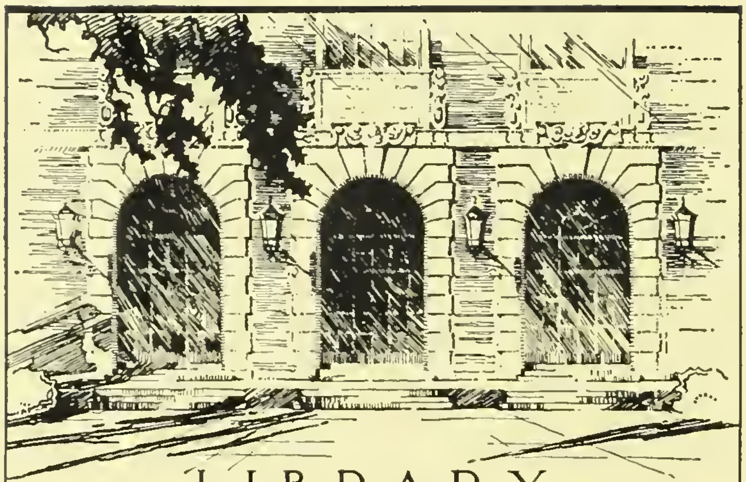

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SITE PLANNING FOR *Sand and Gravel Operations*

By John G. Baxter
University of Illinois

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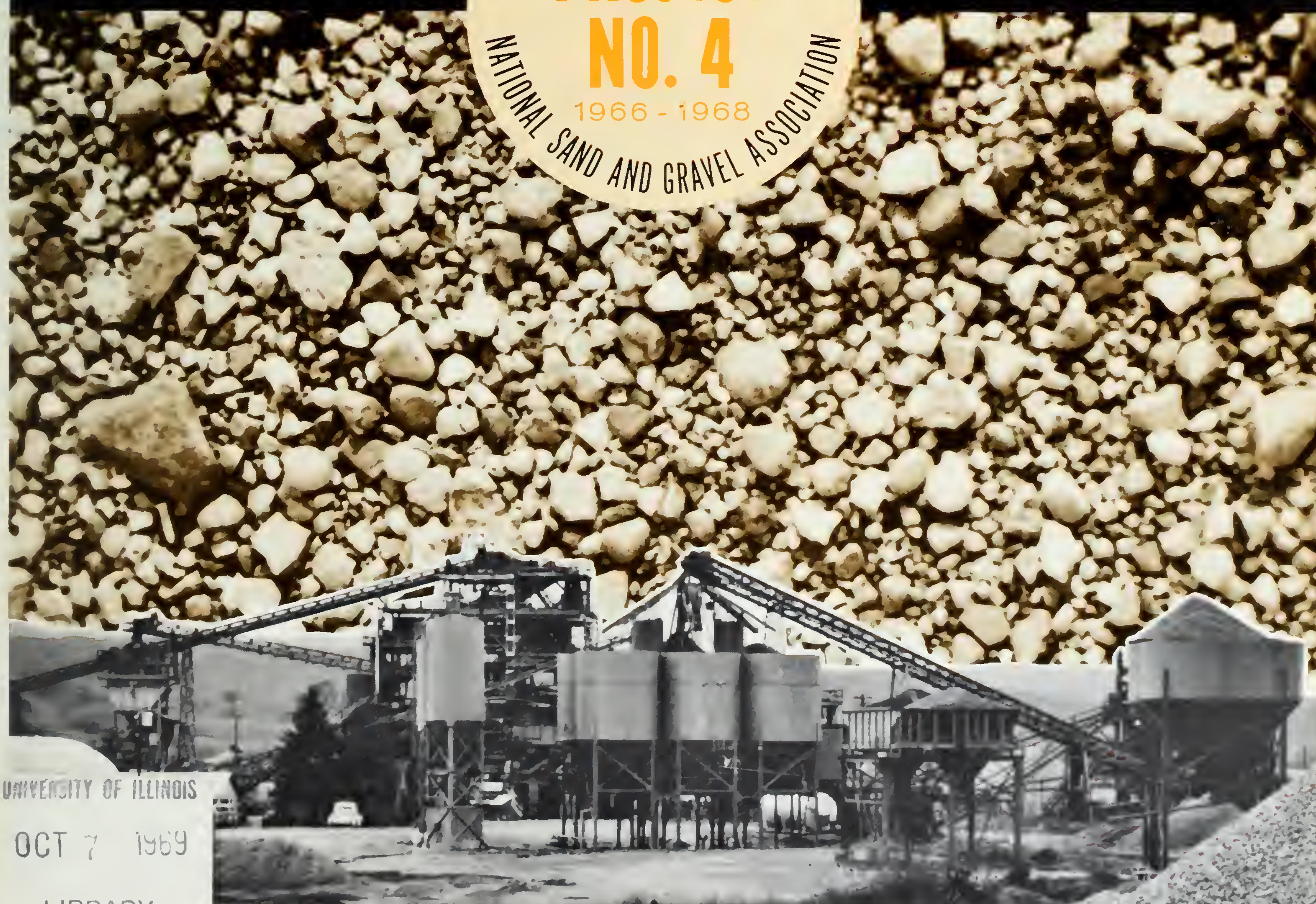

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(Photo by Montana Historical Society, Helena)

Figure 1 — "Public Image" caused the California Legislature of 1884 to completely outlaw hydraulic gold mining.

Preface

The Building of a Positive Industry Image

Presently the sand and gravel industry is confronted by its greatest challenge for existence in this century. Yesterday, the public formed a mental opinion of today's mining operation. Tomorrow's success in acquiring new mining access depends largely upon today's image.

Currently, many mining producers realize the importance of a good "public image" concerning future access to new minable deposits, which largely depends upon the industry's ability to create a favorable image in the minds of the general public. Although more than 52% of the industry practices reclamation, and feels a responsibility as stewards of their land, one sore-thumb operation in a community can lead to an adverse categorization of the total industry within the same community. This report is prepared to assist the producer who has practiced reclamation and will, hopefully, motivate the *producer* who hasn't as yet arrived at a reclamation decision.

The total annual production of sand and gravel in this country during 1966 was approximately 938 million short tons. Of this amount approximately ten percent is attributable to navigable waterways production. Because of the restrictions imposed by local governments and threatened future legislation that would impede wet, dry and waterway production, the sand and gravel industry must convert its public image if it intends to increase its land acquisitions or right of mining to prolong its growth past the national average life of deposits, including reserves, of about eighteen years. The private citizen must become aware of this crisis and be informed of the essentiality of the sand and gravel industry in terms of our national construction effort and its significant contributions to the national economy. At the present, this industry is exemplary as the mining industry's champion of applied reclamation and this fact should become known to the general public. The historical development of a "public image consciousness" by this industry is mandatory if it is to survive the battles of future demands for usable land. (See Fig. 1)

Site Planning for Sand and Gravel Operations

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Figure 2 — Public image is created by similar attitudes

Chapter I

Introduction

Significance of Image

Many producers realize the crucial nature of a good public image in terms of their present existence and opportunities for future expansion. Public image in this report may be defined as a mental conception applied to a given subject by a group of people, who experience similar attitudes with symbolic meaning toward the subject.

The public image of any industry is formed after things have happened and people have had the time to develop personal attitudes. Man's five senses funnel data to the human mind for reactive processing and the development of attitudes based on experience and knowledge. If the incoming impressions are pleasing, the pubic reaction is to accept and/or encourage the industry's efforts. The reverse process can destroy any potential for future development.

Basically, the public image of a sand and gravel operation is formed by the combined impressions from the public's reaction as it moves past an operation, from the experiences sensed by the neighboring public landowner, or by persons who have entered the mining property. The excavation pit activity, the processing plant operations, and the movement of transportation equipment all mold public attitudes of the sand and gravel industry. The total site image is dominated by physical characteristics which are later expressed by public acceptance or rejection. The producer's responsibility, in order to establish a desirable public image, is to implement physical improvements outside and inside the operating site which will be conducive to a harmonious landscape with public acceptability.

Private landownership adjoining the operating site generally includes the following land-use categories: (1)

Figure 3 — Both functional and visual image problems involve the operating site

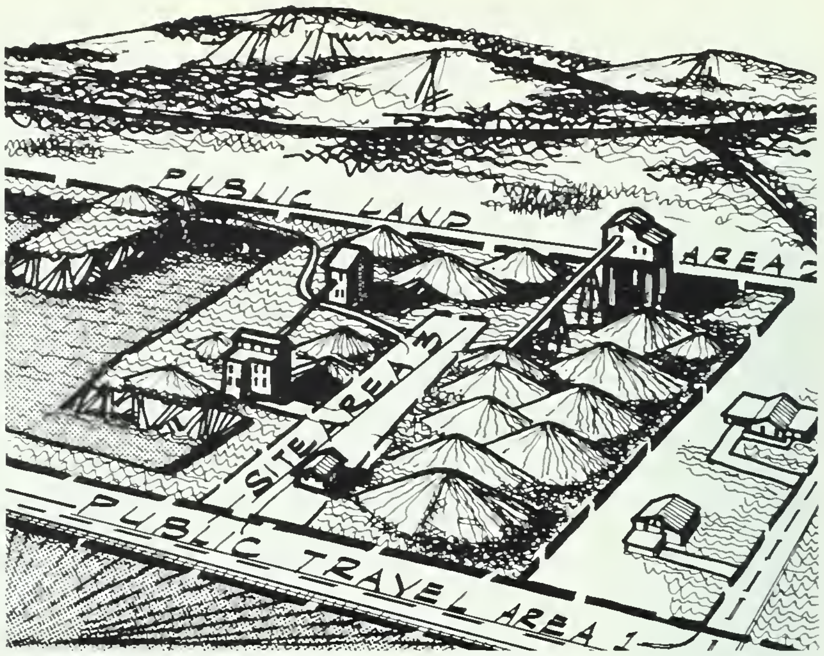


Figure 4 — Public image areas of concern 1, 2, and 3

agricultural, (2) industry, (3) housing, (4) commercial and (5) recreational uses. From the highway or from the window of a passing train, the traveling public is exposed to mining techniques and housekeeping procedures. Air travel is but a secondary consideration due to travel speed and visual distance. The on-site visitor may have entered the operation out of curiosity or by attending an operational tour, but regardless of the reason an operational effect will be registered. (See Figure 3 & 4)

Public image problems confronting the sand and gravel producer can vary in each community. Site location, magnitude of operation, and duration of activity largely determine the operational effect upon the public. These factors are:

1. SITE LOCATION—involves the relationship in distance between the operation and the surrounding community. Generally, as the distance increases from the public, the dust, noise, and other operational effects are reduced. In a U.S. Department of Agriculture SCS Study, "Restoring Surface-Mined Lands," surface-mined lands are treated as rural in nature because more than four-fifths are removed from population centers. They are at least a mile away from communities having a population of more than 200; the majority are more than 4 miles into rural areas. Of all the nearly fifty mining commodities, the sand and gravel industry is generally closer to community areas; thus the industry has been regulated by sometimes unbearable local government regulations.

2. MAGNITUDE OF OPERATION—the size of the intended excavation area largely determines the area required for the processing plant complex. The average processing plant, stockpile areas and transportation routes utilize approximately 10 to 20 acres. The average mining site size used as a demonstration project for this report is 610 acres. The larger the operation, the more chance there is to produce functional and visual annoyances upon surrounding areas.

3. DURATION OF ACTIVITY—the average deposit-life or duration of mining in this country is approximately 20 years, depending upon the amount of minable deposit and the consistent demands of the market. The length of an operational day in terms of hours when noise, dust, etc., are occurring is another major consideration.

Typical Image Problems

The primary function of the sand and gravel industry is typical of most bulk-commodity mining industries with respect to achieving the basic goal of providing a product efficiently and in large amounts for consumer use. Two general types of image problems which are produced by operating sites can be identified as functional annoyances and visual appearance. Within these categories the areas of major importance are:

A. FUNCTIONAL ANNOYANCES involving problems which are produced through the operating activities and experienced by the public from outside or within the mining site, such as:

1. PUBLIC SAFETY—affected by vehicles entering or exiting public highways, poor definition of movement routes, excessive activity areas, steep cut banks, hazardous water bodies, and operation equipment within public access.
2. ATMOSPHERIC NUISANCE—the potential disturbances caused by noise and dust produced during the active mining operation and transferred from the mining site to surrounding public areas.
3. SURFACE CONTAMINATION—the emittance of material spillage on site entrance and exit points adjoining highways and soil erosion of cut banks due to surfaces stripped of vegetation and water discoloration.

B. VISUAL APPEARANCES concern the physical characteristics of objects such as mining equipment, structures, and mining-produced land forms which induce public reaction when viewed from inside or outside the operation. Important considerations include:

1. DISORDER—resulting from unrelated forms and colors of equipment, structures, and land forms viewed by the public. Due to physical disorder, the total site appearance can become visually meaningless and unrelated to the adjacent landscape and total environment.
2. UNINTERESTING VIEWS—the arrangement of mining objects and mined land forms many times produce little visual interest because the human eye sees no focal point of physical interest.
3. DESIGN QUALITY—represents basic site details which are obvious to the public, such as: signs, fencing, walls, and night lighting. These physical details must be tastefully maintained if a poor appearance is to be avoided.

Site Planning Potential

Site planning deals with the total organization of 3-dimensional objects found upon the land for man's use. It is concerned with both functional and visual aspects of landscape development. Each sand and gravel site contains its own particular physical characteristics which man must determine the validity of altering. Site planning is the art of arranging all man-made objects upon the land in harmony with each other. The total external physical environment of sand and gravel sites can be assisted by site planning arrangements in complete detail. Two basic considerations are essential in developing a positive image for the sand and gravel industry: (1) satisfying requirements for an efficient mining operation and (2) relating features and processing activities harmoniously with the surrounding community landscape.

Potential solutions and suggested alternatives for site adjustment will concern four areas of landscape design: (See Figure 5)

1. SITE ORGANIZATION—primary relationships of operational activities and site elements.
2. LAND FORM DESIGN—emphasis upon the visual and functional aspects of berms, cut banks and stockpiles.
3. PLANTING ARRANGEMENTS—screening techniques and visual definition of land use areas.
4. SITE DETAILS—the coordination of site elements with special emphasis upon individual mining features.

Basic types of solutions for major operational effects will attempt to solve the problems in one of three ways:

1. ELIMINATION—completely remove cause of the problem.
2. MINIMIZATION—reduce the operational effects by separation or interference.
3. COMPENSATION—offset severe effects by substitution or balance.

The suggested solutions will attempt to point-up effective and economic alternatives for solving typical operational problems using basic criteria of: (1) immediate adaptability, (2) design simplicity, and (3) convenient implementation.

Scope and Objectives

This research report will identify typical problems and demonstrate how site planning principles may be effectively utilized to alleviate objectionable site conditions by:

1. Analyzing the physical components of the operating site and pointing up functional and visual relationships of typical problems from outside and inside the operation.
2. Developing alternative solutions to typical problems and demonstrating site planning proposals involving a case study found in Chapter IV.

Limitations of This Study

The scope of this report involves general operating problems and suggested alternatives. Specific and detailed design solutions are not proposed as general statements because most principles of site planning are applicable only to a particular site with definite needs and physical controls. Also topics involving the technical consideration of each site are identified by general suggestions rather than specific solutions. For specific services a professional landscape architect should be consulted.

Most site planning principles of this report are not original concepts of the author. An attempt to condense and apply these principles for the sand and gravel industry are expressed with individual ideas.

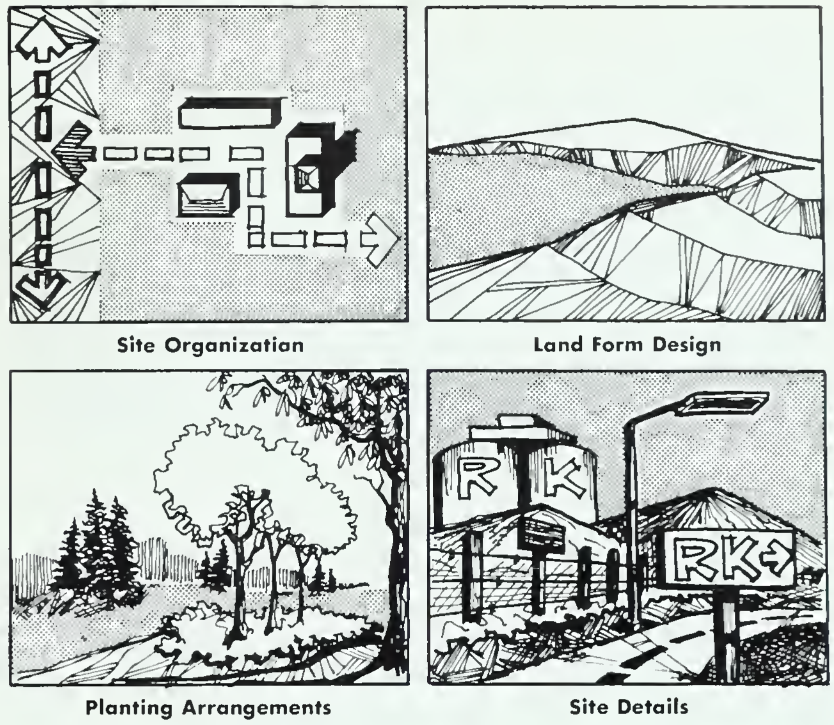


Figure 5 — Site planning considerations

The Case Study Sites

The study area is located in the Pleasanton-Livermore Valley, which is approximately 35 miles south-east of San Francisco. This area represents one of the most active sand and gravel mining areas in the United States. Four major operating sites are adjoined by neighboring landownership.

As a totality, the four operations produce approximately 5 million tons annually or nearly 50% of all sand and gravel consumption in the San Francisco Bay Region. The Livermore deposit area is composed of coalescing alluvial fans built by Arroyo Del Valle and Arroya Del Mocho creeks which have been a major source of sand and gravel for the Bay area since the early 1900's. Together, Kaiser Sand and Gravel, Pacific Cement and Aggregates, Rhodes and Jamieson, and California Rock and Gravel make up the total mining area of which approximately 1400 daily truck trips and 820 weekly rail carloads lead to and from the four processing plants. These mining operations use excavation equipment capable of extracting aggregate products to a depth of 55 feet below water level and about 140 feet below surface grade. The thickness of overburden ranges from zero in the stream bed to about 35 foot depths into the fan deposit.

Figure 6 — Case study area — Pleasanton-Livermore, California

The mining operations are located between the two cities of Pleasanton and Livermore and are bisected by a major highway that services the two cities.

These four company operations were selected as demonstration sites for this report because of their concentrated location and peculiar physical characteristics in terms of site planning choices conditioned by the eventual physical environment encroached upon by the two growing cities.

Summary of Findings

The major focus of this report emphasizes site planning concepts which are necessary considerations in providing a positive industrial image. There are no universal site planning techniques which guarantee image effectiveness with the large diversity of physical conditions unique to each individual mining operation.

Public image areas have been identified in this study to emphasize typical land uses surrounding mining operations which influence public attitudes toward sand and gravel mining. Site operators must consider each "image area" with respect to individual site conditions before an effective site development plan can insure maximum public cooperation.

IMAGE AREA 1 considers the majority of public observers of the three image areas identified. This physical land area encompasses highways and rail systems which adjoin or bisect the mining operation.

IMAGE AREA 2 focuses upon surrounding public land, with primary emphasis upon residential and commercial uses over those of agricultural, industrial, and recreational developments.

IMAGE AREA 3 is a defined area within the mining operation including the site entry, central office, visitor parking area and any other on-site points of destination the public visitor or perspective client might travel or view. (See Figures 3 & 4)

Important findings by general analysis of each "image area" include the following significant factors:

IMAGE AREA 1—influences the majority of all public observers during highway travel passing the operating site. Visual appearance of the site from the roadside view is of utmost importance. Visual problems concern the unorganized industrial site. Functional problems in this area produce secondary effects upon the public with emphasis upon public safety and the unsafe movement and mergence of mining vehicles with highway travel.

IMAGE AREA 2—generally involves a small number of public observers compared with image area 1, yet this minority of public attitudes are most instrumental for the future acceptance of new mining operations. Both functional and visual aspects of site operations have equal importance.

The site appearance must consider the stationary observer with respect to views upon the site which are in good harmony and remain pleasing in appearance over a long period of time. Both dust and noise contribute equal amounts of public dissatisfaction within this area of public opinion.

IMAGE AREA 3—combines problems of areas 1 and 2 with dust and noise equaling the importance of interior views, which communicate attitudes of industrial order or chaos. Important determinants involve dusty entry roads with less appealing office buildings communicating poor interior views.

Site planning proposals and alternative solutions are most effectively utilized if combined principals of use organization, land form design, and planting arrangements are applied to land improvements which enhance the site appearance and reduce negative functional effects.

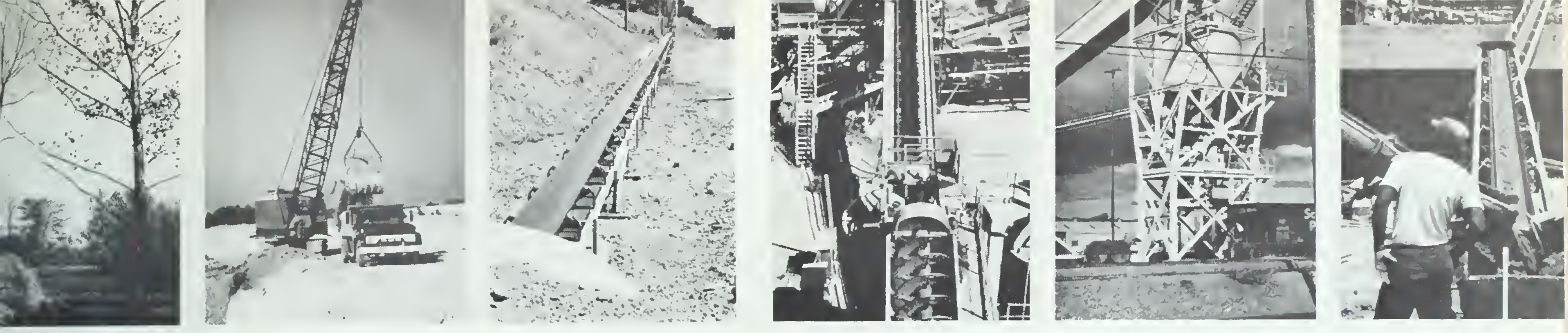
These combined alternatives must satisfy the following primary controls of each image area:

IMAGE AREA 1 requires land form design, planting arrangements, and use organization to complement the public observer in motion. Sufficient entry and exit mergence lanes must coordinate operational traffic upon proper locations of highway travel. Land forms and planting masses must offer views in sequence upon the site, of which spacing of planting and earth forms must screen or emphasize elements within the operating site.

IMAGE AREA 2 requires on-site areas of transition which contain planting masses and earth forms which complement the stationary public observer. These areas of transition must exhibit visual screens and effectively reduce functional noise and dust by filtering the operational nuisance.

IMAGE AREA 3 requires combined alternatives which complement the imageable site entry yet reduce negative views and operational noise and dust. Physical definition of roads must separate public travel from truck movement and provide parking and pedestrian areas for an appropriate central office.

Preplanning of the total operating site must consider and analyze each unique site condition involving dynamic views which are imageable and operational areas which produce negative effects. Many times adjoining operating sites with common boundaries offer total development potential for image area continuity, thus relating each site visually and functionally by site improvements involving use organization, planting arrangements, and land form continuity.



pile of overburden | Excavation | Material movement | Material processing | Consumer transportation | Consumer use

Figure 7 — Major activities of the operating sand and gravel site

Chapter II

Functional Considerations

The typical mining site is composed of many complex and related functional patterns which involve the excavation, processing, and transportation of sand and gravel. Before any planning principles can suggest alternatives to produce a more pleasing site character, a thorough analysis of the major operating functions is required. These important functions are related by major activity linkages within the mining operation.

