BIOLOGICAL TREATMENT OF TAILINGS SOLUTION

NICKEL PLATE MINE

Kutcho

Eskay Creek
Snip

Giant Nickel

Nickel Plate

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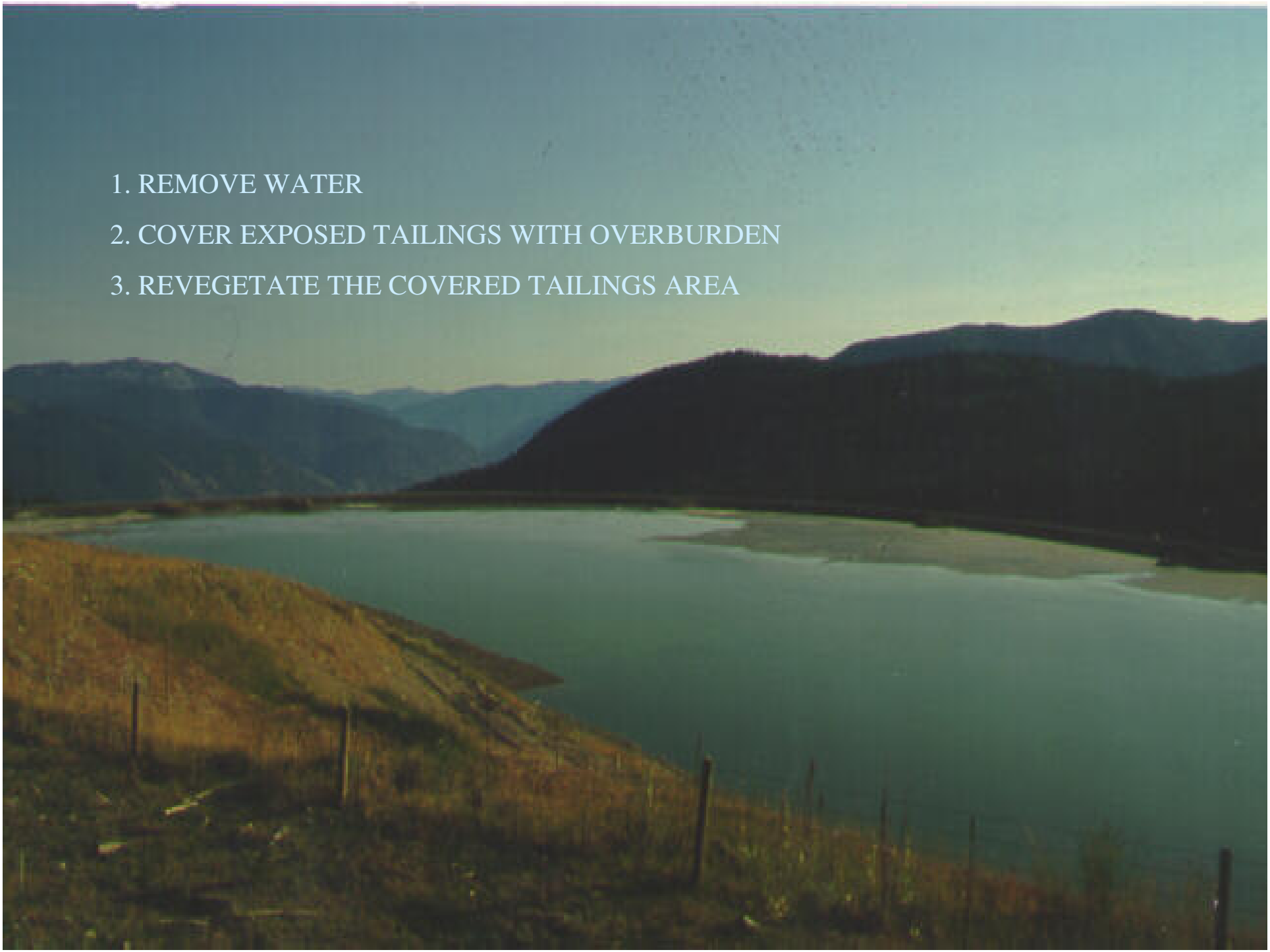
HISTORY OF NICKEL PLATE

- Mining started in 1899 - underground gold operation
- First of many closures in 1931
- Second boom period from 1934
- 1955 all operations ceased, mine fenced off and abandoned
- Comeback in 1980's due to high gold prices - official re-opening in 1987
- Operated for ~10 years as an open pit operation - closed mid-1996

