Diploma thesis

Exploration and operation of gypsum deposit Zchatlbila of the company Knauf in Georgia with Contract mining

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„ I declare that this diploma project entirely my own work, except where indicated otherwise. The statements and ideas taken from other sources are cited as such. Diploma thesis has not been submitted, partly or wholly, for the degree of any other organization, both in Germany and in the other country, and has not been published previously.”

Place, Date Signature

Gratitude

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Annotation

This work is devoted to disclosure issues open pit mining in cramped conditions the Zchatlbila deposit of gypsum and carbonic calcium gypsum which located in Akhaltsikhe municipality Georgia.

A feature of this diploma project is an attract subcontractors to all types of mining and transportation of minerals. For execution of work subcontractors will be involved in their own employees, as well as machinery and equipment.

The diploma contains the calculation and justification of the use of technology, mining, primary processing of gypsum, as well as transportation. In addition calculated the cost of 1 ton of gypsum stone and shows the economic effect of development of the deposit Zchatlbila

Thesis work includes specifications equipment that will used to carry out work.

Diploma takes into account the experience of the application of subcontractors directly on Troitsk deposit of gypsum and anhydrite in Chapaevsk, Russian Federation.

Content

1 Introduction

Production of gypsum at the forefront among the non-metallic minerals. So according to the US Geological Survey (USGS) in 2014, the world produced 246 million tons of gypsum. The largest producers are: China (132 mln. t), the United States (17,1 mln. t), Iran (13 mln. t), Turkey (8,3 mln. t), Spain (6,4 mln. t) Thailand (6,3 mln. t).

The company Knauf Gips KG takes leading positions on the production of gypsum in the world, that indicating a large quantity of regional companies. The functioning of a large quantity of factories which manufactured products, the foundation of which is gypsum, implies the existence of an extensive resource base.

At the moment, the company LLC "Knauf Gips Tbilisi" gets a raw material for the production from Azerbaijan by the company Knauf Gilan.

The aim of the diploma project is to development a technological solution to open pit mining in cramped conditions the Zchatlbila deposit of gypsum and carbonic calcium gypsum with annual mineral production 50 thousand tonnes.

The task of qualification work is the development of technological solutions by the method of extraction of the deposit with the involvement of the entire cycle of works subcontractors and obtaining economic benefits in the form of lower raw material costs.

Development of the deposit Zchatlbila will diversify the source of gypsum and reduce its cost.

2 Geology of the deposit Zchatlbila

2.1 General information about the deposit

The total area allocated land allotment and mining lease of deposit Zchatlbila is 8,52 hectares.

The boundaries of the land allotment and mining lease outlined contour of thirteen points, x; y, and the coordinates of which are shown in a Table 1 and are given in the system of UTM WGS 1984.

№	№ Points	Coordinates	
		x	y
1	1	321385	4605682
2	2	321502	4605702
3	3	321580	4605766
4	4	321684	4605644
5	5	321624	4605583
6	6	321697	4605467
7	7	321602	4605390
8	8	321481	4605443
9	9	321456	4605430
10	10	321423	4605467
11	11	321381	4605487
12	12	321393	4605503
13	13	321301	4605607
Area on the plan S=8,5 hectares			

Table 1: Coordinates of the land allotment and mining lease Zchatlbila

As a result of the geological exploration of the deposit were drilled thirteen boreholes total depth of 777 m. Boreholes №№ 1-12 are within the boundaries, and the borehole № 13 was drilled outside the mining lease. The coordinates of boreholes are represented in Table 2.

№	Borehole		Coordinates in UTM WGS 1984	
	№	Depth (m)	x	y
1	1	64,5	0321604	4605732
2	2	59,0	0321530	4605667
3	3	60,0	0321417	4605641
4	4	33,5	0321484	4605564
5	5	49,0	0321337	4605567
6	6	30,0	0321405	4605492
7	7	60,5	0321303	4605607
8	8	71,0	0321358	4605634
9	9	62,0	0321403	4605680
10	10	60,5	0321491	4605697
11	11	72,0	0321563	4605702
12	12	80,0	0321574	4605754
13	13	75,0	0321391	4605749
In general:		777,0		

Table 2: The coordinates of geological exploration boreholes

On the basis of geological exploration were defined borders calculation of reserves in an area of 53065 m^2. Schematic view of boundaries of the land allotment and mining lease, boundaries of reserves estimation and exploration boreholes represented in Figure 1.

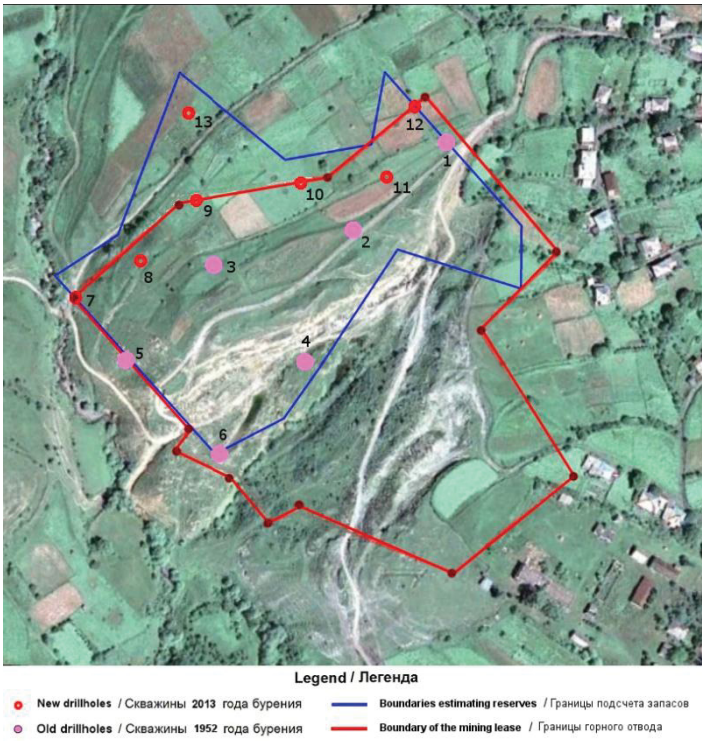

Figure 1: Schematic view of boundaries of the land allotment, mining lease and boundaries of reserves estimation of the deposit Zchatlbila

2.1.1 Regional belonging

Deposit of gypsum is located in the municipality Akhaltsikhe of Samtskhe-Javakheti region, on the territory near the village Zchatlbila. Zchatlbila village located to the south-west from town of Akhaltsikhe in the valley Potshovistskali, at an altitude of 1300 m above sea level. Near the village are: Naohrebi, Tsinubani, Abathevi and city of district subordination Vale (1962).

Center of the region is the town of Akhaltsikhe, which was built in Akhaltsikhe's foundation pit on both sides of the river Potskhovi (Potshovistskali).

Akhaltsikhe municipality bordering with the Borjomi and Aspindza municipalities to the east, in the west - Adigeni municipality, in the north - with Baghdad and Kharagauli municipalities, and in the east and south-east - with Turkey. Its total area is 1,023 sqm. The municipality consists of two cities - Akhaltsikhe and Vale, and 47 villages.

Samtskhe-Javakheti region in the west of borders with Ajarian Autonomous Republic, in the north - Guria and Imereti regions, in the north-west and west - Shida Kartli and Kvemo Kartli regions, and in the south and south-west - with Turkey and Armenia.

2.1.2 Surface

The territory municipality has a complex topography – there are leveled terraces, meridian valleys, small pits, hills and volcanic mountains, which are located at an altitude of 950 m (village Atskuri) 2964 m (mount Gumbati). In its northern part, on the southern slope of the Meskheti Range is erosive mountain-valley surface. In the southern part - on the northern slope of the ridge Erushetskiy, mid-mountain, weakly dissected relief.

2.1.3 Climate

The bulk part of climate municipality is mountain steppes, cold winter with little snow, summer - long and warm. At the bottom of the foundation pit Akhaltsikhe average temperature in January is -3,8 °C, in August +20,5 °C, the absolute minimum -32 °C, the absolute maximum +39 °C. In the higher zone, on the Meskheti range is marine climate, humid, and continental, the crest part of the Erushetsky ridge is mountain steppes climate, summer is short, winter - cold, the annual precipitation in the lower area does not exceed 520 mm, and on the slopes of which are adjacent to the ridges is 1200 mm.

Table 3 shows the one-dimensional data of different climate-related characteristics, and Table 4 - average quarterly, monthly and annual data with the appropriate parameters.

№	List	Unit	Value
1	Barometric pressure	kPa	895
2	Amount of precipitation in a day	mm	513
3	Daily maximum of precipitation	---"---	62
4	Weight of snow cover	kPa	0,68
5	Quantity of days with snow cover		63
6 a)	Air pressure (W_0): once of 5 years	kPa	0,30
b)	Once of 15 years	---"---	0,48
7 a)	The highest air speed: Once of 1 year	m\sec	19
b)	Once of 5 years	--"---	23
c)	Once of 10 years	--"---	27
d)	Once of 15 years	--"---	28
e)	Once of 20 years	--"---	29
8 a)	Normative depth of seasonal freezing of soils: clay and loam	cm	59
b)	Fine and silty sand, sandy loam	---"----	71
c)	Large and medium gravel sand	---"---	77
d)	Clumpy	---"---	88

Table 3: One-dimensional data of different climate-related characteristics

№	List	Unit	January	February	March	April	May	June	July	August	September	October	November	December	Average annual	Absolute minimum	Absolute maximum
1	Direct (S) solar radiation on a horizontal surface in the month	kW/h/m^2	27			74			128			64					
2	Total (Q) solar radiation on a horizontal surface in the month	-----"----	61			145			199			106					
3	Direct (S) solar radiation on a horizontal surface in a day	----"------	0,9			2,5			4,1			2,1					
4	Direct (S) solar radiation on the surface of the southern targeting with α angle	-----"-----	2,2			2,8			4,2			2,1					
5	Total (Q) solar radiation on a horizontal surface in a day	-----"-----	2,0			4,8			6,4			3,4					
6	Total (Q) solar radiation on the surface of the southern targeting with α angle	-----"-----	3,0			5,3			6,5			4,6					
7	Average air temperature	^{0}C	-3,8	-1,9	3,2	9,0	14,0	17,2	20,4	20,5	16,3	10,4	4,1	-1,2	9,0	-32	39
8	Average amplitude of air temperature	---"----	10,6	11,3	13,0	14,8	14,2	14,5	13,8	14,3	15,0	14,5	12,0	10,6			
9	Maximum amplitude of air temperature	---"----	22,4	24,1	25,8	27,6	27,4	27,7	27,0	27,5	28,2	27,9	25,2	20,8			
10	Relative air humidity	%	75	74	69	65	66	66	64	63	66	71	76	78	69		
11	Partial pressure of atmospheric water vapor	GPa	3,8	4,2	5,2	7,1	10,3	12,9	15,1	14,5	11,6	8,4	6,4	4,5	8,7		
12	Height the sun at noon, the 15th day of the month	degree	27,8	35,9	46,8	58,7	67,8	72,3	70,6	63,2	52,1	40,6	30,6	25,7			

Table 4: Average quarterly, monthly and annual data of climate characteristics

2.1.4 Hydrology

The main rivers of the municipality – is Mtkvari (its length within the district 40km) Potshovistskali (Potskhovi) and its tributaries – Kvabliani, Uraveli. The small rivers are Tsinubnistskali and Chvintagele. In the spring of rivers abounding in water, from the autumn their level begins to decrease and winter comes to a

minimum. During heavy rains periodically arise mudslides. The rivers are used for irrigation.

2.1.5 Soils

On the territory of the municipality there are three main areas: 1) The forest-steppe; 2) Mountain forest; 3) Mountain meadow. At the foot are developed brown meadow and alluvial carbonate meadow soils In the foothills Meskheti and Erusheti ridges – brown forested and gray-brown soils; on the forested slopes of the Meskheti and Erusheti ridges – forest humus, which is at a higher level is changing mountain-meadow soils. On the terraces above the floodplain – alluvial soil.

2.1.6 Vegetation cover

Within the municipality there are landscapes of plains with a moderately dry subtropical climate with humid mountain forest and moderately humid climate, mountain steppe and subalpine, among them are:

1. The flood land contain are mainly tugai vegetation and alluvial soils;

2. Terraced foundation of pit with mountain, steppe and phryganoid vegetation and gray-brown soils;

3. Medium mountains with oak and eastern hornbeam forests, brown and black soil;

4. Medium mountains with beech forests and black soil;

5. Volcanic mountains of medium height, with beech and pine forests, mostly black soil;

6. Sub-alpine meadows with mountain meadow soils.

2.2 The geological structure of the deposit

2.2.1 Stratigraphy

Geological structure - the most ancient rocks of the deposit are represented by thick volcanic formations Middle Eocene, widely distributed in almost all over the region. The sediments are three stratas: 1) Lower tuff interbedded variegated strata; 2) Tuff breccia strata; 3) Upper interbedded tuffaceous strata.

The first two stratas are widely distributed in the area. Relatively complete section of the first strata is represented outside the area in the southern part of the Adjara-Trialeti Range in the middle of the valley of the Mtkvari between Atskuri and Akhaldaba. Power rainfall reaches 4000 m. In the mountains, there are plenty of intraformational sweep andesite lava. These sweep are associated with the lower horizons of volcanic strata and form orogeny with them. The apparent thickness of the strata in the deposit area 685 m. Average strata represented by thick massive, large and small-sized tuff breccias, low power of tuff and tuff-sandstones packs, stratal lodes diabase porphyries. Tuff breccias and tuff are reversed. Strata is widespread outside the area on the southern slope of Adjara-Imereti ridge.

The upper strata is similar to the lower. It is a complex thin-bedded tuffs and tuffaceous greywacke sandstones which changing of layers of marl and clay. The power of strata 200 - 300 m.

Volcanogenic sediments of Middle Eocene is transgressive overlain by sediments of the Upper Eocene which represented tuff breccias, tuff, sandstone, clay and marl, stratal and intersecting veins and diabase porphyries teschenites. The power of strata within wide limits ranging from 400 to 1200 m.

On different levels of the upper Eocene placed potent continental volcanic effusion formation of Upper Miocene - Lower Pliocene.

