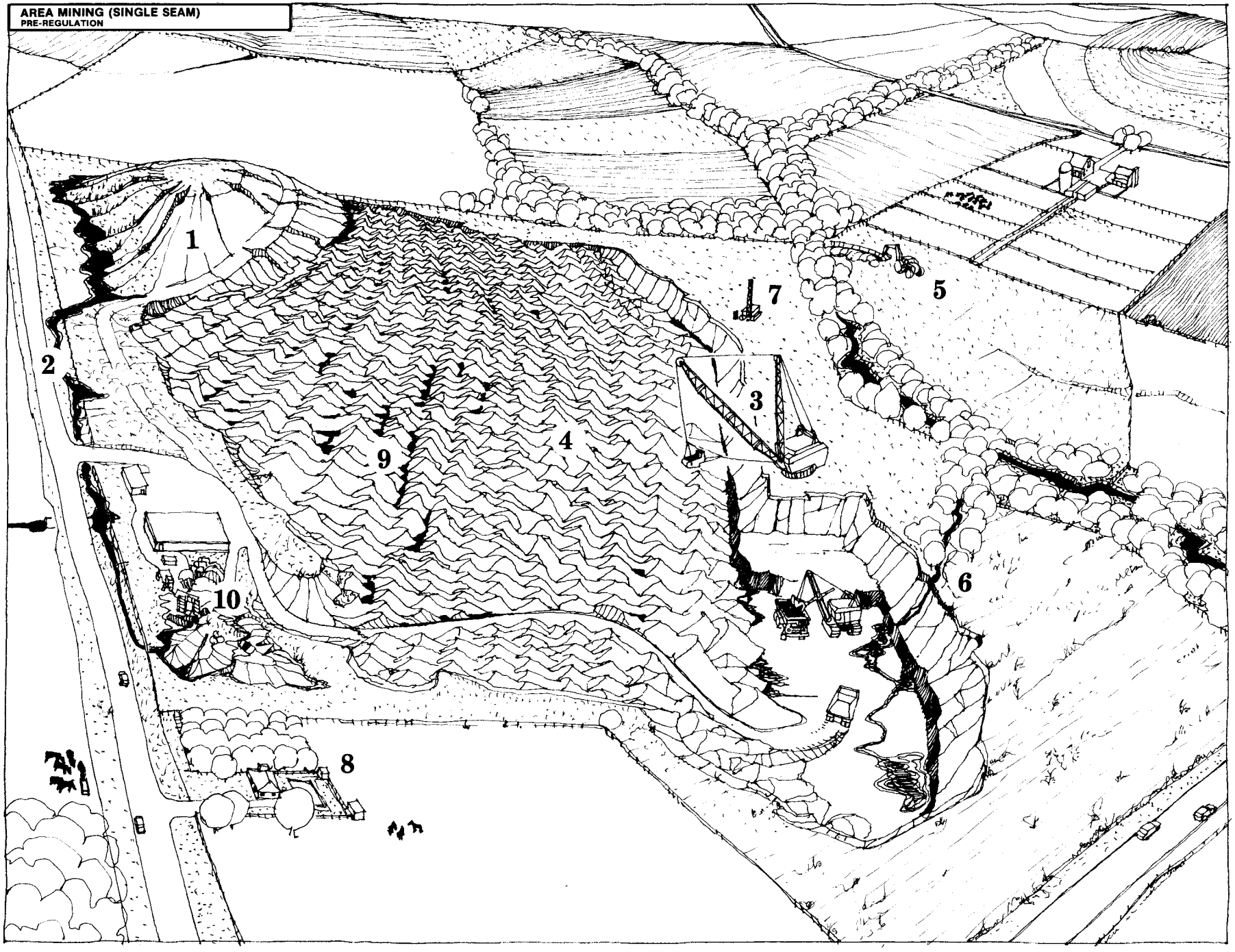
CHAPTER 4

MINING OPERATIONS

The drawings on the following pages illustrate various surface mining methods, and the operations which are involved in each. The first drawing for each method shows an unregulated mine, and the key below identifies problems which arise during and after mining and the Sections of the Regulations which are intended to solve these problems. The next drawing for each method shows phases of a mine which meet the requirements of the new Regulations. The key below identifies each operation, the Section of the Regulations relevant to that operation and the title and number of "Data Sheets" which are found in Chapters 6 and 7. These illustrations obviously do not cover all situations encountered during surface mining. However we hope that operators will be able to identify commonly occurring problems in these hypothetical examples.


AREA MINING (SINGLE SEAM)
PRE-REGULATION
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AREA MINING (SINGLE SEAM)
PRE-REGULATION

More coal is extracted using area mining than by any other technique. However, due to the economics of scale most operations are large. Much of the coal which is exploitable by area surface mining is found in states west of the 100th meridian but large quantities are also found in midwestern states, often beneath good farmland.

Small operators are probably more likely to work a site using scrapers, dozers and/or loader-truck or shovel-truck combinations; but some will use draglines or shovels as the prime earthmovers. Shown here is a dragline, working a single seam site with a ratio of overburden to coal of about 8:1 and swell factor of 10%, prior to any regulations requiring reclamation.

In order to be economic, area mining operations must minimize double handling of overburden. Thus, a pile of overburden is usually made close to the initial box-cut. The overburden from subsequent cuts is then cast into the previous cut leaving a series of hills and dales. Upon completion of the mining operations prior to the enactment of regulations, the final cut remained, often partially filled with water and with the highwall exposed.

Depending on the machinery and working methods being used, spoil was usually inverted, the topsoil and subsoil being buried, the strata close to the coal on top. This often resulted in a surface layer which was unsuitable, chemically or physically, to support plant life.

Where this technique is used, the problems of soil erosion are not as severe as in the case of mining in mountainous terrain; nor is acid mine drainage, mostly because runoff is easier to control. Nevertheless, where large areas are stripped at one time, and no reclamation is carried out, the impact of area mining in terms of loss of farmland, deterioration of the quality and quantity of surface and groundwater and other environmental values can be serious.

The Regulations

The Regulations require that all land which is surface mined is restored to its "approximate original contour." This means that some double handling of spoil from the initial box-cut will be required. The highwall and all depressions must be eliminated and, to do this, hauling much of the box-cut spoil will be necessary. All topsoil must be removed separately and placed on reclaimed areas immediately when possible. The Regulations require a minimum delay in restoration so that it proceeds in conjunction with the working.

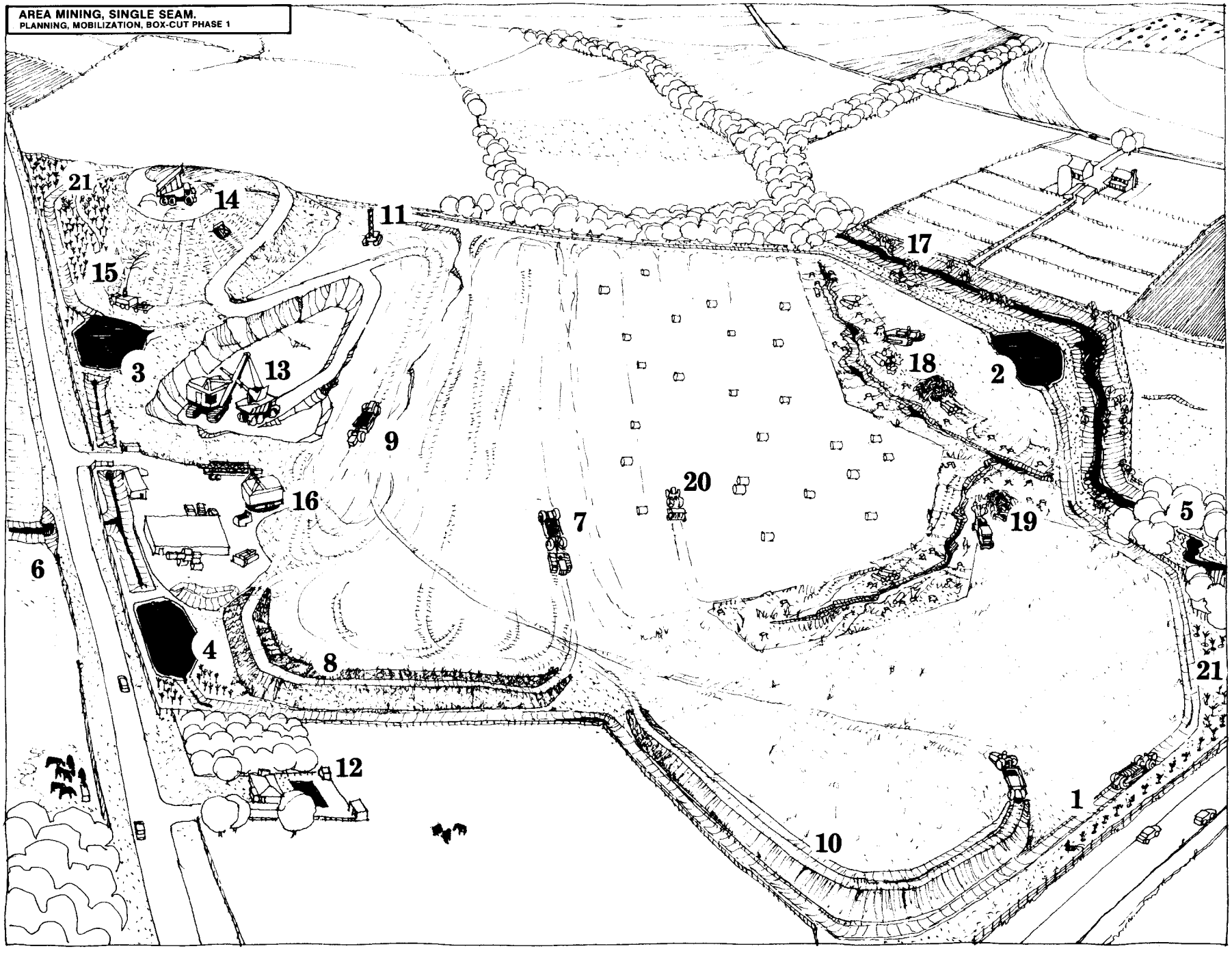
These operations require careful pre-planning if machinery is to be fully and effectively utilized while meeting the requirements of the Regulations.

In cases where the land is classified as "prime farmland" special performance controls will be enforced. These include the requirement that 4' of soil and soil material be reconstructed during reclamation. If an operator is using scrapers to remove topsoil and unconsolidated (drift) overburden, and to replace these materials on regraded areas immediately, this requirement may not increase costs of earthmoving greatly if the operations are planned carefully.

**Regulatory Program promulgated by the Office of Surface Mining of the Department of the Interior in accordance with the Surface Mining Control and Reclamation Act of 1977.*

OPERATION KEY	OPERATION DESCRIPTION	PROBLEMS
	(NOTE: Text includes references to illustration opposite.)	
1	Overburden from an initial box-cut is dumped on a spoil heap (1) using scrapers or shovel/dump-truck combination.	— Topsoil and subsoil are not stripped from the box-cut and stockpiled but are dumped with overburden. — Topsoil is buried beneath the soil heap. — Overburden on spoil heap begins to erode immediately. If pyrite is present in the spoil, acid mine drainage may be a problem. — Sediment as a result of erosion causes surface water pollution and (in this case) is clogging roadside ditches and culverts (2).
2	Ditching	
3 4	Dragline (3) casts overburden from subsequent cuts into the one before in a continous digging operation. A series of ridges and furrows (hill and dale) results (4).	— Topsoil is mixed with overburden. — Acid-forming material, drift overburden and solid overburden are cast in no orderly way resulting in spoil of highly diverse quality, which is often unsuitable for survival and growth of vegetation. — The physical form of hill and dale does not allow any economic post-mining land use.
5 6	Backhoe (5) digs diversion for stream which will be mined through. The size of the channel is based on the operator's judgment.	— A tributary of the stream is already being mined through (6) resulting in some backflow into the pit making pit dewatering a major problem. — Poorly designed and constructed diversions will result in water pollution, flooding and bank erosion problems.
7 8	Drilling rig (7) drills and shoots overburden.	— Probably due to fracturing of the aquifer, groundwater at farmers well (8) has been polluted and the yield has become unreliable.
9	Runoff collects in "dales" (9) and seeps into the unconsolidated overburden.	— Where overburden contains pyritic materials, acid drainage will result. This can contaminate groundwater resources.
10	Dumping of miscellaneous refuse from the maintenance yard (10).	— This is an eyesore and a nuisance to the nearby dwelling. It can also cause a pollution hazard to surface water.
11	Unrestored land results in permanent loss of farmland (11 not shown).	— Unrestored mine lands may continue to erode and contribute sediment and acid drainage to receiving waters for years after mining ceases.

