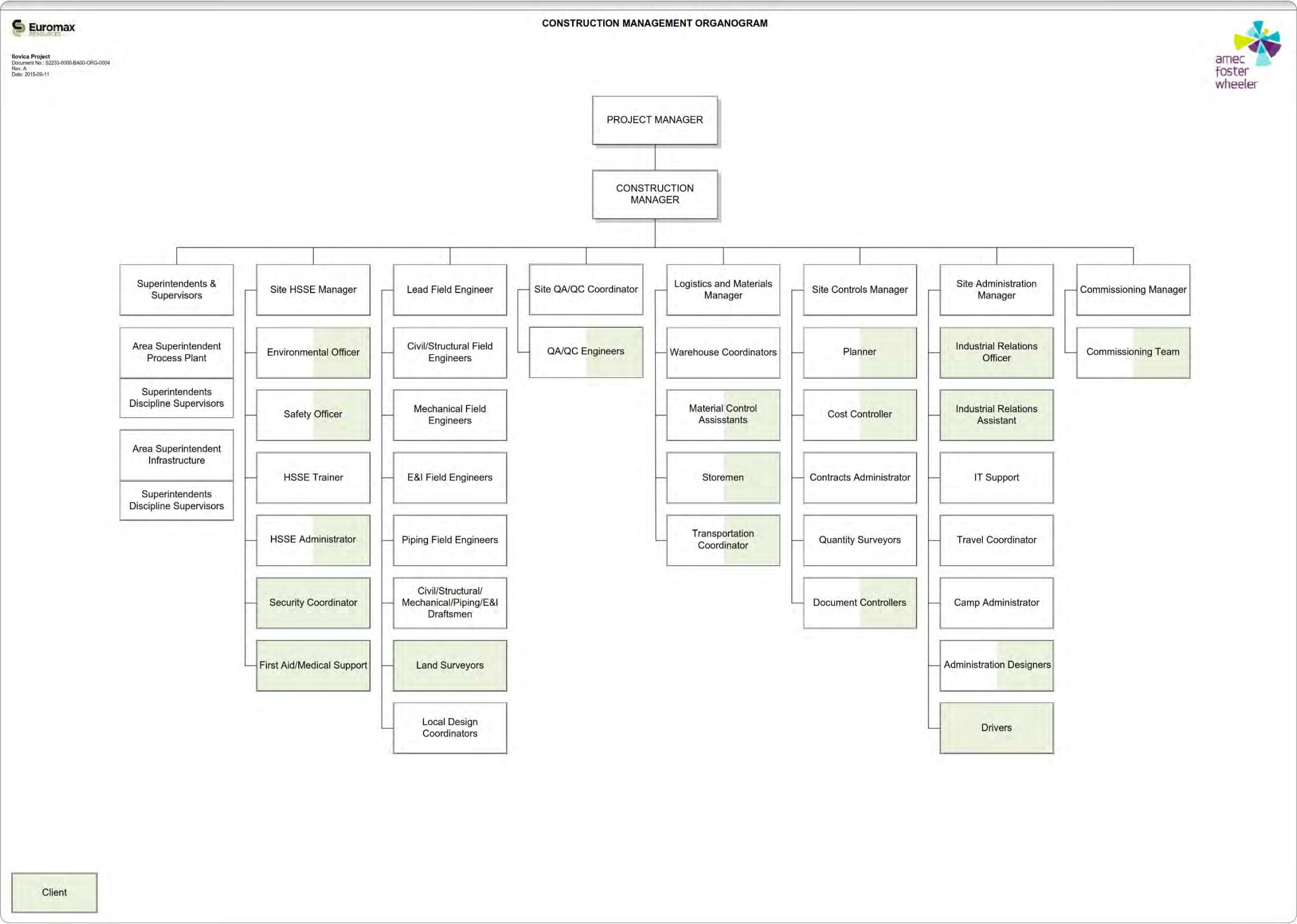
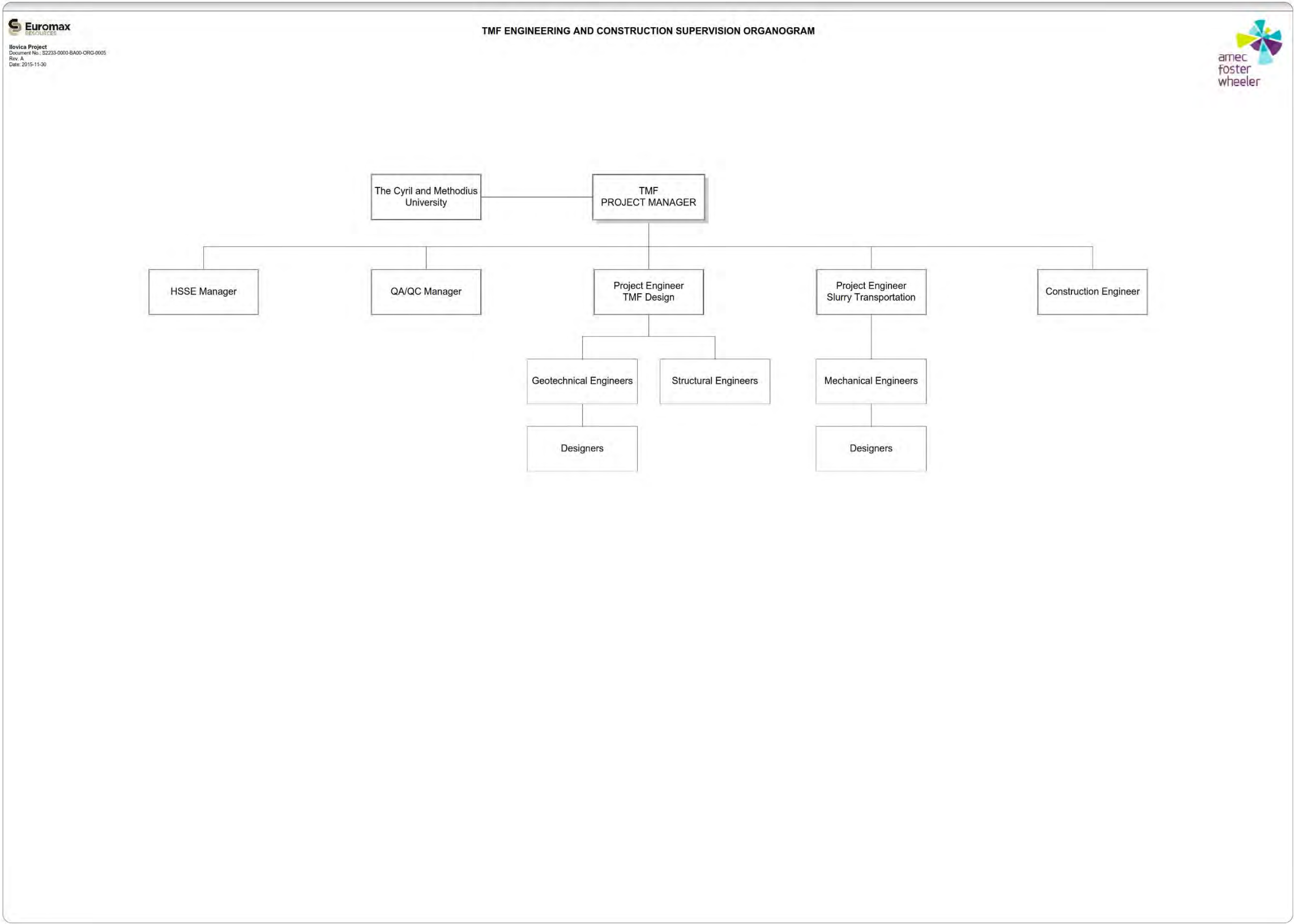


Figure 24.8
Golder Engineering and Construction Supervision Organogram



24.3.1.6 Project Controls

Key project controls deliverables include:

- A baseline schedule
- Key milestone table
- Basis of schedule
- Progress reports and graphs (all disciplines and phases)
- A control budget estimate
- Basis of estimate
- Cost report
- Cash flow and commitment curves
- Dashboards for contracts and site packages
- Dashboard for purchase orders
- EPCM man h report and manpower curves
- Manpower histograms (EPCM and contractors)
- Engineering document and deliverable register

Project coding Structure

Project control processes are defined and structured in such a way as to facilitate the integration between them and other project management practices utilised on a project. The integration is facilitated by the WBS. This WBS is applicable for referencing project control processes such as the cost estimate, budget and schedule of activities as well as for project management practices such as the management of change, risks, quality, human resources and procurement.

The WBS is an effective communication aid for project team members when referencing project data. Project controls will be responsible for ensuring the development and implementation of project coding structures suitable for use in management and control of all aspects of the project related to:

- Project coding structure
- Organisational breakdown structure
- Amec Foster Wheeler engineering WBS

Project Milestone Schedule

The function of planning is determining what needs to be done, who will do it, and how the project predetermined objectives are to be met. It represents a form of decision-making as it involves choosing a course of action from available alternates.

Scheduling determines when the work identified within the planning phase will be done.

Scheduling can be accomplished by a variety of methods but for this project, Primavera database critical path method (CPM) bar charts will be used.

The schedule uses CPM processes that create a logically linked programme of works that indicates the float between all work areas within the schedule. To effectively manage contractor claims and mitigate schedule slippage during the project lifecycle, the critical path method is utilised.

The project master schedule is the tool that will be used to bring all the schedule levels and stages together. It serves to incorporate information provided by various project stakeholders into a CPM tool that will provide the project with the overall status of the project from the beginning to the end of its lifecycle.

The overall planning and scheduling process can be represented in two major stages:

- Project planning and schedule development resulting in the formation of a baseline schedule.
- Schedule management, monitoring, analysis, reporting and mitigation resulting in regular periodic schedule updates.

Level 1 – Management Summary Schedule

The level 1 schedule provides a high level management summary of the project. It will represent a summary of all areas and key project milestones.

Level 2 – Project Master Schedule

The level 2 schedule will be used by the project leadership team as a strategic management schedule. It will represent a summary of all phases under each sub area and all area key milestones.

Level 3 – Project Control Schedule

The level 3 schedule is a detailed control schedule containing full CPM logic and resource loaded engineering and construction activities. It contains the entire project scope (100% rule) covered by the project's WBS. This schedule at the level 3 detail becomes the control schedule against which progress is measured and monitored for the remainder of the project. This schedule will be supported by level 4 schedules incorporating the various third party subcontractor schedules through to project completion.

The following are some key features of the level 3 schedule:

- It represents the scope and execution strategies for EWPs, purchase orders and contract packages, off site fabrication packages, construction work packages (CWP) and pre-commissioning activities.
- It presents a clear understanding of the project scope of work in alignment with the project coding structure.
- It shows control dates and interface milestones for special consultants and major contractors to provide clear linkage to their schedules.
- It contains an adequate number of activities with realistic activity durations to clearly show the sequence and logic in performing the project in a systematic manner.
- It defines the project critical paths and activity free and total floats.
- It is used to coordinate and control all activities on the project, and to perform critical path analyses and "what-if" schedules.

The level 3 and level 4 schedules will be updated bi-weekly providing the basis for status reporting, change forecasting, and controlling the project. A schedule change request process will be introduced to control and manage minor and major changes to the baseline schedule.