2.2.2 The geological structure of the deposit and mining lease

Zchatlbila deposit of gypsum and carbonic calcium gypsum is connected with the horizon colored clay Goderdzy strata (Miocene, Sarmatian stage). The gypsum is located in the form of layers. At the base of the section are oligocene clay-sand sediments, most of which also contains gypsum. The thickness of the color formation 180-200 m and it is represented by colored gypsum and clay lagoon facies dense fine-grained sandstones. According to the content section of the gypsum rocks composing deposit is divided:

- fine grained sandstones with clay content of yellow, yellowish-gray (12 - 33,25 m);
- clay, yellow, yellowish-gray (1.5 - 5 m);
- productive pack, provided by the layers of colored crystalline gypsum (gray, pink-gray, greenish-gray) with layers of gray gypsous clay (carbonic calcium gypsum).

The thickness of the individual layers of gypsum varies from 0,8 to 4 m, gypsous clay (carbonic calcium gypsum) 0,2 - 2-3 m. The total thickness of all layers of the productive strata is on average 30 m. Grey gypsous clay, turning deep to green clay in which there are a large quantity of inclusions white crystalline gypsum. The strata thickness is about 60 m. Colored clay with occasional veins of selenite contained thickness 25 m.

Deluvial sediments distributed in the northeast and east of the deposit. Their thickness varies from 0,5 to 15 m.

On the territory of the deposit in gypseous rocks are fixed karsts forms of small sizes.

The morphological type of ore-bearing bodies – layered.

Distribution of the ore body – across the pitch for 300 m, down the pitch - 130-300 m.

The thickness of ore-bearing body - thickness of the individual layers of gypsum varies from 0,8 to 4 m, gypsous clay - from 0,2 to 2,3 m. The total thickness of the productive band is 30 m on average.

The element occurrence of ore-bearing bodies - direction of true dip: in the northern part - southeast 125°, angle of inclination – 80-90°, in the north-west – 315°, angle of inclination – 10-25°.

2.2.3 Hydrogeological conditions

The hydrogeological conditions of processing deposit are advantageous. Hydrous horizons in the stope are not fixed. The field is located over the basis of local erosion, which promotes draining underground and atmospheric water. The mining and technical conditions are favorable.

2.3 Qualitative characteristics of minerals

On the basis of geological report, the exploration works at deposit Zchatlbila are performed in 1946, 1952 and 2013.

In Table 5 presents the qualitative indicators of the mineral (gypsum and carbonic calcium gypsum) for exploration works, which carried out in 1946 and 1952.

Table 6 contain the percentages of CaSO4 * 2H2O for each well separately (with their intervals and capacity) and, in general, that have been identified in minerals (gypsum-containing rocks and gypsum) and waste (in contact overlapping and underlying parts) by average parameters. Such results were obtained on the basis of geological exploration work in 2013.

№	List of characteristics	Unit	Content	
			Minimum	Maximum
I 1	Gypsum Chemical composition:			
a)	SiO_2	%	2,75	45,10
b)	Al_2O_3	---"---	1,22	19,66
c)	Fe_2O_3	---"---	1,42	5,97
f)	CaO	---"---	7,37	34,15
d)	MgO	---"---	0,60	3,16
e)	SO_3	---"---	6,26	46,90
f)	H_2O	---"---	5,20	7,39
g)	$CaSO_4 * 2H_2O$	---"---	62,54	98,3
h)	Loss by heating	---"---	11,23	15,69
2 a)	Physical and mechanical properties: Specific gravity	g/cm^3	2,30	2,42
b)	Volume weight	g/cm^3	1,32	2,38
c)	Normal thickness of the dough	%	66,6	100
d) 1 2	Bonding time: Initial Final	 min min	 4 10	 30 57
e)	Tensile strength	kgf/cm^2	2,2	7,25
II 1 a)	Gypsum Chemical composition: SiO_2	 %	 4,53	 22,29
b)	Al_2O_3	---"---	1,21	10,24
c)	Fe_2O_3	---"---	1,5	3,2
d)	CaO	---"---	22,57	33,44
e)	MgO	---"---	0,88	1,9
f)	SO_3	---"---	27,79	43,37
g)	H_2O	---"---	5,26	7,64
h)	$CaSO_4 * 2H_2O$	---"---	31,0	70,0
i)	Loss by heating		10,10	11,87

Table 5: Qualitative indicators of the mineral for exploration works 1946 and 1952 years

№	Borehole №	**Contact** overlapping **part**				**Gypsum-containing rocks**				**Gypsum**				**Contact** underlying **part**			
		Sample length (m)			Percentage $CaSO_4*2H_2O$	Sample length (m)			Percentage $CaSO_4*2H_2O$	Sample length (m)			Percentage $CaSO_4 * 2H_2O$	Sample length (m)			Percentage $CaSO_4 * 2H_2O$
		from	to	Thick.		from	to	Thick.		from	to	Thick.		from	to	Thick.	
1	7	26,0	27,1	1,1	61,7	27,1	50,0	22,9	72,7	27,1	32,55	5,45	89,9	50,0	60,5	10,5	48,2
2	8	35,0	37,0	2,0	32,7	37,0	69,6	32,6	65,1	37,0	44,0	7,0	81,0	69,6	71,0	1,4	32,8
3	9	42,5	44,0	1,5	17,1	44,0	58,0	14,0	67,8	44,0	49,0	5,0	86,4	58,0	61,0	3,0	50,1
4	10	40,0	42,0	2,0	44,2	42,0	55,0	13,0	71,2	42,0	46,6	4,6	89,6	55,0	60,5	5,5	53,0
5	11	31,8	33,1	1,3	61,7	33,1	70,5	37,4	57,7	33,1 49,0	35,5 55,0	2,4 6,0	82,9 75,8	70,5	72,0	1,5	25,5
6	12	42,0	44,5	2,5	20,2	44,5	76,5	32,0	68,3	45,55	51,3	5,75	86,8	76,5	80,0	3,5	26,2
7	13	56,7	58,0	1,3	27,8	58,0	73,0	15,0	67,6	58,0	64,1	6,1	82,3	73,0	75,0	2,0	47,9
Total:					265,4				470,4				674,7				283,7
Average:					37,9				67,2				84,3				40,53

Table 6: Percentages CaSO4 * 2H2O on the basis of exploration work in 2013

2.4 Estimation of reserves

As of January 01, 2010, at the state balance of mineral reserves Georgia, reserves of gypsum and carbonic calcium gypsum of the Zchatlbila deposit of gypsum and carbonic calcium gypsum, including by quantity and categories, as set out in Table 7 below.

№	Types of mineral resources	Reserves (thous. tonnes)			
		A	B	C_1	A+B+C_1
1	Gypsum	52,0	672,0	416,0	1140,0
2	Carbonic calcium gypsum	86,0	825,0	1008,0	1919,0

Table 7: Reserves a gypsum and carbonic calcium gypsum of Zchatlbila deposit

The Zchatlbila's deposit of gypsum and mining lease, which is included in its contour, taking into account the geological structure, quality indicators and other factors, belong to deposits Group II by difficulties which the search for categories B + C_1. For of reserves category B accepted search network 50-100 m, and for categories C_1 - 100-200 m.

The estimation of reserves involved boreholes №№ 1; 2; 3; 4; 5 and 6 which drilled before the reporting period (1952), and in the reporting period boreholes №№ 7; 8; 9; 10; 11; 12 and 13 (including №13 boreholes has been drilled on the search area, outside of the northern contour a mining lease).

Thirteen boreholes placed on six sections of the search, which were based on the compiled by geological and lithological sections №№ I-I^1, II-II^1; III-III^1; IV-IV^1; V-V^1 и VI-VI^1.

The reserves were calculated by the method of vertical parallel sections.

Table 8 is a table summarizing the calculation of reserves both the calculation of reserves both for gypsum-containing rocks and productive layers of of gypsum for each block individually and as a whole, taking into account the volume of soil, deluvium and overburden.

Table 9 contains the data for each borehole individually, with indication of intervals of intersections to a depth gypsum layers and gypsum-containing rocks, the thickness and the percentage of $CaSO_4$ $2H_2O$.

When determining the amount of estimated reserves before the reporting period, as the volume weight was accepted 2,06 t/m^3.

№	Block №	№ Section	Gypseous rocks				Gypsum				Quantity soil cover and deluvium	Quantity overburden rocks	Ratio between the overburden and gypsum-containing rocks, m^3/m^3	Stripping ratio
			Percent. $CaSO_4$ $2H_2O$ % in block	Volume	Volume weight (mass), t/m^3	Quantity consider. volume weight (mass)	Percent. $CaSO_4$ · $2H_2O$ % in block	Volume	Volume weight (mass), t/m^3	Quantity consider. volume weight (mass)				
				m^3		t		m^3		m^3	m^3	m^3		
1	Bl-1	I-I[1] II-II[1]	66,0	204600	2,06	421476	80,9	57660	2,06	118780	9991	201100	1 : 2,09	0,48
2	Bl-2	II-II[1] III-III[1]	68,8	230640	2,06	475118	85,4	62713	2,06	129189	10907	375100	1 : 1,27	0,79
3	Bl-3	III-III[1] IV-IV[1]	72,4	212812	2,06	438392	89,5	55193	2,06	113697	9027	470843	1 : 0,93	1,07
4	Bl-4	IV-IV[1] V-V[1]	61,3	147300	2,06	303438	81,9	27150	2,06	55929	3292	247890	1 : 1,22	0,82
5	Bl-5	V-V[1] VI-VI[1]	60,0	167325	2,06	344689	80,7	27807	2,06	57282	5893	188301	1 : 1,83	0,55
Total:			65,7	962677	2,06	1983113	83,7	230523	2,06	474877	39110	1483234	1 : 1,33	0,75

Table 8: Table summarizing the calculation of reserves both and for each block individually

№	Borehole №	Gypsum-containing rocks				Gypsum			
		Interval (m)			Percentage $CaSO_4$ · $2H_2O$ %	Interval (m)			Percentage $CaSO_4$ · $2H_2O$ %
		from	to	Thick.		from	to	Thick.	
1	1	22,0	53,0	31,0	58,1	25,3	31,0	5,7	91,4
						40,0	47,2	7,2	75,8
						50,0	53,0	3,0	74,8
2	2	29,5	50,0	20,5	76,9	29,5	35,5	6,0	92,4
						42,2	50,0	7,8	80,9
3	3	33,5	56,0	22,5	88,8	33,5	56,0	22,5	88,8
4	4	1,5	23,0	21,5	59,5	1,5	7,3	5,8	99,3
						10,5	13,0	2,5	93,9
						18,0	23,0	5,0	93,9
5	5	13,5	47,4	33,9	66,2	13,5	18,7	5,2	93,2
						33,0	37,0	4,0	81,2
6	6	2,6	25,2	22,6	61,9	2,6	5,6	3,0	78,2
						8,0	14,0	6,0	73,1
						19,2	25,2	6,0	71,3
7	7	27,1	50,0	22,9	72,7	27,1	32,55	5,45	89,9
8	8	37,0	69,6	32,6	65,1	37,0	44,0	7,0	81,0
9	9	44,0	58,0	14,0	67,8	44,0	49,0	5,0	86,4
10	10	42,0	55,0	13,0	71,2	42,0	46,6	4,6	89,6
11	11	33,1	70,5	37,4	57,4	33,1	35,5	2,4	82,9
						49,0	55,0	6,0	75,8
12	12	44,5	76,5	32,0	68,3	45,55	51,3	5,75	86,8
13	13	58,0	73,0	15,0	67,6	58,0	64,1	6,1	82,3

Table 9: Characteristics boreholes which contains indication of intervals of intersections to a depth gypsum layers and gypsum-containing rocks

2.5 Conclusions

As of January 01, 2010, at the state balance of mineral reserves Georgia, including the following gypsum reserves of deposit Zchatlbila:

- A category – 52,0 thous. t;
- B category – 672 thous. t;
- C_1 category – 416 thous. t;

Total: A+B+C_1 category – 1140 thous. t.

The total area allocated land allotment and mining lease is 8,52 hectares.

Gypsum-containing rocks – 962,6 thous. m^3, i.e. 1983,1 thous. t (considering volume weight 2,06 t/m^3); the average content $CaSO_4$ $2H_2O$ – 65,7%.

Gypsum – 230,5 thous. m^3, i.e. 474,9 thous. t (considering volume weight 2,06 t/m^3), the average content $CaSO_4$ $2H_2O$ – 83,7%.

Total quantity of soil cover and deluvium – 39,1 thous. m^3.

Total quantity of overburden rocks – 1483,2 thous. m^3.

Ratio between the overburden and gypsum-containing rocks – 1:1,33 m^3/m^3.

The average stripping ratio – 0,75.

Estimation of reserves was performed on an area of 53065 m^2.

3 Mining operations

3.1 Choice a method of deposit development

The boundaries of part of the deposit, which is scheduled for development were defined by contours of reserves a gypsum and carbonic calcium gypsum by the categories A+B+C_1 (approved at the state balance mineral reserves of Georgia, as of January 1, 2010).

Regard to the sizable thickness of productive strata (13,0...37,4 m) and a relatively small thickness of the overburden (15,0...35,0 m), angled of mineral deposits, the possibility of placing close to the borders of open pit a rock dumps, crushing and screening plant, as well as mountain-valley topography, concluded the feasibility of developing the deposit of gypsum and carbonic calcium gypsum Zchatlbila by open method in cramped conditions the entire depth of the approved reserves.

3.2 Determination of the boundaries of surface works

Definition of rational borders open pit mining and the construction of the pit outline was made taking into account the mining and geological conditions of deposit, used the analogies of when making steady angles of pit slopes of non-working and most complete involvement in the development of reserves of gypsum and carbonic calcium gypsum which was agreed.

When choosing a stable angles a slope sides of open pit mining took into account the possibility of adjustment to the results of scientific research carried out during the construction and operation of open pit that allowed USR during field development open method (p. 52).

3.3 Opening of open-pit field and the choice of technological transport of gypsum-containing and overburden

The immediate objective deposit opening is the establishment of cargo and transport links between the horizons of development in open pit and technical structures on the surface.

