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LAND CLASSIFICATION FOR USE IN PLANNING

THE sequence is familiar all over the country. The cover of trees or other vegetation is ripped from the land. Foundations are dug in soils not before used for building. Houses go up. Wells are dug, for there is no city water supply. Septic tanks are installed. Roads and curbs are placed. Parks and other public facilities are laid out. Acres of farmland or woodland are transformed in a short time into a new, treeless development.

It is another place where hundreds of families can see their dreams of modern houses, lawns, and gardens come true. Unhappily for many, the dream becomes a nightmare.

The septic tank does not function properly, and the water in the well is polluted. Floods menace houses in lowlands. Cracks appear in outside walls. Foundations slip. I can give scores of examples of these and other ruptured dreams and the loss and inconvenience that occur when poor sites are selected for homes.

Nor is the loss confined to private dwellings. In Fairfax County, Va., a site for a new school was obtained, and construction began. It was soon evident that the soil, high in content of unstable clay, would not keep the planned foundation from settling. A more substantial foundation added about a quarter of a million dollars to the cost of construction. Another place within the school property and only a few hundred feet away was well suited as a site for the building.

When foundations settle and crack, when new road pavements buckle and break, when septic tanks fail, or when floods drive people from their homes, the loss to the individual, the community, and the Nation normally is not the result of an unpredictable whim of Nature. It is the result of not knowing the soils on the landscape.

But how can a school board be expected to know that soils on a site they selected for a new school will not bear the load of the structure? Or how can they know that some soils swell when wet and shrink when dry and thus exert stresses that tear apart anything but an expensive, sturdy foundation?

How does a planning board, or zoning board, or county governing body discover that one site is suited to septic tanks and another is not? How do they know which sites are subject to a high water table during winter, spring, and long wet spells?

Appearance at the surface may tell them nothing, yet they need to know about these things if they are to approve or disapprove an area when a developer or contractor requests permission to build.

Actually, it is no more reasonable to expect that these people will be able to tell good soils from poor soils than it would be to expect an untrained person to repair a watch or fly a jet airplane.

Many contrasting soils look alike at the surface, even to an expert. To find their worth for any particular purpose, we must dig into them. We must observe closely, and with understanding, the properties of each layer, and to think how these affect the intended use.

Many soil properties do not change, but their significance does, according to the intended use, whether it be digging a foundation, building a road, laying a waterline, planning a park, or simply selecting a plot for a garden.

That is the job of soil scientists, men who are trained in mapping, classifying, and interpreting soils. Since 1900, soil scientists have helped farmers, ranchers, foresters, and others who produce food and fiber. They have investigated the different kinds of soil in the United States and have prepared detailed soil maps for many counties and areas. Each year they map additional acres. About 55 million acres had been mapped in 1963.

Although civil engineers and soil scientists began to work together in 1925 or so, only during this recent time of rapid growth of the metropolitan fringe have urban planners and developers learned about soils. Now they have a new awareness that soil scientists can help them avoid costly failures and aid them in discovering savings in design and construction. With costly designs, houses and roads can be built on soils that are poorly suited for that use. Unfortunate experiences on those sites, however, often lead to overdesign and extra costs on soils that are well suited for houses and roads.

Great losses still occur, but the trend is downward.

Businessmen in Atlantic, a city in Cass County, Iowa, had a soil scientist interpret soil maps before they selected a tract for a golf course. The scientist inspected the proposed sites with the builders. He described the soils on each site and assessed their suitability for greens, fairways, and roughs. Then each site was evaluated, and costs for construction and landscaping were estimated. Because they then could select a site that had no unfavorable soils, contracting costs were 30 thousand dollars less than on any of the other sites proposed. The cost of seeding and maintaining fairways also was less. The soil scientist found a suitable site for a pond on the course to store water. He located sand that could be used in establishing a proper mixture of silt and sand for the subgrade of the greens.

