Proceedings of the 10th Annual British Columbia Mine Reclamation Symposium in Vernon, BC, 1986.
The Technical and Research Committee on Reclamation

RECLAMATION AT QUINTETTE COAL LIMITED

1982 - 1985

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INTRODUCTION

On December 1, 1983, the first unit train left the coal loadout at Quintette Coal Limited for Ridley Island, on schedule and 17 months after construction startup. This event was the culmination of work which began 14 years earlier.

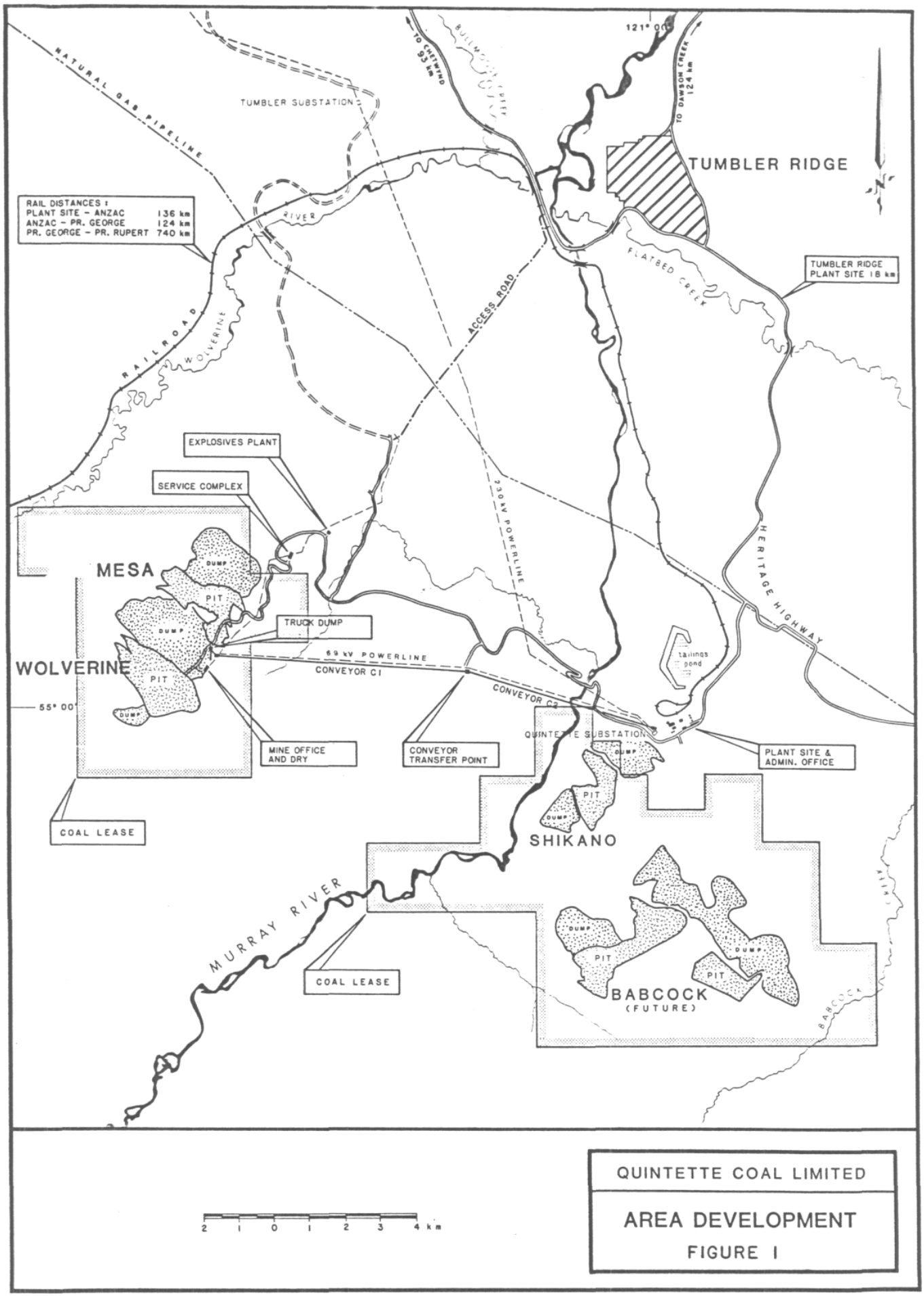
The original Quintette coal licences were acquired by Denison Mines Limited in 1969 and now consist of 202 licences which encompass 49,510 hectares (Figure 1). The estimated coal reserves in this area total 3.2 billion tonnes with 327 million of these being proven metallurgical product coal.

