WILLIAMS CREEK PROJECT

A PROPOSAL FOR FUNDING TO OPERATE

A

SOLVENT EXTRACTION PILOT PLANT

FOR WILLIAMS CREEK COPPER ORE

by

WESTERN COPPER HOLDINGS LIMITED
900 - 850 W. Hastings St.
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for

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March 1993

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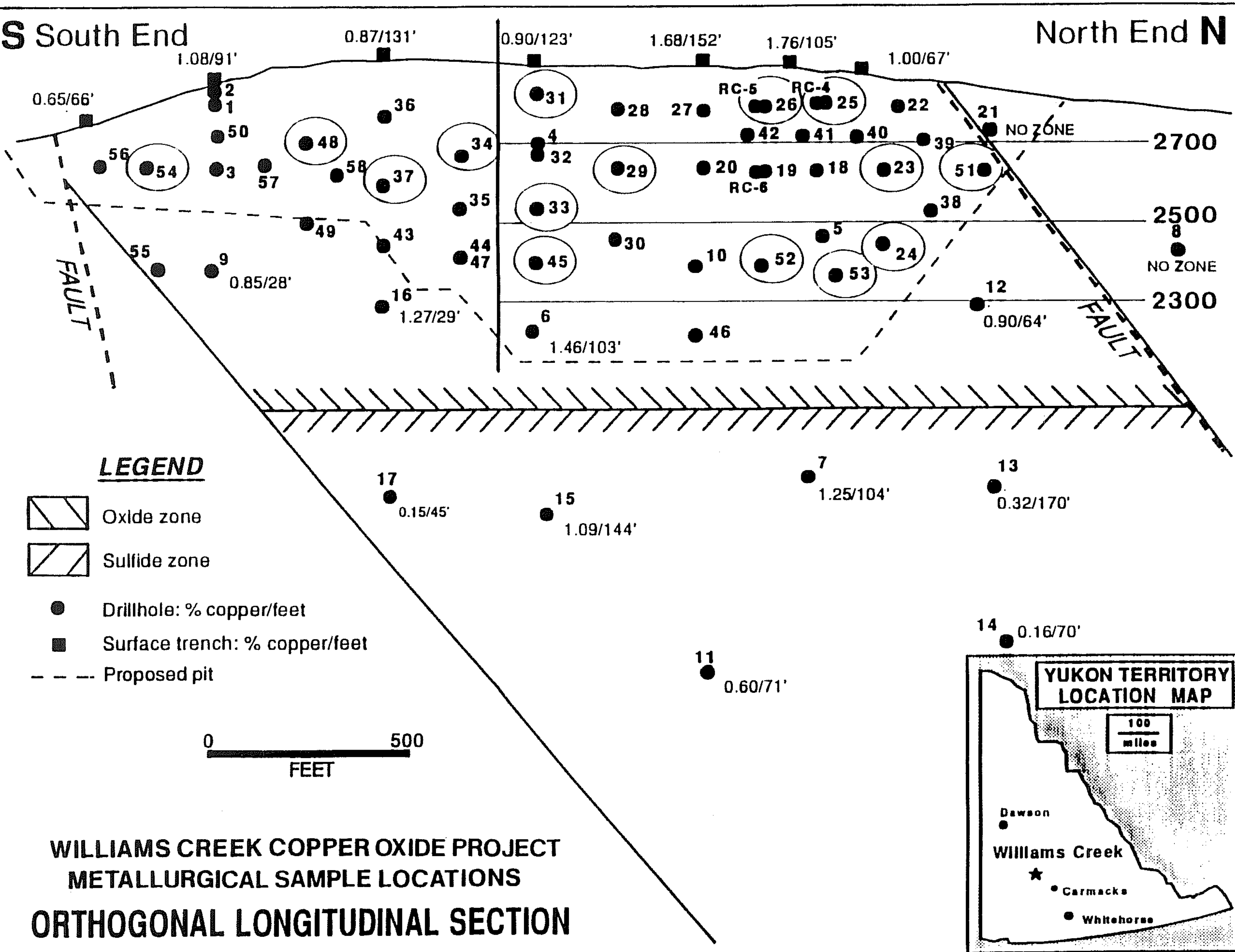
INTRODUCTION

The Williams Creek Project is located 200 kilometres northwest of Whitehorse and 40 road-kilometres northwest of Carmacks, Yukon. The property is currently accessible by a two-wheel driveable road from Carmacks. Copper mineralization at Williams Creek was discovered in 1970 during a regional exploration program. Defined economic mineralization at Williams Creek occurs in the No. 1 Zone which is a northwest striking, steeply dipping (70° E) tabular zone averaging 29 metres in width, is exposed for 550 metres along strike and has been intersected in drill holes to a depth of 425 metres below surface. Primary mineralization consists of disseminations and fine veinlets of bornite, chalcopyrite, pyrite and minor molybdenite. Due to the porosity of the schistose host, primary copper minerals have been oxidized to azurite, malachite and cuprite. There are gold and silver credits associated with the copper minerals.

A detailed, fill-in drill program completed in 1991 improved the defined resource of the No. 1 Zone. Resampling of the trenches showed that there is no barren zone at surface. Deep drilling confirmed the oxide copper mineralization extends to a depth of at least 210m below surface. The revised diluted reserve estimate now stands at 13.6 million tons grading 1.08% copper and 0.014 ounces of gold per ton.

A feasibility study is currently underway to determine the viability of this project which will include sections on: 1) Permitting and Environmental Review, 2) Metallurgy, 3) Capital Cost Estimates, 4) Operating Cost Estimates, 5) Mining Reserve and Exploration Potential. These parameters are interactive in that definition of the mining reserve and metallurgy are required to determine the type and size of process plant required. Once defined, the capital costs and, operating costs can be estimated and the environmental impact ascertained. Work is continuing on all aspects of the study.



WILLIAMS CREEK COPPER OXIDE PROJECT
METALLURGICAL SAMPLE LOCATIONS
ORTHOGONAL LONGITUDINAL SECTION

HOLE	INTERVAL TRUE WIDTH	% Cu
1	80'	1.26
2	40'	0.45
3	40'	1.50
4	66'	0.69
5	190'	1.34
10	105'	1.30
18	160'	1.61
19	139'	0.96
20	124'	1.55
22	127'	1.19
23	203'	1.82
24	160'	1.14
25	130'	1.36
26	129'	0.83
27	136'	1.53
28	123'	0.98
29	121'	1.06
30	99'	1.51
31	112'	0.84
32	90'	1.07
33	56'	1.10
34	76'	1.45
35	57'	1.08
36	69'	0.76
37	61'	0.84
38	166'	0.55
39	83'	0.54
40	110'	1.36
41	155'	1.22
42	137'	1.11
43	131'	1.09
45	84'	0.99
46	174'	1.31
47	116'	1.39
48	55'	1.32
49	70'	0.78
50	127'	0.84
51	82'	0.31
52	165'	1.35
53	183'	1.17
54	35'	1.38
55	1.2'	1.39
56	30'	1.42
57	75'	1.16
58	121'	1.15
RC-4	118'	1.39
RC-5	130'	1.06
RC-6	126'	1.13

The metallurgical studies are designed towards developing the process flowsheet. Initially, bottle roll tests were used to scope out basic parameters for the other tests to follow. The bottle rolls are relatively quick and inexpensive, however, it is difficult to relate this information to a full scale operation.