The most important factors influencing the choice of method of opening the deposit, are:

- topographical features of the earth's surface and the presence of barren areas that determine the overall layout of ground technical constructions, the direction of the transport route and the possible variant of its entry into open pit;
- mining and geological conditions of the deposit, the most important value of which belongs to the depth of the mineral deposit and spatial form which influence selection of the position of transport communications (stationary or moving) and forms the track permanent trench (simple loop, spiral etc.);
- thickness and depth of the occurrence mineral resources, that influence the choice placement of rock dumps (external, internal or external and internal);
- geotechnical conditions of open-pit fields that define slope stability sides of open pit mining, on which the inception of permanent trench (external, internal, or mixed);
- production and technical conditions of mining company (volume of traffic, the rate of reduction of mining operations, etc.) that determine the shape of the longitudinal profile of permanent trench and necessary quantity of transport trips from the open pit.

When large volumes of traffic the slope value of permanent trench may be reduced, and at a high rate of advancement of mining in depth and cramped open pit parameters, on the contrary, will increase. Quantity departures from the pit is determined capacity and carrying ability of permanent trenches.

№	List of characteristics	Unit	Value
1	Maximum mark surface of the upper contour of open pit	m	1300
2	Minimum surface elevation	m	1260
3	Dimensions open pit in the plan (length x width)	m	320 x 170
4	Mark the bottom of the open pit	m	1220…1228
5	Thickness of overburden	m	15,0…35,0
6	Approved geological reserves gypsum by category $A+B+C_1$	thous. t.	1140,0
7	Exploitation reserves gypsum and carbonic calcium gypsum in contour of open pit by category $A+B+C_1$	thous. t. thous. m^3	1218,65 591,58
8	Volume of the rock mass in the open pit	thous. m^3	1611,69
9	Average stripping ratio	m^3/m^3 m^3/t	1,73 0,84

Table 10: Main parameters of open pit

Location of permanent trenches are depends on many factors. Thus, external permanent trenches due to their high cost and duration of construction, as a rule, applied for the opening superficial deposits that develop just two or three benches, or for opening the upper benches in deep pits, which are composed of unstable rocks.

Trenches internal laying commonly used for the opening deep pits and the average depth pits with stable overburden and enclosing rocks.

When tracing of permanent trenches, subject to availability, always preferred a fixed track that does not require periodic reconstruction.

In practice, especially in the steep dip of the mineral deposits, opening of deposit is often carried out sliding cross-over, that are gradually moving in a stationary position when they reach the final contour pit.

Most common way opening of open-pit fields are:

- opening of separate trenches. Thus each active horizon has an independent transport, cargo flows of rock and mineral completely separated and directed to the surface independently of each other. This method of opening is most commonly used for large volumes of traffic, using the of a powerful mining equipment and a small amount (2-3) mining horizons;
- opening of group trenches applied to horizontal and gentle sheetlike and lenticular deposits of high thickness of overburden and which are

developing using 4-6 benches. Thus one group trenches opens waste rock, and the other - mining benches;

- opening of common trenches used for relatively small volumes of transportation on the deep and medium depth pits with steady rocks that form unworkable sides of open pit mining, and a large quantities of working benches. General trenches have a minimum mining and construction volume and relatively low cost of construction.

Considering the small volumes of transportation of mined rock, concluded on the appropriateness of removals from the pit of the rock mass of heavy road transport, which is widely used in many pits of ore and non-metallic minerals.

The main advantages of this type of transport is self-contained and high mobility, it can be used in any conditions of mineral deposits, as well as the development in the limited conditions a deposits with short distance transportation of the rock mass.

Using for this purpose conveyor transport at insignificant depth of occurrence a minerals, small parameters of open pit and placing close to him the dump, crushing and sorting complex is inefficient not only because of its high cost, but also highly dependent on climatic conditions, physical and mechanical properties of rocks transported, the presence blasting operations in pit and others. In this case, the use of conveyor transport does not preclude the construction of the inside and outside of pit a roads that are needed for repair of large equipment, delivery to the pit and dump various materials etc., which significantly increases the volume of capital investments in the construction and makes it more expensive open pit mining operation.

The use of rail transport for hauling rock mass at small parameters of pit and insignificant annual volumes and distances traffic is irrational. Furthermore, for input to the pit the railways would be required costly construction of approach railway line. In this case it is not possible to avoid the use of roads in the field for various applications, as in the variant of the conveyor transport.

Where there is asphalted road, which passes 1,9 km from the south-western end of the career that connects the district to field transport network of Georgia,

the use of rail transport for removals overburden, gypsum and carbonic calcium gypsum becomes more pointless.

Based on the foregoing, in the conditions Zchatlbila deposit, which has upland surface relief, relatively low volume of traffic (up 86 thousand. m^3 per year), quite a stable, not watered overburden and enclosing rocks, angled occurrence a thicknesses productive strata, therefore opening of of open-pit fields taken to implement (applicable to the selected transport mode) without a stationary opening to surface, because the relief of the surface and roads allow develop the field without permanent trench. Opening the lower horizons of pit is planned to implement by sliding cross-overs.

This solution allows to reduce the volume of capital mining operations in a pit, minimize their costs and to avoid unnecessary costs associated with the restructuring of the transport track.

Parameters of opening to surface chosen with regard to the size and technical capabilities of accepted dump trucks and conditions that ensures their safe operation.

Opening the new working horizon produced by drifting initial cut with a width at the base of 8 m. Place laying chosen based on specific conditions a situation of mining at the moment.

The width of career stationary two-lane roads that are placed in transport berms and sliding cross-overs adopted 8 m, which is limited by the width of dump trucks Volvo FM 12.440, MAZ - 6501, is 2,5 m, and the necessity of leaving from the slopes of the overlying and underlying benches a cuvette and safety strip.

The width of the stationary two-lane automobile cross-овepc were determined the following calculation: distance from the top edge of the underlying bench to the bottom edge of the safety of rock shaft accepted of 2 m, width along the ground of the safety shaft - 2,8 m, distance from the shaft to axis of the rock the two-lane road - 5 m, width of the drainage leat on top - 2 m and width of the drainage leat on top - 2 meters and the distance from the drainage leat to the bottom edge of the overlying bench - 1 m.

Ruling gradient open pit roads, given the relatively small amount of traffic received 90 ‰, that allows a sufficiently high velocity of the loaded and empty dump trucks on uphills or downhills.

Ruling gradient of sliding cross-overs adopted 90 ‰.

3.4 Mining method

Mining method is a safe and cost-effective implementation of a complex of overburden, mining and auxiliary works in pit, which provides its planned capacity at the rational use of mineral resources.

The main features of methods of open mining determined by methods the production of overburden operations.

The main production processes in a pit are drilling, breaking the rock mass, excavation and loading operations, transport of minerals and overburden and unloading.

Methods for moving overburden determine the most important parameters of the basic elements of the stripping system: height and the quantity of working benches, width of working platforms, the pace of the pushback, value of the working area, quantity of opened and prepared for extraction reserves, etc.

The major stripping systems, most often used when developing mineral deposits are:

- non-transport stripping system. Under this system overburden excavation equipment (mostly draglines) transshipping directly (or with a certain volume of re-handling) to the dump (or with a certain amount of re-handling) to the dump, which is located in the mined-out space of open pit. Non-transport system is technologically the most simple and economical. However, it limits the transverse dimension (workspace) of pit, and its parameters are in direct proportion to the size of overburden excavators. Furthermore, the number of opening and ready to excavation reserves under this system is strictly limited. The field of application non-transport

systems are deposits with a relatively small (up to 30...40 m) thickness of overburden and low (10...12 m) thickness of minerals;

- transport stripping system. Under this system transportation overburden to dump (internal or external) carried out by means wheeled vehicles, the size of pit is not restricted, and the most important parameters of the system do not depend on the working size of the excavation and loading equipment. Field of application of the transport stripping system has practically no technical limitations and the amount of accessed mineral reserves created out of need;
- combined stripping system has intermediate characteristics of non-transport and transport stripping system. Relative difficulty and economy depends on share participation in it systems with transshipment and transportation of overburden. Availability transshipment rock which limits the transverse dimension of the working space pit, when combined stripping system is used in all cases, therefore, the quantity reserves opened under it is strictly limited.

Under the conditions of gypsum and carbonic calcium gypsum of the Zchatlbila deposit, when the thickness of overburden and productive strata of more than 30 m, cramped conditions and upland field type, use of non-transport stripping system it is not possible for several reasons:

- opportunity to expose the bottom of the pit and placing on it the internal dumps only after 5...6 years after the start of development of the deposit;
- absence of overburden equipment, use of which would allow, when transshipment of overburden in internal dumps, to dispense without blockage wastes rocks of productive strata;

The use of the transport stripping system with the movement of overburden wheeled vehicles in specific geological conditions of the deposit Zchatlbila has a minimum various restrictions, as the only acceptable solution.

Based on the foregoing, the stripping system of the deposit Zchatlbila accepted a transport with removal of overburden first to the external and then to internal dumps.

Coefficient of residual loosening rocks in a dump adopted 1,1.

In the internal and external dumps envisaged to store about 1,02 million. m^3. Due to the fact that the development of deposit upland type is carried out in cramped conditions, since the beginning the development and before sixth year the overburden capacity 235500 m^3 will be stored in the external dump, located within the mining lease, but located outside the boundaries of estimating reserves.

Proceeding from mining and geological conditions, the first to the sixth year of the development of an external dump will be placed on the overlying slope, relative to a career, on the horizon in 1298, 1318 and 1333. Therefore should consider measures to strengthen the dump massif to avoid possible falling asleep pit of overburden.

Use of internal dumps allows fill part of pit the waste rock without clogging of the ground surface.

In perspective further development of mining operations, after the sixth year, despite the possibility of partial placement of overburden in the internal dumps, will be necessary search area to accommodate of the external dump outside the existing mining and land allotment.

Accepted stripping system is able to provide intensive development of productive strata and enterprise performance.

One of the key elements of the stripping system is the height of the working benches from which to a large extent depend on many technical and economic performance indicators of open pit.

Under the conditions of deposit Zchatlbila in the presence of different layers overburden and minerals, height of overburden and mining benches accepted 8 m. This is due to the fact that mining and overburden operations will be used equipment of subcontractor that has a restriction on the technical possibilities. Moreover, this height benches optimal for use in the specific geological conditions and ensures the stability of massif and continuity of mining process.

Losses gypsum and carbonic calcium gypsum will take place both in the development of contact zones with the waste rock, as well as in the performance of the individual processes (blasting, loading and unloading, crushing and sorting, transportation and storage operations).

Dilution of the mineral will be connected with the development of contacts productive strata with the covering, underlying and enclosing overburden and with interlayers overburden.

The minimum width of working platforms was determined based on the conditions for the free placing and safe operation of mining and transportation equipment, outside the prism caving, as well as the shotpile. When developing overburden it is accepted 23 m, for mining operations - 28 m.

The minimum width of working platforms was determined by taking the distance from the top edge underlying bench to the carriageway of two-lane road - 6 m, width of a two-lane road - 8 m, distance from the carriageway of the road to the bottom edge of the overlying bench - 1 m, width of excavator stope is 8 m in developing overburden.

In work will be constantly 4-8 benches, including 2-4 mining benches and 3-5 overburden benches.

Direction the development of mining operations planned from the southwest contour of open pit where, according to the geological report, marked the crop of minerals to the surface, and then north-easterly direction.

Slope angles of working benches accepted 55…60° for overburden and minerals.

The height of each of the non-working double benches set out in the final position adopted 8 m.

Between the benches provided for leave cleaning berm (safety) width 5 m.

The angles of slopes of non-working benches accepted 55°.

Making of open pit slope, for set in its final position, will be made by using a hydraulic excavator "backhoe". Height of working benches at the approach mining operations to the borders of open pit should not exceed 8 m, which will allow

unimpeded career excavators flatten unworkable benches taken up to angles of slope stability in the project.

Average pace lowering mining operations for the entire period of mining reserves Zchatlbila is 4 m/year.

3.5 Calendar plan of mining operations

Calendar plan of mining operations developed on the basis of the calculated horizon volume of the rock mass and reserves and reserves layers of gypsum and carbonic calcium gypsum in the open pit.

Mining and construction activities in a pit envisaged to start at the same time with the mining operations in the first year of mining operations.

Necessary to remove 45 thous. m^3 of overburden for ensure the stable mining operations in a pit.

Commissioning of the mine excavator and wheel loader provided for as follows.

For the development of the first overburden bench (in the first year of mining operations) provided to be used excavator JS175W (Annex, p.VI) and one wheel loader XCMG LW321F (Annex, p.VII) will be used to support operations.

Second wheel loader will be put into operation for servicing a crushing and screening unit (CSU).

During the first year of mining operations in the removals of overburden will be employed 2, and in the second year - 2 dump trucks MAZ - 6501. Subsequently, as the development works in pit, will be put into operation other mining equipment.

Schedule development of productivity a pit Zchatlbila is shown in Table 11.

Horizon-oriented volume of overburden operations are presented in Table 12, and mining operations - in Table 13.

