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United States  
Department of  
Agriculture

Natural  
Resources  
Conservation  
Service

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**Part 651**  
**Agricultural Waste Management**  
**Field Handbook**

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**Chapter 8**

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**Siting Agricultural Waste  
Management Systems**

Issued July 2010

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# Acknowledgments

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### 651.0800 Introduction

Chapter 8 focuses on arranging and integrating components of agricultural waste management systems (AWMS) into an existing or proposed farmstead. Properly siting AWMS components can improve efficiency, minimize adverse affects, and improve aesthetics. The specific components of an AWMS will vary depending on the type of waste and local ordinances. Specific component design is addressed in Agricultural Waste Management Field Handbook (AWMFH), Chapter 10, Agricultural Waste Management System Component Design.

A supplemental checklist is included in appendix 8A to further aid in using the information provided.

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### 651.0801 Process

Various physical components are needed to address the six basic functions of an AWMS: production, collection, transfer, storage, treatment, utilization. The nine-step conservation planning process described in AWMFH, Chapter 2, Planning Considerations, is the basis for determining which components are needed.

During the planning process, it is critical to arrange and locate the various AWMS components so they are functional and compatible with the surrounding landscape. It is also important to properly locate components so they meet local ordinances, such as locating lagoons at the proper setback distance from streams and placing components to minimize impacts to adjacent land uses.

#### (a) Siting the system components

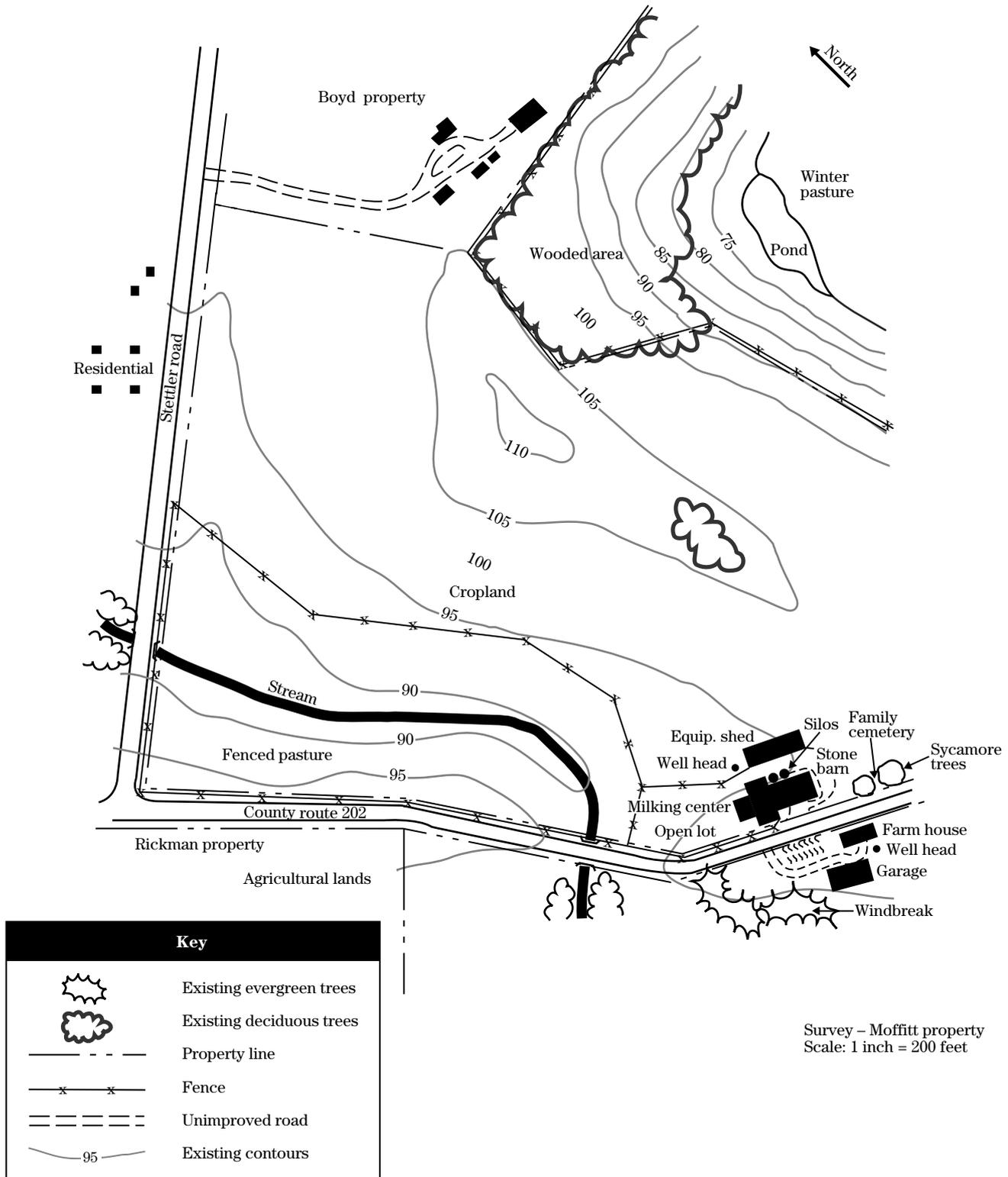
The process of placing AWMS components on the land is similar to that for integrating other conservation practices. The following process will help site the system, as well as provide a means to document planning decisions.

##### (1) Base map

During the planning process, a topographic survey or aerial photograph is prepared (fig. 8-1). (A conservation plan map may be sufficient for this purpose.) Although the decisionmaker's objectives will influence the scope and detail of the survey, the data to be obtained should include:

- property lines, easements, rights-of-way
- names of adjacent parcel owners
- positions of buildings, wells, culverts, walls, fences, roads, gutters, and other paved areas
- location, type, and size of existing utilities
- septic systems
- location of wet areas, streams, and bodies of water
- rock outcrops and other geological features
- geologic and soils data
- existing vegetation

Figure 8-1 Base map



- elevations at contour intervals of 1 foot around anticipated storage/treatment areas and 2 to 5 feet around anticipated utilization areas
- zoning ordinances and deed restrictions
- land uses—onsite and adjacent
- climatic information, including prevailing wind directions

## (2) Site analysis

One method of understanding site conditions and implementing step 4 in the planning process (analyze the resource data) is to prepare a site analysis diagram (fig. 8–2). This step of the process is the identification of problems and opportunities associated with installation of the AWMS. A topographic map, aerial photograph, or conservation plan map should be taken into the field where site conditions and observations can be noted.

The site analysis should note such things as:

- land use patterns and their relationships
- potential impacts to or from the proposed AWMS
- existing or potential odor problems
- existing or potential circulation (animals, equipment, and people) problems or opportunities
- soil types and areas of erosion
- water quality of streams and water bodies
- drainage patterns
- vegetation to be preserved and/or removed
- logical building locations, points of access, and areas for waste utilization
- good and poor views
- sun diagram documenting location of sunrise and sunset in winter and summer to determine sunny or shaded areas
- slope aspect
- prevailing summer and winter wind directions
- frost pockets and heat sinks
- areas where snow collects and other important microclimatic conditions

- farmstead features that have special cultural value or meaning to the decisionmaker
- options for removal or relocation of existing buildings to allow for more siting alternative for AWMS components

Figure 8–2 illustrates a site analysis for a 100 cow dairy on which the decisionmaker wishes to install an AWMS. The decisionmaker has requested an open view of the dairy operation and adjoining cropland from the residence and does not want views of the barn blocked. During summer, several neighbors downwind of the operation have complained of unpleasant odors. The site includes a family cemetery and some large sycamore trees that have special meaning. The existing stone barn structure is unique to the area and is in good condition.

## (3) Concept plan

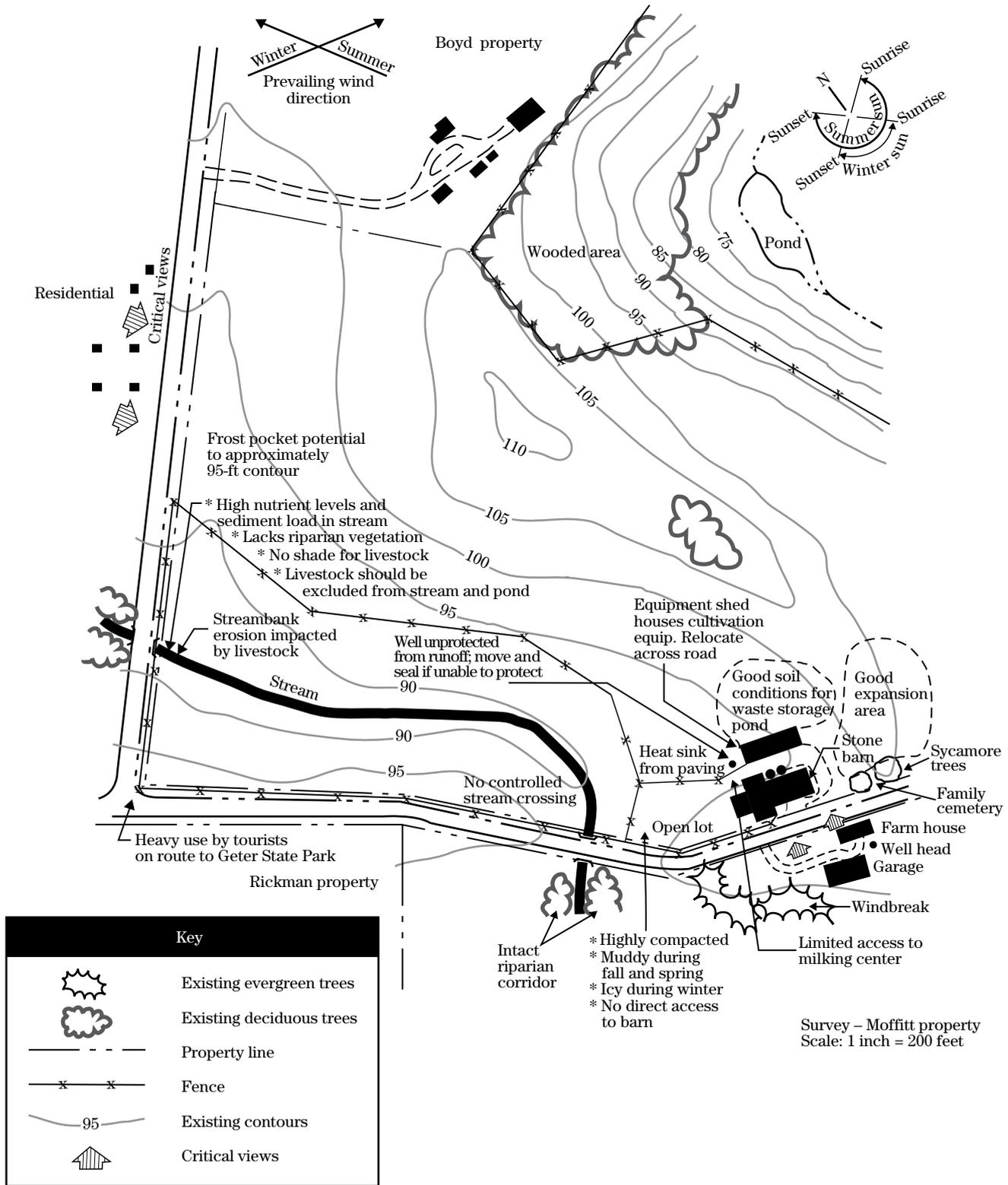
As a part of steps 5 and 6 of the conservation planning process (formulate and evaluate alternatives), conceptual plans are developed to evaluate alternatives (fig. 8–3). The area required for collection, transfer, storage, treatment, and utilization of waste is determined and first displayed at this step of the process. This and related information, such as associated use areas, access ways, water management measures, vegetated buffer areas, and ancillary structures, should be drawn to approximate scale and configuration directly on the site analysis plan or an overlay.

