UNIVERSITAS TRISAKTI

Mine Plan

Genap 22/23

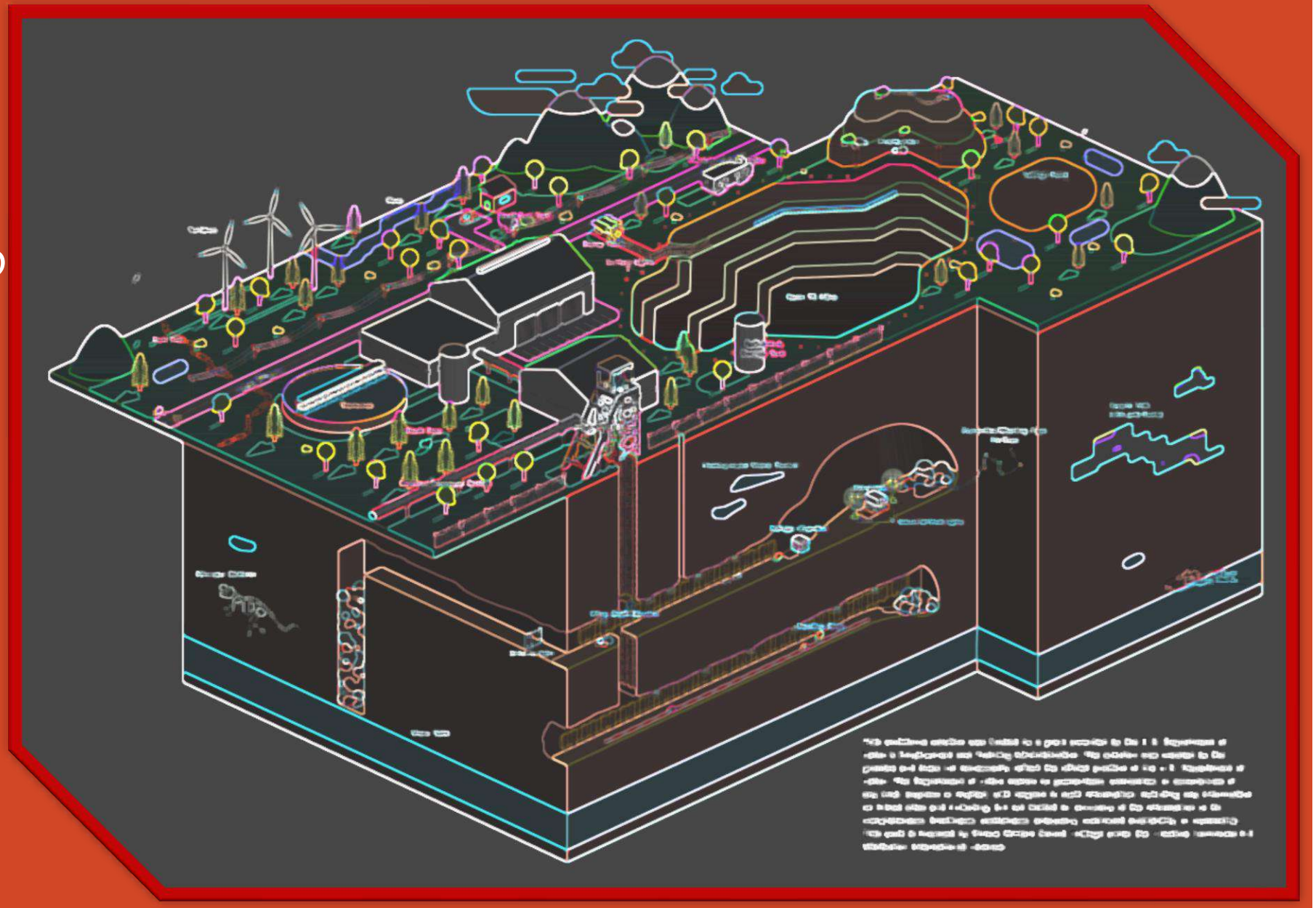
9th Session

Hydrology

Speaker

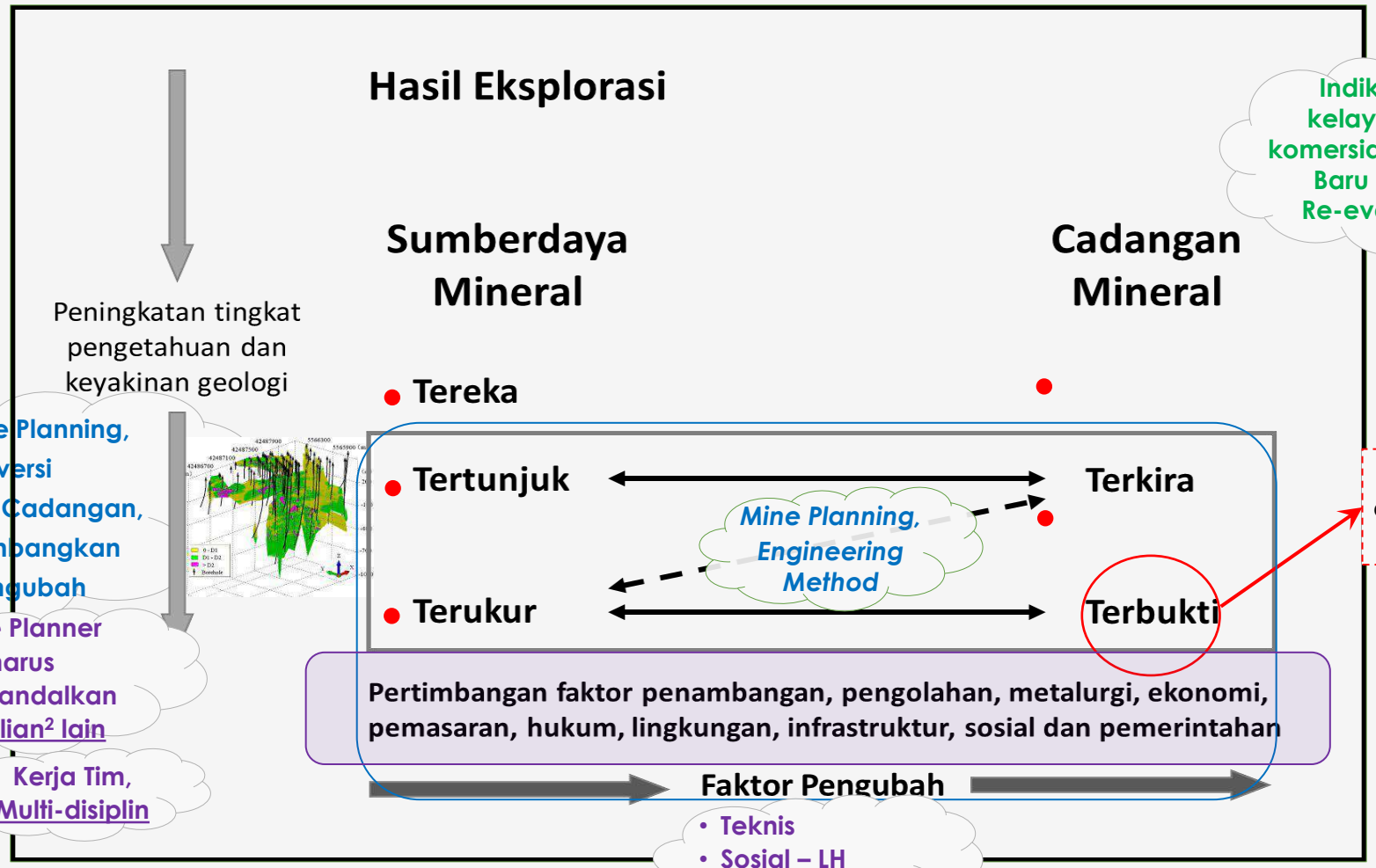
Ir. Andre Alis, ST, MBA, IPM

Danu Putra, ST, MT, IPP



Kerangka Kerja Universal Pelaporan HE– S/d– C/d

- sebagai refleksi penerapan konsep keekonomian tambang -

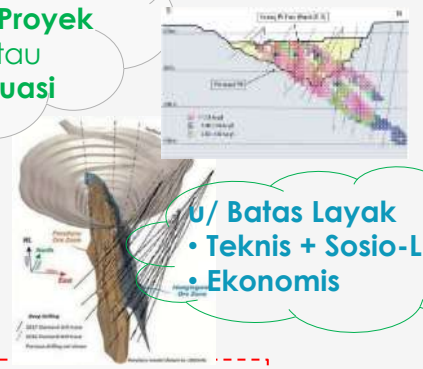


Metodologi Mine Planning, mengkonversi Sumberdaya → Cadangan, dgn mempertimbangkan 10 faktor pengubah

Mine Planner harus mengandalkan keahlian[2] lain

Kerja Tim, Multi-disiplin

Indikator kelayakan komersial Proyek Baru atau Re-evaluasi



U/ Batas Layak
• Teknis + Sosio-LH &
• Ekonomis

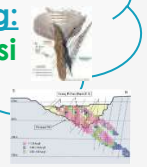
Akurasi tinggi, dasar komersialisasi prospek tambang

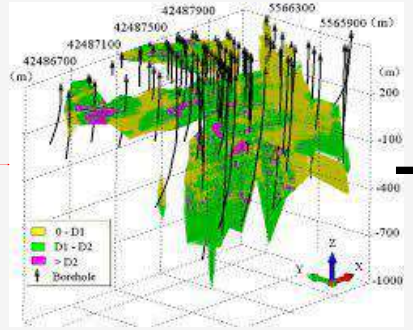
Adapt. Kode KCMI : 2017, ps. 11++
(dan Kode[2] CRIRSCO),
SNI 4726/ 5015, fig. 1,
& all textbook

(Framework-A) Mine Planning = Mining + Financial Engineering

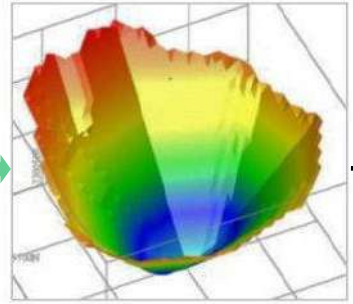
Analisis strategi eksploitasi, BESR, dll.

Tujuan mine planning: Meng-estimasi cadangan





Mining Engineering



Shell Hasil Optimisasi

Go

NO-Go

TEST-2

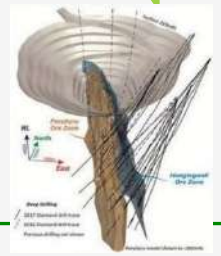
Cadangan = tonase & kualitas, bagian sumberdaya yg *economically mineable*

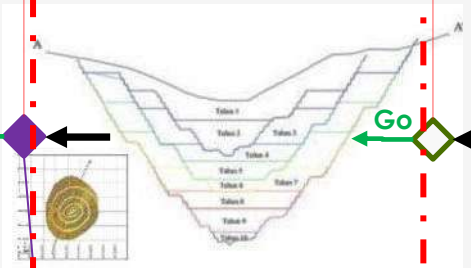
Financial Engineering

NPV
DCFROR
PB

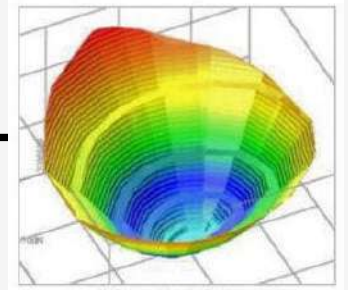
Evaluasi Keekonomian

Go Komersial





LOM Production Scheduling



Konseptual Pit Design

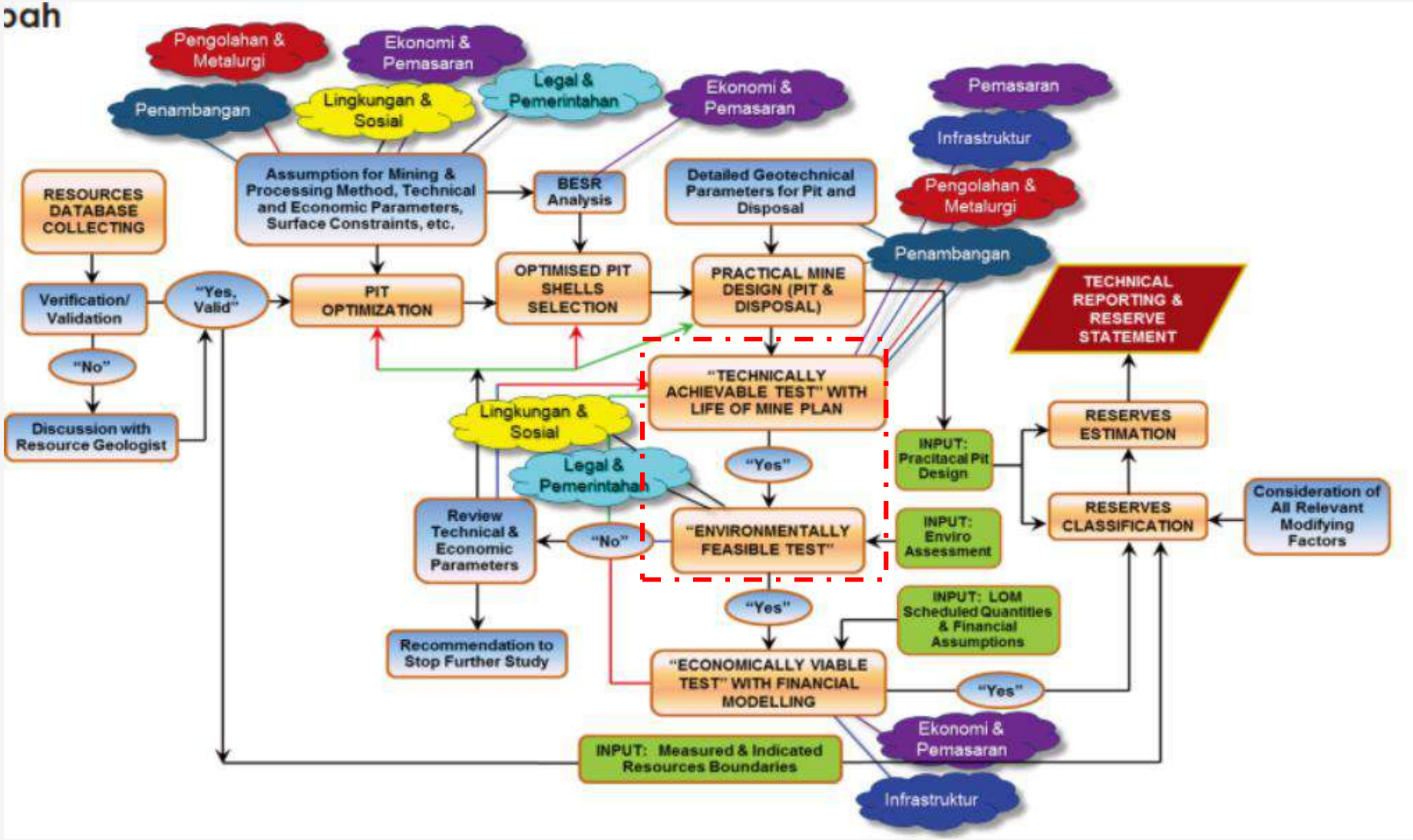
- Test-1 : layak teknis & Sosial-LH
- Test-2 : layak ekonomis