Currently only the Mesa and Wolverine pits are being mined with current production at 5 million tonnes of clean metallurgical coal. Mining methods are conventional truck/shovel operations with the coal hauled to a breaker station at the headworks of a 13.2 km conveyor which transfers the coal to the preparation plant (Figure 1).

In 1981 on February 10 a sales agreement with the Japanese Steel Industry was signed, and the initial service contracts were awarded in July. Later that year camp and access construction began.

Major construction contracts were awarded in July 1982 and pre-stripping began at the same time. Construction activities and manpower peaked in August of 1983 with the preparation plant being completed in November of 1983, 16 months after construction started.

Reclamation began in late summer of 1982 and proceeded in concert with construction activities. Of the areas disturbed by construction and mining most of the areas available for reclamation to date have been reclaimed, representing a total of 372 hectares.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TUMBLER SUBSTATION
TO CHETWYND 93 km
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121° 00'
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RAIL DISTANCES :
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RIVER
FLATBED CREEK
TUMBLER RIDGE PLANT SITE 18 km
ACCESS ROAD
RAILROAD
WOLVERINE
EXPLOSIVES PLANT
SERVICE COMPLEX
230 kV POWERLINE
HERITAGE HIGHWAY
MESA
DUMP
PIT
TRUCK DUMP
69 kV POWERLINE
CONVEYOR C1
CONVEYOR C2
tailings pond
WOLVERINE
55° 00'
QUINTETTE SUBSTATION
MINE OFFICE AND DRY
CONVEYOR TRANSFER POINT
PLANT SITE & ADMIN. OFFICE
COAL LEASE
SHIKANO
MURRAY RIVER
COAL LEASE
BABCOCK
(FUTURE)
BABCOCK CREEK
2 1 0 1 2 3 4 km
QUINTETTE COAL LIMITED
AREA DEVELOPMENT
FIGURE 1

The major objective of the Quintette reclamation program up to this point has been to eliminate excessive sedimentation through construction of water management structures and establishment of a self sustaining plant cover.

In what follows the establishment of the plant cover on the Quintette project is described.

RECLAMATION PRINCIPLES

Reclamation planning at Quintette has considered reclamation in two phases with each phase including a research component.

The first phase consists of reclamation of construction disturbance. In this instance the surficial material and soil has been disturbed but not removed. This disturbance results from road construction, sediment pond construction, camp decommissioning and other such activities. The objectives are to control erosion and quickly establish a self-sustaining cover of vegetation. The methods used to achieve this have been recontouring, culvert removal or replacement, installation of water control structures, and application of a seed and fertilizer mix by hydroseeding, aerial seeding or tractor/harrow seeding. As required, a mulch and tackifier are added.

The second phase consists of reclamation of mining disturbance; specifically, dumps. The objective of this phase is to return the mined area, or portions thereof, to some predetermined post mining land use. In this case either forestry or wildlife habitat or a combination of both.

In 1982 a fall seeding program was undertaken on portions of the project following seed and fertilizer specifications used in British Columbia by the forestry industry. This mix emphasized several species of grasses with little emphasis on legumes. Subsequent evaluation showed that this program was not sufficiently successful to fully achieve the objectives outlined above.

Although results of a field assessment were not available in the winter of 1982-83, reconsideration of the fall 1982 reclamation program and a literature review dictated that a different approach was required for future reclamation undertakings. Accordingly, Dr. Ed Watkins of Mine Waste Reclamation Ltd. was retained to assist the Quintette environmental staff in identifying the most appropriate seed and fertilizer applications.

The following principles were applied in determining these applications.

1. Fertilizer treatment would be based on soil testing procedures which define the relationship between nutrient content and availability in a given soil, and the nutrient requirements of selected plant species.

2. Root biomass was considered more important than shoot biomass because of its significance to plant survival, soil building, site stability and erosion control.

