Gold Test on the Toson Terrace Placer, Zaamar Goldfield of Mongolia

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ABSTRACT

Bulk testing of the Toson Terrace placer gold deposit in the Zaamar Goldfield of Mongolia was carried out by Golden Tiger Corporation in 1996. The sampling methodology is described, with special attention to determination of the considerable 'swell factor' (45-60%) in order to calibrate the results of gold grade for loose material (LCM) with that for 'in situ' virgin ground (BCM). The Bulk Testing was by a Pilot Plant with an electric water pump rated to deliver l00m^3/hour of water, a 100m suction line and foot valve delivering to an 80mm diameter wire-reinforced quick-coupled flexible delivery line. Material was fed into a 6m^3 hopper protected by a 150mm grizzly, and discharged onto an inclined belt conveyor fitted with a Ramsey Weighbridge Belt Scale, giving continuous throughput readings, and fed into a 4m long trommel (incl. 1m scrubber) via a feed chute equipped with water spray to produce a slurry. The trommel screened off oversize at >5mm. The <5mm was pumped to a 75cm Knelson^{TM} concentrator. The feed slurry was c.40% solids, and the Knelson^{TM} had a maximum feed capacity of 20m^3/hour of solids. Concentrates were collected after each c.100m^3 batch sample. Power supply was a 125KVA generator coupled to a Cummins diesel engine, equipped with an electronic control switch panel 220/380 volts. The results indicate a gold grade of 320 mg/m^3 ('in situ' BCM) for a 3m thick Low Grade Zone, and 415 mg/m^3 ('in situ' BCM) for a 4m thick High Grade Zone. The top 30cm of the underlying bedrock material yielded a gold grade of 317 mg/m^3 ('in situ' BCM). 200m^3 of sluice tailings were processed by the Pilot Plant and the KNELSON^{TM} recovered 29.02 grams of gold, indicating a grade of 145mg/m^3 (loose material LCM). These tailings were from the High Grade Zone, thus the sluice mining achieved only 51% gold recovery.

Introduction

Golden Tiger Corporation (GTC) in co-operation with Gazar Holdings initiated a bulk testing programme on the Toson Terrace gold placer in the Zaamar Goldfield, to determine the gold grades contained in the overburden, payzone and bedrock layers. The bulk testing program took place from 6th August 1996 to 25th September 1996, on Mining License A-066 (renamed as A-184), held by Gazar Toson Ltd., at that time a daughter company of Gazar Holdings Ltd, who began the Toson Mine on this placer in 1993, and produced 460 kilos of gold in the 1993-1996.

The Toson Terrace gold placer deposit is approximately 200km north-west of Ulaanbaatar, in the Zaamar Gold District. Access is by bitumen road for 110km and 90km by hard pack all-weather dirt road. Infrastructure is limited to 6000Volt electrical power supplied via power grid, with a local substation.

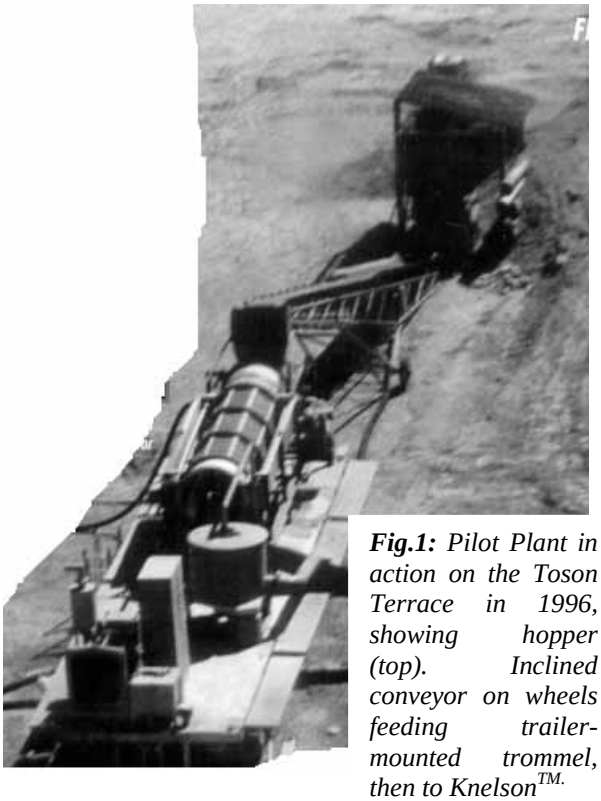

Fig.1: *Pilot Plant in action on the Toson Terrace in 1996, showing hopper (top). Inclined conveyor on wheels feeding trailer-mounted trommel, then to Knelson$^{TM.}$*

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Background to Geology of Toson Terrace

The Toson Deposit is formed in the linear zone along the right terrace of the Tuul River, covering an area 5km in length and c.2.1km in width, which is situated between two right tributaries of the Tuul River, namely Tosongin Gol and Tsagaanbulag.