"What one looks for are the packages of activity which will not function well unless they are located in one place or which demand similar site characteristics, and note the group of activities that are conventionally put together."[1]

The major focus of this chapter will therefore identify major operating activities which can be adjusted to produce a positive public image and achieve site organization with maximum operating efficiency.

Operational Activities

The internal structure of the typical operating site can be divided into three basic operating functions; the extractive or excavation processes, the material processing function, and the movement of material between these two operational areas.

Five major activities are typical of most operating sand and gravel sites. (See Figure 7)

1. The removal and stockpiling of overburden material.
2. Excavation of sand and gravel aggregates through wet or dry mining techniques.
3. The movement of rough material from the excavation area to the processing plant.
4. Material processing into a commodity that meets local demands and specifications.
5. Material transportation from the processing area to the consumer.

The excavation process involves the removal of sand and gravel from a natural deposit formation. The removal and stockpiling of both vegetation and topsoil is a prerequisite step before excavation. Preplanning is important to insure only one movement of overburden and can be accomplished by proper phasing of overburden in land forming for fill areas, screens, and buffer earth mounds.

The processing plant is the most dominant physical feature of the operating site. Incoming rough sand and gravel material is processed into various sizes, then moved into the stockpile or transportation area of the processing complex. The processing complex is the most active area within the site, due to the concentration of various movement systems, as truck transport, conveyor systems, and rail movement. The processing plant, stockpile loading area, equipment maintenance station, and

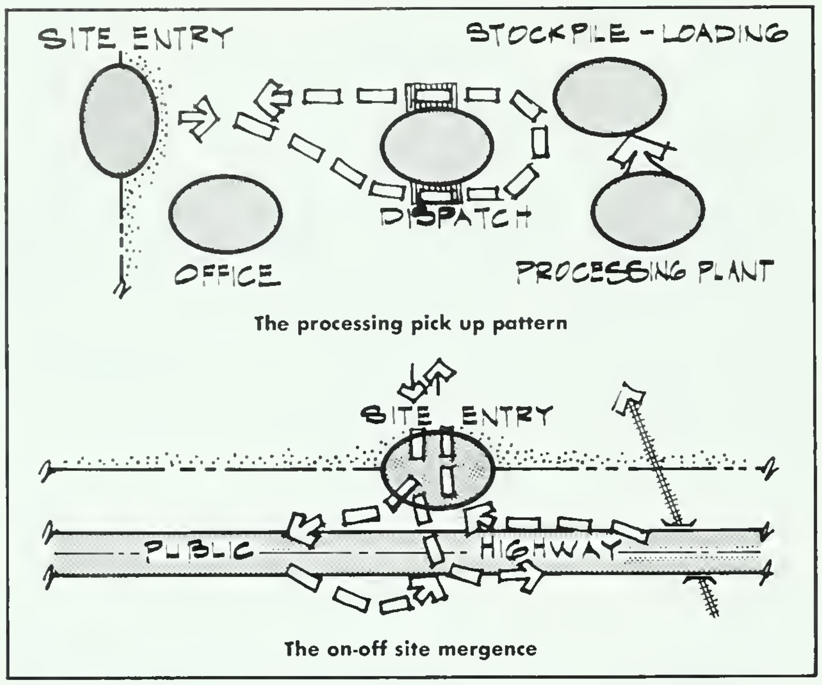


Figure 8 — Two primary movement patterns

the office-dispatch area all make up the processing complex. Typical processing complex areas average in size from 10 to 20 acres, depending on amount of excavation and transportation.

The size and amount of the deposit to be mined largely determines the size and location of the processing complex. Many times the processing complex and excavation areas are two separate operational groups, being physically separated by distance and directly related by the transportation system which links them. In this sense, the dredge or floating plant represents the most functional relationship between the excavation and processing areas.

Conditions

The physical organization of the mining site and its operational parts are influenced by two major site location controls; first the deposit formation characteristics and second, surrounding transportation and utility systems which are located within usable access for site operations.

Looking more closely at the operating functions of the processing complex, we see that both off and on-site transportation is an important location control. The processing plant must first locate in close proximity to the excavation area, yet must relate well with off-site transportation to be functionally efficient.

The on-site transportation linkage involves the excavation areas and three major components of the processing complex; the processing plant, the stockpile and loading area, and the office control and dispatch unit. The office area is usually located to control incoming and outgoing traffic and acts as the sales and control center. It is most important that traffic movement be organized in a simple, efficient manner to reduce congestion both on and off the site. (Organization of the operating elements will be discussed in more detail in Chapter IV.)

The movement of aggregates from the excavation area through the processing complex comprises various transportation functions, which can be identified as the major "activity linkage" relating all site operations. The industrial site owner must utilize logical and economical planning procedures which will insure an efficient movement system not only for the current operation but also for future production.

The processing plant is the major activity hub because all movement patterns, wheel or rail, move to and from this common focus. Two primary movement patterns make up the operating transportation system: the processing pick-up and the on-off site mergence. (Figure 8)

The Processing Pick-up Pattern concerns three major vehicle types which congest traffic flow within the operating complex.

1. TRUCK TRANSPORT involves a three point destination pattern within the processing area. The trip destinations include such vehicle points as; the processing dispatch and truck weight station—then moving to the stockpile or loading area and a return stop to the dispatch and truck load weighing before site exit.

2. AUTOMOBILE TRAFFIC involves the visiting client and site employee and should be considered potential operation and safety hazards.

3. RAIL MOVEMENT usually concerns the large operation, in which the primary point of destination is the stockpile and loading area, near which vacant rail cars must be stored during the loading process.

ON-OFF SITE MERGENCE includes access and egress between the site movement systems and public routes of circulation, particularly highways. The usefulness of any industrial site is determined by its accessibility to off-site transportation. Both public and operational problems involving transportation systems result from the lack of organized vehicle access. Wheeled vehicles involving both the excavation and processing movements are the most critical movement types, utilizing vehicle paths on the site and also public highways.

Site Elements

Good site planning must consider all major elements of the site. The following are important and typical considerations which influence the organization of operational elements into optimum site relationships: (Figure 9)

1. NATURAL FEATURES, including land forms, topsoil vegetation, water bodies, and excavated soil materials.
2.. USE OR ACTIVITY AREAS, including excavation, processing, circulation, commodity stockpiles, equipment, storage and maintenance, control center, and vehicle parking.
3. STRUCTURES, including processing plant, loading bins, dispatch unit, maintenance buildings, and business office.
4. OPERATING EQUIPMENT, including excavators, earth movers, conveyors, loaders, and transport vehicles.

Operational Effects

The previous information has involved a review of typical operating site functions which are referred to in

Natural features

Activity areas and structures

Operating equipment

Figure 9 — Site elements

the three prior NSGA reports and can define the operating site in a simple structure diagram. By analyzing the site in terms of its essential elements and activities, it is possible to pinpoint the source of negative effects. Three major problems originate during the operation function and can affect the surrounding public in a negative manner, namely: (Figure 10)

1. SAFETY—Operational hazards of cut banks, water bodies, and equipment accessible to the public including hazardous equipment and vehicle congestion during entry-exit mergence with the operating site.
2. NUISANCE—The physical disturbance produced by the movement of operational equipment emitting noise and dust.
3. CONTAMINATION—Land surface deposits of spillage on highways, water discoloration and soil erosion.

The remainder of this chapter will therefore identify these practical problems in detail and propose site improvement alternatives.

Part I

Public Safety

Public safety hazards can be defined as any object or activity which involves risk or a chance of danger. The typical sand and gravel operation does not produce what might be considered extreme public hazards such as vertical cliffs or the use of explosive methods in aggregate removal; yet, operational problems involving trucks emerging upon public highways and some site features can produce potential dangers to the public.

Problems involving public safety within the mining site can be classified into two groups: first, those situations resulting from public access and vehicle circulation, and second, hazardous land forms and water bodies and related operational activities.

Public safety

Nuisance

Contamination

Figure 10 — Operational effects

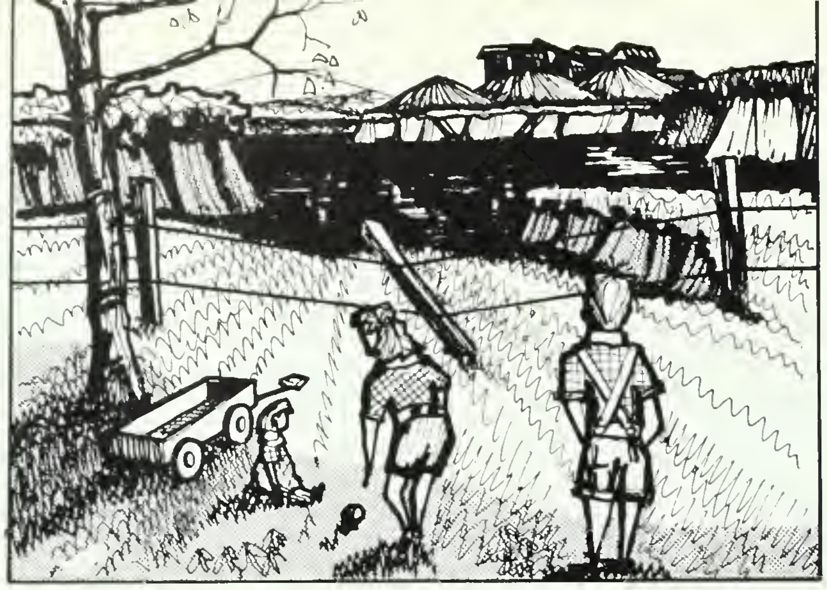


Figure 11 — The attractive nuisance

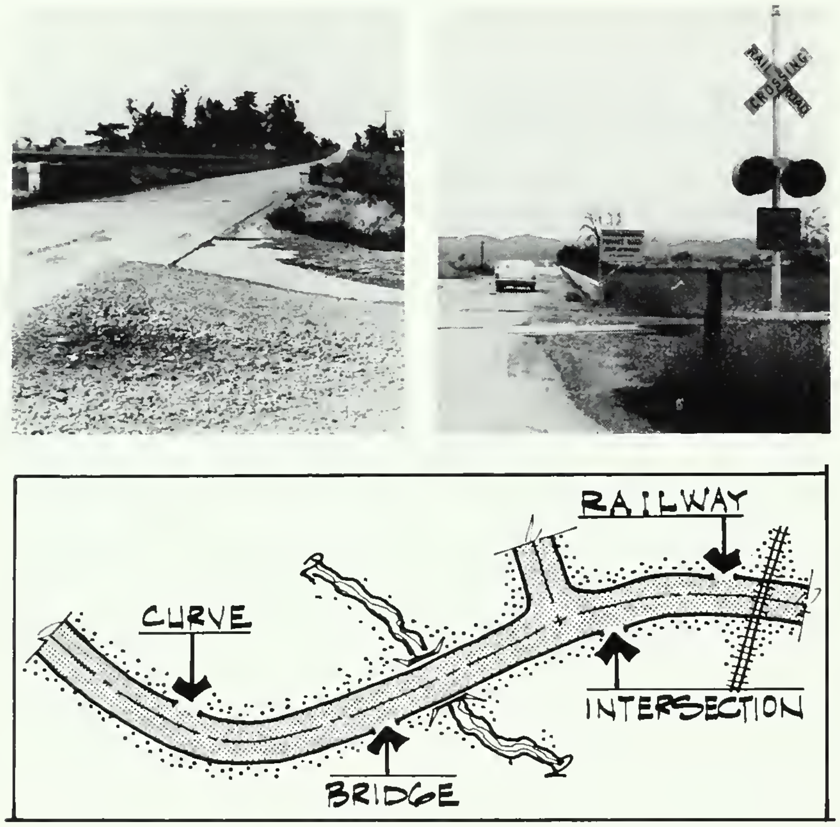


Figure 12 — Poor site entry locations

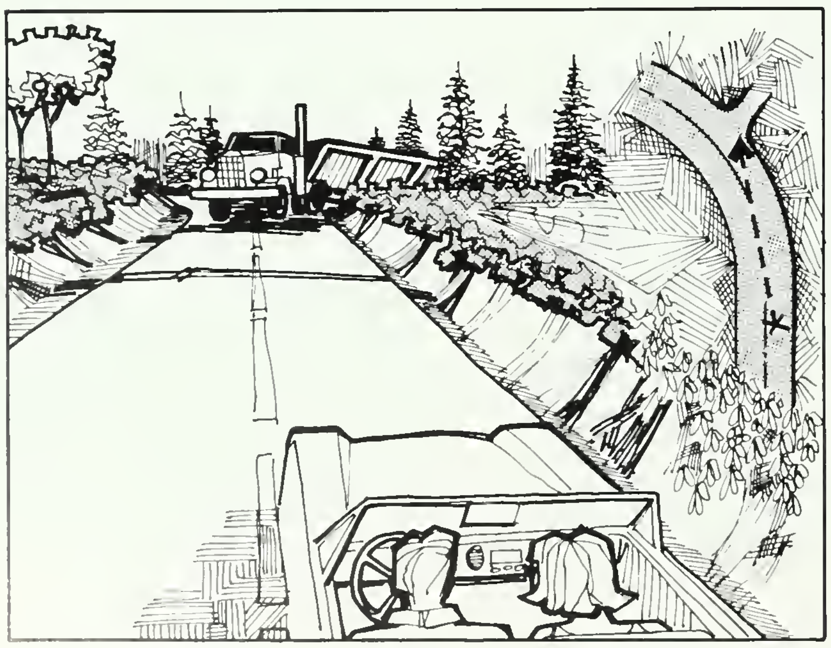


Figure 13 — Lack of entry definition

These safety problems, which are not employee oriented, include considerations of protection and/or control. For example, PROTECTION deals with those problems which may happen by chance as with a young child or an adult in an accident, whereas, CONTROL problems concern situations which could have been prevented.

The primary problems can be identified as to their importance, namely:

1. HAZARDOUS LAND FORMS include steep high banks, especially those which exceed the normal angle of repose of the specific soil type. Water bodies of any size with depths in excess of 6 inches are potential hazards to the public. (Figure 11) Children are often visually attracted to these land forms and water bodies for play. They are then an "attractive nuisance." Areas of primary concern include such land forms which adjoin the site boundaries and are located in close proximity to the neighboring public.

2. EQUIPMENT types involved in the mining operation, as power shovels, dragline, scrapers, graders, bulldozers, clamshells, slackline cables, belt conveyors, desanders, front-end loaders and large trucks can offer potential safety hazards if left within easy access of venturesome children.

3. VEHICLE CONGESTION and hazardous movement problems result from poorly designed entry and mergence routes which are not coordinated with public highway travel. These problems are most important since they daily remind the passing public of a poorly organized entry, and produce vehicle congestion by:

a. Poor site entry location in relation to other public movement systems; location near bridges, railroads, and highway curves or banks. (Figure 12)

b. Hazardous site mergence which parollels other types of movement (rail-frontage roads) and vehicle crossing of two movement routes.

c. Lack of entry definition to facilitate incoming and outgoing traffic with deceleration lanes and a safe visual control distance. (Figure 13)

Control of the mining site is a necessary precaution to safeguard the public and provide adequate warning of hazardous areas within the operating site. Physical barriers, as a berm planted with no-walk-through vegetation (thorns), or fences provide this needed transition zone. In general the NO-TRESPASSING posting provides legal protection to the landowner if a teen or adult violates this control and experiences an accident. However, young children who trespass on hazardous mining land must have the added protection of physical control.

Safety problems which usually arouse public opinion against the industry are:

A. TRAFFIC ACCIDENTS involving transport trucks in movement to urban centers along public highways and poor site entries which provide potential hazard zones.

B. PUBLIC ACCIDENTS within the operating site boundaries may involve young children playing on excavation equipment and unstable land forms or falling from high banks into water bodies. Control of site boundaries is essential if children live in close proximity to the operation.

Principles

Site planning considerations involving the reduction of potential hazards produced by operations concern both

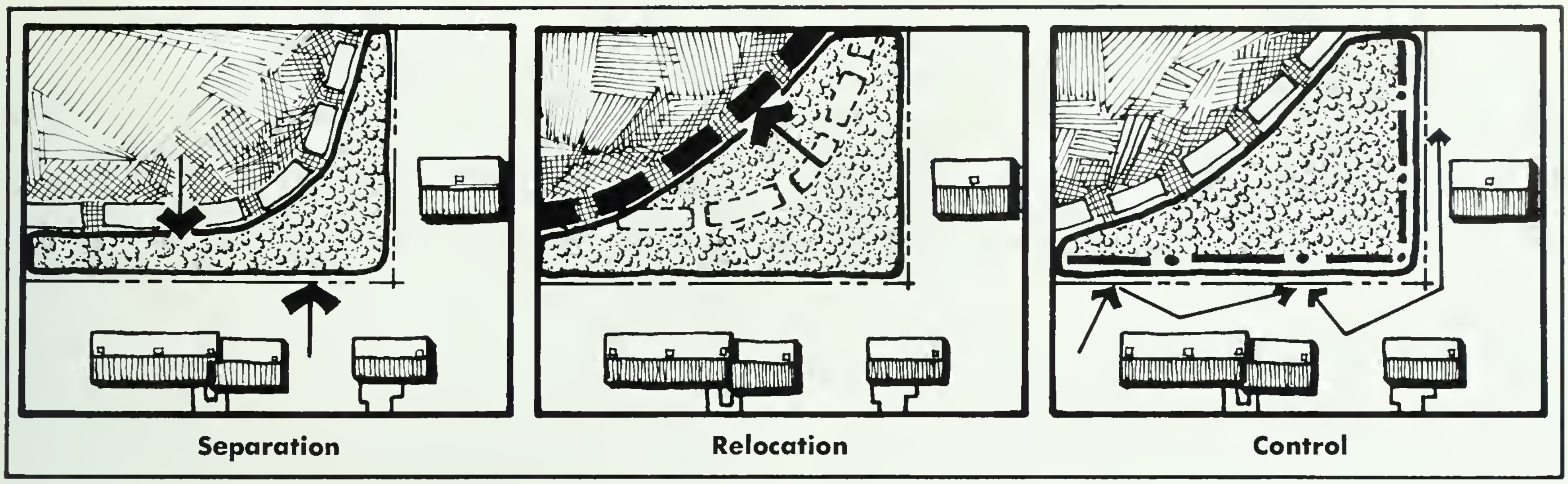


Figure 14 — Site planning considerations

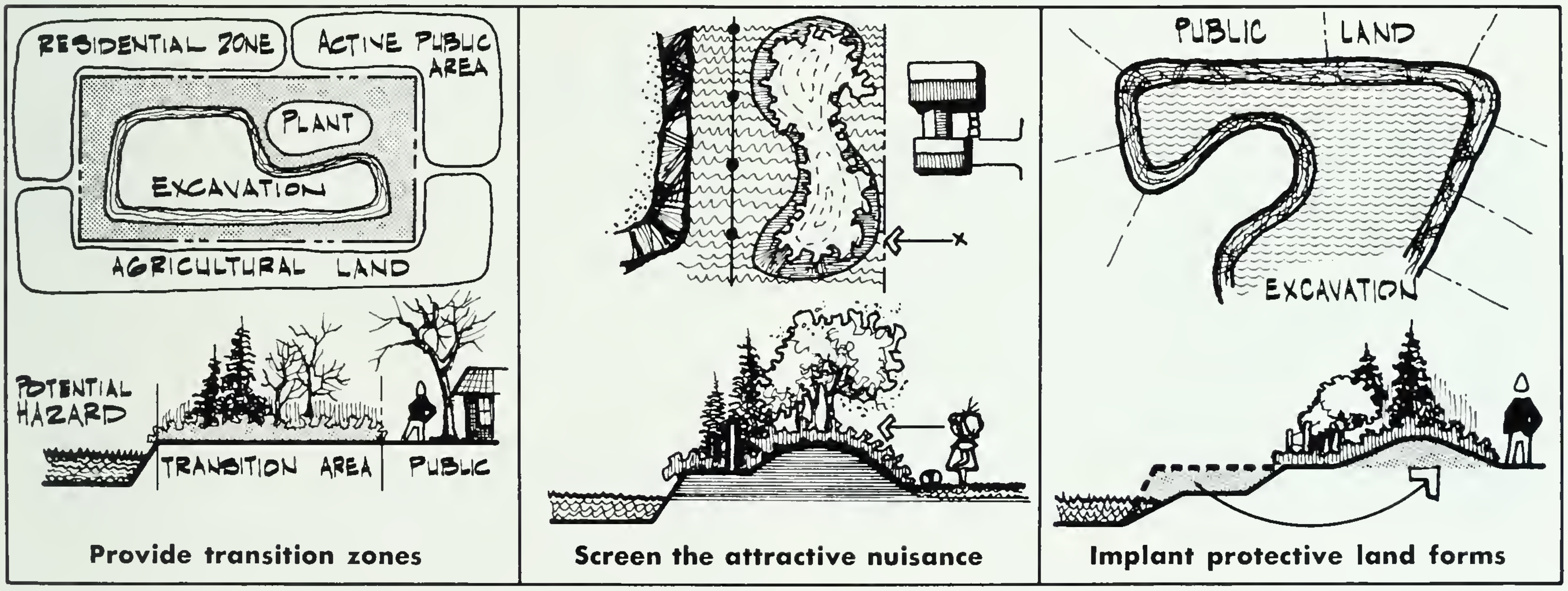


Figure 15 — Mining site boundaries (Image areas 1 and 2)

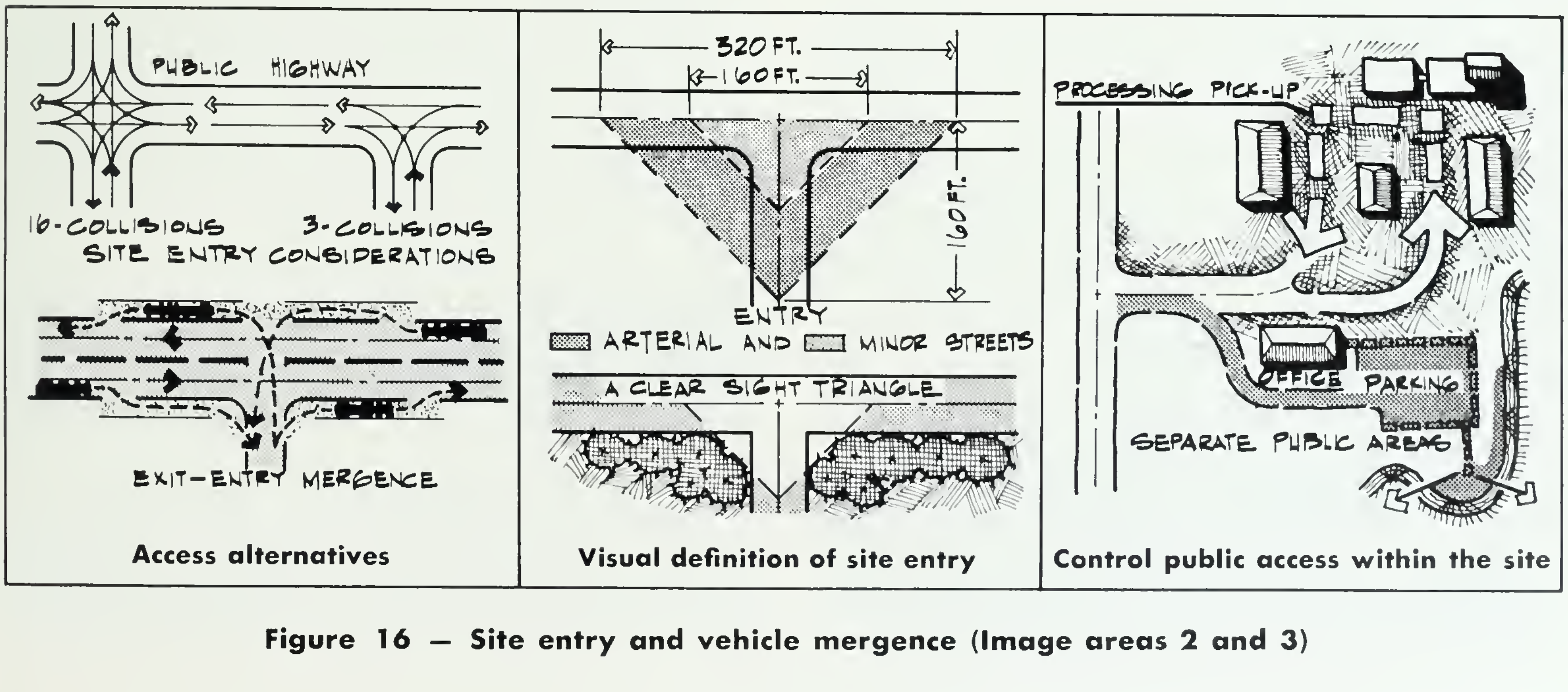


Figure 16 — Site entry and vehicle mergence (Image areas 2 and 3)