REQUIREMENTS OF THE REGULATIONS* SECTION	REQUIREMENT
816.21	Before disturbance of an area, topsoil and subsoil to be saved must be removed and segregated from other materials. This includes topsoil from areas to be used for spoil dumps, haul roads, diversions and sedimentation ponds. Topsoil shall be
816.23	stockpiled "only when it is impractical to promptly redistribute such materials on
815.45	regraded areas." The temporary mound of box-cut spoil should be protected from erosion by mulching and seeding. "All surface drainage from the disturbed
816.42(a)	area . . . shall be passed through a sedimentation pond." Discharges of water from disturbed areas are also sub-
816.42(a)(7)	ject to effluent limitations.
816.101	Rough backfilling and grading shall be completed within 180 days following coal removal and shall not be more than
816.103	four spoil ridges behind pit being worked. Any acid-forming or toxic-forming materials identified in the "Geology Description" [779.14] must be selectively handled and be covered with a minimum of 4' of non-toxic material.
816.44	Diversions must be approved by the RA. Temporary diversions must be designed to carry runoff from a 10 yr/24 hr precipitation event. Permanent diversions must
816.44(d)	be designed for a 100 yr/24 hr event, and they should be restored to "approximate pre-mining stream characteristics" including pools, riffles, meanders, etc.
816.62	Where mining operations are carried out within ½ mile of a dwelling, the owner can request a pre-blasting survey which shall give special attention to the condition of wells.
816.50	Mining shall be carried out to prevent discharge of acid, or otherwise harmful drainage water into groundwater systems.
816.89	"Disposal of non-coal wastes" shall be placed in a controlled manner in a designated portion of the permit area.
Part 823	Part 823 contains special performance standards for restoration of prime farmland.
816.116	Part 816, however, requires restoration of other farmland to a level of productivity of at least 90% of the productivity of the approved reference area.


AREA MINING, SINGLE SEAM.
PLANNING, MOBILIZATION, BOX-CUT PHASE 1
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AREA MINING, SINGLE SEAM.
PLANNING, MOBILIZATION, BOX-CUT PHASE 1

If area mining is carefully preplanned and carried out in an orderly way, it is usually feasible to restore land to its original productivity within a short period and to minimize the impact on surface water and groundwater during and after working.

It is also possible to plan contemporaneous reclamation operations to occur steadily as mining progresses without incurring large increases in earth-moving costs. The importance of avoiding the double handling of overburden to the economics of area mining is recognized. However, it may be necessary to rehandle much of the overburden taken from the first box-cut in order to fill the final void and to eliminate the highwall. In cases where there is excess of fill in the site [816.105] it may be possible to place much of the overburden from the first box-cut permanently and avoid the need to double handle it as backfill for the final void.

The control of surface water on area mine sites is usually much easier than on contour mines. Points at which drainage from the site is discharged can be minimized. In the illustrated example drainage and overland flow is directed around the edge of the permit area in diversions to sedimentation ponds before discharging into receiving waters.

When the site is "prime farmland" the special performance standards in Part 823 apply. Whether or not the site is prime farmland is determined during the application process [779.27]. This Section contains a list of conditions, any one of which will result in the land not being classified as prime farmland. One important condition is that the Soil Conservation Service soil survey has not designated any soil map units as prime farmland.

Probably the major difficulty posed by the new Regulations for the small surface mine operator will be the greater amount of machinery required and the precision with which the operation must be planned to avoid delays. The requirement for contemporaneous reclamation will increase the importance of scrapers in the operation, and the requirement to transport box-cut spoil (to eliminate depressions and the highwall) will necessitate a large number of haulage trucks.

The Small Operator Assistance Program provides assistance for the small operator during the application process, notably with the analysis of overburden from core samples and assessment of the impact of the proposed mining activities on surface and groundwater [Part 795]. In spite of this assistance, the operator will be well aware of the need for careful preplanning of area mining operations if the requirements of the Regulations are to be met.

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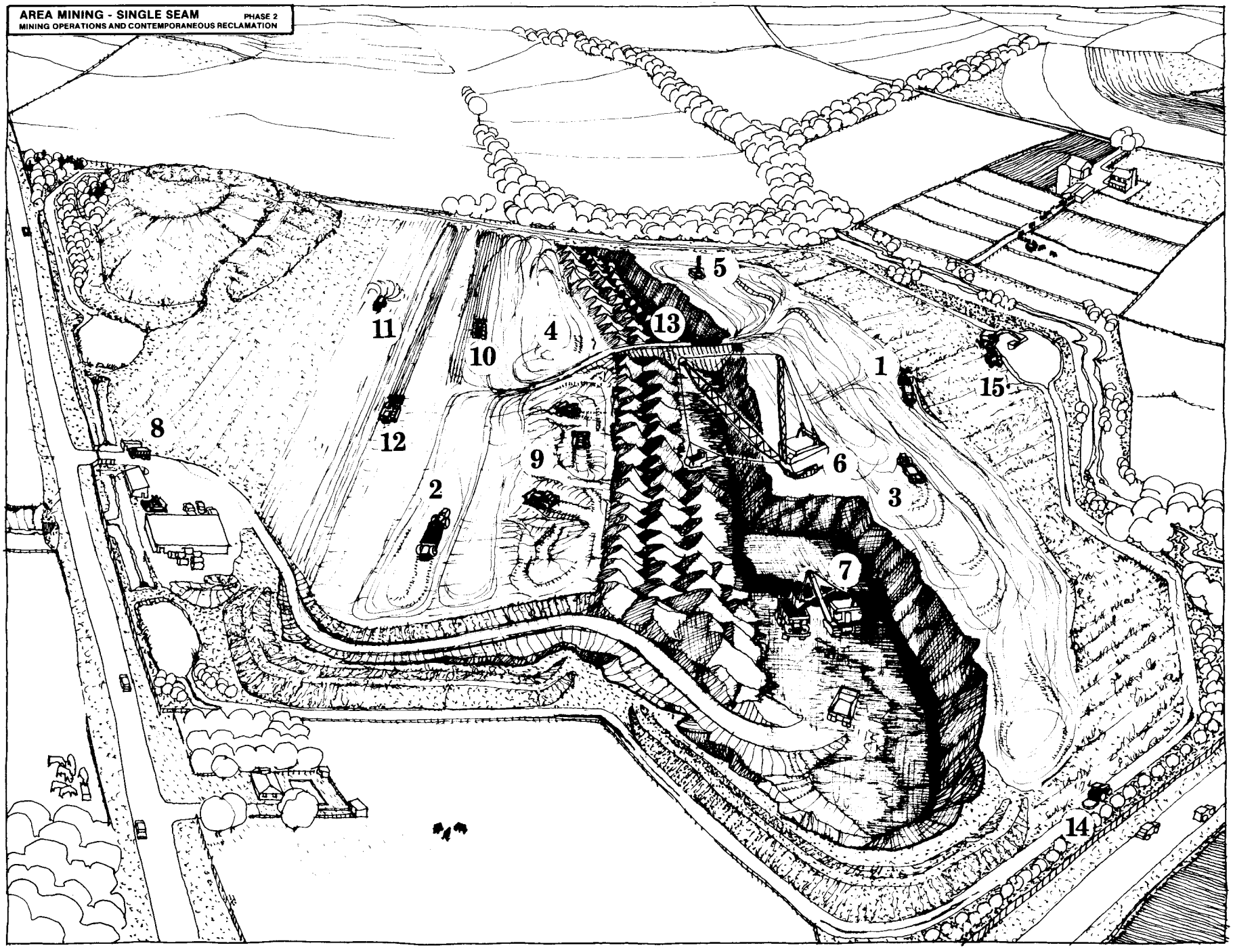
OPERATION		REQUIREMENT OF THE REGULATIONS*		DATA SHEET	
KEY	DESCRIPTION OF OPERATION	SECTION	REQUIREMENT	SHEET TITLE	NO.
(NOTE: Numbers in text refer to illustration opposite.)					
1	Diversions to convey overland flow around the edges (1) of the site both to minimize interference with mining, and to reduce contamination of stormwater have be constructed.	816.43	"Overland flow . . . and flow in ephemeral streams may be diverted away from the disturbed area by means of temporary or permanent diversions." Temporary diversions to be designed for a 2-year storm.	Stream diversions: Overland flow and ephemeral streams.	6:4
2-4 5,6	Flow from these diversions pass through three sedimentation ponds (2,3,4) prior to discharge from permit area (5,6). These ponds must be constructed before disturbance of the site.	816.42(a)(1) 816.46(a)(1)	"All surface drainage from the disturbed area . . . passed through a sedimentation pond." "Sedimentation ponds shall . . . be constructed before any disturbance of the . . . area to be drained into the pond."	Sedimentation Ponds	6:3
7 8	Topsoil is being removed by scraper (7) and stockpiled (8). Topsoil beneath the spoil dump (14) was also removed.	816.21 816.22 816.23	Topsoil: General Requirements. Topsoil: Removal. Topsoil: Storage.	Clearance of vegetation and removal and storage of topsoil	6:6
9 10	Unconsolidated (drift) overburden is being removed by scraper (9). Subsoil is being stockpiled (10) and the rest is being used to cover consolidated overburden on the spoil dump (14).	816.22(d)	"The B horizon and portions of the C horizon . . . shall be segregated and replaced as subspoil if the regulatory authority determines that . . . [it] is necessary."		
11	Drilling rig (11) drills consolidated overburden which is then shot.	816.62	A resident or owner of a dwelling within ½ mile of the permit area may request a pre-blasting survey to be carried out.		
12	Dwelling with a water supply well (12).				
13 14	Shovel digs first box-cut (13). Spoil is transported by dump truck to spoil dump (14). This is graded with maximum slopes of 1v:2h and covered with subsoil.	816.101	Box-cut spoils will largely have to be transported to the final cut. However, the RA in this case is permitting some of the box-cut spoils to be placed permanently and the left-hand slope of the spoil dump has been topsoiled and planted.	Temporary Spoil.	6:7
15	A hydroseeder (15) applies seed and fertilizer to the temporary spoil mound (14) and to the stockpiles of topsoil and subsoil (8,10).	816.23(b)	"Stockpiled materials shall be . . . protected from wind and water erosion. . . " Protection is usually accomplished by seeding with a cover crop of annual and perennial species.	Cover Crops.	7:11
16	Dragline assembly (16) is in progress. Construction of office and maintenance yard is complete.	816.150- 816.155	These Sections contain performance standards for Class I roads which will apply to the area here and to the access to the public road.	Haul Roads.	6:2
17	The stream has been diverted permanently (17). The channel has been graded and and constructed to reflect its natural character. The design standards for permanent diversions are more stringent than for temporary diversions, but the latter must be restored.	816.44(a) 816.44(b)(2) 816.44(d)	Flow from perennial streams . . . may be diverted only with the approval of the RA. Permanent diversions must be designed to carry flow from a 100 yr/24 hr precipitation event. The natural riparian vegetation and other natural characteristics of the stream should be restored.	Stream diversions: Perennial and intermittent streams.	6:5
18	Logging and destumping (18) are in progress along the old stream channel.	816.22(a)	This Section requires that "vegetative cover that would interfere with the use of the topsoil is cleared from the areas to be disturbed."	Clearance of vegetation and removal and storage of topsoil.	6:6
19	Slash from clearance is being chipped (19) for use as mulch.				
20	Note that much of the permit area is still in agricultural production (20), in this case a crop of mulch hay being harvested under contract for use during restoration. A feature of area mining is that it allows the minimum area of the site to be disturbed at any one time. The new Regulations emphasize the importance of minimizing the area disturbed and of contemporaneous reclamation.	816.22(f)(1) 816.45(b)(1)	"The size of the area from which topsoil is removed at any one time shall be limited." . . . Disturbing the smallest practicable area at any one time during the mining operation."	Mobilization and mining operations: General.	6:1
21	The operator has planted trees (21) on some areas of the site which will not be affected by mining.		This action is not required by the Regulations.	Revegetation: Trees and Shrubs.	7:13


AREA MINING - SINGLE SEAM
PHASE 2
MINING OPERATIONS AND CONTEMPORANEOUS RECLAMATION
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AREA MINING - SINGLE SEAM — PHASE 2
MINING OPERATIONS AND CONTEMPORANEOUS RECLAMATION

Section 816.100 (Contemporaneous Reclamation) of the Regulations requries that "reclamation efforts, including. . .backfilling, grading, topsoil replacement and revegetation of all land that is disturbed by surface mining activities shall occur as contemporaneously as practicable with mining operations." The reclamation plan[780.18], required as part of the application process, must contain "a detailed timetable for the completion of each major step in the reclamation plan."

