DRAINAGE GUIDELINES

by
The Structural Committee

of
The Foundation Performance Association

Houston, Texas

www.foundationperformance.org

Document # FPA-SC-17-0

ISSUE HISTORY (Some internal committee issues omitted)

Rev #	Date	Description	Subcommittee Chair	Subcommittee Members
A	7 Oct 09	For Committee Review	Gerard J. Duhon	Kumar Arya Gary Beck Francisco Carrillo Dan Jaggers Ron Kelm Mike Qaddumi Michael Skoller Nicole Wylie
FF	26 Oct 11	For FPA Peer Review		
KK	29 Feb 12	For Committee Review		
0	5 Mar 12	Issued for Website Publication		

PREFACE

This document was written by the Structural Committee and has been peer reviewed and accepted for publication by the Foundation Performance Association (FPA). This document is published as FPA-SC-17 Revision 0 (i.e., FPA-SC-17-0) and is made freely available to the public at www.foundationperformance.org so all may have access to the information. To ensure this document remains as current as possible, it may be periodically updated under the same document number but with higher revision numbers such at 1, 2, etc.

The Structural Committee is a standing committee of the Foundation Performance Association. At the time of writing this document, the Structural Committee was chaired by Ron Kelm and 30 to 45 members were active on the committee. The Structural Committee sanctioned this paper on 25 March 2009 and formed an ad-hoc subcommittee to write the document. The subcommittee's chair and members are listed on the cover sheet of this document and are considered this document's co-authors.

Suggestions for improvement of this document shall be directed to the current chair of the Structural Committee. If sufficient comments are received to warrant a revision, the committee will form a new subcommittee to revise this document. If the revised document successfully passes FPA peer review, it will be published on the FPA website, superseding the previous revision.

The intended audience for the use of this document are persons seeking an understanding of the function of drainage and the proper construction to effect proper drainage in the vicinity of new and existing residential and low-rise building construction, including builders and contractors, owners, surveyors, foundation design engineers, geotechnical engineers, landscapers, landscape architects, civil engineers, and others. The committee does not foresee geographical limitations on the use of this document.

This document was created with generously donated time in an effort to improve the performance of foundations. The Foundation Performance Association and its members make no warranty regarding the accuracy of the information contained herein and will not be liable for any damages, including consequential damages, resulting from the use of this document. Each project should be investigated for its individual characteristics to permit appropriate application of the material contained herein. Please refer to the FPA's website at www.foundationperformance.org for other information pertaining to this publication and other FPA publications.

GLOSSARY

Basin – A depression in the surface of the land. The **basin effect** is the action of collecting water towards the low point of the basin.

Catch basin – Term used to describe the surface water collector in a drainage area, such as in an area drainage system. This term is also used outside of this paper for a container/reservoir in a piped system.

Channel flow – Controllable water flowing downslope through a surface depression much longer than it is wide. Some examples are ditch flow and a street gutter.

Daylight – Terminating a drainage conduit to the open air, for the purpose of disposal.

Detention – A storm water mitigation requirement designed volume such as a pond or swale that receives and temporarily holds a specific volume of storm water before releasing the water at a controlled rate into a drainage system.

Discharge – Exiting of water flow from a drainage device or conduit.

Disposal, dispose, disposal point – The discharge of water flow to a specific site. Disposal may be to a drainage infrastructure, a dry well, remote property, or other surface features or drainage devices.

Drainage Infrastructure – System components for handling water runoffs from residential and commercial properties, administered by a city, county, or area drainage authority. The system may include rivers, canals, ditches, storm sewer systems, and detention/retention ponds.

Drop – Elevation difference from collection point to discharge point.

Drop, available – Elevation difference available from the collection point to the discharge point.

Drop, required – Elevation difference required to collect, transport, and discharge drainage water.

Dry Well – A subterranean chamber having stones or gravel inside and used to collect rainwater runoff or excess water which dissipates the water into the ground.

Free water – Water that is not retained in the soil matrix; water that can be drained from the soil.

French drain – An underground system designed to collect and convey subsurface water. The water collection scheme is sometimes referred to as “pipe, rock, and sock”.

Geotextile – A permeable synthetic sheet material resistant to passage of silts. Appearance is similar to landscaping fabric, also referred to as geocloth or geofabric. Geotextile fabrics are rated and designed to provide long-term separation and filtration of soil materials for drainage systems. Geotextiles are sometimes used with heavier open geogrid type fabrics which function primarily as extra reinforcement to control movement of heavier materials like bull rock or large gravel.

Grade – The surface of the ground.

Inlet – The water collector in a drainage system.

Landscaping – Alteration of ground surface by adding or removing material including soil, rock, pavement, flatwork, or plant life.

Media – Material that forms a continuous matrix through which water can flow. An example is river rock.

Mitigation – A design and management practice of resolving storm water run-off and drainage issues for one or many properties. Mitigation planning is normally performed by an engineer, the goal of which is the prevention of undesirable flooding of individual properties, communities, or cities. One example of mitigation is onsite detention to compensate for an increase in impervious cover. Another example is floodplain mitigation resulting in a net zero increase in volume in a designated floodplain, or no net decrease in storage volume.

Outfall – The location where a river, drain, or ditch, discharges into a sea, river, or lake.

Perched Water – Water trapped in the ground above an impermeable subsurface layer.

Pervious/Impervious – Characteristic of a surfacing material, product, or soil describing whether it will/will not transmit surface water to the soil below. This characteristic of the soil can be checked with a percolation test. Sometimes it may be referred to as Permeable/Impermeable.

Retention – A designed volume such as a pond that receives and indefinitely holds a specific volume of storm water.

Sheet flow – Water flowing downslope over a generally flat area with water depth approximately the same throughout the area. Water flowing down a low-slope roof is an example.

Silting – Filling of the flow channel with silt or other water-borne material.

Slope-for-drainage – The slope built in conveyance piping or conduit or grade to carry water away from collection to the disposal point. Slopes generally range from 1/2% to 2+%.

Swale – Shallow channel with sides gently sloped, bottom-sloped for drainage towards the area of disposal, used to convey water for purposes of drainage.

Topography – The configuration of the ground surface, including vertical relief.

Watershed – The surface area providing runoff water. Also, the runoff water itself.

TABLE OF CONTENTS

1.0 INTRODUCTION

Scope

The purpose of this paper is to provide information on drainage systems and methods that may be employed to control water, which may have an effect on the performance of the foundation.

General Considerations

Drainage can have a direct effect on the performance of a foundation. In new construction, unless the local building codes disallow such, the foundation pad should be sufficiently elevated on the lot in order to accommodate the control of various surface drainage conditions. Experience has shown that the installation of a raised pad for concrete slab-on-ground foundations as well as crawl space foundations provide economical insurance against future foundation performance issues. Drainage can also affect many other aspects of an owner's experience as described hereinafter.

Improper drainage can lead to erosion, poor lawn health, flooding/ponding, infestation of mosquitoes and algae, wood rot, and other undesirable consequences. Proper drainage will not adversely affect the foundation, yard, surrounding properties, or the infrastructure transport and disposal system. Proper drainage may also serve to replenish the soil with moisture and to recharge aquifers.

Drainage can be studied from the point of view of its path from the time it is introduced into the environment surrounding the building to the time it discharges into a body of water or the soil. The study can be sub-divided into the following processes: source, collection, management, and disposal. These sub-divisions are not well demarcated.

Describing drainage involves using terms which may have two or more commonly used meanings, such as the word "grade": 1) inclination with the horizon, and 2) the level at which the ground intersects the foundation of a building, and 3) the surface of the ground. Also consider the word "drain": 1) verb, to draw off liquid, 2) noun, means (such as piping) by which liquid matter is drained, and 3) noun, a plumbing fixture that provides an exit point for waste water. Also, there are many local variations on terms used and there is little standardization of terms in the description of manufactured products. An effort has been exerted in this paper to reduce the ambiguities in the use of drainage language, including a glossary, but the reader should be aware of the imprecision in the language and consider the context.

There is normally more than one way to design a drainage system. Regarding surface water, there is the choice between a design that collects and drains water at the surface, and one that collects and drains water through a subsurface piping system. Subsurface drainage system failures cannot be seen until a problem manifests downstream or upstream from the unknown point of failure. Surface drainage systems are usually preferable and have inherent advantages over subsurface drainage systems, including the ability to examine the system visually, reduced

capital expenditures, and the resistance to clogging and silting. Surface drainage systems, depending on the soil type, also return a portion of the water back to the soil, and lessen the impact on the drainage infrastructure. Surface drainage systems are sometimes impractical to install. For example, re-grading can cause problems where the grades meet other structures and features, standing water in a swale or channel may be undesirable, erosion in the swale or channel could occur, etc. Advantages and disadvantages of each system, cost, maintenance and life cycle should be considered before deciding which system to install.

There is also normally more than one way to construct a drainage system. The construction considerations subsections in Section 2 are written to help the user to understand the construction process. Professionals should be employed in more complex construction projects.

There has been recent interest in installing rain barrels or bladders to collect rain runoff from roofs to use for irrigation for environmental reasons, and in some areas the use of these systems are mandatory due to water supply shortages. These systems are outside of the scope of this paper.

Requirements of local jurisdictions should be addressed prior to design and installation of a drainage system.

Systems that contain standing water and are open to the atmosphere can function as mosquito-breeding areas, can create a possible safety hazard, and should be avoided.

Section 2 describes the sources, collection and management, and disposal of storm water in drainage systems. Section 3 describes the effects of drainage on foundation performance. Section 4 includes references. The Appendices include documents in the references that are out of print or not easily obtained. These materials are provided in order to preserve their availability for years to come.

2.0 DRAINAGE

2.1 SOURCES OF WATER

Water can come from many sources, including rainfall, snowmelt, irrigation systems, underground percolation, and runoff from adjacent property. All sources of water should be considered when implementing a drainage plan.

2.1.1 Rainfall

The most common source of water requiring drainage mitigation is rainfall. It is generally distributed uniformly on a given lot and may then be concentrated due to runoff from roofs and paved areas, and discharge from gutters. Local jurisdictions may provide the maximum rainfall event for which a drainage system should be designed, e.g. 5 in./hr.

2.1.2 Irrigation systems

Irrigation by sprinklers or other irrigation systems are the second most common source of water on developed property. They are designed with the goal of maintaining landscaping, and the impact of an irrigation system on the nearby foundation is often ignored. A common defective condition is to find sprinklers in planter beds that discharge towards the foundation, thereby collecting water against the foundation. It is also common to encounter chronically soggy soil near foundations due to over-watering. Evidence of over-watering by an irrigation system may also include ponding water, yellowing or dying plant life, or mildew or algae on nearby surfaces. Water meters can be employed to aid in developing proper maintenance plans by dividing the water usage by the acreage served. This can aid in proper watering rates that sustain vegetation but minimize water saturation. Irrigation valve boxes should be placed sufficiently away from the foundation and backfill zone.

2.1.3 Underground

A less obvious source of water is underground percolation. Aquifers occur throughout the United States and are generally well known. A lesser-known underground water source is found in a perched water table when a granular soil layer is sandwiched between clay layers or underlain by a clay layer beneath a foundation. The granular soil provides an easy path for water to flow and the relatively impermeable clay confines the water to the granular soil layer. This may create a problem for a foundation when the supporting members extend into the granular soil layer. The foundation can act as a dam causing water to accumulate beneath a slab. A geotechnical study should indicate if a risk of perched water exists on the developed site.

2.1.4 Neighboring properties

Neighboring properties may impact the water a lot receives. Most codes and regulations require new construction to produce no more water than pre-developed conditions, to ensure no concentrated flows occur that can damage adjoining properties and if possible to eliminate any new drainage onto a neighbor's lot. A lot may naturally drain to its neighboring lot, but increased impervious areas, concentrated flows and grade that changes drainage patterns must be prevented to mitigate impacts of the new construction on adjoining properties.

An example of lot line impact would be where a neighbor builds up the soil at a fence line, clogging a swale that exists below the fence, or redirecting the way water travels between lots. Another example is where concentrated flow is directed onto an adjacent lot through the use of downspouts or other discharges.

2.1.5 Condensate

Condensate from air conditioning equipment discharged adjacent to the foundation can produce unequal and problematic soil-foundation pressures in one area. Additional drainage planning should be provided to distribute or eliminate such point water sources near buildings.

2.2 COLLECTION AND MANAGEMENT

This section covers the methods by which water runoff enters the drainage system.

2.2.1 Roof gutters, pitched roofs

Roof gutters are used to collect the rainfall runoff from the roof. The transport and disposal of the runoff will be covered in this section.

Roof gutters can be subdivided into three categories: 1) low capacity common sizes attached to eaves, 2) high capacity semi-custom sizes attached to eaves, 3) integral gutters constructed into the roof contour above the eaves.

Roof gutters are required by IRC R801.3 in areas where expansive or collapsible soil are known to exist next to foundation walls (e.g. basements, stem walls). The code also states that the gutter system must collect and discharge all roof drainage to the ground surface at least 5 feet from foundation walls or to an approved drainage system. Basement walls typically have backfills that could exceed 5 feet in width at the surface, in which case the code-prescribed minimum distance of 5 feet would be too close to foundation walls.

Expansive soil with effective plasticity index (PI) of 35 or greater (usually soil with high clay content) have a large shrink/swell potential with changes in moisture content of the soil. This soil condition can affect both slabs-on-ground and foundation walls. Therefore, in these cases, full guttering with underground drainage (non-perforated piping) is recommended with appropriate water management to carry the water away from areas that can affect the foundation support soil.

If a rainwater harvesting system is applied, the rainwater cistern overflow occurring during a high rainfall event should be designed to be carried away from the foundation edge.

2.2.1.1 Purpose & Application

Rain runoff from roofs can result in several problems. The water that falls from a non-guttered eave can strike with enough force to result in erosion. The concentrated roof runoff from a valley can overload the gutter system or can cause soil erosion from non-guttered roofs. Redirecting the runoff to a different area may result in a more efficient method of management.

2.2.1.2 Planning

Gutter and downspout sizing should be based on a recognized standard. The International Plumbing Code (IPC), Table 1106.6, shows sizing of semi-circular gutters for roof drainage.

Gutter systems consist of a horizontal collector at the eaves (normally called the gutter), the drop outlet, which is the connection between the gutter and leader, and the leader, or downspout, which directs the water collected in the gutter to the ground level and through the downspout extension. The discharge at the base of the downspout must be managed. The systems can spill onto the ground, discharge onto a splash block, be extended by flexible plastic pipes away from the foundation, be directed in formed downspout extensions, or can be deposited into an underground drainage system. Gutters should be sloped rather than placed level. A 1% to 2% slope can efficiently move granules and wind-borne soils to the point of discharge. Owners must ensure gutters are regularly maintained and leaders and buried systems are free of debris.

Buried systems require that the drop outlet have a screen placed on it so that debris is captured in the maintainable area at the roofline and not in the buried portions of the drainage system. On multi-level roofs, the discharge from a high level gutter can be discharged onto the roof below, or through a leader to a lower level roof or gutter.

Low capacity gutters are readily available in 4 inch and 5 inch sizes. The most common shape is called a K-style or Ogee. Gutter material is usually formed from strip aluminum, and comes in different thicknesses. Vinyl and galvanized steel materials are also available. Though gutters are stated as being a specific size, there is no industry standard for this measurement; as a practical matter, the size can be identified by measuring from the overflow lip to the opposite corner of the profile. Gutters can be purchased in specific lengths to be cut and jointed to match the roof plan, or can be formed on-site to length by a gutter contractor.

High capacity gutters are less readily available. The K-style gutter profile may be available in 6-inch to 8-inch sizes. Normally 6-inch size would be the maximum for a residential roof. The material, thickness, and fabrication of these larger capacity sizes are consistent with the smaller capacity sizes.

A second style available in the higher capacities is the half-round contour. This is a more expensive product. It can be constructed from Galvalume, copper, and galvanized steel. Galvanized steel is the material most used in the past in the half-round style. These are more typical on tiled roof systems that, due to profile of the edge tile, demand larger gutter systems.

Integral gutters take the shape of the decking structure underneath; the profiled structure is lined with roofing membrane or metal flashing. The membrane or flashing must be sealed at the joints. These gutters also have drop outlets that penetrate the eave or more typically drain through a wall or column. This gutter type is subject to leaks and is more difficult to maintain. The gutter is not visible from the ground. Consideration of the membrane's life, the means of replacement, and impacts of ultraviolet damage must be made for these systems.

The decision to install guttering should be based upon the following considerations:

First, consider that gutters concentrate the runoff from the roof to a few points at ground level. If the water is not controlled properly, the effects on the yard drainage and the foundation can be worse after the installation of gutters.

Second, consider the environment and maintenance. Trees overhanging gutters will fill the gutters with debris and cause them to spill over, unless leafless gutters are used. Loose aggregate from shingle roofs will collect in the gutters.

Third, if the gutters are not lapped and flashed properly with the roof, the gutters are not maintained, or for various other reasons, the installation will result in deterioration of the structural and architectural portions of the roof's eave.

Fourth, gutters should be installed to drain towards the drop outlets. This will normally cause the gutters to be misaligned with the roofline. Contractors sometimes install the gutters in

alignment with the roofline, resulting in standing water in the gutters. The use of a non-sloped gutter normally requires a greater size than a sloped gutter.

For the reasons given above and others, gutters should be considered using a cost-benefit analysis. Gutter systems are valuable when needed to solve a problem, when sized and installed correctly and when properly maintained.

The discharge of the gutter system can be onto a splash block. The splash block will carry the water 18 inches or more from the foundation. Splash blocks are usually made from concrete or fiberglass. When the yard is subject to erosion, such as when bare or before the sod is established, the splash blocks may be installed in reverse in order to reduce the velocities of the water. Afterwards, the splash blocks should be installed in the permanent fashion. In all cases, the splash block discharge should be away from the foundation. Discharge into a splash block will violate the 5-foot criteria for expansive soil conditions noted in the code.

If a rainwater harvesting system is utilized, the gutter downspout should include a debris diverter at or immediately above the rainwater storage device.

The discharge of the gutter collection system can be directed away from the foundation, or the discharge can enter a subsurface piping system. The available resources, such as available drop and restrictions to surface flow, should be considered when making this choice.

The watershed area of the roof draining into the gutters should be measured for consideration of the sizing of the gutters.

2.2.1.3 Construction Considerations

Due to the lack of consumer availability of various components of gutter systems, especially the larger sizes, and the lack of material selection, a professional gutter installer should be strongly considered.

A professional gutter installer will survey and measure the eave and other areas, and plan a system to achieve the desired result. Often, construction of the gutter runs will be performed by constructing the gutter run on-site with profile forming equipment, using rolled sheet as material. This reduces the joints in the system and provides more strength than using pre-fabricated sections.

Proper installation will include splashguards at gutter intersections with valleys, a slight slope in the gutter for drainage (1/8” per foot is desirable), sealing of joints, and secure attachments. Attachments may have to be more robust in windstorm areas. The drip edge of the roof should extend past the lip of the gutter so no water will leak behind the gutter.

2.2.1.4 Maintenance

Maintenance of the gutter system is important for proper performance. If trees limbs are overhead or nearby, the gutters may become clogged. Leaf shedding guards can be installed above the guttering; there are many different styles, and some are more effective than others.

2.2.2 Roof drainage, low sloped roofs

With a pitched roof, the water management normally begins at the edges of the roof, due to the natural flow of water from the inclined roof surface. With a low-sloped roof, water management must be considered throughout the surface of the roof. Low-sloped roofs must be installed with features to manage the rainfall loads. Typical features for a low-sloped roof are a slight slope for drainage, normally no less than ¼" in 12 inches, roof drains, and scuppers/overflow scuppers through parapet walls.

2.2.2.1 Purpose & Application

Balcony decking must be installed with the same considerations given to a flat or low-sloped roof installation. The primary difference is that the deck covering should be resistant to foot traffic and protect the roofing membrane beneath the walking surface.

Low-sloped roofs are common in large commercial buildings, such as "big box" stores. Low-sloped roofs in residential construction are normally installed for a specific purpose, such as balconies, aesthetics, architectural style, or building height restrictions.

2.2.3 French drains

The term "French drain" is often misused. A French drain does not refer to a single-point surface drain. Some will call a gravel filled trench drain a French drain (see Section 2.2.6), but a French drain is a system for collection of subsurface free water, transport and disposal; and is not used to drain surface water.

2.2.3.1 Purpose & Application

The application for French drains is typically for the desiccation of chronically wet soil and for diversion of groundwater away from a subterranean structure, such as a basement.

Subsurface free water is undesirable in several residential situations. In the case of basements and retaining walls, this water can swell clay (active) soil, causing damage. In the case of inactive soil around a basement and retaining walls, the hydrostatic pressure, due to the water height above the base of the wall, may result in structural damage and water leakage at the walls. In the case of slab-on-ground or elevated foundations founded on active soil, excessive and varying moisture results in large volumetric changes in the soil, affecting the stability of the foundation. In both active and inactive soil, excessive moisture results in decreased soil strength leading to excessive soil movement or bearing failure.

The French drain system works by collecting free water from the adjacent soil at low rates and transporting the water to the final disposal point. The main problems relating to a French drain are keeping the soil from silting the piping, repair of the system if silting occurs, and transporting the water without loss to the point of disposal. The movement of the soils will affect the slope of the drain, whether by frost action, heave or settlement.

A French drain system will aid in the reduction of a wet soil condition, but does not correct the cause of the resultant water. Consideration should be given to eliminating the problem at the

source. Some remedial schemes could include installing a water barrier between the source and the affected area or relocating the source's discharge to another area. The source of the water should be determined; such sources could include overwatering, sewer leaks, AC condensate drainage and irrigation system leaks. These point sources should be ruled out before a French drain system is contemplated and installed.

In cases where areas of soil are to be drained, especially if the source of water is rain, and with particular application to perched water, a PVC pipe system with Smart Drain® laterals can be effective. The Smart Drain® material is a polymer strip with slots that collect and carry water. This can be effective for draining areas rather than for use as a barrier collection method. Other engineered spider systems or dendritic systems can be used.

French drainage can be set up into laterals, sub-mains and mains, resulting in the drainage of areas of wet soil.

2.2.3.2 Planning

Before constructing a French drain in the yard, check for the presence of free water under the soil surface and investigate for the presence of free water in depressions in the area. If free water is not present at the surface, use a plumber's probe to find the condition of the subsurface soil. If any question exists about the presence of free water, dig a posthole in the area a few feet deep. If free water is not found immediately after digging, place the spoils at the perimeter of the hole, cover with a plastic sheet to keep animals and rain from entering the hole, and recheck a few days later, see Figure 2.2.3.2.1. All areas to be drained should be investigated for free water. The test may not be conclusive during an extended dry period. If the free water test is inconclusive, consult a geotechnical engineer to investigate with the use of piezometers.

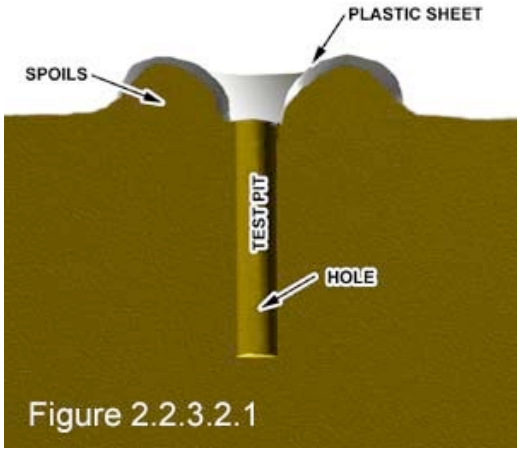


Figure 2.2.3.2.1

After the presence of subterranean free water is verified at all areas to be drained, the layout of the collection piping can be determined. From IRC 2604.4, to avoid undermining foundations, the collection piping trench cannot be located within a 45 degree line (1V:1H) from the bottom edge of a footing, see Figure 2.2.3.2.2. However, the prohibited zone typically used for sandy soils is 1V:4H, and for clay soils is 1V:3H. The collection piping will then connect to the disposal area by means of the transport piping. Choose a disposal method suitable for the situation, e.g. a dry well distant from the foundation, daylighting to a remote area, sump pump basins, or the storm sewer system.

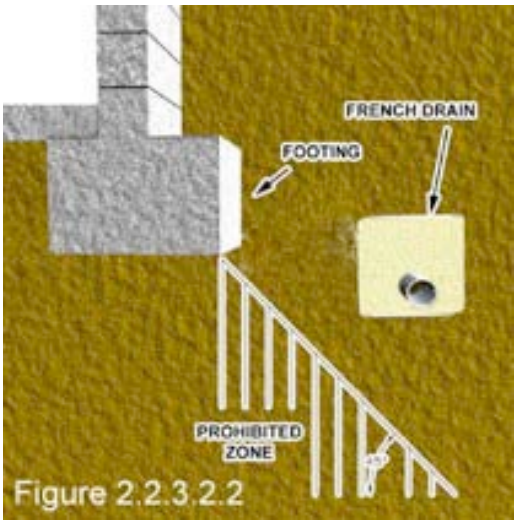


Figure 2.2.3.2.2

The collection piping will have to be sloped for drainage, at the rate of 1 to 2% (1/8" drop per foot to a preferred ¼" drop per foot), as will the transport piping.

The depth of the collection piping should be sufficient to drain enough water to be effective for its intended purpose. In the case of basement window wells, the collection should be below the window. The collection should also be below any basement wall joints. In the case of slab-on-ground foundations, deeper is more desirable, but can be more costly and troublesome. Another consideration is that a few inches of sod over the French drain will allow grass to grow evenly across the drain. Window wells should have a vertical riser with a grated inlet to capture water that flows into the window well. The window well soil should be 6-inches below the sill of the window.

For areas that do not require draining or areas with tree roots that are within the layout of the collection pipe system, these sections should use the non-perforated transport pipe.

In the case of basement foundations, current practices include a drainage system outside the wall and footing, commonly called a perimeter drain; see Figure 2.2.3.2.3 for an example. These drains can become clogged and ineffective over time, in which case repair should be performed.

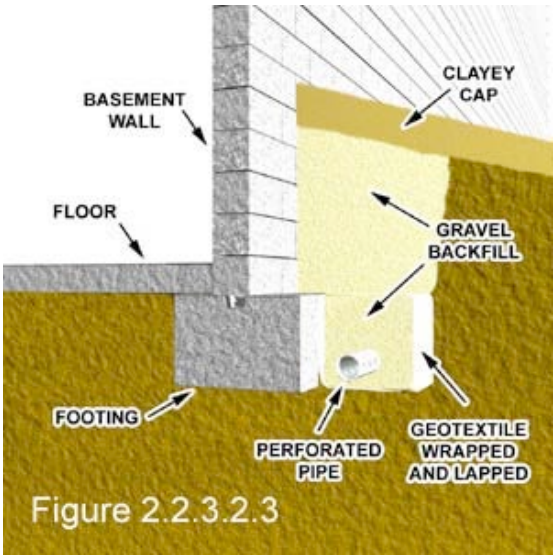


Figure 2.2.3.2.3

Repair may utilize video and include cleaning similar to sewer pipes or excavation and replacement of the drain. If the depth, slope, and placement of the original system were appropriate, then the vertical and horizontal layout should be maintained. The source of the failure should be identified and remedied prior to installation of the new system. Rehabilitation from the interior may be possible under the supervision of a company that has experience with modifying basement wall drainage systems, see Figure 2.2.3.2.4 for an example.

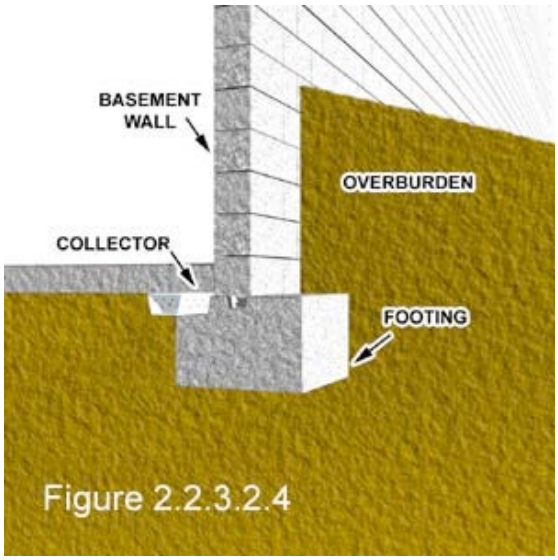


Figure 2.2.3.2.4

If both a French drain system and a surface drainage system are installed, care should be taken if both systems share transport piping; the surface drainage system at capacity should not be designed to introduce water into the French drain collection piping (called charging). This error will increase water to the soil rather than removing water from the soil at the French drain level.

There are two types of collection piping available, rigid polyvinyl chloride (PVC) and flexible corrugated pipe (typically polyethylene (PE)). The PVC collection pipe is usually available in 4" and 6" sizes, but the 6" piping capacity may be too large for subsurface water collection; it is intended for use in a trench drain. The rigid PVC is perforated with ¾" diameter holes at intervals in two axial lines, see below, left photo. The flexible corrugated pipe, available in 4" size, is slit at intervals to allow drainage to the interior, see below, right photo. The flexible corrugated piping is less expensive than the rigid piping. The flexible corrugated piping cannot be mechanically cleaned (rooted or rodded) if it becomes clogged or silted, but can be water jetted. The flexible corrugated piping is more difficult to maintain proper drainage slope due to its flexibility; it is totally dependent on the support media. The flexible corrugated piping has slits all around; orientation of the slits is not a factor.

Cleanouts should be installed in the rigid system at the same frequency as in a domestic drainage system. IRC P3005.2 directs cleanouts to extend vertically above grade and be accessible, no more than 100 feet apart in horizontal lines, installed at each change of direction greater than 45 degrees, but not more than one is required in each 40 feet of run.

Some geotextiles are available with root inhibitors; these should be considered if tree roots could be a problem in the future as the roots can infiltrate the gravel pack and drainage system.

2.2.3.3 Construction Considerations

There are many sources in the public domain that give methods of construction of French drains and basement perimeter drains. This section will not cover installation of basement perimeter drains.

Before trenching, check for buried utilities and other service installations in the area to be excavated.

Trenching: Trench the yard to accommodate the location of the collection and transport piping. Trench width should be a minimum of 12 inches. Leave enough clearance under the planned pipe depth to affect proper drainage slope by manipulating the fill media. Check the trench location and dimensions thoroughly before proceeding. Taper the transition at the end of the collection area to keep water from collecting in this area. The trench should have the same slope that the pipe will have. Water will collect at the bottom of the trench and flow in the gravel pack, prior to entry in the pipe.

Geotextile: In the area of the collection piping, place the geotextile into the trench so that the fabric is fit to the contour of the trench. The width of the fabric should be sufficient to overlap at the top by at least eight inches, sometimes called a "burrito wrap". Excess overlap is not a problem. The edges of the fabric should be kept secured outside of the trench until the fabric is to be overlapped. Alternatively the geotextile fabric may be applied directly around the perforated pipe, commonly known as a pipe sock. Because of the reduced filter area, installing the geotextile fabric only around the perforated pipe should be avoided if lower maintenance and higher design life is desired.

Media and fill: In the area of the collection piping, place the fill media into the trench in sufficient quantity to support the perforated pipe. In the area of the transport (non-perforated) piping, provide sand or select fill bedding in sufficient quantity to support the pipe and maintain proper slope. Geotextile should be installed around the media.

Type of media: The fill media should consist of gravel or rounded rock, preferably between 1" and 2" in size. Cementitous fill materials, such as limestone or crushed concrete, should not be used, nor should sand, due to its resistance to releasing free water from the porosity matrix.

Lay collection piping: In the area of the collection piping: lay the perforated pipe with perforations down, holes in the 4 and 8 o'clock positions. Dry fit, then cement the joints. This will allow collection and transport, see Figure 2.2.3.3.1. Fill the trench to near the surface grade with the fill media, lap the geotextile as much as possible, secure the lap, and carefully top with soil, level with grade. The system may also be used to capture surface water if the geotextile lap is covered with gravel rather than sod.

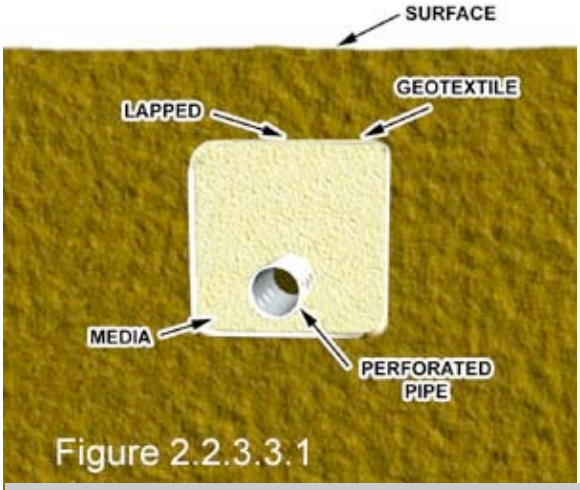


Figure 2.2.3.3.1

Lay solid piping: In the area of the transport piping, lay non-perforated pipe, see Figure 2.2.3.3.2. If the discharge point limits the diameter of the pipe to less than 4", such as at a curb, the 4" or 6" perforated collection pipe can transition to 2" or smaller, non-perforated transport pipes. Dry fit and then bond joints. Check for proper drainage slope and adjust support as necessary. The transport pipe may now be fully backfilled with soil. Mechanically consolidate soil as it is placed in the trench.

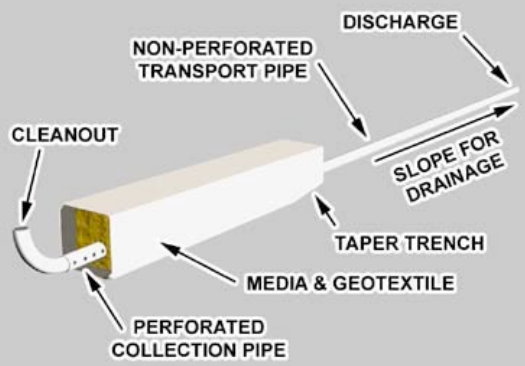


Figure 2.2.3.3.2

Maintenance: Over time the French drain collection system can become clogged, or silted. Access through the cleanouts will allow

maintenance of the system without digging out the trench materials. The first effort at clearing the system should be a water hose with a jet nozzle at the end, feeding into the pipes through the cleanout. Successful clearing would be evident by observing water at the exit. If the water hose method is unsuccessful, a rotating rooter may clear the line. A sewer camera may be used to inspect the lines if needed.

2.2.4 Area drains

An area drain collects surface water from a small area on the surface. An area drain can either be set into soil, as shown in the photo on the right, or into a hard surface. This section will cover the application of area drains in soil applications only. An area drain is sometimes referred to as a surface drain, point drain, or yard drain.

The collection point for a street's storm drain system is called an inlet.

An area drain system consists of collectors at the surface and non-perforated piping underground. Roof runoff is often drained into the underground piping of the area drainage system.

2.2.4.1 Purpose & Application

Area drains are effective when they are installed at the low point in the surface where water will pond or collect. If the ground surface does not have natural features where an area drain collector location would be effective, the surface should be contoured to direct water into the collector.

The collection and direction of water into the area drain collector is called the basin effect. If the surface is not graded either naturally or manually to collect and direct runoff into the collector, the collector will be capturing only a small portion of the runoff.

Collector boxes normally have a sump area below the outlet that serves to collect sediment before it enters the piping.

Area drainage systems normally consist of several collectors connected to a single outlet.

2.2.4.2 Planning

A topographical survey, typically utilizing a 25 ft. grid, should be conducted to establish the existing grade. Investigate the site to find the low areas that will be suitable locations for collectors. These low areas may be the result of improper backfill and should be remedied before being used for drainage. If re-grading is necessary to create the basin effect, determination of the impacted graded area and landscape area should be established.

Calculate the required drop of the subsurface system to ensure adequate slope of the trench and/or pipe. Measure the available drop for the system. If available drop is less than the drop required to achieve grading and pipe slopes, then a simple collector piping outlet system may be less functional than a surface drainage system. In that case, reconsider landscaping as a method of surface drainage.

If the underground piping system remains the best option, consider a sump well and sump pump to discharge water to the surface where the drainage system can direct it away from the area. The selected sump pump should be of adequate capacity to handle the anticipated flow.

Disposal of the drainage water into a dry well is usually not a practical option due to the large dry well capacities that may be required, nor is a dry well suitable for areas with low permeability such as clay soil.

If drainage is to discharge to the street, a cutout of the curb may be necessary. A curb cut may require the approval of the governing jurisdiction. Normally, this discharge is through a 4-inch Schedule 40 PVC pipe. If grated sidewalk chases are used, consideration for pedestrian safety such as bike traffic on the edge lane should be addressed. The curb may be less structurally compromised if the line is split into two 3-inch pipes prior to penetrating the curb. In all cases it is important to trim the pipe flush to the front surface of the curb, to eliminate possible damage to the exposed pipe.

If permitting authorities do not allow curb penetrations, a pop-up discharge (bubbler) on the yard side of the curb is an option. Pop-ups are subject to clogging, algae buildup and ice formation on sidewalks or curbs. Note that water will remain in the pipe upstream of the pop-up, which in some areas can lead to pipe damage due to freezing at the shallow depths.

The collector consists of the following parts, from top to bottom: Grate, optional riser, optional debris basket, base. The optional riser can connect to an inlet pipe, and will require more drop. The base connects to the outlet piping. The base can normally connect to either 3-inch or 4-inch pipe.

In a typical residential yard, each 8 to 12-inch collector can handle the watershed from about 300 square feet. The limitation on this capacity is the transition of the water from the collector base into the piping. If temporary ponding can be tolerated then a single collector may drain larger watersheds.

A 4-inch pipe can handle the drainage from about 4 to 8 collectors, depending on the slope-for-drainage of the piping system and the flow restrictions, such as elbows. Collectors can be connected to the exit piping and to each other either in a parallel or serial fashion; in a parallel layout the collector would connect directly to the exit pipe, as would all of the other collectors; in a serial layout the collector would connect to the next collector, which would connect to the next collector, and so on, terminating at the exit pipe. The parallel layout is advantageous when there is minimal available drop. Serial systems require fewer materials. When drain legs connect together, the downstream pipe should be a larger size.

Some contractors do not bond the piping connections, but bury them with dry fit joints. This will incur some minor leakage. Dry fit connection systems can be easier to repair or modify. Dry fit connections should not be used under or near foundations.

Area drain system piping should maintain a normal slope-for-drainage of about 1/8 inch per foot (pipe larger than 4" may maintain a flatter slope), plus approximately 10 inches of depth for the collector box (distance between grating and outlet), plus a few inches for the basin effect. Some collector boxes have a shorter depth.

The relationship of flow to other drainage system variable can be calculated. The classic Manning equation is:

$$Q = A * 1.49/n * R^{0.667} * S^{0.5}$$

where:
Q – flow rate; cubic feet per sec (cfs)
A – cross sectional area of flow; square feet (ft^2)
n – the fluid drag coefficient; dimensionless; per the tables below
R – hydraulic radius (ft); defined below
S – slope of pipe; feet of height / feet of length (ft/ft)

$$R = A \div P$$

where:
R – hydraulic radius (ft)
A – cross sectional area of flow; square feet (ft^2)
P – wetted perimeter (ft)

The flow of water through piping can be calculated by using the Manning equation simplified for water near 70^o F and clean unpressurized plastic pipe. Note that the following equations use different units than the classic Manning equation.

$$h = .016 * l * Q^2 \div ID^{5.33}$$

$$ID = 0.46 * (l/h)^{0.188} \times Q^{0.376}$$

$$Q = 7.9 * (h/l)^{0.5} * ID^{2.66}$$

where:
h – head (in)
l – pipe length (ft)
Q – flow rate; gallons per minute (gpm)
ID – inside diameter of pipe (in)

Note that 448 gallons per minute (gpm) = 1 cubic foot per second (cfs).

If piping materials other than plastic are used, the above equations become:

$$h = 162 * l * (Q * n)^2 \div ID^{5.33}$$

$$ID = 2.63 * (Q * n)^{0.38} \div (h/l)^{0.188}$$

$$Q = (.0785 \div n) * (h/l)^{0.5} * ID^{2.66}$$

where:
h – head (in)
l – pipe length (ft)
Q – flow rate; gallons per minute (gpm)
ID – inside diameter of pipe (in)
n – fluid drag coefficient; dimensionless, per the table below:

MATERIAL	FLUID DRAG COEFFICIENT, n
Plastic	.010
Steel	.011
Concrete	.012
Corrugated Steel	.022

The Manning equation in a more complex form can also be used for open channels with various channel linings.

$$h = 15.6 * (Q * n)^2 * l * p_w^{1.34} \div A^{3.34}$$

$$A = 2.28 * (Q * n)^{0.6} * (l/h)^{0.3} * p_w^{0.4}$$

$$Q = (0.253 \div n) * (h/l)^{0.5} * A^{1.67} \div p_w^{0.67}$$

where:
h – head (in)
l – pipe length (ft)
Q – flow rate; gallons per minute (gpm)
A – cross section area of fluid (in^2)
p_w – wetted perimeter (in)
n – fluid drag coefficient; dimensionless, per the table below:

SURFACE MATERIALS	n
Earth, uniform section, clean, recently completed	.016-.018
Earth, uniform section, after weathering	.018-.020
Earth, uniform section, short grass, few weeds	.022-.027

SURFACE MATERIALS	n
Earth, uniform section, graveled soil, clean	.022-.025
Earth, fairly uniform section, no vegetation	.022-.025
Earth, fairly uniform section, grass, some weeds	.025-.030
Earth, fairly uniform section, dense weeds or aquatic plants in deep channels	.030-.035
Earth sides, fairly uniform section, clean gravel bottom	.025-.030
Earth sides, fairly uniform section, clean cobble bottom	.030-.040
Channels not maintained, dense weeds to height of flow	.080-.120
Channels not maintained, clean bottom, brush on sides	.050-.080
Channels not maintained, clean bottom, brush on sides, highest stage of flow	.070-.110
Channels not maintained, dense brush, high stage	.100-.140

The head is the same as the available drop. For instance, 80 feet of 4-inch schedule 40 pipe carrying 100 gallons per minute will require an available drop of 7.6 inches. Fittings will increase the head required to provide the same flow rate; this can be stated as equivalent lengths of pipe. For 4-inch pipe, a 90-degree elbow is equivalent to 13 feet of pipe; a long sweep elbow is equivalent to 5 feet of pipe.

When the available drop is less than the required drop, the pipe slope-for-drainage must be reduced below the 1/8 inch per foot minimum for a 4-inch pipe. The flowrates through the drainage system will be less than if the minimum slope was maintained, but if drop is available, then flow will occur. When the slope-for-drainage is reduced below the recommended amount, the possibility of a belly or reverse flow is magnified if the soil has high shrink/swell potential.

Figure 2.2.4.2.1 shows two examples of drainage systems that have equivalent flow capacities; the first example is simply a pipe accepting water at grade, and the second example is a pipe exiting an area drain. Since the head is 12 inches in both cases, the flow capacities are the same.

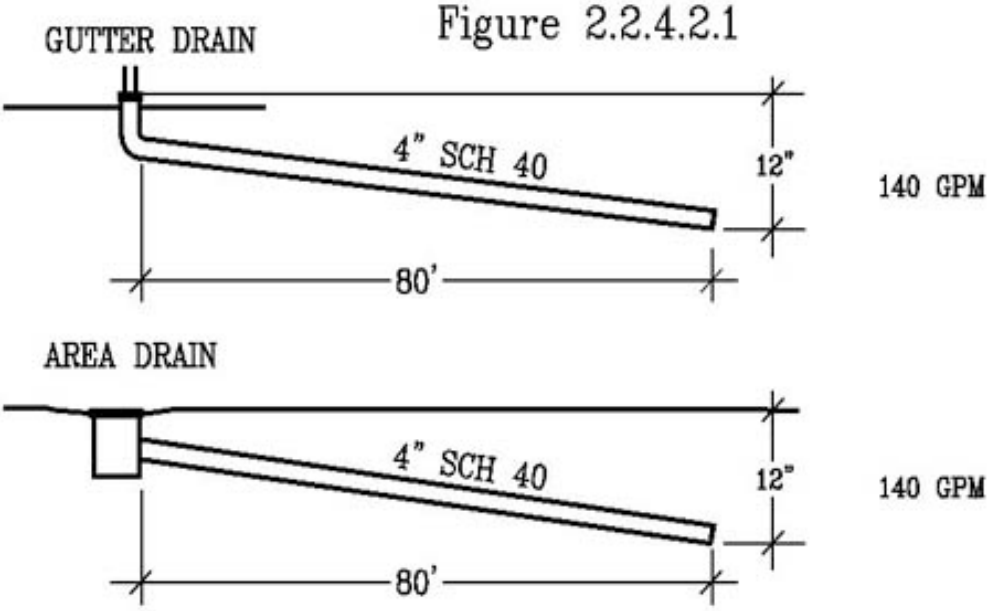
Figure 2.2.4.2.1 also shows three examples of drainage systems where there is little available drop. In the first case the pipe is laid level throughout its course. In the second case the pipe has been constructed with a belly. Both of these installations will have the same flow rates, but the bellied pipe will hold water and sediment will drop out. The third installation, which installs the pipes at minimum slope for drainage and uses a sediment catch midway to offset the height of the pipe, loses about 5% of its flow capacity due to the installation of the sediment catch, but does not incur the problems associated with below minimum slope to drain.