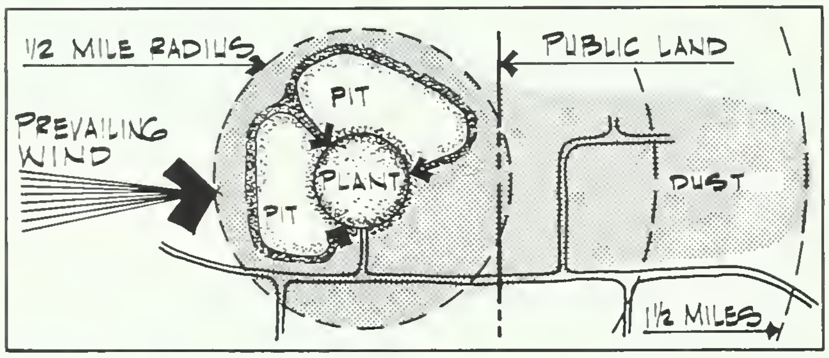


Figure 17 — Dust emission by vehicle routes and processing

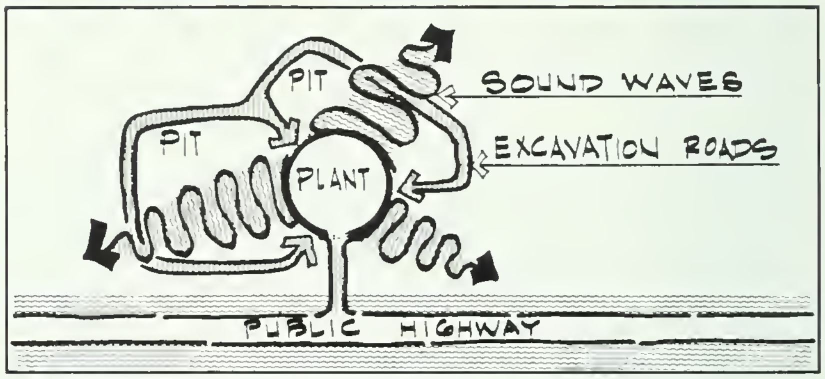


Figure 18 — The processing plant and vehicle routes generate maximum sound waves

PROTECTION and CONTROL measures and suggest improvement of unsafe land forms and vehicle routes by: (Figure 14)

1. SEPARATING potential hazard zones from public access by land areas of transition to better isolate the mining operation from adjoining public land.
2. RELOCATE highly active functions which adjoin public land and pose a constant threat to public safety, as settling ponds, transport roads and deep cut-banks.
3. Provide control measures which generate good public relations yet limit public access to areas of danger.

Alternatives

The following examples suggest possible solutions to insure public safety:

A. Protection of the total site boundary with special emphasis upon neighboring areas of high public use. Easements adjoining property lines vary in widths from 10 to 30 feet and represent a transition area of no-excavation. Widths of 20 to 30 feet are preferable for those areas joining active public use zones. (Figure 15)

The first corrective measure concerns the screening of potential hazardous areas to eliminate the "attractive nuisance." Second, provide protective land forms which alleviate the potential danger of water and steep banks by reducing high slopes.

B. Entry upon the mining site must be considered as an element which relates operational areas and activities within the total space and must exhibit a functional access rather than an unnecessary barrier. The site entry should be a limited access route into the processing area. This entry should not occur within 150 feet of any other intersection, bridge, or rail crossing. If possible entry and exit should occur on secondary public roads where high vehicle intensity and speed are nominal factors. (The 4-point intersection exhibits 16 collision points where the T-intersection is reduced to 3 collision points.) (Figure 16)

Due to the slow starting and stopping capacities of large transport trucks emerging onto public right of ways, provide maximum stopping and starting lanes for mergence with speeds above 30 mph, and facilitate visual control of oncoming highway traffic. (Figure 16)

The entry must accommodate the largest vehicle types of 32 foot minimum turning radius for large tractor-trailer vehicles.

C. CONTROL—Legal measures involve the total site perimeters, of which proper fences and sign posting must be coordinated to conform with zoning and local requirements. (Figure 15) Details such as fencing and sign use are important visual details of the industry. (See Visual Quality, Chapter III)

Part II

Atmospheric Nuisance

Two important annoyance factors which directly influence the surrounding public during site operations and play an effective role toward the future acceptance of sand and gravel operations which adjoin public-use areas

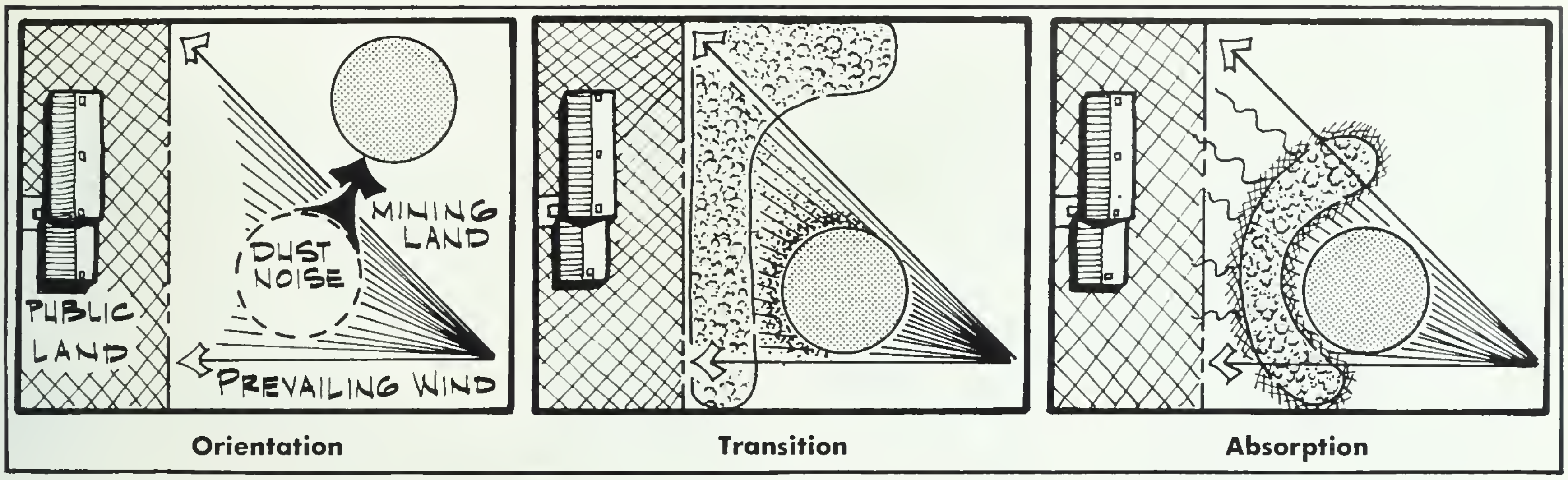


Figure 19 — Site planning principles

are the emittance of dust and the creation of noise produced by mechanized mining activities.

Although the complete elimination of these nuisance properties is impossible, important preventative measures can be taken to reduce these factors to negligible amounts.

Dust

Dust emission consists of fine soil particles which move by air currents. The heaviest of these particles fall within approximately a one-half mile radius of the activating source. However, wind velocities determine the dust carrying range and the direction of predominant particle movement.

Operational areas which produce dust can be categorized in the following order of importance:

1. HIGH USE VEHICLE ROUTES within the site can be the primary contributions to dust emission. These roads are usually compacted earth and non-surfaced types, which allow soil breakdown by heavy moving equipment. (Figure 17)
2. THE PROCESSING COMPLEX is the secondary contributor of dust. The operational process of grading and crushing aggregate material within the plant is a partial source. Other activities as vehicle movement with loading and dumping operations make up the remainder of dust emittance in this area. (Figure 17)
3. THE EXCAVATION AREA produces least amounts of dust because material under excavation usually contains enough subsurface moisture to prevent dust. However, overburden material or cut-banks which lack moisture or cover can also be a dust source.

Sound is usually defined as pressure waves capable of being heard, while NOISE is a human attitude depicting unwanted sound—good sounds to one person could be noise to another.

An important psychological factor is the human tendency of the listener to ignore background sounds considered normal. Public complaints usually occur when noises are abrupt and louder than the normal background sounds or interfere with sleep and daily activities. The following table taken from the Chicago Zoning Ordinance indicates approximate estimates of noise level in ratio to public reactions.

Decibles	Residence 72	Business 79	Manufacturing 72-79	Heavy Manufacturing 75-80
Less than 0	— No observed reaction			
0 - 10	— Sporadic complaints (sand and gravel sites produce more than 82 DB's in a residential zone above the average residential DB's of 72-75.)			
5 - 15	— Widespread complaints			
10 - 20	— Threats of community action			
15 - +	— Vigorous community action			

Public response when in excess of these numbers

The 1958 dust and noise research study by Industrial Hygiene Foundation of America, Inc. indicated the following Noise Intensities:

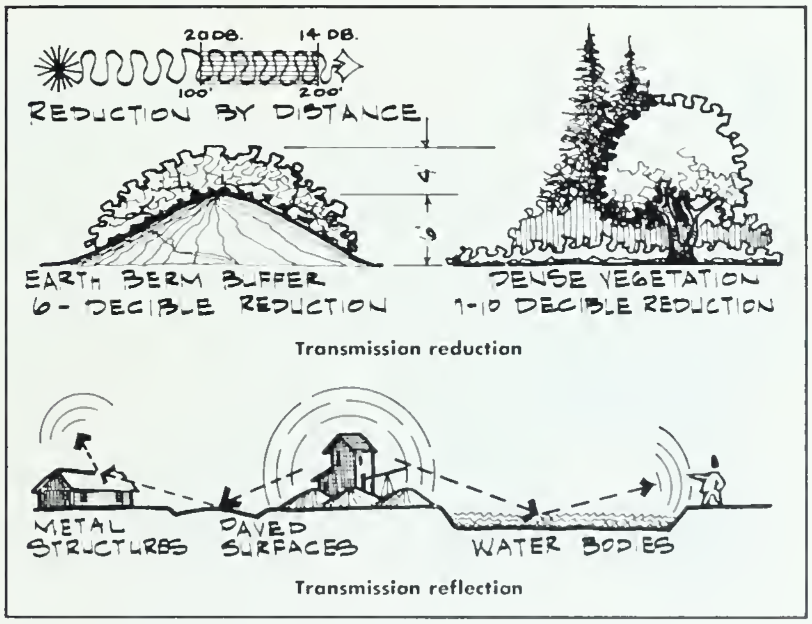
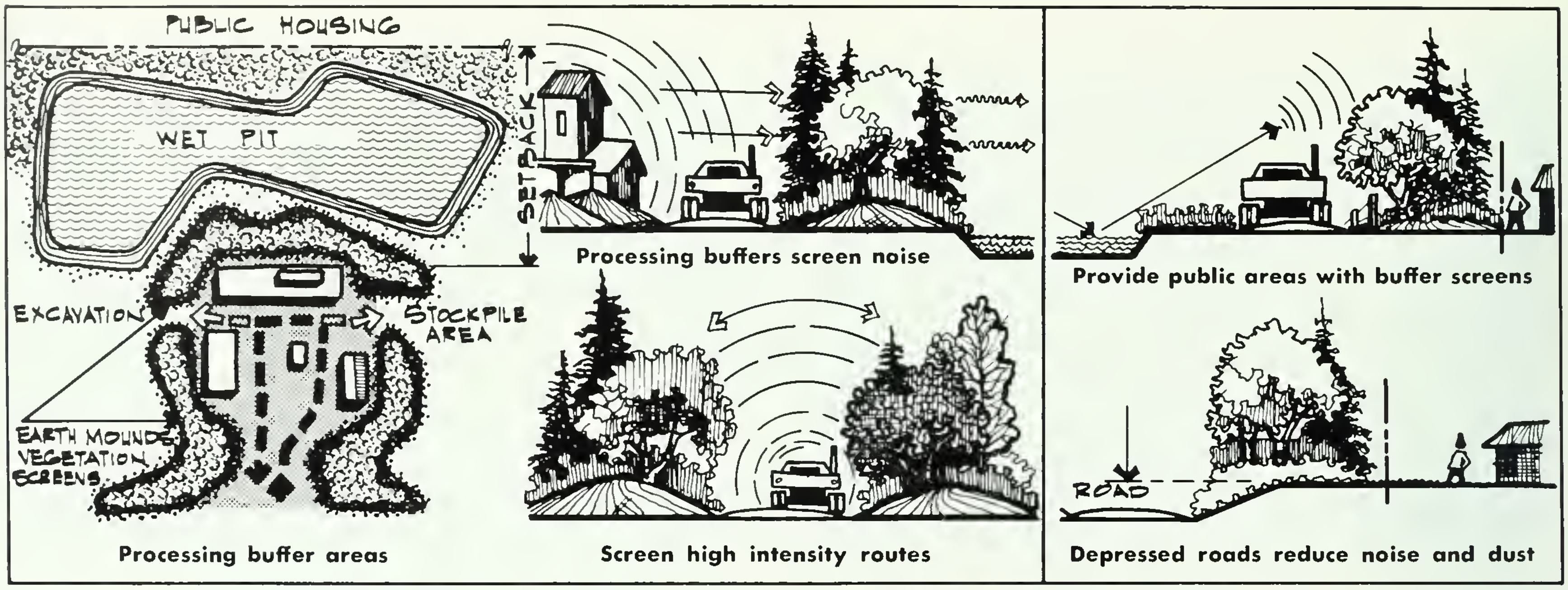


Figure 20 — Noise reduction and reflection



Processing buffer areas

Processing buffers screen noise

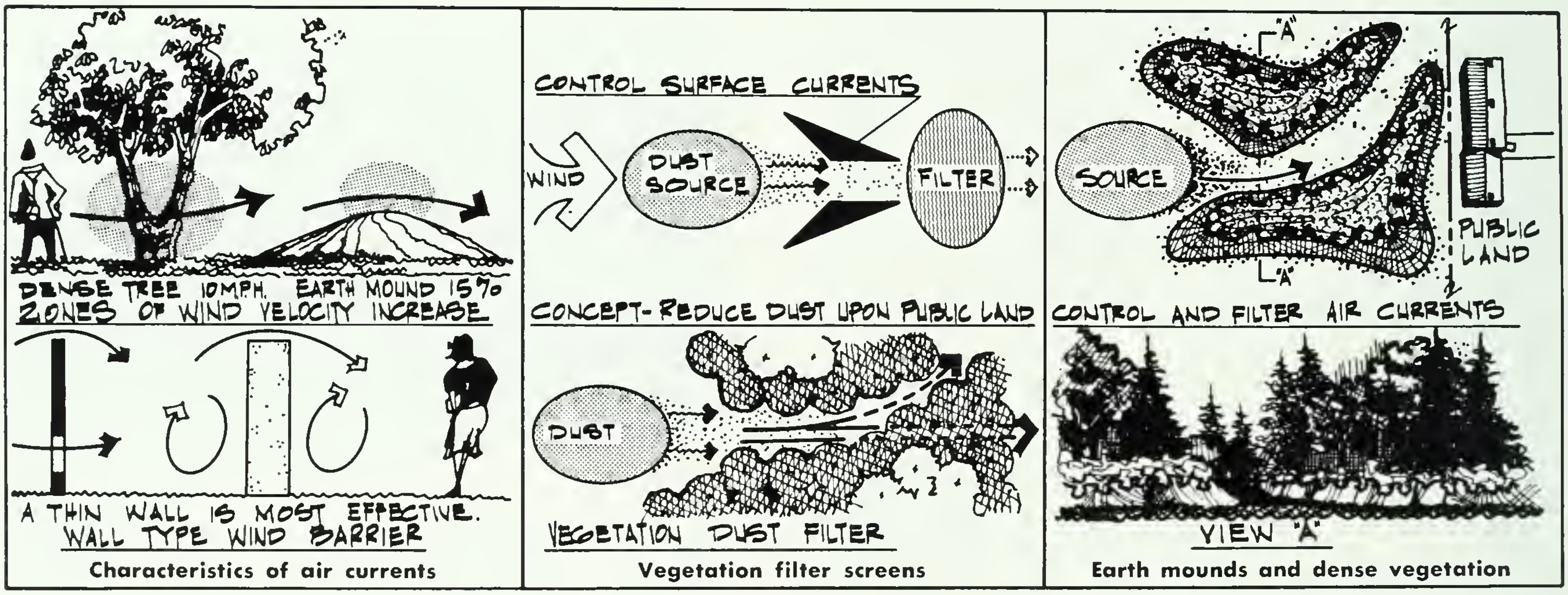
Screen high intensity routes

Provide public areas with buffer screens

Depressed roads reduce noise and dust

Image area 3 *Image areas 1 and 2*

Figure 21 — Processing and vehicle route — buffer zones



Characteristics of air currents

Vegetation filter screens

Earth mounds and dense vegetation

Figure 22 — Dust filtering alternatives

Figure 23 — Material spillage

Figure 24 — Visual character — no after use. Water erosion

1. The Processing Plant generates maximum sound waves by the steady operating activity of crushing, screening, elevators, conveyors, and vibrators. (Figure 18)
2. Vehicle transportation involving heavy truck movement of material on and off the operating site is a secondary major noise contributor.
3. Excavation machines of all types can also be noise contributors. Usually the operation of these types of equipment are located at sufficient distances to give secondary public effects.

Design Principles

The following site planning principles suggest adjustment to typical operating techniques. (Figure 19)

1. Provide orientation and placement of operational elements as processing structures, roads and overburden piles in relationship to predominant winds and surrounding public lands.
2. Provide transition elements which separate and filter both air and sound waves within the active operational areas.
3. Absorption or reflective material should be placed near or around the operational source to provide a complete or partial barrier between the source and public.

All physical materials as soil, vegetation, and structural forms maintain a fixed transmission loss which varies with the frequency of sound. Textures and densities of materials (structural and vegetative) determine the ability to absorb sound and dust factors. The deflection of sound is accomplished by reflective materials or site features as metal surfaces, water bodies, and concrete surfaces.

Alternative Solutions

The noise level from a given source can be reduced by increasing the distance between the source and the listener. The sound intensity can be reduced by 6 decibles for every doubling in distance or spreading sound in all directions. (Figure 20)

The installation of barriers, such as fences, concrete walls, earth embankments, and plant materials placed as close as practicable to the emitting source can also reduce noise and dust transmission.

The effectiveness of the barrier increases as the barrier height increases, and also when it is moved closer to either source or listener.

1. Processing buffers to alleviate both noise and dust effects include the processing plant setback with wider buffer areas for vehicle roads within the processing complex. Effective screens should reduce the amplification of operational sounds which adjoin water bodies by large sheet metal buildings and concrete paving areas. (Figure 21)
2. TRAFFIC ROUTE BUFFERS—When traffic is heaviest, a width of 45 feet of right-of-way on each side of the adjoining highway route is desirable to provide for shoulder, drainage, and planting space.
3. FILTERING BARRIERS—To establish an efficient exterior dust filtering barrier, the movement characteristics of air currents provide important design criteria; (Figure 22)
   a. Basically all air currents are at their lowest velocities near the ground surface. As height from the ground increases the wind velocities increase.
   b. Air movements are most affected by features (trees, buildings, etc.) above grade and especially those with rough and irregular surfaces. They are least affected by smooth surfaces as water bodies, concrete paving, and smooth ground cover.
   c. Sloping topography with ridge line barriers can reduce wind velocities and vary the direction of air movement.
   d. Wind currents within 3 feet of ground surface are most effectively influenced by rough textured low growing plant materials.

If dust particles are to be filtered by vegetation screens, shrubs, and trees, there should be well adapted types with foliage colors of light tones and gray greens.

Stabilization *Restoration*

Figure 25 — Site planning considerations

Part III

Surface Contamination

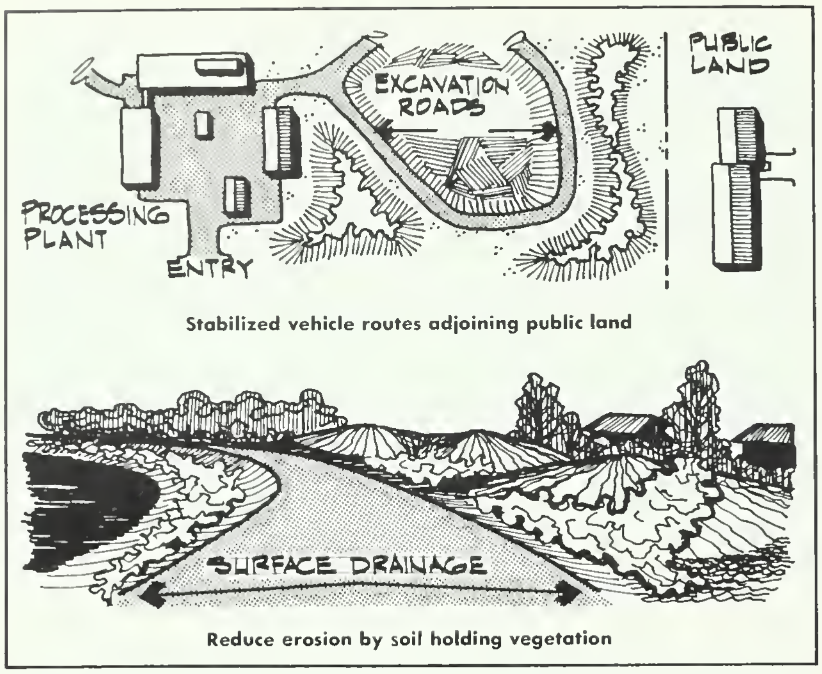
Contamination problems are the result of man's activities and disturbance of natural elements upon the land.

"Surface contamination" deals with the introduction of undesirable elements upon public land surfaces and within surface water which leaves the mining site.

The industry experience shows the two principle reasons for public objection to sand and gravel operations are: (1) the manner in which trucks hauling sand and gravel are driven over the streets and highways and (2) the condition in which the land is left after completion of operations.[2]

Trucks hauling sand and gravel can be the major causes of aggregate spillage and the distribution of mud debris upon public highways and streets. Water contamination produced by the disposal of waste fines and soil bank erosion are also important operational problems to be considered in this section.

Three primary types of contaminants considered are soil erosion, deposition, and material spillage. Water and poor surface drainage are major activating agents in producing these operational problems.



Stabilized vehicle routes adjoining public land

Reduce erosion by soil holding vegetation

Figure 26 — Control site drainage and soil movement

The physical adjustment of surface soil, vegetation, and ground topography all effect surface water drainage patterns. How and where water drains are important considerations the sand and gravel producer must satisfy.