3. Selection of a chemical which will extract from the soil a consistent portion of plant nutrient was considered critical. Although time constraints precluded a rigorous scientific determination it was concluded that:

    i) The cold temperatures at Quintette, especially during optimum seeding periods, dictate that higher starter applications of phosphate should be made at the time of seeding as uptake of phosphate is temperature dependant.

    ii) Nitrogen rates were revised as the recommended rates provided too much nitrogen in relation to phosphorous. Nitrogen encourages grass growth at the expense of legume growth. In addition, grass growth inhibits colonization by native species.

4. With respect of seed mixtures the following principles were assumed:

i) The species selected would be adaptable to the area.

ii) They would require no maintenance.

iii) They would permit the invasion and colonization by native species except in areas where native colonization would be detrimental to operations.

iv) They would not present a fire hazard.

Reclamation History

1982

Seedings made in the fall of 1982 followed seed mixture and fertilizer specifications previously used in B.C., primarily by the B.C. Forest Industry (Table 1). These mixtures were seeded mainly in the forest zone of the property and included the plant site access road, part of the plant site, pit access road, plant site sediment ponds and sections of the conveyor right-of-way.

Assessment of this program in 1983 revealed that growth was stunted and plants showed much discoloration (yellow-red) giving many sites a scorched appearance. Ground cover was often less than 50% and alfalfa root systems were generally characterized by complete absence of nodule formation.

The scorched appearance of the 1982 seedings was attributed to potassium deficiency as a consequence of the 1982 fertilizer application. Grasses require high levels of potassium which is accentuated by high nitrogen fertilization.

Soil depth and soil moisture also showed a correlation with plant growth and discoloration. More acceptable levels of plant growth were apparent in areas where a soil probe could penetrate a minimum of four to six

TABLE 1

COMPOSITION OF SEED MIXTURES, 1982 REVEGETATION PROGRAM

MIXTURE	SPECIES	%
#1	Meadow Foxtail	15
	Durar Hard Fescue	15
	Boreal Creeping Red Fescue	20
	Climax Timothy	10
	Alsike	10
	Revenue Slender Wheat Grass	20
	Reubens Canada Blue Grass	10
#2	Durar Hard Fescue	15
	Boreal Creeping Red Fescue	30
	Alsike	7.5
	Alfalfa	7.5
	Revenue Slender Wheat Grass	15
	Reubens Canada Blue Grass	10
	Red Top Fescue	5
	Climax Timothy	10
#3	Boreal Creeping Red Fescue	40
	Kentucky Blue Grass	15
	Alsike	7.5
	Alfalfa	7.5
	Red Top	5
	Climax Timothy	10
	Crested Wheat Grass	15

Application Rates

Seed Mix	- 70 kg/ha
10-20-0 Fertilizer	- 244 kg/ha
Silva Fibre Mulch	- 1345 kg/ha

inches and where 12 inches of penetrable soil existed some stands of excellent growth were observed.

1983

The 1983 program differed from the 1982 program in the greatly increased emphasis on achieving legume dominated stands. Six mixtures were initially selected (Table 2) which differed from the 1982 application in several ways:

1. reduction in number of species per mix;
2. increase in the percentage of legumes;
3. emphasis on the use of creeping red fescue as the major grass specie;
4. evaluation of three legumes, namely birdsfoot trefoil, alfalfa and white clover.

Because of the change in emphasis from grass dominated seed mixes to legume dominated seed mixes the fertilizer type and rate of application was radically altered. The 1982 application of 16-20-0 at 240 kg/ha was changed to 5-20-20 at 800 kg/ha plus 0-46-0 at 400 kg/ha.

1983 was the major construction period with an estimated cumulative total of 900 ha of disturbance. 1983 was also the year of the greatest reclamation activity with a total of 215.6 ha revegetated.

This included:

- access roads to the Babcock area, camps, borrow areas, sediment ponds, explosive storage and tailings pond;
- most major road allowances including remedial treatment of the 1982 work;
- plant site and mine site sediment dams and borrow areas;
- rail right-of-way;