In instances where several sites may satisfy the decisionmaker's objectives, propose the site that best considers cost differences, environmental impacts, legal ramifications, and operational capabilities. Continued analysis can further refine the location, size, shape, and arrangement of waste facilities. If the best area for a component will require a buffer, provide adequate space. If no site seems viable, reassessment of the objectives in cooperation with the decisionmaker is appropriate. Generally, a minor adjustment in goals and objectives offers viable alternatives. Where a potential for major adverse effects exists, however, it may be necessary to make significant adjustments in operations requiring a large economic commitment and attention to management.

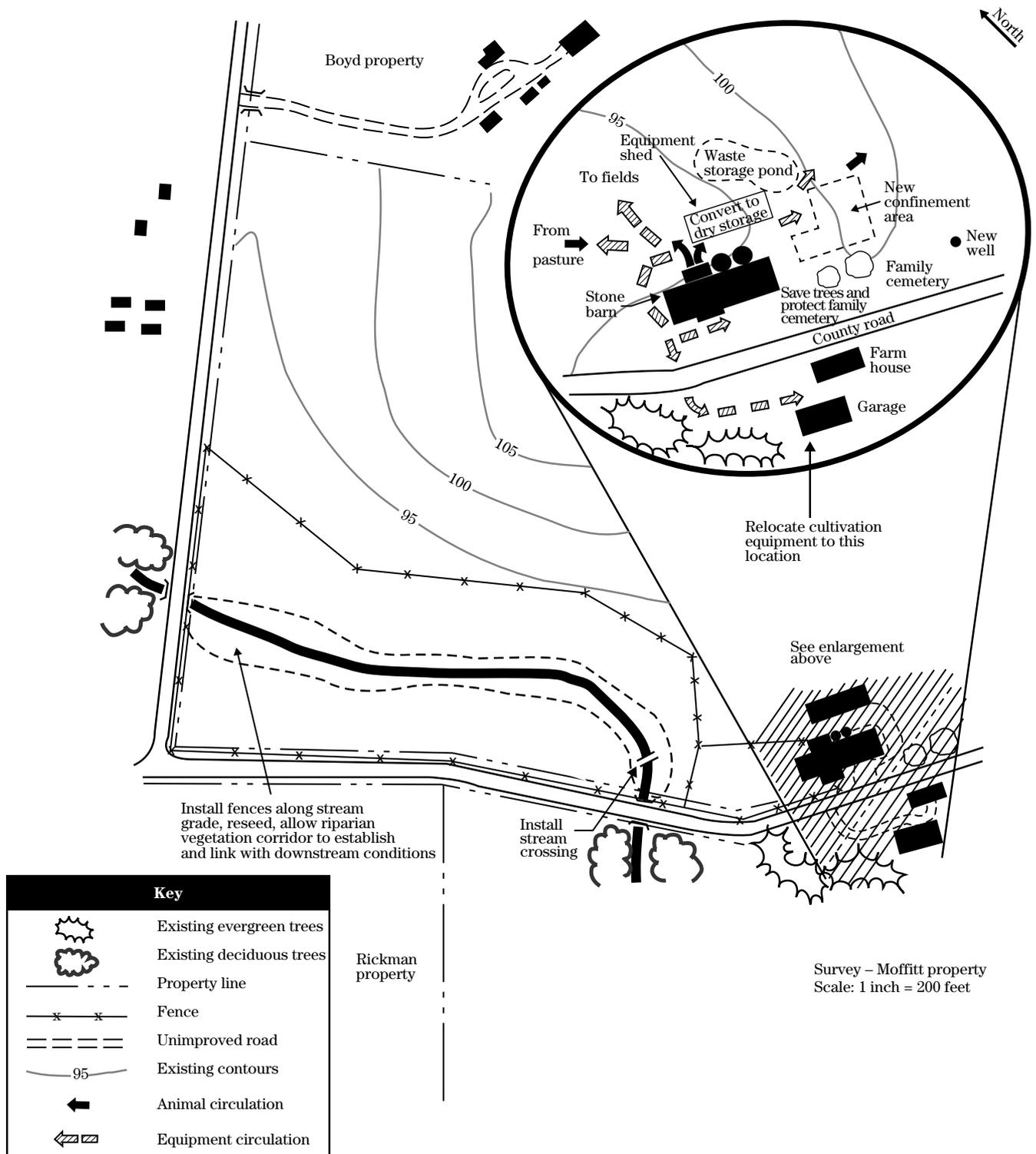
## (4) Site plan

Completion of subsequent steps of the planning process results in the final site plan (fig. 8–4) as preface to

Figure 8-2 Site analysis diagram



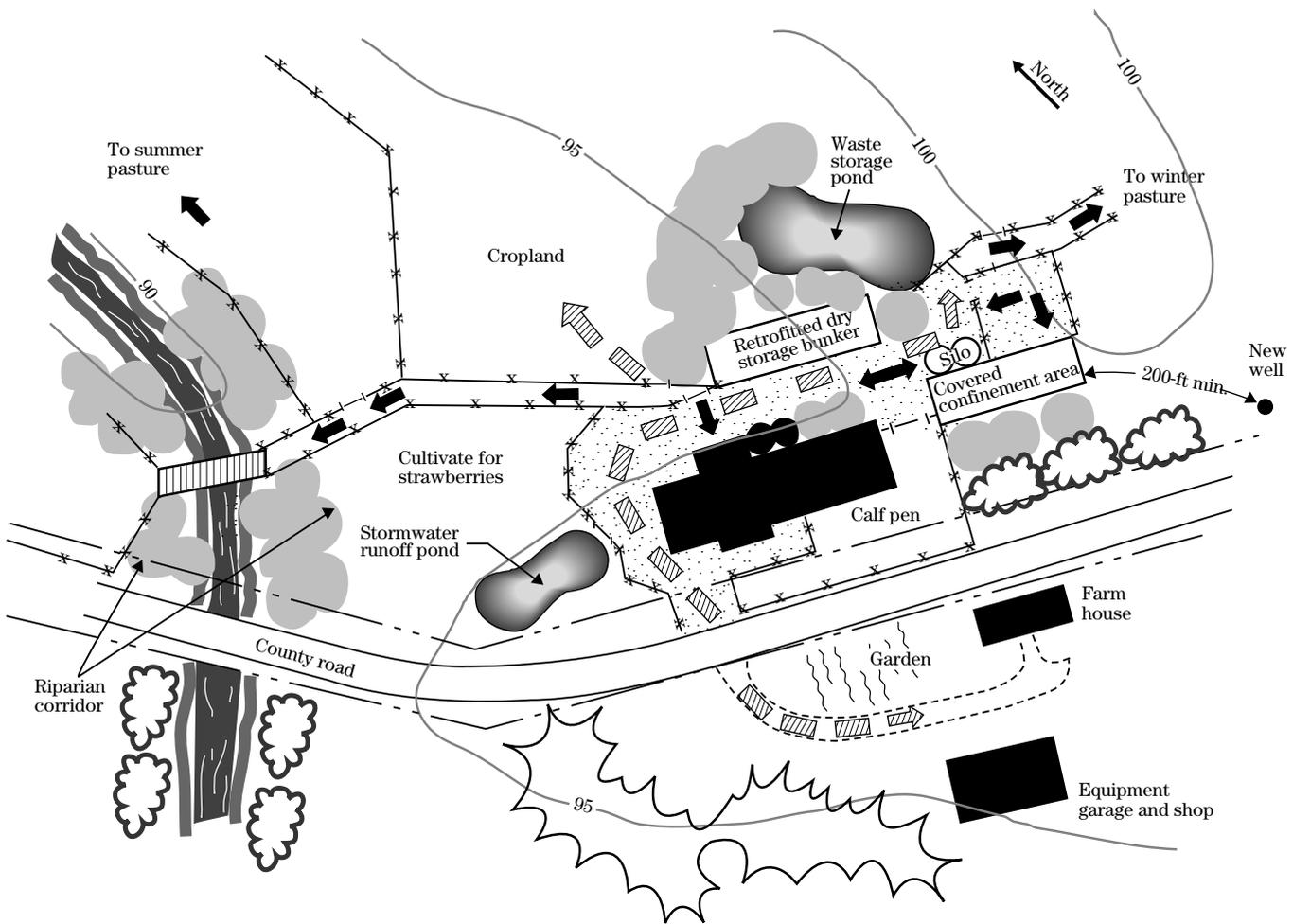
**Figure 8-3** Concept plan



construction drawings and specifications. Final locations and configurations of proposed components and ancillary structures, finished elevations, construction materials and exterior finishes, suitable plant species

and planting areas, circulation routes, utility corridors, and utilization areas are examples of information to be included. This plan is submitted to the decisionmaker for approval.

