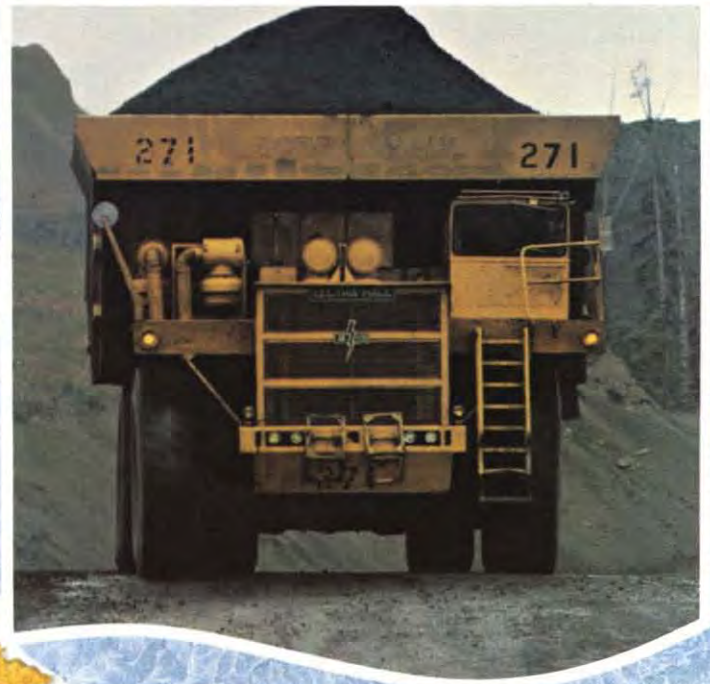
COAL MINING AND PROCESSING IN BRITISH COLUMBIA

KAISER RESOURCES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BRITISH COLUMBIA
ALBERTA
SPARWOOD
VANCOUVER
WASHINGTON

KAISER RESOURCES
...at a glance

- Kaiser Resources Ltd., incorporated in British Columbia in 1967, operates coal mining and processing facilities at Sparwood, in the southeastern region of the province. These operations produce approximately six million tons of clean metallurgical coal per year.
- Most of the coal is sold to the Japanese steel industry under a long-term contract. The company also delivers metallurgical coal to Eastern Canada, Korea, Mexico and Italy.
- Coal for overseas shipment is transported 700 miles by unit trains from Sparwood to the company's port facilities at Roberts Bank, south of Vancouver, B.C.
- The mining and port operations represent a capital investment of more than $160 million and employ about 2,000 people.
- Approximately 85 percent of the coal produced by the company is mined by surface methods. The remainder is mined underground, mainly by the hydraulic method.
- Environmental protection is an integral part of the company's coal mining and processing operations.

IN THE BEGINNING...

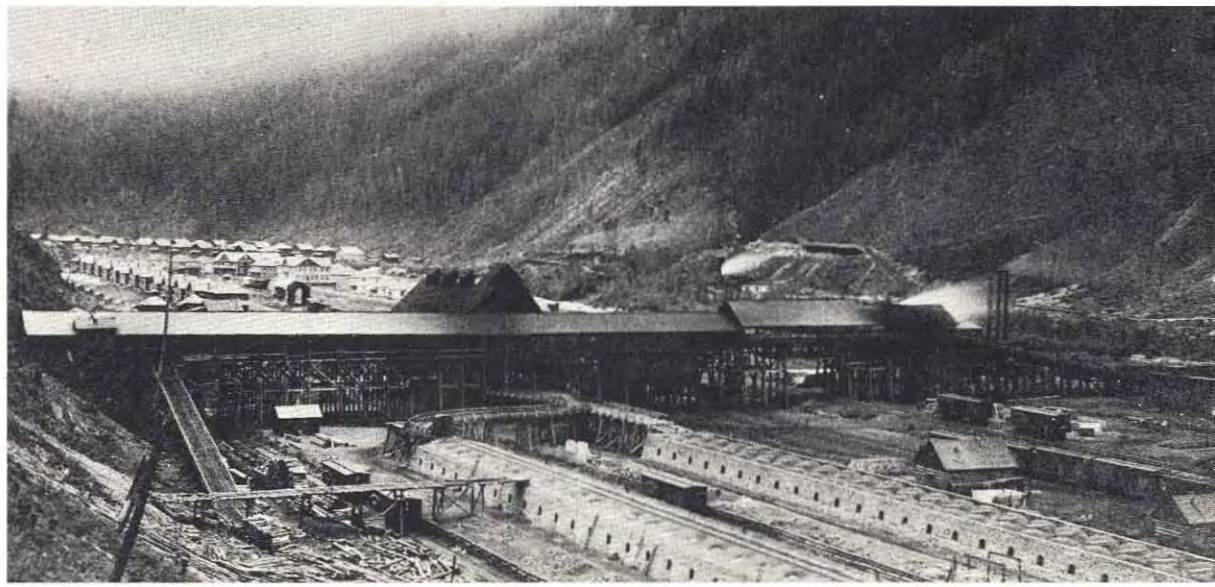
Coal was discovered in the Crowsnest area of southeastern British Columbia more than 100 years ago by prospectors looking for gold. History records the gold-seekers were bitterly disappointed to find nothing more than "useless" coal.

In 1897, an experienced miner named William Fernie reported a major coal discovery which led to the formation of the Crow's Nest Pass Coal Company to supply the steam locomotives on the new Canadian Pacific Railway line through the Crowsnest Pass. The mining community which emerged was named Fernie, in honour of the miner whose efforts helped to establish the new industry.

For more than 50 years, the railways represented a major market for coal from the Crowsnest Pass area and other Western Canadian coals. But as technological progress shunted steam locomotives off the rails and eliminated coal stoves from Canadian homes, the mines shut down or drastically reduced production.

The Coal Depression lasted for nearly two decades before a new market brightened the industry's prospects. In the late 1960's, the burgeoning Japanese steel industry began to look for new sources of metallurgical coal. It was this market that stimulated the revival of the coal industry in Western Canada–revitalizing established mines and causing the development of new mines.

Coal mining in the early 1900's.



The Japanese requirements provided markets for Western Canadian coal on a scale not previously envisioned. Kaiser Resources acquired extensive coal deposits in the Crowsnest area in 1967 and arranged a long-term sales contract with Japanese steel mills. The contract calls for 4.75 million long tons of clean coal per year, plus or minus five percent at the buyer's option.

In addition, the company now supplies metallurgical and thermal coals, coke and by-products to customers in Canada, the United States, Europe, Korea and Mexico.

To meet its contracts, Kaiser Resources has developed a major surface mining operation using some of the largest equipment available for overburden removal, including equipment designed and manufactured especially for the project. The company has also developed an underground operation using the hydraulic mining method.

The combined surface and underground mining operations produce more than seven million tons of raw coal per year. The coal is processed or washed in a preparation plant to produce clean coal at market specifications.