Cleanouts should be installed at the same frequency as in a domestic drainage system. IRC P3005.2 directs cleanouts to extend vertically above grade and be accessible, no more than 100 feet apart in horizontal lines, and installed at each change of direction greater than 45 degrees (but not more than one required in each 40 feet of run).

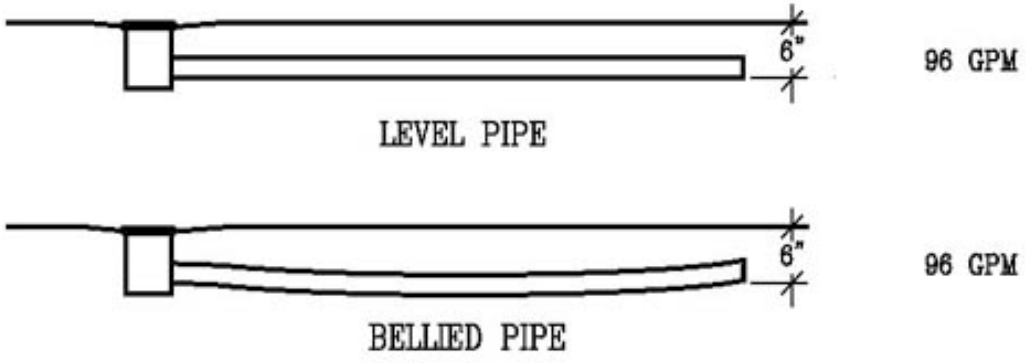
Depending on the size, material, and availability, the pipe segments can have dry fit connections, gasketed push-on connections, or cemented connections.

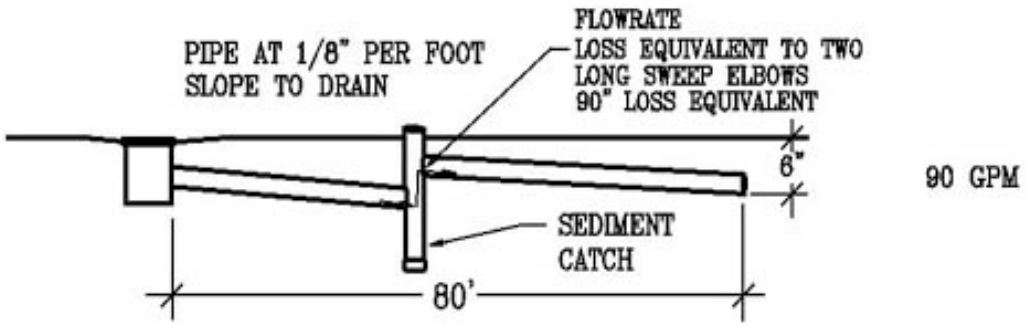
Depending on the size of the PVC piping, it may be available in Schedule 40, thinner wall Schedule 20, and even thinner wall SDR pipe. SDR pipe may be available in sizes SDR26, SDR35, and SDR40, and is usually colored green.

Figure 2.2.4.2.1



THE ABOVE TWO DRAINAGE LAYOUTS YIELD EQUAL FLOWRATES.





2.2.4.3 Construction Considerations

Select the area drain collectors. Some styles of collector bases are made from polymer concrete, most are made from plastic. Grates for collectors set into soil are normally plastic and fiberglass.

Obtain the piping. Grade the area as required for proper drainage into the collectors. Dig the piping trenches and the collector holes. Place the collector on a stable base, such as a puddle of concrete or packed gravel. Locate the base so the grate will be slightly below surrounding grade. Dry fit the piping. Check that the slope-for-drainage is relatively constant. Use pipe cement to seal the pipe connections when required. If pipe joints are not physically connected, disconnections from ground movement may occur. Joints below or near foundations must be physically connected and sealed. Fill the trench and hole. Terminate the piping system as required.

2.2.4.4 Maintenance

Keep grass trimmed from the collection grate. The collector and underground piping can become silted and will have reduced capacity or will clog. During a rain or with a water source, check that the flow from the discharge is equal to the inflow to ensure free flow through the system. If the flow at the discharge is reduced, check the collector debris basket first. If cleanouts were installed, run a water hose with a jet nozzle into the lines from the cleanouts until the blockage is cleared. If no cleanouts were installed, run a water hose with a jet nozzle into the lines at the collectors until the blockage is cleared.

The grated inlet cover should be removed and sediment cleaned as part of standard maintenance.

2.2.5 Berms, ditches, swales, and other surface structures

2.2.5.1 Berms & Swales

A berm is a raised area, while a swale is a ditch with a gentle slope. Berms can be used to slow runoff on steep slopes, and swales lined with grass or other plants can direct water toward a storm drain or street. Because swales reduce the amount of runoff, very little water that enters a vegetated swale will actually make it to the street or drain.

2.2.5.2 Diversion wall

A short wall between the upslope source of runoff and the property to be protected can be installed to divert the runoff.

2.2.6 Trench drains

A trench drain is a system to collect surface water. Examples of trench drains are shown below. The collection area is many times longer than it is wide, and is generally laid across sloping landscape or hard surfaces. The collection area of the system is at grade. Other names are strip drains, slot drains, or grate drains.

Trench drains take two general forms: A perforated pipe and media system constructed similar to a French drain, used in soil surface applications; and a grate and open channel system somewhat similar to a street gutter, used in hard surface applications. The former will be called a field system and the latter a hard surface system.

The field trench drain is constructed like a surface-exposed French drain.

Another product, which falls within the definition of trench drain, is the slot drain, shown to the right. Slot drains are incorporated into hard surfaces, the collection area is narrow, open, and without grating.

Other products in general use are slot drains for pool decks, which are prefabricated plastic channels with permanent grates. A common problem occurs when the discharge is not an adequate distance away from the foundation.

2.2.6.1 Purpose & Application

Water in sheet flow can be difficult to collect by means of area drains. Trench drains placed across the direction of flow can collect and divert the flow. For example, sheet flow water that is threatening to flood a residence or garage entry can be collected and redirected with a slot/trench drain.

Large basins that receive water collected from nearby higher elevations can have the watershed diverted by use of a trench drain.

Percolation fields, used to return septic tank effluent to the soil, can be kept more effective by diverting watershed by use of a trench drain.

In applications subject to vehicular or pedestrian traffic, such as a driveway or road, a trench drain is advantageous. In applications where surface evenness is not a factor, such as a pasture, a ditch or swale might be more appropriate.

The trench drain system works by collecting sheet flow surface water and transporting the water to the final disposal point. The main problems that a trench drain must surmount are keeping the soil from silting the channel or media and repair of the system if silting occurs. Silting will be much worse if the watershed source is not hard surfaced.

Trench drains are also used to form a perimeter around areas that may encounter spills of hazardous liquids. Trench drains have other uses, such as collection and transport of water from pool decks and at the threshold of handicap accessible showers.

2.2.6.2 Planning

Since trench drains are placed on sloping surfaces, the path of the collection drainage affects the slope-for-drainage. The design of trench drain systems should be based upon the following considerations:

First, the layout of the trench drain must be determined. Factors involved in the layout decision should be capturing the watershed while creating the required slope-for-drainage.

Second, the watershed area must be determined.

Next, the size of the trench drain channel must be chosen. The sizing of the channel must consider the watershed area, the rate of rainfall, water production, or spillage, and the slope-for-drainage of the channel. The International Plumbing Code (IPC), Table 1106.6, shows sizing of semi-circular gutters for roof drainage. This data may be used as a basis for sizing hard-surface trench drains.

Also, the following equation, derived from the IPC data, may be used for sizing the area of the channel. SLOPE is in units of percent, rainfall RATE is in units of inches per hour, watershed AREA is in units of square feet. CHANNEL AREA is in units of square inches.

$$CHANNEL\ AREA = (0.08 * AREA * RATE \div SLOPE^{0.7})^{0.4}$$

The IPC also shows the 100-year rainfall event for Southeastern Texas as 4.5 inches per hour, in Figure 1106.1 of IPC. Since transit time for water within a drainage system is much less than an hour, the rate used to design a drainage system should be increased. See Figure 2.2.6.2.1 for the relationship of rainfall intensity to time intervals for areas with 4.5 inches per hour intensity and 100-year rainfall frequency. For different areas, other charts may be available for other 100-year intensities. If overflow or overcapacity of a drainage system would result in damages, then a design considering the higher shorter-duration intensities appropriate to the traverse time of the drainage system should be used.

Intensity vs. Time of Concentration vs Rainfall Frequency
Source: Hydro 35/TP-40

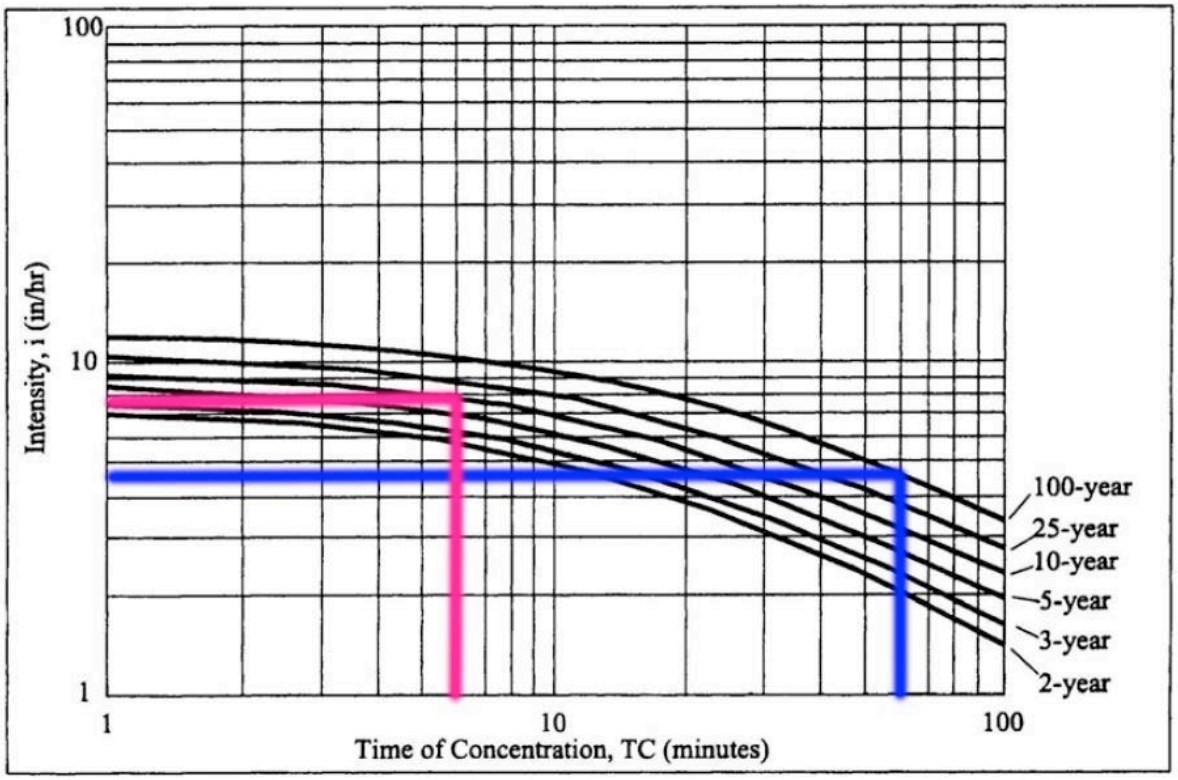


Figure 2.2.6.2.1

As an example, in figure 2.2.6.2.1 the blue line traces the intersection of 60 minutes (1 hour time of concentration, bottom axis), 100-year event (curved black line), and 4.5 inches per hour (intensity, left axis). As a second example, the red line traces the intersection of 6 minutes time of concentration, 10-year event, and 8 inches per hour intensity.

Field trench drain trenches are either filled with media only or media with flexible corrugated piping. The use of piping will increase the flow capacity. The media will resist the flow of water in a way that has not been factored into the calculations above. A resistance factor should be used based on the size and space between the pieces making up the media. Larger pieces and larger spaces will allow more flow. The flow reduction with normal media might range from 60 to 90%. If piping is a significant portion of the cross-section of the trench drain, then the media's contribution to flow capacity can be ignored, but it is beneficial to the amount of flow that can be achieved.

If a hard surface trench drain is to be installed, then the materials for the channel should be chosen. Hard surface trench drains can be cast-in-place, former systems, pre-cast concrete, or liner systems. Cast-in-place channels are created using wood forms and placing concrete against the forms. When the forms are removed the grate frame and drainage plumbing are in place. Former systems, also called prefab form systems, use expanded polystyrene (EPS) or cardboard in the shape of the channel with the grate frame in place. After concrete has set

against the EPS, the EPS form is removed. Pre-cast concrete and liner systems are shells that are placed and set in concrete. The shells stay in place.

2.2.6.3 Construction Considerations/Maintenance

A field trench drain is constructed by creating a ditch with a rounded bottom to promote self-cleaning. Keeping a consistent slope-for-drainage is also important to allow cleansing velocities and avoid sediment depositing or silting. After the ditch is created the excavated cross-section is filled with the media. Flexible corrugated piping may also be installed near the bottom. The trench should be lined with geotextile and a separate top layer installed which can be later removed for maintenance.

The cast-in-place trench drain is constructed by installing a form that will create the channel of the drain. Excavate the soil in the area of installation to achieve at least 6 inches of concrete around the channel. The form is set into position and affixed to the ground with stakes and pieces of rebar. The top of the form is at the final finished surface of the concrete that will later be placed. The bottom of the form should have slope-for-drainage. If the grate requires a frame, the frame may be attached to the top edge of the form. The drainage piping is attached to the end of the form. The concrete is poured and finished, and after setting firm, the forms are removed.

The prefab form trench drain uses a purchased form of EPS or corrugated cardboard to replace the form of the cast-in-place method. The grate frame is pre-installed on the form. Excavate the soil in the area of installation to achieve at least 6 inches of concrete around the channel. The form is set into position and affixed to the ground with stakes or rebar, or purchased jigging. The top of the form is at the final finished surface of the concrete that will later be placed. The drainage piping is attached to the form. The concrete is poured and finished, and after setting hard, the forms are removed.

The pre-cast concrete and liner systems use a shell that forms the channel. The pre-cast concrete may be polymer concrete or other construction materials. The liner systems are thinner and may be constructed from fiberglass, plastic or steel. The shell has a cast slope-for-drainage. The grate frame is pre-installed on the form. Excavate the soil in the area of installation to achieve at least 6 inches of concrete around the channel. The form is set into position and affixed to the ground with stakes or rebar, or purchased jigging. The top of the form is at the final finished surface of the concrete that will later be placed. The drainage piping is attached to the form. The concrete is poured and finished, and the shell stays in place. Installation instructions will be provided with these products.

Over time, the field trench drain can become clogged, or silted. If the drain has the corrugated flexible piping installed, use a water hose with a jet nozzle feeding into the pipes from the daylight end. If the drain has a separate top layer of geotextile installed below the surface rock, remove the geotextile and rock above and clean/replace. If the drain does not have piping or geotextile sheet, then remove the media and wash it.

The hard surface drains may also become silted, particularly if the cross-section is square-bottomed rather than rounded. Remove the grates and use a water hose with a jet nozzle to clear the channel.

2.2.7 Ground Surface

In all of the collection methods described above, it is presumed that either the natural or constructed topography has supplied water runoff to the collectors. The contribution of the condition and topography of a yard or hard surface to the success of a drainage system cannot be overemphasized.

The flow of water in a channel, such as a ditch, is dependent on the grade, cross-sectional profile and area, obstructions, and absorption of the ground. The flow of water outside a channel, called sheet flow, does not depend on cross-sectional profile and area. Also, while absorption of the ground has a small effect on channel flow, it can be a great effect in sheet flow. If rainfall rates are low, and the ground is absorptive, either because it is dry or due to the type of soil, and grades are slight, water runoff may never reach the bottom of the grade but rather be absorbed by the soil.

Grasses and vegetation on the surface slow down the water velocity, and the flowing height of the water over the surface is increased. Grasses and vegetation, and flat drainage slopes, serve as buffers to mitigate intense short-lived watershed load. Slopes of vegetated swales should be a minimum of 0.5 percent. Excessive slopes can result in erosion.

Hard surfaces vary in their capacity to absorb surface water. Concrete and asphalt are considered impervious, pavers or bricks with sand or clearance between units are considered semi-pervious.

When the collection occurs at a point, such as an area drain, it is very important that the nearby soil surfaces are graded to create a low area. For instance, if a house is constructed on a hill, upstream runoff may affect the house and it may be necessary to create a swale to interrupt and divert the natural flow of water so that it does not reach the house.

Bare soil has little capacity to resist water flow, resulting in higher velocities and more intense loads on a drainage system. Bare soil can experience erosion that will cause a loss of soil and channeling of the surface. Runoff over bare soil will transport silts and other water-borne materials, depositing these materials where the flow is reduced, in low spots or into a drainage system. It is important to sod the bare soil in the watershed to a drainage system.

In flat areas where water stands after a rain, and where there are no other drainage problems, a solution to the soggy soil problem is the cultivation of a healthy lawn with generous thatch. The thatch distributes the pedestrian foot loading over a broader area, and provides some separation of the standing water from pedestrians.

Soil with more organic content should be more pervious and reduce the load on a drainage system. Returning grass cuttings to the lawn by using a mulching mower, and using compost or manures rather than chemical fertilizers, should increase this effect.

In common practice, landscapers use river rock to fill drainage channels. When the river rock is placed in a trench next to the foundation water may collect at the foundation perimeter. In areas of flat terrain, it is likely that this will also result in ponding adjacent to the foundation,

which may not be apparent to the observer. In most situations, this will adversely affect foundation performance.

Common practice is the use of mulch and landscape beds around foundations. The top surface of the mulch is not a drainage plane; the actual surface drainage mechanics are hidden below the mulch.

Bed borders, sometimes of brick, concrete, or steel, can impound water even if the ground surface slopes away from foundation. Water should never be impounded or allowed to pond near a foundation.

2.2.7.1 Lot Grading Types

Many states have laws designed to protect lot owners from being impacted from a change in water flow onto their properties from neighboring construction. Therefore in the early planning stages of new construction, it is important to establish the lot grading philosophy in order to achieve proper drainage and foundation performance while not impacting neighboring adjacent lots. Decades ago the Federal Housing Administration (FHA, see Appendix) specified permissible lot grading types as part of their loan approval process.

Today, overall lot-grading types may be established by the local codes, ordinances, or deed restrictions. Historic FHA lot grading type nomenclature is still commonly used. For example Figure 2.2.7.1.1 below shows the three common FHA lot grading types. The three grading types shown are:

Type A – Rear-to-front grading
Type B – Rear-to-rear and front-to-front grading
Type C – Front-to-rear grading

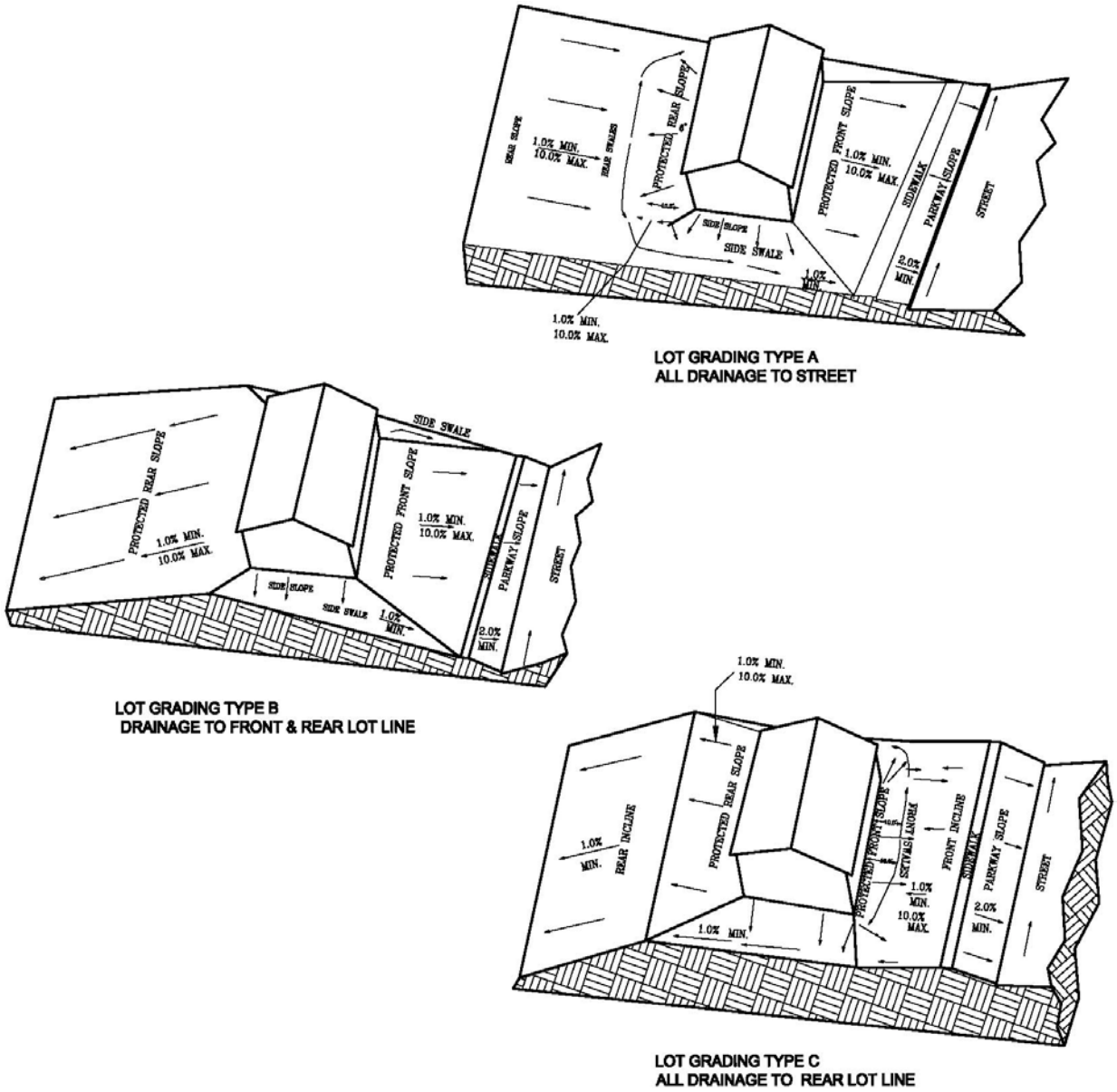


Figure 2.2.7.1.1

2.2.7.2 Purpose & Application

Surface drainage is the most natural method of collecting runoff. Modifying natural and existing surfaces to protect foundations and structures can also have beneficial results in the form of returning water to the soil, less maintenance, and more dependable foundation performance.

2.2.7.3 Planning

An elevation survey of the area to be drained and the area utilized to transport the runoff is performed. All features that will impact the installation of drainage, such as fences, existing drainage installations, trees, and other obstructions should be documented. The documentation should extend to the area where the runoff will be discharged.

Excavation for swales or channels should avoid getting too close to trees, in order to avoid cutting tree roots and possibly damaging the trees.

The drainage plan can also be used to correct the inadequate or excessive exposure of the foundation face. If the edge of a building abuts a drainage area, then the height of the exposed face of the foundation should be documented. The sill plate should be minimum 6 inches above the grade or as required by local jurisdictions. In areas with sloping natural grades, exposures can be expected to be greater where the lower grades meet the building foundation.

For new structures, a site plan and topographical drainage plan should be developed to ensure that there is adequate drainage and clearance, and that storm water is properly discharged without impacting neighboring lots. A grading certification should be provided at final grade or landscaping to ensure that the construction has complied with the requirements laid out for the site.

For existing structures, the elevations and site features are documented on a drawing, called the existing conditions survey. Another drawing is created called the proposed improvements drawing. The problems, as shown on the existing conditions survey, are addressed and solved on the proposed improvements drawing. The elevations of the areas to be drained, the foundation exposure height, and the elevations of the areas of discharge are the most important data and the proposed improvements plan must provide the drop required to carry water away. Generally, surface grade is used to shed water, and then swales are used to transport the water towards the area of discharge.

The proposed improvements on the drawing are annotated with arrows indicating drainage direction and the path for swales. Then, desired elevations that cause water to drain from the affected areas to the areas of discharge are annotated onto the proposed drawing. If the area to be drained is not loaded by water shed from neighboring properties, so that large amounts of water do not need to be managed, then low slopes (down to 0.5% for hard surfaces and 1.0% for grass areas) can be utilized for the drainage topography. Lower slopes allow a more natural appearance to the drainage system, more flexibility in designing the drainage system, and some of the water to return to the soil. The area adjacent to the foundation should be sloped to affect a drop of 6 inches within 10 feet (IRC R401.3). Steeper slopes, up to about 1:3 (rise:run), can be safely used if the soil is sodded after landscaping. Compare the elevations in the existing conditions survey and the proposed improvements drawing, and annotate the proposed improvements drawing with the changes in elevations required. For added clarity, the changes can be signed (positive or negative) and boxed to eliminate confusion with the elevations.

Based on the depth of soil to be removed or added, and the areas affected, a net disposal or addition volume of soil can be determined. Provisions for this amount of soil to be cut or filled should be made prior to construction.

2.2.7.4 Construction Considerations

Using the proposed improvements drawing, remove sod in areas to be adjusted. If the existing surfaces are sodded, the sod can be removed, set aside and reinstalled. Install wooden stakes

into the ground at appropriate locations and mark the final grade in order to define the amount and boundaries of the cut and fill.

If the native soil is adequate for the site regarding, then relocate the soil from the cut to the fill areas. After the soil has been placed, rough grade to the height marked on the stakes. Fill in and compact soft spots as required, and finish the grades in accordance with the grading improvement plan. Rough grade should be installed to a tolerance of ± 0.2 feet and fine grade to ± 0.1 feet. When the earthwork is finished, the surfaces may be sodded or seeded to prevent surface erosion. Ensure the landscaping does not adversely impact the drainage pattern.

2.2.8 Point to Point Drainage

If one area is to be drained to another area, a simpler improvement method can be used. A usual case would be to relieve an area of ponding in the back yard by moving the water to the street. Given that there is available drop from the ponding surface to the curb, a simple swale may be installed.

The following describes one way of improvement: Run a string line from point to point, with intermediate support stakes if the line is long. The string line would be raised above the surface of the soil a fixed amount, for instance, 12 inches above the ponding surface and 12 inches above the curb. The string line should be checked that it does indicate slope for drainage at all points along the route; a string level is useful for this purpose. The soil in the area under the string line can be removed or added to provide a constant depth under the string, in our example, 12 inches. This will create a centerline for the swale. Remove the string line. Modify soil surfaces at the sides of the centerline to create a gentle slope to transition to the existing yard surfaces. A carpenter's level can assist in obtaining a consistent and correct slope. After all earthwork is done, the surfaces should be hard-surfaced, stabilized, sodded, or seeded.

2.2.9 Soil Terracing

A sloping soil surface may be modified by terracing. Terracing may be performed to make the surface more useable for agriculture, for architectural purposes, erosion control, or drainage.

Terracing consists of moving (usually cutting and filling) the existing soil to create a surface resembling steps. Terracing does not allow the water to run down the slope, but keeps the water constrained to a terrace until it spills over to the lower terrace. The water ponding on the terrace allows time for the water to be absorbed by the soil. This also results in reduced erosion.

When the water spills from the terrace, there is the likelihood of erosion if the water drop is not managed. Management may consist of blocking the spillage of water from the terrace lip except in certain areas where these spillage areas are covered with erosion-resistant materials. Embedded piping may also be used to transfer the water between terraces.

2.2.10 Retaining walls

A sloping ground surface may be modified by installing one or more retaining walls. A retaining wall may be placed to stabilize an unstable slope, reduce erosion, or for greater utilization of the site. Near foundations, they are used to create a stable area of foundation support soil.

Retaining walls consist of a vertical or near-vertical structure with soil on the upslope side. The downslope side is exposed to view.

While terracing usually consists of shallow steps with no structure at the vertical surface, retaining walls consist of deep steps with a structure at the vertical surface. Also, terracing drainage normally occurs over the edge of the terrace, while retaining wall drainage is normally through or behind the wall.

There are many ways to build small retaining walls using materials such as pre-cast retaining wall dry-stack blocks (see photo below), dry stack stones and landscape timbers. On these small retaining walls, soil may be placed directly against the upslope side of the retaining wall.

A typical dry stack manufactured block wall is designed with a locking tab plus a 7 to 15 degree backward lean that extends back into the terraced hill. This built-in design resists soil pressures and allows water to flow between each block to reduce hydrostatic pressures. Without such simple design features, it is common for improperly designed small retaining wall sections as short as 18 to 24" to begin to lean outwards within a few years. In more demanding conditions, geosynthetic mat tiebacks and special wall drainage features may be required.

Proper design of all retaining walls is essential to long-term performance. Most jurisdictions require that retaining walls be engineered. IBC 105.2 and IRC R105.2 require that a permit be obtained for retaining walls with more than 4 feet of height from the bottom of the wall footing to the top of the wall. Additionally, these codes require a permit if the retaining wall is supporting a surcharge such as a building, independent of the height. These taller retaining walls, and those that are used to maintain stability of slope for structural purposes, or for safety, must use structural materials, such as solid masonry, mortared, reinforced, and grouted CMU, pressure treated wood, or reinforced cast-in-place concrete, and have structural features to resist movement. Terraced walls present a special case that normally requires engineered designs.

The differential soil lateral load at the retaining wall is not the only load that must be considered; if water is allowed to build up at the upslope side it can greatly increase this lateral load and may cause the wall to fail. For this reason structural retaining walls that may have water build-up at the upslope side should utilize a drainage system at the upslope side to drain the water to the downslope side. The system usually consists of an aggregate backfill with

through-wall drainpipes at the base of the wall or French drains on the upslope side, typically just above the base of the wall.

2.2.11 Water barrier

Subterranean water drainage can cause foundation problems with new construction. This can occur if a natural watercourse is filled with non-compacted materials (sometimes discarded construction materials) as site preparation for house construction. This can also occur due to perching of water at hillsides.

The presence of water underneath or near the foundation can possibly be determined by digging test pits or installing piezometers, and conclusively determined by the use of resistivity testing accompanied by borings to characterize the porous water-bearing strata and the nearby soil (see FPA-SC-02-0, *Test Methods for Evaluating Existing Foundations*). Once the direction and depth of water flow has been determined, a water barrier can be installed to divert the water away from the foundation. A geophysical engineer should be consulted for the design of the system. The barrier is installed by creating a trench and inserting a water resisting membrane, then backfilling.

2.2.12 Flood Mitigation

Generally, flooding occurs due to one of two causes:

The first cause is drainage from an area located upslope that has experienced a large amount of additional surface water. The additional surface water can be from sustained rain, or melting snow. The flooding normally occurs days or weeks after the additional water is experienced upslope. This type of flooding is not common in Southeast Texas.

The second cause is a large amount of additional surface water due to rain in an area where the surface topography does not allow adequate drainage rates, resulting in an accumulation of water. This can occur in Southeast Texas and other coastal areas. Tropical Storm Allison of June 2001 is an example of an event caused by high and sustained rainfall rates resulting in the accumulation of water due to level terrain and a drainage infrastructure inadequate to handle the amount of water introduced to the system. This event caused extensive flooding damage in the Houston area. Since that event, many regional jurisdictions, including the City of Houston and Harris County, have instituted measures to improve the drainage infrastructure. These jurisdictions have also instituted measures to require mitigating the effects of drainage from developed properties so as not to burden the infrastructure.

One common feature designed for this mitigation is a detention volume. A detention volume is designed to receive and collect a specific volume of the storm water, the majority of which is held for 24 to 72 hours before being released into the receiving storm water system at a controlled rate. The effect is to reduce the flow of surface storm water so as not to overburden the local storm water system during a heavy storm. Detention can take many forms such as a detention pond, detention swales, or detention storage containers located above ground or underground. Some authorities have even allowed rain barrels to mitigate very small detention volumes, however the requirement to design and operate these for 48 to 72 hour outfall drainage is difficult to confirm. Detention systems should be engineered.

A second storm water mitigation feature is a retention pond. A retention pond is a surface depression that collects and holds drainage from the areas to be mitigated. It is designed to collect the water that cannot be absorbed by the soil covered by buildings and other impervious hardscape areas. The collected and retained water will be absorbed into the soil at a greater rate due to the static pressure of the water, and will eventually be absorbed into the soil below rather than flow into the drainage infrastructure or nearby properties.

A detention volume can be designed to be temporarily held on top of retention volume so a single storm water mitigation landscape feature can serve for both detention and retention services.

In areas where the natural surface is within the flood plain, new building construction is required to have floor levels above the base flood elevation (BFE) in order to not displace water in the flood plain.

2.2.13 Sump pumps

A sump pump removes water that has accumulated in a water-collecting sump pit, commonly found in the basements of homes. They are also used to convey water when there is not enough available drop for effective gravity drainage, and to drain water from inaccessible areas when the presence of water is detrimental, such as in hillside seeps (see Section 2.1.3) affecting foundations.

Sump pumps are either electrical powered (hard-wired on a dedicated circuit to comply with NEC), or powered by the supply water source. Pressured water powered, inverter/battery powered, or a second battery powered DC sump pump, are effective strategies for maintaining the pumping during electrical power outages.

Dual or redundant battery-backup pumps are usually specified when high dependability is required. An alarm system is normally installed to warn of excessive water level in the sump pit.

There are two types of sump pumps, pedestal and submersible. The pedestal's motor is mounted above the pit; the submersible is completely within the pit. The pedestal type is easier to service, but is more conspicuous.

The sump pit can either collect water from a subsurface area or from the surface, depending on the need. Sump pumps can handle some debris, but measures must be taken to keep large debris out of the sump pit, such as screens. Also, the pit can become silted up, so periodic inspection and cleaning is important. There are sump liners available for use in sump pits, or sump liners can be created from re-purposed items.

The sump pump has a water-level sensor that turns the pump on when the water in the pit rises to a certain level, and turns the pump off when the water level drops to a certain level. Sump pumps have an integral check valve to keep water from flowing back into the pump when resting.

Sump pumps are available in various flow rate and pressure capacities. The pump should be sized for the anticipated loads. The pressure capacity describes the lifting head (such as 12 feet), which is the height from the level of the sump pump to the discharge point. Long piping runs and bends will reduce the rated lifting head.

2.3 DISPOSAL

This section covers the delivery of water to the drainage infrastructure or to the ground.

2.3.1 Curb-and-Gutter street drainage

The normal drainage disposal from an urban or suburban yard is to the street. The street is curbed and "turtle-backed" or crowned so that it will carry reasonable amounts of water at the curb gutters, which are sloped to storm inlets. At high rainfall intensity rates the streets will flood because the storm sewer systems are normally designed for 2-year rainfall events.

Private streets and alleys may be constructed to direct water toward the street centerline where the pavement will collect water and direct toward the discharge point.

Jurisdictions typically require habitable floors to be 12 inches or more above either the top of the curb or the crown of the street. IBC Section 1805.3.4 and IRC Section R403.1.7.3 require that "the top of any exterior foundation shall extend above the elevation of the street gutter at point of discharge or the inlet of an approved drainage device a minimum of 12 inches (305 mm) plus 2 percent". In other words, where the drainage flows over the curb is the discharge point and the top of the foundation must be set at an elevation of +12 inches plus 2% of the distance from discharge point to foundation. In flood plains, the top of the foundation will need to be at some specified elevation above the base flood elevation. Permitted and effective alternatives are allowed by the IBC.

The street is considered, in this case, part of the drainage infrastructure. Most street drainage construction includes storm drains. The storm drainage system consists of inlets at the street curb above a large collection basin, with large drainage pipes carrying water under the street to a surface watercourse.

2.3.2 Roadside ditch

Drainage consists of natural flows and outfalls, and the addition of drainage along and across roadways. The roads are normally built above the level of the surrounding ground surface and drainage perpendicular to the road is allowed by the use of culverts underneath the road or bridges over the drainage channel. Normally ditches are created alongside of the road to manage the flow of water. Culverts are placed below driveways that cross the ditch to allow flow across the driveway.

2.3.3 Dry well

In cases where disposal options are limited, such as when it is difficult to convey the water to the point of disposal, and the amount of water to be disposed of is limited, dry wells are a

viable option. Dry wells consist of a surface drain above a collection well. The water is received into the well during a rainfall event, and disposed of slowly into the surrounding soil.

The dry well can consist of a shell made of plastic, metal, or other materials, with holes at the bottom and sides for drainage into the surrounding soil. Dry well shells can be purchased, or the shells can be made from plastic or metal drums, culvert material, etc. The dry well can also have no shell, but with geotextile between the collection well medium and the surrounding soil. The dry well fill medium normally consists of rock or gravel. The purpose of the medium is to prevent caving of the soil around the well, and allow the collection of water into the interstices of the medium.

French drain collection and dry well disposal are well matched due to the low amount of water rates of production and disposal.

2.3.4 Subsurface sinks

Where an impervious layer at the surface, called a hardpan, does not allow easy absorption of water into the soil and is above a pervious layer, a subsurface sink can be used to drain the water from the surface into the pervious layer. The sink consists of a hole dug through the impervious layer to reach the pervious layer, and filled with a porous medium, such as consistently sized round rock. The hole can be lined with geotextile if erosion of the soil is a problem.

2.3.5 Evaporation and Plant Uptake

Evaporation is virtually ineffective during a rainfall event due to the high humidity associated with rainfall. Afterwards, evaporation acts to eliminate water that has not drained.

If a surface hardpan exists, and water ponds after a rain, evaporation may be an effective means of disposal. Grading the soil surface level to expose the largest area of water surface can enhance evaporation.

Another phenomenon that has little effect during a rainfall event but can mitigate ponding is the uptake of water from the soil by plants. A healthy lawn with a thick thatch can not only absorb water but also insulate the pedestrian from the ponded water. The soil near a tree, which would normally be very dry, can absorb a substantial amount of water. A hole constructed like a subsurface sink near the tree can drain ponded water into the dry subsurface soil.

2.3.6 Soil absorption

At low rainfall rates, when soil is not saturated, soil absorption can be a substantial disposal method. The rate of absorption can be increased by working non-clay constituents into the soil, by terracing, by plantings, and by aeration of the soil. Dry clayey soil which shows surface cracking can absorb a large quantity of water.

Soil absorption can also be useful in subsurface pipe drainage systems. Perforated pipe can be used when sufficiently away from the foundation, typically five to ten feet. This feature will

reduce the water volume delivered to the drainage infrastructure, since water is absorbed into the ground.

Another system that takes advantage of soil absorption is a French drain system which discharges water into a subsurface soil by percolation through perforated pipe. The use of perforated pipe to dispose of drainage water is the same method used to dispose of the discharge of septic tanks.

Yet another system that takes advantage of soil absorption is one in which part of the drainage path is on the pervious surface. For instance, water from a gutter downspout strikes a splash-block and pours onto the ground, proceeding to a remote area drain or the street, in contrast to the downspout discharging directly into a drain.

The rate of soil absorption can be determined by running a percolation test. This test is a requirement for the permitting of a septic system. A hole is dug into the ground, and filled with water, and monitored for the rate of dropping of the water surface.

The amount of water absorbed on a property is determined by the amount of pervious surface. A property containing a building and a yard covered in impervious surfaces would drain all of its water to the drainage infrastructure. Choosing pervious surfacing materials such as pavers, grass, and crushed granite to landscape the yard will reduce the amount of drainage to manage on the property and limit the amount of load on the drainage infrastructure.

2.3.7 Impact on neighboring property

In an effort to prevent flooding or to control drainage at a property, neighboring properties can be impacted, which is often not allowed by jurisdictions. Some jurisdictions do not allow a net increase of soil fill when constructing new residences. Most jurisdictions allow a net increase, provided that new drainage does not impact neighboring properties. Some jurisdictions limit the amount of impervious surface without mitigation, or require mitigation of any increases in impervious area.

The practice of piping surface water into the sanitary drainage system is illegal in most cities, and threatens neighbors with sanitary sewer backups.

3.0 DRAINAGE EFFECTS ON FOUNDATION PERFORMANCE

Good foundation performance normally requires positive drainage around the foundation. This applies to both shallow and deep supported foundations.

Shallow supported foundations include slab-on-ground concrete foundations and crawlspace systems supported on spread footings or grade beams founded near the surface. Other common shallow supported structures include pavements, pools, and retaining walls. Deep supported foundations can be similar to the above, but with the primary vertical support derived from deep-founded structural elements such as piers or piles. In some cases deep supported concrete foundations may be isolated from the upper soil and any associated surface drainage issues

through the use of void spaces typically 4 to 8 inches tall. For a detailed description of some of the common lightly loaded foundation types used in Texas, see FPA-SC-01-0, *Foundation Design Options for Residential and Other Low-Rise Buildings on Expansive Soils*.

In the subsections that follow, considerations are offered to help the user understand the impact of some common site conditions or characteristics related to drainage that can affect foundation performance.

3.1 COMMON DRAINAGE PROBLEMS

Some of the more common drainage conditions that cause or exacerbate foundation performance problems are listed in FPA-SC-06-0, *Homebuyers' Guide for Foundation Evaluation*. The following checklist items, from the aforementioned document intended for potential homebuyers, may help the user of this document to design and construct better drainage systems that are less likely to impact future foundation performance:

- *Observe the ground slopes in the vicinity of the foundation. The adjacent grade should clearly slope away from the foundation on all sides. Ground sloping toward the foundation usually allows water migration toward the foundation and may be a source of foundation problems.*

- *Note the location of all drains and downspouts. Downspouts should discharge away from the foundation, into an underground drainage system, onto sloped paving, or onto splash blocks sloping away from the house. If downspouts connect to a drain, determine the location of the discharge to ensure the drain is functioning.*

- *If the residence has a crawl space, verify that at least one square foot of net ventilation is provided for each 150 square feet of crawl space floor area. Observe if the crawl space is moist or wet. If a sump pump is provided verify that it operates.*

- *The ground beneath the landscaping topsoil or mulch should clearly slope downward away from the foundation on all sides.*

- *Note tree stumps close to the house. If these do exist, determine how long ago the trees were removed. Removal of trees near the foundation may permit moisture in the soil to increase. This may cause the expansion of clay soils resulting in upward foundation movement.*

- *Note planters adjacent to the house. These areas should be well drained to prevent water from ponding or seeping under the foundation.*

- *Note the location of sprinkler heads relative to the foundation. Turn on the sprinkler system to ensure the heads spray away from the foundation.*

- *Note the use of cobblestones and other types of rock fills as decorative landscaping. When adjacent to the foundation, this type of landscaping may provide a path for water to seep under the foundation.*

- *Note areas, such as split-levels or sunken rooms where the finished floor elevation is below the final grade of the backfill or paving. Improper construction techniques can lead to water leaking into the below grade areas.*

Also note that flatwork such as driveways and concrete patios that abut foundations should properly slope away from the foundation.

3.2 SITE SOIL TYPES

Certain types of soil can increase the impact on foundation performance when site drainage is substandard. It is important to be aware of the soil composition in the upper strata in order to evaluate the risks associated with inadequate drainage. Most soil reports prepared for foundation design, particularly those prepared in accordance with FPA-SC-04-0, *Recommended Practice for Geotechnical Explorations and Reports*, will provide information on soil composition. If a soil report is not available for the site, access the US Government's USDA soil survey database at: http://websoilsurvey.nrcs.usda.gov, which contains soil data for the upper 5 to 7 feet for most sites in the country.

The subsections below describe additional considerations for each of the major soil types commonly encountered in drainage work around foundations: clay, silt and sand.

3.2.1 Clay

Clay can be differentiated from other types of soil in that its particles are microscopic and can chemically bond to water molecules. Hence clay is categorized by geotechnical engineers as "cohesive". At greater depths, usually more than 30 feet, clay will tend to be almost impervious because of its cohesive characteristics. However, above that, most clay found will be relatively permeable because of fracturing of the soil matrix. This fracturing is usually due to the existence or pre-existence of vegetation roots. These soil cracks may be the tracks of roots from trees that died years, decades, or centuries earlier and will cause high permeability in the clay matrix. Because of this possibility, foundation design engineers must be concerned with proper surface drainage. Ponding and leaking water near the surface can permeate tens of feet in a matter of months, wetting other, sometimes more active clays.

Unsaturated clay, i.e., clay soil stratum located above the permanent groundwater table, presents design challenges in locations where the near surface clay is active, the climate is variable, and a lightly loaded structure is present. Geotechnical data should be utilized for the design of all foundations on active soil. If piles or piers are utilized, their depth below grade must be engineered.