Peran Analisis Finansial

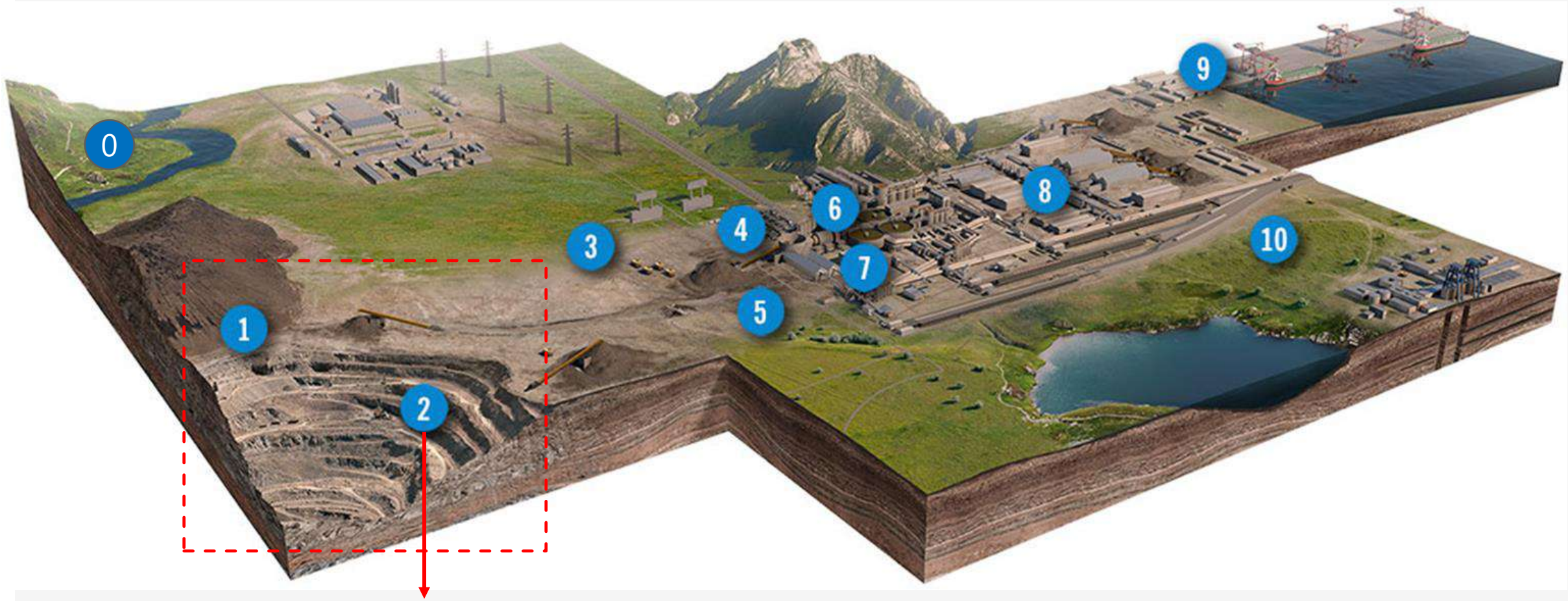
TEST-1

Adjust. fr. Lufi Rachmad, 2017

(*Framework-A*) ***Mine Planning*** = *Mining + Financial Engineering*

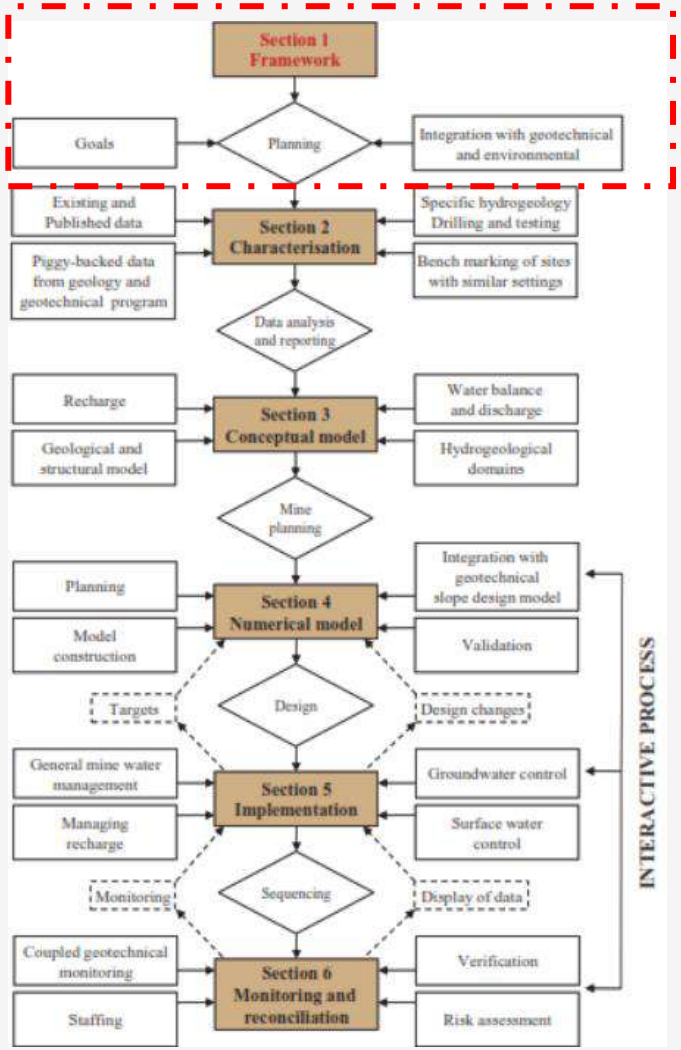


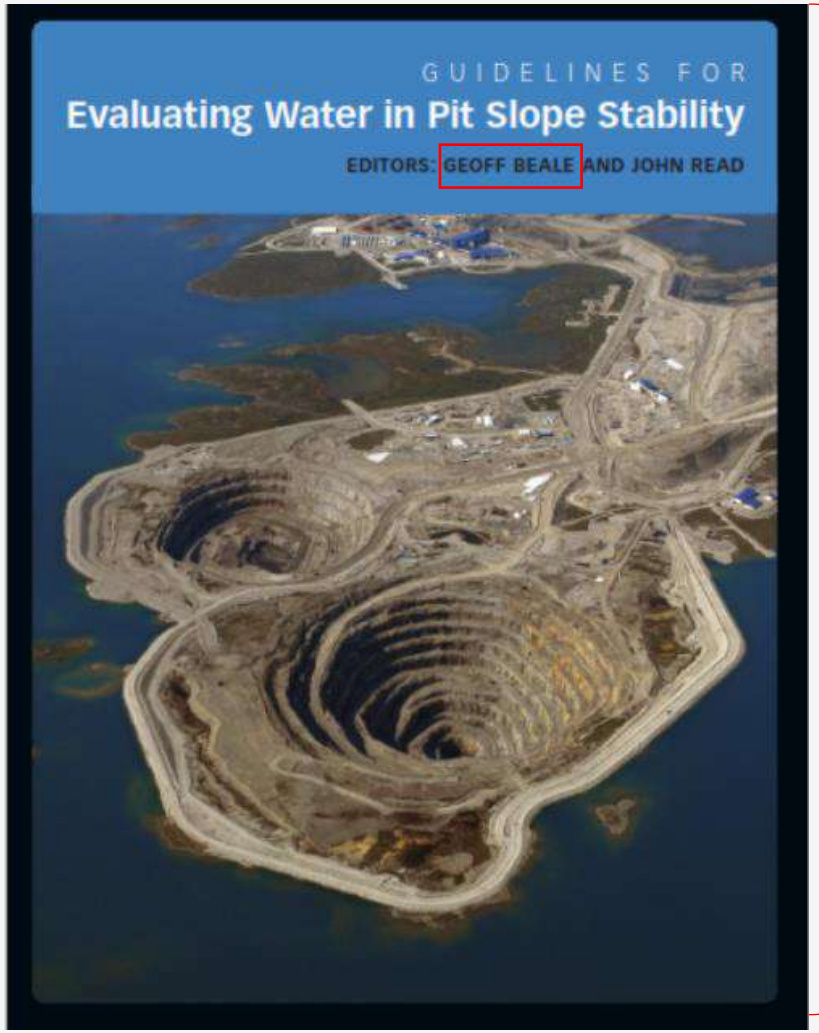
Scope of Work



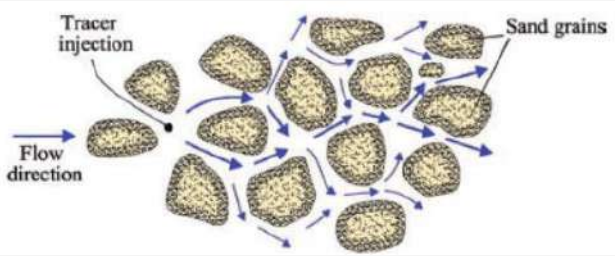
Whittle Consulting,2020

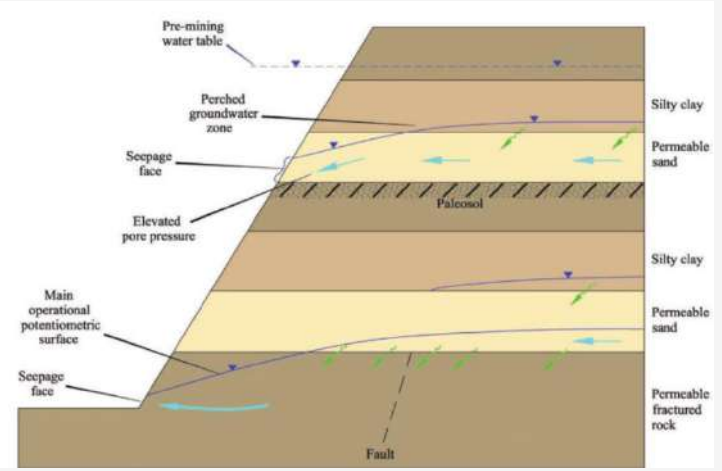
Framework - Introduction





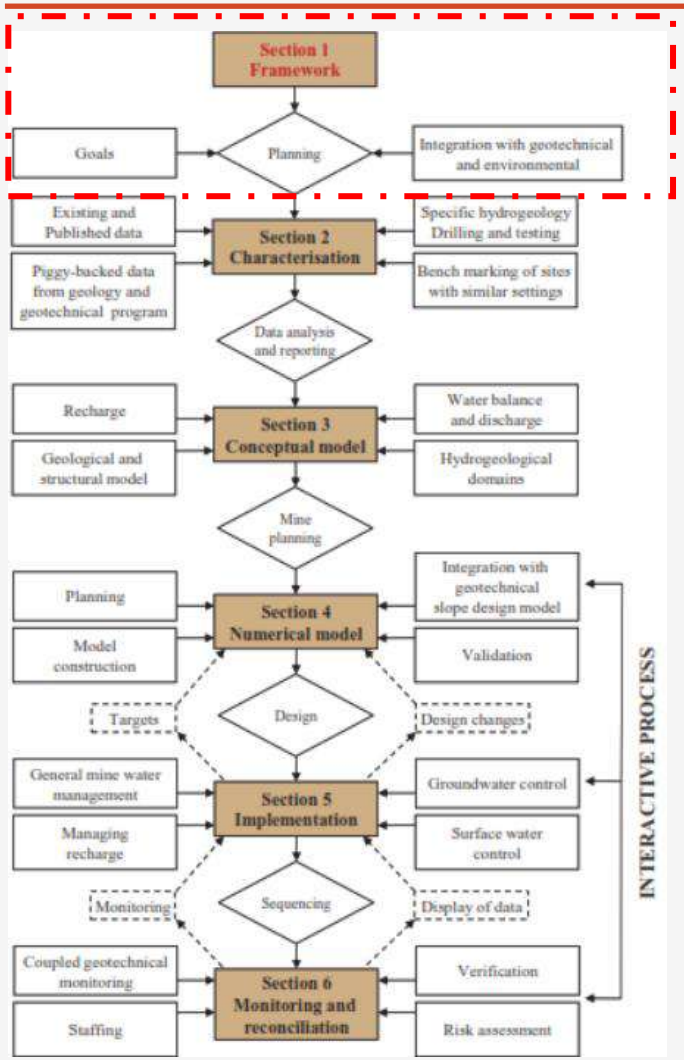
Slope stability perspective

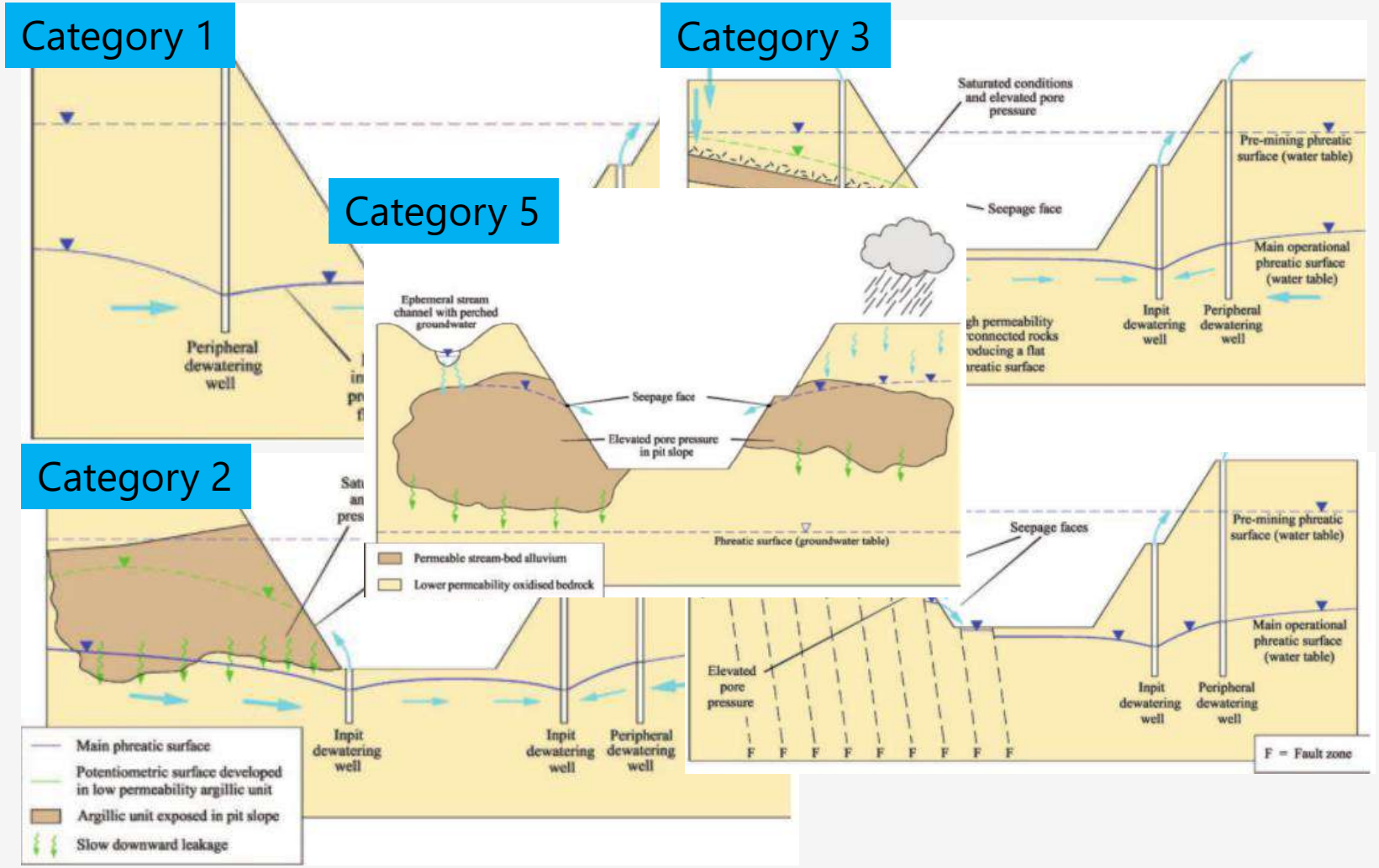




Guidelines for Evaluating Water in Pit Slope Stability, 2013

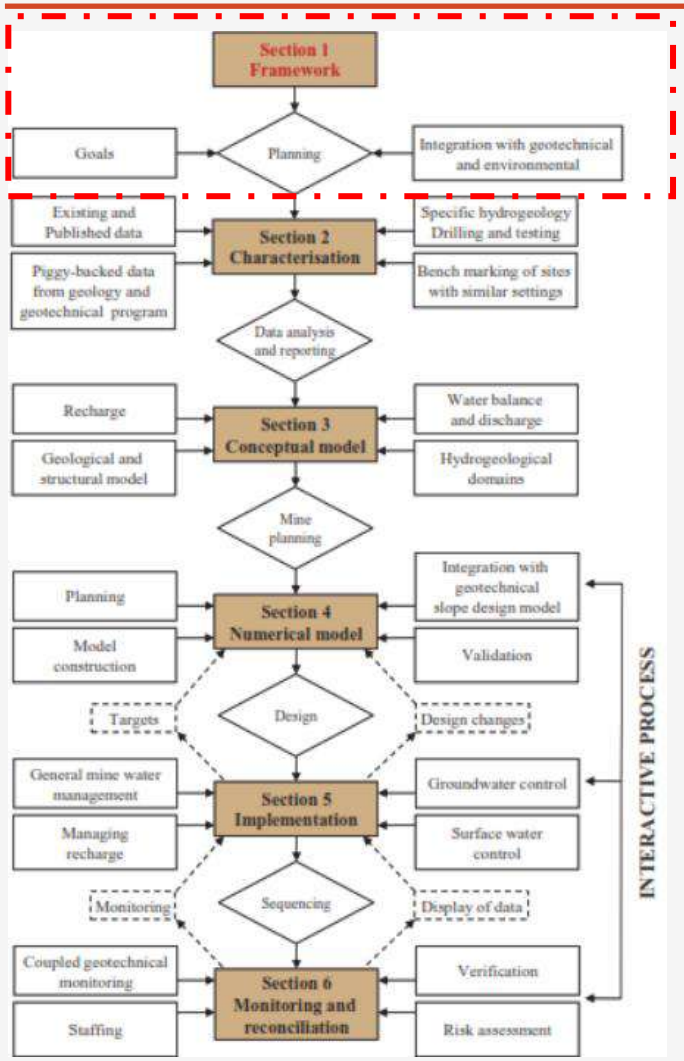
Framework – Typical groundwater condition

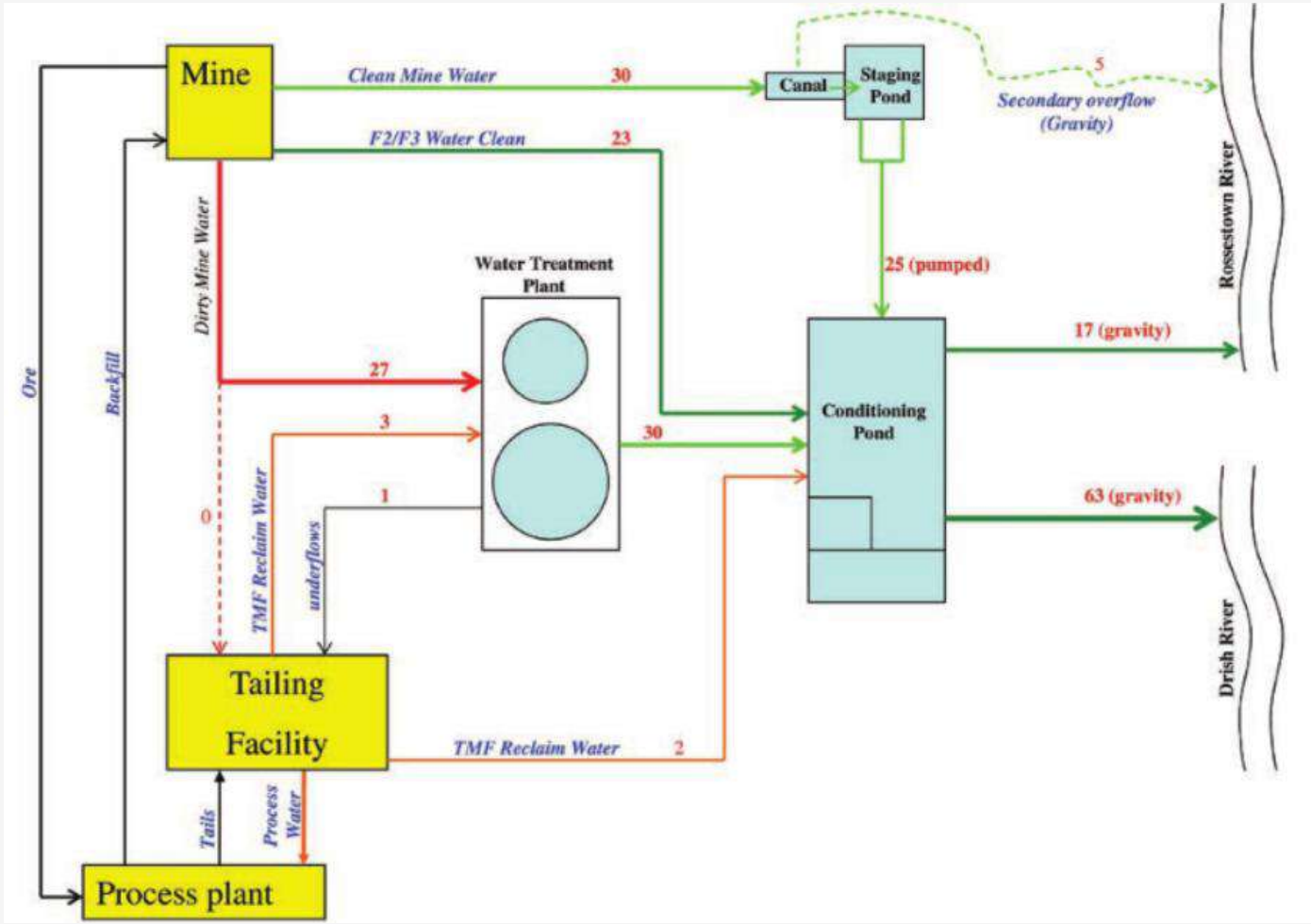




Guidelines for Evaluating Water in Pit Slope Stability, 2013

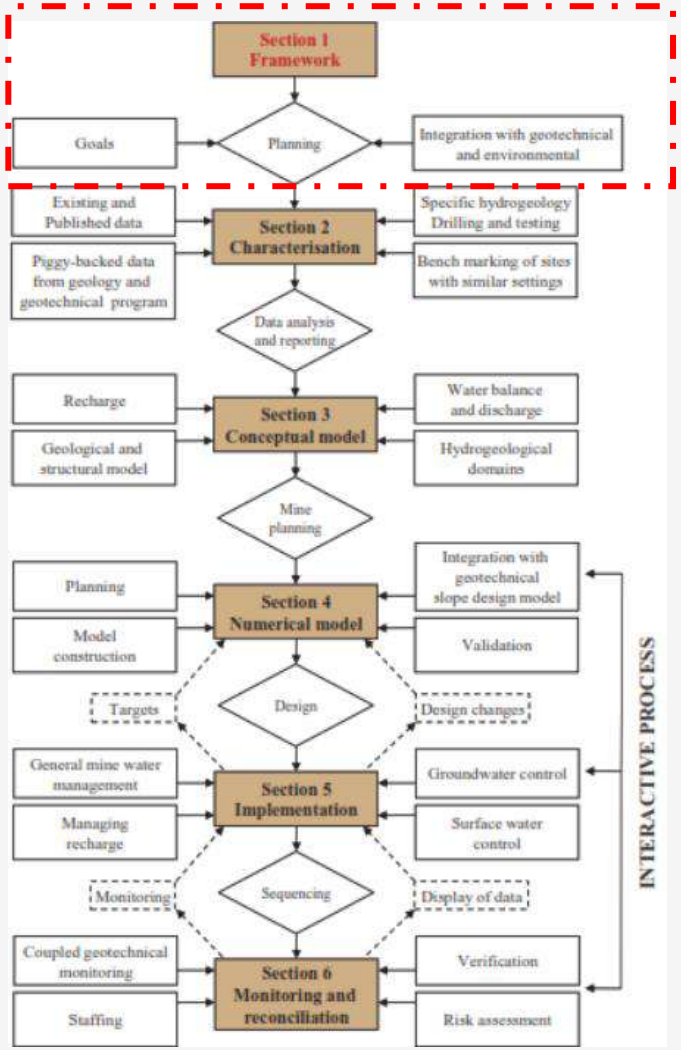
Framework – Mine water close circuit

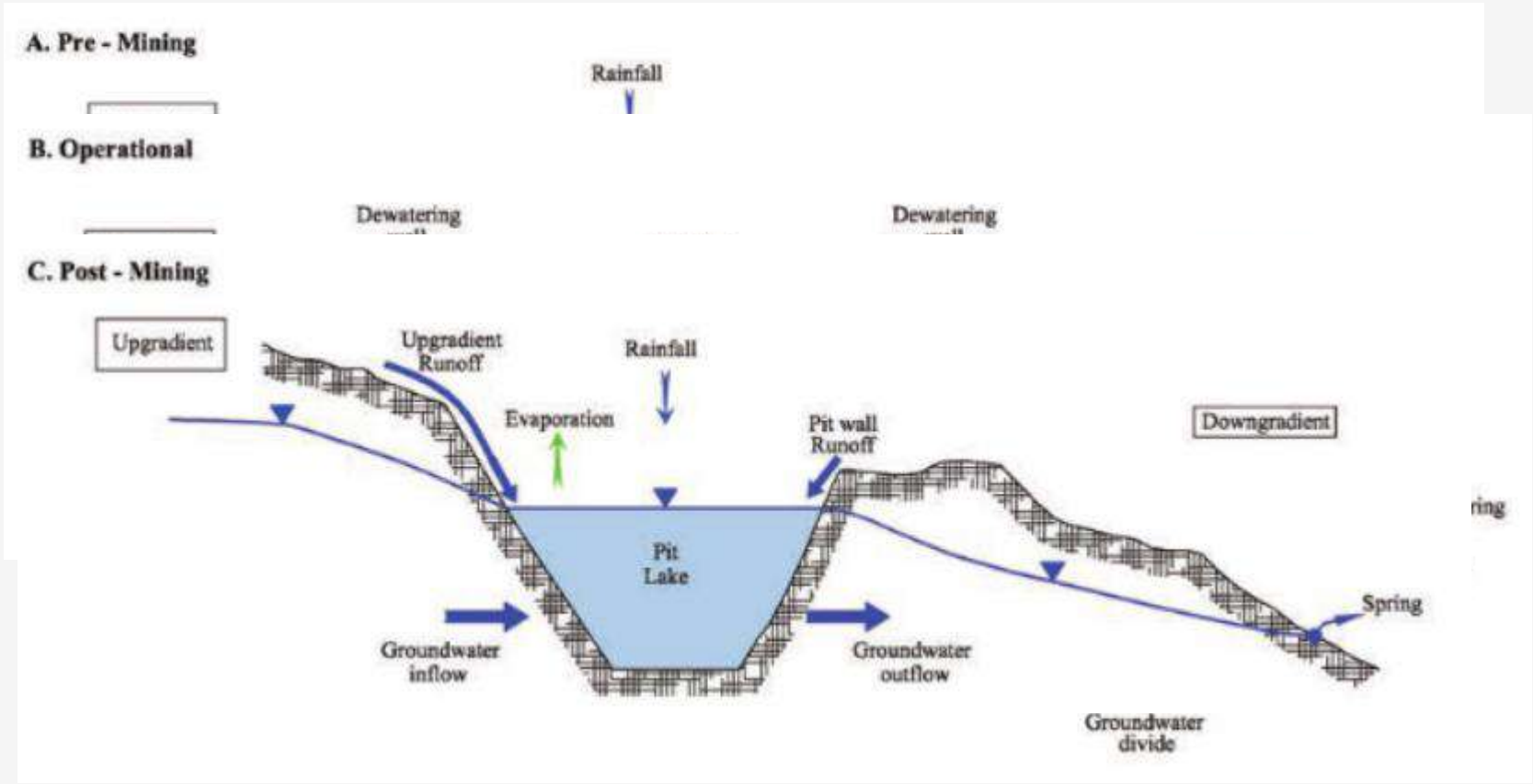




Guidelines for Evaluating Water in Pit Slope Stability, 2013

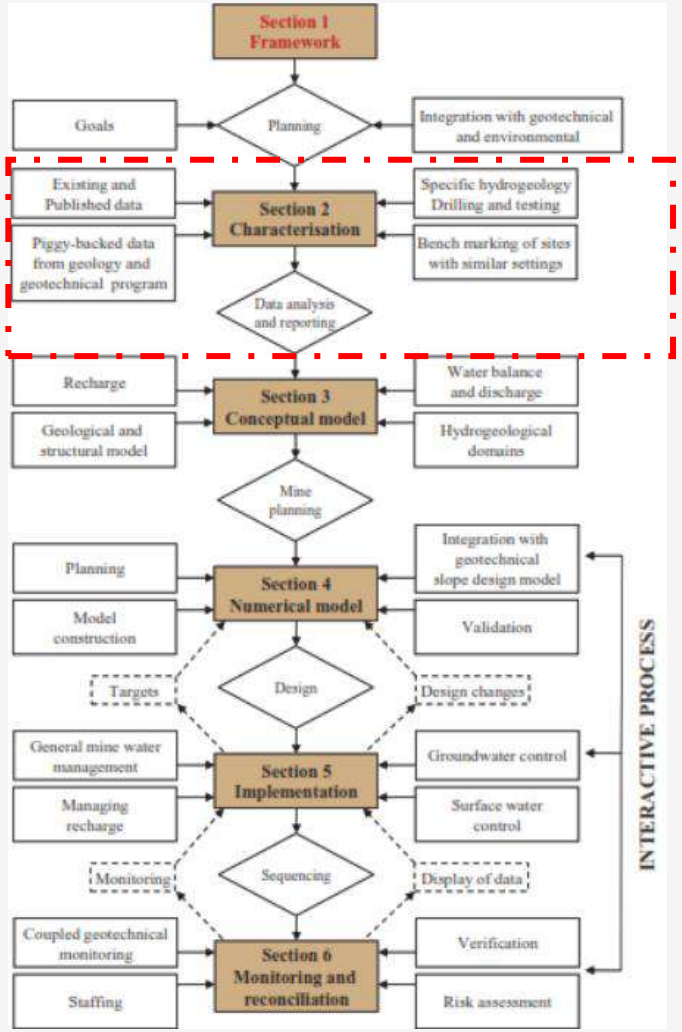
Framework – Typical hydrology condition based on mining phase





