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Sand and Gravel Resources: Protection, Regulation, and Reclamation

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Rock Products

Chapter 1. Introduction

Sand and gravel producers typically are regarded as undesirable neighbors. They scar the land, make noise with heavy equipment, spew dust over the landscape, and run fleets of trucks. Consequently, most local governments have treated them as necessary nuisances, like junkyards, rendering plants, or stockyards. From the local governments' point of view, it would be better if they were in another jurisdiction. If they cannot be pushed somewhere else, they need to modify or control nuisances at whatever cost.

While there is no denying the nuisance characteristics of sand and gravel operations, sand and gravel is a crucial resource for urban development. In most regions, it is the primary source of aggregate for the construction and paving industries. Its most common use is for portland cement, but it also is used extensively as a base or subgrade material for highways, railroads, runways, in road surfacing, and in asphalt paving mixtures. Since sand and gravel is easily compacted and has good internal drainage, it is the preferred material for fills, for use in utility trenches and storm drains, and for bringing houses and building pads up to grade.

So widespread is the demand for sand and gravel that our annual national consumption is above five tons per capita. And it is so vital to the general urban economy that it is considered one of the best indexes of economic activity for a region.

Unlike that of oil or copper, the supply of sand and gravel is not likely to be exhausted; but it can become scarce within a locality. Near large cities where it is needed, either it may have never existed in adequate quantities, it may have been depleted through use, or it may be rendered unavailable through unplanned urban growth. In some localities, oyster shells or crusted rock may be substituted, but, nevertheless, sand and gravel should be husbanded as one would other nonrenewable resources.

Scarcity of these materials can have a tremendous impact on the costs of construction—both for government and the private sector. What is important for the planner to consider is the *place value* of these resources. Sand and gravel are heavy, bulky products. They may be cheap at the pit or quarry, but transportation costs are high. *Consequently, the deposits become more valuable the closer they are to the site of the use.* For example, in 1978, the value of sand and gravel at the pit averaged about $2.50 per ton. *At haulage rates of 12 or 13 cents per ton mile, the price is doubled to a customer 20 miles from the pit site.* A deposit of sand and gravel close to the growing areas of a city is a valuable asset, whereas one 100 miles away may not be because of the high cost of transporting the material. The fact that a state is rich in sand and gravel resources does not mean that a particular urban area is blessed with the same wealth.

Planners can do nothing about natural scarcities or already depleted resources, but they do have a role in protecting available resources—particularly, when those resources are limited. They can help prevent valuable deposits from becoming inaccessible due to urban development. They can ease the impact on the surrounding community by carrying out the mining process in a socially responsible manner, and they can help to reclaim the site once the resource has been extracted.

Planning for sand and gravel resources, however, involves difficult choices. Sites with sand and gravel deposits are often also good development sites. Is it better to allow development in those particular locations or try to discourage it in order to have the sand and gravel resources? Also, while the resources are important to the general economy of an area, mining can depress the value of property in the immediate vicinity—particularly residential property. What is the balance between the rights of the surrounding property owners and the general welfare of the community? As with other resource protection programs, protecting sand and gravel resources may provide windfalls for some and not others. If some deposits are to be protected and others are not, what effect does this have on competition in the industry?

This report will explore these and other areas of concern. It is divided into three major chapters: (1) Protecting Sand and Gravel Resources; (2) Living with Sand and Gravel Operations; and (3) Reclaiming Mining Sites. While these three phases of resource management seem relatively distinct, in actuality they are closely interrelated. The type of protection given to sand and gravel deposits will determine the type of restrictions that must be placed on the actual mining operations. If incompatible uses are allowed to encroach on the sites, then the mitigating measures must be more restrictive. Likewise, the ultimate use of the site once it is reclaimed will be determined by the types of uses allowed in the area, before and during mining operations, and by economics. Also, the final land use will dictate the type of reclamation plan that must be in operation while the deposits are being extracted.

In addition to reading this report, planners who will be protecting and regulating sand and gravel resources should visit the mining sites and exchange information with the operators. Early contact will prevent problems that could arise at later stages of protection, regulation, and reclamation.

Chapter 2. Protecting Sand and Gravel Resources

All local governments recognize that sand and gravel is a valuable resource on which their future development will depend. For some, it is a limited resource, and, consequently, it is in the public interest to protect it. In these situations, it is necessary to understand the geology of sand and gravel deposits—also the characteristics of the sand and gravel industry.

THE LOCATION AND VALUE OF DEPOSITS

Like other sedimentary materials, sand and gravel is the product of the breakup of preexisting rock material. Individual sand and gravel deposits consist of material that has been separated more or less completely from all other substances. The primary differences between sand and gravel, according to a commonly accepted geologic classification, is grain size. Material ranging in grain size from 1/16 to 2 millimeters is termed "sand," and material ranging in grain size from 2 to 3 or 3 1/2 millimeters is called "gravel." Sand may occur without gravel, as in dunes or on beaches, but gravel is seldom found without sand. Sand and gravel also may be found as part of a mixture with boulders, pebbles, and clay. In such a mixture, sand and gravel have little commercial value.

Most commercial deposits of sand and gravel are found in and around valleys, terraces, and fans of existing and preexisting rivers and streams; in coastal plain and lake deposits; and in formations where they were deposited by receding glaciers.[1]

Deposits Along Existing and Preexisting Rivers and Streams

Sand and gravel deposits produced by a stream or river that has—or has had—a large volume and a steep gradient are common in or near mountainous regions. California, the nation's largest producer of sand and gravel, has many sites resulting from waterway deposits. In the San Francisco Bay region, a major source is the Livermore Valley, just west of the Coastal Range. Here, as floodwaters emerge from the narrow canyons and gorges of the Coastal Range onto the broad valley floor, they lose their capacity to carry sand and gravel. Deposits are dropped in fan-shaped formations at the mouths of canyons. Such deposits left by floodwaters are called *alluvial* deposits. In Los Angeles County, streams flowing from the San Gabriel Mountains left sand and gravel alluvial deposits on the valley floor until dams were built.

East of the Coastal Range, sand and gravel is deposited along the terraces, bars, and channels of the numerous waterways that drain from the Sierra Nevada range. Sand and gravel deposited by ordinary river or stream action, and not by floodwaters, are called *fluvial* deposits.

Coastal Plain and Lake Deposits

Sand and gravel also occurs along oceanic coastlines and on lake bottoms. These deposits usually are less desirable for commercial usage since they have a high proportion of fine sands and a scarcity of gravel. In selected instances, this problem can be overcome. For example, north of Monterey, California, marine sands are now being dredged for use with other materials—such as crushed rock—that are deficient in sand. The sand and crushed rock are mixed to meet the specifications of various uses.

Glacial Deposits

Around half of the country's sand and gravel comes from the glaciated parts of the northeastern and middle-western states. Geologists use a variety of terms, such as *eskers, kames,* and *valley trains*, to identify the different kinds of glacial formations in which the deposits occur. These formations are typically high quality sources.

The commercial value of the deposits depends upon more than just the size and purity of the product. As already discussed, it also depends upon its location in relationship to markets. For example, the finest sources of sand and gravel in Ohio are the valley train deposits in the central and southern part of the state. However, these deposits are too far away to supply Ohio's northern industrialized area. Operators in these areas must use less desirable deposits closer to their markets.

Consequently, when preparing resource protection

[1]For further information about sand and gravel geology, see Robert L. Bates, *Geology of the Industrial Rocks* (New York City: Harper and Brothers, 1960); and S. J. Lefond, ed., *Industrial Rocks and Minerals*, 4th ed. (New York City: Society of Mining Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers, 1975).

plans, planners must consider local conditions. There are no general standards or criteria for defining a valuable deposit; instead, it is necessary to study the local sand and gravel industry to find out the characteristics that make deposits valuable in a particular locality.

For the sand and gravel producer, the commercial potential of a deposit depends on the following factors:

1. Thickness and variability of the overburden;
2. Thickness and extent of the deposit;
3. Physical properties of the deposit, including particle-size distribution, mineralogy, durability, etc.;
4. Accessibility of deposit to heavy-duty roads, railroads, or navigable waterways;
5. Distance from the point of use;
6. Availability of sufficient water supply;
7. Depth to groundwater; and,
8. Governmental restrictions placed on operations, such as locally restrictive zoning ordinances.

Sand and gravel does not have to be used in exactly the same physical state in which it is found. It can be artificially upgraded by screening, washing, and combining grade sizes. But unsatisfactory size gradations or ratios can require costly processing to meet market specifications. Thus, geologically, the ideal sand and gravel deposit is one that consists of clean, hard particles that are present in quantity in a wide range of grade sizes. Large mining operations may produce a dozen or more sizes of material ranging from coarse gravel to fine sand for different construction and paving specifications.

For aggregate, high quality deposits usually contain at least 25 percent gravel in a variety of particle sizes necessary for both coarse and fine aggregate. In general, the more gravel, the more valuable the deposit is to the producer.

When there is a high sand ratio and a low amount of coarse and medium-sized gravel, the producer may be required to blend crushed stone with the naturally occurring material or may screen the material to meet market specifications. Some producers will avoid such deposits altogether. Similarly, an excess of coarse material may require costly crushing operations that could discourage operators from mining the site. But, in all types of sites, there are lower quality deposits that are economically valuable for producing useful grades that meet specifications less restrictive than those for use in concrete.

Geologic factors tell only part of the story for determining the value of mining a particular site. Operators also consider the size and permanence of markets, freight rates, and truck weight limits. Operators are also interested in the existing zoning and land-use regulations covering the potential mining site. For example, an operator may be hesitant to develop a site that is likely to become controversial with local residents. Protracted disputes about regulations are costly for the producer.

There is no one optimum size for a sand and gravel deposit. Most operators will not develop a site smaller than 20 acres. If there is a group of small sites in a concentrated area, the operator will want to consolidate the parcels into a site large enough for profitable operation. Exceptions to this practice include small companies that will work on almost any size site and public agencies that own and operate their own small pits for municipal use. In rural areas, average site size tends to be larger than in urban areas: 650 acres per site versus 250 acres. Most sites fall in the 100 to 500 acre range, according to a survey by the National Sand and Gravel Association.

DEVELOPING RESOURCE PLANS

Resource plans serve three purposes: (1) they provide data about the location, amount, and quality of earth resources and an assessment of market needs over time; (2) they state community goals, balancing the benefits of preserving or using particular sites against the need to make other uses of the same sites; and (3) they serve as a basis to establish legal devices to control the use of potential sites for exploiting earth resources.

Identifying Deposits

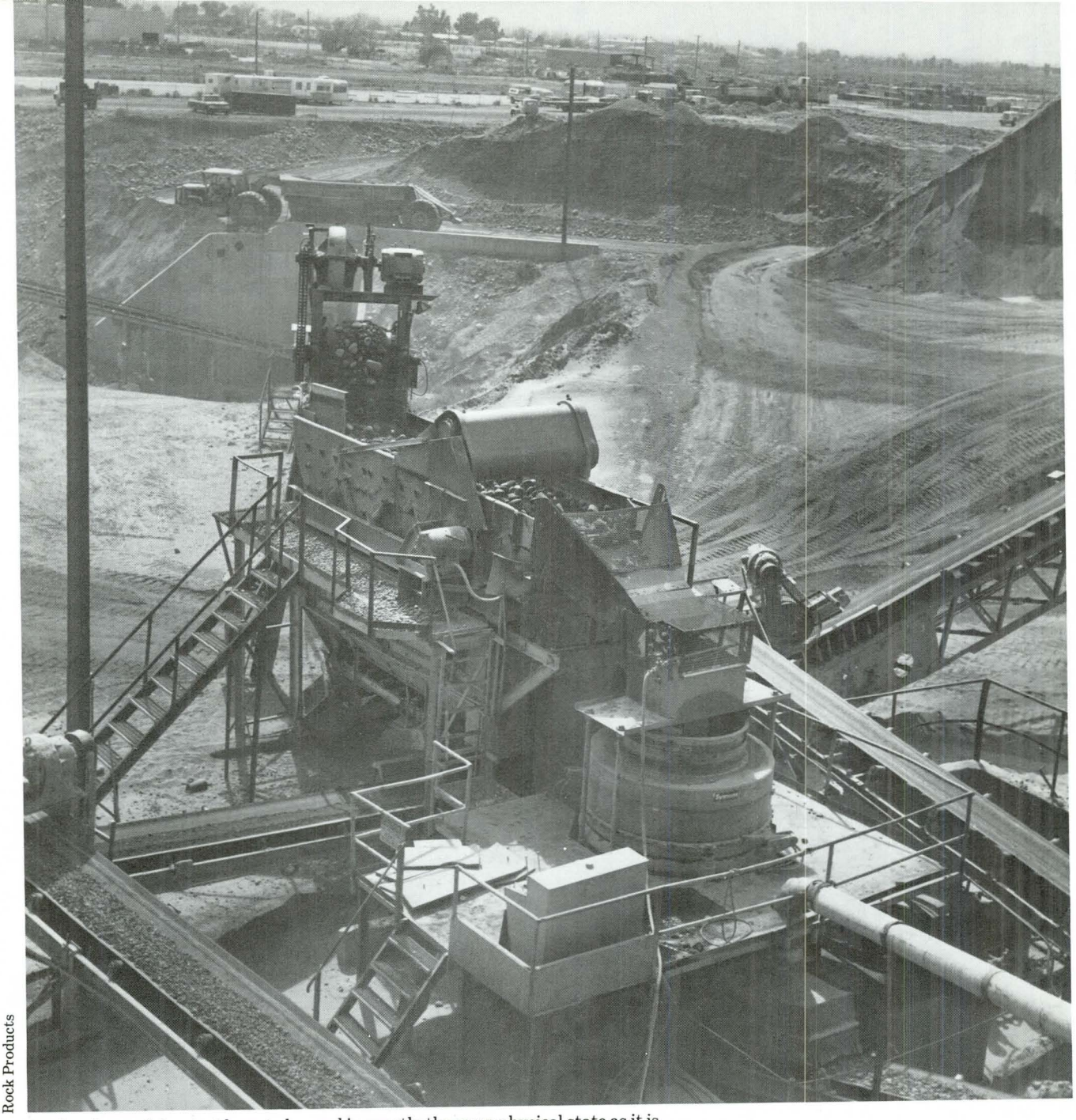
The first step in preserving any resource is to identify its location. In terms of geologic history, there is always a reason why mineral deposits occur in a particular location, and, once the reason is understood, it is possible to classify other lands as potential hosts to the same kinds of deposits. In the case of prospecting for sand and gravel resources, the key is understanding local geology. Gathering geologic data, however, cannot be done overnight—it requires painstaking mapping, sampling, testing, and analysis.

The quality of the data needed, of course, depends upon its final use. If a government finds it necessary to set up resource protection zones, then the data need to be reasonably precise so that these areas can be mapped with some accuracy. Such data are necessary to back up boundary decisions against legal challenges. On the other hand, if the resources are being identified simply to give information to decision makers when considering land-use policies—prior to developing regulations—then it may be possible to use more generalized information. Such data collection is not, of course, an either/or proposition. The sites of potential deposits may be mapped first and then the detailed analysis of each individual site scheduled over a period of time or as the need arises.