	Excavation of overburden, thous. m^3	Extraction gypsum-containing rocks, thous. t	Current stripping ratio, m^3/t
1st year	45,0	50,0	0,90
2nd year	38,5	50,0	0,77
3rd year	62,2	50,0	1,24
4th year	43,7	50,0	0,87
5th year	32,4	50,0	0,65
6th year	13,7	50,0	0,27
Total for 6 years	235,5	300,0	0,79
Residue	784,615	918,645	0,85
Total	1020,115	1218,645	0,84

Table 11: Schedule development of productivity a pit Zchatlbila

Calendar year	Mark of horizon	Thickness, m	Volume of excavation, thous. m^3
1st year	+1284,00	0-4	1,41
	+1276,00	0-8	16,39
	+1268,00	0-8	27,20
Total for 1st year			45,00
2nd year	+1284,00	0-7	2,19
	+1276,00	0-8	13,86
	+1268,00	0-8	16,80
	+1260,00	8	5,65
Total for 2nd year			38,50
3rd year	+1284,00	0-7	2,15
	+1276,00	0-8	13,21
	+1268,00	0-8	17,53
	+1260,00	8	29,31
Total for 3rd year			62,20
4th year	+1284,00	0-8	1,60
	+1276,00	0-8	7,56
	+1268,00	0-8	14,24
	+1260,00	8	18,33
	+1252,00	0-6	1,96
Total for 4th year			43,70
5th year	+1284,00	0-7	0,72
	+1276,00	0-8	7,97
	+1268,00	0-8	13,48
	+1260,00	8	10,23
Total for 5th year			32,40
6th year	+1276,00	0-8	1,72
	+1268,00	0-8	7,50
	+1260,00	8	2,98
	+1252,00	0-3	1,50
Total for 6th year			13,70
Total for 6 years			235,50

Table 12: Horizon-oriented volume of overburden operations open pit Zchatlbila

Calendar year	Mark of horizon	Thickness, m	Volume of excavation, thous. m³	Volume of excavation, thous. t
1st year	+1276,00	0-8	4,48	9,23
	+1268,00	0-8	19,79	40,77
Total for 1st year			24,27	50,00
2nd year	+1276,00	0-8	1,27	2,63
	+1268,00	8	5,45	11,22
	+1260,00	8	17,55	36,16
Total for 2nd year			24,28	50,01
3rd year	+1276,00	0-8	0,48	0,99
	+1268,00	8	8,54	17,60
	+1260,00	8	15,25	31,41
Total for 3rd year			24,27	50,00
4th year	+1276,00	0-8	0,14	0,29
	+1268,00	8	3,27	6,74
	+1260,00	8	5,30	10,91
	+1252,00	8	15,57	32,07
Total for 4th year			24,27	50,00
5th year	+1276,00	0-3	0,05	0,10
	+1268,00	8	1,62	3,33
	+1260,00	8	4,58	9,42
	+1252,00	8	18,04	37,15
Total for 5th year			24,27	50,00
6th year	+1260,00	8	3,13	6,45
	+1252,00	8	21,14	43,55
Total for 6th year			24,27	50,00
Total for 6 years			145,63	300,01

Table 13: Horizon-oriented volume of mining operations open a pit Zchatlbila

3.6 Technological processes and mechanization of mining operations

In order to improve mobility and increase the productivity of the equipment in the open pit mining is planned to use the excavation and loading and ancillary equipment with diesel drive.

3.6.1 Drilling operation

Physical and mechanical properties of the enclosing rocks and minerals presented in the pit of mudstone, sandstone, clay, gypsum and carbonic calcium gypsum require preliminary destruction blasting prior to excavation.

Blasting of massif is produced using borehole charges.

Boreholes are planned take place at an angle 60° to the vertical. Their length for 8 meter bench accepted (with overdrill) 10 m.

Diameter of boreholes accepted 120 mm, the distance between them is 6 m, the distance between the rows of boreholes 6 m.

The rocks which are subject fragmentation, relatively the classification of UTS, by difficulty drillability refer to V-VII categories.

Drilling operations and operational exploration at the deposit provides for the involvement of specialized organizations.

3.6.2 Blasting operations

Minerals of Zchatlbila deposit by difficulty explosion refer to 3 group according to the classification UTS.

The deposit hasn't water intrusion water in the pit will fall into only due to melting snow and rainfall. Therefore, boreholes intended to be filled explosives will be practically dry, so you can use in explosions relatively cheap and common explosives, for example, Powergel Magnum 365.

In wet holes (if such will be) expected to be used as Powergel Magnum 365 that is versatile explosives which can be used in both dry and wet holes.

Specific consumption of explosives accepted for dry and wet holes 0,19 kg/m^3.

Envisaged single-row blasting boreholes.

Blasting operations in the pit is planned to carry out by specialized organizations.

Passport of drilling and blasting operations will be updated during the field development.

Cutting oversize (pieces of more than 600 mm in diameter) will be made a hydraulic hammer, which is mounted on a excavator-loader JCB - 4CX ECO (Annex, p.III).

3.6.3 Excavation

As the excavation and loading equipment of open pit mining accepted hydraulic excavators and wheel loaders.

When choosing the type and brand of career excavator considered primarily factors such as:

- reliable operation;
- longer duration overhaul life;
- availability of the diesel drive;
- high productivity per unit time bucket;
- ability to develop strata of loose rock benches up to 8 m.

Excavator JS175W (application p.VI) accepted for use in the excavation of overburden rocks.

Analysis of the kinematic characteristics of excavator JS175W "backhoe" with a bucket capacity of 0,995 m3 and a maximum digging height of 9 m showed that it can safely develop benches loose rocks up to 8 m.

Machine JS175W is capable of to destroy interlayers of soils, quickly replacing the bucket to hydraulic breaker and back (hydraulic breaker to bucket).

Productivity of mining excavators depends, first of all, that is level of organization of work in the mining company. Calculating it analytically, as a rule, does not meet the real achievable results in open pit mining. This is due to the fact that it is very difficult to take into account in the calculations factors such as driver qualifications, quality of preparation the bench, providing excavator of transport, and the methods that are used for repairs etc.

Wheel loader XCMG LW321F (Annex, p.VII) planned to use for mining operations.

High-speed wheel loader equipped with a bucket capacity 1,8 m^3, it has the ability to develop exploded shotpile up to 2,9 m.

Productivity of front loader is 828 m^3/shift.

Thus working out the exploded mining bench will be as the front faces and the horizontal layers of the roof formation to the bottom of it.

Operating mode excavation and loading equipment accepted with continuous working week 92 days per year in the summer. The amount of shifts per day - 1. The duration of each shift - 8 hours.

3.6.4 Auxiliary operations

Auxiliary services in open pit consists of clearing berms non-working pit slopes of crumbled from the soil and dumped pieces of rock from the slopes overlying benches, cleaning leates silted watercourses, maintain roads in working order, cleaning the roof layers of minerals from the waste rock, cutting oversize, irrigation roads and exploded rock massifs and others.

Use a backhoe loader JCB - 4CX ECO (Annex, p.III) is provided on the excavation faces cleanup, clearing ditches roads and upland ditches and clearing security berms.

Purification of the road on working sites from exploded shotpile is planned to carry out a bulldozer T-130 (Annex, p. II).

Excavator-loader JCB - 4CX ECO provided use for cutting oversize, using hydraulic hammer, which is mounted on it.

Specialized organizations will be carried out irrigation roads and faces in the maintenance of mining, dump and connecting roads in working condition and delivery workers to places of work in pit and waste rock dumps.

Operating mode of auxiliary equipment accepted the same as the excavation and loading.

3.6.5 Technological transport

When selecting vehicles for removals rock mass from the pit was considered dump trucks subcontractor LLC "Astoria +", which will carry out the overburden

and mining operations, as well as the transportation of gypsum-containing rock to the crushing and screening plant, and waste rock to dump.

Cars Volvo FM 12.440 (Annex, p.IV), MAZ - 6501 (Annex, p.V) adopted as a dump trucks of pit.

The value ruling gradient of stationary transport incline between the surface and horizon 1260 m in the pit accepted 90 promiles, horizons between 1260 m and 1252 m in pit accepted 90 promiles also.

Ruling gradient sliding cross-overs accepted 90 promiles.

Ruling gradient access into the waste rock dump accepted 90 promilles.

Average length transportation of waste rock from the working faces of his career to the point of unloading on the external dump in the 3rd year from the start of mining operations at the deposit is 0,6 km, the length of the transportation of mineral to the crushing and screening plant - 0,4 km.

Average speed of the dump trucks in the pit (around the working sites, on the rise and descent) on the surface and on the dump, full and empty directions was accepted of 30 km/h.

Quantity of buckets which will be loaded with an excavator to dump truck MAZ - 6501 carrying capacity of 20,1 tons, is 12 units.

Weight of transported cargo by dump trucks for one trip will be 19,7 tons.

Total time of one trip MAZ – 6501 during transport of overburden will be 17 minutes.

Quantity of working trips per shift during transportation a dump truck with waste rock to the dump taking into account the 8-hour work shift and utilization ratio MAZ - 6501 by time 0,93 is 24 trips.

The dump trucks, which engaged in the transport of waste rock to dump, in the amount of 20,5 thous. t/year, will be 2 units.

Weight of gypsum-containing rocks in the bucket of front wheel loader XCMG LW321F calculated 3,7 tonnes.

Quantity buckets loaded wheel loader XCMG LW321F to dump truck Volvo FM 12.440 capacity of 32 tonnes, will be 11 units.

The mass of gypsum-containing rocks transported in one trip Volvo FM 12.440, 30,6 t.

Total time of the trip Volvo FM 12.440 during transportation gypsum-containing rocks on the crushing and screening plant will be 17 minutes. Quantity of working trips per shift of one dump truck with 8-hour work shift and utilization ratio Volvo FM 12.440 by time equal 0,93, will be 23.

Quantity working trips a dump truck during the year – 2116.

Productivity of dump truck, in the transportation gypsum-containing rocks from the pit to the crushing and screening plant, is 64,7 thous. t/year.

The dump trucks, which engaged in the transport of minerals to the crushing and screening plant in the amount of 50 thous. t/year, will be 1 car.

Inventory amount of dump trucks MAZ - 6501 with a coefficient of technical readiness of 0,85 will be 3 units, dump trucks Volvo FM 12.440 - 2 units.

Operating mode of dump trucks MAZ - 6501 and Volvo FM 12.440 accepted 92 days. The amount of shifts per day - 1, duration of each shift - 8 hours.

Total width of the pit and dump process of roads, which are placed on the set to the final position slopes, as well as on the mound, adopted on 8 m.

Envisaged to replace the faulty machine on a similar characteristics in order to minimize downtime due to repair dump trucks.

Main subcontractor of LLC "Astoria +" will be carried out repairs of technological roads.

3.6.6 Dumping

Total volume waste rock (in the dense body), which are subject to the storage of overburden dumps, will be 1 020,115 thous. m^3.

Overburden of deposit Zchatlbila or the most part consist carbonic calcium gypsum, which is on the state balance of mineral resources of Georgia. Consequently, dumps, which will be placed waste rock to form a technogenic deposit.

Fertile soil needs to be stored separately from the waste rock in an external dump, which directly adjacent to the overburden dump.

External dump is planned to create in three tiers on the horizons 1298, 1318 and 1333 m.

Height external tiers the dump accepted: first - 20 m, the second - 20 m, the third - 15 m. The surface of the first tier is located on mark 1298 m, its based on a mark 1278 m. Angle of slope tiers accepted to 35°. Security berm between tiers planned width of 8 m.

Dumping technology on the external dump taken using dozer equipment.

Waste rock dump trucks will be unloaded, without reaching 10 meters up to the top edge of the dumps, then the rock will be facing down the slope over with bulldozer T-170 (Annex, p.I).

Envisaged to lead regular visual and instrumental monitoring of the the dump slopes (and pit). Work in these areas will be terminated immediately and unload dump trucks moved to alternate unloading deadlocks, if there will be violations of the surface of the the dump.

3.7 Main mining and transportation equipment of open pit Zchatlbila

A list of the main mining equipment of open pit Zchatlbila shown in Table 14.

Directly surveying work at the deposit Zchatlbila will provide LLC "Astoria +".

Geological surveying tracking of mining operations includes:

- estimation of reserves in the extraction unit: bench, excavation block, according to data of operational exploration;
- control of the correct direction of mining operations, including the continuous monitoring of progress faces and comparing their situation with the planned schedule;
- geological documentation of faces consisting of sketches on the basis of instrumental scale 1:50 with remote data sampling and

verbal descriptions, which contains the characteristics of the rocks, they changes, measuring angles and azimuths fall contacts, stratification and other geological elements;

- instrumental measurements of mined-out space;
- sampling, which consists in grab sampling every tenth truck with a total weight of sample 10,5 kg.

№	Name and short technical characteristics	Model	Company, country of origin	Q-nty, units
1	Hydraulic excavator "backhoe" wheeled, diesel drive power of 128 kW and a bucket capacity of 0,995 m^3, maximum digging height of 9,2 m, maximum digging depth of 6,5 m and weight of 17,5 t	JS175W	JCB, United Kingdom	1
2	Front loader wheeled with diesel drive 92 kW, a bucket capacity of 1,8 m^3 and weight of 10 t	LW321F	XCMG, China	2
3	Hydraulic excavator-loader, with diesel drive power of 74,2 kW, excavator bucket capacity 1 m^3 and general purpose bowl capacity 1,3 m^3. Maximum digging height excavator bucket 5,45 m, the maximum depth of of digging excavator bucket 4,32 m. Maximum height of unloading, general purpose bucket 2,69 m, maximum digging depth of general purpose bucket 0,14 m. The weight of 8,5 tons.	4CX ECO	JCB, United Kingdom	1
4	Drilling rig on tracks, power 186 kW, drilling diameter 90-127 mm, maximum drilling depth of 32 m and a weight of 18,5 t.	Titon 300	Sandvik, Sweden	1
5	Bulldozer on crawlers with diesel drive 125 kW, blade width 3,42 m, height 1,31 m blade and weight 15 t.	T-170	CHTZ Uraltrac, Russia	1
6	Bulldozer on crawlers with diesel drive 118 kW, blade width 3,42 m, height 1,31 m and weight 12,7 t.	T-130	CHTZ Uraltrac, Russia	1
7	Dump truck capacity 32 tons with diesel drive power 294 kW, body volume 22 m^3	FM 12.440	Volvo, Sweden	2
8	Dump truck capacity 20,1 t with diesel drive power 294 kW, body volume 13,3 m^3	MAZ - 6501	MAZ, Belarus	3

Table 14: List of the main mining equipment

Main task of surveying service will be the prevention of excessive losses and dilution in relation to the project.

Determination of the losses will be made by two methods: direct - instrumental measurements of volume of ore that is left at the bottom layer and enters the overburden in its roof, and indirectly - on the difference between the ore reserves, estimated according to operational exploration, and according to the geological survey records by the formula

$$(Q_w - Q_{worked}/Q_w) \times 100\%$$

where Q_w – reserves, calculated according to the operational exploration,

Q_{worked} – reserves actually worked.

Main sources dilution will be:

- entering the enclosing rocks to mined-out space, in top and bottom layer;
- mixing of waste materials to the the enclosing rocks as a result of slumping and creep benches.