In the town of Wilton, Conn., an owner of 22 acres planned to develop a site for housing. The planning commission could not issue a permit because of the flood hazard from the Norwalk River. A community club, aware of a need for outdoor recreation, asked a soil scientist to determine the suitability of the tract as a recreation area. He showed the area to be suitable for a pond and a park. The people of the community bought the acreage and made an attractive sandy beach, which borders a spring-fed pond for swimming and skating.

In Stamford, Conn., a suggestion arose to convert a 30-acre swamp to a city dump. But property values nearby would be lowered. Study of a soil map showed the tract to be well suited for a recreational area. Some drainage was installed, and several ponds for wildlife were built. The people of the community now use this area for fishing, skating, hiking, and observing the wildlife attracted by the ponds.

These examples illustrate the advantages of using soil maps. Homeowners, farmers, engineers, real estate dealers, planners, and others benefit from information on soil maps in hundreds of ways. They help people in growing flowers, shrubs, grass, and trees; in growing corn, cotton, wheat, and truck crops; in building highways, schools, and homes.

To GET FULL advantage from the maps, however, we need to know more about the methods the soil scientist uses and about the kinds of maps he makes.

Most soil scientists are employed by Federal and State agencies. The Soil Conservation Service, an agency of the Department of Agriculture, employs approximately 1,500 soil scientists, who are stationed in all States.

Soil scientists prepare the maps and the descriptions that accompany them as part of a broad cooperative program, called the National Cooperative Soil Survey. The Soil Conservation Service is the agency that has primary Federal responsibility for making soil surveys. All of the work is cooperative with the State agricultural experiment stations and other Federal, State, and local agencies. This work includes field and laboratory investigations, classification of the soils according to a national system, and publication in a standard series by the Department of Agriculture.

Soil surveys have been published for many counties in the United States. Preliminary reports and maps for many other areas can be seen in local offices of soil conservation districts or in the office of participating State and local agencies. The unpublished maps can be interpreted and used for planning purposes.

The soil scientist walks over the land, and studies the soils, vegetation, and features of the landscape. With his knowledge of soil genesis and soil behavior, he classifies the different kinds of soils and records their boundaries on a map.

He identifies the different soils by digging holes and examining the layers of soil, usually to a depth of 5 feet. He can make predictions, however, about the nature of the soil material below 5 feet for soils that derive from uniform parent materials.

He examines the thickness and arrangement of each layer; its color; the proportion of sand, silt, and clay; the shape, size, and consistence of the natural aggregates; the kind of parent material; the number of stones; acidity or alkalinity; and the content of organic matter. He evaluates other features that have importance to the use of soil.

Each of the many thousands of different kinds of soil in the United States are described in terms that have special meaning to soil scientists. The properties of each layer are studied and evaluated. The important properties are compared with those of similar soils that have been named in the national soil classification system. A soil that is unlike all others classified to date is given a new name.

We can transfer experience and information from one place to another when we have named and classified the soils. If we find that septic tanks do not work satisfactorily on some kinds of soil, for example, the results of such experience can be applied to other areas that have the same kinds of soil. Thus knowledge about the soils can be related to the problems and management of other areas of similar soils.

Then, from what the soil scientist has seen and determined by tests and from his knowledge of soil research and experience in the area, he draws inferences concerning the soil qualities that cannot be seen. This is the kind of information that can be useful to farmers, suburbanites, and others and can prevent costly mistakes.

He has observed, for example, grayish or bluish colors in the soil; from that he can infer poor drainage. Or by observing, molding in his hands, and perhaps obtaining laboratory tests on certain soil layers, he learns that it is of the kind that swells when wet and shrinks when dry. From this he infers undesirable stability and strong resistance to penetration of water.

When the qualities of the soil have been determined, the soil scientist can make predictions concerning its behavior. The soil with the bluish-colored layers may not be suitable for houses requiring septic tanks, but it may be suitable for agriculture, parks, recreation, or other uses.