Project Control Budget

The major aspects of cost management include:

- Establishing a control baseline (budget)
- Change management
- Monitoring and tracking (committed, incurred)
- Analysing and forecasting (trending, forecasting)
- Reporting
- Participating in potential mitigation processes
- Contingency controls

Original Budget

The original budget is prepared by recasting the cost data from the approved FS estimate. The cost elements are coded and grouped to reflect the project execution strategy, mapped to the project coding structure and loaded into the Convero cost system as the original budget.

Commitment Cost

Commitments are the value of awarded contracts, purchase orders, service agreements or any other agreement. They represent what Euromax Resources and contractor or vendor has agreed or committed to in terms of the goods and services that are to be provided.

The value of commitments made during the project is defined as follows:

- The committed value is the face value of the contract, including approved change orders.
- The contract / purchase order values with forex components are loaded into Convero in the foreign currency values as per the agreement with the contractor and converted to Euro at the project exchange rates.

Cost Forecasting

Forecasting is an essential part of the project control system. In order to develop an accurate forecast at completion (FAC) for a commitment package, the following assessments need to be made: commitments to date, known variations in various stages of processing, progress, schedule, estimated work to complete and allowances for potential changes.

Forecasting of the project cost will be the result of monitoring work performed against the original budget, analysing changes from the control base, and predicting forecasted performance. The forecasting process will incorporate the trending process as well as the independent application of analytical techniques and tools.

On a monthly basis the forecasting process will necessitate a review of the following direct commitment package components:

- Commitment amount; the initial award amount and all subsequent revisions or amendments to the purchase order / subcontract.
- Correspondence; all correspondence that may be in the form of letters, vendor or contractor claims, approved trends, work authorisations, etc. that may have a cost impact associated with the package.
- Progress to date; actual progress to date versus planned progress to ascertain any potential cost impacts associated with less than expected progress. Earned value versus incurred or productivity factors may also be used in the assessment of this component.
- Impacts of delays; any impacts from late engineering, late delivery of Euromax Resources supplied material or lower than expected productivity.
- Back charges and recoveries.

Cash Flow

Based on control budget, cost forecast, and project schedule, a cash flow will be developed and maintained. The cash flow will be compared with actual incurred costs over time. Cash flow forecast will be updated on a monthly basis based on the latest information supplied by the contractor and schedule changes.

Cost Reporting

Monthly cost reporting provides a snapshot of the financial health of the project. It provides cost details relating to project budgets, commitments, scope changes and trends, contingency and forecast at completion costs. Information contained within the tables and curves provided in the reporting, is used by management as a measure against key project performance indicators. Convero will be used for reporting, consolidating, analysing, and forecasting all project controlled costs and will include:

- Original budget
- Current budget
- Commitments
- Incurred costs
- Final forecast

Cost reports by package and area will be issued on a monthly basis, as agreed.

Management of Allowances and Contingency

Drawdown from contingency is only permitted based on approval from Euromax Resources.

Contingency will be reviewed periodically by evaluating each component of the cost forecast. Euromax Resources and Amec Foster Wheeler project management teams will participate in the analysis. The evaluation will identify areas of potential cost risk and assess the financial impact of each. As risks are eliminated or impacts realised during the course of the project, the values will be trended into or out of the budget / forecast and the contingency revised accordingly. Contingency drawdown curves will be produced on a monthly basis.

A generated “savings account” is used as follows:

- On close out of contracts, surplus funds are transferred.
- Transfer of budget from packages with redundant scope of work.
- Based on approval from Euromax Resources (through an approved trend), funds can be transferred to packages with shortfalls.
- Generated savings drawdown curves will be produced on a monthly basis.

Project Accounting

Incurred costs are the contractual value of work completed at a specific time that can be invoiced.

Incurred costs are evaluated relative to a status or cut-off date that is consistent with status dates set for progress measurement. Therefore, no estimating of costs incurred will be allowed as only measurable / completed work will be claimed based on a certified progress certificate.

The following methods of incurring costs will be used depending on the commercial nature of the item:

- Reimbursable engineering, procurement and project management
- Procured items
- Reimbursable direct and indirect labour costs
- Lump sum contracts

Invoicing and Payments

Generally invoicing is represented in two categories:

- Invoices from the project to Euromax Resources
- Invoices received from service providers, material vendors and sub-contractors

The process of invoicing and payments is managed by the project accounting group, but is an integrated effort with the procurement officer or contracts administrator and cost control, who assist with validation and alignment with incurred costs.

Progress and Performance Monitoring

Project controls supports the project by providing an objective measure on the performance of engineering, procurement (pre-award activities) and construction phases. The monitoring systems will be based on information generated from Convero, contractor level 4 schedules and the P6 baseline schedule.

The following earned value rules will be used on all engineering contracts:

- Percent complete is derived from physical progress (work accomplished)
- Budget man hs = estimate plus approved change orders (trends)
- All budgeted items are progressed
- Earned man hs = percent complete x budget man hs

Overall Project

The overall progress will be calculated using the sum of the weighted engineering, procurement, manufacture and delivery, and construction progress. The weightings used to calculate overall progress will be agreed during project setup.

Engineering

Engineering actual progress will be reported out of Convero home office module. Convero is loaded with level 4 deliverables to get a representation of the work required. The system reports progress on engineering deliverables using earned value methodology based on budgeted hours per deliverable type earning hours on an agreed milestone basis.

Manufacturing

Manufacturing progress will be calculated according to agreed milestones on manufacturing packages and construction packages with an off site fabrication component. The packages will be weighted in P6. The progress will be measured and calculated based on physical work completed as verified by the expediting team.

Construction

Each of the construction contracts will be weighted with their percentage of the budgeted man hrs. The construction progress is obtained from each of the contractor's schedules and this is applied to the budgeted man hrs for that contract.

24.3.1.7 Change Management

Project change will result from factors outside the control, and under the direct control, of the project. All changes must be documented and controlled.

Trends are raised to cover deviations from the following baselines:

- Scope
- Project execution plan
- Schedule
- Control budget estimate

Work will not proceed on a scope change without approval by Euromax Resources.

Effective implementation of the project controls management plan will result in trends being raised and processed to ensure that:

- All changes and decisions are captured, reviewed, evaluated, approved and implemented.
- All technical changes are reviewed, assessed and tracked through implementation and closure.
- Potential cost and schedule impacts are identified, evaluated and mitigated.
- All contractual commitments are monitored and satisfied.
- Changes to all project delivery elements are evaluated, monitored and controlled.

The timely analysis of the project data and processing of the trends ensure the current budget and FAC costs are as accurate and current as possible, the schedule impacts are captured as early as possible and the change orders for the project are managed.

Project change control and trending is a critical aspect of project management and controls and must be strictly adhered to.

The project change control and trending process is represented in three major steps:

- Trend alert
- Trends
- Contract amendment

Trend Alert Stage

The trend alert form is an internal Amec Foster Wheeler document. The trend alert stage provides for quick and early warning of a potential project impact. A trend alert will be presented to Euromax Resources with a brief description, rough order-of-magnitude cost, and schedule impact. Euromax Resources approval or rejection is required prior to further action. Trend alerts are captured in a trend register and assigned a number.

Trend Stage

Upon approval of a trend alert, project controls will proceed with the work in accordance with Euromax Resources instruction provided. A formal trend with appropriate level of cost estimate and schedule, properly coded in alignment with project coding structures will be prepared. This will allow for incorporation into the budgets and schedule for proper control of the scope addressed by the trend. The trend will be submitted for Euromax Resources' approval. Euromax Resources approval is required prior to incorporation into the project controls. Upon approval, the trend will be processed in Convero. Trends are captured in the trend register.

Contract Amendments

Once the trend is approved by Euromax Resources a contract or purchase order is amended, if required. Board approval is then required.

Site Variation Requests

Approved site variation requests (SVR) will be combined into a trend (per package) and submitted for Euromax Resources approval on a monthly basis, or as required. SVRs are usually initiated by the area managers and approved by Euromax Resources.

Each SVR may include:

- Changes to the quantities of an item of work included in the contract (however such changes do not necessarily constitute a variation).
- Changes to the quality and other characteristics of any item of work.
- Changes to the levels of, positions and/or dimensions of any part of the works.
- Omission of any work unless it is to be carried out by others.

- Any additional work, plant, materials or additional services necessary for the works.
- Changes to the sequence or timing of the execution of the works.

24.3.1.8 Project Administration and Document Management

Project Administration

The project administrator document controller (PADC) will assume the responsibility of overseeing the administrative and document management functions of the project, reporting to the project manager. The PADC will ensure that the relevant procedures are adhered to.

Administrative duties will include, but will not be restricted to:

- Setting up of project templates
- Taking minutes at meetings as instructed by the project manager
- Preparation, formatting and distribution (via document control) of project documentation, including minutes, presentations, organisation charts, correspondence and reports
- Arranging meetings at the project office, and elsewhere as instructed by the project manager
- Attendance at project meetings as instructed by the project manager
- Arranging project team events as requested by the project manager
- Assisting with travel arrangements and permit and visa requirements
- Arranging applicable personal protective equipment (PPE) for site visits
- Workflow leave and expense claim forms
- Management of home office petty cash for sundry expenses

Document Management

The project manager will ensure that:

- Approved procedures for document management are created and made available
- All staff working under his / her direction is familiar with the appropriate procedures
- The procedures are being followed

The document management group is responsible for project document storage, retrieval, and distribution of all current and superseded documents in accordance with project procedures.

The primary functions of the information management and document management group are:

- Coordinate the use of the electronic document management system
- Project document numbering
- Engineering document management
- Vendor document management
- Project document filing

- Project document archiving

Convero

Convero is Amec Foster Wheeler's integrated project management system that includes the project electronic document management system.

Convero's document control module facilitates engineering planning for document progress measurement; materials management for planning and expediting of vendor documentation and data and construction management for the planning and delivery of documents to CWP's. Convero provides registration, transmission, tracking and reporting functionality.

SharePoint

SharePoint workspace and web will be set up for use on this project to ensure that all documents are stored in a controlled, auditable environment that provides real-time access.

SharePoint will be the database platform used as the repository for all project documents. This platform can be accessed by everyone engaged on this project. The web site will be used for communication between Amec Foster Wheeler, Euromax Resources, vendors and other stakeholders.

Access to web and workspace is restricted to those having a valid network account for the project.

Project Document Numbering

Correct document numbering (Section 24.3.3.9) is essential to the functionality of document management and is the unique identifier for document tracking.

Email Communication

A project mailbox and email address will be established by Amec Foster Wheeler IT. All outgoing project emails will be copied to the project mailbox address. All incoming project email should be copied to the project mailbox as well. Amec Foster Wheeler email receivers will take responsibility for forwarding any project emails to the mailbox should the originator not have done so. The project mailbox will be unmonitored; project emails are copied to this address for record purposes only as Amec Foster Wheeler privacy policies do not allow for access to individual's mailboxes.

Project Filing

The document management group will maintain structured and current filing of project documents.

Engineering and administration documents (hard copies and electronic copies loaded to workspace) are filed according to:

- Discipline
- Document type
- Sequential number

Documents loaded to web are loaded according to:

- Package number
- Document type

- Sequential number

Note: When a new revision is received, the previous revision will be stamped “SUPERSEDED” and filed as per project requirements.

Vendor and contractor documents are filed according to:

- Package number
- Vendor code
- Sequential number

Note: When a new revision is received, the previous revision will be stamped “SUPERSEDED” and filed as per project requirements.

Archiving

The document management group will ensure structured and safe archiving of project documentation as required during the project evolution and at project closeout.