**Figure 8-4** Site plan



Site plan – Moffitt property  
Scale: 1 inch = 100 feet

Key			
	Existing evergreen trees		Animal circulation
	Existing deciduous trees		Equipment circulation
	Property line		Gate
	Fence		Proposed trees
	Unimproved road		Paved area
	Existing contours		Bridge

## 651.0802 Design considerations

The AWMS should be designed to blend into the site and its surroundings with no adverse environmental effects. The following design considerations will aid the planner in achieving this objective.

### (a) Landscape resources

Consider landscape resources in the design: visual quality—the appearance of the landscape, visibility—who views the landscape, and landscape use—how people use the landscape. All three factors need to be considered when siting AWMS components.

#### Visual quality and landscape character

Visual quality is acknowledged as an integral part of daily life and underlies economic and other decisions about the land (fig. 8–5). Many land management decisions, including those related to planning and design of an AWMS, are made because of a decisionmaker's perception of what will enhance visual quality and reflect a stewardship ethic to neighbors.

Highly visible AWMS components, such as storage tanks that are easily identified by their color, and associated conservation practices may be installed because

they are attractive and show that the decisionmaker cares about stewardship. Conversely, decisionmakers may be reluctant to install an AWMS that contradicts aesthetic norms for attractive or well-cared-for farmsteads and land.

The farm's layout and structures also should be discussed with the decisionmaker to identify special features. Long-established and enjoyed views from the farmhouse, large trees or windbreaks planted by ancestors, and an old springhouse or stonebase banked barn are just a few of the many possibilities that often provide a sense of place and have special meaning to the farm family or community.

The composition or structure of the site's surroundings must be understood so that waste management systems are designed to fit onto the landscape. To accomplish this objective, the patterns and linkages formed by farmsteads, riparian corridors, and similar features on the landscape should be examined.

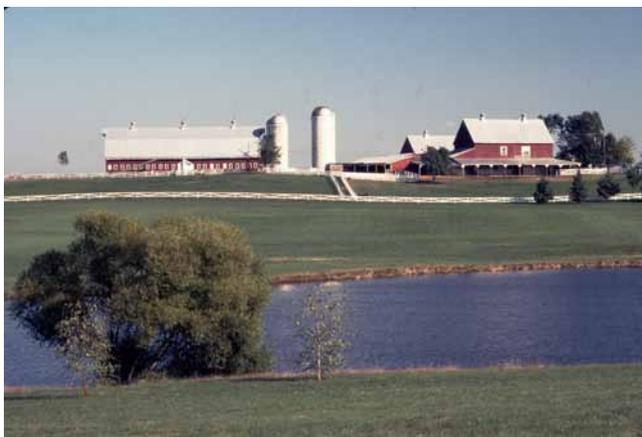
Patterns of land use and management, siting and design of structures, and field size and shape reflect cultural values that have long guided farmstead planning and determined variations in landscape character. Landscapes are organized in response to surrounding environmental and cultural conditions and the decisionmaker's objectives.

### (b) Landscape elements

Landscape elements of landform, structures, vegetation, and water can be used to describe the landscape character of the site. Manipulation of landscape elements can improve the operation of an existing AWMS or help to integrate a new AWMS into the farmstead.

Each farm can be viewed as a series of spaces used for different operations linked together by roads or paths. The arrangement of structures, landform, water, and vegetation within this system affects the aesthetic quality, operational efficiency, energy consumption, runoff, and specific functions on the site. Manipulation of these elements can establish desirable views, buffer noise, determine circulation of animals and equipment, manage odor, modify air temperature, affect snow or windblown soil deposition, and optimize use of available space. In addition, proper placement can help

**Figure 8–5** The visual quality shown on this farm is often important to the farm family.



reduce health and safety hazards and enhance quality of life values.

Depending upon objectives, components of the AWMS can be subdued or made prominent on the landscape. Generally, the components should blend with the surrounding landscape or be screened from view. The relationship of existing farmstead features to each other in terms of spacing, height, width, and orientation provides a clue to alternative siting locations. On a landscape divided into fields, hedgerows, and farmsteads, the AWMS components should be located where they will not disrupt existing relationship patterns.

**(1) Landform**

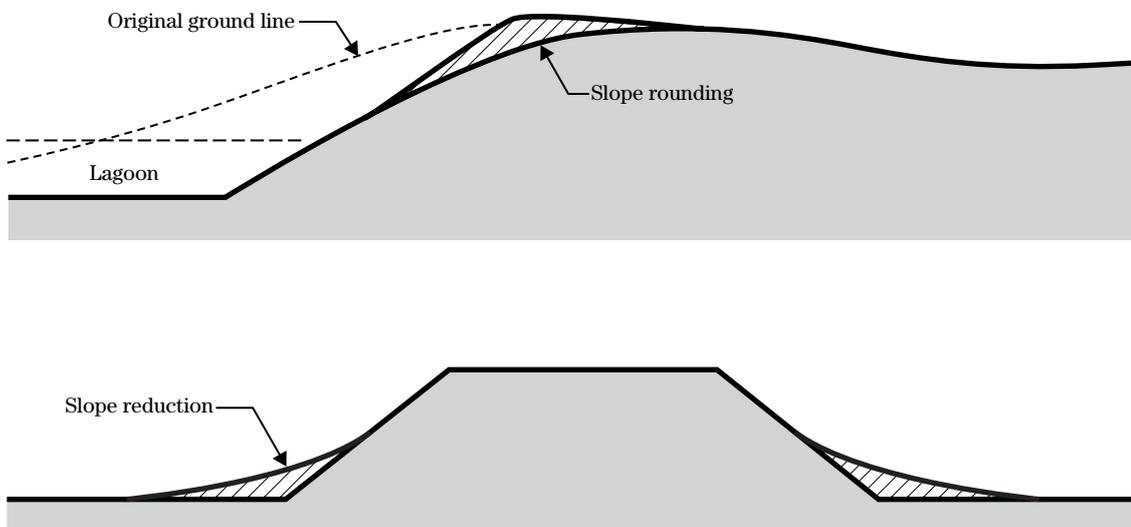
Landform can be used as it occurs on the site, or it can be modified to improve farm operations, direct or screen views, buffer incompatible uses, reduce massiveness of aboveground structures, control access, improve drainage, and influence microclimates. Landforms often provide a backdrop for an AWMS (fig. 8-6) and serve as a model for designing new landforms, such as embankments, berms, and spoil disposal mounds. An existing landform can serve as a model for the design of new earth mounds.

Slope rounding and slope reduction (fig. 8-7) are two of many earth grading and shaping techniques that can reduce erosion and help to blend landforms into the landscape.

**Figure 8-6** The landforms screen the view of the AWMS.



**Figure 8-7** Slope rounding and reduction help to blend landforms onto the landscape.



Integrating aboveground AWMS components into flat landscapes (fig. 8–8) is more difficult because structures often project above the horizon as prominent features. Many landform modifications can be employed to address this and other site conditions or land user objectives. Excavated soil, for example, can be used to build small landforms to reduce the prominence of new components. This effect is further enhanced through the addition of vegetation.

In excavating for a pond or lagoon, the shoreline can be irregularly shaped with smooth, curved edges to make the pond or lagoon appear natural (fig. 8–9). Operation and maintenance requirements of the structure need to be considered. Embankments may also be shaped to match the surrounding landform.

Landform mounds constructed from excess excavated material can be used to convey runoff and save the cost of hauling excess material to a disposal site. Either excess or imported soil can be used to fill depressions and improve drainage.

## (2) Structures

Structures provide space for ongoing farm activities by creating enclosure. Existing barns, sheds, houses, fences, storage tanks, ponds, and silos are structural elements to be considered when siting components of an AWMS.

Planning for new AWMS components may give the decisionmaker an opportunity to update and reorganize farm structures and land uses between them. Existing operations and equipment may have indoor and outdoor spaces very different in size and shape than those currently needed. Structures also provide options for collecting runoff, channeling or dispersing air flows and wind, controlling circulation of animals and equipment, and separating use areas.

Coordinating colors of a new AWMS with colors and materials of the existing farm buildings will reduce their visibility and preserve existing landscape character. The newly installed aboveground storage tank shown in figure 8–10 is sited to be an inconspicuous part of the overall farmstead. Its color is also compatible with those of the surrounding landscape.

Large concrete surfaces of aboveground waste storage tanks or paved travel ways around below grade ponds can be textured or color tinted (earth-tone colors

**Figure 8–8** Structures projecting above the horizon are prominent features on this flat landscape.



**Figure 8–9** The shoreline and reflective surface of this waste storage pond make it appear to be a traditional farm pond.



**Figure 8–10** An aboveground storage tank is inconspicuous on this highly scenic landscape due to careful design, siting, and color.



based on surrounding soil conditions) to reduce contrast and reflectivity. Reflective metal can be painted or otherwise treated to harmonize with surroundings. Existing and planned facilities should be unified in style and materials.

Architectural style is an indication of an area's cultural values. Unique structures, materials, or construction methods should be considered to avoid possible conflicts from proposed improvements. A historic barn, for example, can be diminished by locating an above ground waste storage tank adjacent to it, whereas a properly designed waste storage pond may serve the need and be less disruptive.

Existing structures can often retain their original exterior appearance while their interiors are altered. The added expense may well be justified by the value of preserving an important cultural resource.

The architectural style (shape, height, and materials) of farmstead buildings should be analyzed to blend new structures into those existing. Modern, prefabricated buildings differ from traditional structures, which tend to be large, multistory, and have a dramatic roof line. The large floor space of traditional structures is balanced by height. Modern, prefabricated buildings generally have a lower profile, creating a greater horizontal appearance. Where possible, emulate the architectural style of existing farm buildings in the design of new structures.

### (3) Water

Clean water has magnetic appeal. It can add to aesthetic quality, modify temperature, serve as a buffer between use areas, or divert attention from undesirable views. Water features created by an AWMS may not be a visual asset. If scum or other material can be seen floating on the surface, the water feature will be perceived as a negative quality (fig. 8–11). When siting water features, determine their potential for affecting visual quality and locate them accordingly.

### (4) Vegetation

Vegetation can be used to organize space and circulation; establish desirable views; buffer noise, wind, or incompatible uses; promote or impede airflows; reduce massiveness of aboveground structures; absorb particulates and/or gaseous compounds to mitigate odor; cool air temperature; and reduce soil erosion and runoff. As with other elements, vegetation can be used to divert attention to other features.

Existing vegetative patterns, such as hedgerows, stream corridors, and even aged stands of trees or shrubs, can be expanded or duplicated with plantings to integrate a new AWMS into an existing landscape.