The next stage of metallurgical work involved completing a series of column tests. In our case, four foot and ten foot high columns of six inch plastic pipe were filled with ore that has been crushed to - 3/4 inch. The columns were irrigated for an average of approximately sixty days.

Data from these tests is being incorporated into a computer model which will predict optimum conditions for the leaching operating. The accuracy of the optimized model will be tested by leaching a 20 foot column for approximately 90 days.

The Williams Creek project is unique in that it will employ conventional heap leach technology at a northern latitude. Conditions such as frost penetration and operating conditions will be difficult to estimate from the laboratory studies. These parameters are best determined from an existing operation or by running a pilot plant.

Western Copper is proposing to run a pilot study of a bulk sample during the summer and fall of 1993. The pilot study will have many positive aspects including:

1) confirmation of the column test results.
2) operational experience in freezing conditions.
3) demonstration of the effectiveness of the technology at a northern latitude.
4) public education of the extraction process.
5) preproduction training for potential work force.

The pilot plant study will provide a greater confidence in the projected success and operational capacities of the project.

PROJECT DETAILS

We anticipate operating a bulk test similar to that run by Cominco Resources International at Quebrada Blanca in Chile. In designing the test, the following basic parameters have been set out:

Size	200 tons
Grade	1.2-1.4% Total Copper
	0.015 to 0.025 ounce per ton Gold
Recovery	80% copper
Duration	90 Days
Acid Consumption	35 Kg/Ton
Pregnant Leach	
Solution Grade	2 to 10 g/l
Solution Flow Rates	4 Litres/Min
Acid Strength	15g H_2SO_4/l - initial
Raffinate Ph	1.0 to 1.58
Pregnant Leach Solution (PLS) Ph	2.3 to 3.3
Average Ambient Temp	+13°C to -15°C
Total Pad Dimensions	9 x 18 metres
Safety Berm Height	.6 metres

Lakefield Research has been contracted to supply supervisory personnel and document the test results. Documentation will be of a standard required to facilitate project financing.

Work for the study will be coordinated through four phases. In the first phase a suitable site for the pilot plant will be chosen. The gravel pit next to the village of Carmacks dump would be preferred for the following reasons:

1) infrastructure - utilities and road access available year round.
2) greater public accessibility.
3) housing and local workforce availability.
4) isolated from both rivers
5) isolated from nearby housing

For the test an insulated crib will be constructed with approximate dimensions of 4 x 4 x 7m high, with a 200 ton capacity. The crib will be made of plywood, insulated,lined with a corrosion resistant plastic and surrounded with a .6M berm. It will be built on an impervious double plastic membrane which will also cover the berm. A wooden fence and storage shed will be erected to restrict public contact with the reagents. The fenced compound will enclose an area of approximately 15m x 30m.

Pregnant Leach Solution (PLS) will be collected in a lined holding pond. The pond will have dimensions of 7.6M x 7.6M x 1M with side slopes of 30° and an approximate capacity of 30,000 litres. The leach solutions will require less than 24 hours to travel through the pile. The PLS pond will have a capacity to hold two full days of irrigation. The additional capacity is designed to collect any precipitation which may fall on the pad.

The solvent extraction/electrowinning plant will be leased from Lakefield Research. The equipment will be unitized and will require minor assembly on site. Electrical hook-up and plumbing for the PLS pond to the plant and returning barren acid (raffinate) to the top of the pile will be required.

Construction of the ore crib, storage ponds and pilot plant will require 3 - 4 weeks to complete. Work will have to be started in early July in order to commence leaching on schedule in early August.

Phase II will involve the mining and transportation of the ore sample. Mining will commence once the crib has been prepared and will be completed while the pilot plant is being assembled.

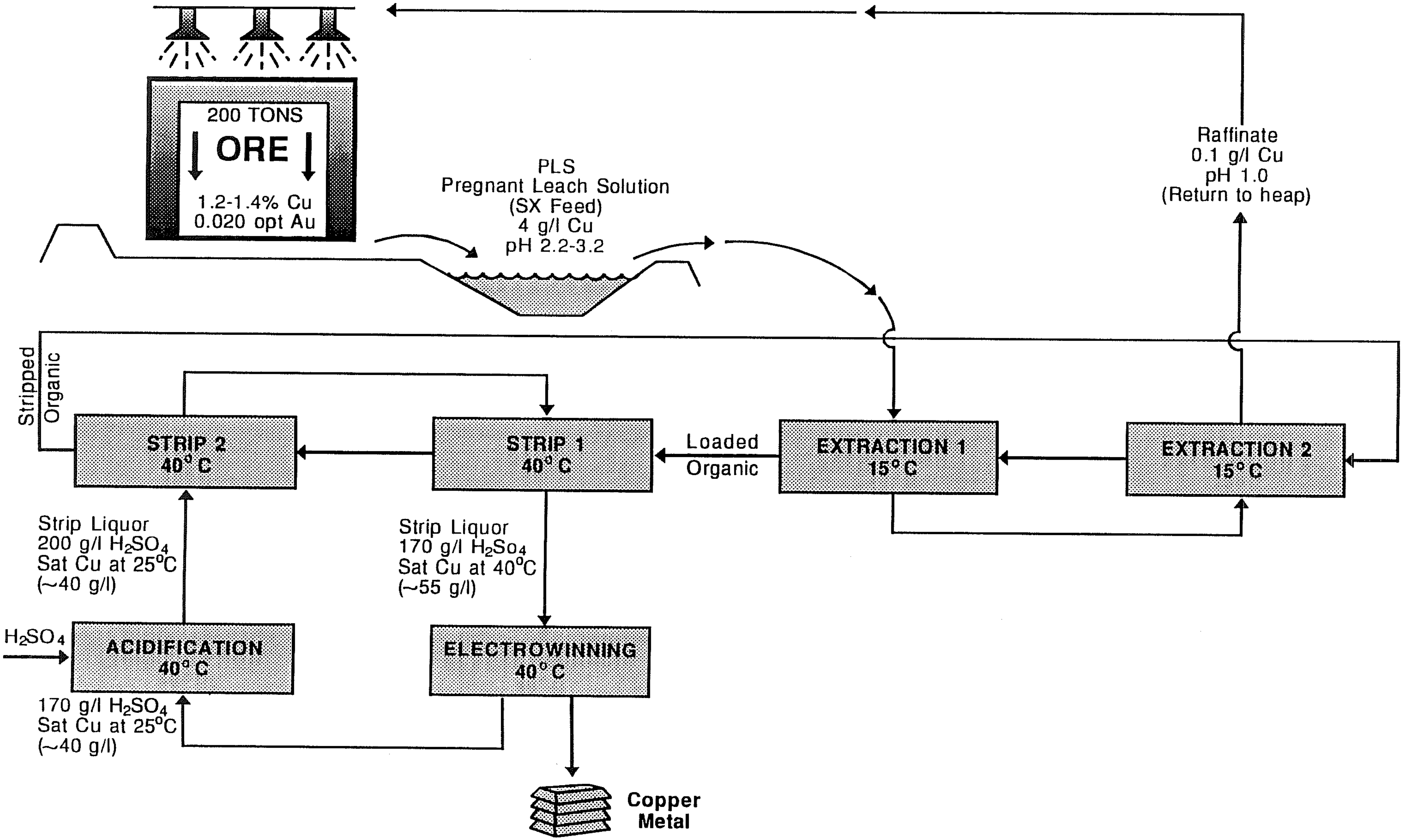
The ore sample will be mined from 3 or 4 trenches across various sections of the deposit. A bulldozer will prepare the trenches prior to air track drilling of blast holes. Cuttings from the drill holes will be collected and used to estimate the sample grade. Once blasted, a representative cut will be excavated out of each trench and shipped to Carmacks using ten ton dump trucks. Unweathered material will be used in the test which will require stripping up to 6M of rock from the top of each trench.