MATERIAL SPILLAGE involves the distribution of undesirable sands and gravels upon public highways. The on-off site transport trucks can be primary contributors due to overloading of materials which exceed truck carrying capacities. Poorly drained vehicle routes within the site can produce considerable amounts of mud which can be transmitted to public highways and produce wet or muddy exit-entry points. Unsurfaced routes within the site are subject to constant compaction by mechanized movement producing a primary soil breakdown factor. With periodic saturation, these soil surface roads become primary sources in producing the operational emission of dust and mud. (Figure 23)

WATER CONTAMINATION concerns the discoloring of water by solid particles. This problem is not a permanent situation yet excessive amounts of silts should be removed. Any excavation process, such as dredge or dragline operations, must practice necessary measures in mining to return satisfactory water to public use. Soil and bank erosion is also a primary contributor, which results during and after operations where moisture holding vegetation has been stripped away leaving bare soils to erode when slope angles are extreme.

Usually any land which reflects the visual character of a no-after-use gives a negative feeling. Deeply cut slopes produced by water erosion give this "unusable character" more than any other natural force. (Figure 24)

Material spillage upon public highways not only gives a poor visual affect of the operating site, but also conveys a message of poor safety standards.

Principles

Two site planning considerations suggest possible solutions to surface contamination problems: (Figure 25)

1. STABILIZATION involving the control or keeping in place all surface elements of the operating site.
2. RESTORATION of soil and vegetation to a good condition in harmony with the existing landscape character.

Both principles of stabilization and restoration suggest treatment of physical features to control site drainage and soil movement. The following are four site planning alternatives in order of use: (Figure 26)

1. Locate operational activities to minimize contaminating effects, as roads in relation to processing plant and site entries.
2. Provide functional land forms which reduce soil erosion on cut banks within the pit excavation area. Grading techniques must direct surface drainage away from transportation routes and active vehicle areas within the processing complex.
3. Plant soil surfaces with cover vegetation to restore slopes, prevent bank erosion and water contamination.
4. Construct load control devices and stabilize road surfaces.

Alternative Solutions

A. VEHICLE ROUTES—Reduce soil breakdown at unsurfaced vehicle routes, and within the processing complex during material excavation with gravel or concrete surfacing.

1. Crushed gravel is a good stabilizing material and requires less water application during intense dry seasons. Gravel surfacing reduces the accumulation of mud to be trucked off-site onto public highways.
2. Surfacing material is better within the processing complex along roads of high-intensity use. These roads are primary routes of travel and are of permanent nature during site operations.

B. CUT BANKS AND WATER EROSION—Generally cutbanks which are west and south facing exposures to the sun are subject to a high moisture evaporation. Wind is also a drying agent to these slopes, and without ground covering vegetation those slopes become major soil contributors by wind and water erosion. These slopes should take priority in providing hill-holding vegetation.

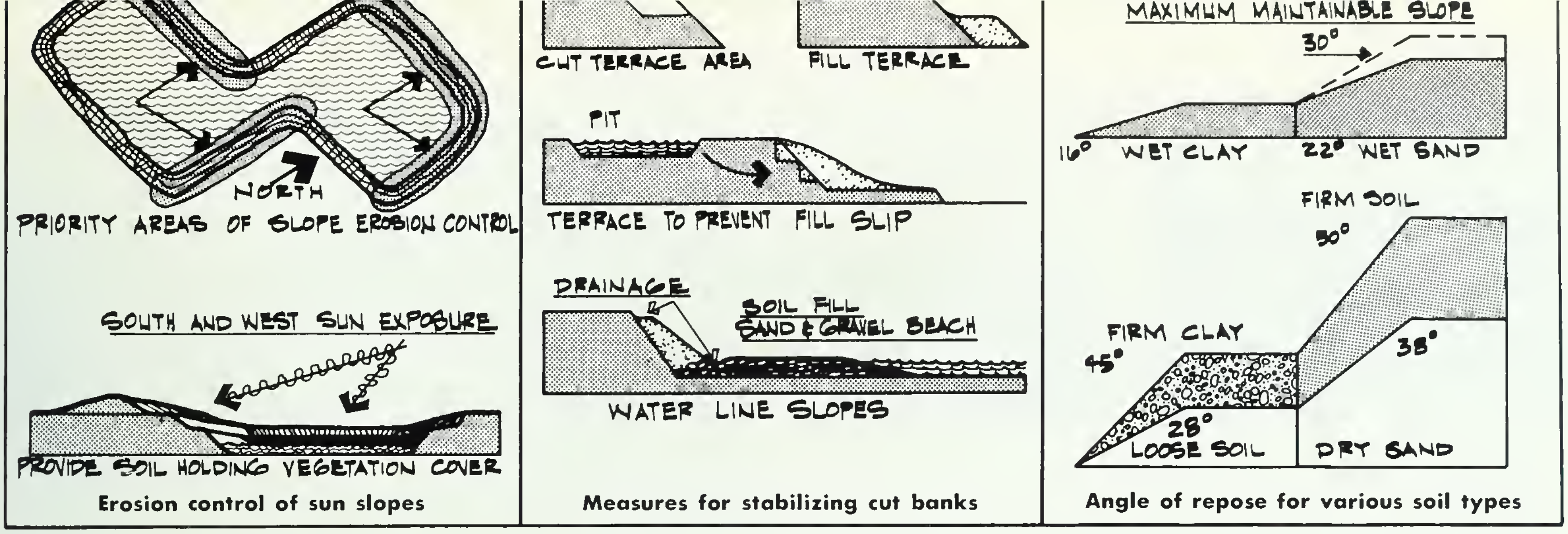
1. Grading of cut and fill slopes—the angle of slopes—should relate to the ability of the soil to withstand the erosive effect of surface water. Slopes which require maintenance should be kept within a 2:1 to 6:1 gradient. The following illustrations point up typical slope situations and suggestive stabilizing measures for cut slopes, fill slopes and water line slopes. (Figure 27) The physical angle of repose for the following soil types is: firm earth 50°, loose earth 28°, firm clay 45°, wet clay 16°, dry sand 38°, and wet sand 22°.

C. CONTROL OF OPERATIONAL WATER—Settling ponds and the control of excavation waters can remove soil particles from water before its return to public rivers or reservoirs. (Figure 28)

D. VEHICLE LOAD CONTROL DESIGN SUGGESTION—The transport pickup pattern moving finished aggregates off-site can prevent highway spillage and the distribution of track mud, by drainage, grade, vibration, and vehicle route surfacing.

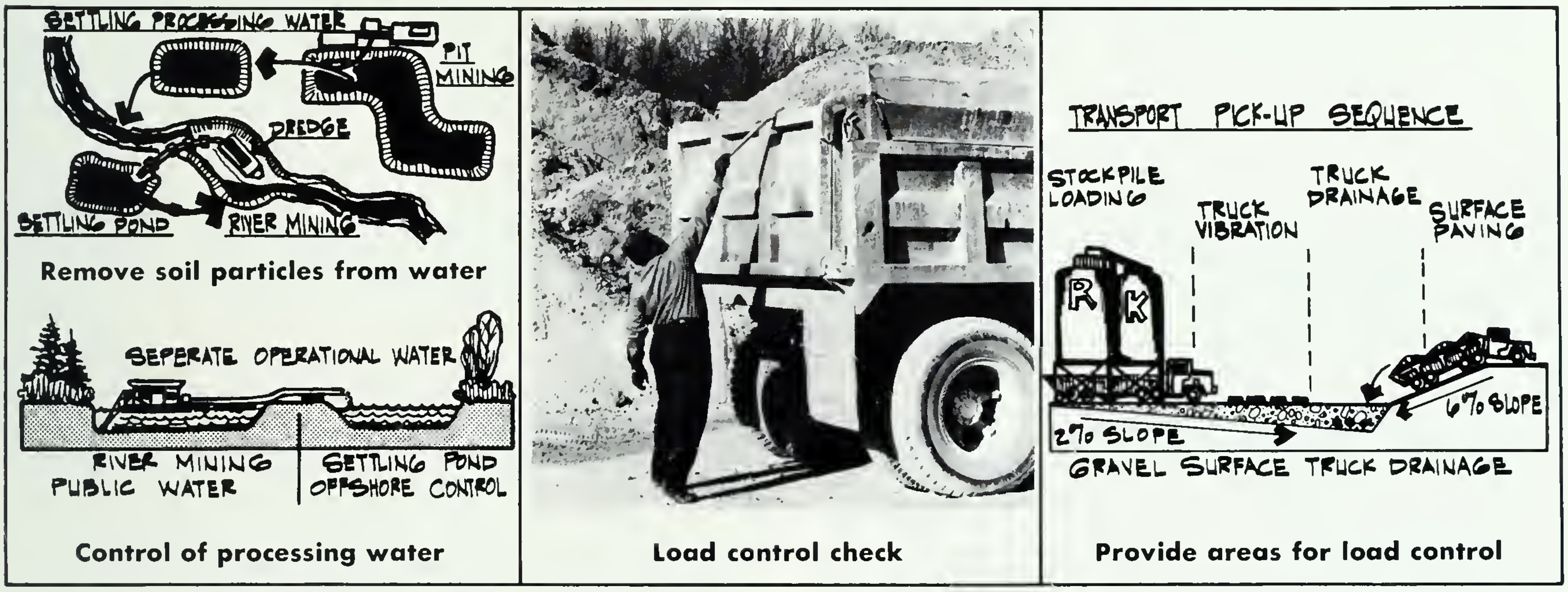
Summary

In review, these operational problems concerning Public Safety, Atmospheric nuisance, and Surface contamination are all related and can produce a total nega-



Erosion control of sun slopes | Measures for stabilizing cut banks | Angle of repose for various soil types

Figure 27 — Stabilize and restore excavation produced land forms



Remove soil particles from water

Control of processing water | Load control check | Provide areas for load control

Figure 28 — Control of processing water and highway spillage

tive affect upon the public. Specific solutions to the functional annoyances are found in Chapter V, where treatments of the case study sites are demonstrated.

The primary goal in reducing the total affect of these problems is to provide control, yet make these adjustments appear natural and harmonize with the surrounding landscape. The physical relationships of these problems can be grouped into general areas of the operating site; first, the major activity hub of the processing complex and site entry; (image area 3) and second, the physical edges or boundaries of the site (image areas 1 and 2). Composite design solutions must solve access while reducing operational effects of dust, noise, material spillage and public safety with screens and buffer zones to reduce adverse effects.

The important aspect of these implications is to note the relationships with the problem source for solving the total effect. Generally, physical controls as screens, fence controls, and buffer plantings can be combined into one transition area to restrict negative operational effects.

Effective circulation is a key to the success of any industrial site; this includes a clear visual identity of movement routes with special emphasis upon entrances for on and off-site mergence. Logical locations of entry and vehicle routes are prime factors in producing maximum safety and coordination with public movement system.

PREPLANNING the site is the first step toward physical readjustments of problem areas in order to alleviate operational effects. Important combined considerations include the organization and location of operational areas in relating to the surrounding public, and treatment of site conditions by location, grading, and planting. (See Chapter IV for combined solutions.)

FOOTNOTES

Chapter II

[1]KEVIN LYNCH, *Site Planning*, MIT Press, 1965, p. 27.

[2]VINCENT P. AHEARN, JR., *Land Use Planning and the Sand and Gravel Producer*, National Sand and Gravel Association, p. 23.

Recreation *Public highway* *Residential housing*

Figure 29 — Views upon the operating site

Chapter III

Visual Considerations

A view of the typical mining site is composed of numerous natural and man-made elements forming a physical composition. This composition primarily involves space, color, and form (mined land and structural forms) which together are either simple and easy to understand or visually chaotic creating a feeling of awkwardness. The visual message or feeling experienced by the observer produces attitudes and is the expression of a total "public image," which relates the typical visual characteristics of operating sites.

Visual effects are equally as important as the functional aspects of any operational activity. Although the functional aspects concern operation efficiency, the physical form suggests the effectiveness for use. Function and form many times require separate criteria which must be coordinated in design for a harmonious relationship. (Figure 30)

Visual Elements

Basic visual elements which comprise all views are form, and color, together producing a visual effect.

"Color, value, texture, point, line and area radiate different amounts of visual energy. Colors and form of objects together either attract, or repel each other."[4] The types of views considered in this chapter will involve both mined land forms and man-made structures.

Dominant site features which convey visual messages can be grouped into the two basic operational parts of the mining sites: (Figure 31)

1. The excavation and processing areas which include natural features or mined land forms, water bodies, and vegetation.
2. Man-made elements include mining structures, equipment forms, and site details.

Natural features of topography, water, and vegetation must be visually related to the permanent structures of the processing plant and the pit excavation forms.

Viewing Conditions

The following factors are basic concepts of how people observe physical objects upon the landscape and the visual limitations involved:

1. Distance and angle of vision concerns the public observer who is in a stationary position or while in movement.
2. Objects and spaces concern general concepts in vision with respect to the focus of attention produced by the placement of physical elements.

Scale is the term most generally used to define the relative size of objects. Relative scale concerns how objects relate in size within a given composition, such as the difference between the proportions of a processing plant and the company office. The absolute scale of

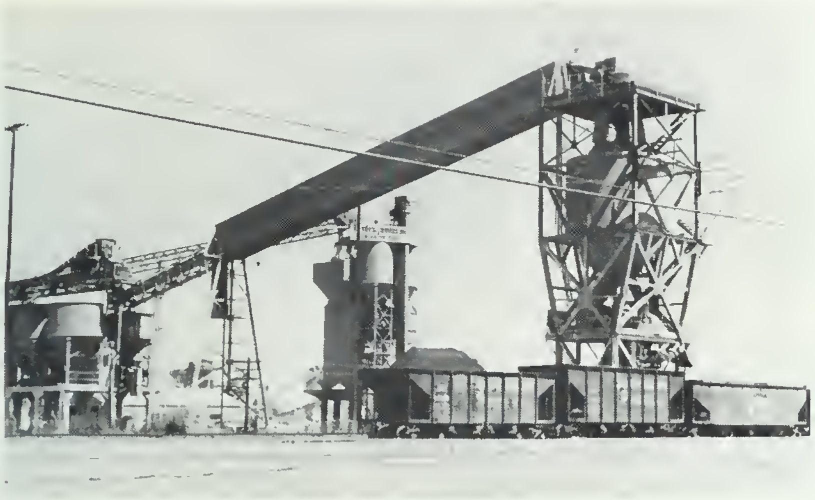


Figure 30 — Visual form follows function

objects involves the visual scene and how man's size (6 feet) relates to the objects involved, for example, a man standing beside a clamshell, or a doorway in a tall building.

Man's general field of view is approximately 30′ up, 45′ down and 65′ to each side. It has also been noted that beyond the distance of 4,500′ physical objects lose structural detail and generally produce a harmonious scene. (Figure 32)

Vision in motion is a most important consideration especially since most sand and gravel sites are located in rural areas and most public observers view the mining operation during highway travel. The stationary observer's eye level is 6′ while the auto traveler's eye is approximately 4′ above road surface.

Spaces between earth and vegetation mounds used in screening and transition zones must be coordinated as to size in relation to the speed of travel. Without proper focal points a negatively blurred scene prompts the observer to look to the horizon line rather than the landscape. If an operation is properly screened, the occupants of a passing car will be able to view little of the operation, yet the view can be an interesting scene during travel.

Natural features *Man-made elements*

Figure 31 — Dominant site features

Objects and Spaces

"The human eye is best oriented to see detail of an object which is located within the distance of its largest dimension (height or width)."[5] This distance should equal the height of the object at approximately 45′ from eye level. The physical height of objects is of primary importance since the viewer shifts his glance up and down more freely than horizontally. The processing plant, if on the same level as the road, will be viewed long before the eye finds the office. The closer one stands to a surge bin, the less possibility that a viewer may notice the trees on either side. As the distance between the person and the object increases, the eye encompasses both horizontal and vertical dimensions. (Figure 33)

Color is usually perceived before we visually determine the shape of objects in view. In this respect color should harmonize with the surrounding land and structure tones to avoid unrelated objects and poor site harmony. Visual

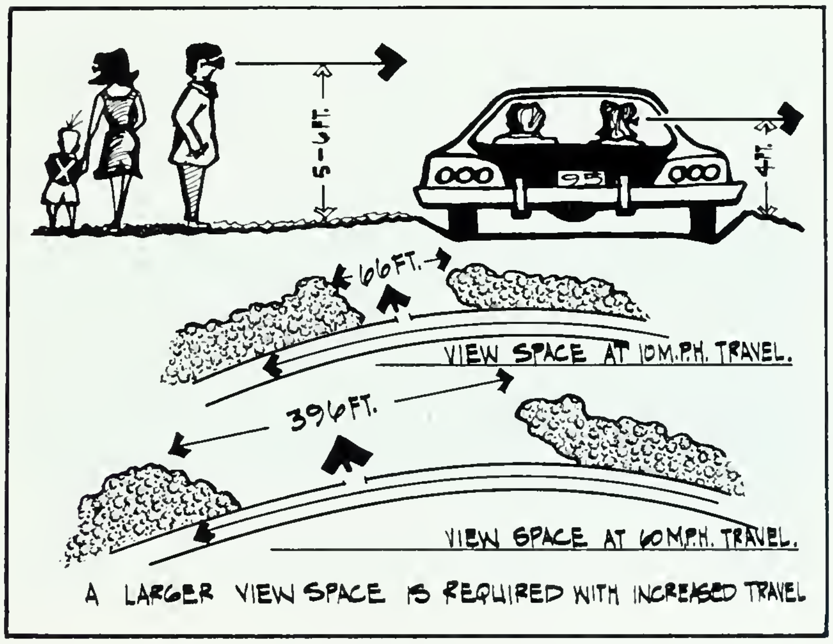


Figure 32 — Vision in motion is a most important consideration

attention is generally attracted to those objects which are simple, easily understood, and many times familiar to the observer through personal training. Objects which are extremely angular are sometimes disturbing. One dominant object usually forms a visual focal point, such as the processing plant, while two objects produce a spatial tension between the objects. Three objects provide the needed third-dimensional volume or space.

Visual Effects

The following sections of this chapter will therefore attempt to identify visual problems and propose alternative solutions to improve the physical appearance of the operating site. The four primary aspects of visual appearance to be considered are: (Figure 34)

1. ORDER—Visual order deals with the visual composition of the total mining site. All forms, spaces, textures, and

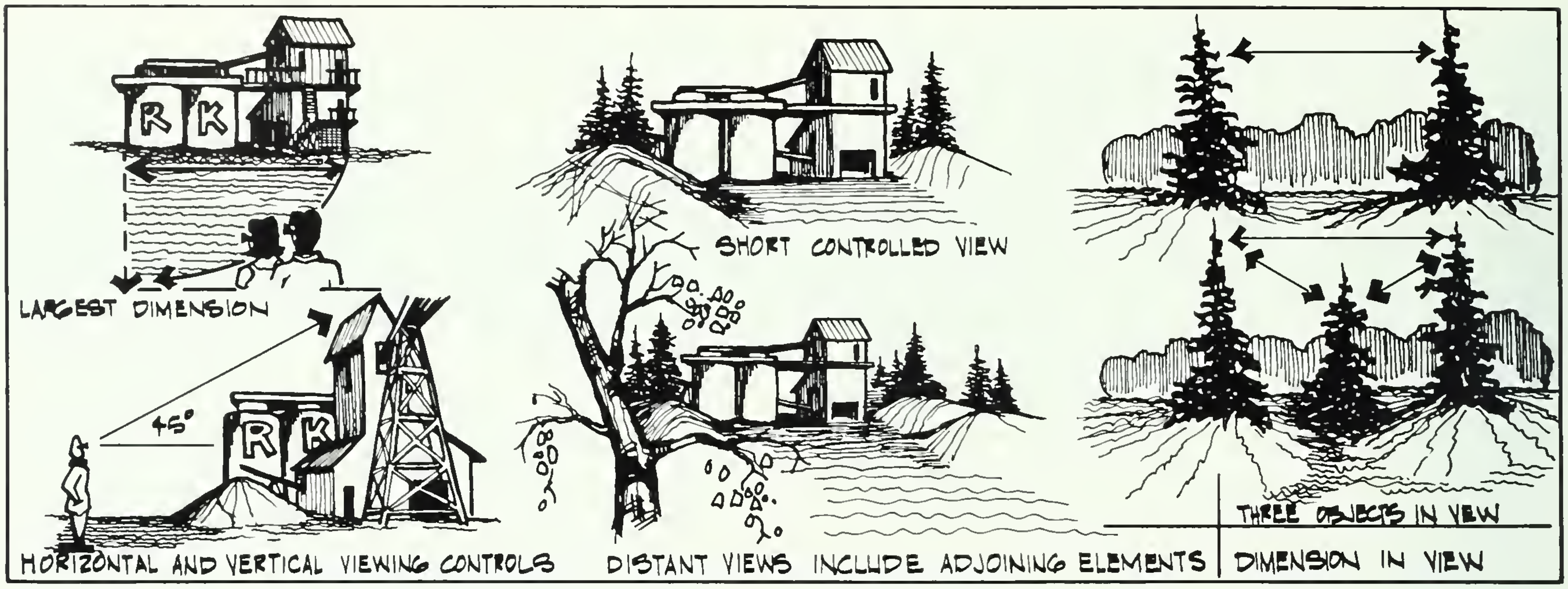


Figure 33 — Visual considerations — views and viewing conditions

Figure 34 — Visual effects — order, compatibility, interest and quality

Figure 35 — Chaotic arrangements of mining equipment

colors must relate to produce a pleasing physical appearance.

2. COMPATIBILITY suggests physical relationships which are appropriate for good views and relate in form and color with the surrounding landscape.

3. INTEREST involves operational objects and mining activities which should be emphasized for public view and includes those objects which attract visual attention.

4. QUALITY will point up the visual importance of the site detail. Detail in this report is a term used to describe objects which directly relate messages of human scale to the public observer. These details appear in places where people work, walk, drive, and also signs which give direction and identification.

The primary objective of this visual analysis is to identify operational elements and natural features for arrangement and composition in producing a desirable visual scene with a positive image.

Part I

Visual Order

All forms of physical objects and spaces make up the total visual image of the operating site. Pleasure in viewing an operation can result from the spectator's understanding of the ordered relationship of the mining site features. Chaotic arrangements with poor physical configurations are confusing to the observer and result in a poor visual image. (Figure 35) A total survey of the surrounding views of the site should determine dominant focal points for the mining operation.

The success in producing a pleasing visual unity of the mining site, depends on how the forms, sizes and colors of the site features are combined into an orderly

ocation — views from public land and ghway travel

Object — form relationships after entry upon the operating site

Definition of structural elements — produces a positive or negative effect

Figure 36 — Important factors which determine visual effectiveness (Image areas 1, 2, and 3)

whole. Important transition areas between objects are major focal points of attention and can produce visual unity.

Three important factors which determine the visual effectiveness of site order might be defined as: (Figure 36)

1. Location and placement of objects within the site in respect to the visual distance from the public observer. Long viewing distances produce large site compositions involving many elements of the operating site.
2. PHYSICAL RELATIONSHIPS of the objects composing the view, which must be related by form and colors. Distance determines the detail of objects seen.
3. DEFINITION conveys the visual message of object detail. Some large elements as the processing plant and excavation pits become dominant elements within view. Elements with unrelated forms and colors are defined by being unrelated or contrasting in physical appearance.

"Our pleasure in the composition of a landscape depends on our appreciation of the ordered relations which exist among its parts. . . . that is, the separate objects in the composition must be either harmonious in color or shape or texture or else harmoniously related one to another by repetition or sequence or balance."[6]

Two types of visual effect are produced by the typical operating sand and gravel site. Site elements appear organized or site features appear disorganized and chaotic. (Figure 37)

1. DISORGANIZATION or view tension is usually produced by unstable forms, uncontrasting colors, unfamiliar elements, and dominating features. The processing plant area is a product of function being composed of many equipment forms, structural shapes and contrasting features. The processing area with its many structural angles produces the visual dominance of the site and can be the most disorganized in view. Unsimilar form relationships surrounding the plant such as vehicle storage areas and equipment forms should be screened from view.
2. FEATURES OF UNITY, such as pit forms, overburden and stockpile forms, suggest a pattern of unified mining activities.