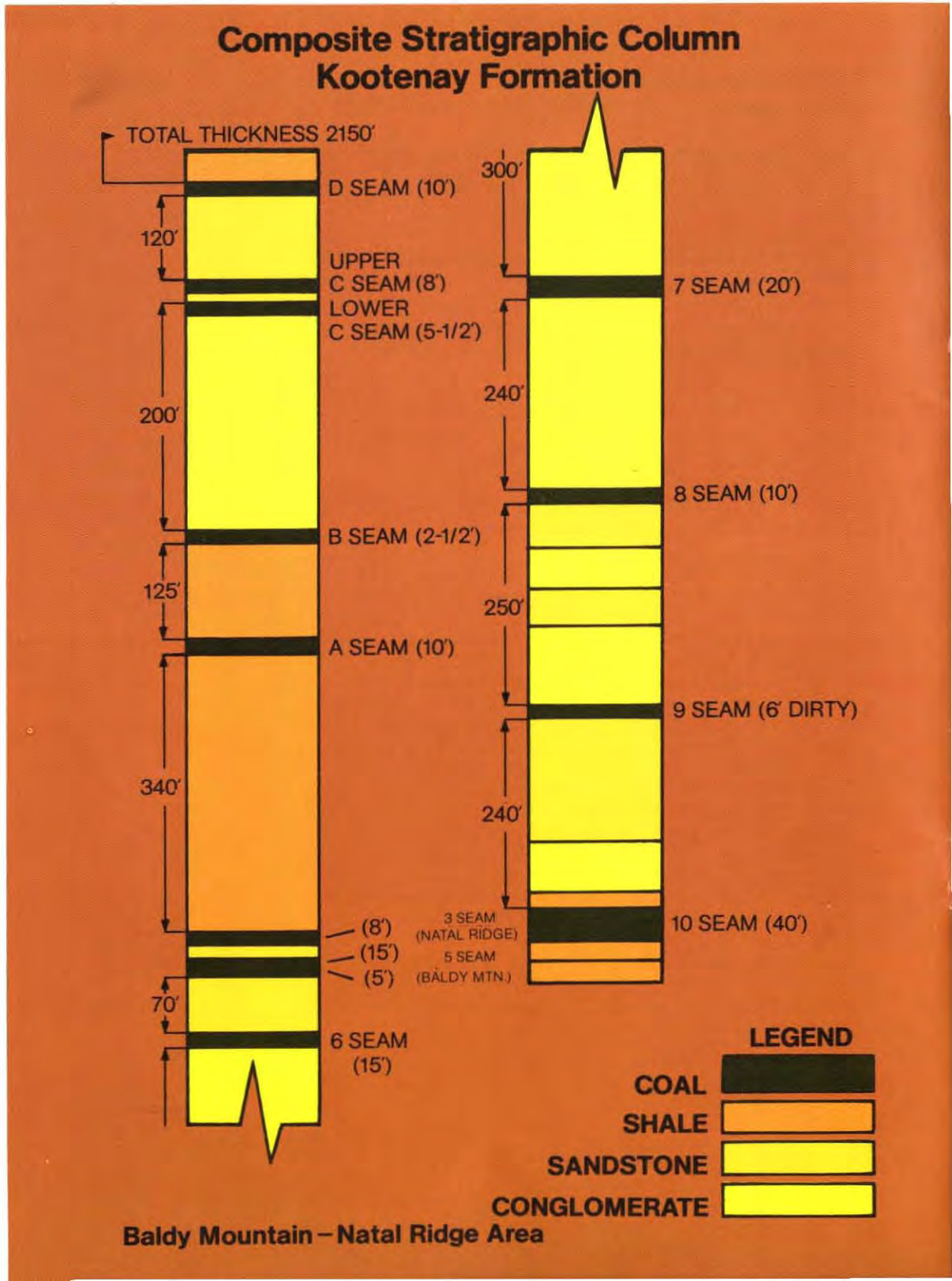
GEOLOGY

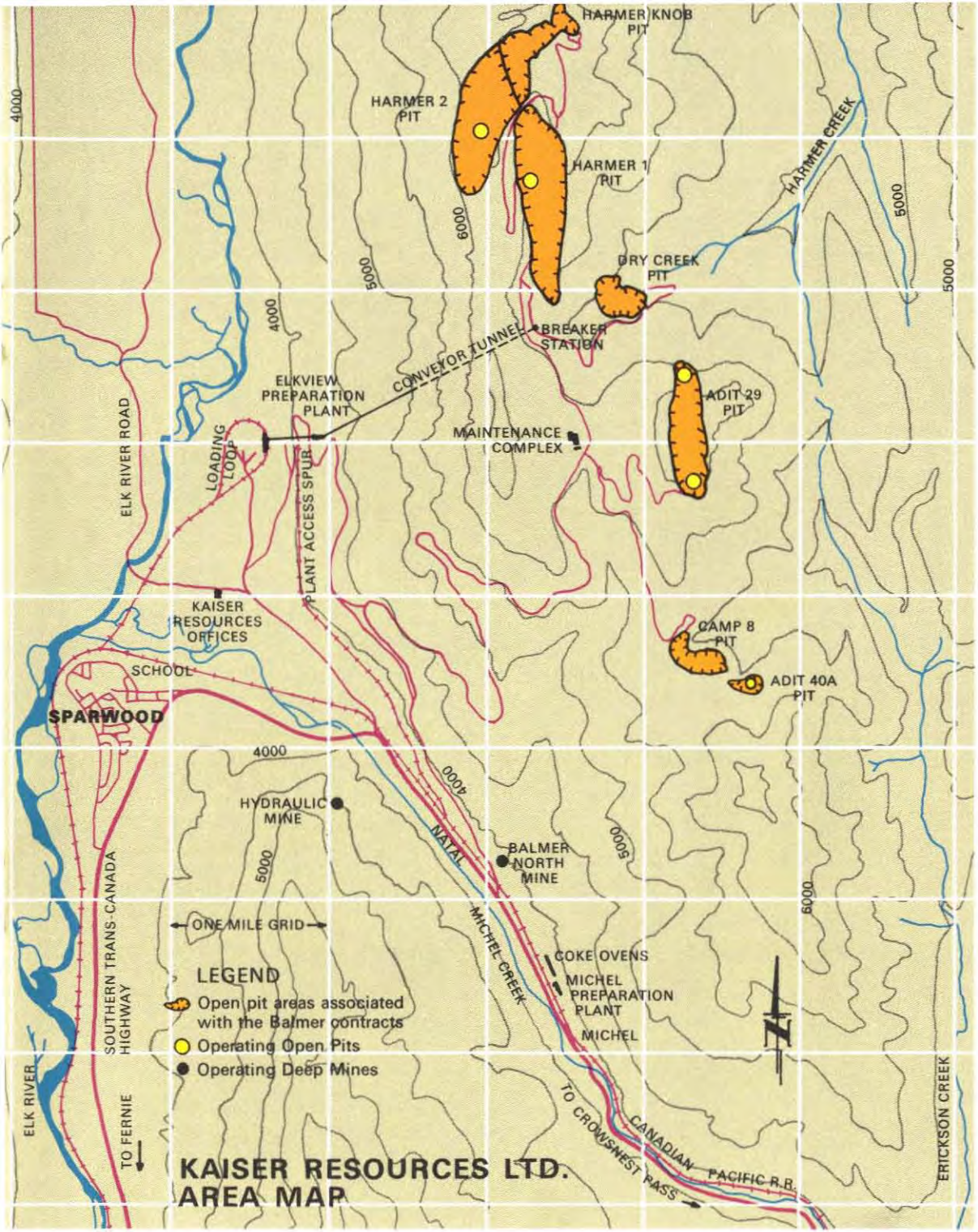
The coal properties of Kaiser Resources comprise the central part of a belt of coal measures that extends about 100 miles northward from the international boundary in southeastern British Columbia to the inner foothills of Alberta. These coal deposits lie in three basins: the Flathead, Crows Nest and the Upper Elk Valley, and occur in a long, structural trough that has protected them from erosion. This belt of coal was once connected to the Inner Foothills Belt in Alberta but the two were separated by faulting during the formation of the Rocky Mountains.

The Kootenay Formation in which Kaiser Resources is mining reaches a maximum thickness of about 2,000 feet and contains from eight to 15 coal seams ranging in thickness from five to 50 feet. Shale and sandstone overlie the coal seams.

Volatile contents of the coal range from 18 per cent to 38 per cent and vary with the stratigraphic location of the seams–the greater the depth, the lower their volatile matter.

Coal suitable for coking has a low volatile content. Kaiser Resources primarily mines Number 10 seam which is 50 feet thick and occurs at the bottom of the Kootenay Formation. Because erosion has removed the upper seams at the north end of the formation, it is possible to mine the bottom seam by surface methods. The seam is also characterized by steep pitching and some faulting, created by a succession of upheavals. In general, the seam dips from east to west at 20 to 30 degrees.