At Carmacks the sample will be off loaded and crushed to 100% passing a 3/4 inch screen. A two to five ton sample will be split off at the crusher and sent to Vancouver for duplicate column testing. The material being placed in the crib will be preconditioned with sulphuric acid at a concentration of 200 g/l. Preconditioning reduces the inherent acidity front which is generated when the first solutions are run through the pile. Reducing the acidity front also reduces the risk of the Ph becoming high enough to cause precipitation of the copper before the solution can migrate to the PLS pond. Preconditioning will add 2 to 5 percent moisture to the ore.

The preconditioned ore will be conveyed into the crib. Temperature and Ph/EH probes will be placed systematically throughout the pile. A drip irrigation system will be installed 1 to 1.5M below the top of the pile and insulated using preconditioned ore. When irrigation lines and PLS recovery pumps have been connected to the plant, the test will be ready for leaching.

Phase III will involve the actual leaching/pilot plant operation beginning in early August and continuing through October. Copper will be dissolved with dilute sulphuric acid with a Ph between 1.0 and 1.5. Pilot plant flow rates will vary between 4 and 8 litre/min. The pregnant solution will average 3 g/l copper at a Ph of 2.2 to 3.2.

WILLIAMS CREEK PROJECT
PROPOSED PILOT PLANT - FLOW SHEET



The test will be initiated by preparing a 24 hour supply of artificial raffinate with similar dissolved metals composition to the natural ones generated during the testwork. The raffinate will be mixed in the PLS pond and pumped through the extraction cells and onto the pile. Starting the test in this manner will accomplish two tasks. Loading the acid with metals will buffer the solubility of those metals from the ore and reduce the overall acid consumption of the test. Secondly, the extraction plant will be engineered to be efficient with PLS grades of 2 to 4 g/l copper. The initial PLS will grade as high as 10 g/l copper. Having some barren solution in the pond to dilute the PLS will help reduce the spike in copper grades while maintaining good plant efficiencies.

In general, the pilot plant operates as three closed loops of distinct fluids. In the first loop, PLS is collected, run through the extraction process where copper is removed from solution, and the raffinate (barren solution) returned to the top of the ore pile. In the second loop, a petroleum based organic solvent is diluted in an immiscible liquid (Kerosene). The organic is highly selective in extracting only copper from the PLS. In the third loop, the copper is stripped from the organic by contacting it with concentrated sulphuric acid. The barren organic is then returned to the extraction cells. Rich electrolyte, the product of the stripping stage, is used to produce pure copper by the process of electrolysis in the electrowinning plant. The lean electrolyte will be returned to the stripper tanks.

Prior to solvent extraction, the heap leach solution will be clarified for the removal of suspended solids by pumping it through a filter cartridge, then into a SX feed surge tank. The clarified solution will be pumped from the SX feed surge tank through two stages of extraction. During extraction, the SX feed solution containing copper will be contacted with an organic extractant such as Acorga M5640 in kerosine. The contact takes place in a mixer in which copper is transferred into the organic extractant to produce a loaded organic. Typical mixing times are 20 to 30 seconds. The organic/aqueous dispersion flows into a settler where it coalesces and separates into two phases. The aqueous phase depleted in copper will be recycled to the heap leaching operation.

The loaded organic phase will be pumped through one stage of stripping for removal of copper. The stripping process involves contacting the loaded organic phase with the strip solution containing 200 g/l h_2SO_4 at 40°C. The rich electrolyte will be treated in a laboratory scale electrowinning cell for production of copper metal. The lean electrolyte will be recycled to the strip circuit.

At the completion of the leach test, up to 30,000 litres of raffinate will require treatment and disposal. The solution will be aerated to oxidize any ferrous iron to ferric. Hydrated lime will be added to neutralize the solutions. Ferric iron sulphate and aluminum sulphate will be the main compounds precipitating. Iron sulphates are strong scavenger compounds which will increase the removal of other metals from solutions. Comparison assays of acidic raffinate versus neutralized raffinate are given in Appendix 2.

The neutralized raffinate will have metal contents acceptable for mine drainage regulations and current drinking water guidelines. However, copper levels will remain ten times higher than that considered toxic for fish. The liquids will require dilution prior to discharge. The most appropriate site would be in the village of Carmacks, sewage lagoon. Once in the lagoon, normal evaporation and percolation would take place. Discharge would be in those volumes recommended by village of Carmacks officials.

A second objective of the test will be to demonstrate cold weather operation. In December, irrigation will be resumed using only fresh water. Fresh water and the raffinate have similar freezing points, therefore, there would be no advantage to using acid. The water will be heated to 15°C, which is the approximate temperature the raffinates in the actual operation will be heated to. Heat loss through the top of the pile and collection pond will be monitored daily. The collection pond will be protected from freezing by being covered with two layers of insulated swimming pool cover. Irrigation will continue for one to two months, monitoring for two to four months.

Phase IV will be the reclamation of the site. In the spring of 1994, the crib will be taken down and examined for fluid channelling, sulphate precipitation and frost penetration. All of the material will be removed and the site returned to its original condition.

MATERIAL HANDLING

Materials involved in the pilot test which may be classed as industrial or hazardous materials will include:

1)	Concentrate Sulphuric Acid 20,000 lbs 9,000 kgs	
2)	Organic Solvent Extraction Reagents 220 lbs 100 kgs	
3)	Kerosene Dilutant 650 gal or 3030 litres	
4)	Hydrated Lime 2000 lbs or 900 kg	
5)	Aluminum Sulphate	440 lbs or 200 kg
	Iron Sulphate	220 lbs or 100 kg

The concentrated acid will be shipped in an approved container which will be left on site for the duration of the test. The container will be secured in such a way as to prevent public access to the material. Only persons who have been trained in the safe handling of the acid will be allowed access to it. All material handling will be in accordance with practised industry standards. Emergency and safety equipment will be supplied and stationed in accordance with government regulations.

Organic solvent extraction liquids are petroleum derivatives of formulated organic chemicals based on 5-nonyl salicyladoxine. They contain 4 nonylphenol and a small quantity of hydrocarbon solvent to reduce the visocity of the product. They are not classed as flammable, but will burn if involved in a fire and will emit noxious or toxic fumes. Technical description of the product is provided in Appendix I.

The organic solvent is diluted to 15 volume percent in technical grade kerosene (Esso product "Escaid 100"). The kerosene and solvent will be shipped and stored in 225 litre drums. The drums will be stock piled in a secured area with approved fire fighting equipment available on site.