Calculations of actual dilution will be carried out by the formula:

$$(C_w - C_{worked}/C_w) \times 100\%$$

where C_w – average mineral content according to operational exploration,

C_{worked} – average mineral content according to commodity testing.

4 Processing of gypsum

Commodity production a open pit Zchatlbila will be crushed factional gypsum stone. Fractions are shipped factory LLC "Knauf Gips Tbilisi" have a size -300+60 mm and -60+5 mm (shipped separately). Thus at a fraction of -60+5 mm contents -5+0 mm shall not exceed 30%.

Crushing of minerals that was mined in the pit, provides a stationary crushing and screening unit (CSU), installed in the immediate vicinity of the southern pit slope on the horizon in 1280 in one of the production sites which area 422 m^2. Subsequently exploitation of the deposit is considered the replacement of stationary to mobile CSU, which will be placed directly into a pit with 3 years of development. Dimensions of the site for crushing and screening plant, unloading area made taking into account safe operation of the transport (loader XCMG LW321F length 6,8 m, turning radius 5,7 m, dump truck Volvo FM 12.440 turning radius 10 m and a MAN TGS 40.400 length 8,6 m and a turning radius 10 m).

4.1 Justification of the choice crushing and screening plant

The choice crushing and screening plant for Zchatlbila deposit carried out based on the availability of equipment from subcontractors.

Construction company LLC "Astoria +" is available a stationary jaw crusher SCHDP-15x21 and grizzley GIT-62, which are suitable by technical characteristics for use in the Zchatlbila deposit.

Also, the company LLC "Astoria +" expressed its readiness, following the signing of the contract about cooperation, to buy a mobile CSU to place it in pit and optimize the process of mining.

4.2 Technological equipment of crushing and screening plant

Crushing and screening plant includes jaw crusher SCHDP-15x21 and grizzley inertial heavy type GIT-62.

Jaw crusher SCHDP-15x21 is a stationary crusher with simple movement of jaw.

Grizzley inertial heavy type GIT-62 used to resorting extracted materials lump type on 3 different factions. The size of each piece of sorted materials should not exceed 500 mm. Main indications for use of the grizzley: sort of material, which is used in construction, mining or processing industries. Grizzley inertial heavy type GIT-62 is different durability and relatively high resource.

Technical characteristics of jaw crusher SCHDP-15x21 shown in Table 15, the characteristics of the inertial grizzley GIT-62 - Table 16.

№	Technical data	Value
1	Dimensions of the receiving hole (W * L), mm	1500*2100
2	Largest size a piece of source material, mm	1300
3	Width the outlet in the phase opening, mm	
	- nominal	180
	- regulation range, not less	±45
4	Productivity at the nominal width of the output gap, $m^3 \cdot h^{-1}$, not less	600
5	Dimensions (without drive) (L * W * H), mm, not more	7500*5100*5200
6	Specific power consumption, $kW \cdot h \cdot m^{-3}$, not more	0,42
7	Engine power the main drive, kW, not more	250
8	Average resource to the first overhaul, h, not less	35000
9	Mean time between failures, h, not less	600
10	Coefficient technical use, not less	0,94

Table 15: Technical characteristics SCHDP-15x21

№	Technical data	Value
1	Size of screening surface, mm	2000x5500
2	Amount screen tiers	2
3	Largest allowable size of a piece of source material, mm	500
4	Maximum weight of a body-mass screening bulk material, t/m^3	2,8
5	Productivity not more m^3/h	450-1000
6	Angle of inclination the screening surface, deg	10-20
7	Power of electric motor, kW	22
8	Overall dimensions of the vibrating screen, mm	6200x2650x1300
9	Mass grizzley without electric drive, kg	5400

Table 16: Technical characteristics of inertial grizzley GIT-62

4.3 Operating mode of crushing and screening plant and the expected production output

Operating mode crushing and screening plant accepted with continuous working week 92 days per year in the summer. The amount of shifts per day - 1. The duration of each shift - 8 hours. Annual limit of working time CSU when utilization ratio of the working time 0,94 is defined 35,000 hours. Average hourly capacity of the unit is calculated in 775 t.

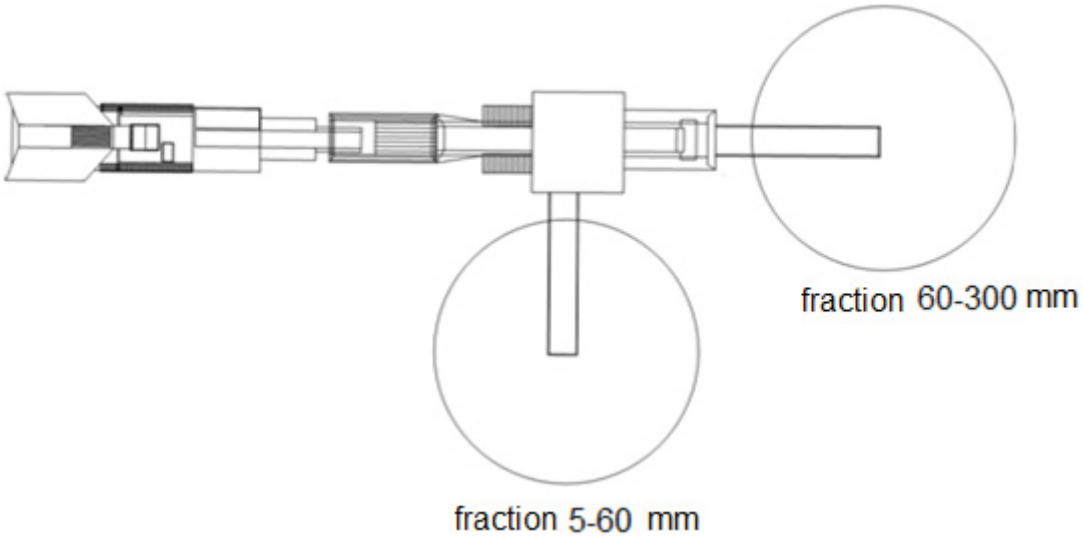

Figure 2: Technological line for processing of gypsum

Front loader XCMG LW321F on wheels with diesel drive power 92 kW bucket capacity of 1,8 m^3 which is intended for loading of gypsum, which is mined in the quarry, in the jaw crusher SCHDP-15x21.

Loading commodity fractions gypsum produced at the output of inertial grizzle of heavy type GIT-62, to dump trucks MAN TGS (Annex, c. X-XIII) will be carried out the same front-end loader XCMG LW321F.

Bulldozer T-130 crawler, with diesel drive 125 kW, blade width 3,42 m, blade height 1,31 m and weight 15 t will be used to auxiliary works on the crushing and screening plant.

5 General plan and transport

5.1 General plan

Enterprise on the basis deposit Zchatlbila of gypsum and carbonic calcium gypsum is located 230 km from Tbilisi, where the plant LLC "Knauf Gips Tbilisi", 16 km south-west from the municipal center - the town of Akhaltsikhe, 0,2 km south-west from the village Zchatlbila of Akhaltsikhe municipality and 1,9 km from the asphalted road E691.

Zchatlbila village, city Vale, Akhaltsikhe and Tbilisi are connected of asphalt road. City Vale, Akhaltsikhe and Tbilisi are connected railway.

The relief of the municipality is difficult - there are leveled terraces, meridian valleys, small pits, hills and volcanic mountains that are located at an altitude of 950 m (v. Atskuri) 2964 m (mount Gumbati).

In the area of designing a climate mountain steppes, winter is cold, with little snow, summer - long and warm. The absolute minimum -32°C, the absolute maximum +39°C. Annual rainfall to lowest zone is not more than 520 mm, and on the slopes of the surrounding mountain ranges up to 1200 mm.

The composition the planned enterprise includes the following objects:

- open pit;
- dump of waste rocks;
- roads of pit;
- crushing and screening plant;
- temporary storage of gypsum;
- industrial site for employees with parking for machinery;
- industrial site for the crushing plant and the temporary storage of gypsum.

The pit is located two kilometers to the south-east of asphalted road E691.

The industrial site is located to the south 50 meters from the pit outline on the horizon 1280 m. Area of industrial site is 422 m^2. Crushing and screening plant,

which consists of of jaw crusher and universal screening at the site located in south-western, north-eastern part - bings of crushed gypsum fractions 0-300 mm.

The second industrial site for the placement of equipment, as well as trailers for workers located in the eastern part of the mining lease. Area of the industrial site 1046 m^2. Module buildings for personnel, stock of spare parts and toilets are expected to be placed in the south-west and west industrial site. Eastern part of the industrial site will perform the function of parking for dump equipment.

5.2 Transporting crushed gypsum to the factory LLC «Knauf Gips Tbilisi»

A distance transportation of gypsum stone from the open pit Zchatlbila to LLC "Knauf Gips Tbilisi" is 230 km.

Transport network of Akhaltsikhe municipality is such that the transportation of minerals is possible to carry out by road on the highway E691, as well as by rail from the cities Vale and Akhaltsikhe.

Condition of roads is satisfactory and allows transporting the gypsum to the cities of Vale, Akhaltsikhe and Tbilisi using trucks.

Peculiarity of the railway line is that the nearest town, which has a railway line, is the town Vale. However, the length of the railway Vale Akhaltsikhe is in disrepair and needs a complete overhaul because it uses no more frequently than once a year, also due to lack of overhead construction work of electric locomotive is not possible, only the diesel locomotive. As a result, transportation gypsum using of the railway, is possible only from the station Akhaltsikhe, which will be carried out an overload from the dump trucks to open wagons.

Based on these conditions, it is possible to implement one of the two schemes of transportation that will be the most rational:

1) Gypsum stone, immediately after the primary processing is transported using subcontractor «Devitrans» and its dump trucks MAN TGS (Annex, p.X-XIII) to the railway station Akhaltsikhe. On the base station Akhaltsikhe will be carried out the temporary storage and transfer of minerals to open wagons PS-63 (Annex. p.XVI) with the subsequent formation of railroad

train, which moves using electric locomotive VL10 / VL11 (Annex, p.XIV-XV) for further transportation to station Tbilisi and then to the factory LLC "Knauf Gips Tbilisi."

2) Gypsum stone, after primary processing using a crushing and screening plant, transported using subcontractor «Devitrans» and its equipment MAN TGS (Annex, p. X-XIII) directly to the factory LLC "Knauf Gips Tbilisi".

Characteristic feature of the transport company, which is engaged in maintenance and operation of railways «Georgian Railway», due to the geographical location of Georgia, due to the geographical location of Georgia, is the fact that in the first place preference for transportation of fuels and lubricants (crude oil), the second important - transportation of military equipment of the Armed Forces of Georgia. Implementation of applications for transportation of cargoes other than the first two categories of importance, carried out on the residual principle, which can lead to irregular supplies of gypsum stone. In addition, due to delays can be applied penalties for demurrage of railroad train, which may lead to an increase in the cost of mineral.

Also, a clear disadvantage of the first scheme transportation is the use of several subcontractors that may lead to lack of coordination and interruptions in the delivery of gypsum company LLC "Knauf Gips Tbilisi."

The advantages of the second scheme transportation is that the delivery of minerals will be carried out in such volumes that allow process it immediately upon receipt, without dumping in large quantities, in which case may need the construction of a warehouse.

However, the final choice scheme transportation will be carried out after the calculation cost of 1 ton of gypsum.

6 Economic efficiency development of deposit Zchatlbila

6.1 Subcontractors

One of the main directions of the diploma project is the argumentation and the choice of subcontractors who will carry out the development of deposits Zchatlbila, primary processing and delivery of minerals to LLC "Knauf Gips Tbilisi".

The choice subcontractors for the overburden and mining operations, as well as primary processing gypsum carried out among construction companies, who had to prove itself on the territory of Georgia, as those who had a good reputation and technical possibilities which required for the development of the Zchatlbila deposit.

Among the 28 companies it has been defined most preferred construction company LLC "Astoria +" from Akhaltsikhe. This company is engaged in repair of roads in the municipality of Akhaltsikhe. Moreover it has extensive experience in the mining, as currently developing two a pits where for their own needs produces crushed granite. Also, LLC "Astoria +" possesses a considerable quantity construction machinery, which is presented in Table 17, and the base on the territory of which there are concrete and asphalt plants. In addition, the builder of "Astoria +" is ready to make a commitment on carrying out power line to the deposit, buying of mobile crushing and screening unit, as well as the laying and maintenance of the roads to the deposit, in the case of signing a contract on cooperation.

Drilling and blasting operations will be carried out LLC "Astoria +" with the assistance of specialized organizations.

Transportation of minerals, with the use of rail transport, from the station Akhaltsikhe to Tbilisi, may be implemented by the company «Georgian Railway», which is a company-monopolist. As transport equipment, in this case will be used railway trains formed of open wagons to PS-63 (Annex, p.XVI) and which will be driven by electric locomotives VL10/VL11 (Annex, p.XIV-XV).

№	Name and short technical characteristics	Model	Company, country of origin	Q-nty, units
1	Hydraulic excavator "backhoe" wheeled, diesel drive power of 128 kW and a bucket capacity of 0,995 m^3, maximum digging height of 9,2 m, maximum digging depth of 6,5 m and weight of 17,5 t	JS175W	JCB, United Kingdom	1
2	Front loader wheeled with diesel drive 92 kW, a bucket capacity of 1,8 m^3 and weight of 10 t	LW321F	XCMG, China	2
3	Hydraulic excavator-loader, with diesel drive power of 74,2 kW, excavator bucket capacity 1 m^3 and general purpose bowl capacity 1,3 m^3. Maximum digging height excavator bucket 5,45 m, the maximum depth of of digging excavator bucket 4,32 m. Maximum height of unloading, general purpose bucket 2,69 m, maximum digging depth of general purpose bucket 0,14 m. The weight of 8,5 tons.	4CX ECO	JCB, United Kingdom	2
4	Drilling rig on tracks, power 186 kW, drilling diameter 90-127 mm, maximum drilling depth of 32 m and a weight of 18,5 t.	Titon 300	Sandvik, Sweden	1
5	Bulldozer on crawlers with diesel drive 125 kW, blade width 3,42 m, height 1,31 m blade and weight 15 t.	T-170	CHTZ Uraltrac, Russia	1
6	Bulldozer on crawlers with diesel drive 118 kW, blade width 3,42 m, height 1,31 m and weight 12,7 t.	T-130	CHTZ Uraltrac, Russia	1
7	Dump truck capacity 32 t with diesel drive power 294 kW, body volume 22 m^3	FM 12.440	Volvo, Sweden	
8	Dump truck capacity 20,1 t with diesel drive power 294 kW, body volume 13,3 m^3	MAZ - 6501	MAZ, Belarus	4
9	Dump truck capacity 24 t with diesel drive power 294 kW, body volume 16 m^3	P400 CBx4EHZ	Scania, Sweden	1
10	Concrete plant	-	-	1
11	Asphalt concrete plant	-	-	1

Table 17: List of the main construction machinery company LLC "Astoria +"

Alternative mode of transport for the transport of gypsum are a dump trucks. However, the company LLC "Astoria +" does not have enough dump trucks to ensure continuous operation. As a result of these features is planned to attract the company «Devitrans», which is a sufficient quantity of dump trucks of the brand MAN TGS (Annex, p.X-XIII), furthermore the company plans to purchase new models of dump equipment.