Soils poorly suited for residential use may be well suited for growing agricultural crops. Some kinds of crops may be better adapted than others. By recording and assembling research data and experiences by kinds of soil, he can make predictions and suggest alternative uses. The soils can be rated or grouped into classes ranging from the best to the poorest for a specific use.

The soil scientist is impartial in his interpretations. He does not suggest what the use of any soil shall be. He predicts what its behavior will be under specified uses. The decision on use is left to the owner, buyer, or others concerned.

The soil scientist checks his predictions about soil behavior by studying the results of research and experience on known kinds of soils. He prefers data from research farms or plots, because on these the soils have been tested under controlled conditions, and the results have been tabulated. The Department of Agriculture and the State agricultural experiment stations have many research plots on identified kinds of soil.

Where such data are lacking or insufficient, the soil scientist depends more on his observation of crops in farmers' fields, of trees in woodlands, of plants on ranges, of highways on different kinds of soil, and so on. He examines areas where drainage, irrigation, or sewer systems have failed.

THE NEXT STEP is to design a map that will best serve all who can benefit from the information that has been recorded about each soil.

The detail of mapping depends on the location of the area, what investigation has shown to be the potential of the soils, what demands are now made of the soils, and what demands will probably be made in the future.

Soil maps are designed for use by farmers and those who work with them in planning the management for farms and fields. The increasing complexity of agriculture has created a demand for more and more detailed soil maps and more precise interpretations.

These modern soil maps, although designed mainly for agricultural use, can be interpreted for soil engineering, urban planning, and other purposes.

Soil maps are made at different intensities and scales, depending on the needs of the person who uses them. Two different levels of intensity commonly are made—general soil maps and detailed soil maps.

General soil maps show the soil resources for broad areas and their suitability for different uses. They are suited for the general planning of broad areas and usually cover a township, county, or several counties.

The general soil map is drawn on a small scale that covers an entire county or equivalent area and shows the different patterns, or associations, of major soils on the different kinds of landscape. A map of this kind may be made at a scale of a quarter of an inch to the mile and show as many as 10 different soil associations. Each soil association has its own pattern of soils.

By rating the soils according to their suitability for a particular use, one can determine the areas that are well suited or unsuited for that use. Such information is useful to those who are studying large areas for residential, industrial, or recreational development. It is also useful to farmers, food processors, and others who are searching for large areas that may be suitable for growing certain crops.

General soil maps give planning and zoning groups valuable clues to the location of broad areas suitable for various uses. Having found areas that are suitable for a particular use, they can then use the detailed map, at its larger scale, to achieve more precise selection of sites.

A DETAILED soil map, frequently at a scale of 4 inches to the mile, is made on an aerial mosaic that shows such features as natural drains, rock outcrops, lakes, ponds, levees, railroads, roads, powerlines, and buildings.

A detailed map provides the nearest practical approximation of the shape and extent of the areas of each kind of soil. Nevertheless, it is not feasible to show on a detailed map the exact boundaries of every area of each kind of soil, nor to delineate separately those areas of a given kind of soil that occupy 2 acres or less. Thus, an area delineated on the detailed map, and named for a given kind of soil, may contain up to 15 percent of another kind of soil. Also, soils of different kinds can occur in such intricate patterns that it is not practical to separate them at the scale ordinarily used for detailed soil maps. Boundaries are drawn around areas of such intricately mixed soils, and the soils within the boundaries are described and named as complexes.

In using a detailed map, therefore, one has to know that small areas of highly contrasting soils may lie within any area shown on it. The presence of contrasting soils in an area used to grow plants may not be of particular significance, but may be of critical importance in building a road, house, or swimming pool. It is therefore necessary to go to the site tentatively selected for a structure and examine it carefully. Preliminary inspection of the detailed map, however, shows which sites are definitely not suitable for the proposed structure; thus the number of the field examinations that otherwise would be needed is reduced.

The detailed soil map, properly interpreted, provides planning and zoning boards and other local government officials with the kind of information about soils that they need to approve or reject requests for development.