Vendor Documents

The document management group will manage and control all incoming documents from vendors, the review of those documents, and the return or issue of any documents to vendors.

Vendor documentation requirements are detailed in the vendor’s purchase order or contract. At the kick off meeting, the vendor will be briefed on the requirements for issuing documents. All documents are to be issued on transmittal which contains the following information:

- Package number
- Vendor code
- Vendor document number
- Project document number
- Document title or description
- Revision
- Reason for issue / issue purpose

Documents received from vendors without transmittals will be rejected and returned to vendors.

Engineering Progress

Engineering deliverable documents are identified in Convero by the metadata field UD1 ad DEL (engineering deliverable).

Milestones are updated only on documents that have been identified as engineering deliverables and are based on actual issue purposes and requires that a transmittal be generated and issued on Convero in order to update the milestone codes.

The milestone codes to be used on this project will be agreed during project setup.

Information Management

Information management is defined as management of the technical data residing in all engineering systems, together with data generated by the external parties that must be delivered to Euromax Resources. Much of this technical data will reside electronically in more than one system simultaneously throughout the execution of the project. Management of this technical data must deal with several key issues that contribute to the overall efficiency of the project execution and the quality and integrity of the deliverables.

The principal philosophies that will be implemented to achieve effective information management are:

- Enter data once; use it many times.
- The project must have the correct data in the correct format at the correct time.
- Know the status of the data at all times.

The process for transferring data between systems must be defined. Where data exists in multiple locations, the data must be identical in all locations and one location must be identified as the master. A data map is required to show the data flow between the sources.

Requisitions for Telephones, Computers, Hardware and Software

The project manager will review and approve all project requests for telephones, computers, and related software.

Correspondence and Templates

A project set of templates will be created within a SharePoint library for use by all project team members.

Email

To control emails a project email address will be created which will be used as a Cc on all outgoing and incoming emails.

Formal email will be in accordance with standard Amec Foster Wheeler procedures.

24.3.1.9 Project Quality

Quality Management/Assurance

The project will implement a quality management program in accordance with Amec Foster Wheeler requirements. The Amec Foster Wheeler quality assurance (QA) program includes the following activities during project execution:

- Quality planning
- Performance assessments:
 - QA audits
 - Risk-based auditing
- Action requests (utilising workflow system within SharePoint)
- Vendor quality surveillance

- Progressive learning
- Customer satisfaction surveys
- Quality orientations and training
- Management of quality-related documents and records

Quality Objectives

The quality objectives for the project are:

- To meet Customer contract quality requirements
- To comply with all relevant regulatory body requirements
- To comply with the project mission statement
- To comply with the project value objectives
- To follow approved procedures as defined by all components of the project management plan (PMP)

Project Quality Plan

The project quality plan will include quality processes and PIFs for all disciplines and project phases covering the full scope of the project.

Key Quality Elements

Key quality elements of project management include, but are not limited to:

- Kick-off and alignment meetings
- Contract, technical, commercial, operational, maintenance, and safety reviews
- Planning and scheduling processes and project controls
- Process design control processes and validation
- Project management processes and project documentation
- Quality documentation and quality audits
- Project reporting

Audits

Quality audits will be carried out on the project to verify conformance of the approved PMP with the standard procedures.

An audit plan will be developed for each phase of the project scope by the Project Quality Manager, identifying the type (start-up, internal, external, process and close-out), duration, and timing of the audits.

Action Request (AR)

Action requests and root cause analysis on the project will be carried out in accordance with standard procedures.

The Project Manager and Quality Manager will ensure that all actions resulting from audit findings will be closed in an expeditious manner, managed through workflowed SharePoint actions.

Preventative and Corrective Actions

All internal and external preventative and corrective actions will be recorded and managed through workflowed SharePoint actions.

Requests for Information

All internal and external requests for information (RFI) will be recorded and managed through the RFI Centre on SharePoint.

24.3.1.10 Project Close-out

Euromax Resources Satisfaction

The timing and frequency for soliciting and recording feedback from internal and external client satisfaction surveys (CSS) will be in accordance with guidelines defined in the PMP.

The CSS report shall highlight re-occurring or key comments and provide recommendations to management. Senior Management shall review the survey results with the Project Manager and jointly determine positive reinforcement or remedial action as appropriate. A project action log will be generated for any actions resulting from CSS.

Progressive Learning

Progressive learning (PL) is a value based program that provides standard controls, business assurance and opportunities for change. It is based on the philosophy that learning should include implementing change, and instilling accountability for that change so improvement and progress can be captured, analysed and implemented. To effectively implement change, PL focuses on identifying what went well and what should be repeated and what areas of work require improvement.

The requirement for the execution of PL sessions on the project is determined by corporate management requirements as well as Euromax Resources requirements and will be identified in the PMP.

Inputs for PL sessions or sharing include:

- Euromax Resources feedback
- Documentation deficiency
- Process deficiency
- Design issue
- Best practice
- Project review
- Project milestones
- Project kick-off and project close-out
- PMP

Project Close-out and Handover

Contractual

Contract closure is the process of terminating contracts with external organisations or businesses. These contracts may be vehicles for providing technical support, consulting, or any number of services supplied during the project. Contracts can be brought to closure for a variety of reasons, including contract completion, early termination, or failure to perform.

All capital equipment purchase orders / contracts shall be considered complete when the equipment is delivered and installed, all data books and documents as detailed in the technical specification and purchase order / contract are checked and received, and the requirements of the specification for delivery and viewing of spare parts and maintenance documents have been fulfilled.

SCM correlates all close out input from the responsible parties and updates the close out report. Following all approval signatures SCM finalises the close out file, obtains the Project Manager's final approval signature and transmits the original file to document control for delivery to Euromax Resources, with all the necessary documentation.

Close-out of purchase orders and contracts shall be done progressively throughout the Project period as Contractors and Vendors complete the performance of their obligations.

Financial

Typical activities performed during financial project close-out include:

- Final performance reporting – reporting on variances between control budget amounts and final expenditure values.
- Financial closure – closing out all cost records and paying outstanding invoices.

Financial closure is the process of completing and terminating financial and budgetary aspects of the project. It includes both (external) contract closure and (internal) project account closure. All expenditure must be accounted for. When financial closure is completed, all expenditures made during the project have been paid as agreed to in purchase orders and contracts.

Once a purchase order or contract has been financially closed out, confirmation will be provided to SCM for final close out of the purchase order or contract.

Document Control

The project will develop a data implementation, operation, and hand-over plan in consultation with Euromax Resources. The data management plan will define what data will be required for handover and the originating sources, master databases, format of the data, and how and when data will be transmitted to Euromax Resources.

The scope of this handover must be established at the beginning of the project to meet Euromax Resources' data expectations and requirements. It can include engineering design tool applications, project controls, project services applications and contract and purchase order close outs.

In order to close out a purchase order or contract, it is important to collect all of the pertinent documentation for review. This will include the original contracts and supporting documentation such as schedules, contract changes, and performance reports. This documentation needs to be reviewed thoroughly to ensure there are no unrealised contract issues, including contract milestones, services provided or deliverables and documentation delivered.

A complete set of contractual records for the project will be archived and kept in a safe and accessible place in case they need to be referenced at any point in the future.

Technical

Planning of the close-out of engineering and handover is a discrete phase of planning which will occur in the early stages of project implementation; prior to setup of engineering systems and commencement of design.

Engineering design will be closed out at the completion of design deliverables such as 3D model, drawings and approval of supplier technical documents. At this stage all documents issued for construction (including the revisions which occurred during the design phase) will be available. Formal handover of agreed documents will occur together with project close-out, as part of the formal archiving process.

The engineering close-out phase will commence when engineering design is substantially complete; initiated when progress against design deliverables has reached 90%. Final engineering sweep checks will occur in order to confirm completion of engineering and design effort. The engineering sweep focuses on the following principal areas:

Outstanding Information (Inputs)

Outstanding information could relate to many aspects of the project. However, the chief areas of focus are outstanding vendor and supplier information, outstanding requests for information, unresolved holds on drawings and any documents which may require information which, not having been available at earlier stages, were subsequently noted as “to be advised”.

Outstanding Actions

This includes all outstanding actions arising from peer reviews, internal audits and design reviews. Outstanding actions may also include unresolved risks within the project or technical risk register or outstanding approvals.

Outstanding Documents and Design (Outputs)

Checking of outstanding documents and design essentially entails verifying that the engineering scope of work has been satisfied. All items in the mechanical equipment list, piping line list, valve and instrument list, electrical equipment list, buildings list and engineering document list must be fully accounted for and reconciled against documents issued for construction. Also included in the area of outstanding design is final checks for unresolved 3D model clashes, incomplete 3D modelling elements, and unresolved exception reports for engineering databases.

Following completion of final engineering sweep checks, engineering documents and deliverables shall be prepared for handover. Table 24.3 lists documents and data typically generated by Amec Foster Wheeler that are generally expected to be handed over during close-out of engineering design.

All documents and information received from suppliers, vendors, contractors and third party consultants will be available and will be handed over in the format in which they were received and certified.

At the completion of engineering and design close-out, a close-out and design report together with a document dossier will be issued for Euromax Resources review. The design report will contain a summary of all design decisions, outstanding design risks and a safety-in-design register. The document dossier will include a catalogue of design deliverables and supplier documents.

Table 24.3 Documents and Data for Handover		
Document	Format	Status
Design Criteria	PDF	Issued for Construction
Piping and Instrumentation Diagrams	AutoCAD; *.dwg	Issued for Construction
Process Flow Diagrams	AutoCAD; *.dwg	Issued for Construction
Mass and Water Balance	Spreadsheet	Issued for Construction
Function Control Philosophy	PDF	Issued for Construction
Functional Specifications	PDF	Issued for Construction
Wiring and Termination Diagrams	AutoCAD; *.dwg	Redlined; As Built
Instrument Loop Diagrams	AutoCAD; *.dwg	Redlined; As Built
Single Line Diagrams	AutoCAD; *.dwg	Redlined; As Built
Equipment Lists	Spreadsheet	Issued for Construction
Equipment Datasheets	PDF	Issued for Construction
General Arrangement Drawings	AutoCAD; *.dwg	Issued for Construction
Layout Drawings	AutoCAD; *.dwg	Issued for Construction

24.3.2 Health, Safety, Security and Environment

The role of all employees as leaders on all levels in the project is emphasised to ensure that no one is injured and a process of continuous improvement is implemented as a basis for achieving a zero lost time accident frequency. Every employee must leave their place of work every day in the same physical condition, in which he / she arrived at that place of work. The leadership role by management to develop workers to make safe decisions will be emphasised and developed through the implementation of the behaviour based Safety Intervention processes.

The HSSE Execution Plan, PMP Volume 6, will be developed on international good practices in accordance with the National OSH regulatory framework for Macedonia, the OSH LAW (13/98) and the Occupational Health and Safety Law for Macedonia, no 92/7.

Note, mining in Macedonia is regulated through a number of Laws and Rulebooks, under the Ministry of Economy. Occupational Safety and Health in mining is covered in detail within these regulations and rulebooks. A specialised Mining Inspection works within the Ministry of Economy, will ensure full compliance of the National Legislation and standards covering above ground and underground mineral exploitation, and by that to ensure compliance with Occupational Safety and Health standards. Amec Foster Wheeler, together with Euromax Resources, will engage with the Mining Inspection Works to ensure the HSSE Management System for the project is in compliance with all regulations.