6.2 Determination of the cost of gypsum

The cost of 1 ton of gypsum was determined taking into account all types of work, as well as possible schemes of transportation, based on the price of the work received from potential subcontractors, Table 18.

In addition, to determine the cost of minerals taken into account the stripping ratio 0,84 m^3/t, and the exchange rate as at July-November 2014, with 1 euro = 2,40 lari.

№	Parameter	Cost, Lari (GEL)	Cost, Euro (EUR)	Company name
1	Overburden operations	10 GEL/t	4,17 EUR/t	LLC "Astoria +"
2	Drilling and blasting operations	3 GEL/t	1,25 EUR/t	
3	Mining operations	3 GEL/t	1,25 EUR/t	
4	Processing by crushing and screening plant	14 GEL/t	5,83 EUR/t	
5	Warehousing and loading on transport	4 GEL/t	1,67 EUR/t	
6	Transportation along the route Tskaltbila-Akhaltsikhe	15 GEL/t	6,25 EUR/t	
7	Transportation 1 open wagon (60 t) along the route Akhaltsikhe-Tbilisi	1474,76 GEL (24,59 GEL/t)	614,48 EUR (10,24 EUR/t)	Georgian Railway
8	Transportation on the route Tskaltbila-Tbilisi	30 GEL/t	12,5 EUR/t	Devitrans

Table 18: Cost of works potential subcontractors

Cost of 1 ton of gypsum is calculated as:

$$C_g = C_{o.b.}k_o + C_{m.w.}, \text{euro/t}$$

where $C_{o.b.}$ – costs transportation of overburden, waste rock development, auxiliary works in the mine, dumping, overload, euro/t;

k_o – stripping ratio, m^3/t;

$C_{m.w.}$ – cost of transportation minerals, excavations, auxiliary works in the pit and reloading, euro/t.

Considering the cost of the work, stripping ratio, exchange rate and transportation scheme calculated the cost 1 ton of gypsum.

Version №1. Overburden, drilling and blasting, mining operations, processing using crushing and screening plant, taking into account the storage and loading of on transport and transportation of gypsum along the route Tskaltbila-Akhaltsikhe performs LLC "Astoria +". Then the delivery minerals performed along the route Akhaltsikhe-Tbilisi using the company Georgian Railway.

$$C_g = 4{,}17 \cdot 0{,}84 + 1{,}25 + 1{,}25 + 5{,}83 + 1{,}67 + 6{,}25 + 10{,}24 = 29{,}99\ (\text{euro/t})$$

$$C_g \approx 30(\text{euro/t})$$

Version №2. Overburden, drilling and blasting, mining operations, processing using crushing and screening plant, taking into account the storage and loading of transport, performed by LLC "Astoria +". Delivery gypsum along the route Tskaltbila-Tbilisi using dump trucks performs the company "Devitrans".

$$C_g = 4{,}17 \cdot 0{,}84 + 1{,}25 + 1{,}25 + 5{,}83 + 1{,}67 + 12{,}5 = 26\ (\text{euro/t})$$

$$C_g = 26\ (\text{euro/t})$$

Taking into account the cost calculation of 1 ton of gypsum, the ability to minimize delays in the delivery of gypsum stone and convenience of control over the performance of work subcontractors accept Version №2 with delivery gypsum dump Tskaltbila along the route Tbilisi using the company Devitrans.

As you know, at the moment, the company LLC "Knauf Gips Tbilisi" gets gypsum from the company Knauf Gilan, which is located in Azerbaijan. The cost of obtained minerals is 35,42 euro/t.

Considering as Version №1 and Version №2 cost of gypsum reduced by 5,42-9,42 euro/t, that given the volume of 50 thousand. t. will allow to save from 271 thous. up to 471 thous. euro per year.

Availability own raw material base in the form of a open pit Zchatlbila a positive impact on the production process of LLC "Knauf Gips Tbilisi", due to the fact that will be possible to control the quality, volumes, lumpiness and time of delivery of raw materials. In addition, the decrease in the cost of gypsum stone will increase the amount of income and the level of profitability of the enterprise.

7 Protection of labor

Exploitation of mineral deposits by open method is carried out according to the Uniform safety rules which are binding on all institutions engaged this type of activity.

As you know, Georgia, which until 1991 was part of the Soviet Union, engaged in the extraction minerals by open methods under the Uniform safety rules when developing mineral deposits by open way, the USSR State Technical Supervision approved August 30, 1968, second edition, revised and expanded, 1987.

After the disintegration of the Soviet Union, the countries included in the CIS, took over the basis of Uniform safety rules in 1987, and then on the basis of which was to create a uniform safety rules for each country.

Moreover, we know that Russia, which has an impressive amount of minerals on its territory, the most active improved USR due to exploitation of mineral deposits

When writing section Protection of labor was based on the Uniform rules of safety in the development of mineral deposits by open way by September 9, 2002.

7.1 Safety in mining mechanization

Admission to the operation of mining, transport, road construction machinery, processing equipment, after installation and major repairs performed with the participation of representatives of local authorities of State Technical & Mining Inspectorate Georgia.

Vehicles that have been maintenance and repair must meet the requirements that govern the technical condition of equipment and vehicles, to part related to traffic safety, which must be confirmed by an appropriate document.

Technological equipment, which is worn out, shall be subject to examination with registration in the prescribed manner industrial safety expert statement on the results of examinations and tests, which are the basis for the decision by the operator to hold the repair, modernization and withdrawal of equipment from use.

Mining, transportation, construction and road machines that are in operation are undamaged, equipped with signaling devices, brakes, fences accessible moving parts (couplings, gears, pulleys, etc.) and work sites, fire-fighting appliances, have light, set of serviceable tools, devices, protective means against electric shock and the necessary instrumentation, as well as regularly acting overload protection and overwinding.

Nomenclature and quantity of fire-fighting equipment for each type of machine to be agreed with the Georgian State Technical Supervision. Serviceability and complete machines should be checked every shift by driver (operator), weekly - mechanics, electricians of site and monthly - chief mechanic, chief electrician of pit or other appointed person. The test results should be reflected in the log of Acceptance a shift. Do not use defective machinery.

Operation, maintenance of technological equipment, technical devices and their installation, disassembly must be done in accordance with the instruction manual, technical passports and other legal documents of the manufacturers.

Standardized manufacturers specifications must be maintained throughout the period of operation of the equipment.

Moving parts of the equipment represent a source of danger to the public should be protected, except for parts which it is fencing impossible because of their functionality.

Before starting work or movement the machine (mechanism) the driver is obliged to ensure the safety of crew members and others.

Warning signal shall be audible and duration must be at least 6 seconds, and it should be heard throughout the danger zone.

Before starting up the mechanisms and the beginning of the movement of machinery, vehicles, loading equipment required warning sound or light signals developed by the organization operating the facility open mining operations, with the value of which should be familiar all workersThus signal must be audible (visible) to all the workers in area of the machines (mechanisms).

Workers who perform work of high risk, including control of technological equipment (a list of occupations sets head of the organization), before the start

shift, and in some cases, and at its end must pass a compulsory medical checks for alcohol and drug intoxication.

In after-hours mining, transportation and road-building machines should be withdrawn from the face in a safe place, a working body (bucket, etc.) - lowered to the ground, the cabin - locked, with the supply cable is voltage removed.

Works using mining, transport and road construction machinery should be conducted on a local project of works (passport). Passports must be in vehicle cab.

Prohibited mining operations without an approved passport, as well as deviations from it.

Driving mining, transport and road construction machinery (excavators, drilling machines, etc.) and transportation them in vehicles must be in accordance with technological maps approved by the technical director of the organization.

Prohibited the presence of unauthorized persons in the cab and on the external sites excavator and drilling rig at their work except technical director shift and persons having special permission technical head of the organization.

Lubrication of machinery and equipment should be carried out in accordance with the operational documentation and manufacturer's instructions.

The lubrication system must have devices that prevent splashing and spills oil.

All of the devices included in the lubrication system must be kept in good condition, clean and safe to be in service.

Lubrication actuator of equipment and machinery that has no built lubrication systems during operation, prohibited.

Structural elements of the transport and dump bridges, spreaders and excavators, as well as their ladders and platforms should be cleaned every shift of the rock mass and dirt.

Lubricants and cleaning materials should be stored in closed metal boxes. Storage and transportation of mining machines flammable substances are not permitted.

7.2 Drilling operations

Workplace for conducting drilling operations must be ensured:

- prepared scope of work (cleaned and planned work platform);
- set of serviceable drilling tools;
- project (passport and technology card) for drilling.

Surveying providing drilling and blasting operations should be in accordance with the requirements.

Drilling machine must be installed on the planned site at a safe distance from the top edge of the benche, determined by calculation or by a draft, but not less than 2 m from the edge to the nearest point of support of the machine,determined by calculation or by a draft, but not less than 2 m from the edge to the nearest point of support of the machine, and its longitudinal axis during the drilling of the first row boreholes should be perpendicular to the brow bench.

Prohibited underlay pieces of rock under the jacks machines. When installing drilling rigs for roller drilling at first row boreholes from slope then machine control must be carried out remotely.

Moving drilling machine with a raised gantry allowed on the bench of a planned site. When moving the drilling rig from bench to bench or under high-voltage line, gantry to be laid down to the transport position, the drilling tool - removed or securely fastened.

Drilling wells must be carried out in accordance with the instructions, established by the organization on the basis of the standard for each drilling method (fiery, rotary, etc.).

Screws in rotary drilling machines with non-mechanized assembly-disassembly drilling rod and cleaning of collar should have fences, semi-detached with the power supply to the motor rotator.

Prohibited work on the drilling machine with faulty overwinding limiters of drill also with defective brake winch and dust suppression system.

Hoisting ropes of drilling rig hould be calculated on the maximum load and have a five-fold margin of safety. When choosing a rope must be guided

factory act - certificate. Not less than once a week the site engineer or other specially appointed person should carry out an external examination of the rope and make a log entry on the results of the inspection.

The protruding ends of wires must be cut off. In the presence of the hoisting ropes than 10% of torn wires lay on the step length should be replaced.

When drilling hammers and electric drill working width of berm shall not be less than 4 m. Prepared for drilling oversized pieces should be stacked steadily one layer outside the the possible caving bench.

7.3 Blasting operations

Blasting operations in the pit shall be conducted in accordance with the "Uniform safety rules at blasting operations" Kiev, "Normative" in 1992.

Blasting operations takes place on the basis of a standard project, surveying capture data of unit, physical, mechanical and other characteristics of the blasted rock.

Identify safe distances for flying individual pieces into the rock by blasting borehole charges is made according to "Uniform safety rules for blasting operations," Appendix 8 to §67, §68, §69, §70; "Instructions for determining safety distances in blasting operations and storage of explosive materials".

$$R = 1250\eta_f \sqrt{\frac{f}{1+\eta_{tam}} \cdot \frac{d_b}{a}}, m$$

where η_f, fill factor explosives in borehole;

$f = 2$, coefficient fortress rocks by M. M. Protodyakonov;

η_{tam}, fill factor tamping in borehole;

$d_b = 0{,}12\ (m)$, borehole diameter;

$a = 6\ (m)$, distance between boreholes in row or rows of boreholes;

Fill factor explosives in borehole η_f determined by the formula:

$$\eta_f = \frac{l_{charge}}{L} = \frac{5}{10} = 0{,}5$$

Fill factor tamping in borehole $\eta_{заб}$ determined by the formula:

$$\eta_{tam} = \frac{l_{tam}}{l_f} = \frac{5}{1} = 5$$

where l_f – length of the free place from charge to top borehole, m.

When full the free part of borehole tamping $\eta_{tam} = 1$, when blasting borehole charges without tamping $\eta_{tam} = 0$.

$$R = 1250 \cdot 0{,}5\sqrt{\frac{2}{1+5} \cdot \frac{0{,}12}{6}} = 51(m)$$

7.4 Single-bucket excavators

When moving crawler excavator on a horizontal site or upraise of drive undercarriage should be back, and when downrise – ahead. The bucket must be emptied, and be no more than 1 m from the ground and the boom should be placed along the excavator.

When driving an excavator on the rise or downhill is necessary to provide the measures excluding spontaneous slipping.

Driving the excavator must be carried out on the highway, located outside the prism caving, with slopes not exceeding permissible on the data sheet of the excavator and having a width sufficient to maneuver. Driving the excavator must be carried by the signals assistant engineer or a designated person, they must be provided with permanent visibility between them and the excavator operator.

The excavator must be placed on the bench or dump on a leveled ground with a slope not exceeding the permissible technical passport excavator. The distance between the slope bench, dump or vehicle and an counterweight of excavator mounted passport of face, depending on geological conditions and the type of equipment, but in any case shall not be less than 1 m.

When using an excavator with a bucket capacity of less than 5 m (base model), his cabin should be in the side opposite to the slope bench.

When loading in trucks, drivers vehicles are obliged to obey the signals excavator operator, the value of which is established by management.