When siting components, avoid creating gaps in existing vegetative corridors. If corridors are affected, try to restore the connectivity by adding vegetation.

The waste storage pond in figure 8–12 was designed to take advantage of an existing screen of shrubs and trees. Views of the pond from outside of the farmstead are blocked.

**Figure 8–11** The solids on the surface of this liquid manure storage pit would be perceived as having a negative visual quality.



**Figure 8–12** Vegetation near this recently constructed waste storage pond provides a screen.



Caution must be used when working near existing vegetation. The heavy equipment used during construction or operation and maintenance compacts the soil. Soil compaction reduces the amount of air available to the roots of plants, which can kill them. Therefore, these activities should be avoided in the root zones where the vegetation is to be saved.

New plantings can be used to help integrate AWMS components into a farmstead. The storage tank in figure 8–13(a) is located close to the farmhouse. Notice how the addition of vegetation (fig. 8–13(b)) helps to soften the impact.

**Figure 8–13** Newly planted trees and shrubs can help blend farmhouse and nearby waste storage tank into the landscape (as shown in simulation).

(a) Waste tank installation adjacent to farmhouse



(b) Simulation of newly planted trees and shrubs soften the visual impact of the tank on the farmhouse. Earth-toned concrete helps the tank blend into landscape.



An important design consideration is restoring the site to a vegetated condition after construction is completed. In figure 8–14, the decisionmaker backfilled, graded, and reseeded the area to reduce erosion and blend the structure into the landscape. Once established, the newly planted trees will further enhance this effect.

New plantings used to minimize the scale or geometric appearance of components should not attract attention by their color, texture, or form. Planting techniques include grouping plants in random arrangements to simulate natural patterns and using several sizes and species to duplicate the natural vegetation. Figure 8–15 illustrates common vegetative patterns that can be used as models. The best guide, however, is to duplicate the vegetation patterns of the locality or region. Naturally occurring vegetation is more likely to be in irregular configurations rather than straight, geometric arrangements.

In selecting new vegetation, avoid plants that may later cause problems. This includes plants that are wrong for the available space, require frequent pruning, are poisonous to livestock, will not survive the ordinary growing conditions on the farm, or require more than normal maintenance.

Surface runoff patterns need to be evaluated when planting new vegetation or utilizing existing vegetation near an AWMS. If plantings are not designed as water

**Figure 8–14** Vegetation can quickly restore a construction site.



quality buffers, runoff that contains high concentrations of nutrients and other contaminants may overwhelm the vegetation. Water management practices may be needed to protect adjacent vegetation from harmful runoff.

**(5) Visibility**

Visibility involves both views from within the site and views of the site. Important views to mountains and valleys, water bodies, or areas of special meaning to the decisionmaker should not be blocked when siting components unless other alternatives are not available. Views from adjacent landowners and roads also need to be evaluated to determine potential visual impacts.

Blending proposed facilities with the surrounding landscape while satisfying the decisionmaker’s objectives should be a primary consideration in designing an AWMS. If blending is not possible, screening the facilities from view becomes an option.

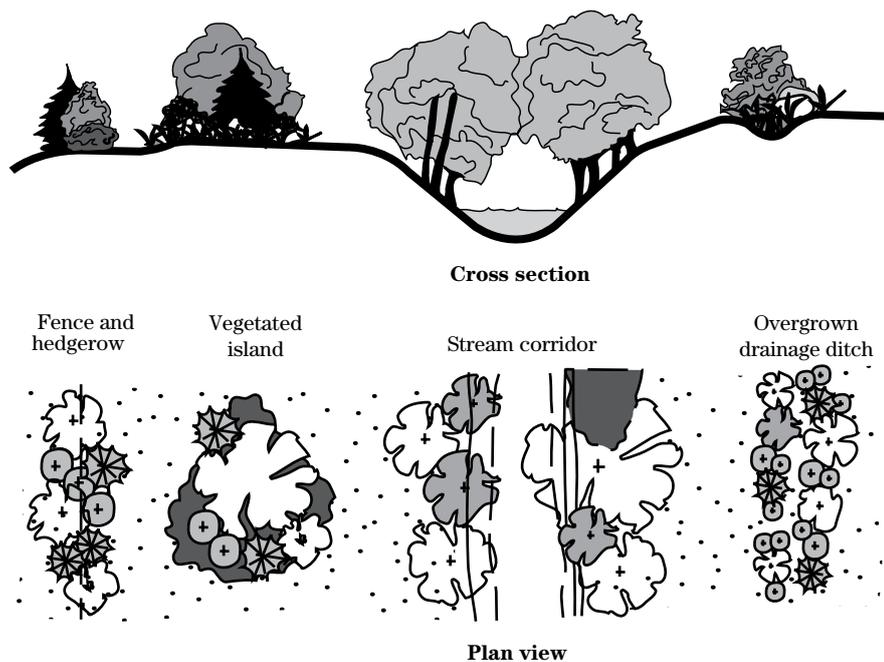
The waste storage pond shown in figure 8–16 is visible from an adjacent road. The concrete liner, made necessary by existing soil conditions, contrasts dramatically

with the dark manure and surrounding soil and vegetation. Using color stains or additives in the concrete to make its color more compatible with that of the soil would be one way to reduce its visibility. If this is not possible, landform and vegetation can be used to

**Figure 8–16** A nearby road and contrasting concrete liner make this waste storage pond highly visible.



**Figure 8–15** Common vegetative patterns



screen the component from view and transition it into the site. Vegetation can also be used to direct attention away from the pond. The landform or vegetative patterns common to the existing landscape should be reproduced to screen an AWMS component.

Reducing the visibility of an obtrusive facility is not accomplished simply by covering it with vegetation. To be effective, vegetation should be placed as an intervening feature between the viewer and the object being viewed. Generally, the closer the vegetation is to the viewer, the more effective it becomes in reducing visibility of the obtrusive facility.

Where vegetation is used to reduce visibility, the resulting effects upon available sunlight, air movement, snow drift, freezing and thawing, and pest control should be considered.

Structures can screen views of agricultural waste facilities. In figure 8–17, existing barns and other farmstead structures effectively screen a storage pond as viewed from the farm residence and the highway. Roads and other landscape elements can also direct a viewer's attention away from AWMS components.

### (6) Landscape use

People value landscapes based on how they are used. Landscapes can be used directly by physical interaction, such as farming or recreating, or indirectly by gaining benefits, such as wind protection or screening an undesirable view from a shelterbelt. Evaluating

both the direct and indirect uses on the site and adjacent areas is important when locating AWMS components.

Existing activities on the site need to be identified during the site analysis. AWMS components should be located so they do not eliminate or hinder critical activities. Circulation patterns also need to be evaluated when siting components.

Analyzing the compatibility of the proposed design alternatives with adjacent land uses helps to prevent potential conflicts. In poultry areas, for example, where most residents are involved in poultry production, associated activities and impacts are expected and more likely to be accepted. The potential for incompatible land use is less likely in these situations than in those where isolated poultry operations are mixed with other uses.

### (c) Circulation

The circulation patterns of animals and equipment can be easily affected by installation of an AWMS. New roads and pathways are often required to ensure an efficient new system. Roads, pathways, and other forms of circulation should lead to their destination in an orderly and efficient manner. They ought to optimize the use of available area by providing adequate width, gradient, and turning space. In some cases, existing shortcuts must be abandoned and new circulation barriers must be used to accomplish this.

For example, an existing manure storage pond (fig. 8–18(a)) may take cropland out of production and require additional maneuvering by cultivation equipment. The visual simulation (fig. 8–18(b)) places the pond on an unused, marginal cropland site adjacent to the brooder house, leaving more land available for production.

Alignment of roads and pathways should attempt to follow the existing contour of the land to prevent steep gradients and excessive cuts and fills. Sufficient drainage (0.5 to 0.75 in/ft of slope for gravel surfaces and 0.25 to 0.5 in/ft of slope for paved surfaces) should be provided. A minimum of 14 feet of vertical clearance should be allowed to accommodate equipment. Where feasible, existing roads, pathways, or parking areas can be eliminated or relocated to increase operational efficiency (fig. 8–19).

**Figure 8–17** Farmstead buildings effectively block views to a waste storage pond.



**Figure 8-18** Alternative location for waste storage pond improves circulation and enhances cropland production (as shown in simulation)

(a) Existing photo



(b) Simulation



**Figure 8-19** Farmstead roads consolidated to improve operations (as shown in simulation)

(a) Existing photo



(b) Simulation illustrates road consolidation for improved operations



### (d) Odor mitigation

The odor associated with the six functions of agricultural waste management often generates the most immediate response from the decisionmaker and adjacent residents. The amount of odor depends on animal species, housing types, manure storage and handling methods, size of the odor sources, and implementation of odor control technologies. The impact of odor on adjacent land uses is dependent on the amount of odor produced, weather conditions, and topographical and structural features.

By anticipating the intensity, duration, and frequency of odors, AWMS components can be planned to mitigate odors and the associated complaints. Odor problems can be prevented or reduced through adequate drainage, runoff management, keeping animals and facilities clean and dry, and appropriate waste removal, handling, and transport.

Odor-mitigating techniques include using manure storage covers, manure amendments, organic mats, and biofilters on building exhaust fans. Odors can also be dispersed or masked using stacks, chimneys, vegetated and structural windbreaks, air flow alteration, windbreak walls, site selection, setback distances, and deodorant or masking agents.

Locate waste management facilities and utilization areas as far as practical from neighboring residences, recreational areas, or other conflicting land uses. Avoid sites where there are radical shifts in air movement between day and night, such as those near large bodies of water or steep topography. A component's location in relation to surrounding topography may also strongly influence the transfer of odor because of daily changes in temperature and resulting air flow. To provide optimum conditions, prevailing winds should carry odors away from those who might object.

Odor can be further mitigated by providing conditions or design features that alter the microclimate around specific AWMS components. An abundance of sunlight and good ventilation, for example, helps keep livestock and poultry areas dry and relatively odor free. A southern exposure with adequate slope to provide positive drainage for runoff is a preferred condition.

Keeping waste aerated and at appropriate moisture and temperature levels slows the development of anaerobic conditions and reduces odor.