All the laws, regulations and requirements will be identified and integrated in the HSSE management system for the project. The management system will be augmented further when required, to ensure complete compliance with Euromax Resources' needs and requirements.

24.3.2.1 HSSE Management System

The HSSE management system endorses the prime responsibility for HSSE as a line management function with the contractors. The construction contractors working under the umbrella of the Project HSSE Management Plan will be monitored and audited for the integrity of their HSSE implementation by Amec Foster Wheeler, who will focus on continuous development, complying as a minimum with specified statutory and other requirements.

The Project HSSE management system will be built around the following framework:

- Planning
- Implementation and operation
- Checking and corrective action
- Management review.

The core of the management system is the identification and mitigation of risk, and a drive towards behaviour based HSSE management, recognising that people and a proactive approach form the basis of successful HSSE management.

The Project HSSE Management System shall include, but not be limited to, the following components:

- Occupational health, safety and environmental and community policies for the project
- Requirements in terms of the construction contractor's structure and responsibilities
- Minimum requirements in terms of operating procedures and standards (based on minimum legal requirements and best practices)
- Monitoring and reporting procedures and processes
- Management review of the implementation of the HSSE management plan
- Induction details and requirements, including entry and exit medicals
- Training and competency requirements for contractors' employees
- Risk assessment process
- Communication and consultation forums and requirements
- Industrial theatre initiatives, addressing specific hazards - for example, radiation contamination, HIV/AIDS awareness, working at heights, lifting operations, and alcohol and drug abuse
- Awareness and safety campaigns
- Behaviour based initiatives such as safety interventions and HSSE deviation reporting
- Emergency preparedness and response
- Environmental Management Plan

- General HSSE operating procedures and standards - for example isolation and lockout, scaffolding, and rigging and lifting requirements.

The construction contractors will be monitored for the integrity of their HSSE planning during the pre-award process, at mobilisation and at kick-off, and continually throughout their construction activities. Worker participation will be sought through the various construction contractors and Amec Foster Wheeler supported initiatives; namely, safety awards, consultative forums and industrial theatre.

24.3.2.2 Safety Performance Initiatives

In pursuit of excellence in health and safety issues during the construction phase, a target for the cumulative lost time incident frequency rate (LTIFR) and all injury frequency rate (AIFR) will be set for the project.

In terms of continuous improvement, this target will be continuously reviewed so as to ensure that the risk to employees is reduced. The key in achieving the LTIFR target will be a comprehensive risk management system with baseline, issue-based and continuous risk assessments as the foundation, leading to behaviour-based safety.

Safety performance will be promoted through the introduction of a site HSSE Performance Index system, whereby an HSSE floating trophy will be awarded to the contractor achieving excellence in HSSE management performance.

24.3.2.3 Personal Protective Equipment

All Amec Foster Wheeler, Euromax Resources and Contractor staff must implement and comply with OSH LAW and the following Amec Foster Wheeler's mandatory requirements.

Protective clothing shall be provided by all Euromax Resources to their employees free of charge and shall be worn at all times, except in the offices. Records of issuing shall be available for inspection.

All personnel at the site, including visitors, must use the following minimum personal safety equipment at all times when on site:

- Safety hard hat
- Hearing protection
- Safety boots with steel toe protection; Safety shoes are not allowed
- Long trousers - Wearing of Short Trousers / Pants on site is strictly prohibited
- High visibility vests as required
- Safety glasses
- Two piece cotton overalls as per legal requirements. Contractors shall not be permitted to wear short sleeves on site. The overall must have the following:
 - Reflective markings on the trousers, jackets (arms, front and back)
 - Company name must be identified on the rear of the jacket
- Employees working near live electrical installations shall wear non-metallic helmets.

- Other protective equipment, such as gloves, safety glasses, goggles, face shields, respirators, hearing protection, and safety harnesses with a double lanyard, shall be issued and used when required.
- Additional safety equipment may be required for certain activities or areas.
- Hard hats shall be colour coded as prescribed by the project for the appointed employee.

These requirements will be detailed in the guidelines and management plans that will be developed for the project.

24.3.2.4 Site Visits and Training Requirements

Inductions

All personnel involved on the project, including occasional and short duration visitors (see Visitors Induction), shall be expected to comply with the following induction program:

Amec Foster Wheeler's Site Induction

All personnel must complete the Project Site Induction prior to entering / working on the site. The purpose will be to ensure that all personnel are made aware of and are conversant with the requirements as specified, site rules, environmental requirements, cultural heritage and community relations.

- Project contractors must allow a minimum of one full day for general induction
- Contractors shall also provide their own internal company induction. Evidence to be provided.
- All personnel must complete Job Specific Inductions for the contracted works prior to commencing work. These inductions will be the responsibility of specific Contractors.

Visitors Induction

A Visitor's Safety Induction program will be established explaining the site and the conditions applicable to their entry onto site and the necessary PPE they will be required wear.

Site Access Card

A project representative will be stationed at the Induction Centre for the issuing of Site Access Cards. All personnel who attend and satisfactorily complete each induction must be issued with a photo identification site access card. The access card will record information in acknowledgment that they have attended the induction program. The access card is to be carried at all times on site. On demobilisation, contractors are responsible to return access cards to the Induction Centre.

Education, Training and Competency

Task specific training remains the responsibility of each contractor. Proof of training in the safe work procedures for each activity must be kept for auditing purposes.

The Contractor must train all his employees in the risk assessments pertaining to a specific task. Proof of this training must be kept available for auditing purposes.

Workers in specialised work categories are required to be certified by an approved organisation as defined in the relevant acts; i.e. crane drivers, forklift drivers, etc. Records of equipment and tools, including inspection reports must be available at all times to Amec Foster Wheeler.

The competency review procedure will be included in all final tender documents to ensure contractor alignment with competency requirements.

Health and Safety Awareness Campaigns

These will be run to ensure good safety awareness amongst employees. It is anticipated that as part of the health and safety awareness campaigns the following will be instituted:

- Industrial theatres shall cover issues including; AIDS, Safety, Tuberculosis, etc.
- Contractors will be required to have their own individual safety campaigns per company.

Records of all training will be kept available for auditing purposes.

The Contractors must ensure:

- Identification of the competencies required by employees along with selection, placement and any training requirements.
- Identification and implementation of the process that will be used to ensure that employees hold the required competencies.
- The identification of minimum core and health and safety skills required by persons in leadership and supervisory roles.
- Identification assessment and management of hazards.
- The development of a training plan that ensures personnel attains the desired skills and is also able to monitor refresher-training requirements.
- Mechanisms to review the effectiveness of training where appropriate.
- A site induction and orientation system that includes specific site issues and requirements and compliments the General Induction.
- Methodology for briefing personnel on new or changed standards, site rules and or procedures, particularly after absence from site.
- Compliance with Amec Foster Wheeler's training and competency requirements.

Contractor's Safety Training Programs

Contractors' safety training programs should include coverage of the following where relevant to individual's duties:

- The project's Safety Specification
- Contractors' Safety Plans
- Fitness to work
- Operating mobile plant
- Slings and moving loads and using lifting devices

- Manual handling
- Working at height
- Potable electrical equipment
- Contractors' site specific inductions
- Confined space entry
- Hot work
- Pre-start checks
- PPE use and training
- Excavation
- Isolation
- Scaffolding; and
- Hazardous substance handling, storage and use.
- Permits – Hot work / Excavation / Isolation / Working near overhead power line

At the completion of all training, competency of individuals must be validated by the trainer. This will be by means of an examination (written, oral or practical) or an assessment of the trained person's performance during the training.

A record of safety training undertaken by each employee will be documented and retained permanently on a database and the employee's site identification and security card.

Emergency Procedures

The Contractor must ensure that all personnel on the site, including visitors, are properly instructed in the Site Emergency Response Procedures.

Contractors Health and Safety Management Handbook

- The project will issue pocket size safety handbooks at completion of induction.
- The Contractor must ensure that each employee acknowledges receipt of the Contractor's Health and Safety Management Handbook by way of signature. The Contractor is responsible for producing these records of signature and acknowledgement if audited.
- Where reading skills and/or language is an issue with the workforce the contractor must propose an alternative to the above, maintaining the intent of the above, for acceptance by Amec Foster Wheeler.

24.3.2.5 Special HSSE, Personnel and Security Plan Needs

Minimum standards of fitness to perform work on the Project

The occupational medical practitioner conducting the examination should be satisfied in each case that no disease or impairment is present which could be significantly aggravated by working on the project or which represents an unacceptable health or safety risk to himself or any other employee on the project.

Legal Requirements

Amec Foster Wheeler will adopt Macedonian legislation as applicable to this project. Amec Foster Wheeler Project HSSE Manager is responsible for identifying HSSE legislation applicable to the project, and will ensure that all guidelines and procedures are in compliance with the legislation.

Socio-Economic Requirements

Amec Foster Wheeler will ensure adherence to the socio-economic principles and commitments of the project, such as provision of business and employment opportunities to local individuals and supporting Euromax Resources' initiatives and arrangements in this area.

Environmental Requirements

Amec Foster Wheeler is committed to environmental protection. As such, its prime objective is to maintain a healthy and safe environment and to minimise impact on the environment within Amec Foster Wheeler scope of services.

Euromax Resources will compile an Environmental Management Plan on which project environmental provisions will be detailed. Euromax Resources' document shall be the overriding document for Environmental management. Amec Foster Wheeler will incorporate Euromax Resources' environmental requirements in the project Environmental Specification which will describe the methods, processes, and actions by which Amec Foster Wheeler and all Contractors, will comply with environmental legislation, project commitments, and applicable environmental standards in the area of the project.

Security Requirements

The purpose of project security is to protect workers, property, and other assets from injury, harm, and damage from criminal, hostile, or malicious act by implementing suitable security provisions to manage identifiable project security needs.

A security fence will be erected around the perimeter of the site during the early part of construction and site establishment. Access will be controlled and only people with project access badges will be allowed on site. A badge will only be issued to a person upon successful completion of the project induction program and will be de-activated once a person is demobilised. The access card will record information in acknowledgment that the personnel have attended the induction program. The access card is to be carried at all times on site.

Contractors will be responsible for the security of their own individual laydown areas. Access onto site will require that all personnel attend a general project induction. On completion of the project induction a photo identification site access card will be issued.

The security provisions for the project will be identified and documented in the Project Security Plan which will be generated prior to execution.

Occupational Health Requirements

Occupational Health will be taken into consideration during all stages of the project, and the focus of a minimum standard of fitness of contractor employees to perform work, shall be implemented.

Health Assessments and Health Monitoring

Amec Foster Wheeler, Euromax Resources and all Contractors must ensure that all personnel are healthy and medically fit for their respective assignments and must certify the same to Amec Foster Wheeler, if so requested. Amec Foster Wheeler, Euromax Resources and all Contractors are responsible for pre-placement and exit medicals and ongoing health assessments for all of their own staff.

All employees who will be working for more than 7 consecutive days on the Project will be required to undergo a pre-employment medical prior to mobilisation to site as well as an exit medical examination. The examinations will be to the cost of the applicable employer.

Amec Foster Wheeler, Euromax Resources and all Contractors shall provide first aid facilities for their own personnel for the treatment of minor injuries, such as the removal of splinters, treatment of minor cuts and bruises and the like. For this purpose of a proper first aid kit must be available in the contractor's site office and a contractor's employee qualified to render first aid must be appointed. The Contractor shall keep a record of all first aid treatments, a copy of which is to be given to Amec Foster Wheeler HSSE manager.

Euromax Resources shall provide a clinic manned by qualified personnel. An emergency vehicle shall be available to transport the injured from the construction site to the clinic for stabilisation. The clinic shall liaise with the nearest off site medical facility, if case evacuation of the injured is required.

Hygiene

Amec Foster Wheeler, Euromax Resources and the Contractors must ensure that his personnel and sub-contractor personnel maintain high standards of hygiene in connection with the performance of work. Amec Foster Wheeler, Euromax Resources and the Contractors must maintain all work areas in a clean and tidy state and must promptly and appropriately dispose of waste material. Eating areas are to be kept in a clean and tidy manner to the satisfaction of Amec Foster Wheeler as well as any statutory requirements.

Alcohol and Drugs

Amec Foster Wheeler, Euromax Resources and the Contractors must ensure that personnel under its control and authority do not at any time, during the performance of the work, take or work under the influence of any alcoholic and/or other drug other than for bona fide medical reasons or other proper reasons that have been approved in advance and in writing by Amec Foster Wheeler's Project Manager. Measures to be taken by Amec Foster Wheeler, Euromax Resources and the Contractors will include a drug test prior to such personnel starting work on the site. The Contractors must ensure that personnel under their control and authority comply with the Project site program of random testing for alcohol and other drugs.

Traffic Management Requirements

Amec Foster Wheeler recognises that the operation of workplace transport vehicles is among the highest risks on construction sites. Amec Foster Wheeler is committed to the effective management and elimination or reduction of this risk as part of its overall management of health and safety.

Rules and procedures must be implemented to manage driving and workplace transport risks on the project, both on site and off site. As a minimum, these should include:

- Design and planning of arrangements for traffic / pedestrian segregation on site
- Provision to manage and change traffic routing during project construction
- Maintenance programs and routine vehicle / plant inspections
- Ensuring that drivers are trained and experienced.

Unlicensed persons must not be permitted to control vehicles on the premises. All vehicles used by the Contractor on the premises must be roadworthy and registered by the appropriate Traffic Authority.

Owing to heavy traffic operating in and through the construction site and in the interest of general safety only the minimum necessary number of Contractors vehicles is permitted on site. All cars parked on site are parked at Euromax Resources' / Contractors' own risk.

In order to maintain a "Zero Tolerance" Policy in the use of self-propelled equipment the following rules should be adhered to at all times on site.

- As far as driving / operating of any self-propelled vehicle / equipment on site Amec Foster Wheeler requires that the driver / operator of such equipment is appointed in writing by the Contractors Construction Manager and confirm that the person has attained the age of 18 years and:
- Does not suffer from defective sight or hearing or any other infirmity, mental or physical, likely to interfere with the efficient discharge of his duties.
- Has completed a satisfactory course of training; and has been found competent or in possession of a driver's license issued by a provincial authority for which authorisation is granted.

When transporting long and wide loads, the Contractor must ensure compliance with the Road Traffic Regulations. Amec Foster Wheeler's representative is notified so those necessary requirements can be made where an escort may be necessary and so that the appropriate entrance can be arranged.

24.3.3 Engineering and Technical

The Engineering Execution Plan, PMP Volume 2, will be developed during the early stages of project implementation to define how the engineering and technical content of the work is resourced and managed to execute the project-defined engineering and technical responsibilities for the project.

The Project Engineering Manager is responsible for the preparation and implementation of this project specific Engineering Execution Plan, with the approval of the Project Manager and the Regional Manager of Engineering.

The Engineering Execution Plan forms part of the overall PMP and should be used in conjunction with the PMP.

24.3.3.1 Engineering Objectives

Engineering focuses on successfully achieving the following engineering-related objectives:

- Meeting the design basis
- Ensuring the design is consistent with established design standards

- Maintain technical integrity throughout the design process
- Achieving sustainable design with respect to safety and the environment throughout construction and operations
- Achieving efficiency in the design process
- Ensuring constructability in design
- Ensuring maintainability in design

The engineering objectives indicated above are typically followed. However at the commencement of project implementation, these objectives shall be re-evaluated, prioritised and reaffirmed by agreement between all appropriate stakeholders.

24.3.3.2 Engineering Scope and Organisation

The scope of work for engineering will be fully defined at the commencement of the project implementation phase.

The scope of work will be reflected in the Engineering scope of work and the engineering scope of services documents. The scope of work documents will define the extent of project deliverables which the engineering group will be responsible for designing. The scope of services will define the activities and level of effort which the engineering group will be performing in order to support the delivery of the scope of work.

The scope of work and scope of services for engineering will, in turn, be embodied in the Basis of Engineering Estimate. This document will define the basis on which the engineering effort has been estimated and it is from this estimate that the engineering group will be organised.

The project will be typically organised hierarchically according to engineering functional disciplines. Each functional discipline, incorporating design engineers, CAD designers, tracers and drafting checkers will report to the respective Project Discipline Lead Engineer. Each Lead Engineer will report to the Project Engineering Manager. The Project Engineering Manager will be supported by the Project Design Coordinator, who'll be responsible for coordinating and reporting on design activities and progress.

The Project Discipline Lead Engineers, as well as respective subordinates, will be supported by the respective Functional Engineering Managers regarding training and development.

24.3.3.3 Engineering & Technical Basis

The engineering and design on the Ilovica Project will be performed according to the criteria, requirements, constraints, conditions and practices indicated in the project specific Project Basis of Design.

The Project Engineering Manager is responsible for confirming that the documentation and information provided at commencement of this project are fully defined and reflected in the basis of design.

The overall Project Basis of Design will, in turn, be supported by the discipline-specific design criteria for civil, structural, mechanical, piping, electrical, and control and instrumentation.

24.3.3.4 Engineering Procedures, Instructions and Forms

All engineering and design will be done according to the established, approved and unmodified standard procedures, instructions and forms.

The Project Engineering Manager should ensure that approved PIFs are available, that all Discipline Lead Engineers are familiar with the applicable PIFs, and that the PIFs are used appropriately. Any modification to standard PIFs or the formulation of any new PIFs on the project will require approval from the Technical Director prior to implementation.

Discipline Lead Engineers shall be responsible for ensuring that PIFs are being followed. Discipline Leads may be supported by their respective functional management to ensure both awareness and compliance with all project documentation.

24.3.3.5 Principal Design Documents

The success of engineering execution is dependent on the progress and the timely approval of the Principal Design Documents. Almost all technical documents developed for a project are based on one or more of the Principal Design Documents; these are:

- Process and Engineering Design Criteria
- Process and Engineering Design Philosophies
- Design and Material Standards
- PFDs and Mass / Heat / Energy / Water Balance
- P&IDs
- Electrical Single Line Diagram
- Control System and Communications Block Diagram
- Site Plan and Facility Layouts
- Equipment Layouts (General Arrangements)
- Major Equipment Specifications
- Process Control Philosophy

The Project Engineer Manager, Area Leads, Project Discipline Leads and Area Discipline Leads are responsible for the timely completion of these documents.

Changes to principal design documents must be managed for any changes that take place after the principal design document has been issued for design. Changes to principal design documents are captured as trend alerts and trends which capture the engineering and capital cost implications of the changes. The agreed project trend notification process and forms shall be used.

24.3.3.6 Engineering Quality & Technical Assurance

Engineering technical assurance will support the policies, processes and requirements of the overall project quality plan. In general, engineering quality assurance processes will address: (a) engineering and design set-up and (b) execution of work.

Technical integrity is the consistency of actions, values, methods and measures taken to deliver an error-free outcome for the project.

To ensure technical integrity three primary processes will be implemented: (a) compliance and validation with Euromax Resources' (contractual) requirements, (b) engineering and design reviews and (c) ongoing training and human resource performance review.

Compliance and Validation with Euromax Resources' Requirements

All project engineering team members shall review the list of requirements and identify the key Euromax Resources' contractual documents for their respective discipline and project area.

The necessary and appropriate documentation relating to contractual requirements will be made available and accessible by all engineering personnel on the project.

The requirements included in Euromax Resources' contractual documents are considered to be compulsory and the basis of the validation of the design. Any ambiguity or clarification that is sought will be processed by means of technical queries issued by engineering through the Project Manager.

Any proposed deviation from contractual requirements will follow a similar process to technical queries, whereby a Technical Deviation Notice or Concession Request will be formally approved and issued to Euromax Resources.

Engineering and Design Reviews

There will be various reviews conducted throughout the engineering design schedule of the project. The Project Engineering Manager, with the assistance of the Project Manager, and the Quality Manager defines the scope, frequency, and resources of the various engineering and design reviews. If Euromax Resources has any technical review requirements for the project, then these reviews will be combined with them where possible.

The various reviews planned for the project are:

- **Principal Engineering Reviews**; conducted by functional management or principal engineers to determine conformity or nonconformity of the engineering to requirements mandated by the execution plan.
- **Technical Peer Reviews**; undertaken for all the principal design documents and for any significant technical risk items identified in the Risk Register.
- **Design Reviews**; ongoing reviews of technical documents and the model where constructability, operability, maintainability, and safety are also reviewed. Reviews of the engineering design are held in parallel with design development to confirm that the engineering design takes into account operational end user requirements.
- **HAZOP Reviews**; performed on all piping and instrumentation diagrams to ensure safety and operability, and implemented prior to final issue or subsequent to any change to P&IDs after being issued for design.

- **Internal Document Reviews**; consisting of discipline checks, interdisciplinary (squad check) reviews, approval and professional sealing of appropriate documents guided by the technical document approval matrix.
- **External Document Reviews**; performed systematically on technical documents received from an external party, such as Euromax Resources, contractor, or a vendor, for use on a project. External documents can be drawings, specifications, schedules (lists) of technical information, manuals, design calculations, reports, and material take-offs.
- **Key Quantity Analysis**; performed to examine adherence to allowable quantitative limits for materials and equipment, to determine value studies and opportunities to reduce quantities at the outset, effective bulk material purchases to minimize waste and unused material, effective bulk material control to manage installation. The Project Manager, Project Engineering Manager, and Cost Control Manager determine how often key quantity analyses should be conducted and for what materials and equipment.

24.3.3.7 Engineering Change Management

An engineering change is a change from the contract, Engineering Scope or Work, Engineering Scope of Services or Design Basis, or a change in the principal design documents from that which was originally prescribed. A design change is considered as such once the engineering design documentation has reached defined gateways. Prior to this gateway, any change identified is treated as a trend.

All members of the Project Engineering Team, through the Project Engineering Manager, shall identify to project management all engineering changes that affect cost, schedule, technical specifications, and execution strategy. They must also initiate appropriate management of change documentation.

24.3.3.8 Engineering Setup and Execution

The engineering and design work for this project will be implemented and controlled to meet the project objectives.

Engineering Work Packages

All engineering and design will be performed in predetermined batches of EWPs. The Project Engineering Manager together with input from the Project Controls Manager, is responsible for defining and setting up EWPs. EWPs represent parcels of engineering documents and drawings grouped together according to discipline, budgeted work, WBS and timing. All EWPs will hence also be scheduled as discrete activities in order to monitor and control.

The Project Engineering Manager is responsible for ensuring that estimating, planning and scheduling for engineering and design activities (as EWPs) are performed accurately and conveyed to the project controls group.

Discipline Leads are responsible for day-to-day estimating, planning, scheduling and control of their discipline. This includes organising the deliverables in EWP and following up that the completion of each work package is planned and coordinated with the requirements of the CWPs.

The Level 3 schedule provides the framework for coordination of the engineering discipline and development of the dates for the engineering document list, as derived from the programme for completion of the respective EWP.

As part of progress reporting, Engineering will provide regular updates to project controls to allow the accurate reporting of design progress. During the early stages of design, before the issue of 2D deliverables for Euromax Resources review, progress must be reported with reference to the 3D model.

3D modelling progress will be monitored for every modelling area and will measure progress as percentage complete for mechanical equipment, structural steelwork, piping and valves, electrical cable routing and concrete layout. 3D modelling progress will also be based on pre-set modelling milestones reviews.

Engineering Interfaces

The Project Engineering Manager is responsible for assigning responsibility for each of the following important interfaces:

- Between engineering disciplines; by means of engineering and design reviews
- Between engineering and supply chain; by means of engineering requisitions, technical bid evaluations and purchase requisitions processes
- Between engineering and vendors; by means of vendor and vendor document review process
- Between engineering and construction; by means of agreed EWPs and CWP
- Between engineering and commissioning; based on mechanical completion and system commissioning packages
- Between engineering and external agencies; by means of document management process, request for information process and technical query process.

Significant effort, communication, and commitment are required to make the interfaces work. The success of each engineering activity is dependent on all parties involved in an interface delivering the data and work packages as required.

Engineering Resource Planning

Early in the project, the Project Engineering Manager will identify the staffing requirements of the project. The Project Engineering Manager is responsible to identify personnel to assume the engineering roles and schedule when they are required. The plan includes the staff type, level of experience, and timing for all their project personnel requirements. For more information on project staffing plans, refer to the PMP sections on Project Resource Management and the Project Staffing Plan.

Early in the project, the Project Engineering Manager works with the Project, Construction, and Commissioning Managers and Euromax Resources to identify the follow-on engineering requirements of the project. The Project Engineering Manager is responsible for identifying personnel to assume the follow-on engineering roles and schedule when they are required. It is anticipated that a small engineering team will be based on site during the construction and commissioning phase of the project.

24.3.3.9 Project Numbering & Identification Systems

The Project Engineering Manager, with input from project discipline leads, is responsible for the plant equipment and item numbering system for mechanical and electrical equipment, instrumentation, rooms, modules, and other items. The project numbering systems must be sympathetic to Euromax Resources' requirements.

The numbering conventions for equipment, facilities and documents will be reflected in the project-specific engineering and document numbering procedure.

24.3.3.10 Engineering Systems

The Engineering Systems Group supports cross-discipline applications such as 2D CAD, 3D Plant Design, and Intelligent P&ID systems, including the following activities related to these programs:

- Training
- CAD environment, borders, set-up, Euromax Resources' standards, etc.
- Large format plotting, troubleshooting and support
- 3D model creation, database, and project grid set-up and administration
- Catalogue and specification database administration
- Creation of model review files
- P&ID database set-up and administration
- Other database administration
- Software enhancements, coding and application writing
- Approvals of hardware and software acquisitions

The Engineering Systems Group works with the local IT Group to ensure the correct computer systems (i.e. Standard, CAD and Special) are deployed to the appropriate Project Team members. The Engineering Systems Group determines any special computing or WAN bandwidth requirements the project needs and conveys those requirements to the local IT Group at the outset of the project.

The engineering systems such as CAD platforms, analysis software and design databases form an integral part of the Basis of Engineering Estimate. In general terms, the project will use the following:

- 3D Modelling - AVEVA E3D
- 2D Drafting - AutoCad
- Process Modelling - Metsim and JKSImMet
- Engineering Build Information - AVEVA Engineering, AVEVA AI12 and AVEVA AE12

3D models shall be produced using the standard Amec Foster Wheeler applications and procedures together with those present in the 3D modelling applications. The 2D deliverables produced from these models shall comply with Euromax Resources documents mentioned above and relevant discipline job notes, and work instructions.

The Project Engineering Manager, Engineering Systems Manager, Project Discipline Lead, and Euromax Resources (if applicable) will together decide which software is to be used for design and calculation for the project.

All software used as part of design calculations will be verified. If design software is not identified in the engineering project software registry, then the software outputs must be independently verified through the checking and design verification processes.

24.3.4 Supply Chain Management

The SCM Execution Plan, PMP Volume 3, will be developed to organise, perform and execute the SCM related responsibilities for the project.

SCM responsibilities are to undertake the procurement of all services, equipment and materials leading to formation and placement of a contract or purchase order plus the post award procurement activities necessary to achieve the project execution schedule and through to close out of the Contracts and Purchase Orders.

This process is to be achieved by effective procurement set in the context of the project complexity and the overall project procurement strategy. As appropriate, the scope of work / services or supply, health, safety, environment, price, quality, financial stability, code of conduct compliance, delivery, past / current performance and applicable regulations should be taken into consideration.

The following Amec Foster Wheeler Work Instructions focus on defining further details about how these methods and responsibilities are to be executed:

- SCM-IST-000012 Purchasing Instruction
- SCM-IST-000013 Contract Formation and Award
- SCM-IST-000028 Contract Post Award Administration

Other SCM activities are defined in:

- SCM-PRO-000003 Expediting
- SCM-PRO-000005 Vendor Quality Surveillance
- SCM-PRO-000019 Home Office Material Control
- SCM-PRO-000020 Shipping and Logistics
- SCM-PRO-000021 Site Material Control

24.3.5 Contract Terms

For the purposes of this write-up the project execution strategy is EPCM. As such, the contract to be placed between Euromax Resources and Amec Foster Wheeler would be the White Book (Client/Consultant Model Services Agreement).

Amec Foster Wheeler's role will be three-fold:

- Responsible engineer

- Placing contracts for and on behalf of Euromax Resources
- Supervising the work carried out by the contractors

On signing of contracts with contractors the Civil Contractor will be specifically named the “Main Contractor” to fulfil the role as single point of contact to the government of Macedonia. To this end the Civil Contractor will accompany the appointed committee on the final site inspection, hand over all certificates of completion and apply for the operating license.

24.3.5.1 General Form of Contract

The contracting conditions will be the FIDIC Suite of Conditions of Contract, First Edition, 1999.

The concepts of “Early Warning”, and “Risk Registers” are required to be written into any contract drafted to achieve pro-active risk management and certainty in outcome (result, cost and time).

The Project will further develop the policies and procedures to be followed during project execution.

24.3.5.2 Particular / Special Conditions of Contract:

These are intended to serve as a method of providing additions, deletion or amendments to the Contract usually due to either Euromax Resources requirements or peculiarities of the project; these will be drawn up and agreed between Amec Foster Wheeler and Euromax Resources.

The following particular clauses will be stated in all execution enquiries:

- Euromax Resources has the right to terminate for convenience and this right is absolute.
- Euromax Resources will determine how he will deal with the penalty plus any proven costs incurred by the contractor, should they elect to terminate.

24.3.5.3 Types of Contract

Fixed Price or Lump Sum Contracts (Yellow Book)

This will be used when there is a high level of definition of the scope of work. Also for high cost proprietary items.

Bill of Quantities Based Contracts (Red Book)

This will be used for most re-measurable site contracts, as it facilitates competitive tendering and provides for making and valuing changes easily.

Cost Reimbursable plus Fee Contracts – Professional Services (White Book)

It is proposed that this contract would form the basis of the contract with Amec Foster Wheeler.

Supply and Delivery Purchase Orders

For all supply and delivery purchase orders the standard Amec Foster Wheeler terms and conditions will be used as a starting point to draw up and agree the terms and conditions with Euromax Resources taking into consideration all site rules and regulations and country statutory requirements.

24.3.6 Construction, Completions, Commissioning (C3) Management

24.3.6.1 General

The Works will be managed by a construction management team reporting to the Construction Manager. As far as possible the key components for the plant will be delivered in package form in the largest practical component size to minimize site work. Once the project is approved for implementation, a detailed Construction Management Execution Plan, PMP Volume 4, will be developed for approval by Euromax Resources and implemented.

Amec Foster Wheeler will liaise with the other two major consultants appointed by Euromax Resources to ensure that the respective scopes of work are coordinated with that of Amec Foster Wheeler. These consultants are:

- Independent Mining Consultant - Mining
- Golder - TMF

24.3.6.2 Permitting

It is assumed that all required permits would be obtained by Euromax Resources in time to support the Early Works Program.

24.3.6.3 Construction Management Organisation

Construction management will be the responsibility of a dedicated Construction Manager, reporting to the Project Director. The Construction Manager will supervise the management of all discipline superintendents, scheduling, supervision of contractors and any subcontractors, contract management, site project controls, site materials control, field engineering, field office administration, health and safety, environmental management and compliance, quality assurance and pre-commissioning activities.

The Construction Manager will be supported by Area Superintendents that match the functional areas of the Area Managers. These Area Superintendents will be supported by Construction Supervisors in sufficient numbers as dictated by their respective areas of responsibility.

The proposed Construction Management Organogram is presented in Figure 24.7.

24.3.6.4 Constructability

During engineering regular constructability reviews will be performed that will focus on providing constructive input to the performance of activities. The constructability reviews will happen in parallel with construction and logistics planning, and this will provide additional opportunities to maximize opportunities for cost and schedule improvements. Modularisation will be a key theme of the constructability reviews, as this concept will reduce site labour hours and costs.

24.3.6.5 Construction Program Development

Once the project is approved, the Construction Manager will participate with the project team in the development of the construction schedule to ensure the project is construction driven.

Construction Work Packages

CWPs is the single most important item to define at the start of any construction driven project. CWPs will be created to ensure flexibility in work completion and define the relationships with EWPs and Procurement Packages to support execution of the CWPs in the field.

Working Back the Schedule

Many tool sets are available to complete estimates and schedules for projects. With Amec Foster Wheeler construction driven approach previous knowledge and experience is combined with the implementation of these tools to define durations for key activities to work the schedule back to an end date for engineering for each CWP.

For each CWP there is a defined duration to work the schedule back. Once the engineering completion date for the CWP is reached it can then be worked back to the engineering start date to define the engineering duration. At this stage all the durations can be checked to ensure that ends dates are attainable.

Once the CWPs and their respective back passes have been completed the overall construction sequence and interfaces between EPC packages and other CWPs are defined and included in the schedule.

Commissioning Integration

- Define CWP commissioning battery limits
- Integration of components into systems
- Definition of commissioning responsibilities
- Operator's Interface with Amec Foster Wheeler / Contractors
 - Training
 - Take Over / Hand Over

Ensure Schedule is compatible with the Form of Contract.

Define productivity norms to be used in the schedule and man h forecasting.

24.3.6.6 Industrial Relations

Amec Foster Wheeler will manage the implementation of the project labour agreement (PLA) or similar, to be developed by Euromax Resources. The PLA aims to harmonize industrial relations practices on site to avoid conflicts between contractors on site.

24.3.6.7 Early and Temporary Works Program

Establish and implement an Early and Temporary Works Program for Temporary and Preparatory Works to ensure a seamless commencement of Permanent Construction.

Site Establishment

Early site establishment of Amec Foster Wheeler will be in rented office space in the nearby town of Strumica from where the preparation of the site to commence the Early Works Program will be coordinated from. Once sufficient infrastructure had been created, the Construction Management Team would relocate to the temporary offices on site.