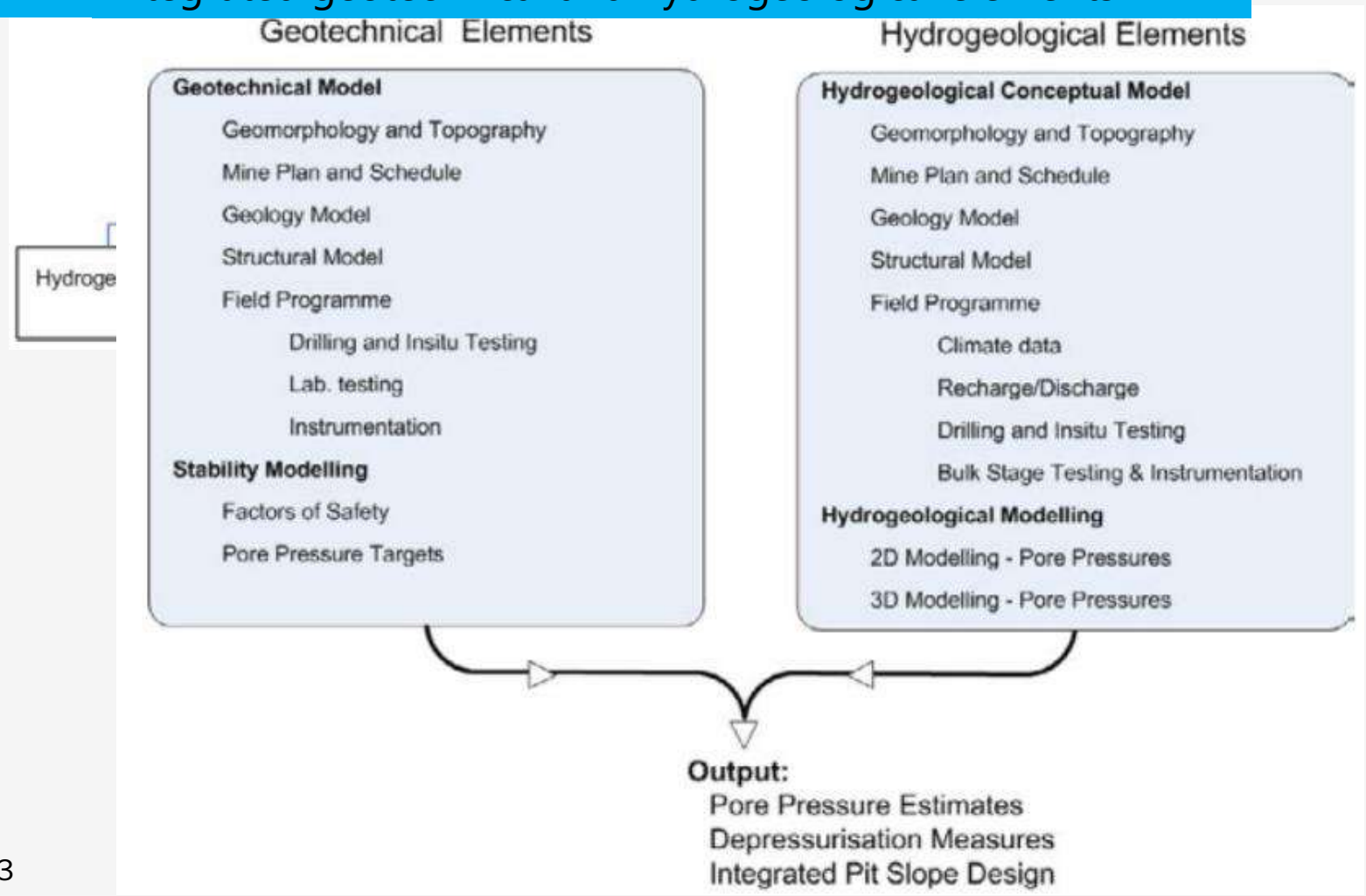
Guidelines for Evaluating Water in Pit Slope Stability, 2013

Site characterizations – Typical mine organization and workflow

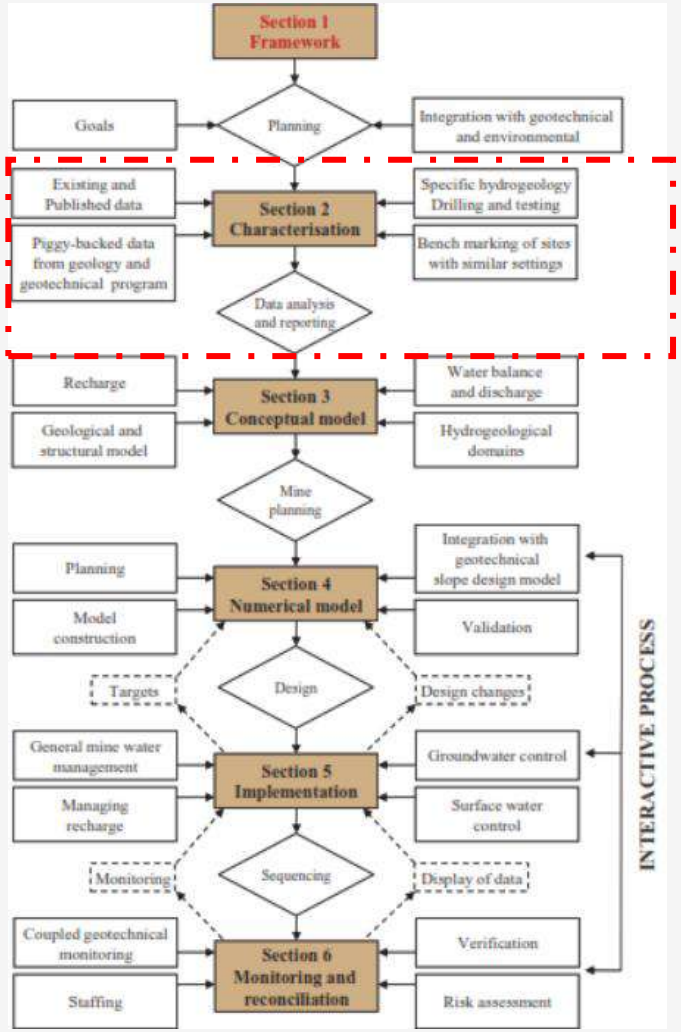


Guidelines for Evaluating Water in Pit Slope Stability, 2013

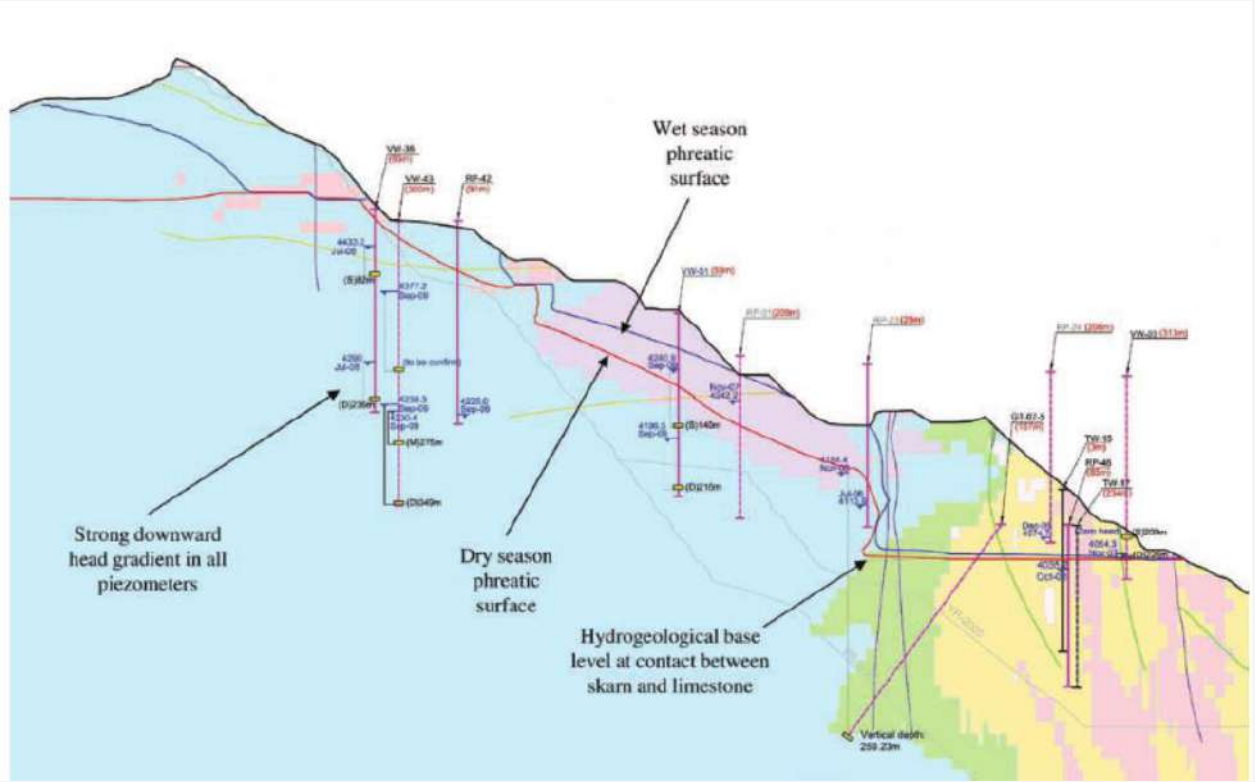
Mine or Integrated geotechnical and hydrogeological elements



Site characterizations – Typical integrated hydrogeotechnical model



Hydrogeotechnical model in 2D



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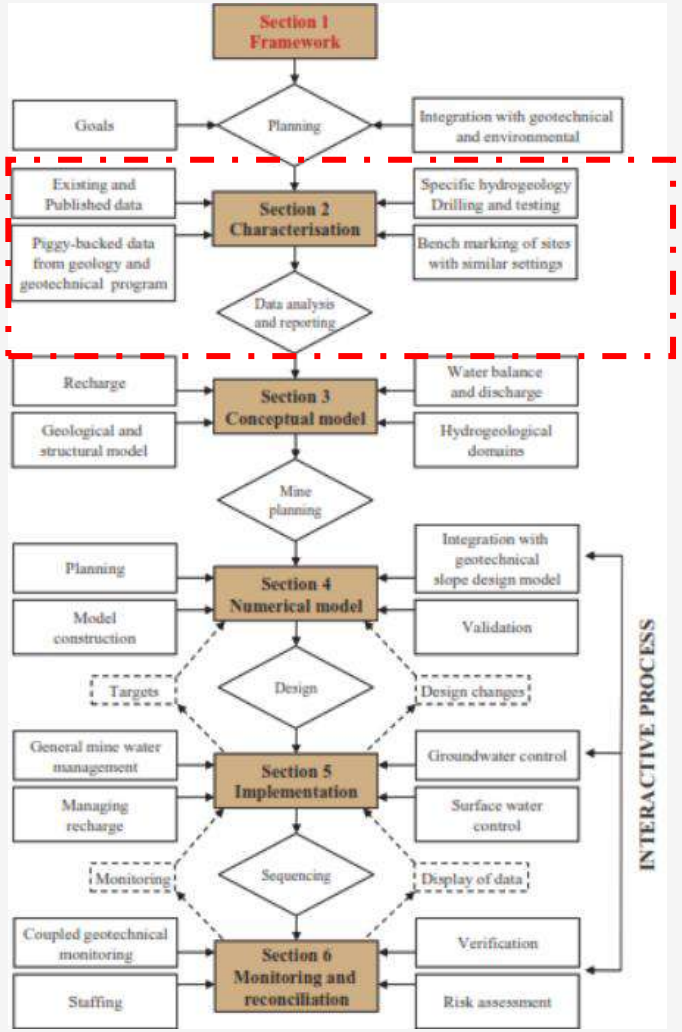
Site characterizations – Confidence level hdrogeotechnical analysis



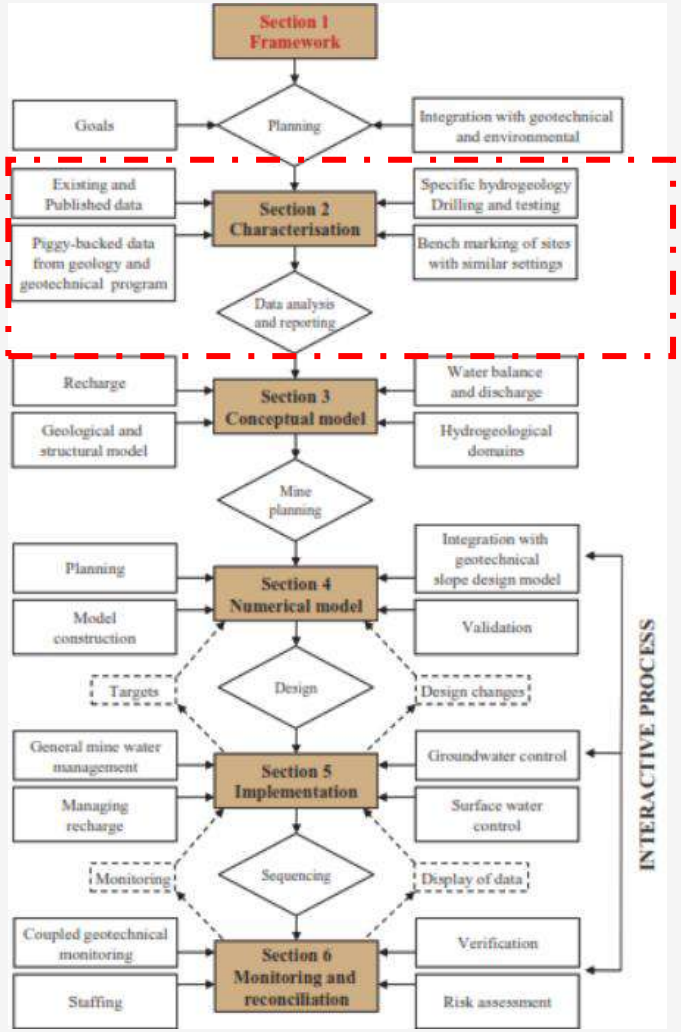
Greenfield

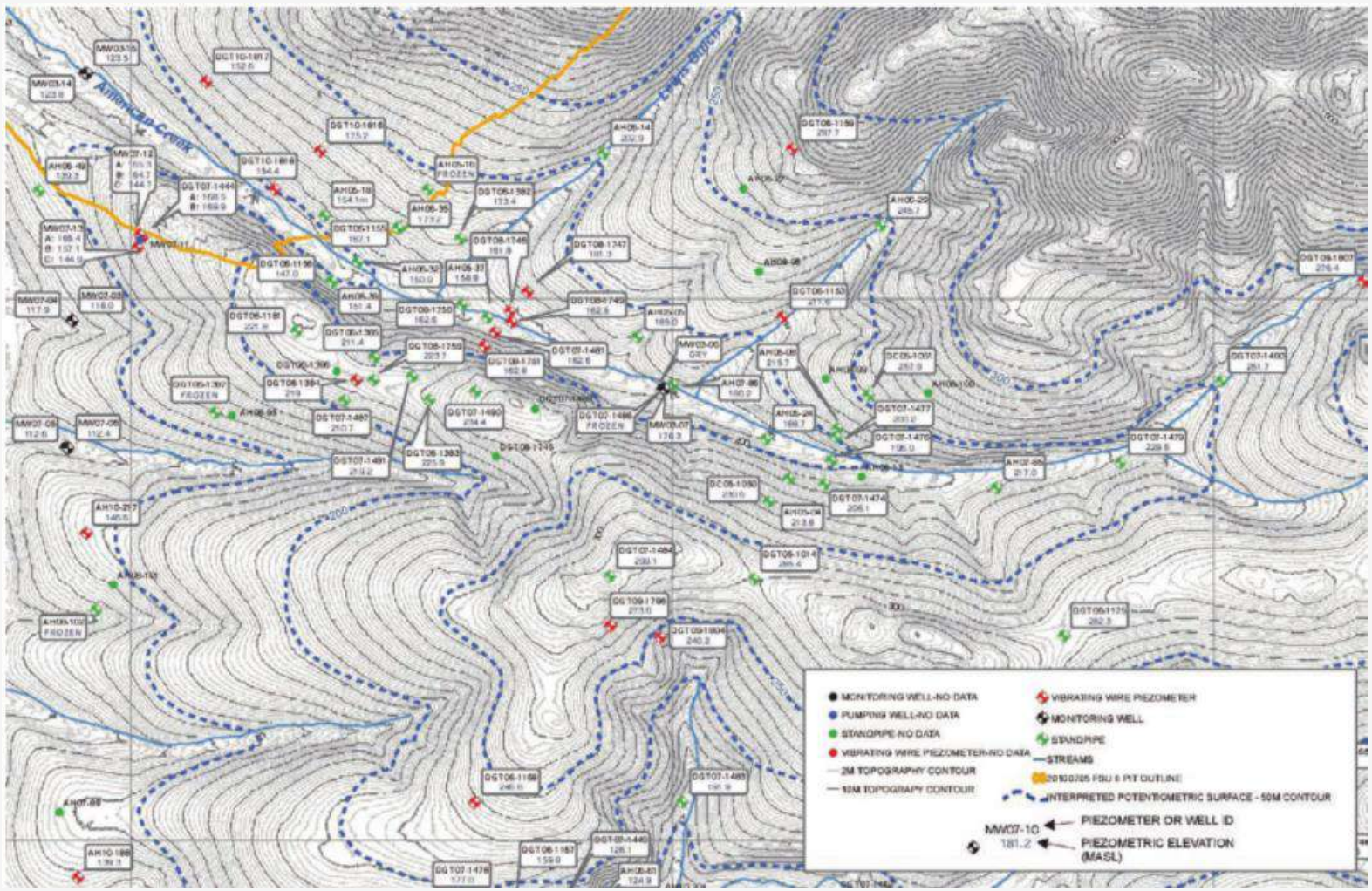
Brownfield

	Project Objectives	Hydrogeological Objectives
Conceptual Level 1	Preliminary assessment of Brownfields concept to determine development potential. Assessment relies on experience at the project site. All options considered. Potential "showstoppers" are identified.	Initial assessment of hydrogeological conditions based on preliminary groundwater level and aquifer characteristics inferred from monitoring data and operating experience within the existing operation. Groundwater risks and likely impacts to development and operation usually based on operating experience.
Pre-Feasibility Level 2	Determine the potential of a project by evaluating all options to enable a decision to be made on whether or not to commit funds and resources to take the project to Feasibility.	Confirmation (or otherwise) of continuation of known hydrogeological domain. Comprehensive characterisation and understanding of groundwater domain, as an extension to the existing mine. Adjustments to the existing conceptual hydrogeological model are made based on new data. Additional monitoring networks established. Additional drilling and test pumping undertaken as required. Integrate with engineering studies (e.g. slope stability, tailings and waste rock dumps). Predictive modelling capability modified to encompass project area. Local and regional impacts of operation on groundwater flow and quality assessed.
Feasibility Level 3	Optimise and comprehensively define the project development option. Complete sufficient design and engineering to provide cost estimates, financial analysis and risk assessment to a level at which a decision to invest/finance can be made.	Requirement for additional groundwater water management installations assessed. Implementation schedule synchronously with mine development plan developed. Obtain all necessary approvals for drilling, abstraction and discharge of groundwater. Optimise designs, costs and sustainable development outcomes. Ongoing monitoring to extend baseline. Finalise groundwater management plan.
Design & Construction & Operations Levels 4 & 5	Complete detailed engineering and undertake procurement, construction, commissioning to achieve approved scope (budget, schedule, quality, safety, environmental and social parameters).	Implement groundwater management plan. Continue to monitor and add to monitoring network. Undertake periodical reviews of data to establish if dewatering/depressurisation targets are being met.

Guidelines for Evaluating Water in Pit Slope Stability, 2013

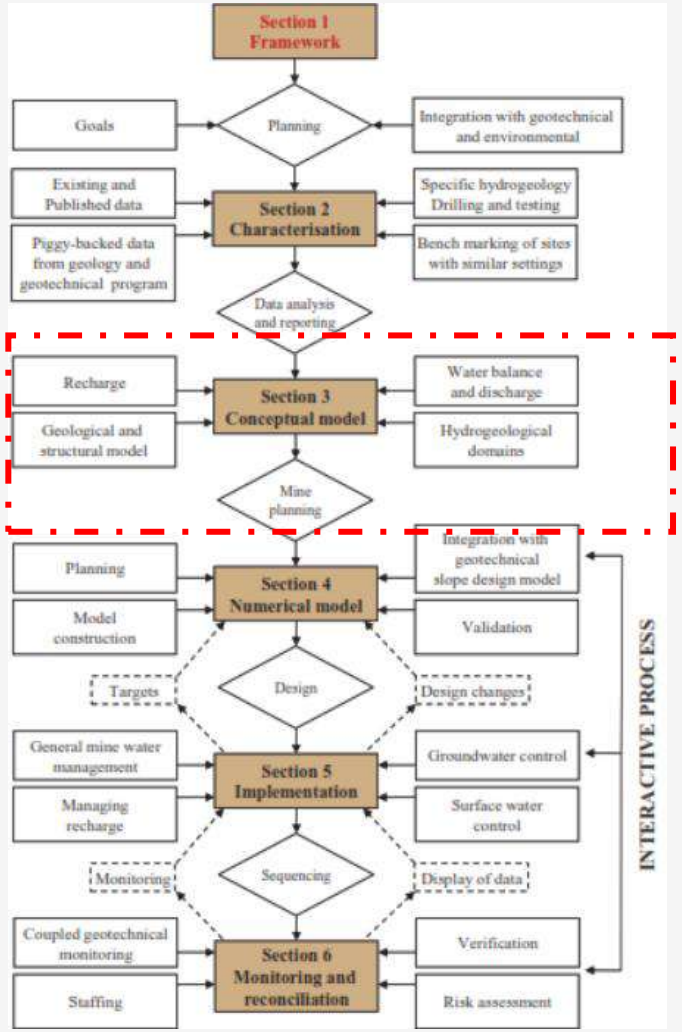
Site characterizations – Confidence level ydrogeotechnical analysis