WASTE ROCK
DUMPS
OPEN PIT
TAILINGS POND
MILL BUILDINGS
CANTY PIT (reclaimed)

RECLAMATION COMPONENTS

- Mill site / Infrastructure
- Pit Area Reclamation
- Waste Rock Dump Reclamation
- Tailings Pond Reclamation
- Nickel Plate Mine Creek Water Treatment
- Treatment and Release of Tailings Pond Water


1. REMOVE WATER
2. COVER EXPOSED TAILINGS WITH OVERBURDEN
3. REVEGETATE THE COVERED TAILINGS AREA

NICKEL PLATE MINE CREEK
HIGH NITRATES ARE REMOVED BY DENITRIFICATION
IN OUR WATER TREATMENT PLANT

TAILINGS WATER REQUIRED
TREATMENT BEFORE RELEASE
TO ENVIRONMENT

PARAMETERS REQUIRING TREATMENT

- Cyanide
- Thiocyanate
- Ammonia
- Nitrate
- Metals

WATER TREATMENT OPTIONS

- Breakpoint Chlorination
- Hydrogen Peroxide
- Inco SO2/Air Process
- Biological Treatment

Cyanide Treatment Comparison

	WAD Cyanide	*Thio - Cyanate*	*Ammonia*	*LC50*
Biological	Yes	Yes	Yes	Yes
Hydrogen Peroxide	Yes	Some	No	No
Chlorination	Yes	Yes	No	No
Inco/SO4	Yes	Some	No	No

PROCESS BIOCHEMISTRY

- Aerobic circuit
  - Thiocyanate → Ammonia, Sulphate, and Carbon Dioxide
  - Cyanide (WAD) → Cyanate → Ammonia
  - Ammonia → Nitrite → Nitrate

2 Anaerobic circuit
  - Nitrate → Nitrite → Nitrogen gas

EVALUATION OF BIOLOGICAL TREATMENT OPTIONS

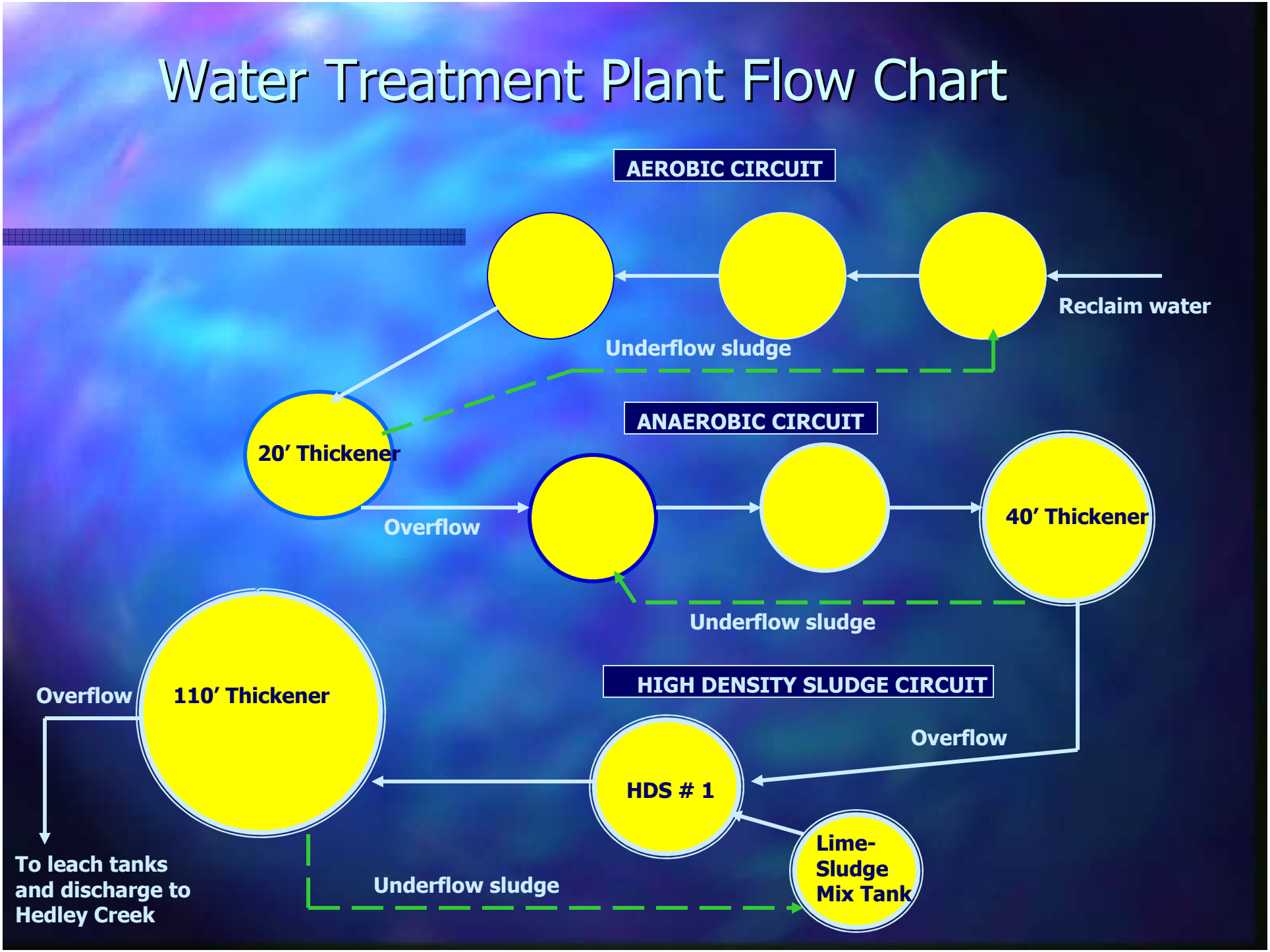
- "The Bug Palace"
- Activated Sludge Process
  - microorganisms in aeration tank remove waste
- Rotating Biological Contactors (RBC's)
  - microorganisms growing on rotating drum in tank remove waste