Active clay, also referred to as "high plasticity clay", "high PI clay", "fat clay", and "expansive clay", changes volume when the clay's moisture content changes. The addition of moisture to active clay causes it to expand in volume while the extraction of moisture from the active clay will cause it to shrink in volume. Either of these changes in volume can adversely affect the performance of lightly loaded foundations, particularly when the moisture and volume changes are not uniform. The addition of moisture is of main concern in the discussion of drainage.

Most foundation design engineers working in active clay areas of Texas design lightly loaded foundations with the assumption and the requirement that the building pad and surrounding grade will have positive drainage during construction, when construction is complete, and throughout the life of the foundation. For example, Sections 3.1 and 3.2 of FPA-SC-15-0, *Foundation Construction Drawing Notes for Residential and Other Low-Rise Structures* lists the following drainage related engineering design assumptions in the FPA's recommended drawing notes. The assumptions are:

- *A reasonably uniform soil moisture level is maintained around the foundation for the life of the structure.*

- *Positive drainage away from the structure is maintained for the life of the structure and the contractor shall convey this requirement to the owner.*

- *The initial and all subsequent owners maintain the foundation in accordance with the latest revision of document no. FPA-SC-07, "Foundation Maintenance and Inspection Guide for Residential and Other Low-Rise Buildings".*

- *Site grading and drainage around the foundation shall be maintained at all times during construction in such a manner that surface or ground water will not collect around or within the footprint of the foundation.*

- *Fill required adjacent to the footprint of the foundation or any flatwork shall be compacted to the same specifications required within the footprint of the foundation and for a horizontal distance of 3 feet for every foot that the finished floor concrete elevation is above existing grade.*

3.2.2 Silt

Whereas clay is considered a cohesive soil, silt, the next larger size soil particle, and visible to the naked eye, is considered cohesionless in that the grains do not bond to water as does clay. A silt matrix contains more air space between its particles and is highly permeable compared to normal fractured clay found near the surface. Silt's air spaces can be readily filled with available water. However, because there is not an affinity for water to bond to silt particles as in the case of clay, water movement in silt and other cohesionless soil is by gravity only. Therefore, the water must come from a higher elevation in silt whereas in active clays water can be pulled in from all directions. Note there have been reported cases of finding active silt but these are rare.

Most engineers design lightly loaded foundations in silty areas of Texas with the same drainage assumptions listed in the previous subsection for clay. They do this because silt often has low bearing capacity when dry, even for lightly loaded structures. Silt can quickly lose, via water lubrication, much of its bearing capacity when exposed to excessive moisture conditions. Even when the foundation extends through a surficial silt stratum into a supporting active clay, the design can still be compromised because poor drainage above or within the silt stratum will quickly permeate the supporting clay stratum below, causing the foundation performance problems discussed in the previous subsection.

3.2.3 Sand

Sand particles are larger than silt and are also considered cohesionless. Because its particles are larger, sand exhibits more roughness, and, therefore, has a higher bearing capacity than silt, particularly when its air spaces are filled with water. When the surficial sand stratum is sufficiently deep and dense, drainage will be of less concern to foundation design engineers for lightly loaded structures.

Erosion of sand can be of concern in that the removal of sand grains can undermine a grade-supported foundation. There can also be concern for transmitting water below the foundation that may attract tree roots that could grow large enough to lift slab-on-ground foundations. And, as with silt, if the foundation is supported in a clay layer below the sand stratum, the high permeability of the sand matrix can create a foundation performance problem, as described in the previous section.

Rough grading material, when used around a foundation, should be a select fill or other cohesive soil that is compactable and less permeable than sand and silt. Sand and silt should never be used for rough grading over active clays as this may create a perched water table or "bathtub" effect.

4.0 REFERENCE MATERIALS

City Of Houston, Texas. Department of Public Works & Engineering. *Infrastructure Design Manual, Chapter 9 Stormwater Design Requirements.* July 2009.

City Of Houston, Texas. Department of Public Works & Engineering. *Infrastructure Design Manual, Chapter 13 Storm Water Quality Design Requirements*. July 2009.

City Of Houston, Texas. Department of Public Works & Engineering. *TP-101 Guidelines For Consideration Of Overland Flow For The Extreme Event For Improvement Projects In The City Of Houston, Harris County, Texas Region.* April 15, 2005.

Deltona, Florida. City Commission. *Residential Lot Grading Guidelines*. September 16, 2003.

Foundation Performance Association. Document No. FPA-SC-01-0. *Foundation Design Options for Residential and Other Low-Rise Buildings on Expansive Soils.* 2004.

Foundation Performance Association. Document No. FPA-SC-02-0. *Test Methods for Evaluating Existing Foundations.* 2010.

Foundation Performance Association. Document No. FPA-SC-04-0. *Recommended Practice for Geotechnical Explorations and Reports*. 2011.

Foundation Performance Association. Document No. FPA-SC-06-0. *Homebuyers' Guide for Foundation Evaluation.* 2005.

Foundation Performance Association. Document No. FPA-SC-15-0. *Foundation Construction Drawing Notes for Residential and Other Low-Rise Structures.* 2008.

IBC. International Building Code. Country Club Hills, IL. International Code Council. 2006.

IPC. International Plumbing Code. Country Club Hills, IL. International Code Council. 2003.

IRC. International Residential Code for One- and Two-Family Dwellings. Country Club Hills, IL. International Code Council. 2006.

Mesa County, Colorado. Mesa County Board of County Commissioners. *Stormwater Management Manual, Section 400 Drainage Policy*. March 27, 2006.

NDS. *Principles Of Exterior Drainage - Short Course.* NDS. 2007. 20 Oct 2011 http://www.ndspro.com/images/stories/pdfs/drainage/principles-of-exterior-drainage.pdf.

NDS. *Principles Of Exterior Drainage- Quick Review.* NDS. 2007. 20 Oct 2011 http://www.ndspro.com/images/stories/pdfs/drainage/principles-of-exterior-drainage-quick-review.pdf.

Schwartz, Max, and Hamid Azizi. *Builder's Guide to Drainage & Retaining Walls.* Builder's Book, Inc., 2007.

Tyler, Jeffrey B. *Exterior Drainage Principles And Erosion Control, Part 1.* Landscapeonline.com. Nov 2003. 20 Oct 2011 http://landscapeonline.com/research/article/3888.

Tyler, Jeffrey B. *Exterior Drainage Principles And Erosion Control, Part 2.* Landscapeonline.com. Feb 2004. 20 Oct 2011 http://landscapeonline.com/research/article/4148.

United States of America. Department of Housing and Urban Development. *HUD Data Sheet 72.* (See Appendix B)

United States of America. Department of Housing and Urban Development. *HUD Handbook 4140.3*. (See Appendix A)

United States of America. Federal Housing Administration. *HUD Data Sheet 79g*. (See Appendix C)

United States of America. National Oceanic and Atmospheric Administration/National Weather Service. *Hydro 35*. Maryland, 1977.

APPENDIX A

HUD HANDBOOK 4140.3

CHAPTER 1. LAND PLANNING DATA SHEETS AND BULLETINS

1-1. GENERAL.

a. Due to reorganization of Field Offices, turnover of technical and processing personnel and issuance of new procedures, there may be some confusion on the part of field personnel as to what bulletins or data sheets on land and environment are currently effective and available for use.

b. The data sheets normally used in processing housing proposals were formerly a part of FHA Land Planning Bulletin No. 3, Neighborhood Standards. Distribution of the localized editions of Bulletin No. 3 was stopped in 1968. Individual data sheets, however, continue to be printed, distributed and used. Examples of the current data sheets are attached following this chapter. Additionally, two bulletins are current and are listed in Paragraph 1-2 below.

c. The current data sheets and bulletins may be useful to the following persons and organizations, and should be distributed to them as needed:

(1) HUD/HPMC field processing and technical personnel
(2) Builders and developers
(3) Technical personnel employed by builders and developers
(4) Professional planning personnel
(5) Local authorities engaged in planning activity

1-2. BULLETINS. The following Bulletins will be separately printed and issued:

a. Planned-unit Development with a Homes Association, Land Planning Bulletin 6, HUD-TS-6, Reprint 1971 is current.

b. Land-use Intensity, Land Planning Bulletin 7, HUD-TS-6, Reprint 1971 is current.

1-3. PROCEDURES. Although procedures cited in the above publications have changed since their most recent issuances and will continue to change, the basic concepts or principles expressed therein remain valid. Specific technical procedures and processing

guidelines are contained in applicable HUD-FHA issuances.

1-4. SUPPLIES OF DATA SHEETS AND BULLETINS.

a. Minimum supplies of the listed data sheets may be reproduced locally. Quantities required in excess of 100 should be requisitioned by Administrative Officers from the Regional Office, General Services Division. Supplies of Bulletin 6, HUD-81-F and Bulletin 7, TS-6 should be requisitioned by Administrative Officers on Form HUD-10 directly from the Central Office. Requisitions for these two bulletins should include the complete identifying numbers shown above.

b. Request to HUD-FHA personnel for data sheets and bulletins from persons and organizations identified in subparagraph 1-1c, above, shall not be referred to the Central Office. Field Offices should honor such requests in accordance with reference (1) of the foreword.

c. Copies of Bulletin 6, HUD-FHA-81-F are for sale at $1.00 per copy by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. If deemed advisable by the local office, private individuals or private organizations requesting multiple copies of this bulletin should be directed to procure their needs from the Government Printing Office.

1-5. LIST OF CURRENT DATA SHEETS. Data sheets in current use follow.

HOUSING AND URBAN DEVELOPMENT

FEDERAL HOUSING ADMINISTRATION

ECONOMICALLY PLANNED SUBDIVISIONS

COST SAVINGS may be effected in the development of land for housing projects by planning for the economical development of new subdivisions. A well-thought-out plan will include appropriate and adequate utilities and street improvements at minimum costs for both installation and future maintenance. Primary factors which directly affect the land cost of low-cost housing development are:

1. Selection of usable undeveloped land in a suitable location.
2. A practical plan of development adopted +o the physical characteristics of the site.
3. Installation of adequate utilities and street improvements which are economically constructed.

SELECTION OF SITE

For the purpose of economy housing, care must be exercised in the selection of land that will require minimum preparation in the way of clearing, grading, drainage, and other necessary improvements. Obviously, cheap raw land that requires extensive preparation is expensive to develop. The objective is to provide a maximum number of usable lots with a proper relationship between cost of a lot as improved, and the sales price of the house and lot.

The most economical site for development is a tract of slightly rolling ground and natural drainage outlets. The land should be free of outcroppings of rock and not heavily wooded.

Experience has shown that flat land creates many difficulties that are costly to overcome. Inadequate run-off of surface water often causes ground saturation which results in a high water table adversely affecting house foundations, basements, pavements, and individual water-supply and sewage-disposal systems. Flat land usually requires extra grading to obtain adequate street gradients for surface drainage, and lengthy collection mains for storm-water disposal.

Properties with regular boundary lines are easier to develop than those having acute angle corners, narrow extensions, and extremely irregular shapes.

Sites that have stable soils will generally be more suitable and economical to develop than sites with wet or saturated soils. The latter usually require subsurface drainage in order to create the stability necessary for building foundations, and street improvements.

Before final selection of a site, consideration should be given to convenience of transportation and accessibility to necessary community facilities. High daily and weekly costs for transportation to centers of employment, stores, and schools may offset savings in land and improvement costs.

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

Figure 3.

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

Figure 4.

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

Figure 5.

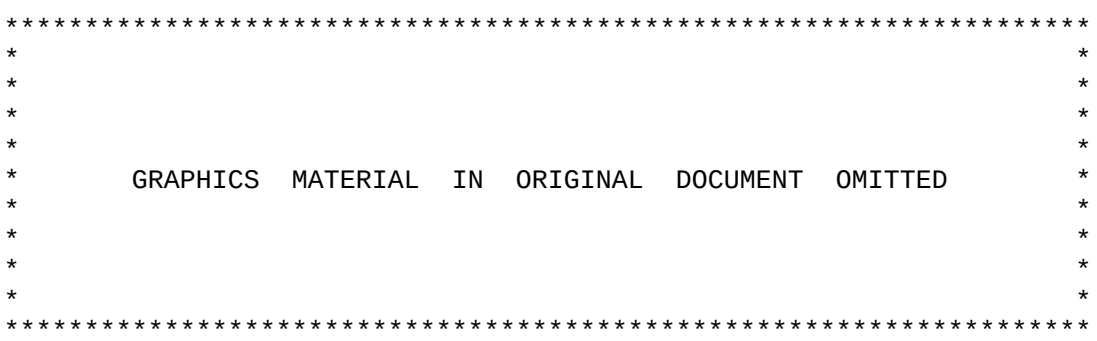


Figure 1.

DEVELOPMENT PLAN

A plan designed for a particular site is more economical than one in which the site is reshaped to fit a preconceived plan.

A general over-all development plan and determination of its details are important factors in the economical development of a subdivision. The cost of a good plan will be saved many times by the economics of site development that may be effected by it. Properly planned streets and lots logically related to site conditions are prime factors in producing low improvement costs.

The development of some sites may create inaccessible corners and interior areas of large irregular blocks. By the use of culs-de-sac and loop streets these areas may be utilized and additional building sites obtained.

In designing the street pattern to provide adequate and convenient access, to create desirable building sites on both sides of the street the topography of the site is an essential consideration. To reduce grading and drainage costs accurate profiles and cross sections usually are necessary to establish reasonable grades and to balance cut and fill. Where grades are steep, it is generally desirable to cut diagonally across the contour lines, as shown in figure 6. Properties on each side of the street then will have a reasonable relationship to the street and excessive grading and retaining walls for individual lots will be avoided.

The undesirable condition created by a street parallel with contour lines on steep topography is shown in figure 7. The houses on both sides of the street bear no relation to each other as to grade and have

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

Figure 2. Irregular sites increase development costs.

an undesirable, impractical relationship to the street. Usually many steps in the walks are required to provide access to the public sidewalk and frequently costly retaining walls are required to retain front and rear yards.

Figure 8 indicates the undesirable renditions created when a street is built directly up a steep slope. Excessive street grades are created and expensive retaining walls are necessary along side lot lines to take up the difference in grade between adjoining houses and lots.

The street pattern in a subdivision is composed of both collector streets and minor residential streets. Streets which act as collectors and feeders of traffic between residential areas and main highways should be more heavily constructed than minor residential streets. Good planning will assure the minimum length of collector streets necessary to adequately service a development. Obviously this will prove to be a substantial economy in construction, since minor streets may be narrower and require less costly treatment.

Gridiron street patterns are usually expensive, because of the excessive number of cross streets and expensive street intersections. In a gridiron layout most streets become through traffic arteries which require greater width and higher type of improvements.

IMPROVEMENTS

Inadequate utilities and street improvements are as uneconomical for economy housing as excessive or extravagant improvements. It is less costly to install improvements correctly in the beginning to repair and rebuild inadequate improvements. The purchasers of economy housing cannot afford

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

Figure 6.

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

Figure 7.

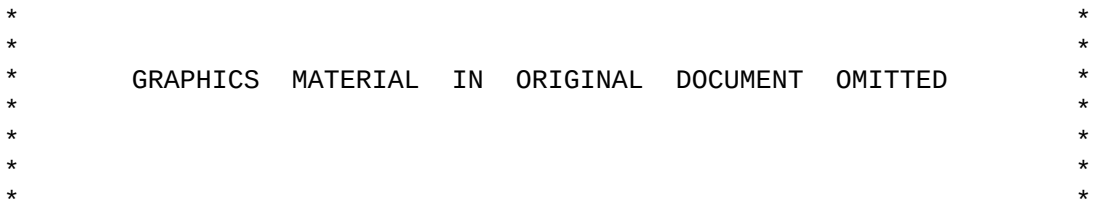


Figure 8.

DATA SHEET 6

large short-term expenditures under special assessments for installation or reconstruction of street paving or drainage. Street improvements are ultimately less costly and more easily paid for when the original installation is adequate and is paid for under long-term mortgages on the individual properties.

Figure 9 illustrates three ways in which surface drainage sometimes may be carried satisfactorily along the edges of street pavements. These methods are usually less costly than either concrete curbs and gutters or graded and sodded swales with culverts at each driveway and at street intersections. Concrete curbs and gutters are usually necessary to prevent erosion and avoid saturation and failure of the pavement base where street gradients are steep or relatively flat, or where lots are of limited width.

Where existing soils are composed entirely of coarse material such as sand and gravel or coarse material with only small amounts of clay, consideration should be given to a stabilization method which will provide a good pavement base. This process involves the addition to the existing soils of a binder material, such as asphalt, cement, or binder soils. Where practicable, stabilization of existing soils may effect an economy because soils can be processed in place instead of removing existing soil and bringing other road material to the job.

Competent site planning can result in the saving of both time and money in the development of subdivisions without sacrifice of good neighborhood character or lasting home-ownership appeal.

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

Figure 9.

HOW TO USE THE LUI NUMBER OF YOUR SITE

As sponsor of a proposed multifamily project, planned-unit development, or Title X land development with a multifamily or PUD use, one of the first thing you get from your FHA office is a land-use intensity (LUI) number for your site. It is arrived at by FHA's consideration of many variable factors and weighting their significance to produce a composite determination. Those include knowledge and judgement of the local housing market, site characteristics, appropriate building types and economic considerations.

The LUI number of your site tells you certain basic requirements for planning your site, such as maximum floor area and minimum amounts of outdoor open space, car parking and green livability space. The requirements are expressed as planning relationships, called land-use intensity ratios. They involve only the total amounts of various project components, leaving to you and your planner maximum freedom in design of your project.

To find out what the LUI number of your site means, a line should be drawn horizontally at your LUI number on Illustrations 2, 3, 4 and 8, and vertically on Illustration 7.

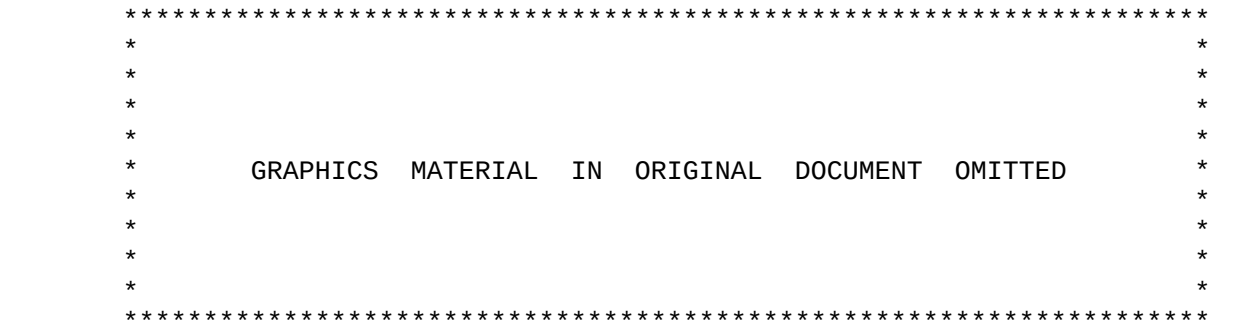


Illustration 1. DEVELOPMENT POSSIBILITIES OF A ONE ACRE SITE

LAND-USE INTENSITY 1 DATA SHEET 19

4/73

HUD-Wash., D.C.

4140.3

1. ACCEPTED BUILDING PROGRAM

Your LUI number interlocks with the building program for your site, that is, with the building type or types, and the number, composition and size of living units. If your program is yet to be defined completely, as is often the case early in the proposal of a planned-unit development or a Title X, use Part 2 on the next page as a guide in preparing and testing a complete program. It is equally useful in initiating or modifying a program.

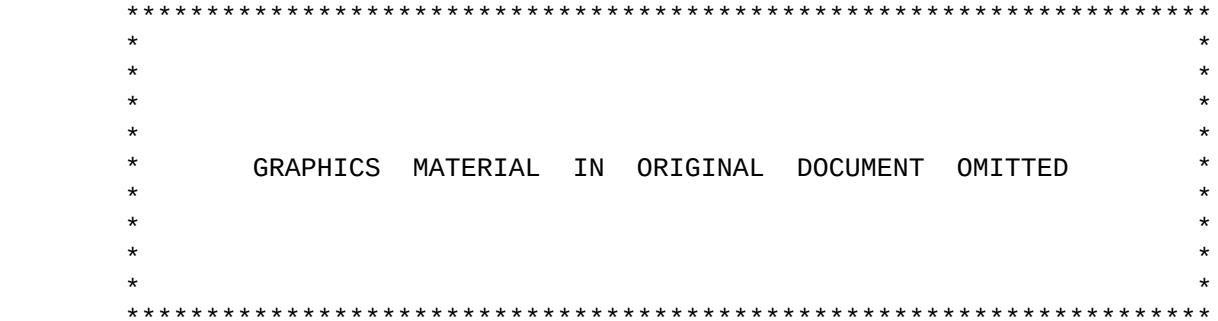
Once your building program is defined completely and accepted by you and FHA, skip Part 2 and go directly to Part 3 for information about using the LUI ratios in designing your project.

2. PROGRAMMING GUIDES

Building Type. Your development program should call for one or more building types considered especially suited to your site and market. The selection should recognize special opportunities, as for example, increasing the number of stories in the structure to free up extra ground level space. (Insert here the illustration of 10-story and 2-story buildings)

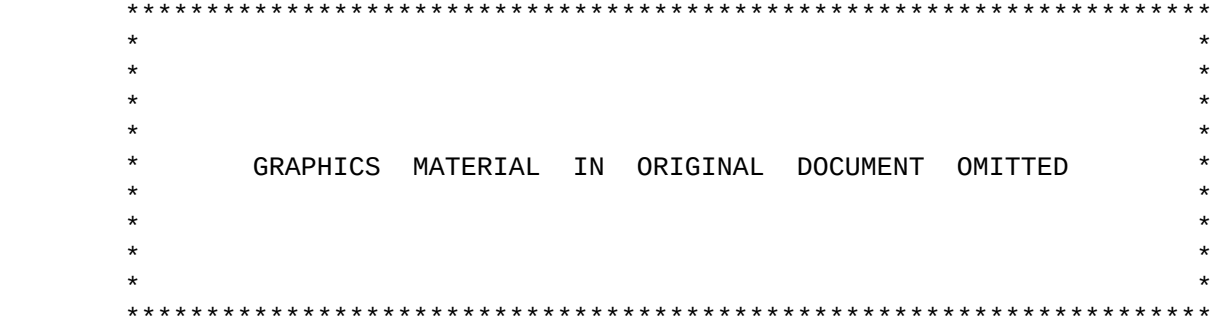
Look at the pencil line drawn on Illustration 7 for your LUI number. Where it crosses the range bars at the top of the chart it suggests one or more building types.

Illustration 2 DENSITY FOR WALK-UP APARTMENTS



4/73
HUD-Wash., D.C.

If you use several types of buildings in your project, you offer a market choice and visual variety. This is particularly important in a large project. Consider not only the suggested types but also a blend of the building types shown on Illustration 7 for land-use intensities somewhat higher and somewhat lower than your LUI number.



Density. At the top of illustration 7, the pencil line or your LUI number gives a rough approximation of the number of living units of an average size that you can build on each acre of your site. Use the gross land area of your site for all LUI estimates, as explain under the ratios in Part 3.

If your project is to be the elevator apartment type. refer to Illustration 3 for better data on number of living units. The horizontal line drawn under the LUI

number for your site helps you to read, under each vertical column representing net floor area, the number of living units each acre of land area will yield. If your project is to be garden apartment buildings, use Illustration 2. If It is townhouses or other single family building types, so in a typical planned-unit development with a homes association, use illustration 4.

If your project is to be a combination of two or more of these types, you should find the approximate density factors in the tables and apply them to the number of acres devoted to each respective use.

Note that the tables for apartments have an allowance of 10% in walk-ups and 17% in elevator types for the common space of halls, stairs, elevators, lobbies, etc. Thus the floor areas in the column headings are net rentable living spaces. If your proposed building design should result in a different percentage for halls, stairs, etc., say 15%, use the table of Illustration 4, but reduce the unit count by whatever the percentage of common space will be in your design, such as 15%.

Optional Test For Program Feasibility. You can get a still better idea of the living unit yield and other project components by using the LUI ratios appearing on page 8 and discussed in Part 3. Knowing your LUI ratios, you or your planner can try out your proposed building program, and any alternative ideas, both physically and economically. The ratios let you make these tests before doing any design. This can save time by eliminating false starts. It can also increase your project returns by leading you to the building program of greatest financial soundness.

To test the physical feasibility of your proposed building program, use a copy of the worksheet illustrated on page 6, FHA Form No. 1028, Project Planning Program. Instructions are on the back of the form. You find the amount of building area, open space and other physical components of a project with a particular building type. In doing this, you should refer to details in the site planning chapter of the Minimum Property Standards for Multifamily Housing.

To check whether your proposed building program is economically feasible, use the living unit count and the other physical components of the project found in your arithmetic on Form 1028. With this data you can estimate your construction cost, income, expenses, etc.

LUI Ratios for Your Site. Each LUI ratio is briefly defined on page 8. Their relationships are shown on the chart in Illustration 7. Their values can be read directly from the table of Illustration 8; the ratios for your site are on the horizontal line drawn at the LUI number for your site. They apply to residential area and use; any commercial is considered separately.

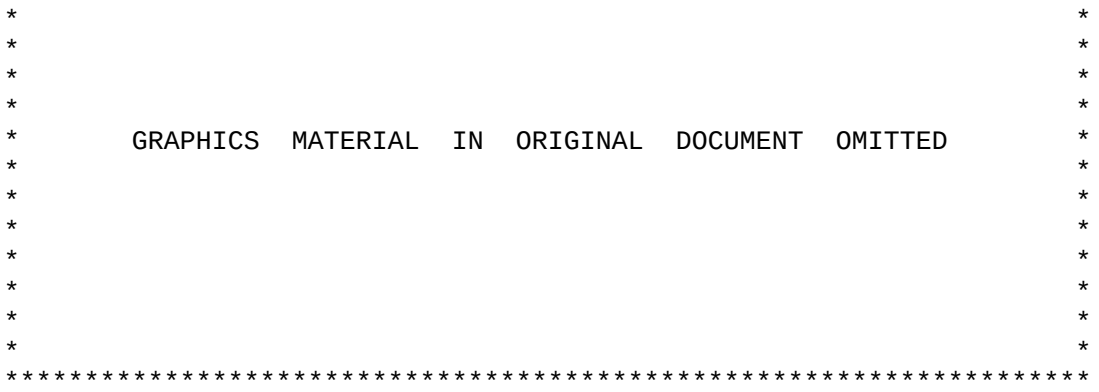
For LUI density estimates and floor area ratio, count all the land which benefits your project. This includes half of abutting streets, as well as the owned area of the site itself. You may also count part of any other adjoining beneficial land area, such as a park or other permanent open apace. The amount to count is defined under "Land Area" in the site planning chapter of the Minimum Property Standards for Multifamily Housing.

The LUI ratios allow you great flexibility in project design, permitting you to plan for the most effective use of your site at its appropriate intensity. The ratios provide positive measures of space requirements, but are only minimums. The skill and ingenuity of the designer is still needed to arrange the component parts to make an economical and attractive site plan.

Checking Your Proposed Design. When your project is designed, check the initial sketch plan and later versions for compliance with the ratios for your LUI number on Illustration 8. Do this on the one-page worksheet called FHA Form No. 1029, Land-use Intensity of a Project Plan. Instructions are on the back of the form. A sample form is on page 7.

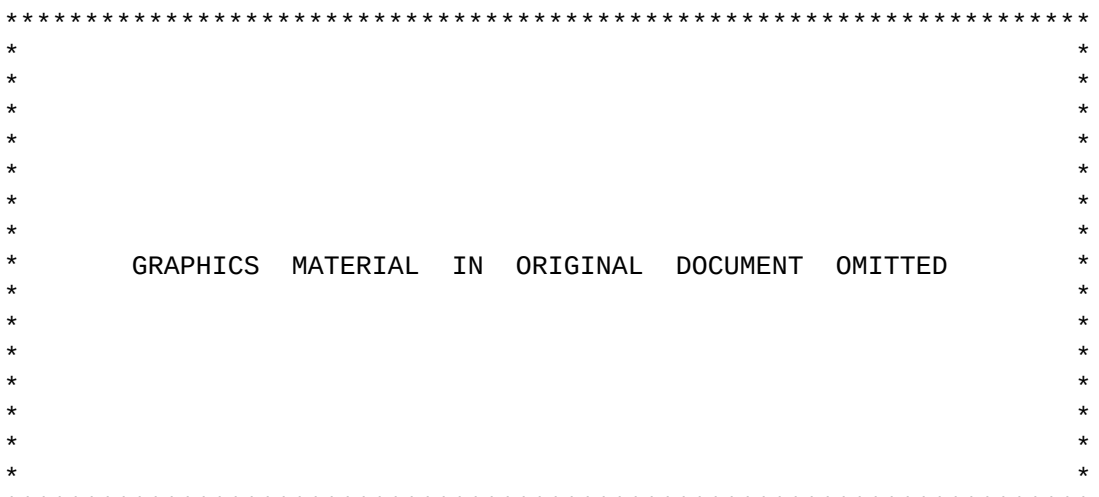
4/73
HUD-Wash., D.C.

Illustration 3.



4

Illustration 4.



5

Illustration 5.

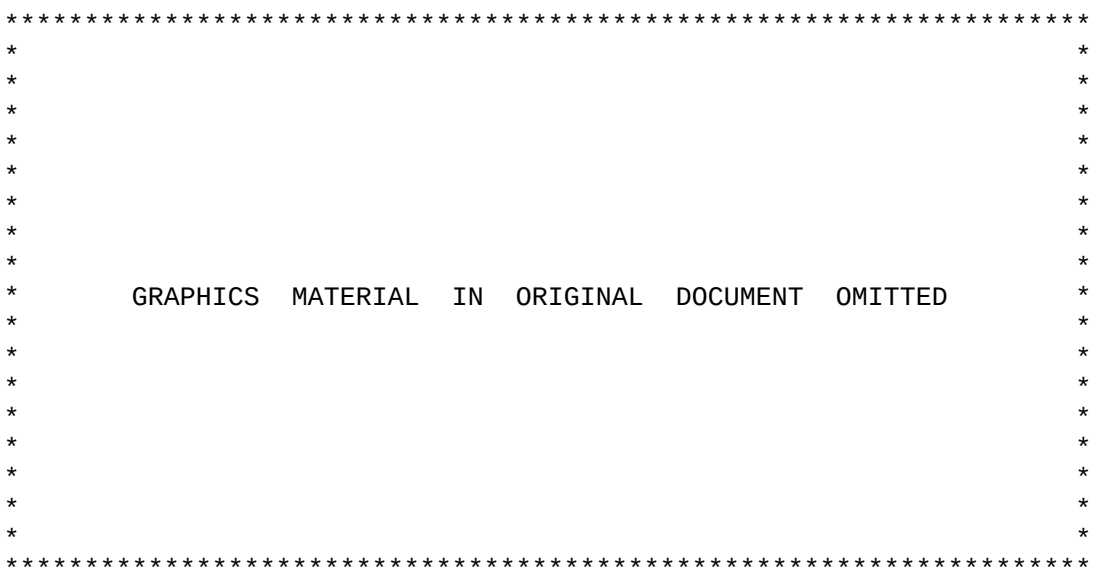


Illustration 6.

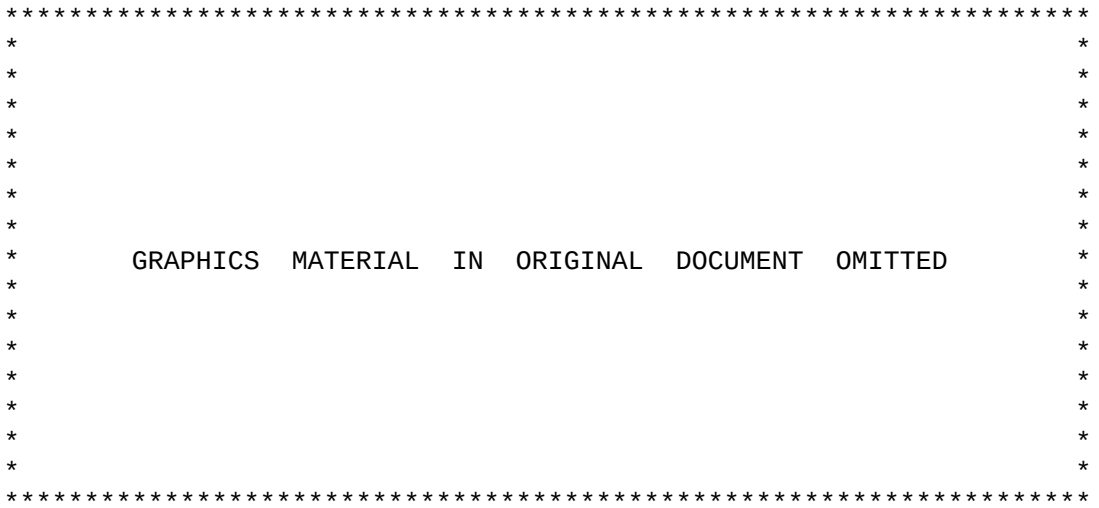
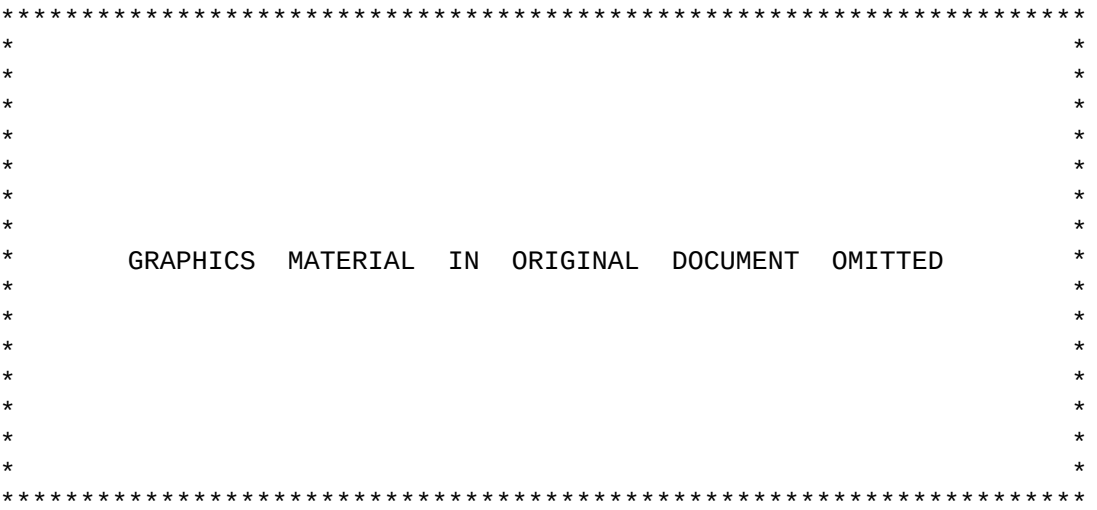
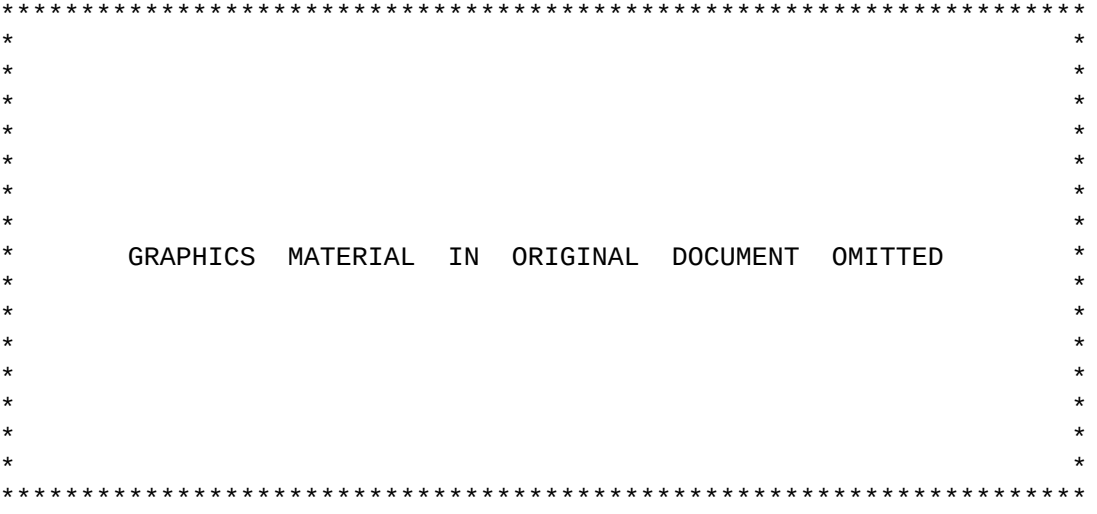


Illustration 7.



4140.3

Illustration 8



PROTECTIVE COVENANTS
FOR DEVELOPMENTS OF SINGLE-FAMILY DETACHED DWELLINGS

This information is offered as a general guide to sponsors who desire to obtain for individual properties maximum protection against inharmonious land uses.

Protective covenants are essential to the sound development of proposed residential areas. Covenants properly prepared and legally sound contribute to the establishment of the character of a neighborhood and to the maintenance of value levels through the regulation of type, size and placement of buildings, lot sizes, reservation of easements. and prohibition of nuisances and other land uses that might affect the desirability of a residential area.

They should provide enforcement provisions, be recorded in public land records and be made superior to the lien of any mortgage that may be on record prior to the recording of the protective covenants.

Protective covenants regulating the use of land represent an express agreement between the subdivider and the lot purchasers. Through this agreement all parties seek to gain certain advantages, the subdivider to aid his land development program and the purchasers to protect their investments. Strict enforcement of suitable protective covenants gives best assurance to each lot owner that no other lot owners within the protected area can use property in a way that will destroy values, lower the character of the neighborhood, or create a nuisance.

In zoned communities protective covenants are an important supplementary aid in maintaining neighborhood character and values. The extent of zoning protection is limited to governmental exercise of police powers of maintaining and promoting public health, safety, and welfare. Protective covenants being agreements between private parties can go much further in meeting the needs of a particular neighborhood and is providing maximum possible protection.

Development sponsors should have their protective covenants drafted by legal counsel. The preliminary draft of the covenants should be submitted to FHA for comment at the same time that the sponsor presents his preliminary subdivision plan to FHA for comment.

The proper form of protective covenants varies in the different states. A generally acceptable and enforceable form is a written declaration by the owner of the entire tract which is recorded in land office records. Frequently in smaller complete developments, the covenants and conditions are stated on the recorded map. When a separate declaration is made it is good practice to record it simultaneously with the recordation of the subdivision map.

The written declaration of covenants is a preferable form for establishing a uniform scheme for the development and protection of the entire area. Piecemeal control by inserting covenants in individual deeds at the time properties are conveyed is not conducive to harmonious development.

PROTECTIVE COVENANTS DATA SHEET 40

4/73

HUD-Wash., D.C.

4140.3

DETAIL COMMENTS

AREA OF APPLICATION

In small developments complete protective covenants usually should he applied to the entire development area and, in addition, to any adjacent area which would possibly affect the properties within the development if put to a nonconforming use. Adjoining or nearby lands should be made subject at least to covenants regulating land use and type of building, lot size, and prohibition of

nuisances and temporary structures.

For large tracts of land to be developed by sections it is desirable to establish protective covenants over the entire area in connection with the development of the first section, particularly with respect to land use, type of building, lot size, and prohibition of nuisances and temporary structures. Where only a section of a large development is to be made subject to all covenants, the protection should extend to and include a buffer area immediately adjacent to the section. When subsequent sections of the development are opened, complete protective covenants are extended to new sections and adjoining buffers in the same manner.

When nonresidential uses such as parks or business are to be provided special covenants applying to specific locations should be included. The degree of the effect upon fully protected properties may then be anticipated.

SAMPLE CLAUSES

PART A. PREAMBLE

(Include the date, purposes, names and addresses of all parties and legal descriptions of all lands involved.)

PART B. AREA OF APPLICATION

B-1. FULLY-PROTECTED RESIDENTIAL AREA. The residential area covenants in Part C in their entirety shall apply to _____
(Include entire subdivision or suitable portion of it. Include any adjoining land in other ownership to which all residential covenants are to apply.)

B-2. PARTIALLY-PROTECTED ADJOINING RESIDENTIAL AREA. The residential area covenants numbered _____and _____ in Part C shall apply to _____

B-3. PARK AREA. The park area covenants in Part D shall apply to _____

B-4. CIVIC AREA. The civic area covenants in Part E shall apply to _____
(Areas, if any, for churches, community buildings, schools, etc.)

B-5. BUSINESS AREA. The business area covenants in Part F shall apply to _____

PART C. RESIDENTIAL AREA COVENANTS

C-1. LAND USE AND BUILDING TYPE. No lot shall be used except for residential purposes. No building shall be erected, altered, placed, or permitted to remain on any lot other than one detached single-family dwelling not to exceed two and one-half stories in height and a private garage for not more than two cars.

4/73

HUD-Wash., D.C.

4140.3

ARCHITECTURAL CONTROL

This is best accomplished by establishing an architectural control committee to review plans and specifications of buildings, fences, walls and planting as to location and exterior design. The covenant should apply both to new construction and to future alterations.

DWELLING QUALITY AND SIZE

A protective covenant establishing a minimum dwelling cost or quality and size is important in maintaining property values because protection is afforded to desirable dwellings from the encroachment of buildings below the standards of residential character originally established.

BUILDING LOCATION

The most satisfactory method of regulating the depth of front yards is by reference to building setback lines shown on the recorded plat as it is sometimes desirable to vary the setback because of topographic conditions.

On corner lots there should be little if any difference in setback distances from both streets. This prevents projection of the side or rear of a corner

dwelling beyond the building lines of adjacent dwellings.

A minimum side yard regulation for principal buildings is essential to provide necessary light, air and privacy. Occasionally this covenant also establishes a minimum aggregate total of both side yards.

Generally, dwellings at rear of lots have had an adverse effect on the successful use of the remaining land in a subdivision and in maintaining its highest desirable value.

C-2. ARCHITECTURAL CONTROL. No building shall be erected, placed, or allowed on any lot until the construction plans and specifications and a plan showing the location of the structure have been approved by the Architectural Control Committee as to quality of workmanship and materials, harmony of external design with existing structures, and as to location with respect to topography and finish grade elevation. No fence or wall shall be erected, placed or altered on any lot nearer to any street than the minimum building setback line unless similarly approved. Approval shall be as provided in part G.

C-3. DWELLING COST, QUALITY AND SIZE. No dwelling shall be permitted on any lot at a cost of less than $ _____ based upon cost levels prevailing on the date these covenants are recorded, it being the intention and purpose of the covenant to assure that all dwellings shall be of a quality of workmanship and materials substantially the same or better than that which can be produced on the date these covenants are recorded at the minimum cost stated herein for the minimum permitted dwelling size. The ground floor area of the main structure, exclusive of one-story open porches and garages, shall be not less than _____ square feet for a one-story dwelling, nor less than _____ square feet for a dwelling of more than one story.

C-4. BUILDING LOCATION.

(a) No building shall be located on any lot nearer to the front lot line or nearer to the side street line than the minimum building setback lines shown on the recorded plat. In any event no

building shall be located on any lot nearer than _____ feet to the front lot line, or nearer than _____ feet to any side street line, except that on all lots abutting _____ (collector and arterial streets) no building shall be located nearer than _____ and _____ feet respectively to the street property lines of said streets.

(b) No building shall be located nearer than _____ feet to an interior lot line, except that no side yard shall be required for a garage or other permitted accessory building located _____ feet or more from the minimum building setback line. No dwelling shall be located on any interior lot nearer than _____ feet to the rear lot line.

(c) For the purposes of this covenant, eaves, steps, and open porches shall not be considered as a part of a building, provided, however, that this shall not be construed to permit any portion of a building, on a lot to encroach upon another lot.

(d) (Include any exceptions by lot number and permitted minimum.)

Architectural design, construction quality, side-yard dimensions and fences should be controlled to prevent neighborhood blight.

LOT AREA AND WIDTH

Unless the protective covenants specifically prohibit the resubdivision of lots, which is not considered advisable, as some allowance should be made for adjustment of location of buildings to fit exceptional topographic conditions, a covenant establishing minimum lot area and width should be included. Generally, there is no need of resubdividing if the development plan is properly

prepared.

EASEMENTS

It is preferable that electric and telephone pole lines be erected along rear or side lot lines to avoid the unsightly appearance of these utilities with lead-in wires along streets. To provide for immediate or future installation and maintenance, the protective covenants should reserve easements for poles and wires along interior lot lines. Sometimes it is advantageous because of topography or subsurface conditions to also install sewer lines or other utilities along these easements.

NUISANCES

Protective covenants should prohibit trade or business, any activity obnoxious or offensive to residential use, and shacks or other structures for temporary occupancy.

(e) (Use of the following clause permits greater flexibility necessary in controlling house locations on steep topography.)