SURFACE MINING

To reach the coal, overburden of shale and sandstone from a few feet to several hundred feet in depth has to be removed. The overall rock to coal ratio is about five cubic yards of rock to one short ton of coal. The annual development ratio for several years, however, will be about 6.7:1. It is necessary, therefore, to remove more than 40 million bank cubic yards of overburden a year to produce the required tonnage of coal.

The surface mining operation is continuous with 480 employed on production and 420 on equipment maintenance. Daily production targets are approximately 120,000 bank cubic yards of rock and 17,000 tons of coal, equivalent to handling 285,000 tons of material per day.

The surface mine comprises several pits, developed according to a long-range mining plan which details the sequence of rock removal, coal recovery, construction of haul roads and the location of spoil piles.

Mining equipment includes four 25-cubic yard and four 15-cubic yard electric shovels; 22 haul trucks with a capacity of 200 tons; 28 haul trucks with 100 tons capacity; seven 12¼-inch drills; one 9⅞-inch drill; and a supporting fleet of crawler and rubber-tire dozers, graders and miscellaneous vehicles.

The mining area encompasses about 900 acres of mountainous terrain, most of it more than 6,000 feet above sea level. The climate at this elevation and the terrain present conditions that have to be met with special considerations. The snowfall, for example, averages more than 300 inches a year and adequate snow removal is required to maintain haul and access roads. Spring breakup requires special attention to road maintenance. Low cloud formations and fog occur in late fall or early spring and lighting has been installed on haul roads to improve visibility. In general, the operation is prepared to overcome all problems created by adverse weather.

Special roadbuilding techniques have been developed to construct and maintain stable roadbeds with unstable construction materials such as the native shales and sandstones.

Open pit mining operations are situated between 6,000 and 7,000 feet above sea level in mountainous terrain.

DRILLING AND BLASTING is the first stage in removing the rock overburden. Large rotary drills produce blastholes 12¼ inches in diameter and 50 feet deep. Explosives are delivered to the holes from an on-site bulk loading and storage facility.

A blast comprises six to 10 rows of holes and an average of 300,000 pounds of explosives, and is initiated by a specially-designed time delay system for close control. Such a blast will produce approximately 300,000 bank cubic yards of fragmented rock for removal by large shovels and trucks.

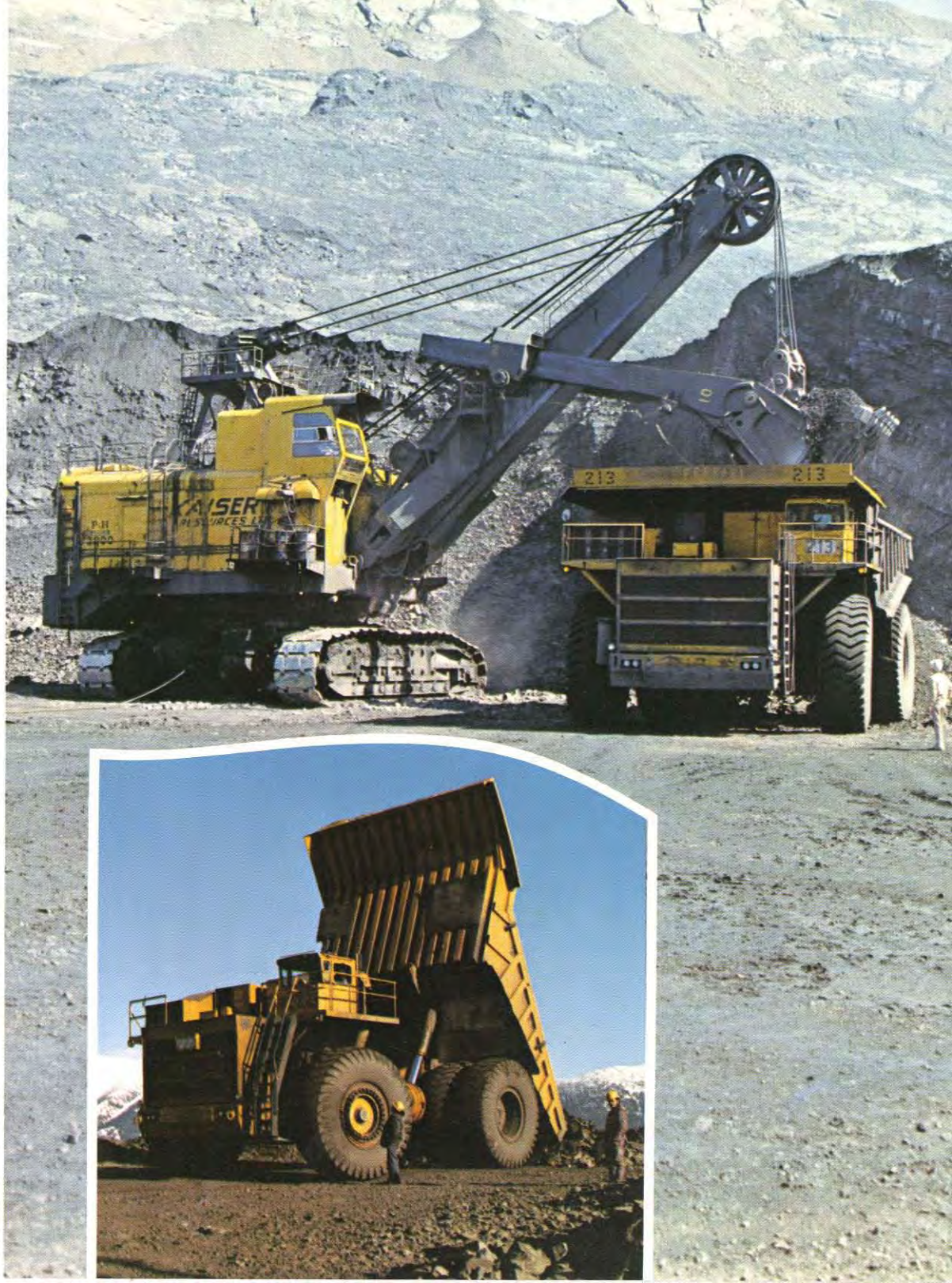
IN REMOVING the rock, 200-ton trucks are generally matched with 25-cubic yard shovels, in areas where the digging is good and where a minimum of shovel moves are required. The 15-cubic yard shovels are normally used with 100-ton trucks in rock near the coal seam. The rock is hauled to disposal areas that are selected and designed for stability, capacity, access, and future reclamation.

Mining begins near the outcrop or highest elevation of the coal seam. To provide minimum haul road grades, the rock disposal areas are maintained at or near the pit floor elevation. As more rock is removed and the pit floor lowered, the haul roads and the disposal areas are relocated and lowered correspondingly, at intervals of about 100 feet.

The rock dumps are "wrapped around" inactive mountain slopes to obtain greatest stability and capacity, and to facilitate reclamation after the dump is dormant or no longer in use. The dumps are monitored continuously by surveyors for movement or other signs of instability.

Maintenance of haul roads, essential to keeping equipment and tire costs at a minimum, is assigned to a special road crew. Because of the size of tires on the haul trucks—4000 x 57 on the 200-ton trucks and 2700 x 49 on the 100-ton trucks—replacement costs are high. Therefore, good road and pit floor conditions are maintained to achieve optimum tire life.

Overburden is removed in 50-foot benches to reach the coal seam.

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Coal is pushed off the seam with dozers, loaded into 100-ton trucks and hauled to the central breaker station.

COAL RECOVERY is assigned to a crew skilled in removing rock near the surface of the coal seam without wasting coal. After as much rock as possible is removed near the seam by shovels, bulldozers are used to push the remaining rock from the hanging wall. The dozers work parallel to the strike with special hydraulic slopers mounted on the blades to avoid cutting into the coal. Operators control the angle of the sloper blades along the dip of the coal seam to remove the hanging wall without wasting coal. The method is also used to clean coal off the footwall which has a similar dip as the hanging wall.