WATER TREATMENT PLANT
"Bug Palace"

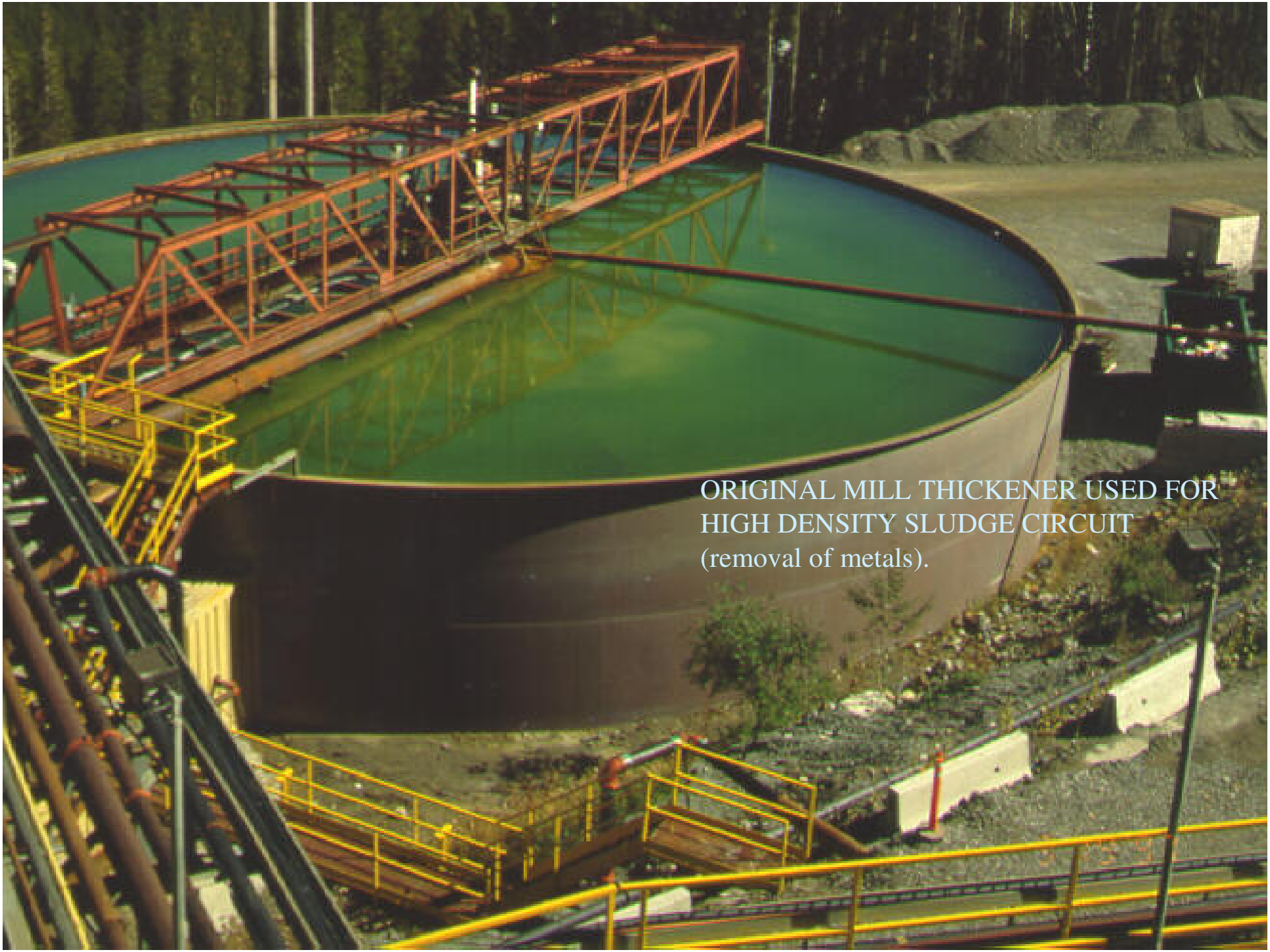
ACTIVATED SLUDGE
TANKS

ROTATING BIOLOGICAL CONTACTORS

Water Treatment Plant Flow Chart

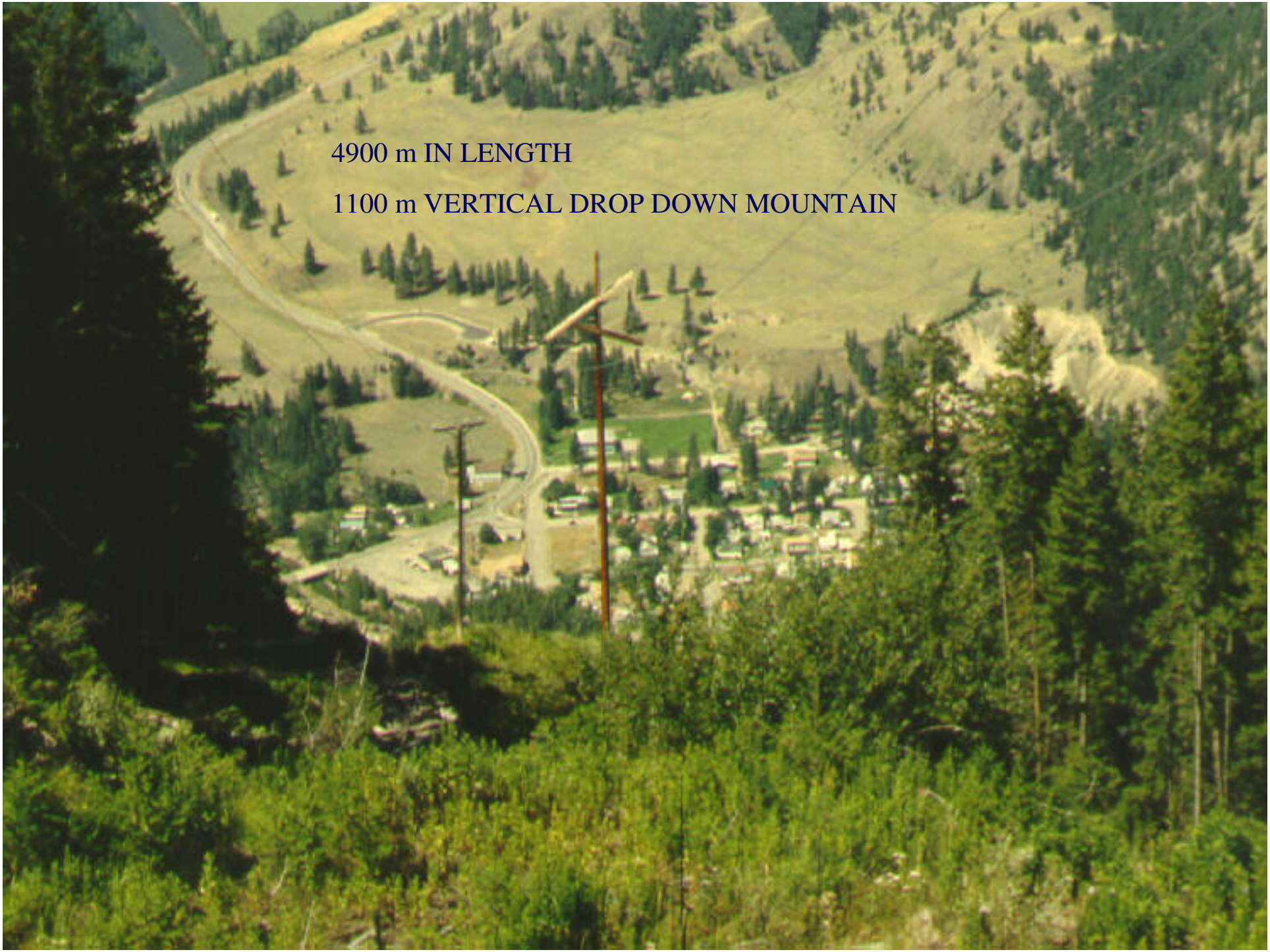


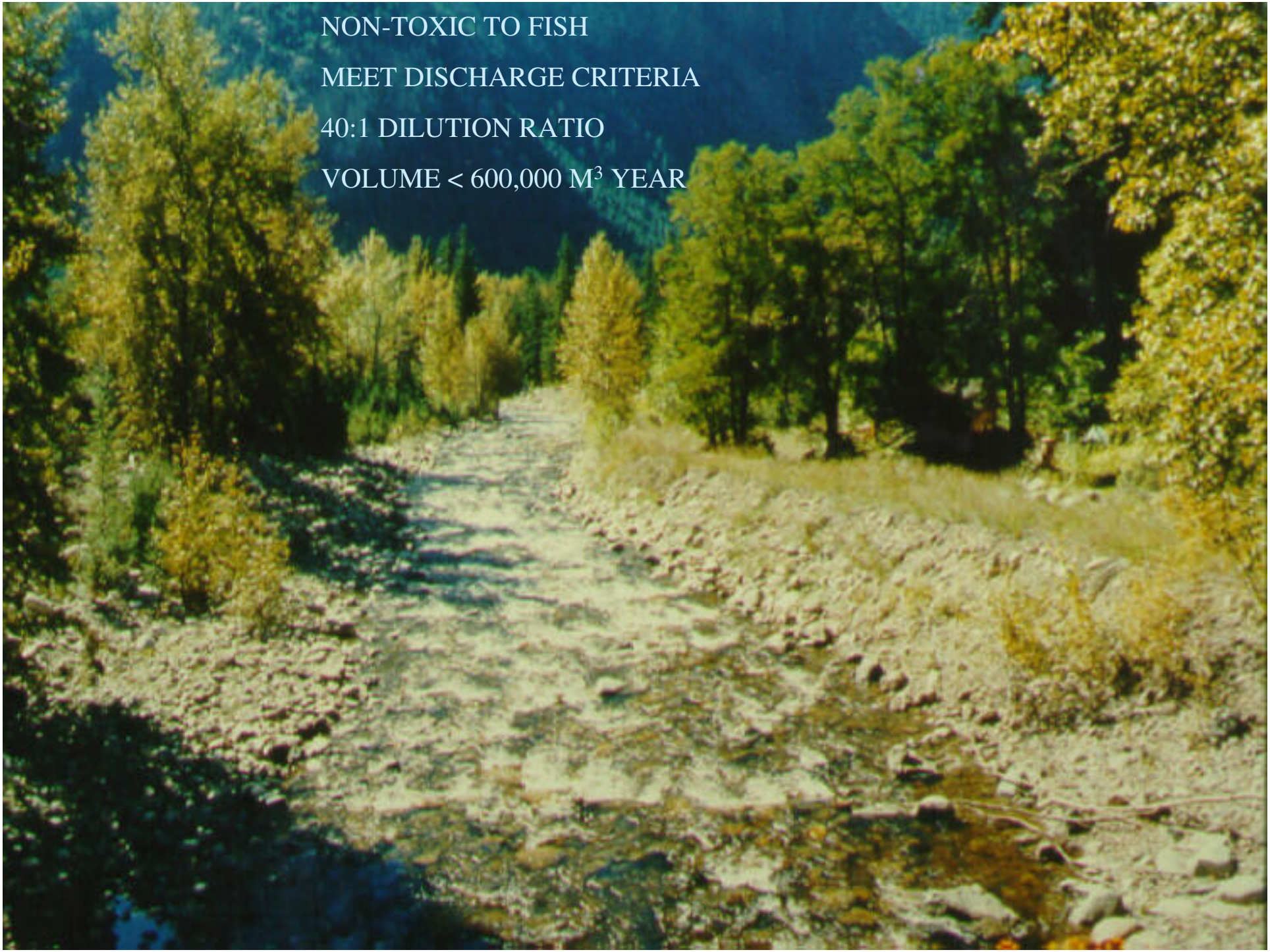
1. TRIM PROP BLADES
2. ADD DIFFUSERS
3. APPLY SPRAY FOAM INSULATION



ORIGINAL MILL THICKENER USED FOR HIGH DENSITY SLUDGE CIRCUIT (removal of metals).

9 19'97


4900 m IN LENGTH
1100 m VERTICAL DROP DOWN MOUNTAIN


NON-TOXIC TO FISH
MEET DISCHARGE CRITERIA
40:1 DILUTION RATIO
VOLUME < 600,000 M^3 YEAR

AVERAGE WATER QUALITY IN 1997

Parameter	Reclaim	Activated Sludge Circuit			Permit Criteria
