ASLA Technical Workshop: LARE Prep Section 4

Handouts

This packet includes:

- LARE Section 4 Overview and Specifications
- Universal Slope Calculator
- Contours: Some Basic Rules and Considerations
- Basic Surveying Terms
- Soil Basics
- Grading a Roadway
- Flow Calculations
- 2010 ADA Standards for Accessible Design

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Section 4 - Construction Documentation (120 items)

- Section 4 Construction Documentation is a compilation of the old Section D Structural Considerations, Materials and Methods of Construction and Section E Grading & Drainage and Stormwater Management. CLARB has published the Examination Specifications for this section. You will note that they are written in the form of "Prepare" statements, meaning that the minimally competent Landscape Architect should be able to prepare documentation with respect to performance in the areas noted. The Specifications are not subdivided into sections as is Section 3 Design, therefore, they are not weighted in terms of importance. You are expected to be proficient in all areas.

- Below is our analysis of the requirements for each of the **(Prepare)** issues on the Examination Specifications. Keep in mind that these are our assessments only and are our judgment as to what is likely to be covered on the exam. Neither CLARB nor ASLA has any responsibility for the accuracy or the completeness of this document. It is to be considered a study guide.

- All exam questions will be in the format listed below. There is no indication from CLARB as to what percentage of each question type will appear on the exam.

  Multiple Choice (MC)- select one response from a possibility of four
  Multiple Response (MR)- check all that apply - could be one to four
  Hot Spot (HS)- place a X in the appropriate spot on a given drawing
  Drag and Place (DP) - Drag an object, e.g., a contour, a spot elevation and place it on the appropriate situation as given on a drawing

- CLARB has informed us that there will be no Reference Manual as in previous years. However, if reference manual type information is required, it will be included in the question being addressed. Each question is a separate entity in that an answer will not be predicated on answering a previous question correctly.

Section 4 Construction Documentation Specifications

- **Prepare Existing Conditions Plan**
  - Surficial geology
    - underlying geological situation relative to any expected landuse.
  - Soil types and capability
    - Bearing capacity - for foundations, etc. - be able to discuss and understand issues
    - Permeability - issues of infiltration or lack thereof - rate from fast to slow
    - Quality - growing crops or landscape plants

- Slope - along with contours
  - 0 to 1% - flat - poor drainage in all use areas - building, play, sports
  - 2 to 5% - generally acceptable for structures, play areas, sports fields
  - 6 to 15% - OK for some structures and some free play activities
  - 15% - and greater - generally not considered buildable
- Ridge lines and watersheds
  - Delineate ridge lines
  - Outline watersheds - relative to runoff and/or impoundment
- Vegetation
  - Vegetative types
  - Trees - quality assessment regarding decisions to save or remove vegetation
- Property Boundaries
  - Bearings
  - Point of beginning - benchmarks
  - Coordinate systems
- Easements - for utilities
  - Function
  - Where located
  - Common width
- Rights of Way - for access across properties
  - Function - streets, roads
  - Where located
- Waterways
- Wetlands and wetland conditions
  - Issues relative to construction - runoff, erosion
  - Issues relative to setbacks
- Structures - grades and slopes
- Utilities
  - Water
  - Electric
  - Gas
  - Telephone
  - Sewer
    - storm - slope of pipe, depth of cover
    - sanitary - gravity system - takes precedent over other lines
  - Fiber optic telecommunications, telemetry, or data cable
- Zoning - landuse
- Setbacks
  - Property - front and side boundaries
  - Eco situations - drainage, wetlands, streams
- Hardscape elements - location
- Archaeological info - protect unique archaeological sites

- **Prepare Demolition and Removal Plan**
  - Items from the above to be removed
  - Demolition processes
    - Order of removal
    - Items to be protected, e.g. trees, historic sites, buildings, etc
  - After removal site condition
    - erosion control

- **Prepare Site Protection and Preservation Plans (e.g. soil, existing features, existing pavements, historic elements, vegetation)**
  - This topic utilizes the Existing Conditions plan and the Demolition plan. It states how any particular site element or situation will be protected or preserved.
    - This is Construction Documentation and has nothing to do with assessment of whether a site or object should or should not be preserved
  - Best management practices - with regard to health, safety, welfare

- **Prepare Erosion and Sediment-Control Plan**
  - