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MINES BRANCH INVESTIGATION REPORT IR 74-49

**DETERMINATION OF GOLD AND PLATINUM
CONTENT IN A LOW-GRADE ALLUVIAL GRAVEL
FROM THE TULAMEEN RIVER AREA
OF BRITISH COLUMBIA**

by

**D. RAICEVIC AND R. W. BRUCE
MINERAL PROCESSING DIVISION**

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C.D.

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Mines Branch Investigation Report IR 74-49

DETERMINATION OF GOLD AND PLATINUM CONTENT IN A LOW-GRADE
ALLUVIAL GRAVEL FROM THE TULAMEEN RIVER AREA OF BRITISH COLUMBIA

by

D. Raicevic* and R. W. Bruce**

- - -

SUMMARY OF RESULTS

Six samples of Tulameen gravel, weighing approximately 14 tons each, were received for this investigation.

The gold and platinum minerals in the alluvial gravels were free and sparsely disseminated, causing difficulties in proper sampling which result in unreliable gold and platinum analyses. To circumvent this problem, the precious metals in the whole 84 ton shipment of the Tulameen gravel were first concentrated from each sample by applying gravity and magnetic methods. The products were assayed and the gold and platinum content in each sample calculated.

The overall combined results, calculated from each gravel sample, are summarized in the following table:

Product	Weight %	Assays - oz/ton		Distn %	
		Au	Pt	Au	Pt
Comb low intensity mag	0.1662	0.0052	0.0059	4.5	67.6
Comb cleaner gold conc	0.0220	0.213	0.031	24.1	32.4
Comb cl and ro tailings	12.8805	0.0011	N.D.	71.4	-
Comb + 20-mesh material	86.9313	Nil	Nil	-	-
Comb feed (calcd)	100.0000	0.00019	0.000021	100.0	100.0

The average gold and platinum contents in the combined six samples, therefore, were as follows:

Au - 0.00019 oz/ton of gravel
Pt - 0.000021 oz/ton of gravel

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INTRODUCTION

It has been known for nearly a century that alluvial gravel along the Tulameen River in south-central British Columbia contains gold and platinum values as well as other metallic minerals. The recovery of precious metals from this gravel received intermittent attention from various mining companies particularly in the early 1900's, but no economic operation has been realized. Due to present high prices of gold and platinum, attention to the Tulameen gravel is active again.

Location of the Gravel

Metcon Resources Ltd. hold over sixty placer leases along a twenty mile stretch of the Tulameen River, but these leases are not continuous over that distance. They are grouped into five main blocks of which the largest is nearest to Princeton and is known as the "Peterson" leases. The other blocks are known as "Chinook", "Brown", "Coney Island", and "Lincoln" and are located, respectively, upstream of the "Peterson" block (6).

Purpose of Investigation

During the past ten years, a number of samples of Tulameen gravel from various locations along the Tulameen River in British Columbia have been investigated at the Mines Branch to determine the gold and platinum contents in these samples as well as to investigate the possibility of concentration of these precious metals. Although the results obtained showed that the contents of the precious metals in these samples were low and not economical to concentrate, it was felt that the samples investigated, weighing only several hundred pounds of gravel, might not be representative of the areas and thus the conclusion could be misleading.

At a meeting in Ottawa with representatives of Metcon Resources Ltd. from Vancouver, it was decided that the Mines Branch would carry out an investigation on a large sample of approximately 100 tons of Tulameen gravel to accurately determine gold and platinum values.

Origin and Description of Sample

Under the supervision of Dr. L. J. Cabri of the Mines Branch, approximately 84 tons of Tulameen gravel, including boulders, were taken for this investigation from the six test-pits on the "Peterson" block (PML-1833) located approximately half way between the villages of Coalmont and Princeton⁽⁶⁾. About 14-ton samples were taken from each pit and shipped to Mines Branch, Ottawa. Between 54 and 72% by weight of the samples were in the form of boulders and material coarser than 6 mesh. In five samples the gravel was loose and easy to separate from the other material, whereas Sample No. IV contained above-average amounts of angular and sub-angular material as well as above average amounts of mafic and ultramafic rocks⁽⁶⁾ and less boulders than the other five samples.

It is felt that this large sample is representative of a significant quantity of alluvial material from the Tulameen River area. However, it was expected that the area sampled would contain finer-grained and probably poorer values, because it was located further downstream from the original source of the precious metals⁽⁶⁾.

Sampling and Analysis

Based on the results of the mineralogical examinations^{(3) (4) (5)}, it was agreed by Mr. Bainbridge of Metcon Resources Ltd., Mr. R. Ellerman, Consultant, Wright Engineers Ltd., both from Vancouver, B. C., Dr. L. J. Cabri of Mineral Sciences Division, Mines Branch, Ottawa and staff of Mineral Processing Division, Mines Branch, Ottawa, that the portion of Tulameen gravel coarser than six mesh had no gold and platinum values and, therefore, should be rejected by screening prior to concentration.

It was also agreed that, due to the nature of the material, a reliable gold and platinum analysis of the minus six-mesh material could not

be expected. As a result the minus 10-mesh fractions were screened out from the minus 6-mesh head samples and representative samples (about 500 grams) pulverized for fire assays. No detectable gold and platinum were found (0.003 oz/t. is the lower limit of the assay method); even by the X-ray fluorescence method, only scarcely detectable traces were indicated which showed that the Tulameen gravel samples for this investigation contained very low amounts of gold and platinum. The only alternative method for determining the gold and platinum contents in the gravel sample was to concentrate the precious metals and then calculate the metal content from the assayed products. To achieve the highest accuracy possible in sampling, where convenient, the total amounts of the concentrates were pulverized to minus 200 mesh and assayed. The pulverizing equipment was cleaned out with barren quartz and the pulverized quartz was also assayed.

Metcon Resources Ltd. requested that gold and platinum analyses on the products be done by the Analytical Chemistry Subdivision of the Mines Branch in Ottawa, as well as by B. H. Levelton and Associates Ltd. in Vancouver, British Columbia. When the gold and platinum analyses of the B. H. Levelton and Associates were 20 to 300 times higher than the Mines Branch assays, it was agreed to obtain an umpire analysis by a reliable third party. For this purpose, four identical sets of samples of the typical products were prepared. One set was analysed by Mines Branch, one by Levelton and Associates, and the third set by Ledoux and Company of New Jersey, U. S. A., with the agreement that Ledoux's values would be accepted as the umpire assays.

The Ledoux's and Mines Branch analyses of these "umpire" samples are given in Table 1.