Although the coal is too hard when in place for free digging, it does not require blasting. Bulldozers are used to break up the coal and push it down the dip. The loose coal is loaded into 100-ton trucks by large front-end loading machines equipped with 20 and 22-cubic yard buckets.

The coal is hauled from all pits to a central breaker station where it is crushed to four inches or less and transported by an 8,000-foot belt conveyor, through a 5,000-foot tunnel, to the raw coal silos at the preparation plant.

QUALITY CONTROL of raw coal is provided by laboratory analyses of field samples. A group comprising a geologist, an auger truck operator and four samplers monitor coal quality prior to and during coal recovery to ensure a consistent blend is delivered to the preparation plant.

Samples taken with a coal auger are analyzed in the laboratory to determine coal properties for blending. The depth of oxidized coal that may cover metallurgical coal near an outcrop is also defined by sample analyses.

Current information on coal quality is essential for proper process selection at the preparation plant, and for delivery to the plant of a uniform feed.

◀*Rock removal totals approximately 45 million bank cubic yards per year.*

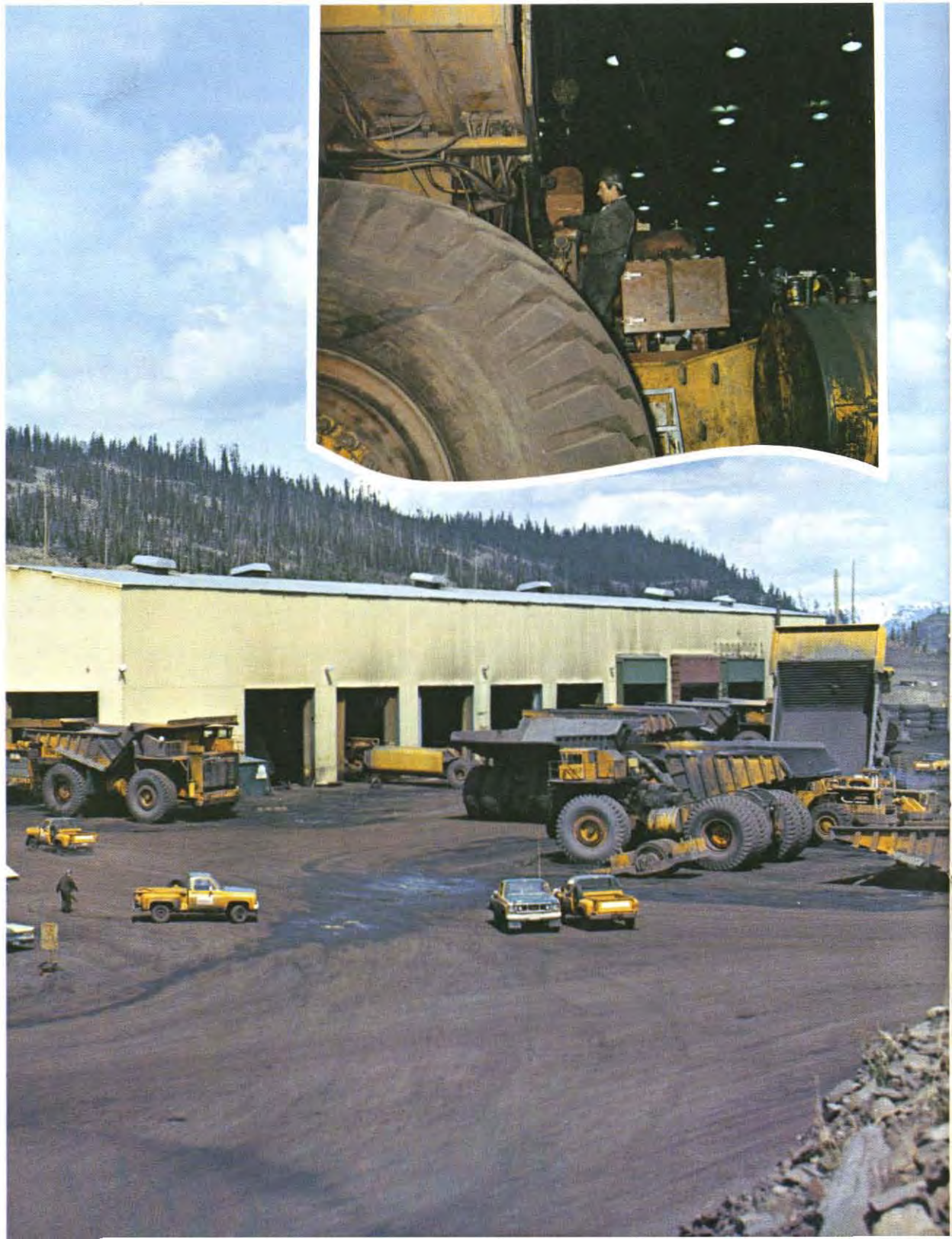
EQUIPMENT MAINTENANCE facilities for the surface mining operation are centred in a complex that provides easy access from all mining areas.

The centre is fully equipped for preventative and repair maintenance of all types of mining equipment and includes a wash bay, two preventative maintenance bays, two additional truck bays, two bays for support equipment, a welding bay and ancilliary shops.

Separate facilities handle bulldozer maintenance and the servicing of more than 200 light duty support vehicles.

Maintenance employees number 420, including supervisory and clerical staff. The ratio of maintenance to production personnel is high due to the type of equipment in use and the continuous production schedule.

All maintenance is controlled by work orders generated from inspections, reports from operators, scheduled servicing and emergency repairs. The work order system facilitates planning, co-ordinates the activities of skilled tradesmen, and provides a comprehensive history of each unit.



Central maintenance complex at Harmer.

HYDRAULIC MINING

The company's underground hydraulic mining operation produces approximately one million tons of raw coal per year. The hydraulic technique, introduced by the company in the early 1970's, uses a high pressure water jet to dislodge the coal. Combined with water, the coal is flumed out of the mine to a dewatering plant on the surface. The water is separated from the coal by screening and recycled in a closed circuit for reuse in the mine.

Gravity flow for fluming the coal is provided by a seven percent incline of the entry and sublevels in the coal seam.