Table of signals should be displayed on the body of the excavator in a prominent place, it must be familiar excavator operator and vehicle drivers.

Prohibited during operation excavator stay of people (including staff) within range of the excavator.

In the case of threat of collapse or slumping bench during operation the excavator or detecting explosives failed charges then excavator driver is obliged to stop work relocate an excavator to a safe place and notify the head of the technical shift.

Moving an excavator from the face should always have easy access. Oversized pieces of rock mass should fall stable in a single layer, not creating obstacles to the movement of mining equipment at the site.

When the excavator on the ground, do not withstand the pressure of caterpillars, special measures should be implemented, reflected in the passport face to ensure its stable position.

7.5 Dozers, loaders

All self-propelled machinery (graders, bulldozers, loaders, etc.) must have data sheets containing their main technical and operational characteristics.

They must be equipped:

- fire extinguishing agents;
- emergency stop signs;
- first aid kits;
- stops (shoes) to place under the wheels (for wheeled vehicles);
- intermittent audible signal when reversing;
- flashing light yellow color, installed on the cab;
- two rear-view mirrors;

- repair tool provided by the manufacturer.

On the line of vehicles can be issued only on condition that all their units and components that provide safety, and security other works, provided the use of the technology are in good technical condition.

In all cases, when the vehicle is reversing should beep sounds.

Not allowed to drive the self-propelled machinery (bulldozers, loaders, etc.). across the prism possible collapse of bench.

Formation of the safety shaft to transfer points made in accordance with the passport transshipment point, with the movement of the bulldozer should be done only with a knife forward.

Not allowed to leave the self-propelled machinery with the engine running and raised a knife or a bucket, and at work - the guide wire, to become suspended in the frame, knife or bucket, as well as work equipment across steep slopes at angles not provided for the manufacturer's instructions.

Do not operate a bulldozer (tractor) in the absence or malfunction of the lock, which eliminates the start of the engine when the gearbox is enabled or the device to start the engine from the cabin.

For repair, lubrication and adjustment of the bulldozer or loader it must be installed on level ground, the engine is turned off and a knife or a bucket lowered to the ground or the specially designed support.

In the event of an emergency stop self-propelled machinery on an inclined plane should be taken to exclude its spontaneous movement of downhill.

Do not stand under a raised knife and bucket self-propelled equipment.

To inspect the blade or bucket below it should be lowered to secure the pad, and turn off the engine.

Maximum angles of the slope face when operating the bulldozer should not exceed the limits set by the manufacturer's operating instructions.

A distance from the edge of the caterpillar bulldozer or front axle loader (wheel dozer) to the edge of the slope is determined by taking into account mining

and geological conditions and shall be recorded in the passport of doing work in the pit (dump) or transfer points.

7.6 Transport safety

Width the roadway of pit roads and longitudinal slopes of set in project with the requirements of existing rules and regulations, based on the size of cars and trucks.

Temporary entry into the trenches shall be constructed so as to leave free passage of a minimum width of 1,5 m on both sides along them in traffic.

Radius of curves and cross slopes of roads provided with regard to the existing building regulations.

In the most cramped conditions in the quarry and dump the roads value of curve radii may be taken of at least two structural vehicles turning radius of the front outside wheel - when calculating for a single vehicle and at least three structural turning radius - calculated on articulated vehicles .

Part of the road within the pit outline (except downhole roads) must comply with current building regulations and to be protected from the possible collapse of the prism breed shaft or a protective wall. The height of the rock shaft is received not less than half the diameter of the wheels of the largest payloads operated on the career car. The vertical axis drawn through the top of the rock shaft must be located outside the sliding wedge.

The distance from the inner edge of the rock shaft (defensive wall) to the roadway should be at least 0,5 diameter wheels of the car maximum capacity operated in a pit.

Each car must have a technical passport containing its basic technical and operational characteristics. Career in service cars must be equipped:

- fire extinguishing agents;
- emergency stop signs,
- first aid kits;

- stops (shoes) to place under the wheels;
- intermittent audible signal when reversing;
- locking device (signaling) lifting body under overhead lines for dump trucks with carrying capacity of 30 tons or more;
- two rear-view mirrors;
- communication facilities.

On the line of vehicles can be allocated only on condition that all their units and components that provide safety, and other security works, provided the use of the technology of vehicles are in good technical condition. They should also have the necessary reserve of fuel and a set of tools provided by the manufacturer.

Drivers must have a document on the right to drive a car.

Drivers who drive a car with a diesel-electric drivetrain, should have qualification group on electrical safety is not below II.

During the overhaul and during subsequent operation within the time specified by the manufacturer (on the list), should be carried out inspection units, parts and units of heavy dump trucks that affect safety.

Speed and the order the movement of vehicles, automobile and tractor trains on roads established a pit and technical head of the organization of motor transport enterprisetaking into account local conditions.

Towing defective dump trucks load capacity 27 tons or more must be made with special trailers. Do not leave the road defective dump trucks.

Allowed short-term remission dump truck on the road in case of sudden failure, when the fence on both sides of the car with warning signs in accordance with the rules of the road.

Traffic on the technology of roads should be regulated by road signs, provided the applicable rules of the road.

Instruction on security measures for drivers of vehicles operating on open pit mining site, the performed administration organization of motor transport. At employment and after practical acquaintance with the routes, the driver must be issued certificates for work in the facility open pit mining.

Drivers of vehicles and self-propelled of technological equipment (graders, bulldozers, loaders, etc.) should be issued traveling sheets, which are work orders.

One-time entry within the mining lease of cars, tractors, trucks, loaders, lifting equipment, etc. owned by other companies, is allowed only with permission from the organization operating the object after the compulsory instruction of the driver (driver) with a record in a special journal.

Control over technical state dump trucks, compliance with traffic regulations should be provided by officials of motor transport service of organization and the operation of motor vehicles a contractor working under a contract, - officials of contractor.

When leaving on the line and return to the garage should be provided pretrip and after-control drivers and officials of the technical condition of vehicles, the procedure and in the amounts approved by the technical director of the organization.

On the technological road movement of cars should be carried out without overtaking.

In some cases, when using vehicles with different technical speed, overtaking is allowed, while ensuring safe traffic conditions.

When loading of the rock mass in vehicles by excavating machines must meet the following conditions:

- car that is waiting for the loading must be outside the range of the excavator and become for loading only after enable signal excavator operator;
- car is under the loading should be within sight of the driver of the excavator;
- car is under the loading has to be slowed down;
- loading into the vehicle body must be carried out from behind or from the side, carrying the bucket above the cab of the car is prohibited;
- drop height should be as short as possible and in any case not exceed 3 m;
- laden car can follow to the point of unloading only after enable signal excavator operator.

Unilateral or oversized load, as well as exceed the established capacity of the car is not allowed.

Cab dump truck intended for use in the facility open pit mining should be blocked by a special protective visor, providing driver safety when loading.

In the absence of a protective visor car driver is obliged to go to download time from the cabin and be outside the maximum range of the excavator bucket (loader).

When working on the line are prohibited:

- movement of the car with a raised body;
- repair and unloading under the power lines;
- loading reversing more than 30 meters (except for work related to the trenches);
- crossing cables laid on the ground and enclosed by special safety devices;
- transportation of strangers in the cabin without authorization;
- exit from the cabin of the car to a complete lifting or lowering of the body;
- stopping the vehicle on a slope and the rise;
- movement along the railroad tracks at a distance of less than 5 m from the nearest rail;
- operating a vehicle with a faulty starter motor.

When you stop the car on the rise or fall due to a technical failure, the driver shall take measures to avoid the spontaneous movement of the car.

In all cases, at car movement reversing should beep sounds.

Cleaning the body from adhering and the frozen rock mass should be done in a special place with the use of mechanical or other means.

Tyre works should be carried out in separate rooms or in special areas equipped with the necessary mechanisms and guards. Persons performing tire works, must be trained and instructed.

Loading and unloading points must have the necessary front for maneuvering operations loading equipment, cars, trucks, bulldozers and other technologies involved in machinery and equipment.

7.7 Safety in dumping

The choice sites for the dumps must be preceded by geotechnical and hydrogeological investigations. The project should be brought soil characteristics in areas designated for placement dumps.

The procedure of formation and operation of dumps, filling dips and areas of waste facilities open pit mining should be determined by a special project.

Mining dumps with intermediate (warehouses) performed under the project approved by the technical director of the organization.

Prohibited to place dumps on the deposit area to be working off the open way.

Locations transfer points in the work area the pit determined in accordance with the plans of mining operations.

Transfer point must be carried out under the project approved by the technical director of the organization. Project transfer point determines the order of its formation and exploitation, the number and size of the sectors, the scheme lighting and electricity excavator scheme maneuvers unloading platform transfer point, the path of movement of people, light and sound alarms, etc.

When placing dumps on hillsides necessary to provide for special measures to prevent slipping dumps. The project must provide drainage of groundwater, flood and rainwater.

If signs of landslides work on dumping should be discontinued prior to the development and adoption of special security measures. Work stopped, and in case of exceeding the regulated instructions dumping velocity, deformation dumps. Work on the dump renewed after positive control strain rate measurements with the written permission of the head of the technical the pit.

The height of the waste dumps and dump tiers, angles of slope and sliding wedge, the forward speed of the front dump works set project depending on the

physical and mechanical properties of rocks and dump its foundation, methods of stacking and terrain.

Carriageway roads should be located outside the boundaries of sliding pieces of rock from the slopes dumps.

At dumps should be set warning labels about the danger to people on the slopes, near their bases and places of unloading of vehicles.

Cars and other vehicles must be unloaded on dump in places, provided passport and outside caving prism. Dimensions of the prism are set surveying service employees and regularly communicated to the persons working on the dump.

At dumps should be established traffic schemes of cars. The discharge zone should be marked with signs on both sides of the image with a raised dump truck body with pointers unloading direction.

Platforms dozer dumps and transfer points must have on all fronts unloading cross slope of not less than 3°, directed from the edge of the slope in depth by the length of dump base operating dump trucks, and the necessary front for maneuvering operations cars, trucks, bulldozers, etc.

The discharge zone should be limited on both sides signs. Across the front in the unloading area must be formed in accordance with the passportdumping rocks (safety shaft) with a minimum height of 0,5 diameter wheel maximum load capacity of the car used in these conditions. Safety shaft serves as a reference for the driver.

Prohibited call in on the safety shaft during the unloading. In the absence of such a shaft and a height less than that required to drive up to the brow prohibited dump closer than 5 m or closer distance specified in the passport. All work in the dump and transfer points should be instructed with the passport under signature.

Supply dump truck to unload should be reversing, and the work of the bulldozer is perpendicular to the top of the brow of the slope area. The motion of bulldozer is only performed only blade forward with simultaneous formation before dozer blade a safety shaft in accordance with the passport reloading point.

Prohibited dump trucks unloading within the prism caving when undermining tier of excavating slope.

Work in the sector must be made in accordance with the passport of reference works and regulated by special marks.

Prohibited simultaneous operation in the same sector, bulldozers and dump trucks with an excavator.

The distance between standing on unloading and passing vehicles must be at least 5 m.

Prohibited device contact network on the viaduct unloading area.

In the storage area of the rock mass (rock) for unloading sites, transfer points (warehouses) are not permitted to unauthorized persons, vehicles and other equipment not related to the technology of loading and unloading operations. In all cases, people must be from the mechanism for at least 5 m.

Geological surveying service of organization must be organized systematic monitoring of the stability of rocks in the dump, when placing dumps on slopes - instrumental observations of the entire area of dump deformation. Frequency of observations, the number of profile lines and their length, the location, the type of ground reference points, and the distance between them on the relevant lines are determined by project observation stations.

7.8 Electrical safety

Design, operation and maintenance of electrical installations, object open pit mining should be carried out in accordance with the applicable regulatory requirements for the safe operation of electrical equipment.

At each site of open pit mining should be available:

- circuit power applied to the mine plan, approved by the technical manager. On the scheme indicates power and electrotraction networks, location of electrical (transformer substations, switchgear, etc.);
- principle single-line diagram that indicates the power networks, electrical (transformer substations, switchgear, etc.), type of current, cross-section of

wires and cables, their length, brand, voltage and power of each installation, grounding of all places, the location of protective and switching equipmen etc.;

- separate power supply circuit for the season prior to entering their electrical installations in operation.

All occurred in the operation changes in the scheme electricity supply applied to the mine plan, should be reflected on it at the end of the work signed by the person responsible for electrical of the object.

For the organization of safe maintenance of electrical installations and networks should be identified and designed by management orders border electrical service personnel, assigned to the person responsible for the organization and business units.

Those responsible for the safe operation of electrical installations must be trained and certified on the knowledge of the rules of safe operation of electrical installations.

On each start-up unit shall be clearly marked to indicate they include the installation.

When working in electrical installations and power lines must be carried out organizational and technical measures, provided appropriate regulatory documentation.

When servicing the electrical installations must be used electroprotective agents (insulating gloves, boots and carpets, voltage indicators, insulating rods, portable grounding, etc.) and personal protective equipment (goggles, electrician belts and claws, etc.).

Protective equipment must conform to the requirements of the rules of application and test remedies that are used in electrical installations, and government standards of health and be subject to mandatory periodic electrical tests in a timely manner.

Before each application of protective equipment necessary to check their serviceability, no transportation damage, contamination, the shelf life of the stamp.

Using means that have expired prohibited.

The staff are allowed to work with electrical devices, electric tools or contacting the nature of the work with the electric machinery should have qualification group on electrical safety.

All employees of organization should be trained in methods of getting rid affected from the effects of electric current, first aid of electric current and other traumatic factors.

Newly assembled or reconstructed electrical and technological equipment and launch complexes, powered by electric, should be taken into operation in accordance with the applicable rules and regulations regarding the safe operation of electrical equipment.

Electrical installations with grounded neutral should have circuit breakers.

All electric excavators, drilling rigs, bulldozers, pumps must be equipped with an electric lock, which excludes self-starting mechanism, after the supply voltage.

Bare conductive parts of electrical devices, bare wire and tires, contacts of circuit breakers and fuses, terminals of electrical machinery and apparatus, etc., available accidental contact must be protected by robust fencing.