TABLE 1

Ledoux's and Mines Branch Analyses on "Umpire" Samples

Product	Chemical Analyses - oz/ton			
	Ledoux's		Mines Branch	
	Au	Pt	Au	Pt
Rougher magnetics 1	0.018	0.007	0.011	0.004
Cleaner concentrate 1	0.502	0.047	0.50	0.054
Cleaner tailing 1	0.016	<0.001	0.005	0.016

These results showed that the Mines Branch assays were in close agreement with those of the Ledoux's procedure.

After B. H. Levelton and Associates Ltd. corrected their Au-Pt analytical procedure, their assays of these "umpire" samples were in close agreement with the Ledoux and Mines Branch assays. As a result, the metallurgical balances of the products from all gravel samples (lots) were done using Mines Branch assays.

MINERALOGY OF TULAMEEN GRAVEL

The geology of Tulameen River area has been described by C. Camsell in 1913⁽¹⁾. In recent years, other mineralogical investigations and technical publications^{(2) (3) (4) (5) (6)} have been carried out on Tulameen gravel from various areas by Dr. L. J. Cabri of the Mineral Sciences Division, Mines Branch, Ottawa and by others. Only the pertinent summaries of these publications, related to the geology of the district and specifically to the sample received for this investigation, will be recorded in this report.

"The main constituent of the placers in the Tulameen area is quartz with variable quantities of rock fragments and boulders. Magnetite and

chromite are common heavy minerals; their relative proportion varies with location. Minor heavy minerals are garnets, (ferroan spessartite and manganian almandine), hematite, zircon, sulphides (principally pyrite), ilmenite, gold, and hydrated iron oxides. Platinum-group minerals, as discrete mono-mineralic grains and as complex multi mineral nuggets and flakes, occur as minor constituents of these placer deposits. Tulameenite occurs associated with cubic iron-bearing platinum as rounded to irregular areas up to about 400 μm in diameter, as free grains, or as grains with complex inclusions (Fig. 1). When occurring as an outer zone on a nugget or flake of cubic iron-bearing platinum, tulameenite is distinguished by its relatively inferior polished surface"⁽³⁾.

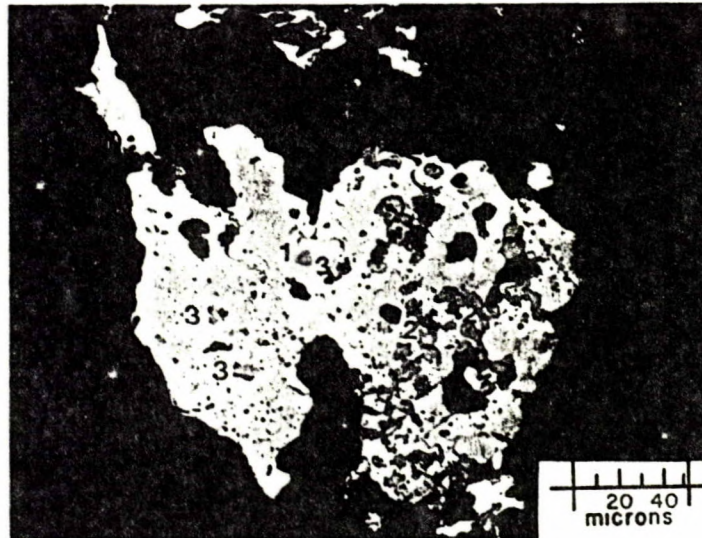


Fig. 1. Photomicrograph of a complex tulameenite grain showing inclusion of geversite (1) - PtSb_2 - and chalcopyrite (3) - CuFeS_2 - with, on the lower part, darker grey inclusions of a new Ir (Rh) - Sb-S mineral (2). Black areas are pits.

The tulameenite is distinctly magnetic in a low-intensity magnetic field while the cubic iron-bearing platinum mineral is non-magnetic in the same field.

The minerals of economic interest are iron-bearing platinum, tulameenite, platiniridium, and gold, all of which occur as liberated grains with respect to the silicate and oxide gangue. These economic minerals are in sizes smaller than 28 mesh. They can all be concentrated by gravity methods using heavy liquids. The tulameenite and magnetite can be further separated by means of a hand magnet. The platinum-group minerals contain some or several other metals such as Ir, Fe, Os, Ru, Cu, Ni and Sb in solid solution⁽⁴⁾.

OUTLINE OF INVESTIGATION

The mineralogical examination of the samples from the "Peterson" area indicated that most of the gold and platinum values were present in the gravel as free grains finer than 28 mesh. As the gravel material received for this investigation contained some waste material over 12 inches in diameter, this waste material had to be rejected by screening prior to concentration. To assure that no values were lost during the screening operation, it was agreed to reject material coarser than six mesh and carry out the concentration on the material finer than six mesh.

The mineralogical examinations of the samples from various Tulameen gravel areas showed that this gravel is composed of 15-20 different minerals of various chemical compositions with a various range of specific gravities as shown in Table 2.

TABLE 2

Specific Gravity of Minerals in Tulameen Gravel

Minerals	Amounts	Specific Gravity
Quartz	main constituent	2.6 - 2.7
Magnetite	major	3.9 - 4.2
Chromite	major	4.3 - 4.6
Garnets	minor	3.2 - 4.3
Hematite	minor	4.9 - 5.3
Zircon	minor	4.2 - 4.7
Pyrite	minor	5.0
Ilmenite	minor	4.5 - 5.0
Fe oxides	minor	4.2 - 5.3
Gold	very low	15.6 - 19.3
Platinum	very low	17.0
Pt minerals	very low	7 - 10

Because of the high specific gravity of the precious metal values, gravity concentration was used to concentrate them from the gangue minerals present in the gravel.

The magnetite and tulameenite present in the gravity concentrates were concentrated by low-intensity magnetic separation.

DETAILS OF INVESTIGATION

To concentrate most of the gold and platinum minerals effectively, and particularly the free grains, two-stage jigging was done on the unsized minus 6-mesh material using a Denver Duplex Mineral Jig. This produced two jig rougher concentrates.

As jigging of an unsized material containing particles of a wide range of sizes is not very effective in recovering fines of even heavy minerals, most of the fine material remained in the jig tailings including

some gold and platinum values. These heavy fines are lost to the jig tailings unless they are concentrated by an additional treatment. To determine the distribution of the precious metals, jig tailings were separated by screening into various size fractions. When the assays showed that no gold and platinum values could be detected in the plus 20-mesh fraction of the tailings, this fraction was discarded and the minus 20-mesh fraction of the jig tailing was tabled on a Wilfley sand-deck table. This produced a third rougher concentrate.

Slimes from the Wilfley table were tabled on a Deister slime deck table to recover a fourth rougher concentrate.