Before they can rule on an individual building application, however, they need to inspect the lot. Inspection of the detailed map shows whether a lot is subject to flooding, but it may not be precise enough to indicate tiny beds of peat, muck, or gravel that would seriously affect construction.

For example, a planning group receives a request for development of a subdivision beyond present sewerlines. The soil map shows that some of the soils in this area are slowly permeable, others have a high water table part of the year, and still others are less than 3 feet deep over rock. The local officials can point out these limitations and suggest changes to fit the soils or reject the request for development on the basis that the soils are not suited for residential use.

WHEN THE SOIL scientist has named, described, and mapped the soils in his area, he works out ways to present the information in a way convenient for people to use for their needs.

Interpretations can be made for the individual kinds of soil or they can be made by grouping the soils that respond similarly to use and management. More precise interpretations can be made for the individual kinds of soil, but soil groupings are helpful for some uses.

Soil groupings help introduce some map users to the more precise information on soil maps. For that reason, many groupings of soils have been worked out, each designed to serve specific users. The basic principle for each of these groups, whether for city planners, farmers, woodland managers, or ranchers, is that of placing together soils similar in the characteristics and qualities that affect the intended use.

Thus for many years groupings of soils have been primarily for farmers who grow cultivated crops; other groupings for those who produce trees; and yet other groupings of soils for those who manage rangelands. More recently, groupings have been made that show relative suitability for use for recreation and wildlife refuges and for septic tanks, roads, and other structures based on engineering tests.

Depending on the need, the soil scientist can prepare a number of different groupings and interpretations of soils, since he has recorded, in detail, the nature of each kind of soil in the area he has surveyed.

A FAMILIAR SYSTEM of grouping, one used by the Soil Conservation Service to help farmers develop conservation plans on their farms, is the land-capability classification. It provides information about soils at three levels of generalization—the capability unit, the capability subclass, and the capability class.

The capability unit, a group of soils similar in management needs and in response to that management, contains the most specific interpretations of the three. It is valuable in planning management of individual farms and fields.

The subclass is a grouping of capability units similar in kinds of limitations and hazards. Four general kinds of limitations or hazards are recognized: Erosion, wetness, root-zone limitations, and climate.

The third and broadest category places all the soils in eight capability classes. The risks of soil damage or the limitations in use increase as the class numbers increase from I to VIII. Soils in class I have few or no limitations when used for common cultivated crops, but those in class VIII will not justify inputs of management without major reclamation.

Soils are grouped into capability classifications primarily on the basis of their ability to produce common cultivated crops and pasture plants without soil deterioration over a long period of time. This soil grouping helps farmers to understand their soil and water conservation problems and to see which areas are best suited to cultivation and to permanent vegetation. The classification also shows them the hazards and limitations to use of the different soils on their farms.

Other groupings are more commonly used to express the suitability of soils for range and woodland. In like manner, soils are also grouped to show their suitability as sites for homes, public buildings, and similar structures. Many other special groupings can be made according to the need.

Community planners, local officials, developers, contractors, and prospective homeowners are not experienced in interpreting soil maps and cannot be expected to know all the characteristics and qualities of soils that are likely to affect their suitability for urban uses. Through the use of soil maps, however, they can learn about some of the major soil properties that influence the use of the soil.

PREDICTIONS can be made about the hazard of runoff and erosion.

The results of erosion can be seen in most urban-fringe areas. It is a serious problem on some kinds of soil, especially in places where contractors unnecessarily scalp the surface of all vegetation and leave the soil bare for long periods. The amount of soil that washes downhill depends on the kind of soil, the amount and intensity of rain that falls, and the cover on the surface.

Runoff water from heavy rains erodes the soil, and concentrated runoff cuts gullies in most soils. The sediment fills the basements of partly built houses, washes out streets, damages newly dug or filled areas, clogs up ditches and culverts along roads, and fills lakes with silt.

The developer has to clean up the area he owns and must try to regain his expenditure for this by increasing the price of his product in a competitive market. The community, and perhaps more than one community downstream, has to tolerate the damage done outside the development or take measures to remedy it.