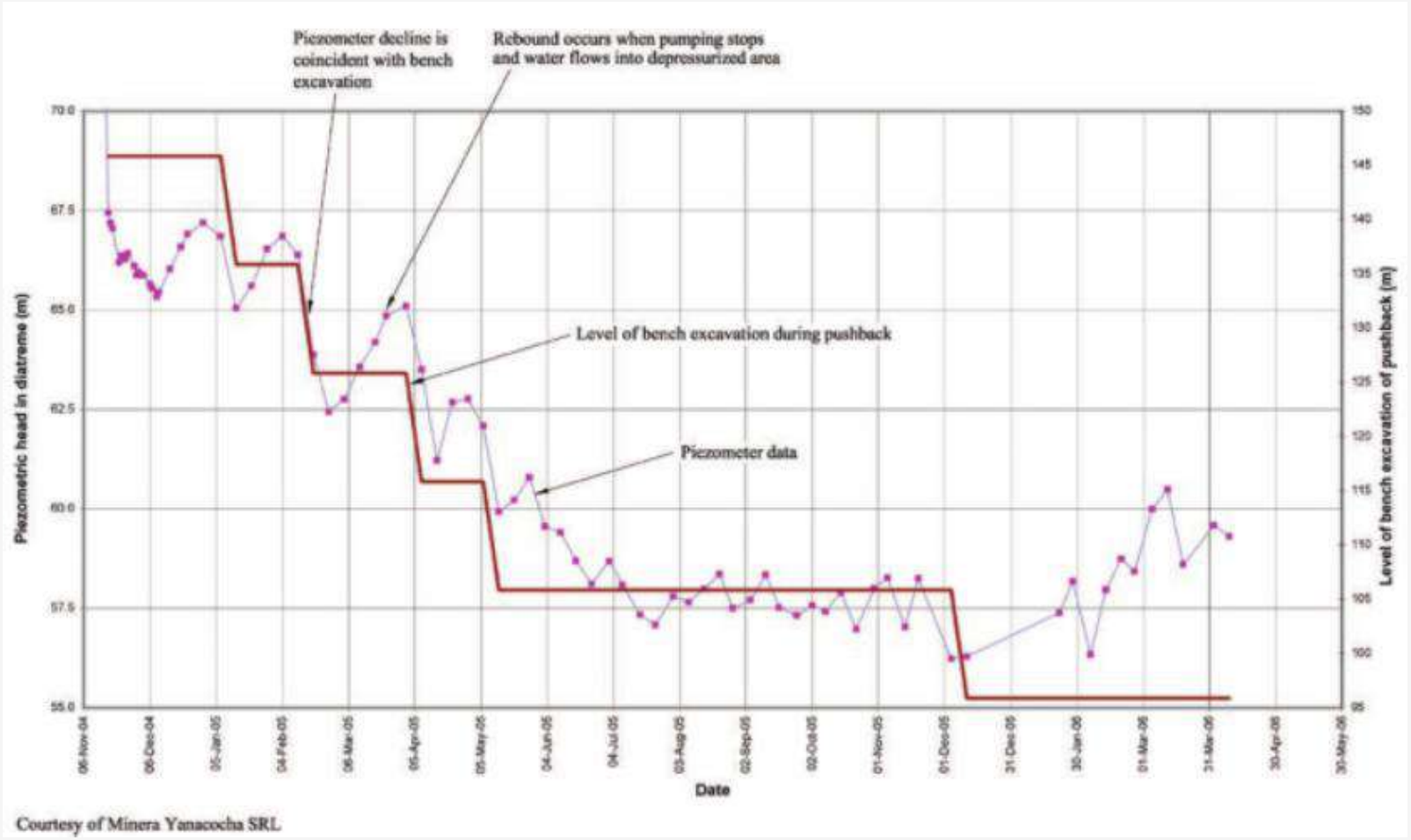




Guidelines for Evaluating Water in Pit Slope Stability, 2013

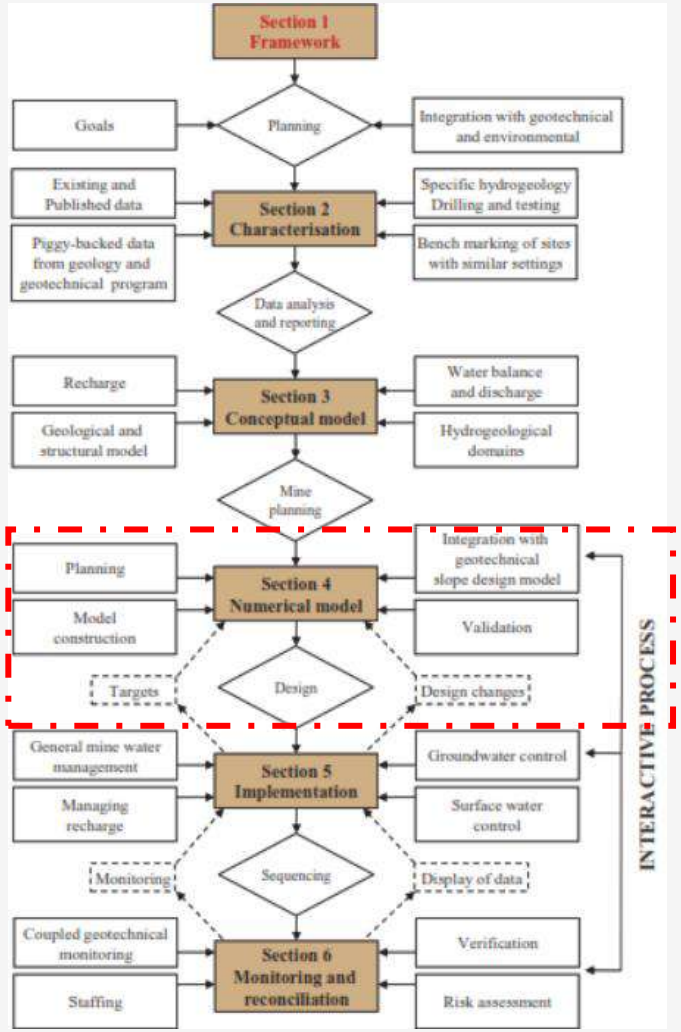
Conceptual Model – Model derived from piezometric data





Guidelines for Evaluating Water in Pit Slope Stability, 2013

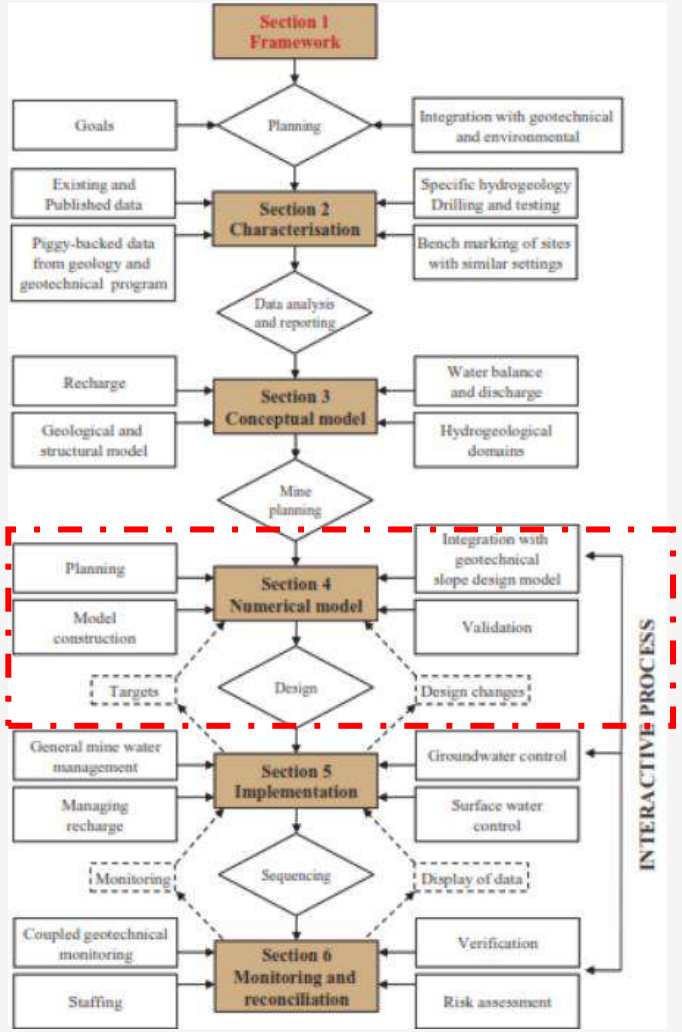
Numerical Model – Confidence level hdrogeotechnical model

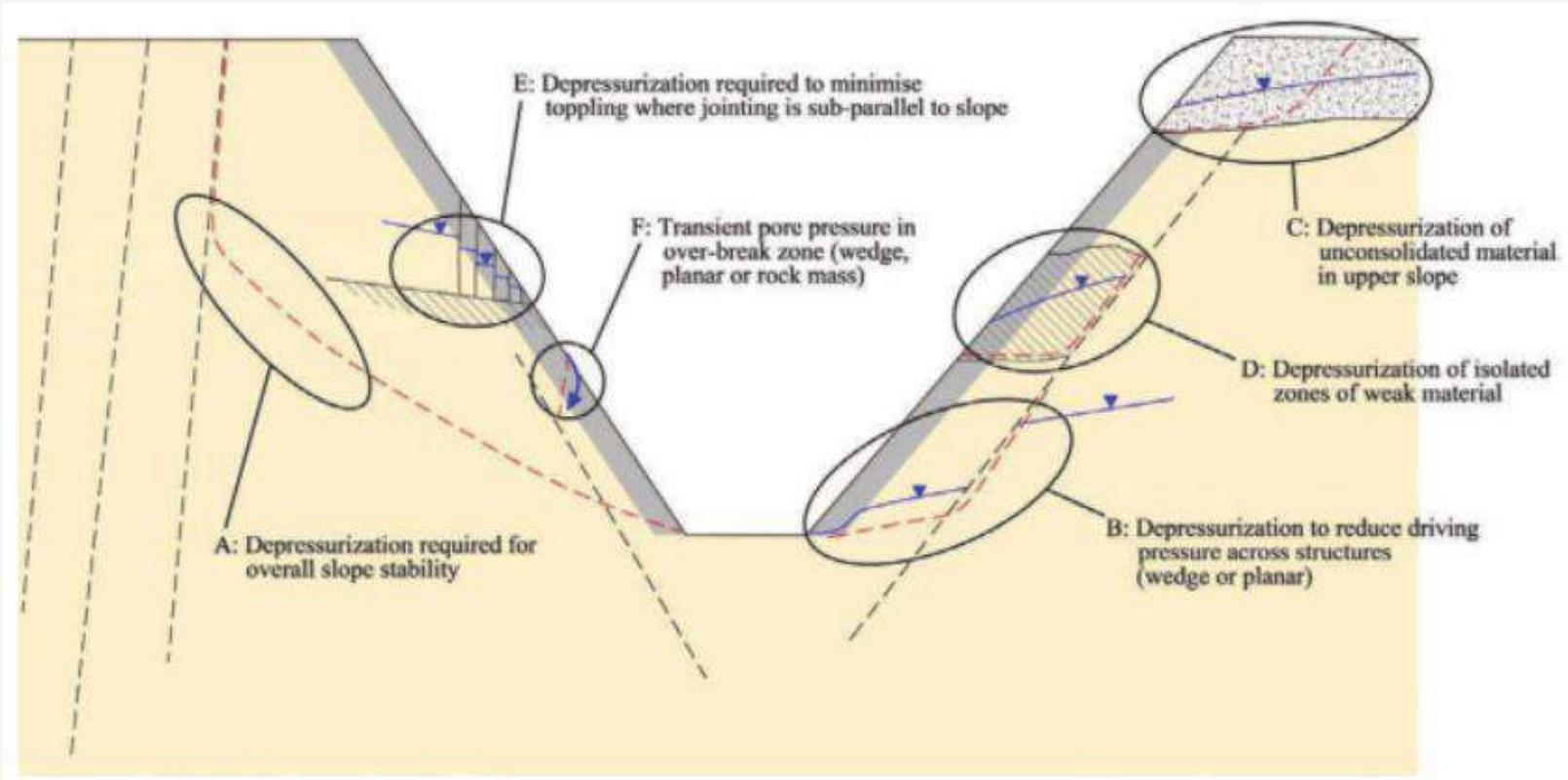


Stage	Type	Input	Calibration	Prediction	'Accuracy'
Conceptual (Level 1)	Analytical or simple numerical (axisymmetric)	Simplified (homogeneous & isotropic) geology Estimate of hydraulic properties using data from proxy sites Conceptual mine plan Screening-level geotechnical analysis	Preliminary or based on *benchmarking*	Preliminary estimates of inflow Screening analysis of dewatering and slope depressurisation options Identification of slower-draining pit sectors	Order of magnitude
Pre-Feasibility (Level 2)	Axisymmetric or preliminary mine-scale 3D	Layered geology with lateral-to-vertical anisotropy Preliminary field-derived values of hydraulic parameters Time-variable mine plan Geotechnical modelling and interaction	Based on initial site-specific data, but also relying on benchmarking	Estimates of inflow over time and phreatic surfaces for the pit slopes sufficient to allow estimate of costs Uncertainty analysis	Factor of 5
Feasibility (Level 3)	Regional or site-scale 3D and sector-scale 2D	Full 3D representation of geology Detailed field-derived values of hydraulic properties, including some cross-hole testing Actual mine plan and slope designs Data on recharge, pumping, and surface water Measured water levels and flows to allow calibration Interaction with geotechnical models	Good for overall site and for key defined pit sectors. Requires transient calibration	Amounts of water to be managed and effects of various dewatering schemes Sufficient to provide boundary conditions for pore pressure predictions with supporting data Impact analysis Uncertainty analysis	Factor of 2
Design & Construction (Level 4)	Regional or site-scale 3D and sector-scale 2D	Fully 3D representation of geology including structures Field-derived values of hydraulic properties and good understanding of range of values Detailed cross-hole testing and test pumping Pilot dewatering or slope depressurisation trials Detailed mine plan with applicable geotechnical input and interaction Data on recharge, pumping, and surface water Comprehensive water level and flow data (for calibration)	Good for all pit sectors, with specific calibration to pumping trials and/or cross-hole testing	Detailed design and optimisation (location and timing) of dewatering system Changes in water levels and impacts on water resources Close interaction with pore pressure models Input to water balance and detailed plan for discharge of excess water Uncertainty analysis Solute transport from tailing, etc. Inflow to a 'pit lake'	±30% (better with time)

Guidelines for Evaluating Water in Pit Slope Stability, 2013

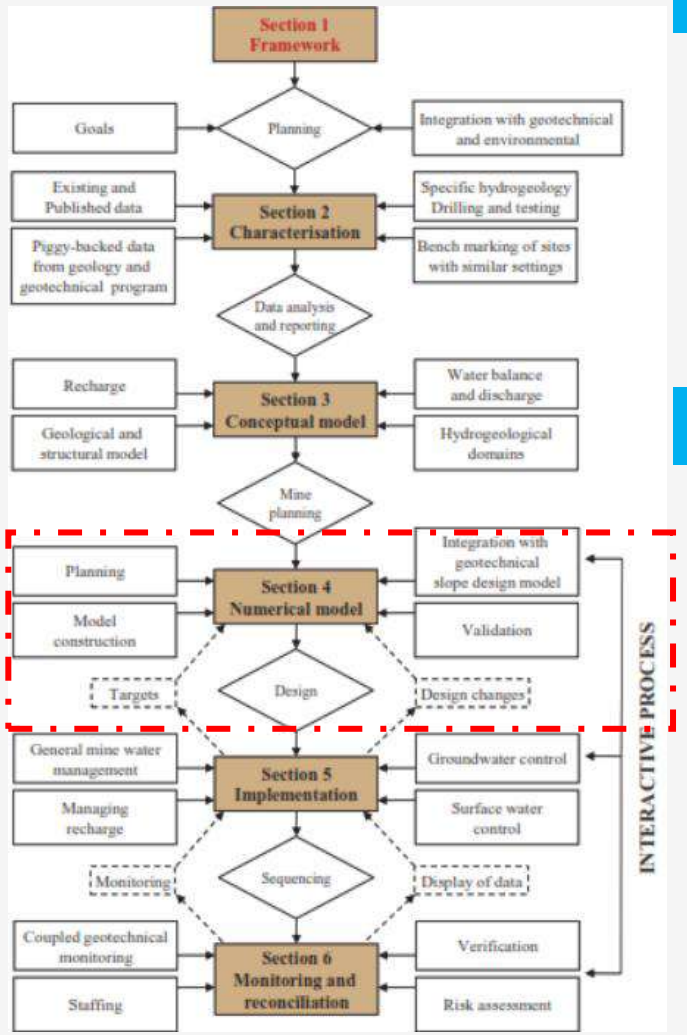
Numerical Model – Confidence level ydrogeotechnical analysis





Guidelines for Evaluating Water in Pit Slope Stability, 2013

Numerical Model – Confidence level ydrogeotechnical analysis



Climate input/data

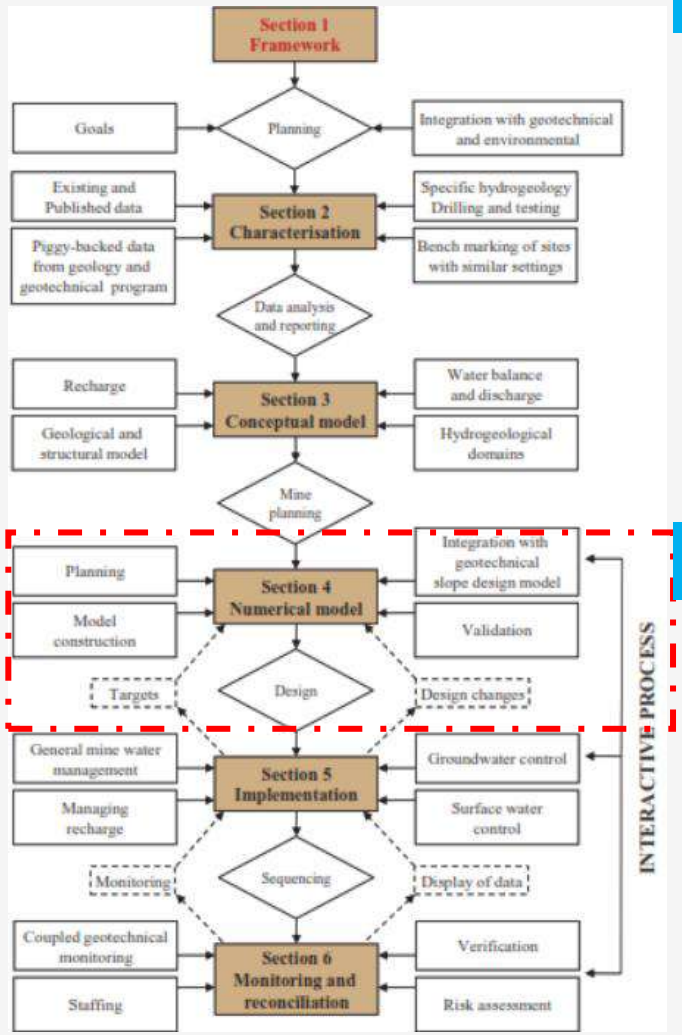
Regional- and mine-scale models	Sector-scale models
• Long-term average monthly precipitation; proportion of precipitation that occurs as snow; published regional isohyets	• Normally requires monthly average and annual average precipitation and evaporation data from at least one on-site climate station
• All available data on the intensity and frequency of precipitation events	• Any available data that may indicate local-scale variations in rainfall intensity
• Monthly pan evaporation and/or published regional potential evaporation isohyets	• Local climatological variables that may allow alternative calculations of actual evaporation
• Multiple stations, even if outside the model domain, are preferred	• Measurements of water pumped from sumps (that may help calibrate rainfall-runoff models for the pit)

Geological input/data

Regional- and mine-scale models	Sector-scale models
• Regional geological maps and cross-sections; including zones of alluvium, glacial or recent flood plain (or lacustrine) deposits	• Mine-property surface geological maps
• Maps showing the elevation of key geological contacts; and/or isopach maps showing the thickness of key geological units	• Mine geological block model and structural wireframe; in conjunction with maps showing the elevation of key geological contacts where these are continuous (such as the bedrock surface, the surface of the weathered zone or the surface of the leached zone
• In areas of sparse data, maps showing the elevation of the bedrock surface as a minimum starting point	• Structural geology model and an interpretation of the locations of the primary and secondary structures
• Regional structural geology maps; any information on the weathering profile	• Alteration model and/or mineralisation model
• Geophysical maps/interpretations	• Borehole logs (geological, geotechnical and geophysical)
• Borehole logs (geological, geotechnical and geophysical)	• Borehole geology logs for sterilisation/condemnation holes
• Remote sensing data (satellite imagery)	• Pit slope geology maps
• Existing public-domain hydrogeological studies, models or modelling reports	• Geotechnical domains

Guidelines for Evaluating Water in Pit Slope Stability, 2013

Numerical Model – Confidence level ydrogeotechnical analysis



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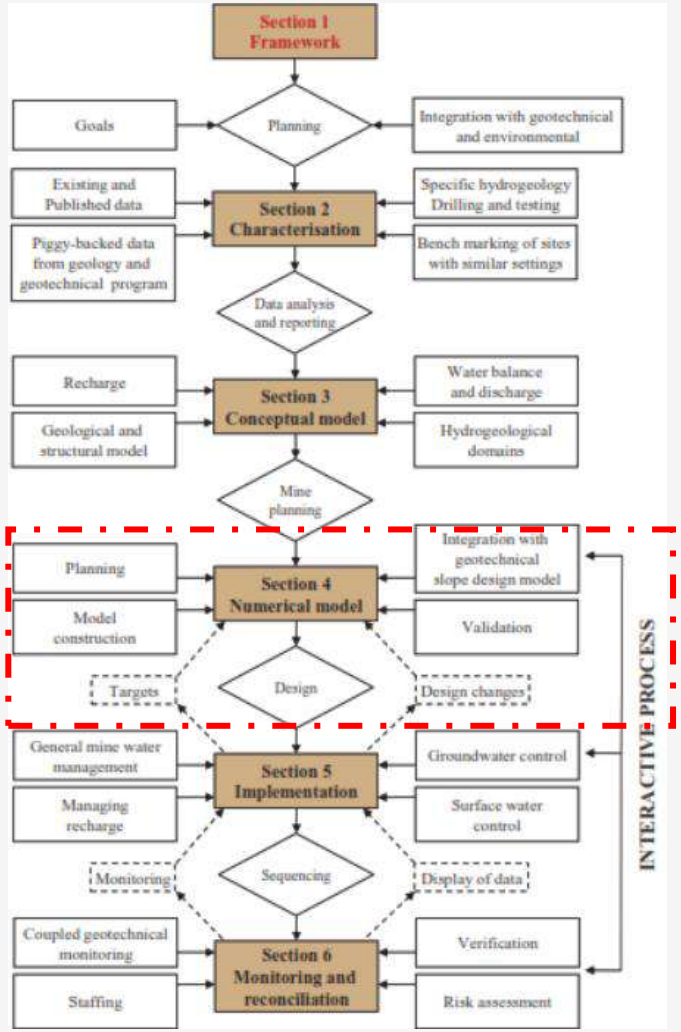
Available source data

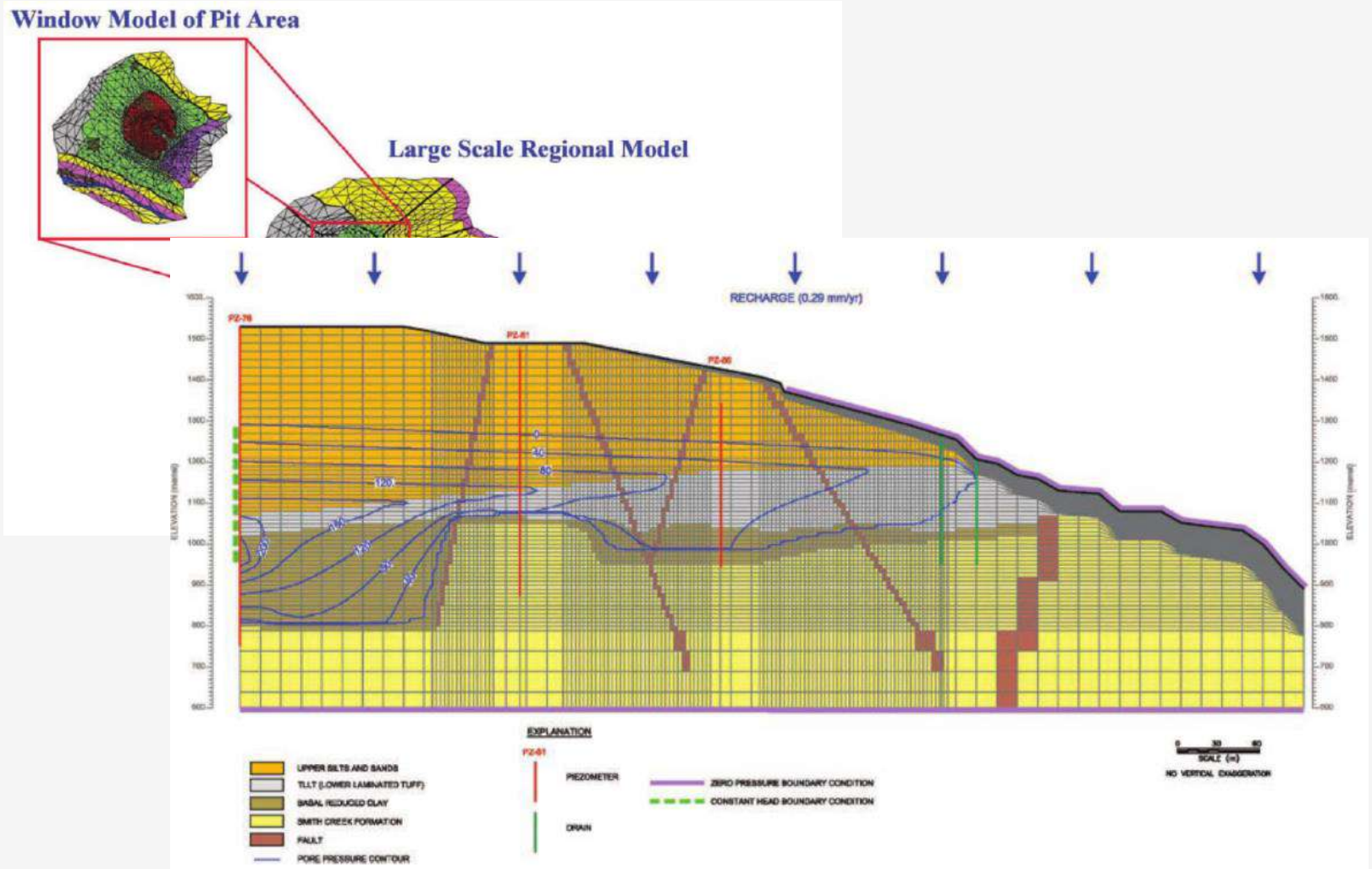
Regional- and mine-scale models	Sector-scale models
• Published or government groundwater monitoring data and maps • Monitoring data from other local landowners or third parties (which may require careful quality review) • Water level measurements in mineral exploration holes, definition holes or condemnation (sterilisation) holes • Mine site environmental monitoring wells (hydrographs over as long a time period as possible) • Dedicated observation wells and piezometers from the hydrogeology program (hydrographs) • Published regional aquifer maps • Dedicated hydrogeological monitoring points that may include: – existing mine shafts – study monitoring wells – springs and seeps streams	• Multiple-level vibrating wire piezometers completed within major lithological units, alteration types, structural compartments and potentially the blast damaged zone (where transient pore pressures are important) • Water levels in blast holes • Locations of water encountered in horizontal drain holes • Open standpipe piezometers (they are not ideal, but they provide useful data in some circumstances). • Observations in the pit, which may include old exploration drill holes, flowing drill holes, levels of seepage faces, sump levels