Units mg/L unless noted	Influent	Aerobic Circuit Effluent	Anaerobic Circuit Effluent	HDS Circuit Effluent	Discharge to Hedley Creek
Volume Discharged - US Gallons/Year				126,215,209	
Flow - US Gallons/min		283.8		277.1	40:1 Ratio
pH - pH Units	7.3	7.9	7.3	8.18	7 - 10
Total Dissolved Solids	4497.0			4276.0	7500.0
Toyal Suspended Solids	9.8			11.6	
Cyanaide - Total	1.4	1.14	0.940	0.81	3.0 CNt + SCN
Cyanide - Wad	0.37	0.16	0.090	0.07	0.200
Thiocyanate - SCN	675.8	0.20	0.20	0.3	3.0 CNt + SCN
Ammonia - NH3 - N	54.4	0.20	0.20	0.40	1.0
Nitrate - NO3 - N	12.40	195.30	1.10	0.80	10.0
Sulphate - SO4	2548	3194	3146	2805	3500.0
Arsenic - Total	0.46	0.25	0.25	0.01	0.07
Arsenic - Dissolved				<0.01	
Cobalt - Dissolved	2.88	2.42	2.1	1.75	
Copper - Total	0.32	0.06	0.02	0.02	0.04
Copper - Dissolved	0.27	0.03	0.01	0.01	
Iron - Total	0.34	0.20	0.14	0.19	
Iron - Dissolved	0.07	0.05	0.06	0.05	0.50

* CNt + SCN

AVERAGE WATER QUALITY IN 2008

Parameter	Reclaim	Activated Sludge Circuit			
Units mg/L unless noted	Influent	Aerobic Circuit Effluent	Anaerobic Circuit Effluent	HDS Circuit Effluent	Overall % Removal
Volume Discharged - US Gallons/Year				79,267,433	
Flow - US Gallons/min		155.5		149.9	
pH - pH Units	7.72			8.27	
Total Dissolved Solids	2233.5			2414.4	
Toyal Suspended Solids	7.0			5.8	
Cyanaide - Total	0.458			0.285	37.8%
Cyanide - Wad	0.144			0.025	82.6%
Thiocyanate - SCN	277.05	0.02	0.02	0.02	100.0%
Ammonia - NH3 - N	18.370	0.057	0.041	0.076	99.6%
Nitrate - NO3 - N	4.391	70.668	0.048	0.359	91.8%
Sulphate - SO4	1076.2	1498.2	1431.5	1505.1	
Arsenic - Total	0.2798	0.1565	0.0590	0.0009	99.7%
Arsenic - Dissolved	0.2518				
Cobalt - Dissolved	0.6745	0.6187	0.5385	0.5382	20.2%
Copper - Total	0.0078	0.0071	0.0062	0.0053	32.1%
Copper - Dissolved	0.0058	0.0045	0.0031	0.0040	31.0%
Iron - Total	0.290	0.199	0.182	0.154	46.9%
Iron - Dissolved	0.045	0.022	0.026	0.022	51.1%

Combining biological processes with a high density sludge treatment

has been a successful and cost effective approach to water treatment at the Nickel Plate Mine .

START-UP PROBLEMS

- Lime Addition Malfunction
- Pipeline Freeze-up
- High Copper
- Scale on Inside of Tanks
- Ammonia Fluctuations
- Sulphuric Acid Malfunction