By no means all of the erosion takes

place during the year or two that the soils are exposed during completion of the development.

When the homes, streets, and parking lots are all built, less area of soil is exposed to absorb water. Before the area of exposed soil was reduced by roofs and pavement, perhaps most of the gentle rains were absorbed. But in the same area, after much of it is under roof and concrete, a gentle rain can build runoff of destructive volume.

The water goes in one direction—downhill.

Suppose, then, that the lower end of a watershed has been developed and its storm sewers and water disposal systems have been installed. This older community may be suddenly confronted with a flow of water that its storm sewers cannot handle. It is water coming from the new development above—water that once soaked harmlessly into the soil.

This need not happen.

No one should be allowed to disturb a lot or tract of land for nonagricultural use without first obtaining a permit from the county or local officials. They should have a master plan for future expansion that is based on the potential needs of the area and on information from soil maps.

The maps will provide local authorities, the developers, contractors, and property owners with the location of the different soil areas and the predictions concerning the suitability of the soil for various uses. The master plan should show location of sewage disposal systems, water and sewer lines, roads, and parks. It should include a plan for controlling erosion, controlling sediment, and disposing of water. The plan should be for a watershed, and it should be based on the probable hazards when the watershed is fully developed.

The plan a contractor or developer presents should show where the lots, houses, and roads will be located; explain his plans for control of sediment and water; specify the size and location of waterways, storm sewers, and diversion terraces; and indicate how he will use vegetation as a means of controlling erosion. The local officials then should approve this plan only if it meets requirements of the master plan.

Every effort should be made to acquaint developers, contractors, and others with the master plan. Soil maps, and their interpretations, should be available for reference. With the aid of a soil map, the developer should be able to plan for maximum utilization of the soils. Soils not suited for houses can be used for streets, parks, and other uses. Size and layout of building lots can be planned to fit the soils and topography of the area.

Shrinking and swelling of soil material is critical in selecting sites for structures, but that quality is not detected easily. Soils that contain unstable clays, even if nearly level, swell when wet and shrink when dry. Buildings placed on such soils shift and crack unless they have a sturdy foundation. Underground pipelines may break. Buildings placed on sloping soils of this kind may be damaged when the unstable soil slips downhill. If the shrink-swell properties of soils are known, it will not be necessary to overdesign structures built on soils that do not shrink or swell significantly.

Some soils tend to run when wet and fail to support foundations or other structures. Organic soils—peat and muck—are poor sites for construction because of their low ability to support loads. These organic deposits that the engineer wants to avoid may be sought by landscape supply businesses.

Wetness can seriously affect the suitability of a soil. A soil that is wet to the surface the year around is not a suitable site for construction. The soils that can cause serious trouble for the unsuspecting are those that are wet only part of the year, or that have a water table that moves up and down without reaching the surface, or that absorb water too slowly or too rapidly.

If the water table in a soil rises near the surface some time during the year, a septic tank filter field will not function properly during that time. Such a soil, furthermore, is not suitable for houses with basements, and foundations may be damaged.

Wet soils freeze in cold climates. If such soils are used under driveways or paved roads, ice may form under the pavement. Water keeps coming in by flow under the slab from higher ground or by capillary movement from the water table below. The deposits of ice grow until they heave up and break the pavement. If the hazard is discovered before construction, the contractor can raise the grade or add coarse-grained material to make a firm, well-drained subgrade.

DEPTH OF A SOIL critically affects many uses. The homeowner may envision tall shade trees around his new house, but he faces some real problems if he discovers that the soil on his lot is only a foot deep to hard rock. It is also difficult to dig a basement or pit for a septic tank in such a soil.

When the city of San Antonio, Tex., planned to install a 24-inch steel main along an owned right-of-way, the bids reflected the fact that the route was underlain by limestone. Through the use of a soil survey, a somewhat shorter route was found that was free of rock. The city saved a considerable amount in construction costs, even though easements for a new right-of-way had to be obtained.