Hydrated lime will be shipped in 22.5 kg (50 lb) sacks. The lime will be put into dry storage. It will be available to neutralize any acid spills which may occur over the duration of the test.

Artificial raffinate will be prepared by dissolving the iron and aluminum sulphates in acid prior to the start of irrigation. The material will be shipped in 25 kg sacks and put into dry storage on site.

PERSONNEL

Equipment and labour required for the project are listed below:

TABLE 1

ACTIVITY EQUIPMENT	LABOUR	MAN DAYS
Mining - Excavator - Air Track	1 Blaster & Helper 1 Operator	30
Trucking - 2 x 10 ton trucks	2 drivers	20
Construction - Excavator	1 Operator 1 Carpenter 1 Plumber 1 Electrician 1 Supervisor 2 Helpers	65
Leaching	1 Engineer 3 Technicians 1 Metallurgist 1 Consultant	420
Cold Weather Operations	1 Technician 1 Supervisor	140
Decommissioning - 1 Excavator - 1 Truck	1 Supervisor 2 Operators	25
TOTAL		460

Mining, trucking and construction activities are scheduled for July. Leaching will begin in early August and run through to October.

Local labourers and contractors will be used as much as possible. Supervisory positions will require specialized training and will be contracted through Lakefield Research. The remaining technician positions will use local labour where applicable. Once the operation has stabilized, schools and local organizations will be encouraged to tour the project.

PRECIOUS METAL RECOVERY

As noted in the introduction, the No. 1 Zone contains 13.6 million tons grading 1.08% copper and 0.014 ounces per ton gold. Highgrade sections of the deposit average up to 0.024 ounces per ton gold. This is a significant potential resource which by current technological standards is unrecoverable. As it has been omitted from any economic analysis of project.

Western Copper recognised the economic potential of recovering this precious metal and initiated a search for a lixiviant compatible with sulphuric acid copper leach. To date, results have been mixed using several different reagents. Although some lixiviants have been found which work in bench scale tests, none were applicable for larger scale testwork.

Precious metal recovery has for the time being been purposely omitted from this pilot plant application. A substantial amount of additional laboratory work is required before any process can be considered for incorporation into the test.

CONCLUSION

The proposed test heap-leach/pilot plant project will satisfy criterion for the feasibility study permitting and project financing. Confidence in the laboratory studies and operational expertise increase dramatically with the size of the test. Operating a pilot plant is an environmentally low risk way of confirming all of the preliminary test details while providing solid financial information.

Secondly, a pilot plant can act as a catalyst for increasing public awareness and education about a project. Many mines receive undue criticism, not because of inadequate planning or engineering but rather, due to poor communication between the operating company and the general public. By running a large scale working model of the project, the public will be able to see first hand the mechanics of the proposed mine. This knowledge will provide a term of reference for the public, Government, and Water Board members when reviewing any subsequent proposal for the mine itself.

The pilot plant study is part of the progression of evaluating a mineral deposit. It can be omitted from the feasibility study process, however, by completing the test an invaluable amount of information will be obtained at relatively low risk. This information will be available for other projects with similar metallurgy. This alternative technology would allow them an opportunity to diversify away from conventional milling techniques, possibly having significant impact on the viability of these projects. Once the pilot plant has been completed, confidence in the technology will have been demonstrated and will be independent of the economics of the Williams Creek project.

APPENDIX I

PILOT PLANT STUDY
PROPOSED BUDGET

PILOT PLANT STUDY
PROPOSED BUDGET

Excavation of 200 Ton Sample	
- Cat Time 150 hrs @ $100	15,000
- Drilling and Blasting 50 hrs @ $300	15,000
- Assaying of Cuttings - 200 @ $20	4,000
- Equipment Mob-Demob	5,000
- Trucking to Carmacks 250 tons @ $8	2,000
- Supervision 14 days @ $350	5,000
	46,000
Site Preparation	
- Supervision 17 days @ $350	6,000
- Cat Time 32 hrs @ $125	4,000
- Plastic Liner (Double)	
- Acid Resistant	6,000
- Labour	4,000
- Crib	
- Materials	4,000
- Labour	5,000
- Plumbing	
- Supplies	1,000
- Labour	3,000
- Electrical	
- Supplies	1,000
- Labour	3,000
- Fencing	3,000
	40,000
Sample Preparation	
- Equipment Set-up	5,000
- Blending, Crushing, Conveying	2,500
- Acid Pretreatment - Labour	3,000
- Equipment Mob-Demob	10,000
- Temperature, Ph/Eh Probes	2,500
- Supervision - 10 days @ $350	3,500
	26,500

90 Day Leach Test

- Labour	
- On site engineer 1 x 120 days @ $750	90,000
- Technicians 3 x 90 days @ $250	67,500
- Metallurgist 5 days @ $600	3,000
- Consultant (Lakefield) 31 days @ $1000	31,000
- Room and Board 360 days @ $100	36,000
- Acid - 10 tons @ $500 F.O.B. Carmacks	5,000
- Power	5,000
- Pilot Plant Rental 3 Months @ $4000	12,000
- Copper Sulphate Disposal	1,000
- Trucking Water	200
- Acid Tanker Rental 3 months @ $2,000	6,000
- Environmental Tests	5,000
- Duplicate Column Tests	40,000
- Air Fare	10,000
- Truck - Rental & Fuel 120 days @ $70	8,400
	320,100

Cold Weather Operations

- Labour 120 days @ $200	24,000
- Propane	2,000
- Supervision 20 days @ $350	7,000
	33,000

Site Decommissioning

- Hydrated Lime 2000 lbs	2,000
- Trucking	
- Neutralized Raffinate	200
- Leached Ore	1,500
- Raffinate Precipitate to Faro	1,000
- Cat Time 20 hrs $125	2,500
- Labour 2 x 14 days @ $250	7,000
- Supervision 16 days @ $350	5,600
	19,800

WESTERN COPPER EXPENSES	20,000
	505,400
SAY	500,000

k\lwalton.doc

APPENDIX 2

PROPOSAL TO OPERATE THE PILOT PLANT FOR THE WILLIAMS CREEK PROJECT BY LAKEFIELD RESEARCH

LAKEFIELD RESEARCH

185 Concession Street, Postal Bag 4300, Lakefield, Ontario, K0L 2H0

Facsimile No. (705) 652-6365
Telephone No. (705) 652-2024

To: Mr. Ken McNaughton

From: Steven Webster

Date: March 15th, 1993

Company: Silver Standard Inc.

Fax No: 604-689-3847

Project No. Cu SX/EW Pilot Plant

This transmission consists of __ 5 __ pages including this one.

Thank you for the opportunity given to Lakefield Research to submit a proposal for the supply and operation of a solvent extraction/electrowinning pilot plant for the Williams Creek copper oxide project in Carmacks, Yukon.

A new solvent extraction/electrowinning pilot plant, specifically sized for the 16 m^2 heap leaching test, will be constructed at Lakefield and shipped to the Yukon. Our trained engineers will set up the plant on site and operate it 24 hours per day throughout the 3 month test. I will act as the Project Leader with overall supervision and coordination of the SX/EW pilot plant. I will be available for travel to the site at least three times during the project.