Sources of Information

The best source of data is the state Geological Survey. In some states, such as California, the state Division of Mines and Geology may handle survey responsibilities. The assignments of the state survey office will vary according to state law, but the Illinois survey office, one of the country's largest offices, serves as an illustration of services provided:

- They acquire and maintain a file of geologic information for the entire state, including records on well drillings;
- They study and map geologic and mineral resources in the state; and
- They are required to report their findings to the



Rock Products

Sand and gravel does not have to be used in exactly the same physical state as it is found. It can be upgraded by screening, washing, and combining grade sizes.

public, government agencies, and industry through publications, letters, and conferences.

The Illinois survey office is particularly interested in mapping large sand and gravel deposits and delineating deposits in areas that have not yet been developed and so can still be protected. Some of the survey's mapping is done in response to requests from county planning agencies. Deposits are usually classified into three types and subtypes based on their depositional histories as interpreted from their geometry and particle-size distribution. A typical Illinois survey map will delineate seven categories of sand and gravel deposits, ranging from the thickest, most widespread, coarse-grained types to the most restricted, finest-grained deposits. Well records provide important information on particular sites since they record the depth and quality of specific deposits.

Since sand and gravel deposits usually follow stream beds and glacial formations, the location of sites of already identified deposits should be a useful key in locating potential nearby deposits. Therefore, it is very important to inventory existing and abandoned deposits as a first step to protecting these resources. The engineer or geologist conducting this inventory will first note all visible deposits in exposures in railroad and highway cuts, stream banks, and excavations, and under the water of streams, ponds, or lakes. He will also consult existing maps and well records available from public agencies and private mining operators.

One source of maps for inventorying current operations

is the county office of the U.S. Agricultural Stabilization Conservation Service. Although these offices concentrate on agricultural concerns, their aerial photographs can be used to identify sand and gravel deposits currently being mined or mined in the past. Marathon County, Wisconsin, is using such photographs in their comprehensive inventory of all sand and gravel operations in Marathon County. The photos show sites of both abandoned and operational mines. Soil Conservation Service maps are another useful source of identifying the location of existing and abandoned pits. However, they are not appropriate for determining the quality of those deposits.

Another possible source of information about the location of deposits is the mining operators themselves. These operators plan ahead for 10 or 20 years or more. In many instances, they buy parcels for their projected needs. However, not all operators may be willing to share information about their holdings. Sometimes operators are wary of publicizing the locations of their holdings because of potential tax increases. In most instances, operators will be reluctant to divulge information about the quality of their deposits for fear of information leaking to their competitors. However, operators will often have other information of value to planners, such as local hydrologic data, land-use and ownership patterns and trends, land productivity, soil quality, and bore hole data.

Other sources of information are local and state highway departments and the U.S. Army Corps of Engineers. Since highway departments are prime users of sand and gravel, they should have records of existing sites. They are also likely to have identified sites along the paths of projected highway construction. The Corps will have information on sites associated with dredging operations in waterways and along coastal areas.

Planners should consult all of the sources mentioned above for information about the location of potential deposits yet to be identified, mined, or abandoned. Geologists use geophysical methods to locate sites of future deposits, as well as maps, reports, and their own common sense and experience.

Estimating Demand

Identifying the supply of sand and gravel in a particular jurisdiction is one important task. But it should be accompanied by an identification of the demand for these products in the region. The key here is recognizing that the consumption of sand and gravel corresponds to the state of the local economy and the relative growth or decline of the region. In a region experiencing fast growth, there will be a lot of construction and thus high consumption of sand and gravel. The consumption curve will peak as the growth rate peaks and will decline according to any subsequent decline of the economy. In a mature economy, the consumption of sand and gravel will remain more or less constant.

Approximate demand estimates can be calculated once the figures for the average annual per capita use in the region is known and the state of the economy is taken into consideration. In San Diego County, for example, planners noted that about 5 1/2 tons per person per year were being used in the county. Based on this figure, planners estimated that the county population would use about 775 million tons each of sand and gravel in the next 50 years. This demand was determined by multiplying the average annual population between 1978 and 2030 x 50 years x per capita use. These projections were based on the following assumptions: (1) the San Diego County population will continue to increase by approximately 45,000 per year; (2) concrete will continue to be a major construction material well into the foreseeable future, and the per capita consumption will remain approximately the same; and (3) no aggregate will be transported into or out of the county. San Diego planners compared the demand for sand to the identified supply of sand in their county. Their estimates are shown in Table 1.

TABLE 1. SUPPLY AND DEMAND FOR SAND IN SAN DIEGO COUNTY, CALIFORNIA

Area	In Millions of Tons		Relationship
	Supply	Demand	
San Diego Market Area	285	600	Supply half of demand
North County	600	165	Demand one-third of supply
County Total	785	765	Equal

These figures indicate that all of the currently available construction-quality sand in the rivers of western San Diego County would have to be mined to supply the 50-year demand. From these estimates planners conclude that they would have to devise a way to protect *all* of the available sand sources where they occur in the western portion of their county.

As for gravel, San Diego planners estimate that the demand would equal the demand for sand since concrete contains about 50 percent sand and 50 percent coarse aggregate. The supply of coarse aggregate, although not specifically calculated, was considered quite large in the county, and, consequently, it was not a resource issue.

Ranking the Deposits for Protection

After the deposits have been identified and the demand estimated, it is necessary to categorize the deposits by their importance. In making these decisions, the planner must consider both the producer's requirements for a deposit to be commercially valuable and the set of factors important for the public interest. *Planners also should consider that large-scale pits will take 20 to 40 years to be excavated.*

A number of local indicators should be considered when making these ranking decisions. For example, sand and gravel pits near the sites of projected construction projects should probably be protected until the projects are completed. The local demand for sand and gravel will be high along the public rights-of-way of new highways and extensions of highways. The supply of sand and gravel should be protected to fulfill this demand.

Government consumes about 35 percent of the sand and gravel produced in the U.S. Many local governments own or lease their own pits to fulfill their own primary need for

TABLE 2. CRITERIA FOR DECIDING WHETHER A SAND, GRAVEL, OR ROCK DEPOSIT WARRANTS PROTECTION

	Write It Off	Consider for Protection	Protection Desirable	Protection Highly Desirable (1000′ × 2,000 × 20′)	Protection Critical
Economic Value	Small or low-grade deposit.	Small deposits (less than 2,000 tons) located near use area or near processing plant.	Medium-sized deposit (5 million tons). Deposit made economical to mine by upgrading material. Large, low-grade deposit that might be economical to mine in the future.	Large deposit (7.5 million tons). Can be mined economically in near future by upgrad- the material.	Very large deposit (10 million tons) of concrete quality sand.
Access	Only practical route to site is through a residential area. More than 15 miles from use area. No noise buffering can be provided between existing access road and adjacent uses.	Longer alternate access route can be built.	Within 10 miles of use area; alternate access route available.	Large deposit, presently beyond economical hauling distance to present use areas. Near highways; access can be provided.	Within 5 miles of use area, adjacent to highway with access for trucks; adequate noise buffering for access road.
Compatibility with Surroundings	Adjacent land use presently incompatible with mining (appreciable residential development within range of excessive noise, dust, blasting vibrations, etc.)	Scattered development within outer range of impacts of mining; owners may not object to mining.	Adjacent land suitable for development and within commuting distance of use area.	Imminent incompatible development on adjacent land.	No incompatible land uses existing or likely in the forseeable future (adjacent land in national forest, operator's ownership, agricultural land-use category, or with very steep topography, etc.).
Impact of Noise	Noise level in adjacent presently developed areas would clearly exceed standards if mining occurred.		Noise level in adjacent undeveloped areas would exceed standards for likely use, but use of these areas can be easily delayed or economical mitigation can be provided by barriers.		Noise at adjacent residential area less than 50 dB(A) due to distance or topographical barrier; berm can be constructed easily.
Impact of Blasting	Too close to existing subdivision.				Blasting not required; permanent open space between quarry and other uses; topographic barrier between quarry and other land uses; only occasional light blasting; blasting compatible with adjacent uses.

TABLE 2. CONTINUED

	Write It Off	Consider for Protection	Protection Desirable	Protection Highly Desirable (1000′ × 2,000 × 20′)	Protection Critical
Impact of Truck Traffic	Only access is local road through residential area.	Slightly longer alternate route exists.	Alternate truck route can be built at reasonable expense; alternate transportation (conveyor or slurry pipeline) can be used past residential streets.		Adjacent to freeway with access to site.
Visual Impact	Mining would destroy or create.	Mining activity cannot be screened and would permanently alter landscape.	Some activity visible from residential areas, but no permanent deterioration of landscape.	Mining activity can be easily screened by berms and/or vegetation.	Activity screened by topography or vegetation, or appreciably reduced by distance.
Biological Impact	Major stand of oaks; rare and endangered plants or animals on site.	Site includes prime wildlife habitat that would be permanently removed by mining.		Minor or temporary loss of wildlife habitat.	No significant biological resources; rehabilitation of site would replace or create riparian wildlife habitat.
Impact of Flooding	Mining would cause erosion of adjacent property; could be prevented only at great expense.		Mining would create erosion hazard for roads, bridges, and utility lines; however, these structures could be strengthened at reasonable costs.		Mining would create flood control channel and would not damage adjacent land.

sand and gravel—maintenance, upgrading, and construction of public roads. *Sand and gravel deposits that are not large enough to be commercially valuable to private producers may be good sources of supply for municipalities.*

Once the location of deposits have been inventoried, consulting engineers conduct a series of tests to determine the quality of the deposits. Sample borings are obtained through a variety of methods depending upon the location of the deposits. The materials in the borings are screened (in an operation called a "sieve analysis") and run through a number of tests to determine the amount of sand versus the amount of gravel; grading and physical character of the material; and the amount and type of undesirable matter. The result of these procedures is a three-dimensional picture of each of the mapped deposits.

While the geologic evaluation of the deposits is underway, planners can begin their appraisal of the other variables that affect ranking the deposits. A comprehensive approach to ranking deposits is to develop a matrix that delineates all of the important private and public variables. San Diego County planners have developed such a matrix. The economic, land-use, and environmental factors used in San Diego are ranked from most negative on the left to most positive on the right (see Table 2).

They make a few other recommendations for helping to determine whether deposits warrant protection:

1. Where the total supply of either sand, gravel, or crushed rock is limited, an attempt should be made to protect all but the most marginal deposits. If a supply of one material—such as sand as opposed to gravel—is abundant, only selected portions would merit protection.
2. It is best to preserve separate sites 10 or so miles apart from each other, rather than to have one huge consolidated site. In that way, hauling costs to cover the entire market within the jurisdiction of the planning authority can be reduced.
3. Alternate sites should also be preserved to stimulate competition among industry operators, thus holding down prices. Planners must be careful that their designations for protection do not give an undue advantage to one operator over another. Court suits are sure to follow if operators sense unequal protection of their resources.

CHOOSING THE BEST PROTECTION TECHNIQUE

The amount of effort required to achieve adequate protection will vary from site to site. In some cases, sand and gravel deposits, along with necessary buffer areas, may already be purchased or leased by companies. In these situations, there is little need for governmental protection.

For deposits not already bought or leased, the problems are more difficult. The easiest method for local governments is to use their land-use regulations as a protective device by designating these deposits as "resource conservation areas" or "extractive-use districts." The primary aim of these land-use controls is to ensure that uses incompatible or conflicting with extraction activities are minimized. For example, it would be poor planning to allow permanent structures to be built on areas designated for mining since such buildings would prevent such mining.

However, these zoning powers are only effective for sites that are likely to be developed in the near future. San Diego planners use five years as a rule of thumb for zoning protection. If the resource is likely to be developed within the next five years, they feel that zoning controls offer reasonable protection. However, if the resources are likely to be in reserve for a period of longer than five years, they feel that the zoning classifications will be ineffective. In these cases, it is necessary to use other techniques, such as special state actions or lease and purchase agreements between the government and local owners of the property.

There are three ways to minimize such incompatibilities:

1. Create a special extraction district in which only extraction is allowed by right and all other uses are controlled through a conditional use or special exception process.
2. Create an overlay zone into which deposits are placed as soon as they are identified. In this way, mining operations are subject both to the requirements of the overlay zone and the existing zone in which they occur.
3. Map identified deposits into existing use districts, such as agricultural, open space, or industrial, in which excavation is permitted by conditional use or special exception.

Special Extraction Districts

Some communities have designated special mineral reservation districts for extracting and processing valuable resources. Orange County, California, for example, has created a Sand and Gravel Extraction District. Extraction of sand and gravel along with other similar resources is given primary status in this district. Other compatible uses are allowed subject to a special permit.

Orange County, California, Ordinance (Excerpt)

§7-9-104.3. Uses permitted subject to an SG site permit.

The following uses may be permitted in the SG "Sand and Gravel Extraction" District with an SG site permit:

(a) Mining, quarrying, and the commercial extraction of rock, sand, gravel, earth, clay, and similar materials.

§7-9-104.4. Additional uses permitted subject to an SG site permit.

The following additional uses may be permitted in the SG "Sand and Gravel Extraction" District with an SG site permit:

(a) Storage, stockpiling, distribution, and sale of rock, sand, gravel, earth, clay, and similar materials.

(b) The installation and operation of plants or apparatus for rock crushing or cement treatment of base materials, and appurtenant screening, blending, washing, loading, and conveyor facilities.

(c) Concrete batching plants and mixing plants for either portland cement or asphaltic concrete.

(d) The manufacture of concrete and clay products and prestressed structural units in conjunction and concurrent with excavation on the site.

(e) Sanitary landfilling, including inert materials disposal sites.

(f) Shops, garages, and warehouses for the repair, maintenance, and storage of equipment and supplies necessary for the conduct of the uses permitted.

(g) Offices for the conduct of the uses permitted.

(h) Not more than two (2) single-family dwelling units for employees engaged in guarding or carrying on the uses permitted.

(i) Public and private parks and recreation areas and appurtenant buildings and improvements when they are compatible with all other authorized uses on the site and the reclamation of the site.

(j) Agricultural and other types of open space uses.

(k) Any other uses necessary or incidental to mining operations on the site.

§7-9-104.5. Compliance with other laws.

Any uses permitted in the SG "Sand and Gravel Extraction" District shall comply with all other applicable laws and ordinances and, specifically, with "The Sand, Gravel, and Mineral Extraction Code of the County of Orange" (Division 10) insofar as said Code is applicable to the uses permitted.

Clear Creek, Colorado, Ordinance (Excerpt)

§17.M-1. (Mining One) District

A. Use Regulation
No building or land shall be used and no building shall be hereafter erected, converted, or structurally altered, unless otherwise provided herein, except for one or more of the following uses:

1. Any use specifically required for the mining, prospecting, exploring, milling, and/or placering of mineral resources upon property defined by a patented mining claim or mill site or identified by a location certificate recorded in the County Clerk and Recorder's Office, all as represented by maps approved by the Board of County Commissioners.
2. Any use specifically required for the mining, prospecting, exploring, milling, and/or placering of mineral resources upon property or adjacent to property defined in §17A.1 above and classified according to §25C.15 or upon property identified by a location certificate and classified according to §25C.15.
3. Such other uses that are not more detrimental to the highest and best uses of the land in said district than are the uses hereinbefore enumerated.