Primary considerations concerning visual order will include relating land use areas with structures and equipment forms.

Principles

Basic forms of order involving the harmonious relationships of natural and man-made objects composing the mining scene include the following arrangements of physical units: (Figure 38)

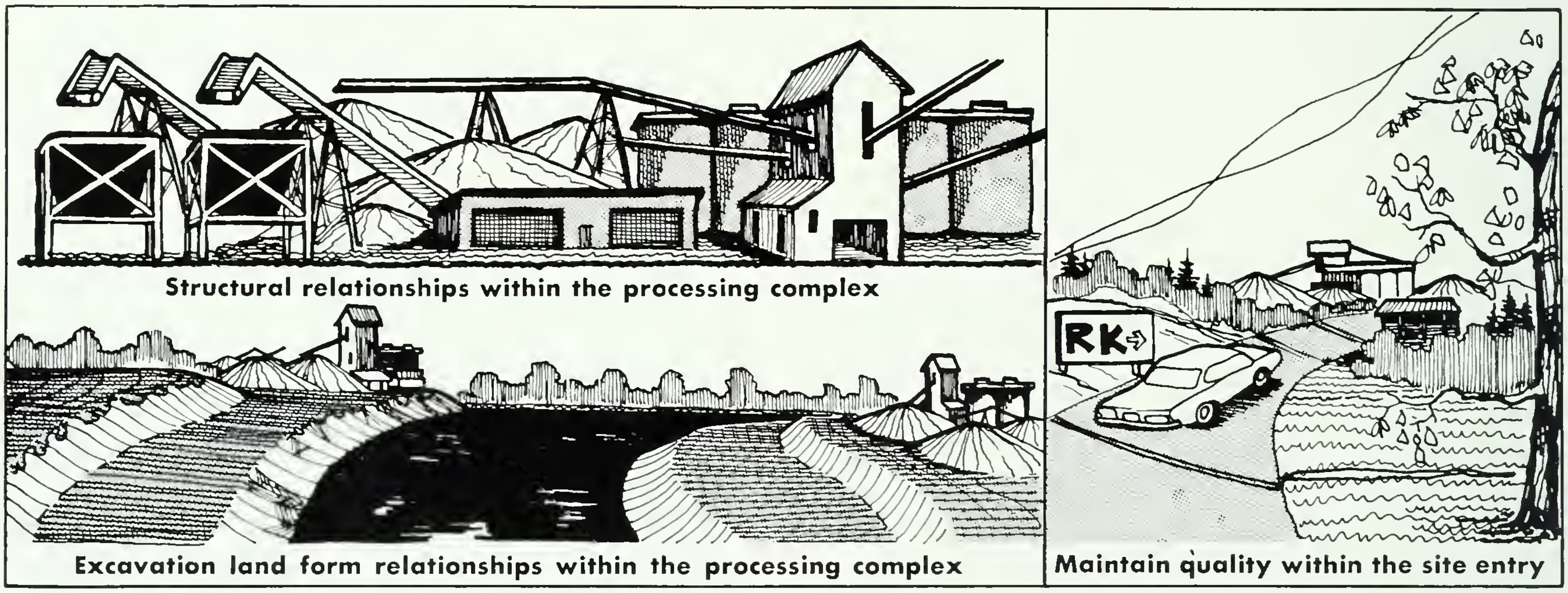
1. BALANCE—The units may be such and so arranged that the attention is directed equally in opposite directions from a vertical axis.
2. SEQUENCE—The units may be so arranged that motion of attention from unit to unit is easiest in a certain direction.
3. REPETITION—The units may be all the same in their interest and consequent ability to attract attention, or at least the same throughout in some characteristics.[7]

The basic forms of order—repetition, balance, and sequence—thus produce the needed visual unity of all parts within the operating site.

Figure 37 — Site elements either appear organized or disorganized (Image areas 1 and 2)

Balance *Sequence* *Repetition*

Figure 38 — Principles of order for visual harmony



Structural relationships within the processing complex

Excavation land form relationships within the processing complex

Maintain quality within the site entry

Figure 39 — Visual unity suggests grouping related site elements (Image area 3)

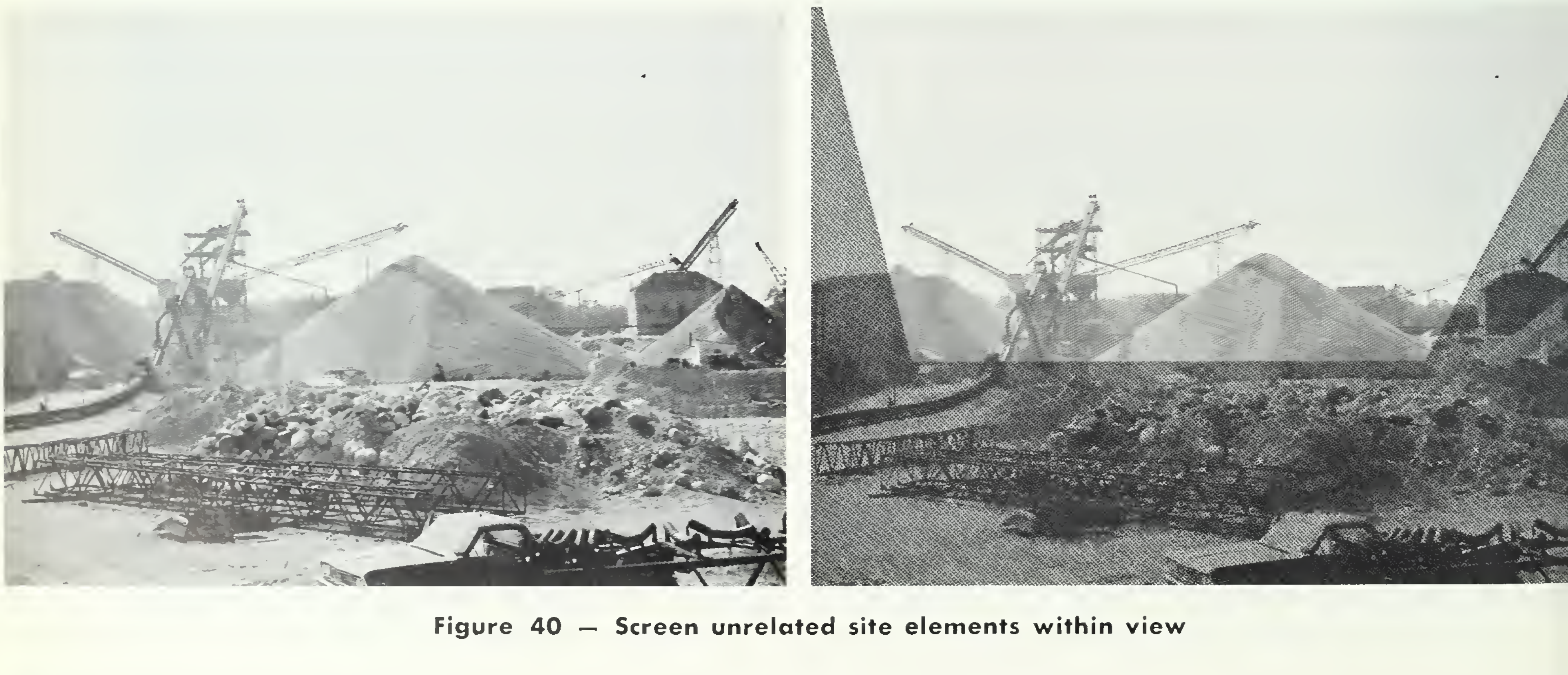
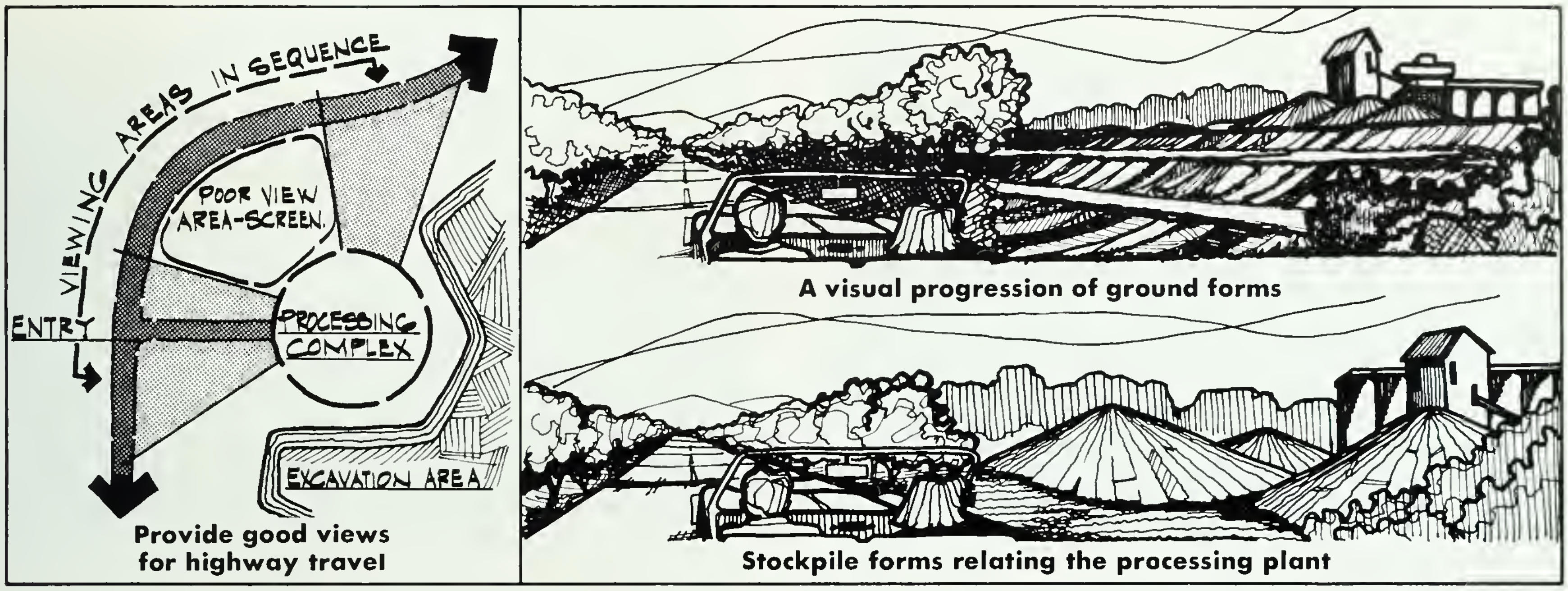


Figure 40 — Screen unrelated site elements within view



Provide good views for highway travel

A visual progression of ground forms

Stockpile forms relating the processing plant

Figure 41 — Visual unity adjoining public travel areas (Image area 1)

Possible Alternatives

Visual unity can best be suggested by grouping site elements which are related in functional use and physical appearance including: (Figure 39)

1. The structural relationships of the processing complex.
2. The physical relationship of the processing complex with the pit excavation land forms.
3. The visual quality of site elements and details contained in the typical site entry.

Physical features which are used to enhance the visual composition are earth forms, vegetation, and structural details.

1. SCREEN VIEWS without meaning or visual importance. (Figure 40)
   a. a dusty vehicle roadway and utility easements
   b. areas of unrelated objects as the maintenance storage areas
   c. areas which depict a poor use—settling ponds, steep cut banks, regimented pit forms, or rail right-of-ways.
2. ENHANCE VIEWS which produce a pleasing mining image.
   a. water bodies, free form slopes, natural grade shore lines
   b. overburden mounds as screens and stockpiles which can accentuate slopes and views.
   c. vegetation cover to define by enclosure—space definition
3. RELATE PHYSICAL OBJECTS by form and function:
   a. The structural relationships of the processing complex—
   Group buildings which are related in form, and the site function they perform. (Figure 41)
   A structural complex (the processing complex) has its own landscape character—which can be enhanced or screened.
   Maximum visual impact is produced by one or more view points upon the complex—lines of approach—as adjoining highways or site entry.
   b. The processing plant and excavation area relationship—
   The tall vertical element such as the processing plant is a dominant focal point which can be enhanced by a progression of ground forms creating visual scale.
   Group the dominant horizontal forms such as a series of stockpile peaks balancing the dominant vertical forms of the processing plant.
   c. Site details—
   Relate the structural detail of a highway view adjoining the operating site—highway paving, signs, fences, and site entry.

Part II

Compatibility

Compatibility deals with the physical appearance of typical objects and land forms spaces which exist together and produce site harmony with the surrounding landscape. We have learned that man experiences visual pleasure by perceiving or understanding the harmonious relationships of objects. This enjoyment by perception or visual understanding produces an experience of beauty.

To attempt a general statement indicating what objects are compatible is quite ambiguous since each site contains its own controls for determining what is appropriate in physical appearance. We will, therefore, attempt to identify typical objects and spaces which have similar characteristics as form and color.

Remembering that "ugliness" is the visual effect produced by a lack of unity among elements and the conflict of one or more unrelated elements; what we are looking for could be termed "FITNESS"—which might be defined as the use of the right form, size, and color for visual compatability. (Figure 42)

Green spaces and buffer zones act as a unifying element or a transition zone improving the industrial site by blending masses of vegetation and ground forms with the surrounding landscape. Earth forms and vegetation masses are always appropriate in site use and are needed to soften and screen hard architectural forms and new cut pit banks. (Figure 43)

The grouping of structures around the processing complex is an important consideration where focal distance requires a defined setback of structural elements to harmonize groups of large structural forms of the processing complex.

Figure 42 — Compatibility — the use of the right form, size and color

Figure 43 — Vegetation masses soften hard architectural forms

The processing plant, raised storage, and loading surge bins are typical structures requiring a large setback and focal distance.

Typical problems involving visual compatibility concern groupings of unrelated structural elements, split composition, many dominant elements, and a poor use of colors in composition. The arrangement of structures within the complex and also the excavation pit forms define land spaces. Defined open spaces as pit forms should illustrate access by man for a use rather than impassable cut banks.

Principles

Design principles to achieve visual harmony include: (Figure 44)

1. CLUSTERING—The grouping of related structures and earth elements as vegetation masses and ground forms.

2. RHYTHMIC COORDINATION—Visual interest and variety is produced by relating differences between groups of objects or natural elements.

Alternatives

Natural elements of soil and vegetation are the dominant unifying features which should define and relate use areas within the site as, movement routes, the structural complex, site boundaries, and the screening of unrelated structural forms.

1. DEFINE LANDSCAPE SPACES by: (Figure 45)
   a. shaped land forms confining open land space should not be choked and cluttered with vegetation masses or storage of mining equipment.
   b. areas defined by structures are important visual spaces, and must exhibit a transition zone between the structures and adjoining land.
2. RELATE similar structural forms and screen contrasting objects:

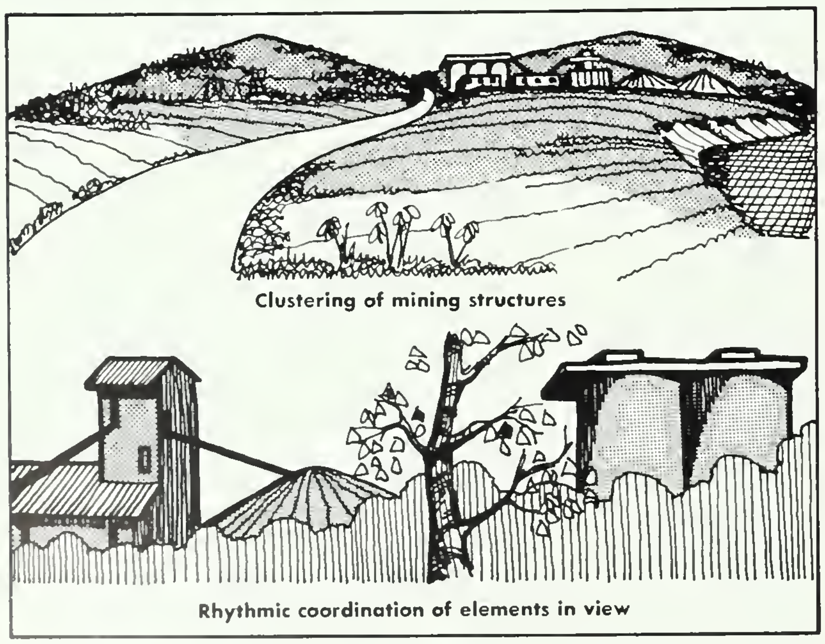
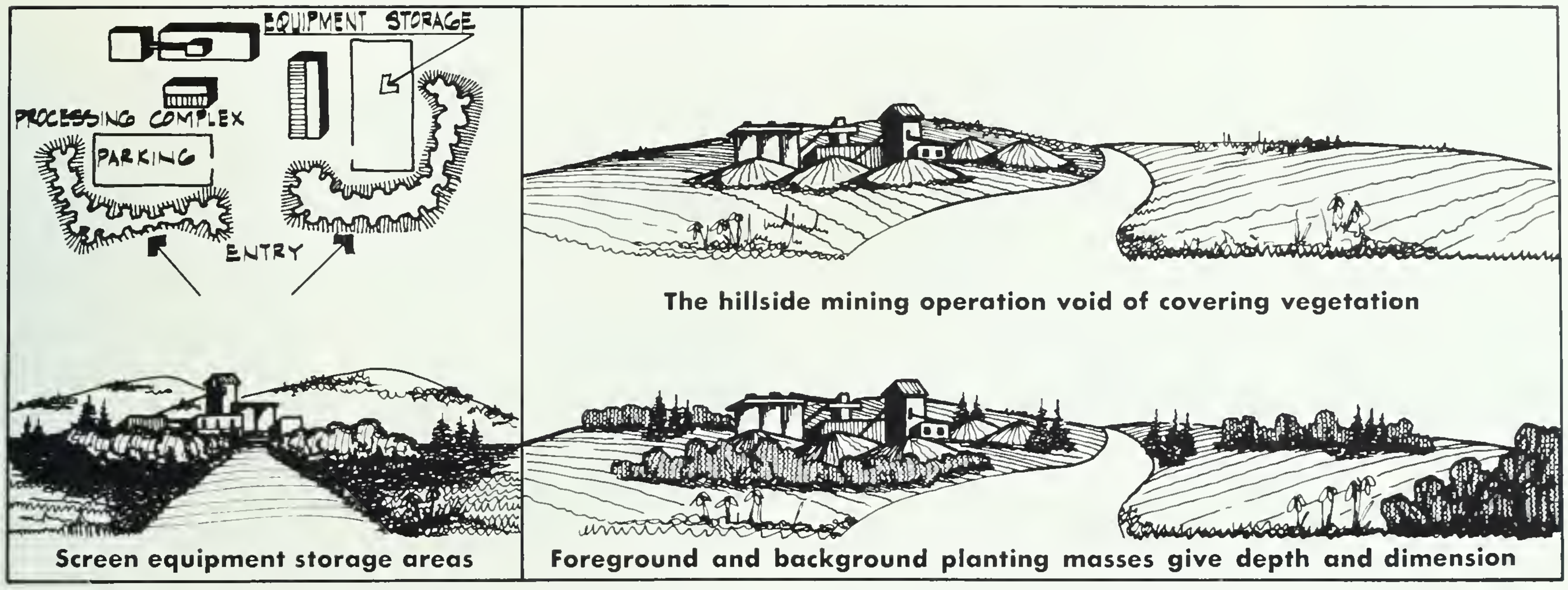


Figure 44 — Principles which influence visual harmony

Figure 45 — The sky line edge and angular lines are dominant focal points



The hillside mining operation void of covering vegetation

Screen equipment storage areas

Foreground and background planting masses give depth and dimension

Figure 46 — Planting considerations for site compatibility

a. if possible group similar structural forms—the skyline edge is a dominant focal point.
b. Structures grouped in rectangles, and cylinders as office buildings, (flat roof edge) and volumetric cylinders (body surge bins.)
c. Structures with angle lines are dominant focal points—angled roof tops—processing plant sloping boom shapes of excavation equipment within equipment storage area.

3. ADJUSTING the foreground and background elements can provide visual screens and exaggerate the visual distance. (Figure 46)

a. the overlapping of closer objects gives the screen depth and dimension.
b. the line of sight at spectator eye level should be accentuated or screened by foreground elements—topographic land forms and vegetation masses. (Two eye levels—6 feet for the stationary observer and approximately 4 feet for the auto traveler.)

4. The major concern with colors is the appropriateness of their use. Color in nature, earth-trees-rock-water, are blended in harmonious tones; color patterns — in this respect color use within the processing structures equipment forms—and earth forms—overburden—stockpiles areas should exhibit harmony in color. "One color will always dominate (for sand and gravel site—natural earth colors) and the remaining colors should synchronize with it."[8] The sand and gravel producer must contemplate how best to implement good color use with the structural forms of the processing complex and also operational equipment types. The following options are important considerations for color use.

a. If all structures within the processing complex exhibit similar color combinations, the complex will produce an ordered effect with continuity among the architectural forms. Likewise equipment colors might exhibit related colors with the processing structures.
b. Mining structures can exhibit colors which blend with the dominant background tones surrounding the structure as:
(1) a low horizon line with dominant blue tones of the structural skyline.
(2) background tones formed by the dense green foliage of evergreen trees or brownish soil tones, etc.
(3) architectural continuity of the processing plant can also be neighbor-related by using similar colors of the surrounding industrial sites.
(4) proper safety colors can code an operating function within the site as to potential safety hazards.

In general, the more intense in tone certain color accents are, the smaller objects may appear in size in relation to the surrounding mined land or structures; for example, if a processing structure is screened and only the top portion is visible—the right intensity of color tone will diminish to a significant degree the remaining visual size.

Part III

Visual Interest

Interest involves the use of good views which focus upon fascinating objects and activities within the mining operation. The concept that every object or mining activity should be blocked from public view is a poor

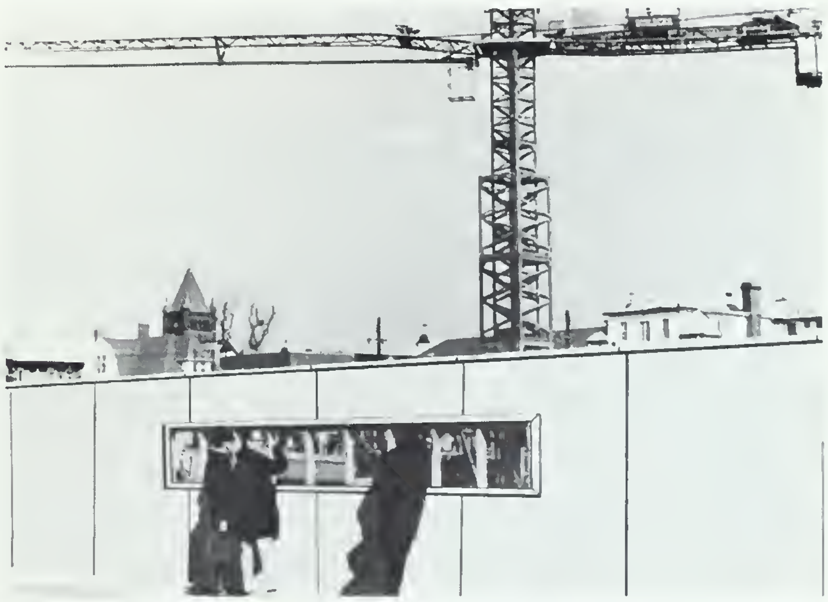


Figure 51 — Public curiosity of construction and development

Figure 52 — Views which are interesting and meaningful to mining

idea, and usually when objects are enclosed, people are most curious to find what is hidden—the sense and act of surprise. (Figure 51) The physical attention produced by objects is of primary importance in any landscape design. In this respect many physical objects found on the operating site possess forms and colors of visual interest. We could say that many of these objects exhibit visual dominance and are descriptive of the mining industry—they are imageable.