With written approval of the Architectural Control Committee, a one-story attached garage may be located nearer to a street than above provided, but not nearer than _____ feet to any street line, where the natural elevation of the lot along the established minimum building setback line is more than either eight feet above or four feet below the established roadway level along the abutting street and where in the opinion of said committee the location and architectural design of such proposed garage will not detract materially from the appearance and value of other properties. Furthermore, under similar conditions and approval, a dwelling may be located nearer to a street than above provided, but not nearer than _____ feet to any street line.

C-5. LOT AREA AND WIDTH. No dwelling shall be erected or Placed on any lot having a width of less than _____ feet at the minimum building set-back line nor shall any dwelling be erected or placed on any lot having an area of less than _____

square feet, except that a dwelling may be erected or placed on lots numbered _____ as shown on the recorded plat.

C-6. EASEMENTS. Easements for installation and maintenance of utilities and drainage facilities are reserved as shown on the recorded plat and over the rear five feet of each lot. Within these easements, no structure, planting or other material shall be placed or permitted to remain which may damage or interfere with the installation and maintenance of utilities, or which may change the direction of flow of drainage channels in the easements, or which may obstruct or retard the flow of water through drainage channels in the easements. The easement area of each lot and all improvements in it shall be maintained continuously by the owner of the lot, except for those improvements for which a public authority or utility company is responsible.

C-7. NUISANCES. No noxious or offensive activity shall be carried on upon any lot, nor shall anything be done thereon which may be or may become an annoyance or nuisance to the neighborhood.

C-8. TEMPORARY STRUCTURES. No structure of a temporary character, trailer, basement, tent, shack, garage, barn, or other outbuilding shall be used on any lot at any time as a residence either temporarily or permanently.

OTHER RESIDENTIAL COVENANTS

While protective covenants on the foregoing subjects usually are included in and are sufficient for most subdivisions, special conditions in some developments necessitate the inclusion of other

protective covenants, such as preservation of screen planting, protection of water courses, prohibition against oil drilling or mining operations, installation of individual sewage disposal systems and exclusion of signs.

WATER SUPPLY

The water supply should be capable of providing satisfactory service which will permit the owner full continuous enjoyment at reasonable costs. Usually such service can best be obtained from a public system. However, if no public system is available then consideration should be given to the feasibility of obtaining service from an existing or proposed community system. Only after it has been determined that public or community service is not feasible should consideration be given to the installation of individual water supply system.

SEWAGE DISPOSAL

Each property should be provided with sewage disposal service which will permit the owner to fully enjoy the property without creating a health hazard or public nuisance. Connection to a public system typically can best accomplish these objectives. However, if it is not feasible to obtain sewer service from such a system, consideration should be given to using a community system. Only after it has been established that sewer service from a public or community system is not feasible should an investigation be made to determine if the soil and site conditions will permit the successful use of individual sewage disposal systems.

C-9. SIGNS. No sign of any kind shall be displayed to the public view on any lot except one professional sign of not more than one square foot, one sign of not more than five square feet advertising the property for sale or rent, or signs used by a builder to advertise the property during the construction and sales period.

C-10. OIL AND MINING OPERATIONS. No oil drilling, oil development operations, oil refining, quarrying or mining operations of any kind shall be permitted upon or in any lot, nor shall oil wells, tanks, tunnels, mineral excavations or shafts be permitted upon or in any lot. No derrick or other structure designed for use in boring for oil or natural gas shall be erected, maintained or permitted

upon any lot.

C-11. LIVESTOCK AND POULTRY. No animals, livestock, or poultry of any kind shall be raised, bred or kept on any lot, except that dogs, cats or other household pets may be kept provided that they are not kept, bred, or maintained for any commercial purpose.

C-12. GARBAGE AND REFUSE DISPOSAL. No lot shall be used or maintained as a dumping ground for rubbish. Trash, garbage or other waste shall not be kept except in sanitary containers. All incinerators or other equipment for the storage or disposal of such material shall be kept in a clean and sanitary condition.

C-13. WATER SUPPLY. No individual water-supply system shall be permitted on any lot unless such system is located, constructed and equipped in accordance with the requirements, standards and recommendations of _____. (state or local public health authority). Approval of such system as installed shall be obtained from such authority.

C-14. SEWAGE DISPOSAL. No individual sewage-disposal system shall be permitted on any lot unless such system is designed, located and constructed in accordance with the requirements, standards and recommendations of _____ (state or local public health authority). Approval of such system as installed shall be obtained from such authority.

PROTECTIVE SCREENING

Use of protective screenings necessary in securing a reasonably effective physical barrier between residential properties and adjoining business uses, between arterial streets and lots backing into them, and is minimizing adverse views at block ends. Appropriate use of fences, walls and plant materials, or a combination thereof, generally serve to achieve objectives of protective screening.

C-15. PROTECTIVE SCREENING. Protective screening areas are established as shown on the

recorded plat, including a _____ foot strip of land on the residential lots along the property lines of _____ (arterial streets, other streets having adverse influences, business areas, etc.). Except as otherwise provided herein regarding street intersections under "Sight Distance at Intersections", planting, fences or walls shall be maintained throughout the entire length of such areas by the owner or owners of the lots at their own expense to form an effective screen for the protection of the residential area. No building or structure except a screen fence or wall or utilities or drainage facilities shall be placed or permitted to remain in such areas. No vehicular access over the area shall be permitted except for the purpose of installation and maintenance of screening, utilities and drainage facilities.

C-16. SLOPE CONTROL AREAS. Slope control areas are reserved as shown on the plan titled "_____", dated "_____", and recorded as a part of these covenants. Affected lots are _____ and _____, as shown on the recorded subdivision plat. Within these slope control areas no structure, planting or other material shall be placed or permitted to remain or other activities undertaken which may damage or interfere with established slope ratios, create erosion or sliding problems, or which may change the direction of flow of drainage channels or obstruct or retard the flow of water through each lot and all improvements in them shall be maintained continuously by the owner of the lot, except for those improvements for which a public authority or utility company is responsible.

C-17. SIGHT DISTANCE AT INTERSECTIONS. No fence, wall, hedge or shrub planting which obstructs sight lines at elevations between 2 and 6 feet above the roadways shall be placed or permitted to remain on any corner lot within the triangular area formed by the street property lines and a line connecting them at points 25 feet from the intersection of the street lines, or in the case of a rounded property corner from the intersection of the street property lines extended. The same sight-line limitations shall apply on any lot within

10 feet from the intersection of a street property line with the edge of a driveway or alley pavement. No tree shall be permitted to remain within such distances of such intersections unless the foliage line is maintained at sufficient height to prevent obstruction of such sight lines.

PARK, CIVIC AND BUSINESS AREA COVENANTS

If the subdivision plan includes a park or recreation area, business site, sites for social or civic activities, or other nonresidential uses, covenants should be included at least for front and side yards, height of buildings, and land uses.

Once the need for a local shopping area has been determined to be economically justified, particularly where the small local shopping area is concerned, it may become a great asset or a blight for its neighborhood. Experience indicates that business area covenants help assure success of the shopping center and the protection of the neighborhood.

A minimum-size neighborhood shopping center typically contains a food market, a drug store, variety store and several small shops and offices. A filling station may or may not be appropriate for the small center. Large shopping centers need covenants permitting two-story buildings, theatres, gasoline stations and other appropriate uses.

Covenants for all shopping centers abutting residential areas should contain appropriate provisions regulating types of business uses, building locations and size, architectural control, amount of parking, signs and other features related to safety and neighborhood protection. Covenants for a business area should be an integral part of the legal instrument which contains the covenants for the residential areas in a development.

ARCHITECTURAL CONTROL COMMITTEE

Initially the committee is selected by the developer, but as the development nears completion and the builder's interests lessen the membership of the committee should be selected by property owners

enjoying the protection of the covenants. Experience has indicated that the control of this function usually should be retained by the developer through membership appointed by him until the development is substantially built up. It is usually advisable for the developer to designate a membership of disinterested persons including an architect and possibly a landscape architect to pass on the technical as well as aesthetic qualities of the plans.

C-18. LAND NEAR PARKS AND WATER COURSES. No building shall be placed nor shall any material or refuse be placed or stored on any lot within 20 feet of the property line of any park or edge of any open water course, except that clean fill may be placed nearer provided that the natural water course is not altered or blocked by such fill.

PART D. PARK AREA COVENANTS

(Include appropriate covenants for any designated area.)

PART E. CIVIC AREA COVENANTS

(Include appropriate covenants for any designated area.)

PART F. BUSINESS AREA COVENANTS

(Include appropriate covenants for any designated area.)

PART G. ARCHITECTURAL CONTROL COMMITTEE

G-1. MEMBERSHIP. The Architectural Control Committee is composed of _____ (names and addresses of three members). A majority of the committee may designate a representative to act for it. In the event of death or resignation of any member of the committee, the remaining members shall have full authority to designate a successor. Neither the members of the committee, nor its designated representative shall be entitled to any compensation for services performed pursuant to this covenant. At any time, the then record owners of a majority of the lots shall have the power through a duly recorded written instrument to change the membership of the committee or to withdraw from the committee or

restore to it any of its powers and duties.

In developments where adequate public maintenance of park areas, streets or other facilities is not available, it is advisable to establish a property owners' maintenance association or other acceptable community maintenance organization with adequate powers to provide maintenance and to assess the benefiting property owners at a reasonable rate and collect such assessments. Establishment of a property owners' association is also advisable to provide an effective means of obtaining adherence to protective covenants. The architectural control committee may be a part of the association.

GENERAL PROVISIONS

Protective covenants to be effective should run with the land and be binding on all property owners in the protected area. They should be effective for a stipulated time, after which they are to be automatically extended for successive stated periods unless a change is agreed upon by a stipulated proportion of property owners affected by the instrument.

The periods for which covenants are to run without change should be sufficiently long to protect the original investments and permit amortization of the capital. Rights to modify should never be reserved to one individual.

The covenants should contain a general provision for prosecuting any proceedings in law or in equity against violations of any covenant.

G-2. PROCEDURE. The committee's approval or disapproval as required in these covenants shall

be in writing. In the event the committee, or its designated representative, fails to approve or disapprove within 30 days after plans and specifications have been submitted to it, or in any event, if no suit to enjoin the construction has been commenced prior to the completion thereof, approval will not be required and the related covenants shall be deemed to have been fully complied with.

PART H. GENERAL PROVISIONS

H-1. TERM. These covenants are to run with the land and shall be binding on all parties and all persons claiming under them for a period of thirty years from the date these covenants are recorded, after which time said covenants shall be automatically extended for successive periods of 10 years unless an instrument signed by a majority of the then owners of the lots has been recorded, agreeing to change said covenants in whole or in part.

H-2. ENFORCEMENT. Enforcement shall be by proceedings at law or in equity against any person or persons violating or attempting to violate any covenant either to restrain violation or to recover damages.

H-3. SEVERABILITY. Invalidation of any one of these covenants by judgment or court order shall in no wise affect any of the other provisions which shall remain in full force and effect.

PART I. ATTEST

(Include the date and signatures of all parties. Include signatures of prior lien holders to evidence consent to subordination of existing lien to covenants.)

Those requirements are a part of FHA Neighborhood Requirements. They apply in residential developments in which properties are offered or are to be offered as security for FHA insured mortgages. They apply in their entirety to developments proposed on unimproved land under centralized control. For other developments they apply to the extent determined

by the local FHA office.

AREA OF APPLICATION. Protective covenants shall apply to the entire area of development and, to the extent necessary for adequate protection, to adjacent areas which may affect properties in the development. If a tract is to be developed progressively by sections, complete protective covenants shall be applied initially for the entire development or progressively for the protection of each section.

LAND USE. The covenants shall provide adequate protection of neighborhood quality and property values by appropriate regulation in both residential areas and any non-residential areas of:

a. Land use and building type.
b. Size, quality, design and location of structures.
c. Lot size.
d. Easements.
e. Nuisances.
f. Other objectional uses.

PROPERTY-OWNERS' ASSOCIATION. The covenants shall establish an appropriate property-owners' committee of association as necessary for architectural control, for maintenance of any neighborhood improvements not otherwise provided with suitable maintenance, and for any other appropriate neighborhood services.

RECORDATION. The protective covenants shall be effective for an appropriate stated period of time, properly executed and recorded in the public land records.

PROTECTIVE COVENANTS DATA SHEET 41

GENERAL ADVICE ON STREET IMPROVEMENTS FOR

DEVELOPMENTS OF APARTMENTS AND ROW HOUSES

Street improvements in developments of apartments and row houses should be suitable to this type of development and be durable under the use and maintenance contemplated. They should be constructed in a manner acceptable to local authorities and the FHA and be provided with satisfactory maintenance. Street improvement specifications and details should be prepared on a basis of sound engineering principles.

The street improvements should extend continuously from the existing improved street system to provide suitable vehicular and

pedestrian access to each lot upon which a dwelling is built, to permit adequate connections to existing or future streets at the boundaries of the development and to provide convenient circulation for vehicles. Boundary streets and highways should have all improvements on the development side and at least one traffic lane on the opposite side.

For apartment and row housing developments, the standard practice of having rights-of-way at least 60 feet wide has proven satisfactory. The pavements should be wide enough to provide two moving lanes and two parking lanes or approximately 36 feet wide. The civil authorities should be consulted during the planning stage to determine the necessary width or rights-of-way and pavements for any existing or proposed arterial streets or highways.

Street grades should be established during the planning stage to provide proper relation between the streets and the first floor elevations or the houses and to permit convenient and economical access to and drainage of the lots. Proper establishment of street grades is necessary for the drainage design for both lots and streets and for the determination of the proper depth for the underground utilities. Street gradients should be sufficient for the run-off of storm water but not so steep as to be hazardous to traffic.

This type of development will usually require more underground pipe and catch basins for the drainage system than developments of one-family detached homes. To prevent flooding of the streets and abutting properties, catch basins should be provided at all low points, at street intersections and at intermediate locations as necessary to prevent overloading of the street gutters. Catch basins should be connected to collection mains of adequate size with outfalls approved by the civil authorities having jurisdiction. The elevation of the ground water should be determined in the planning stage and, if necessary, open joint or perforated pipe should be involved in the drainage design in order to lower the water table.

Apartment and row housing developments should have cement concrete curbs or curbs and gutters for the pavement edging. This practice has proven to be the most satisfactory method of protecting the edges of the pavement and of providing a direct surface channel to catch basins for storm water.

Because of the high density in this type of development, pavements should be of a higher type than those generally used for developments of one-family detached homes.

Asphaltic concrete constructed 2" thick on a pavement base that is designed to carry the contemplated traffic load is considered good practice, and will be economical to maintain. Cement concrete pavement to properly designed and constructed are considered permanent pavements. The practice of many municipalities of using cement concrete on excessive grades is practical. This prevents erosion and holds maintenance costs to a minimum. When cement concrete pavements are constructed, curbs should be an integral part of the pavement. The cost of a cement concrete pavement with integral curbs often compares favorably with the cost of a macadam base, asphaltic concrete top and cement concrete curbs and gutters, and offers the advantage of reduced maintenance cost.

Driveways should be paved from the street pavement to connect with any driveways on the properties. The driveway aprons at the curb should be adequately flared to provide convenient turning on and off the street pavement. Where access to garages and private parking spaces is from the rear, as in typical row-house developments, the rear alleys should be at least 15 feet wide and be provided with good drainage and permanent paving.

To provide proper convenience and safety for the residents of the apartment and row-house

developments, cement concrete side-walks should be at least 5 feet wide and 4 inches thick except at driveway crossings where the sidewalks should be increased to 6 inches thick. Sidewalks provide safe access for pedestrains walking to and from transportation stops, shopping centers, schools, and playgrounds.

Where suitable existing trees are not retained in good condition street trees should be planted approximately fifty feet apart or in naturalistic groups in order to increase the livability and appeal of the development. The trees should be selected for adaptability to local climate and soil

conditions, for resistance to disease and insect pests, for healthy foliage that withstands dust and smoke and for a root system that will not damage nearby utility lines and paved areas. Street trees should have open growth, high branching and an ultimate size proportionate to the surroundings. While trees of at least three inch caliper are usually satisfactory, it is sometimes desirable to plant trees of larger caliper to obtain an immediate effect in the development.

To hold down dust and prevent erosion, a thick stand of grass or other plant material should be established in the unpaved areas in the rights-of-way. Topsoil should be of good quality and of sufficient depth to support continuous plant growth. Seed mixtures or other plant materials to be used for the unpaved areas should be selected for adaptability to local climate conditions.

Street signs are one of the lowest cost and most important conveniences to any community and should be located at every street intersection. They should be of durable construction and be easily readable.

GENERAL ADVICE ON STREET IMPROVEMENTS FOR DEVELOPMENTS OF TYPICAL ONE-FAMILY DETACHED HOUSES

Street improvements in developments of typical one-family detached houses should be suitable to this type of development and be durable under the use and maintenance contemplated. They should be constructed in a manner acceptable to local authorities and the FHA and be provided with satisfactory maintenance. Street improvement specifications and details should be prepared on a basis of sound engineering principles.

The street improvements should extend continuously from the existing improved street system to provide suitable vehicular and pedestrian access to each lot upon which a dwelling is built, to permit adequate connections to existing or future streets at the boundaries of the development and to provide convenient circulation for vehicles. Boundary streets and highways should have all improvements on the development side and at least one traffic lane on the opposite side.

For one-family detached house developments, the standard practice is to have rights-of-way of 60 feet for collector streets, 50 feet for minor streets and 40 feet for short culs-de-sac and marginal access streets. The civil authorities should be consulted during the planning stage to determine the necessary widths of rights-of-way and pavements for any existing or proposed arterial streets or highways. The pavement width for collector streets should provide for two traffic lanes and two parking lanes or approximately 36 feet. For minor streets, culs-de-sac and marginal access streets the pavement should provide for three lanes or approximately 26 feet. Culs-de-sac should terminate in a turning circle of approximately 100 feet in diameter for the right-of-way and 80 feet diameter between the curbs.

Street grades should be established during the planning stage to provide proper relation between the streets and the first floor elevations of the houses and to permit convenient and economical access to and drainage of the lots. Proper establishment of street grades is necessary for the drainage design for both lots and streets and for

the determination of the proper depth for the underground utilities. Street gradients should be sufficient for the run-off of storm water but not so steep as to be hazardous to traffic.

This type of development will normally require some underground pipe and catch basins for the drainage system. To prevent flooding of the streets and abutting properties, catch basins should he provided at all low points, at street intersections and at intermediate locations as necessary to prevent overloading of the street gutters. Catch basins should be connected to collection mains of adequate size with out-falls approved by the civil authorities having jurisdiction. The elevation of the ground water should be determined in the planning stage, and if necessary, open joint or perforated pipe should he included in the drainage design in order to lower the water table. This is particularly important if it is intended to use individual sewage disposal systems.

Developments or one-family detached houses should have cement concrete curbs or curbs and gutters for the pavement edging. This practice has proven to be the most satisfactory method of protecting the edge of the pavement and of providing a direct surface channel to catch basins for storm water. There should be adequate provision to carry the surface water across intersections where no catch basins are to be built. Experience shows that for this type of development a pavement equal to a one inch bituminous road mix top or a double bituminous surface treatment constructed on a base designed to carry the contemplated traffic load is usually satisfactory.

Driveways should be paved from the street pavement to connect with driveways on the properties. The driveway aprons at the curb should be adequately flared to provide convenient turning on and off the street pavement.

To provide proper convenience and safety for the residents of one-family detached house developments,

cement concrete sidewalks should be at least 4 feet wide and 4 inches thick except at driveway crossings where the sidewalks should be increased to 6 inches thick. The general practice of constructing sidewalks on all streets provides the maximum safety for pedestrians. However, on minor streets under certain conditions, it may only be necessary to have sidewalks on one side of the street and in some instances they may he eliminated entirely from minor streets.

Where suitable existing trees are not retained in good condition, street trees should be planted approximately fifty feet apart or in naturalistic groups in order to increase the livability and appeal of the development. The trees should be selected for adaptability to local climate and soil conditions, for resistance to disease and insect pests, for healthy foliage that withstands dust and smoke and for a root system that will not damage nearby utility lines and paved areas. Street trees should have open growth, high branching and an ultimate size proportionate to the surroundings. While trees of at least three inch caliper are usually satisfactory, it is sometimes desirable to plant trees of larger caliper to obtain an immediate effect in the development.

To hold down dust and prevent erosion, a thick stand of grass or other plant material should be established in the unpaved areas in the rights-of-way. Topsoil should be of good quality and of sufficient depth to support continuous plant growth. Seed mixtures or other plant materials to be used for the unpaved areas should be selected for adaptability to local climatic conditions.

Street signs are one of the lowest cost and most important conveniences to any community and should be located at every street intersection. They should be of durable construction and be easily readable.

GENERAL ADVICE ON STREET IMPROVEMENTS FOR DEVELOPMENTS OF COUNTRY HOMES

Street improvements in developments of country house should be suitable to this type of development and be durable under the use and maintenance contemplated. They should be constructed in a manner acceptable to local authorities and the FHA and be provided with satisfactory maintenance. Street improvement specifications and details should be prepared on a basis of sound engineering principles.

The street improvements should extend continuously from the existing improved street system to provide suitable vehicular and pedestrian access to each lot upon which a dwelling is built, to permit adequate connections to existing or future streets at the boundaries of the development and to provide convenient circulation for vehicles. Boundary streets and highways should have all improvements on the development side and at least one traffic lane on the opposite side.

For country homes developments the standard practice is to have rights-of-way of 40 to 50 feet. The civil authorities should be consulted during the planning stage to determine the necessary widths of rights-of-way and pavements for any existing or proposed arterial streets or highways. The pavement width for all streets should provide for two lanes of traffic plus any additional space needed for street parking.

Street grades should be established during the planning stage to provide proper relation between the streets and the first floor elevations of the houses and to permit convenient and economical access to and drainage of the lots. Proper establishment of street grades is necessary for the drainage design for both lots and streets and for the determination of the proper depth for the underground utilities. Street gradients should be sufficient for the run-off of storm water but not so steep as to be hazardous to traffic.

Developments or country homes will usually require some underground pipe and catch basins for the drainage system to prevent flooding of the streets and abutting properties, catch basins should be provided at all low points, at street intersections and at intermediate locations as necessary to prevent overloading or surface drainage channels. Catch basins should be connected to collection mains or adequate size with outfalls approved by the civil authorities having jurisdiction.

The elevation of the ground water should be determined in the planning stage and, if necessary, open joint or perforated pipe should be included in the drainage design in order to lower the water table. This is particularly important if it is intended to use individual sewage disposal systems. Where it is necessary to drain the lots with use of open drainage ditches, these ditches should be located along the rear lot lines. Experience shows that this type of ditch can be connected to culverts to carry the water under paved streets without being a traffic hazard. In this type of development the lots are usually sufficiently deep so that individual sewage disposal systems will not be adversely affected. The use or open turf or grass swales in the street rights-of-way usually leads to many difficulties. The depth of the swales, particularly at intersections, may be a traffic hazard where constructed deep enough to use culverts under intersections. Where gradients are relatively flat and run-off is slow, the swales may become temporary reservoirs. This may saturate the ground, raise the water table, do damage to the pavement base, interfere with individual sewage disposal systems, block driveways and cause inconvenience to pedestrians.

Developments of country homes should use cement concrete valley gutters for the pavement edging. This practice has proven

to be a satisfactory method of protecting the edge of the pavement and of providing a direct surface channel to catch basins for storm water. It also eliminates ditches in the rights-of-way and culverts at driveways and intersections. There should be adequate provision to carry the surface water across intersections where no catch basins are to be built.

The streets in this type of development carry less traffic than those in one-family house developments having smaller lot widths. The pavement base should be constructed sufficiently stable to carry the contemplated traffic load. The practice of applying at least a light bituminous surface treatment has been found to be low in cost and, with proper maintenance, will retain the shape of the base, hold down dust and prevent erosion.

Driveways should be paved from the street pavement to connect with driveways on the properties. Driveway aprons at the curb or pavement edge should be adequately flared to provide convenient turning on and off the street pavement.

To provide convenience and safety for the residents of country homes developments the sidewalks on collector streets should be at least 4 feet wide and 4 inches thick except at driveway crossings where the sidewalks should be increased to 6 inches thick. In this type of development it will usually be found that sidewalks are not necessary on minor streets.

4140.3

Where suitable existing trees are not retained in good condition, street trees should be planted in naturalistic groups in order to increase the livability and appeal of the development. The trees should be selected for adaptability to local climate and soil conditions, for resistance to disease and insect pests,

for healthy foliage that withstands dust and smoke and for a root system that will not damage nearby utility lines and paved areas. Street trees should have open growth, high branching and an ultimate size proportionate to the surroundings. While trees of at least three inch caliper are usually satisfactory, it is sometimes desirable to plant trees of larger caliper to obtain an immediate effect in the development.

To hold down dust and prevent erosion, a thick stand of grass or other plant material should be established in the unpaved areas in the rights-of-way. Topsoil should be of good quality and of sufficient depth to support continuous plant growth. Seed mixtures or other plant materials to be used for the unpaved areas should be selected for adaptability to local climatic conditions.

Street signs are one of the lowest cost and most important conveniences to any community and should be located at every street intersection. They should be of durable construction and be easily readable.

4/73 HUD-Wash., D.C.

STREET IMPROVEMENT REQUIREMENTS

These requirements are a part of FHA Neighborhood Requirements. They apply in residential developments in which properties are offered or are to be offered as security for FHA insured mortgages. They apply in their entirety to developments proposed on unimproved land under centralized control. For other developments they apply to the extent determined by the local FHA office.

1. SUITABILITY OF IMPROVEMENTS. Street improvements shall be appropriate to the type of development and durable under the use and maintenance contemplated.

2. GOVERNING REQUIREMENTS. The highest requirements, whether in local regulations or in

these requirements, shall govern.

3. APPROVAL OF CONSTRUCTION. All construction shall be completed in accordance with the specific conditions of the commitment and the accepted drawings and specifications, and in a manner acceptable to the FHA and the local authorities having jurisdiction. When changes from the accepted drawings and specifications become necessary during construction, written acceptance by the FHA and civil authorities having jurisdiction shall be secured before the execution of such changes.

4. MAINTENANCE. Adequate provision for the satisfactory maintenance of all streets shall be made by dedication to, and acceptance for maintenance by local authorities having jurisdiction, or by other acceptable means.

5. EXTENT OF IMPROVEMENTS. The street improvements shall extend continuously from the existing improved street system to provide suitable vehicular and pedestrian access to each lot upon which a dwelling is built, to provide adequate connections to existing or future streets at boundaries of the development and to provide convenient circulation for vehicles.

6. RIGHT-OF-WAY AND PAVEMENT WIDTHS. The rights-of-way shall be adequate width to accommodate the contemplated widths of pavement, sidewalks and planting strips. Pavements shall be of adequate widths to accommodate the contemplated parking and traffic load in accordance with the type of street.

7. GRADING. Centerline gradients and cross-section grading of the rights-of-way shall provide suitable grade elevations for pavements and any contemplated sidewalks, planting and other facilities. The grading shall provide reasonable safety for traffic, convenient access to the lots, adequate surface drainage of the rights-of-way, and necessary means of draining other areas. The height and steepness of slopes to lots, culverts and other facilities shall be such as to provide stability and reasonable freedom from erosion.

8. STORM SEWER SYSTEM. An adequate storm sewer system consisting of catch basins, and

other underground drainage structures with approved outlets shall be constructed where the run-off of storm water and the prevention of erosion can not be accomplished satisfactorily by surface drainage facilities. Outlets shall be approved by the owners of the properties affected and local authorities having jurisdiction.

9. PAVEMENT EDGING AND SURFACE DRAINAGE. Pavements other than cement concrete shall be protected at the edges by curbs, gutters or other suitable means where necessary in order to prevent ravelling of the wearing surface and shifting of the pavement base. Adequate surface drainage shall be provided by concrete gutters or other drainage channels constructed of suitable materials and at suitable gradients to prevent erosion, to carry storm water to the storm newer system or to other acceptable outlets and to permit convenient access to the lots.

10. PAVEMENT BASE. The pavement base shall be constructed on a suitable subgrade and of highway materials which have proven satisfactory for the local climate and soil conditions. The base shall be properly drained and suitably constructed to support the contemplated traffic load.

Continued

11. PAVEMENT WEARING SURFACE. Pavements other than cement concrete shall be provided with a bituminous wearing surface that is impervious to water in order to protect the base and provide a pavement which is durable under the traffic load and maintenance contemplated. For developments of country homes and for housing under Section 203(i), however, bituminous surfacing is at the discretion of the Chief Underwriter, based on analysis of the need.

12. DRIVEWAYS. Where appropriate because of custom or the type of development or where local regulations prohibit continuous street parking, a driveway from the pavement to the lot line shall be provided for vehicular access to each built-upon

lot. Driveways shall be of adequate width and constructed with suitable subgrade, base, drainage and surfacing to be durable under the use and maintenance contemplated.

13. SIDEWALKS. Sidewalks shall be provided where necessary or appropriate for the safety and convenience of pedestrians. Sidewalks shall be of adequate width and of durable construction for the contemplated use and maintenance.

14. STREET TREES. The streets shall be provided with long-lived shade trees as necessary and appropriate for the comfort of the residents and the appeal of the development. Street trees shall be of species suitable for local soil and climatic conditions and adapted to street use. They shall be properly spaced and located, and planted so as to have continued growth under the contemplated maintenance.

15. PLANTING STRIPS. Where necessary to prevent erosion. to hold down dust, and to enhance the appeal of the development, the unpaved areas in the rights-of-way shall be provided with a thick stand of permanent grass with suitable soil to support growth, or with other appropriate treatment.

16. STREET NAME SIGNS. Appropriate street signs of suitable material shall be installed as necessary for convenient identification of the streets.

HUD-Wash., D.C.

BLOCK AND LOT GRADING

Proper grading is an important element in preventing wet basements, damp crawl spaces, eroding banks, muddy yards and overflowing septic tank systems. It also eliminates costly corrective work such as retaining walls, regrading operations and extra drainage pipe lines. To obtain such construction savings and property betterments requires know-how both by the builder's planners who determine the key grade elevations and by his superintendent and grading foreman out on the job.

Planning and execution of good grading involve certain basic steps pertaining to street

layout, block grading and lot grading. The objective is to establish the street grades, floor elevations and lot grades in proper relation to each other and to existing topography, considering property protection, appeal and use.

STEPS FOR THE BUILDER'S PLANNERS

1. If the street layout is still subject to design or adjustment, fit it to the topography to obtain the most favorable types of block and lot grading which are compatible with other objectives.
2. Determine type of block grading for each block or portion of a block and indicate the lot grading type for each lot by identifying letter or drainage arrows.
3. Determine any easements and other provisions needed for satisfactory block drainage and erosion control.
4. Determine general lot grading limitations for local conditions, such as minimum gradients for grass swales and slopes and maximum for walks and drives.
5. For each type of house and lot, determine the specific lot grading limitations along a typical lot grading control line from the street to the house and determine the minimum street-to-floor rise; see sample computations for illustrated lot grading types.
6. If the street profiles are to be designed or adjusted, establish them so as to facilitate the provision of good drainage for both the lots and the streets, giving due consideration to existing topography and the lot limitations determined in 4 and 5 above.

7. For each property, determine proposed elevations for key points on the lot and for the dwelling floor, giving due consideration to street elevations, existing topography and the lot grading limitations determined in 4 and 5 above.
8. Discuss the objectives of the grading plans with the job superintendent and grading foreman.

STEPS FOR THE MAN ON THE JOB

1. Become familiar with the various grading types shown in this data sheet in order to create their essential features as the ground.

2. Follow your job grading plans and the suggestions of the builder's planner.
3. Set floor elevations only as shown on accepted drawings.
4. Complete all rough grading as soon as practicable to subgrades needed for final grading. This provides better drainage during construction operations.
5. Before topsoiling and finish grading each lot, set grade stakes at key points as needed (see illustrations), true-up the subgrades and check the entire lot for good drainage.

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

BLOCK GRADING TYPE 1: RIDGE ALONG REAR LOT LINES

BLOCK GRADING TYPES

Block Grading Type 1 has a ridge along rear lot lines and each lot is graded to drain surface water directly to the street independent of other properties. It is the most simple and desirable type of block grading. Topography, however, will often require other block grading types.

Block Grading Type 2 for a gentle cross-slope involves drainage of some surface water from lots of the high side of the block across the lower tier of lots. Difficulties are not encountered, however, if slopes are gentle and if the water always drains over short routes to the streets and does not concentrate or accumulate in volume at any point inside the block.

Block Grading Type 3 for steep cross-slopes and Type 4 for a valley along rear lot lines require special provision for block drainage and erosion control.

Erosion is controlled by provision of intercepting drainage swales in easements at the top of the rear lot incline or at intermediate locations along it, and by treatment of the steep slope itself.

Drainage easements in Block Types 3 and 4 must have alignment, width and improvements appropriate for the expected use and maintenance. Assurance of permanent and adequate outfall is essential. The easements must be permanently

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

established by proper legal methods, with continuous maintenance assured by public authority, property-owners' association or individual owners, as appropriate to the situation. Walls, buildings and any other obstructions to drainage flow, such as dense planting or tight fencing, must be legally prohibited in the easement area.

LOT GRADING TYPES

Protective slopes away from all sides of all buildings are essential elements of all lot grading types (see drawings). Their purpose is to drain roof water and other surface water away from all building walls and backfilled areas. Where such a protective slope meets a slope which drains towards the building, a drainage swale of adequate width, depth and longitudinal gradient is necessary to carry away the surface water without flooding against buildings or ponding any lot areas.

The location of these swales is directly related to the block grading type which, as shown in the block diagrams, actually determines the lot grading type.

In Lot Grading Type A (see drawing), rear swales behind the house carry surface water from the rear yard to side-yard swales which carry it to the street for disposal through the street gutters and the public storm drainage system.

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

*
*
****

BLOCK GRADING TYPE 2: GENTLE CROSS-SLOPE

For Lot Grading Type B which drains both to the street and to the rear lot line, only side-yard swales are needed. They should extend back of the line of the rear building wall; then splash blocks from rear roof downspouts should be placed to direct roof water to the side swales for drainage directly to the abutting street. Thus the amount of water carried on the rear slope to easements or other properties is kept as small as possible. This reduces erosion and disposal problems.

In Lot Grading Type C draining entirely to the rear lot line, front swales are essential to carry surface water from the front yard to side-yard swales which carry it to the rear for disposal in easements or across other properties. Proper cross-section of the street gutter, curb and parkway strip are essential to stop street water from flowing onto the lot.

Easements and erosion involving Lot Types B and C are discussed above with Block Grading Types 3 and 4.

For lots with steep cross-slopes due to street gradients, similar lot grading types are used, the lot cross-slopes being taken up by walls or steep slopes along side lot lines or by changing grade levels along the front and rear house walls.

Where high slopes occur along side or rear lot

****
*
*
*
*
*
*
*
*
*
* GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED *
*
*
*
*
*

lines, the lot line if possible should be located at the top of the slope. The appearance of the slope and any erosion from it directly affects the property below. That owner therefore is more interested in owning, stabilizing and maintaining the slope than is the owner of the property above whose outlook is over and beyond it.

LOT GRADING CONTROL LINE

The single most important grade relationship for proper lot grading and drainage, is house floor elevation in relation to street elevation. If the floor elevation is too low in relation to adjoining street grades, adequate protective slopes and drainage swales cannot be provided to drain the lot satisfactorily. If the floor elevation is too high, unnecessary terracing, expensive outside stairs and awkward appearance will result.

Proper floor elevation and lot grades for any lot can be obtained by establishing on plans and on the ground a lot grading control line appropriate for the specific property. The line is located differently for each lot grading type as shown by the circles lettered "A", "B", "C", etc. in the accompanying lot diagrams. Each control line starts at the top of the street curb near the indicated high or low lot corner and ends at the

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

point along the house wall where the outside finish grade controls the floor elevation. In the case of no street curbs, the starting point and elevation should be the normal curb location and the street center line elevation.

The minimum street-to-floor rise for any lot is found by adding and subtracting the required rises and permitted falls along the lot grading control line for the property. The method is illustrated by the sample computation accompanying each of the three lot grading diagrams. For actual building operations, the relationship should be figured out specifically for each lot or group of typical lots because such factors as building setback, building depth, lot width and swale gradient may change the relationship considerably.

Minimum gradients for grass swales and other unpaved areas depend upon practical limits on precision in grading and maintaining land surfaces and upon the capacity of the ground to percolate water held back by surface texture and depressions. A gradient of 1/4 inch-per-foot (2%) is a practical minimum in areas subject to ground frost. Flatter gradients are usable, however, where the supplementary ground percolation at all seasons is adequate to prevent any prolonged saturation of soil or standing water. For example, 1/8 inch per foot (1%) is satisfactory on

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

sandy well - drained soils in areas not subject to ground frost.

General limitations for protective slopes around buildings and for other elements affecting the lot grading control line are outlined in Section 1200 of FHA Minimum Property Standards. If necessary the control line sometimes may be flattened satisfactorily by special methods, such as using a paved driveway as a side-yard drainage channel at 1/16 inch per foot (1/2 %) instead of a grass swale at 1/4 inch per foot (2 %).

Floor elevation in relation to outside finish grade must be high enough to protect wood construction from moisture and insects. With 8" minimum from ground to wood sill, the minimum ground-to-floor rise as follows for typical construction:

Concrete slab on ground:..... 8" (0.7')
Wood floor framing, 8" joists:..... 19" (1.6')
Wood floor framing, 10" joists:..... 21" (1.8')

For Lot Grating Type C which drains away from the street, the lowest floor elevation in relation to street grade is also affected by maximum driveway gradient and by local custom and acceptance of proportion below the grade of the abutting street.

It should also be recognized that there are other lot grading types not illustrated here; each will have its own grading control line which will govern its minimum street-to-floor rise.

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

BLOCK GRADING TYPE 4: VALLEY ALONG REAR LOT LINES

ADJUSTMENTS TO EACH PROPERTY

After the minimum lot grading control line and minimum street-to-floor rise have been determined, they should be adjusted upward as suitable for existing topography and other conditions of each property.

For a house with a basement, check is made of elevations of drains for basement floor and any basement plumbing fixtures. For a house with a crawl space, floor elevation is checked for height of access space and drainage of interior ground (MPS 803-3). For a concrete slab house, floor elevation is checked against excessive depth of fill under the slab (MPS 808-4).

Then general lot grading is checked for feasibility and suitability. Proposed grades at any necessary additional key points are determined, and all grades are further adjusted as needed. These additional points and adjustments cover such items as grades of walk and driveway, variation of outside finish grade along building walls, width and gradients of usable yard areas, and transition to grades of adjoining properties.

After all key elevations have been properly determined by these adjustments in the planning stage, then execution of good grading on the ground is relatively easy. Care must be taken primarily to set grade stakes correctly at key points and to build and grade to them in accordance with the practices outlined in this data sheet and in the FHA Minimum Property Standards.

BLOCK AND LOT GRADING
FOR
FLAT LAND

Typical solutions for the grading problems of the average development are illustrated in FHA Data Sheet 72. This data sheet presents special supplemental techniques for the solution of grading

problems on land without appreciable slope which, for convenience, is referred to as flat land.

Flat land is the most difficult to grade to provide proper surface drainage away from the buildings and off the lots and blocks to streets or other suitable outlets. Foundation height above existing ground levels and the need for fill material are usually the serious problems encountered in grading flat land.

The first consideration in solving these problems is lowering the street profile as much as possible. Next, paved driveways are used for drainage channels at relatively flat gradients instead of grass swales at steeper gradients. Then the gradient of grass swales may be reduced below the swale gradient normally used. Finally, drainageways may be used along rear lot lines. Another solution to the need of material for fill is to construct houses with basements rather than slab construction.

STREET PROFILE

The slope of lots on flat land can he increased for better surface drainage by lowering the street profile. This not only lowers the outfall of the swales and driveways but also provides fill material for the abutting lots with practically no haul.

The usual municipal requirement for the way slope, between the front lot line and the curb, is 1/4 inch fall per foot (2%) to permit quick runoff of surface water from the public sidewalks. In some instances municipalities will permit a lesser slope thus helping in the grading of flat land.

PAVED DRAINAGE CHANNELS

The elevations of the lot areas and the dwelling floor may also be lowered by the use of paved driveways and paved side channels as drainageways at minimum gradients. The necessary fill under a floor slab and for the protective slope thereby may be kept to a minimum.

With very careful workmanship, concrete driveways and gutters can be paved to a gradient as low as 1/32 inch per foot (1/4%) with sufficient accuracy to provide run-off for surface water. When paved channels at 1/32 inch per foot (1/4%)

are substituted for grass swales at 1/8 inch per foot (1%) or 1/4 inch per foot (2%), the finish grades at the building and the floor level are lowered substantially.

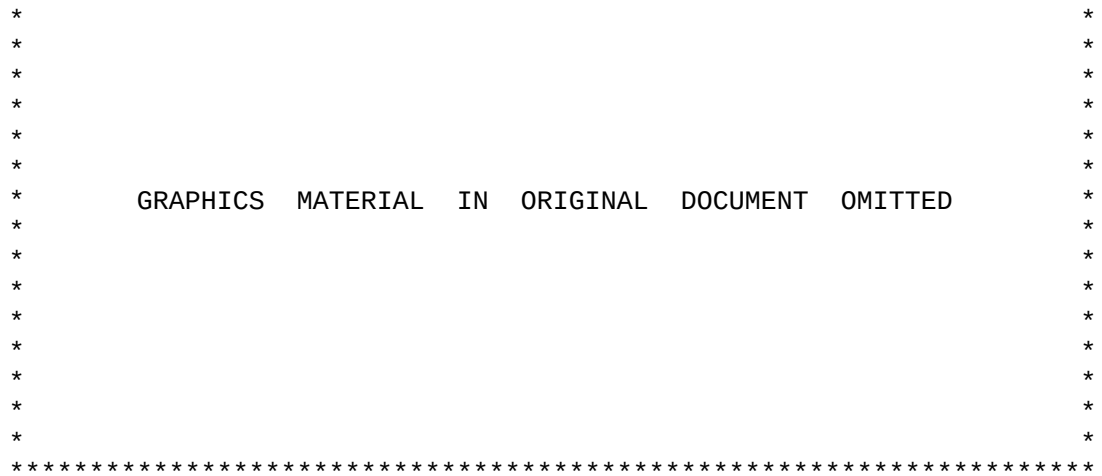
Lot Grading Type A-b and Type A-c (see drawings) illustrate two satisfactory methods of grading and draining lots on flat land by using paved drainage channels along side lot lines. They are adaptations of Lot Grading Type A on Data Sheet 72.

The sample computations under each drawing illustrate how the elevation of the various points and distances on the lot grading control lines may be arrived at. These elevations and distances will change with various lot widths, building size and location, and street gradients.

LOT GRADING TYPE A-b. For this grading type which drains all surface water to the street, grass swales are needed only at the rear of the dwelling. They are constructed parallel to the rear of the building, curve at both sides of the lot and outfall the surface water to the paved driveway channels along both side lot lines which carry the surface water to the street. Splash blocks are placed to direct the roof water to the side channels.

In a group of lots the most economical method of providing paved drainage channels along both side lot lines is to locate paved driveways so that there is a driveway along each side lot line and to construct each driveway with grade and cross-section such that it will drain both a portion of the lot on which it is located and a portion of the adjoining lot. Otherwise a separate additional paved channel is required on each lot, or grading is done as described below under Lot Grading Type A-c with a paved driveway channel along one lot line and a grass swale along the other.

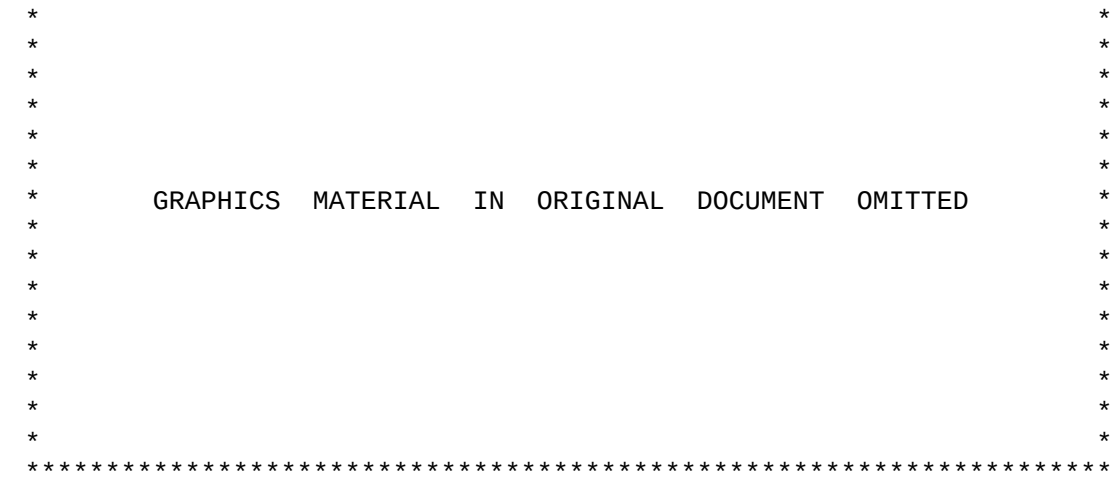
The extent to which Lot Grading Type A-b will lower elevations of the lot areas and dwelling floor may be seen by comparing the sample computation here with that for Lot Grading Type



A on Data Sheet 72. The length and location of the grading control lines are substantially identical in the computations. For these identical sample conditions and for 1/4":1' grass swales (2%), a slab floor elevation in 12 inches lower in Type A-b than in Type A(23 inches total above curb instead of 35 inches). For 1/8":1' grass swales (1%), it is 5 inches lower (19 inches total instead of 24 inches).