Prinicipal water table

Regional- and mine-scale models	Sector-scale models
• Measured flow in perennial reaches of rivers and streams and changes within the modelled area • Measured flow in significant springs or other identified groundwater discharge zones • Evaporation rates from significant water bodies (lakes) in communication with the regional water table • Bulk pumping rates from regional and third partly wells, wells associated with mine facilities other than the pit, existing underground mine operations, historical pits (sumps and/or wells) • Pumping rates from the existing dewatering operation (wells, drains and/or sumps) • Sources of artificial groundwater recharge which may include infiltration from irrigation water, water supply collection reservoirs and other sources	• Pumping rates from individual mine dewatering wells • Discharge rates from individual pit slope horizontal drains or drain sets grouped by geology, domain and sector • Discharge rates from underground drainage galleries and, where possible, with drain hole flows grouped by geological domain • Discharge rates from seeps or flowing wells within the pit (estimates or measured) • Estimation of evaporation fluxes from wet zones within the pit walls or floors • Local-scale groundwater recharge and resulting transient responses to the groundwater system, which may result from ponding of precipitation, runoff channels, leakage from mine facilities

Numerical Model – The model expected





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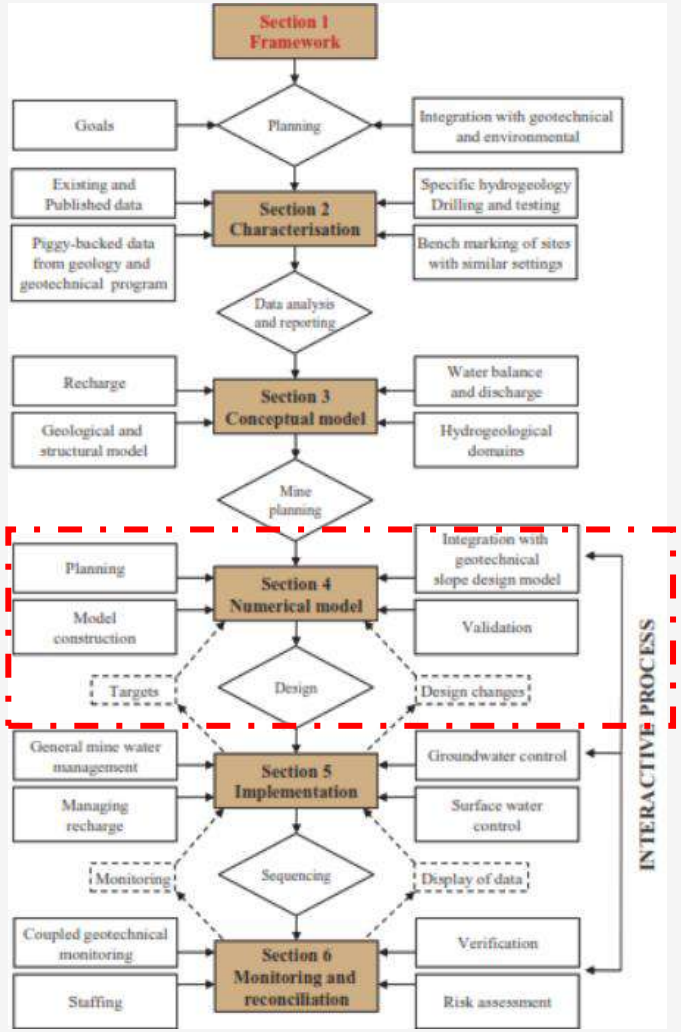
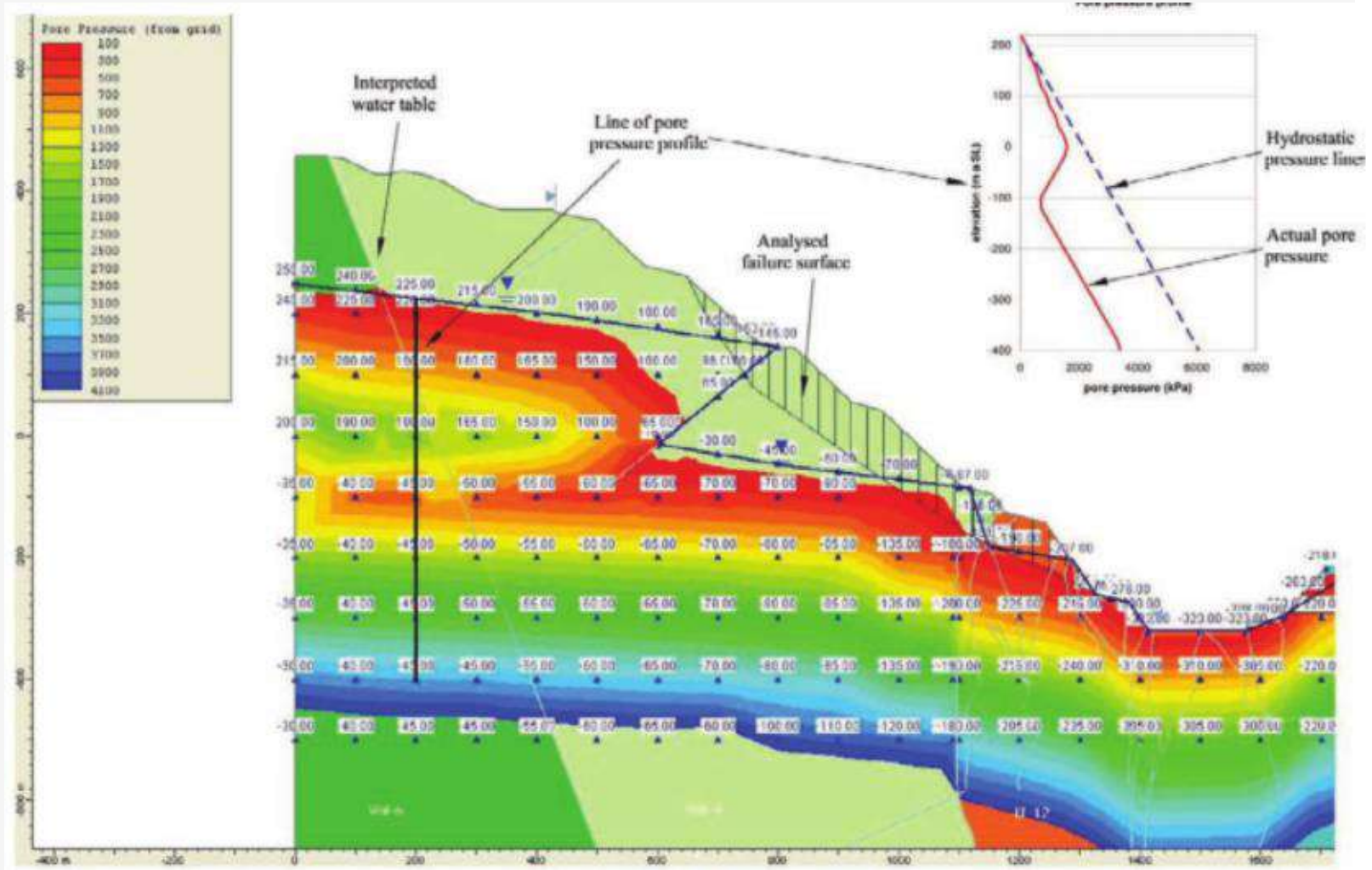
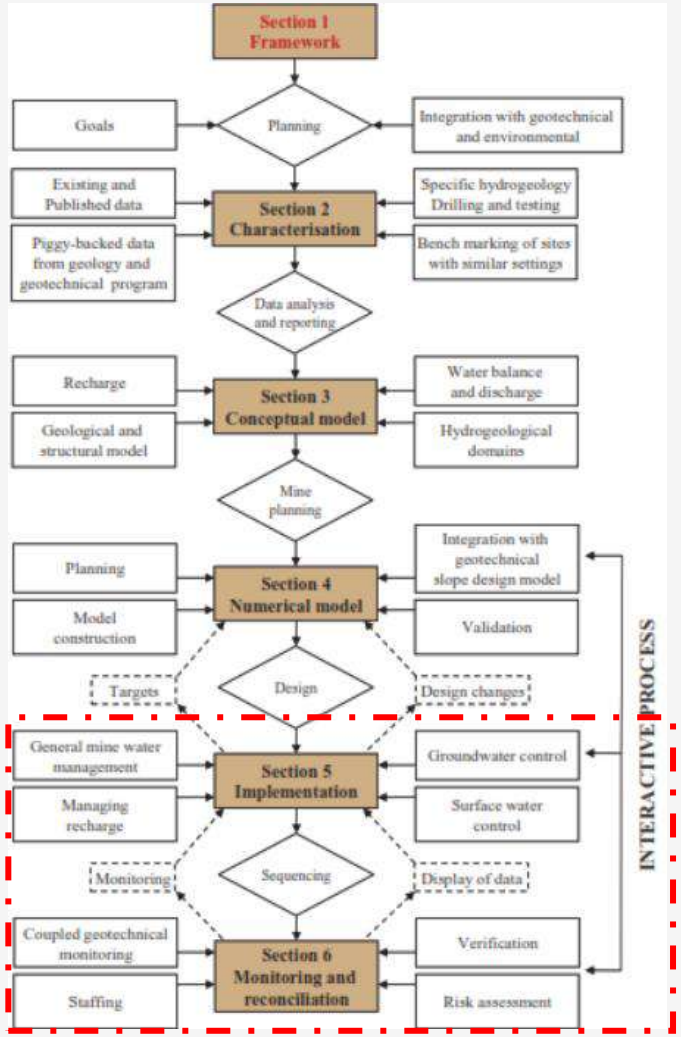
Numerical Model – Validation

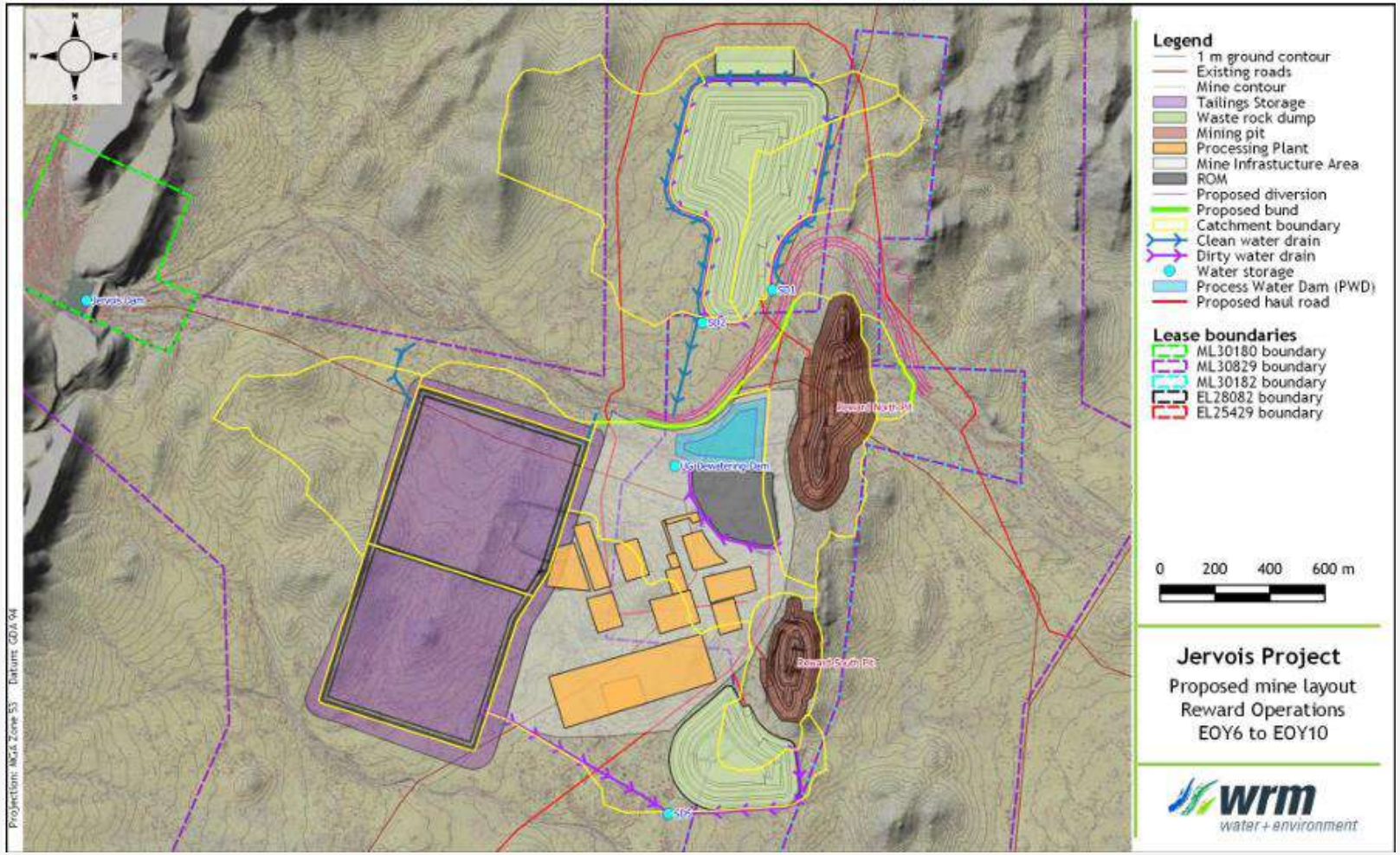




Guidelines for Evaluating Water in Pit Slope Stability, 2013

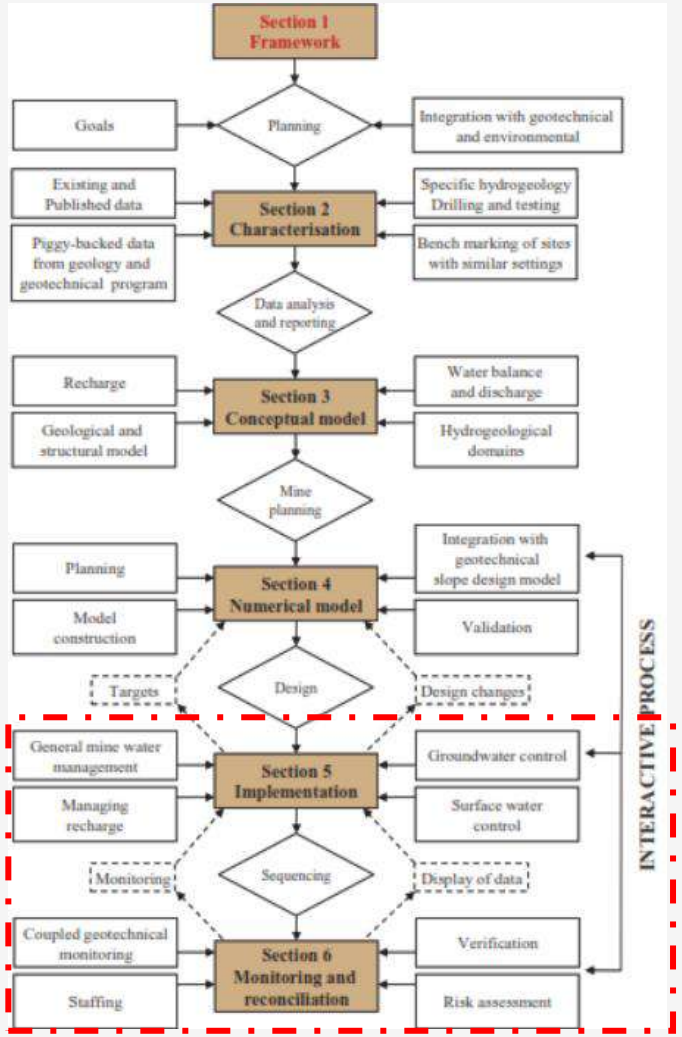
Implementation and Monitoring – Layout





Guidelines for Evaluating Water in Pit Slope Stability, 2013

Implementation and Monitoring – Water system schematic



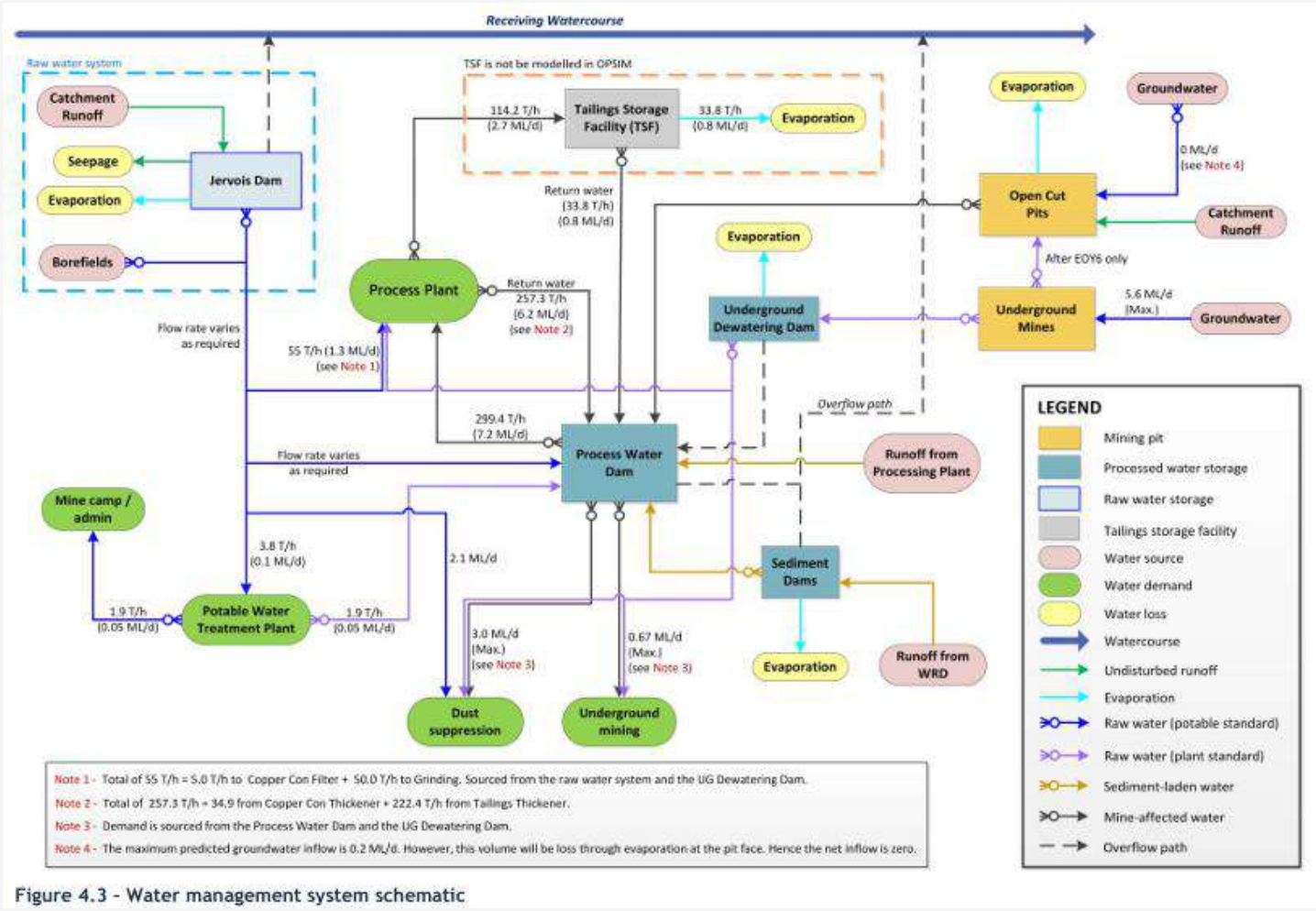
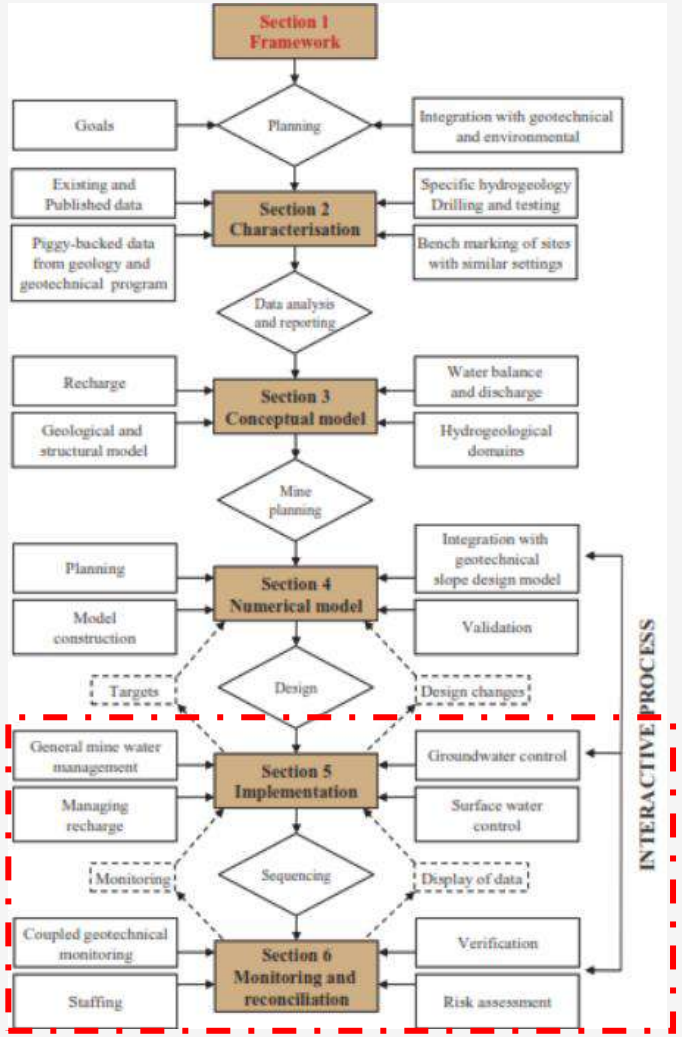
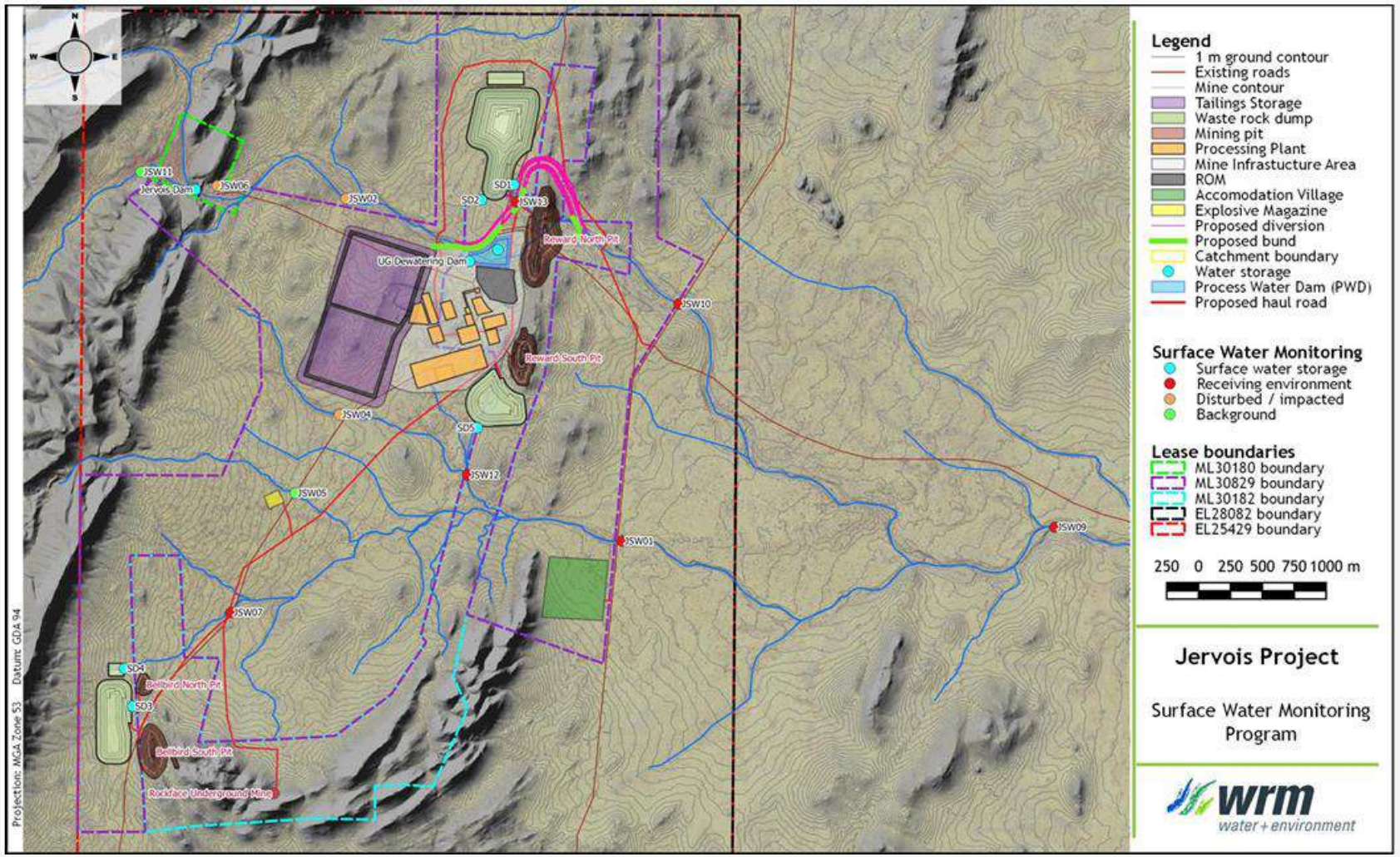