Offices

Amec Foster Wheeler proposes to establish temporary offices, including utilities, for themselves and Euromax Resources' Owners Team while the permanent office accommodation is constructed. The temporary offices would be trailer type offices which would be used as satellite offices once the permanent offices are completed which would then be used by both Amec Foster Wheeler and Euromax Resources' Owners Team.

Site IT and Communications

Early communications would be mobile phones with 3G data connectivity while a fibre optic link be established. Once this link is commissioned, voice over internet protocol (VOIP) communications and connectivity to Amec Foster Wheeler systems would be established.

Materials of Construction

A crushing and screening facility will be established on site for the production of aggregate and sand for concrete. Commercial borrow pits have been identified by Euromax Resources for the sourcing of road construction materials. This would form part of the early works requirement to ensure sufficient stockpile is available at start of construction.

Construction Water Supply

The base case for obtaining water for construction is from boreholes on site. Testing of this option has not commenced. As an alternative, sourcing water from the nearby Ilovica reservoir will be investigated, in particular to supply the mining infrastructure development close by. Pumping from this reservoir to the Fire Water Tanks at the Plant Site, to be erected early will also be investigated to remove the requirement for boreholes. In the early works portion of work contractors will need to pump water directly from the reservoir with their own pumps. Euromax Resources will need to ensure the necessary permits are in place to allow this to happen.

Access Road

The main access road needs to be constructed early to allow delivery of the mine fleet for early assembly. At this time it is assumed that the fleet would be assembled at the mine infrastructure area and walked to the mine area once assembled.

Laydown Areas

Laydown areas were identified and detailed on the layout drawings both at the mine development area as well as at the process plant area. Due to the hilly nature of the terrain, it will be difficult to have a consolidated area where all laydowns are located making the provision of services more complex.

Temporary Warehousing

The future Core Shed in the mine infrastructure area would be constructed early and equipped as a temporary warehouse. For sensitive equipment requiring climatic control, a section of the shed would be partitioned for this purpose.

Equipment for Site Materials Handling

It is currently foreseen to rent equipment for site materials handling. Equipment would include cranes, forklifts, tractors and trailers. Once contractors are fully established equipment arriving at site would be signed over directly to the installation. The required equipment would be more fully specified once the procurement and contracting schedule had been finalised and the logistics management plan established.

Site Security

To prevent unauthorised access by the local community to collect wood on the concession area, the mine and process plant would be fenced off appropriately early in the early works engineering and execution phase and the required access control points be established. A security service provider would be sourced locally.

Construction Sewage Disposal

A permanent sewage plant would be established within the concession. Septic tanks would be constructed at the process plant, mine and TMF sites and transported to the permanent installation for treatment by means of a vacuum truck. Contractors would be required to construct similar septic tanks. The transfer of the sewage would be centralised and be included in the scope of the solid waste management contractor.

Construction Power

Insufficient capacity within the existing local medium voltage system determines that diesel generation will be used for supply of construction power.

Construction Waste Disposal

A landfill site will be developed for all waste generated at the plant. This landfill will be constructed early to handle waste generated during construction. Consideration will be given to recycling during the design of this facility.

Hazardous waste will be taken to an appropriate, licensed facility.

On Site Medical and Emergency Facilities

The medical facility will be in the mine infrastructure area. This facility will be staffed by a recognised international emergency service provider such as International SOS. This facility will be established early and be of sufficient capacity to cater for the construction workforce as well. An ambulance and fire truck would be stationed at this facility, as soon as possible during the construction and commissioning phase.

Training Facility

The training facility will be constructed early in the mine infrastructure area. This would be used to train local people from the nearby villages to participate in the construction phase of the project as well as operators for the mine, process plant and TMF during operation.

Site Transportation

Passenger vehicles and light duty vehicles (LDV) would be purchased locally for the Owners Team and Construction Management Team to be used on a non-exclusive, shared basis. The construction workforce will be bussed to the job site. The sourcing of this bussing solution could be passed to the various construction contractors or alternatively centralised under the Project and be used as a local business opportunity. Staggered working hours would be considered to reduce congestion on the road at start and end of shifts and to reduce the number of busses required.

Fuel Storage and Dispensing

As there would be a relatively high demand for fuel during the initial phase of construction that will run concurrent with mine development and TMF construction, the permanent fuel storage and dispensing facility would be established early. This is currently located in the mine infrastructure area. A Fuel Supply and dispensing contract would be established to provide reliable fuel supplies and to dispense to the authorised users. An accounting and back-charge system would be implemented for contractors.

In early works phase contractors would be required to make their own provision for fuel with that as the default position written into contracts. Once the fuel storage facility is established a back charge system could be implemented.

Plant and Equipment Maintenance Facilities

The Mine workshop would be established as early as possible to provide a vehicle maintenance facility on site. Contractors would be required to establish maintenance facilities for their own plant and equipment.

Janitorial Services

A janitorial services contractor would be required to provide janitorial and building maintenance services to the project. This could also be an opportunity for the development of a small local enterprise.

24.3.6.8 Civil Construction

The civil construction activities include earthworks and buried services.

The intent is to complete earthworks early under a separate earthworks contract followed by completion of buried services under the civil contract that will allow clean working areas with access benefits for subsequent contractors.

24.3.6.9 Structural, Mechanical, Piping and Plate Work

A SMPP Contractor will be appointed responsible for:

Structural Steel

- Detailed fabrication drawings
- Supply of structural steel
- Fabrication and painting of structural steel
- Delivery of structural steel to site
- Erection of structural steel
- Touch-up painting on site as required

Installation of Mechanical Equipment

The mechanical equipment will be installed as soon as it is delivered to site.

All packages will be assembled and installed by the SMPP contractor under the vendor's supervision.

The SMPP contractor will be responsible for the preservation of equipment under direct Amec Foster Wheeler management. Preservation will be performed as per the vendor instructions and manuals and in accordance with Amec Foster Wheeler's procedures.

Piping Installation

The piping material will be procured by the SMPP contractor who will prefabricate the piping spools. Small bore piping, 50 mm diameter and less will be field run.

The piping will be installed in a predetermined sequence. Amec Foster Wheeler will determine the installation sequence during the project by reviewing the timing and availability of work fronts.

The SMPP Contractor will be responsible for C1 and C2 Commissioning and commissioning assistance for C3 and C4 Commissioning.

24.3.6.10 Electrical, Instrumentation and Control

An electrical, instrumentation and control contractor will be responsible for:

- Supply and delivery of bulks to site, including cabling, cable trays, secondary support steel and all required consumables.
- Installation of electrical, instrumentation and control scope
- C1 and C2 Commissioning
- Commissioning assistance for C3 and C4 Commissioning

24.3.6.11 Field Engineering

Amec Foster Wheeler will not have full time field engineers in all disciplines for the duration of construction but rather support construction from the Home Office. This will be coordinated by Project Engineers in the Home Office reporting to the Area Managers. The role of field engineering will be assumed by the Construction Supervisors and will include:

- Resolution of technical queries from construction contractors. Any technical queries that cannot be resolved at site will be referred back to the Home Office where the correct discipline engineer will address it.
- Ensuring all drawings and technical document is correctly understood by construction contractors.
- Performing any adjustments to engineering documentation and drawings if required.
- Inspection of the installed works to ensure it complies with the design intent and drawings and is safe to operate.
- Sign Certificate of Design and Completion.
- Coordination of when discipline engineers are required on site.
- Coordination of when Vendor's are required on site.
- Discipline Engineers will closely work with the site team from the Head Office and will visit site regularly to provide the required support.

24.3.6.12 Site Materials Management

The Field Logistics Manager, in conjunction with the Construction Manager, is responsible for the on site receipt, storage, and issue of material and equipment procured on behalf of Euromax Resources. This includes but is not limited to the following functions:

- Material receipt
- Material inspection
- Schedule, description, quantities, special handling requirements of inbound material
- Over, short or damaged materials
- Material storage including segregation
- Material issue
- Material reconciliation

Initially, prior to mobilisation of the construction contractors, equipment will be received and stored by Amec Foster Wheeler and signed over to the installation contractors once they are established on site.

Once installation contractors are established, materials and equipment arriving at site would be signed over to these contractors directly, except those requiring special storage regimes until installation.

Sensitive equipment requiring protected storage will be stored in the core shed which would be converted temporarily into a Construction Warehouse.

The detailed site materials management plan will be developed early in the execution phase.

24.3.6.13 Site QA/QC Management

The overseeing of the quality of a contractor's work at site is achieved by knowledge of what is required, constant surveillance and good communications with all levels of staff. From this a level of confidence can be established.

In order to formalise contact with the contractor it is essential that site quality plans and their requirements be specified in the respective scopes of work, discussed and prepared at the earliest opportunity prior to site establishment and certainly prior to the commencement of the relevant activities in order to allow time for formal approvals. The development of site quality plans may be a continuing operation, dependent on the technical requirements of the work.

The quality plans shall be prepared on Amec Foster Wheeler format which will be specified in the contract package scope of work or on the contractor's standard format if this contains equivalent data.

24.3.6.14 Commissioning, Ramp-Up and Handover

Objectives of Commissioning

- To have a systematic approach to commissioning all sections of the plant to prove design throughput.
- To turn over to Operations and Maintenance an integrated operating plant capable of continuous and reliable performance as designed. The commissioning plan addresses both the quality of turnover packages and the mechanical proving of integrated systems through a range of anticipated conditions.
- To achieve the design tonnage of at the earliest possible date.
- To begin ramp-up of the facilities in line with the project schedule.
- To commission the facility with zero lost-time incidents.
- To execute the commissioning plan with an integrated team including Euromax Resources Operations Team, Amec Foster Wheeler, Contractors, key vendor representatives and other personnel as appropriate.
- To capture and turn over knowledge, experience, data, ideas and recommendations relevant to further optimisation and effective operation of the facilities.

Commissioning Stages

The specific term "commissioning" refers to the stages from construction completion, when equipment and systems are operated for the first time and then operated under significant load, with process materials, slurries and other operating fluids. In general, however, the commissioning plan also manages the key elements of the transition from construction to normal operations. Amec Foster Wheeler proposes a six-stage commissioning system (C1 to C6) to check out, start up, commission, and operate the process plant and ancillary systems.

- C1, C2 Certification: Construction completion resulting in the release of the project for wet commissioning. C1 certification includes verification of design drawings against field installation. C2 certification includes the site acceptance testing (SAT).
- C3 Certification: Pre-operational testing, or wet commissioning. This is a transitional phase where component functionality is tested and allows the introduction of fluids into the system.

- C4 Certification: Commissioning, or product commissioning. This step starts with the introduction of ore into the system or streams and ends when the system operates successfully under load for a defined period of time.
- C5 Certification: Project completion which is achieved when the facilities are operating at design capability.
- C6 Certification: Final certificate.

Amec Foster Wheeler will define the commissioning and handover systems for the entire scope and ensure that the transition from bulk construction to completion by system occurs. All handover packs are created and tracked using a handover database.

Responsibilities during Commissioning

Responsibility during commissioning is summarised in Table 24.4.