Two types of pay zones can be found in this deposit. Most of placer gold was deposited in the terraces of the Tuul River. In this part of Tuul River, the second and third terraces (II, III) were developed very well, the width of these terraces sometimes reach 200-400m with relatively thin overburden (3-5m thick). The widths of the first and fourth terraces (I, IV) are narrower, only 50-150m wide, which are covered by thick overburden (5-15m). 90% of the gold reserve of this deposit is located in these terrace sediments of the Tuul River.

The second pay zone was formed in the alluvium of the small right tributaries of the Tuul River, as Ar Sair and Uvur Sair Valleys which cover the terrace sediments of the Tuul River. This pay zone is characterised by thin overburden (only 1m), relatively low grade (400-700 mg/m^3) and smaller reserves (10% of the total reserve).

Selection of Sample Site and Mining

Preliminary bulk test on sluice tailings from Block Cl-29 was basically the determining factor in site selection for mining of bulk sample. The objective, to determine the gold grades of the different layers such as the overburden, pay zone and the bedrock. Mining sequence started with the stripping of the topsoil of the target area, and started mining the overburden zone using Russian-made equipment. At least 400m^3 of overburden materials were extracted from this zone for the bulk test.

The second phase covered the mining of the pay zone as identified by Gazar Holdings. A total of 300m^3 of pay zone materials were mined and tested. The bedrock was relatively difficult to strip and mine due to inherent limitations of the equipment and the type of material being moved (metamorphic schist). 80m^3 of the bedrock materials were processed.

TYPICAL CROSS-SECTION Toson Terrace – Block C1-29				Geological Interpretation
Top Soil		Top soil / silt / clay	0.2m – 2.5m	Recent soil cover
Low Grade Zone		Gravel/sand & minimal silt Sand & Silt	0.1m – 2.5m 0.1m – 3.0m	Shallow placer deposit
Clay Intercalation		Clay	0.05m–1.5m	Barren zone
High Grade Zone		Grave/sand & silt	0.2m – 5.0m	Deeper placer deposit
Bedrock		Metamorphic schist	0.3m	Bedrock with placer gold content

Bulk Testing Procedure – Description of Pilot Plant

The Pilot Plant consists of a main water pumpset driven by a 37-kW electric motor, rated to deliver l00m^3 of water per hour. A 100 metre suction line and foot valve deliver to 80mm diameter wire-reinforced quick coupled flexible delivery line.