The total estimated cost, including the equipment, travel expenses, and our charge out rate for the engineers is $167,100. A prepayment of $25,000 will be required as a deposit, and credited to our monthly billing. The deposit will cover our start-up costs for construction of the SX/EW pilot plant and air fares to the Yukon. Please do not hesitate to contact me, if you would like further discussions regarding the proposal.

Regards

Steven Webster
Metallurgist - Hydrometallurgy

SAW:jm

p.c. - CJF
SAW
BJS
Master

LAKEFIELD RESEARCH

Proposal to Supply and Operate an SX/EW Pilot Plant for the Williams Creek Copper Oxide Project

Lakefield Research
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185 Concession Street
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Telephone - 705-652-2000
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Steven Webster
Metallurgist - Hydrometallurgy

Cesar Joe Ferron, Ph.D.
Manager - Hydrometallurgy

INTRODUCTION

This proposal is for a programme to supply and operate a solvent extraction/electrowinning pilot plant, for a large scale heap leaching test, on Williams Creek copper oxide ore at Carmacks, Yukon. The pilot plant will continuously produce a representative raffinate to be recycled back to the test heap. Copper from the purified strip liquor will be electrowon, producing cathode grade copper for product evaluation. The Proposal is based on information provided by Mr. Ken McNaughton of Silver Standard Resources Inc., during a telephone conversation on March 12, 1993.

Heap Leaching

The design, construction and operation of the 200 tonne test heap will be the responsibility of the client. The heap will have an area of 16 m^2 and an irrigation rate of 14L/h/m^2 (0.005 imp. gal./min/ft^2). The heap leaching test will produce 3.7 L/min of pregnant leach solution containing approximately 3 g/L copper.

Solvent Extraction

A new SX pilot plant, specifically sized for this application, will be constructed at Lakefield and shipped to the site. The pilot plant will consist of 2 extraction and 1 stripping stages. All auxiliary equipment including mixer motors, pumps, tubing will be supplied with the pilot plant. The retention time in the mixers will be at least 2 minutes and the settler will have a specific flowrate capacity of 3.2 $m^3/h/m^2$.

Electrowinning

An electrowinning cell will be constructed at Lakefield and supplied for the project. The electrowinning cell and power supply will be capable of plating 100% of the copper produced from the solvent extraction plant. The cell will consist of 12 stainless steel cathodes, having a total plating area of 2.5 m^2 and 13 lead alloy anodes. The cell will be operated at approxiamtely 24 amps at 30 volts from Lakefield Research's 0 - 30 amp, 0 - 120 volts power supply. Approximately 1900 kg of cathode copper will be produced during the test.

Personnel

The SX/EW pilot plant will be operated and supervised by Lakefield Research personnel. Three technicians will be provided by the client, from the local labour force in the Yukon, to assist in the operation of the plant. At least one senior technologist from Lakefield Research will be on site during the 3 month test working 10 hour days. The technologists, to be rotated after 6 weeks, will include Warren Reishus and Steve Ackerman. They will be responsible for the day to day operation of the SX/EW pilot plant and for copper and sulphuric acid determinations on the pregnant leach solution, raffinate, rich electrolyte and spent electrolyte. The project will be supervised by Steven Webster, Metallurgist - Hydrometallurgy, who will act as Project Leader, retaining overall responsibility for solvent extraction/electrowinning aspects of the project. The project leader will visit the site for 3 seven day periods (during start-up, changing of the technologist, and plant shutdown) and will be available at Lakefield for consulting and reporting. Chris Fleming, our Vice-President and General Manager and Joe Ferron, our Manager, Hydrometallurgy, will be available and retained as consultants.

COST ESTIMATE

1.	SX/EW Pilot Plant Rental	$ 2,000 per month	$ 6,000
2.	Operation of SX/EW Pilot Plant		
	Onsite: Senior Technologist 1 x 120 day at $750		90,000
3.	Supervision of SX/EW Programme		
	On-site: Hydrometallurgist (Project Leader) 1 x 21 days		21,000
	At Lakefield: supervision, consultation and reporting		10,000
4.	Travel and shipping expenses		
	5 return flights at $2,200 each		11,000
	Living expenses $100 per person for 120 + 21 days		14,100
	Transportation of Equipment		5,000
5.	Contingency		10,000
	Total Estimated Cost (GST not included)		$ 167,100

APPENDIX 3

TECHNICAL INFORAMTION
ACCORGA
SOLVENT EXTRACTION REAGENTS

Replaces MC 2.80 which should be destroyed

acorga

Product Description and Physical Data

ACORGA P-5100

The product contains 48·0 ± 1·0% by weight of 5-nonyl salicylaldoxime, calculated on 100% oxime as determined by copper uptake. It contains 4·75% by weight of 'Escaid' 100; the balance is 4-nonyl phenol.

Physical Data

Appearance:	Clear, amber-coloured liquid, free from visible impurities.
Specific gravity (25°/25°C):	0·97 – 0·98
Viscosity (cP at 25°C):	*not more than* 2000
Flash Point (°C):	*not less than* 62
Pour Point (°C):	−2 *(approx.)*

Performance Specifications

Property		*Units*	**ACORGA P-5100**
Copper uptake		g/l per v/o	0·554 to 0·577
Extraction kinetics (approach to equilibrium at 25°C)		% %	not less than 85 in 15 sec not less than 95 in 30 sec
Strip kinetics (approach to equilibrium at 25°C)		%	not less than 95 in 15 sec
Copper extraction isotherm point at 25°C			
	Organic	g/l	not less than 4·5
	Aqueous	g/l	not more than 1·5
Copper strip isotherm point at 25°C			
	Organic	g/l	not more than 2·4
	Aqueous	g/l	not less than 32·5
Copper/iron selectivity			not less than 500
Phase disengagement			
	Extraction	sec	not more than 60 clean sharp interface
	Strip	sec	not more than 60 clean sharp interface
Complex solubility at 0°C after 24 hours			No precipitation

[§] Product information on Acorga P-5300 may be obtained on application.

Standard Methods of Test

The standard methods used for confirming that **Acorga** P-5100 conforms to the above specification are set out in Technical Information MC 3.80 along with details of analytical test methods used for determination of copper and iron.

Safety, Storage, Handling

Hazard data and information relating to storage and handling are contained in Technical Information MC 4.80.

Packaging

Acorga P-5100 is packed in polyethylene-lined metal drums each containing approximately 200 kg net.

acorga

Technical staff of Acorga Limited will be pleased to discuss specific projects with individual customers on a confidential basis and enquiries may be made directly to:

ICI Americas Inc
Technical Service Center
(Products of Acorga Ltd)
postal address: PO Box 1431
Phoenix, Arizona 85001
USA
street address: c/o Van Waters & Rogers
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acorga

Product Description

Acorga P-5000 Series products are formulated organic chemicals based on 5-nonyl salicylaldoxime. They contain 4-nonyl phenol and a small quantity of hydrocarbon solvent ('Escaid',100) to reduce the viscosity of the products at normal storage temperatures to a level consistent with easy handling. The pour point of the products is of the order of -2°C and the residual volatile organic matter is controlled during manufacture to ensure that the flash point (Pensky-Martens closed cup) is not less than 62°C.

