GEODATA

Initial Civil Risk Engineering Survey : **Las Lajas, Aucayes & Alfalfal II** Underground & Civil Works

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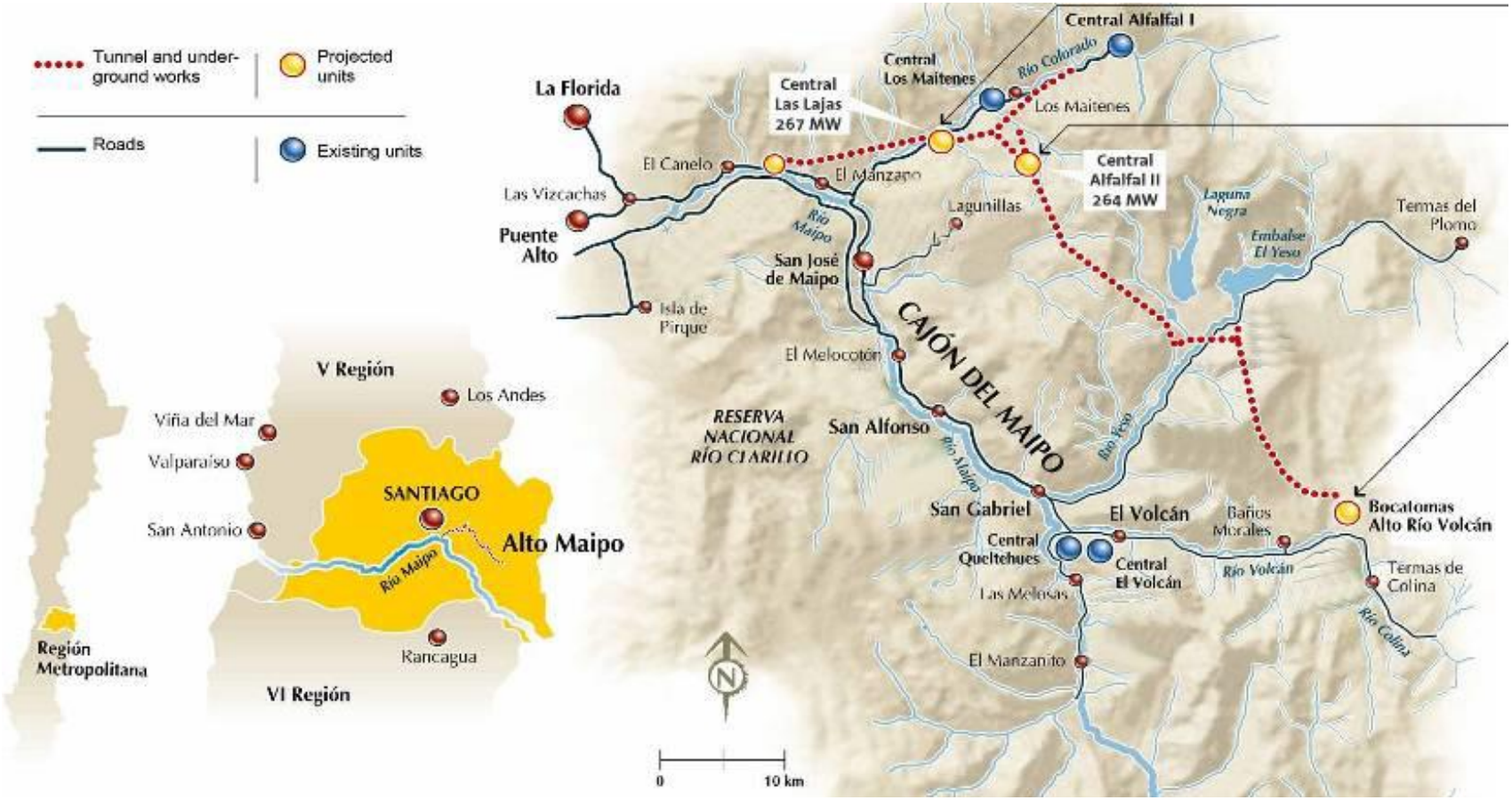
Hydroelectric Project Alto Maipo Co.630/620A + 620B/610

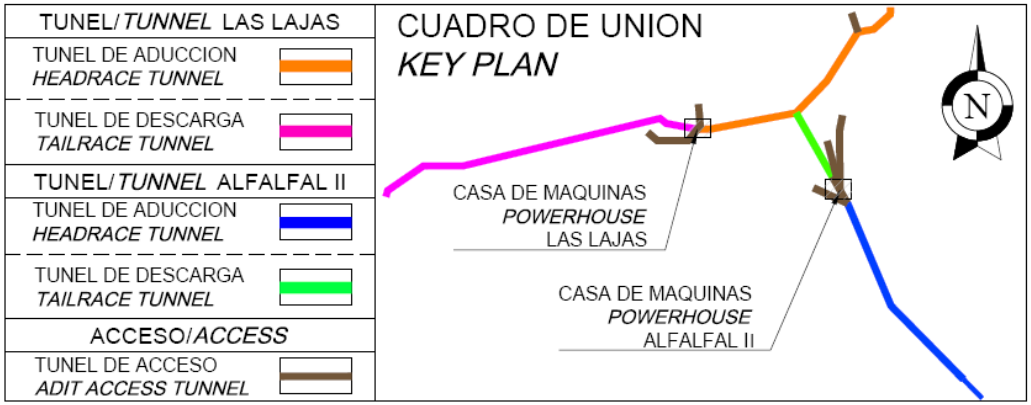


Hydroelectric Project Alto Maipo Co.630/620A + 620B/610

Underground structures :

D&B tunnels (4x4 – 8x8 m)	22.543 m
TBM tunnels (dia.3.4, 4.5, 6.9m)	22.362 m
Caverns (D&B)	
C-620 Alfalfall II	34.230 m³
C-630 Las Lajas	41.400 m³
Raiseboring (2.0-5.0 m)	19.523 m³

(for vert.pressure and surge shaft of Las Lajas)



Surface structures :

Muck Deposits :
MD5, 6, 7, 8, 9, 11, 12, 13, 14

Portals :
VA1,VA2, VL7, VL8, VL5, VL4, L1

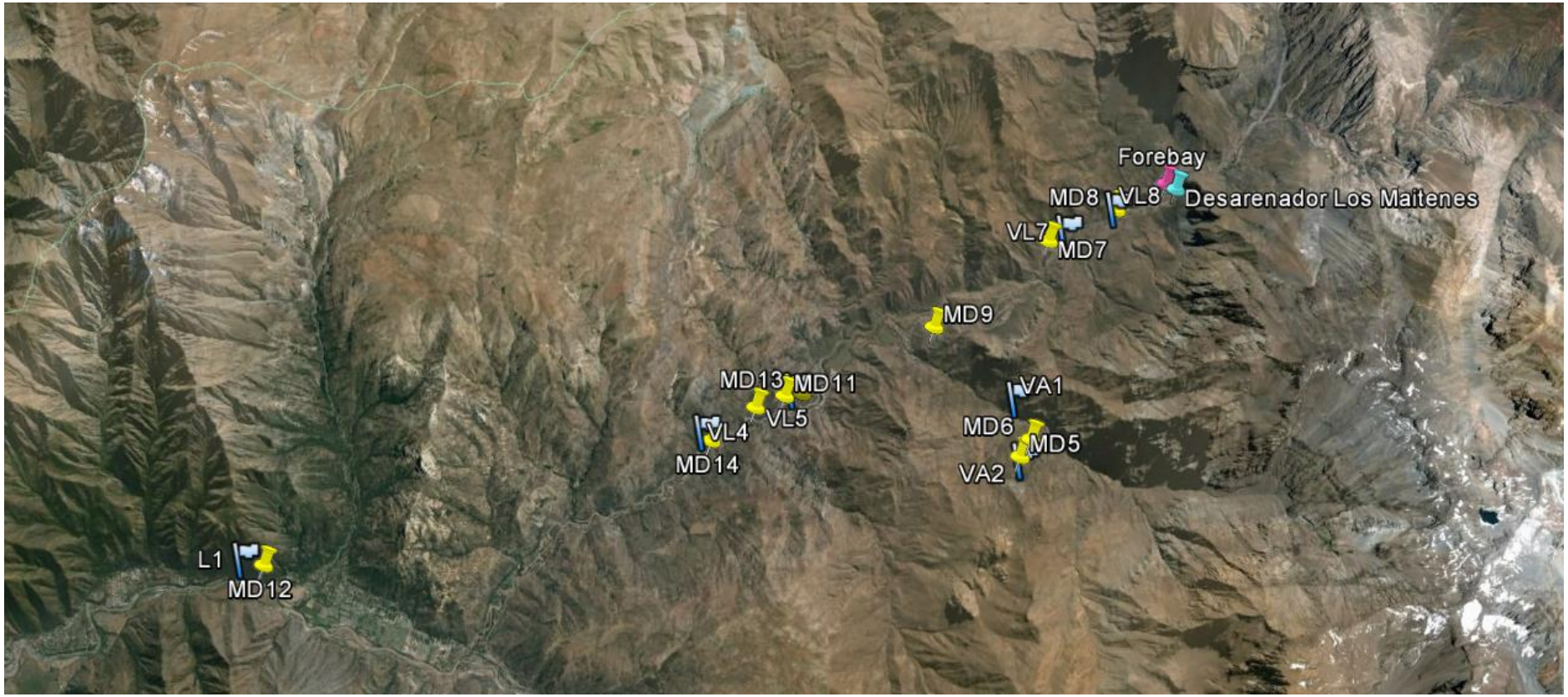
Forebay + Inlet Maitenes
Forebay Alfalfal II
Outlet L1

Access roads to portal areas

Construction time : **4,5 years**

Civil Design : Design Scope

Location of MD and Portals



Civil Design : Design Scope

Main structural parts

Permanent works

Tunnels TBM and D&B 46,5 km
Shafts
Caverns

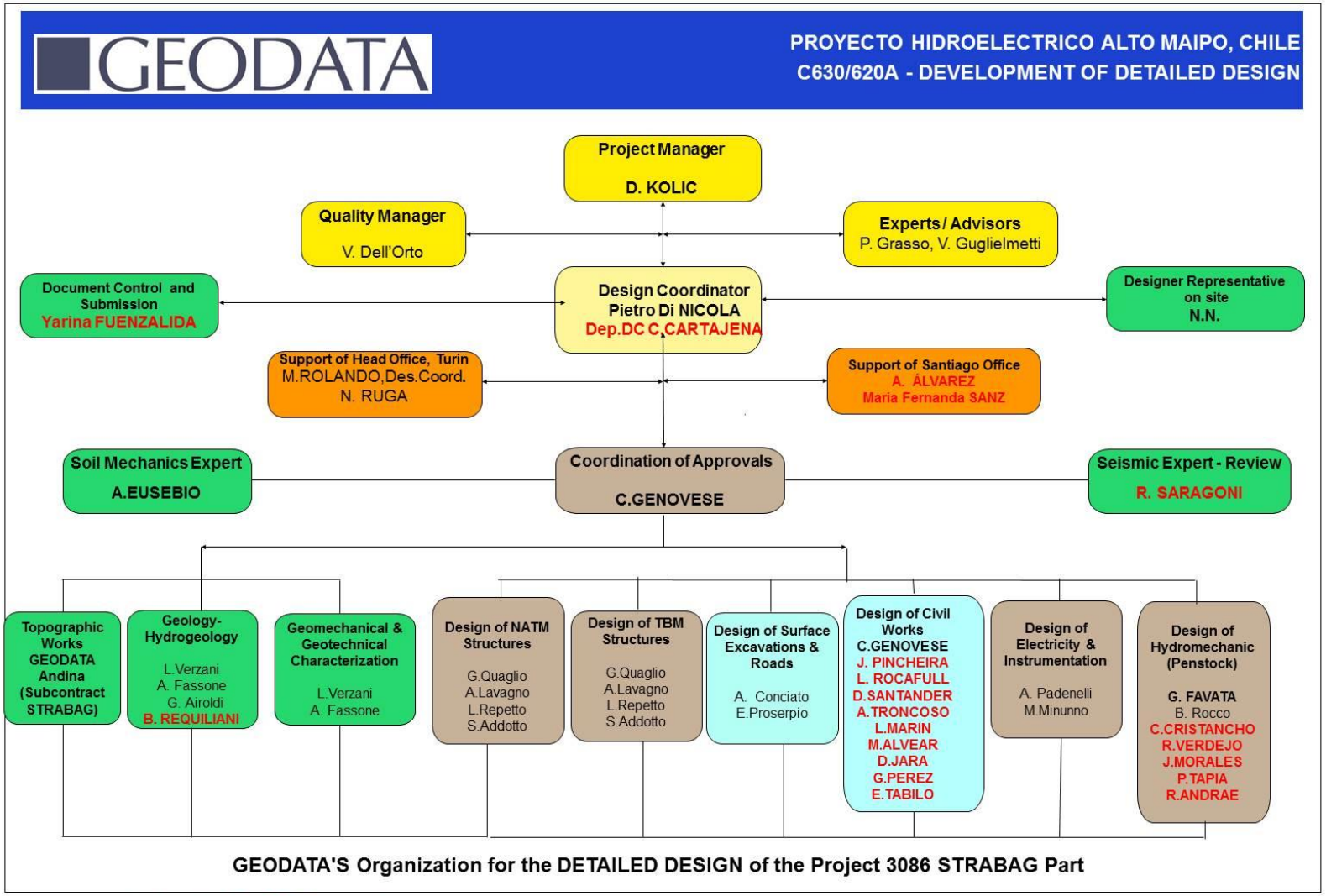
Muck Deposits
Inlets, Forebay, Outlet

Access roads (some)
Electric lines

Temporary works

Access roads (some)
Portals (partly)

Civil Design : Design Status



GEODATA'S Organization for the DETAILED DESIGN of the Project 3086 STRABAG Part

Ver. : Apr.22, 2014, in red : **employed by GD Chile,** **bold red and black : present in Santiago** , small letters : in Torino most of the time