TABLE 2

COMPOSITION OF SEED MIXTURES, 1983-1984 REVEGETATION PROGRAMS

SEED MIXTURE	SPECIES	VARIETY	%
1	Creeping Red Fescue	Common Boreal	60
	Birdsfoot Trefoil	Leo	40
2	Creeping Red Fescue	Common Boreal	66
	Alfalfa	Anik	34
3	Creeping Red Fescue	Common Boreal	65
	Kentucky Blue Grass	Nugget	25
	Alfalfa	Algonquin	10
4	Creeping Red Fescue	Common Boreal	60
	Kentucky Blue Grass	Nugget	25
	Red Top	Common	5
	White Clover		10
5	Creeping Red Fescue	Boreal	60
	Birdsfoot Trefoil	Empire	40
6	Creeping Red Fescue	Boreal	65
	White Clover		10
	Kentucky Blue Grass	Common	25
7 (Alpine)	Creeping Red Fescue	Boreal	50
	Kentucky Blue Grass	Common	20
	Hard Fescue	Durar	15
	Slender Wheat Grass	Revenue	15

Application Rates

Seed Mix	-	100 kg/ha
5-20-20	-	800 kg/ha
0-46-0	-	400 kg/ha
Silva Fibre Mulch and Tachifier	-	454 kg/ha

- conveyor works in floodplain;
- powerlines;
- bridge approaches;
- water pipeline right-of-way;
- borrow areas;
- portions of the plant site.

Two major areas were deferred to 1984, namely landscaping and revegetation of the administrative building area, and the conveyor right-of-way.

1984

During this period the conveyor right-of-way was reclaimed. This included recontouring, construction of water bars, placement of rip rap, replacement or repositioning of culverts and revegetation using the 1983 seed and fertilizer application. By this time the 1983 reclamation of the access to the two pits was largely complete and sediment levels were rapidly falling in streams earlier affected by access construction. The plant site area was recontoured where necessary and revegetated, and the area of the administrative building was sodded and landscaped.

In addition, smaller areas were reclaimed and some remedial work was done, in all cases the 1983 applications were used.

As part of the 1984 program, a qualitative assessment was undertaken to determine the relative success of the seed applications made in 1983 as opposed to 1982. It was found that ground cover from the 1983 application was virtually complete in most cases as opposed to very sparse cover from the 1982 application. Nodule development was excellent as opposed to the 1982 application where no nodule development was noted. The same observation was made with seed head development. In addition, root development in the 1983 application was excellent whereas the 1982

application showed as a general rule very shallow root development. It was also noted that rill and gully erosion was greatly reduced in areas where the 1983 application was made but still was common in areas of the 1982 application.

1985

In 1985 only a relatively small area consisting of 43.9 hectares was reclaimed. This included disturbance created by redesigning one of the mine settling ponds, powerline work and reclamation of exploration trails and sites. In addition, only mixes 3, 6, and 7 were used (Table 2), with fertilizer application of 5-20-20 at 400 kg/ha and 0-45-0 at 200 kg/ha.

Results

As well as the just mentioned activities, a qualitative but comprehensive evaluation of the QCL reclamation program to October 1985 was undertaken by Ms. K.J. Pomeroy.

Results of this investigation showed the following:

- In low to mid-elevation areas at the mine site (to approximately 1300 m) both alfalfa (seed mix 3) and clover (seed mix 6) gave good results and would be utilized in the future.
- Alfalfa shows a better rate of establishment and vigor than clover in low elevation areas on coarse textured, rocky or shaley sites. Alfalfa shall be used in future on areas of this type.
- Creeping red fescue (mix 3, 6 and 7) has been a highly successful specie at the Quintette property. Establishment and growth of the red fescue has been good to excellent at all elevation levels.
- Kentucky Bluegrass also shows a good success rate and will remain in seed mixes 3 and 6.

An evaluation of 1982 alpine seed mixtures and Alpine mix 7 (Table 2) used from 1983 to 1985 was also undertaken. Based on the results to date the most promising high elevation species in order of priority are:

- Creeping Red Fescue
- Slender Wheatgrass
- Timothy
- Hard Fescue
- Kentucky Bluegrass

Based on the above, a modified alpine mix will be utilized in 1986. As follows:

- Creeping Red Fescue	50%
- Slender Wheatgrass	20%
- Climax Timothy	15%
- Hard Fescue	15%

In 1984 an alpine reclamation research program was initiated and the results of this program were also evaluated by Ms. Pomeroy in 1985. The site selected for this program was an exploration trail which traversed three different alpine microhabitats; specifically, dry, mesic and wet tundra communities. The findings of this study were as follows:

Plot 1 Dry Site - Windswept Ridgetop

Native Plant Community: This site is in an extremely exposed, windswept ridgetop location with a coarse, rocky substrate. The native plant community, dominated by Dryas sp. achieves a 20-40% cover.