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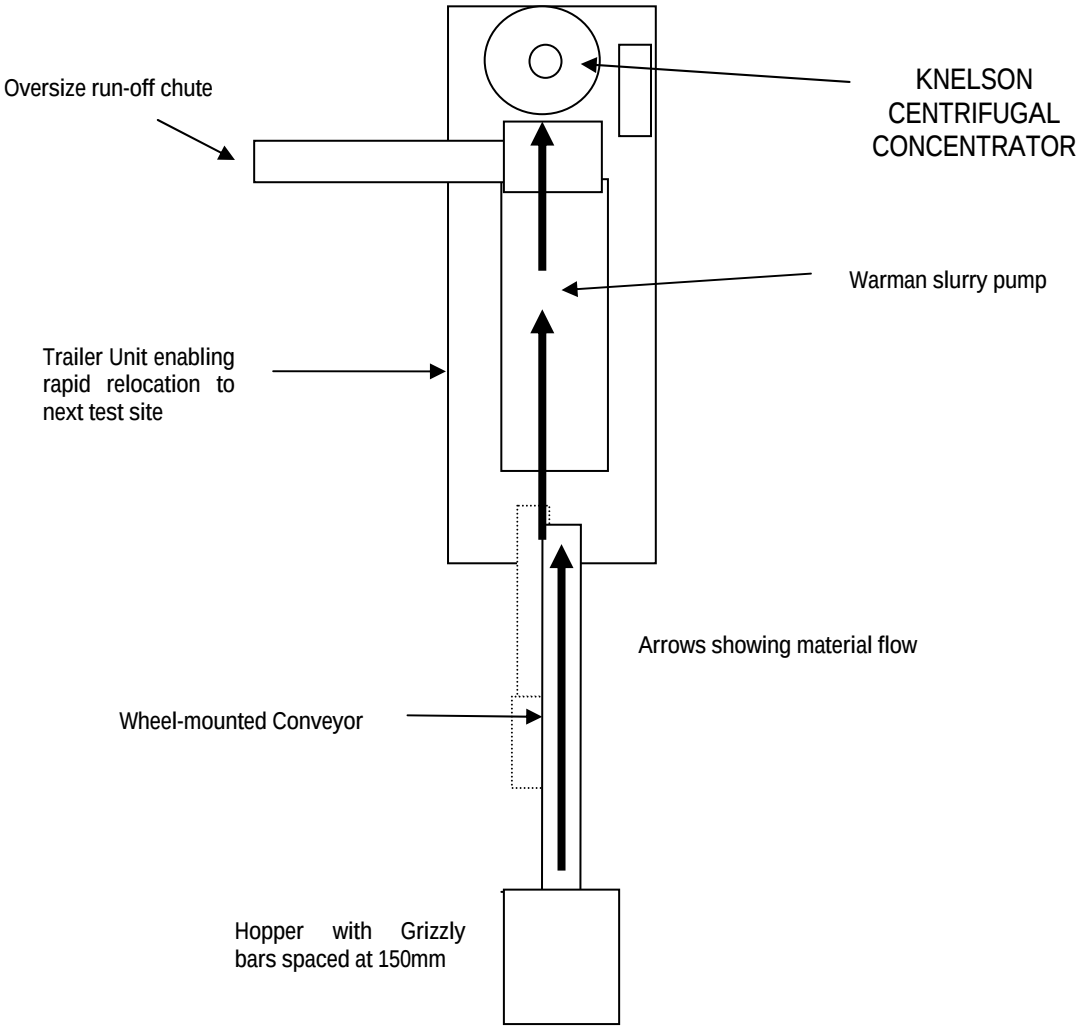
Material is fed into a 6m^3 hopper fitted with a 150mm grizzly. The hopper is equipped with an adjustable gate and a variable speed belt feeder. The material is discharged onto an inclined belt conveyor fitted with a Ramsey Weighbridge Belt Scale, which provides continuous 'throughput readings. The power is supplied by a 125KVA generator coupled to a Cummins Diesel Engine, equipped with an electronic control switch panel 220/380 volts.



Bulk Testing Procedure – Treatment of Ore

The ore from the conveyor belt is fed into a trommel via a feed chute equipped with water spray to fluidise the ore into a slurry. A 1m scrubber forms part of the 4m long trommel. The screen panels are designed to allow for easy replacement with different screen sizes, as may be required, depending on the type of material being processed from various test areas. The screen mesh apertures presently allow for minus 5.0mm material.

The minus 5mm material is pumped to a 75cm KNELSON^{TM} Hydrostatic Centrifugal Concentrator. The unit is essentially a high-speed, ribbed rotating cone with a 7.5-kW belt drive. The ore slurry is approximately 40% solids. The concentrator has a maximum feed capacity of 20m^3 per hour of solids. Concentrates are collected at the end of a batch sample of approximately 100m^3.

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Principles of the Knelson Concentrator

The KNELSON Concentrator utilises the principle of hindered settling and centrifugal force. A central perforated cone containing horizontal ribs welded along the inside wall is rotated at 400 rpm, at which speed it generates a force of +60g. Heavy particles are forced out against the walls and trapped between the ribs. Light particles are carried by the water flow and ejected.

The cone is surrounded by a pressurised water jacket that forces water through holes in the cone to keep the heavy particles fluidised. The force of the water acts against the centrifugal force of the rotating cone. This counter force is strong enough to inhibit severe compaction of the collected concentrate. As a result the mineral grains remain mobile, allowing particles with a higher specific gravity to penetrate. As the process continues, lighter particles in the mobile bed are replaced by incoming heavier ones, until only the heaviest particles in the feed are retained.