Odor-causing substances from waste material are frequently attracted to dust particles in the air. Collecting or limiting the transport of dust aids in reducing odor. Vegetation is very effective in trapping dust particles as is demonstrated by observing dust-covered trees and shrubs on the edges of unpaved roads and quarry sites. Surface features on leaves or needles, such as spines, hairs, and waxy or moist films, help trap particulates (fig. 8–20). These complex surface features can also help to enable odorous gases to adsorb to the vegetation and remove them from the atmosphere or a concentrated air flow. In figure 8–21, black pines were planted to create both a visual barrier and particulate trap between the swine operation and nearby residence.

**Figure 8–20** Dust particles trapped on leaves next to building exhaust fan



**Figure 8–21** A vegetative screen between house (behind vegetative screen) and swine operation traps dust particles.



In addition to trapping dust particles, vegetation, landform, and structures can channel wind to carry odors away from sources of potential conflict (fig. 8-22).

### (e) Temperature and moisture control

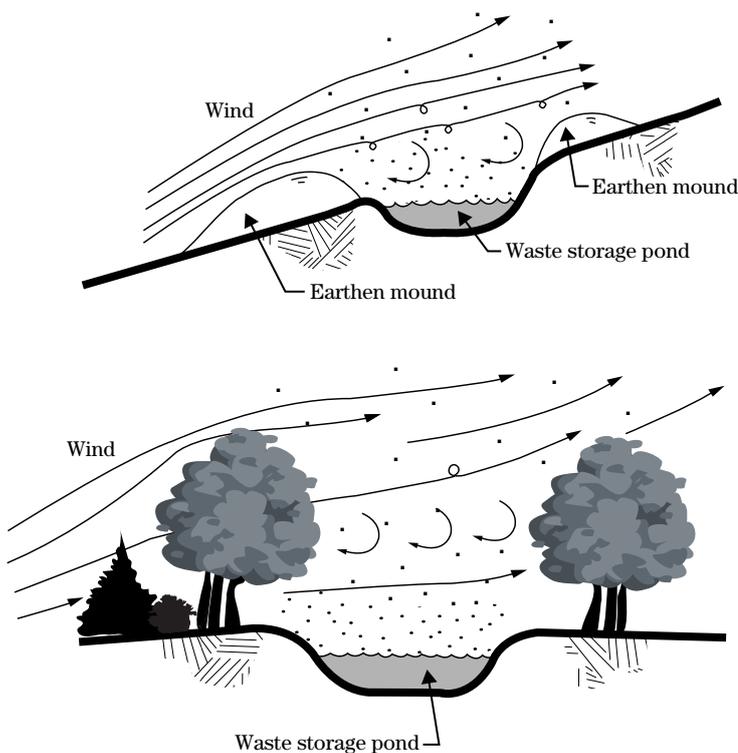
Vegetation can alter microclimates and lower temperatures. By shading the areas beneath the vegetation and through the process of evapotranspiration, trees and shrubs produce a cooling effect. They can also regulate temperature by reducing or increasing wind velocity. The placement of vegetation can help cool buildings in summer and allow heat generating sunlight to penetrate in winter (fig. 8-23).

Dairy animals and other livestock seek streams or ponds and the shade of trees for their cooling effects. Where access to these features is removed, the animal should be provided other means of cooling. The

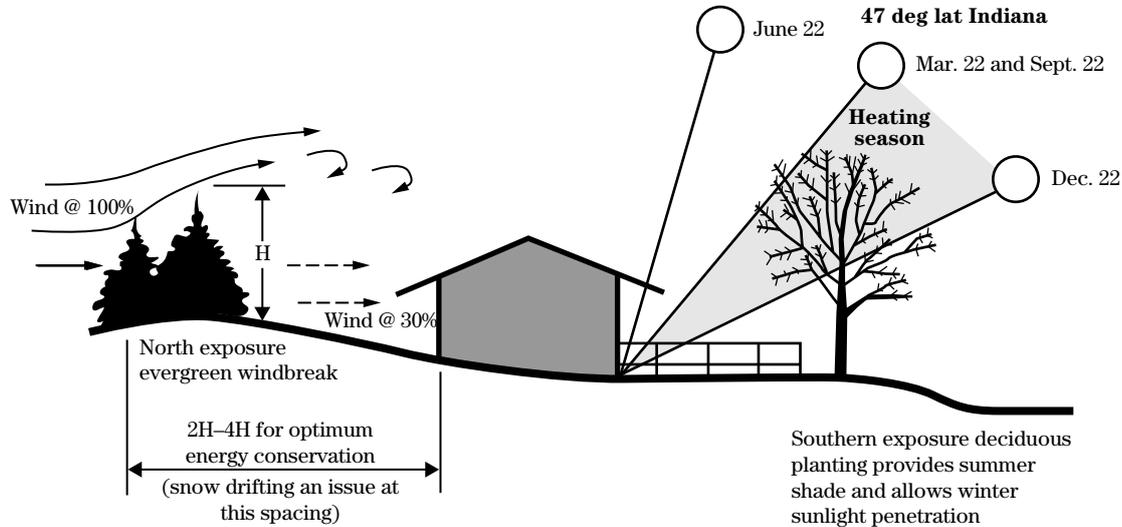
benefits and liabilities of sunlight, shade, and wind must be weighed in each geographic region. Bacterial activity in waste treatment lagoons is slowed by cooler temperatures, which reduces the potential for odor generation and thus, necessary treatment of odor. Too much shade in a feedlot can allow an increase in snow or ice buildup and the amount of runoff during periods of thaw. It can also promote an increase in algae growth on paved surfaces, creating unsafe footing for animals and operators. Too little ventilation can cause the temperature and humidity to soar, while too much ventilation, especially in the form of winter winds, can create life-threatening conditions for animals.

Structures can be located to influence internal temperatures (fig. 8-24). The central or long axis of new buildings can be oriented to regulate the angle and duration that sunlight strikes the roof and sides. In cool or temperate regions, for example, heat can be generated in buildings where drying of waste is needed by:

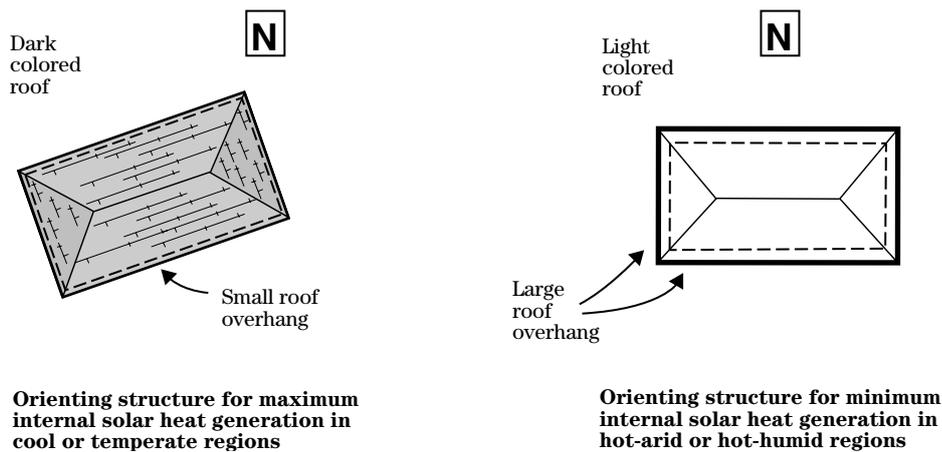
**Figure 8-22** Topography, structures, and vegetation can uplift winds to disperse odor.



**Figure 8-23** Vegetation modifies temperature in various ways.



**Figure 8-24** Orientation can influence the amount of internal sun-generated heat within buildings.



- orienting the long axis of the building in a northeast-southwest direction
- constructing the roof with a small overhang to allow maximum sunlight to strike the sides of the building
- locating the windows along the south and west walls
- using dark roofing materials to enhance radiation adsorption

If livestock buildings are naturally ventilated, shelterbelts should be setback 150 feet in order not to interfere with ventilation.

Where minimal internal heat is desired, such as in the hot, arid Southwest or the hot, humid Southeast, different building orientation and architecture are recommended. In these regions, it is best to minimize the amount of sunlight on the sides of the building. Because the arc of the sun is higher in the sky, a minimum amount of sunlight can be expected to strike the south side of the building during midday. Therefore, the long axis of the building should be oriented in an east-west direction. The amount of wall and window area along the east and west walls should be minimized to reduce early morning and late afternoon exposure. The windows should be along the north and south walls. The roof should have wide overhangs and be finished in a light color.

If increased humidity is desirable, consider locating storage ponds or treatment lagoons upwind of livestock or poultry confinement facilities. The air flowing over the pond or lagoon will pick up moisture and carry it through the confinement facilities. Care must be exercised, however, to avoid directing undesirable odor-bearing winds through the facilities. Ventilation can also be enhanced by orienting buildings to optimize prevailing winds. Care should be exercised where prevailing winds will have an adverse effect upon the temperature or humidity within confinement facilities.

Temperature and moisture conditions greatly affect the presence of insects, rodents, and other pests, often a major concern of the decisionmaker and source of complaints from neighbors. Each type of livestock or poultry operation attracts specific species of insects that can affect not only the health and productivity of

the animals, but also the quality of the food product and the cost of production.

Several species of flies commonly breed in moist animal manure. House flies, which can impact areas up to 4 miles from their breeding location, are a major carrier of more than 100 human and animal pathogenic organisms. Other species of insects can range equal or further distances.

Because sanitation, including proper and timely manure handling procedures, has been reported to be the most important factor in reducing fly populations, the AWMS must be designed with this factor in mind. Avoid areas that have odd shapes or corners, which prevent thorough scraping or other means of removing manure. Provide adequate drainage to aid in moisture control.

Many practices used for insect control also apply to rodents. Reducing nesting sites by careful selection and placement of vegetation around buildings and waste facilities helps to lower populations of insects and rodents. Many insect traps work best in full sunlight; one of many reasons to plot the course of sunlight through the farmstead.

## (f) Climatic conditions

Snow and ice often hamper farm operations and cause critical runoff conditions during periods of melt.

Where appropriate, the depth and location of snowdrift as well as ice and other winter conditions should be considered when siting an AWMS. Accumulation of snow on a waste storage pond or lagoon may not be desirable in areas where precipitation is abundant, especially as a waste storage pond nears capacity late in winter. Conversely, in more arid regions or areas where most of the precipitation is received as snow, accumulation within the waste storage facility may be desirable. In both cases, vegetation and fences are effective in trapping snow.