Health Considerations

Ingestion of **Acorga** P-5000 Series products will cause only slight effects unless large amounts are swallowed. The Acute Oral LD_{50} lies between 200mg/Kg and 2000mg/Kg and a probable lethal dose in the human body might be about 100g. They are severe skin irritants and contain 4-nonyl phenol which has been shown to cause vitiligo (skin bleaching). They are moderate eye irritants; inhalation of vapours may cause headache and stupor.

Ingestion, inhalation of vapours and prolonged contact should be avoided by good standards of industrial hygiene and by the use of suitable protective clothing including gloves and eye protection and the provision of adequate ventilation. A concentration in the atmosphere of 100ppm has been suggested as the highest value that should be accepted in an enclosed working environment.

First Aid Procedure

Skin: Contamination of the skin should be removed promptly by copious irrigation with clean water. Contaminated clothing should be removed and laundered before re-use.

Eye: Contamination of the eyes should be removed promptly by copious irrigation with clean water continuing for at least 15 minutes. Medical attention should be sought as soon as possible.

Ingestion and Inhalation: Symptomatic treatment.

Fire and Explosion

Acorga P-5000 Series products are not classed as flammable, but will burn if involved in a fire and will emit noxious or toxic fumes. If necessary, fire fighters should use breathing apparatus. Normal extinguishing media, i.e. water mist, foam, dry chemicals and CO_2 may be used. They are incompatible with oxidising materials; hazardous polymerisation will not occur.

Spillages and Disposal

Spillages should be absorbed on to sand, sawdust or earth and swept up for disposal. The area should be washed with copious amounts of clean water.

Disposal is notifiable in the United Kingdom under the regulations made under the Deposit of Poisonous Wastes Act, 1972. Disposal is normally achieved by burying on an approved tip or burning under carefully controlled conditions.

E.P.A. Registration

Components of **Acorga** P-5000 Series products have been registered with the U.S. Environmental Protection Agency (E.P.A.) under the Toxic Substances Control Act (TOSCA) regulations, and, as such, will appear on the amended E.P.A. inventory. 5-nonyl salicylaldoxime may be identified by its C.A.S. number 50849-47-3 and 4-nonyl phenol by its C.A.S. number 25154-52-3.

Recommended Storage Practices

The products are stable under normal conditions of transport, storage and use. However as a matter of good housekeeping and to avoid unnecessary problems:-

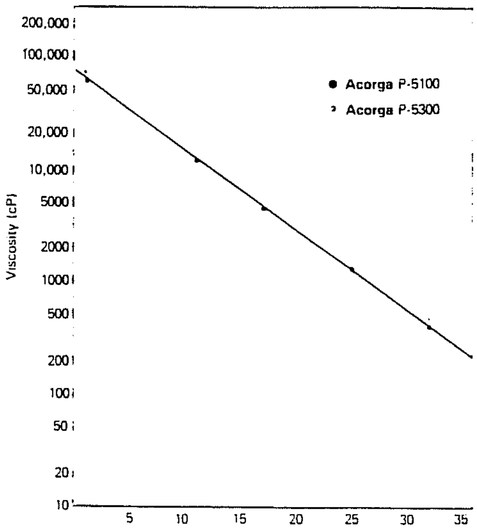
- Drums should be protected from external attack by corrosive liquids.
- Storage in direct sunlight for prolonged periods should be avoided. If this cannot be conveniently arranged, bungs should be eased during the hottest weather to avoid the effects of pressure build-up on drum linings.
- Storage at low temperatures will not affect the performance of reagents but, if frozen, products should be brought slowly up to 10°C before use.

Product Handling

Acorga P-5000 Series products are packed in polyethylene-lined metal drums each containing approximately 190Kg net. The drums are sealed with a single screw bung 45mm in diameter at one end. At normal ambient temperatures (greater than 10°C) the products are readily pourable liquids and drums may be emptied in a straightforward manner. Any small amount of residual product may be emptied by rinsing the drums with an appropriate hydrocarbon diluent, for example, that in use in the solvent extraction plant.

Below 10°C the viscosity of the products increases (Fig. 1) and the application of gentle heat may be necessary to ensure complete removal of the product from the drums. A simple method of doing this might be to cover the drums with a tarpaulin and to inject live steam under the tarpaulin for about an hour to bring about the necessary viscosity reduction.

Fig. 1
Viscosity Vs Temperature



Note

1. The above statements apply only to the **Acorga** P-5000 Series products. In practical industrial situations these products are invariably used in organic diluents. The toxicity and handling precautions for these diluents should always be checked with the manufacturers.

2. Where there is any reference to United Kingdom legislation in this note, customers elsewhere are advised to consult their local regulations.

Technical staff of **Acorga** Limited will be pleased to discuss specific projects with individual customers on a confidential basis and enquiries may be made directly to:-

ICI Americas Inc
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Phoenix, Arizona 85001
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Phoenix, Arizona 85043
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c/o ICI Ltd
Organics Division
PO Box 42
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Blackley, Manchester M9 3DA
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PO Box 650
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Extraction processes using **Acorga** P-5100 and **Acorga** P-5300 are the subject of United States patent 4,142,952 (Imperial Chemical Industries Limited) and the oxime formulated therein is the subject of United States patent 4,020,106 (Imperial Chemical Industries Limited).

Corresponding patents or pending applications also exist in many major mining countries.

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APPENDIX 4

COMPARISON ANALYSIS
ACIDIC RAFFINATE
VS
NEUTRALIZED RAFFINATE

ICP REPORT

Project No: 92-006B
Client: Silver Standard Resources Inc.
Project Name: Williams Creek
Samples: Raffinate and neutralized raffinate from leach test L19 (+27H, 3/4 inch, 20 g/L H2SO4).
Raffinate at pH 1.8 was neutralized in a stirred tank reactor for 1 hour with slurried lime under aerated condtions, to pH 7.0.

Report Date: July 3/92

Results:

Sample Descr	Mo	Cu	Pb	Zn	Ag	Ni	Co	Mn	Fe	As	Hg	Sr	Cd	Sb	Bi	V	Ca	P	Cr	Mg	Ba	Ti	B	Al	Na	Si	W	Be
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Raffinate	0.074	1.791	0.07	8.950	0.021	0.743	0.960	4.320	1274	0.12	<.02	2.113	0.122	0.49	<.05	3.112	458.2	52.51	0.264	350.5	0.171	0.113	N/A	574	32	340	0.03	0.134
Neutr. Raffinate	0.022	0.037	<.02	0.133	0.008	0.020	0.008	2.020	2.92	0.02	<.02	0.941	0.015	0.05	0.05	0.008	529.5	8.46	0.009	374.2	0.094	0.030	N/A	0.22	34	0.79	<.02	0.001

APPENDIX 5

TOXICITY TEXT DETAILS
AFFECTS ON BACTERIA ACTIVITY
OF NEUTRALIZED RAFFINATE

Environmental Services for
Industry and Government

Vancouver, Canada
Seattle, U.S.A.

EVS ENVIRONMENT
CONSULTANTS

Our File: 9/576-01

July 2, 1992

Mr. Ken McNaughton
Exploration Manager
Silver Standard Resources Inc.
Suite 900 - 850 West Hastings
Vancouver, B.C.
V6C 1E1

Dear Sir:

Re: Microbial Toxicity Test of Treated Mine Effluent

Please find attached the results of the above toxicity test.