Cleanup is accomplished by stopping the cone, opening the drain at the bottom, and flushing out the concentrate. This is usually done at the end of a shift. Tailings are consistently checked for gold loss by panning.

Bulk Testing Procedure – Ore Dressing

The primary concentrate from the 75-cm KNELSON^{TM} Hydrostatic Centrifugal Concentrator is weighed (+/- 40kg per batch) and screened to minus 1.5 mm and fed into a 15cm KNELSON^{TM} Hydrostatic Centrifugal Concentrator for further upgrading. The plus 1.5mm minus 5.0mm is hand panned for coarse gold.

The minus 1.5 mm (+/- 3.5kg concentrate) is screened to 0.710mm and demagnetised, this is also hand panned for gold. The minus 0.710mm is then screened to 0.500mm and demagnetised, this material is passed over a revolving gold riffle which produces a clean gold concentrate 96% gangue-free material. The minus 0.500mm is screened to 0.250mm and subsequently demagnetised. This material is also passed over the revolving riffle. Each gold sample of different sizes is weighed dry on an electronic balance to 1/1000 of a gram. The weight is recorded in relation to grain size distribution as a percentage and stored in a safe box for further purity analysis by an independent laboratory.

Bulk Testing Procedure – Rock Density & Particle Size Analysis

The work activities involved in the determination of the rock density (specific gravity) and particle sizes included:

a) site selection;
b) site preparation;
c) sample collection and handling;
d) weighing of samples;
e) screening;
f) brief lithologic/stratigraphic classification.

a) Site Selection

Four sampling areas were considered for preliminary evaluation. The test works were conducted in both active and abandoned mining areas. Careful decision is observed in locating the sampling points with the proper representation of the rock formation in the area as main factor considered.

b) Site Preparation

The area (face) to be sampled is cleaned from the bottom (bedrock level) up to the topsoil. All loose materials are removed and the surface is almost even. A ladder is used to gain access where the portion is already high. Since the lower portions are normally covered with

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materials, clearing by digging down to the bedrock level is undertaken. An adequate area for sample collection should also be provided.

c) Sample Collection

Channel sampling is employed. The channel is about 0.15m wide and 0.15m deep. At every metre interval from the bottom upward, 5 containers (cylindrical bucket with a capacity of 0.0110581 m^3) of samples are collected.

Before cutting any material from the channel, a tarp material is laid out at the bottom to catch the desired amount of sample. Careful cutting of materials is observed to prevent dilution from the adjoining areas. After collection of approximately 5 buckets worth of loose materials, the resulting mass is thoroughly mixed. The mixed materials are then loaded unto the bucket and weighed. The data gathered from this exercise constitute five 5 trials for the determination of rock density (specific gravity) for each particular one-metre sampling interval.

d) Sample Weighing

For every metre of samples from a particular channel, the materials are manually screened. Screen apertures used are 5mm, 25mm, and 50mm. Each of the products of the screens (-5mm, +5mm to -25mm, +25mm to -50mm, and +50mm) are weighed separately before discarding.

e) Lithological & Stratigraphical Clasification

In order to inter-relate the various rock formations and stratigraphic classification of the ore deposit within the area, a brief lithological/stratigraphic description is also noted.

Bulk-Testing Procedure – Determination of 'Swell Factor'

Rationale of 'Swell Factor'

The volume measurements of ore in actual operations are always based on the **loose cubic metres (LCM)** of materials being handled in the Pilot Plant. It is of great importance to note that the volume of materials-in-place or **bank cubic metres (BCM)** will be more frequently used especially for purposes of actual ore extraction, feasibility studies and other more delicate and relevant calculations. The relationship between these two 2 figures should be determined to serve as guide and reference in most engineering calculations involving the quantity and quality of ore to be mined. This is termed the **Swell Factor (Sf)** and expressed as follows:

$$Sf = (LCM/BCM) \times 100\%$$

Test Procedure for 'Swell Factor'

Three test pits at the Toson Mine were dug using a Backhoe Excavator. The dimensions of the pits ranged from 4.80 - 5.61m long, 1.31 - 1.42m wide and 4.09 - 5.17m deep. In all cases, the excavator operator was instructed to dig until the bucket reached the bedrock and the materials from each of these pits were stockpiled in almost conical shape beside the hole.