Section 816.101 requires that in area strip mining "rough backfilling and grading shall be completed within 180 days following coal removal and shall not be more than four spoil ridges behind the pit being worked. . ." In the illustrated example, the operator is ahead of this deadline.

Contemporaneous reclamation demands very careful allocation of machinery and preplanning, but the feasibility of contemporaneous reclamation in area mining is a feature which makes this form of mining more acceptable environmentally than most other forms of surface extraction. In the example shown, the operator has placed a temporary ramp across the pit to reduce the haul for scrapers carrying out contemporaneous stripping and replacement of unconsolidated overburden and topsoil.

Contemporaneous reclamation ensures that a minimum part of the permit area is disturbed at one time and therefore the hazards of erosion and water pollution are minimized. Note that in the illustration the land at the left of the site has already been regraded, topsoiled and revegetated. (Disturbance of the temporary spoil mound will occur at a later date.)

The temporary spoil mound and the stockpiles of topsoil and subsoil are protected from erosion by vegetation, and they will remain undisturbed until the backfilling of the final cut begins.

The diversions which carry overland flow from the site to the sedimentation ponds are kept mown in order that the resistance of the grass to erosion will not be reduced. One of the sedimentation ponds shown here is being dredged. This is required when sediment accumulates to 60% of the design sediment storage volume.

In order to clarify the method of working, some machines are shown more than once on this drawing. It is unlikely for instance that, on a site of this size, there would be 4 scrapers. Coaling may be done with a loader rather than a shovel as shown, and the operator will be able to find other unrealistic details in this example.

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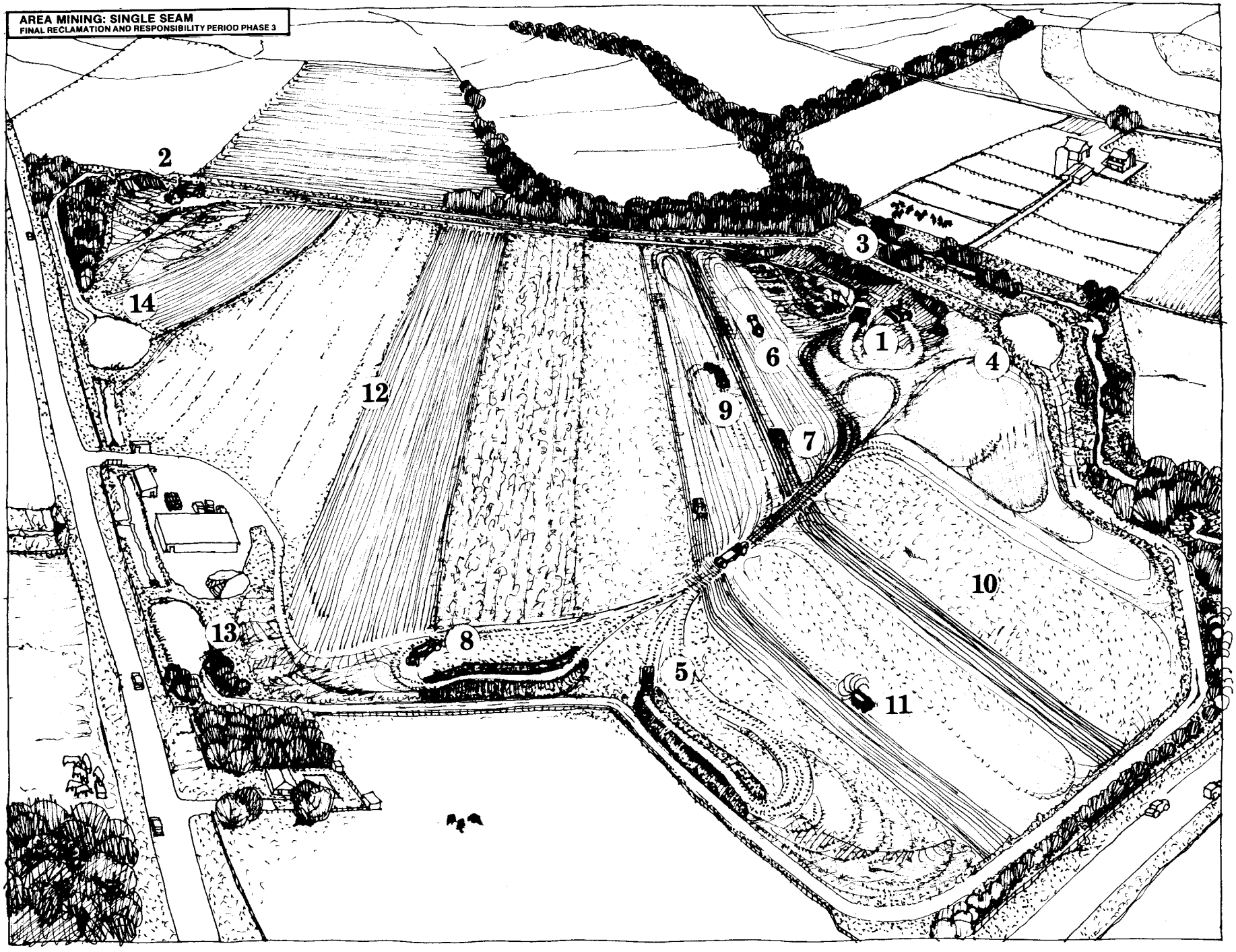
OPERATION KEY	DESCRIPTION OF OPERATION	REQUIREMENT OF THE REGULATIONS* SECTION	REQUIREMENT	DATA SHEET SHEET TITLE	NO.
	(NOTE: Text includes references to illustration opposite.)				
1 2	Scrapers remove topsoil (1) and redistribute immediately on the area being restored (2).	816.23(a)	"Topsoil . . . shall be stockpiled only when it is impractical to promptly redistribute . . . on regraded areas."	Removal and storage of topsoil	6:6
3 4	Scrapers remove subsoil and unconsolidated "drift" overburden (3) redistributing immediately (4) following rough grading of the cast spoil.	816.22(d) Part 823	The regulations do not require subsoil to be replaced separately unless the RA determines that it is necessary. In the case of prime farmland [Part 823] a minimum of 4' of soil material must be reconstructed.	Replacement of topsoil and cultivation	7:5
5	Drilling rig (5) bores blast holes, and shoots unconsolidated overburden.	816.61- 816.68	Preblasting surveys may be required. All blasting must be between sunrise and sunset and a blasting schedule must be published.		
6	Dragline (6) digs and casts overburden onto previously mined area.				
7 8	Shovel (7) digs coal which is removed by road trucks which are weighed and cleaned (8) prior to entering the public highway.	701.5 816.150- 816.176	Roads within the "immediate mining pit area" are not subject to the performance controls relating to haul raods in Part 816, but all others are.	Haul roads	6:2
9	Bulldozers carry out rough grading (9) of overburden followed by replacement of unconsolidated overburden by scrapers (4). Grading should approximate to general nature of pre-mining topography.	816.101(a)(3) 816.101(b)(1) 816.102(a)	"Rough grading shall be completed within 180 days following coal removal and shall not be more than four spoil ridges behind the pit being worked. . ." "All disturbed areas shall be returned to their approximate original contour." "Post-mining final graded slopes need not be uniform but shall approximate the general nature of the pre-mining topography.	Rough backfilling and grading	6:10
10	Crawler (10) sacrifies the area prior to the replacement of topsoil (2) to reduce compaction of regraded spoil. On sloping sites, regrading operations should be parallel to the contour.	816.24(a) 816.102(e)	"After final grading and before the replacement of topsoil . . . regraded land shall be scarified. . ." "All final grading, preparation of overburden before replacement of topsoil . . . shall be done along the contour. . ."	Final grading Replacement of topsoil and cultivation	7:3 7:5
11	Lime spreader (11) in operation and the necessary fertilizers are also spread.	816.25	"Nutrients and soil amendments in the amounts determined by soil tests shall be applied to the redistributed surface soil layer. . ."	Soil amendments: lime and fertilizer	7:6
12	Cultivation and seeding (12) takes place. These operations should be carefully timed and the seed mix chosen to ensure satisfactory growth. The area must be mulched unless the RA suspends the requirements.	816.111(b) 816.113 816.114(a)	"All revegetation shall be. . .carried out in a manner which encourages a prompt vegetative cover. . ." "Seeding. . .shall be conducted during the first normal period for favorable planting conditions. . ." "Suitable mulch. . .shall be used. . ."	Revegetation: general Revegetation: herbaceous species Chemical stabilizers Cover crops Mulches	7:12 7:14 7:14 7:10 7:11 7:9
12	A temporary ramp (13) across the working pit reduces the haul for scrapers involved in contemporaneous stripping and regrading. It will be mined through and then replaced by the dragline.	816.100	This facilitates the requirement of the performance controls for contemporaneous reclamation.		
14	Grass in the waterways is being mown (14) as are the embankments of the sedimentation ponds to ensure the erosion resistance of vegetation.	816.43	"Hydrologic balance: diversions and conveyance of overland flow. . ." This Section does not require diversions to be mown but this will help to prevent erosion.	Stream diversions: overland flow Grass waterways	6:4 6:4 7:4
15	Sedimentation pond is being cleaned out (15) because accumulations of sediment are reducing its effectiveness.	816.46(h)	"Sediment shall be removed from sedimentation ponds when the volume of sediment accumulates to 60% of the design storage volume.	Sedimentation ponds	6:3


AREA MINING: SINGLE SEAM
FINAL RECLAMATION AND RESPONSIBILITY PERIOD PHASE 3
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AREA MINING: SINGLE SEAM
FINAL RECLAMATION AND RESPONSIBILITY PERIOD PHASE 3

The Regulations require not only restoration of land to pre-mining productivity levels but also require that changes in quality and quantity of both surface water and groundwater are minimized [816.41].

Section 816.116 (b) (3) requires that the success of revegetation of areas to be used for cropland be judged in comparison to an approved reference area. Areas proposed for pasture [816.115] must have a grazing capacity equal to that of similar non-mined lands. The "period of extended responsibility" under the performance bond requirements of Subchapter J continues for a period of five years (in areas with more than 26" of rain which includes all areas covered by this Handbook). "Ground cover and productivity shall equal the approved standard for the last two consecutive years of the responsibility period" [816.116(b) (1) (i)].

When permit areas are 40 acres or less, reference areas as a standard for revegetation success can be replaced by standards set out in Section 816.116(d), and then only with the approval of the RA. The responsibility period and success standards are longer and more stringent on prime farmland [Part 823].