Civil Design : Design Status

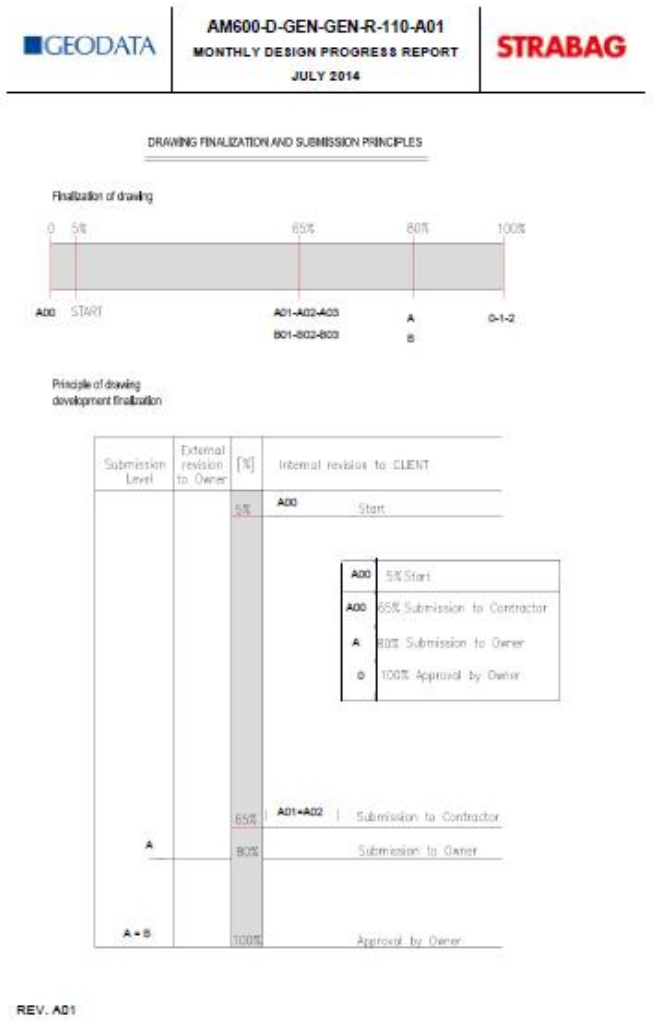
Design Performance :

Planned time : 16 mo, Sep13/Dec14
Performed time : 11 mo
Percentage : 68,75 % time used

Total dwgs : 1075
Delivered : 725
Percentage : 67,44 %

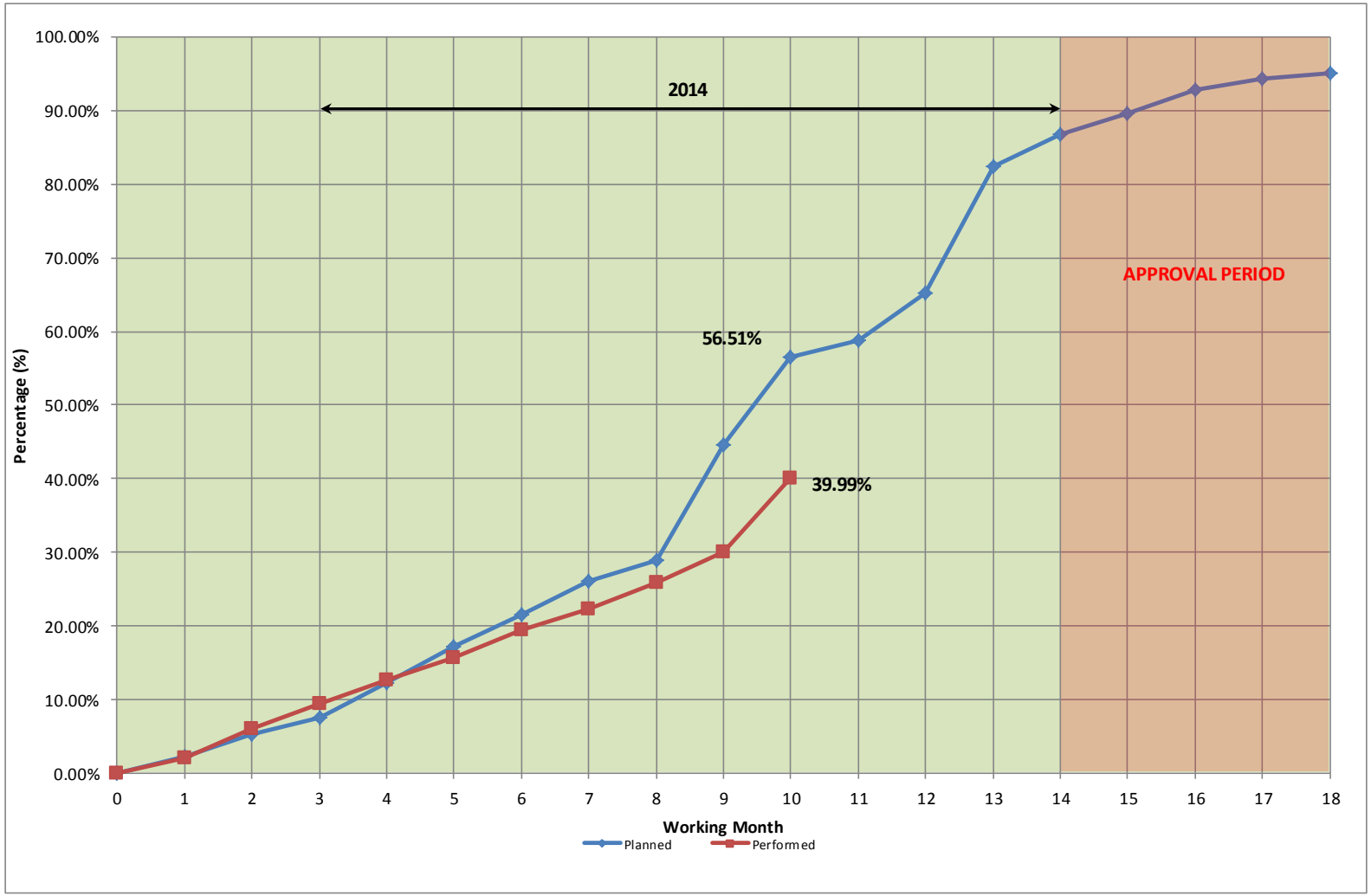
Planned perform. : 56,51 %
Performed : 39,99 %

No.dwgs approved: 27
Perc.of delivered : 3,72 %



GEODATA

Civil Design : Design Status



Performance curves : planned and performed, status as of : July 31, 2014

Civil Design : Site Investigations

LAS LAJAS Sector , Part 1

Las Lajas Sector	Location	Scheduled explorations	Performed explorations	OE's Recommendation (additional investigations)	Remark
L1	Portal Area	– Horizontal drilling without core recovery	– Granulometry – Attenberg limits – Modified Proctor – 5 inclined drillings with core recovery in rock formation: in total 89,5 m	It's recomended that all investigation drill holes should be drilled incline downwards since the tunnel alignment is much lower than the area where it's possible to drill from.	+
	Portal Area	– 30 degree drilling without core recovery	see above		+
	Muck Deposit 12	2 pits 2 samples per pit (at 2 m depth and at the bottom of the pit)	– Granulometry – Attenberg limits – Modified Proctor	– additional pit in the midle of the Muck Deposit – Granulometry, Atterberg Limits, Proctor Test, Shear Test	+

LAS LAJAS Sector , Part 2

Las Lajas Sector	Location	Scheduled explorations	Performed explorations	OE's Recommendation (additional investigations)	Remarks
VL4	Portal Area		– Granulometry – Attenberg limits – Modified Proctor – Triaxial		+
	Portal VL4		– 1st drilling campaign: 3 holes without core recovery (46,5 m) – 2nd drilling campaign: 7 holes without core recovery (117,32 m) – 3rd drilling campaign: 6 holes without core recovery (81,4 m) – 4th drilling campaign: 6 holes with core recovery (in progress)	campaign 2 to 4 was instructed by the Owner	**In work**
	Muck Deposit 14A	3 pits 2 samples per pit (at 2 m depth and at the bottom of the pit)	– Granulometry – Attenberg limits – Modified Proctor		+
	Muck Deposit 14B	2 pits 2 samples per pit (at 2 m depth and at the bottom of the pit)	– Granulometry – Attenberg limits – Modified Proctor – Nuclear densitometer		+

Civil Design : Site Investigations

LAS LAJAS Sector , Part 3

Las Lajas Sector	Location	Scheduled explorations	Performed explorations	OE's Recommendation (additional investigations)	Remarks
VL5	Muck Deposit 10	2 pits 2 samples per pit (at 2 m depth and at the bottom of the pit)	– Granulometry – Attenberg limits – Modified Proctor		open
	Portal Area		– Granulometry – Attenberg limits – Modified Proctor – Triaxial		open
	Portal VL5	2 vertical drillings with core recovery over tunnel axis at each side of the road. (if vertical drillings are not possilble, 3 horizontal drillings along tunnel axis without core recovery, once acces road is built)		Horizontal and incline drilling from the tunnel portal is recommended .	open
VL 7	Muck Deposit 7	not ready now		– Granulometry – Attenberg limits – Modified Proctor – 2 samples per pit (2m, at bottom)	open
	Portal VL7			No investigation required	+

Civil Design : Site Investigations

LAS LAJAS Sector , Part 4

Las Lajas Sector	Location	Scheduled explorations	Performed explorations	OE's Recommendation (additional investigations)	Remarks
VL 8	Portal VL8			No investigation required	+
	Muck Deposit 8		– Nuclear densitometer		+
Maitenes	Forebay	3 Exploratory drillings with core recovery and SPT every 3m, Lefranc every 5m			In work
	Forebay	6 pits	– Granulometry – Attenberg limits – Modified Proctor		+
Main workshop	Muck Deposit 11			– 2 pits If is not rock – Granulometry – Attenberg limits – Modified Proctor – Sheartest – 2 samples per pit (2m, at bottom)	open
Camp Aucayes Bajo	Camp Aucayes Bajo		– Granulometry – Attenberg limits – Modified Proctor		+
	Camp Aucayes Bajo		– Nuclear densitometer		+

Civil Design : Site Investigations

ALFALFAL II Sector

Alfalfal II	Location	Scheduled explorations	Performed explorations	OE's Recommendation (additional investigations)	Remarks
VA1	Portal Area			no requirements	+
	Portal VA1	(Slope protection required)		no requirements	+
Muck Deposit 9	Muck Deposit 9	(Keep safety distance to existing slope crest	– Granulometry – Attenberg limits – Modified Proctor – Triaxial	– existing muck deposit	+
VA1 - VA2	VA1 - VA2 Road	(Currently no inspections possible except manual digging) – 4 pits (as agreed on joint site visit on 22nd of July)	– geophysical investigations – manual digging of 5 exploratory pits and taking samples at a depth of 2 m and at the bottom of the pit	As constructed, if necessary – Granulometry – Attenberg limits – Modified Proctor – Triaxial/shear test if possible	+
	First road stretch		– Granulometry – Attenberg limits – Modified Proctor – Triaxial – Nuclear densitometer		+

Antic.Ground & GrWater Conditions

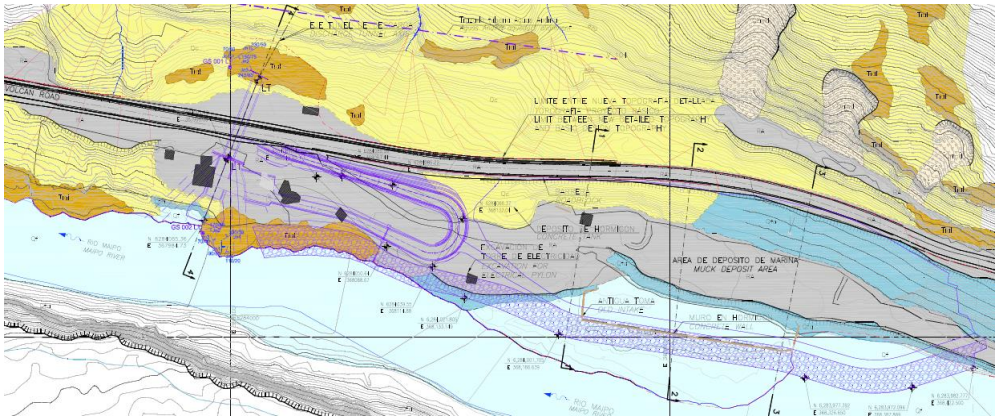
EXAMPLE ON MD12

- **Geological setting** :

1. Basis is the “Basic geological reference model” + on-site geological survey

2. Geotechnical verification

- Estimated geotechnical parameters
- Verification using method of limit equilibrium
- Ground water levels estimated and included in design on safe side (no detailed basic data available)