After digging a hole, the collar of the pit is cleared of any loosened materials to have a flatter and more convenient surface to perform any measurements to be made. The dimension of the hole collar is then carefully measured. Every 1m along its length, the tape is dropped to the pit bottom to measure the corresponding depth in that particular section. All other abnormal portions of the hole are carefully measured to be properly reflected in the computation of the pit's volume (BCM). A ladder is used to provide easy access in zeroing the tape at the bottom of the pit, as well as in the measurement of all abnormal portions of the pit. This procedure was applied to ail the 3 test pits that were excavated.

Each of the stockpiled loose materials is measured. For regular conical mound of materials (single apex), measurement is normally done by zeroing the tape at the apex of the cone. Average radius of the cone is measured by extending the tape toward the north, south, east

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and west directions. Additional measurements are done towards intermediate directions whenever necessary.

The height of the cone is measured by levelling the tape (using ladder. whenever necessary) then another tape is dropped from the first tape level down to the base perimeter edge of the cone. Every 0.5m interval from the apex of the cone (zero point) down to its base, intermediate height measurements are done to account for any irregular section of the cone. These measurements are also done towards the north, south, east and west directions to account for any irregular shape of the cone.

After doing all the above measurements, the volume is calculated (LCM). Where the volume involved is small, the calculation using the cone volume formula is maintained. For higher mounds usually involving bigger volumes, these are reshaped to a cylindrical and/or cube configuration for easier calculation and more reliable results.

After doing all the calculations, the data gathered revealed consistent figures, but are relatively higher than expected. Further review of the procedures pointed to some factors involving accuracy of measurement of the stockpile. There are inherent plus factors in the suspended tape measurements such as correction due to sag of tape, improper levelling of tape and possibly the decision where to have the final reading in the bouldery portion of the base of the cone. Correction factors for height measurements are likely to be affected by sag of tape and improper levelling of the tape. To determine the correction factor that can be applied with acceptable reliability to the measurements of the stockpile, one stockpile at Toson with a rough volume of one cubic meter was considered. The volume of the materials was actually measured using a pre-measured cylindrical bucket and cross-checked using the tape measurement method. The result of this exercise yielded a correction factor of 0.922. This figure was applied in all the 3 tests that were conducted.

Bulk Testing Results – Engineering Test Results

'Bucket Factor'

Determination of the 'bucket factor' is required in calculating the total volume fed to the Hopper of the Test Plant. In this instance, the 'bucket factor' refers to a Russian-made Backhoe Excavator:

1 premeasured container	0.37m x 0.68m x 1.01m	0.2541m^3
2 premeasured containers	0.57m x 0.68m x 1.01m	0.7830m^3
	Capacity of bucket:	1.0371m^3

Results for 'Swell Factor'

The test results yielded the following figures:

Test Pit	Block	Estimated 'Swell Factor'
1	C1-29	144.63%
2	C-49	159.49%
3	C2-34	152.75%

It is important to note that the above figures fall within the 136%-171% range of swell factors that were reported in a feasibility study available at Gazar-Toson. However, if these figures are compared to the 138%-152% range of swell factor conveyed by Mr. Ken Conner (Mining Consultant), the figures are relatively high. Thus it may be necessary to conduct further tests. These new test works will require the services of **test pit diggers**. In these pits, walls are smoother and relatively uniform in shape from top (collar) to bottom. This will ensure more accurate and reliable data. Furthermore, expansion analyses per layer of rock formation as recommended by Ken Conner can be undertaken.

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Results for Specific Gravity Determination

The test results yielded the following figures:

SPECIFIC GRAVITY (DENSITY) OF PLACERS Toson Terrace – Block C1-29				VOLUME Standard Bucket	WEIGHT Range	WEIGHT Average	SPECIFIC GRAVITY Average	SPECIFIC GRAVITY Weighted Average
Top Soil		Top soil / silt / clay	0.2m – 2.5m					
Low Grade Zone		Gravel/sand & min. silt Sand & Silt	0.1m – 2.5m 0.1m – 3.0m	0.011058 1m	18.70-19.62kg	19.17kg	1.73	
Clay Intercalation		Clay	0.05m–1.5m					1.83
High Grade Zone		Grave/sand & silt	0.2m – 5.0m	0.011058 1m	20.66-21.84kg	21.24kg	1.92	
Bedrock		Metamorphic schist	0.3m					

Results for Particle Size Distribution of Placers

The test results yielded the following figures for Block C1-29:

PARTICLE SIZE DISTRIBUTION Toson Terrace – Block C1-29				Larger than 50mm	50mm to 5mm	Less than 5mm
Top Soil		Top soil / silt / clay	0.2m – 2.5m			
Low Grade Zone		Gravel/sand & min. silt Sand & Silt	0.1m – 2.5m 0.1m – 3.0m	4.64%	32.02%	63.30%
Clay Intercalation		Clay	0.05m–1.5m			
High Grade Zone		Grave/sand & silt	0.2m – 5.0m	19.93%	43.44%	36.64%
Bedrock		Metamorphic schist	0.3m			

It is evident that the fraction >50mm particle size in the High Grade Zone of Block C1-29 is considerable (19.93%). Of 4 blocks tested, this figure ranged from 7.94% in Block C2-34 to 26.46% in Block C2-20.

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Bulk Testing Results on Virgin Ground – Summary of Findings

A summary of the bulk testing results on 'virgin ground' is presented in the following chart:

SUMMARY OF BULK TESTING Toson Terrace – Block C1-29				Total Gold Recovered	Loose Material Processed (LCM)	Gold Grade gm/m³ (LCM)	Swell Factor	Bankside Material Processed ((BCM)	Gold Grade gm/m³ (BCM)
Top Soil		Top soil / silt / clay	0.2m – 2.5m	N/A	N/A	N/A	N/A	N/A	N/A
Low Grade Zone		Gravel/sand & min. silt Sand & Silt	0.1m – 2.5m 0.1m – 3.0m	8.49 gm	400m³	0.221	44.63%	276.57m³	0.320
Clay Intercalation		Clay	0.05m–1.5m	N/A	N/A	N/A	N/A	N/A	N/A
High Grade Zone		Grave/sand & silt	0.2m – 5.0m	86.11 gm	300m³	0.287	44.63%	207.43m³	0.415
Bedrock		Metamorphic schist	0.3m	15.38 gm	80m³	0.192	65% *	48.48m³	0.317

(* Swell factor used for bedrock assumed at 65% based on practical experience on hard-rock mining; no actual tests done)

Bulk Testing Results – Grain Size Distribution of Gold

The grain size distribution of the gold was determined for the High Grade Zone and for the underlying bedrock. A feature is that the gold grain sizes in the bedrock are substantially larger. Conversely, 17.72% of the gold in the overlying High Grade Zone is less than 250µ (micron), thus demonstrating the need for gold recovery systems to be capable of recovering fine gold.

GOLD SIZE DISTRIBUTION Toson Terrace – Block C1-29				Total Gold Recovered	Larger Than 750µ	750µ to 500µ	500µ to 250µ	Less Than 250µ
Top Soil		Top soil / silt / clay	0.2m – 2.5m	N/A				
Low Grade Zone		Gravel/sand & min. silt Sand & Silt	0.1m – 2.5m 0.1m – 3.0m	8.49 gm				
Clay Intercalation		Clay	0.05m–1.5m	N/A				
High Grade Zone		Grave/sand & silt	0.2m – 5.0m	86.11 gm	18.94%	18.33%	45.01%	17.72%
Bedrock		Metamorphic schist	0.3m	15.38 gm	30.44%	29.72%	34.27%	5.57%

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Bulk Testing Results on Tailings – Summary of Findings

A summary of the results of the bulk testing of tailings from the Toson Mine on the Toson Terrace is presented in the following chart:

TAILINGS Toson Mine on Toson Terrace				Total Gold Recovered	Loose Material Processed (LCM)	Gold Grade gm/m^3 (LCM)
Tailings		Gravel/sand & minimal silt	Variable thickness	29.02 gm	200m^3	0.145

Toson Terrace Placer Mine Concept for 1997

After the end of the testing of the Toson Terrace, Golden Tiger Corporation (GTC) commenced with modifications on the Test Plant. The objective was to increase the current throughput of the plant and enter into a contract mining agreement with Gazar Holdings for the Toson Terrace license area in 1997.

Based on the current geological drill data and the 1996 test results from the Pilot Plant operation, Golden Tiger Corporation was confident that a small-scale mine operation (capacity of approximately 75m^3/hour) – when planned and managed efficiently – can operate profitably. With new process technology and proper mine planning, an economic cut-off of 200 mg/m^3 is achievable. Total capital investment would be approximately US$ 550,000.

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