LOT GRADING TYPE A-c. For this grading type which drains all surface water to the street, rear swales and a side swale are constructed. The surface water drains from one rear swale to the paved side channel which in this illustration is a paved driveway. The other rear swale drains the surface to a grass swale on the opposite side of the lot from the driveway. The side paved channel and side swale carry the surface water to the street. Splash blocks are placed to direct the roof water to the side paved channel and the side swale.

With Lot Grading Type A-c, all drainage may be carried on the subject lot, entirely independent of conditions on adjoining lots. Consideration should be given however to possible grade differentials on abutting lots.



Comparison of Grading Type A-c with Grading Type A for identical sample conditions and 1/4":1' grass swales (2%), shows a slab floor elevation 6 inches lower in Type A-c (29 inches total instead of 35 inches). For 1/8:1' grass swales (1%), it is 3 inches lower (21 inches instead of 24 inches).

As is the case with similar information on Data Sheet 72, it should be recognized that there are other lot grading types and variations not illustrated here. Also the sample computations show only a method by which elevations on a grading control line may be computed to fit a specific situation. They do not fix arbitrary elevations for application to the varying conditions encountered on specific properties.

REDUCED SWALE GRADIENTS

When the above methods do not provide for full solution of a grading problem on flat land, consideration may be given to reduction of the gradient of grass swales below the gradients normally required as minimum. As provided in the FHA Minimum Property Standards these minimum gradients are 1/4 inch per foot (2%) where frost affects the

ground or where a high clay content in the soil renders it almost impervious, and 1/8 inch per foot (1%) where the frost has no effect on the ground and the soil is sufficiently pervious to dispose of some surface water through percolation.

For areas located further than 15 feet from a building or required usable outdoor area, the MPS permit lesser gradients than those shown above provided that (1) the lesser gradient will drain the lot without detrimental effect on buildings or upon lot use and improvements, including any individual sewage disposal system and (2) there will be no prolonged standing of water at any season. In establishing a lower minimum gradient of grass swales for a specific situation, consideration should be given to climate, soil conditions, grading methods and methods of establishing and maintaining grass.

DRAINAGE ALONG REAR LOT LINES

Block Grading Type 4 and Lot Grading Type B on Data Sheet 72 illustrate another method that under certain conditions may be used to drain flat land. This method, when practical, will hold floor elevations to a minimum since it eliminates the swale turn and rear swale from the grading control lines of Lot Grading Types A, A-b and A-c.

In order for this method to produce the desired results, consideration must be given to the outfall for the drainage easement at the lower end of the block. There must be proper provisions at the low end of the block for either outfalling on the street or carrying under the street to other suitable outfalls. In some instances a catch basin may be installed in the low end of the block, connected to the drainage system.

Proper provisions must also be made for carrying storm water through the rear lot line easement to the outfall at the low end of the block. This may be by natural stream, paved gutter or in some cases by a grass swale or a ditch. The latter are especially subject to the disadvantage that during rains of above average intensity there is a possibility of temporarily pooling the surface water along the rear sections of the lots. In some localities, however, this may not be too serious if the lots are very deep and if there is assurance that any temporary pooling will not affect the dwellings and access to them. The porosity of the soil at all seasons and the quantity of run-off are important factors in considering this method.

FEDERAL HOUSING ADMINISTRATION

ORGANIC SOIL CONDITIONERS

For residential developments in which the FHA Insuring Office considers that this type of improvement is necessary for grass seeding, sodding, spot sodding, sprigging and/or ground cover plants.

A APPLICATION

A-1 If sufficient plant food elements and water are judiciously applied to a workable permeable soil in a proper management system, grass and other vegetation can be established and maintained without the addition of organic matter. Plant food elements of nitrogen, phosphorus and potash along with water, climate and other environmental conditions, are the principal factors involved in lawn establishment and management.

B ORGANIC MATERIALS AND FERTILIZATION

B-1 Organic matter such as peat moss, compost, sawdust, bark, wood shavings, activated sludge, straw or animal manures are helpful in providing favorable conditions in the soil for development of lawns and vegetative growth. Organic matter stimulates favorable chemical modification in the soil in addition to improving its physical capacity to absorb and retain necessary moisture for plant growth. Plant food elements of nitrogen, phosphorus and potash need to be applied in the form of commercial fertilizers in accordance with the initial establishment need and subsequent fertilization requirements as indicated by chemical laboratory tests of the soils. For optimum lawn growth the pH or acidity of the soil should not be less than 5.0 or greater than 7.8. Most lawn soils thrive best at a pH of about 6.5.

C SOIL CHARACTERISTICS

C-1 Soils. Whether natural or in a disturbed state, soils are not necessarily deficient in organic matter content. In deep cuts and fills

or sites where the natural organic soil layers have been stripped or disseminated, organic matter deficiency is to be expected. The upper soil layer of horizon of most soils converted from agricultural or forested use contain adequate

organic matter content developed and sustained by decomposed vegetative residues left in and on the soil.

C-2 Soils temperature, precipitation and evapo-transpiration rates are significant factors in maintaining organic matter levels. In hot climates, organic matter loss in accelerated, particularly in open sandy soils where permeability and leaching is rapid.

C-3 Many natural soils have serious inherent deficiencies such as "hardpans", "clay-pans" or impervious rock layers which cannot be completely corrected by any soil amendments including plant food or organic matter.

D SOIL SAMPLING FOR CHEMICAL LABORATORY TESTS

D-1 After site grading in complete the upper four inch lawn and planting strip soil layer shall be sampled and tested to determine any chemical soil deficiency which effects its ability to adequately support and sustain lawn and vegetative growth.

D-2 One half pint of a composite of representative soil sample shall be collected for testing from the planting area. Each individual area should be uniform in soil type and past fertilization treatment. Dissimilar limed or fertilized areas should be sampled and tested separately. Using a trowel, knife or shovel, cut a

small hole to a depth of four inches. Small amounts of soil should be taken from the length of the exposed cut. One single excavation should represent about 2000 square feet in area. The total sample should be collected in a clean container or cardboard carton. Samples are mailed to the Agricultural Extension Division or Land Grant College serving the area sampled, for free testing, or to a private testing laboratory. In most states the State Agricultural and Land Grant College, usually through its Extension Divisions, will make soil tests without charge. The Agricultural College technicians

can also easily identify agricultural or pedological soil textural classification from the small samples submitted. However, should the State college performing these chemical tests be unable to provide textural soil classification it should be obtained from private laboratories or others qualified to make these determinations. By use of a conversion table, F, shown below, soil textures may be correlated with the Unified Soil Classification System. This procedure can eliminate a costly engineering test procedure.

D-3 All soils, whether disturbed or natural, can be grouped into two categories of the Unified Soil Classification System for the purpose of determining organic soil condition or needs. Soil texture and grain size is emphasized, since it is the most important characteristic affecting organic requirements and moisture retention capabilities.

D-4 Many soils, particularly those with hard cemented strata can be greatly improved physically by the use of rototillers, rotovators, blenders, disks and subsoilers.

E. RATE OF ADDING ORGANIC SOIL CONDITIONERS TO SOIL

E-1 GROUP I COARSE TEXTURED SOILS
GW, GP, GM, GC, SW, SP*

Where laboratory tests indicate organic matter deficiency, organic soil conditioners such as peat, peat moss, compost, activited sludge, bark, wood shavings, sawdust, straw or animal manures shall be added to the upper four inch soil layer at a rate indicated by the testing technician to bring up the organic matter content to a minimum of 2.0% by weight. The material should be well mixed and blended into the upper four inch layer. The organic soil conditioners should have a minimum nitrogen content of O.5 %.

E-2 GROUP II FINE-TEXTURED SOILS
SM, SC, ML, MH, CL, CH*

Where laboratory tests indicate organic matter deficiency organic soil conditioners such as peat, peat moss, compost, activated sludge, bark, wood shavings, sawdust, straw or animal manures shall be added to the upper four inch soil layer at a rate indicated by the testing

technician to bring up the organic matter content to a minimum of 1.5% by weight. This material should be well mixed and blended into the upper four inch layer. The organic soil conditioners should have a minimum nitrogen content of 0.5%.

* Unified Soil Classification System.

F. SOIL CLASSIFICATION TERMINOLOGY CONVERSION TABLE

GROUP I COARSE-TEXTURED SOILS

UNIFIED CLASSIFICATION SYSTEM	DEPT. OF AGRICULTURE CLASSIFICATION SYSTEM
GW	GRAVEL
GP	GRAVEL
GM	GRAVELLY LOAMS GRAVEL
GC	GRAVELLY LOAMS GRAVEL
SW	LOAMY SANDS SANDS
SP	LOAMY SANDS SANDS

GROUP II FINE-TEXTURED SOILS

SM	SANDY LOAMS SILTY SANDS
SC	SANDY LOAMS CLAYEY SANDS
ML	LOAMS, SILT LOAMS SILTY CLAY LOAMS, SILTS
MH	LOAMS, SILT LOAMS SILTY CLAY LOAMS SILTS

CL .....CLAY, SILTY CLAY

CH .....CLAY, SILTY CLAY

The remaining three units of the Unified Soil Classification System, OL, OH, Pt do not require the addition of any organic conditioners.

222574-P HUD-Wash.,

HUD-Wash., D.C. 4/73

4140.3 CHG

LAND DEVELOPMENT WITH CONTROLLED EARTHWORK

Part 1 of 2 Parts

CONTENTS

1. APPLICATION. This data sheet applies to any land development in which building foundations will be placed on filled ground, and/or any development in which the depth of fill below floor slabs (including basement floor or garage floor) will exceed that permitted by the Minimum Property Standards (MPS) for normal compaction methods. The scope of these applications includes soils which will be blended, replaced, or reworked, or which will be stabilized or modified by use of additives. HUD-FHA considers such development in subdivisions or projects where it is elected by the Developer and/or where determined necessary and appropriate for HUD-FHA purposes. This data sheet does not apply to developments in which earth will be placed below water level or as hydraulically-discharged material or developments in which fills will involve the placing of an appreciable quantity of rock larger than 6". Where land will be salvaged from prior urban occupancy, use of these procedures will be permitted only if full compliance with all stated objectives can be assured to HUD-FHA's satisfaction.

   a. Developments of this type usually involve general reshaping or regrading of the land. HUD-FHA requires that all grading be properly controlled to prevent differential earth movement, sliding, erosion, and/or other occurrences which might damage dwellings, streets or other improvements.

   b. A specific analysis is made of each project to determine the required exhibits, details and specifications for the particular development. The requirements for grading in this type of development are outlined in this data sheet. Adjustment of

these standards is made by HUD-FHA where advisable to fit special conditions or where alternates are proposed which will fully attain Departmental objectives.

c. In the case of a land development for homes on regraded areas, these requirements are in addition to customary subdivision requirements. These additional requirements are also applied to properties individually in accordance with MPS and in other specific conditions on individual commitments for HUD-FHA mortgage insurance.

d. For multifamily housing projects, the exhibit requirements in this data sheet are subject to general adjustment to fit Departmental procedures for processing multifamily projects. The objectives of Paragraph 9, Controlled Slopes and Paragraph 10, Controlled Earthwork, apply to multifamily housing as shown.

2. GENERAL ADVICE

a. Careful and detailed study must be made of every phase of the operation to assure that streets, dwelling sites and structures are appropriately designed and properly constructed. The expense incurred in this type of land development can be disproportionate to the value created, particularly if there are no compensatory factors present or if the development is not fitted to the natural topography. However, this type of development, when properly applied, may result in substantial economies. Many local consultants and contractors throughout the country are practiced in the techniques required for optimum application.

b. Serious problems of changed drainage ways, control of slope erosion and specially designed footings may arise in these land developments, and extreme care is necessary during construction to complete the land development as specified. These conditions make essential the procurement by the developer and builder of qualified and competent site planning, engineering and architectural services and supervision. Proper coordination of these talents may yield a developer an economic return or give him a competitive advantage.

c. Site planning and grading design should give careful consideration to fitting and preserving desirable features of the natural topography and landscape, wherever possible and practical. This, and providing improvements appropriate to these features, often will reduce total earthwork quantities, and will enhance the development by avoiding a "scorched earth" appearance and by

preserving trees and other native plant materials.

d. The use of procedures defined in paragraphs 3f-j may be practical for specific situations involving expansive soils or other problem soils. Application of these procedures individually or in combination requires very thorough preliminary and analysis and construction supervision. Appropriate specifications for such procedures typically will be more detailed than those illustrated in Paragraph 10, Controlled Earthwork guide specifications.

e. When a land development will involve soils subject to differential movements, the costs of controlling soils problems through special earthwork procedures should be compared with the costs of special foundation systems, before final development decisions are reached.

3. DEFINITIONS. The following terms used in this data sheet are defined for HUD-FHA purposes, as follows:

a. Slope Control Area: An area established for the purpose of achieving the continuous stabilization of slopes, which otherwise might seriously affect properties. The area is identified on plans and in agreements running with the land. Continuous stabilization is to be achieved by slope control drainageways, slope control planting and other necessary initial work, and by continuing land use limitations and maintenance provisions, designed to preserve and maintain the slope control measures taken for the benefit of the properties.

b. Slope Control Easement: A legally established easement granting to the land developer, the builder, a local public authority or to a property-owners' association, the right of access to and over a slope control area for slope control purposes.

c. Slope Control Planting: Soil-fixing grasses and plants planted to help to prevent erosion and to stabilize the slope surface.

d. Slope Control Specialist: A professional landscape architect or other professional person experienced in erosion control work, retained by the developer in a professional or consultative capacity (not as a contractor performing construction work in the development), and responsible for analysis, plans, specifications, supervision and certifications regarding slope control planting and related slope control work, other than grading, for a specific project.

e. Soil Engineer: A registered professional engineer experienced in soil mechanics, retained by the developer and responsible for the soils engineering work outlined in this data sheet, including supervision, analysis and interpretation of field investigations and laboratory tests for a specific project, preparation of soils engineering recommendations and specifications, and supervision of the grading construction work.

f. Blending: A term for the intermixing and compacting of natural site soils (such as of materials from two natural soil horizons). or for the intermixing and compacting of natural site soils with imported soil and/or chemical characteristics of natural site soils and/or for reducing concentrations of adverse soil chemicals (such as sodium sulphate).

g. Replacement: A term for the removal and wasting of natural soil materials adjudged unsuitable for the support of dwellings or other site improvements, and their replacement with suitable soil materials properly compacted.

h. Reworking: A term for the mechanical densification or consolidation of natural loose or unconsolidated soils. The objective of reworking is to preconsolidate a site to preclude harmful settlements that might otherwise occur after structures or other improvements were completed.

i. Stabilization: A term for any procedure that will result in increased shear strength in a soil.

j. Modification: A term for any procedure that will reduce the Atterberg limits (liquid limit, plastic limit and Plasticity Index) of a soil.

4. PRELIMINARY EXHIBITS. The following preliminary exhibits shall be submitted to the HUD-FHA for preliminary analysis before any grading is done and before a subdivision report is issued:

a. Preliminary Sketch for Subdivision Plan: As illustrated on page 2 of HUD-FHA Data Sheet 140, clearly showing in addition the tentative spot elevations and slope ratios for heavy grading, location or all natural drainage channels, proposed changes in any of these channels, and the drainage areas involved. See Paragraph 9, Controlled Slopes, below.

b. Preliminary Subdivision Plan: After concurrence with the Preliminary sketch has been obtained, as outlined on page 3 of Data Sheet 140, clearly showing in addition the tentative spot elevations and slope ratios for heavy grading, location or all natural drainage channels, proposed changes in any of these channels, and the drainage areas involved. See Paragraph 9, Controlled Slopes, below.

c. Preliminary Subdivision Plan: After concurrence with the Preliminary sketch has been obtained, as outlined on page 3 of Data Sheet 140, with the additional items listed in Paragraph 4a above.

d. Site and Soils Data for Earthwork Proposal: Sufficient soil samples to represent a true cross-section of the cut and fill areas and of the material to be used as fill shall be taken and tested under the supervision of the Soils Engineer. All soils shall be classified in accordance with the Unified Soil Classification system (Technical Memorandum No. 3-57, Volume 1, Waterways Experiment Station, Corps of Engineers, March 1953, or as amplified and supplemented by FHA Publication No. 373, "Engineering Soil Classification for Residential Developments."). Reports, including all test reports by the Soils Engineer, shall be submitted covering the following:

(1) Field and laboratory tests of the land to be covered with fill to determine the characteristics of the soil including its expansive qualities, the bearing value of the land, consolidation potential, and a statement as to whether the land can support the proposed fill and structures. In those areas where saline or alkaline soils or other problem conditions may be encountered, sufficient information to define the problem and evaluate its solution shall be submitted to HUD-FHA for review.

(2) Field and laboratory soil analysis of the material proposed for the fill, including its source and expansive quality and a statement as to its suitability. The analysis shall also specify the optimum moisture content at which each type of proposed fill material compacts to 100% dry density in accordance with current ASTM Test of Moisture Density Relations of Soils Using 10-1b. Rammer and 18-in. Drop; or, where maximum fill depth will not exceed five feet current ASTM Test for Moisture-Density Relations of Soils, Using 5.5-1b. Rammer and 12-in. Drop.

(3) Field and laboratory soil analysis of existing soil conditions in proposed cut locations, including expansive qualities and bearing values. If steep slopes are proposed data sufficient to permit slope stability analysis shall be submitted.

(4) Any potential ground water condition which may affect soil strength, consolidation, or slope stability shall be defined and evaluated. This is of particular importance in areas subject to vibratory or shock loadings.

(5) Proposals to replace, rework or blend, or to stabilize or modify with additives either the natural site soils or the proposed fill materials, shall be supported by appropriate laboratory analyses and such other data as may be necessary for evaluation of the proposal.

(6) For shallow fills (generally not more than 3 feet in depth) the HUD-FHA, after a site inspection of natural ground conditions, may accept a professional statement by the Soils Engineer, covering the various soils characteristics called for, in lieu of laboratory analysis.

e. Specification for Grading: A complete and detailed specification prepared by the Soils Engineer for clearing, grubbing and all aspects of grading, including filling with the material specified in 4.c.(2) above, with special emphasis on the depth of fill layers, compaction methods, moisture content, frequency of field density tests, horizontal and vertical survey control of the job, and minimum density to be obtained in the field as related to laboratory density tests. See Paragraph 10., Controlled Earthwork guide specifications, below.

f. Statement Regarding Specified Grading and Slopes: By the Soils Engineer, giving a professional opinion regarding (1) shrinkage or settlement of a fill constructed in compliance with the proposed Specification for Controlled Earthwork, (2) the safe load-bearing capacity for such controlled sites, (3) the maximum slope ratios necessary for slope stability for proposed fill and cut slopes, with the assumption of proper planting on the slope to assure freedom from erosion, and (4) the remaining movement anticipated in cut areas. Any forecast of appreciable settlement shall be supported by appropriate site and soils data.

Data Sheet 79g

g. Specification for Slope Control Planting: A complete and detailed specification prepared by the Slope Control Specialist. The specification shall specify the material and methods for slope control planting in the various slope control areas, with special emphasis on (1) soil preparation, fertilization, plant material and methods of planting and (2) initial maintenance of the plant material and slopes until a specified percentage of plant coverage is established uniformly on the cut and fill slopes.

h. Statement Regarding Specified Slope Control Planting: By the Slope Control Specialist giving a professional opinion regarding (1) the length of time after planting in which the specified planting with the specified initial maintenance will normally produce, on the slopes in the slope control areas, the specified percentage of plant coverage, and (2) the length of time in which this specified plant coverage, without any special additional maintenance, will normally produce a coverage of permanent planting which will control erosion.

5. PRE-APPLICATION EXHIBITS. The following exhibits also will be required for analysis prior to submission of individual applications for mortgage insurance commitments:

a. Final Development Plans: As specified in the subdivision report per applicable portions of Data Sheet 150 and showing location of all slope-control areas and any easements for drainage or slope control.

b. Proposed Protective Covenants or other suitable legal instrument establishing the slope control areas and any slope control easements or drainage easements, and providing continuous land use regulations and maintenance provisions which are designed to preserve and maintain the established slope ratios, erosion control planting, drainageways, and other slope control measures taken for the benefit of the properties.

6. PRE-COMMITMENT EXHIBIT. During processing of applications and prior to the issuance of any commitment for mortgage insurance, the HUD-FHA writes the sponsor and mortgagee regarding the requirement that no building construction is to be started on graded areas before receipt of HUD-FHA's written acceptance of completed grading certifications. This letter states that, for dwellings having footings placed on

controlled soils, any dwelling construction which is started prior to the review and acceptance by HUD-FHA of the exhibits listed in Paragraph 7 below will be ineligible for mortgage insurance under the forthcoming HUD-FHA commitments. Acknowledgment is required from the sponsors and mortgagees that they have received the HUD-FHA letter.

7. PRE-CONSTRUCTION EXHIBITS. The following exhibits are required before any building construction:

a. Notice Regarding Start of Grading: Notification shall be delivered to the field office advising it of the start of grading operations at least 2 Departmental working days in advance of the starting date, and of any resumption dates when grading operations have been stopped for any reason other than adverse weather conditions.

b. Reports of Field Density Tests: Density tests made by the Soils in Paragraph 10.m. below) shall be submitted progressively to HUD-FHA. Dry density, moisture content, and the location, elevation and sampling date of each sample taken shall be reported, along with sufficient data to correlate with laboratory analyses submitted in compliance with Paragraph 4.c. above.

c. Certification Regarding Completed Grading: By the Soils Engineer, (1) that the site was graded and filled with accepted material in accordance with the accepted specifications, and (2) giving his professional opinion regarding remaining shrinkage or settlement, expansive characteristics, slope stability, load bearing qualities, saline or alkaline conditions, and of any other condition pertinent to construction upon the completed cut or fill.

d. Certification Regarding Completed Rough Grade Elevations: By a registered Civil Engineer or licensed Land Surveyor that the general grading has been completed and the resulting grade elevations are in substantial conformity (grading variations not exceeding five-tenths of a foot) with the previously accepted detailed development plan.

e. Movement Observation Programs: In unusual instances where remaining differential earth movements may be difficult to forecast or subject to question, earth movement observations may be required by HUD-FHA to demonstrate the fill, cut and/or

slope stability results actually achieved upon a project or site,

as a precommitment condition. If a determination of such need is made, a movement observation program acceptable to HUD-FHA shall be initiated. Observations from such a program will then be evaluated by the Department to determine the acceptability of the grading results.

f. Special Structural Designs: Required only upon specific request by HUD-FHA after its examination of the Certification Regarding Completed Grading, 7c above, and/or of the findings from a Movement Observation Program, 7e above. In response to HUD-FHA's request, designs of footings, foundations and/or slabs, prepared, signed and sealed by a registered structural or civil engineer specializing in structural design, will be submitted to HUD-FHA for review to assure satisfactory performance. The seal of a registered structural or civil engineer will be interpreted by HUD-FHA to mean that the designing engineer has familiarized himself with any unusual soil problems that might exist at the site and has submitted a design that will prevent future development of structural defects in the foundations and superstructure attributable to differential movement of the supporting soils.

8. PRE-CLOSING EXHIBITS. The following exhibits are required prior to the issuance of mortgage insurance.

a. Notice Regarding Start of Slope Control Planting: Notification shall be delivered to the field office advising it of the start of slope control planting at least 2 Departmental working days in advance of the starting date, and of any resumption dates when planting operations are stopped for any reason other than adverse weather conditions.

b. Certification Regarding Slope Control Planting: By the Slope Control Specialist that the slope control planting, except initial maintenance, has been completed in accordance with the accepted Specifications for Slope Control Planting, 4.f. Where necessary, due to season or other factors beyond the control of the sponsor, temporary postponement of the installation of slope control planting will be considered by HUD-FHA provided that an escrow agreement or other acceptable assurance of completion is established, including repair of slopes, related damage, and installation of slope control planting within a satisfactory specified time; for Escrow Procedure and Escrow Agreement, see the Administrative Instructions and Procedures Handbook (4115.1).

c. Assurance of Slope Maintenance: An escrow agreement or other acceptable assurance of completion assuring that the slopes and

slope planting in the slope control areas will be watered and will receive other initial maintenance in accordance with the accepted Specification for Slope Control Planting; see agreement referred to in 8.b. above. Not required for area in which specified initial maintenance has been completed.

d. Easements for Escrow Agreements: To prevent possible legal objection by owners of property to the performance of the work contemplated by escrow agreements or other assurances of completion, entered into under Paragraphs 8.b. and 8.c. above. Short-term easements for access to and over the slope control areas to perform the work covered by any completion agreement shall be reserved by the sponsor for itself and the escrow holder. Such easements should not be perpetual but should last for a period of time determined to be necessary by the HUD-FHA to insure the fulfillment of the work covered by the completion agreement.

9. CONTROLLED SLOPES. Where a serious hazard or nuisance could be caused by lack of stabilization of a slope, the HUD-FHA requires effective control of the slope to assure its continuous stabilization. Plans and other required exhibits for such controlled slopes shall comply with the following:

a. Slope Ratios: Slopes generally shall be no steeper than 2 horizontal to 1 vertical for either fill or cut slopes. Where particular conditions make it appropriate to vary from these slopes, the HUD-FHA requires flatter slopes or accepts steeper slopes, such as in the case of a stable rock face. HUD-FHA determination of acceptable slope ratios for mortgage insurance purposes is predicated on a stability analysis of the data and certifications of soil characteristics and slope stabilization required in Paragraphs 4. and 5. above, and its analysis of light, air, open space and other factors relating to the properties.

b. Slope Benches: Where site conditions indicate the need, slopes having a vertical height exceeding 25 feet shall have benches to provide breaks in the high slopes in order to intercept surface water and to aid in doing maintenance work on the slopes. Slope benches shall be at intervals not exceeding 25 feet vertical height. Benches shall be at least 6 feet wide and constructed to intercept surface water from the slopes and to carry it in paved drainageways at suitable gradient to proper outfalls.

c. Lot Line Locations: Insofar as practicable, lot lines shall be located at the top of banks or along slope benches, instead of at the toe of slopes or at intermediate locations.

d. Usable Rear Yards: Provide a usable rear yard at least 15 feet deep from building wall to the toe of a slope with vertical height exceeding 15 feet. Increase the horizontal distance of the required 15-foot usable rear yard at the rate of 1/4 foot horizontal for every foot of bank height over the first 15 feet.

e. Usable Front and Side Yards: Maximum 2 1/2 inches per foot (21 percent) away from building for a maximum 4 foot distance. At toe of slope where height of bank exceeds 4 feet, increase the horizontal distance of the minimum 4-foot usable yard at the rate of 1/4 foot horizontal for every foot of bank height over the first 4 feet.

f. Storm Water Runoff: Storm water runoff shall not be carried over the controlled slopes but shall be provided for as follows:

(1) Wherever attainable without producing disproportionate disadvantages, each lot shall be graded so that storm water will drain from the back yard through the side yards and front yard directly to the abutting street and not across other lots or onto controlled slopes.

(2) When the above does not apply, water shall be collected along the top of the slopes by means of paved gutters and shall be carried in them to a proper outfall. The paved gutters shall be located in properly established slope control areas or in drainage easements.

g. Boundaries of Slope Control Areas: Where a serious hazard or nuisance to one property could be caused by lack of stabilization of a slope located in whole or in part on another property, the slope shall be included in a slope control area which is established by a proper legal instrument. Drainageways necessary to the stabilization of such slopes shall also be included in the slope control area unless located in separate rights-of-way or easements of a local public authority or property-owners' association. Boundaries may fall within required yard areas unless the slope control area is in the ownership of a public authority or an association. Boundaries shall be legally

established, usually by reference to a map in the protective covenants or other legal instrument which sets up the permitted use and required maintenance of the slope control area.

h. Permitted Use and Required Maintenance of Slope Control Areas:

Were practicable, the slope control areas shall be established as rights-of-way or easements of a local public authority or properly constituted property-owners' association. Otherwise they shall be established as slope control areas which are identified in recorded protective covenants or other legal agreements running with the land, and which are made subject to appropriate agreements regarding use and maintenance by each individual property owner. In any case, the agreements with the public authority or property-owners' association, or among individual owners under the covenants, shall include both land use restrictions in the slope control area and maintenance provisions designed to preserve, protect, maintain and assure the continuous effectiveness of slope control drainageways, slope control planting, established slope ratios, and other slope control measures taken for the benefit of the properties.

i. Slope Control Planting: Slopes located in the slope control areas shall be fertilized and planted with soil-fixing grasses, vines or shrubs, or otherwise treated as necessary to adequately stabilize slopes for the specific development.

j. Initial Maintenance of Slopes: Initial maintenance of slopes and planting in slope control areas shall be continued until stabilization has been assured.

k. Retaining Walls: Retaining walls shall be avoided wherever possible, particularly at the toes of high slopes. Retaining walls installed in slope control areas shall be constructed of concrete or other masonry and adequately designed to carry all earth pressures including any embankment surcharge.

l. Fences: Fences of proper design and construction shall be installed for safety purposes along the top of slopes exceeding 15 feet vertical height and 3 to 1 slope ratio, and along the top of walls exceeding 4-feet vertical height.

10. CONTROLLED EARTHWORK. For any development in which buildings are to be placed on graded areas, all earthwork shall be designed, engineered and constructed in such a manner that there will be no

adverse differential movement which may cause damage to the structures, utilities, lot improvements and street pavements. The following may be used as a guide, not used verbatim, in writing a specification for filled areas using non-expansive soils. For a specific project, it is necessary to prepare the specification predicated upon the analysis of the material proposed to be used

for the fill and other conditions pertaining to the project. As may be appropriate, similar or special specification items shall be included for cut areas or areas of critical natural soils. Very important changes from these guide specifications are necessary if expansive soils or other problem soils are to be used. Among other soils, this includes any soil which has a Liquid Limit greater than 30 or a Plasticity Index greater than 10. For such soils, the moisture content and density to which the soil is to be compacted, the manner and location of placement of the soil and other factors affecting strength and/or volume change for the soil shall be properly specified in the project specifications.

a. General Description: This item shall consist of all clearing and grubbing, removal of existing structures, preparation of land to be filled, filling of the land, spreading, compaction and control of the fill, and all subsidiary work necessary to complete the grading of the cut and fill areas to conform with the lines, grades and slopes as shown on the accepted plans.

b. Clearing Area to be Filled: All timber, logs, trees, brush and rubbish shall be removed, piled or burned or otherwise acceptably disposed of.

c. Scarifying Area to be Filled:

   (1) All vegetable matter shall be removed from the surface upon which the fill is to be placed, and the surface shall then be plowed or scarified to a depth of at least six inches (6"), and until the surface is free from ruts, hummocks or other uneven features which would tend to prevent uniform compaction by the equipment to be used.

   (2) Where fills are made on hillsides or slopes, the slope of the original ground upon which the fill is to be placed shall be plowed or scarified deeply or where the slope ratio of the original ground is steeper than 5 horizontal to 1 vertical, the bank shall be stepped or benched. Ground slopes which are flatter than 5 to 1 shall be benched when considered necessary by the Soil Engineer.

d. Compacting Area to be Filled: After the foundation for the fill has been cleared and plowed or scarified, it shall be disced or bladed until it is uniform and free from large clods, brought to the proper moisture content, and compacted (typically) to not less than ninety (90%) of maximum density in accordance with current ASTM Density Test No. D 1557 (5 layers-25 blows each layer-10 1b. hammer-18" drop-1/30 cu. ft. mold), or to such

other density as may be determined appropriate for the materials and conditions and acceptable to the Department.

e. Fill Materials: Materials for fill shall consist of materials selected by the Soils Engineer from sources identified in laboratory reports, which reports have previously been accepted by the Department. The materials used shall be free from vegetable matter and other deleterious substance and shall not contain rocks or lumps having a diameter of more than six inches (6").

f. Depth and Mixing of Fill Layers: The selected fill material shall be placed in level, uniform layers which, when compacted, shall have a density conforming to that stipulated in the HUD-FHA accepted earthwork specifications. Each layer shall be thoroughly blade mixed during the spreading to insure uniformity of material in each layer. Compacted layer thickness normally will be six inches (6"), however, it may be specified otherwise if compaction equipment of demonstrated capability will be used.

g. Rock: When fill material includes rock, the maximum rock size acceptable shall be six inches (6"). No large rocks shall be allowed to nest and all voids must be carefully filled with small stones or earth, properly compacted. No large rocks will be permitted within twelve inches (12"), of the finished grade.

h. Moisture Content: The fill material shall be compacted at the appropriate moisture content specified for the soils being used, as identified in laboratory and soils reports which have previously been accepted by the HUD-FHA. (See item 4.c.(2) above.) Moisture content tolerances should be clearly defined for placement of each material proposed for use in a fill. Appropriate moisture content is defined, typically, as optimum moisture content, however for expansive soils it may be greater than optimum moisture content, and other moisture contents may be necessary to produce the desired results with specific soils.

Data Sheet 79g

i. Amount of Compaction: After each layer (lift) has been placed, mixed and spread evenly, it shall be thoroughly compacted to the specified density. The specified density will be stated as a percentage of the maximum density attainable using current ASTM Density Test No. D 1557 (5 layers-25 blows each layer-10 1b. hammer-18" drop-1/30 cu. ft. mold). The specified density typically will be ninety percent (90%) of maximum for most, cohesive, non-expansive soils, however it will be established as appropriate for the materials and environment defined. For example, granular soils may require compaction to 95% of maximum

density and expansive soils may require compaction to densities less than 90% of maximum density. To achieve the desired fill quality, it may be necessary to specify acceptable density tolerances for the compacted fill.

j. Compaction of Fill Layer: Compaction equipment shall be of such design that it will be able to compact the fill to the specified density. Compaction shall be accomplished while the fill material is at the specified moisture content. Compaction of each layer shall be continuous over its entire area and the compaction equipment shall make sufficient trips to insure that the required density has been obtained.

k. Compaction of Slopes: Fill slopes shall be compacted. Compacting operations shall be continued until the slopes are stable but not too dense for planting on the slopes. Compacting of the slopes may be done progressively in increments of three to five feet (3' to 5') in fill height or after the fill is brought to its total height.

l. Density Tests: Field density tests shall be made by the Soils Engineer of the compaction of each layer of fill. Density tests shall be taken in the compacted material below the disturbed surface. When these tests indicate that the density of any layer of fill or portion thereof is below the required density, the particular layer or portion shall be reworked until the required density has been obtained. Sufficient density tests shall be made and submitted to HUD-FHA to support the Soils Engineer's certification of each fill layer.

m. Supervision: Supervision by the Soils Engineer shall be continuous during the grading operations so that he can certify that all cut and filled areas were graded in accordance with the accepted specifications.

Data Sheet 79g

n. Seasonal Limits: No fill material shall be placed, spread or rolled while it is frozen or thawing or during unfavorable weather conditions. When the work is interrupted by heavy rain, fill operations shall not be resumed until the Soils Engineer indicates that the moisture content and density of the previously-placed fill are as specified.

Data Sheet 79g

INSTRUCTIONS REGARDING PROPERTIES AND LAND DEVELOPMENTS
WITH CONTROLLED EARTHWORK

Part 2 of 2 Parts

1. APPLICATION. These instructions apply to the use of Data Sheet 79g, entitled, "Land Development With Controlled Earthwork." Data Sheet 79g and these instructions supersede all previously issued Data Sheets in the 79 series and outstanding instructions for their use. The instructions apply to all individual properties and developments in which building footings or building foundations are placed on filled ground or in which floor slabs are placed on fill in excess of that permitted by the applicable Minimum Property Standards. Within these limits, they apply to proposed fills, to fills placed prior to submission to HUD-FHA, and to sites that have had their soils modified by any blending or replacement technique unless experimental earthwork under Section 233 is involved. At the Department's option, these instructions apply to sites where cut may have exposed materials with adverse characteristics or sites with any kind of soil or slope stability problem. In any case, serious problems of land development and soils engineering may be involved. Failure to recognize and solve such problems properly may result in major monetary losses due to soil movement, sliding and erosion and to structural failure of dwellings, utilities and street improvements.

2. SPECIAL PROBLEMS. All HUD field offices will routinely advise the Office of Technical and Credit Standards of any unusual problems relating to soils, earthwork construction, earthwork processing procedures, or earthwork requirements, that they may encounter, and the recommendations appropriate for their resolution. Their Civil Engineer should be responsible for the technical input of this information memorandum.

3. EXISTING FILLS.

   a. Properties or developments on which fill has been placed prior to submission to the Department or contrary to the following procedure for new development shall be considered ineligible for mortgage insurance if the site will support buildings, unless:

      (1) The Civil Engineer serving the field office recommends acceptance of the existing fill;

(2) The Area or Insuring Office recommends acceptance of the existing fill;

(3) The Regional Civil Engineer recommends acceptance of the existing fill; and,

(4) These three recommendations are then reviewed by the Office of Technical and Credit Standards, which may authorize acceptance of the existing fill.

b. For a determination of eligibility of such a site with existing fills, the field office and central office require satisfactory evidence proving beyond any reasonable doubt that the site planning and engineering evaluations actually obtained in the development are at least equal to those which HUD-FHA would have required as minimum for the development if the site had been submitted to this Department in its original natural condition and had then been analyzed and improved in accordance with Departmental procedures and minimum requirements.

c. When the Civil Engineer reviews an existing fill proposal and finds that the existing fill and associated improvements comply with the objectives of 3b above, he recommends its acceptance to the field office.

d. When a field office evaluates a development with existing fill whose acceptance is recommended by their Civil Engineer and the development is found acceptable in all other respects, the Director forwards the file to the Regional Civil Engineer with the Director's recommendation that the existing fill be accepted for the support of dwellings. If the Regional Civil Engineer concurs with the Director's recommendation, after review of the exhibits and other pertinent data, he will forward the file to the Office of Technical and Credit Standards with a memorandum recommending acceptance of the existing fill. If the Regional Civil Engineer does not consider the existing fill acceptable, of course, he returns the file to the field office with a memorandum setting forth the reasons for his determination.

4. PROPOSED DEVELOPMENTS.

a. General: The field office should advise a land developer or sponsor to assure himself that the expense of land development with controlled earthwork will not be disproportionate to the

Data Sheet 79g

value created. The Department must assure itself that "scorched earth" practices will not be unnecessarily used and that natural site features or other amenities that will be modified or destroyed will not adversely affect the marketability or livability of the development.

b. Site Planning & Civil Engineering: All proposals involving land development with controlled earthwork shall be submitted to the Site Planner and Civil Engineer serving the field office for site analysis. Proper site planning and site engineering techniques will, in many instances, eliminate the need for extensive regrading of the land and generally will reduce the amount of grading to be done.

c. Architectural Adaptation of Buildings: Just as proper Site Planning and Civil Engineering will generally reduce total earthwork quantities, so will proper Architectural adaptation of buildings to the site. The skills of the Architectural and Engineering Section should thus be used during early subdivision analysis of project analysis stages to assure maximum harmony between the site and the structure.

5. APPLICATION OF DATA SHEET 79g.

a. After final determination has been reached with respect to developing land for buildings on fill, a complete analysis of the individual project shall be made to determine the necessary required exhibits, details and specifications for the particular project. All of the requirements, exhibits and procedural time-schedules described in Data Sheet 79g will usually be required for these developments. It should be noted, however, that the slope control requirements are not required for a project in which the slopes are such that a serious hazard or maintenance problem is unlikely.

b. In some special cases, complete analysis of a project may indicate that certain specific parts of Data Sheet 79g are not needed to properly protect the interest of the Department. The field office shall decide special case variances of this nature on a project-by-project basis. However, if acceptance of a variation from a standard provision in Data Sheet 79g or these instructions would establish a precedent for similar acceptance in repetitive projects, the variation shall not be accepted; instead the office

shall refer the matter to the Office of Technical and Credit Standards Central Office, with a request to establish revised local instructions for general local use. An example of required concurrence by Central Office would be the typical and repetitive acceptance by an insuring office of slopes which are steeper than 2 horizontal to 1 vertical.

c. The field office is authorized to require submission of the Pre-Commitment Exhibit (Item 6 of Data Sheet 79g) as a Pre-Application Exhibit (Item 5 of Data Sheet 79g). This procedural variation will be particularly desirable where processing is for quality, but time limitations makes an exchange of correspondence impractical during the application processing period. Where this procedural variation is elected by the field office, it should be appropriately stipulated in the Feasibility Letter.

6. SUBDIVISION REPORT. All or part of the typical subdivision clauses needed to protect properly the interests of the Department on a specific development, shall be incorporated as conditions of the commitment.

7. THE DUTIES AND RESPONSIBILITIES OF THE VALUATION SECTION.

a. To exercise diligent effort to determine the presence of any existing fill that may support dwellings or improvements on unimproved tracts and on existing lots, and refer problems to the Civil Engineer and Site Planner for solution.

b. To incorporate conclusions of the Civil Engineer and Site Planner into processing of the subdivision or individual property, as the case may be.

c. To reflect results of solution in marketability and valuation analysis of individual properties.

d. To maintain a progressive record of compliance with the above exhibit requirements.

8. DUTIES AND RESPONSIBILITIES OF THE SITE PLANNER AND CIVIL ENGINEER.

a. They eliminate or reduce the problems through planning and engineering techniques insofar as possible.

b. They assist in the establishment and administration of procedures

to assure professional review of exhibits required in Parts 4, 5, 6, 7 and 8 and Data Sheet 79g, prior to Feasibility Letter, Commitment, Construction, and Insurance, respectively.

c. They determine technical exhibit requirements and acceptable compliance therewith regarding the following:

(1) Section 4, Preliminary Exhibits:

Analyses by Site Planner:
Items 4b, 4f and 4g.

Analyses by Civil Engineer:
Items 4a, 4c, 4d, and 4e.

(2) Section 5, Pre-Application Exhibits:

Analysis by Site Planner & Civil Engineer, collaboratively:
Items 5a and 5b.

(3) Section 7, Pre-Construction Exhibits:

Analysis by Civil Engineer:
Items 7b, 7c and 7e.

(4) Section 9, Controlled Slopes:

Analyses by Site Planner:
Items 9e, 9i, 9j and 9h.

Analysis by Site Planner and Civil Engineer, collaboratively:
All other items in Section 9.

(5) Section 10, Controlled Earthwork Guide Specifications:

Exhibit compliance by Civil Engineer.

The various individual or collaborative analyses of the Site Planner and/or the Civil Engineer are incorporated into reports upon the specific project.

d. The Site Planner and the Civil Engineer each maintain a progressive record of compliance for those items on each Data Sheet 79g proposal for which they are responsible. When the Site

Planner and Civil Engineer recommend actions to complete a given stage of subdivision or project analysis, they should so advise either by memorandum or by forwarding a copy of his (their) progressive record of compliance.

e. The Civil Engineer and the Site Planner train personnel of the field office on construction compliance on grading, planting and other land improvement work. When requested the Civil Engineer advises upon appropriate methods and procedures for evaluating and recording routine compliance exhibits.

f. The civil Engineer's review of Item 7e is made to advise of any special or unexpected conditions which warrant further exploration or indicate the need for special structural design.

9. DUTIES AND RESPONSIBILITIES OF THE FIELD OFFICE.

a. Determine exhibit requirements and acceptable compliance therewith regarding the following:

(1) Section 7, Pre-Construction Exhibits:

Items 7a through 7f, inclusive.

The Civil Engineer establishes the criteria for Item 7e, Movement Observation Program, if required, and is responsible for compliance inspection and administration of observation reports.

When it has been determined that the completed earthwork construction does not fulfill usual site eligibility criteria, the field office is responsible for evaluation of special structural designs that may be proposed to counter site deficiencies. Such special structural designs may be required as specified in Item 7f. Any questions regarding the adequacy of proposed designs will be referred to the Office of Technical and Credit Standards.

(2) Pre-Closing Exhibits:

Items 8a and 8b.

b. Maintains a progressive record of compliance with above exhibit requirements.

c. Makes frequent inspections of grading and slope control work

during construction operations.

d. From above exhibit examinations and construction inspections, determines whether or not construction is in compliance with the drawings, specifications and other exhibits accepted for a particular proposed development.

10. SERVICES OF SPECIALIZED PERSONNEL. Where specialized advice or assistance is needed to reach proper conclusions and is not otherwise available, the insuring office shall request assistance from the Office of Technical and Credit Standards.