Clear Creek County, Colorado, uses a similar type of reserve district to protect mineral resources, among which are sand and gravel. The one significant difference between Clear Creek County's approach and that of Orange County and other jurisdictions is the exclusive protection of mineral reserves given in their zoning ordinance. As illustrated in the excerpt shown above, mining is considered the highest and best use in the district. Other uses that are typically allowed by permit, such as those illustrated for Orange County, are considered detrimental to the goal of protecting mineral resources for future extraction.

Overlay Districts

One technique to protect and regulate extraction is to create a natural resource overlay zone or district. Overlay districts are mapped zones that protect resource use—in this case, natural resources such as sand, gravel, and crushed rock. A natural resource overlay district allows land to be used for resource extraction while preserving the long-term land use designated for the area. The following Fairfax County, Virginia, example illustrates this approach.

Fairfax County Natural Resource Overlay District. Like other overlay zones, the Natural Resource Overlay District is mapped on the county's official zoning map. Any parcel of land lying in the district also lies in one or more of the other underlying zoning districts. In Fairfax County, natural resources have been identified in one vein that runs across the county. The overlay zone has been drawn over a variety of uses, including sparse residential development and small farms. Operators who want to mine within the overlay district must obtain a special permit from the Board of Zoning Administrators. Mining operations are regulated by the special permit regulations of the overlay zone and the underlying zone in which the mining site occurs. The excerpt below from the Fairfax County zoning ordinance shows which uses are permitted in the overlay district.

Fairfax County, Virginia, Ordinance (Excerpt)

§7-305. Permitted Uses
Within an adopted Natural Resource Overlay District, all uses shall be permitted pursuant to the district regulations of the zoning district in which such Natural Resource Overlay District is located; and, in addition, those uses shall be permitted as specified in Part 1 of Article 8.

Group 1—Special Permit Uses

1. Removal of sand or gravel by excavating, stripping, dredging, mining, or otherwise taking other than as permitted by right under the provisions of §2-601, but not including the treating, crushing, or processing of the same. No permit for such sand or gravel removal shall be approved by the BZA for any parcel or area not designated in the adopted comprehensive plan for consideration of such a use.
2. Removal of soil by excavating, stripping, dredging, mining, or otherwise taking other than as permitted by right under the provisions of §2-601, but not including the treating, crushing, or processing of the same.
3. Stone quarrying.
4. Extraction of materials other than those specifically enumerated in this part.
5. Crushing, treating, washing, and/or processing of materials resulting from a use permitted under the four immediately preceding paragraphs when conducted on the same property.

Sacramento County, California, has a program similar to Fairfax County's. Its identification and protection program is the prototype upon which the state of California based its Surface Mining Designation and Classification System. The county uses two planning tools to protect its resources:

1. A conservation element in the general plan that establishes a policy for management and protection of the resources; and
2. The surface mining overlay zone—very similar to the Fairfax County overlay zone in its intention and provisions—which identifies where the resources are located; it states that mining is an appropriate use of these sites and that the final reclaimed site must fit the use requirements of the respective zone underlying the overlay zone.

County officials have noted two consequences of their protection approach. First, as soon as the mining sites were incorporated into the overlay zone, they were bought by the mining operators. In the past, the operators were reluctant to speculate upon mining sites, even sites of valuable deposits, because they feared that such sites would be preempted by other surrounding uses. Second, the overlay zone has been a useful warning to other people who might buy land or build in the areas that may have mining sites as neighbors. They have become aware of the area's classification before they, too, run the risk of jeopardizing their investments. Consequently, the overlay district approval is considered a success by these officials.

Mapping Deposits into Existing Use Districts

Some communities protect their resources by mapping them into existing zoning districts whose uses are not detrimental to future extraction. Typically, these districts are agricultural, industrial, and open space. The important criteria for determining whether permitted uses would jeopardize future extraction is the level of investment on the particular mining site. Generally, residential and commercial uses that involve a considerable investment in buildings will preclude future mining. When communities, such as San Juan County, Washington, and McHenry County, Illinois, do allow mining in specified use districts, mining operations and reclamation are regulated by a conditional use permit, operational standards, and requirements for a reclamation plan.

In general, this approach is less popular than the mineral reservation district or overlay zone for protecting resources. It also has several drawbacks. Since the deposit sites are not mapped into a specific resource extraction district or zone, potential land developers and/or residents are not alerted to the community's interest in preserving resources on adjacent and affected properties. As a result, local governments could open themselves up to legal challenges for inverse condemnation. Second, governments that pursue this approach typically do not rank their deposits for protection. The approach is more valuable for regulating and controlling the operations and for reclamation of existing mining activities than for protecting specified resources for future extraction.

Multitiered Approach

Some communities, such as San Diego County, use a combination of techniques to protect their resources. The protection approach of San Diego County includes Resource Conservation Areas (RCAs) and Special Study Areas (SSAs).

Resource Conservation Areas (RCAs). RCAs are mapped areas that identify a variety of environmentally sensitive lands that are to be protected. RCAs apply to wildlife habitats, groundwater problem areas, historical sites, and other resources, as well as sand and gravel deposits. The County Planning Department is currently mapping these RCAs on community plans. RCAs alert people and public agencies, particularly the environmental review board, to the fact that the area should have some form of special consideration. However, designation of a sand and gravel deposit as an RCA does not, in itself, ensure protection.

Special Study Areas (SSAs). The county also delineates SSAs as areas in which development should be restricted pending completion of detailed review or study. Again, SSA designation is an interim strategy with no legal power to ensure protection.

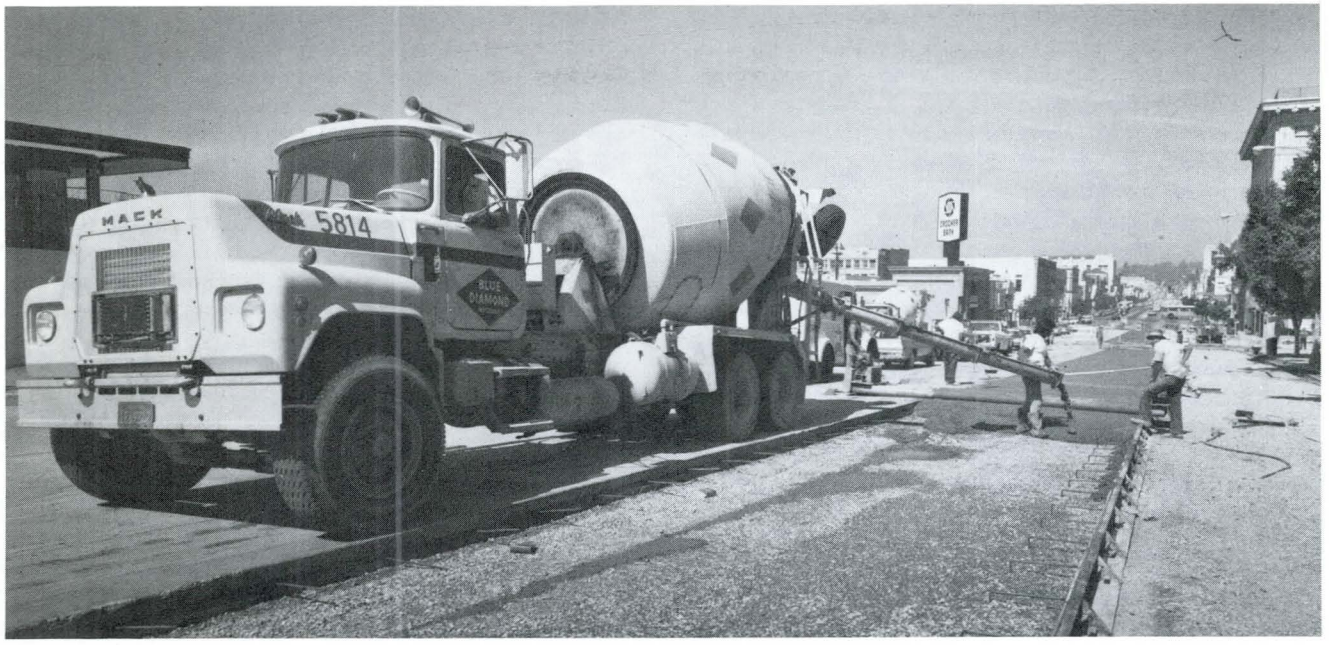
The county uses existing zoning regulations to protect deposits in the "Impact Sensitive" and "S-82 Extractive Use Zone" for five years. However, neither of these zones is specifically designated for extraction of mineral resources. Thus, the county is proposing a general plan amendment that would create an extractive use zone in which the primary use of the land will be for resource extraction. The proposed amendment reads:

> **Extractive**
> This designation is applied only to areas containing economically or potentially economically extractable mineral resources. The designation promotes extraction as the principal and dominant use. Uses other than extraction and processing of mineral resources are permitted only when they will not interfere with present or future extraction. Uses such as processing, agriculture, and open space which are supportive of, or compatible with, mining are also permitted. Interim uses which are not compatible, but which will be removed, may be permitted. Upon completion of mining, areas designated extractive will be changed to other appropriate land-use designations through the General Plan Amendment Process.
>
> A minimum parcel size of 20 acres is required.

When completed, the county's resource protection system will be coordinated with the state of California's protection system to provide a double level of protection for valuable resources such as sand and gravel.

Other Protection Techniques

State Action. The long-term protection of sand and gravel deposits from urban development may be as difficult as the long-term protection of agricultural land from urban development. One of the most hopeful signs for its protection has been the increased interest shown on the part of state governments. Since these resources are



Vanguard Photography, Hollywood, California

Sand and gravel is used extensively as a base or as sub-grade material for highways, railroads, runways, in road surfacing, and in asphalt paving mixtures.

ultimately of regional importance, it makes sense that their protection and utilization be managed in a comprehensive fashion.

California, for example, has developed a system for identifying sand and gravel or aggregate deposits of regional significance and for providing a planning process to protect the resources and regulate mining operations and reclamation. As it is fully implemented over the next few years, state officials hope that this state support will provide a means for local officials to make politically unpopular decisions.

The system was established by the California Surface Mining and Reclamation Act of 1975. The state Division of Mines and Geology has been designated as the key state agency to work with local lead agencies through the various phases of the system. The State Mining and Geology Board established policies and minimum standards for guiding the Division of Mines and Geology and local agencies. The California process was initiated in the fall of 1978. It is expected that by May 1980, the San Fernando Valley in Los Angeles County will become the state's first area to be classified by the chief geologist. The California State Mining and Geology Board will have one year to designate the classified land.

The two key phases of the resource protection process are called "classification" and "designation." In the classification phase, the state geologist, using a set of criteria established by the Mining Board, identifies the locations of mineral resources in the state and assesses the demand in each market for those resources. Essentially, this is the same type of activity as pursued by any mineral exploration geologist. First, the geologists conduct a basic literature search. They use well logs from research publications, data from operators, existing geologic maps, flood control studies, and university data. Only when there is very little information will they take sample borings.

In the next step, the geologists project the estimated demand in the market area for a 50-year period. In assessing the market demand, the geologists do a standard market analysis. The geologists use public utility commission haul rate booklets showing tonnage rates per mile to determine where one market area begins and the other ends. The market boundaries fall at those points where the rates become equal. To calculate demand projections for each market, the geologists study past consumption rates and future population projections. Consumption rates typically vary from two to eight tons per capita per year. In areas of high past growth, there are obviously higher consumption rates. The consumption data is supplied by the operators.

The final classification step is dividing the state into the following mineral resource zones (MRZs):

1. MRZ-1: areas that do not contain significant reserves, based on available information.
2. MRZ-2: areas that do contain significant reserves, based on available information.
3. MRZ-3: areas that might have usable reserves, based on available information, but not enough is known to classify as MRZ-2.
4. MRZ-4: areas in which enough information is not yet available to put into other classifications.
5. MRZ-Scientific Zone: areas of scientific significance, such as La Brea Tar Pits in Los Angeles.

In the designation phase, the state works with the local lead agencies to designate resource areas that should be protected, based on the results of the classification phase. The primary objective of designation is to protect deposits of regional or statewide significance. The decision is based on an evaluation of the geologic information from

the classification phase, the configuration of local land uses, and local resource needs. The decision works like this: if there is a supply of two million tons in a market or submarket region and the demand in that region is one million tons, then the state and local officials determine the best location for protecting a total of one million tons.

State legislators anticipated that the designation decisions would overcome the inevitable parochialism and politics of local land-use decision making. Although the local lead agencies take part in the designation phase, the Mining and Geology Board makes the final designation decisions. By law, the California system requires local governments to incorporate a conservation element into their general plans and develop their own planning tools to protect identified resources. The local government must apply information from the classification and designation process so that permitted land uses will not jeopardize the extraction of officially designated resources. If a local government denies a permit to extract a resource designated as being of regional or statewide significance, the mining operator can appeal to the Mining and Geology Board. However, the Board does not have the power to overturn local decisions; it would be necessary to go to court.

As of now, the California system has yet to be tested in court.

Development Code and Mineral Resource Protection Policies. In counties and cities in which resource protection is clearly a primary goal, another land-use-control approach is the creation of a "development code" and accompanying mineral resource protection policies. A development code is basically a unified building, zoning, and subdivision code that replaces the zoning and subdivision ordinance. Landowners, such as mining operators, who want to know how they can develop their land, turn to the development code for specific development criteria, including setbacks, building types, etc. Together with the resource protection policies of a general plan, the code can help ensure that development is prohibited over identified resource areas until the resources are extracted.

The best example of the use of this approach is San Bernadino County, California. San Bernadino County is the nation's largest county, and the largest county-level producer of mineral resources apart from the oil and gas counties of Louisiana and Texas. Clearly, it is not typical. However, its approach to mineral resource protection may provide useful guidelines for other local governments interested in protecting their own resources.

The San Bernadino strategy is founded on the assumption that the location of deposits should dictate the methods used to protect them. These deposit sites transcend political and other boundary lines. The logic of the new development code is to allow mining operations *unless* there is a specific prohibition against mining on a particular site. In concept, this is an important reversal of the logic of conventional zoning ordinances. Over the years, county officials had noticed that their zoning ordinance had grown by accretion. If there was not a site-specific allowance for mining, planners noticed, mining was not allowed. In effect, the ordinance—ostensibly designed to protect mineral extraction—had actually reduced the probability that an operator would get a permit for mining on a particular site.

The county has developed mineral resource management policies in their new general plan that recognize mineral extraction as the highest and best use of the land. The county is also drafting community plans that will use the development code to specify and map the locations of the resources. In sum, the county will have a powerful legal foundation for protecting its resources for at least 20 years (the time frame for the general plan) and, perhaps, 50 years (the time frame recommended by the state).

Approaches Under Consideration

There are various other approaches under consideration by governments to ensure protection. Following are the prime examples.

Land Dedication. Boulder, Colorado, has been working with one mining operator on a tradeoff that would benefit both the operator and the community. The operator will dedicate his mined lands to the city following the completion of mining activities. The operators gets a tax writeoff for the dedication; the city gets a swath of land on its urban fringe that will be reclaimed as a greenbelt.

Transfer of Development Rights. Another resource protection approach is to use transfer of development rights (TDR). In exchange for foregoing development on parcels near extraction sites, developers can be allowed higher densities for sites away from the mining area.