The distance to which a fence or vegetative windbreak will affect snow accumulation is dependent on its height and porosity and on the wind speed. A solid fence (0% porosity) causes most snow deposition to occur on the upwind (windward) side. However, its effective distance downwind (leeward) is so limited it is not recommended for use with an AWMS. Fences that

have 15 to 25 percent porosity trap snow on the downwind side in an area that is as long as the fence and as wide as four or five times the fence's height. The standard snow fence is 4 feet high and 50 percent porous. Deposition occurs from the base of the fence to about 40 feet downwind. Figure 8–25 illustrates how fence porosity affects snow deposition patterns. As shown, a 50 percent porous barrier captures about four times as much snow as a 15 percent porous barrier. The same conditions are true for windblown soil in the more arid regions of the country.

Because of the additional height, vegetative windbreaks influence snow and windblown soil deposition over a greater distance than fences. Depending upon location, they may provide additional benefits including odor and particulate filtration and mitigation, screening, temperature control, and wildlife habitat. Available planting space and the amount of snow or soil deposition anticipated will influence the location, width, and alignment of windbreaks.

When managing snow or soil deposition, the use of fences and vegetation should be combined whenever feasible. The fence will provide immediate results, while vegetation, which may require several years

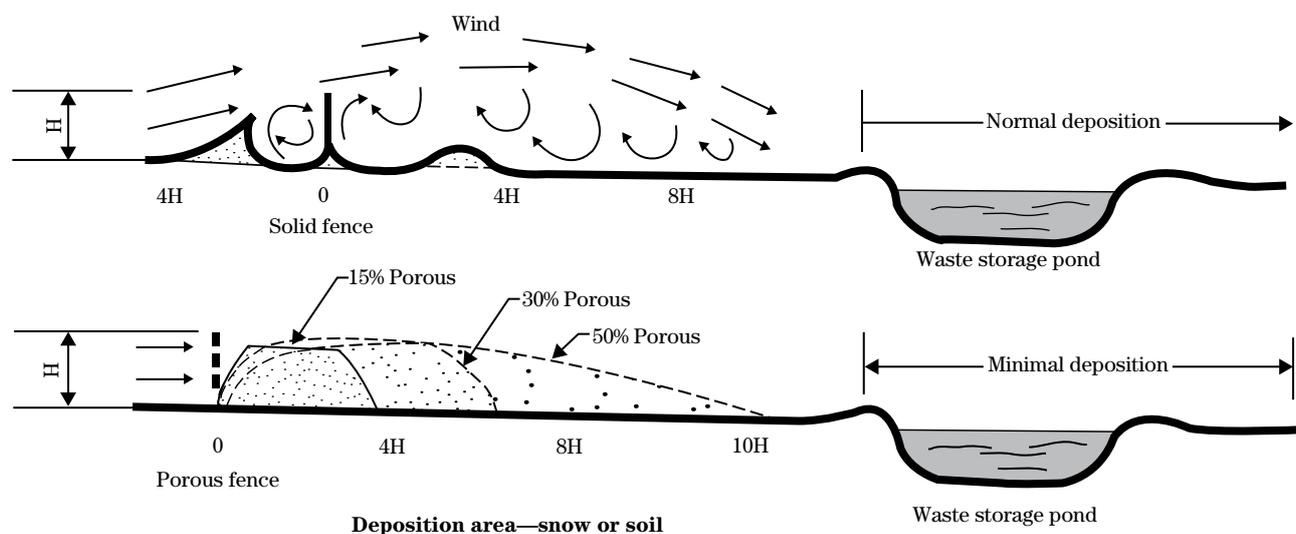
growing time, often provides additional multiple benefits. A second fence may be required near windbreaks to prevent livestock from damaging the vegetation. Figure 8–26 illustrates how a fence and multiple rows of vegetation with 50 percent porosity influence deposition.

Agricultural waste facilities that have the back wall protected from the wind, such as an open-front dry manure storage building, tend to have some snow accumulation just inside the front door. To prevent this, a 6- to 8-inch slot can be cut in the rear wall near the eaves to provide some wind penetration.

Ice buildup can be reduced by considering shade patterns of buildings and vegetation. Because deciduous trees shade only in summer and allow heat-generating sunlight in the winter, they are more effective than evergreens in regulating a microclimate affecting ice and snow accumulations. A mixture of deciduous trees and evergreen understory can often provide a desired screen during winter while serving the need to minimize buildup.

Fences used for wind control should not connect directly to the corner of buildings, otherwise wind

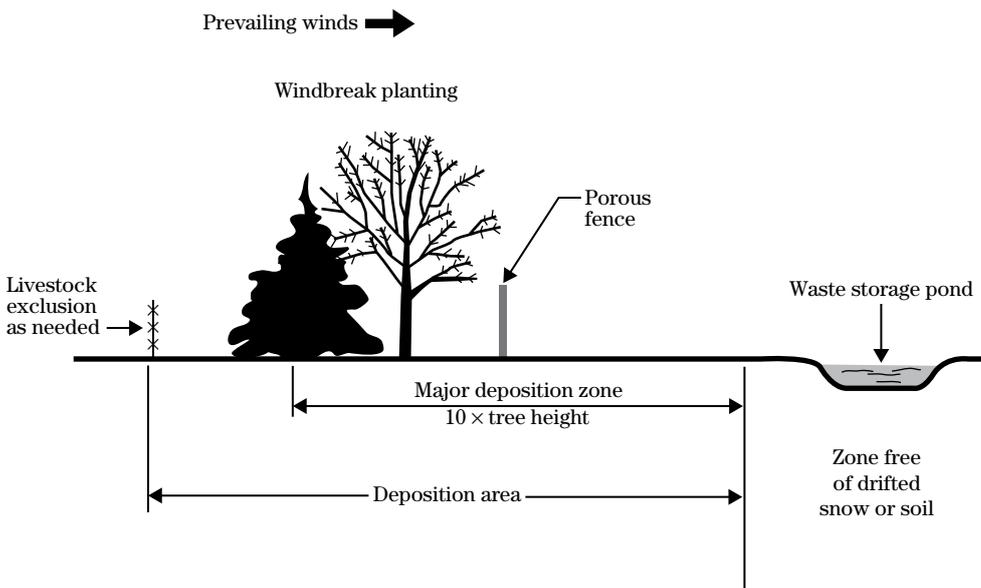
**Figure 8–25** Fence porosity affects snow deposition



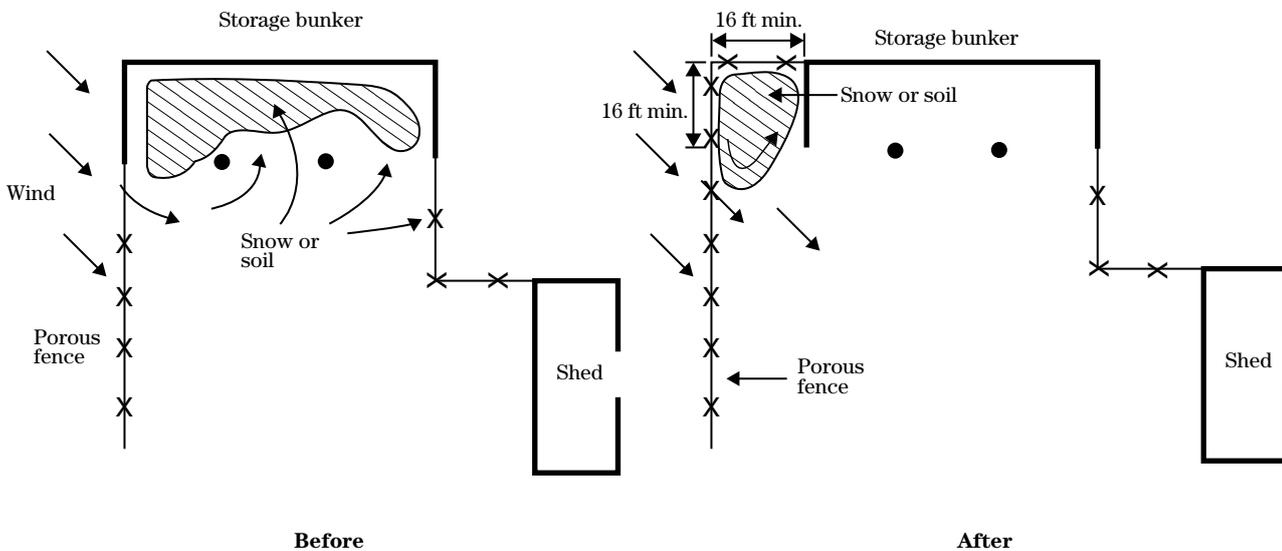
and snow can be directed inside the building. Fences should be placed at least 16 feet out from the building and 16 feet from the corner as illustrated in figure 8-27. Any gates should be of the same height and porosity as the rest of the windbreak fence.

The prevailing wind direction for a site can be determined by looking at wind rose diagrams (fig. 8-28). Search the Internet for the NRCS Water Climate Center; navigate to Climate → Climate Data → Wind Data for U.S. → Wind Rose Data Sets, then select the nearest weather station to the site. Use the wind rose diagrams to determine the frequency of prevailing winds.