11. CONSTRUCTION COMPLIANCE ON GRADING, PLANTING AND OTHER WORK.

a. Upon completion of their review and acceptance of required design exhibits (Sections 4 and 5 of Data Sheet 79g) the accepted exhibits are used in design analyses and in compliance examinations.

b. Item 7a of Data Sheet 79g requires that field offices be notified at least two Departmental working days in advance of the start of grading and also of resumption dates of grading when grading has been stopped for any reason other than adverse weather conditions. Item 8a requires that field offices be notified at least two Departmental working days in advance of the start of slope control planting and also of resumption dates of planting when slope control planting has been stopped for any reason other than adverse weather conditions.

c. When these notifications are received, the field office arranges to make field inspections of grading and slope control planting as it progresses in the project. These inspections are scheduled as frequently as possible with the objective of daily inspections wherever practical. It is advisable to have the same compliance inspector follow through on any one project.

d. In order that the compliance inspectors will be as well trained as possible in this work, the Civil Engineer and Site Planner serving the office will conduct a continuous training program as outlined in 13 below.

e. The Site Planner and the Civil Engineer are informed of the start of earthwork operations on each development or project. If possible, the Civil Engineer and/or the Site Planner visit the site with the inspector at the start of grading operations, or as soon thereafter as arrangements can be made for them to

do so. The purpose of this visit is to assist the inspector at the start of operations and give him the benefit of the Civil Engineer's and/or the Site Planner's professional experience. The Civil Engineer or the Site Planner make additional visits to the tract during operations as requested. Advice and recommendations from such observations are reported by memorandum from the Site Planner or Civil Engineer.

f. For each development of this type, the inspector familiarizes himself with the accepted engineering and planning reports, drawings and specifications regarding proposed grading, planting and other work.

g. During each inspection, the inspector examines completed work, equipment on the site and work in progress in order to make limited determinations regarding compliance with accepted specifications and the required work shown on the accepted exhibits. In making his inspection and writing his report, he recognizes that HUD-FHA requires laboratory reports on the compacted fill, engineering certifications and other exhibits (6 and 7 of Data Sheet 79g) and that these will be examined as well as his field reports before the Department makes a final determination of the acceptability of any of this required work. He limits his statements during inspection and in his report accordingly. He does not use the statement "Work is acceptably completed." Instead he uses such statements as "Correction is essential to compliance as follows," or "Correction required by report dated is not acceptably completed," or "The following work is now in progress or completed, appears from this inspection to be in compliance, but is subject to other reports and required exhibits before acceptance by the Department."

h. At each inspection, the inspector inspects and reports on all work completed since the last inspection and on all work in progress, unless he specifically notes otherwise as to limitations on the area or type of work covered in his report. This includes both work involving land development as outlined in Data Sheet 79g and also other required improvements listed in the Subdivision Report, such as storm drainage and street improvements as outlined in other instructions.

The inspector inspects and reports on the items listed below regarding site development. Frequent field inspection during the progress of construction is important because correction of many items of work is difficult or impractical at a later date and because the information obtained from progress inspections

is essential to final determination of the acceptability of all work when completed. The items inspected, with parenthetic letter-number references to Data Sheet 79g, are as follows:

(1) Controlled Earthwork Guide Specifications: (References are to HUD-FHA guide specifications; inspection objective shall be to determine compliance with specific job specifications accepted by the Department.)

(a) Preparing area for fill (10b, 10c, 10d)

(b) Fill material and source (10c, 10f, 10g)

(c) Depth of fill layers (10f)

(d) Moisture content (10h)

(e) Compaction (10j)

(f) Compaction of Slopes (10k)

(g) Continuous supervision by Soils Engineer (10m)

(h) Seasonal Limits (10n)

(i) Any special control items required for specific job.

(2) Slope Ratios and Locations:

(5a and 9a through 9f, inclusive)

(3) Retaining Walls:

(5a and 9k)

(4) Slope Control Planting:

(4f, 5a, 8c, 9i)

(a) Soil preparation and fertilization.

(b) Plant material.

(c) Planting methods.

(d) Seasonal limits.

(e) Initial maintenance.

j. The inspector reports each inspection. He designates the report as a "Subdivision." He writes the name, number and location of the subdivision or tract in the heading. He writes a complete report. He dates and signs the report and leaves the first carbon copy as an unapproved report for the convenience of the sponsor and his soils engineer.

k. After review of the inspection report, the report is distributed as follows:

Original to the sponsor of the tract or subdivision. Second carbon copy to the subdivision (or tract) Compliance Inspection Binder.

l. Where there is known to be an HUD-FHA mortgagee engaged to furnish development construction loans and mortgage financing, Compliance Inspection Reports may be provided to the mortgagee.

m. Reports of field density tests are required to be made by the sponsor's soils engineer progressively during grading construction and to be submitted to the Department (7b of Data Sheet 79g). Immediately upon their receipt, the inspector or other designated design professional examines them to determine if the fill material is compacted in accordance with the accepted specifications. He considers the number and location of tests as well as the results reported. He correlates the test results with information obtained from field inspections. He prepares a letter for the Director's signature addressed to the sponsor acknowledging receipt of the reports. In the memo he accepts the reports as partial compliance, requires correction essential to compliance, or asks for verification or correction of questionable work, as appropriate in each instance. A copy is sent to the sponsor's soils engineer. A copy is placed in the Subdivision Compliance Inspection Binder. A copy is sent to the mortgagee receiving compliance inspection data under the conditions described in 11e.

n. Certifications regarding completed grading and slope control planting are required when all work is completed (7 and 8 of Data Sheet 79g). When these are received, a final examination of field inspection reports, density test reports and these certifications is made. A determination of acceptability of the completed work is made only after this final examination has

been made. The conclusions are written in a letter to the sponsor for the Director's signature. Copies are distributed to the sponsor's soils engineer or slope control specialist, to the Subdivision Compliance Inspection Binder, to the Subdivision File, and to any mortgagee receiving progress reports.

o. During the above compliance inspections and examinations of required exhibits the Civil Engineer or Site Planner should be consulted for advice or guidance whenever their technical aid may be needed to reach proper and correct conclusions. Such liaison is particularly desirable when earthwork operations will involve unusual procedures or when the field office has had only limited experience with controlled earthwork.

12. TRAINING ON CONSTRUCTION COMPLIANCE.

a. Periodically, the Civil Engineer and Site Planner hold meetings with personnel to train them in determining construction compliance on grading, planting and other land development work. Arrangements for such training are as directed by the field office.

b. The Site Planner and the Civil Engineer make field trips as needed to keep thoroughly familiar with developments of this type in the field office jurisdiction. When considered desirable, the Site Planner or Civil Engineer will advise the field office that additional compliance training or other actions are necessary to achieve the objectives of Data Sheet 79g and these instructions.

13. ESCROW AGREEMENT FOR POSTPONED SLOPE CONTROL PLANTING AND SLOPE REPAIR.

a. Due to the importance of obtaining complete slope stabilization to prevent erosion of slopes, it is required in 8b of Data Sheet 79g that the Slope Control Specialist certify prior to mortgage insurance that slope control planting work, except initial

maintenance, has been completed in accordance with the accepted specifications as called for in Item 4.f.(2). Every effort shall be made to have the work completed prior to insurance. It is usually to the advantage of the builder and HUD-FHA to complete this work immediately following site grading and prior to any building construction.

b. There may be instances where, due to season or other factors

behind the control of the sponsor, it may be advisable to postpone temporarily the installation of slope control planting if the field office agrees that a postponement is necessary. Where the potential danger of damage to dwelling construction presents a high degree of risk because of steepness and height of slopes, slope location, climatic conditions, or other factors which necessitate an excessive escrow amount, deferment of the work is not acceptable.

c. In cases where an escrow is determined to be acceptable, HUD-FHA Forms 2606 and 2606a are used with the following modifications:

Form 2606 - Change heading to read "Escrow Agreement for Postponed Slope Control Planting and Slope Repair."

Form 2606a - Add the following under "Itemized Statement of Work ....."

"This work shall consist of the repair of slopes and related damage and installation of slope control planting in accordance with the accepted Development Plans and Specifications identified as follows: '_____'. Work shall be performed within the slope control areas in Blocks_____ as identified on the accepted plans and in the agreement running with the land titled '_____ and dated _____."

On the back of the form substitute the following statement in lieu of the corresponding existing paragraph:

"Request for Inspection.
This request shall be accompanied by a certification by the Slope Control Specialist that slope control.

planting, except initial maintenance, has been completed in accordance with the accepted specifications.

Where repair of slopes and related damage is involved, a certification by the Soils Engineer is required stating that the slopes and related damage have been repaired in accordance with the accepted Development Plans and Specifications."

14. ESCROW AGREEMENT FOR INITIAL MAINTENANCE OF CONTROLLED SLOPES.

a. Item 9j of the data sheet states that "Initial maintenance of slopes and planting in slope control areas shall be continued until stabilization has been assured." Dwelling construction is often started as soon as fills are placed and slope control planting is installed. In some cases, properties will be completed and insurance of loans will be desired before the necessary period of initial maintenance of slopes is completed. In such cases, it is necessary to establish an escrow agreement for initial maintenance in order to give the needed assurance that the planted slope control areas will receive watering and other initial maintenance until the specified percentage of plant coverage has been obtained. In general, a period of a few months is sufficient for most planting if it is properly specified and is done in the proper season.

b. The escrow forms identified above are used with the following modifications:

Form 2606 - Change heading to read "Escrow Agreement Initial Maintenance of Controlled Slopes."

Form 2606a - Add the following under "Itemized Statement of Work . . . . . ."

"This work shall consist of initial maintenance of slope control planting and any related slope repair within slope control areas located in Blocks_____ as identified on the Accepted Development. Plans and Specifications titled ' _____ _____' and dated _____.

Initial maintenance consisting of watering, cultivating, pruning, and replacement of

Data Sheet 79g

dead material shall begin immediately following completion of the slope control planting and shall be continued until the amount of plant growth as stated in the accepted specification has been achieved. Initial maintenance shall also include the repair of slopes to correct any erosion damage and the cleaning and repair of paved gutters, catch basins and other drainage

structures."

On the back of the form substitute the following statement in lieu of the corresponding existing paragraph:

"Request for Inspection:
This request shall be accompanied by a certification by the Slope Control Specialist that the initial maintenance period has been completed and the specified amount of plant growth achieved."

Data Sheet 79g

PRELIMINARY SUBDIVISION PLAN

(GENERAL PLAN)

The preliminary subdivision plan of a proposed development should be based upon accurate knowledge of existing site conditions and topography. It should include the entire land holding to be developed by the sponsor. However, before either a topographic map or a preliminary subdivision plan is prepared, the sponsor should have initial conferences with the local planning officials as well as with representatives of the local FHA office.

ACCURATE BASIS FOR PLANNING

Topographic and other data should be accurately prepared by a competent engineer or land surveyor. Inaccurate and hastily prepared surveys are worse than none as they handicap economical development.

The topographic survey should show existing conditions on both the sits and lands immediately adjacent and should be at an appropriate engineering scale. It should show the data in the following check list unless the local FHA office indicates otherwise.

1. Boundary lines: bearings and distances.
2. Easements: location, width and purpose.
3. Streets on and adjacent to the tract:

   a. name and right-of-way width and location;

b. type, width and elevation of surfacing;
c. any legally established center-line elevations;
d. walks, curbs, gutters, culverts. etc,

4. Utilities on and adjacent to the tract:

a. location, size, and invert elevation of sanitary, storm and/or combined sewers;
b. location and size of water mains;
c. location of gas lines, fire hydrants, electric and telephone poles, and street lights;
d if water mains and sewers are not on or adjacent to the tract, indicate the direction and distance to, and size of nearest ones, show invert elevation of sewers.

---

5. Ground elevations on the tract:
a. for land that slopes less than approximately 2% show spot elevations at all breaks in grade, along all drainage channels or swales, and at selected points not more than 100 feet apart in all directions;
b. for land that slopes more than approximately 2% show contours with an interval of not more than 5 feet where ground slope is regular and such information is sufficient for planning purposes, or show contours with an interval of not more than 2 feet where necessary

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

because of irregular land or need for more detailed data for preparing plans and construction drawings.

6. Subsurface conditions on the tract:
   a. location and results of tests made to ascertain subsurface soil, rock and ground water conditions;
   b. depth to ground water unless test pits are dry at a depth of 5 feet;
   c. location of percolation tests if individual sewage disposal systems proposed; see Subdivision Sewage Disposal Report, FHA Form 2064c.

7. Other conditions on the tract: water courses, marshes, rock outcrop, wooded areas, isolated preservable trees one foot or more in diameter, houses, barns, shacks, and other significant features.

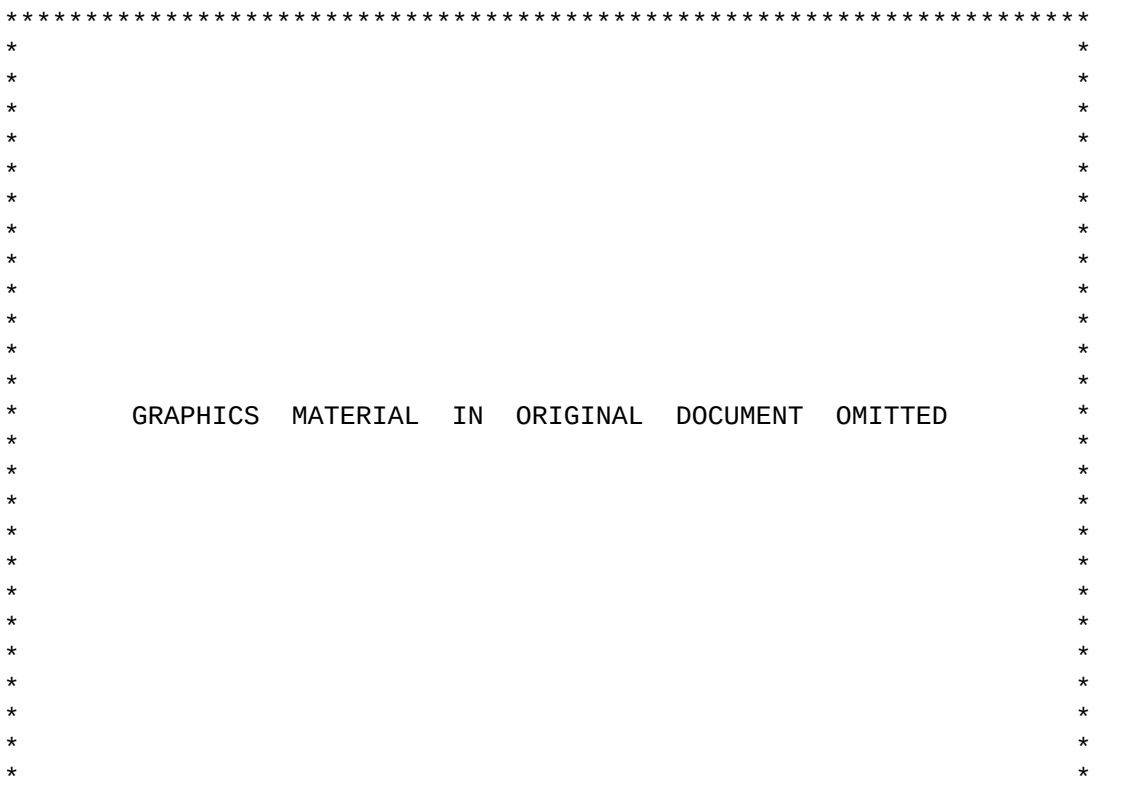
8. Other conditions on adjacent land:
   a. approximate direction and gradient of ground slope, including any enbankments or retaining walls:
   b. character and location of buildings, railroads, power lines, towers, and other nearby non-residential land uses or adverse influences;
   c. approximate area of off-site water-shed draining into tract.
   d. owners of adjacent unplatted land;
   e. for adjacent platted land refer to subdivision plat by name, recording date and number, and show approximate percent built-up, typical lot size and dwelling type.

9. Photographs: camera locations, directions of views and key numbers.

10. Zoning on and adjacent to the tract.

11. Proposed public improvements: highways or other major improvements planned by public authorities for future construction on or near the tract.

12. Title and certifications: name of tract or development, location, scale, north arrow, datum, benchmarks, certification of registered civil engineer or surveyor, date of survey.



SKETCH PLAN DRAWN ON PRINT OF TOPOGRAPHIC SURVEY

SKETCH PLAN FIRST

Economies and maximum opportunities of the site can be realized throughout the planning and development stages by employing a competent site planner.

The preliminary subdivision plan of a development should be first submitted to the FHA for advice in simple sketch form so that any suggestions may be incorporated easily and inexpensively. This first submission may be a freehand pencil sketch made directly on a print of the topographic survey. The sketch plan should show the proposed layout of streets, lots and other features in relation to the site conditions; also proposed sites of any schools, churches, parks, playgrounds, shopping and other neighborhood facilities. A key plan should be included on the sketch to show how the

proposed subdivision plan will fit into the surrounding neighborhood. While the plan is still in sketch form, the sponsor or his planner should consult local planning and engineering officials, as well as utility companies regarding their requirements.

PRELIMINARY SUBDIVISION PLAN — When the sketch plan is satisfactory to all concerned, preparation may begin on the more accurately drafted preliminary subdivision plan. This plan should provide the following data:

1. Streets, rights-of-way and roadway widths; approximate grades and gradients.
2. Other rights-of-way or easements.
3. Storm drainage system.
4. Spot elevations and slope ratios for any heavy grading.
5. Lot lines and lot numbers.
6. Sites, if any, for park, churches, etc.
7. Minimum building setback lines.
8. Key plan, legend and notes.
9. Site data, including acres in parks, etc.
10. Title, scale, north arrow and date.

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

****

PRELIMINARY SUBDIVISION PLAN PREPARED AFTER AGREEMENT ON SKETCH PLAN

EXHIBITS DATA SHEET 140

4/73

HUD-Wash., D.C.

4140.3

FINAL DEVELOPMENT PLANS

Final Development Plans show the final design for the location and improvement of street residential lots and other features in a proposed development. They usually include grading and drainage plans, utility plans, street improvement plans and plans for other neighborhood improvements.

The exhibits should clearly show all proposed improvements so that full consideration may be given to them in FHA valuations and mortgage insurance commitments. Skillful arrangement of improvements and their suitable adaptation to topography produce both substantial savings in construction costs and maximum values in the completed properties.

To avoid wasted effort, final development plans should be prepared by competent technicians, but only after the sponsor's Preliminary Subdivision Plan has been accepted both by FHA and by the local authorities.

If a development is large, the Final Development Plans should be prepared separately for each section as construction progresses, rather

****

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

Figure 1. NEIGHBORHOOD GRADING PLAN.

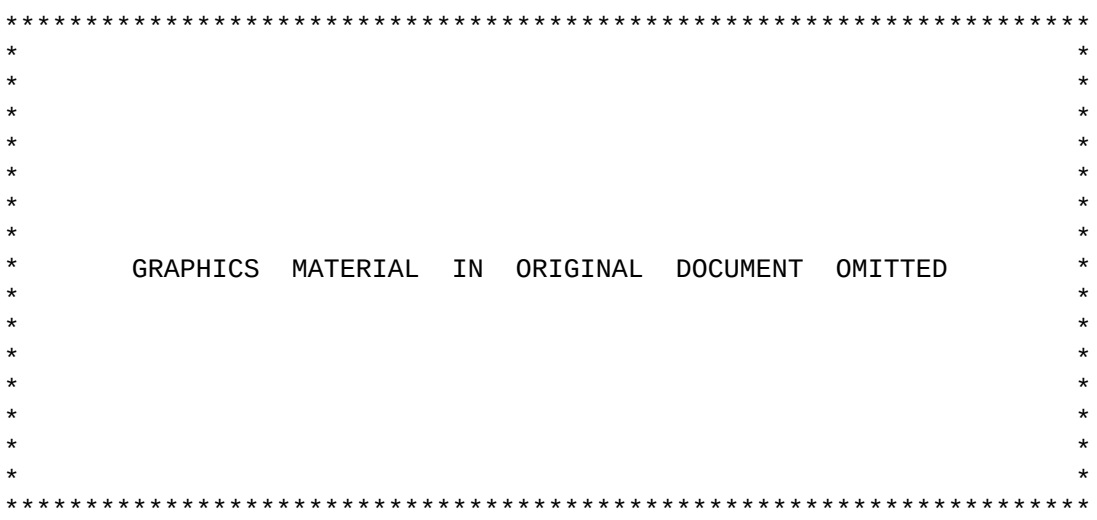


Figure 2. NEIGHBORHOOD DRAINAGE PLAN.

than for the entire development at one time. This eliminates unnecessary advance investment in detail plan work. Each successive section should have sufficient area and proper boundaries to provide street traffic circulation and satisfactory drainage without depending upon proposed future construction of other sections.

Portions of several sample plans are illustrated in this data sheet to suggest the manner in which required information can usually be shown satisfactorily. Other methods may be used if appropriate to a specific development. For example the data may be combined on fewer drawings, such as a single Neighborhood Grading and Drainage Plan instead of two separate exhibits (Figures 1 and 2). The illustrations moreover are not intended as required drafting techniques or as design standards.

The kind and extent of information to be shown on the Final Development Plans vary for different developments according to existing conditions and the characteristics of the development. The check list on page 4 is for selective use as appropriate for each development.

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

Figures 3 and 4.

MASTER PLOT PLAN (above) Showing Non-repetitive Data on Each Property. Repetitive Data needs to be Shown only Once, on the TYPICAL PLOT PLAN (right) for Each House Type. By Using A Master Plot Plan Together With Typical Plot Plans, the Required Data is Shown With a Minimum of Drafting.

CUSTOM BUILDING. Where land development is for individualized custom building, the developer's final development plans should show only the neighborhood improvements for which he is responsible. These are not only the off-lot improvements but also those on-lot improvements necessary to make each lot a buildable site independent of other lots. An example of the latter is rough grading of a block area to establish a workable pattern for surface drainage.

The required exhibits usually are a Neighborhood Grading Plan (Figure 1), a Neighborhood Drainage Plan, (Figure 2) and others in the check list, excluding the Master Plot Plan, Typical Plot Plan and Master Lot Grading Plan. The detailed improvement data on each individual property will be presented later by the lot buyer or custom builder, individually with each single application for mortgage insurance.

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

OPERATIVE BUILDING BY OTHERS. Where land development is for the sale of groups of lots to others for operative building, the land developer's final development plans are similar

to the above for custom building. For these developments, however, each operative builder furnishes for his own part of the development a Master Plot Plan (Figure 3). Typical Plot Plans (Figure 4) and Master Lot Grading Plans (Figure 5). These are furnished when he submits applications for mortgage insurance on a group of properties.

The Master Plot Plan and Master Lot Grading Plan show the relationship of the improvements on each individual lot to the street, and to adjoining properties. They permit each property to be studied and adjusted in relation to nearby properties to solve grading and drainage problems and to obtain a sound, attractive development. These master plans may be prepared by adding data directly on translucent prints of the original drawing of the accepted Preliminary Subdivision Plan, providing it is at an appropriate scale, generally no smaller than one inch equals fifty feet.

All information which is basically the same for each of a number of properties of a single type should be shown on a single Typical Plot Plan. However, special lot conditions will always require the preparation of individualized plot planning data either on the Master Plot Plan if its scale permits, or on an enlarged portion of the Master Plot Plan, or on Individual Plot Plans as required in the Minimum Property Standards.

DEVELOPMENT COMBINED WITH BUILDING. Where the same firm does both the land development and all the home-building in the tract, the data required on the final development plans is the same as outlined above for operative building by others. Since all is done by the same firm, however, the data may be prepared either on a series of drawings as indicated above, or on a single drawing as illustrated in Figure 6. The single Composite Development Plan is preferred because it is easier to prepare and analyze, and is more useful during construction and inspection. It needs to be at a relatively large scale.

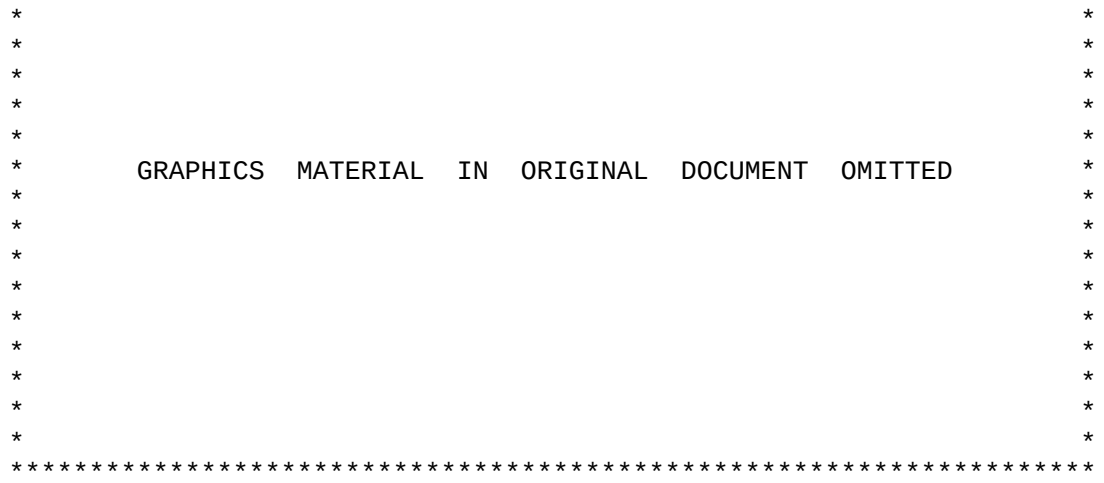


Figure 5. MASTER LOT GRADING PLAN.

SPECIAL TYPES. Where land development involves row housing, building on controlled fill or other special types of land conditions, treatment or use, the nature and extent of the final development plans may vary considerably from those listed and illustrated in this data sheet. For such developments, exhibit requirements should be discussed fully with the local FHA office before preparation of exhibits is begun.

4/73

HUD-Wash., D.C.

CHECK LIST FOR FINAL DEVELOPMENT PLANS

All exhibits should show the name and location of the development, the date of preparation or revision and, when appropriate, the scale, north point, datum and approval of local authorities. Drafts may be presented to FHA for comment before submittal to local public agencies for final approval.

A. Neighborhood Grading Plan.

1. Subdivision layout: data from the accepted Preliminary Subdivision Plan; include existing topography, street names, and lot numbers.
2. Proposed grading by contours or by spot elevations.

B. Neighborhood Drainage Plan.

1. Subdivision data as in A-1 above.
2. Storm sewer plans, profiles, design criteria and specifications.
3. Plans for disposal of subsurface water as needed.
4. Details and specifications for inlets, manholes, catch basins, headwalls and surface drainage channels.
5. Adjacent contributory drainage area: If adjacent land drains into, or is diverted around the development, show data on size of adjacent drainage area, and slope of land. For any proposed diversion system, show design flow computations and details.
6. Plans, profiles, cross-sections and details of off-site outfall drainage to a point where backwater will not affect subdivision.
7. Data on necessary easements.

C. Utility Plans

1. Water supply and sewage disposal.
   Public: exhibits which will enable the insuring office to determine that continuous satisfactory service will be provided.
   Community: complete construction plans and specifications, and details of the proposed maintenance organization.
   Individual: see par. 104 and Chapter XI of FHA Minimum Property Standards for One and Two living Units.

2. Street lighting: type and location.

D. Street Plans.

1. Plan and profile of each street.
2. Cross-section of each street type.
3. Details and specifications for pavement base and surfacing, curbs, etc.

E. Other Neighborhood Improvement Plans

1. Protective screening.
   Fences and walls: plan, details and specifications.
   Planting: plan for a typical 100 ft. length of screen planting; quantities, sizes, species and specifications.
2. Alleys, cross-walks, entranceways, park, etc.: plans, details and specifications.

F. Master Plot Plans, Typical Plot Plans and Master Lot Grading Plan.
   See FHA Minimum Property Standards for One

and Two Living Units (102, Drawings For Group Applications).

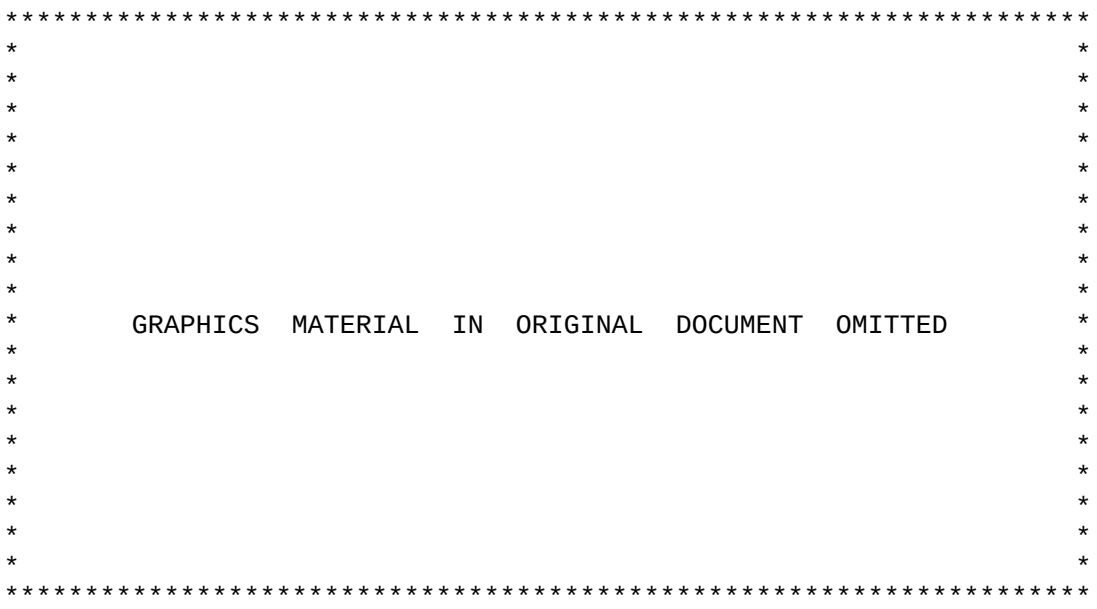


Figure 6. COMPOSITE DEVELOPMENT PLAN

SUBDIVISION PLAT

A subdivision plat, when properly prepared and filed in the public land records, establishes a legal description of the streets, residential lots and other sites in a residential development.

The plat should be prepared by a competent land surveyor or engineer. It should conform with a development plan which has previously been accepted by the FHA and approved by local authorities having jurisdiction.

The following check list of information to be shown on a subdivision plat should be used when and as indicated by the local FHA office.

1. Right-of-way lines of streets, easements and other rights-of-way, and property lines of residential lots and other sites, with accurate dimensions, bearings and curve data.
2. Name and right-of-way width of each street or other right-of-way.
3. Location, dimensions and purpose of any easements.
4. Number to identify each lot or site.
5. Purpose for which sites, other than residential lots, are dedicated or reserved.
6. Minimum building setback line on all lots and other sites.
7. Location and description of monuments.
8. Names of record owners of adjoining unplatted land.
9. Reference to recorded subdivision plats of adjoining platted land by record name, date and number.
10. Certification by surveyor or engineer.
11. Statement by owner dedicating streets, rights-of-way and any sites for public uses.
12. Approval by local authorities.
13. Title, scale, north arrow and date.

SUBDIVISION PLAT

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

HUD-Wash., D.C. 4/73

4140.3

HOUSING AND URBAN DEVELOPMENT
FEDERAL HOUSING ADMINISTRATION DATA SHEET SG-102

GENERAL GRADING

***

For residential developments in which HUD-FHA considers this type of improvement suitable, specifications and details which conform with local regulations and equal or exceed this specification may be used.

***

1. DESCRIPTION:

1.1 This item shall consist of necessary clearing and grubbing, removal of existing structures, excavating, filling, spreading and compacting the areas to be filled in accordance with these specifications and in conformity with the lines, grades, slopes and typical cross-sections shown on the accepted plans.

2. MATERIAL:

2.1 Material for the fill shall consist of material obtained from the excavation of banks, borrow pits or other approved sources. The material used shall be free from vegetable matter and other deleterious substances and shall not contain large rocks or lumps.

3. CONSTRUCTION METHODS

3.1 Grading Tolerance: Areas to be graded by cutting or filling shall be rough graded to within 0.2 of a foot of the accepted elevation after necessary allowance has been made for the thickness of topsoil, paved areas and other installations.

3.2 Stripping and Storing Topsoil: Where suitable topsoil exists on

areas to be disturbed by grading or building operations, the topsoil shall be stripped in the amount needed to complete finish grading operations, and shall be piled in convenient locations for storage during construction.

3.3 Clearing and Grubbing: All timber, logs, trees, brush, vegetable matter and other rubbish shall be removed, piled and burned or otherwise disposed of so as to leave the areas that have been disturbed with a neat and finished appearance.

3.4 Removal of Debris: All tree stumps, masonry and other obstructions shall be removed to a depth as follows:

For Paved Areas:	2'	Below Subgrade
For Lawn Areas:	2'	Below Finished Grade

(over)

solid rock, shale or other similar material shall be removed to a depth as follows.

For Paved Areas: 15" Below Subgrade
For Lawn Areas: 2' Below Finished Grade, except when it is impractical to remove rock outcropping.

3.5 Preparing Areas To Be Filled. In order to insure proper bond and prevent slipping between the original ground and the fill the surface of the original ground shall be scarified to a reasonable depth. Where fills are made on hillsides or slopes, the slope of the original ground upon which the fill is to be placed shall be plowed or scarified deeply. where the nature of the ground justifies taking greater precautions for binding the fill to the original ground, steps shall be cut into the original ground before filling is begun.

3.6 Placing, Spreading and Compacting Fill material: The selected fill material shall be placed in layers which when compacted shall not exceed 8 inches. Each layer shall be spread evenly and shall be thoroughly blade mixed during spreading to insure uniformity of material in each layer.

The moisture content of the fill material shall be such that the fill can be compacted to maximum practical density. If the moisture content of the fill material is below the needed amount necessary to create the necessary density the proper amount of water shall be added. Similarly if the moisture content of the fill material is above the needed amount necessary to create the desired density the fill material shall be aerated by blading or other satisfactory method until the moisture content of the fill material is satisfactory.

After each layer has been placed, mixed and evenly spread it shall be thoroughly compacted to maximum practical density. Compaction shall be by means of tamping or sheeps foot rollers, multiple-wheel pneumatic tired rollers or other types of rollers or equivalent which

will be able to compact the fill to the desired density. Rolling shall be accomplished while the fill material is at the desired moisture content. Rolling of each layer shall be continuous over its entire area and sufficient trips shall be made by the rolling equipment to insure that the desired maximum practical density has been obtained.

3.7 Completion of General Grading: Excavating of cut areas shall continue until these areas conform with the lines, grades, slopes and typical cross-sections shown on the accepted plans. Placing, spreading, filling and compating areas to be filled shall also be continued alternately until these areas conform with the lines, grades, slopes and typical cross-sections shown on the accepted plans.

4. SEASONAL LIMITS:

4.1 No fill material shall be placed, spread or rolled while the ground or fill is frozen or thawing or during unfavorable weather conditions. when the work is interrupted by heavy rain, fill operations shall not be resumed until the moisture content and density of the fill are as previously specified.

TREE PLANTING

For residential developments in which FHA considers this type of improvement suitable, specifications and details which conform with local regulations and equal or exceed this specification may be used.

1. DESCRIPTION:

1.1 Trees shall be true to name in accordance with the current issue of "Standardized Plant Names" published by the American Joint Committee on Horticultural Nomenclature, and shall be planted in accordance with these specifications as outlined below. Species, varieties, sizes and planting locations both on-site and off-site, shall be in accordance with accepted plans.

2. MATERIALS

2.1 Trees. Trees shall be in accordance with "American Standard for Nursery Stock" as published by the American Association of Nurseryman, Inc. For plants not covered by this Standard, Standards issued by an agency of State Government, if any, shall be used as a guide. Trees furnished shall be suitable to climate, exposure, soil conditions and intended use, be freshly dug and unless otherwise specified, nursery grown stock. They shall be well formed specimens with growth typical of the species and varieties named and be free from injurious insects and disease. All evergreen trees shall be balled and burlapped or well established in cans.

2.11 The root-ball, bare-root mass or container grown roots shall contain sufficient fibrous feeding roots to permit satisfactory growth after planting. When delivered all trees not to be immediately planted shall be protected from the sun, wind and freezing temperatures. Bare root trees shall be "puddled" and "heeled-in".

2.2 Soil for Planting Backfill. Soil acceptable to FHA, for back filling planting pus shall be fertile and be capable of supporting plant life. It shall be free from stones, lumps, weeds, debris and other material harmful to plant growth. Where required by FHA, and in all multifamily housing projects and townhouse-on-the-green planned-unit developments the soil can be tested by facilities located usually at the land grant college, or by a private soil chemical testing laboratory. Soil tests shall show soil type according the Unified Soil Classification System, reveal any deficiencies in plant food elements and organic matter, and any deficiency or excess in acidity or alkalinity. The soil shall be improved as recommended by the agency or as indicated by laboratory test.

2.3 Mulch. Mulching material shall consist of bark, peat moss, or well-rotted and unleached animal manures which shall contain not more than 20 percent straw or shavings. or similar extraneous material, or other locally acceptable material.

2.4 Stakes. Stakes shall be of a strong, durable material and after being driven into the ground shall be of sufficient height and cross-section to support the specified tree.

3. PLANTING METHODS

3.1 Planting Pits. Each tree pit shall have vertical sides, be 12 inches greater in diameter and 6 inches greater in depth than the specified burlapped tree root ball, container grown roots or bare root mass and be not less than 24 inches deep.

3.2 Planting. Prior to planting, not less than 6 inches of top soil to be used as backfill shall be placed in bottom of pit and compacted. Container, if not subject to decomposition during the guarantee period, shall be removed. Each tree shall be placed in vertical position in center of pit and set at same ground level in relation to finish grade as originally grown in the nursery. Twine and burlap on balled trees shall be freed from the top of the ball. The trees shall be planted by placing and working backfill soil around the root ball or bare roots until approximately 2/3 of backfill is completed. The planting shall then be thoroughly watered and the plant pit filled to finish grade with firmly tamped backfill soil.

3.3 Mulching. A 3 inch mound of soil shall be placed around outside edge of pit to form a shallow watering basin around tree. A 3 inch mulch shall be applied over basin surface and saturated with water.

3.4 Staking. All deciduous trees and large evergreen trees identified by FHA shall be supported with sufficient number of stakes to firmly hold the tree in a vertical position. Stakes shall be driven into ground to a minimum depth of 30 inches. Stakes shall not be driven through the tree root mass or ball. Each staked

tree shall be wired to the stake or stakes in a manner which will avoid damage to the tree trunk or branches and will not restrict its growth.

3.5 Pruning. Approximately 1/3 of the growth of large trees (those with 2 inch caliber or over) shall be pruned. Pruning shall remove superfluous branches, as well as those which cross and run parallel. The main leader of trees shall not be cut back. Branches shall be thinned out and not merely cut back. Long side branches, however, may he shortened. Trees that have been so badly pruned as to spoil their natural form shall be removed and replaced.

4. SEASONAL LIMITS

Planting shall be performed during the proper season and during favorable working conditions.

5. MAINTENANCE

Trees shall be watered, pruned, sprayed, weeded and protected until this work is provided by occupants of properties, local authorities, homes associations, project management, or others.

6. GUARANTEE

all trees shall be guaranteed for one full growing season, shall be true to name and size and be in a visible growing condition at the end of the guarantee period. Replacements shall be made at the beginning of the first succeeding planting season.

214850-P

HOUSING AND URBAN DEVELOPMENT
FEDERAL HOUSING ADMINISTRATION DATA SHEET SO-120

SHRUB PLANTING

For residential developments in which FHA considers that this type of improvement is suitable, specifications and details which conform with local regulations and equal or exceed this specification may be used.

1. DESCRIPTION

1.1 Shrubs shall be true to name in accordance with the current issue of "Standardized Plant Names", published by the American Joint Committee on Horticultural Nomenclature, and planted in accordance with specifications outlined below. Species, varieties, sizes and planting locations shall be in accordance with accepted plans. Shrubs shall include deciduous and evergreen shrubs, hedge plants, ground cover plants and vines.

2. MATERIALS

2.1 Shrubs. Shrubs shall be in accordance with "American Standard for Nursery Stock" as published by the American Association of Nurserymen, Inc. For plants not covered by this Standard,

Standards issued by an agency of State Government, if any, shall be used as a guide. Shrubs furnished shall be suitable to climate, exposure, soil conditions and intended use, be freshly dug and unless otherwise specified, shall be nursery grown stock. They shall be well formed specimens with growth typical of the species and varieties named, be undamaged, and be free from injurious insects and disease. All evergreens shall be balled and burlapped or well established in cans.

2.2 The root-ball, bare root mass or container grown roots shall contain sufficient fibrous feeding roots to permit satisfactory growth after planting. When delivered, all shrubs not to be immediately planted shall be protected from the sun, wind and freezing temperatures. Bare root shrubs shall be "puddled" and "heeled-in".

2.3 Soil for Planting Backfill. Soil acceptable to FHA, for back filling planting pits shall be fertile and be capable of supporting plant life. It shall be free from stones, lumps, weeds, debris and other material harmful to plant growth. Soil can be tested by facilities located usually at the land grant college, or by a private soil chemical testing laboratory. Soil tests shall show soil type according to the Unified Soil Classification System, reveal any deficiencies in plant food elements and organic matter, and any deficiency or excess in acidity or alkalinity. The soil shall be improved as recommended by the agency or as indicated by laboratory test. Backfill soil used for acid loving plants shall be improved with such materials as oak leaf mold, peat moss, rotted sawdust or finely ground sphagnum moss, sufficient quantities of the selected materials being added and mixed with the backfill soil to produce a degree of acidity within a pH range of 4.5 to 5.5.

2.4 Mulch. Mulch material shall consist of bark, peat moss or well-rotted unleached manure containing no more than 20% straw, shavings or similar extraneous material, or other locally acceptable mulch material.

3. PLANTING METHODS

3.1 Planting Pits and Beds. Excavations for pits shall have approximately vertical sides. For all shrub planting the diameter of pits shall be at least 1-1/2 times the spread of the roots, top soil ball mass or container. Excavation for planting beds shall have approximately vertical sides and be of the size and shape as shown on the accepted planting plans. Otherwise, the beds shall provide no less than a 6 inch clearance between the top soil root ball or bare root mass of the plant and the edge of the bed. Depth of the planting pits or beds shall be no less than 6 inches greater than the depth of the root system, the specified depth of the burlapped shrub ball or container but not less than 15 inches.

3.2 Prior to planting not less than 6 inches of appropriate backfill soil shall be compacted in the bottom of the pits or beds. Each plant shall be placed in an upright position and set at the same ground level in relation to the finished grade as originally grown in the nursery. Twine and burlap on balled plants shall be freed from the top of the ball but need not be removed. Cans shall be

removed. The shrubs shall be planted by placing and working the appropriate non-acid or acid type top soil around the root ball or bare roots until approximately 2/3 of backfill is completed. The planting shall then be thoroughly watered and backfill completed to finished grade and firmly tamped.

3.3 Mulching. After planting has been completed, a sound of soil at least 2 inches high shall be found around the outside edge of the plant pits and beds to create a shallow watering basin. Soil between and around plants shall be raked smooth and the beds neatly edged. A 2 inch layer of mulch shall be applied over the entire surface of the pit or bed and saturated with water.

3.4 Pruning. Approximately 1/3 of the twigs of bare root deciduous shrubs shall be removed by pruning damaged or undesirable branches, or as necessary to balance the root system. Pruning shall be done in a manner to preserve the natural shape and characteristics of the shrubs. Generally, evergreens shall not be pruned except to remove dead or injured branches.

4. SEASONAL LIMITS

Planting shall be performed during the proper season during favorable working conditions.

5. MAINTENANCE

Shrubs, including vine and ground cover plantings shall be watered, cultivated and weeded as necessary until work is provided by occupants of properties, local authorities, homes associations, project management, or others.

6. GUARANTEE

all shrubs, vines and ground cover shall be guaranteed to be true to name and size and to be invigorous growing condition. All plants shall be guaranteed for one full growing season. Replacements for dead plants shall be made at the beginning of the first succeeding growing season.

214850-P

HOUSING AND URBAN DEVELOPMENT
FEDERAL HOUSING ADMINISTRATION DATA SHEET SP-101

GRASS SEEDING

For residential developments in which FHA considers that this type of improvement is suitable, specifications and details which conform with local regulations and equal or exceed this may be used.

PART A - SEEDING PRIMARY LAWN AREAS

1. DESCRIPTION

1.1 Work shall consist of the preparation of an acceptable seed bed on ground which has been finish graded. Seed is then sown in

accordance with these specifications in areas designated on the FHA accepted drawings.

2. MATERIALS

2.1 Top Soil. The top layer of seed bed soil physically identified either as existing soil, soil initially stripped, and respread, or soil imported to the site, shall be fertile and capable of improvement to permit a normal growth of grass. It shall be free of extraneous materials harmful to plant growth. Where required by FHA, and in all multifamily housing projects and townhouse-on-the-green planned-unit developments the soil can be tested by facilities located usually at the land grant college, or by a private soil chemical testing laboratory. Soil tests shall show soil type according to the Unified Soil Classification System, reveal any deficiencies in plant food elements and organic matter, and any deficiency or excess in acidity or alkalinity. The soil shall be improved as recommended by the agency or as indicated by laboratory test.