External inspection of the entire earthing network should be carried out electrical personnel at least once a month, and after blasting operations in the area of possible damage to the grounding devices.

Inspection of the grounding network is performed in accordance with the requirements of normative-technical documentation for the safe operation of electrical open pit mining.

All air cable lines within the boundaries of dangerous zones at the time of the explosion should be disabled.

After the explosion, before turning on the power lines need to be inspected and identified the damage to eliminate.

8 Conclusion

The thesis project has been examined the development of the open-pit mine in cramped conditions. In the conditions Zchatlbila deposit, which has upland surface relief, relatively low volume of traffic (up 86 thousand. m^3 per year), quite a stable, not watered overburden and enclosing rocks, angled occurrence a thicknesses productive strata, therefore opening of of open-pit fields taken to implement (applicable to the selected transport mode) without a stationary opening to surface, because the relief of the surface and roads allow develop the field without permanent trench. Opening the lower horizons of pit is planned to implement by sliding cross-overs.

Direction the development of mining operations planned from the southwest contour of open pit where, according to the geological report, marked the crop of minerals to the surface, and then north-easterly direction.

Average pace lowering mining operations for the entire period of mining reserves Zchatlbila is 4 m/year.

The stripping system of the deposit Zchatlbila accepted a transport with removal of overburden first to the external and then to internal dumps.

Coefficient of residual loosening rocks in a dump adopted 1,1.

In the internal and external dumps envisaged to store about 1,02 million. m^3. Due to the fact that the development of deposit upland type is carried out in cramped conditions, since the beginning the development and before sixth year the overburden capacity 235500 m^3 will be stored in the external dump, located within the mining lease, but located outside the boundaries of estimating reserves.

Proceeding from mining and geological conditions, the first to the sixth year of the development of an external dump will be placed on the overlying slope, relative to a career, on the horizon in 1298, 1318 and 1333.

In perspective further development of mining operations, after the sixth year, despite the possibility of partial placement of overburden in the internal dumps, will be necessary search area to accommodate of the external dump outside the existing mining and land allotment.

Crushing of minerals that was mined in the pit, provides a stationary crushing and screening unit (CSU), installed in the immediate vicinity of the southern pit slope on the horizon in 1280 in one of the production sites which area 422 m^2.

The combination of interaction subcontractors of LLC "Astoria +" and “Devitrans” that was offered, provides the lowest cost to the gypsum stone and can be a guarantee of uninterrupted supply of raw materials to the company LLC "Knauf Gips Tbilisi".

Also, cost of gypsum stone decrease by 9,42 euro/t relatively minerals, which is produced by the company Knauf Gilan. This entails cost savings up to 471 thous. euro per year.

Availability own raw material base in the form of a open pit Zchatlbila a positive impact on the production process of LLC "Knauf Gips Tbilisi", due to the fact that will be possible to control the quality, volumes, lumpiness and time of delivery of raw materials. In addition, the decrease in the cost of gypsum stone will increase the amount of income and the level of profitability of the enterprise.

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CSU	Crushing and screening unit
U. S. R.	Unified safety regulations for development of ore, non-metallic and placer deposits of mineral resources by open pit method
UTS	Uniform time standards

Annex

Bulldozer T-170

№	Technical data	Characteristic
	General metrics	
1	Constructive weight, kg	15000
2	Chassis type	track-type
3	Base, mm	2517
4	Rut, mm	1880
5	Engine power, kW (h.p.)	125(170)
	Refill capacity	
6	Fuel tank, l	300
7	Cooling system, l	60
8	Engine lubrication system, l	32
	Overall dimensions	
9	Length, mm	4600
10	Width, mm	2480
11	Height, mm	3180

Table 19: Technical characteristics of bulldozer T-170

Bulldozer T-130

№	Technical data	Characteristic
	General metrics	
1	Constructive weight, kg	12720
2	Chassis type	track-type
3	Base, mm	2478
4	Rut, mm	1880
5	Engine power, kW (h.p.)	140
	Refill capacity	
6	Fuel tank, l	290
7	Cooling system, l	60
8	Engine lubrication system, l	32
	Overall dimensions	
9	Length, mm	5193
10	Width, mm	2475
11	Height, mm	3085

Table 20: Technical characteristics of bulldozer T-130

Excavator-loader JCB- 4CX ECO

№	Technical data	Characteristic	
	Overall dimensions		
1	Transport length, m	5,91	
2	Full overall height, m	3,54	
3	Bucket width, m	2,33	
	Engine		
4	Standard of engine	Stage 1Mb	
5	Manufacturer	JCB	
6	Displacement, l	4,4	
7	Cylinder count	4	
8	Rated engine speed, r/min	2200	
9	Type of fuel	Diesel	
	Dimensions when using a loader	**General purpose bucket**	**Bucket "six in one"**
10	Dump height, m	2,69	2,69
11	Loading height over the board, m	3,21	3,18
12	Lifting height a hinge of loader bucket, m	3,46	3,46
13	Swinging radius of bucket hinge ahead, m	0,41	0,41
14	Swinging radius at ground level (cutting blade in the horizontal position), m	1,42	1,39
15	Max, swinging radius at full lift, m	1,21	1,17
16	Swinging radius at full lift and total unloading, m	0,82	0,76
17	Digging depth, m	0,14	0,18
18	Angle of the bucket load at ground level, degree	45°	45°
19	Dumping angle of the bucket, degree	45°	45°
20	Opening width of the jaw bucket, m	-	0,95
	Dimensions when using a excavator		
21	Max, digging depth (standard saE), m	4,32	
22	Operating altitude (standard saE), m	5,45	
23	Maximum loading height over the boards, m	3,84	
24	Bucket swing	201°	

Table 21: Technical characteristics of excavator-loader JCB- 4CX ECO

Dump truck Volvo FM 12.440

№	Technical data	Characteristic
1	Engine	400 h.p. (294 kW)
2	Fuel tank, l	350
3	Chassis	8x4
4	Payload, kg	32000
5	Front tires	385/55 R22.5
6	Rear tires	315/70 R22.5
7	Body space, m^3	22

Table 22: Technical characteristics of dump truck Volvo FM 12.440

Dump truck MAZ – 6501

№	Technical data	Characteristic
1	Engine	400 h.p. (294 kW)
2	Fuel tank, l	300
3	Chassis	6x4
4	Payload, kg	20100
5	Front tires	315/80 R22,5
6	Rear tires	315/80 R22,5
7	Body space, m^3	13,3

Table 23: Technical characteristics of dump truck MAZ – 6501

Excavator JS175W

№	Technical data	Characteristic
1	Service weight, kg	17520
2	Complete engine power, kW (h.p.)	128(172)
3	Max, digging depth, mm	6451
4	Maximum swinging radius at ground level, mm	9163
5	Max, loading height over the boards, mm	7174
6	Travel speed (upper limit), km/h	30
7	Variants of machines	MONO (mono-boom)/TAB (three-section boom)
8	Maximum breakout force on the handle, kN	108
9	Maximum breakout force on the bucket, kN	105

Table 24: Technical characteristics of wheel excavator JS175W

Wheeled loader XCMG LW321F

№	Technical data	Characteristic
1	Overall dimensions, mm	6800/2470/3025
2	Payload, kg	3000
3	Total weight, kg	10000
4	Maximum traction force, kN	80
5	Static linear load, kg	6500
6	Angle of rotation of the working elements, degree	35
7	Minimum turning radius, mm	5700
8	Maximum speed, km/h	35
9	Engine	YC6108G
10	Engine power, kW	92
11	Bucket capacity, m^3	1,8
12	Maximum breakout force/lifting, kN	100/35
13	Time of full cycle, s	10,5
14	Loading height, mm	2900

Table 25: Technical characteristics of wheeled loader XCMG LW321F

Drilling rig Sandvik Titon 300

№	Technical data	Characteristic
1	Diameter of bit, mm	90-127
2	Diameter the drill rod, mm	90-127
3	Length of the drill rod, mm	4000
4	Weight, t	18,5
5	Dimensions LxWxH, m	10,5x2,5x3,13
6	Magazine capacity, m	32
7	Compressor	14 m^3/min/17 bar
8	Engine	186 kW

Table 26: Technical characteristics of drilling rig Sandvik Titon 300

Dump truck Scania P400 CBx4EHZ

№	Technical data	Characteristic
1	Engine	400 h.p. (294 kW)
2	Fuel tank, l	350
3	Chassis	6x4
3	Maximum load on the front axle, kg	9000
4	Maximum load on the rear axle, kg	2x15000
5	Payload, kg	24000
6	Front tires	385/65 R22.5
7	Rear tires	315/80 R22.5
8	Body space, m^3	16

Table 27: Technical characteristics of dump truck Scania P400 CBx4EHZ

Dump truck MAN TGS 33.440

№	Technical data	Characteristic
1	Engine	D2066LF36
2	Configuration	6X4
3	Gearbox	Manual
4	Number of gears	16
5	Wheel base, cm	390
6	Maximum load on the front axle, kg	8,000
7	Body space, m^3	13,5
8	Dead weight, kg	12430
9	Payload, kg	13570
10	Total weight, kg	26000
11	Dimensions LxWxH, cm	630x237x90

Table 28: Technical characteristics of dump truck MAN TGS 33.440

Dump truck MAN TGS 40.440

№	Technical data	Characteristic
1	Engine	D2066LF02
2	Configuration	6x4
3	Gearbox	Manual
4	Number of gears	16
5	Wheel base, cm	325/95 R24
6	Maximum load on the front axle, kg	9000
7	Body space, m^3	25
8	Dead weight, kg	10920
9	Payload, kg	29080
10	Total weight, kg	40000
11	Dimensions LxWxH, mm	7592x2240x3367

Table 29: Technical characteristics of dump truck MAN TGS 40.440

Dump truck MAN TGS 40.400

№	Technical data	Characteristic
1	Engine	MAN-D2676
2	Configuration	6x4
3	Gearbox	Manual
4	Number of gears	16
5	Wheel base, cm	390
6	Maximum load on the front axle, kg	9000
7	Body space, m^3	18
8	Dead weight, kg	15000
9	Payload, kg	25000
10	Total weight, kg	40000
11	Dimensions LxWxH, mm	8600x2476x3443

Table 30: Technical characteristics of dump truck MAN TGS 40.400

Dump truck MAN TGS 41.480

№	Technical data	Characteristic
1	Engine	D2676FL02
2	Configuration	8X8
3	Gearbox	Manual
4	Number of gears	16
5	Wheel base, cm	390
6	Maximum load on the front axle, kg	15000
7	Body space, m^3	20
8	Dead weight, kg	14000
9	Payload, kg	27000
10	Total weight, kg	41000

Table 31: Technical characteristics of dump truck MAN TGS 41.480

Mainline cargo-and-passenger locomotive of continuous current VL10

№	Technical data	Characteristic
1	Year of start of production	1961
2	Year of end of production	-
3	Class of service	Cargo
4	Wheel arrangement	2o-2o-2o-2o
5	Adhesion weight, tf	184
6	Axleload, tf	23
7	One-hour rating, kW	5200
8	Continuous operation rating, kW	4500
9	Tangent rating on the current rise, kW	5650
10	Traction effort of hour mode, kgf	39540
11	Traction effort of continuous operation, kgf	32000
12	Tangent traction effort on the current rise, kgf	46500
13	Speed of hour mode, km/h	47,3
14	Speed of continuous operation, km/h	50
15	Design speed, km/h	100
16	Speed on the current rise, km/h	45,4
17	Efficiency coefficient, %	90,2
18	Motor braking	Regenerative
19	Length over pulling faces of couplers, mm	32840
20	Width of body, mm	3160
21	Height from the rail head to the lowered collecting pantagraph, mm	3121
22	Wheel size, mm	1250
23	Type of traction engine	TL-2K
24	Amount of traction engines	8
25	Traction motors	support-axles
26	Gearing	bidirectional, helical
27	Contact ratio of gearing	88:23
28	Metal consumption per unit of power hour mode electric locomotive, kgf/h.p.	26,2
29	Power hour mode electric locomotive per unit mass, h.p./t.	38,5

Table 32: Technical characteristics of mainline cargo-and-passenger locomotive of continuous current VL10

Mainline cargo-and-passenger locomotive of continuous current VL11

№	Technical data	Characteristic
	General data	
1	Current type	constant 3 kV
2	Class of service	Cargo
3	Wheel arrangement	2(2-2)
4	Weight with 2/3 sand stock, t	184
5	Axleload, t	23
6	Design speed, km/h	100
7	Minimum radius of curves, m	125
	Continuous mode	
8	Traction effort, kgf	32000
9	Speed, km/h	51,2
10	Tangent rating, h.p.	6060
11	Shaft power of traction electric motor, kW	4600
12	Efficiency coefficient, %	0,88
	Hour mode	
13	Traction effort, kgf	39450
14	Speed, km/h	48,7
15	Tangent rating, h.p.	7110
16	Shaft power of traction electric motor, kW	5360
	Construction	
17	Body structure	frame
18	Standardization	VL10, VL80^{s}
19	Motor braking	Regenerative
20	Main controller	KME-013
21	Amount positions of controller	37
22	Current collector	T-5M1
23	Length over pulling faces of couplers, mm	32880
24	Width of body, mm	3160
25	Height for the pantograph, mm	5120-7000
	Running gear	
26	Gear ratio	3,826
27	Type of traction engine	TL-2K1
28	Type of traction electric motor	collector
29	Traction motors	support-axles
30	Actuator of driving wheelpair	individual
31	Bogies	jawless
32	Wheels	banding
33	Wheel size, mm	1250

Table 33: Technical characteristics of mainline cargo-and-passenger locomotive of continuous current VL11

Railway high-sided wagon PS-63

(model 12-4004)

№	Technical data	Characteristic
1	Payload, t	63
2	Body capacity (geometric), m^3	73
3	Unladen weight, t	22,4
4	Empty weight-to-carrying capacity ratio	0,36
5	Amount of axes	4
	Boundary dimensions, mm:	
6	length over coupler	13920
7	width	3130
8	height from top of rail	3484
9	Dimensions body inside	12126x2878x2060
10	Number of hatches	14

Table 34: Technical characteristics of railway high-sided wagon PS-63 (model 12-4004)