Each rougher concentrate was then treated by a low-intensity magnetic separator to eliminate magnetite. Each non-magnetic portion of the four rougher concentrates was then tabled to produce cleaner concentrates; the first, second and third on a Deister sand-deck table and the fourth on a slime-deck table.

In one case (Lot III), the cleaner concentrate #1 was subjected to a dry high-intensity Stearns magnetic separator (not shown on the flowsheet) to observe the effect of this kind of magnetic treatment on the separation of the low-magnetic minerals contained in the cleaner concentrate.

The flowsheet of this procedure is presented in Figure 2 and jigging conditions in Table 3. Detailed results of the investigation, attached to this report, are given in Tables 4 to 9, pages 14 to 19, with calculated gold and platinum contents in each lot; the results from combined concentrates and tailings from each lot are recorded in Tables 10 to 15, pages 20 to 24. Based on the results from Tables 4 to 9, the assays and gold and platinum distributions in the combined feed (all six lots combined) are calculated in Table 16, page 26. The summary of the results from all lots combined is given in Table 17, page 27.

The overall concentration results, with the average gold and platinum contents in all six lots combined, are recorded in Table 18, page 28.

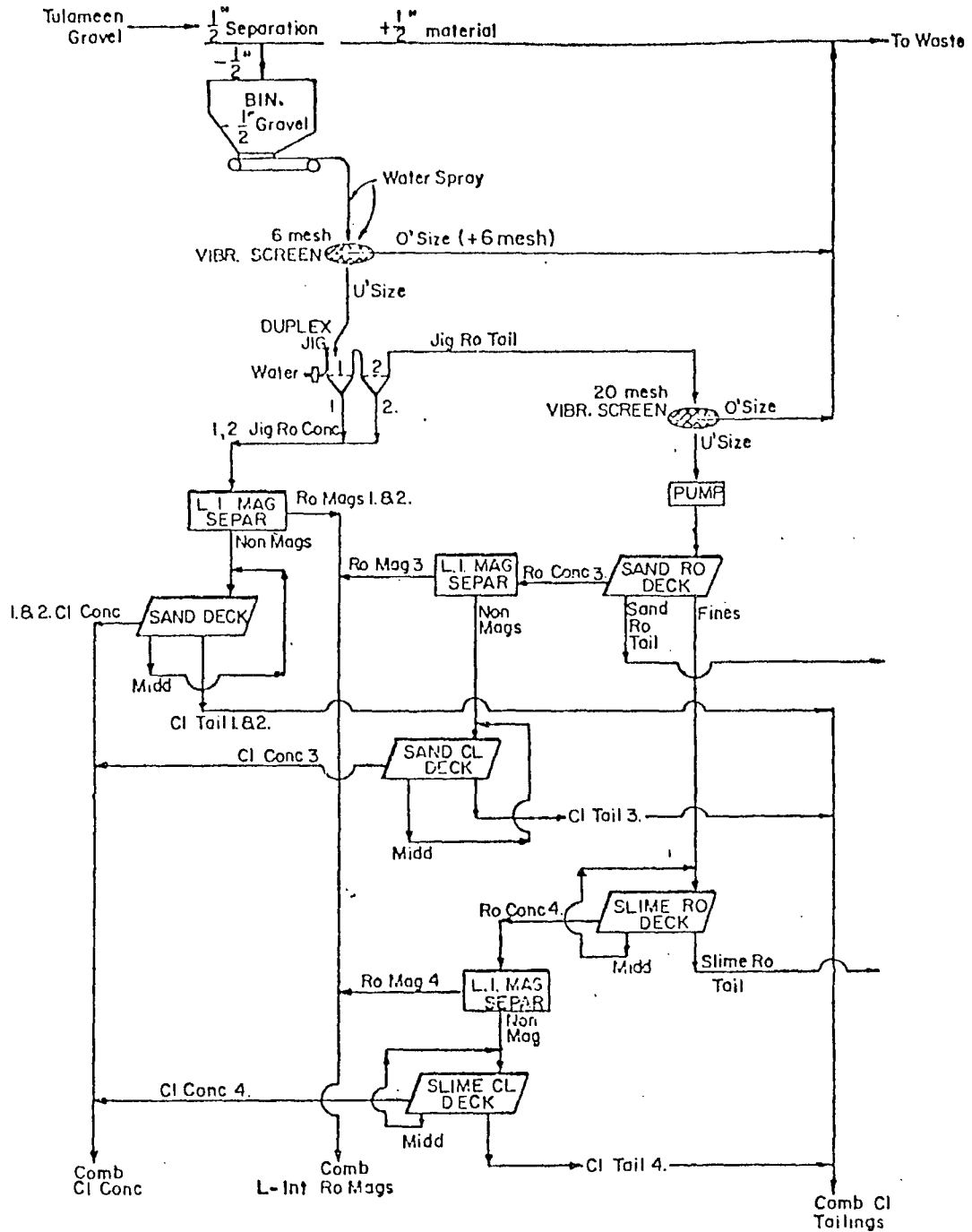


Figure 2- Pilot-Plant Flowsheet

TABLE 3

Jigging Conditions

COMPANY : Metcon Resources Limited, Vancouver, B.C.

SAMPLE: Tulameen Alluvial Gravel, Samples I to VI

JIG: Denver Duplex Mineral Jig, 8 in. x 12 in.

OPERATING CONDITIONS:

Speed: 250 rpm

Stroke: 1/4 in.

Ragging: Hutch No. 1 Hutch No. 2

Type. Samson Shots

Size. 1/4 inch and 3/16 inch, mixed - approx 3:1 ratio

Weight. 28 lb 24 lb

Supporting Screen: 1/16 inch wedge bars

Water: U.S. gal/min

Top 2.3

Bottom 6.7

Feed:

Rate (average): 800 lb/hr

Size: -6 mesh

SUMMARY AND CONCLUSION

The main constituents in the Tulameen placer deposit are quartz, variable amounts of rock fragments and boulders, with magnetite and chromite as major heavy minerals. Garnets, hematite, zircon, sulphides (principally pyrite), ilmenite, hydrated iron oxides, gold, platinum-bearing minerals and some gangue minerals, are the minor constituents in the gravel, with gold and platinum being the only constituents of an economic interest.

Six Tulameen gravel samples processed by applying jigging, tabling and low-intensity magnetic separation, contained very low amounts of gold and platinum minerals averaging 0.00019 oz Au/ton and 0.000021 oz Pt/ton. All of the gold and platinum values were in the minus 20-mesh fraction of the gravel comprising about 13% of the gravel by weight (see Table 17).

Due to low gold and platinum contents in the gravel, the magnetic and gravity concentrates produced had low gold and platinum grades (see Table 18).