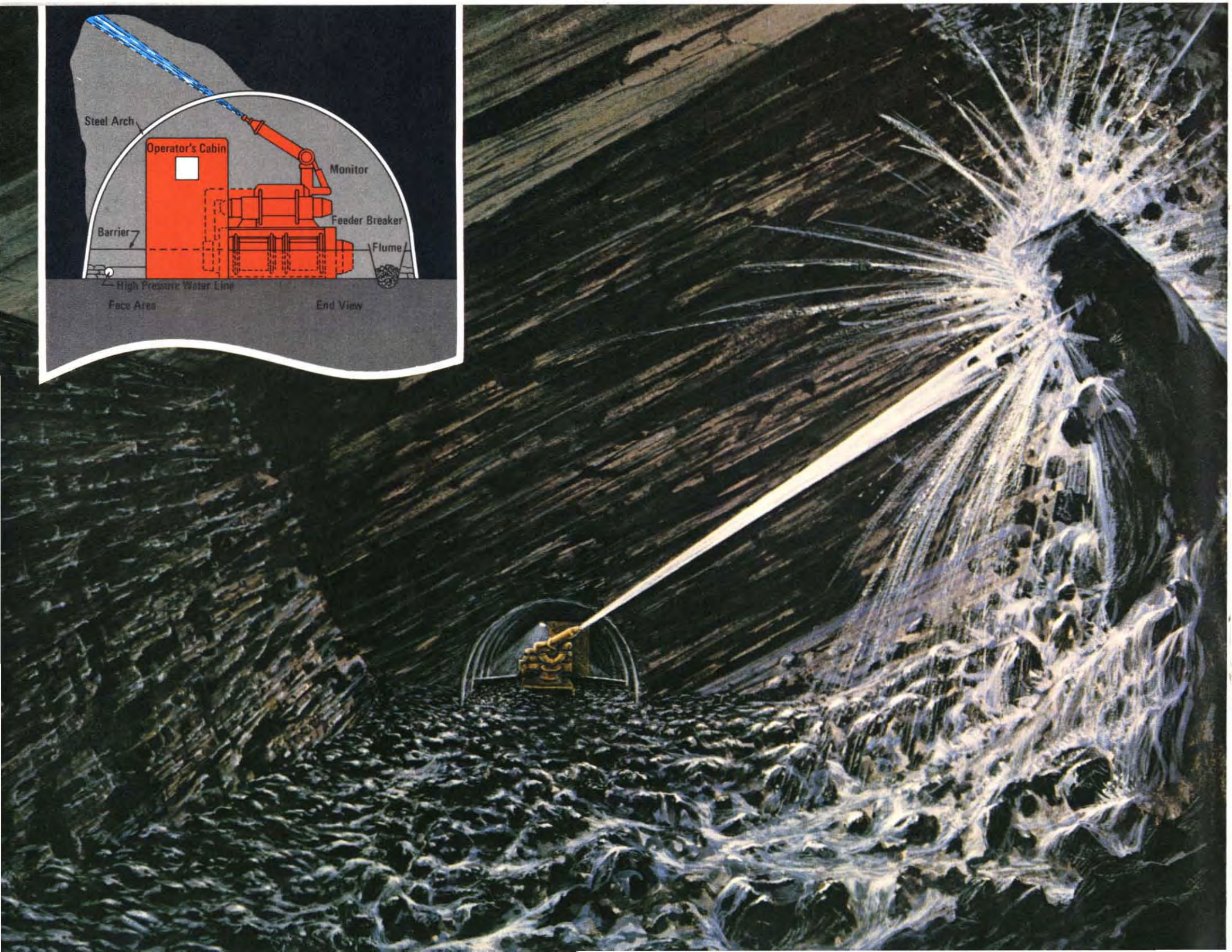
Full retreat mining is employed with continuous mining machines driving the development entries and sublevels. The hydraulic monitor then moves into the sublevels to extract the coal, starting at the upper end. All headings are supported by steel arches which are retracted as the monitor retreats. The monitor has an effective cutting range of about 60 feet. Therefore, the retreat increments average 40 to 60 feet and the sublevels are spaced about 60 feet apart. As the coal is dislodged, it is washed into a feeder breaker behind the monitor and crushed to a flumable size.

Hydraulic mining is considered one of the most advanced underground coal mining systems, providing greater recovery of the coal seam at lower cost, and with increased safety. Recovery by hydraulic mining is about 60 percent, compared to 10 to 12 percent achieved in the same seam by conventional room and pillar mining. Productivity averages about 30 tons per man shift.

Safety is increased because employees are not required to work at the coal face and healthier working conditions are created by the elimination of dust. The monitor operator's cabin is situated about 50 feet behind the production area and is in fresh air intake at all times.

In 1974, Kaiser Resources entered into a license agreement with the U.S.S.R. and Mitsui Mining Company, Limited of Japan covering the exchange and international marketing of hydraulic coal mining technology. Under the agreement, the Soviet Union, Mitsui and the company will share equally in any royalties as a result of worldwide sales of their combined technologies to other coal producers. In two years following the agreement, three sublicenses were negotiated.

Hydraulic monitor (above) as viewed from behind the operator's cabin. Continuous mining machines (below) are used for hydraulic mine development.


Steel Arch
Operator's Cabin
Monitor
Feeder Breaker
Barrier
Flume
High Pressure Water Line
Face Area
End View

COAL PROCESSING

Raw coal from the surface and hydraulic mining operations is washed in the preparation plant to reduce incombustible material (the ash content) to 9.5 per cent or less. The average yield of clean coal from raw coal is approximately 76 percent.

In the preparation process, raw coal is conveyed from the storage silos to the wash plant and screened. Raw coal larger than 3/8-inch is washed in heavy media vessels and delivered directly to the 60,000-ton clean coal silos. Finer coal is screened in two sizes for washing by separate processes. After washing, the two size fractions are recombined and conveyed to a thermal dryer to reduce the moisture content . From the dryer, the coal is conveyed to the clean coal silos.

Coal dust in the dryer exhaust is recovered by four large cyclone collectors and a wet scrubbing process, and is also delivered to the clean coal silos.

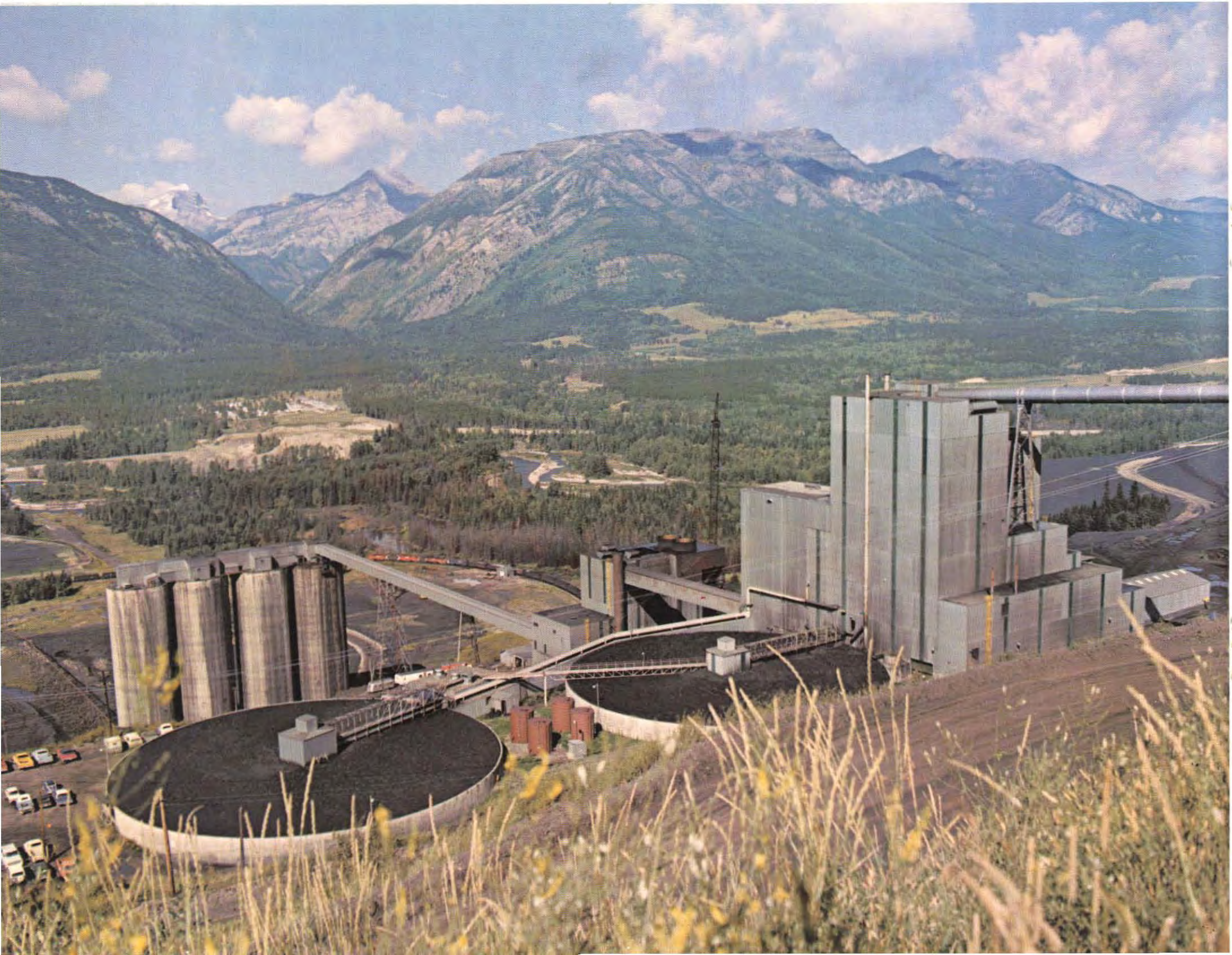
Coarse refuse separated from the clean coal is deposited along a neighboring hillside, contoured, and seeded in grass. Refuse from the fine coal circuits is delivered in the form of a slurry into large impoundments or ponds from which the water is dehydrated as the fines settle. When the ponds are full, they are also seeded. Dust and waste control as well as reclamation of the waste disposal areas are required by legislation and are covered in another chapter