Intergovernmental Coordination. Local governments try to persuade other governmental or quasi-governmental organizations that own or control their own sand and gravel resources to preserve them for future extraction. San Bernadino County, for example, has signed an agreement with the Bureau of Land Management of the U.S. Department of the Interior. This technique is particularly important in the absence of any statewide protection plan.

If local or county governments would like to protect identified deposits, the easiest technique is to buy the sites outright. The public acquisition of deposits could be included as part of a total development package for open space or industrial development lands. Potential extraction sites would then be included as part of a broader development program. Such land banking is not common practice in the U.S., and the sheer expense of purchasing the land generally makes it impossible.

Short of buying the land, another approach to controlling land development is for the community to buy the development rights to the land. Since local units of government have the legal authority to acquire land for open space, parks and recreation, and industrial parks, it is feasible that deposit sites be purchased as projected areas for development. To overcome the economic burden of buying the land, the community could lease the land to the operator for the duration of excavation, then redevelop it into the permanent use.

Another possible technique is project land banking. Using this approach, a municipal or county government would purchase specific resource sites for later resale as needed by private operators. San Diego County is presently looking into the feasibility of this approach.

Chapter 3. Living with Sand and Gravel Operations

To design regulations for sand and gravel operations, it is necessary to consider what process of mineral extraction is expected and the adverse effects that such operations may have on either surrounding natural environment or urban development. The task of the planner is to find the best way to balance the needs of the operators with the public's right to minimum nuisance potential resulting from extraction. Sand and gravel operations engender nuisances like other industrial operations; to nearby residents, mining sites are ugly, dirty, and noisy, and abandoned sites can be a safety hazard as well as an eyesore.

Truck traffic is the greatest of these nuisances. In one Connecticut example, a loaded 10-yard truck was to leave a mining site every two minutes for 10 hours a day, six days a week, and make a return trip. Such heavy truck traffic can ruin roads and bridges not suited for heavy use; it can increase maintenance and street cleaning costs due to spillage; and it can cause traffic and safety problems.

In addition to these general industrial problems, the mining operation can harm the environment. The very nature of the business requires major changes in landform, and one must be alert for any resulting problems.

One environmental impact from sand and gravel excavation is the effects on surface and groundwater quality. Where extraction reaches the water table or occurs in a water body, siltation and turbidity problems can occur. Draglines and dredging equipment can disturb existing sediment in streams and coastal areas. In many operations, however, water moves *into* the pit, not *out* of it, so the potential for surface water pollution is negligible. All sand and gravel mining operators must abide by various federal and state water pollution regulations that prohibit most instances of point-source discharges into streams, including those from sand and gravel pits. Groundwater, on the other hand, may be a more immediate problem. Clays can settle during the extraction process and cover an aquifer. This, in turn, can cause the water table to lower, which will cause drought problems for surrounding lands.

Along with water problems, sand and gravel mining operations also may be a source of air pollution. Sand and gravel excavation and processing produces dust—not as much as some other surface mining operations—but enough to be a nuisance to nearby development. Typically, the dust contains no toxic substances, but it can aggravate respiratory problems, as well as affect the value of surrounding property.

Since excavation strips the topsoil off the site, erosion damage can make the site unsuitable for use if a cover crop sufficient to hold topsoil in place cannot be subsequently developed. Topsoil lost by removal or erosion must be replaced once a site is mined so that the area can be stabilized.

Often planners will also find themselves balancing concerns of competing economic interests. San Juan County, Washington, located on Puget Sound, is such an example. It is rich in nonmetallic minerals, but it also has important agricultural and coastal resources. County planners found it necessary to set forth some basic policies about mineral extraction in their comprehensive plan. These policies direct the county's decisions when reviewing permits for mineral extraction:

1. The county should encourage the development of mineral extraction operations in nonshoreline areas before considering their location in shoreline areas.
2. Mineral extraction operations which would adversely affect agricultural activities or remove agricultural lands from production should not be permitted when feasible alternatives exist.
3. Mineral extraction operations should be conducted in a manner which will minimize the adverse effects on water quality, fish and wildlife, adjacent activities, and the scenic qualities of the shorelines.
4. No mineral extraction operation should be permitted in the absence of a detailed plan for site reclamation.

While they obviously value their mineral extraction industry, they want to be sure that it does not needlessly damage other economic interests.

These general policies are further refined with a set of regulations in the plan. These regulations require a detailed report on the type, quality, and quantity of the minerals to be extracted, as well as a reclamation plan that complies with the county's Master Plan. In addition, because of beach erosion problems, they specifically forbid the use of marine beach or feeder bluff or any lake beach minerals to be used for commercial or industrial purposes or any extraction within 50 feet of water bodies or wetlands. They also require that topsoil, or other overburden that has value for agricultural and other beneficial uses, must be removed or disposed of in a manner that will not prevent its future use.

While San Juan County's conditions may require a more complicating balancing act than most, generally communities find it necessary to review each site on a case-by-case basis. Typically, they use two types of regulations. First, they make extraction a conditional use or a use by special permit within specified districts, and, second, they outline a set of operational standards the sand and gravel producer must follow.

CONDITIONAL USE REQUIREMENTS

As discussed in the previous chapter, mineral extraction may have its own district designation. However, it is more common to allow it in a combination of agricultural, open space, and industrial districts, either as a conditional use or by special exception.

The San Joaquin County, California, ordinance is a typical example. Through the provisions of a zoning ordinance amendment requiring an excavation permit, San Joaquin County allows excavations, processing, storage, and material transport under a set of minimum conditions in four districts: limited manufacturing (M-1), general manufacturing (M-2), general agricultural (G-A), and exclusive agricultural (E-A). The conditions are: (1) if the Soil Conservation Service rating is Class IV, V, VI, or VII and if the Storie rating for the property is less than 60[2] (this provision limits mining to land that is not productive for agricultural purposes); and (2) if the application is for grading, as defined by the ordinance, or for the removal of sand and gravel deposits beneath the soils. Subject to the excavation permit, excavation sites, both permanent and temporary, are permitted uses; included are equipment, structures, and facilities necessary for or convenient for extracting, processing, storing, and transporting materials. This includes but is not limited to sand and gravel separation plants, rock crushers, concrete batching plants, and asphalt batching plants.

The Storie rating is a soils classification system that, for the most part, has been supplanted by the more general and universal Soils Classification System. Since not all of the soils have been reclassified according to the Soils Classification System, San Joaquin County must still consider the Storie rating. The Storie rating uses three basic soils characteristics—profile, texture, and slope—and other conditions to classify soils on a scale of 1-100, based on the ability to grow varied crops.

San Joaquin County has established a series of application requirements to guide the application review process. (See Figures 1, 2, and 3.) Even with the delineation of the minimum conditions and application requirements, the

[2]The Soils Classification Service System rates land on its ability to be used for agricultural purposes. Classes I, II, and III are prime agricultural; Class IV is permanent vegetation, such as hay, pasture, and trees; Class V is permanent wetlands; and Class VI and Class VII are areas unsuited for cultivation.

FIGURE 1. SITE PLAN

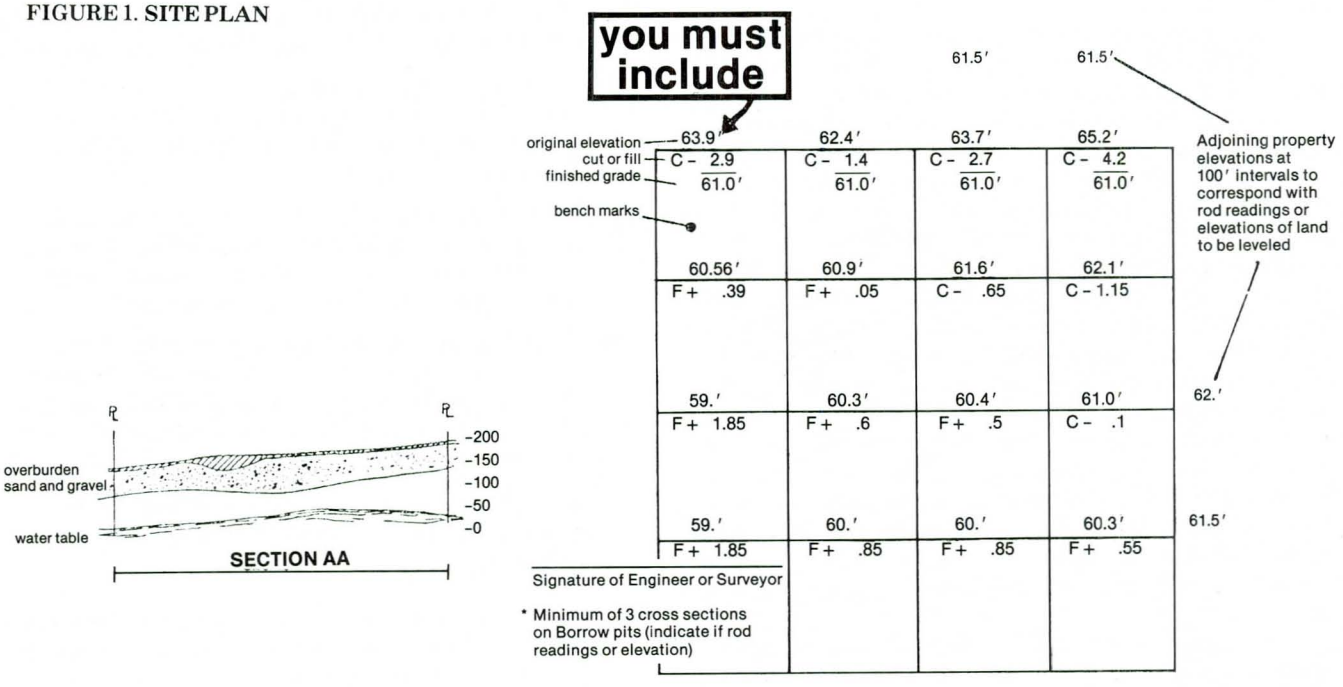
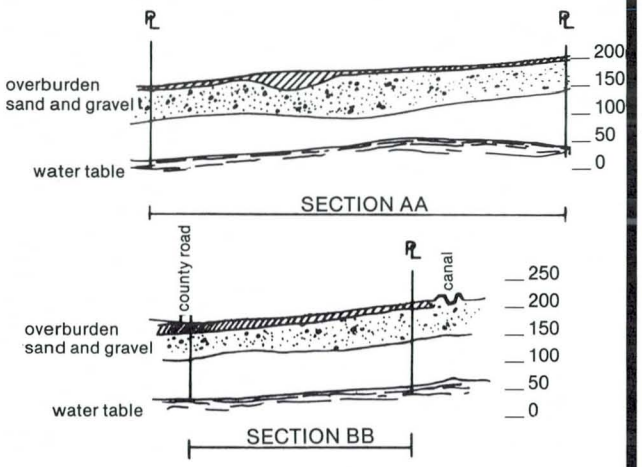


FIGURE 2. QUARRY EXCAVATION SITE PLAN



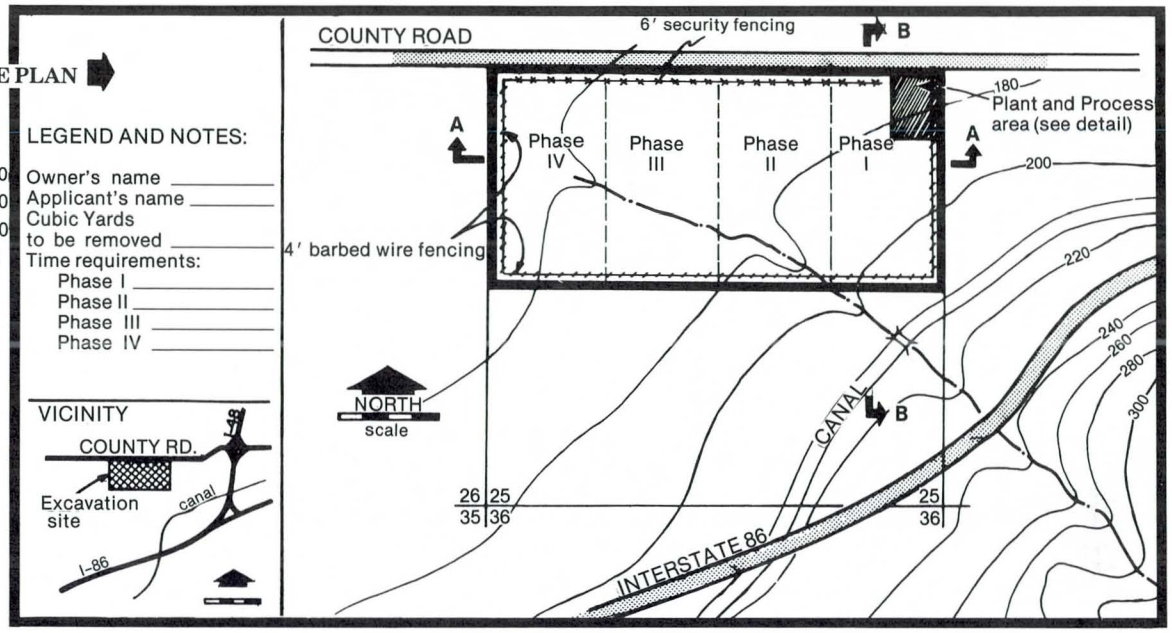
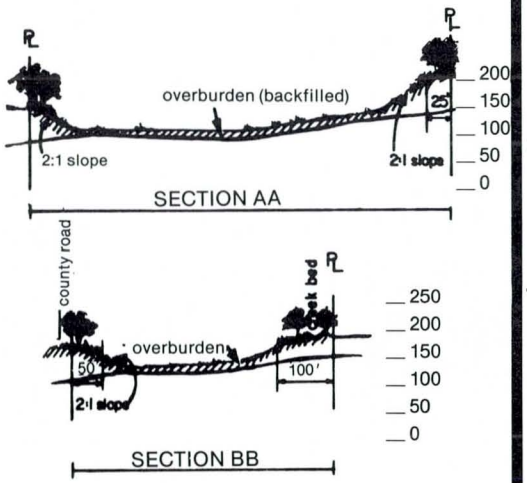
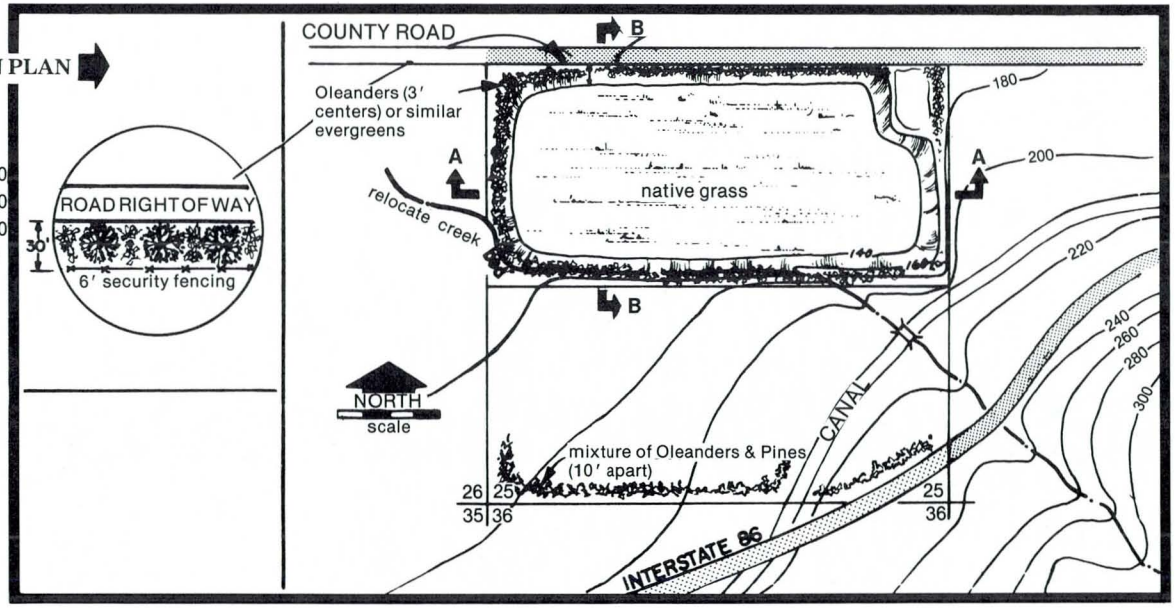