Soil	c [kPa]	ϕ [°]
Qf, Qfa, Qc	10	34
Mucking	0-10	36-40

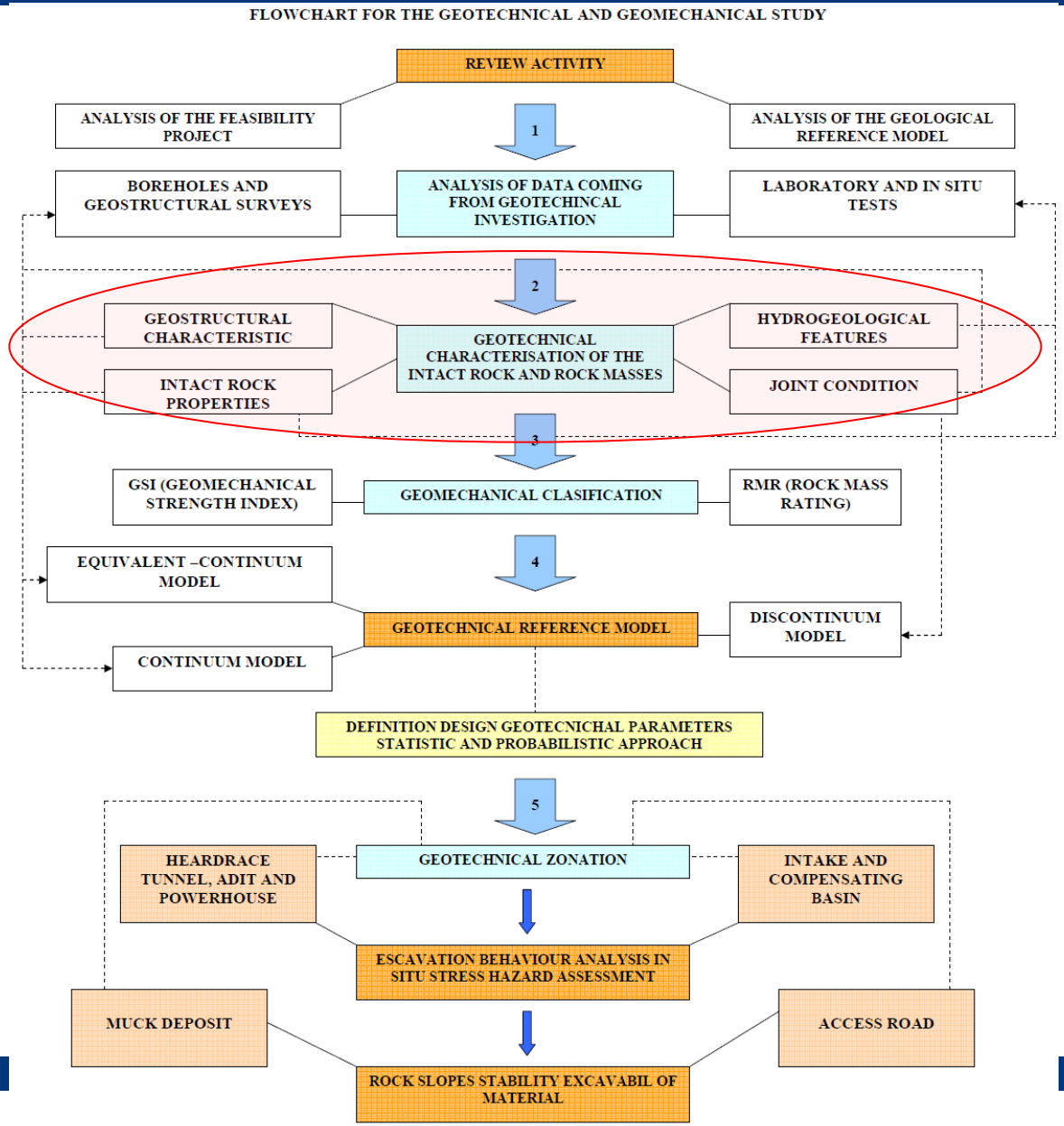
Civil Design : Ground Ref.Conditions

GEOTECHNICAL BASELINE REPORT

- Borings and samples taken form the site for laboratory investigations
- Report oin work for different sites
- So far work based on onaticipated ground conditions

- Samples and borings at L1 portal

Civil Design : Rock Mass Properties



ROCK MASS CHARACTERIZATION

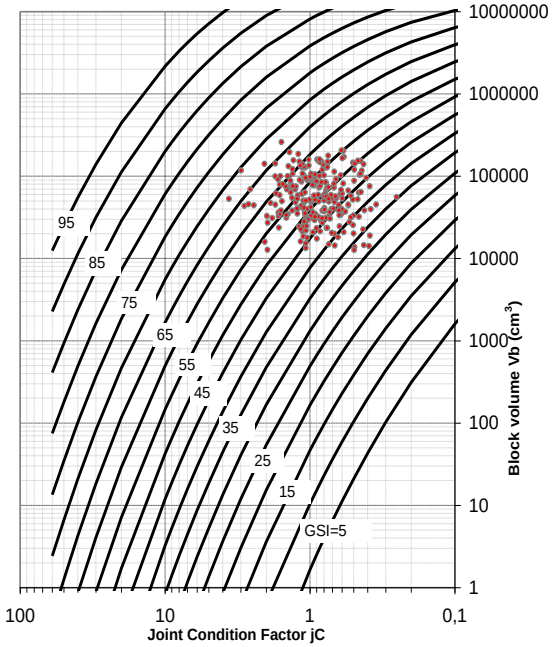
Based on :

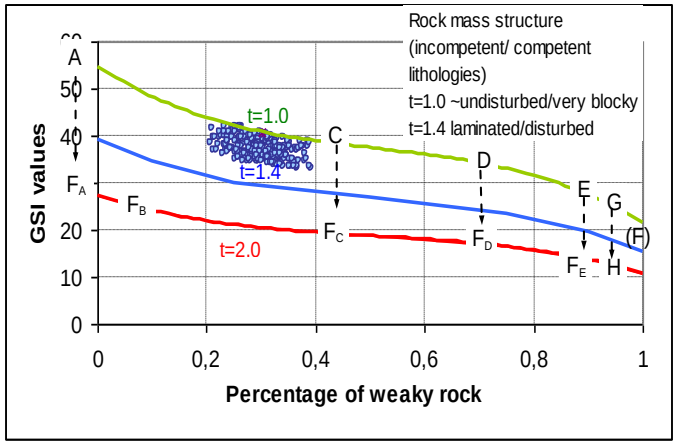
- Boreholes
- Geophysiscs surveys
- Laboratory and in situ tests

Geological surveys in period Sep.2013-Feb.2014

Civil Design : Rock Mass Properties

Example of GSI estimation using quant.probabilistic approach using structural survey results (Russo 2007,2009)





Example of GSI probab. GSI estimation by using Hoek-Marinos chart for heterogenous rock masses.

Principles described in “Design Manual”.

Civil Design : Seismic Loading

SEISMIC DESIGN of SURFACE STRUCTURES

Based on international practice and local guidelines and conditions application of seismic loading on surface structures :

Suggested improval of approach with reduced seismic loading bei SeiExp :

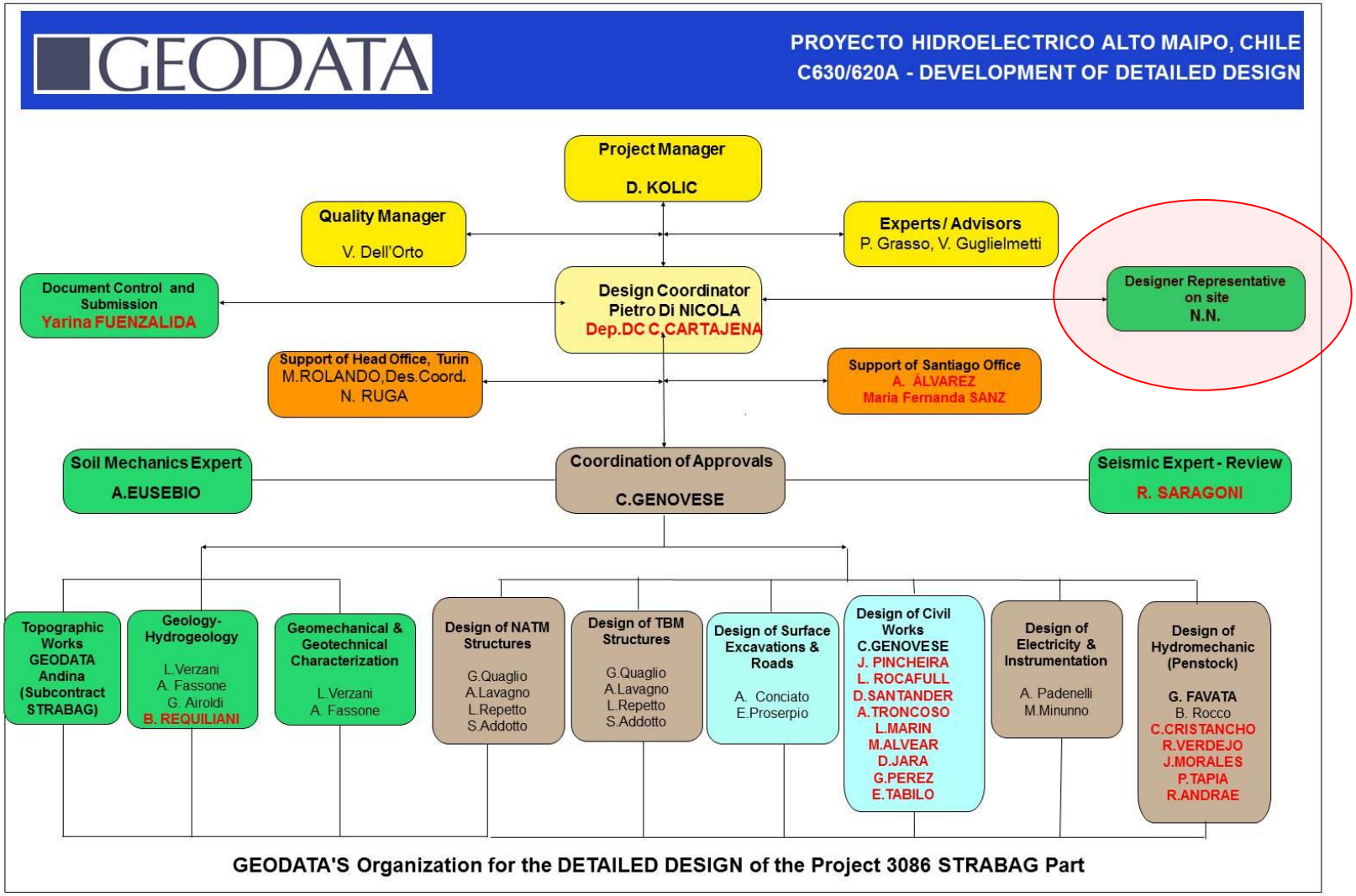
1. Surface structures (inlets, outlets RC, portals)

* Seismic coefficient Kh = 0.18 and Kv= 0.12

2. Earthworks and Muck Deposits MD

* Seismic coefficient Kh = 0.18 only

Civil Design : Role of Designer on Site



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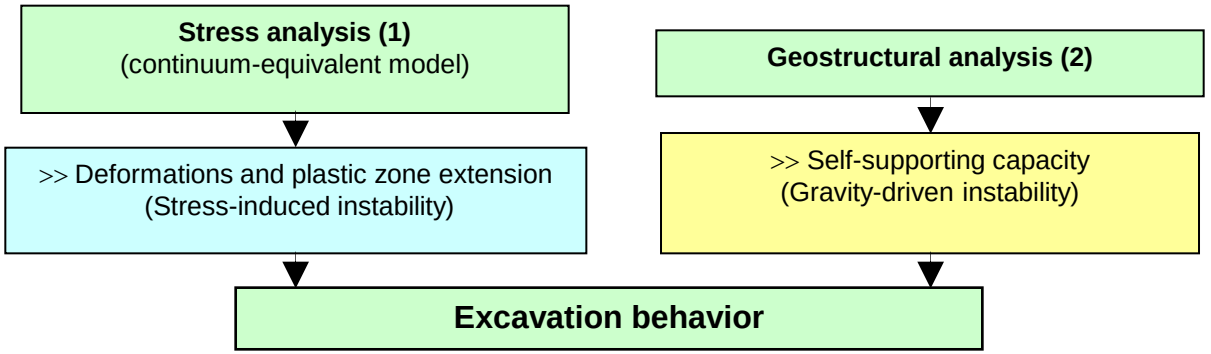
DRM : Risk Management Procedures

EXAMPLE of LAS LAJAS CAVERN

Flowchart of the excavation behaviour forecast analysis.

1. Flowchart illustrating the rationale of the excavation behavior forecast analysis



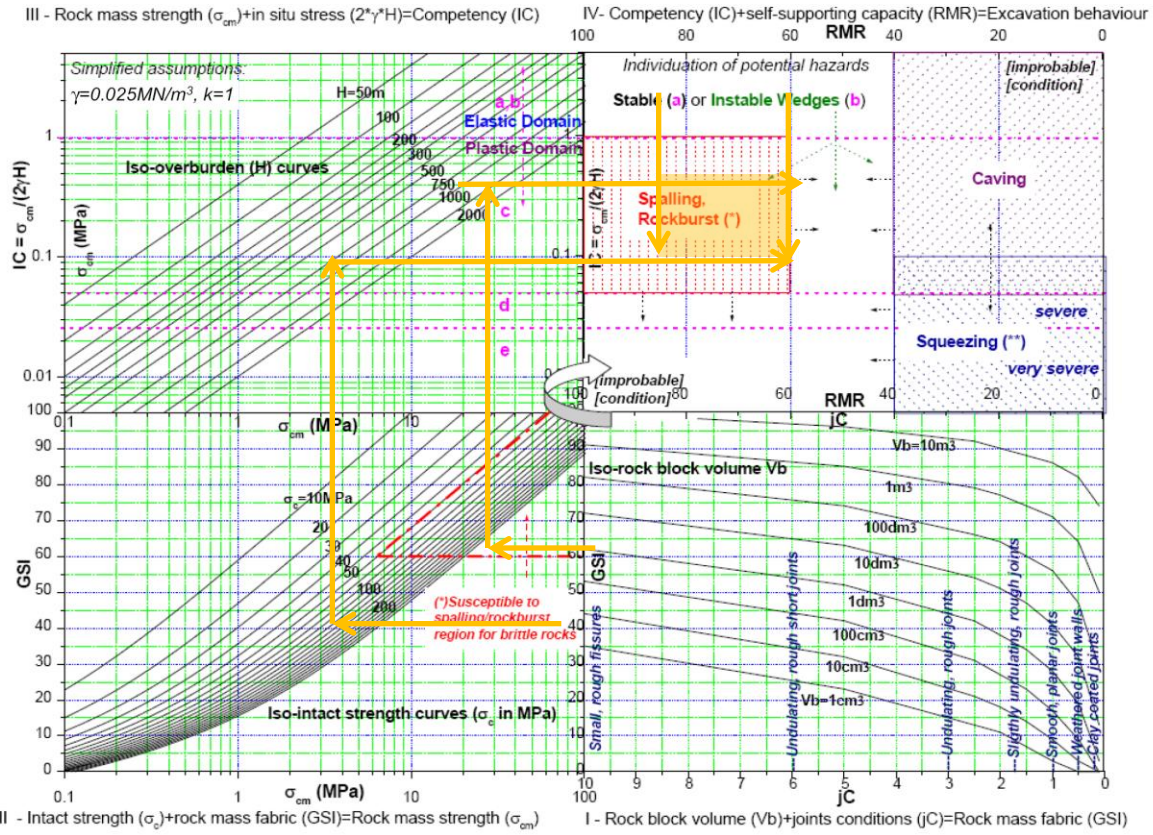
Scheme of excav behaviour.