All of the platinum in the gravel was recovered in two concentrates but only 28.6% of the gold in the gravel was recovered in the same two concentrates (see Table 18). Over 71% of the gold, therefore, remained in the rougher and cleaner tailings. No platinum was detected in either rougher or cleaner tailings (see Table 18). Particularly high gold losses occurred in rougher and cleaner tailings from Lot IV where about 90% of the gold in this sample remained in the tailings, reducing the overall gold recovery considerably.

It appears, therefore, that gold present in the gravel from the sample was either not as free as the platinum or in very fine sizes and thus it was less amenable to concentration.

No grinding of the tailings was applied in this investigation.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the assistance of Mr. A. Boissonault and the mill staff for initial screening of the gravel and setting and operating the pre-concentration circuit.

Acknowledgements are also extended to laboratory technicians, J. C. Banks, M. Raicevic and L. Gratton, for the upgrading operations and, to the latter two, for sample preparation of the mill products.

Specific acknowledgements are extended to the Analytical Chemistry Subdivision of the Mines Branch, Department of Energy, Mines and Resources in Ottawa, namely, Mr. P. E. Moloughney and his analysts, for carrying out a large number of gold and platinum analyses.

Acknowledgement is also extended to Dr. L. J. Cabri for providing Figure No. 1, reports as references and for storage arrangements for the last two shipments received for this investigation.

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TABLE 4
Detailed Results from Tulameen Gravel

Lot No.: 1

Weight: 28,700 lb

Product	Weight		Assay-oz/ton		Content		Distn %	
	Lb	%	Au	Pt	Au	Pt	Au	Pt
L-Int ro bags 1	22.33	0.0775	0.603	0.030	0.0002235	0.0022350	3.6	74.6
Cl conc 1	2.22	0.0075	0.516	0.067	0.0000563	0.0006566	63.8	21.9
Cl tail 1	4.69	0.0162	0.694	N.D.	0.0000630	-	0.9	-
Jig ro conc 1	23.20	0.1002	0.653	0.029	0.0053443	0.0026916	70.7	96.5
L-Int ro bags 2	22.50	0.1132	0.603	Tr.	0.0003356	-	4.5	-
Cl conc 2	3.75	0.0131	0.132	0.006	0.0017222	0.0006786	22.9	2.6
Cl tail 2	273.50	0.9531	N.D.	N.D.	-	-	-	-
Jig ro conc 2	369.75	1.0791	0.602	0.0001	0.0020628	0.0006786	27.4	2.6
L-Int ro bags 3	7.23	0.0252	0.603	N.D.	0.0000756	-	1.0	-
Cl conc 3	0.69	0.0023	0.612	0.011	0.0000208	0.0000266	0.4	0.9
Cl tail 3	63.00	0.2192	N.D.	N.D.	-	-	-	-
Sand D ro conc	71.00	0.2472	0.6004	0.0001	0.0001634	0.0006666	1.4	0.9
L-Int ro bags 4	0.02	0.0007	0.603	N.D.	0.0000032	-	Tr.	-
Cl conc 4	0.01	0.0003	0.348	N.D.	0.0000014	-	0.1	-
Cl tail 4	3.42	0.0117	0.693	N.D.	0.0000300	-	0.4	-
Slime D ro conc	3.45	0.0120	0.653	N.D.	0.0000273	-	0.5	-
Co. D ro conc	433.00	1.4751	0.693	0.052	0.0075578	0.0029166	150.0	100.0
Sand D ro tail	1,325.00	4.6171	N.D.	N.D.	-	-	-	-
Slime D ro tail	255.00	0.7520	N.D.	N.D.	-	-	-	-
20 mesh material	1,298.50	4.2669	0.663	0.005	0.0075578	0.0029558	11.9	100.0
120 mesh jig tail	5,050.00	17.597	N.D.	N.D.	-	-	-	-
16 mesh fraction and boulders	20,100.00	69.991	N.D.	N.D.	-	-	-	-
Feed (total)	28,700.00	100.000	0.6004	0.060	0.0075578	0.0029558	100.0	100.0

* Estimated

TABLE 5

Detailed Results from Tulameen Gravel

Lot No: II

Weight: 29,741 lb

Product	Weight		Assay-oz/ton		Content		Distn %	
	lb	%	Au	Pt	Au	Pt	Au	Pt
L-Int ro mags 1	49.05	0.1649	0.003	N. D.	0.0004950	-	1.8	-
Cl conc 1	3.35	0.0113	0.520	0.072	0.0058760	0.0008136	21.8	85.6
Cl tail 1	19.60	0.0659	0.003	N. D.	0.0001977	-	0.7	-
Jig ro conc 1	72.00	0.2421	0.027	0.003	0.0065687	0.0008136	24.3	85.6
L-Int ro mags 2	33.00	0.1110	N. D.	N. D.	-	-	-	-
Cl conc 2	3.90	0.0131	0.055	0.006	0.0007205	0.0000786	2.7	8.3
Cl tail 2	53.72	0.1806	N. D.	N. D.	-	-	-	-
Jig ro conc 2	90.62	0.3047	0.002	0.0002	0.0007205	0.0000786	2.7	8.3
L-Int ro mags 3	10.65	0.0358	0.003	N. D.	0.0001074	-	0.4	-
Cl conc 3	1.89	0.0064	0.020	0.009	0.0001280	0.0000576	0.5	6.1
Cl tail 3	71.26	0.2396	0.003	N. D.	0.0007191	-	2.6	-
Sand D.ro conc	83.80	0.2818	0.0034	0.0002	0.0009545	0.0000576	3.5	6.1
L-Int ro mags 4	0.07	0.0002	0.004	N. D.	0.0000008	-	Tr.	-
Cl conc 4	0.04	0.0001	0.130	0.005	0.0000130	Tr.	0.1	Tr.
Cl tail 4	4.47	0.0151	N. D.	N. D.	-	-	-	-
Slime D.ro conc	4.58	0.0154	0.0001	Tr.	0.0000138	Tr.	0.1	Tr.
Comb. ro conc	251.00	0.8440	0.010	0.0011	0.0082575	0.000950	30.6	100.0
Sand D.ro tails	3400.00	11.4320	0.0015	N.D.	0.0171480	-	63.4	-
Slime D.ro tails	240.00	0.8070	0.0012	N.D.	0.0016149	-	6.0	-
-70 mesh material	3391.00	11.4030	0.0021	0.0007	0.0270195	0.000950	100.0	100.0
120 mesh jig tails	6500.00	21.8554	N.D.	N.D.	-	-	-	-
46 mesh fraction and boulders	19350.00	65.0616	Nil*	Nil*	-	-	-	-
Feed (cal'd)	29741.00	100.0000	0.00027	0.00001	$\frac{0.0270195}{100}$	$\frac{0.000950}{100}$	100.0	100.0