FIGURE 3. REHABILITATION PLAN





San Joaquin, California, Ordinance (Excerpt)

§2F.5. Requirements for Application.
The application shall include a development plan, operational statement, and rehabilitation plan. The following information shall be submitted:

A. A Site Plan prepared by a registered civil engineer, registered surveyor, or a landscape architect. An 18″ x 26″ or larger sepia or other reproducible along with 10 copies of a Site Plan which shall include the following:

1. North point, scale, and date.
2. Extent of the area to be excavated.
3. Location, width, and grade of all easements or rights-of-way on or abutting the property.
4. Location of all structures on the property.
5. Location of all areas on the property subject to inundation or flood hazard, and the location, width, and directions of flow of all watercourses and flood control channels that may be affected by the excavation.
6. Bench marks.
7. Existing elevations of the total property at intervals of not more than 100′ in both north-south and east-west directions and existing elevations of abutting properties at intervals of not more than 100′ around the perimeter of the property and 100′ from property lines. This requirement can be modified by the Development Committee on applications for quarry excavations, if the size of the site and uniformity of the grade is such that this information is not necessary in the review process of the application.
8. Typical cross-sections, showing the extent of overburden, extent of sand and gravel deposits, and the water table.
9. Processing and storage areas.
10. Proposed fencing, gates, parking, and signs.
11. Ingress-egress roads, plus on-site roads and proposed surface treatment and means to limit dust.
12. A map showing access routes between the property and the nearest arterial road.
13. Areas to be used for ponding.

B. An Operational Statement, which shall include:

1. The approximate date of commencement of the excavation and the duration of the operation.
2. Proposed hours and days of operation.
3. Estimated type and volume of the excavation.
4. Method of extracting and processing, including the disposition of overburden or top soils.
5. Equipment proposed to be used in the operation of the excavation.
6. Operating practices proposed to be used to minimize noise, dust, air contaminants, and vibration.
7. Methods to prevent pollution of surface or underground water.

C. A Rehabilitation Plan, which shall include:

1. A statement of planned rehabilitation, including methods of accomplishment, phasing, and timing.
2. A plan indicating: the final grade of the excavation; any water features included in the rehabilitation and methods planned to prevent stagnation and pollution; landscaping or vegetative planting; and areas of cut or fill. This plan, if clearly delineated, may be included with the Site Plan. For quarry applications, the final grade shall mean the approximate planned final grade.
3. A phasing plan, if the excavation of the site is to be accomplished in phases. This plan shall indicate the area and extent of each phase and the approximate timing of each phase.
4. The method of disposing of any equipment or structures used in the operation of the excavation upon completion of the excavation.

D. The name, address, and signature of the property owners and applicant.

E. A written legal description or record of survey of the property.

F. A fee, as established by resolution of the Board of Supervisors.

G. In agricultural areas as shown in the General Plan, a soils report, prepared by a person qualified to analyze agricultural soils, shall be required for all proposals where the top soil is not to be replaced upon completion of the excavation.

Board of Adjustment or Board of Supervisors has reserved the right to deny an application "which conveys the problems of the property involved to any adjoining property or poses a threat to the public's health, safety, or welfare." The application requirements from the San Joaquin County zoning ordinance are typical of other municipal and county zoning ordinance requirements.

Some communities, such as Anne Arundel County, Maryland, also require a aerial photograph of the excavation area including:

1. All land requested in petition for special exception;
2. All contiguous land that is or has been used by the owner, by a leasehold applicant for sand and gravel extraction, treatment, and storage, or by a resource-related industry;
3. All public roads that can provide first point of access;
4. All residentially zoned land within 500 feet.

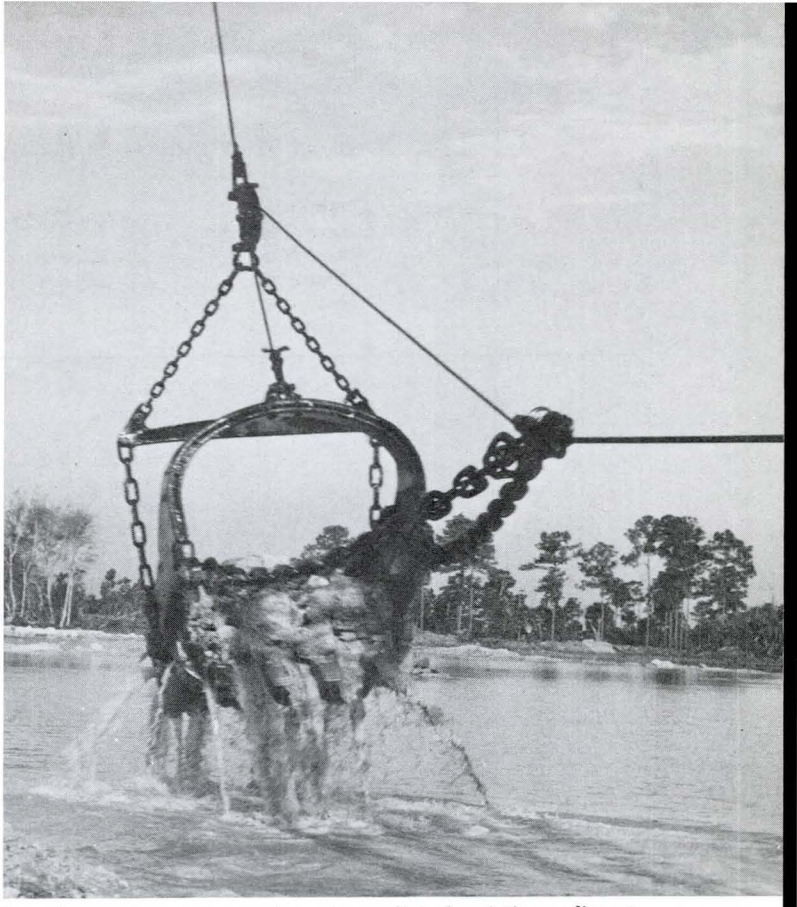
The photo is to be enlarged so that one inch equals 200 feet, from original photography flown at a negative scale no smaller than one foot to 1,000 feet, and certified as flown not earlier than two months prior to date of application. These photographs enable the county to identify possible conflicts.

Both the industry operators and planners stress the importance of early and continuing contact once an operator has begun to consider extraction on a specific site. Industry operators note that local boards and planning commission members do not know the technical aspects of sand and gravel mining. Consequently, they should go out and look at the site and talk to the operator about the mining conditions. Similarly, planners should encourage operators to obtain information and guidance before making a financial commitment or incurring substantial expense in preparing plans, surveys, and other data.

In addition to the materials required for application cited above, many communities include the following requirements:

1. Receipts for certified letters mailed to all contiguous property owners notifying the owners that an application for the proposed use is being filed with the appropriate officials. Such notices are required to be delivered 60 days prior to public hearings for permit approval.
2. A letter signed by the applicant and the owner of the property granting the right of entry upon the property to appropriate public officials—such as the planning director or head zoning administrator, law enforcement agents, members of land restoration or reclamation boards, and other local inspectors—for the purpose of inspecting and bringing law enforcement to the property, during the term of the permit.

Local units of government inspect the mining sites periodically to make sure the operations are following the agreed-upon plans. Typically, long-term excavations (more than two years) are inspected semiannually, and short-term excavations (under two years) are inspected at least four times during the duration of excavation. The effective time limit of permits ranges in varous jurisdictions from two or three years to the expected life of the operation. Permits for less than the anticipated life of the deposit should be specifically renewable if the conditions of the permit are being complied with.



Pit and Quarry

Draglines and dredging equipment can disturb existing sediment in streams and coastal areas.

Frequently communities will exclude small sand and gravel pits from all conditional use requirements; the cut-off ranges from three acres in St. Mary's County, Maryland, to 20 acres in Fairfax County, Virginia. However, even in these cases, appropriate local or areawide erosion- and sediment-control permits should still regulate those aspects of extraction.

OPERATIONAL STANDARDS

Minimum operational standards should be set out either in the zoning ordinance or in a separate mineral extraction ordinance. Operational standards can complement zoning controls when incompatibility of land uses or environmental hazards are anticipated. As many planners realize, any environmental hazards or land-use conflicts that can be reduced by technical means will reduce the amount of expensive land tied up in providing reduction by distance alone. Such trade-offs must be made on a case-by-case basis when reviewing conditional use permits.

For most local communities, the operational standards are primarily aimed at traditional industrial impacts like noise and traffic; but some situations have also necessitated environmental regulations to protect the community against dust, run-off, and the destruction of aquifers. This section will discuss both these types of operational standards.

TABLE 3. STANDARDS FOR SETBACKS (MINIMUM FOOTAGE TO BOUNDARIES)

City	Distance from Zoning District Where Mining Sand and Gravel Not Permitted	Distance from Adjoining Property Line	Distance from Right-of-Way of Existing or Platted Street, Road, or Highway	Other Provisions or Qualifications
Chapel Hill, North Carolina	100 feet	50 feet, unless written consent is secured. 100 feet to adjoining property, residentially zoned and occupied.	100 feet	Distance of 300 feet required to right-of-way and to adjoining property residentially zoned and occupied, for equipment for sorting, crushing, and operating structures and facilities.
Memphis and Shelby County, Tennessee		75 feet from any property line. 250 feet from an inhabited building.	100 feet	Standards hold where adjoining property is not part of operation through lease or easement waiving this condition.
Kane County, Illinois	200 feet	100 feet	150 feet	For product processing or excavation unless otherwise specifically provided in special use permit.
Lake County, Illinois		30 feet	30 feet	
North Hempstead, Long Island, New York		50 feet (except where adjoining property is also being excavated); 50 foot area must have berm with minimum slope of 1 inch to 1 foot from top down to property line.		
Fairfax County, Virginia		200 feet from contiguous property subdivided into residential lots of one acre or smaller, not owned or controlled by applicant. 250 feet from occupied dwelling.		
Orange County, California		50 feet, if any parcel is not in the sand and gravel district.	50 feet	100 feet (at permitted slopes) 50 feet at 3:1 slope from any property or right-of-way line of flood control channel or retarding or conservation basin. 750 feet for rock-crushing plant or other apparatus for manufacturing of rock, sand, and gravel except primary crushing operations in conjunction with excavation of boundary line of any residential zone. 400 feet for crushing plant, if below ground level.
Alameda County, California		25 feet, except where adjoining property is being mined.	50 feet of right-of-way or future (width) line of any street.	

Establishing Buffer Widths

The most common device for mitigating industrial impacts is the use of buffers. Buffers provide two-way protection. They protect mining operations from possible intrusions or conflicts from adjacent uses, and they protect adjacent residents and property owners from the impact of the operation. Typically, the widths of buffer areas vary not only from community to community, but from one mining site to another. Table 3 shows the variety of buffer requirements in local ordinances.

These standardized buffers are useful for establishing some basic separation between sand and gravel operations and other uses, but for buffering noise, they are less satisfactory. It is difficult to get specification standards for noise emanating from sand and gravel operations. First, these operations have a number of noise sources—operating bulldozers, rock-crushing equipment, and trucks operating on the site. Unlike many industrial noise sources, some of these sources are mobile, and, as a result, the noise impacts will vary as the mining progresses over the years.

The location of the equipment on a large site, as well as the particular topography and other characteristics of the site, will all influence the level of noise coming from the site. Finally, acceptable levels of noise also vary with the surrounding uses. Consequently, any standardized buffer distance may at one time be over-regulation and at another time may be inadequate.

Because of these many variables, and because one can assume that distance is not the only means of reducing noise to acceptable levels, most communities apply their noise performance standards to the mining operations. These standards can be set at different levels for different adjoining uses, and they also allow the operators to use techniques other than distance alone to reduce noise. Table 4 shows those standards developed by San Diego County for their various residential, commercial, and industrial zones. Noise is reduced by 3 to 4.5 decibels for each doubling of distance. Thus, if distance alone is used to reduce the noise level, considerable land around the pit is rendered unusable. In general, county planners recommend locating very noisy sources, like crushers, near the center of the pit, with the least sensitive uses closer to the noise source and the most sensitive further away from it. Walls and vegetation also can be used to buffer noise.

Truck Traffic and Traffic Safety Precautions

Another serious problem with sand and gravel operations is the amount and size of the truck traffic they generate. According to some operators, the truck traffic problem is becoming the single most important concern to opponents of sand and gravel operations. The planners' concern is not whether there will be trucks, but only where the trucks will be. Some mitigation can be done on the site itself. All communities require that the site provide adequate space for parking trucks, as well as employee vehicles, to make sure that there is no spillover onto neighboring streets. Also, haul roads within the sites can be designed so that they stay away from property lines, and, thus, some of the noise is buffered on the site itself. But the most serious problems with truck traffic—the noise and safety problems—take place on public rights-of-way. Even when the federal standards of 80 decibels at 50 feet are imposed on new trucks in 1982, truck traffic is still likely to generate complaints. Officials from the California Division of Highways have found that complaints start coming in at 65 dB(A); by 75–80 dB(A), they will receive letters of protest; and by 85–90 dB(A), they are likely to get legal action.

There are a number of methods that have been suggested for dealing with truck traffic and its noise. These include: speed limitations, use of alternate transportation methods such as conveyor belts or slurry pipelines, construction of noise barriers, or the purchase or lease of

TABLE 4. DISTANCES REQUIRED TO REDUCE NOISE LEVELS TO ACCEPTABLE LEVELS IN VARIOUS ZONES*

Permitted Zones	Acceptable Noise Level** dB(A)	Distance Required to Reduce Noise to Acceptable Level***	
		Mobile Equipment 75 dB(A)	Crusher 95 dB(A)
R-S, R-D, R-R, A-70, S-80, S-87, S-88, S-90, R-V, and R-U use regulations with a density of less than 11 dwelling units per acre.	50	890	4,500
R-RO, R-C, R-M, C-30, S-84, S-86, R-V, and R-U use regulations with a density of 11 or more dwelling units per acre.	55	500	3,140
S-94 and all other commercial zones.	60	280	2,250
M-50, M-52, and M-54.	70	90	890
S-82, M-58, A-72, and all other industrial and agricultural zones.	75	50	500

* From §36.404 — *Sound Level Limits*, San Diego County Code of Regulatory Ordinances.

** Between the hours of 7 a.m. and 7 p.m.; acceptable noise levels are lower at night when extraction operations normally are not allowed.