1. General scheme of the excavation behavior

↓ Analysis →		Geostructural →		Rock mass: Continuous ↔ Discontinuous ↔ Equivalent C.
Tensional ↓				RMR: I / II / II / IV / V
Deformational response ↓	δ_0 (%)	$R_{pl,max}/R_0$	Behavioral category ↓	
Elastic ($\sigma_\theta<\sigma_{cm}$)	negligible	-	a	STABLE
			b	INSTABLE WEDGES — CAVING
Elastic - Plastic ($\sigma_\theta\geq\sigma_{cm}$)	<0.5	1-2	c	SPALLING/ ROCKBURST
	0.5-1.0	2-4	d	
	>1.0	>4	e	SQUEEZING
			(f)	→ Immediate collapse of tunnel face ↑

LAS LAJAS CAVERN

Simplified approach for the preliminary assessment of the excavation behaviour in rock tunnelling by Russo (2008,2014)



DRM : Design Risk Registers

LAS LAJAS Powerhouse

- application criteria for the support types

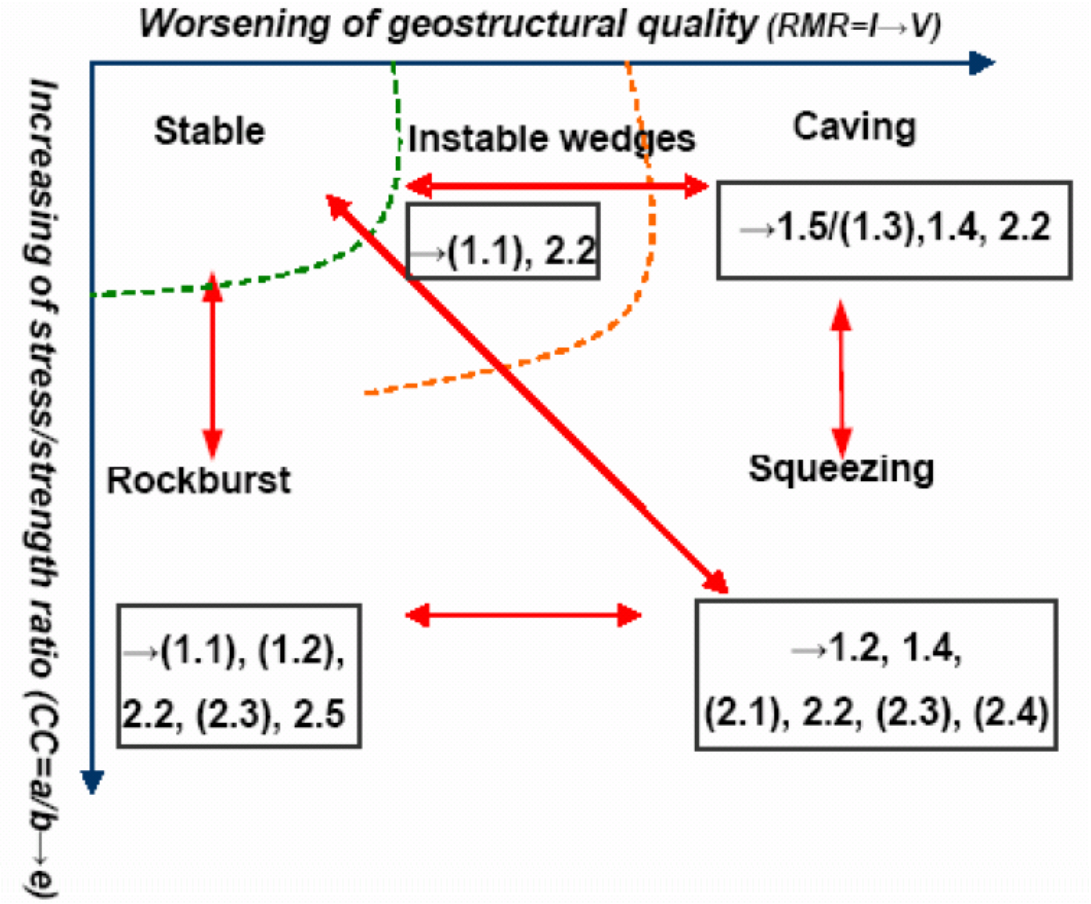
1. Application criteria of the support types

Prevalent Hazard	Geomechanical classification		Excavation behavior	Support Type
	BC	RMR		
Local wedge	"a"	I	Stable rock mass, with only possibility of local rock block fall; rock mass of very good quality with elastic response upon excavation	-
Wedge instability	"b"	II	Rock wedge instability; rock mass of good quality with elastic response upon excavation	Cavern
Rockfall	"a/b" - "c"	IIIa	Pronounced tendency to rockfall; rock mass of fair quality, with possible occurrence of a moderate development of plastic zone	
Spalling/ Rockburst	"c"	II	Mild brittle failure, even associated to minor rock block ejection; overstressed hard, good rock mass (→Minor spalling/rockburst)	
	"c"	I-II	Sudden brittle failure, even associated to moderate rock block ejection; overstressed hard, good rock mass (→Moderate spalling/rockburst).	-
	"c"	I-II	Sudden and violent brittle failure, even associated to rock block ejection; highly overstressed hard, good rock mass (→Severe spalling/ heavy rockburst)	-

DRM : Principal Loss Scenarios

LAS LAJAS Powerhouse

- Mitigation measures linked to excavation behaviour (Russo, Grasso, 2006-2007).



DRM : Principal Loss Scenarios

LAS LAJAS Powerhouse

- Mitigation measures linked to excavation behaviour

	1. Mitigation measures linked to excavation behavior	
#	Design Action	Example of Stabilization Measures
(1) In Advancing the Excavation		
(1.1)	Pre-confinement of instable wedges	Inclined bolts, forepoling, …
(1.2)	Rock mass reinforcement	Fully grouted rockbolts and dowels, …
(1.3)	Forward stabilization of poor ground	Sub-horizontal pressure grouting or jet-grouting canopy
(1.4)	Supporting the tunnel face	Shotcrete, steel bars, injected fibreglass elements, …
(1.5)	Forward reinforcement of poor ground	Umbrella arch
(2) During Excavation		
(2.1)	Allow for convergence	Over-excavation
(2.2)	Provision of a excavation support pressure	Support system differently composed by steel ribs, lattice girder, shotcrete with steel wire mesh, bolts, …
(2.3)	Rock mass reinforcement	Fully grouted rockbolts and dowels
(2.4)	Controlled de-confinement to allow high convergences	Sliding steel-ribs, shotcrete with joints and/or deformable elements, …
(2.5)	Protection against rockfalls and spalling	Rock bolt and/or shotcrete, wire mesh, …

DRM : Design Check and Appr. Proc.

DETAILED DESIGN as PART OF DESIGN and BUILD PROCEDURE

- Involvement of Soil Mechanic And Seismic Design Experts in Design Procedure
- Parallel analyses by different empirical and numerical methods
- Development of design and construction risk scenarios separately for each part of the project and each structural part.
- Approval in compliance with checkers in headquarter office (based on analyses and experience.

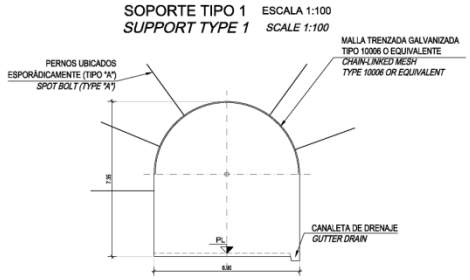
TUNNELS (Conventional+TBM) and CAVERNS

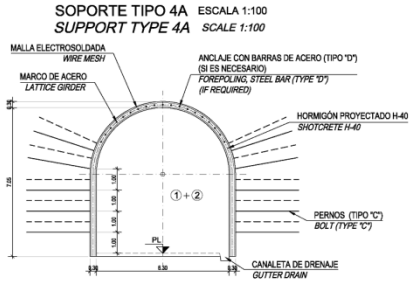
- Dimensioning and structural verification for each support type

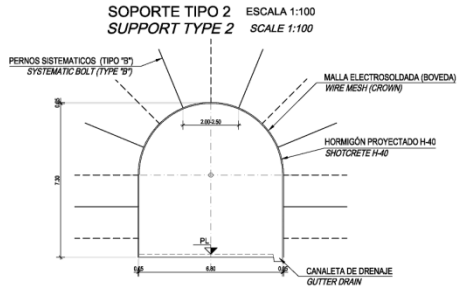
Support type			Analysis methods	
NATM	BASIC (GDE)		Primary support / Outer and Inner support (without cast in concrete)	Secondary support / Inner support (cast in concrete)
I	1-2 (A-B)		Empirical method (Grimstad & Barton)	Numerical method (FEM-BBM analysis)
	3 (C1)		Limit equilibrium method (Unwedge analysis or analytical formulations)	
II			Convergence-Confinement method	
II-III	4 (C2)	4 (C3)	Convergence-Confinement method + Numerical method (FEM analysis)	
I-II	3 (C4)	3’ (C5)	Hybrid empirical/numerical method (FEM analysis)	
III-IV	5 (D)		Numerical method (FEM analysis)	
V	5’ (E)		Numerical method (FEM analysis)	
VI	5’’ (F)		Numerical method (FEM-BBM analysis)	

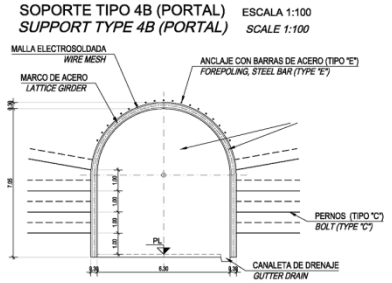
CONVENTIONAL TUNNELLING

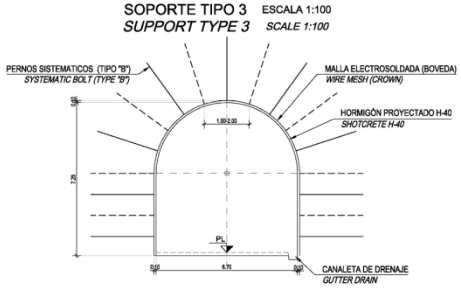
- foreseen generally 5 class types
- Class 1 : spot bolts
- Class 2 : systematic bolts + wire mesh + shotcrete (SFRC)
- Class 3 : systematic bolts + wire mesh + shotcrete 2 layers (SFRC)
- Class 4a-b: systematic bolts + wire mesh + shotcrete 2 layers (SFRC) + lattice girders+ forepoling
- Class 5 : systematic bolts + wire mesh + shotcrete 2 layers (SFRC) + lattice girders+ forepoling + face anchors
-

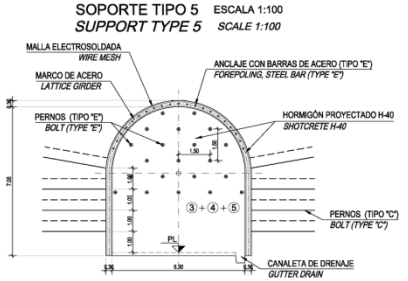










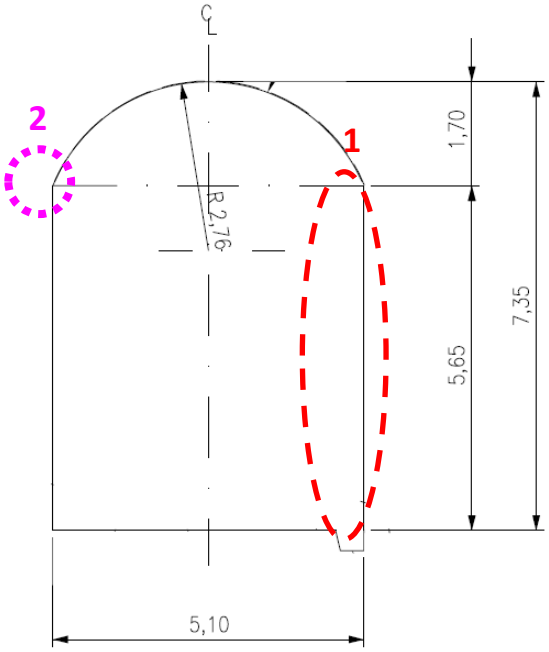


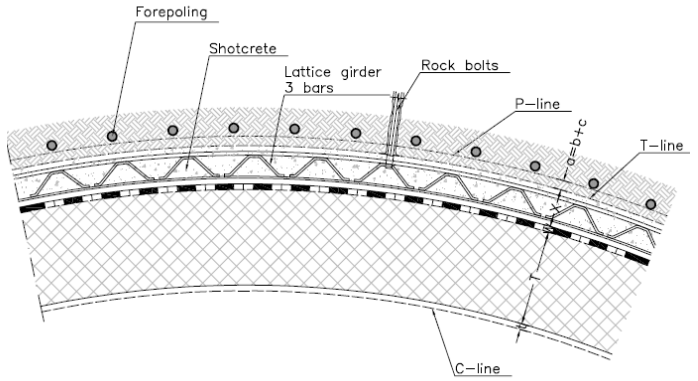
CONVENTIONAL TUNNELLING

Verification + improvements

- vertical side walls and sharp edges : shape improves stress redistribution and concentrations
- theoretical excavation line definition

(no convergencies foreseen)