* Fabricated

TABLE 6

Detailed Results from Tulameen Gravel

Lot No: III

Weight: 26,733 lb

Product	Weight		Assay-oz/ton		Content		Distn %	
	lb	Z	Au	Pt	Au	Pt	Au	Pt
L-Int ro mags 1	23.00	0.0860	0.004	N. D.	0.000344	-	1.3	-
H-Int mags 1	1.07	0.0038	0.008	0.076	0.000030	0.000099	0.1	1.3
Re-cl conc 1	1.79	0.0067	0.632	0.014	0.004234	0.000094	16.3	1.2
Cl tail 1	52.75	0.1973	N.D.	N. D.	-	-	-	-
Jig ro conc 1	78.56	0.2938	0.016	0.0007	0.004608	0.000193	17.7	2.5
L-Int ro mags 2	20.50	0.0767	0.005	N. D.	0.000383	-	1.5	-
Cl conc 2	4.41	0.0165	0.070	N. D.	0.001155	-	4.4	-
Cl tail 2	43.50	0.1627	N.D.	N. D.	-	-	-	-
Jig ro conc 2	68.41	0.2559	0.006	N. D.	0.001538	-	5.9	-
L-Int ro mags 3	10.53	0.0394	0.004	0.155	0.000157	0.006107	0.6	79.2
Cl conc 3	1.35	0.0050	0.591	0.280	0.002955	0.001400	11.4	18.3
Cl tail 3	81.60	0.3053	N.D.	N. D.	-	-	-	-
Sand D ro conc	93.48	0.3497	0.009	0.0215	0.003112	0.007507	12.0	97.5
L-Int ro mags 4	0.31	0.0011	0.015	N. D.	0.000016	-	0.1	-
Cl conc 4	0.03	0.0001	0.019	0.007	0.000091	Tr.	Tr.	Tr.
Cl tail 4	8.21	0.0308	N.D.	N. D.	-	-	-	-
Slime D ro conc	8.55	0.0320	0.008	Tr.	0.00017	-	0.1	-
Coal ro conc	249.00	0.9314	0.010	0.0383	0.009275	0.007700	35.7	100.0
Sand D ro tail	5340.00	19.9751	N.D.	N.D.	-	-	-	-
Slime D ro tail	890.00	3.3597	0.005	N.D.	0.016546	-	4.3	-
20 mesh material	6479.00	24.2359	0.0011	0.0037	0.025921	0.007700	100.0	100.0
120 mesh jig tail	5760.00	21.5464	N. D.	N.D.	-	-	-	-
16 mesh fraction and boulders	14494.00	54.2177	N.D.	N.D.	-	-	-	-
Feed (calcd)	26733.00	1000.000	0.00026	0.0001	0.025921 (100)	0.007700 (100)	100.0	100.0

* Estimated

TABLE 7

Detailed Results from Tulameen Gravel

Lot No.: IV

Weight: 27,525 lb

Product	Weight		Assay-oz/ton		Content		Distn %	
	lb	%	Au	Pt	Au	Pt	Au	Pt
L-Int ro mags 1	3.90	0.0142	0.032	0.002	0.0004544	0.0000284	0.9	31.4
Cl conc 1	0.88	0.0032	0.490	0.006	0.0015680	0.0000192	3.1	21.1
Cl tail 1	9.46	0.0344	0.006	N.D.	0.0002064	-	0.4	-
Jig ro conc 1	14.24	0.0518	0.043	0.001	0.0022288	0.0000476	4.4	52.5
L-Int ro mags 2	8.63	0.0314	0.035	N.D.	0.0010990	-	2.2	-
Cl conc 2	2.28	0.0083	0.129	N.D.	0.0010707	-	2.1	-
Cl tail 2	123.93	0.4501	0.003	N.D.	0.0013503	-	2.7	-
Jig ro conc 2	134.84	0.4898	0.007	N.D.	0.0035200	-	7.0	-
L-Int ro mags 3	7.20	0.0262	0.008	N.D.	0.0002096	-	0.4	-
Cl conc 3	1.46	0.0053	0.110	0.007	0.0005830	0.0000371	1.2	41.0
Cl tail 3	91.51	0.3325	0.005	N.D.	0.0016625	-	3.3	-
Sand D ro conc	100.17	0.3640	0.007	0.0001	0.0024551	0.0000371	4.9	41.0
L-Int ro mags 4	0.02	0.0001	0.070	0.005	0.0000070	0.0000050	Tr.	5.5
Cl conc 4	0.07	0.0003	0.021	0.003	0.0000063	0.0000009	Tr.	1.0
Cl tail 4	3.66	0.0133	N.D.	N.D.	-	-	-	-
Slime D ro conc	3.75	0.0137	0.001	0.0005	0.0000133	0.0000065	Tr.	6.5
Comb ro conc	253.00	0.9193	0.009	0.0001	0.0082172	0.0000912	16.3	100.0
Sand D ro tail	2031.00	7.3787	0.005	N.D.	0.0368935	-	72.8	-
Slime D ro tail	139.00	0.6566	0.008	N.D.	0.0054928	-	10.5	-
-28 mesh material	2475.00	8.9846	0.006	Tr.	0.0506035	0.0000912	100.0	-
+28 mesh jig tail	5730.00	20.8174	N.D.	N.D.	-	-	-	-
+8 mesh fraction and boulders	19322.00	70.1980	Nil*	Nil*	-	-	-	-
Feed (calcd)	27525.00	100.0000	0.0605	0.00001	<u>0.0506035</u> 100	<u>0.060</u> 100	100.0	100.0