*** Buffering distance can be reduced appreciably if a barrier is present or can be constructed.

land along portions of the access roads. However, in most cases, the community is likely to have to live with the problem, and the best approach is to try to minimize the problems by being sure that access roads do not feed into residential streets and that entrances onto public highways are properly designed. The provisions of the Kane County, Illinois, ordinance are probably the most succinct on these points:

> Not more than one (1) entrance and one (1) exit from a highway or road shall be provided to the area of operation. Such entrance shall be subject to approval by the Department of Highways having jurisdiction and shall, preferably, be located along a secondary road and shall be located as to avoid the routing of vehicles to and from the mining operation over streets that primarily serve abutting residential development. If required by the Highway Department having jurisdiction, acceleration and deceleration strips shall be provided on either side of such entrance and exit, of not less than one hundred (100) feet in length each, and shall be paved of such material as shall be required by the Highway Department having jurisdiction. Furthermore, a paved road from the entrance and exit, a distance not less than three hundred (300) feet from the right-of-way line into the area of operation shall be provided in order to minimize the deposit of dirt and gravel from trucks onto the public highway. Such pavement shall be in accordance with the specifications of the County Highway Department. Entrances and exits shall be provided, with the gates to be securely locked during hours of inoperation.

Alameda County, California, which has similar provisions, also requires that the necessary traffic control devices (signs and pavement markings at the access road entrance) be installed and maintained by the operator. They also have a provision that "during hauling operations, any spillage of materials on county roads shall be promptly and completely removed."

Restricting Days and Hours of Operation

Because of the problems of noise and traffic, some communities restrict the hours and, sometimes, the days of operation. Generally these provisions include exceptions for public emergencies or when the operator is repairing equipment. The following examples show the range of these regulations:

Orange, California	6 a.m. to 8 p.m. (can be extended to 10 p.m. with special permit)
Kane County, Illinois	6 a.m. to 6 p.m.
Fairfax County, Virginia	7 a.m. to 6 p.m.

These hours are set by consideration of the surrounding uses and the particular traffic patterns in the community. Most of the communities are concerned with reducing noise and traffic during evening and nighttime hours.

These regulations do not cover one additional problem. Planners need to involve people who live along potential alternate truck routes in the public hearing process. These are the people whose lives may be affected if original routes are denied. Incorporating them into the hearing process at an early stage may minimize potential stumbling blocks at a later stage.

Public Safety

Sand and gravel operations may look like excellent open space opportunities when they are closed at night, but they are not. It is good practice to require fencing around the site to prevent the public from wandering onto the site at night. The following provision from the Alameda County, California, zoning ordinance provides an example of a comprehensive fencing regulation.

> **Fencing**
> Prior to the commencement of mining operations, a fence shall be constructed enclosing the area authorized by permit to be excavated. Said fence shall be located not less than ten (10) feet from the top edge of any exterior cut slope. Where excavation is authorized to proceed in stages, only the area excavated plus the area of the stage currently being excavated need be fenced. Fences shall be at least five and one-half (5½) feet in height and constructed of woven wire fabric and barbed wire on metal posts. Details of fence construction and materials shall conform to the applicable provisions of §80, Subsection 80-2.01 through 80-2.02, of the California Division of Highway Specification, 1971 Edition. The bottom strand of the woven wire mesh shall be two inches from the ground and the small mesh openings of the woven wire fabric near the ground. The fence shall have four strands of barbed wire as specified above the woven wire fabric, the first strand being four inches above the top of the woven wire mesh. The second strand of barbed wire shall be spaced seven inches above the first. The third and fourth strands of barbed wire shall be spaced nine inches and eighteen inches, respectively, above the second strand of barbed wire. Gates, the same height as the fence, shall be installed at all points of vehicular or pedestrian ingress and egress and shall be kept locked when not in regular use.

If fencing is not required, another possible physical barrier is a berm planted with thorny shrubs.

Other fencing provisions that are tailored to steep slopes, depth of excavation, or nearness to residences include the following: Naugatuck, Connecticut, requires a fence "at least six feet high where the excavation is to a depth of 10 feet or more or the slopes are more than 1:2 verticle-horizontal ratio." North Stonington, Connecticut, requires a fence where there is a drop of 30 degrees adjacent to a highway, and Middleton, Connecticut, requires a fence where the excavation is six feet deep and less than 1,000 feet from any house.

Environmental Regulations

Environmental regulations naturally vary with the situation in each community. In some situations, there is

simply a need to hide the operation in order to protect the community aesthetically; in other situations, there is a need to protect water supplies or air quality.

Aesthetic Controls

It is probably best to enjoy sand and gravel operations for their own aesthetics, but when these operations are near residential areas the appreciation may be hard to develop. In such situations, communities require the operators to screen the site. Orange, California, is such a place, and it allows a variety of methods.

The general rule on screening mounds, according to the National Sand and Gravel Association, is to construct them so as to completely screen objectionable views. "Those which hide only a portion of the objectionable features of a sand and gravel operation will only increase the viewer's curiosity to see what is behind the rest of the mound," the Association warns its operators.

Dust Control

Most communities include operating standards that are designed to reduce the amount of dust coming from the site. The sources of dust most easily controlled are the haul roads, access roads, and loading areas within a site. If not properly designed, these roads will not only generate dust on the site, but the tracks may carry mud from the site which, when deposited on public highways, will contribute to dust problems over a wider area.

McHenry County, Illinois, has regulations that deal specifically with these problems.

§422-01-6

The owner of the operation shall maintain all ways and roads within the site in a dust-free condition, providing such surfacing or other treatment as may be deemed necessary by the McHenry County Zoning Enforcement Officer, provided that the treatment produces no potential pollution hazards to the ground and surface waters of the area. All gravel pit access roads shall be provided and maintained with a dustless non-oiled surface not less than twenty-two (22) feet wide from the connection to a public road to a point within one hundred (100) feet of the loading area. Access roads shall also be constructed and maintained in such a manner that the deposit of earth materials on public roads is minimized.

Controlling dust from the mining operations is more difficult. Good operating practice has reduced the amount of dust generated, however, and some communities have specified that these practices be followed. For example, Woodbury, Connecticut, limits the excavation to no more than "five contiguous acres open at any time" in their regular zones and 20 acres in their special earth extraction zone. Such a regulation helps ensure that the operator will resurface and restore vegetation in completed areas of the

Orange County, California, Ordinance (Excerpt)

Screening

Extracting and processing operations shall be screened in such a manner that they are not readily visible from a public street. An opaque screen shall be installed and maintained as necessary in order to minimize such visibility. At his option, the operator may install such screening either along the street or along the perimeter of the visible portion of the area being operated.

The required screen shall have a total height of not less than six feet. Where there is a difference in elevation on the opposite side of the screen, the height shall be measured from the highest elevation. A screen shall consist of one or a combination of the following types:

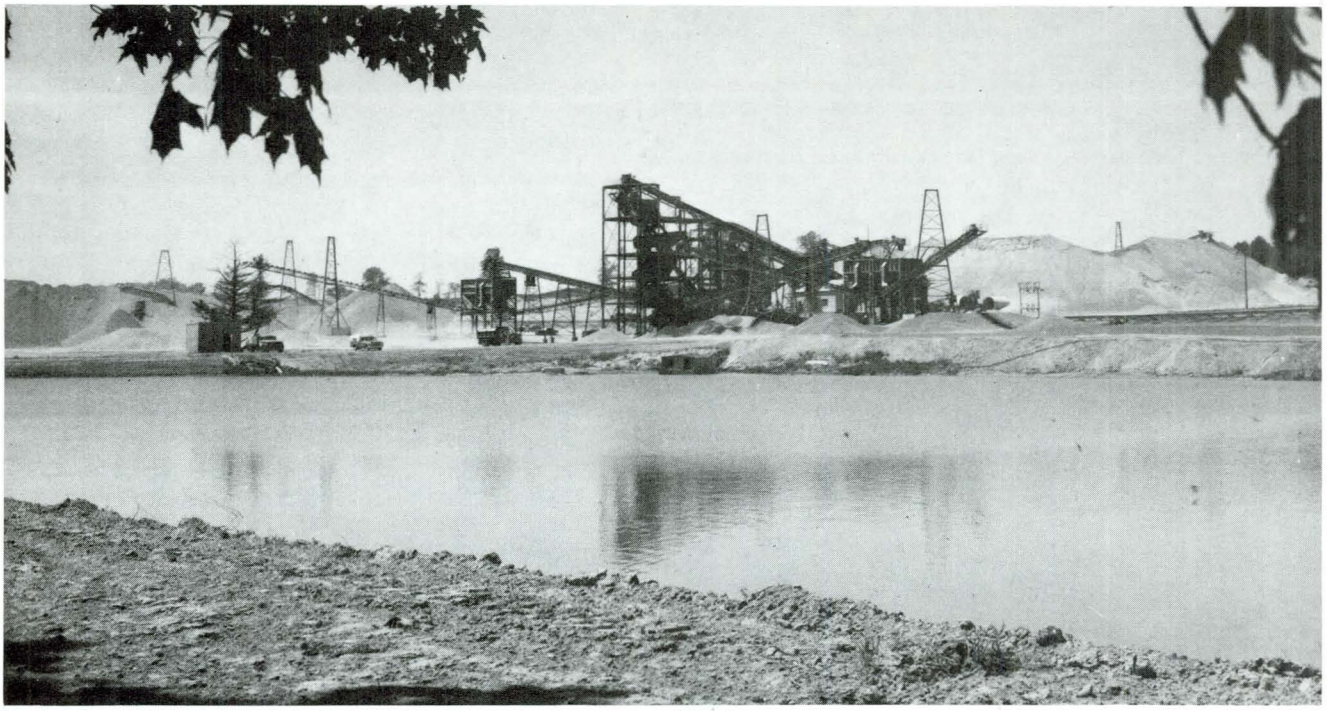
1. Walls: A wall shall consist of concrete, stone, brick, tile, or similar type of solid masonry material a minimum of four inches thick.
2. Berms: A berm shall be constructed of earthen materials, and it shall be landscaped.
3. Fences, Solid: A solid fence shall be constructed of wood and shall form an opaque screen.
4. Fences, Open: An open weave or mesh-type fence, when not used in combination with a berm, shall be combined with plant materials to form an opaque screen.
5. Planting: Plant materials, when used as a screen, shall consist of dense evergreen plants. They shall be of a kind or used in such a manner so as to provide a continuous opaque screen within 24 months after commencement of operations in the area to be screened. Plant materials shall not be limited to a maximum height. Said design shall be prepared by a licensed landscape contractor or an architect.
6. The Directors of Public Works shall require that either (1), (2), or (3) above shall be installed if, after 24 months after commencement of operations in the area to be screened, plant materials have not formed an opaque screen, or if an opaque screen is not maintained.
7. Intersections: Required screening shall be set back at least 20 feet from the point of intersection of:

(a) A vehicular accessway or driveway and a street;

(b) A vehicular accessway or driveway and a sidewalk; and

(c) Two or more vehicular accessways, driveways, or streets.

8. Installation: Required screening shall be installed prior to commencement of operations.



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Sand and gravel operations are often regulated to protect the water table of surrounding lands.

site and will not strip new areas far in advance of actual mining.

The National Sand and Gravel Association also recommends that operators install such plantings to help buffer sites from winds that may cause dust problems. Trees and other vegetation can be used as wind breaks around sand and gravel operations, just as they are used in agricultural areas to prevent wind erosion. Operators take their own steps to control dust: they use chemicals and wet suppression; insulate ready-mix concrete plants; and meet a standard of 20 percent capacity in air quality.

Erosion Control

The most serious problems of erosion—and subsequent siltation of adjacent water bodies—come during the process of removing the overburden and during the period of reclamation. As with dust control, the best practice is to keep the amount of land in these exposed conditions to a minimum. As already discussed, Woodbury, Connecticut, sets standards for the amount of exposed ground. Alameda County, California, takes another approach. It has set a performance standard of no discharge that will result in higher concentrations of silt than existed in off-site water prior to mining operations. Erosion must be controlled on site by constructing "properly designed retarding basins, settling ponds, and other water treatment facilities, ditches, diking, and revegetation of slopes." The particular method of control is left up to the operator.

Protection of Watertables

Sand and gravel operations can affect the watertable of surrounding land if the excavations cut into these shallow aquifers. The lake created at the excavation site will essentially act as a drain for the surrounding water. Because of these problems, it is common to set maximum permitted depths for excavation. Alameda County, California, for example, prohibits the destruction of usable waterbearing strata:

> Excavations which may penetrate near or into usable water-bearing strata shall not reduce the transmissivity or area through which water may flow unless approved equivalent transmissivity or area has been provided elsewhere, nor subject such groundwater basin or sub-basin to pollution or contamination.

Kane County, Illinois, on the other hand, allows it, but with a cautionary note about lowering water tables:

> Maximum depth of excavation shall not be below existing groundwater, except in such cases where the reclamation plan indicates that a lake or lakes will be part of the final use of the land or where such plan indicates that adequate fill from overburden is to be used to refill such excavation for conformance to the approved reclamation plan.
>
> No extraction operations shall be conducted in such a manner as to permanently lower the water table of surrounding inhabited properties.

It is important to remember that if excavations go below the water table and are refilled, that filling process must be in accordance with water pollution control regulations. Fill material may cause serious water pollution problems in the future.

Chapter 4. Reclaiming Mining Sites

It makes good planning sense to take necessary steps before, during, and after the extraction process to ensure that affected mining sites are restored to a usable state. In urban areas, where the value of land is very high, the economic incentive to reclaiming the mining site for profitable use is obvious. In Los Angeles, for example, sand and gravel pits have been sold to the city for use first as landfills and, then, restored for industrial or residential development. Some operators have been going into the development business themselves. In these cases, mining sites are no longer treated as parcels whose only economic potential lies in their mineral resources. Mining is approached as a transitory use of the land. Long before the first shovel is turned, these operators have considered the future use and appearance of the reclaimed land. Both the title and the text of the National Sand and Gravel Association's most recent source book, *Sand and Gravel Operations: A Transitional Land Use*, focus attention on the reuse of land. The Association characterizes its members not only as suppliers of aggregates but as land developers.

But some operators' only interest is in mining the site, leaving, and going on to the next site. The past operating practice of leaving abandoned sites has led local and state governments to adopt a more forceful approach to reclamation. The approach centers on the permit process. Mining permits or licenses are not issued unless an acceptable reclamation plan is approved by the appropriate regulatory agency.

One of the central issues in mining regulation is determining whether state or local government should have the authority for granting mining permits. Over 40 states have laws requiring the reclamation of surface mining areas. In 22 of these states, the state regulates reclamation of land mined for any minerals, including sand and gravel. In these states, many local communities still tie the operation of the mine to the conditional use permit process, and the community may go beyond the state regulations in administering more stringent rehabilitation standards. But to many municipal and county planners in these states, the crux of the regulatory issue is just how much authority *is* left at the local level to regulate extraction and reclamation. Frequently, the state versus local issue is resolved in court on a case-by-case basis, and decisions are based on interpretations of the state mining laws. Thus, there is no resolution generalizable to the entire nation.