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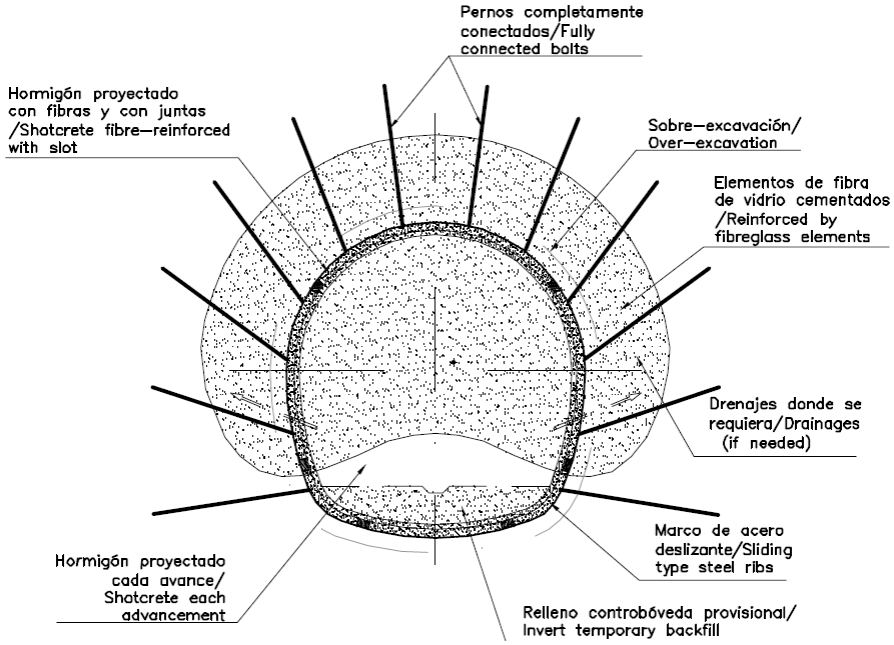
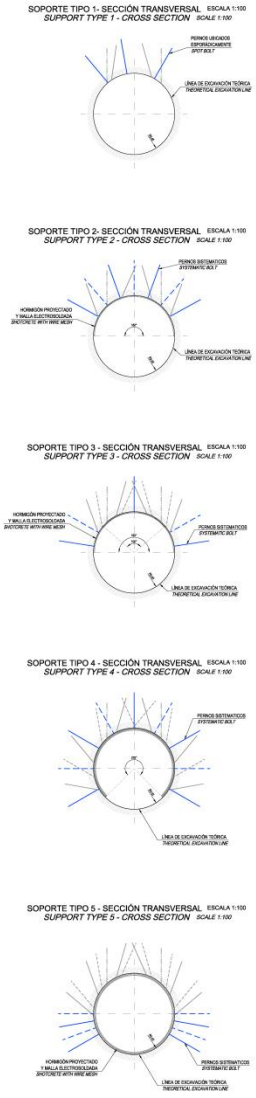
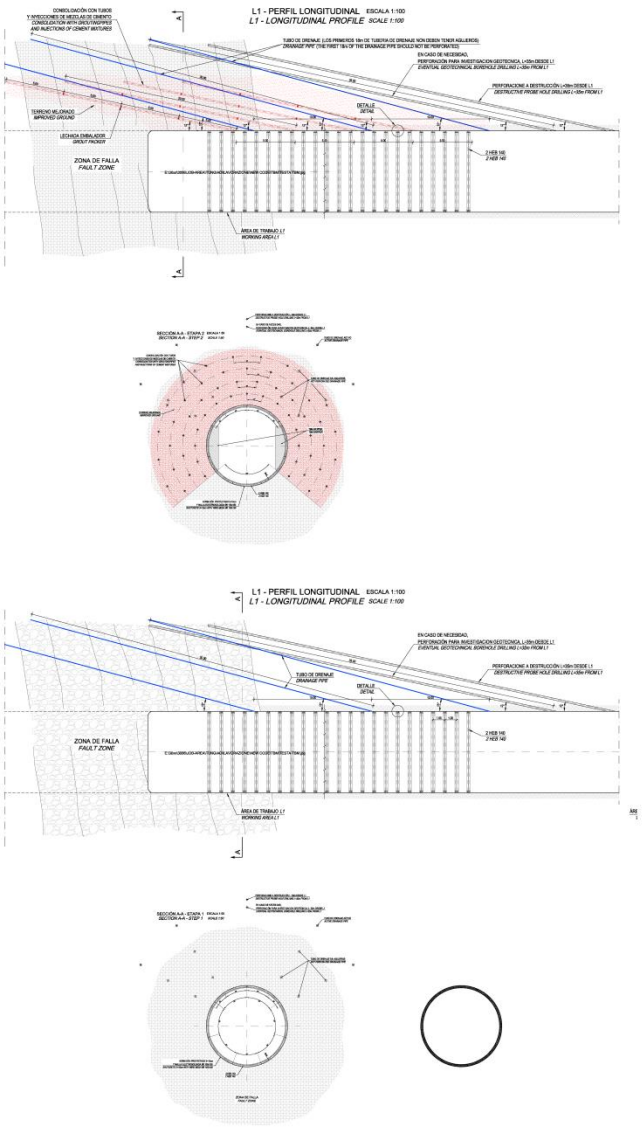


TBM Tunnelling

- foreseen generally 5 class types:
- Class 1 : spot bolts + systematic bolting + wire mesh+ SpB 50 mm
- Class 2 : spot bolts + systematic bolting + wire mesh+ SpB100mm
- Class 3 : systematic bolting + wire mesh + SpB150mm + steel ribs UPN140
- Class 4 : systematic bolting + wire mesh– full ring+ SpB100mm + steel ribs UPN160
- Class 5 : systematic bolting + wiremesh-full ring + SpB100mm full ring + arches TH25/28 full ring
- If required : probe drillings + drainage pipes (35m)+consol. with grout pipes

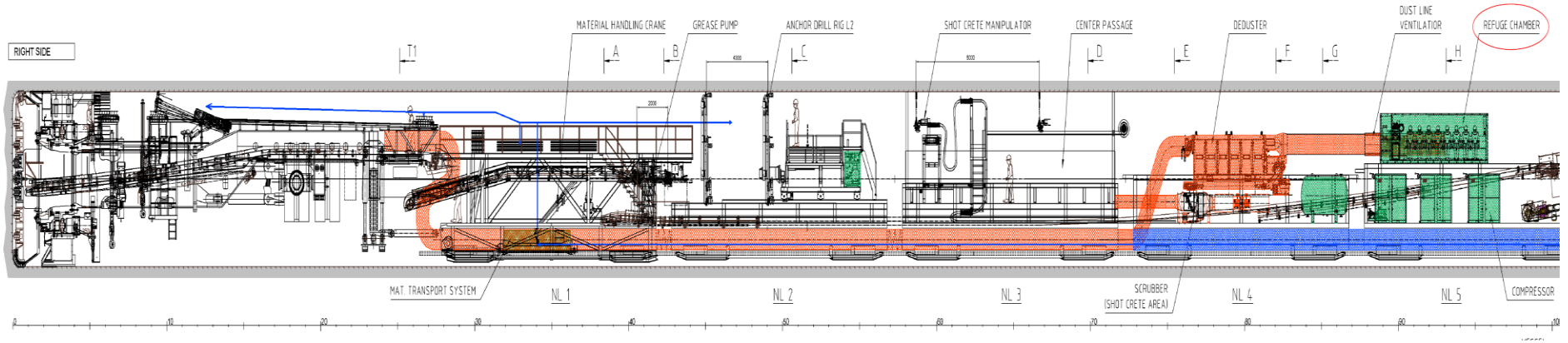




UC : TBM Specifications

TBM Tunnelling

- 6.90 m excavation diameter, open shield gripper TBM
- Herreknecht machine for 10.0 km of 12.9 km of Las Lajas tailrace tunnel starting from L1 upwards



- Another TBM tunnel of 4.53 m diameter open type expected for about 9.5 km of 14.5 km of Afalfal II tunnel, starting form downstream upwards

UC : TBM Specifications

TBM Tunnelling

STRUCTURE AND MATERIAL	
Shield Type	Open type gripper TBM, new
GRIPPER SHIELD	
Nominal Diameter	6.900 mm
ROOF SHIELD	
Dimensions (bore x rod x stroke)	240mm x 200mm x 250mm
Nominal force	7.238 kN @400 bar
SIDE SHIELD	
Nom. Working range	+110mm/-120mm of nom. Bore diameter
Dimensions (bore x rod x stroke)	320mm x 220mm x 800mm
Nominal force	6.434 kN@400 bar
Nominal force (pull force)	1.206 kN
WORKING PLATFORMS	
Main beam	Ring beam platforms
Main beam	Roof drill platforms

UC : TBM Specifications

TBM Tunnelling

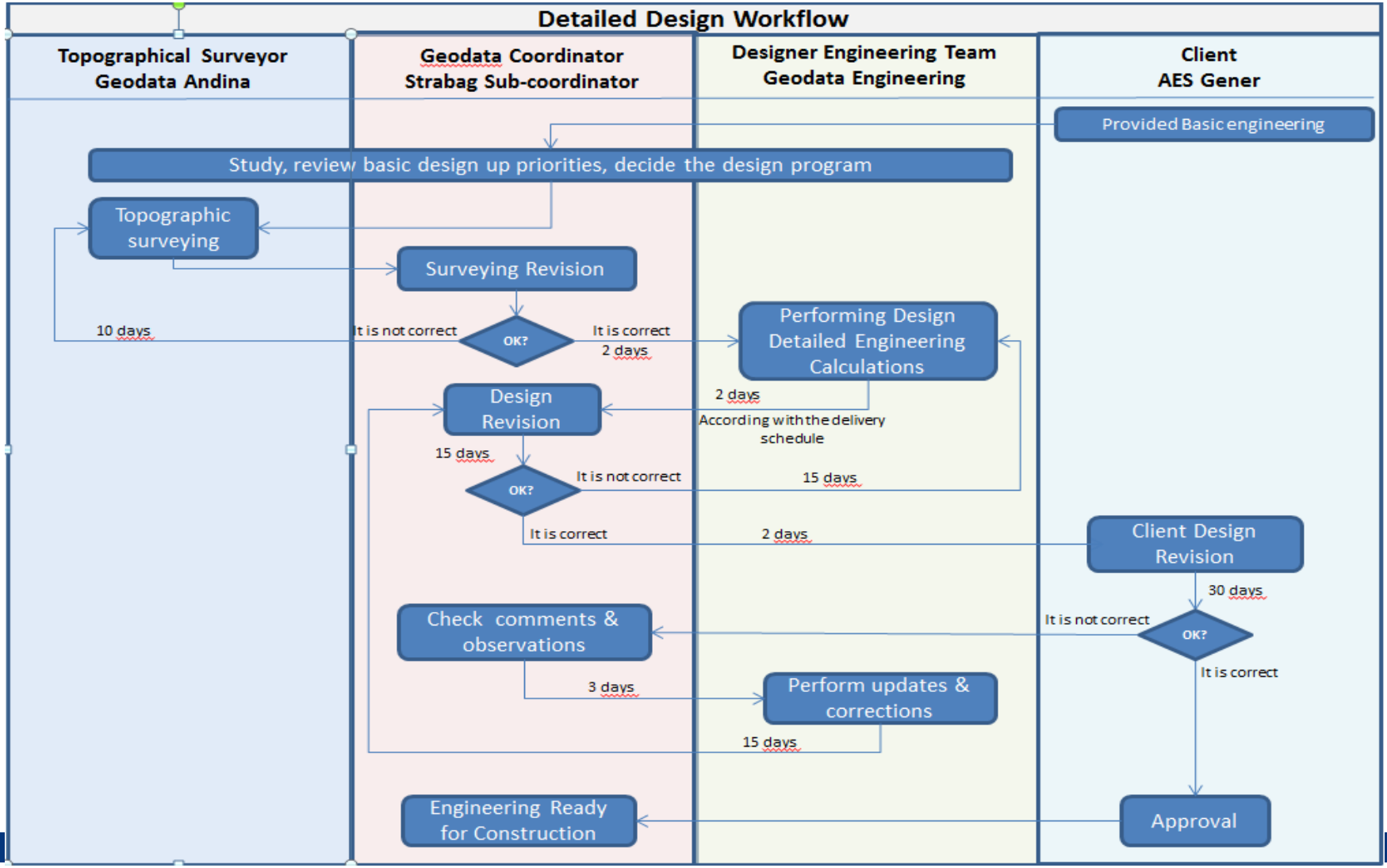
HYDRAULIC SYSTEM	
Power installed	110 kW
System operating pressure	350 bar
Max. System pressure	400 bar
Reservoir capacity	~3.500 lt
Filtration system	Continuous loop filter system
OPERATORS CABIN	
PLC system	SIEMENS PLC control system of all TBM functions from operators cab
TBM guidance system	TUnIS navigation gripper & TUnIS navigation office
COMUNICATION	
Communication phones on TBM/BU	5pcs
GAS MONITORING EQUIPMENT	
Sensors and monitoring equipment	1 set, sensor set consists of: methane, 3 pcs; carbon monoxide, 1 pcs; nitrogen monoxide, 1 pcs; hydrogen sulfide, 1pcs