* Estimated

TABLE 8

Detailed Results from Tulameen Gravel

Lot No.: V

Weight: 27717 lb

Product	Weight		Assay-oz/ton		Content		Distn Z	
	Lb	Z	Au	Pt	Au	Pt	Au	Pt
L-Int ro mags 1	3.09	0.0112	0.005	0.003	0.0000560	0.0000336	3.3	16.3
Cl conc 1	0.61	0.0022	0.255	0.067	0.0005698	0.0001034	33.6	50.1
Cl tail 1	8.57	0.0309	0.007	N.D.	0.0002163	-	12.8	-
Jig ro conc 1	12.27	0.0443	0.019	0.0031	0.0008421	0.0001370	49.7	66.4
L-Int ro mags 2	4.88	0.0176	N.D.	N.D.	-	-	-	-
Cl conc 2	2.80	0.0101	0.027	N.D.	0.0002727	-	16.1	-
Cl tail 2	54.52	0.1967	N.D.	N.D.	-	-	-	-
Jig ro conc 2	62.20	0.2244	0.0012	-	0.0002727	-	16.1	-
L-Int ro mags 3	5.53	0.0200	0.004	N.D.	0.0000300	-	4.7	-
Cl conc 3	0.74	0.0027	0.157	0.007	0.0004239	0.0000189	25.0	9.2
Cl tail 3	48.74	0.1758	N.D.	N.D.	-	-	-	-
Sand D ro conc	55.01	0.1935	0.0025	0.0001	0.0005059	0.0000189	29.7	9.2
L-Int ro mags 4	0.14	0.0005	0.005	0.041	0.0000025	0.0000205	0.1	9.9
Cl conc 4	0.12	0.0004	0.187	0.075	0.0000749	0.0000300	4.4	14.5
Cl tail 4	7.13	0.0258	N.D.	N.D.	-	-	-	-
Slime D ro conc	7.59	0.0267	0.003	0.002	0.0000773	0.0000505	4.5	24.4
Comb ro conc	136.67	0.4939	0.0031	0.0011	0.0016560	0.0002064	100.0	100.0
Sand D ro tail	2340.00	8.4425	N.D.	N.D.	-	-	-	-
Slime D ro tail	285.13	1.0287	N.D.	N.D.	-	-	-	-
-20 mesh material	2762.00	9.9651	0.00017	0.00002	0.0016560	0.0002064	100.0	100.0
120 mesh jig tail	8546.00	30.8331	N.D.	N.D.	-	-	-	-
16 mesh fraction and boulders	16409.00	59.2618	N.D.	N.D.	-	-	-	-
Feed (total)	27717.00	100.000	0.00007	0.00002	0.0016560	0.0002064	-	-

* Estimated

TABLE 9

Detailed Results from Tulameen Gravel

Lot No.: VI

Weight: 26535 lb

Product	Weight		Assay-oz/ton		Content		Distn %	
	lb	%	Au	Pt	Au	Pt	Au	Pt
L-Int ro mags 1	11.69	0.0441	0.011	N. D.	0.000485	-	15.2	-
Cl conc 1	2.48	0.0093	0.145	0.003	0.001348	0.000027	42.1	100.0
Cl tail 1	26.25	0.0989	N. D.	N. D.	-	-	-	-
Jig ro conc 1	40.42	0.1523	0.017	0.0002	0.001833	0.000027	57.3	100.0
L-Int ro mags 2	9.88	0.0372	0.007	N. D.	0.000260	-	8.1	-
Cl conc 2	1.70	0.0064	0.037	N. D.	0.000236	-	7.4	-
Cl tail 2	31.20	0.1176	N. D.	N. D.	-	-	-	-
Jig ro conc 2	42.78	0.1612	0.003	N. D.	0.000496	-	15.5	-
L-Int ro mags 3	14.15	0.0533	0.009	N. D.	0.000479	-	15.0	-
Cl conc 3	2.25	0.0085	0.046	N. D.	0.000391	-	12.2	-
Cl tail 3	98.10	0.3697	N. D.	N. D.	-	-	-	-
Sand B ro conc	114.50	0.4315	0.002	N. D.	0.000870	-	27.2	-
L-Int ro mags 4	0.11	0.0005	N. D.	N. D.	-	-	-	-
Cl conc 4	0.26	0.0010	N. D.	N. D.	-	-	-	-
Cl tail 4	5.93	0.0223	N. D.	N. D.	-	-	-	-
Slime B ro conc	6.30	0.0236	-	N. D.	-	-	-	-
Comb ro conc	294.00	0.7668	0.004	Tr.	0.003199	0.000027	100.0	100.0
Sand B ro tail	3974.00	14.9802	N.D.	N.D.	-	-	-	-
Slime B ro tail	255.00	0.9610	N.D.	N.D.	-	-	-	-
-20 Mesh material	4434.00	16.7100	0.0052	Tr.	0.003159	0.000027	100.0	100.0
120 mesh jig tail	5417.00	20.3957	N.D.	N.D.	-	-	-	-
16 Mesh fraction and boulders	16689.00	62.8943	Nil*	Nil*	-	-	-	-
Feed (total)	26535.00	100.0000	0.03003	Tr.	0.00312 100	Tr.	100.0	100.0

* Estimated

TABLE 10

Results from Combined Concentrates and Tailings

Lot No. I

Weight 28,700 lb.

Product	Weight %	Assay-oz/ton		Distn %	
		Au	Pt	Au	Pt
Lt-Int ro mags 1	0.07450	0.003	0.030	3.0	74.6
" " " " 2	0.11320	0.003	Tr.	4.5	-
" " " " 3	0.02520	0.003	N.D.	1.0	-
" " " " 4	0.00007	0.003	N.D.	Tr.	-
Comb L-Int ro mags	0.21307	0.003	0.010	8.5	74.6
Cl conc 1	0.00980	0.516	0.067	66.8	21.9
" " 2	0.01310	0.132	0.006	22.9	2.6
" " 3	0.00240	0.012	0.011	0.4	0.9
" " 4	0.00003	0.048	N.D.	0.1	-
Comb cl conc	0.02533	0.269	0.030	90.2	25.4
Cl tail 1	0.01600	0.004	N.D.	0.9	-
" " 2	0.95310	N.D.	N.D.	-	-
" " 3	0.21970	N.D.	N.D.	-	-
" " 4	0.01190	0.003	N.D.	0.4	-
Comb cl tails	1.20070	Tr.	N.D.	1.3	-
Comb ro conc	1.4390	0.005	0.002	100.0	100.0
Sand D ro tail	4.0732	N.D.	N.D.	-	-
Slime D ro tail	0.7526	N.D.	N.D.	-	-
-20 mesh material	6.2648	0.0013	0.0005	100.0	100.0
+20 mesh jig tail	21.0801	N.D.	N.D.	-	-
+6 mesh fraction and boulders	72.6551	Nil*	Nil*	-	-
Feed (calcd)	100.0000	0.00008	0.00003	100.0	100.0

* Estimated

TABLE 11

Results from Combined Concentrates and Tailings

Lot No.: II

Weight: 29,741 lb.