Figure 4.3 - Water management system schematic

Guidelines for Evaluating Water in Pit Slope Stability, 2013

Implementation and Monitoring – Monitoring





Guidelines for Evaluating Water in Pit Slope Stability, 2013

Ada Pertanyaan?

UNIVERSITAS
TRISAKTI

Mine Plan
Gasal 22/23

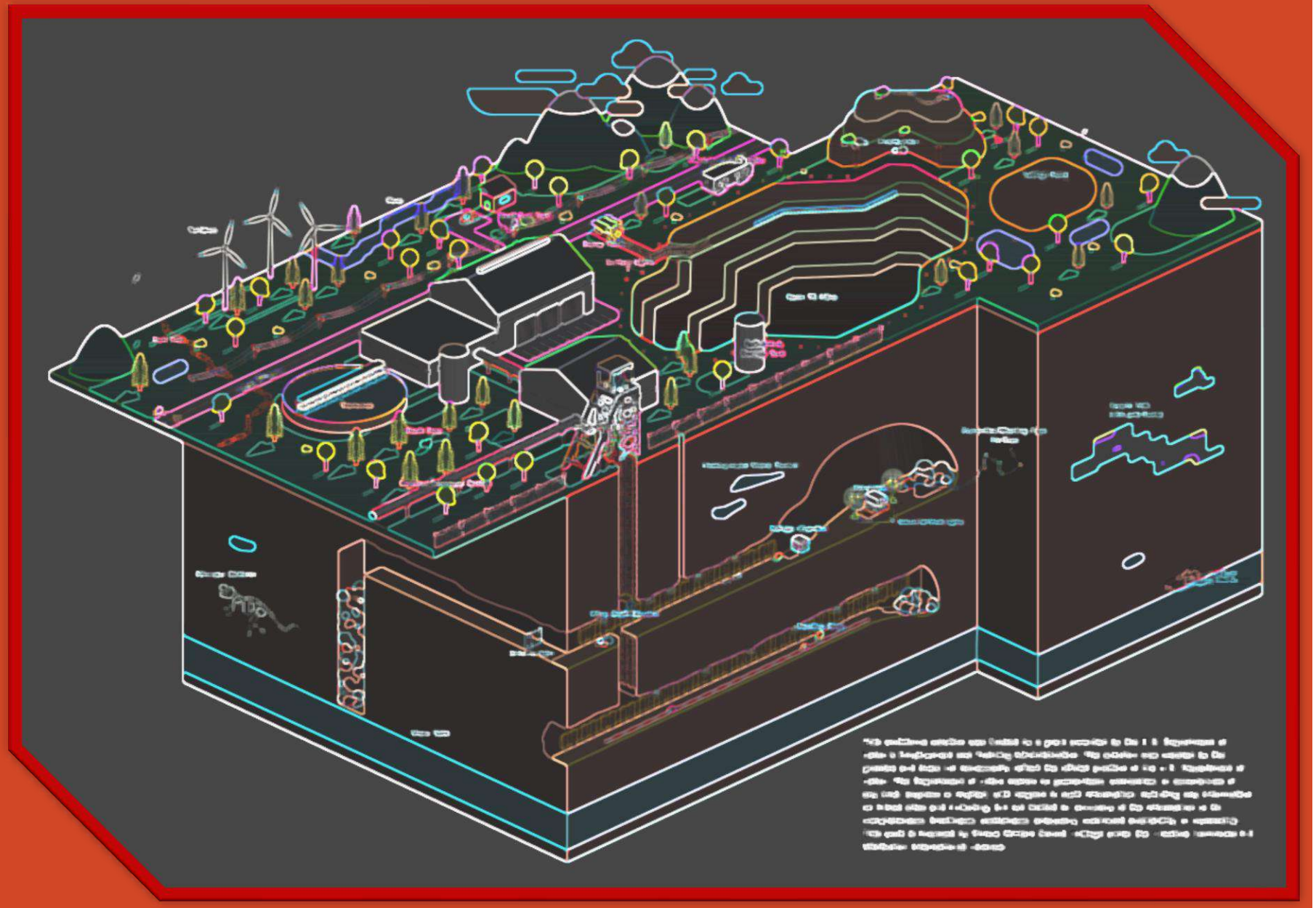
10th Session

Environment

Speaker

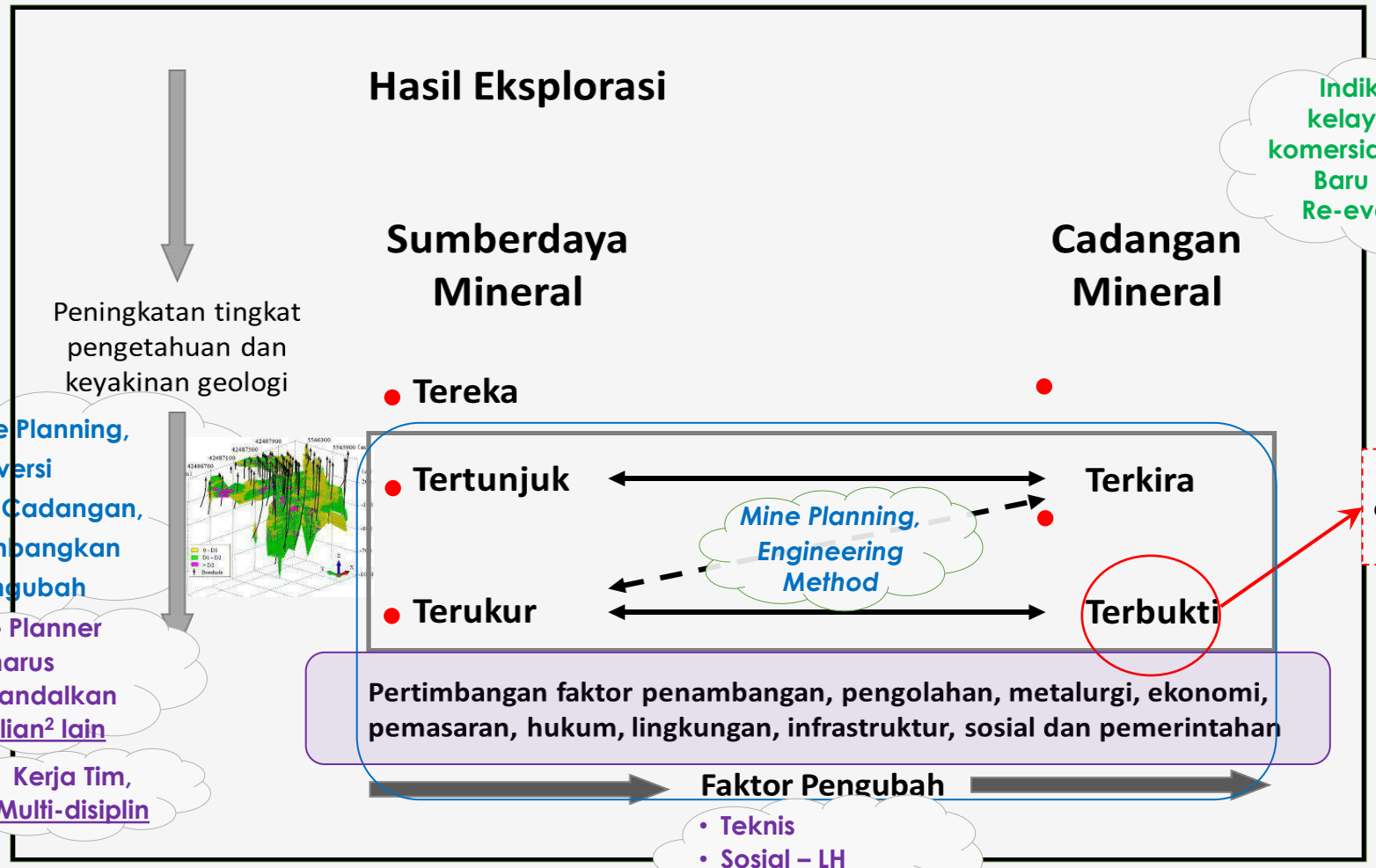
Ir. Andre Alis, ST, MBA, IPM

Danu Putra, ST, MT, IPP



Kerangka Kerja Universal Pelaporan HE– S/d– C/d

- sebagai refleksi penerapan konsep keekonomian tambang -

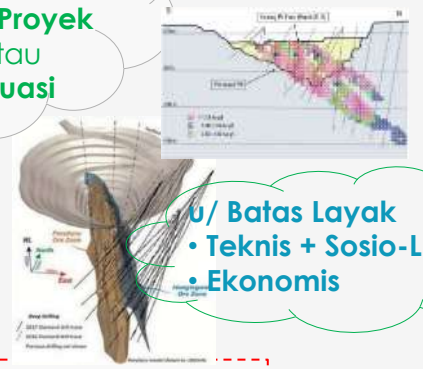


Metodologi Mine Planning, mengkonversi Sumberdaya → Cadangan, dgn mempertimbangkan 10 faktor pengubah

Mine Planner harus mengandalkan keahlian[2] lain

Kerja Tim, Multi-disiplin

Indikator kelayakan komersial Proyek Baru atau Re-evaluasi



U/ Batas Layak
• Teknis + Sosio-LH &
• Ekonomis

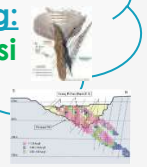
Akurasi tinggi, dasar komersialisasi prospek tambang

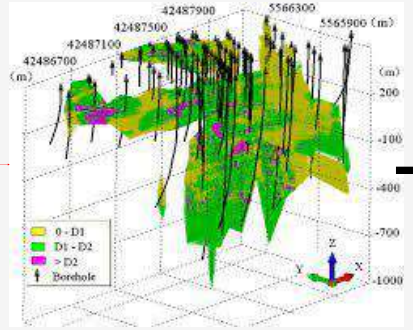
Adapt. Kode KCMI : 2017, ps. 11++
(dan Kode[2] CRIRSCO),
SNI 4726/ 5015, fig. 1,
& all textbook

(Framework-A) Mine Planning = Mining + Financial Engineering

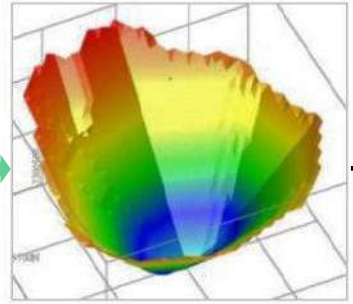
Analisis strategi eksploitasi, BESR, dll.

Tujuan mine planning: Meng-estimasi cadangan





Mining Engineering



Shell Hasil Optimisasi

Go

NO-Go

TEST-2

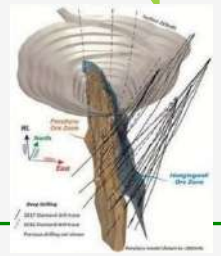
Cadangan = tonase & kualitas, bagian sumberdaya yg *economically mineable*

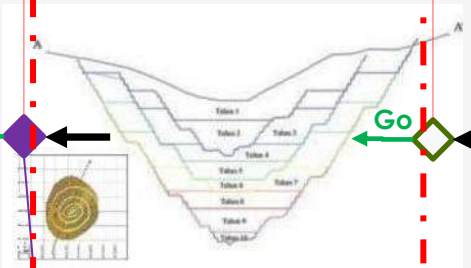
Financial Engineering

NPV
DCFROR
PB

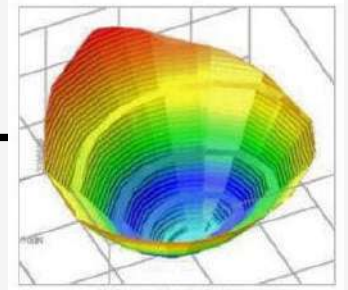
Evaluasi Keekonomian

Go Komersial





LOM Production Scheduling



Konseptual Pit Design

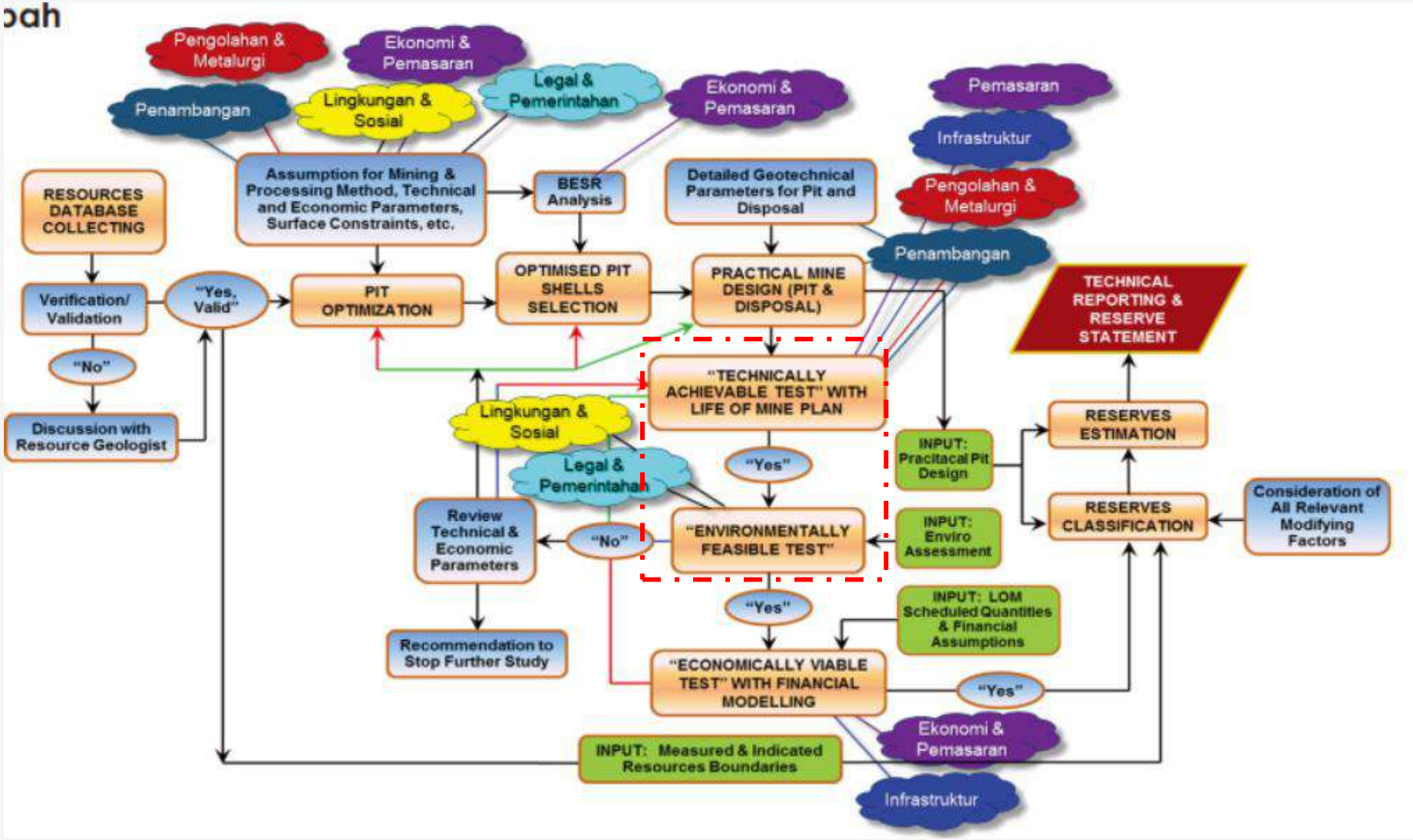
- Test-1 : layak teknis & Sosial-LH
- Test-2 : layak ekonomis

Peran Analisis Finansial

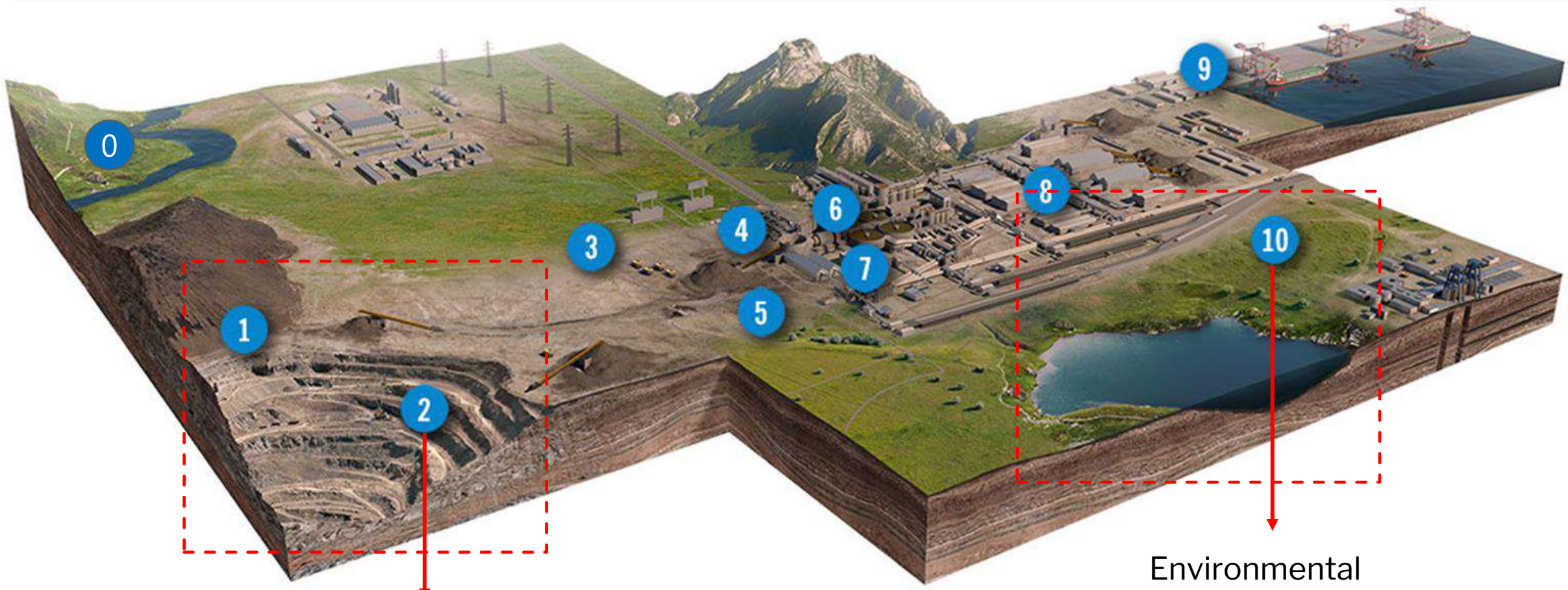
TEST-1

Adjust. fr. Lufi Rachmad, 2017

(*Framework-A*) ***Mine Planning*** = *Mining + Financial Engineering*



Scope of Work



Whittle Consulting,2020

Scope of Work

Mine Environment

Perlindungan lingkungan

- Dampak lingkungan
- Pengelolaan lingkungan
- Pemantauan lingkungan
- Organisasi Lingkungan
- Pascatambang

Keselamatan lingkungan

- Manajemen risiko
- Pengelolaan K3
- Pengelolaan keselamatan operasi pertambangan
- Organisasi K3
- Penyediaan peralatan penambangan
- Rencana penggunaan dan pengamanan bahan peledak