UC : TBM Specifications

TBM Tunnelling

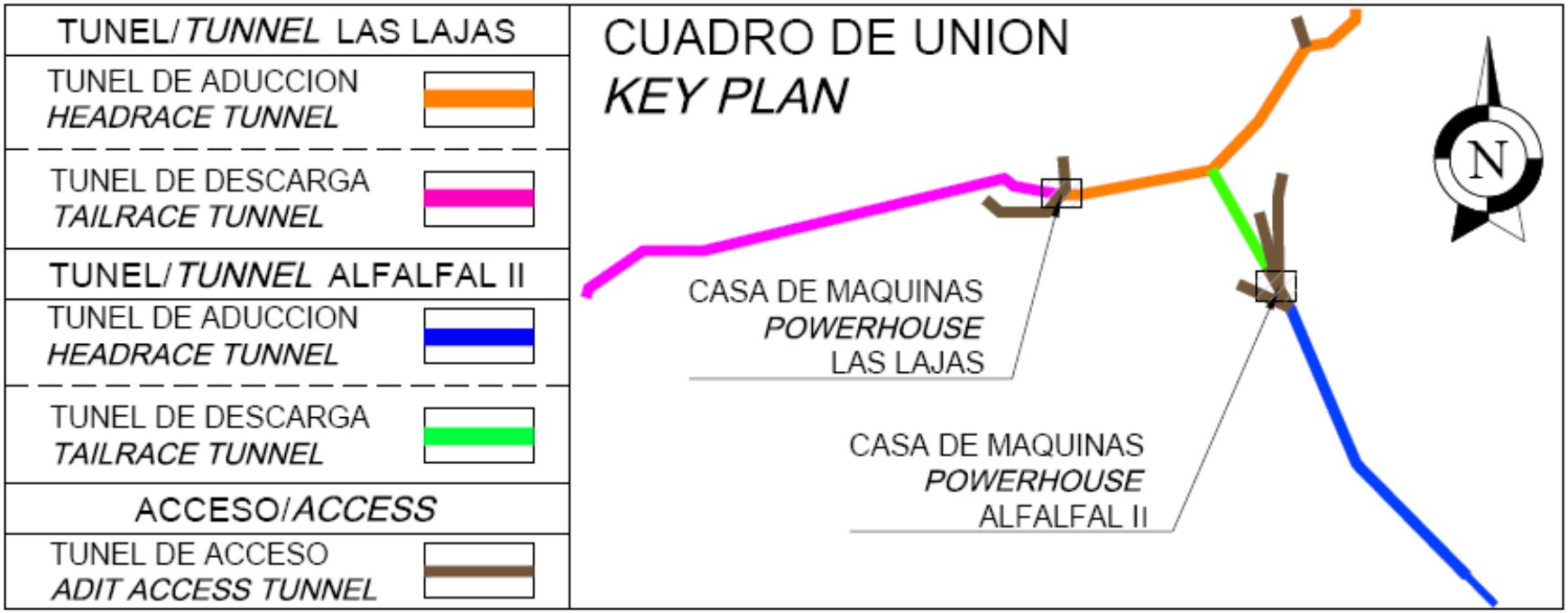
TBM CONVEYOR	
rain size	Max. 300mm x 300 mm x 500 mm
Belt width	800 mm
Transport capacity	800 to/hr
Belt speed	0 – 2.5 m/s, VFD controlled
Belt type	EP 630/4, 10+4mm, UTS class A
Misting system	1 pcs @transfer point to BU conveyor
Metal detector	1 pcs

TBM Tunnelling



LAS LAJAS Powerhouse

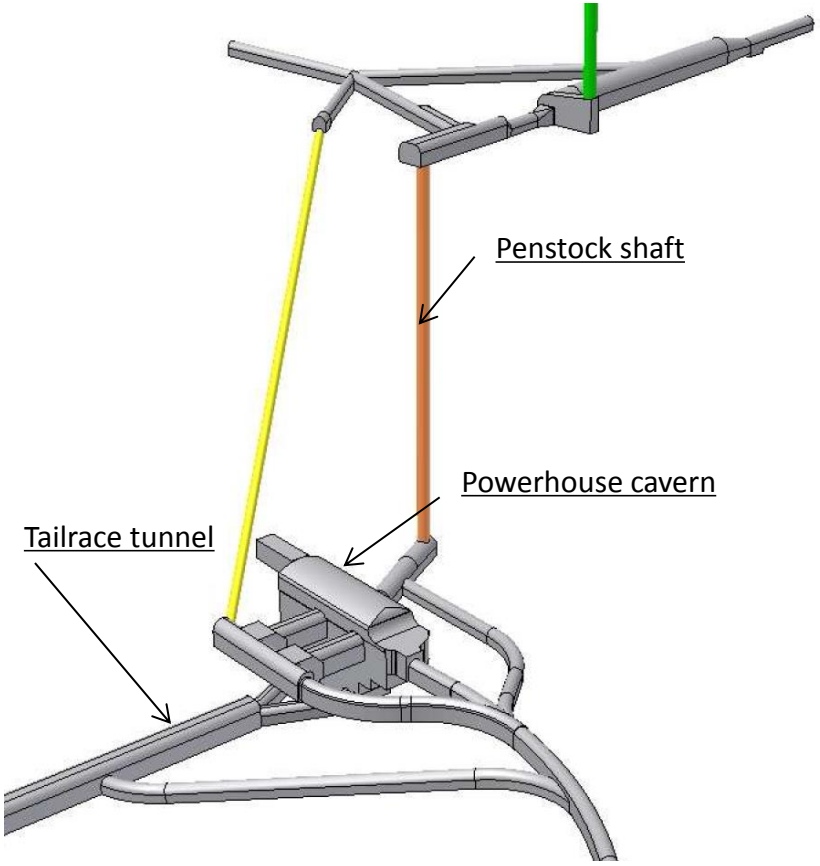
- 2 powerhouses with Las Lajas and Alfalfal II with 267+264 MW capacity
- Las Lajas powerhouse in Colorado river valley, downstream 3 km
- Headrace tunnel collects water of Alfalfall I ,Alfalfall II, Maitenes plants toward Las Lajas, 65 m^3/sec, 483 m height = 267 MW



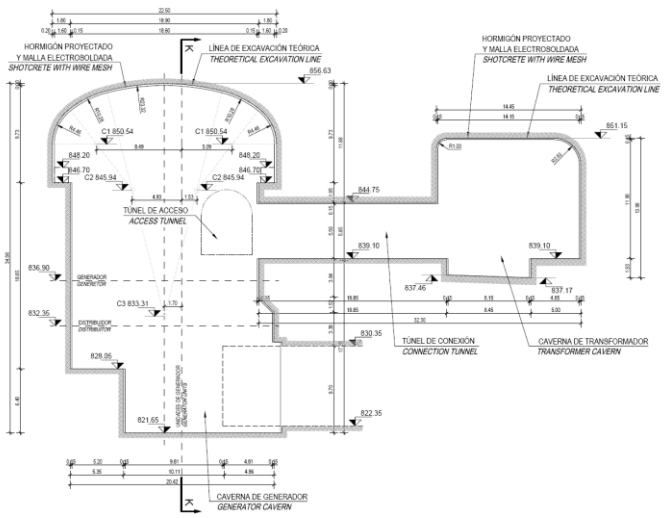
UC : Cavern Design

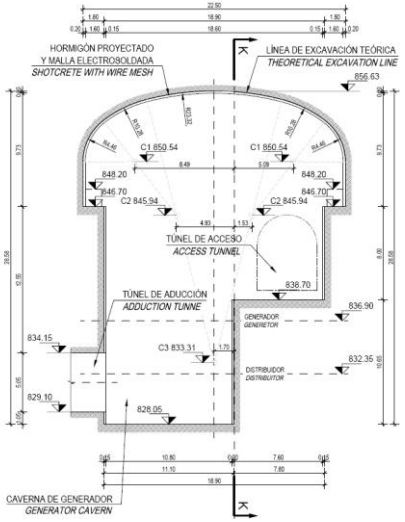
LAS LAJAS Powerhouse

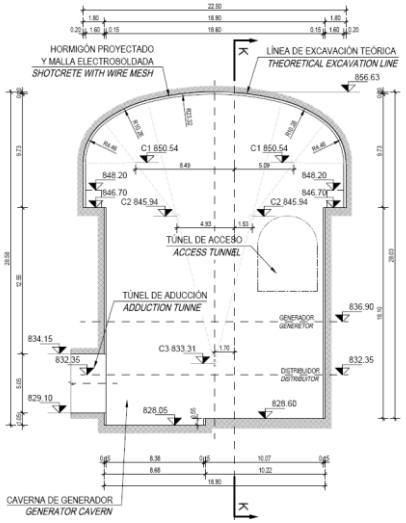
- located with about 500 m overburden, left side of the Colorado River
- with tailrace tunnel stretching downwards
- Geological Setting
- Rock masses of Abanico occidental Formation, Unit A
- rock masses at the depth ofthe Las Lajas PH foreseen stratified,
- With strata thicknesses from some tens of centimeters to some meters
- Expected : medium-high quality rock mass ,RMR II-IIIa



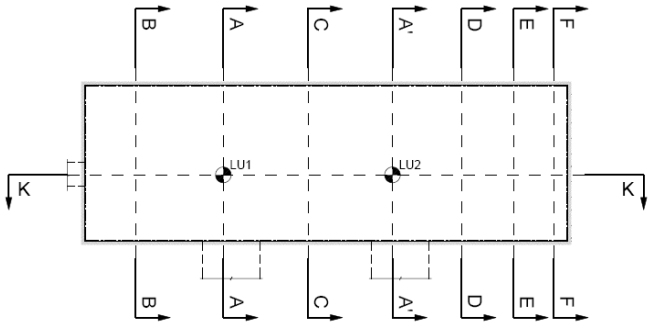
LAS LAJAS Powerhouse – Typical Cross Sections







Section A-A **Section B-B** **Section C-C**



LAS LAJAS Powerhouse

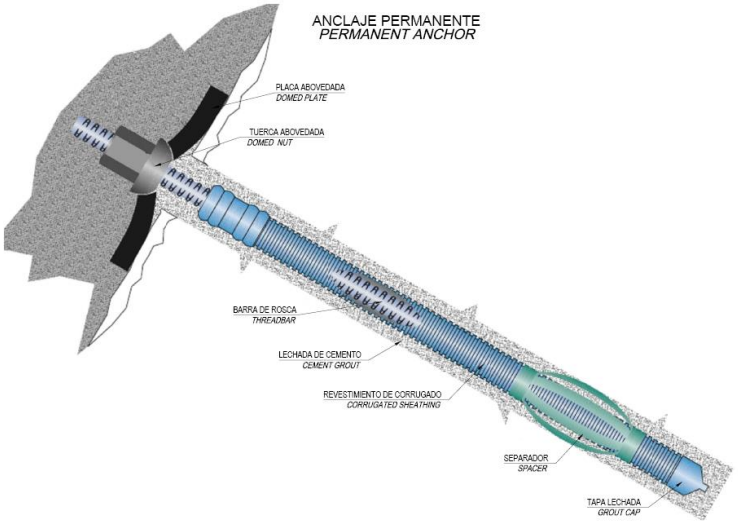
- application criteria for the support types

1. Application criteria of the support types

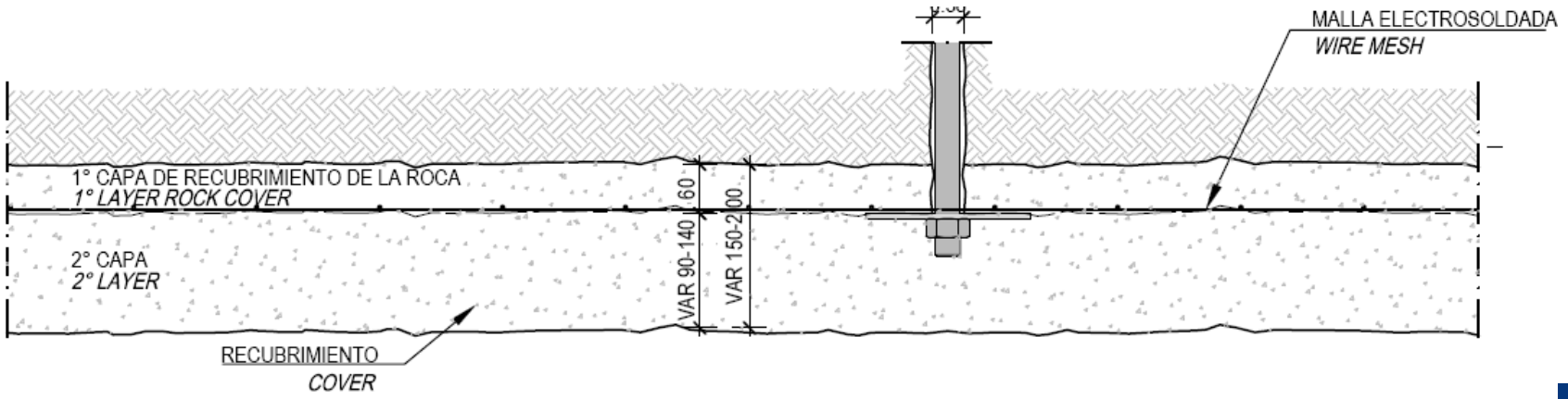
Prevalent Hazard	Geomechanical classification		Excavation behavior	Support Type
	BC	RMR		
Local wedge	"a"	I	Stable rock mass, with only possibility of local rock block fall; rock mass of very good quality with elastic response upon excavation	-
Wedge instability	"b"	**II**	Rock wedge instability; rock mass of good quality with elastic response upon excavation	Cavern
Rockfall	"a/b" - "c"	**IIIa**	Pronounced tendency to rockfall; rock mass of fair quality, with possible occurrence of a moderate development of plastic zone	
Spalling/ Rockburst	"c"	**II**	Mild brittle failure, even associated to minor rock block ejection; overstressed hard, good rock mass (→Minor spalling/rockburst)	
	"c"	I-II	Sudden brittle failure, even associated to moderate rock block ejection; overstressed hard, good rock mass (→Moderate spalling/rockburst).	-
	"c"	I-II	Sudden and violent brittle failure, even associated to rock block ejection; highly overstressed hard, good rock mass (→Severe spalling/ heavy rockburst)	-