Product	Weight	Assay-oz/ton		Distn %	
	%	Au	Pt	Au	Pt
Lt-Int ro mags 1	0.1649	0.003	N.D.	1.8	-
" " " " 2	0.1110	N.D.	N.D.	-	-
" " " " 3	0.0358	0.003	N.D.	0.4	-
" " " " 4	0.0002	0.004	N.D.	Tr.	-
Comb L-Int ro mags	0.3119	0.002	N.D.	2.2	-
Cl conc 1	0.0113	0.520	0.072	21.8	85.6
" " 2	0.0131	0.055	0.006	2.7	8.3
" " 3	0.0064	0.020	0.009	0.5	6.1
" " 4	0.0001	0.130	0.005	0.1	Tr.
Comb cl conc	0.0309	0.206	0.031	25.1	100.0
Cl tail 1	0.0659	0.003	N.D.	0.7	-
" " 2	0.1806	N.D.	N.D.	-	-
" " 3	0.2396	0.003	N.D.	2.6	-
" " 4	0.0151	N.D.	N.D.	-	-
Comb cl tails	0.5012	0.002	N.D.	3.3	-
Comb ro conc	0.8440	0.010	0.0011	30.6	100.0
Sand D ro tail	11.4320	0.0015	N.D.	63.4	-
Slime D ro tail	0.8070	0.002	N.D.	6.0	-
-20 mesh material	13.0830	0.0021	0.0007	100.0	100.0
+20 mesh jig tail	21.8554	N.D.	N.D.	Nil	Nil
+6 mesh fraction and boulders	65.0616	Nil*	Nil*	Nil	Nil
Feed (calcd)	100.0000	0.00027	0.00001	100.0	100.0

* Estimated.

TABLE 12

Results from Combined Concentrates and Tailings

Lot No.: III

Weight: 26,733 lbs.

Product	Weight	Assay-oz/ton		Distn %	
	%	Au	Pt	Au	Pt
Lt-Int ro mags 1	0.0860	0.004	N.D.	1.3	-
" " " " 2	0.0767	0.005	N.D.	1.5	-
" " " " 3	0.0394	0.004	0.155	0.6	79.2
" " " " 4	0.0011	0.015	N.D.	0.1	-
Comb L-Int ro mags	0.2032	0.0045	0.030	3.5	79.2
Cl conc 1	0.0105	0.602	0.019	16.4	2.5
" " 2	0.0165	0.070	N.D.	4.4	-
" " 3	0.0050	0.591	0.280	11.4	18.3
" " 4	0.0001	0.019	0.007	Tr.	Tr.
Comb cl conc	0.0321	0.261	0.050	32.2	20.8
Cl tail 1	0.1973	N.D.	N.D.	-	-
" " 2	0.1627	N.D.	N.D.	-	-
" " 3	0.3053	N.D.	N.D.	-	-
" " 4	0.0308	N.D.	N.D.	-	-
Comb cl tails	0.6961	N.D.	N.D.	-	-
Comb ro conc	0.9314	0.010	0.0083	35.7	100.0
Sand D ro tail	19.9753	N.D.	N.D.	-	-
Slime D ro tail	3.3292	0.005	N.D.	64.3	-
-20 mesh material	24.2359	0.0011	0.0032	100.0	100.0
+20 mesh jig tail	21.5464	N.D.	N.D.	-	-
+6 mesh fraction and boulders	54.2177	Nil*	Nil*	-	-
Feed (calcd)	100.0000	0.00026	0.0001	100.0	100.0

* Estimated.

TABLE 13

Results from Combined Concentrates and Tailings

Lot No.: IV

Weight: 27,525 lbs.

Product	Weight	Assay-oz/ton		Distn %	
	%	Au	Pt	Au	Pt
Lt-Int ro mags 1	0.0142	0.032	0.002	0.9	31.4
" " " " 2	0.0314	0.035	N.D.	2.2	-
" " " " 3	0.0262	0.008	N.D.	0.4	-
" " " " 4	0.0001	0.070	0.005	Tr	5.5
Comb L-Int ro mags	0.0719	0.025	0.0005	3.5	36.9
Cl conc 1	0.0032	0.490	0.006	3.1	21.1
" " 2	0.0083	0.129	N.D.	2.1	-
" " 3	0.0053	0.110	0.007	1.2	41.0
" " 4	0.0003	0.021	0.003	Tr.	1.0
Comb cl conc	0.0171	0.189	0.0034	6.4	63.1
Cl tail 1	0.0344	0.006	N.D.	0.4	-
" " 2	0.4502	0.003	N.D.	2.7	-
" " 3	0.3325	0.005	N.D.	3.3	-
" " 4	0.0133	N.D.	N.D.	-	-
Comb cl tails	0.8304	0.004	N.D.	6.4	-
Comb ro conc	0.9193	0.009	0.0001	16.3	100.0
Sand D ro tail	7.3787	0.005	N.D.	72.8	-
Slime D ro tail	0.6866	0.008	N.D.	10.9	-
-28 mesh material	8,9846	0.006	Tr.	100.0	100.0
+28 mesh jig tail	20.8174	N.D.	N.D.	-	-
+8 mesh fraction and boulders	70.1980	Nil*	Nil*	-	-
Feed (calcd)	100.0000	0.00008	0.00003	100.0	100.0

* Estimated

TABLE 14

Results from Combined Concentrates and Tailings

Lot No.: V

Weight: 27,717 lbs.

Product	Weight	Assay-oz/ton		Distn %	
	%	Au	Pt	Au	Pt
Lt-Int ro mags 1	0.0112	0.005	0.003	3.3	16.3
" " " " 2	0.0176	N.D.	N.D.	-	-
" " " " 3	0.0200	0.004	N.D.	4.7	-
" " " " 4	0.0005	0.005	0.041	0.1	9.9
Comb l-Int ro mags	0.0493	0.0028	0.0011	8.1	26.2
Cl conc 1	0.0022	0.259	0.047	33.6	50.1
" " 2	0.0101	0.027	N.D.	16.1	-
" " 3	0.0027	0.157	0.007	25.0	9.2
" " 4	0.0004	0.187	0.075	4.4	14.5
Comb cl conc	0.0154	0.087	0.010	79.1	73.8
Cl tail 1	0.0309	0.007	N.D.	12.8	-
" " 2	0.1967	N.D.	N.D.	-	-
" " 3	0.1758	N.D.	N.D.	-	-
" " 4	0.0258	N.D.	N.D.	-	-
Comb cl tails	0.4292	0.0005	N.D.	12.8	-
Comb ro conc	0.4939	0.0034	0.0004	100.0	100.0
Sand D ro tail	8.4425	N.D.	N.D.	-	-
Slime D ro tail	1.0287	N.D.	N.D.	-	-
-20 mesh material	9.9651	0.00017	0.00002	100.0	100.0
+20 mesh jig tail	30.8331	N.D.	N.D.	-	-
+6 mesh fraction and boulders	59.2018	Nil*	Nil*	-	-
Feed (calcd)	100.0000	0.00002	0.000002	100.0	100.0

* Estimated.

TABLE 15

Results from Combined Concentrates and Tailings

Lot No.: V1

Weight: 26,535 lbs.