Note that in the illustrated example, a 2-acre lake (1) has been proposed as a farm pond for livestock. Under Section 816.49(a) "permanent impoundments are prohibited unless authorized by the RA." The proposal, however, is quite compatible with the proposed post-mining uses and would probably be allowed. Unless approval for this variance is obtained from the RA, Section 816.101(b) (1) requires that "all spoil shall be transported, backfilled and graded to eliminate all highwalls, spoil piles and depressions." This, in effect, would disallow any of the box-cut spoil remaining on the site of the temporary dump as has been shown (the wooded slope at the left will remain and the remainder graded to a gentle slope). However, the RA has discretionary powers to establish the final provisions for the disposal of box-cut and it is felt that, in this example, transportation of box-cut spoil to the final cut is encouraged in order that the requirements of 816.101(b) (1) for elimination of highwalls, spoil piles and depressions be satisfied to a reasonable degree without requiring rehandling of **all** box-cut spoil.

Note that 816.102 specifies that slopes need not be uniform but in "general nature" should approximate to pre-mining topography. With a bulking factor less than the ratio of coal to overburden, the final grades must be lower than in pre-mining terrain. The important consideration is to make sure that surface drainage is feasible across the site which would make uneven lowering of the site necessary and occasionally changing convex slopes to concave thus insuring surface drainage.

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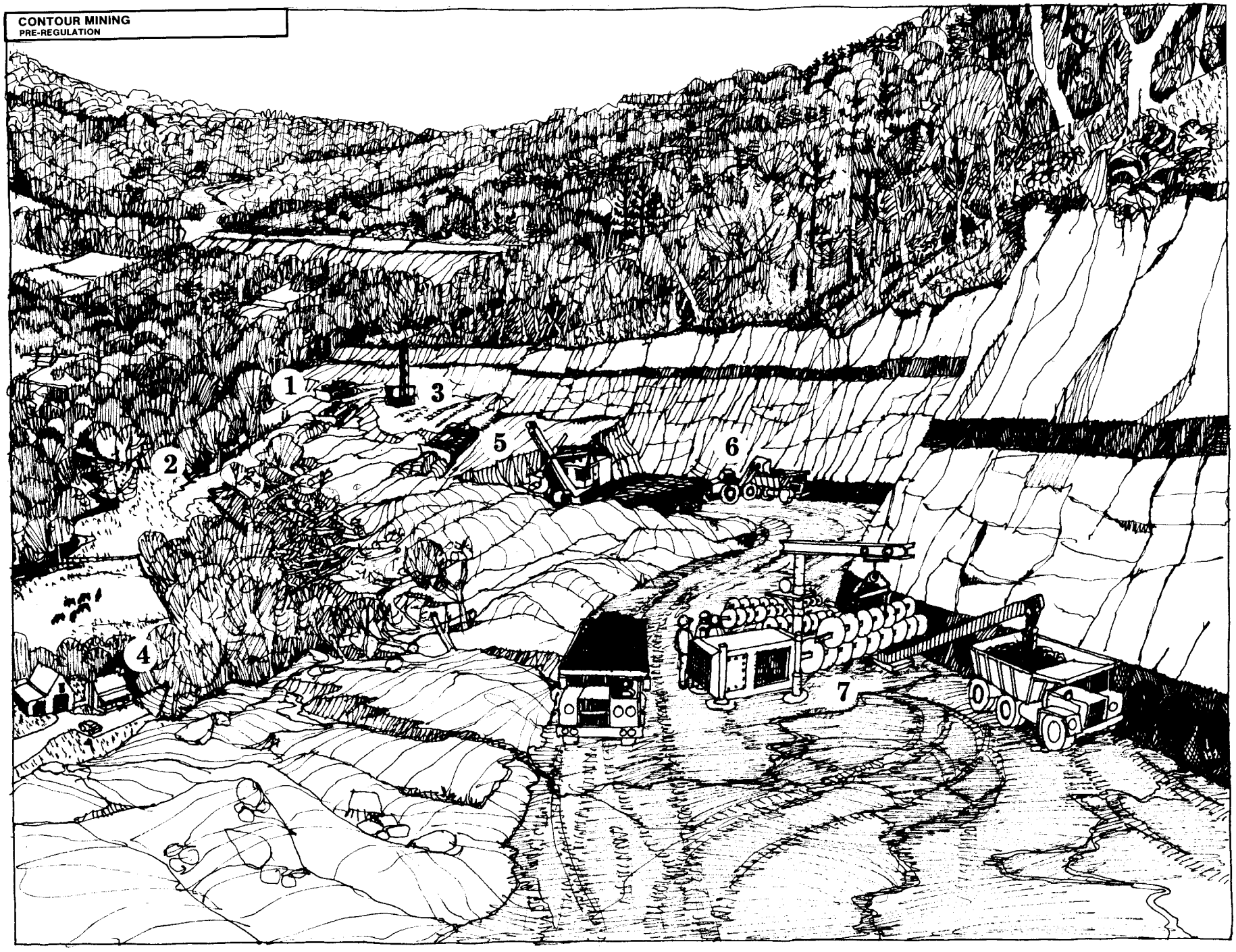
OPERATION KEY	OPERATION DESCRIPTION	REQUIREMENT OF THE REGULATIONS* SECTION	REQUIREMENT	DATA SHEET SHEET TITLE	DATA SHEET NO.
	(NOTE: Text includes references to illustration opposite.)				
1 2 3 4	Bulldozers carry out grading in the final void (1) which has been partially filled from the box-cut stock pile (2). Dump trucks (2) bring the loads of stockpiled overburden, partially back-filling the final void. The highwall, which is still just showing (3), will be completely eliminated. The depression (1) will remain in part to form a 2-acre lake for livestock also incorporating the sedimentation pond (4).	816.101(b)(1) 816.102(a) 816.49(a)	". . . all disturbed areas shall be returned to their approximate original contour. All spoil shall be transported, backfilled, compacted. . . and graded to eliminate all highwalls, spoil piles and depressions." "Post-mining final graded slopes need not be uniform but shall approximate the general nature of the pre-mining topography." Stockpiling and transportation of box-cut spoil to the final cut is encouraged. Permanent impoundments are prohibited unless authorized by the RA.	Rough backfilling and grading. Temporary spoil	6:10 6:7
5 6	Scraper removes stockpiled subsoil (5) for spreading on the backfilled cut (6). The area of this stockpile will require soil amendments, cultivation and seeding.	816.23(b)	Stockpiled materials shall not be disturbed until "required for redistribution on a regraded area."	Rough backfilling grading	6:10
7	A ripper pulled by a crawler tractor (7) scarifies the regraded area to reduce the compaction of regraded spoil prior to the replacement of topsoil (9). On sloping sites all regrading operations must be carried out parallel to the contour.	816.24(a) 816.102(e)	"After final grading and before the replacement of topsoil . . . regraded land shall be scarified . . ." "All final grading, preparation of overburden before replacement of topsoil . . . shall be done along the contour . . ."	Final grading	7:3
8,9	Scraper returns to topsoil stockpile (8) after spreading (9). After removal, stockpile area must be cultivated and seeded. In the case of prime farmland refer to Part 823.	816.24(b) Part 823	"Topsoil . . . shall be redistributed in a manner that achieves an approximate uniform, stable thickness consistent with the approved post-mining land uses . . . prevents excess compaction. . . and protects topsoil from . . . erosion . . ." Topsoil requirements on prime farmland.	Replacement of topsoil and cultivation	7:5
10	After final grading and topsoiling, this area (10) was seeded with a **temporary** cover crop as the season was not correct for seeding the permanent species. It is now being cultivated and lime and fertilizer spread before seeding perennial species.	816.114(c)	"Annual grasses and grains may be used alone . . . or in conjunction with another mulch when the RA determines that they will provide adequate soil erosion control and will later be replaced by perennial species . . ."	Cover crops Soil amendments; lime and fertilizer	7:11 7:6
11	Lime and nutrients have been applied in this area (11) which is being cultivated and seeded. The area must be mulched after seeding unless the RA suspends the requirement.	816.113 816.114(a)	"Seeding . . . shall be conducted during the first normal period for favorable planting conditions after final preparation." "Suitable mulch . . . shall be used . . . The regulatory authority may . . . suspend the requirement for mulch, if . . ." (see Regulations)	Soil amendments . . . Revegetation: Herbaceous species Mulches Chemical stabilizers	7:6 7:14 7:9 7:10
12	These areas (12) are being managed for grazing and cropland. "The period of extended responsibility" [816.116(b)] lasts for 5 years and begins "when ground cover equals the approved standard after the last year of augmented seeding, fertilizing. . .or other work. . ." Note that the 5-year responsibility period is applicable where annual precipitation is more than 26" (i.e., all areas covered by this Handbook). Elsewhere the period is 10 years.	816.115 816.116(b)(3)	When the approved use is pasture land, the grazing capacity must be approximately equal to that of "similar non-mined lands." This stand must be met for at least 2 years of the 5-year responsibility period. For areas to be used for cropland, success of revegetation will be judged by comparison with an approved reference area. Crop production must be equal to or greater than that of the approved standard for the last 2 growing seasons of the responsibility period.	Revegetation: General Revegetation: Herbaceous species	7:12 7:14
13,14	Sedimentation ponds (4,13,14) are still in position as all reclamation in areas drained by them has not been completed.	816.46(u)	Sedimentation ponds shall not be removed until the disturbed area has been restored and the revegetation requirements of Sections 816.111-816.117 are met.	Sedimentation ponds	6:3


CONTOUR MINING
PRE-REGULATION
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CONTOUR MINING
PRE-REGULATION

In the eighteenth century coal was discovered outcropping in the hills of Virginia. Settlers began to dig into these outcrops, removing the coal until the amount of overburden above the coal became too great. Then drift tunnels were cut into the seams. Overburden and debris from these operations were pushed over the downslope.

With mechanization, it was possible to remove much more overburden from above the coal seam before it became uneconomic. All this spoil, together with trees, vegetation and debris was pushed onto the downslope. These spoil banks eroded, depositing huge volumes of sediment in the streams. The overburden lying directly above the coal was usually dumped on the top of these spoil banks, and, because this often contained pyrite and other acid-forming minerals, the drainage from these banks was frequently highly acidic.

Spoil dumped onto steep outslopes was very unstable and landslips were common. The high rainfall and the method of dumping resulted in unconsolidated spoil with a very low shear strength. The shear stress was high in the steep terrain. Slips of abandoned spoil banks resulted in exposure of unweathered spoil which tended to prolong the problem of acid mine drainage, and to delay the natural colonization of vegetation.

Auger mining helps to increase the recovery of coal when it is no longer economic to strip overburden from the seam. However, though augering increases the recovery of coal, it has a low percent recovery rate and effectively makes it impossible to extract nearby coal by deep mine operations in the future. Unplugged auger holes are a serious source of acid mine drainage. Sometimes auger holes penetrated flooded, abandoned deep mines releasing large quantities of polluted water.