KOMPONEN KEGIATAN / KOMPONEN LINGKUNGAN	Koordinasi rencana kegiatan	Penggantian tanam tumbuh	Penerimaan Tenaga Kerja Untuk Konstruksi	Mobilisasi Peralatan Berat dan Material Konstruksi	Pembukaan dan Pematangan lahan	Pembangunan Washing Plant	Pembangunan Pelurusan sungai dan Pembangunan Jembatan Sungai Biu	Pembangunan Sarana Penunjang 1 (workshop dan jembatan di KM 4)	Pembangunan Sarana Penunjang 3 (KM 10, KM 16, KM 22-29)	Penerimaan TK Operasional Tambang	Mobilisasi alat berat operasional tambang	Pembersihan lahan tambang yang akan dibuka	Pengupasan dan penimbunan tanah pucuk	Pengupasan dan Penimbunan tanah penutup batubara (overburden)	Peledakan (blasting) termasuk Plant	Penambangan batubara	Pengangkutan batubara (termasuk pengoperasian jalan non tambang)	Penimbunan batubara di stockpile	Pengolahan batubara (MCCP dan SMCP)	Penirisan air tambang dan sistem drainase	Reklamasi dan re-vegetasi lahan berjalan	Pengoperasian utilitas (gen-set, limbah padat, air bersih) termasuk yang di Pelabuhan	Pengoperasian sarana penunjang workshop di KM 4, klinik & Incinerator	Pengoperasian sarana penunjang TPA limbah domestik	Pencucian batubara	Penimbunan batubara di stockpile (product)	Penanganan air limbah di sedimen pond	Penanganan dan pengangkutan lumpur	Penimbunan batubara di stockpile	Pemuatan batubara ke ponton	Pengangkutan batubara (TMCT ke loading point)	Pembuatan dan Operasional Tambat Ponton	Pengisian dan penimbunan BBM	Pengoperasian Laboratorium QC batubara	Stone Crusher & Stock pile agregat	Asphalt Mixing Process	Pengangkutan Asphalt	Pembongkaran bangunan fasilitas tambang dan penunjang	Reklamasi dan re-vegetasi lahan (melanjutkan lahan yg belum dieksekusi)	Penanganan Tenaga Kerja Pasca Tambang	Demobilisasi peralatan
	PRAKONSTRUKSI			KONSTRUKSI						A.OPERASIONAL TAMBANG															B. OPERASIONAL WASHING PLANT				C. OPERASIONAL -PELABUHAN BATUBARA / TMCT						D. OPERASIONAL AMP			PASCA OPERASI			
	1,1	1,2	1,3	2,1	2,2	2,3	2,4	2,5	2,6	3,1	3,2	3,3	3,4	3,5	3,6	3,7	3,8	3,9	3,10	3,11	3,12	3,13	3,14	3,15	3,16	3,17	3,18	3,19	3,20	3,21	3,22	3,23	3,24	3,25	3,26	3,27	3,28	4,1	4,2	4,3	4,4
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
A. FISIKA – KIMIA																																									
1. Bentang alam dan kestabilan lereng							x						x	x		x					x																		x		
2 Iklim mikro												x																													
3 Kualitas udara				x	x	x	x	x	x		x	x	x	x		x	x	x	x			x	x	x	x	x		x	x	x				x	x		x			x
4. Kebisingan				x	x	x	x	x	x		x	x	x	x	x	x	x	x	x			x	x		x			x	x	x				x	x		x			x
5 Getaran															x																										
6 Kualitas air sungai					x		x					x	x	x				x		x	x	x	x			x	x	x						x	x			x		
7 Kualitas air laut																						x							x		x		x					x		
8 Air limpasan permukaan (run-off)					x							x									x					x			x				x		x	x			x		
9 Erosi tanah					x		x					x	x	x							x																		x		
10 Kesuburan tanah					x							x	x								x																		x		
11 Kualitas / kuantitas Air tanah																x							x	x																	
12 Timbulan limbah B3/ non B3																											x														
B. HIDROLOGI																																									
13 Pola Arus laut																																									
14 Abrasi dan sedimentasi							x					x	x	x																x	x										
15 Topografi dasar sungai							x																																		
C. BIOLOGI																																									
16 Flora darat					x							x					x				x										x								x		
17 Fauna darat					x							x			x						x																		x		
18 Biota air sungai					x		x					x	x	x			x	x		x	x	x	x			x	x							x	x			x		
19 Biota air laut																						x							x	x	x	x	x	x				x		
D. SOSIAL EKONOMI & BUDAYA																																									
20 Kesempatan kerja			x							x																					x								x	
21 Mata pencaharian dan Peluang berusaha		x	x							x																					x								x	
22 Pendapatan masyarakat		x	x							x																					x	x							x	
23 Perekonomian lokal			x							x																														x	
24 Kependudukan			x							x																														x	
25 Persepsi masyarakat	x	x	x	x	x		x			x	x		x	x			x			x	x			x	x	x	x			x	x								x	
26 Pola interaksi			x							x																														x	
E. KESEHATAN MASYARAKAT																																									
27 Kesehatan masyarakat				x	x	x	x				x	x	x	x	x		x	x		x		x			x	x	x		x	x					x	x		x			x
F. TATA RUANG																																									
28 Fungsi dan penguasaan lahan		x																																					x		
29 Transportasi darat				x							x					x	x							x				x								x				x
30 Transportasi laut											x																				x										

Perlindungan Lingkungan – Pengelolaan Lingkungan

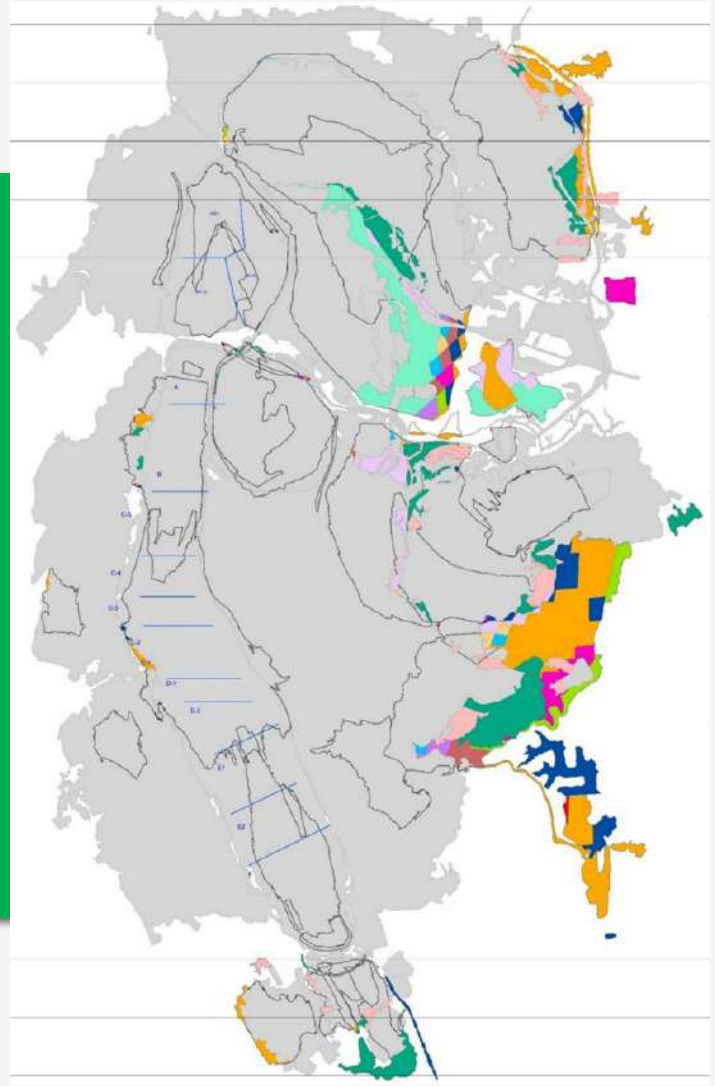
- Perlindungan lingkungan
  - Dampak lingkungan
  - Pengelolaan lingkungan
  - Pemantauan lingkungan
  - Organisasi Lingkungan
  - Pascatambang

- Pengelolaan Limbah
  - Sedimen
  - Air Pencucian Batubara dan Stockpile
  - Limbah B3, Non-B3, Hidrokarbon

- Pengelolaan Kualitas Udara

Perlindungan Lingkungan – Pengelolaan Lingkungan

Layout area



Rencana Reklamasi

Tabulasi area

- Area Bukaan
- Area Reklamasi
- Area Reklamasi Pascatambang
- Void

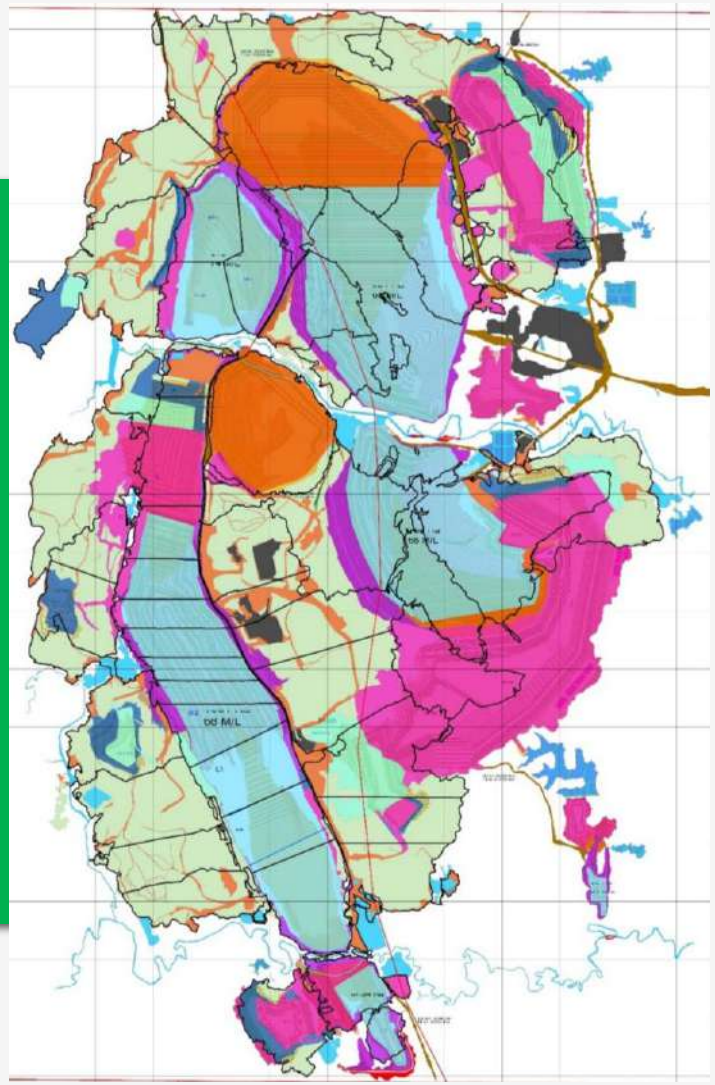
Rencana Pembukaan Lahan(ha)	Aktual Sampai 2020	2021	2022	…	2043	Total
Pit	1.003,05	-	43,17	…	-	
Waste Dump	879,89	25,00	31,59	…	-	
Settling Pond	111,68	14,61	-	…	-	
Road	-	10,21	-	…	-	
Stock Top Soil	-	-	-	…	-	
Channel	-	-	-	…	-	
Fasilitas Penunjang	-	-	-	…	-	

Jika tambang sudah berjalan

Rencana Produksi Top Soil (MBCM)	2023	2024	…	2043	Total
Pit A	1,904	0,318	3,130	-	7,143

Perlindungan Lingkungan – Pengelolaan Lingkungan

Layout area



Rencana Reklamasi

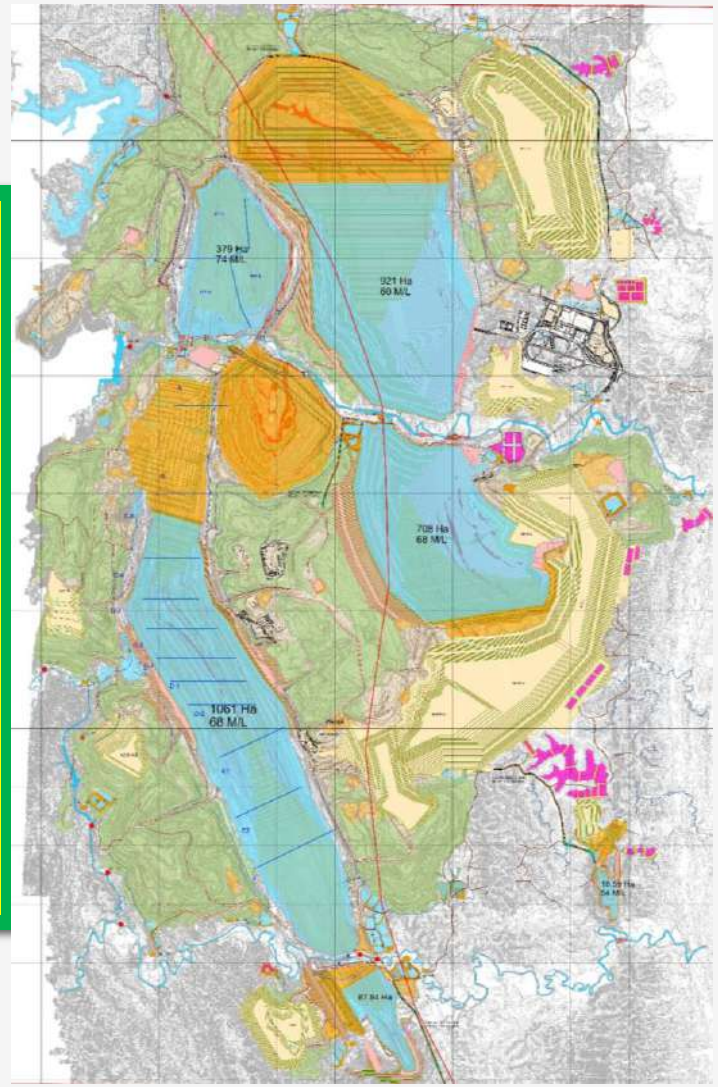
Tabulasi area

- Area Bukaan
- Area Reklamasi
- Area Reklamasi Pascatambang
- Void

Area	Actual	Rencana Reklamasi 2021-2043				Potensial Lahan Reklamasi Terganggu (ha)	Kumulatif (ha)
	End 2020	2021	2022	2023-2043	Total		
	A	B	C	D	E (B+C+D)	F	G (A+E-F)
Blok A	4.914,51	94,43	20,33	113,93	228,69	14,76	7.176,39

Perlindungan Lingkungan – Pengelolaan Lingkungan

Layout area



Tabulasi area

Area Bukaan

Area	Aktual	Rencana Bukaan Lahan 2021-2043				Kumulatif (ha)
	<2020	2021	2022	2023-2043	Total	
	A	B	C	D	E = B+C+D	F = A+E
Blok A	11.265,40	-	-	0,03	0,03	13.091,83
Blok B		-	2,02	8,31	10,33	
Blok C		-	3,55	42,50	46,05	
Blok D		13,37	44,42	22,91	80,70	
Blok E		49,82	74,76	492,91	617,49	
Blok F		93,91	169,35	481,31	744,57	
Blok G		-	-	107,32	107,32	
Facility	305,10	-	-	- 85,16	- 85,16	

Harus sama

Area	Aktual	Rencana Area Reklamasi 2021-2043			Pasca	Void	Reklamasi Terganggu	Kumulatif (ha)
	<2020	2021						
	A	B	C	D	F	G	H	I=A+B+C+D+F+G-H
Blok A	4.914,51	94,43	20,33	113,93	172,58	379,75	14,76	13.091,83
Blok B		-	-	25,09	372,91	-	8,66	
Blok C		166,12	280,47	367,69	595,85	1.061,89	164,53	
Blok D		52,48	-	104,64	101,84	87,84	43,54	
Blok E		89,80	160,04	536,27	1.134,18	921,82	541,90	
Blok F		32,77	47,45	1.117,55	315,59	708,39	217,43	
Blok G		-	-	43,64	46,23	16,59	-	

Perlindungan Lingkungan – Pengelolaan Lingkungan

Perlindungan lingkungan

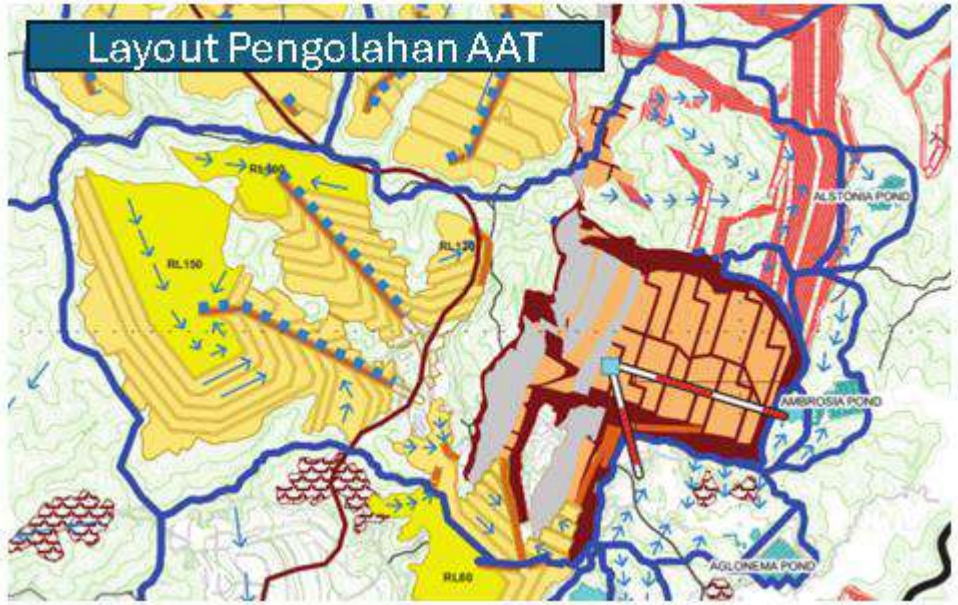
- Dampak lingkungan
- Pengelolaan lingkungan
- Pemantauan lingkungan
- Organisasi Lingkungan
- Pascatambang

Studi Geokimia dan Pengelolaan Air Asam Tambang

Studi

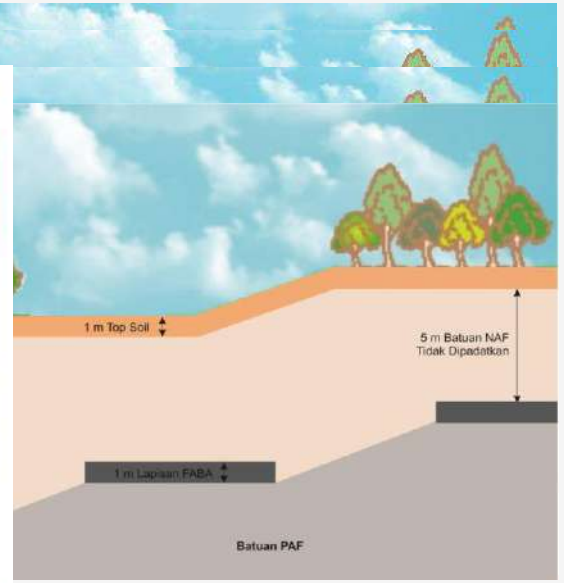
TYPES	Values (kg H2SO4/t)	Remarks

Pengolahan

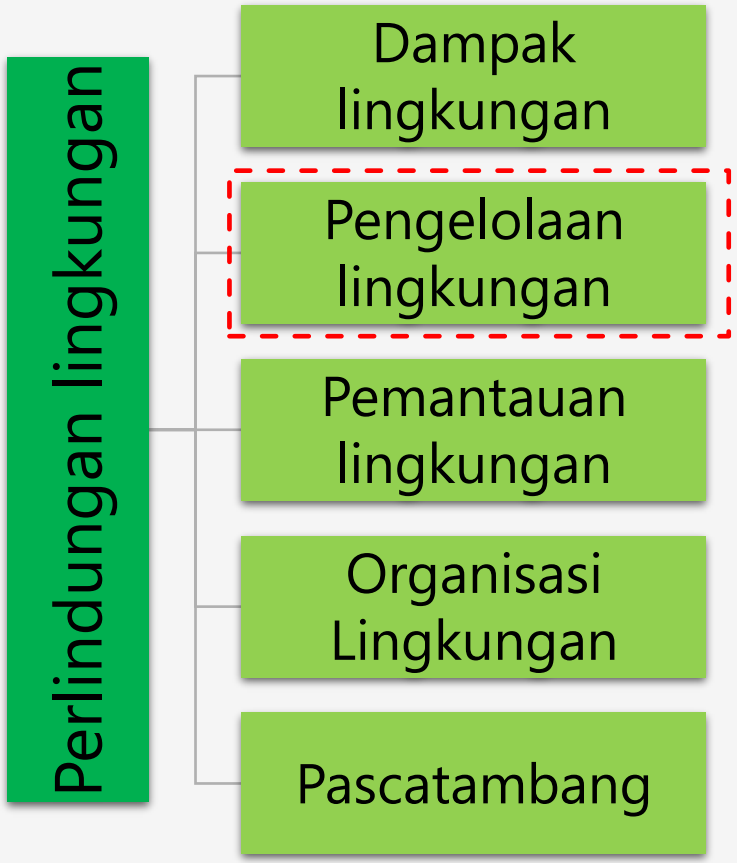


Pencegahan

PIT	NAF	PAF
A	93.7%	6.3%
B	77.6%	22.4%
C	89.0%	11.0%
D	59.0%	41.0%
E	74.3%	25.7%



Perlindungan Lingkungan – Pengelolaan Lingkungan

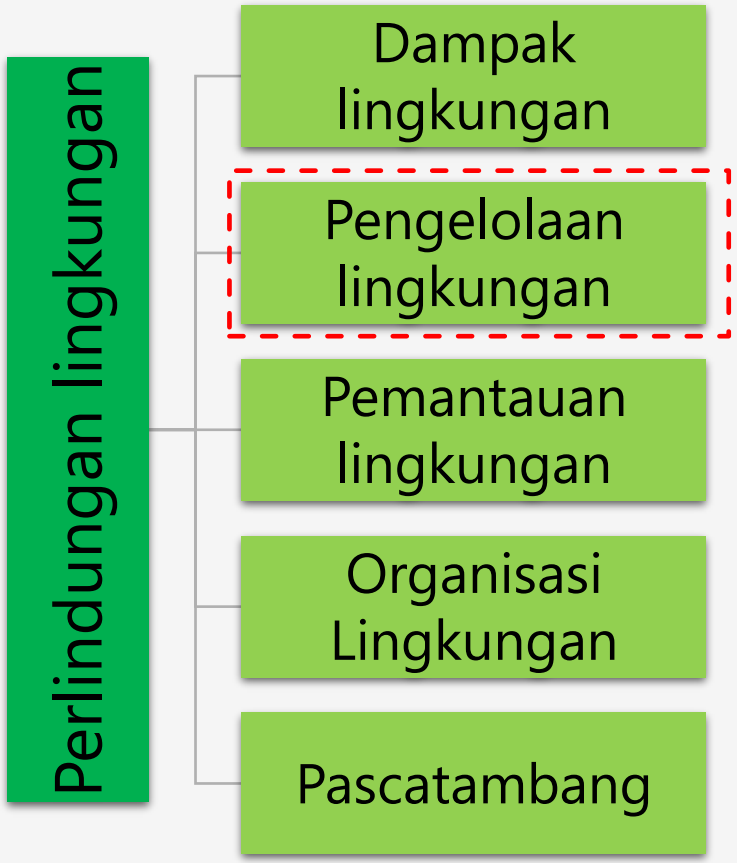


Studi Geokimia dan Pengelolaan Air Asam Tambang

Matriks Pengelolaan Lingkungan Berdasarkan Dampak

No	Komponen kegiatan	Komponen lingkungan yang terkena dampak	Tujuan pengelolaan	Upaya pengelolaan
1.	Pembersihan lahan	- Laju Erosi		
		- Kualitas dan kesuburan tanah		
		- Kualitas air sungai		
		- Flora terestrial		
		- Fauna terestrial		
		- Biota akuatik sungai		
		- Adaptasi ekologis	-	
		- Kesehatan masyarakat dan pekerja		
2.	Pengupasan, Pemindahan, dan Penyimpanan Tanah Pucuk	- Kualitas Udara		
		- Kebisingan		
		- Kualitas dan kesuburan tanah		
		- Kualitas air sungai		
		- Biota akuatik sungai		
		- Persepsi dan sikap masyarakat		
3.	Pengeboran dan Peledakan Batuan Penutup	- Getaran		
		- Persepsi dan sikap masyarakat		
		- Kualitas udara		
		- Kebisingan		
		- Kesehatan masyarakat dan pekerja		