2.2 Seed. Seed shall not exceed one percent weed content and shall be fresh, clean, new crop seed meeting the minimum percentages of purity and germination in Table I.

2.2-1 Seed mixtures shall be composed of varieties of seed mixed in proportion by weight in accordance with Table II and Table II-A. If the seed is mixed by the dealer, each bag of seed delivered to the project site shall be accompanied by a certification stating the composition of the mixture and percentage of purity and germination of each variety. If seed is to be mixed at the site, it shall be delivered to the project site in the original packages bearing the producer's certification of germination and purity.

2.3 Organic Matter. These materials shall consist of peat moss, compost, sawdust, bark, wood shavings, activated sludge, straw or animal manures.

2.4 Lime and Fertilizer. These materials shall consist of commercial quality ground limestone and commercial chemical fertilizer containing stated ratios of nitrogen, phosphorus and potash. Where specified, the latter shall be transported and stored in containers to insure proper protection and handling.

TABLE I GRASS SEED

VARIETY OF GRASS	PURITY	GERMINATION
Kent Blue Grass	85	80
Chewings Fescue	97	80
Red Top	92	90
White Clover	96	90
Red Fescue	97	80
Bent Grass	95	90

Bermuda (Hulled)-c/	97	85
Centipede	97	70

c/ See Map No. 3

TABLE II SEED MIXTURES
Proportions by Weight

VARIETY OF MIXTURE	BLUE GRASS FESCUE a/	SHADY MIX a/	BLUE GRASS BENT b/
Kent Blue Grass	10	6	10
Chewings Fescue	6	0	0
Red Top	2	0	1
White Clover	1	0	1
Red Fescue	0	4	
Bent Grass	0	0	7

a/ See Map No. 1 b/ See Map No. 2

TABLE II-A
(for poor sandy soil or extremely acid soil)

VARIETY OF MIXTURE a/	PROPORTION OF PERCENTAGE
Chewing Red Fescue	35%
Red Top (recleaned)	20%
Colonia Bent	15%
Kentucky Bluegrass	10%
Rye Grass	15%
White Clover	5%

a/ See Map No. 1

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

Map No. 1 Blue Grass - Fescue Mixture

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

Map No. 2 Blue Grass - Bent Mixture

GRAPHICS MATERIAL IN ORIGINAL DOCUMENT OMITTED

Map No. 3 Bermuda Grass

3. PLANTING METHODS

3.1 Finish Grading. All areas which have been regraded or stripped of top soil shall be scarified, leveled and brought to an accurate subgrade. Stripped top sail or top soil imported for the seed bed shall be spread after subsoil fills are properly compacted, meeting the approved finish grade and shall be at least 4 inches deep when compacted.

3.2 Preparation of Seed Bed. Where existing undisturbed top soil is satisfactory the seed bed shall be prepared by plowing or scarifying to a depth of at least 4 inches, than harrowing and/or dragging thoroughly to smooth the surface. Where FHA has determined the top soil needs improvement to be used as a seed bed, based on tests, either organic materials or chemical fertilizers or

both such materials shall be evenly distributed and mixed into the seed bed at rates specified by the state or county agricultural agency or by the private soil chemistry testing laboratory making the soil tests. Slopes steeper than 3 o 1 (three feet horizontal to one foot vertical) shall be sodded or treated by an acceptable alternative to sodding to prevent erosion of the finish grade or ground surface. Improved top soil shall be harrowed or dragged to form a smooth seed bed.

3.3 Seeding. The prepared seed bed shall be furrowed lightly with a rake, seed sown at the rate designated in Table III, then rolled with a hand or mechanical roller not exceeding 100 pounds of weight per foot of width. All seeded areas shall be sprinkled with a fine spray to avoid runoff of water, and be adequately protected from foot or vehicular traffic during the period grass is being established.

TABLE III RATE OF SEEDING

VARIETY OF MIXTURE	POUNDS PER 1000 SQ. FT.
Blue Grass Fescue	4
Shady Mixture	4
Blue Grass Bout	4
Bermuda (Hulled)	3
Centipede	1/2

4. MAINTENANCE

4.1 All seeded areas shall be watered and maintained until a thick stand of grass is established. After three to four weeks of favorable growing weather, bare spots shall be recultivated, reseeded, raked and rolled as in the original work. Maintenance by the developer shall continue until this work is provided by occupants of properties, local authorities, homes associations, project management, or others.

5. SEASONAL LIMITS

Seeding shall be done during the proper season when the soil is frost-free, and during favorable working conditions.

PART B - SEEDING SECONDARY LAWN AREAS

1. DESCRIPTION

1.1 Treatment shall consist of seeding open spaces which will be maintained as meadows or naturalistic portions of the project. These are areas where the appearance of a typical front lawn quality of grass is of secondary importance to the project. For

those open spaces designated as secondary lawns on the FHA accepted plans, the following shall apply.

2. OPEN AREAS

2.1 Open areas not supporting an established ground cover (excluding unplanted slopes steeper than 3 to 1) and which are subject to erosion, shall be plowed, scarified or otherwise loosened to a minimum depth of 3 inches. These areas shall be seeded with a meadow grass seed or other suitable grass seed mixture to be approved or specified by the local insuring office. This grass seed mixture shall be sown at the rate of not less than 100 pounds per acre. The surface of the grassed area should be sufficiently smooth to permit tractor mowing. Slopes exceeding 3 to 1, as well as banks and areas containing natural rock formations, say also be planted in grass where appropriate or with other locally accepted material such as soil fixing vines or shrubs. Stumps shall generally be cut flush with the ground in all secondary lawn areas designated on the FHA accepted plans.

3. WOODED AREAS

3.1 Undergrowth consisting of suitable ground covers, shrubbery and small trees shall be protected and maintained in non-use areas and where the maintenance of a grass turf in not considered essential to the property.

3.2 Undergrowth consisting of dead trees and ground debris shall be removed. Poisonous plants shall be destroyed. Stumps may remain provided they ore no more than 12" above the ground.

NOTE: These specifications are generally adapted to the areas cross-hatched on the maps included herein, and are suitable for lawn areas having average sunshine and moisture.

HUD-Wash., D.C. 4/73

HOUSING AND URBAN DEVELOPMENT
FEDERAL HOUSING ADMINISTRATION DATA SHEET SP-301

SODDING, SPOT SODDING AND SPRIGGING

For residential developments in which FHA considers that this type of improvement is suitable, specifications and details which conform with local regulations and equal or exceed this may be used.

1. DESCRIPTION

1.1 Work shall consist of the preparation of an acceptable planting bed for grass on ground which has been finished graded. Grass, in the form of sod, spot sod or sprigs shall be installed in accordance

with these specifications in areas designated on the FHA accepted drawings.

2. MATERIALS

2.1 Top Soil. The top layer of seed bed soil physically identified either as existing soil, soil initially stripped, and respread, or soil imported to the site, shall be fertile and capable of improvement to permit a normal growth of grass. It shall be free of extraneous materials harmful to plant growth. Where required by FHA, and in all multifamily housing projects and townhouse-on-the-green planned-unit developments the soil can be tested by facilities located usually at the land grant college, or by a private soil chemical testing laboratory. Soil tests shall show soil type according to the Unified Soil Classification System, reveal any deficiencies in plant food elements and organic matter, and any deficiency or excess in acidity or alkalinity. The soil shall be improved as recommended by the agency or as indicated by laboratory test.

2.2 Lawn Sod. Sod shall be freshly cut and of good quality taken from open ground of a well established lawn or from a well cared-for pasture. It shall be free of obnoxious weeds and coarse grasses, and shall be approved by FHA before laying. Sod that has been stocked or rolled for a long period so that it is bleached or dried out constitutes unacceptable materials. Sod shall be cut from 1-1/4 to 1-3/4 inches thick in strips with straight sides and square ends, preferably 15 inches wide and from 36 to 60 inches long.

2.3 Spot Sod. Spot sod shall be obtained from cultivated and maintained fields. Sod shall be freshly dug, free of obnoxious weeds and coarse grasses and shall be live, vigorous and uninjured at time of planting. Tufts of sod shall have a thickly matted root system and shall be at least two inches square and 1-1/2 inches thick, and shall be protected from drying out and freezing prior to planting.

2.4 Sprigs. Sprigs or small tufts of sod shall be freshly dug, live, vigorous and uninjured at time of planting. They shall be free of obnoxious weeds and coarse grasses. Sprigs or tufts shall have well formed and developed root systems. Sprigs shall be protected from drying out and freezing prior to planting.

2.5 Organic Matter. Materials shall consist of peat moss, compost, saw-dust, bark, wood shavings, activated sludge, straw or animal manures.

2.6 Lime and Fertilizer. Material shall consist of commercial quality ground limestone and commercial chemical fertilizer containing stated ratios of nitrogen, phosphorus and potash.

3. PLANTING METHODS

3.1 Finish Grading. All areas which have been regraded or stripped of top soil shall be scarified, leveled and brought to an accurate subgrade. Stripped top soil or top soil imported for the plant bed shall be spread after subsoil fills are properly compacted meeting

the approved finish grade, and shall be at least 4 inches deep, when compacted, with allowance being made for the thickness of sod.

3.2 Preparation of the Plant Bed. Except on slopes exceeding 3 to 1 (three feet horizontal to one foot vertical) the top soil prepared as a seed bed shall be plowed or scarified to a depth of not less than 4 inches or, in the case of applying sod, 4 inches less the thickness of the sod, then harrowed and dragged to produce a smooth surface. In sodded areas the surface shall be approximately 1-1/4 inches below the approved finished grade. On slopes exceeding 3 to 1 the surface shall be scarified only to the extent of providing a bond between the sod and the bank face. After harrowing and dragging the top soil, the ground shall be raked to provide a clean even surface. Where the soil is dry it shall be thoroughly dampened the night before the grass is laid.

3.3 Sod. Sod shall be laid horizontal to the slope, paralleling the contours, starting at the lower elevations and proceeding upward. Joints shall be tight and the sod immediately lightly tamped or rolled in place. If the sodded surface is still rough and has open joints it shall be leveled by the addition of sufficient quantities of sifted top soil to produce a smooth surface. Areas thus treated shall then be seeded and rolled. The sod shall be watered as soon as it is in place. Sod on slopes exceeding 2 to 1 (two feet horizontal to one foot vertical) shall be securely pegged with 1-1/2 inches square pegs, 12 inches long, and spaced 24 inches on center, driven flush with the top of the sod.

3.4 Spot Sod. Furrows or rows of holes approximately 2 inches deep and spaced not greater than 12 inches apart shall be opened on approximate contour lines. Spot sod shall be placed in the furrows or holes, roots downward and spaced not greater than 12 inches on center, then recovered with top soil, leaving the grass exposed.

3.5 Sprigs. Furrows spaced not less than 8 inches apart and approximately 3/4 inch deep shall be opened on approximate contour lines. Sprigs shall be distributed in furrows, with spacing between sprigs not to exceed 8 inches, immediately covered with a light layer of soil and lightly rolled.

4. MAINTENANCE

All newly planted areas shall be thoroughly sprinkled with fine spray to avoid runoff of water. Thereafter, they shall be watered, replanted and maintained as necessary until possession is taken by mortgagor, or maintenance is provided by local authorities, homes associations, project management or others.

5. SEASONAL LIMITS

Sodding, spot sodding or sprigging shall be done during the proper season when the soil is frost free and during favorable working conditions.

214850-P

APPENDIX B

HUD DATA SHEET 72

BLOCK AND LOT GRADING

Proper grading is an important element in preventing wet basements, damp crawl spaces, eroding banks, muddy yards and overflowing septic tank systems. It also eliminates costly corrective work such as retaining walls, regrading operations and extra drainage pipe lines. To obtain such construction savings and property betterments requires know-how both by the builder's planners who determine the key grade elevations and by his superintendent and grading foreman out on the job.

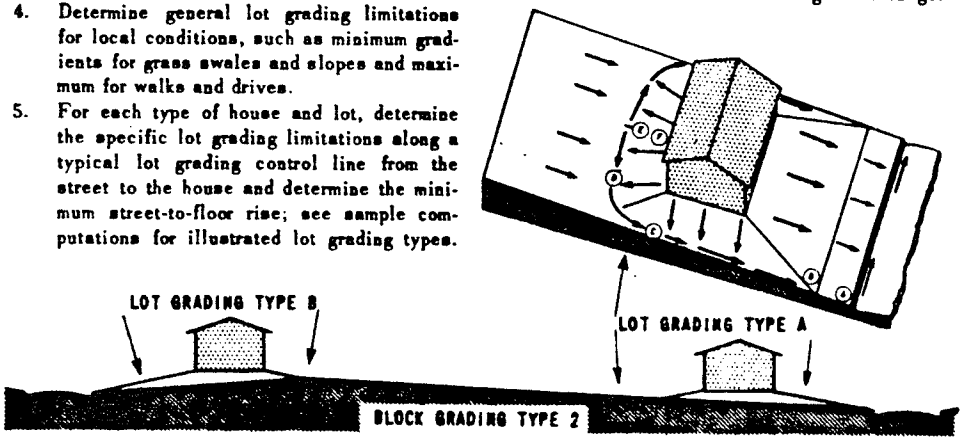
Planning and execution of good grading involve certain basic steps pertaining to street layout, block grading and lot grading. The objective is to establish the street grades, floor elevations and lot grades in proper relation to each other and to existing topography, considering property protection, appeal and use.

STEPS FOR THE BUILDER'S PLANNERS

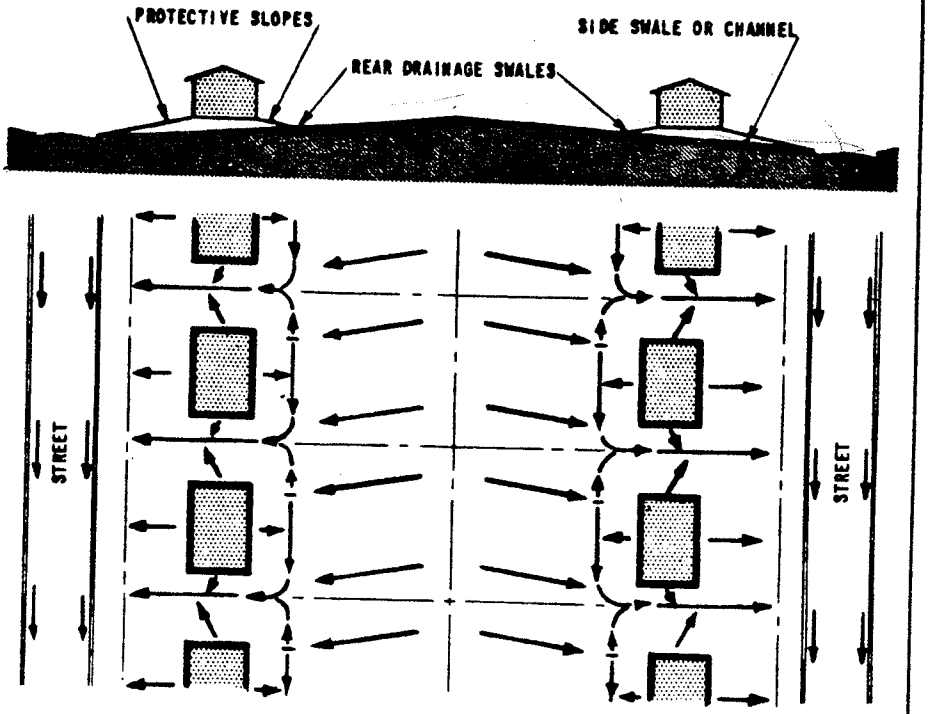
1. If the street layout is still subject to design or adjustment, fit it to the topography to obtain the most favorable types of block and lot grading which are compatible with other objectives.
2. Determine type of block grading for each block or portion of a block and indicate the lot grading type for each lot by identifying letter or drainage arrows.
3. Determine any easements and other provisions needed for satisfactory block drainage and erosion control.
4. Determine general lot grading limitations for local conditions, such as minimum gradients for grass swales and slopes and maximum for walks and drives.
5. For each type of house and lot, determine the specific lot grading limitations along a typical lot grading control line from the street to the house and determine the minimum street-to-floor rise; see sample computations for illustrated lot grading types.
6. If the street profiles are to be designed or adjusted, establish them so as to facilitate the provision of good drainage for both the lots and the streets, giving due consideration to existing topography and the lot limitations determined in 4 and 5 above.
7. For each property, determine proposed elevations for key points on the lot and for the dwelling floor, giving due consideration to street elevations, existing topography and the lot grading limitations determined in 4 and 5 above.
8. Discuss the objectives of the grading plans with the job superintendent and grading foreman.

STEPS FOR THE MAN ON THE JOB

1. Become familiar with the various grading types shown in this data sheet in order to create their essential features on the ground.
2. Follow your job grading plans and the suggestions of the builder's planner.
3. Set floor elevations only as shown on accepted drawings.
4. Complete all rough grading as soon as practicable to subgrades needed for final grading. This provides better drainage during construction operations.
5. Before topsoiling and finish grading each lot, set grade stakes at key points as needed (see illustrations), true-up the subgrades and check the entire lot for good drainage.



DETERMINE THE TYPE OF BLOCK CROSS-SECTION, THEN TYPE OF LOT GRADING, THEN GRADING DETAILS



BLOCK GRADING TYPE 1: RIDGE ALONG REAR LOT LINES

BLOCK GRADING TYPES

Block Grading Type 1 has a ridge along rear lot lines and each lot is graded to drain surface water directly to the street independent of other properties. It is the most simple and desirable type of block grading. Topography, however, will often require other block grading types.

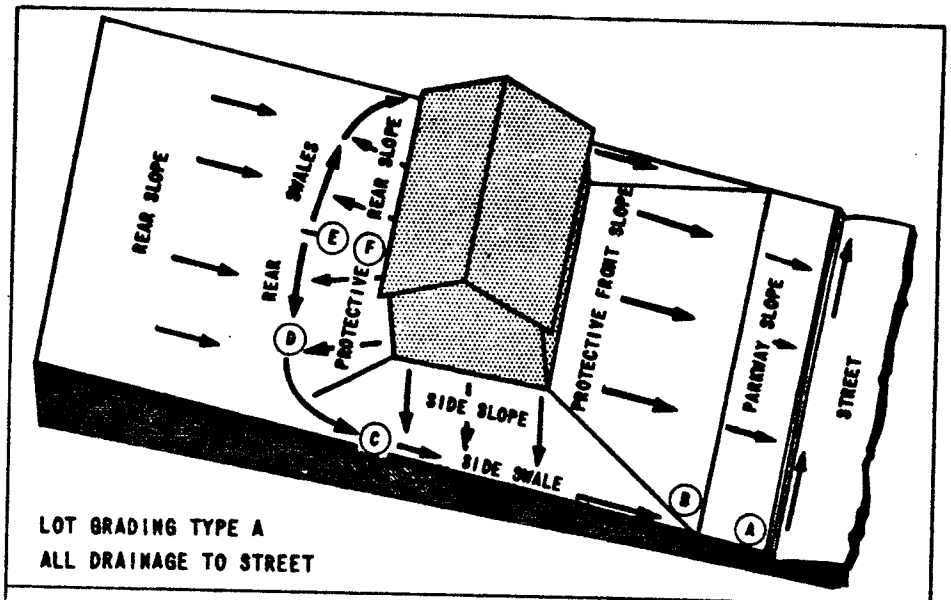
Block Grading Type 2 for a gentle cross-slope involves drainage of some surface water from lots of the high side of the block across the lower tier of lots. Difficulties are not encountered, however, if slopes are gentle and if the water always drains over short routes to the streets and does not concentrate or accumulate in volume at any point inside the block.

Block Grading Type 3 for steep cross-slopes and Type 4 for a valley along rear lot lines require special provision for block drainage and erosion control.

Erosion is controlled by provision of intercepting drainage swales in easements at the top of the rear lot incline or at intermediate locations along it, and by treatment of the steep slope itself.

Drainage easements in Block Types 3 and 4 must have alignment, width and improvements appropriate for the expected use and maintenance. Assurance of permanent and adequate outfall is essential. The easements must be permanently

HUD-Wash., D.C.



LOT GRADING TYPE A
ALL DRAINAGE TO STREET

SAMPLE COMPUTATION OF GRADING CONTROL LINE A-F FOR A 60' LOT ON AN 0.5% STREET, WITH 28' SETBACK, 28' BUILDING DEPTH AND 2% SWALES			RESULTS USING 1% SWALES	
A	Curb-top on lot-line extension at high lot corner			
A-B	Parkway slope: 12' grass and walk at ¼"/ft. (2%) . . .	3" (0.3')		3" (0.3')
B-C	Side swale: 56' grass at ¼"/ft. (2%)	14" (1.2')		7" (0.6')
C-D	Swale turn with 10' radius: 16' grass at ¼"/ft. . . .	4" (0.3')		2" (0.2')
D-E**	Rear swale: 13' grass at ¼"/ft. (2%)	3" (0.3')		1" (0.1')
E-F*	Protective rear slope at least from [illegible] swale . .	3" (0.3')		3" (0.3')
Sub-total A-F from curb-top to ground at rear bldg. wall		27" (2.3')		16" (1.4')
Minimum rise from curb-top to slab-floor: 27" + 8"		35" (2.9')		24" (2.0')
Minimum rise for wood-floor using 8" joists: 27" + 19"		46" (3.8')		35" (2.9')

* Where there is a high bank nearby or a long slope toward house, a minimum 6" protective slope is required.

** Length D-E = ½ [lot width - (2 x swale turn radius) - (lot width x street gradient ÷ swale gradient)]

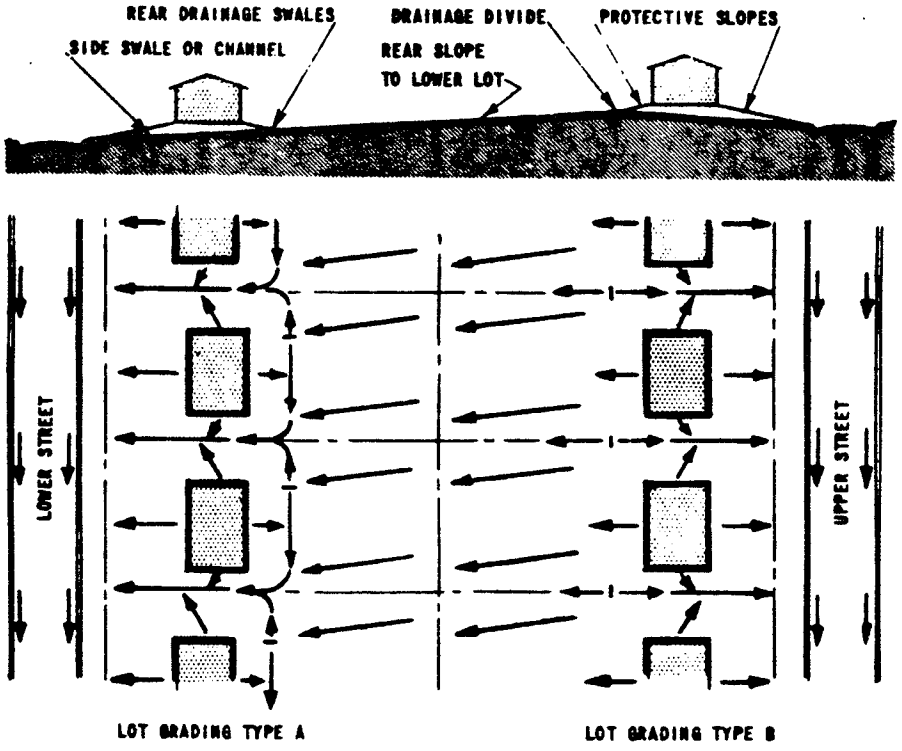
established by proper legal methods, with continuous maintenance assured by public authority, property-owners' association or individual owners, as appropriate to the situation. Walls, buildings and any other obstructions to drainage flow, such as dense planting or tight fencing, must be legally prohibited in the easement area.

LOT GRADING TYPES

Protective slopes away from all sides of all buildings are essential elements of all lot grading types (see drawings). Their purpose is to drain roof water and other surface water away from all building walls and backfilled areas. Where such a protective slope meets a slope which drains towards the building, a drainage swale of adequate width, depth and longitudinal gradient is necessary to carry away the surface water without flooding against buildings or ponding any lot areas.

The location of these swales is directly related to the block grading type which, as shown in the block diagrams, actually determines the lot grading type.

In Lot Grading Type A (see drawing), rear swales behind the house carry surface water from the rear yard to side-yard swales which carry it to the street for disposal through the street gutters and the public storm drainage system.



BLOCK GRADING TYPE 2: GENTLE CROSS-SLOPE

For Lot Grading Type B which drains both to the street and to the rear lot line, only side-yard swales are needed. They should extend back of the line of the rear building wall; then splash blocks from rear roof downspouts should be placed to direct roof water to the side swales for drainage directly to the abutting street. Thus the amount of water carried on the rear slope to easements or other properties is kept as small as possible. This reduces erosion and disposal problems.

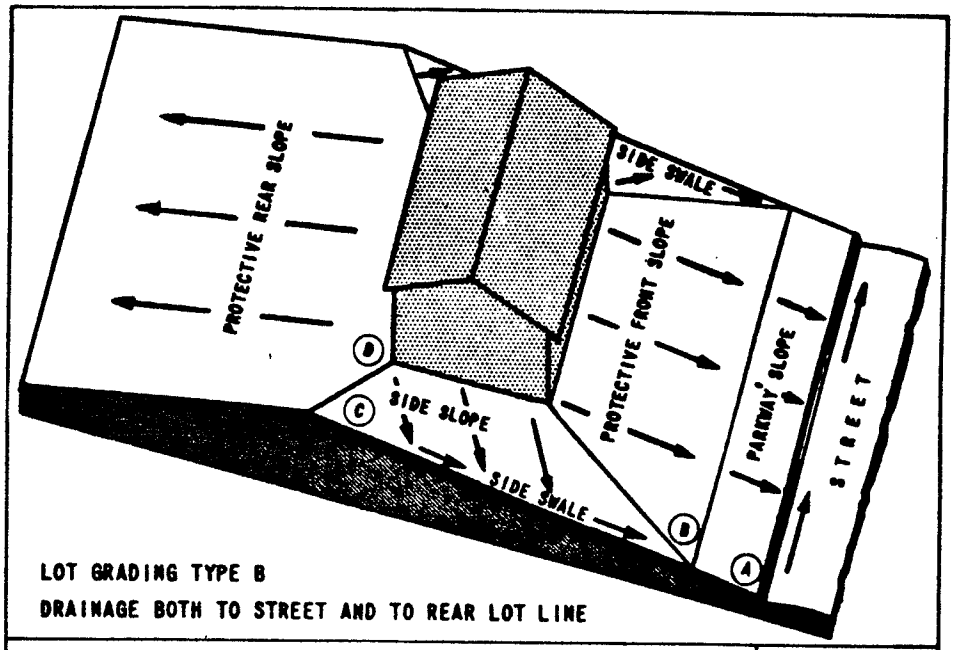
In Lot Grading Type C draining entirely to the rear lot line, front swales are essential to carry surface water from the front yard to side-yard swales which carry it to the rear for disposal in easements or across other properties. Proper cross-section of the street gutter, curb and parkway strip are essential to stop street water from flowing onto the lot.

Easements and erosion involving Lot Types B and C are discussed above with Block Grading Types 3 and 4.

For lots with steep cross-slopes due to street gradients, similar lot grading types are used, the lot cross-slopes being taken up by walls or steep slopes along side lot lines or by changing grade levels along the front and rear house walls.

Where high slopes occur along side or rear lot

HUD-Wash., D.C.



LOT GRADING TYPE B

DRAINAGE BOTH TO STREET AND TO REAR LOT LINE

SAMPLE COMPUTATION OF GRADING CONTROL LINE A-D FOR A 60' LOT WITH 28' SETBACK, 28' BUILDING DEPTH AND 2% SWALES			RESULTS USING 1% SWALES	
A	Curb-top on lot-line extension at high lot corner			
A-B	Parkway slope: 12' grass and walk at ¼"/ft. (2%) . . .	3" (0.3')	3"	(0.3')
B-C	Side swale: 56' grass at ¼"/ft. (2%).	14" (1.2')	7"	(0.6')
C-D*	Protective side slope at extension of rear wall . . .	3" (0.3')	3"	(0.3')
Sub-total A-D from curb-top to ground at rear bldg. wall . . .		20" (1.7')	13"	(1.1')
Minimum rise from curb-top to slab floor: 20" + 8"		28" (2.3')	21"	(1.8')
Minimum rise for wood floor using 8" joists: 20" + 19" . . .		39" (3.2')	32"	(2.7')

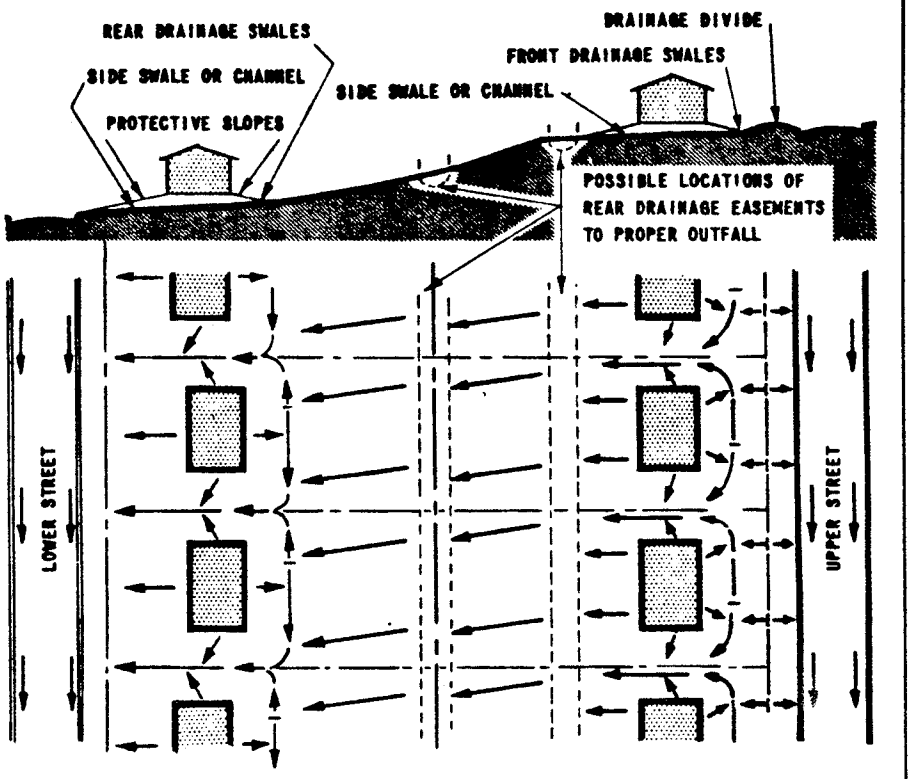
* Where there is a high bank nearby or a long slope toward house, a minimum 6" protective slope is required.

lines, the lot line if possible should be located at the top of the slope. The appearance of the slope and any erosion from it directly affects the property below. That owner therefore is more interested in owning, stabilizing and maintaining the slope than is the owner of the property above whose outlook is over and beyond it.

LOT GRADING CONTROL LINE

The single most important grade relationship for proper lot grading and drainage, is house floor elevation in relation to street elevation. If the floor elevation is too low in relation to adjoining street grades, adequate protective slopes and drainage swales cannot be provided to drain the lot satisfactorily. If the floor elevation is too high, unnecessary terracing, expensive outside stairs and awkward appearance will result.

Proper floor elevation and lot grades for any lot can be obtained by establishing on plans and on the ground a lot grading control line appropriate for the specific property. The line is located differently for each lot grading type as shown by the circles lettered "A", "B", "C", etc. in the accompanying lot diagrams. Each control line starts at the top of the street curb near the indicated high or low lot corner and ends at the



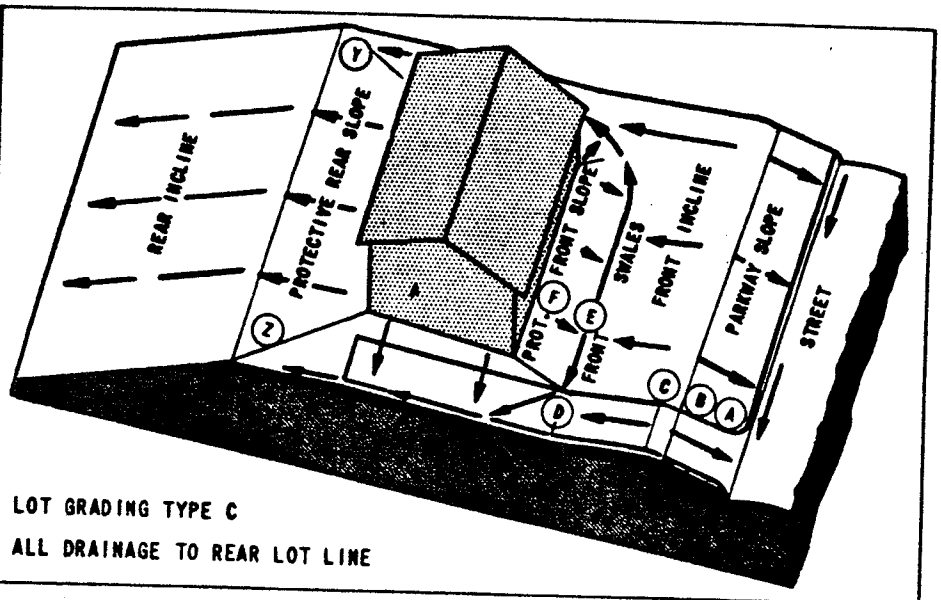
BLOCK GRADING TYPE 3: STEEP CROSS-SLOPE

point along the house wall where the outside finish grade controls the floor elevation. In the case of no street curbs, the starting point and elevation should be the normal curb location and the street center-line elevation.

The minimum street-to-floor rise for any lot is found by adding and subtracting the required rises and permitted falls along the lot grading control line for the property. The method is illustrated by the sample computation accompanying each of the three lot grading diagrams. For actual building operations, the relationship should be figured out specifically for each lot or group of typical lots because such factors as building setback, building depth, lot width and swale gradient may change the relationship considerably.

Minimum gradients for grass swales and other unpaved areas depend upon practical limits on precision in grading and maintaining land surfaces and upon the capacity of the ground to percolate water held back by surface texture and depressions. A gradient of 1/4 inch-per-foot (2%) is a practical minimum in areas subject to ground frost. Flatter gradients are usable, however, where the supplementary ground percolation at all seasons is adequate to prevent any prolonged saturation of soil or standing water. For example, 1/8 inch per foot (1%) is satisfactory on

HUD-Wash., D.C.



LOT GRADING TYPE C

ALL DRAINAGE TO REAR LOT LINE

SAMPLE COMPUTATION OF GRADING CONTROL LINE A-F FOR A 60' LOT, 28' SETBACK, 13.5% DRIVEWAY, and 16' FRONT SWALE D-E AT 2%			RESULTS USING 1% SWALES	
A	Curb-top at high side of drive near low lot corner			
A-B	Parkway slope: 12' grass and walk at ¼"/ft. (2%)	3" (0.3')		3" (0.3')
B-C	Driveway grade change: 4' vertical curve from up-grade drive in street to down-grade drive outlet	0" (0.0')		0" (0.0')
C-D	Driveway down-grade to point 28' from curb, 28' at 13.5%	-23" (-1.9')		-23" (-1.9')
D-E	Front swale: 16' at 2%	4" (0.3')		2" (0.2')
E-F*	Protective front slope up from high-point of swales	3" (0.3')		3" (0.3')
Sub-total A-F from curb-top to ground at building		-13" (-1.1')		-15" (-1.2')
Minimum fall from curb-top to slab floor; - 13" + 8"		-5" (-0.4')		-7" (-0.6')
Minimum rise for wood floor using 8" joists: -13" + 19" +		6" (0.5')		+4" (+0.3')

* Where there is a high bank nearby or a long slope toward house, a minimum 6" protective slope is required.

sandy well - drained soils in areas not subject to ground frost.

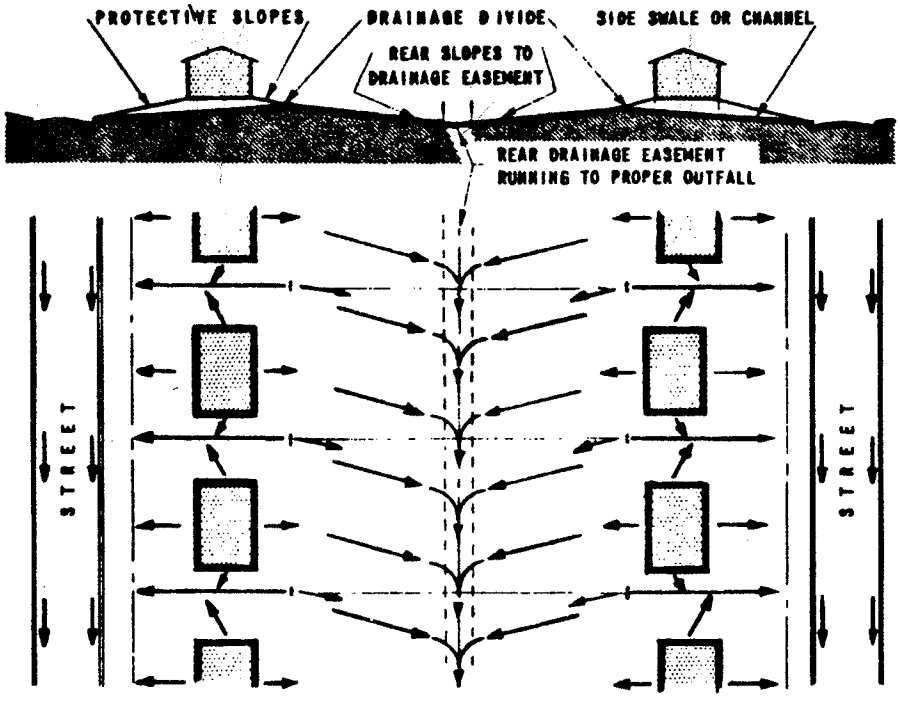
General limitations for protective slopes around buildings and for other elements affecting the lot grading control line are outlined in Section 1200 of FHA Minimum Property Standards. If necessary the control line sometimes may be flattened satisfactorily by special methods, such as using a paved driveway as a side-yard drainage channel at 1/16 inch per foot (½%) instead of a grass swale at 1/4 inch per foot (2%).

Floor elevation in relation to outside finish grade must be high enough to protect wood construction from moisture and insects. With 8" minimum from ground to wood sill, the minimum ground-to-floor rise is as follows for typical construction:

Concrete slab on ground: . . . . 8" (0.7')
Wood floor framing, 8" joists: . 19" (1.6')
Wood floor framing, 10" joists: . 21" (1.8')

For Lot Grading Type C which drains away from the street, the lowest floor elevation in relation to street grade is also affected by maximum driveway gradient and by local custom and acceptance of properties below the grade of the abutting street.

It should also be recognized that there are other lot grading types not illustrated here; each will have its own grading control line which will govern its minimum street-to-floor rise.



BLOCK GRADING TYPE 4: VALLEY ALONG REAR LOT LINES

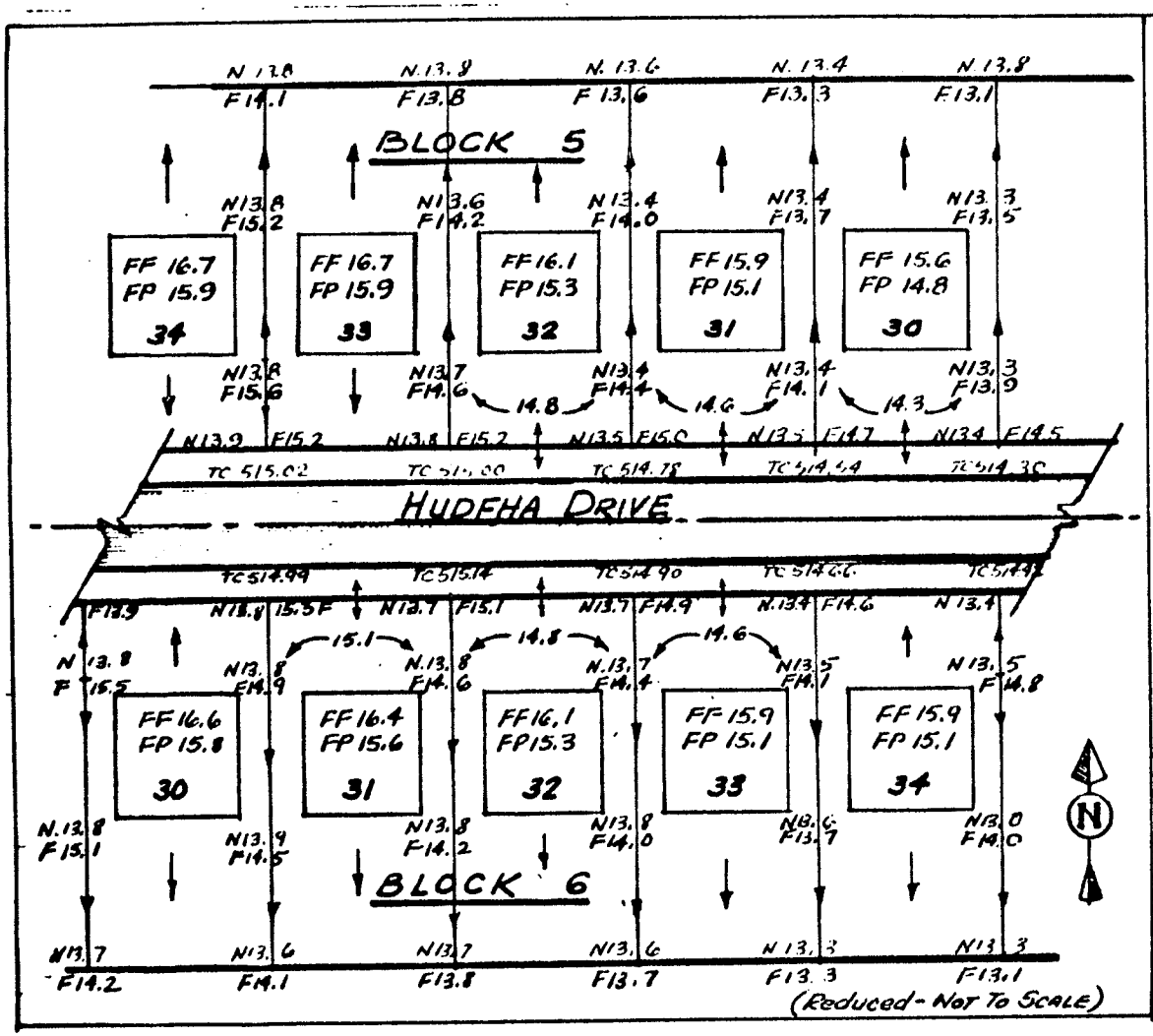
ADJUSTMENTS TO EACH PROPERTY

After the minimum lot grading control line and minimum street-to-floor rise have been determined, they should be adjusted upward as suitable for existing topography and other conditions of each property.

For a house with a basement, check is made of elevations of drains for basement floor and any basement plumbing fixtures. For a house with a crawl space, floor elevation is checked for height of access space and drainage of interior ground (MPS 803-3). For a concrete slab house, floor elevation is checked against excessive depth of fill under the slab (MPS 809-4).

Then general lot grading is checked for feasibility and suitability. Proposed grades at any necessary additional key points are determined, and all grades are further adjusted as needed. These additional points and adjustments cover such items as grades of walk and driveway, variation of outside finish grade along building walls, width and gradients of usable yard areas, and transition to grades of adjoining properties.

After all key elevations have been properly determined by these adjustments in the planning stage, then execution of good grading on the ground is relatively easy. Care must be taken primarily to set grade stakes correctly at key points and to build and grade to them in accordance with the practices outlined in this data sheet and in the FHA Minimum Property Standards.



SAMPLE LOT GRADING PLANS FOR SUBDIVISION EXHIBITS

NOTES

1. Minimum of .8/ft. required from finish floor to finish grade at foundation.
2. Minimum of .5/ft. fall required in first 10 feet away from foundation and/or to high point of swale.
3. Minimum of 1% fall required off lot but not onto adjacent lot.
4. Indicate all drainage arrows.
5. Provide natural grade elevations as shown or by contour lines.
6. Provide finish grade elevations at corners of property, at foundation, at swales, and at change of direction of water flow.
7. Provide lot numbers, block designation, and North arrow on all drawings.