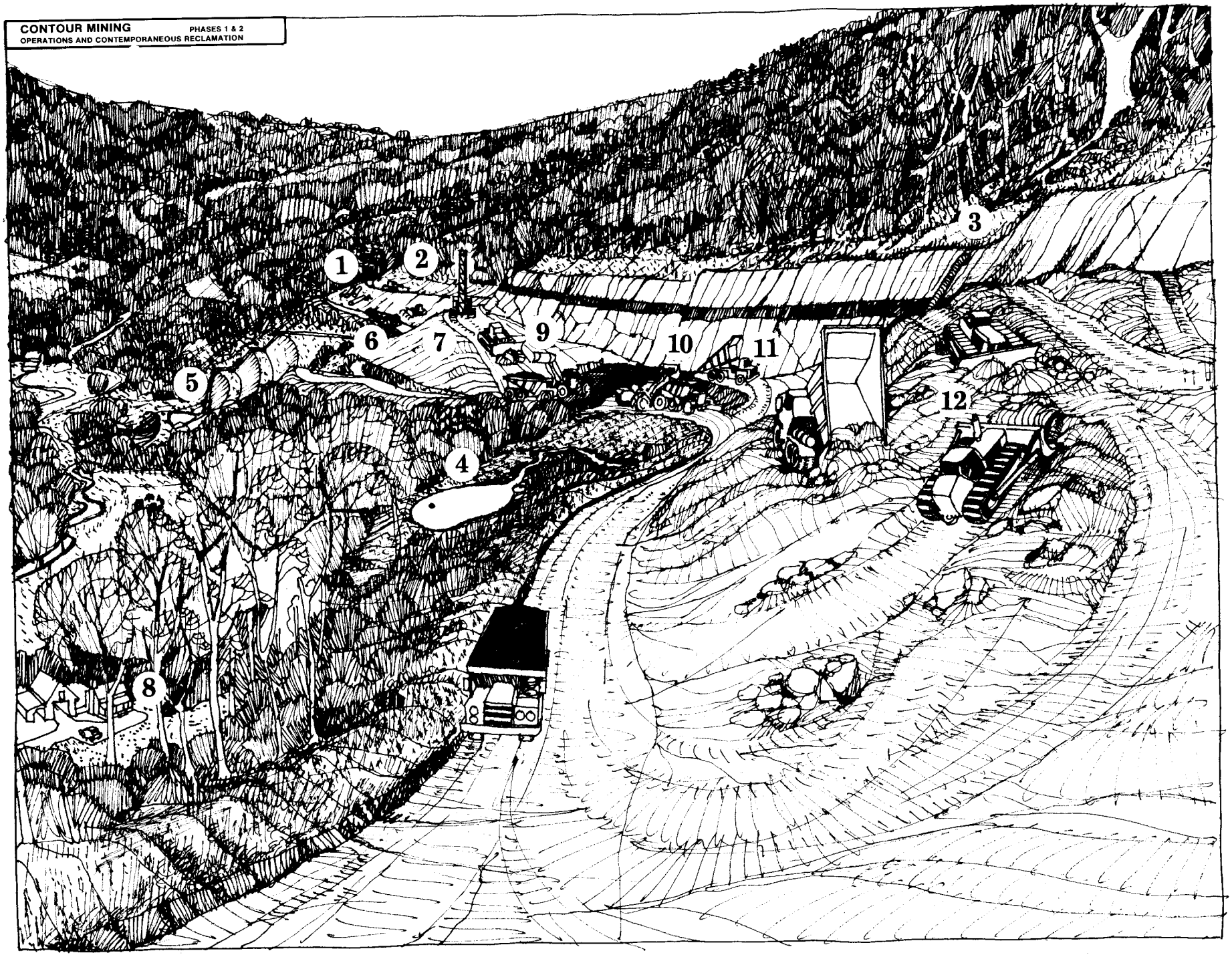
When coaling was complete the mine was abandoned and natural succession began. However, the spoil banks on the downslopes were steep and continued to erode exposing more acid-forming minerals to weathering. Hence revegetation has been very slow and surface waters in Appalachia continue to carry heavy sediment loads and large amounts of acid mine drainage.

The new Regulations for mining in steep terrain specifically forbid placement of spoil, temporarily or permanently, on the downslope. "Steep slopes" are defined in the Regulations as those slopes of 20 degrees or more and are subject to the special performance controls of Part 826. However, operations in steep terrain are also subject to the provisions of the performance standards of Part 816. These performance standards make it necessary to clear vegetation from all areas to be affected by mining, to retain all spoil and debris on the bench, to eliminate the highwall and to regrade the site to the approximate original contour, and to revegetate the area. In effect, this makes it necessary to employ some type of haul-back mining. This substantially increases the amount of equipment needed which may be difficult for small mine operations. It also makes operational planning essential, if the requirements for contemporaneous reclamation are to be met.

**Regulatory Program promulgated by the Office of Surface Mining of the Department of the Interior in accordance with the Surface Mining Control and Reclamation Act of 1977.*

OPERATION KEY	OPERATION DESCRIPTION	PROBLEMS
	(NOTE: Text includes references to illustration opposite.)	
1	Bulldozers push trees, vegetation, topsoil, subsoil, and unconsolidated overburden over the downslope (1).	— Mixing of topsoil, organic debris, subsoil, and overburden makes topsoil utilization impossible. Destruction of trees and vegetation on the downslope makes it highly erodible and sedimentation problems are serious.
2	The field (2) has been affected by a landslip.	— Spoil dumps on the downslope are often unstable and landslips are common.
3	Drilling rig (3) bores blast holes and shoots consolidated overburden.	— In most of Appalachia there is little groundwater available and that which is available is usually very localized. Fracturing of overburden due to blasting, and excavation and augering can change the availability of groundwater and affect base-flow in streams.
4	This farm (4), within ½ mile of the permit area, gets water from a shallow well.	— The quality of groundwater can also be affected, usually by acid contamination.
5	Bulldozer works together with shovel (5) removing the remainder of the overburden and exposing the coal. Spoil is pushed onto the downslope.	— More spoil is dumped on the downslope, worsening both the instability problems and the destruction of vegetation. — Erosion of the highwall, bench, and spoil on the downslope causes sedimentation problems. — Acid-forming spoils dumped on the top of spoil banks cause acid runoff.
6	Front-end loader digs coal and loads truck (6) which uses a coaling road located on the previously mined bench.	— Pyrite, in and close to the coal seam, is exposed to weathering, causing serious acid mine runoff. — Runoff from the bench gathers naturally and cuts deep gullies as it pours over the outslopes.
7	Auger operation (7) in progress removing additional coal from the exposed outcrop.	— Auger operations do increase the recovery of coal, where the resource cannot be extracted by the other methods. But the rate of recovery achieved by augering is very low and the auger holes prevent future extraction by other methods. Augering has also, in the past, led to a worsening in acid mine drainage. — This is due to increasing the oxidation of pyrite by admitting oxygen into the seam and also to releasing contaminated water from the seams and abandoned underground workings. In future the requirement for contemporaneous reclamation will make programming of augering very difficult for small operations.
8	Abandonment (8 is not shown)	— Abandoned, underdrained surface mines continue to produce acid and sediment-rich drainage for many years following coal extraction. — Problems have been well documented particularly in Appalachia (see Chapter 2). Most of the water-related problems are due to erosion of steep, unstable spoil banks which continually exposes new spoil to weathering resulting in acid drainage and sedimentation, and preventing colonization of vegetation which would eventually provide effective protection against further erosion.

REQUIREMENTS OF THE REGULATIONS* SECTION	REQUIREMENT
Part 826	This Part contains special performance standards for mining on steep slopes (20 degrees or more). This Part forbids placement of any spoil, waste or debris on the downslope.
826.12(e)	"Woody materials shall not be buried . . ."
816.22(a)	"Topsoil shall be removed after vegetative cover . . . is cleared."
826.12(b)	". . . the minimum static factor of safety for the stability of all portions of the reclaimed land is at least 1.3."
816.62	". . . a resident or owner of a dwelling . . . within one-half mile" of a permit area may request a pre-blasting survey.
816.52(a)	"When surface mining activities may affect the ground water systems ... ground water levels and ground water quality shall be periodically monitored."
816.54	The operator must "replace the water supply" where interruption of supply or contamination has resulted from mining.
826.12(a)	The operator "shall prevent the following materials from being placed or allowed to remain on th downslope: (A) spoil; (b) waste materials . . . (C) debris . . . (D) abandoned . . . equipment."
816.42(a)(1)	"All surface drainage from the disturbed area . . . shall be passed through a sedimentation pond . . ."
816.48	Acid pollution of surface water or ground water shall be avoided by identifying and burying acid-forming materials (within 30 days after it is first exposed) and preventing water coming into contact with acid-forming materials.
816.42(a)(7)	Discharges of water from areas disturbed by surface mining which are not within the pH range of 6.0-9.0 must be treated using an automatic neutralization process, unless a manual system is approved by the RA.
819.11(a)	"Any auger mining...shall be conducted to maximize recoverability of mineral reserves..."
819.11(b)	"No auger hole shall be made closer than 500 feet in horizontal distance to any abandoned or active underground mine workings..."
819.11(c)	"...each auger hole...shall be plugged so as to prevent the discharge of water from the hole and access of air to the coal..."
819.11(c)(1)	"Each auger hole discharging water containing . . . acid-forming material shall be plugged within 72 hours after completion..."
819.11(c)(2)	Holes not discharging water must be sealed within 30 days.
816.101(a)(1)	"Rough backfilling and grading shall follow coal removal by not more than 60 days or 1,500 linear feet."
826.12(b)	"The highwall shall be completely covered with compacted spoil and the disturbed area graded . . . including, but not limited to, the return of the site to the approximate original contour."
816.21-816.24	Topsoil must be stripped and replaced on all surface mining sites.
816.111(a)	Operators "shall establish on all affected land a diverse, effective, and permanent vegetative cover..."


CONTOUR MINING
PHASES 1 & 2
OPERATIONS AND CONTEMPORANEOUS RECLAMATION
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CONTOUR MINING — PHASES 1 & 2
OPERATIONS AND CONTEMPORANEOUS RECLAMATION

The crucial requirement of the Regulations which makes previous methods of contour surface mining obsolete is that no spoil is to be placed on the downslope, temporarily or permanently. This applies specifically to mines where slopes are in excess of 20 degrees (about 1:2.7 or 37%). In less steep terrain the conditions for mining require regrading to the approximate original contour, and elimination of the highwall. In addition, Section 816.102(a) (1) requires that all overburden and spoil be retained on the solid portion of existing and new benches.

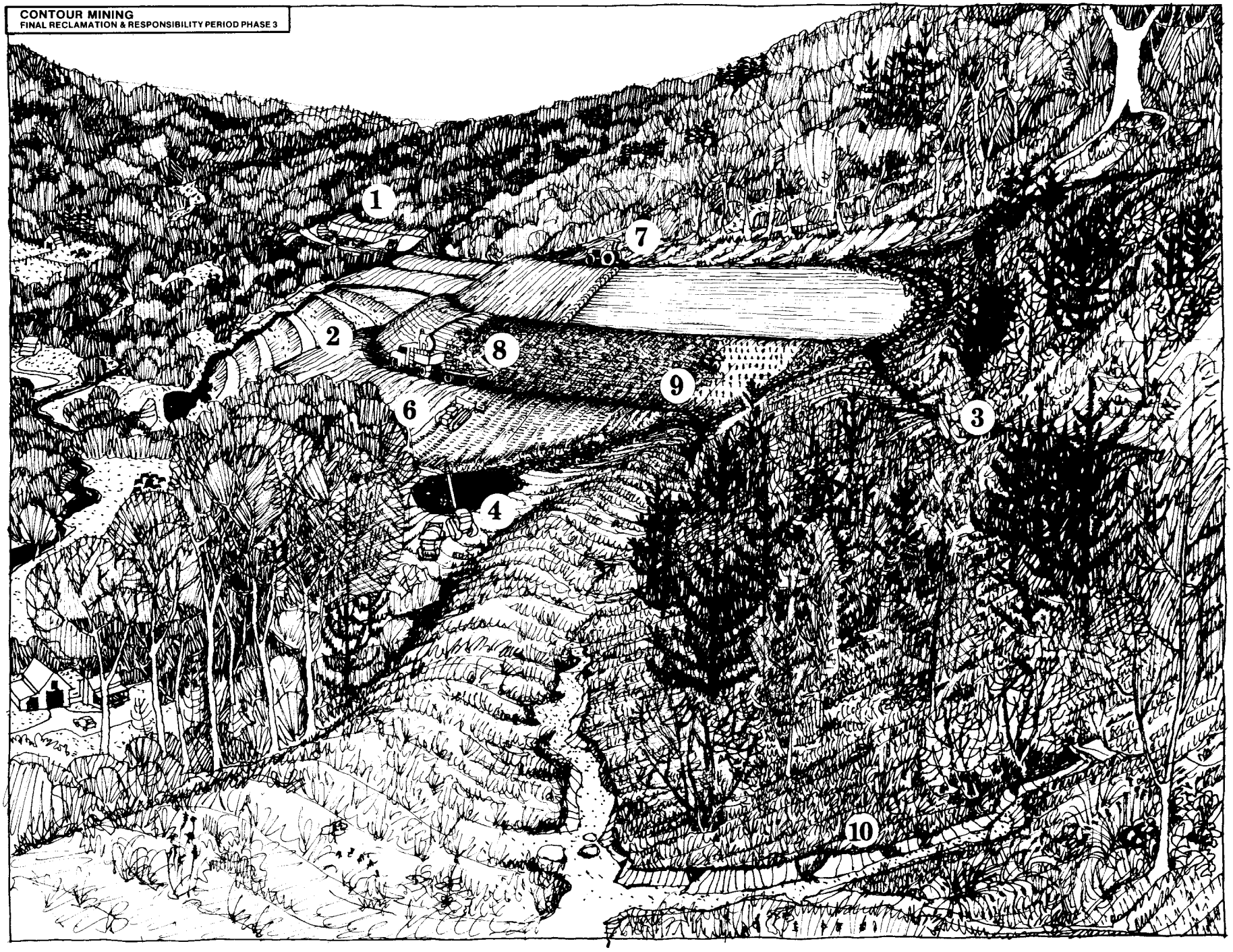
A feasible way to carry out contour stripping in mountainous terrain without violating the conditions of the Regulations is the "Block Cut method" of dragline utilization and the "Haul-back method." In the latter a box cut is made, from which the spoil is placed permanently on an excess spoil disposal site. The following cuts may then proceed in one or both directions along the contour, the spoil from subsequent cuts being "hauled back" to previously worked-out cuts. This technique not only avoids spoil on the downslope but also satisfies the requirement for "contemporaneous reclamation," where, in the case of contour mining, rough backfilling and regrading must follow coaling by no more than sixty days or 1500 feet [816.101(a) (1)].