Perlindungan Lingkungan – Pengelolaan Lingkungan



Studi Geokimia dan Pengelolaan Air Asam Tambang

Matriks Pengelolaan Lingkungan Berdasarkan Dampak

No	Komponen kegiatan	Komponen lingkungan yang terkena dampak	Tujuan pengelolaan	Upaya pengelolaan
4.	Penggalian, Pengangkutan, dan Penimbunan Batuan Penutup	- Kualitas udara		
		- Kebisingan		
		- Kestabilan lereng		
		- Laju Erosi		
		- Air Larian		
		- Kualitas air sungai		
		- Biota akuatik sungai		
		- Bentang alam		
		- Persepsi dan sikap masyarakat		
		- Kesehatan masyarakat dan pekerja		
5.	Penambangan Batubara	- Kualitas udara		
		- Laju erosi		
		- Kualitas Air Sungai		
		- Biota akuatik sungai		
		- Perekonomian daerah		
		- Persepsi dan sikap masyarakat		
		- Kesehatan masyarakat dan pekerja		
6.	Pengolahan Batubara	- Kualitas udara		
		- Kualitas air sungai		
		- Kualitas air tanah		
		- Biota akuatik sungai		
7.	Pengangkutan Batubara	- Kualitas udara		
		- Kebisingan		
		- Kualitas air laut		
		- Biota akuatik laut		

Perlindungan Lingkungan – Pengelolaan Lingkungan

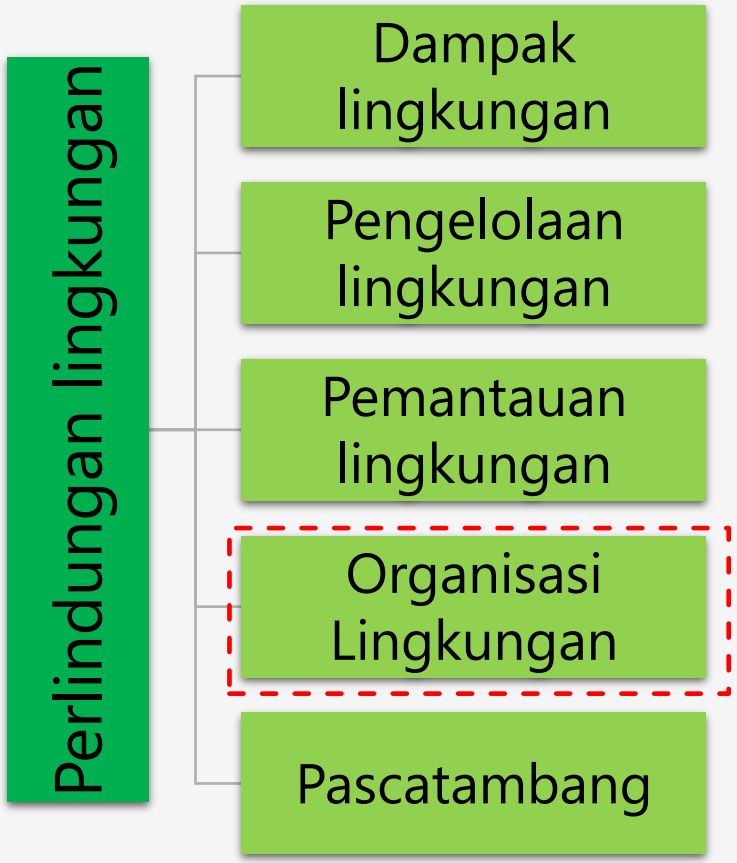
Perlindungan lingkungan

- Dampak lingkungan
- Pengelolaan lingkungan
- Pemantauan lingkungan
- Organisasi Lingkungan
- Pascatambang

Pemantauan

- Pemantauan kualitas air
- Pemantauan curah hujan dan cuaca
- Pemantauan kualitas udara dan getaran
- Pemantauan hidrokarbon dan limbah
- Pemantauan flora dan fauna
- Program kepedulian lingkungan, dll

Perlindungan Lingkungan – Pengelolaan Lingkungan



Susunan organisasi

Divisi	HSES		
Departemen	**Safety Operation**	**HSES System**	**Lingkungan**
Lingkup kerja	▪ Kesehatan Kerja ▪ Pemantauan Keselamatan & Commissioning ▪ Kesiagaan & Tanggap Darurat	▪ Informasi dan Sistem Manajemen KPL & Keamanan ▪ Audit KPL & Keamanan ▪ Pelayanan Pelatihan KPL & Keamanan	▪ Perencanaan & Pemantauan Lingkungan ▪ Reklamasi & Revegetasi ▪ Pengawasan & penanganan Limbah B3, limbah Non-B3 dan Hidrokarbon ▪ Koordinator Proyek

Perlindungan Lingkungan – Pengelolaan Lingkungan

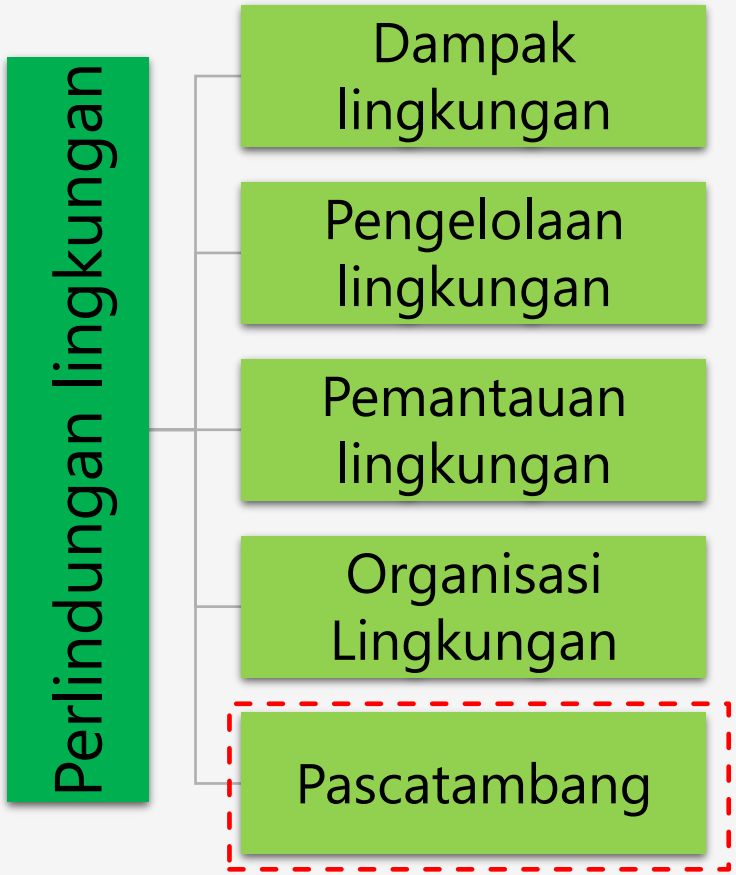
Perlindungan lingkungan

- Dampak lingkungan
- Pengelolaan lingkungan
- Pemantauan lingkungan
- Organisasi Lingkungan
- Pascatambang

Jadwal rencana pascatambang

NO	KEGIATAN	TAHUN
		2022 2031 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071
OPERASI PENAMBANGAN		
	REKLAMASI	
1	Reklamasi berkelanjutan (*progressive reclamation*) selama masa operasi	
2	Penghentian operasi penambangan	
	PENGEMBANGAN MASYARAKAT	
3	Program pengembangan kemandirian masyarakat	
PASCATAMBANG		
	REKLAMASI & PENGELOLAAN LINGKUNGAN	
1	Reklamasi sisa lahan bekas tambang	
2	Reklamasi lahan bekas kolam pengendap	
3	Reklamasi lubang bekas tambang/pengisian air	
4	Perawatan hasil reklamasi	
5	Sosial & Ekonomi	
	- Penanganan tenaga kerja	
	- Pengembangan masyarakat	
	PEMANTAUAN	
6	- Pemantauan Kestabilan Fisik	
	o Pemantauan Kestabilan Lereng	
	o Kestabilan Bangunan Air	
	- Pemantuaan kualitas air	
7	- Kualitas air permukaan	
	- Kualitas air tanah	
8	- Biota teresterial & aquatik	
	- Biota teresterial	
	o Vegetasi	
	o Fauna	
	- Biota akuatik	
9	- Sosial & Ekonomi	
	PENGEMBANGAN MASYARAKAT	
10	Program pengembangan masyarakat	
PENYERAHAN LAHAN PASCATAMBANG		

Perlindungan Lingkungan – Pengelolaan Lingkungan



Komponen biaya pascatambang

NO.			KEGIATAN	Total Costs
1	Biaya langsung			Biaya
	a.	Biaya pada tapak bekas tambang, terdiri atas biaya:		
		1	Pembongkaran fasilitas tambang	
		2	Reklamasi lahan bekas fasilitas tambang (ha)	
		3	Pembongkaran dan Reklamasi jalan tambang	
		4	Reklamasi tambang permukaan (pit, waste dump) (ha)	
			Reklamasi waste dump	
			Reklamasi lubang bekas tambang (ha)	
		5	Reklamasi lahan bekas kolam pengendap (ha)	
	b.	Biaya pada fasilitas pengolahan dan/atau pemurnian, terdiri atas biaya:		
		1	pembongkaran fasilitas pengolahan dan/atau pemurnian	
		2	Reklamasi lahan bekas fasilitas pengolahan dan/atau pemurnian (ha)	
		3	Reklamasi lahan bekas timbunan komoditas tambang (ha)	
	c.	Biaya pada fasilitas penunjang, terdiri atas biaya:		
		1	Reklamasi lahan bekas landfill (ha)	
		2	Pembongkaran sisa bangunan, transmisi listrik, pipa, pelabuhan (udara dan air), dan fasilitas lainnya	
		3	Reklamasi lahan bekas bangunan, transmisi listrik, pipa, pelabuhan (udara dan air), dan fasilitas lainnya (ha)	
		4	Pembongkaran peralatan, mesin, serta tangki bahan bakar minyak dan pelumas	
		5	Penanganan sisa bahan bakar minyak, pelumas, serta bahan kimia	
		6	Reklamasi lahan bekas sarana transportasi (ha)	
		7	Reklamasi lahan bekas bangunan dan pondasi beton (ha)	
		8	Pemulihan (remediasi) tanah yang terkontaminasi bahan kimia, minyak, serta bahan berbahaya dan beracun dan limbah bahan berbahaya dan beracun	
	d.	Pengembangan sosial, budaya, dan ekonomi		
	e.	Pemeliharaan		
	f.	Pemantauan		
SUBTOTAL 1 (US$)				
2	Biaya tidak langsung, terdiri atas biaya:			
	a.	Mobilisasi dan demobilisasi alat (2.5% Biaya Langsung)		
	b	Perencanaan Pascatambang (grafik)		
	c.	Administrasi dan keuntungan pihak ketiga sebagai pelaksana Pascatambang (grafik)		
	d.	Supervisi (grafik)		
SUBTOTAL 2 (US$)				
TOTAL (US$)				

Perlindungan Lingkungan – Pengelolaan Lingkungan

Perlindungan lingkungan

Rencana biaya pascatambang

No.			KEGIATAN	LUAS (ha)	BIAYA (US$)	SATUAN	TOTAL BIAYA	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2071
1	Biaya langsung																	
	a.	Biaya pada tapak bekas tambang, terdiri atas biaya:																
		1	Pembongkaran fasilitas tambang	Luas area	Biaya	$/ha	Biaya											
		2	Reklamasi lahan bekas fasilitas tambang (ha)			$/ha												
		3	Pembongkaran dan Reklamasi jalan tambang			$/ha												
		4	Reklamasi tambang permukaan (pit, waste dump) (ha)															
			Reklamasi waste dump			$/ha												
			Reklamasi lubang bekas tambang (ha)			$/ha												
		5	Reklamasi lahan bekas kolam pengendap (ha)			$/ha												
	b.	Biaya pada fasilitas pengolahan dan/atau pemurnian, terdiri atas biaya:																
		1	Pembongkaran fasilitas pengolahan dan/atau pemurnian			$/ha												
		2	Reklamasi lahan bekas fasilitas pengolahan dan/atau pemurnian (ha)			$/ha												
		3	Reklamasi lahan bekas timbunan komoditas tambang (ha)			$/ha												
	c.	Biaya pada fasilitas penunjang																
		1	Reklamasi lahan bekas landfill (ha)			$/ha												
		2	Pembongkaran sisa bangunan, transmisi listrik, pipa, pelabuhan (udara dan air), dan fasilitas lainnya			$/ha												
		3	Reklamasi lahan bekas bangunan, transmisi listrik, pipa, pelabuhan (udara dan air), dan fasilitas lainnya (ha)			$/ha												
		4	Pembongkaran peralatan, mesin, serta tangki bahan bakar minyak dan pelumas			$/ha												
		5	Penanganan sisa bahan bakar minyak, pelumas, serta bahan kimia			$/Year												
		6	Reklamasi lahan bekas sarana transportasi (ha)			$/ha												
		7	Reklamasi lahan bekas bangunan dan pondasi beton (ha)			$/ha												
		8	Pemulihan (remediasi) tanah yang terkontaminasi bahan kimia, minyak, serta bahan berbahaya dan beracun dan limbah bahan berbahaya dan beracun			$/Year												
	d.	Pengembangan sosial, budaya, dan ekonomi				$/Year												
	e.	Pemeliharaan				$/Year												
	f.	Pemantauan				$/Year												
SUBTOTAL 1 (US$)																		
2	Biaya tidak langsung, terdiri atas biaya:																	
	a.	Mobilisasi dan demobilisasi alat (2.5% Biaya Langsung)			Presentase kerja		Biaya											
	b	Perencanaan Pascatambang (grafik)																
	c.	Administrasi dan keuntungan pihak ketiga sebagai pelaksana Pascatambang (grafik)																
	d.	Supervisi (grafik)																
SUBTOTAL 2 (US$)																		
TOTAL (US$)																		

Keselamatan Lingkungan – Manajemen Resiko

ngkungan

- Manajemen risiko
- Pengelolaan K3
- Pengelolaan keselamatan

Komponen manajemen resiko

- Identifikasi biaya
- Penilaian resiko
- Pengendalian Resiko

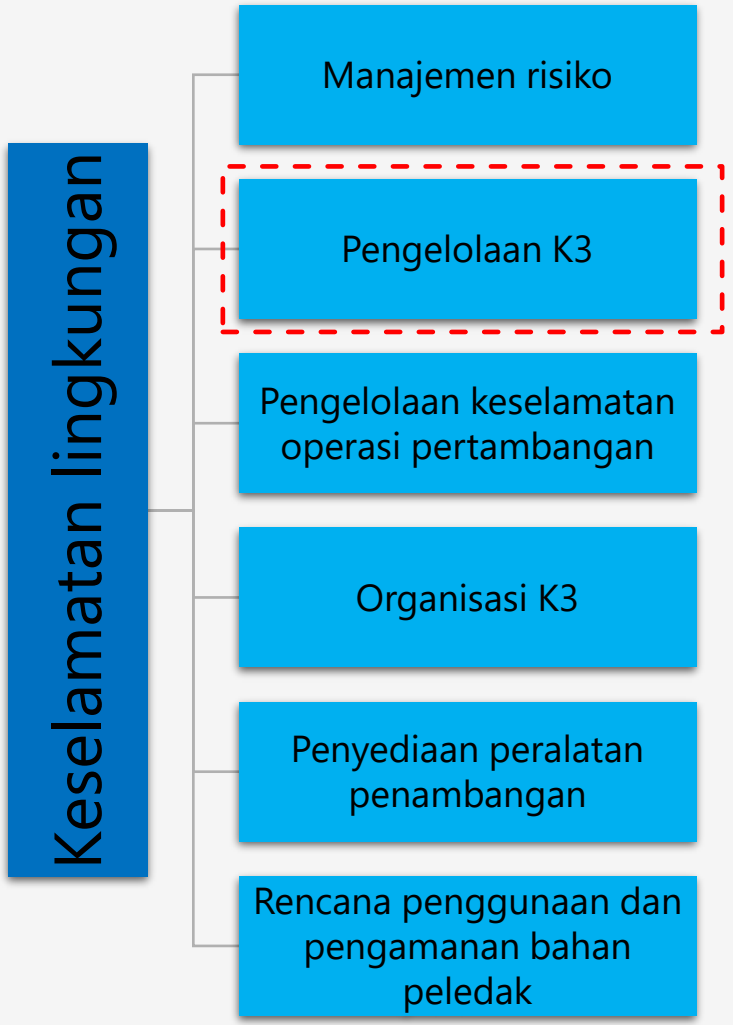
Tabel Matriks Resiko		Keparahan				
		Sangat Ringan	Ringan	Sedang	Berat	Sangat Berat
Frekuensi	Sangat Sering	Sedang	Tinggi	Tinggi	Ekstrim	Ekstrim
	Sering	Sedang	Sedang	Tinggi	Tinggi	Ekstrim
	Sedang	Rendah	Sedang	Sedang	Tinggi	Ekstrim
	Jarang	Rendah	Sedang	Sedang	Tinggi	Tinggi
	Sangat Jarang	Rendah	Rendah	Sedang	Sedang	Tinggi

Kategori Keseringan	Contoh Parameter I	Contoh Parameter II
Sangat Jarang	Terjadi 1X dalam masa lebih dari 1 tahun	Probabilitas 1 dari 1.000.000 jam kerja orang lebih
Jarang	Bisa terjadi 1X dalam setahun	Probabilitas 1 dari 1.000.000 jam kerja orang
Sedang	Bisa terjadi 1X dalam sebulan	Probabilitas 1 dari 100.000 jam kerja orang
Sering	Bisa terjadi 1X dalam seminggu	Probabilitas 1 dari 1000 jam kerja orang
Sangat Sering	Terjadi hampir setiap hari	Probabilitas 1 dari 100 jam kerja orang

Kategori Keparahan	Contoh Parameter I	Contoh Parameter II
Sangat Ringan	Tidak terdapat cedera/penyakit, tenaga kerja dapat langsung bekerja kembali	Total kerugian kecelakaan kerja kurang dari Rp. 1.000.000
Ringan	Cedera ringan, tenaga kerja dapat langsung bekerja kembali	Total kerugian kecelakaan kerja antara Rp. 1.000.000 – Rp. 1.500.000
Sedang	Mendapat P3K atau tindakan medis, tidak ada hilang jam kerja lebih dari 1X24 jam	Total kerugian kecelakaan kerja antara Rp. 1.500.000 – Rp. 5.000.000
Parah	Memerlukan tindakan medis lanjut/rujukan, cacat sementara, terdapat jam kerja hilang 1X24 jam	Total kerugian kecelakaan kerja antara Rp. 5.000.000 – Rp. 10.000.000
Sangat Parah	Cacat Permanen, Kematian, terdapat jam kerja hilang lebih dari 1X24 jam	Total kerugian kecelakaan kerja lebih dari Rp. 10.000.000

Rendah	Perlu Aturan/Prosedur/Rambu
Sedang	Perlu Tindakan Langsung
Tinggi	Perlu Perencanaan Pengendalian
Ekstrim	Perlu Perhatian Manajemen Atas

Keselamatan Lingkungan – Manajemen Resiko



Komponen pengelolaan K3

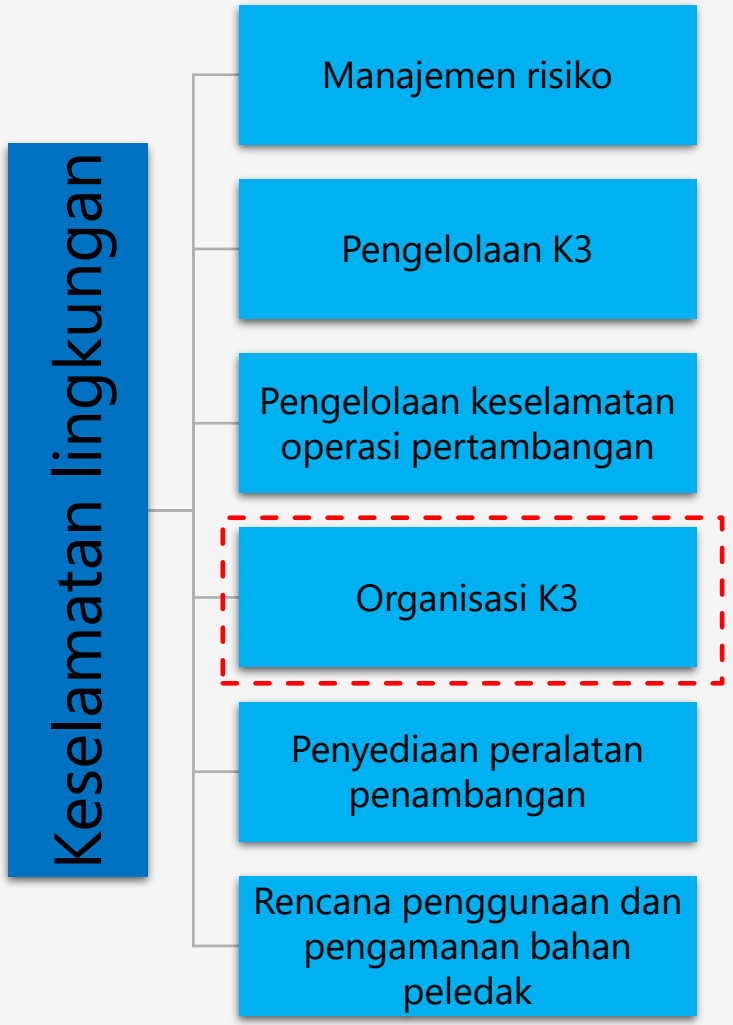
- Pengelolaan keselamatan kerja
- Pengelolaan kesehatan kerja
- Pengelolaan lingkungan kerja
- Sistem manajemen keselamatan epertambangan

Keselamatan Lingkungan – Manajemen Resiko

Komponen keselamatan operasi pertambangan

- Sistem dan pelaksanaan pemeliharaan/perawatan sarana, prasarana, instalasi, dan peralatan pertambangan
- Pengamanan instalasi
- Kelayakan sarana, prasarana, instalasi, dan peralatan pertambangan
- Evaluasi laporan

Keselamatan Lingkungan – Manajemen Resiko



Komponen Organisasi K3

- Struktur organisasi perusahaan
- Organisasi dan personal K3
- Struktur organisasi komite keselamatan pertambangan
- Evaluasi laporan

Keselamatan Lingkungan – Manajemen Resiko

Komponen Penyediaan Peralatan Pertambangan

- Peralatan utama penambangan
- Peralatan penunjang pertambangan

Rencana Penggunaan dan Pengamangan Bahan Peledak

- Struktur organisasi perusahaan
- Organisasi dan personal K3

Ada Pertanyaan?