Dominant Species	Cover (%)
Dryas integrifolia	10-15%
Saxifraga	2%
Unidentified sp.	2%
Poa alpina	1%

Revegetation Success: Plant establishment on the ridgetop was negligible. It is likely that most of the seed was blown away.

Plot 2 Wet Tundra Site

Native Plant Community: The second plot is located in a sedge meadow established in a saddle in a snowmelt/seepage zone. The soil at this

site is organic (peat). The native community achieves 100% cover and is dominated by Carex sp.

Revegetation Success: Where the trail cut across the seepage site and destroyed the surface vegetation, the water table rose to the surface, in effect forming a pool. No vegetation established from seeding at this plot.

Plot 3 Mesic Tundra

Native Plant Community: The third plot is located on a mesic to sub-hygric site. The substrate is much less rocky than at the first site.

Dominant Species	Cover (%)
Salix reticulata	30%
Polygonum viviparum	10%
Carex podocarpa	5%
Aconitum delphinifolium	5%
Mosses	50%
Lichens - Peltigera	5%
Cladonia sp.	10%
Total Cover	100%

Revegetation Success: Results at this site were fairly typical for the trail as a whole with excellent cover establishment at the end of the first growing season.

Conveyor Right-of-Way

The conveyor right-of-way presented the most challenging, and in many ways interesting, component of the Quintette reclamation program. As may be seen in Figure 1 both the conveyor right-of-way, including access to it, and the pit access road are in a single drainage basin with all water flowing into a single creek called M20.

Routine water quality monitoring programs indicated elevated sediment levels in the spring of 1983 attributable to the aforementioned construction activities. The situation was exacerbated by winter construction which led to mixing of the highly friable surficial materials with snow which quickly moved into stream courses at spring melt. In some cases sizable mud flows occurred adjacent to construction areas.

This situation led to strong urging from the government to undertake construction of major sediment control structures in the M20 basin. At the same time as the feasibility study for these structures was underway a parallel study was undertaken by Quintette Coal Limited to determine:

- contribution to sediment levels in M20 by natural and construction sources;
- dilution and dispersal of sediment from M20 in the Murray River;
- types of erosion, observed stabilization of disturbance, and predicted time frame for reduction in sediment yield from M20 by reclamation alone; and
- impacts of M20 Creek sediment on aquatic resources in the Murray River.

Detailed methods and results of these investigations were presented in 1983. The key findings were:

- Sediment levels in M20 were historically high, and natural erosion was an important contributor of sediment;
- Construction disturbances were stabilizing rapidly;
- Completion of construction and revegetation of disturbed ground would eliminate most sources of suspended solids;
- Populations of periphyton, benthic invertebrates, and fish in the lower reaches of M20 Creek were observed to reflect high natural sediment levels, and in some cases, to change in response to increased sediment levels during construction.

  Rapid recovery of some M20 populations (e.g. periphyton) was observed; important habitats or unique fish populations were not

present in M20, and impacts of construction sedimentation on fish populations in the Murray River itself could not be established. Thus, none of the observed changes was judged to constitute a major impact on aquatic resources in the Murray River system.

By the end of 1983 it was apparent that successful revegetation programs quickly reduced sediment generation, in many cases to preconstruction levels, and in most cases more successfully than settling ponds. Indeed, on the largest settling pond on the project, sediment levels out of the pond were higher than those going in as a consequence of the large area disturbed for construction of the pond. It was concluded that settling ponds were not required for short term construction disturbances which would be subsequently revegetated.

Summary

1. Soils Analysis

The Quintette experience clearly highlights the importance of soils or substrate analysis to determine fertilizer and seed applications. On a major mine reclamation program the costs of determining appropriate applications are insignificant. In fact, over the long term cost savings are undoubtedly realized as remedial erosion control will be minimized. Indeed a strong arguement can be advanced for conducting such analyses on a small reclamation program when the relatively higher costs associated with remedial work are considered.