The problem of disposal of excess fill is covered in Sections 816.71-816.74. However, in Section 816.101(b) (1) the Regulations specifically require that "spoil shall be transported, backfilled. . . , and graded to eliminate all highwalls, spoil piles . . ." Exceptions are where spoil is not required to achieve the "approximate original contour" [816.71 (a)]. But, strictly, unless there is a high overburden: coal ratio and swell (bulking) factor, most of the box-cut spoil would be needed to fill the final cut. It is assumed that the term "approximate original contour" would permit some lowering of the original grade in vicinity of the final cut, providing there was sufficient spoil to eliminate the highwall and satisfy other grading requirements. It should be noted that in the Supplementary Information [816.101-816.105] that stockpiling and transportation of box-cut spoil to the final cut is encouraged. Obviously, operators would prefer to place box-cut spoil once and for all, and then to backfill the final cut by "borrowing" from adjacent cuts and this procedure has been used in this example.

In the past, mine operators have tended to prefer working methods which involved shifting overburden by pushing or casting rather than by loading and hauling. The latter is almost inevitably more expensive and involves much more careful operational planning to keep equipment fully utilized. It also requires more equipment which, for operators short of capital, may be a very serious problem. However, haulback methods can solve the environmental problems associated with contour mining.

**Regulatory Program promulgated by the Office of Surface Mining of the Department of the Interior in accordance with the Surface Mining Control and Reclamation Act of 1977.*

KEY	OPERATION — DESCRIPTION OF OPERATION	REQUIREMENT OF THE REGULATIONS* — SECTION	REQUIREMENT	DATA SHEET — SHEET TITLE	NO.
	(NOTE: Text includes references to illustration opposite.)				
1	Trees on areas which will be disturbed or affected by disposal of excess spoil are felled (1) and branches clipped for mulch.	816.22(a)	"Topsoil shall be removed after vegetative cover that would interfere with the use of the topsoil is cleared. . ."	Clearance of vegetation, removal of topsoil	6:6
		826.12(e)	"Woody materials may be chipped and distributed. . .as mulch.	Mulches	7:9
2	Bulldozer creates runoff diversion (2) along upper edge of proposed highwall. The runoff must then be directed across	Part 826	This Part forbids the disturbance of land above the highwall but the RA may grant a variance for reasons which include the control of runoff.	Stream diversions: Overland flow and ephemeral streams	6:4
3	the permit area in chutes (3) with protected outfalls.	816.43	"Overland flow. . .may be diverted away from disturbed areas. . ." if approved by the RA.	Grass waterways	7:4
4	Sedimentation ponds (4) have been installed at all points where drainage leaves the permit area, including the	816.42(a)(1)	"All surface drainage from the disturbed area. . .shall be passed through a sedimentation pond. . .before leaving the permit area." Note the provisions in 816.42(a)(4) for overland flow which is diverted.	Sedimentation ponds	6:4
5	drainage from the Valley fill (5).				
	Only three levels of the Valley fill (5) are completed. More fill will be placed on this disposal site as mining proceeds, due to the high bulking factor and the need to maintain working space in the pit.	816.71	"Spoil not required to achieve the approximate original contour" to be disposed of in accordance with Sections 816.71-816.74. Shown here is a "Valley fill" which drains to the edges of the fill mass. A Valley fill, unlike a Head-of-Hollow fill, need not fill the disposal site to the ridgeline.	Disposal of excess spoil: Head-of-Hollow and Valley fills	6:8
		816.72			
		816.73			
6	Topsoil is removed by a bulldozer. The dozer has also destumped the area to make topsoil removal possible and is pushing soil down where it is being loaded and hauled by a scraper (6). Often in steep terrain topsoil is thin and must be supplemented with consolidated material.	816.21-816.25	The Regulations require a minimum of 6" of topsoil to be removed and redistributed immediately on regraded areas. Only if no areas are available for redistribution may topsoil be stored. If 6" of topsoil is not available, a 6" layer of topsoil and unconsolidated material below should be removed and redistributed.	Removal and storage of topsoil	6:6
7	Drilling rig (7) bores blast holes and shoots consolidated overburden.	816.62	A pre-blasting survey of the well (8) has been carried out.		
8	Pre-blasting survey of well (8).	816.52	Ground water and surface water monitoring may be required.		
9	A bulldozer pushes unconsolidated overburden (9) to a front-end loader which loads it for backhaul directly to a mined out area (12). Front-end loader digs and	816.99(a)	"An undisturbed natural barrier shall be provided beginning at the elevation of the lowest coal seam to be mined and extending. . .for such a distance as may be determined by the RA. . ." This barrier must remain undisturbed throughout operation.	Rough backfilling and grading; acid-forming material	6:10
10	loads coal (10).				
11	Acid-forming overburden, identified in the overburden analysis is selectively placed in the bottom of the pit (11).	816.103(a)	". . . all exposed coal seams. . .and all acid-forming materials" shall be covered by "a minimum of 4' of the best available non-toxic and non-combustible material. . ."	Handling pit water: Acid mine drainage Acid-forming material	6:9 6:10
12	Backfilling and rough grading in progress (12). Spoil hauled directly from above coal seam. Note that the highwall is still showing at this point.	816.101(a)	The requirement for contemporaneous reclamation in contour mining is that rough backfilling and grading shall follow coal removal by not more than 60 days or 1500 ft.	Rough backfilling and grading	6:10
		826.12(b)	"The highwall shall be completely covered with compacted spoil and the disturbed area graded. . .including, but not limited to, the return of the site to the approximate original contour."		


CONTOUR MINING
FINAL RECLAMATION & RESPONSIBILITY PERIOD PHASE 3
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CONTOUR MINING
FINAL RECLAMATION & RESPONSIBILITY PERIOD PHASE 3

Shown here is the site illustrated on the two previous pages undergoing final reclamation and revegetation. In the far distance (1) mining operations are continuing. Notice that the Valley fill (2) has now been completed and has been revegetated.

It should be noted that terraces as shown here must have the approval of the RA and must be compatible with the approved post-mining land use. The sedimentation pond (4) is being cleaned out. The RA's approval for retaining this after reclamation has been obtained.

Grading of reclaimed land must be to "approximate original contour" and must eliminate the highwall, spoil piles and depressions [816.101(b) (1)]. Providing these conditions are met the operator has some flexibility in grading, provided that the slopes "approximate the general nature of pre-mining topography." The importance of good grading and revegetation in conservation of water resources by minimizing erosion is emphasized. Terraces may be approved by the RA to help achieve this [816.102(b)]. Improved access to forest land in steep terrain via roads located on the terraces would make more effective utilization of commercial forest land feasible.

For areas which are to be reclaimed for commercial forestry, woodland planting for wildlife, recreation, or non-commercial-forest uses, the success of revegetation is judged by comparison to a "reference area." An inventory of this area, including what is growing and in what numbers, must be carried out [816.117(c) (1)].

If the approved post-mining land use is commercial forestry, a five-year "period of responsibility" begins as soon as the area has been replanted and there are at least 450 trees and shrubs "alive and healthy" per acre for two growing seasons [817.117(a) (ii)]. For commercial forestry, 75% of these should be commercial tree species. At the time of request for bond release the stocking of trees and shrubs on the reclaimed area must be a least 90% of that on the reference area. In addition, the ground cover must be at least 70% of that on the reference area and must be adequate to control erosion.

Section 816.117 also sets out requirements for revegetation of non-commercial forest land, for wildlife, recreation, etc. The five-year responsibility period begins when the stocking of trees and shrubs on the reclaimed area is 90% of that on the reference area. As is the case for commercial forest land, at the time of request for bond release, stocking of trees and shrubs shall be 90% of that on the reference area and ground cover must be at least 70% of that on the reference area.

Where permit area is less than 40 acres, the "reference area" need not be used if approved by the RA. At least 400 (600 on steep slopes) trees and shrubs must be maintained for five full consecutive years and ground cover which amounts to 70%.