APPENDIX C

HUD DATA SHEET 79g

LAND DEVELOPMENT WITH CONTROLLED EARTHWORK

Part 1 of 2 Parts

CONTENTS

1. APPLICATION. This data sheet applies to any land development in which building foundations will be placed on filled ground, and/or any development in which the depth of fill below floor slabs (including basement floor or garage floor) will exceed that permitted by the Minimum Property Standards (MPS) for normal compaction methods. The scope of these applications includes soils which will be blended, replaced, or reworked, or which will be stabilized or modified by use of additives. HUD-FHA considers such development in subdivisions or projects where it is elected by the Developer and/or where determined necessary and appropriate for HUD-FHA purposes. This data sheet does not apply to developments in which earth will be placed below water level or as hydraulically-discharged material or developments in which fills will involve the placing of an appreciable quantity of rock larger than 6". Where land will be salvaged from prior urban occupancy, use of these procedures will be permitted only if full compliance with all stated objectives can be assured to HUD-FHA's satisfaction.

   a. Developments of this type usually involve general reshaping or regrading of the land. HUD-FHA requires that all grading be properly controlled to prevent differential earth movement, sliding, erosion, and/or other occurrences which might damage dwellings, streets or other improvements.

   b. A specific analysis is made of each project to determine the required exhibits, details and specifications for the particular development. The requirements for grading in this type of development are outlined in this data sheet. Adjustment of these standards is made by HUD-FHA where advisable to fit special conditions or where alternates are proposed which will fully attain Departmental objectives.

c. In the case of a land development for homes on regraded areas, these requirements are in addition to customary subdivision requirements. These additional requirements are also applied to properties individually in accordance with MPS and in other specific conditions on individual commitments for HUD-FHA mortgage insurance.

d. For multifamily housing projects, the exhibit requirements in this data sheet are subject to general adjustment to fit Departmental procedures for processing multifamily projects. The objectives of Paragraph 9, Controlled Slopes and Paragraph 10, Controlled Earthwork, apply to multifamily housing as shown.

2. GENERAL ADVICE

a. Careful and detailed study must be made of every phase of the operation to assure that streets, dwelling sites and structures are appropriately designed and properly constructed. The expense incurred in this type of land development can be disproportionate to the value created, particularly if there are no compensatory factors present or if the development is not fitted to the natural topography. However, this type of development, when properly applied, may result in substantial economies. Many local consultants and contractors throughout the country are practiced in the techniques required for optimum application.

b. Serious problems of changed drainage ways, control of slope erosion and specially designed footings may arise in these land developments, and extreme care is necessary during construction to complete the land development as specified. These conditions make essential the procurement by the developer and builder of qualified and competent site planning, engineering and architectural services and supervision. Proper coordination of these talents may yield a developer an economic return or give him a competitive advantage.

c. Site planning and grading design should give careful consideration to fitting and preserving desirable features of the natural topography and landscape, wherever possible and practical. This, and providing improvements appropriate to these features, often will reduce total earthwork quantities, and will enhance the development by avoiding a "scorched earth" appearance and by preserving trees and other native plant materials.

---

d. The use of procedures defined in paragraphs 3f-j may be practical

for specific situations involving expansive soils or other problem soils. Application of these procedures individually or in combination requires very thorough preliminary and analysis and construction supervision. Appropriate specifications for such procedures typically will be more detailed than those illustrated in Paragraph 10, Controlled Earthwork guide specifications.

e. When a land development will involve soils subject to differential movements, the costs of controlling soils problems through special earthwork procedures should be compared with the costs of special foundation systems, before final development decisions are reached.

3. DEFINITIONS. The following terms used in this data sheet are defined for HUD-FHA purposes, as follows:

a. Slope Control Area: An area established for the purpose of achieving the continuous stabilization of slopes, which otherwise might seriously affect properties. The area is identified on plans and in agreements running with the land. Continuous stabilization is to be achieved by slope control drainageways, slope control planting and other necessary initial work, and by continuing land use limitations and maintenance provisions, designed to preserve and maintain the slope control measures taken for the benefit of the properties.

b. Slope Control Easement: A legally established easement granting to the land developer, the builder, a local public authority or to a property-owners' association, the right of access to and over a slope control area for slope control purposes.

c. Slope Control Planting: Soil-fixing grasses and plants planted to help to prevent erosion and to stabilize the slope surface.

d. Slope Control Specialist: A professional landscape architect or other professional person experienced in erosion control work, retained by the developer in a professional or consultative capacity (not as a contractor performing construction work in the development), and responsible for analysis, plans, specifications, supervision and certifications regarding slope control planting and related slope control work, other than grading, for a specific project.

---

e. Soil Engineer: A registered professional engineer experienced in soil mechanics, retained by the developer and responsible

for the soils engineering work outlined in this data sheet, including supervision, analysis and interpretation of field investigations and laboratory tests for a specific project, preparation of soils engineering recommendations and specifications, and supervision of the grading construction work.

f. Blending: A term for the intermixing and compacting of natural site soils (such as of materials from two natural soil horizons). or for the intermixing and compacting of natural site soils with imported soil and/or chemical characteristics of natural site soils and/or for reducing concentrations of adverse soil chemicals (such as sodium sulphate).

g. Replacement: A term for the removal and wasting of natural soil materials adjudged unsuitable for the support of dwellings or other site improvements, and their replacement with suitable soil materials properly compacted.

h. Reworking: A term for the mechanical densification or consolidation of natural loose or unconsolidated soils. The objective of reworking is to preconsolidate a site to preclude harmful settlements that might otherwise occur after structures or other improvements were completed.

i. Stabilization: A term for any procedure that will result in increased shear strength in a soil.

j. Modification: A term for any procedure that will reduce the Atterberg limits (liquid limit, plastic limit and Plasticity Index) of a soil.

4. PRELIMINARY EXHIBITS. The following preliminary exhibits shall be submitted to the HUD-FHA for preliminary analysis before any grading is done and before a subdivision report is issued:

a. Preliminary Sketch for Subdivision Plan: As illustrated on page 2 of HUD-FHA Data Sheet 140, clearly showing in addition the tentative spot elevations and slope ratios for heavy grading, location or all natural drainage channels, proposed changes in any of these channels, and the drainage areas involved. See Paragraph 9, Controlled Slopes, below.

b. Preliminary Subdivision Plan: After concurrence with the Preliminary sketch has been obtained, as outlined on page 3 of Data Sheet 140, clearly showing in addition the tentative spot elevations and slope ratios for heavy grading, location or all natural drainage channels, proposed changes in any of these

channels, and the drainage areas involved. See Paragraph 9, Controlled Slopes, below.

c. Preliminary Subdivision Plan: After concurrence with the Preliminary sketch has been obtained, as outlined on page 3 of Data Sheet 140, with the additional items listed in Paragraph 4a above.

d. Site and Soils Data for Earthwork Proposal: Sufficient soil samples to represent a true cross-section of the cut and fill areas and of the material to be used as fill shall be taken and tested under the supervision of the Soils Engineer. All soils shall be classified in accordance with the Unified Soil Classification system (Technical Memorandum No. 3-57, Volume 1, Waterways Experiment Station, Corps of Engineers, March 1953, or as amplified and supplemented by FHA Publication No. 373, "Engineering Soil Classification for Residential Developments."). Reports, including all test reports by the Soils Engineer, shall be submitted covering the following:

(1) Field and laboratory tests of the land to be covered with fill to determine the characteristics of the soil including its expansive qualities, the bearing value of the land, consolidation potential, and a statement as to whether the land can support the proposed fill and structures. In those areas where saline or alkaline soils or other problem conditions may be encountered, sufficient information to define the problem and evaluate its solution shall be submitted to HUD-FHA for review.

(2) Field and laboratory soil analysis of the material proposed for the fill, including its source and expansive quality and a statement as to its suitability. The analysis shall also specify the optimum moisture content at which each type of proposed fill material compacts to 100% dry density in accordance with current ASTM Test of Moisture Density Relations of Soils Using 10-1b. Rammer and 18-in. Drop; or, where maximum fill depth will not exceed five feet current ASTM Test for Moisture-Density Relations of Soils, Using 5.5-1b. Rammer and 12-in. Drop.

---

(3) Field and laboratory soil analysis of existing soil conditions in proposed cut locations, including expansive qualities and bearing values. If steep slopes are proposed data sufficient to permit slope stability analysis shall be submitted.

(4) Any potential ground water condition which may affect soil strength, consolidation, or slope stability shall be defined and evaluated. This is of particular importance in areas subject to vibratory or shock loadings.

(5) Proposals to replace, rework or blend, or to stabilize or modify with additives either the natural site soils or the proposed fill materials, shall be supported by appropriate laboratory analyses and such other data as may be necessary for evaluation of the proposal.

(6) For shallow fills (generally not more than 3 feet in depth) the HUD-FHA, after a site inspection of natural ground conditions, may accept a professional statement by the Soils Engineer, covering the various soils characteristics called for, in lieu of laboratory analysis.

e. Specification for Grading: A complete and detailed specification prepared by the Soils Engineer for clearing, grubbing and all aspects of grading, including filling with the material specified in 4.c.(2) above, with special emphasis on the depth of fill layers, compaction methods, moisture content, frequency of field density tests, horizontal and vertical survey control of the job, and minimum density to be obtained in the field as related to laboratory density tests. See Paragraph 10., Controlled Earthwork guide specifications, below.

f. Statement Regarding Specified Grading and Slopes: By the Soils Engineer, giving a professional opinion regarding (1) shrinkage or settlement of a fill constructed in compliance with the proposed Specification for Controlled Earthwork, (2) the safe load-bearing capacity for such controlled sites, (3) the maximum slope ratios necessary for slope stability for proposed fill and cut slopes, with the assumption of proper planting on the slope to assure freedom from erosion, and (4) the remaining movement anticipated in cut areas. Any forecast of appreciable settlement shall be supported by appropriate site and soils data.

---

g. Specification for Slope Control Planting: A complete and detailed specification prepared by the Slope Control Specialist. The specification shall specify the material and methods for slope control planting in the various slope control areas, with special emphasis on (1) soil preparation, fertilization, plant material and methods of planting and (2) initial maintenance of the plant material and slopes until a specified percentage of plant coverage is established uniformly on the cut and fill

slopes.

h. Statement Regarding Specified Slope Control Planting: By the Slope Control Specialist giving a professional opinion regarding (1) the length of time after planting in which the specified planting with the specified initial maintenance will normally produce, on the slopes in the slope control areas, the specified percentage of plant coverage, and (2) the length of time in which this specified plant coverage, without any special additional maintenance, will normally produce a coverage of permanent planting which will control erosion.

5. PRE-APPLICATION EXHIBITS. The following exhibits also will be required for analysis prior to submission of individual applications for mortgage insurance commitments:

a. Final Development Plans: As specified in the subdivision report per applicable portions of Data Sheet 150 and showing location of all slope-control areas and any easements for drainage or slope control.

b. Proposed Protective Covenants or other suitable legal instrument establishing the slope control areas and any slope control easements or drainage easements, and providing continuous land use regulations and maintenance provisions which are designed to preserve and maintain the established slope ratios, erosion control planting, drainageways, and other slope control measures taken for the benefit of the properties.

6. PRE-COMMITMENT EXHIBIT. During processing of applications and prior to the issuance of any commitment for mortgage insurance, the HUD-FHA writes the sponsor and mortgagee regarding the requirement that no building construction is to be started on graded areas before receipt of HUD-FHA's written acceptance of completed grading certifications. This letter states that, for dwellings having footings placed on

controlled soils, any dwelling construction which is started prior to the review and acceptance by HUD-FHA of the exhibits listed in Paragraph 7 below will be ineligible for mortgage insurance under the forthcoming HUD-FHA commitments. Acknowledgment is required from the sponsors and mortgagees that they have received the HUD-FHA letter.

7. PRE-CONSTRUCTION EXHIBITS. The following exhibits are required before any building construction:

a. Notice Regarding Start of Grading: Notification shall be

delivered to the field office advising it of the start of grading operations at least 2 Departmental working days in advance of the starting date, and of any resumption dates when grading operations have been stopped for any reason other than adverse weather conditions.

b. Reports of Field Density Tests: Density tests made by the Soils in Paragraph 10.m. below) shall be submitted progressively to HUD-FHA. Dry density, moisture content, and the location, elevation and sampling date of each sample taken shall be reported, along with sufficient data to correlate with laboratory analyses submitted in compliance with Paragraph 4.c. above.

c. Certification Regarding Completed Grading: By the Soils Engineer, (1) that the site was graded and filled with accepted material in accordance with the accepted specifications, and (2) giving his professional opinion regarding remaining shrinkage or settlement, expansive characteristics, slope stability, load bearing qualities, saline or alkaline conditions, and of any other condition pertinent to construction upon the completed cut or fill.

d. Certification Regarding Completed Rough Grade Elevations: By a registered Civil Engineer or licensed Land Surveyor that the general grading has been completed and the resulting grade elevations are in substantial conformity (grading variations not exceeding five-tenths of a foot) with the previously accepted detailed development plan.

e. Movement Observation Programs: In unusual instances where remaining differential earth movements may be difficult to forecast or subject to question, earth movement observations may be required by HUD-FHA to demonstrate the fill, cut and/or

slope stability results actually achieved upon a project or site, as a precommitment condition. If a determination of such need is made, a movement observation program acceptable to HUD-FHA shall be initiated. Observations from such a program will then be evaluated by the Department to determine the acceptability of the grading results.

f. Special Structural Designs: Required only upon specific request by HUD-FHA after its examination of the Certification Regarding Completed Grading, 7c above, and/or of the findings from a Movement Observation Program, 7e above. In response to HUD-FHA's request, designs of footings, foundations and/or slabs, prepared, signed and sealed by a registered structural or civil engineer

specializing in structural design, will be submitted to HUD-FHA for review to assure satisfactory performance. The seal of a registered structural or civil engineer will be interpreted by HUD-FHA to mean that the designing engineer has familiarized himself with any unusual soil problems that might exist at the site and has submitted a design that will prevent future development of structural defects in the foundations and superstructure attributable to differential movement of the supporting soils.

8. PRE-CLOSING EXHIBITS. The following exhibits are required prior to the issuance of mortgage insurance.

a. Notice Regarding Start of Slope Control Planting: Notification shall be delivered to the field office advising it of the start of slope control planting at least 2 Departmental working days in advance of the starting date, and of any resumption dates when planting operations are stopped for any reason other than adverse weather conditions.

b. Certification Regarding Slope Control Planting: By the Slope Control Specialist that the slope control planting, except initial maintenance, has been completed in accordance with the accepted Specifications for Slope Control Planting, 4.f. Where necessary, due to season or other factors beyond the control of the sponsor, temporary postponement of the installation of slope control planting will be considered by HUD-FHA provided that an escrow agreement or other acceptable assurance of completion is established, including repair of slopes, related damage, and installation of slope control planting within a satisfactory specified time; for Escrow Procedure and Escrow Agreement, see the Administrative Instructions and Procedures Handbook (4115.1).

c. Assurance of Slope Maintenance: An escrow agreement or other acceptable assurance of completion assuring that the slopes and slope planting in the slope control areas will be watered and will receive other initial maintenance in accordance with the accepted Specification for Slope Control Planting; see agreement referred to in 8.b. above. Not required for area in which specified initial maintenance has been completed.

d. Easements for Escrow Agreements: To prevent possible legal objection by owners of property to the performance of the work contemplated by escrow agreements or other assurances of completion, entered into under Paragraphs 8.b. and 8.c. above. Short-term easements for access to and over the slope control areas to perform the work covered by any completion agreement shall be reserved by the sponsor for itself and the escrow holder.

Such easements should not be perpetual but should last for a period of time determined to be necessary by the HUD-FHA to insure the fulfillment of the work covered by the completion agreement.

9. CONTROLLED SLOPES. Where a serious hazard or nuisance could be caused by lack of stabilization of a slope, the HUD-FHA requires effective control of the slope to assure its continuous stabilization. Plans and other required exhibits for such controlled slopes shall comply with the following:

a. Slope Ratios: Slopes generally shall be no steeper than 2 horizontal to 1 vertical for either fill or cut slopes. Where particular conditions make it appropriate to vary from these slopes, the HUD-FHA requires flatter slopes or accepts steeper slopes, such as in the case of a stable rock face. HUD-FHA determination of acceptable slope ratios for mortgage insurance purposes is predicated on a stability analysis of the data and certifications of soil characteristics and slope stabilization required in Paragraphs 4. and 5. above, and its analysis of light, air, open space and other factors relating to the properties.

b. Slope Benches: Where site conditions indicate the need, slopes having a vertical height exceeding 25 feet shall have benches to provide breaks in the high slopes in order to intercept surface water and to aid in doing maintenance work on the slopes. Slope benches shall be at intervals not exceeding 25 feet vertical height. Benches shall be at least 6 feet wide and constructed to intercept surface water from the slopes and to carry it in paved drainageways at suitable gradient to proper outfalls.

---

c. Lot Line Locations: Insofar as practicable, lot lines shall be located at the top of banks or along slope benches, instead of at the toe of slopes or at intermediate locations.

d. Usable Rear Yards: Provide a usable rear yard at least 15 feet deep from building wall to the toe of a slope with vertical height exceeding 15 feet. Increase the horizontal distance of the required 15-foot usable rear yard at the rate of 1/4 foot horizontal for every foot of bank height over the first 15 feet.

e. Usable Front and Side Yards: Maximum 2 1/2 inches per foot (21 percent) away from building for a maximum 4 foot distance. At toe of slope where height of bank exceeds 4 feet, increase the horizontal distance of the minimum 4-foot usable yard at the rate of 1/4 foot horizontal for every foot of bank height over the first 4 feet.

f. Storm Water Runoff: Storm water runoff shall not be carried over the controlled slopes but shall be provided for as follows:

(1) Wherever attainable without producing disproportionate disadvantages, each lot shall be graded so that storm water will drain from the back yard through the side yards and front yard directly to the abutting street and not across other lots or onto controlled slopes.

(2) When the above does not apply, water shall be collected along the top of the slopes by means of paved gutters and shall be carried in them to a proper outfall. The paved gutters shall be located in properly established slope control areas or in drainage easements.

g. Boundaries of Slope Control Areas: Where a serious hazard or nuisance to one property could be caused by lack of stabilization of a slope located in whole or in part on another property, the slope shall be included in a slope control area which is established by a proper legal instrument. Drainageways necessary to the stabilization of such slopes shall also be included in the slope control area unless located in separate rights-of-way or easements of a local public authority or property-owners' association. Boundaries may fall within required yard areas unless the slope control area is in the ownership of a public authority or an association. Boundaries shall be legally

established, usually by reference to a map in the protective covenants or other legal instrument which sets up the permitted use and required maintenance of the slope control area.

h. Permitted Use and Required Maintenance of Slope Control Areas: Were practicable, the slope control areas shall be established as rights-of-way or easements of a local public authority or properly constituted property-owners' association. Otherwise they shall be established as slope control areas which are identified in recorded protective covenants or other legal agreements running with the land, and which are made subject to appropriate agreements regarding use and maintenance by each individual property owner. In any case, the agreements with the public authority or property-owners' association, or among individual owners under the covenants, shall include both land use restrictions in the slope control area and maintenance provisions designed to preserve, protect, maintain and assure the continuous effectiveness of slope control drainageways, slope control planting, established slope ratios, and other slope control

measures taken for the benefit of the properties.

i. Slope Control Planting: Slopes located in the slope control areas shall be fertilized and planted with soil-fixing grasses, vines or shrubs, or otherwise treated as necessary to adequately stabilize slopes for the specific development.

j. Initial Maintenance of Slopes: Initial maintenance of slopes and planting in slope control areas shall be continued until stabilization has been assured.

k. Retaining Walls: Retaining walls shall be avoided wherever possible, particularly at the toes of high slopes. Retaining walls installed in slope control areas shall be constructed of concrete or other masonry and adequately designed to carry all earth pressures including any embankment surcharge.

l. Fences: Fences of proper design and construction shall be installed for safety purposes along the top of slopes exceeding 15 feet vertical height and 3 to 1 slope ratio, and along the top of walls exceeding 4-feet vertical height.

10. CONTROLLED EARTHWORK. For any development in which buildings are to be placed on graded areas, all earthwork shall be designed, engineered and constructed in such a manner that there will be no

adverse differential movement which may cause damage to the structures, utilities, lot improvements and street pavements. The following may be used as a guide, not used verbatim, in writing a specification for filled areas using non-expansive soils. For a specific project, it is necessary to prepare the specification predicated upon the analysis of the material proposed to be used for the fill and other conditions pertaining to the project. As may be appropriate, similar or special specification items shall be included for cut areas or areas of critical natural soils. Very important changes from these guide specifications are necessary if expansive soils or other problem soils are to be used. Among other soils, this includes any soil which has a Liquid Limit greater than 30 or a Plasticity Index greater than 10. For such soils, the moisture content and density to which the soil is to be compacted, the manner and location of placement of the soil and other factors affecting strength and/or volume change for the soil shall be properly specified in the project specifications.

a. General Description: This item shall consist of all clearing and grubbing, removal of existing structures, preparation of land to be filled, filling of the land, spreading, compaction and control of the fill, and all subsidiary work necessary to

complete the grading of the cut and fill areas to conform with the lines, grades and slopes as shown on the accepted plans.

b. Clearing Area to be Filled: All timber, logs, trees, brush and rubbish shall be removed, piled or burned or otherwise acceptably disposed of.

c. Scarifying Area to be Filled:

(1) All vegetable matter shall be removed from the surface upon which the fill is to be placed, and the surface shall then be plowed or scarified to a depth of at least six inches (6"), and until the surface is free from ruts, hummocks or other uneven features which would tend to prevent uniform compaction by the equipment to be used.

(2) Where fills are made on hillsides or slopes, the slope of the original ground upon which the fill is to be placed shall be plowed or scarified deeply or where the slope ratio of the original ground is steeper than 5 horizontal to 1 vertical, the bank shall be stepped or benched. Ground slopes which are flatter than 5 to 1 shall be benched when considered necessary by the Soil Engineer.

---

d. Compacting Area to be Filled: After the foundation for the fill has been cleared and plowed or scarified, it shall be disced or bladed until it is uniform and free from large clods, brought to the proper moisture content, and compacted (typically) to not less than ninety (90%) of maximum density in accordance with current ASTM Density Test No. D 1557 (5 layers-25 blows each layer-10 1b. hammer-18" drop-1/30 cu. ft. mold), or to such other density as may be determined appropriate for the materials and conditions and acceptable to the Department.

e. Fill Materials: Materials for fill shall consist of materials selected by the Soils Engineer from sources identified in laboratory reports, which reports have previously been accepted by the Department. The materials used shall be free from vegetable matter and other deleterious substance and shall not contain rocks or lumps having a diameter of more than six inches (6").

f. Depth and Mixing of Fill Layers: The selected fill material shall be placed in level, uniform layers which, when compacted, shall have a density conforming to that stipulated in the HUD-FHA accepted earthwork specifications. Each layer shall be thoroughly blade mixed during the spreading to insure uniformity of material in each layer. Compacted layer thickness normally will be six

inches (6"), however, it may be specified otherwise if compaction equipment of demonstrated capability will be used.

g. Rock: When fill material includes rock, the maximum rock size acceptable shall be six inches (6"). No large rocks shall be allowed to nest and all voids must be carefully filled with small stones or earth, properly compacted. No large rocks will be permitted within twelve inches (12"), of the finished grade.

h. Moisture Content: The fill material shall be compacted at the appropriate moisture content specified for the soils being used, as identified in laboratory and soils reports which have previously been accepted by the HUD-FHA. (See item 4.c.(2) above.) Moisture content tolerances should be clearly defined for placement of each material proposed for use in a fill. Appropriate moisture content is defined, typically, as optimum moisture content, however for expansive soils it may be greater than optimum moisture content, and other moisture contents may be necessary to produce the desired results with specific soils.

---

i. Amount of Compaction: After each layer (lift) has been placed, mixed and spread evenly, it shall be thoroughly compacted to the specified density. The specified density will be stated as a percentage of the maximum density attainable using current ASTM Density Test No. D 1557 (5 layers-25 blows each layer-10 1b. hammer-18" drop-1/30 cu. ft. mold). The specified density typically will be ninety percent (90%) of maximum for most, cohesive, non-expansive soils, however it will be established as appropriate for the materials and environment defined. For example, granular soils may require compaction to 95% of maximum density and expansive soils may require compaction to densities less than 90% of maximum density. To achieve the desired fill quality, it may be necessary to specify acceptable density tolerances for the compacted fill.

j. Compaction of Fill Layer: Compaction equipment shall be of such design that it will be able to compact the fill to the specified density. Compaction shall be accomplished while the fill material is at the specified moisture content. Compaction of each layer shall be continuous over its entire area and the compaction equipment shall make sufficient trips to insure that the required density has been obtained.

k. Compaction of Slopes: Fill slopes shall be compacted. Compacting operations shall be continued until the slopes are

stable but not too dense for planting on the slopes. Compacting of the slopes may be done progressively in increments of three to five feet (3' to 5') in fill height or after the fill is brought to its total height.

l. Density Tests: Field density tests shall be made by the Soils Engineer of the compaction of each layer of fill. Density tests shall be taken in the compacted material below the disturbed surface. When these tests indicate that the density of any layer of fill or portion thereof is below the required density, the particular layer or portion shall be reworked until the required density has been obtained. Sufficient density tests shall be made and submitted to HUD-FHA to support the Soils Engineer's certification of each fill layer.

m. Supervision: Supervision by the Soils Engineer shall be continuous during the grading operations so that he can certify that all cut and filled areas were graded in accordance with the accepted specifications.

---

n. Seasonal Limits: No fill material shall be placed, spread or rolled while it is frozen or thawing or during unfavorable weather conditions. When the work is interrupted by heavy rain, fill operations shall not be resumed until the Soils Engineer indicates that the moisture content and density of the previously-placed fill are as specified.

INSTRUCTIONS REGARDING PROPERTIES AND LAND DEVELOPMENTS WITH CONTROLLED EARTHWORK

Part 2 of 2 Parts

1. APPLICATION. These instructions apply to the use of Data Sheet 79g, entitled, "Land Development With Controlled Earthwork." Data Sheet 79g and these instructions supersede all previously issued Data Sheets in the 79 series and outstanding instructions for their use. The instructions apply to all individual properties and developments in which building footings or building foundations are placed on filled ground or in which floor slabs are placed on fill in excess of that permitted by the applicable Minimum Property Standards. Within these limits, they apply to proposed fills, to fills placed prior to submission to HUD-FHA, and to sites that have had their soils modified by any blending or replacement technique unless experimental earthwork under Section 233 is involved. At the Department's option, these instructions apply to sites where cut may have exposed materials with adverse characteristics or sites with any kind of soil or slope stability problem. In any case, serious problems of land development and soils engineering may be involved. Failure to recognize and solve such problems properly may result in major monetary losses due to soil movement, sliding and erosion and to structural failure of dwellings, utilities and street improvements.

2. SPECIAL PROBLEMS. All HUD field offices will routinely advise the Office of Technical and Credit Standards of any unusual problems relating to soils, earthwork construction, earthwork processing procedures, or earthwork requirements, that they may encounter, and the recommendations appropriate for their resolution. Their Civil Engineer should be responsible for the technical input of this information memorandum.

3. EXISTING FILLS.

   a. Properties or developments on which fill has been placed prior to submission to the Department or contrary to the following procedure for new development shall be considered ineligible for mortgage insurance if the site will support buildings, unless:

      (1) The Civil Engineer serving the field office recommends acceptance of the existing fill;

(2) The Area or Insuring Office recommends acceptance of the existing fill;

(3) The Regional Civil Engineer recommends acceptance of the existing fill; and,

(4) These three recommendations are then reviewed by the Office of Technical and Credit Standards, which may authorize acceptance of the existing fill.

b. For a determination of eligibility of such a site with existing fills, the field office and central office require satisfactory evidence proving beyond any reasonable doubt that the site planning and engineering evaluations actually obtained in the development are at least equal to those which HUD-FHA would have required as minimum for the development if the site had been submitted to this Department in its original natural condition and had then been analyzed and improved in accordance with Departmental procedures and minimum requirements.

c. When the Civil Engineer reviews an existing fill proposal and finds that the existing fill and associated improvements comply with the objectives of 3b above, he recommends its acceptance to the field office.

d. When a field office evaluates a development with existing fill whose acceptance is recommended by their Civil Engineer and the development is found acceptable in all other respects, the Director forwards the file to the Regional Civil Engineer with the Director's recommendation that the existing fill be accepted for the support of dwellings. If the Regional Civil Engineer concurs with the Director's recommendation, after review of the exhibits and other pertinent data, he will forward the file to the Office of Technical and Credit Standards with a memorandum recommending acceptance of the existing fill. If the Regional Civil Engineer does not consider the existing fill acceptable, of course, he returns the file to the field office with a memorandum setting forth the reasons for his determination.

4. PROPOSED DEVELOPMENTS.

a. General: The field office should advise a land developer or sponsor to assure himself that the expense of land development with controlled earthwork will not be disproportionate to the

value created. The Department must assure itself that "scorched

earth" practices will not be unnecessarily used and that natural site features or other amenities that will be modified or destroyed will not adversely affect the marketability or livability of the development.

b. Site Planning & Civil Engineering: All proposals involving land development with controlled earthwork shall be submitted to the Site Planner and Civil Engineer serving the field office for site analysis. Proper site planning and site engineering techniques will, in many instances, eliminate the need for extensive regrading of the land and generally will reduce the amount of grading to be done.

c. Architectural Adaptation of Buildings: Just as proper Site Planning and Civil Engineering will generally reduce total earthwork quantities, so will proper Architectural adaptation of buildings to the site. The skills of the Architectural and Engineering Section should thus be used during early subdivision analysis of project analysis stages to assure maximum harmony between the site and the structure.

5. APPLICATION OF DATA SHEET 79g.

a. After final determination has been reached with respect to developing land for buildings on fill, a complete analysis of the individual project shall be made to determine the necessary required exhibits, details and specifications for the particular project. All of the requirements, exhibits and procedural time-schedules described in Data Sheet 79g will usually be required for these developments. It should be noted, however, that the slope control requirements are not required for a project in which the slopes are such that a serious hazard or maintenance problem is unlikely.

b. In some special cases, complete analysis of a project may indicate that certain specific parts of Data Sheet 79g are not needed to properly protect the interest of the Department. The field office shall decide special case variances of this nature on a project-by-project basis. However, if acceptance of a variation from a standard provision in Data Sheet 79g or these instructions would establish a precedent for similar acceptance in repetitive projects, the variation shall not be accepted; instead the office

---

shall refer the matter to the Office of Technical and Credit Standards Central Office, with a request to establish revised local instructions for general local use. An example of required

concurrence by Central Office would be the typical and repetitive acceptance by an insuring office of slopes which are steeper than 2 horizontal to 1 vertical.

c. The field office is authorized to require submission of the Pre-Commitment Exhibit (Item 6 of Data Sheet 79g) as a Pre-Application Exhibit (Item 5 of Data Sheet 79g). This procedural variation will be particularly desirable where processing is for quality, but time limitations makes an exchange of correspondence impractical during the application processing period. Where this procedural variation is elected by the field office, it should be appropriately stipulated in the Feasibility Letter.

6. SUBDIVISION REPORT. All or part of the typical subdivision clauses needed to protect properly the interests of the Department on a specific development, shall be incorporated as conditions of the commitment.

7. THE DUTIES AND RESPONSIBILITIES OF THE VALUATION SECTION.

a. To exercise diligent effort to determine the presence of any existing fill that may support dwellings or improvements on unimproved tracts and on existing lots, and refer problems to the Civil Engineer and Site Planner for solution.

b. To incorporate conclusions of the Civil Engineer and Site Planner into processing of the subdivision or individual property, as the case may be.

c. To reflect results of solution in marketability and valuation analysis of individual properties.

d. To maintain a progressive record of compliance with the above exhibit requirements.

8. DUTIES AND RESPONSIBILITIES OF THE SITE PLANNER AND CIVIL ENGINEER.

a. They eliminate or reduce the problems through planning and engineering techniques insofar as possible.

---

b. They assist in the establishment and administration of procedures to assure professional review of exhibits required in Parts 4, 5, 6, 7 and 8 and Data Sheet 79g, prior to Feasibility Letter, Commitment, Construction, and Insurance, respectively.

c. They determine technical exhibit requirements and acceptable compliance therewith regarding the following:

(1) Section 4, Preliminary Exhibits:

Analyses by Site Planner:
Items 4b, 4f and 4g.

Analyses by Civil Engineer:
Items 4a, 4c, 4d, and 4e.

(2) Section 5, Pre-Application Exhibits:

Analysis by Site Planner & Civil Engineer, collaboratively:
Items 5a and 5b.

(3) Section 7, Pre-Construction Exhibits:

Analysis by Civil Engineer:
Items 7b, 7c and 7e.

(4) Section 9, Controlled Slopes:

Analyses by Site Planner:
Items 9e, 9i, 9j and 9h.

Analysis by Site Planner and Civil Engineer, collaboratively:
All other items in Section 9.

(5) Section 10, Controlled Earthwork Guide Specifications:

Exhibit compliance by Civil Engineer.

The various individual or collaborative analyses of the Site Planner and/or the Civil Engineer are incorporated into reports upon the specific project.

---

d. The Site Planner and the Civil Engineer each maintain a progressive record of compliance for those items on each Data Sheet 79g proposal for which they are responsible. When the Site Planner and Civil Engineer recommend actions to complete a given stage of subdivision or project analysis, they should so advise either by memorandum or by forwarding a copy of his (their) progressive record of compliance.

e. The Civil Engineer and the Site Planner train personnel of the field office on construction compliance on grading, planting and other land improvement work. When requested the Civil Engineer advises upon appropriate methods and procedures for evaluating and recording routine compliance exhibits.

f. The civil Engineer's review of Item 7e is made to advise of any special or unexpected conditions which warrant further exploration or indicate the need for special structural design.

9. DUTIES AND RESPONSIBILITIES OF THE FIELD OFFICE.

a. Determine exhibit requirements and acceptable compliance therewith regarding the following:

(1) Section 7, Pre-Construction Exhibits:

Items 7a through 7f, inclusive.

The Civil Engineer establishes the criteria for Item 7e, Movement Observation Program, if required, and is responsible for compliance inspection and administration of observation reports.

When it has been determined that the completed earthwork construction does not fulfill usual site eligibility criteria, the field office is responsible for evaluation of special structural designs that may be proposed to counter site deficiencies. Such special structural designs may be required as specified in Item 7f. Any questions regarding the adequacy of proposed designs will be referred to the Office of Technical and Credit Standards.

(2) Pre-Closing Exhibits:

Items 8a and 8b.

---

b. Maintains a progressive record of compliance with above exhibit requirements.

c. Makes frequent inspections of grading and slope control work during construction operations.

d. From above exhibit examinations and construction inspections, determines whether or not construction is in compliance with the drawings, specifications and other exhibits accepted for a

particular proposed development.

10. SERVICES OF SPECIALIZED PERSONNEL. Where specialized advice or assistance is needed to reach proper conclusions and is not otherwise available, the insuring office shall request assistance from the Office of Technical and Credit Standards.

11. CONSTRUCTION COMPLIANCE ON GRADING, PLANTING AND OTHER WORK.

a. Upon completion of their review and acceptance of required design exhibits (Sections 4 and 5 of Data Sheet 79g) the accepted exhibits are used in design analyses and in compliance examinations.

b. Item 7a of Data Sheet 79g requires that field offices be notified at least two Departmental working days in advance of the start of grading and also of resumption dates of grading when grading has been stopped for any reason other than adverse weather conditions. Item 8a requires that field offices be notified at least two Departmental working days in advance of the start of slope control planting and also of resumption dates of planting when slope control planting has been stopped for any reason other than adverse weather conditions.

c. When these notifications are received, the field office arranges to make field inspections of grading and slope control planting as it progresses in the project. These inspections are scheduled as frequently as possible with the objective of daily inspections wherever practical. It is advisable to have the same compliance inspector follow through on any one project.

d. In order that the compliance inspectors will be as well trained as possible in this work, the Civil Engineer and Site Planner serving the office will conduct a continuous training program as outlined in 13 below.

e. The Site Planner and the Civil Engineer are informed of the start of earthwork operations on each development or project. If possible, the Civil Engineer and/or the Site Planner visit the site with the inspector at the start of grading operations, or as soon thereafter as arrangements can be made for them to do so. The purpose of this visit is to assist the inspector at the start of operations and give him the benefit of the Civil Engineer's and/or the Site Planner's professional experience. The Civil Engineer or the Site Planner make additional visits to the tract during operations as requested. Advice and recommendations from such observations are reported by memorandum from the Site Planner or Civil Engineer.

f. For each development of this type, the inspector familiarizes himself with the accepted engineering and planning reports, drawings and specifications regarding proposed grading, planting and other work.

g. During each inspection, the inspector examines completed work, equipment on the site and work in progress in order to make limited determinations regarding compliance with accepted specifications and the required work shown on the accepted exhibits. In making his inspection and writing his report, he recognizes that HUD-FHA requires laboratory reports on the compacted fill, engineering certifications and other exhibits (6 and 7 of Data Sheet 79g) and that these will be examined as well as his field reports before the Department makes a final determination of the acceptability of any of this required work. He limits his statements during inspection and in his report accordingly. He does not use the statement "Work is acceptably completed." Instead he uses such statements as "Correction is essential to compliance as follows," or "Correction required by report dated is not acceptably completed," or "The following work is now in progress or completed, appears from this inspection to be in compliance, but is subject to other reports and required exhibits before acceptance by the Department."

h. At each inspection, the inspector inspects and reports on all work completed since the last inspection and on all work in progress, unless he specifically notes otherwise as to limitations on the area or type of work covered in his report. This includes both work involving land development as outlined in Data Sheet 79g and also other required improvements listed in the Subdivision Report, such as storm drainage and street improvements as outlined in other instructions.

The inspector inspects and reports on the items listed below regarding site development. Frequent field inspection during the progress of construction is important because correction of many items of work is difficult or impractical at a later date and because the information obtained from progress inspections is essential to final determination of the acceptability of all work when completed. The items inspected, with parenthetic letter-number references to Data Sheet 79g, are as follows:

(1) Controlled Earthwork Guide Specifications: (References are to HUD-FHA guide specifications; inspection objective shall be to determine compliance with specific job specifications accepted by the Department.)

(a) Preparing area for fill (10b, 10c, 10d)

(b) Fill material and source (10c, 10f, 10g)

(c) Depth of fill layers (10f)

(d) Moisture content (10h)

(e) Compaction (10j)

(f) Compaction of Slopes (10k)

(g) Continuous supervision by Soils Engineer (10m)

(h) Seasonal Limits (10n)

(i) Any special control items required for specific job.

(2) Slope Ratios and Locations:

(5a and 9a through 9f, inclusive)

(3) Retaining Walls:

(5a and 9k)

(4) Slope Control Planting:

(4f, 5a, 8c, 9i)

(a) Soil preparation and fertilization.

(b) Plant material.

(c) Planting methods.

(d) Seasonal limits.

(e) Initial maintenance.

j. The inspector reports each inspection. He designates the report as a "Subdivision." He writes the name, number and location of the subdivision or tract in the heading. He writes a complete report. He dates and signs the report and leaves the first carbon copy as an unapproved report for the convenience of the sponsor and his soils engineer.

k. After review of the inspection report, the report is distributed

as follows:

Original to the sponsor of the tract or subdivision. Second carbon copy to the subdivision (or tract) Compliance Inspection Binder.

l. Where there is known to be an HUD-FHA mortgagee engaged to furnish development construction loans and mortgage financing, Compliance Inspection Reports may be provided to the mortgagee.

m. Reports of field density tests are required to be made by the sponsor's soils engineer progressively during grading construction and to be submitted to the Department (7b of Data Sheet 79g). Immediately upon their receipt, the inspector or other designated design professional examines them to determine if the fill material is compacted in accordance with the accepted specifications. He considers the number and location of tests as well as the results reported. He correlates the test results with information obtained from field inspections. He prepares a letter for the Director's signature addressed to the sponsor acknowledging receipt of the reports. In the memo he accepts the reports as partial compliance, requires correction essential to compliance, or asks for verification or correction of questionable work, as appropriate in each instance. A copy is sent to the sponsor's soils engineer. A copy is placed in the Subdivision Compliance Inspection Binder. A copy is sent to the mortgagee receiving compliance inspection data under the conditions described in 11e.

n. Certifications regarding completed grading and slope control planting are required when all work is completed (7 and 8 of Data Sheet 79g). When these are received, a final examination of field inspection reports, density test reports and these certifications is made. A determination of acceptability of the completed work is made only after this final examination has been made. The conclusions are written in a letter to the sponsor for the Director's signature. Copies are distributed to the sponsor's soils engineer or slope control specialist, to the Subdivision Compliance Inspection Binder, to the Subdivision File, and to any mortgagee receiving progress reports.

o. During the above compliance inspections and examinations of required exhibits the Civil Engineer or Site Planner should be consulted for advice or guidance whenever their technical aid may be needed to reach proper and correct conclusions. Such liaison is particularly desirable when earthwork operations will involve unusual procedures or when the field office has had only

limited experience with controlled earthwork.

12. TRAINING ON CONSTRUCTION COMPLIANCE.

a. Periodically, the Civil Engineer and Site Planner hold meetings with personnel to train them in determining construction compliance on grading, planting and other land development work. Arrangements for such training are as directed by the field office.

b. The Site Planner and the Civil Engineer make field trips as needed to keep thoroughly familiar with developments of this type in the field office jurisdiction. When considered desirable, the Site Planner or Civil Engineer will advise the field office that additional compliance training or other actions are necessary to achieve the objectives of Data Sheet 79g and these instructions.

13. ESCROW AGREEMENT FOR POSTPONED SLOPE CONTROL PLANTING AND SLOPE
REPAIR.

a. Due to the importance of obtaining complete slope stabilization to prevent erosion of slopes, it is required in 8b of Data Sheet 79g that the Slope Control Specialist certify prior to mortgage insurance that slope control planting work, except initial

---

maintenance, has been completed in accordance with the accepted specifications as called for in Item 4.f.(2). Every effort shall be made to have the work completed prior to insurance. It is usually to the advantage of the builder and HUD-FHA to complete this work immediately following site grading and prior to any building construction.

b. There may be instances where, due to season or other factors behind the control of the sponsor, it may be advisable to postpone temporarily the installation of slope control planting if the field office agrees that a postponement is necessary. Where the potential danger of damage to dwelling construction presents a high degree of risk because of steepness and height of slopes, slope location, climatic conditions, or other factors which necessitate an excessive escrow amount, deferment of the work is not acceptable.

c. In cases where an escrow is determined to be acceptable, HUD-FHA Forms 2606 and 2606a are used with the following modifications:

Form 2606 - Change heading to read "Escrow Agreement for Postponed Slope Control Planting and Slope Repair."

Form 2606a - Add the following under "Itemized Statement of Work ....."

"This work shall consist of the repair of slopes and related damage and installation of slope control planting in accordance with the accepted Development Plans and Specifications identified as follows: '_____'. Work shall be performed within the slope control areas in Blocks_____ as identified on the accepted plans and in the agreement running with the land titled '_____ and dated _____."

On the back of the form substitute the following statement in lieu of the corresponding existing paragraph:

"Request for Inspection.
This request shall be accompanied by a certification by the Slope Control Specialist that slope control.

planting, except initial maintenance, has been completed in accordance with the accepted specifications.

Where repair of slopes and related damage is involved, a certification by the Soils Engineer is required stating that the slopes and related damage have been repaired in accordance with the accepted Development Plans and Specifications."

14. ESCROW AGREEMENT FOR INITIAL MAINTENANCE OF CONTROLLED SLOPES.

a. Item 9j of the data sheet states that "Initial maintenance of slopes and planting in slope control areas shall be continued until stabilization has been assured." Dwelling construction is often started as soon as fills are placed and slope control planting is installed. In some cases, properties will be completed and insurance of loans will be desired before the necessary period of initial maintenance of slopes is completed. In such cases, it is necessary to establish an escrow agreement for initial maintenance in order to give the needed assurance that the planted slope control areas will receive watering and other initial maintenance until the specified percentage of

plant coverage has been obtained. In general, a period of a few months is sufficient for most planting if it is properly specified and is done in the proper season.

b. The escrow forms identified above are used with the following modifications:

Form 2606 - Change heading to read "Escrow Agreement Initial Maintenance of Controlled Slopes."

Form 2606a - Add the following under "Itemized Statement of Work . . . . . ."

"This work shall consist of initial maintenance of slope control planting and any related slope repair within slope control areas located in Blocks_____ as identified on the Accepted Development. Plans and Specifications titled ' _____ _____' and dated _____.

Initial maintenance consisting of watering, cultivating, pruning, and replacement of

dead material shall begin immediately following completion of the slope control planting and shall be continued until the amount of plant growth as stated in the accepted specification has been achieved. Initial maintenance shall also include the repair of slopes to correct any erosion damage and the cleaning and repair of paved gutters, catch basins and other drainage structures."

On the back of the form substitute the following statement in lieu of the corresponding existing paragraph:

"Request for Inspection:
This request shall be accompanied by a certification by the Slope Control Specialist that the initial maintenance period has been completed and the specified amount of plant growth achieved."