The only clear-cut situation in which state agencies do not have authority for regulating operations or reclamation is mining operations in small pits. Most states establish a minimum acreage under which the state act does not apply. Illinois, for example, does not require reclamation plans for sites smaller than 10 acres. Colorado, on the other hand, requires reclamation plans no matter how small the mining site. The state act does distinguish between regular operations and limited impact operations on less than 10 acre sites.

Although state and local reclamation requirements vary, they are all based on the concept of progressive or integrated reclamation. As its name implies, progressive reclamation involves the development and landscaping of the site simultaneously with the extraction of the resource. By taking this approach, operators can make more efficient use of waste material and of the entire site; they can eliminate waste heaps; and they can generally reduce the objectionable characteristics that offend local residents or adjacent land users. Exceptions, of course, must be allowed in situations where the beginning of reclamation must await the completion of extraction because of site-specific conditions.

Typically, however, progressive or integrated reclamation is comprised of the following steps:

1. Removal and storage of the overburden;

2. Terracing the pit or face walls during the extraction period;
3. Final shaping of the worked-out area;
4. Replacing and contouring the overburden; and
5. Replanting.

RECLAMATION PLANS

The primary objective of requiring a reclamation plan is to ensure that operators will restore their mining sites to productive use through an orderly schedule of steps. Although reclamation plan requirements vary, each plan addresses two basic questions:

1. What useful land form can remain after the pit is mined?
2. How can this restoration be accomplished?

Municipal, county, and state agencies issue reclamation standards to guide the operators through reclamation. Reclamation plans typically consist of a combination of graphic representation and written text. It should include but not be limited to the following elements:

1. Intent of reclamation;
2. Methods and processes of reclamation;
3. Initial condition of mining site;
4. Limits of various operational areas;
5. Phasing of operations and reclamation steps;
6. Final condition of site;
7. Relation of final site condition to adjoining land forms and drainage features; and
8. Relation of reclaimed site to planned or established uses of surrounding land.

Approved reclamation plans are regulatory documents that will be referred to throughout the implementation process. In some communities, reclamation plans are submitted in three parts: (1) a general plan as an overlay for a vertical aerial photograph; (2) a reclamation contour plat, and (3) a description of reclamation methods and materials. All of these parts may be reviewed by municipal, county, regional, and/or state agencies, depending on the respective hierarchy of authority in a specific region.

The McHenry County, Illinois, Regional Planning Commission has developed a very specific list of information required for their permits, starting with information about existing conditions and ending with the use of the reclaimed land. Information requirements for this element should be the same as for the "Final Land Form"

SAMPLE STANDARDS

Communities have developed a variety of performance standards to guide reclamation. The samples below are a compilation of standards drawn from a large number of ordinances. They are not intended as models, but are, rather, elements that may be considered in developing regulations.

Timing

Restoration should proceed in a continuous manner and should be subject to review and approval at each annual inspection and at the end of the permit period. Specifically, the following standards should apply:

1. Topsoil grading and planting of the area designated for restoration during the permit period should be completed before a mining permit is renewed.
2. Overburden should not be removed from an area larger than that mined within one year.
3. Where groundcover or other planting is indicated on the approved reclamation plan, the planting should be made in areas where excavation is completed and land is not being used for material storage, before further overburden is removed.

Site Clearance

All stumps, boulders, and other debris resulting from the excavation or related activities should be removed from the site and disposed of by approved methods. Under exceptional circumstances, such debris may be disposed of on the site if covered with a minimum of two feet of soil.

Slope

All banks should be left in accordance with topography established in reclamation plans, with no slopes greater than two feet horizontal to one foot vertical. If water is to be left in the pit in areas below the water table, the slope can be greater than 2:1.

Removal of Topsoil

When topsoil is removed, sufficient arable soil should be set aside on the site for respreading over the excavated area. These overburden stockpiles should be used to minimize the effects of erosion of wind or water upon public roads, streams, or adjacent land uses and should not be sold or removed from the property.

Drainage

Reclamation should proceed in such a way that natural and storm drainage, where it enters and leaves the premises, shall be altered only to the least degree necessary to carry out excavation and related activities. Any alteration of natural and storm drainage should not adversely affect public roads or neighboring uses.

Replacement of Topsoil

After the area is cleared of debris, it should be covered with a layer of topsoil to a depth of at least six inches, except for areas under water. If the pit is to be used as a basin for spreading water, the topsoil should not be replaced because it would deter the spreading of the water.

Cover and Planting

The reclamation area should be planted with grass, trees, shrubs, or other vegetation to prevent erosion and provide for screening and natural beauty. Technical assistance and soils data should be obtained from the county agricultural agent, appropriate state and federal officials, conservation districts, and the nearest soil conservation service office.

McHenry County, Illinois, Ordinance (Excerpt)

Existing Conditions

A. Site mapping at one inch equals 100 feet preferrable, or one inch equals 200 feet alternative acceptable.

B. Contour interval: two feet for slopes 30 percent or less; 10 feet for greater slopes when map scale is one inch equals 100 feet.

C. Contour interval: two feet for slopes 20 percent or less; 10 feet for greater slopes when map scale is one inch equals 200 feet.

D. Roads or streets: show name, R.O.W. width, and road within R.O.W.

E. Easements: show widths and identify utility or other purpose.

F. Natural land features: show locations of watercourses and drainageways, floods of record, sinks, basins, and wooded areas.

G. Man-made features: show buildings and other structures, dams, dikes, and impoundments of water.

H. Adjacent land features: all of the standards above shall apply to delineation of the area within 300 feet of the perimeter of the mined area. In addition, show all platted subdivision lots and metes and bounds parcels.

I. Groundwater: show locations of at least five borings which show depths to groundwater.

J. Cross-sections, if required to illustrate conditions: show vertical scale equal to, or in exaggeration of, horizontal scale.

Phasing the Operations

A. Site mapping same as for Element 1.

B. Processing areas shall be identified and boundaries shown to scale.

C. Access road to processing and mining areas shown to scale.

D. Sequences of operation showing approximate areas involved shall be shown to scale and serially numbered with a description of each.

E. Location of screening berms shall be shown to scale, and notes shall be provided indicating when they will be used as reclamation material. In the same manner overburden storage areas shall be identified and noted.

F. Fences and gates shall be shown on the site map, and their type or construction shall be described.

G. Proposed location of principal service or processing buildings or enclosures shall be shown, as well as location of settling basins and process water ponds.

H. Site drainage features shall also be shown and flow directions indicated.

Final Land Form

A. Site mapping scales shall be the same as for Element 1.

B. Contour interval same as for Element 1.

C. Show location of any proposed roads within the reclaimed area and their connection to present public roads beyond.

D. Show location of any lakes, ponds, or streams proposed within the reclaimed area and their connections to streams or drainageways beyond.

E. Show location of any proposed works-of-man within the reclaimed area, (dams, buildings, etc.)

F. Show location of all buildings within 300 feet of the perimeter of the mining site.

G. Show areas where vegetation is to be established, and indicate types of vegetative cover.

H. Describe the degree of flexibility considered to be needed in execution of the plan.

Use of Reclaimed Land

Purpose: To show that the final land form portrayed in the drawings for Element 3 has a viable land use compatible with land-use trends of the surrounding area. The base map for this element should be the final land form map upon which shall be shown by overlays or separate drawings and notes one or more developed schemes for land use or uses, each demonstrating that developed areas are accessible by roads and that physical attributes of the final land form are compatible with the proposed use or uses. It is understood that this may be a hypothetical exercise, but it will be evaluated as such and not be considered a commitment to the use portrayed.

Abandoned Uses

Operations should be considered to have been abandoned if: (1) on-site mining or processing is not carried out continuously for two years at any location covered by the permit; or (2) if the operator does not demonstrate his intention to resume operations and keep his bond in force more than one year after operations have ceased. A new permit should be required prior to further excavation or processing.

Termination of Operations

If excavation has ceased for a period of 24 months, the planning commission should hold a hearing to determine with the city council the future disposition of the site and

W. Roy Watson

FIGURE 4. INTEGRATED MINING AND RECLAMATION ACTIVITIES

1. **The 65-acre Livingston–Graham Sun Valley Pit.** Excavation, which has reached a depth of 200 feet, will proceed for four to five more years. While excavation proceeds, seven acres are being used as an inorganic solid fill disposal site. Since the remaining reserves lie under the company offices and concrete batching plant, the company will be moving these functions to another spot on the site, where they will be placed below grade level to reduce noise and visual pollution. Operators hope to convert the site into a sanitary landfill once all mining is completed.

2A and 2B. **The 126-acre Bradley Pit.** Sand, gravel, and rock have been mined here for 30 years to a depth of about 180-200 feet. The eastern portion of this pit (2A) has been a sanitary landfill since 1960. In the western portion (2B), a subsidiary of Conrock Company will operate a sanitary landfill as soon as state permits are granted. State waste discharge requirements prevent refuse placement below a plane 38 feet above the historic high groundwater level. Operators will build an eight-foot thick drain plane before landfilling begins. By the time landfilling does begin, eight years will have elapsed since operators first applied for permits in 1973.

The Bradley landfill reclamation project also includes a methane gas recovery program. The Los Angeles Department of Water and Power will be buying the methane to use as secondary or start-up fuel at its Valley Steam Plant. The current site will yield 900,000 to 2.7 million cubic feet per day for 10 to 15 years, according to a consultant's estimate. Production will be expanded when methane production begins on the adjacent site.

3. **The California Materials Site.** This reclaimed site is currently being leased to an insurance firm handling wrecked autos for weekly auction and to an auto firm for auto storage.

Rock Products

The best planning practice is not to go into specific mining sites with preconceived ideas about the best reclamation approach, but to examine the alternatives for each site.

the source of liability for expenses incurred for restoration of the site.

Bond

To ensure that operators abide by a community's operation and reclamation standards, bond and insurance should be posted before mining permits are issued. In almost all state acts and local ordinances, the size of the bond is based on the size of the mining operation. Generally, the amount ranges from $2,000–$10,000 per acre of ground to be stripped of overburden. In some communities, a cash deposit or deposit of negotiable securities is permitted in lieu of a surety bond.

Insurance

In many communities, operators are required to have public liability insurance with coverage of at least $300,000 for personal injury to more than one person, $100,000 for personal injury to only one person, and $25,000 for damage to property. Insurance should be kept in effect at all times during mining operations.

SAMPLE RECLAMATION STRATEGIES

The objective of all reclamation strategies should be to restore the mined land to a condition that is suitable and amenable to existing or prospective uses of surrounding land. Reclamation is a site-specific activity. The appropriate strategy for each site depends on a number of variables: the value of, and demand for, land in the area; the topographical features; the local zoning provisions; and the political setting. The appropriate use for each site may vary from residential condominium development to industrial parks, recreational parks and lakes, farmlands, open range, wildlife sanctuaries, or commercial development. *The best planning practice is not to go into specific mining sites with preconceived ideas about the best reclamation approach, but to examine the possible alternatives for each specific site.*

Efforts to integrate protection, regulation, and reclamation will be most successful when planners and operators select a strategy that satisfies the land-use needs of the community and that provides an economic incentive for the operator. Ideally, these twin goals can be identified early in the planning process, before actual mining operations begin. If not, irreversible mistakes can be made—as in the following example. About 15 years ago a coal mining company reclaimed a landfill site near a medium-sized town in Indiana. The company spent about $700 an acre to forest the area and, after 12 years, donated the site to the city for use as a landfill. The city then spent over $200 an acre to remove the trees. In addition, all the grading work was destroyed when the landfill operation began. With proper initial planning and cooperation, this site could have been reserved as a landfill at a net savings to both the local taxpayers and the mining operator of up to $900 an acre.[3] Although this example concerns a coal mining operation, poor early planning for sand and gravel reclamation has similar costs.

Several examples of current reclamation practice tailored to differing conditions are described below.

Reclamation in Areas with High Land Value

In areas where land value is very high, many operators have preferred sites where the natural sand and gravel deposits have considerable depth since it requires less land. In these cases, the problem is what to do with the hole once mining is completed. From the operator's point of view, the best solution is one in which the operator can profit both from filling in the hole and from selling the site for development once the hole is filled. In Los Angeles, operators have been using this approach (see Figure 4). First, the site is used as a sanitary landfill. In addition to the ordinary revenues from the landfill itself, landfills provide a secondary revenue source since methane gas from the landfill is sold for profit. A methane recovery program also helps save energy. Once the pit is filled, the site is

[3]This example is taken from "Integrating Mined Areas Reclamation and Land-Use Planning," by James R. LaFevers, J. Lee Guernsey, Gary Kasznyski, and William Rice, Jr. *PAS Memo*, October 1979, No. 10-79, American Planning Association,1313 E. 60th St., Chicago, IL 60637 (free from APA). The *Memo* explains some of the ways in which planners can help to implement the Federal Surface Mining Control and Reclamation Act (PL 95-87). The Act primarily concerns the surface mining of coal.

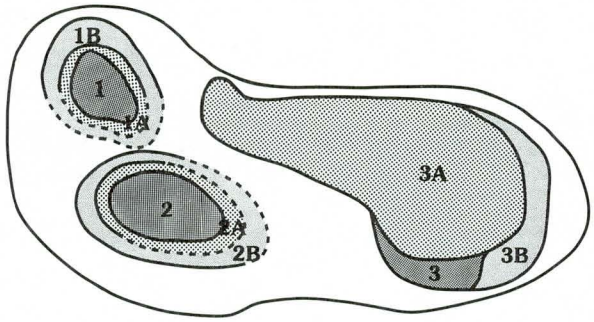

FIGURE 5. STAGING PLAN FOR MINING RECLAMATION

Area 1. Extraction begins here. Land is protected for mining for five years by placing mining sites in the extractive use zone. Operator converts the completed mined area into a recreational lake as one center of forthcoming residential development.

Area 1A. Operator gets lease on development rights here for use as buffer zone.

Area 1B. Owner proceeds with residential development here. TDR can be used; in exchange for forgoing development on parcels closest to the extraction site, the developer can be allowed higher densities for early units of residential development far from the site.

Areas 2, 2A, and 2B. Operator invests money to buy these areas. Ten years later, when land is mined and reclaimed, operator sells land for residential development or develops it himself.

Areas 2A and 2B. Follow same sequence of buffering and developing away from the site itself. Development progresses into the circle as mining operations come to a halt.

Area 3. Local government purchases area for parkland, and it is developed immediately as community center.

Area 3A. Local government buys land for parkland; it is developed for immediate recreational uses such as baseball, riding, bike paths, etc. The entire area is leased to an operator for 10 years in future. After reclamation, portions of area are converted to water-oriented activities.

Area 3B. Will be sold immediately for private residential development.

developed into other uses. In most cases where the pit goes below the water table, the site cannot be used as a sanitary landfill. However, it can be filled with inert fill material. Once again, the operator can make a profit by providing a site for others to dispose of their waste materials.

Reclamation in Areas of Heavy Residential Development Pressure

In areas of heavy development pressures, the community, and perhaps the operator, will want the land restored to a higher use as quickly as possible. One approach to reclamation in these instances is to use the method outlined in Figure 5.

Most residential developments take place on sites where the excavation depth averages about 35–40 feet. Below that depth, the pit would require a prohibitive investment to be filled to a point considered comfortable for residential living. In the words of one county official, "Most people simply don't want to live in a hole." Developers, however, will invest a lot of money to bring shallow pits up to acceptable levels. In one instance, a condominium developer brought 500,000 cubic yards of fill from another area. At $3 to $4 per cubic yard, that is an investment of $2 million.