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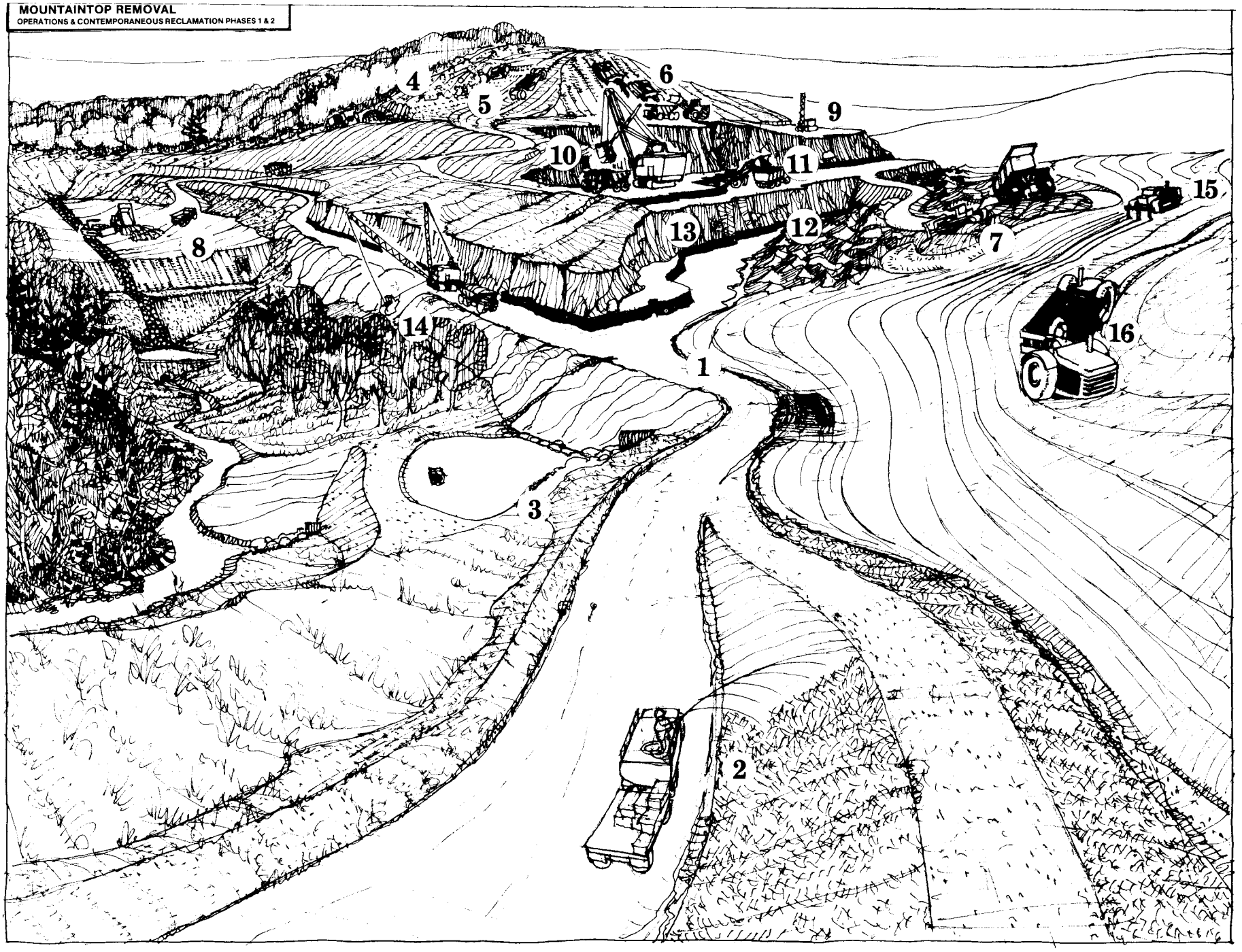
OPERATION KEY	DESCRIPTION OF OPERATION
	(NOTE: Text includes references to illustration opposite.)
1	In the far distance (1), mining operations are still in progress, followed by backfilling and rough grading.
2	The Valley fill (2) has been completed and revegetated. The sedimentation pond at the toe is still in place.
3	The approval of the RA has been obtained for the use of terraces (3) in the restored land. The diversion above the highwall is the first terrace. These terraces have a gentle gradient to direct flow to a safe discharge point; in this case, the riprap channel leading
4	to the sedimentation pond (4). The sedimentation pond (4) is being cleaned out. This must be done if sediment accumulates to 60% of the design sediment storage volume Sedimentation ponds must remain until the site is revegetated but permanent retention requires RA's approval.
5	Final grading operations (5 is not shown) including scarification should be done along the contour, unless this is hazaradous to equipment operators.
6	Topsoil (6) should be spread as part of a contemporaneous operation with topsoil removal. The dozer here is seen spreading topsoil. This slope is too steep for along the contour operation, but the cleat marks of the tracks help prevent erosion. Lime and fertilizer are applied and then the hillside is cultivated with a slope disc (7).
7	Seed, fertilizer, mulch and binder are often applied to steep slopes in one mix
8	by a hydroseeder (8); or, a power mulcher may spray seeded slopes with mulch after seeding. If the season is not correct for permanent revegetation, a cover crop should be used.
9	Hand planting (9) of tree and shrub species is being carried out. Direct seeding tree and shrub species with grass and herbaceous species has not been very successful. Competition from herbaceous species has resulted in poor performance of trees and shrubs. The performance standards emphasize that whatever stocking rate and ground cover is applicable, vegetation must be adequate to control erosion.
10	The erosion gully (10) which has occurred here must be filled and reseeded if it is more than 9" deep [Section 816.106].

REQUIREMENT OF THE REGULATIONS* SECTION	REQUIREMENT
816.101(a)	"Rough backfilling and grading shall follow coal removal by not more than 60 days or 1500 linear feet.
816.72	Performance standards for Valley fills include specifications for underdrains, terraces, etc. The vertical distance between terraces should not exceed 50 ft.
816.102(b)	"On approval by the RA ... cut-and-fill terraces may be allowed..." The width of the individual terrace bench shall not exceed 20 ft., unless ... approved by the RA as necessary for stability, erosion control, or roads included in the approved postmining land use plan." The outslope of terraces "shall not exceed 1v:2h" unless approved by RA.
816.46(h)	"Sediment shall be removed ... when the volume of sediment accumulates to 60% of the design sediment storage volume."
816.46(u)	"Sedimentation ponds shall not be removed until ... "revegetation requirements have been met. If the RA approves retention of a sedimentation pond it must meet the requirements for permanent impoundment. [816.49 and 816.56]
816.102(e)	"All final grading, preparation of overburden before replacement of topsoil . . . shall be done along the contour. . ."
816.24(a)	"After final grading . . . regraded land shall be scarified..."
816.24(b)	Topsoil should be distributed to achieve "an approximate uniform, stable thickness." Topsoil should be protected from erosion after it is seeded and planted. "Nutrients and soil amendments in the amounts determined by soil tests shall be applied to the redistributed surface soil layer..."
816.111-816.117	Requirements for revegetation. The species used depend upon the approved postmining land use. However, generally they should be native species of the same type and variety as are found locally and they must be capable of controlling erosion.
816.113	"Seeding...shall be conducted during the first normal period for favorable planting conditions..."
816.117(b)	Areas reclaimed for forestry must have a minimum stocking of 450 trees or shrubs/acre, and of these 75% shall be commercial tree species. When the stocking is equal to or greater than 450 trees/acre the five-year responsibility period begins.
816.116(d)	On permit areas of less than 40 acres, stocking of 400 trees or shrubs/acre (600 on steep slopes) must be achieved.
816.117(c)	". . . for areas where woody plants are used for wildlife management, recreation, shelter belts, or forest uses other than commercial forest land...the stocking of trees...and ground cover...shall approximate the stocking and ground cover" on the approved reference area.
816.116	The requirements of performance standards with respect to the responsibility period vary according to the approved postmining land use. The period begins when the approved stocking rate and ground cover are met. The period ends after five years if stocking rate and ground cover meet standards specified for each postmining land use in Section 816.116.

DATA SHEET SHEET TITLE	NO.
Rough backfilling and grading	6:10
Disposal of excess spoil: Head-of-Hollow and Valley fills	6:8
Terraces	7:2
Grass waterways	7:4
Sedimentation ponds	6:3
Final grading	7:3
Replacement of topsoil and cultivation.	7:5
Soil amendments: lime and fertilizer.	7:6
Mulches	7:9
Chemical stabilizers	7:10
Cover crops	7:11
Revegetation: general	7:12
Revegetation: trees and shrubs	7:13
Revegetation: herbaceous species.	7:14
Revegetation	7:12 -7:14


MOUNTAINTOP REMOVAL
OPERATIONS & CONTEMPORANEOUS RECLAMATION PHASES 1 & 2
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MOUNTAINTOP REMOVAL

OPERATIONS & CONTEMPORANEOUS RECLAMATION PHASES 1 & 2

Part 824 of the Regulations states that the objectives of Mountaintop Removal are "to enhance coal recovery" and "to reclaim the land to equal or to higher post-mining use," and to protect environmental values.

In the example shown here, two coal seams with a parting of about 15' run right through the ridge. The outcrop of the lower of these seams was contour-mined several years ago. Hence, the performance standard to retain an outcrop barrier [824.11(a) (6)] does not apply. Excess spoil is being disposed of in the Head-of-Hollow fill on the left of the pictures. A Head-of-Hollow fill (which drains to a central rock chimney drain), rather than a Valley fill (which drains to the sides of the fill mass) is permissible in this example as the disposal site will be filled to the level of the adjacent ridgeline [816.73].

Although Mountaintop Removal operations are generally on a much larger scale than contour mining, it is easier to keep all drainage within the site and to limit the discharge to certain specified points. This makes the control of water pollution, particularly sedimentation and acid mine drainage, much more effective. Section 824.11(a) (8) requires that the restored land "drain inward from the outslope, except at specified points where it drains over the outslope in stable and protected channels."

In order to conduct Mountaintop Removal, a variance from the requirement of 816.101(b) (1) for restoring affected areas to their "approximate original contour" must be granted by the RA. Mountaintop Removal realizes an opportunity to create terrain which is suitable for urban and agricultural development in country which is steep and where development land is in short supply. A permit for Mountaintop Removal can only be given when "an industrial, commercial, agricultural, residential or public facility (including recreational facilities) use" is proposed and approved for the affected land [785.14].

The amount of machinery and the scale of operation required for efficient Mountaintop Removal operations is large and consequently only a few small mine operators will have sufficient resources to carry out an operation of this type. However, we show here a fairly small operation. Some of the machinery is shown more than once in order to explain the working of the site more clearly. Note that the old bench from contour mining operations is adapted to intercept runoff from the reclaimed area of the site.

In this example we also show the reclamation of orphan land from a previous mining operation being carried out as part of this mining operation. In this case, after regrading spoil which had been dumped on the outslope, selected unconsolidated overburden is being used as a topsoil substitute.