Table 24.4 Responsibilities During Commissioning		
Project Group	Responsibilities	
	Before Turnover	After Turnover
Amec Foster Wheeler Construction Management	• Complete construction of facilities and systems. • Manage QA/QC program and documentation. • Manage construction contract scope and cost issues. • Manage vendor reps in construction. • Pass completed systems to Amec Foster Wheeler commissioning team. • Complete punch list items.	• Manage and complete punch list items. • Support the commissioning team in any requested modifications, changes and repairs. • Manage contractor warranty issues during commissioning. • Manage contractor close-out.
Amec Foster Wheeler Commissioning Management	• Coordinate strategy of pre-op and turnovers with overall commissioning schedule. • Manage C3 commissioning of facilities and systems. • Manage pre-operational testing of systems. • Manage vendor reps during C3 commissioning. • Manage systems turnovers, including punch lists. • Assemble and transmit turnover packages to Owner.	• Manage contractor work permit system to turned-over areas. • Coordinate deficiency list completion with construction and commissioning team. • Manage resolution of field conditions. • Manage technical problems arising during commissioning: troubleshooting, recovery plans, etc. • Support Euromax Resources Operations team in C4 commissioning operations and testing.

Table 24.4 Responsibilities During Commissioning		
Project Group	Responsibilities	
	Before Turnover	After Turnover
EuromaxResources Owners Team	• Monitor construction activities. • Monitor and witness QA/QC activities. • Witness pre-op tests. • Review turnover packages from Amec Foster Wheeler • Authorize construction expenditures against the project budget.	• Provide support as required.
EuromaxResources Commissioning Team	• Audit QA/QC, non-conformance, field change documentation for turnover quality. • Audit contents of turnover packages. • Manage resolution of field conditions. • Apply acceptance criteria to turnover packages. • Review punch list issues. • Coordinate all turnover issues with Operations and Maintenance. • Accept turnover packages from Amec Foster Wheeler	• Manage C4, C5 and C6 Commissioning Certification. • Manage final custody turnovers to O&M. • Support O&M with key personnel. • Manage vendor reps during commissioning • Control and authorize commissioning expenditures against the project budget.
Owner Operations & Maintenance Personnel	• Contribute to identification and resolution of field conditions. • Participate in punch list items and resolutions. • Participate in QA/QC issues affecting O&M. • Witness critical construction / commissioning activities.	• Operate systems and equipment. • Perform normal maintenance activities. • Accept transition of vendor relationships including warranties. • Monitor and participate in QA/QC issues. • Manage safety lock-out procedures with commissioning team.

The Commissioning Execution Plan, PMP Volume 5, and the Completions Execution Plan, PMP Volume 8, will detail the commissioning process.

24.3.6.15 Project Close-out Activities

Amec Foster Wheeler will complete the following construction close-out activities:

- End of Job Documentation including Redlined, as-built drawings, vendor data books and engineering dossiers
- Purchase order close-out
- Contract close-out
- Assist with commissioning and ramp-up.

25. INTERPRETATION AND CONCLUSIONS

The current Ilovica Gold-Copper Project FS justifies continuing development through FEED and detailed engineering to project execution. Overall the study complies with industry standard practices for FS level and is considered to have an accuracy of plus or minus 10% or better. The scope of the project including mine design, mine schedule, process flow sheet and process plant design and engineering, waste management and TMF have been assessed and viable solutions defined in each case.

Based on the supplied data and application of appropriate methods, a combination of open pit and hillside quarry type mining, a project was outlined that could be profitably mined with the parameters applied that are set out in Table 25.1.

Table 25.1 Mining Parameters	
Parameter	Value
Milling Rate	
Year 1	9.75 Mt/a
Life of Mine	10 Mt/a
Mine Life	20
Average Diluted Mill Feed Grades:	
Gold	0.315 g/t
Copper	0.21 %
Average Yearly Metal Production Delivered to Mill:	
Gold	3.12 t/a
Copper	20 800 t/a
Total Tonnes Milled	198 Mt
Pre-production Stripping	13 Mt
Total Waste Tonnes (incl. Pre-strip)	199.9 Mt
Strip Ratio (incl. Oxide)	1.01

Note: Oxide ore is treated as waste for the purposes of pit optimisation.

Based on the results of a positive economic analysis of the proposed mine, mineral reserves were identified. The detailed production schedule is based on Proven and Probable Reserves.

The pit shell was generated to define blocks within the model that have reasonable prospects for economic extraction. A base case cut-off of US\$16 /t was chosen for sulphide materials and US\$8 /t for oxide materials.

The Mineral Resource for fresh material is summarised in Table 25.2.

Table 25.2 Measured and Indicated Fresh Mineral Resource Based upon a Dollar Equivalent cut-off of US\$16 /t					
Classification	Tonnage	Grade		Contained Metal	
		Au (g/t)	Cu (%)	Au (koz)	Cu (klb)
Measured	147 100 000	0.31	0.23	1500	729 500
Indicated	109 700 000	0.33	0.20	1100	479 000
Total M & I	256 800 000	0.32	0.21	2600	1 208 500

The oxide mineral resources within the constraining pit shell are summarised within Table 25.3.

Table 25.3 Measured and Indicated Oxide Mineral Resource based upon a Dollar Equivalent cut-off of US\$8 /t			
Classification	Tonnage	Grade Au (g/t)	Contained Metal Au (koz)
Measured	12 500 000	0.41	160
Indicated	9 600 000	0.37	110
Total M & I	22 100 000	0.39	280

The quantities presented in Table 25.4 have been estimated to CIM standards from the final pit design.

Table 25.4 Reserves				
Description	Units	Proven	Probable	Total
Sulphide Ore	Mt	112.6	85.5	198.1
Waste	Mt	-	-	199.9
Total	Mt			398
Strip Ratio	t : t	-	-	1.01
Gold Grade	g/t	0.32	0.30	0.32
Gold Content	Moz	1.17	0.84	2.01
Copper Grade	%	0.22	0.19	0.21
Copper Content	Mlb	543.9	355.0	898.9

Note: There may be minor differences in the totals due to rounding of figures.

Mineral reserves are reported to a cut-off grade of 0.22 g/t Au and 0.17% Cu based on a gold price of US\$1 200 /oz less US\$59.52 /oz selling costs and copper of US\$2.50 /lb less US\$0.282 /lb selling costs.

The reserve estimate assumes the construction of a process plant with 10 Mt/a capacity.

Oxide ore is not included and is considered waste for the purposes of pit optimisation.

Processing of the ore using a flow sheet comprising crushing, milling in a SABC circuit, flotation of a copper concentrate and treatment of the cleaner scavenger flotation tails for additional recovery of gold has been defined as a viable process route. The process route has been sufficiently defined in order to establish process operating and capital costs to the required level of detail for a FS level study. Costs

have been established for a 10 Mt/a operation. The process will produce a copper concentrate with payable gold credits and doré bars.

Existing infrastructure has been examined and the required additional infrastructure designed to a level appropriate for the study. This comprises a system of roads and power lines to connect to the local networks, a water pumping network to ensure sufficient makeup water for the plant, a series of buildings and workshops to house the various parts of the project and accommodate the required support for this and a TMF in the Shtuka valley, adjacent to the mine. The footprint is as compact as possible and has the advantage of impacting only the drainage systems, which pass directly by the deposit.

No fatal flaws have been identified within the impact assessment and an international ESIA for financing is currently being finalised in parallel with a local EIA that will accompany submissions for a construction permit in 2016.

Financial analysis of the parameters defined by the FS demonstrates a viable project. The mine schedule taken forward for the economic analysis delivers higher than average grade in the first eight years. The project is most sensitive to changes in metal recovery but still presents a positive return within the range of sensitivities tested for metal recoveries, price, discount rate, operating costs and capital costs.

26. RECOMMENDATIONS

Specific recommendations have been made in the various sections of this report. In general terms the definition of a viable project from the positive results of this FS leads to the recommendation that the project should be advanced to the next phases through FEED and detailed engineering to project execution. Key aspects of this are listed below.

26.1 METALLURGICAL TEST WORK AND MINERAL PROCESSING

Test work is continuing in order to confirm the assumptions made, the test results of the previous test work (PII and PIIR), the current test work (PIII) and to allow the detailed process design phase to proceed to completion during the FEED. The programme will include:

- Repeat tests of any anomalous results where unexpected differences in both recoveries and grades of Cu and Au are experienced. Included in this, duplicate tests to confirm the optimum regrind size of the rougher concentrate, which should also be evaluated with respect to leach recovery.
- Oxide Cu analyses undertaken on the residual core samples to assist in the oxide investigation and to provide additional information relative to metallurgical response. These results will then be interpolated into the resource model. Cu oxide analyses will also be carried out on the various flotation products. These various Cu oxide analyses will allow a less conservative evaluation of the CIL metallurgical response.
- Ag assays on selected tests for balances and recoveries to be calculated. Ag assays are also necessary on core samples for inclusion in the geological block model. Euromax Resources has initiated a re-sampling of coarse rejects from the core drilling over the entire deposit to provide 9 m composites. These will be analysed for oxide Cu using a citric acid method. Ag assays will be included in this exercise.
- Additional LCTs on different domain samples to those carried out in PIIR to confirm the open circuit variability tests. Assessments for plant operations have been done using mathematical techniques to include the effect of stream recycles which is suitable but should be verified with the LCTs.
- Leaching, CIL and de-watering tests on bulk flotation test material.
- CIL test work to confirm leach parameters, adsorption parameters and reagent consumptions, including oxygen requirements. The latter is considered essential since the resource material is relatively high in soluble Cu and S, which are oxygen consumers.
- Adsorption and elution test to establish the behaviour of Cu and Ag. It is known that the leach parameters can be varied to reduce adsorption of Cu onto carbon. A cold elution prior to the hot Au elution can also be effective in removal of Cu. This is to be used for the CIL modelling and prediction of the doré analysis.
- Settling tests of the concentrate and final tailings slurry streams for optimisation of the thickening design requirements.
- Filtration tests to confirm the design parameters for de-watering the concentrate and subsequent transport moisture content.
- Bulk solids tests on ore and concentrate to confirm the parameters of bulk density, angle of repose and valley angle for confirmation of the design characteristics for the transport and storage of the ore and concentrate.

26.2 PRIMARY CRUSHER LOCATION

The primary crusher location at the egress to the open pit has resulted in a pillar of payable material being used to provide a site for the crusher. It is therefore recommended that more detailed work should be undertaken as part of the FEED phase and a trade-off be conducted to evaluate the economics of trucking versus conveying and offset against the loss of revenue from the reduced mine resources.

26.3 OXIDE ORE

The treatment of the oxide ore and hence the need for the stockpile should be reviewed. If this is done in conjunction with the crusher location then access to the crusher via the oxide stockpile would not be required.

26.4 UTILITIES

Based on the power and water supply requirements it is recommended that Euromax Resources:

- Keep in contact with the local utility, EVN, to explore other feasible solutions for the provision of construction power.
- Maintain ongoing communication with MEPSO regarding the application for bulk power supply.
- Conclude the agreement with SPWMC for supply of water.

26.5 GENERAL

Facilitate continuous interaction with the local population and expedite and monitor the permit approvals processes.

27. REFERENCES

Amec Foster Wheeler, 2015, *Ilovica Gold-Copper Project Feasibility Study Report*, S2233-0000-BA00-RPT-1000.

Sections 1, 2, 5, 6, 10 & 11 as contributed by Amec Foster Wheeler.

Sections 1 & 3 as contributed by Tetra Tech.

Sections 1, 4 & 10 as contributed by DMT.

Sections 1, 7, 9 & 10 as contributed by Golder.

Sections 1 & 8 as contributed by SWS.