Neutralized raffinate was tested at concentrations ranging from 8% - 82% for effects on respiration of sewage microbes. The rate of respiration was unaffected by this solution, even at the highest concentration tested. The treated mine effluent is not expected to be toxic to sewage microbes under the test conditions in the above concentration range.

I trust the results of this test are satisfactory. Please do not hesitate to contact me, should you require further details.

Yours truly,

EVS CONSULTANTS

André Sobolewski, Ph.D.
Microbiologist

ABS/abs

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Seattle, WA
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PRINCIPLE OF THE TEST

The test determines the effect of an effluent on the respiration of sewage microbes under standardized conditions. The rate of CO_2 production, a direct measure of overall microbial respiration, is measured for increasing levels of effluent and is compared with control levels (no effluent) to calculate toxicity. The presence of a toxicant should reduce microbial respiration in a dose-dependent manner. Any toxic effect should be detectable within one hour, but the test is run for 6 hours to accurately assess respiration rates.

MATERIALS AND METHODS

Neutralized raffinate (1.2 Litre) was received from PRA on June 29th, 1992. The solution was kept at room temperature until used for the toxicity test on the following day. Sewage sludge was obtained from the Lion's Gate Wastewater Treatment Plant. It was used in the test within 2 hours of sampling.

A sterile glucose solution was prepared to provide sewage microbes with a source of nutrient (carbon source). Glucose was added to a final concentration of 3 g/L in the test. A sterile solution (HCM media) providing additional macronutrients was also added to all test solutions. This solution had the following composition:

Monopotassium Phosphate	1.36 g
Dipotassium Phosphate	1.42 g
Ammonium Nitrate	1.1 g
Magnesium Sulfate	0.05 g
Calcium Chloride	0.01 g
Distilled water	800 mL

The method used for assessing microbial activity was originally described by Bartha and Pramer (1965)[1], and it has since been incorporated in other officially-recognized methods, such as U.S. EPA protocol § 796.3100 - Aerobic aquatic biodegradation. The raffinate, sewage sludge and nutrients were all added to "Biometer flasks", which consist of 250 Enlermeyer flasks modified with a side-arm addition which serves as an alkali (0.2 N KOH) reservoir to trap CO_2 produced by sewage microbes (Shown in Appendix A). A septum in the side-arm allows for the removal of the alkali solution, and the flask has a septum with an Ascarite column that maintains CO_2-free aerobic conditions within the flask. The CO_2 trapped in the KOH solution was measured by titrating a $BaCl_2$ precipitate of this solution with HCl to the phenolphthalein end-point. All standard reagents used in this test were prepared in CO_2-free water.

Each flask received a total volume of 50 mL solution, composed of the standard solutions, sewage sludge, and 41 mL of a dilution series of the effluent made up distilled water, as indicated below. Their proportions follow a logarithmic dilution series.

Dilution	Water	Effluent	Sewage	Glucose	HCMM
0% (Control)	41 mL	0 mL	2.5 mL	2.5 mL	4 mL
8%	37 mL	4 mL	2.5 mL	2.5 mL	4 ml
13%	34.3 mL	6.7 mL	2.5 mL	2.5 mL	4 mL
25%	28.4 mL	12.6 mL	2.5 mL	2.5 mL	4 mL
45%	18.5 mL	22.5 mL	2.5 mL	2.5 mL	4 mL
82%	0 mL	41 mL	2.5 mL	2.5 mL	4 mL

[1]Bartha, R. and D. Pramer. 1965. Features of a flask and method for measuring the persistence and biological effects of pesticides in soil. Soil Science 100: 68-70.

The flasks containing the test solutions were sealed and incubated at room temperature. They were agitated sufficiently to ensure that respiration was not limited by lack of oxygen in solution.

At intervals of 1.5 hours — over a 6 hour period — the KOH solution was withdrawn from each flask and titrated for CO_2. Fresh KOH was then replenished to trap CO_2 for the next sampling. The volume of HCl required for the titration was subtracted from a reagent blank, and the resulting value was multiplied by 25 to convert mL HCl into μmoles CO_2, as indicated below. The rate of CO_2 production was determined from a plot of CO_2 produced vs time.

RESULTS

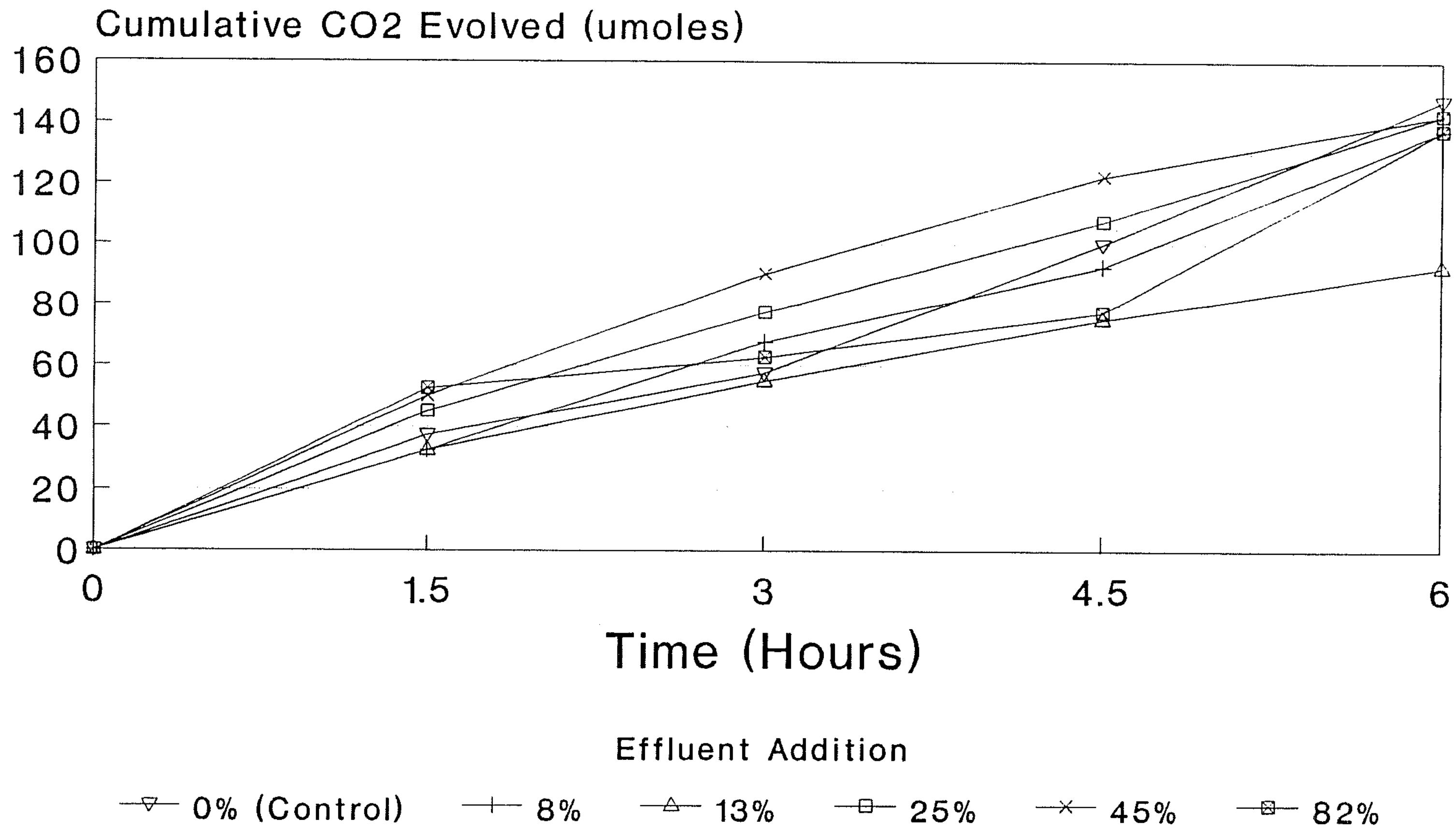
The rates of respiration measured in this test are plotted on the following graph. There are no significant differences in the respiration rate for different effluent dilutions compared with the control incubation, and no consistent dose-response curve can be calculated from these data. The raw data for the titration of CO_2 produced in the flasks are appended to this report.