Many of the mining activities within the excavation area involve interesting types of equipment forms which are not only dominant in physical appearance but are interesting to observe in action, such as: (Figure 52)

1. The operation of draglines and dredging operations,
2. Gravel falling from a conveyor belt, forming a stockpile,
3. Bulldozers and scrapers molding the ground, and
4. Water spraying out from the desander unit.

These four operating activities are physical aspects of the mining site which in most cases are hidden from public view. These activities are not only fascinating to watch, but educate people to appreciate equipment and its function in aggregate mining.

Within the operating site many dominant land forms and structures exist. The structures of the processing complex could be termed the "main subject" of the total operation. In this respect interest is focused upon "main subjects" or dominant elements surrounded by subordinate objects, like vegetation, earth forms and the skyline, or background elements. (Figure 53)

Important considerations of visual interest involve structural expression and the effect of silhouette.

1. STRUCTURAL EXPRESSION—concerns form and color with special emphasis upon those objects with dynamic shapes as: the processing plant, conveyor systems, surge bin forms, and water bodies in relationship to steep cut banks, the dominant angle of the dragline, large scale equipment and scrapers, and all prominent physical objects which force visual attention.

2. THE EFFECT OF SILHOUETTE—produces the outline of a dominant object seen against the sky, and also in relationship to the surrounding ground forms. (Figure 54) Many times the placement of a public highway or the processing complex can maximize the visual effect of a high vertical structure and produce visual attention at long distances. The effect of silhouettes upon the mining site focuses upon the processing plant (the highest vertical element) and subordinate objects as surge bin structures and buildings within the complex.

Figure 53 — Structural expression (Image area 1)

Figure 54 — The effect of silhouette produces dominant views

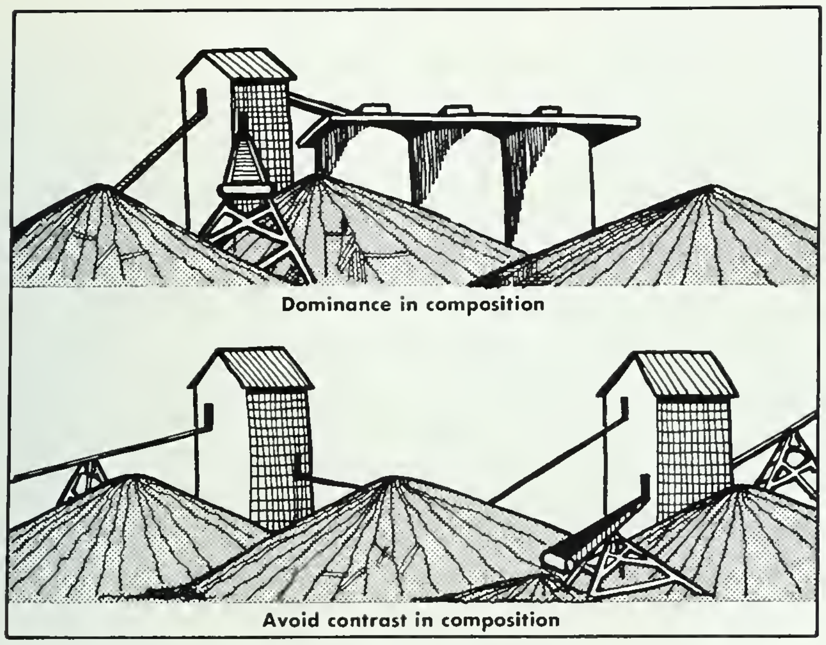


Figure 55 — Principles of interest

Interesting elements are many within the operating site. Basic problems involve the screening or hiding of uninteresting objects and operational activities. Visual emphasis is needed in composition yet more than one dominant focal point in one view is distracting.

Principles

Principles of interest include those of visual order and are interdependent upon each other. (Figure 55)

1. Dominance—order in composition with a dominant focal point or character.
2. Contrast—in view is produced by unequal visual intensity.

Thus visual balance cannot be achieved where unity and dominance have not been considered simultaneously.

Alternative Solutions

Silhouette within the mining site can provide the following visual effects and opportunities:

1. Flat horizontal structures—up to 30′ high can be well sited on elevated ground. In rolling topography these structures can be dominant elements with visual interest.
2. Single elements as the processing plant structure could be defined as an imageable trademark of the industry.
3. Massing of structures can give interesting skyline forms, yet many times conflict in scale demands screen buffers of ground forms.

Operational objects with physical interest concern both natural elements of earth and water and also man-made structures, examples are:

EXCAVATION AREA

1. Volumetric earth mounds with tree mass and overhead cover,
2. Water bodies relating naturalistic land forms,
3. Shore lines, the natural relief of land to water, and
4. High points viewing down into the excavation pit area—water is often most dominant.

PROCESSING AREA

1. The processing plant structure with high vertical rise (120′ average) is most monumental,
2. Dynamic overhead surge bins—large cylinder forms, and
3. The total view of the processing area showing the structural complex: (Dominant elements surrounded by subordinate objects): plant, office, storage, and all structural forms.

Part IV

Visual Quality

Visual quality concerns the total physical effect of the mining site with special emphasis upon details that characterize the sand and gravel industry; for example, visual accent produced by the site entry with focal interests of details used in conjunction with each other giving identity to this function. (Figure 57)

Figure 56 — Commanding viewpoints of the excavation area offer spectator interest (Image areas 1, 2 and 3)

Figure 57 — Site entry accentuates physical elements which identify the sand and gravel industry

Figure 58 — The site appearance with a visual sense of meaning must be considered during day, night and season

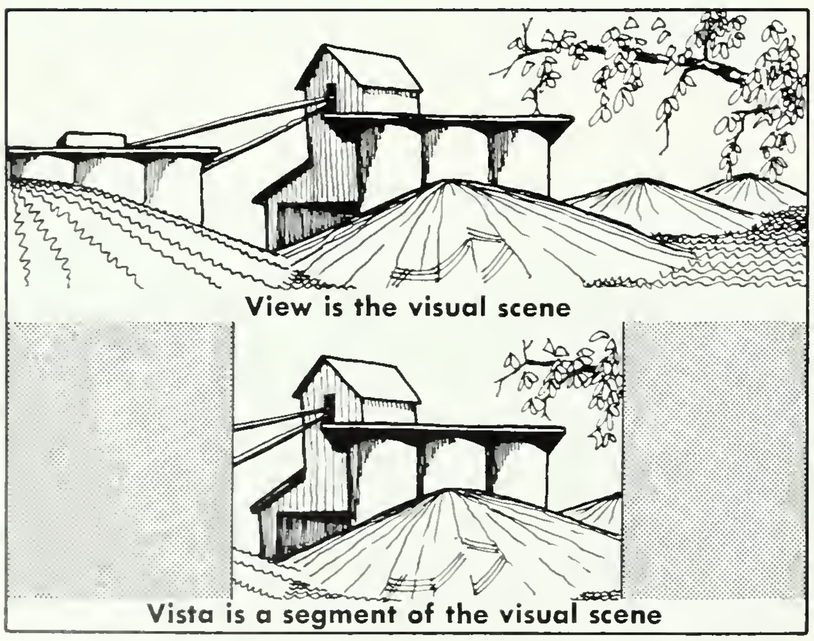


Figure 59 —

Figure 60 — Making a visual survey of the operating site concerns viewpoints of the public spectator

Close location relationships minimize public safety hazards and maxamize public relations

Viewing areas can be educational points of interest for the public spectator

Figure 61 — Provide public areas which create a public understanding of sand and gravel mining (Image area 3)

Upon examining the typical site forms and structural compositions of the processing and excavation areas, basic physical forms are resultant products of functional processes of the mining activity. One of the visual delights which provides quality in view is the sense of orientation provided by the high vertical elements of the plant structure. One is constantly aware of his placement around the site by this dominant feature.

The observer seeks to find meaning in what he sees and detailed objects which are in close proximity to the observer should give the site a sense of meaning. (Figure 58) This meaning emphasizes the use of the area—sand and gravel production.

One major consideration of every site operation should be the exploration of uses of roadside viewpoints. This would be an area of walls, fences, signs, and buffer vegetation masses.

A view can be defined as a scene observed, while a vista generally involves a segment of a view. In this respect a view of a dominant and interesting site feature (structure or land form) should be developed so that the related use areas harmonize and give visual quality to the operating site.

The interesting focal points can be emphasized by arranging objects so that attention will be attracted to the objects of quality.

The principles involved concern enframement or creating a vista. (Figure 59) The vista poses three major planes of enframement—the vertical planes as structures; the base planes as water, road surfacing and flat or sloping topography; and the overhead plane, as tree foliage, sky, and structural forms.

"If a landscape composition is to tell one unified thing it must be segregated from the things on each side of it."[9] This can be defined as the terminus of a view. This terminal feature as (a plant structure) sets the theme and quality of the scene. A well-proportioned vista exhibits good use in balance and rhythm.

Possible Opportunities

After the visual survey surrounding the mining site, prominent objects as the plant structure and pit forms offer interesting views. (Figure 60)

1. structure (strong vertical elements approximately 120′ high).
2. the form and texture of repetitious stockpile areas.
3. The slope and color (round objects—with triangle slopes) produced by the steel structural forms of the conveyor systems in composition with the round forms of elevated storage surge bins.
4. the color and texture of overburden mounds against surrounding vegetation and earth colors.

The use of roadside view points is one major consideration of every site that should be explored. This would be an area of detail; walls, fences, signs, and buffer vegetation masses. Turn-off parking areas within the site boundaries can be provided to educate the public with interesting data as presenting production rates and reuse developments of the mining site after operations. (Figure 61)

1. fence placement in relation to roadway—eye line
2. roadside viewpoint of excavation area

Signs must be used for something more than giving directions and promoting sales. This detail concerns equipment and structures. Three general types of signs are: (Figure 62)

1. instruction types
   a. prohibitory
   b. mandatory
2. information signs—site title operation
3. warning signs—highway and equipment

Signs should be as few as possible, and easily recognizable and placed in good harmony to surroundings. If possible, signs should be mounted together in harmony with shapes and colors. Sand and gravel mining is a bulk

Figure 62 — Quality of sign use influences public attitudes

commodity industry, and the lettering should represent this bold character.

TOTAL SITE QUALITY—should reflect physical forms which relate in form and color, with emphasis upon water forms, high vertical structures, raised surge bins over rail right-of-ways, and the screening effect produced by stockpiles to mask unrelated objects.

Summary

Physical forms must follow function — and the total site structure must convey visual meaning and use to the public. Simplicity in relationships of colors and shapes (natural and man-made objects) is a primary goal to exhibit the needed "good visual image."

The visual composition for the public should convey the meaning and importance of sand and gravel mining. Water bodies are of prime importance to man and are many times produced in the landscape as a result of mining. This is an example of how a natural resource can be extracted and replaced by a much desired water resource for future public use.

Alternative situations must incorporate land organization, grading techniques, planting masses, and quality site details to affect principles of visual order. Physical objects and activities for total effect must consider location, physical relationships, and visual definition.

Important Considerations

Basic steps to improve the physical appearance of the mining site include:

1. The need to explore and survey all areas of public view surrounding the site—highways, rail, and surrounding populated residential or commercial land use areas.
2. Assign priorities to dominant views of the site for highway observers and surrounding landowners.
3. Emphasize good views through masking distracting features to achieve focus or vista upon the site.
4. Harmonize colors, forms and textures in composition with one dominant terminus to each view.
5. Encourage public understanding of the mining operation by providing views of the mining activity.
6. Implement elements as trees and simple forms to which the observer can relate for scale of objects and understanding.

FOOTNOTES
CHAPTER III

[4]Gyrogry Kepes, *The Visual Field*, p. 29.

[5]Messrs., Hegeman and Peets, "Civil Art," (Simonds, p. 189)

[6]M. V. Hubbard and T. Kimball, *Landscape Design*, (Boston: Hubbard Educational Trust, 1959) revised edition, 1917, p. 80.

[7]Ibid., page 93.

[8]H. Bopst, p. 15. *Color and Personality*

[9]Hubbard, p. 126.

Figure 62-A — All instruction, warning and information signs are imageable of site operations

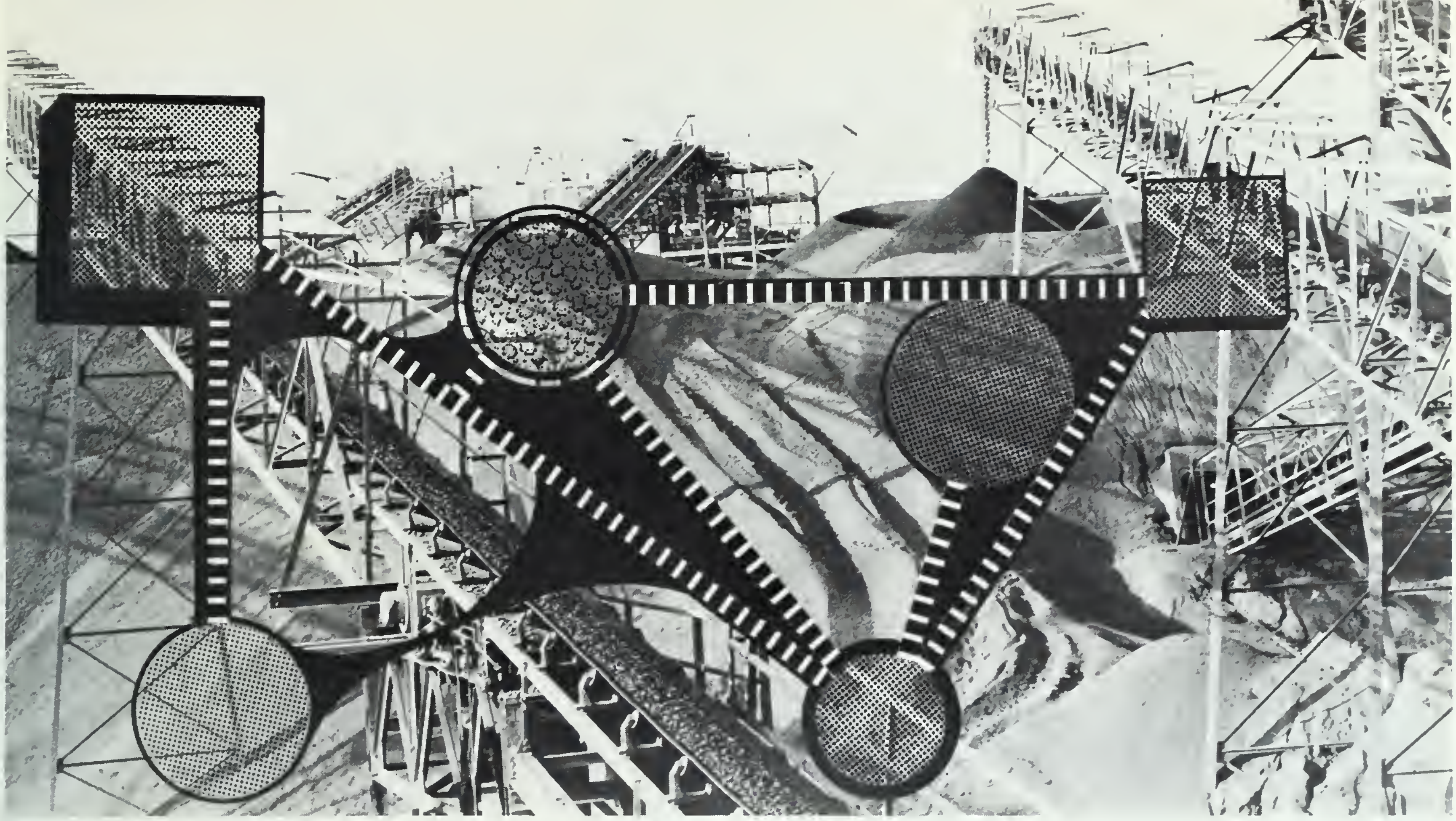


Figure 63 — Movement and nodes

Chapter IV

Site Planning Proposals

Site planning deals with the total organization of objects upon the land for man's optimum use. This organization concerns the physical manipulation and location of both natural and man-made features. Both functional and visual needs must be considered and balanced to produce a mining operation which is efficient and compatible with the surrounding landscape and its people.

This is a special type of site planning, with emphasis upon making the mining operation physically adaptable to the surrounding public. Each site must be considered in terms of its operating activities and also its physical appearance which together communicate the mining image. Operational patterns act as design controls with primary importance. Visual factors involve the total physical appearance of the site, with important emphasis upon areas of dominant views into the site and areas which should be screened from view.

Important criteria concerning the visual success of any site include the spatial definition produced by objects and land and the visual orientation of structures and earth forms in relationship to the surrounding public.

Site Planning Elements

Major elements concerning the operating site must not only be considered as single units but also as to their relationship with various functions of the total operation. These elements can be grouped into natural and operational factors.

TYPICAL NATURAL ELEMENTS include ground forms, drainage area, water bodies, vegetation types, and subsurface conditions such as overburden depth, deposit

Figure 64 — Tree vegetation is an important asset to the operating site and surrounding landscape

formation, waste aggregate material, and the ground water table.

TYPICAL OPERATIONAL ELEMENTS include the excavation pit formations with cut banks and water bodies, types and patterns of movement systems, and the physical formation of structures and stockpile storage areas within the processing complex.

Site Planning Procedures

Before any site decisions can be finalized, it is an optimum situation if the plant engineer, a geologist, and a landscape architect can work together surveying all surface and subsurface features within the site.

Upon analyzing the survey data, functional considerations focus upon the working relationships between deposit and overburden ratio, the pit excavation area related to the processing complex, and the movement system relating the total operating process.

To implement a well-organized operation with good public access, all of the above-elements must be considered with special emphasis upon the natural characteristics. Design decisions for the site result by: (a) stating the major objective or site problem to make the operating site physically and visually more compatible with the surrounding public and (b) considering the above-site elements and operational activities in their order of importance. Finally, the important elements and activity linkages as — excavation, processing, stockpile area, and equipment storage with circulation patterns are synthesized into a total functional and aesthetical site organization.

The remainder of this chapter will deal with three primary site planning considerations appropriate to the typical mining site. Both functional and visual aspects of each topic area will form basic design criteria and concepts for image areas 1, 2 and 3 and suggest alternative design possibilities.

1. USE ORGANIZATION — concerning primary relationships of structures and land forms, with emphasis upon excavation, processing, and transportation relationships.
2. LAND FORM DESIGN — will point up basic grading criteria with emphasis upon the functional and visual aspects of berms, cut banks, and stockpiles areas.
3. PLANTING ARRANGEMENTS — will concern screening techniques and spatial definition of land areas for optimum visual effect.

Part I

Use Organization

In general, those operating sites which have least disturbed existing tree masses, ground forms, and natural drainage patterns exhibit a high degree of site harmony with the surrounding landscape. To a large extent, surface mining does require maximum amounts of earthmoving with land forming activities, yet special attention should be given to the preservation of dominant tree masses and drainage areas whenever possible. The site operator can easily adapt necessary earth moving equipment to quickly reshape harmonious land forms, yet it often takes a 20 year time period to cultivate and replace a mature stand of trees or a wooded valley. (Figure 64)

Characteristics and requirements for location which influence the total arrangements of objects and activities within the operating site are:

1. FUNCTIONAL LOCATION — maximize the total site operating efficiency — excavation, processing, and transportation systems.
2. VISUAL LOCATION — minimize public annoyance problems to improve the industrial image. Improve the physical appearance and reduce unnecessary operational effects — noise, dust, and safety hazards.
3. NATURAL CONTROLS — A. The deposit formation influences possible areas of excavation.
B. Surface elements as tree masses, drainage areas, water bodies, streams, and marshes should be retained if possible.
C. Dominant earth forms which effect construction costs for transportation purposes (bridges and major cut areas for access).

Of the above-location control factors, each must be examined with equal importance and the resultant location of operational objects and activities must be a compromise between the practical and aesthetic needs of the mining site and the public.

Typical location conflicts which most often burden the total site operation include the following:

1. Due to improper pre-planning, areas for the depositing of fill and overburden material have not been allocated, thus the relocation of rough material results in a costly repeated hauling movement.
2. Improper setback standards concerning the processing plant, storage areas, and pit excavation which may reveal poor public views for long periods of operation.
3. Incompatible land forms which are located to maximize operation efficiency, yet ignore the surrounding public. (Steep cut banks, settling ponds, etc.)