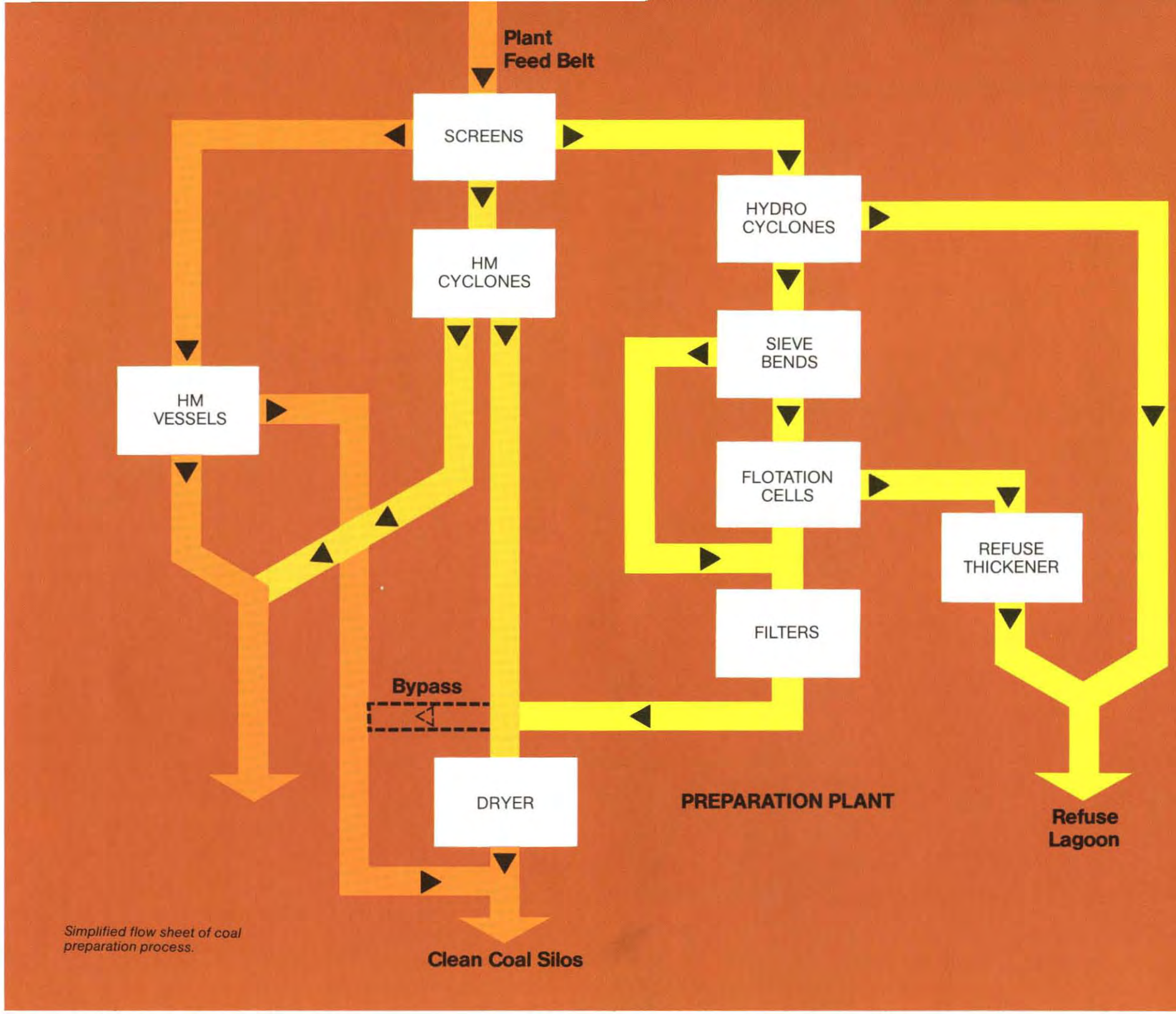
The clean coal is transported by unit trains from the plant to the company's port facilities at Roberts Bank, south of Vancouver. The unit train comprises 106 cars which are flood-loaded to about 100 tons per car as the train passes through the clean coal silos at 0.3 to 0.5 miles an hour. Average loading time is about three hours per train and approximately 13 trains are loaded per week.

After a train is loaded, the cars are sprayed automatically with a dust suppressent to eliminate dusting from the cars during the 700-mile haul to the port.

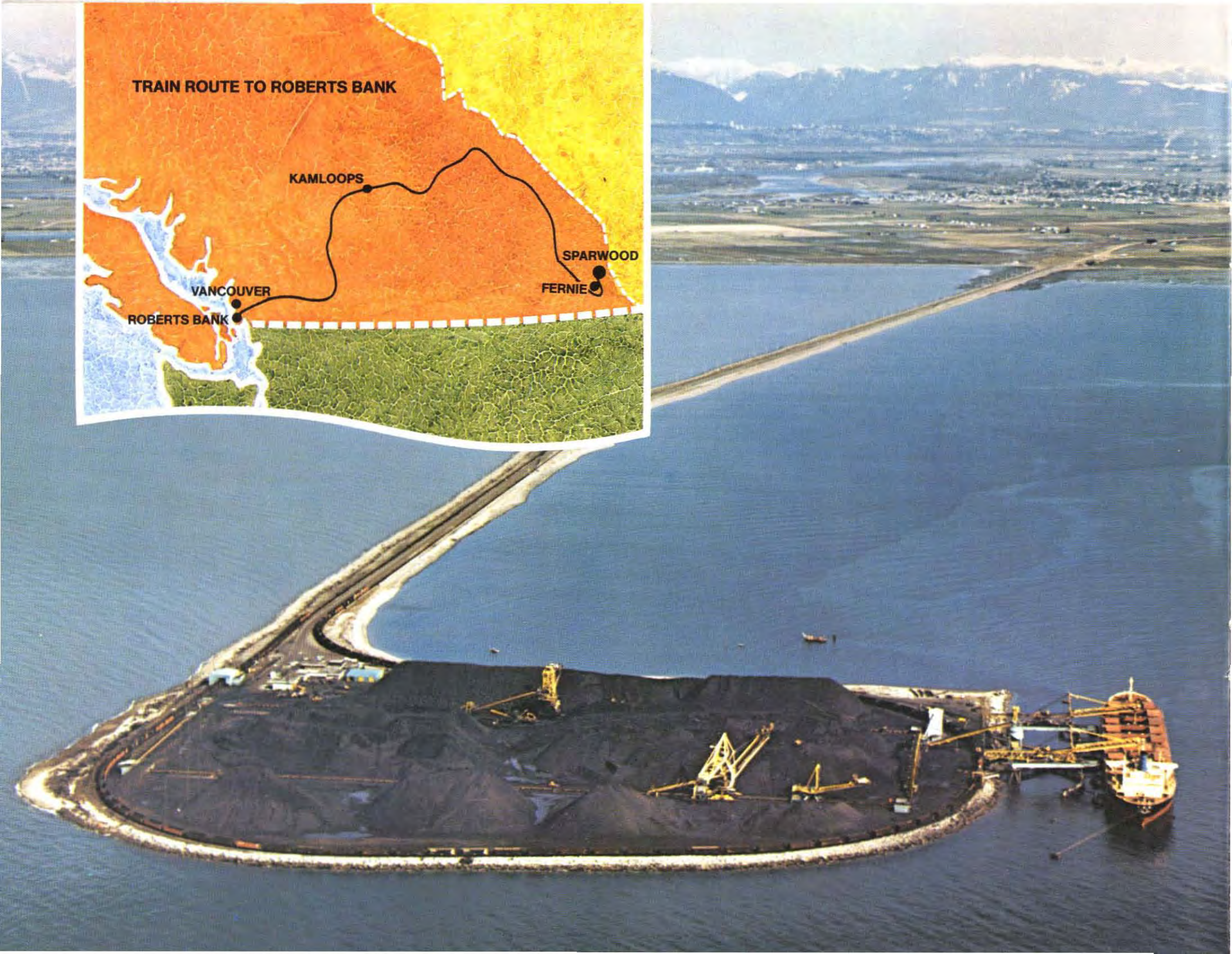
Clean coal is loaded from storage silos into 106-car unit trains for 700-mile haul to port facilities.