Product	Weight	Assay-oz/ton		Distn %	
	%	Au	Pt	Au	Pt
Lt-Int ro mags 1	0.0441	0.011	N.D.	15.2	-
" " " " 2	0.0372	0.007	N.D.	8.1	-
" " " " 3	0.0533	0.009	N.D.	15.0	-
" " " " 4	0.0005	N.D.	N.D.	-	-
Comb L-Int ro mags	0.1351	0.009	N.D.	38.3	-
Cl conc 1	0.0093	0.145	0.03	42.1	100.0
" " 2	0.0064	0.037	N.D.	7.4	-
" " 3	0.0085	0.046	N.D.	12.2	-
" " 4	0.0010	N.D.	N.D.	-	-
Comb cl conc	0.0252	0.078	0.001	61.7	100.0
Cl tail 1	0.0989	N.D.	N.D.	-	-
" " 2	0.1176	N.D.	N.D.	-	-
" " 3	0.3697	N.D.	N.D.	-	-
" " 4	0.0223	N.D.	N.D.	-	-
Comb cl tails	0.6085	N.D.	N.D.	-	-
Comb ro conc	0.7688	0.004	Tr.	Tr.	-
Sand D ro tail	14.9802	N.D.	N.D.	-	-
Slime D ro tail	0.9610	N.D.	N.D.	-	-
-20 mesh material	16.7100	0.0002	Tr.	100.0	100.0
+20 mesh jig tail	20.3957	N.D.	N.D.	-	-
+6 mesh fraction and boulders	62.8943	Nil*	Nil*	-	-
Feed (calcd)	100.0000	0.00003	Tr.	100.0	100.0

* Estimated.

TABLE 16

Gold and Platinum Distribution in Combined
Tulameen Gravel Samples, Lot I - VI

Lot No.	Weight		Assay-Oz/ton		Content		Distn %	
	lb	%	Au	Pt	Au	Pt	Au	Pt
I	28,700	17.2	0.0000755	0.0000300	0.001707	0.000516	6.7	24.5
II	29,741	17.8	0.0002702	0.0000095	0.004810	0.000169	24.8	8.0
III	26,733	16.0	0.0002592	0.0000770	0.004147	0.001732	21.3	58.5
IV	27,525	16.5	0.0005060	0.0000091	0.008350	0.000150	43.1	7.1
V	27,717	16.6	0.0000170	0.0000021	0.000282	0.000035	1.5	1.7
VI	26,535	15.9	0.0000320	0.0000003	0.000509	0.000005	2.6	0.2
I-VI (Comb Feed)	166,951	100.0	0.000194	0.000021	<u>0.019405</u> 100	<u>0.002107</u> 100	100.0	100.0

TABLE 17

Summary Of Results From Tulameen Gravel

Product	Weight		Assay-oz/ton		Distribution - %			
					In Lot		In Comb Feed*	
	Lb.	%	Au	Pt	Au	Pt	Au	Pt
Comb L-Int ro mags, Lot I	61.13	0.2131	0.003	0.010	8.5	74.6	0.6	18.3
" " II	92.77	0.3119	0.0019	N.D.	2.2	-	0.6	-
" " III	54.32	0.2032	0.0045	0.030	3.5	79.2	0.7	46.2
" " IV	19.75	0.0719	0.025	0.0005	3.5	36.9	1.5	2.6
" " V	13.64	0.0493	0.0028	0.0011	8.1	26.2	0.1	0.5
" " VI	35.83	0.1351	0.009	N.D.	38.3	-	1.0	-
Comb L-Int ro mags, Lot I-VI	277.46	0.1662	0.0052	0.0059	n.a.	n.a.	4.5	67.6
Comb cl gold conc, Lot I	7.27	0.0253	0.269	0.030	90.2	25.4	6.0	6.2
" " II	9.18	0.0309	0.206	0.031	25.1	100.0	6.2	8.0
" " III	8.61	0.0321	0.261	0.050	32.2	20.8	6.9	12.2
" " IV	4.69	0.0171	0.189	0.0033	6.4	63.1	2.8	4.5
" " V	2.27	0.0154	0.087	0.010	79.1	73.8	1.2	1.3
" " VI	4.69	0.0252	0.078	0.001	61.7	100.0	1.0	0.2
Comb cl gold conc, Lot I-VI	36.71	0.0220	0.213	0.031	n.a.	n.a.	24.1	32.4
Comb cl tailing, Lot I	344.60	1.2007	0.0001	N.D.	1.3	-	0.1	-
" " II	149.04	0.5012	0.002	N.D.	3.3	-	0.8	-
" " III	186.06	0.6961	N.D.	N.D.	-	-	-	-
" " IV	238.56	0.8304	0.004	N.D.	6.4	-	2.8	-
" " V	118.96	0.4292	0.0005	N.D.	12.8	-	0.2	-
" " VI	161.48	0.6085	N.D.	N.D.	-	-	-	-
Comb cl tailings, Lot I-VI	1,198.50	0.7180	0.0011	N.D.	n.a.	n.a.	3.9	-
Comb ro conc Lot, I-VI	1,512.67	0.9062	0.0069	0.0023	n.a.	n.a.	32.5	100.0
Comb sand-slime ro tails, Lot I-VI	20,330.33	12.1772	0.0011	N.D.	n.a.	n.a.	67.5	-
-70 mesh material, Lot I-VI	21,843.00	13.0834	0.0015	0.00016	n.a.	n.a.	100.0	100.0
+20 mesh material, Lot, I-VI	145,108.00	86.9166	N.D.	N.D.	-	-	-	-
Comb Feed (calcd), Lot I-VI	166,951.00	100.0000	0.00019	0.000021	n.a.	n.a.	100.0	100.0

* Based on Table 16

n.a.=not applicable

TABLE 18
Overall Concentration Results from Combined
Tulameen Gravel Samples, Lot I - VI

Product	Weight		Assay-oz/t		Distn %	
	lb	%	Au	Pt	Au	Pt
Comb L-Int mag conc, Lot I-VI	277.46	0.1662	0.0052	0.0059	4.5	67.6
Comb cl gold conc, Lot I-VI	36.71	0.0220	0.213	0.031	24.1	32.4
Comb mag and gold conc, Lot I-VI	314.17	0.1882	0.0556	0.011	28.6	100.0
Comb cl & ro tailings, Lot I-VI	21,527.83	12,8805	0.0011	N.D.	71.4	-
Comb +20 mesh material, Lot I-VI	145,108.00	86.9313	Nil	Nil	-	-
Comb Feed (calcd), Lot I-VI	166,951.00	100.0000	0.00019	0.000021	100.0	100.0