Figure 65 — The priority movement path for truck transport (Image area 3)

Figure 66 — Locate the processing plant to separate and screen unpleasing elements of the mining operation (Image areas 1, 2, and 3)

Figure 67 — Man-made land forms involving gigantic amounts of cut and fill

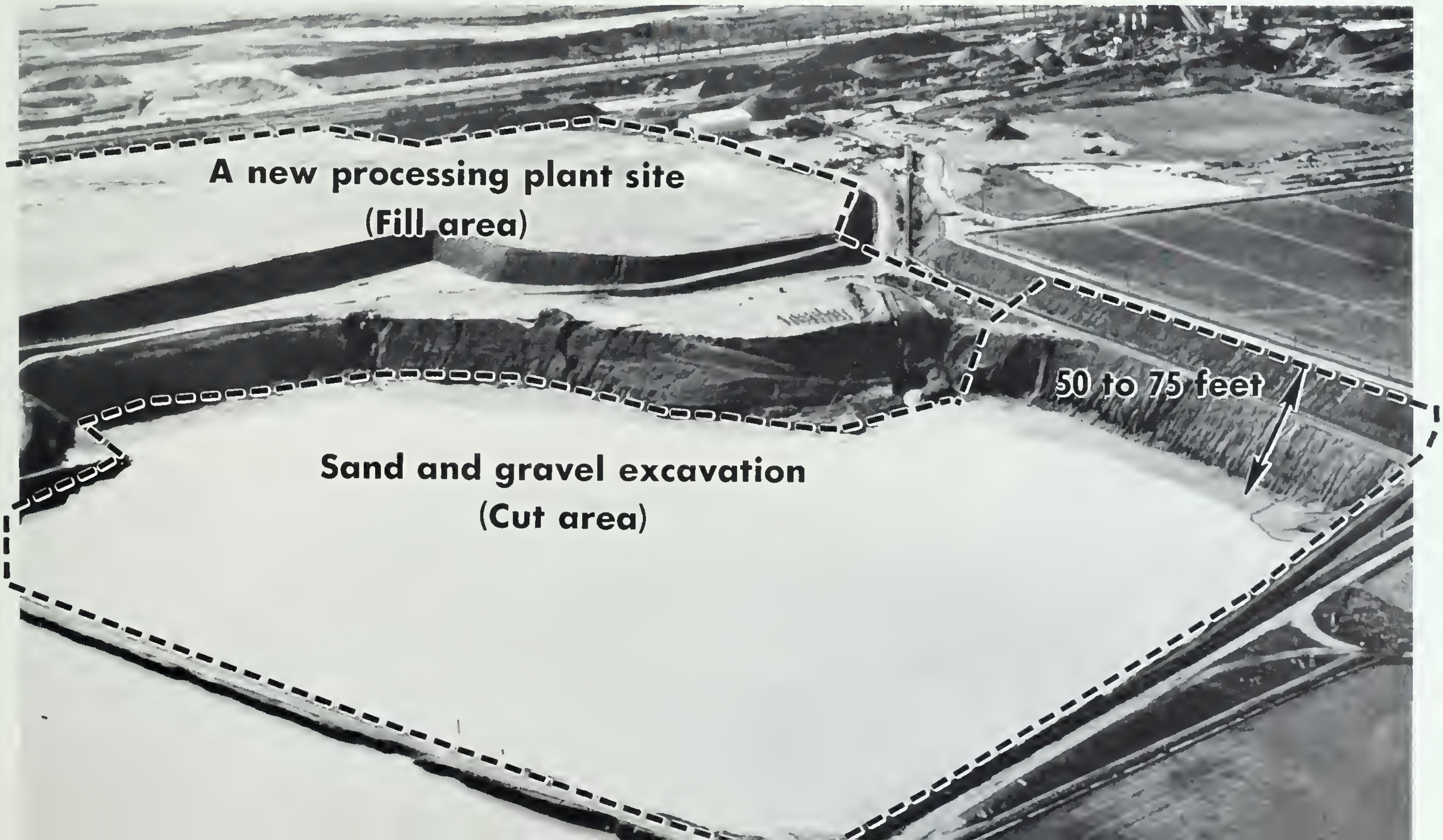
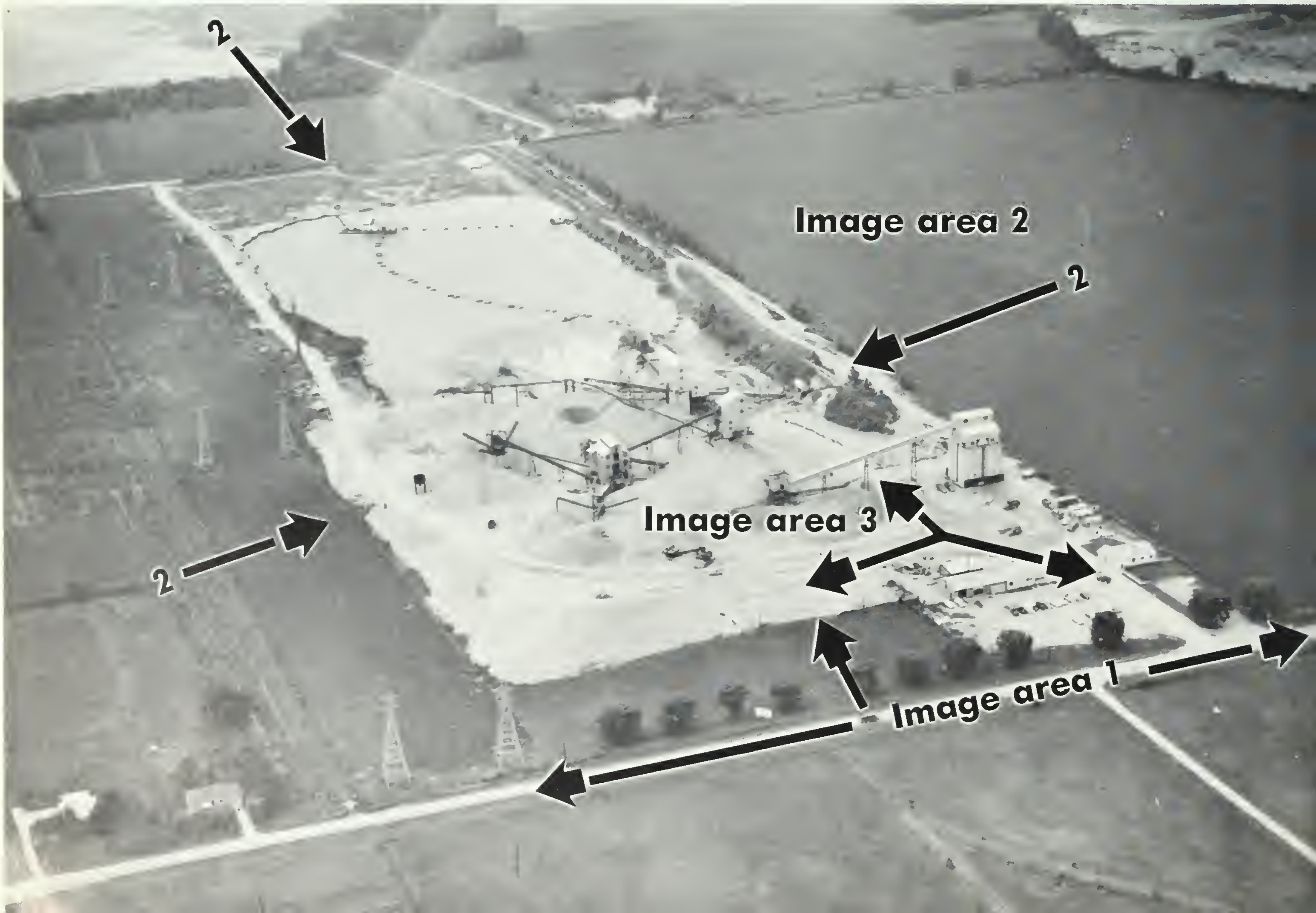
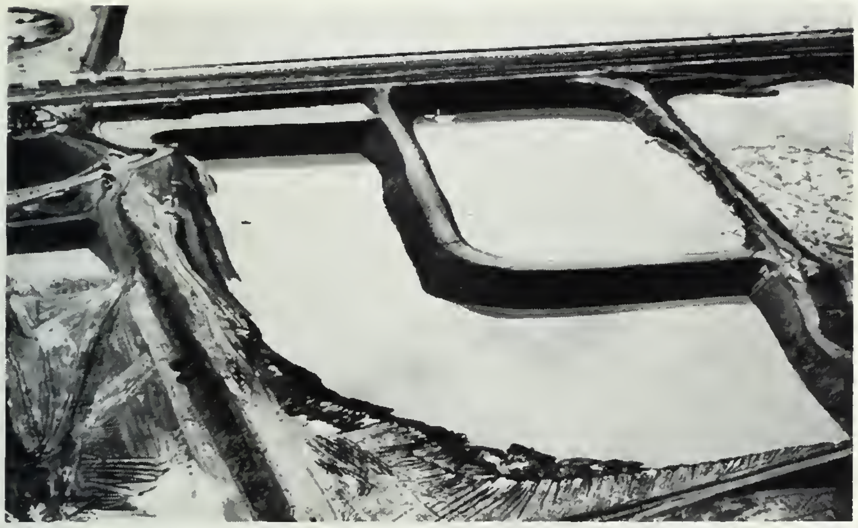


Figure 68 — Multipurpose land forms — stockpile forms provide effective screens for views upon the processing plant (Image areas 1, 2 and 3)

Figure 69 — Visual order and site organization provide operational compatibility of all image areas by proper placing of vegetation cover and land form screens





Visual character exhibits little or no public after-use of land

Figure 70 — Provide waterway dikes and access roads which are conducive to a public after-use of the land

Site Planning Potentials

Principles influencing the location of objects concern two basic factors: the site and the uses imposed upon the site. The following information concerns typical situations involving the location of structures, pit forms, and major operational activities. Both functional and visual aspects are controlling factors.

Basic principles of site organization must consider the following three control limits:

1. SIMPLICITY — coordinates ease of movement systems and operational patterns and also combines simple but good visual controls upon the operation.
2. PROXIMITY — maximizes operational movement with good access yet implements proper transition zones for public safety; and
3. ADAPTABILITY — man-made land features can aid in restoring site harmony with the surrounding landscape.

Alternatives

1. THE EXCAVATION AND PROCESSING AREA RELATIONSHIPS. The Processing Pick-up Pattern, which stimulates the highest intensity of vehicle flow within the operating site, should exhibit a planned sequence in vehicle movement relating vehicle types to site destinations. To provide these frictionless movement paths with maximum site access, each vehicle type (transport truck, automobile, and rail) must be organized as to priority of access within the operations area.

The following considerations provide a checklist to implement this priority of truck movement within the processing complex:

a. Vehicles must be able to circulate within a few feet of the dispatch weight station and the stockpile surge bin structures.

b. Establish a one-way movement pattern with minimum intersections. Minimum turning radius of 35 feet should provide ease of vehicle manipulation.

c. Allow maximum visual control to clarify site destinations.

d. Provide parking space after loading to facilitate load check and excess water release from truck-bed. All other parking areas as the vehicle maintenance and auto parking zones should locate off this flow path. (Figure 65)

e. Automobile considerations — Auto traffic should be separated from truck-transport routes after site entry and should be directed to an off route parking zone, preferably near the office area. This parking area should be removed from other operational movement types and facilitate a safe pedestrian path to the office area.

2. PRIMARY VISUAL ASPECTS

a. Typical compositions of the processing plant complex related to the pit excavation area: Structural dominance — the tall vertical plant; the contrasting angles of conveyors; the volumetric round surge bin forms. (Figure 66)

b. Practical considerations. Necessary setback requirements to form a visual transition zone — for screens or view. (Image areas 1, 2 and 3). The pit excavation adjoining major highways and public land. Locate the processing plant to separate unpleasing elements as: settling ponds, equipment storage, and transition zones to reduce the emission of dust and noise from roads and plant area.

3. SECONDARY SITE FUNCTIONS

a. The phasing of the site operation areas of excavation and overburden, for fill material in pit areas, and material for the construction of mounds and berms.

b. Phasing the site operation for vegetation planting and to resoil cut banks and water body shore lines. (Image areas 1, 2 and 3).

c. Point up areas for future expansion: Locations for future roads and structures and desired pit forms in the excavation area. (Image areas 1, 2 and 3).

Part II

Land Form Design

Within the boundaries of the mining site, many prominent man-made land forms result through the excavation and processing of sand and gravel. (Figure 67). In this respect two major natural elements are involved — soil and water. Important natural functions must be analyzed to insure proper design techniques. The following indicate primary areas of investigation before any land manipulation:

Figure 71 — The natural regeneration of vegetation provides good soil cover yet lacks visual composure.

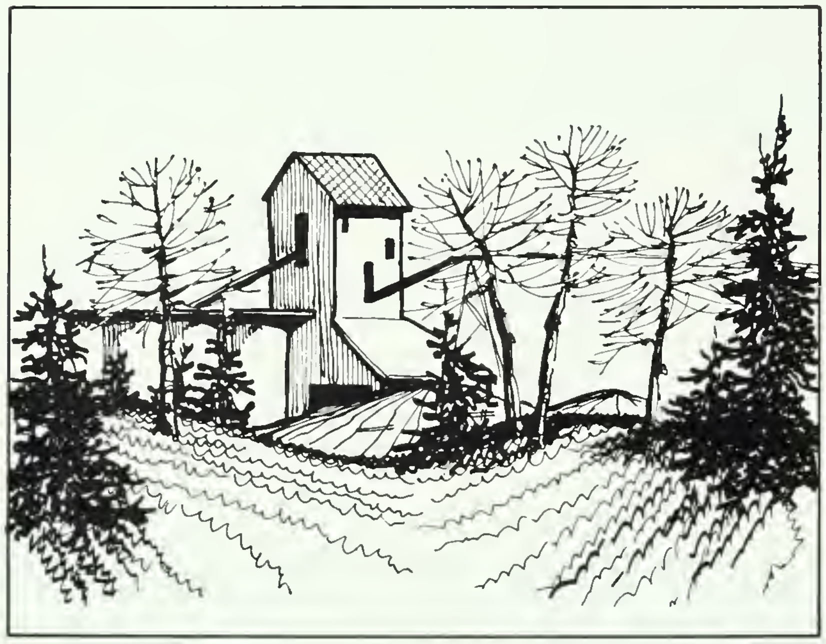


Figure 72 — Evergreen planting for winter seasons

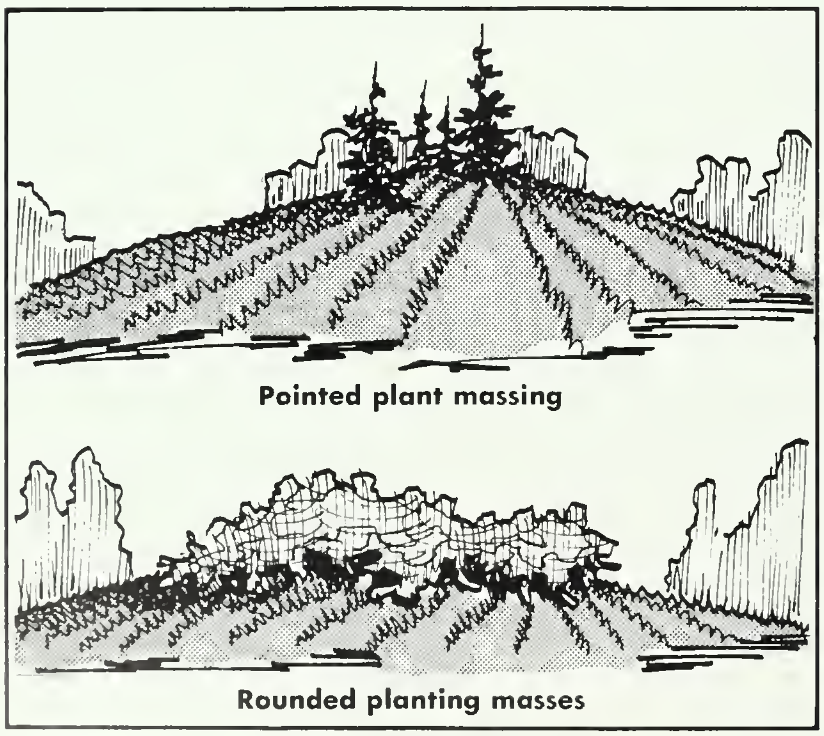


Figure 73 — The visual accentuation of groundforms suggests the plant material form

1. Natural functions of the land — the relationships of soil, atmosphere, water, and vegetative growth; (to determine how much soil erosion will take place).
2. Important surface and subsurface characteristics as: the water table, soil bearing capacity, angle of repose of soil types, and soil permeability with special emphasis upon natural drainage patterns.

Land forms can be considered as a primary by-product of the excavation and processing function. Existing conditions which influence the physical appearance and also the volumetric form of ground shapes include the following factors:

1. The initial amounts of overburden and usable soil.
2. Good equipment access to construct desired earth forms.
3. Adequate storage space for covering materials as top soil and vegetation.

Generally two important land form types exist after the excavation and processing of sand and gravel:

1. Cut forms result from the excavation process, including cut banks, dikes, shore lines, and islands.
2. Fill forms involve new land areas produced through the excavation process as: overburden stockpiles, sand and gravel stockpiles, terrace fills within the pit form, and waste sand deposits.

The most important objective of this section involves the production of harmonious land forms which reflect a landscape for man's use. Important considerations involve the visual and functional implementation in land form design by:

1. The importance of pre-phasing excavation operations to minimize earth moving costs.
2. The "multipurpose potentials" of land form features for screening poor views and reducing the transmission of dust and noise. (Figure 68)

The problems which are most obvious to the surrounding public concern those land forms which exhibit no future use, i.e., unusable landscapes. Most typical situations involve:

1. Poor visual character of unrelated forms and contrasting sub-soil color.
2. Soil types which are sterile to natural vegetation growth and maximize rehabilitation costs.
3. Unstable land forms which produce safety hazards and contribute to water and wind erosion.

Potential

Site planning considerations concerning the design of land form types and the existing topography suggests the control of development for visual landscape character of the site.

If the change in grade is sufficient, a significant land form can provide a sound and visual barrier against operating effects.

A change in ground levels is an important factor in creating a landscape space — which can achieve physical barrier for legal purposes; site boundary definition, prevention of trespass for public safety, and visual purposes; and to provide enclosure, define land use areas, and provide a pleasing visual character in harmony with the surrounding landscape. Controls which influence simultaneous land form construction with operations are:

1. The functional efficiency of land form construction during mining operations.
2. The important economic factor concerning initial construction costs and maintenance costs.
3. The re-use adaptability of land forms upon completion of site operations.

Alternatives

Ground forming with various soil types is still man's cheapest type of construction. Important questions concerning phasing excavation operations are: How much ground forming material do we have, and what do we want to do where?

After the decision has been made concerning potential after-use of the site, important land form controls can be assigned to develop active use areas and passive scenic areas.

Careful analysis of overburden material must be phased with the extraction process to prevent more than one movement of overburden material. Example — (the total excavation phasing and land forming development for visual effect).

Use of land form slopes and buffer screens — can achieve:

1. SITE BOUNDARY DEFINITION — to prevent dust, noise, and poor views.
   a. Berms which produce visual space rather than linear barriers.
   b. Berms in relationship to highways and waterbodies. (Image areas 1 and 2). (Figure 69)
2. SAND AND GRAVEL STOCKPILE ARRANGEMENTS within the processing complex. Angle of repose is an important factor. Avoid repetitious stockpile heights to avoid visual monotony. Screens for plant structures, rail car parking, and equipment storage area. (Image area 3). (See Figure 46)
3. THE FORMATION OF CUT BANKS.
   a. Terracing fills within the pit area.
   b. Visual enclosure with earth mounds for special definition.
   c. Water way dikes and access roads which are conducive to a public afteruse as recreation. (Figure 70)

DESIRABLE SLOPES FOR PUBLIC USE

Slope Use	Slope	Desirable Grade
Private	5 - 20%	1 - 12%
Parking Areas	5 - 8%	1 - 5%
Grassed Swales	1 - 15%	1 - 10%
Grassed Banks (Maintained)	6:1 - 2:1	6:1 - 3:1
Planted Banks	5:1 - 1:1	5:1 - 2:1

Figure 74 — Dominant focal points of structures can be softened and masked with transition planting

Figure 75 — Both land form design and planting arrangements provide needed transition screens for the operating site

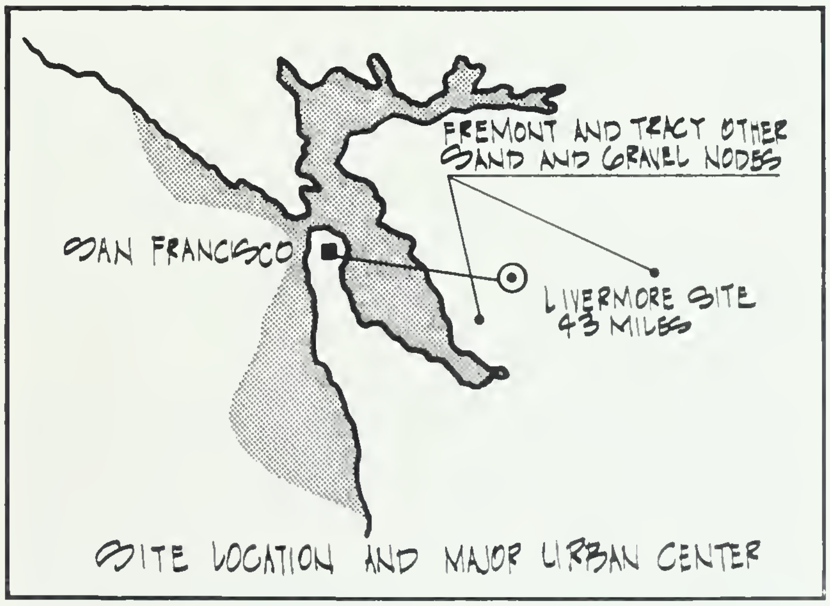


Figure 76 — Regional site location

Part III

Planting Arrangements

Site conditions as climate and seasons vary with geographic location and should influence the use and selection of plant materials. Before outlining suggested criteria in planting design, it is helpful to note that most areas within the mining site that have been stripped of vegetation will regenerate with new plants. Many times those new plants are called "weeds" (Figure 71), but, with time, natural vegetation will cover the ground surface. A typical problem concerning most sand and gravel sites is the lack of vegetation to stabilize harsh new land forms. The timing and growth period is an important control which limits planting use until final land forms exist. Important consideration should be given to implement planting procedures as a first priority of site development during and after excavation. Those areas within the site which will remain as transition zones adjoining neighboring land and highways should be given special attention to provide the 5 to 20 year operation with needed screens and planting masses.

For purposes of this section, "planting arrangements" will primarily concern producing a positive visual effect through vegetative transition zones. These planting areas will also consider the reduction of primary functional annoyances produced during operations by screening and filtering the emittance of noise and dust.

Basically plant materials include trees, shrubs, and ground covers which are selected to grow under natural conditions without constant pruning and maintenance. Special emphasis should be given to the preservation of existing tree and shrub masses. The choice of tree and shrub material should not only be hardy to the area growth zones, but should play a dominant role in the site design.

Planting Principals

Planting design like all other aspects of site planning must satisfy visual order, involving color and form, with balance and visual emphasis. Planting masses within the site must be expressive of the land use function and not convey an artificial physical appearance. Native plants are best adaptable to give visual harmony and alleviate the effect of cultivated artificiality. These plants must be hardy in growth to give fast screening effects yet require minimum maintenance.

A. PLANTING SUGGESTIONS

The following planting suggestions deal with typical site features most dominant upon the operating sand and gravel site. Both visual and functional aspects of site operations must be considered in planting design.

NOTE: Topics such as: schematics of planting design, plant growth habits, site design patterns and planting procedures have been expertly treated in the NSGA report "Site Utilization and Rehabilitation Practices for Sand and Gravel Operations" by Kenneth Schellie and D. A. Rogier.

1. PLANTING FOR VISUAL EFFECT
   a. Form and size relationships
   b. Visual definition by foliage color and texture.
   c. Planting considerations for seasonal effect.
   d. Planting relationships to ground forms, waterbodies, site structures and highways.
2. PLANTING TO REDUCE PUBLIC ANNOYANCE PROBLEMS
   a. Planting for enclosure.
   b. Buffer screens and buffer zones.
   c. Suggested planting filters for dust and noise.
   d. To control public access upon operational hazardous zones.

Planting for Visual Effect

A. FORM AND SIZE

Plant materials are extremely variable in size and form possibilities, however general types of plant materials can be grouped into basic sizes and physical forms. The size range includes:

1. Ground cover plants up to 3 feet.
2. Evergreen and deciduous shrubs from 3 to 15 feet.
3. Small flowering trees vary from 10 to 30 feet.
4. Large evergreen trees from 15 to 50 feet.
5. Large deciduous canopy trees range to 100 feet vertical height.

Basic form variations can be grouped into three general types: round globe forms, rigid pyramidal cone forms, and vertical columnar forms.

Size and form are important to visual composition because they influence the relative proportion and scale of objects and spaces in view; for example, a small plant in relationship to a large object will many times enlarge or distort the scale of the object in view. Columnar trees encourage visual dominance within long distant views and tend to produce a dwarfing in scale of surrounding objects.

B. DEFINITION BY COLOR AND TEXTURE

In general, the sand and gravel producer should be concerned with making his site planting arrangements look like undisturbed nature. Summer foliage colors offer a wide range of greens for use, however the surrounding natural trees and shrubs suggest the appropriate use of color selection. Areas within the operating site which may be subject to accumulations of dust can be in harmony with the grey-greens in foliage color as with the Russian Olive tree. Foliage colors of dark green give visual weight and strong outline forms to plant materials as with spruce and pine trees. Edges and boundaries of the mining site which need physical definition may utilize this dark-green visual effect.

The textures of plants are produced by the size, shape, and surface of the foliage. The physical definition and relationship of texture is an important consideration in planting design as; large leaves which are stiff and heavy give a tree strength in appearance, whereas small leaves which tremble with windy breezes give a soft appearance. Leaves which are small and numerous as those of an evergreen give an effect of heavyness and solidity. This solid and heavy effect is typical of the processing plant structures and suggests a similar effect in planting design. Texture in arranging plant masses gives scale to the size and form of the plant material which allows visual definition of planting masses.

C. PLANTING FOR WINTER EFFECT

Deciduous trees many times display their physical character

Figure 77 — Operating site relationships within the case study area

more plainly in the winter season, with visual definition of the tree branches and trunk. Trees used in composition as they form a screen or boundary transition zone are related individually as a planting mass. It is quite possible to emphasize visual points with the dominant dark green masses of grouped evergreen trees. (Figure 72)

D. PLANTING RELATIONSHIPS

Within the operating site exist many opportunities to relate ground forms with covering plant masses. Plant materials can be placed to accentuate ground forms or to mask these surface changes. Many times a mass of planting looks best if the ground slopes up to the base of the planting. Also a slight slope may be visually increased by plant materials, where the lowest planting merges with the base of the slope and the highest planting accentuates the top of the slope. (Figure 73) Rounded or pointed earth forms can be harmoniously related by similar formed plant materials. Generally when surface grade changes and slopes are slight, the covering plant materials are visually more dominant.