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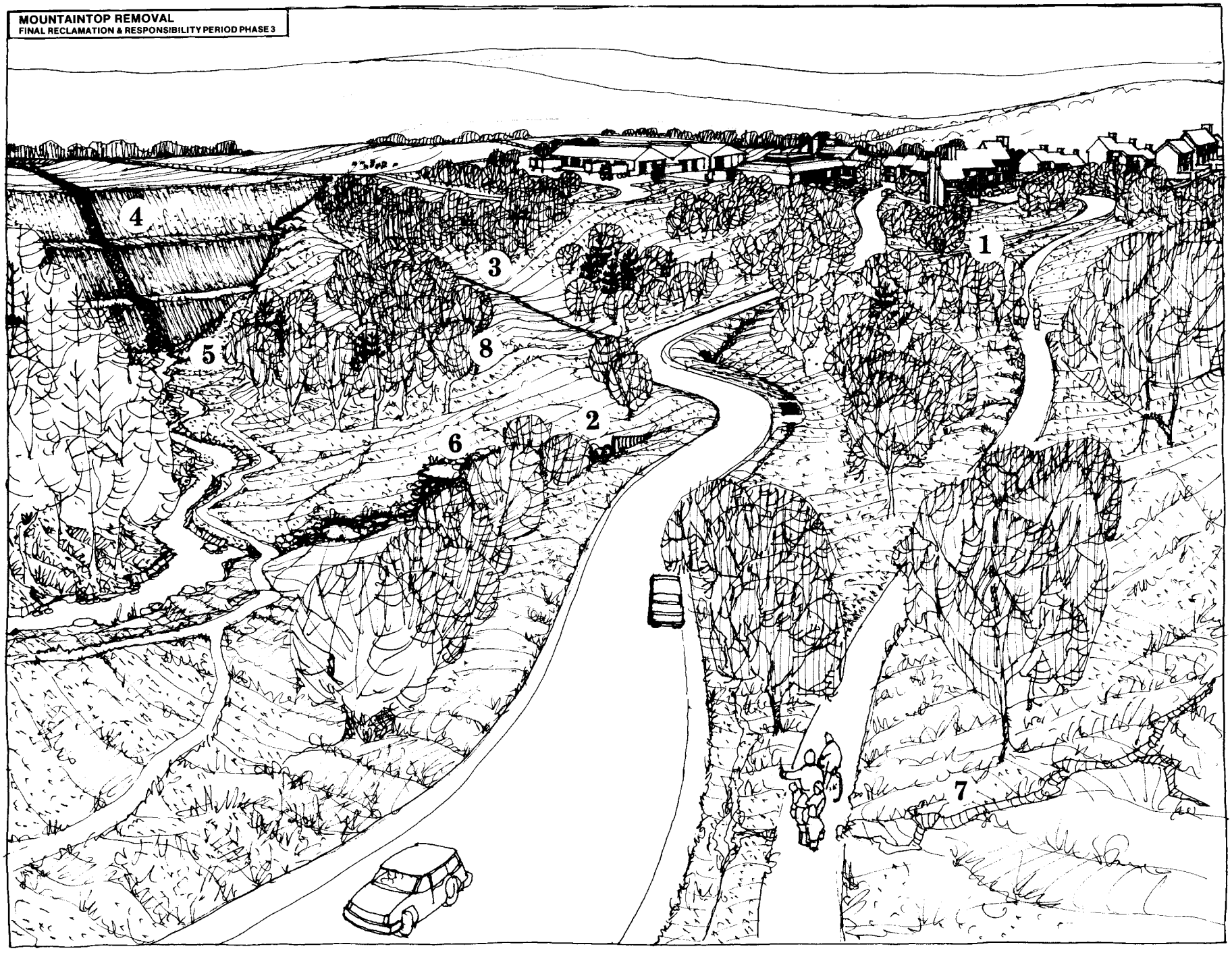
OPERATION KEY	OPERATION DESCRIPTION OF OPERATION	REQUIREMENT OF THE REGULATIONS* SECTION	REQUIREMENT	DATA SHEET SHEET TITLE	NO.
	(NOTE: Text includes references to illustration opposite.)				
1	The abandoned bench (1) from an old contour mining operation is modified to act as a runoff diversion during working of site. In some sections this bench is also used as a haul road.	824.11(a)(6)	"An outcrop barrier of sufficient width" must be retained at the toe of the lowest coal seam, unless this was removed "prior	Operation - General	6:1
		816.150-	to May 3, 1978. . ."	Stream diversions:	
		816.176	Roads (Class I, Class II and Class III)	Overland flow	6:4
				Haul roads	6:2
2	Topsoil stockpiles (2) are mulched and seeded with a cover crop.	816.23(b)	Topsoil protection "shall be accomplished either by an effective cover of . . . plants or . . . other methods . . ."	Removal and storage of topsoil	6:6
				Cover crops	7:11
3	Sedimentation ponds (3) installed at all points where runoff leaves the permit area and at toe of Head-of-Hollow fill (8). Discharge points protected with riprap.	816.42(a)(1)	"All surface drainage from the disturbed area . . . shall be passed through a sedimentation pond. . ."	Sedimentation ponds	6:3
		816.47	"Discharge from sedimentation ponds...shall be controlled...riprap...where necessary..."		
4	Logging teams (4) fell all timber on site in advance of earth-moving. All branches and other vegetataion used as mulch on reclaimed areas. Dozers	816.22(a)	"Topsoil shall be removed after vegetative cover that would interfere with the use of the topsoil is cleared from the areas to be disturbed. . ."	Clearance of vegetation	
5	destump and scraper removes (5) topsoil and subsoil to be spread on area being reclaimed.			Removal and storage of topsoil	6:6
		816.45(b)(1)	"The smallest practicable area" is disturbed at any one time during the mining operation.		
6	Dozers (6) push unconsolidated overburden down to the first bench where it is loaded into dump trucks and hauled to the area being backfilled	816.22(e)	Selected unconsolidated overburden may be used as a topsoil substitute in certain circumstances.		
		816.71	Performance controls covering the dispoal	Disposal of excess	
7	and rough-graded (7) or for disposal	816.74	of excess spoil.	spoil	6:7
8	in Head-of-Hollow fill (8).				
9	Drilling rig (9) drills and shoots consolidated overburden which is	816.101(b)(1)	Only if a variance from the requirement to restore land to the "approximate original contour" is granted may spoil be disposed of in excess spoil disposal areas.	Disposal of excess spoil	6:7
10	loaded by shovel (10) and hauled to either Head-of-Hollow fill (8) or to reclamation area (7).	816.72(b)(1)	Drainage of Head-of-Hollow fill.		
11	Coaling (11) of the upper seam with a front-end loader and trucks. All toxic-forming overburden is backfilled in the bottom of the cut (12).	824.11(a)(10)	"All waste and acid-forming materials . . . are covered with non-toxic spoil to prevent pollution and achieve the approved post-mining land use . . ."	Acid-forming material	6:10
				Handling pit water, acid mine drainage	6:9
12	The stripping of the parting between the	816.100	Overburden which is not being disposed of as excess spoil must be reclaimed as contemporaneously as possible. The	Rough backfilling and grading	6:10
13	upper and lower seams (13 is not shown). Contemporaneous reclamation and rough grading continues (7).	816.101	period is not specified for Mountaintop Removal.		
14	Dragline is rough grading spoil (14) which had been dumped on the outslope during an old contour mining operation.	Part 872	Funds are provided to reclaim abandoned mine land.		
	Excessive compaction of regraded spoil	824.11(a)(7)	Slope requirements for reclamation of Mountaintop Removal operations.	Rough backfilling and grading	6:10
15	is being broken up with ripper (15). These operations must be carried out along the contour.	816.102(e)	"All final grading, preparation of overburden before replacement of topsoil . . . shall be done along the contour . . ."	Final grading	7:3
16	Scraper (16) replacing topsoil immediately following stripping (5). Replacement of topsoil should be carried out along contour.	816.23(a)	Topsoil "shall be stockpiled only when it is impractical to promptly redistribute	Reclamation: General	7:1
				Final Grading	7:3
		816.102(e)	. . ." "Placement of topsoil shall be done along the contour to minimize subsequent erosion and instability."	Replacement of topsoil and cultivation	7:5
	Reclamation operations involving spreading and incorporation of lime and fertilizer, cultivation, seeding,	816.25	"Nutrients and soil amendments . . . shall be applied to the redistributed surface soil layer..."	Soil amendments	7:6
				Mulches	7:9
				Chemical stabilizers	7:10
17	mulching and planting (17 not shown).	816.114	Mulching and other soil stabilizing	Revegetation	7:12
		816.111 -816.117	practices. Revegetation.		-7:14


MOUNTAINTOP REMOVAL
FINAL RECLAMATION & RESPONSIBILITY PERIOD PHASE 3
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MOUNTAINTOP REMOVAL
FINAL RECLAMATION & RESPONSIBILITY PERIOD PHASE 3

In order to be granted a variance from the requirement to restore land to the approximate original contour, necessary for a Mountaintop Removal operation, an applicant must plan to create terrain suitable for urban, agricultural or public facility development. Any proposal to create post-mining land uses which are different from existing uses must be consistent with the plans of the local planning agency and must also be accompanied by a feasibility study [816.133(c)]. The Regulations also specify that a proposed change of use must not result in unreasonable delays in reclamation. In this example mixed uses including residential, commercial, light industrial, warehousing and recreation are shown, either under construction or in use.

The Act requires that the final graded slopes be less than 1v:5h so as "to create a level plateau or gently rolling configuration." In steep mountainous terrain, ridges and mountains graded to level plateaus may destroy the character of the landscape. However, it is hoped that this example illustrates the way in which restored earthforms can be blended into the existing topography while still satisfying the conditions of Mountaintop Removal. One condition is that reclaimed land must be graded "to drain inward from the outslope except at specified points, where it drains over the outslope in stable and protected channels." This should not be interpreted to mean that the regraded sites should be a shallow concave area draining inwards to one point. The use of the term "inward" is to ensure that all drainage flows within the regraded area except at the specified points (as in the drawing).

Even if the land is proposed for urban development, the requirement of the Regulations regarding the replacement of topsoil still holds. Revegetation must also be carried out, sufficient to control erosion prior to construction. "For areas to be developed for industrial or residential use less than two years after regrading is completed, the ground cover of living plants shall not be less than required to control erosion." All other areas are subject to the standards of success for revegetation set out in 816.116 and a five-year period of responsibility during which the operator is responsible for managing the area. Standards for success will vary according to the proposed and approved postmining land use.

Buildings, roads, sewers, etc., constructed on regraded spoil may be subject to settlement damage. This hazard may be serious where overburden is largely unconsolidated material and where it is cast with a shovel or dragline (not the case in the illustrated example). Where there is a danger of settlement occurring, buildings should have a reinforced concrete pad foundation or construction should not take place until settlement has ceased.

**Regulatory Program promulgated by the Office of Surface Mining and the Department of the Interior in accordance with the Surface Mining Control and Reclamation Act of 1977.*

OPERATION KEY	OPERATION DESCRIPTION OF OPERATION	REQUIREMENT OF THE REGULATIONS* SECTION	REQUIREMENT	DATA SHEET SHEET TITLE	NO.
	(NOTE: Text includes references to illustration opposite.)				
	Though no period is specified in the Regulations for Mountaintop Removal, reclamation must be carried out as contemporaneously as possible.	816.100 816.101(a)	"Reclamation efforts. . .shall occur as contemporaneously as practicable with mining operations." A time limit for backfilling and rough grading would be specified by the RA for Mountaintop Removal.	Rough backfilling and grading Reclamation: General	6:10 7:1
1	Note the "gently rolling configuration" (1) of the regraded site. This avoids giving the appearance of a "sawn-off" mountain or ridgetop.	824.11(a)(7)	"The final graded slopes on the mined area [shall be] less than 1v:5h so as to create a level plateau or gently rolling configuration, and the outslopes of the plateau (shall not) exceed 1v:2h. . ."	Final grading Replacement of topsoil Soil amendments Mulches	7:3 7:5 7:6 7:9
2 3	Drainage from the regraded area must only drain off the site at specified points (2). Internal drainage within the site should be directed to these points in stable grass waterways (3).	824.11(a)(8)	The regraded area is to "drain inward from the outslope, except at specified points where it drains over the outslope in stable and protected channels."	Grass waterways	7:4
4	Note that the Head-of-Hollow fill (4) is now complete and that it fills the disposal site to the low point of the adjacent ridge.	816.73(a) 816.73(b)	"The fill shall be designed to completely fill the disposal site to the approximate elevation of the ridgeline." Design of rock-core chimney drain system.	Disposal of excess spoil	6:8
5,6	The two sedimentation ponds (5,6) have been removed. This must not be done until the site is restored and the revegetation requirements are met. The regraded channel contains rock plunge pools and riffles to prevent erosion of the channel.	816.46(u) 816.47	"Sedimentation ponds shall not be removed until the disturbed area has been restored, and the vegetation requirements of Section 816.111-816.117 are met. . ." "Discharge from. . .diversions shall be controlled by energy dissipators, riprap channels and other devices where necessary. . ."	Sedimentation ponds Grass waterways, chutes, flumes, etc.	6:3 7:4
7	The gully (7) shown here, if greater than 9" deep, should be filled and stabilized.	816.106	"When. . .gullies deeper than 9" form. . . (they) shall be filled, graded, or otherwise stabilized and the area reseeded or replanted. . ."		
8	The outslope (8) from the abandoned contour mining operation has been reclaimed as part of the operation. Some subsoil "borrowed" from the Mountaintop Removal operation was used to cover this slope which was then seeded and mulched.	816.116(b)(3)	"For previously mined areas. . ." the ground cover of living plants shall not be less than can be supported by the best available topsoil or other suitable material in the reaffected area. . ." The ground cover must be adequate to control erosion and not be less than that existing before mining.		
	The entire disturbed area, except water areas and roads, shall be vegetated. This applies also to land approved for urban development. Because there are several different post-mining land uses on this site, the requirements for revegetation differ. Generally vegetation of areas planned for urbanization within two years must be capable of effective erosion control. Areas designated for recreational open space will have a requirement for number of trees and shrubs and for ground cover. Areas planned for grazing must have a capacity equal to that of non-mined land.	816.111 816.112 816.113 816.97(d)(11) 816,116	The general requirements for revegetation. Use of introduced species requires approval. Revegetation to be carried out during first favorable period. "Where the primary land use is to be residential, public service, or industrial land use, intersperse reclaimed lands with greenbelts utilizing species of grass, shrubs and trees useful as food and cover for birds and small animals. . ." The standards for success of revegetation are judged by comparison to a "reference area." When the ground cover and productivity of plants on the revegetated area equals that of the reference area for two consecutive years during a five-year "responsibility period," the operator can request bond release. There are different standards for previously mined land and for areas to be developed for urban uses within two years.	Revegetation: General Revegetation: Trees and Shrubs Revegetation: Herbaceous species Post-mining land uses	7:12 7:13 7:14 8
	Note that the "period of extended responsibility" under the performance bond requirement of the Regulations applies even where urban development is approved for the post-mining land-use. The period runs for 5 years for all areas covered in this Handbook.	816.116(b) 816.116(b)(3)			