Soil maps can be used also for design purposes. Through the use of the soil descriptions and interpretations that accompany the soil maps, it is possible to reduce the number of soil borings needed to determine the kinds of soil materials along the rights-of-way of highways.

The reaction of a soil—its acidity or alkalinity—affects metal pipes, cables, and concrete structures. The life of ordinary concrete may be greatly shortened if it is used in soils high in free sulfates or organic acids. It is possible in some places to guard against this damage by use of special, more expensive materials in making the concrete. Studies made by the Bureau of Standards show close correlation between kinds of soil and susceptibility of pipe to corrosion. By knowing the kind of soil, one can predict the seriousness of corrosion and the need for different kinds of pipe and pipe coverings.

NEARLY ALL farmers require some direct technical assistance in developing a plan for their operations and for carrying out that plan.

Such technical assistance is based on a detailed soil map that indicates the alternative uses and combinations of practices for which the different kinds of soil are suited. The plan must be arranged to take advantage of the effects of the different practices on each kind of soil and among fields within the farm unit having different kinds of soil.

Some engineering assistance is needed to make maximum use of the water available and to take care of any excess without damage to crops or soils.

Many users prefer interpretations for single soils. Others prefer to have the soils grouped that are used alike and treated alike. The capability classification, which I mentioned earlier, is one of these groupings. Other, more highly specialized, groupings of soils can be made. For example, soils can be grouped according to their suitability for growing a single crop, such as corn, cotton, rice, wheat, cranberries, apples, or others.

Farmers who have woodlots may want to know what kinds of trees will grow on a given soil and how fast they will grow. Foresters and owners of large tracts of woodland need the same kind of information. Some soils now covered with slow-growing, unproductive trees and shrubs may be suited to fast-growing trees. Other soils are so unproductive of trees that the expenditure for improvement is not worth while.

Soil scientists and foresters determine the rate of growth of different species of trees on the major kinds of soil. With this information it is possible to predict the amount of wood crops that can be produced annually for each kind of soil.

Realtors, credit agencies, and appraisers find soils maps helpful in determining the value of land. The map shows the extent of each kind of soil, and the accompanying interpretations provide information about their capacity to produce. This information on productivity can then be appraised in terms of earning power of the soil considering location, size of unit, and similar factors. Then the size of loan and rate of repayment can be determined.

A prospective buyer of land should study the soil map and the interpretations. He should note the yields predicted for each kind of soil at different levels of management; the suitability of the soils for different crops; the response of the soils to management, including drainage and irrigation; presence of salts; and hazards of erosion. With such information, the prospective purchaser can decide whether he wants to buy and how much he should pay.

Tax assessors use the maps as a basis for valuing land. With appropriate interpretations, the maps can provide an objective basis for predicting the capacity of a soil to produce the major crops. The assessor can list the soils in decreasing order of yield and then assign ratings. The soils producing the most can be assigned a rating of 100; the soil producing the least, a rating of 10; the others get comparable ratings between. In urban and suburban areas, the suitability of the soil for building sites is a basis for arriving at land values for tax purposes.

Of course, kind of soil is not the only factor considered in determining land values and assessments. Buildings, roads, distance to market, and other factors that affect value need to be weighed in determining land values.

Manufacturers, canners, and processors have used soil maps to good advantage in locating their plants, in estimating the supply of raw material available for processing, and in appraising the marketing potential for finished products. Manufacturers of fertilizers, of farm supplies, and farm equipment are among those who profitably use soil maps to determine potential markets. Canners and processors use soil maps in locating their plants where soils and climate are best suited to growing of the crops they want to process. The map, with accompanying description, tells them the extent of the good soils and their probable yield.

More and more people are finding that soil maps are useful for many different purposes. The cost of making and publishing soil surveys is small in comparison to the benefits that can be derived from them. The savings in the construction of a mile of highway or pipeline, or school, or one small subdivision can more than pay the cost of a soil survey for an entire county.

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