Plant masses which adjoin the shore line edge of excavation produced water bodies should appear naturalistic. The shore line or water surface edge is a very dominant focal point due to the flatness of the water surface forming a definite line against the land. Planting masses to the water edge produce a harmony between planting and water and mask the harsh shore line. Also planting which adjoins the shore line is visually magnified in form by shadow reflections upon the water. The taller tree masses which may be set back from the water edge also cast reflections upon the water of the upper portions of the trees. Planting near the water is especially important to provide interesting naturalistic views in areas which are subject to public use as recreation and housing.

To enhance interesting views upon the processing plant and its surrounding structures, planting masses can concentrate attention upon these objects by enframing the composition and masking subordinate views.

Tree masses can form a boundary of visual definition and thus focus attention upon a central object; for example — the site entry can be bordered with trees leading into the processing complex and thus enframe the principle object — the processing plant. (Figure 74)

Dominant focal points of structures are the skyline edge and where the structural form meets the ground surface. The ground edge can be softened and masked with transition planting to give a more natural setting to the structure. Also the skyline edge can be broken-up by tall tree planting to screen conflicting forms. (See Figure 43)

The planting arrangements provided along public highways which adjoin the mining property are important factors in providing the public with a positive visual image of the operating site. Many times highway planting is needed when views upon the site offer no interest. Since highway planting must reflect views which can be enjoyed during highway travel, it is usually desirable to confine the traveler's view to one side of the highway at a time. By providing one view upon the site at one point in travel, the views can alternate in direction (left and right) and thus provide visual interest with sequence in views.

Planting to Reduce Public Annoyance Problems

Major planting masses as trees and shrubs can provide a physical enclosure for the mining site. This planting barrier can act as protection against operation produced by noise and dust, give physical privacy by discouraging public access, and enframe views of the mining property. (Figure 75)

Screens within areas of transition between the mining property and neighboring public can provide the following effects.

Figure 78 — Kaiser Sand and Gravel

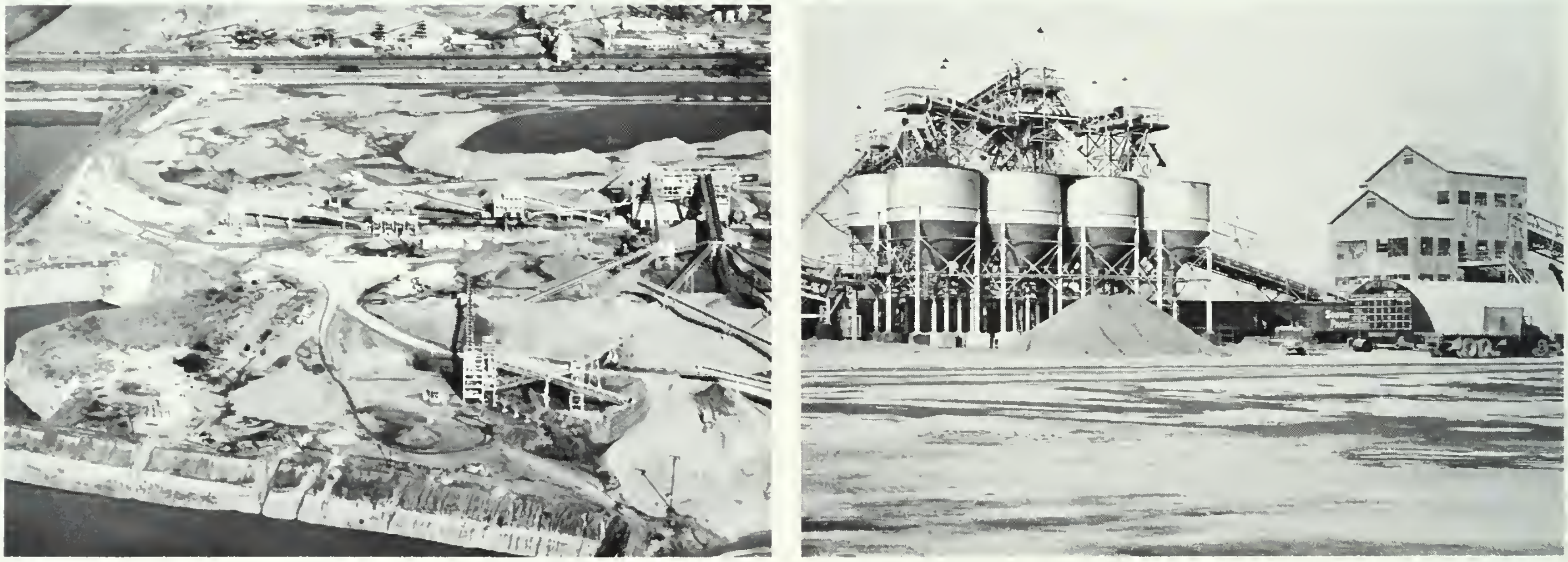


Figure 79 — Pacific Cement and Aggregates

Figure 80 — California Rock and Gravel

Figure 81 — Rhodes and Jamieson

1. Provide visual interest and screen poor views.
2. Introduce both evergreen and deciduous tree planting for winter color and interest.
3. Discourage the "attractive nuisance" to young children of potential safety hazards.

Hedges and medium height shrubs can provide the needed screen of hazardous land forms and discourage public access by thorny foilage and thick mass planting along fence lines which border the mining property.

Part IV

Case Study

The Pleasanton-Livermore Valley in California is the location of the study demonstration area. (Figure 75) There are four major sand and gravel operations active in that area; namely, Kaiser Sand and Gravel, Pacific Cement and Aggregates, California Rock and Gravel, and Rhodes and Jamieson, which have contiguous boundaries and are commonly served by rail and highway routes bisecting the area. (Figure 76)

The following is the operating history of two of the demonstration sites:

KAISER SAND AND GRAVEL—"Kaiser first commenced sand and gravel operations in this area in 1923 at a pit near Livermore. Henry J. Kaiser was the successful bidder on a highway project between the cities of Livermore and Pleasanton which would consume a substantial amount of sand and gravel. He decided that this project would be good justification for going into a permanent sand and gravel operation which could be partially underwritten by the supply contract for the highway. Operations at Livermore were never too extensive and were suspended altogether in 1930. Accordingly, he assigned Tom Price, Kaiser's Chief Geologist, who was responsible for many raw material discoveries in the past three decades, to prospect for a more extensive sand and gravel deposit in the general area.

"Sand and gravel operations had already commenced in several points over this huge alluvial deposit, so Mr. Price chose the most strategically located area—where the Southern Pacific and Western Pacific Railroads join routes to form a "Y". The resulting Radum Plant took its name from the railroad designation. The Plant was opened in August of 1930 and had a rated capacity of 600 tons per hour. It was far and away the largest such operation in the Bay Area, servicing the five metropolitan counties around San Francisco Bay. The material was used essentially for the same applications as today, namely residential construction, highways, and other types of concrete building construction. In those days, of course, most of the material moved by rail.

"In 1936, the capacity of the Plant was increased to 1,000 tons an hour and additional properties were added. The depth of excavation was also increased and Radum became essentially a wet pit operation. Since then, additions and modifications have been made and the production capacity has increased to an effective 1,250 tons an hour. According to 1965 figures from the Federal Bureau of Mines, the Radum Plant led the Nation in total annual production with slightly under 4,000,000 tons. Approximately 120 full-time personnel are employed with minor fluctuations depending on the weather. Excavation will reach maximum depths of 130 feet at certain points and an average of 16 acres per year are consumed, again with minor fluctuations each year. As mentioned above, end uses for the material remain essentially the same as in the early years, but truck shipments now overshadow rail shipments by approximately 4 tons to 1 ton. Longer hauls are accomplished in our own trucks to avoid payment of PUC tariffs. The most distant destination, San Francisco, is still essentially a rail movement.

"Our holdings at Radum now total 1,325 acres. Of this, approximately 655 acres have been depleted and the balance of 670 acres constitute our remaining deposit, which we estimate will be sufficient to support the Plant through the end of this century. Plans are now being finalized to build an entirely new 10 million dollar plant to replace the existing facility, with a capacity of 2,000 tons an hour.

"The land planning firm of Williams, Cook and Mocine has completed a reclamation plan covering all of our holdings at Pleasanton."

PACIFIC CEMENT AND AGGREGATES—"Operations began on our property in the Livermore Valley in 1924, but PC & A began operations in 1928. In 1924 we produced approximately 250 tons of gravel per hour with an approximate employment of 30 people. Production was by drag line. Demand for gravel in those days was limited mainly to Alameda and Contra Costa Counties. Operations were on approximately, one thousand acres of land.

"Currently we are capable of producing 1,000 tons per hour. We employ 62 people at this plant. We are still working on the original thousand acres that we spoke of, but we have another 500 acres that has not been touched. Presently our sand and gravel is being shipped into San Francisco, the south Peninsula, and the San Jose areas. Distance is approximately 35 miles from our plant.

"No definite plans have been developed for final treatment and disposition of the properties. Certain excavated pits are being utilized to collect and store the water from the processing operations. It is believed these pits will be required for this purpose for many years. Other excavated areas are being refilled with stripping materials and sand and gravel materials that are not salable. Present excavated pits are well isolated from the public. The company properties are extensive and when excavations proceed upstream, considerable stripping and reject

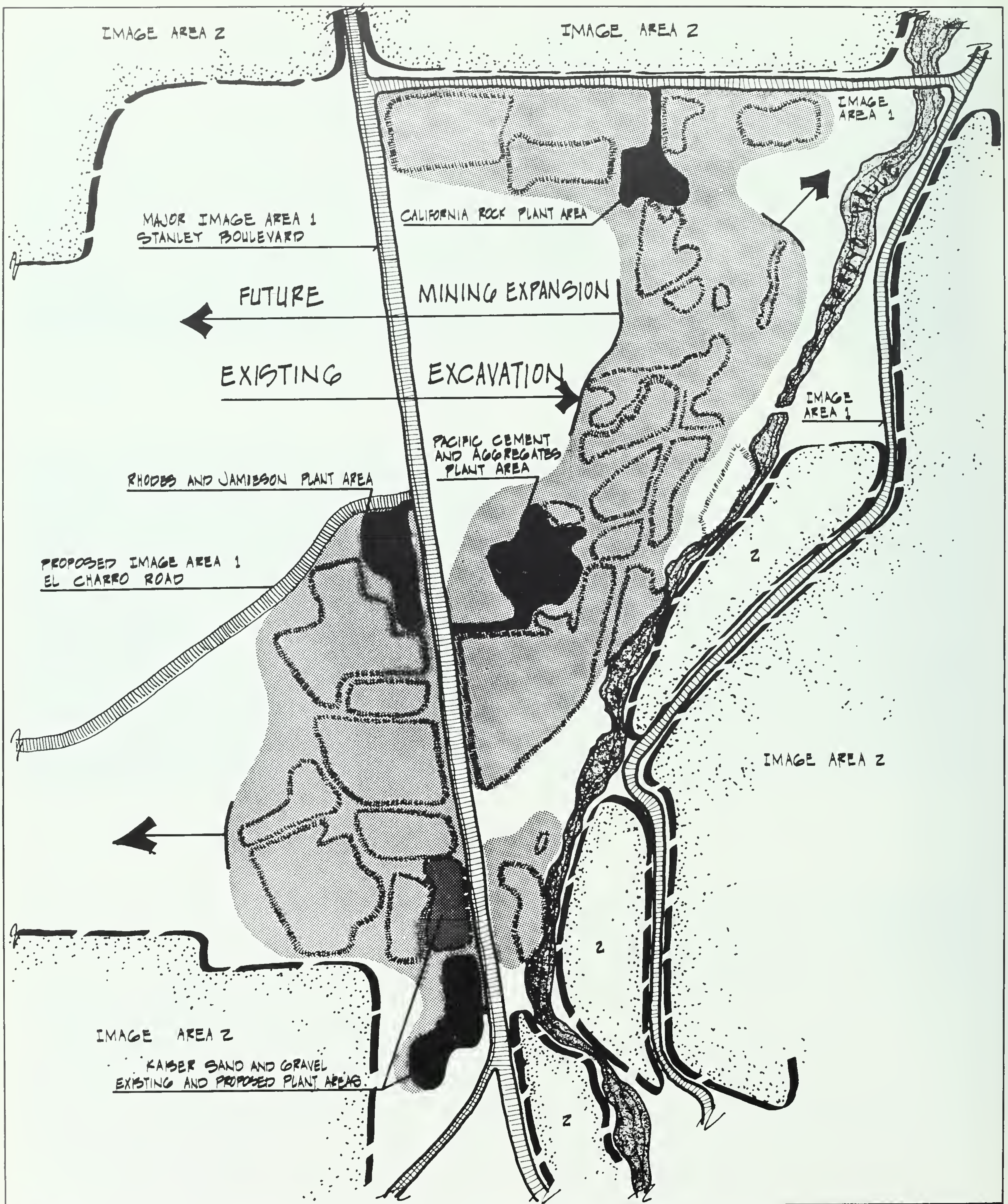


Figure 82 – Image Area Survey

North

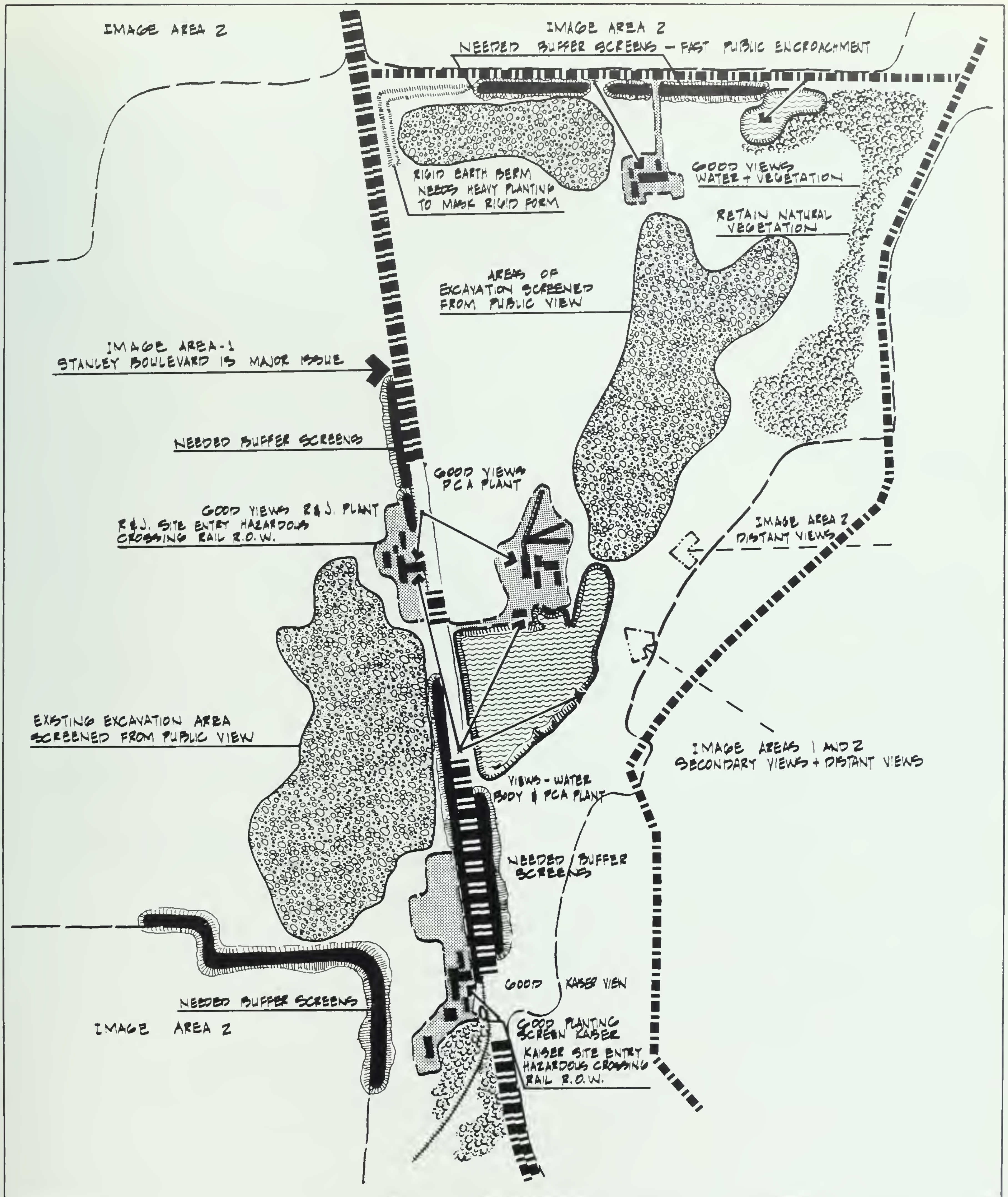


Figure 83 – Area characteristics and image inventory

North

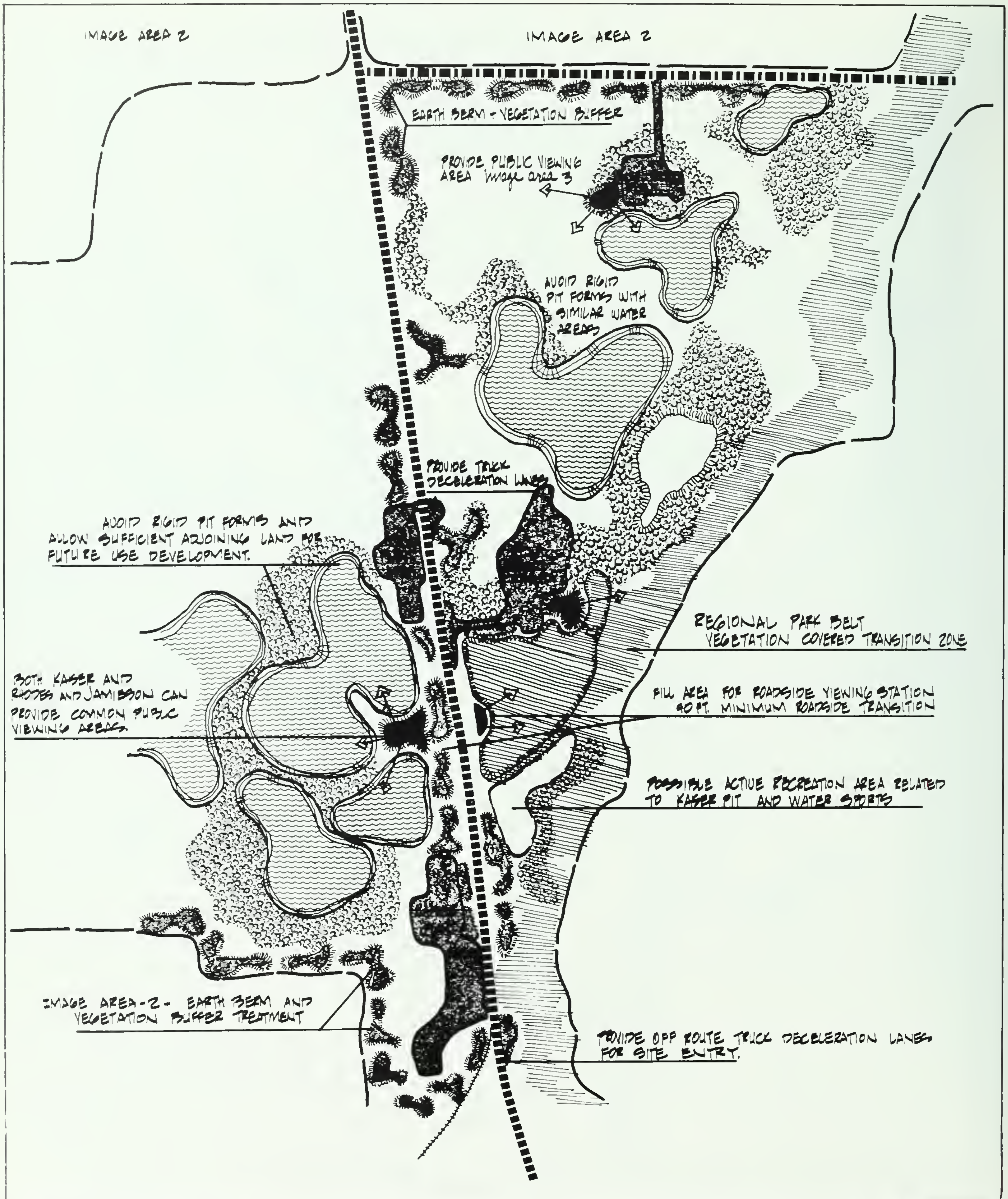


Figure 84 – Image area proposals North

Figure 85 — The needed new landscapes of a high aesthetic value

sand and gravel materials will be used to refill excavated areas. Normal creek run-off will also fill areas of excavation along the creek channel.

"It has long been the thinking of the company management that upon completion of all operations, these properties could be, in cooperation with the County, turned into wonderful recreation areas, with lakes, beaches, parks, playgrounds and other recreation areas. Excavations will have to proceed much further before the full nature of the deposits is known and the full extent of the excavations determined." (Figures 77, 78, 79, 80)

Study Objectives

The major concern here involves pointing up site planning procedures which illustrate site development to maximize public understanding and acceptance of sand and gravel mining. This case study, therefore, focuses upon the "public image" of site operations.

The physical situations of this case study area deals with high intensity sand and gravel mining. Four large operations are joined by common property lines and therefore produce many unique possibilities for producing a good public image.

This study first analyzes functional considerations involving public safety, nuisance and contamination, after which visual considerations are discussed.

The following illustrations will attempt to demonstrate a logical sequence for analyzing both functional and visual considerations as to their public importance in the case study area. Although this demonstration area contains many unique problems and opportunities in building the industry image, the important aspects of this study indicate recognition of the need of all existing and proposed operations to analyze and develop concepts which are constructive toward public acceptance of sand and gravel mining.

The following illustrations will include site inventory and analysis, indicating site characteristics in relationship to the surrounding image areas 1, 2, and 3, as previously defined. (Figures 81, 82)

The image analysis will involve major problems and opportunities which primarily concern the public spectator.

The site planning recommendations will focus upon major opportunities available to the total mining area and also detail points of interest which characterize public areas within and adjoining the mining operations. (Figure 83)

Summary

The typical sand and gravel operation differs very little from other industries, which must consider the site impact imposed upon the surrounding landscape and its people. Sand and gravel mining as an industrial land use has many definite advantages over other industrial sites. These advantages might be termed "available amenities" to sand and gravel mining, such as potential new landscapes feasible through the necessary presence of heavy earth moving equipment which can manipulate earthforms and excavation produced water bodies into physical environments of a high aesthetic value. (Figure 85)

Use organization, land form design, and planting arrangements are essential planning considerations which influence a meaningful organization of the mining site involving elements of water, land areas, vegetation, and structures. The well-organized site must exhibit a meaningful function in harmony with the landscape and be visually imageable to the public observer.

Both visual and functional considerations involving operating problems must be solved simultaneously by total site planning. Total site organization relates mining techniques to site conditions and the surrounding public by providing multi-purpose transition zones of planting screens and land form buffer areas.

Each site planning concept can focus upon individual operating problems, yet when used collectively, total site development provides visual unity and effective control measures of image areas—1, 2, and 3.

Image areas identified in this report consider typical areas of public contact with the mining site condition. The important considerations of "image areas" point-up the need of all existing and future operations to review physical conditions and public use areas surrounding the mining operation, with special emphasis upon areas which are imageable and provide a positive working relationship between machine and man.

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