◀ *High water pressure is used to cut coal in hydraulic mining.*





Simplified flow sheet of coal preparation process.


TRAIN ROUTE TO ROBERTS BANK
KAMLOOPS
SPARWOOD
FERNIE
VANCOUVER
ROBERTS BANK

Port facilities provide for unloading unit trains, stockpiling coal and ship loading.

THE PORT FACILITIES are operated by Westshore Terminals Ltd., a wholly-owned subsidiary of Kaiser Resources. The terminal is a 50-acre man-made site in the Strait of Georgia with facilities to stockpile more than one million tons and accommodate ships up to 150,000 deadweight tons.

In 1975, Westshore Terminals loaded 139 ships with a record 8.2 million long tons of coal, coke and related products. This included 5.2 million long tons of Kaiser Resources' coal and 3 million long tons of products from other companies. From the start-up of operations in 1970, more than 35 million long tons of product has been loaded at the terminal.

The port's bulk-handling facilities have four basic functions: car dumping, stockpiling, reclaiming and shiploading. These operations are programmed from the supervisor's control panel situated in a raised tower.

Car dumping is fully automatic. The cars are solid bottom gondolas with swivel couplings to allow rotary dumping without uncoupling the cars. As the railway track loops around the terminal site, no backing of trains is necessary.

From a hopper underneath the dumper, the coal is conveyed to ground level from where it can be directed to stockpile or to the shiploading system.

Two complete systems are available for stockpiling—a twin-boom travelling stacker and a 200-foot stacker-reclaimer. Three reclaiming systems for shiploading include the stacker-reclaimer and two bucket-wheel machines.

Environmental control is integrated with the coal-handling facilities, and a number of methods are used to overcome dust problems posed by the finely-ground coal being exposed to water-front winds.

Dust control measures include spraying equipment on the stackers which are equipped with pumping systems drawing fresh water from 36-inch flumes which run the length of the yard. In addition, two 3,000-gallon tank trucks with independent high-volume pumps also provide spraying capacity.

A spraying facility also washes empty coal cars to control dust from trains returning to the coal fields.

SUPPORT FACILITIES

About 300 employees are engaged in activities supporting production and maintenance functions. These support activities include administration, accounting, data processing, exploration, facilities engineering, industrial relations, personnel services, purchasing, warehousing and inventory control, reclamation and environmental control services.

RECLAMATION is an integral part of the mining operation. Under existing provincial legislation, the exploration and production phases of coal mining may be carried out only pursuant to reclamation plans which have received prior approval of the Minister of Mines and Petroleum Resources.

The company's current exploration and production plans have been approved, and its performance is secured by a bond and monitored by the Mines Department.

The basic objective of the company's reclamation program is the rehabilitation of industrially disturbed lands in the Sparwood area associated with past and current mining activity. The program is directed primarily towards re-establishing water-shed, plant and wildlife values as soon as possible and in a manner that will be compatible with the optimum surface use of the land.

For a number of years, only small areas of the surface mine workings will become permanently dormant and available for reclamation. For this reason, the company's reclamation activities have been concentrated on rehabilitating old mine workings and on developing the best methods of reclaiming current mining areas.

Considerable success has been achieved in both areas.

By 1976, approximately 1,200 acres disturbed by mining and exploration activity had been reclaimed by cultivation, seeding and planting. Through research, site preparation techniques have been developed to make soil conditions suitable for promoting and sustaining growth.

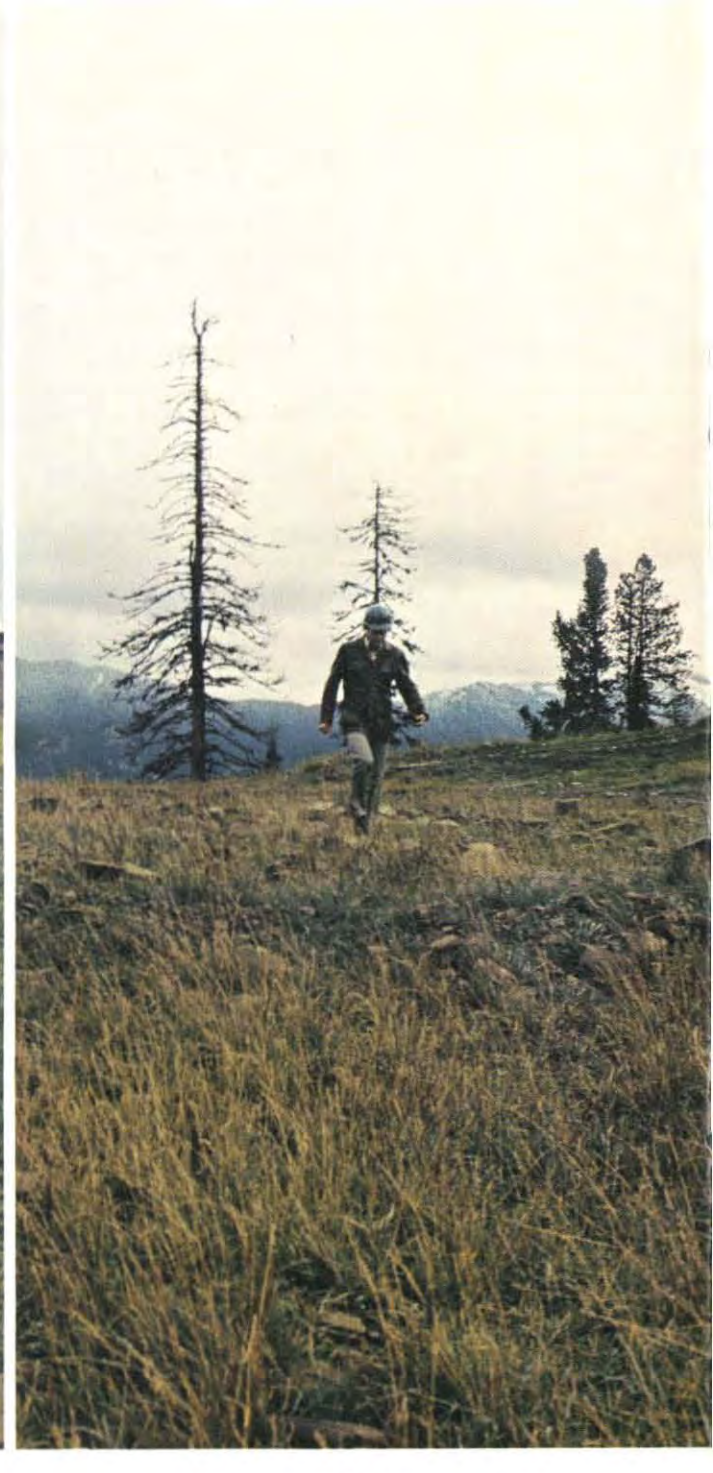
Also through research, suitable species of grasses, legumes, shrubs and trees have been selected and stock material developed in the company's greenhouse-nursery complex.

Studies conducted by government wildlife agencies indicate the reclaimed areas are providing forage as acceptable or better than adjacent native areas.

Stocks of native trees and shrubs for reclamation are propagated in the company's greenhouse-nursery complex.

Site preparation and seeding is done in the early summer.

Growth is established in the first year...



...and provides wildlife forage in a short time.

Air quality monitoring networks are operated continuously.