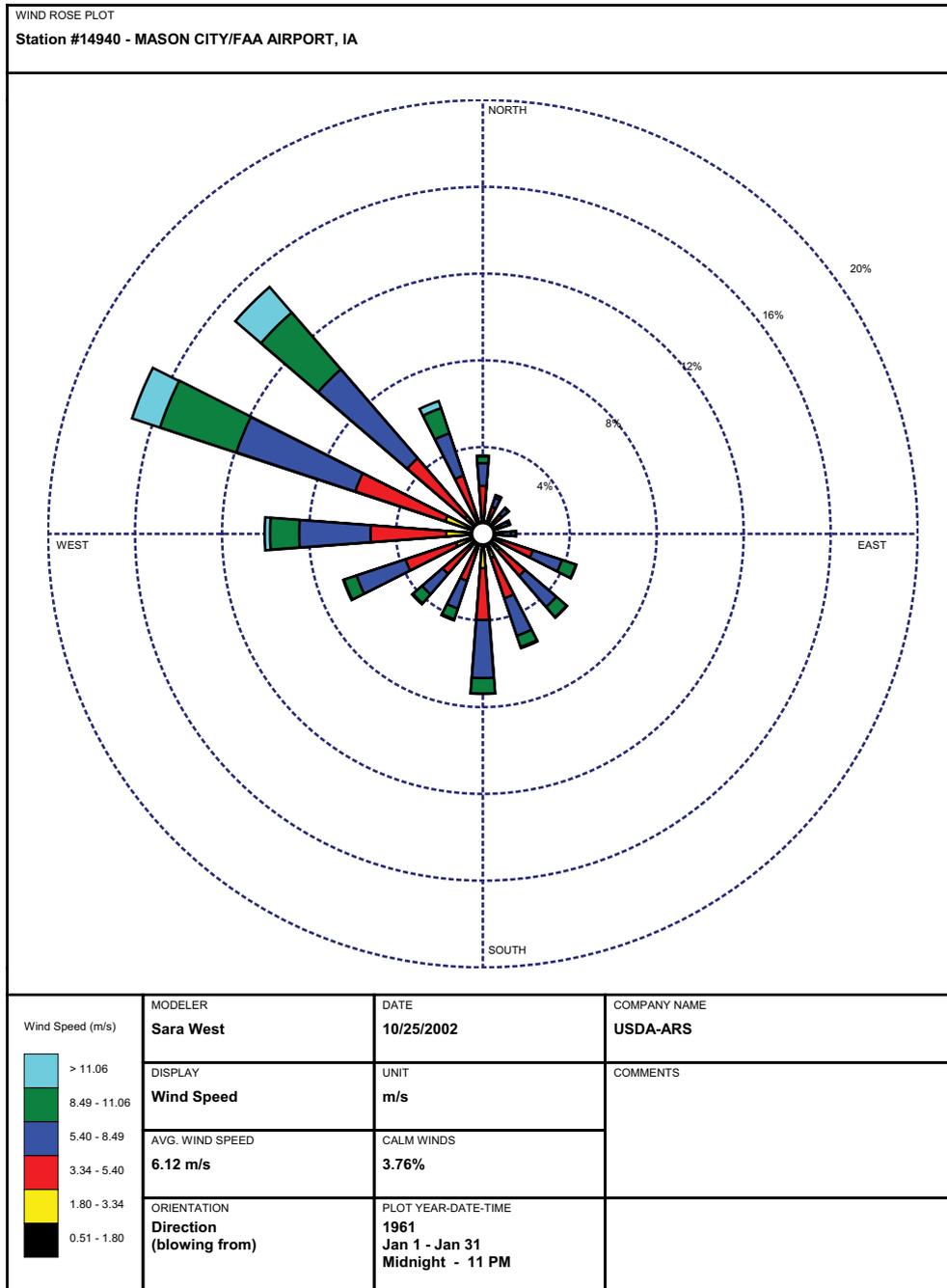
**Figure 8-26** The combination of fence and windbreak plantings greatly enhances the pattern of snow and soil deposition.



**Figure 8-27** Fences affect snow and soil deposition around buildings.



**Figure 8–28** Wind rose diagrams can be used to determine prevailing wind directions. This wind rose diagram is for January from Mason City, IA.



**Note:** Wind speeds shown are in meters per second (m/s). To convert into miles per hour (mi/h), multiply by 2.237. Thus, the 6.12 m/s wind is a 13.7 mi/h wind.

**(g) Water quality**

The design of an AWMS must consider measures to improve and protect water quality. Water bodies in close proximity to the waste source are more susceptible to contamination. Many states have ordinances that define setbacks and buffer requirements when siting AWMS near water courses.

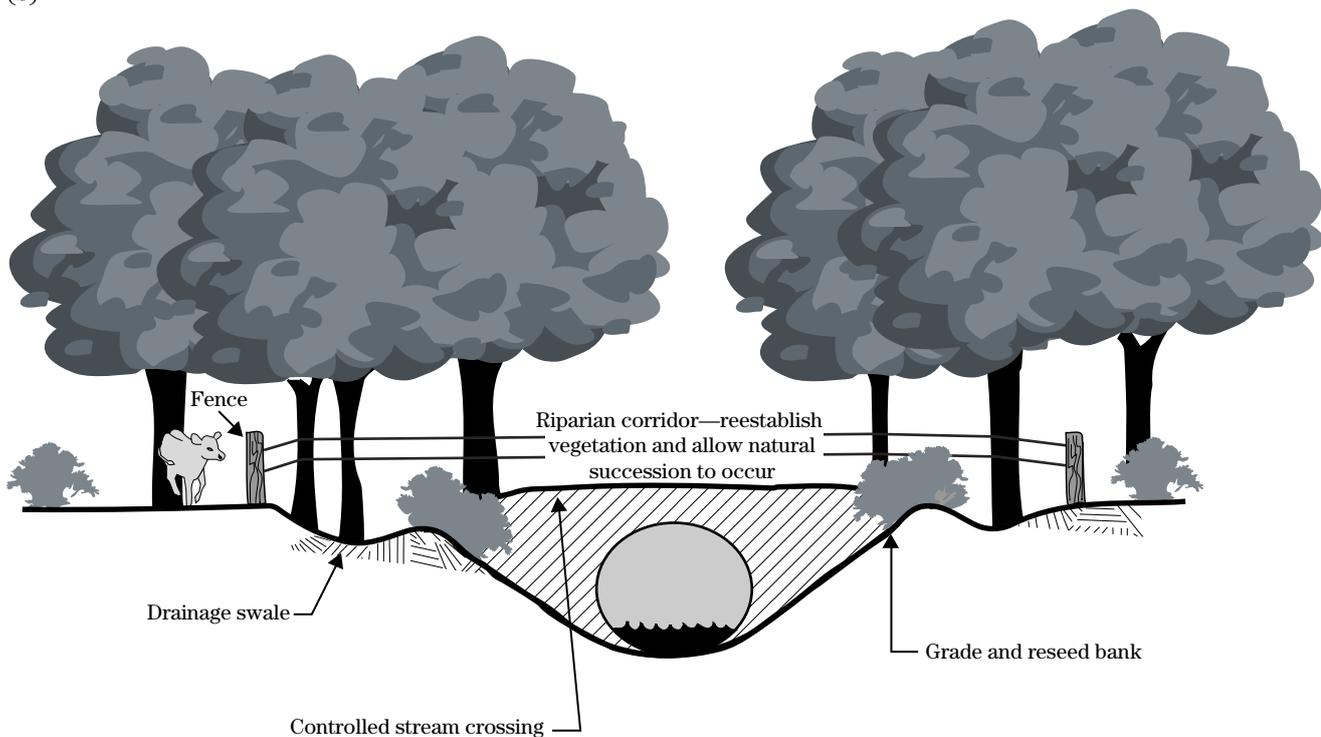
Relocating a pasture to an area further from a stream is often the best solution in preventing degraded streambanks and animal waste from entering the stream (fig. 8–29(a)). Because this is not always possible, such measures as fencing, controlled stream crossings, and regraded and revegetated streambanks can aid in minimizing transport of contaminants in runoff from directly entering the stream (fig. 8–29(b)).

**Figure 8–29** Streamside measures improve water quality

(a)



(b)



Developing a new AWMS or adding to an existing system often presents an opportunity to improve runoff management. The following can be used to minimize muddy areas and contaminated runoff: adding diversions; using roof gutters to separate precipitation from waste sources; paving feedlots or loafing areas, drainage swales; and filter strips.

## (h) Noise

Noise is defined as unwanted sound, such as diesel engines, pumps, and electrical equipment. Some AWMS components can generate undesirable levels of noise. These components should be sited to minimize potential conflicts or abatement measures may be needed. Noise levels are reduced by increasing the distance from a noise source, terrain, vegetation, and natural and human-constructed obstacles.

Noise sources are defined as either point source (stationary) or line source (moving). A roadway would be an example of a line source, and an irrigation pump would be an example of a point source. Sound levels are measured in decibels (dBA) and an increase or decrease of 10 dBA in the sound pressure level will be perceived by an observer to be a doubling or halving of the sound. For example, a sound at 70 dBA will sound twice as loud as a sound at 60 dBA.

Noise levels decrease with distance. Point source noise will decrease by 6 dBA for each doubling of distance. Line source noise varies differently with distance, because sound pressure waves are propagated all along the line and overlap at the point of measurement. It drops off less, about 4.5 dBA for each doubling of distance (if the ground is predominately in pavement 3 dBA is used).

Noise impacts from AWMS can occur when sound levels are unacceptably high (absolute level) or when a proposed component will substantially increase the existing noise environment (substantial increase).

Acceptable absolute levels for various human use areas can be placed into four broad classes of noise abatement criteria (NAC):

- Class A—lands on which serenity and quiet are of extraordinary significance (60 dBA NAC).

- Class B—picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals (70 dBA NAC)
- Class C—developed lands, properties, or activities not included in classes A or B above (75 dBA NAC)
- Class D—undeveloped (no NAC)

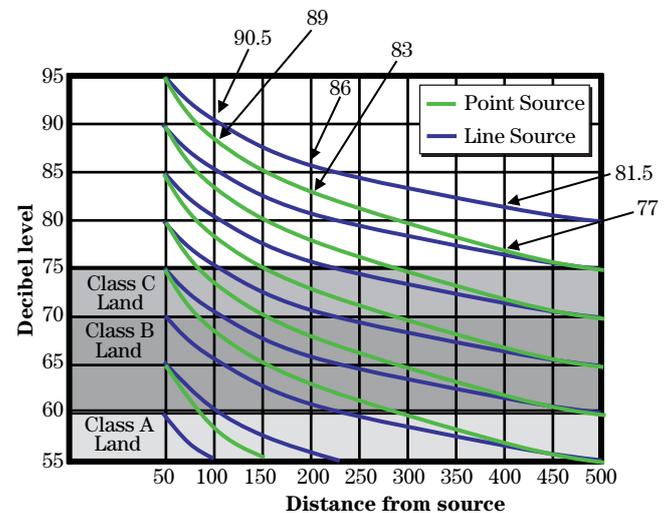
Each class has been assigned a NAC dBA level. The Federal Highway Administration developed the NAC for determining when to use noise barriers next to highways. It is based upon noise levels associated with interference of speech communication. The NAC are a compromise between noise levels that are desirable and those that are achievable.