Lake and Recreational Areas

As shown in Figure 5, sand and gravel pits are very much amenable to future use as lake and recreational areas, given two conditions: (1) the excavation reaches or is near the water table; and (2) gently sloping lake banks can be reshaped for recreation without extraordinary expense. This can usually be done by backfilling the excavation face with overburden as the excavation progresses. One of the more famous examples of a lake reclamation is the creation of Power Boat Lake, in Dayton, Ohio. Power Boat Lake is the site of national championship speed boat races. It also is the site of many city water wells, providing over 75 percent of Dayton's municipal water supply.

Lake and Retarding Basins

Planners and other government officials in water-hungry communities of the southwest have discovered another reclamation potential. The Orange County, California, Water District, for example, has developed a scheme of using the reclaimed sand and gravel pits as retarding basins for their water supply. The district has created recreational lakes in the bottom of the pits for fishing and boating. During rainy periods, the water level rises to the level of a channel that flows through the site. The entire area becomes a groundwater recharge basin. Sand and gravel, of course, have tremendous percolating potential. The water district estimates that it has saved $3 million on groundwater recharge costs using this recharge method. The area also serves as a flood control facility during periods of heaviest precipitation.

Farmlands

In areas where farmland is precious, the highest and best use for a completed sand and gravel pit might be simply to restore the site to farmland. In eastern Colorado, for example, mining sites are being restored as farmland and open range. Those are the highest and best uses in those areas. Whatever the final after-use is, planners should have predetermined appropriate priorities for the mining sites before hearings for the reclamation plan begin.

THE USE OF RECLAMATION FUNDS

In jurisdictions that do not require reclamation plans, mining abandonment may be a significant problem. But just what is required to bring these sites back to productive use? The following steps will be necessary to upgrade the land: (1) removal of abandoned equipment and material; (2) grading of the pit or quarry; (3) replacement of lost overburden; and (4) replanting.

Many states have established a reclamation fund to pay for reclamation of these abandoned sites. Typically, the fund is maintained by mandatory contributions from the operators. Mining permits are neither approved nor

renewed until operators make their annual contribution. Levels of contribution are usually based on the amount of production, rather than on the type of commodity produced.

Although a typical annual contribution is not high, many operators are strongly opposed to the idea of a fund. They contend that those operators who reclaim will be subsidizing those who do not (at least once). Operators may say, "Why reclaim when the state will do it?" Thus, the fund might undermine reclamation efforts; it might stop someone from reclaiming on his own. In light of these criticisms, it is very important that a reclamation fund not be used as a substitute for requiring operators to take every possible means to avoid negative impacts right from the start. If a reclamation fund is proposed in your state, the recommendations of the Marathon County, Wisconsin, Land Reclamation Task Force provide important points to consider in reviewing the proposal (see Table 5 for the breakdown for contributions proposed by Marathon County officials):

1. The operator's contribution should be refunded upon successful completion of reclamation. This will create an incentive for the operator to reclaim.
2. If more than one operator is working the same site, the landowner should be responsible for collecting the extraction fee and forward it on to the fund. In this way, after mining is completed, the last operator or the private landowner could use all the money from the fund to reclaim the site.
3. A minimum contribution should be set. (Marathon County officials suggest $200 per year.)
4. Mining operations should be divided into several categories of production for purposes of establishing levels of contribution.
5. Contributions to the fund by operations existent when the fund is established should cease when fund balances reach $1 million (or a similar figure) and resume when the fund balances drop below $750,000. Regardless of the level of the fund, operations begun after the fund's establishment should contribute for the same number of years that existing operations originally contributed in reaching a $1 million fund balance.
6. Operators should not be allowed to withdraw past contributions if they terminate commercial operations in the state.
7. The fund should not be used for reclaiming unreclaimed mined lands abandoned prior to establishment of the fund.

TABLE 5. PROPOSED BREAKDOWN FOR CONTRIBUTIONS

Annual Production in Tons	Annual Contribution	Approximate Rate Per Ton*
0- 50,000	$ 200	$.008
50,001-100,000	300	.004
100,000-300,000	700	.0035
300,001-500,000	1,100	.00275
Over-500,000	1,500	not determined

*This approximate rate per ton of production was derived by dividing the annual contribution in each category of contribution by the "midpoint" of annual production in the corresponding category of production.

8. The agency administering the fund should have the authority to revise, or suggest the revision of, that level of fund balances at which operator's contributions cease.

For further information about the establishment of a reclamation fund, consult the contacts on page 31.

As this report has illustrated, sand and gravel must be protected for extraction before urban development either prevents their extraction altogether or unnecessarily inflates product costs. But sand, gravel, and any other natural resource must be protected and regulated in a way that is legal, efficient, and cost-effective. No one strategy will serve the purposes of protecting and regulating all sand and gravel deposits in any given community. By using the best mix of planning tools presented in this report, local planners and lay commissioners can work with mining operators, geologists, and regional and state officials to devise the best approach to fit local needs.

Mining operators and public officials can no longer work independently of each other in extracting mineral resources and developing plans and regulations to control such extraction. *Too many mistakes have been made because those who write regulations and plans and those who are regulated have not exchanged information and technical assistance at each stage of the planning and extraction process.* Planners, lay commissioners, and other regulatory officials should visit the mining sites they want to protect and regulate, and they should talk to the mining operators. They should also try to learn the language and technology of surface mining before writing the plans and regulations.

Mining operators, on the other hand, have valuable information, such as the location and quality of their mineral resource holdings, that planners need in order to develop resource protection plans and regulations. Operators and regulators should be willing to cooperate with each other when they understand their common interests.

Appendix A. Selected References

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Valletta, William. *Surface Mining in Connecticut: The Public Need for Planning and Regulation for Sand and Gravel Operations.* Central Naugatuck Valley Regional Planning Agency, 20 E. Main, Waterbury, CT 06702. 1976.

Appendix B. Sources of Information on Protecting, Regulating, and Reclaiming Sand and Gravel Resources

SOURCE	FOR INFORMATION ABOUT:
Doug Sprague Special Representative State Mining and Geology Board 1416 9th St. Sacramento, CA 95814 916-322-1082	California's Natural Resource Protection Program under the State Surface Mining and Reclamation Act.
Lance Bailey Director Advanced Planning Section Planning and Community Development Department County of Sacramento 717 K St. Sacramento, CA 95814 916-440-7783	The Environmental Conservation and Resource Management Element of Sacramento County General Plan (1973) Surface mining overlay zone in zoning ordinance used to implement general plan element Sacramento County's two-tiered protection system, which was the prototype of the state of California's system.
Marion Ely Environmental Analyst Environmental Division San Bernadino County Planning Department 1111 E. Mill St., Bldg. B1 San Bernadino, CA 92415 714-383-3976	Two-tiered protection system: (1) Mineral Resource Management Policies in General Plan; and (2) Development Code to replace zoning ordinance. Community plans will use development code to identify resources. San Bernadina County is the largest mineral producer in the country.
Stanton Soo-Hoo Associate Planner Current Planning Department Gary Johnson City Engineer City of Orange P.O. Box 449 Orange, CA 92666 714-532-0434, 0444	Sand and Gravel (SG) Extraction District to protect resources; comprehensive and detailed operation and reclamation requirements for mining permit.
Richard C. Schaffer Planner San Joaquin County Planning Department 1810 E. Hazelton Ave. Stockton, CA 95205 209-944-2203	Separate "Excavation Ordinance" to protect and regulate extraction.
Charles Lough Environmental Planner Department of Planning and Land Use County of San Diego 1600 Pacific Highway San Diego, CA 92101 714-236-3151	Developing a multitiered protection system, composed of (1) resource conservation areas (RCAs), an interim designation to alert decision makers to the presence of a resource; (2) special study areas (SSAs), another interim designation; (3) extractive use zone being proposed to ensure protection which, when finally mapped, will become part of the county's amendments to General Plan.
Allan Lessler Director Central Naugatuck Valley Regional Planning Commission 20 East Main Waterbury, CT 06702 203-757-0535	General analysis report they sponsored on use and conservation of earth resources under state law, "Surface Mining in Connecticut: The Public Need for Planning and Regulation for Sand and Gravel Operations." Heavy on legal analysis.

SOURCE	FOR INFORMATION ABOUT:
Kevin Quinn Planning Department Town of North Hempstead 220 Plandome Rd. Manhasset, NY 11030 516-627-0590	"Sand Bank and Pit Excavations" ordinance of Town Code.
Steve Aradas Planner McHenry County Regional Planning Commission 2200 N. Seminary Ave. Woodstock, IL 60098 815-338-2040	Allowing extraction as conditional use. Site of potentially significant local-state legal dispute over which level of government has authority to regulate mineral extraction and reclamation in state with a mining conservation and reclamation act.
Dwayne Verggren Education Extension Section Robert E. Bergstrom Principal Geologist National Resource Bldg. Illinois State Geological Survey Urbana, IL 61801 217-344-1481	One of most active state survey offices in one of five states producing the largest amount of aggregate products.
Mike Knowlton Deputy Zoning Administrator Fairfax County Planning Department 10555 Main St. Fairfax, VA 22030 703-691-2381	Uses "Natural Resource Overlay District" to regulate resource extraction.
Thomas J. Wilson Extension Resource Agent Member, Land Reclamation Task Force Cooperative Extension Programs University of Wisconsin-Extension Marathon County Office Courthouse, Rm. 2 Wausau, WI 54401 715-842-0471, Ext. 227	The Land Reclamation Task Force works with a state legislative subcommittee to help draft a state surface mining and reclamation act. Working papers and comments provide good insights into issues and problems that should be addressed by communities and states considering similar legislative action. Marathon County also has a proposed demonstration reclamation project paper for town of Kronenwetter.
Lyle Rucka Planning Department Boulder, CO 80307 303-441-3270	Boulder's negotiations with a mining operator who would dedicate a mining site for greenbelt use on the outskirts of the city when mining is completed; in exchange, land is being annexed and the operator is getting a tax write-off for dedication.
James R. LaFevers Energy and Environmental Systems Division Argonne National Laboratory 9700 S. Cass Ave., Bldg. 8 Argonne, IL 60439 312-972-3398	Argonne National Laboratory's Reclamation and Land-Use Planning Program, which has worked on a variety of research projects and workshops promoting integrated reclamation and land-use planning. The work is funded by the U.S. Department of Energy and the Resource and Land Investigations (RALI) Program of the Department of the Interior. A report analyzing land-use controls in surface mining areas will be published in late 1979.

FEDERAL GOVERNMENT

SOURCE	FOR INFORMATION ABOUT:
Earl Hoover Commodities Specialist U.S. Bureau of Mines 2401 E. St., N.W. Washington, DC 20241 202-634-1194	*Mineral Yearbooks State Mineral Profiles* and *Mineral Commodity Profiles*, published by Bureau of Mines.
Eric Rifkin Council on Environmental Quality 722 Jackson Place, N.W. Washington, DC 20006 202-395-4540	The Academy of Natural Sciences study on the value of a federal act that would parallel the Federal Surface Mining Control and Reclamation Act (which basically covers strip coal mining) in regulating and controlling nonmetallic surface mining operations and reclamation.
E. Tim Smith U.S. Geological Survey Resource and Land Investigations Program, MS 750 National Center Reston, VA 22092 703-860-6717	Survey-sponsored research projects, workshops, etc.

MINING INDUSTRY

SOURCE	FOR INFORMATION ABOUT:
Ed Davison National Sand and Gravel Association 900 Spring St. Silver Spring, MD 20910 301-587-1400	How local planners can get in touch with the appropriate regional office of mining operators or get the names of local operators from the national office (which also publishes books and papers on industry activities).
Gene R. Block Vice-President and Properties Manager Conrock Company 3200 San Fernando Rd. Los Angeles, CA 90051 213-258-2777	Sand and gravel mining from the industry's point-of-view.
Don Reining Executive Secretary Southern California Rock Products Association P.O. Box 40 South Pasadena, CA 91030 213-441-3107	
James Cooley Cooley Gravel Company P.O. Box 5485 Denver, CO 80217 303-423-3660	Sand and gravel mining from the industry's point-of-view.

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306 **Expenditures, Staff, and Salaries of Planning Agencies, 1975.** May 1975. 54 pp. $5; PAS subscribers $3.

307/308 **Performance Controls for Sensitive Lands: A Practical Guide for Local Administrators.** July 1975. 156 pp. $12; PAS subscribers $10.

309/310 **Urban Growth Management Systems: An Evaluation of Policy-Related Research.** August 1975. $12; PAS subscribers $10.

311 **Neighborhood Zoning: Practice and Prospects.** September 1975. 44 pp. $5; PAS subscribers $3.

312 **The Hearing Examiner in Zoning Administration.** September 1975. 26 pp. $5; PAS subscribers $3.

313 **Planning and the Arts.** October 1975. 28 pp. $5; PAS subscribers $3.

314 **Intensity Zoning: Regulating Townhouses, Apartments, and Planned Developments.** February 1976. 40 pp. $5; PAS subscribers $3.

315 **Energy-Efficient Planning: An Annotated Bibliography.** March 1976. 23 pp. $5; PAS subscribers $3.

316 **Planning for Home Occupations.** April 1976. 21 pp. $5; PAS subscribers $3.

317 **Expenditures, Staff, and Salaries of Planning Agencies, 1976.** April 1976. 54 pp. $5; PAS subscribers $3.

318 **The Administration of Flexible Zoning Techniques.** June 1976. 62 pp. $5; PAS subscribers $3.

319 **Recycling Public Buildings.** August 1976. 34 pp. $5; PAS subscribers $3.

320 **Zoning for Fast-Food and Drive-In Restaurants.** September 1976. 46 pp. $5; PAS subscribers $3.

321 **Writing Better Zoning Reports.** October 1976. 8 pp. $5; PAS subscribers $3.

322 **The Language of Zoning: A Glossary of Words and Phrases.** November 1976. 40 pp. $7; PAS subscribers $5.

323 **Audiovisual Materials on Planning: An Annotated Listing from 'Aesthetics' to 'Zoning.'** December 1976. 25 pp. $5; PAS subscribers $3.

324 **Mini-Warehouses.** February 1977. 22 pp. $8; PAS subscribers $5.

325 **Zoning and Subdivision Fees: Current Practice.** March 1977. 13 pp. $8; PAS subscribers $5.

326 **Zoning for Recreational Vehicle Parks.** April 1977. 26 pp. $8; PAS subscribers $5.

327 **Regulating Sex Businesses.** May 1977. 30 pp. $8; PAS subscribers $5.

328 **Caring for the Land: Environmental Principles for Site Design and Review.** July 1977. 94 pp. $9; PAS subscribers $6.

329 **Salaries and Tenure of Professional Planners: 1977.** September 1977. 17 pp. $8; PAS subscribers $5.

330 **Housing Planning: How to Meet HUD's 701 Requirements.** November 1977. 26 pp. $8; PAS subscribers $5.

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*346 **Making the Most of Federal Assistance: Little-Known Programs for Planners.** 16 pp. November 1979. PAS subscribers $5.

*347 **Sand and Gravel Resources: Protection, Regulation, and Reclamation.** January 1980. 33 pp. PAS subscribers $5.

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