Loaded coal trains are sprayed with dust suppressant before departure.

ENVIRONMENTAL CONTROL to maintain water and air quality standards also is integrated with the mining, processing and transportation of coal.

During development of the surface mine site, dams were constructed on streams in the area to provide settling ponds and guard against excessive silting during runoffs from the spring thaw or from heavy rains.

Closed circuit processing operations prevent waste water from entering surface drainage systems. Plant and domestic sewage treatment systems are maintained in all operating areas. A continuous monitoring system is maintained to ensure that water quality is not being deteriorated by the company's operations.

Air quality standards are maintained by effective dust control devices in processing plants and other dust-suppressing measures, some of which have been noted. To ensure the standards are met, two extensive air quality monitoring systems are operated to report on gravimetric dust fall and suspended particulate matter.

Water and air quality standards are set by local, regional, provincial and federal governments and monitoring results are reported regularly to their appropriate agencies.

SAFETY AND TRAINING programs are integrated and co-ordinated with the needs of all operating groups.

Emphasis on safety training is continuous, beginning with the orientation of new employees. Programs include classroom and on-the-job instruction in safety rules, mine regulations, proper equipment operation, housekeeping, emergency procedures, first aid, and in surface and underground mine rescue methods.

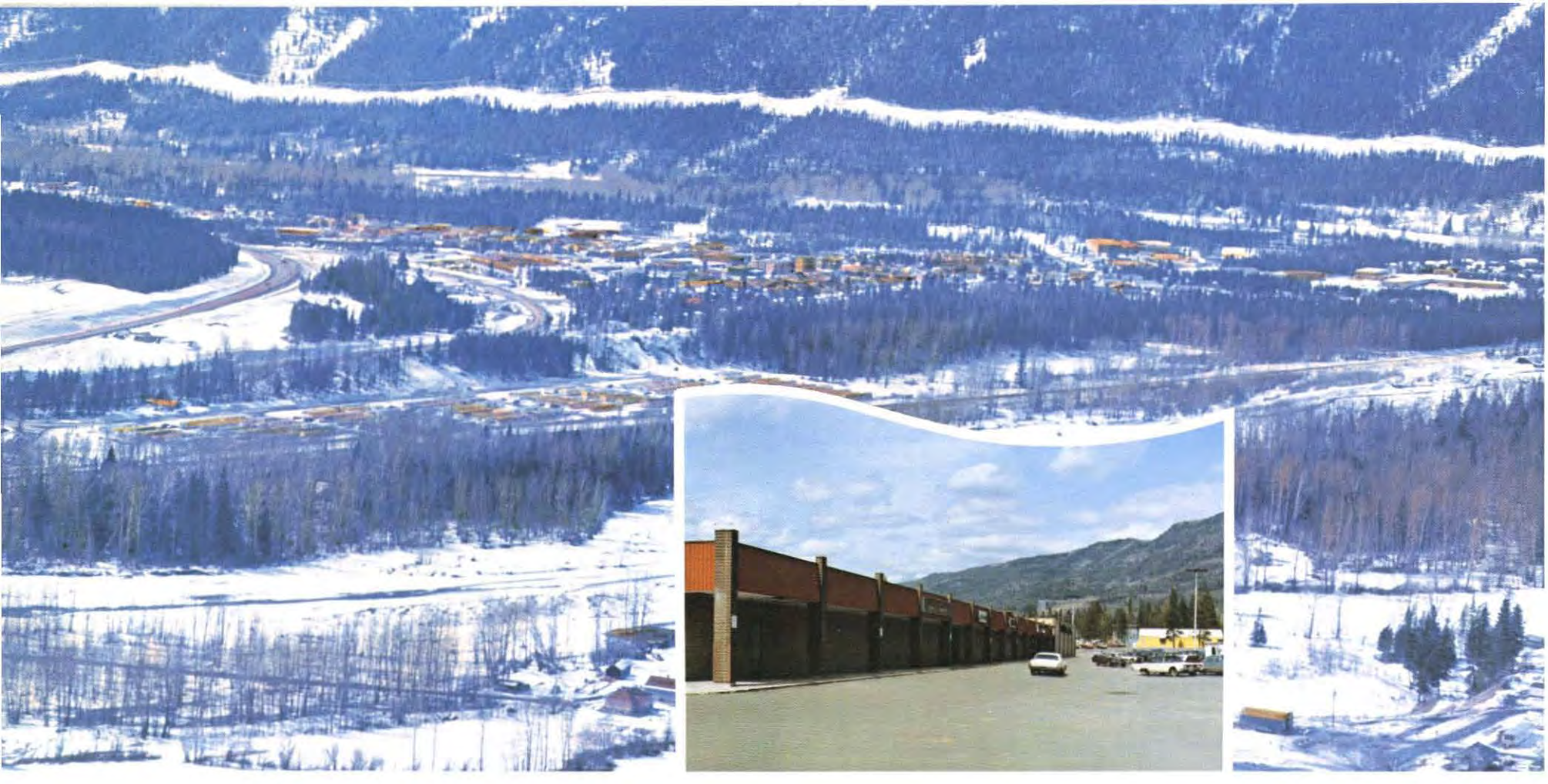
The program also includes:

- A highly-developed B.C. Safety Council awards system adopted to recognize safe work achievements.
- Regular inspection of work areas by designated safety co-ordinators under direction of a safety supervisor.
- Monthly inspections, conducted by a joint safety committee.
- Periodic safety seminars for all supervisors.
- Surface and underground mine rescue training, conducted on a continuing basis. Several teams of company employees have won major competitions.

Occupational training includes an extensive apprenticeship program, operator and trades upgrading courses, and a complete underground training program leading to qualifications as faceman.

Mine rescue training and awards program help to promote accident prevention.

Opposite:
Electronic Data Processing and warehousing are among key support facilities.



COMMUNITY DEVELOPMENT

Most of the company's employees live at Sparwood, within a few miles of the coal mining operation. Others live at Fernie, 20 miles southwest of Sparwood, and in the adjacent rural area.

Both Sparwood and Fernie are situated on Highway 3, between Cranbrook (60 miles west of Fernie) and the B.C.-Alberta boundary (10 miles east of Sparwood).

While Fernie was established in the 1890's, Sparwood is a new community. A few hundred residents relocated there from two nearby old coal towns (Natal and Michel) under a government-sponsored urban renewal program started in the late 1950's. Sparwood is incorporated as a District Municipality and has a current population of about 4,000.

In response to the social and economic impacts of its coal operation on these communities, Kaiser Resources contributed substantially to the development of housing, recreational and commercial facilities, and has undertaken an ongoing program of community development assistance.

To meet a critical housing shortage, the company initiated a home-building/home-ownership program for employees. Under the program, forgivable second mortgages are available to permanent employees to assist them in building or purchasing homes. The company also developed subdivisions at Fernie and Sparwood to make building lots available, built single and family rental accommodation, and developed a mobile home park.

To help meet Sparwood's recreational needs, the company contributed one-third of the cost of a $1.4 million complex housing an ice arena, curling rink and meeting rooms. Contributions were also made towards a new community centre at Fernie and to its golf course and skiing facilities.

A shopping mall was built at Sparwood by the company to assist commercial development.

Both communities have highly developed recreation programs including hockey, curling, skiing, snowmobiling, riding, baseball, soccer, tennis and golf. The area also offers sport fishing, boating, swimming, hunting, hiking, camping, snowshoeing and cross-country skiing.

Cultural activities include amateur theatre and stage productions, performances by visiting artists, and arts and crafts exhibits.

This Western Canadian centre of coal mining is also a land of scenic splendor, of four seasons, and of a mix of people reared in the industry and those who are new. Working together as a team, they have brought together the knowledge and experience of the past, the innovativeness of the present and enthusiasm for the future. As a team, they are building both—an efficient, highly mechanized industry and communities with a new stability.

The community of Sparwood, nestled near the Rockies in the Elk Valley, provides a wide range of social and recreational amenities.

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