LAS LAJAS Powerhouse

- Support type for the cavern

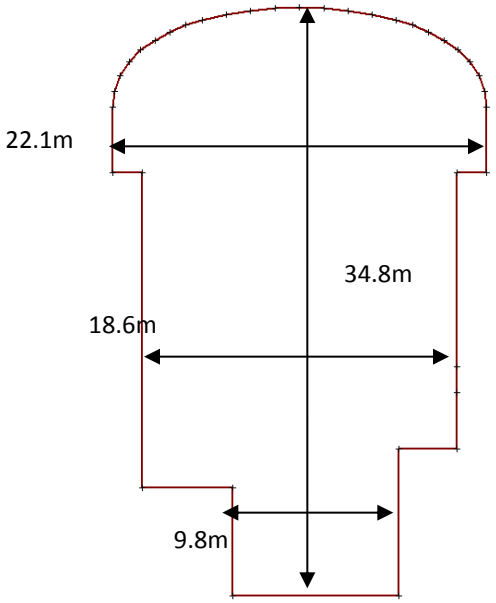


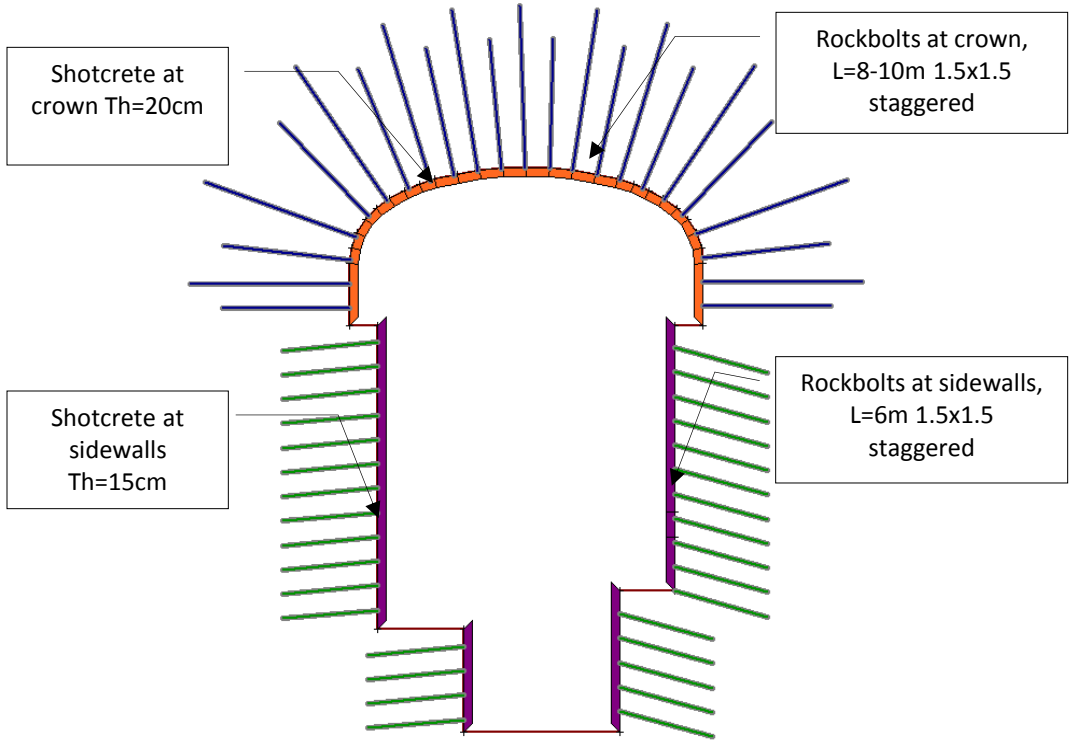
1. Support type of the cavern		
#	**Stabilization Measures**	**Note**
-	Radial drainages, L=12m, pattern 6.0x 6.0m	(*)
2.2	Shotcrete H-40 with steel wire mesh, Th=200mm at crown and Th=150mm at sidewalls	Wire mesh ACMA C-188 150x150 F6mm
2.2	Systematic rockbolt pattern 1.5x 1.5m staggered, L=8-10m at crown and L=6m(min)-9m(max) at sidewalls	-Suggested DCP bolt for Powerhouse cavern



LAS LAJAS Powerhouse

- Rock Support Measures





LAS LAJAS Powerhouse

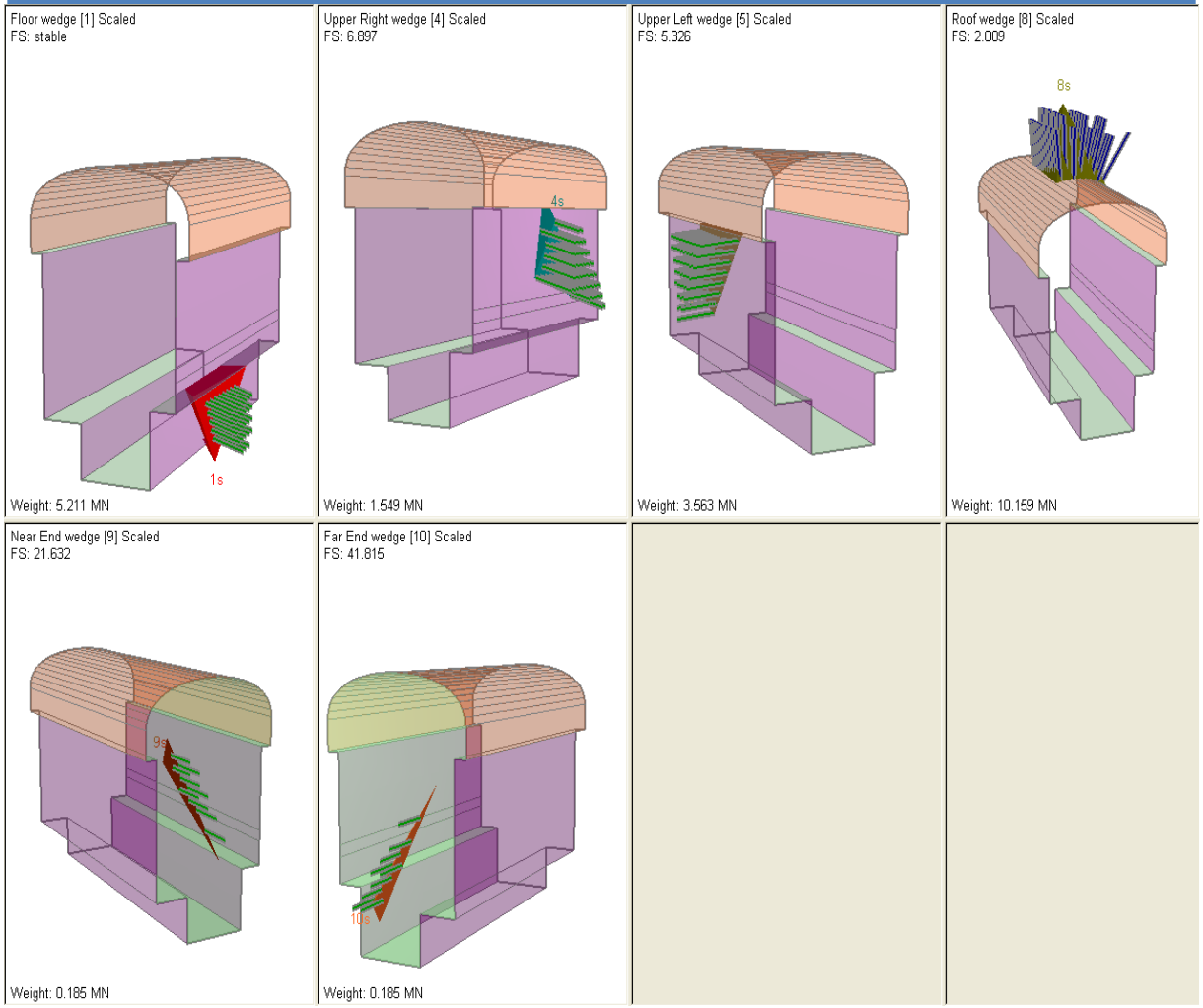
- Mitigation measures linked to excavation behaviour

	1. Mitigation measures linked to excavation behavior	
#	Design Action	Example of Stabilization Measures
(1) In Advancing the Excavation		
(1.1)	Pre-confinement of instable wedges	Inclined bolts, forepoling, …
(1.2)	Rock mass reinforcement	Fully grouted rockbolts and dowels, …
(1.3)	Forward stabilization of poor ground	Sub-horizontal pressure grouting or jet-grouting canopy
(1.4)	Supporting the tunnel face	Shotcrete, steel bars, injected fibreglass elements, …
(1.5)	Forward reinforcement of poor ground	Umbrella arch
(2) During Excavation		
(2.1)	Allow for convergence	Over-excavation
(2.2)	Provision of a excavation support pressure	Support system differently composed by steel ribs, lattice girder, shotcrete with steel wire mesh, bolts, …
(2.3)	Rock mass reinforcement	Fully grouted rockbolts and dowels
(2.4)	Controlled de-confinement to allow high convergences	Sliding steel-ribs, shotcrete with joints and/or deformable elements, …
(2.5)	Protection against rockfalls and spalling	Rock bolt and/or shotcrete, wire mesh, …

LAS LAJAS Powerhouse

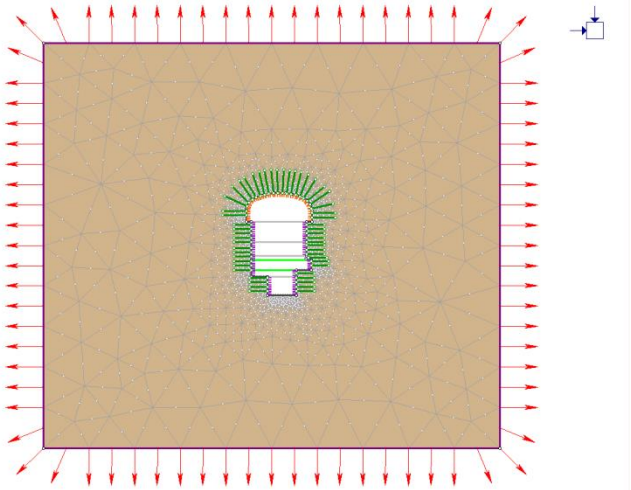
- Support verification
- wedge analysis

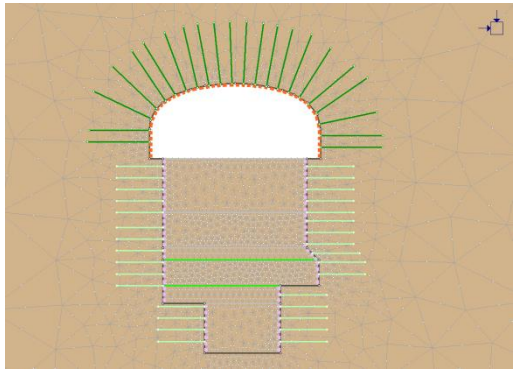
1. UNWEDGE results – Minimum SF resulting from joints S2, S5 and S8 intersection

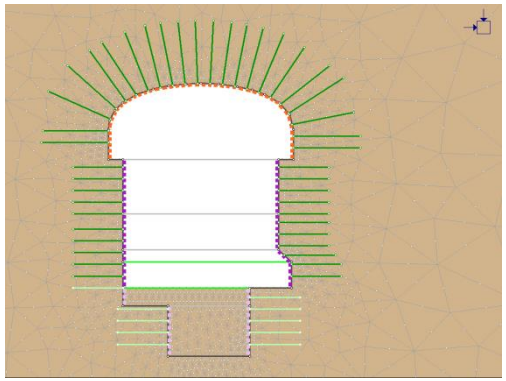


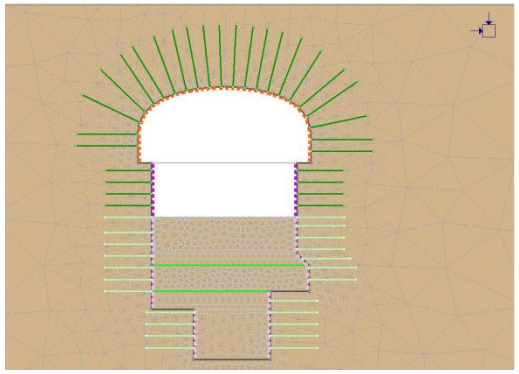
LAS LAJAS Powerhouse

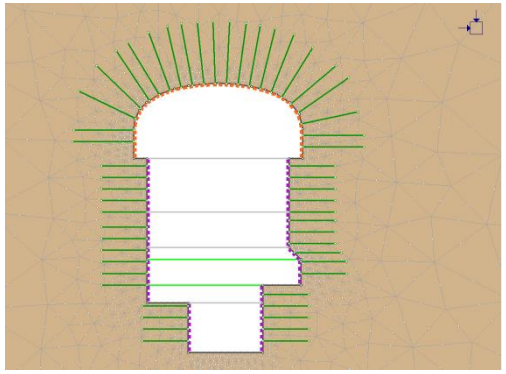
- Support verification
- Numerical model for FEM analysis and sequential excavation analysis in 4 steps





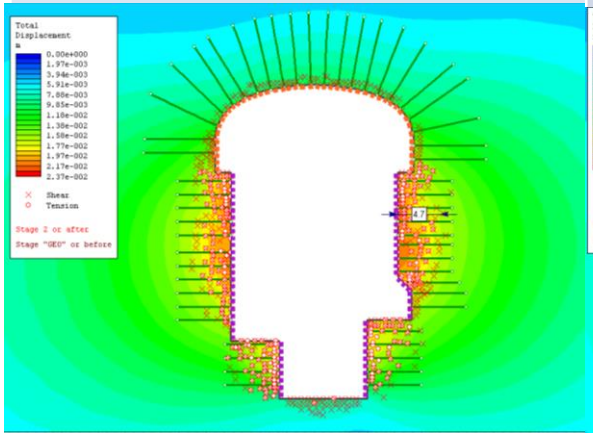
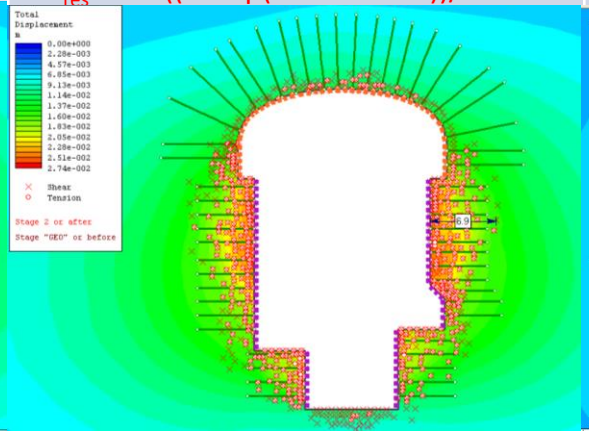
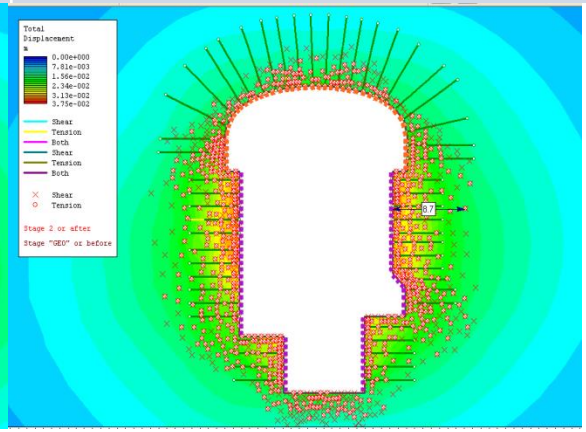