A substantial increase in noise levels can be described as:

- 0–5 dBA—no increase
- 5–10 dBA—minor increase
- 10–15 dBA—major increase
- >15 dBA—substantial increase

Figure 8–30 can be used to determine how much noise levels will decrease with distance. The figure can also be used to determine if noise from AWMS will be a problem to adjacent land uses. For example, if a 85

**Figure 8–30** Noise reduction by distance from source



dBA pump (point source) is located within 100 feet of a residential area (class B land), the noise level would be 78 dBA, which is above the 70 dBA noise abatement criteria for that class. The 8 dBA would be considered a minor increase. If the pump could be relocated to be at least 300 feet from the use area, the dBA would be within the class B 70 dBA criteria. If the pump cannot be relocated, noise abatement measures may be needed.

Solid walls or earthen mounds are effective noise barriers and can reduce noise levels by 10 to 15 dBA, cutting the loudness of noise in half. Vegetative barriers are less effective; wide barriers are needed and only reduce noise levels from 5 to 8 dBA. For a noise barrier to work, it must be high enough and long enough to block the view of the source.

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**Structures**

- \_\_\_\_\_ 1. Will the roof line, shape, materials, and color of proposed structures be designed to blend with existing structures?
- \_\_\_\_\_ 2. Will proposed structures be located where their size and shape contribute to snow and ice management; wind or air flow reduction, promotion, or dispersion; cooling from shade; or windblown soil deposition?
- \_\_\_\_\_ 3. Will outdoor lighting be installed at strategic spots, such as near steps or equipment areas, for safety and security?
- \_\_\_\_\_ 4. Will signs be easily recognizable, legible, and uniform in appearance?
- \_\_\_\_\_ 5. Will visual clutter be reduced by attaching signs to walls or other available structures? Can any signs be combined?
- \_\_\_\_\_ 6. Can fences and walls be combined with plantings?
- \_\_\_\_\_ 7. Will fences be uniform throughout the site to visually link discontinuous parts?
- \_\_\_\_\_ 8. Will fences and walls be properly sited to prevent cold air pockets or snow, ice, and soil accumulation, or to capture sun for maximum comfort levels, or to promote, disperse, or reduce wind or air flow?
- \_\_\_\_\_ 9. Will fences and other linear components be located at existing landscape edges to enhance compatibility?
- \_\_\_\_\_ 10. Will fencing be installed along ridges or the top of landforms where it is emphasized on the landscape? Could it be relocated at the bottom of the slope or below the horizon and still maintain its intended function?

**Landforms**

- \_\_\_\_\_ 1. Will the plan consider highly erodible or ecologically important areas (steep slopes, areas with highly erodible soil, streambanks, natural areas, wetlands)?
- \_\_\_\_\_ 2. Will disturbed areas be as small as possible?
- \_\_\_\_\_ 3. Will established slopes be left undisturbed where possible?
- \_\_\_\_\_ 4. Will grade changes be natural appearing slopes that avoid abrupt transitions?
- \_\_\_\_\_ 5. Will new construction fit elevations of existing landforms rather than requiring grading of the land to a continuous level, which may destroy its character?
- \_\_\_\_\_ 6. Will grading and any new landforms allow successful runoff while assuring that the site is suitable for the agricultural waste management system?
- \_\_\_\_\_ 7. Will excess excavated soil be used to create landforms to act as screens to buffer noise or to promote, disperse, or reduce wind or air flow?

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## Vegetation

- \_\_\_\_\_ 1. Will existing vegetation be retained to serve its important mitigation functions, such as screening, shading, wind or air flow reduction, promotion, or dispersion; erosion control; odor or particulate; and separation of incompatible uses?
- \_\_\_\_\_ 2. Are roads of AWMS components designed to minimize disruption of vegetation?
- \_\_\_\_\_ 3. Will roads, pathways, turnarounds, or other system components permit safe retention or introduction of vegetation?
- \_\_\_\_\_ 4. Will required vegetative removal be staged to decrease the area and duration of exposure thus reducing erosion/sedimentation potential?
- \_\_\_\_\_ 5. Will removal of vegetation impact adjacent properties?
- \_\_\_\_\_ 6. Will vegetation provide a buffer, visual barrier, wind or air flow reduction, promotion, or dispersion, and/or odor or dust mitigation, for adjacent properties?
- \_\_\_\_\_ 7. Will new vegetative species and patterns be based on those occurring naturally or appear compatible with those onsite and in the region?
- \_\_\_\_\_ 8. Will measures be used during construction to protect trees or other vegetation and if so, how successful will they be?
- \_\_\_\_\_ 9. Will the survival rate of installed vegetation be acceptable? If not, what corrective measures can be used to guarantee establishment?
- \_\_\_\_\_ 10. Will vegetation be protected from livestock?

## Water quality

- \_\_\_\_\_ 1. Will existing waterways be used and maintained for full value (open space, landscape character, and wildlife habitat)?
- \_\_\_\_\_ 2. Will the design include measures to prevent runoff from draining across disturbed areas during construction?
- \_\_\_\_\_ 3. Will the design preserve, restore, or enhance streambank vegetation?
- \_\_\_\_\_ 4. Are slope changes designed for minimum slope length and gradient?
- \_\_\_\_\_ 5. Where steeper slopes are unavoidable, will diversions be installed to intercept runoff before it reaches slopes?
- \_\_\_\_\_ 6. Will components be located at sufficient distances from streams and wells to meet local and state ordinances?
- \_\_\_\_\_ 7. Will vegetative filter strips be retained or installed to slow down runoff, trap sediment, and reduce runoff volumes on slopes?

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- \_\_\_ 8. Will clean water be diverted from the waste storage facility?
  - \_\_\_ 9. Will animals be provided with alternative water sources so they can be kept out of streams and ponds?
  - \_\_\_ 10. Can clean water be diverted to storage for such future uses as irrigation and stock watering?
  - \_\_\_ 11. If aquifer recharge is desired, will clean water runoff be directed to retention and infiltration facilities?
  - \_\_\_ 12. Where concentrated runoff leaves paved areas, will provisions be made for stabilized outlet points?
  - \_\_\_ 13. Will runoff be directed away from adjacent properties?
  - \_\_\_ 14. Will the design use paved watercourses where grassed swales would suffice?
  - \_\_\_ 15. Will roadways contribute to effective stormwater runoff management?

### Visual quality

- \_\_\_ 1. Will the AWMS components retain or improve the visual quality of the farmstead and surrounding landscape?
- \_\_\_ 2. Will the AWMS take full advantage of the natural features of the site?
- \_\_\_ 3. Will the building materials and finishes be compatible with those existing?
- \_\_\_ 4. Will color be used either to visually organize features on the site or to direct the eye away from undesirable views?
- \_\_\_ 5. Will concrete and other building materials be textured or tinted to blend it into the landscape or reduce reflective surfaces?
- \_\_\_ 6. Will the design allow for retention of landscape features with special meaning, such as specimen trees, exceptional views, or historic structures?

### Compatibility

- \_\_\_ 1. Will the measure adversely impact adjacent properties?
- \_\_\_ 2. Will the reaction of community and nearby residents to the completed AWMS be positive or negative? What changes might obtain a more favorable response?
- \_\_\_ 3. Will the measure be compatible with adjacent developments in terms of land use, density, scale, identity and overall design?
- \_\_\_ 4. Will structures, landform, water, and vegetation be used fully to buffer incompatible land uses?

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## Visibility

- \_\_\_ 1. Will views from adjacent landowners and roads be considered in locating AWMS components?
- \_\_\_ 2. Will views from farmstead be considered in locating AWMS components?
- \_\_\_ 3. Will visual screens be tall enough to block views?

## Odor reduction

- \_\_\_ 1. Will the design utilize fencing, structures, and/or vegetation for wind or air flow reduction, promotion, or dispersion, and/or odor or dust mitigation?
- \_\_\_ 2. Is the animal waste facility sited downwind as far as practical from the farmhouse and neighbors?
- \_\_\_ 3. Will the design provide maximum sunlight for biological decomposition?
- \_\_\_ 4. Will the site of waste generation be designed to be as well drained as possible?
- \_\_\_ 5. Will vegetation and water bodies be used to keep waste materials at optimum temperatures to prevent odor generation?
- \_\_\_ 6. Will the design use landforms, vegetation, and structures to direct wind over or away from sources of odor?
- \_\_\_ 7. Can equipment, work areas, storage areas, and livestock be kept as clean as practical?

## Temperature and moisture control

- \_\_\_ 1. Will the species of pests on site be identified in order to control them at all stages of their development?
- \_\_\_ 2. Has an Integrated Pest Management plan been considered?
- \_\_\_ 3. Will breeding sites be reduced by improving drainage, increasing sunlight and ventilation to manure generating sites?
- \_\_\_ 4. Will vegetation placed around buildings and other AWMS components reduce pest breeding and nesting sites?
- \_\_\_ 5. Will measures be installed for energy conservation (exposure to wind and sun, vegetation for shading)?
- \_\_\_ 6. Will new structures be oriented and architecturally designed to benefit from or modify solar generated heat and prevailing winds?

## Circulation

- \_\_\_ 1. Will adequate pathways be provided for animals and humans?
- \_\_\_ 2. Will paved walkways function to direct surface runoff?

- \_\_\_\_ 3. Will drainage improvements interfere with vehicular, pedestrian, or animal circulation?
- \_\_\_\_ 4. Will pedestrian, animal, and vehicular traffic be adequately separated?
- \_\_\_\_ 5. Will maintenance access routes serve as pedestrian/animal walkways?
- \_\_\_\_ 6. Will roads, pathways, and parking areas be designed to follow the shape of the land, thereby reducing costly grading and land disturbance?
- \_\_\_\_ 7. Will roads, pathways, and parking areas be designed to allow for future expansion or change in size of equipment?
- \_\_\_\_ 8. Will roads, pathways, and parking areas be designed to minimize disruption of vegetation and cropping practices?
- \_\_\_\_ 9. Will roadways interrupt pedestrian and animal pathways?
- \_\_\_\_ 10. Will sight distances be adequate for safe turning maneuvers?
- \_\_\_\_ 11. Will access points onto highways be located at safe distances from intersections? Will warning signs reflectors, or lane striping be installed as appropriate?
- \_\_\_\_ 12. Will roads avoid wetlands, meadows, creeks, and other ecologically critical areas?
- \_\_\_\_ 13. Will circulation routes be wide enough to accommodate anticipated traffic?

## Noise

- \_\_\_\_ 1. Will adequate sound barriers be provided for noise abatement?
- \_\_\_\_ 2. Will the sound levels be in accordance with Noise Abatement Criteria, (NAC)?