2. Erosion Control

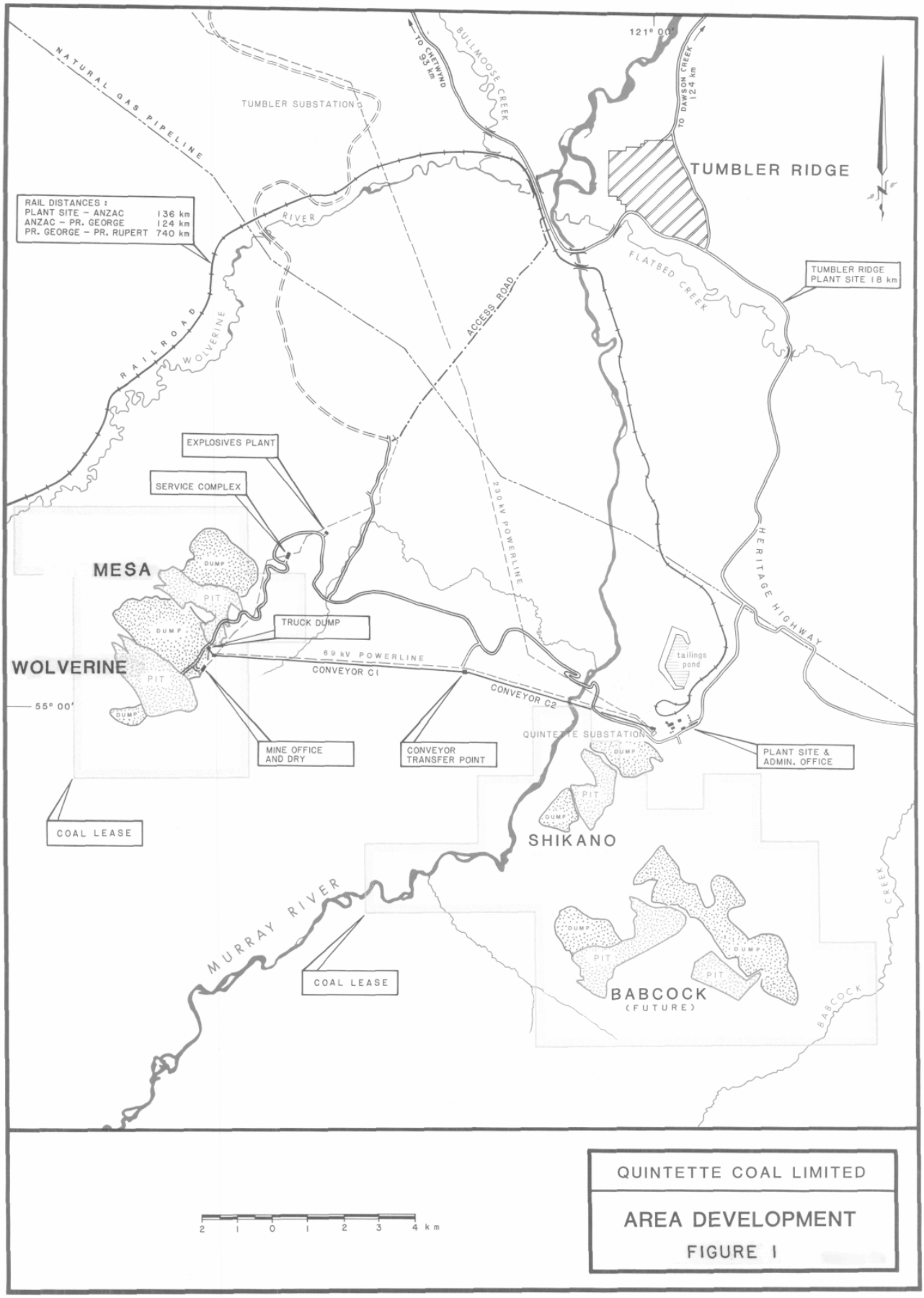
Sediment monitoring programs have clearly shown that construction of major water management structures, especially settling ponds, are not required to control sediment generated by construction, assuming that such disturbance is quickly revegetated and surfaces successfully restabilized.

3. Surface Compaction

Annual evaluations have invariably highlighted surface compaction as a major barrier to revegetation. Back blading must be avoided and surfaces compacted by traffic must be ripped prior to revegetation. Almost invariably wherever a reclamation site was prepared with a tractor or backhoe reclamation was successful.

CONCLUSION

Quintette Coal Limited successfully reclaimed disturbances relating to project construction within two years of project completion. The success of the reclamation in large measure is attributable to comprehensive soils study prior to program initiation which insured that the stated objectives of the program were realized in a very short time frame.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QUINTETTE COAL LIMITED
AREA DEVELOPMENT
FIGURE 1