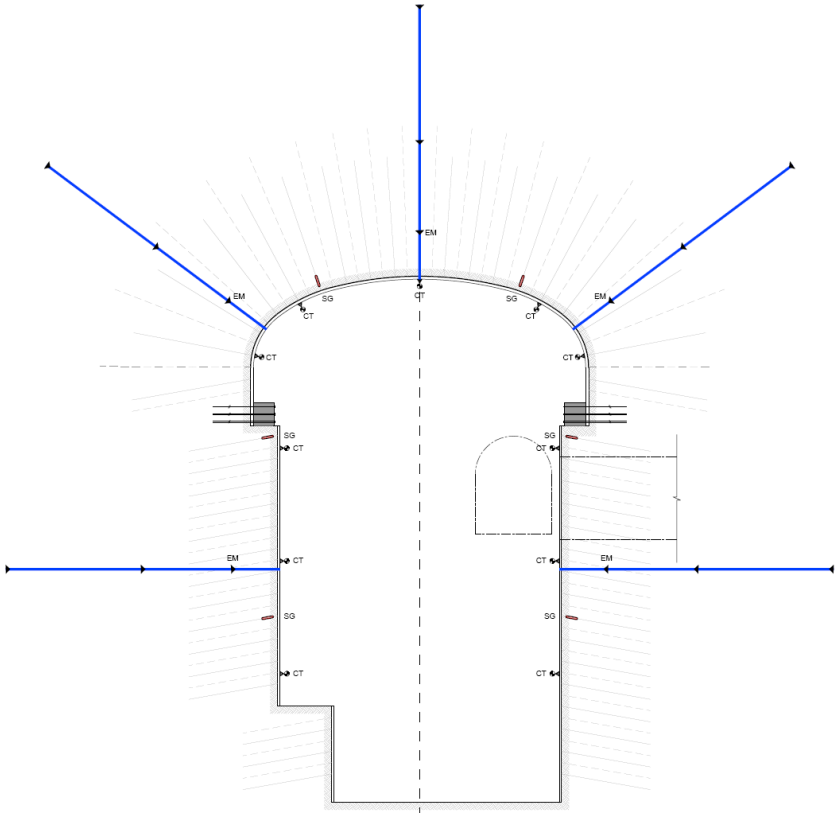
LAS LAJAS Powerhouse

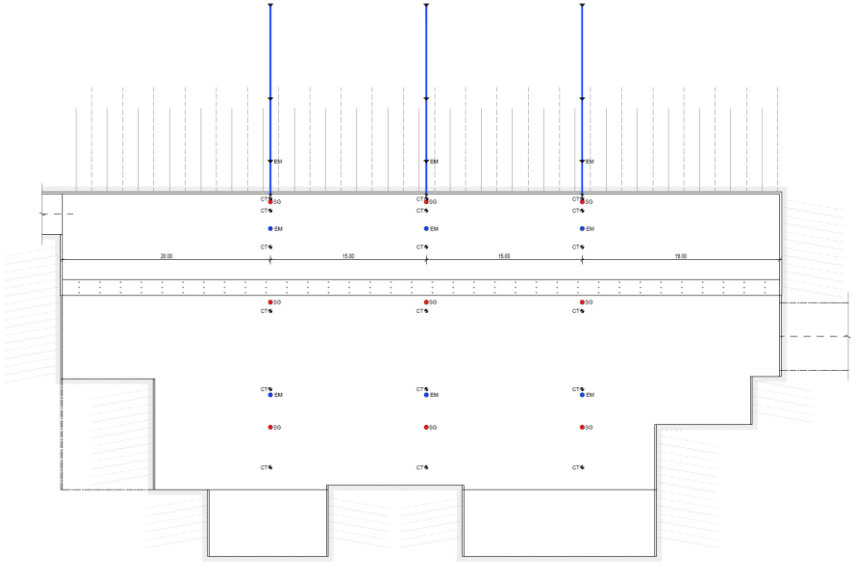
- Support verification
- Comparison of numerical FEM analyses

Analysis 1: Residual parameters according to Hoek (2011)	Analysis 2: Residual parameters according to empirical formulation $GSI_{res}=GSI*((1+exp(-0.0134*GSI))/2$	Analysis 3: Residual parameters according to Cai et al. (2007)
		

LAS LAJAS Powerhouse

- Typical cavern monitoring sections including extensometers, strain gauges and optical targets





LAS LAJAS Powerhouse

- Monitoring vs.action plan

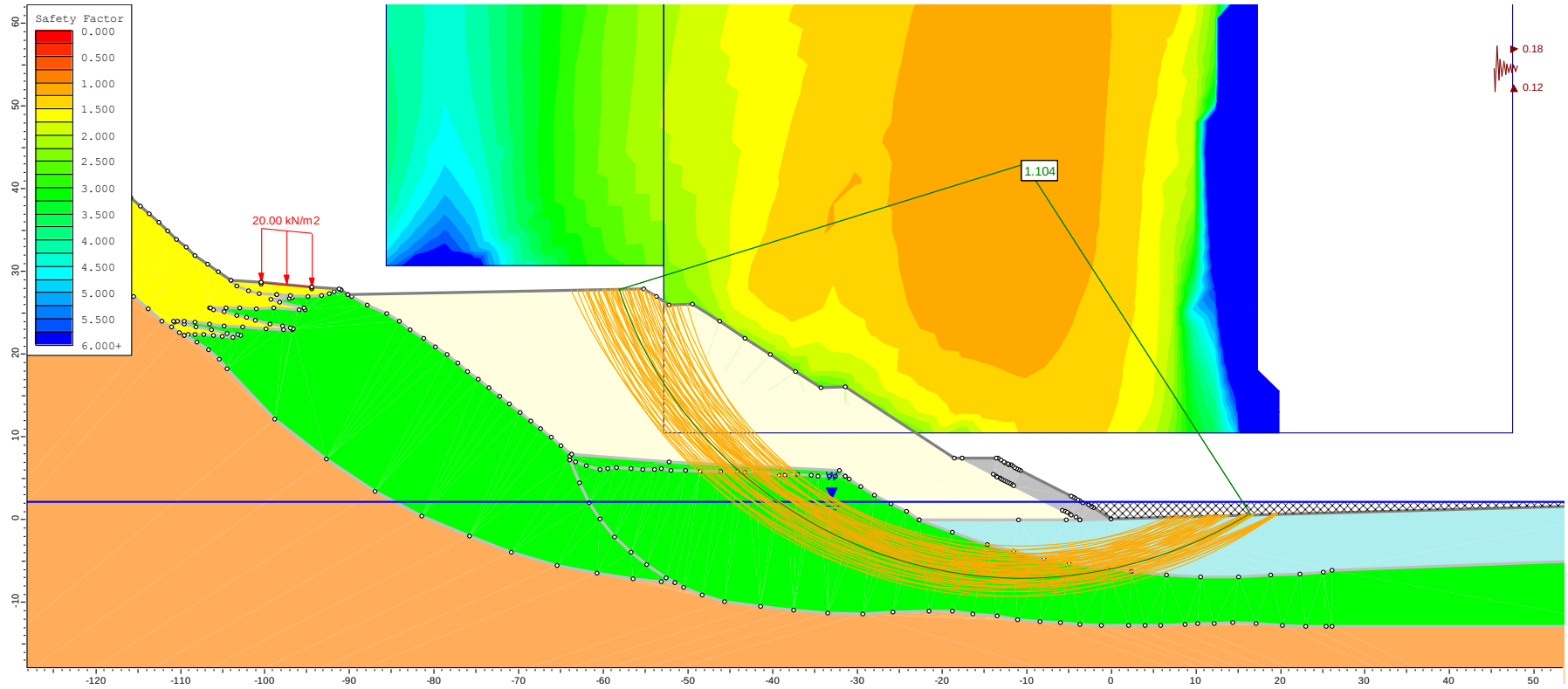
1. Monitoring instruments		
	Monitoring instruments	Monitoring Section Type
		Total of 3 stations
	(CT) optical Targets for Convergence measurements	11
	(EM) Multiple boreholes Extensometer	5
	(SG) Strain Gauges on rockbolts	6

1. Outline Monitoring Schedule		
	Frequency of Reading	
	Daily	Weekly
	Weeks 1-10	Weeks 11 onward

1. Action Plans			
LEVEL	OBSERVATION THRESHOLD	IMMEDIATE ACTIONS	CONSEQUENTIAL ACTIONS
Level 1. Awareness Level	80% of design convergence (25mm)	Inform Designer Increase frequency of readings to 1 per day Assess whether additional readings or more instrumentation is required	The rate of displacement shall be observed and actions taken accordingly
Level 2. Alert Level	100% of design convergence (30mm)	Inform Designer Increase frequency of readings Compile information on construction to ascertain likely causal conditions. Install additional support if required	Following investigation specific counter measures are to be devised
Level 3. Alarm level	120% of design convergence (35mm)	Construction work is to be stopped and any temporary excavation secured. Countermeasures are to be executed	Additional instrumentation is to be installed if required to monitor the performance of the countermeasures. Construction work is only to recommence only once the effects of the countermeasures have been realized

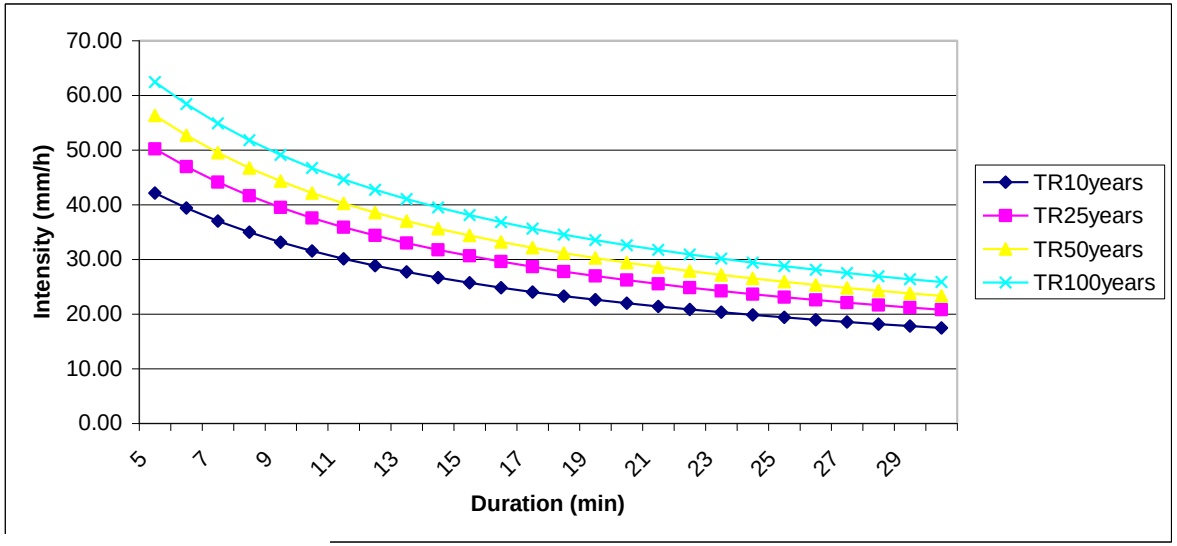
MUCK DEPOSIT 12

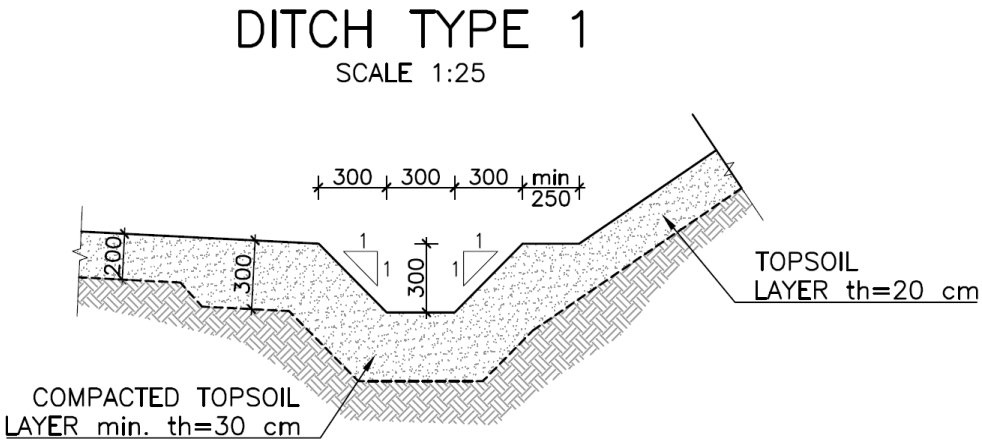
- Section 3-3 of MD 12 : Stability slope analysis –seiismic up conditions SF = 1,104



MUCK DEPOSIT 12

Rain fall intensity and design corresponding to it





MUCK DEPOSIT 12

"……

- The monitoring system shall face the following topics:
- assessing the efficacy of the design technical choices and solutions with reference to the variability of the geological and geotechnical conditions and parameters.
- assessing the possible deformations and ground displacements within the geotechnical influence zone;
- comparing the design calculation and the detected behaviour of geotechnical units.

- For controlling the stability of the deposit either in the construction and operational phase the following monitoring instruments are recommended:
- **optical targets (OT)**
- **1 inclinometer tube (IN)**

GEODATA

View from Aucayes camp, August 15, 2014

Thank you for your attention buena suerte