The 15% dilution flask evidently had a lower respiration rate than the other flasks. The lack of any dose-response relationship in this test indicates that this result was not due to substances present in the raffinate. The result was probably caused by the heterogeneity of the sewage sludge used in this test: this sample likely received a clump of material which did not contain a lot of microbes, thus resulting in an overall reduced respiration rate.

In conclusion, the raffinate tested showed no sign of toxicity to sewage microbes in the concentration range of 8-82% under the test conditions.

EFFLUENT TOXICITY TEST

Inhibition of Microbial Respiration



:30 hr
4:00 PM
:30 PM

Date	Sample	m/s HC1 added	
	Blank		
	Control	34.3 - 16 =	18.
	9%	52.8 - 34.3 =	18.
	15%	71.3 - 52.8 =	18.
	28%	91.0 - 73.0 =	18
	50%	0 - 17.8 =	17.
	90%	35.5 - 17.8 =	17.

3 hrs
5:30 PM

Date	Sample	m/s HC1 added	
	Blank		
	Control	0 - 19.0 =	19
	9%	37.4 - 19.0 =	18.
	15%	56.4 - 37.5 =	18.9
	28%	74.9 - 56.4 =	18.5
	50%	22.0 - 3.8 =	18.
	90%	41.4 - 22.0 =	19.

3/904-02
91/10/21

4:30 hr

7:00 PM

Date	Sample	m/s HCl added	
	Blank	56.3 - 36.5 =	19.
	Control	0 - 18.1 =	18.
	9%	36.9 - 18.1 =	18.[illegible]
	15%	56.0 - 37.0 =	[illegible]
	28 %	74.8 - 56.2 =	18.
	50 %	36.5 - 18.0 =	18.
	90 %	77.2 - 58.0 =	19.

6 hrs

8:30 PM

Date	Sample	m/s HCl added	
	Blank		
	Control	0 - 17.9 =	17.
	9%	35.9 - 17.9 =	18.
	15%	55.0 - 35.9 =	19
	28 %	52.1 - 33.7 =	18.
	50 %	71.4 - 52.4 =	19.
	90 %	88.8 - 71.4 =	17.

APPENDIX A

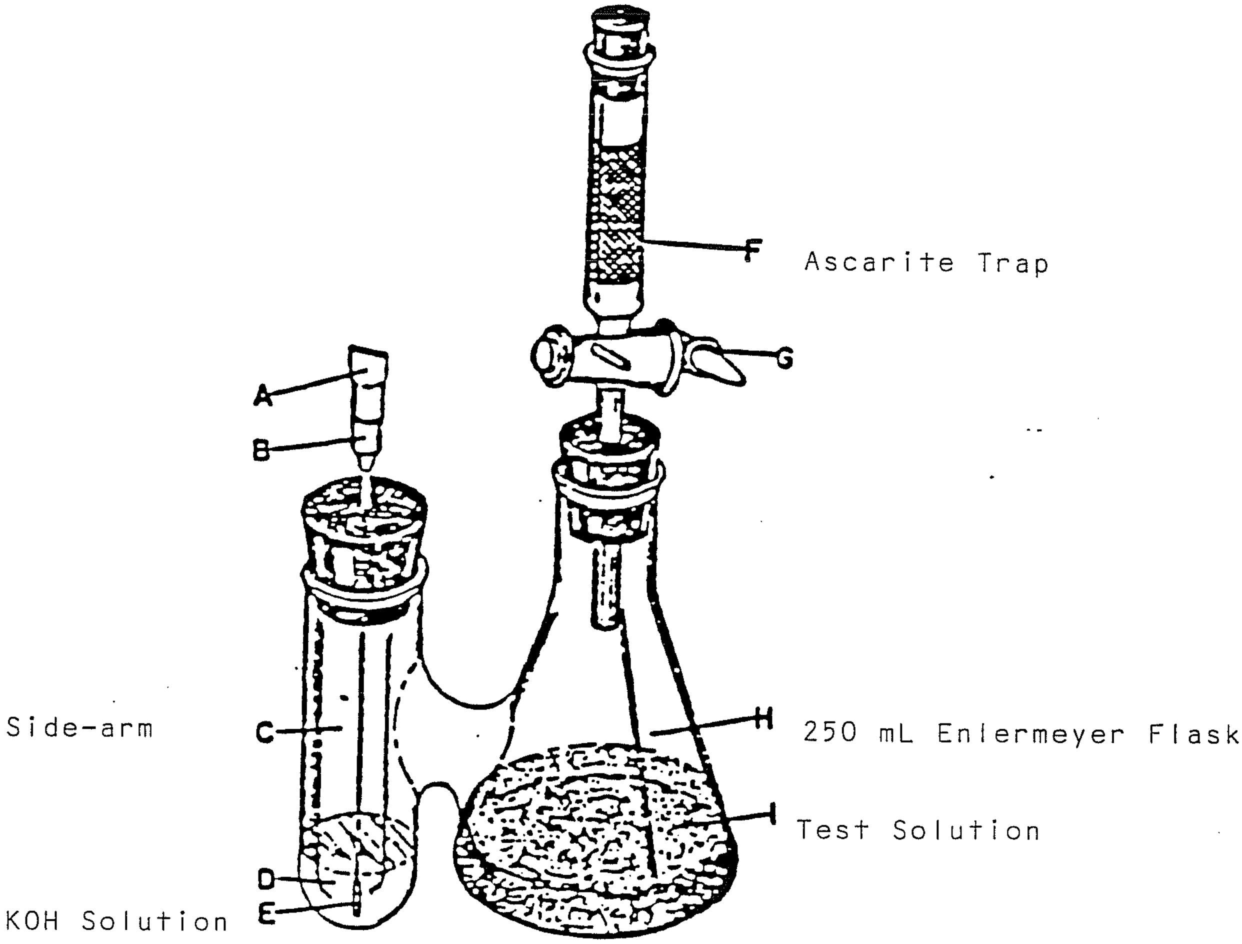


Diagram of a Biometer Flask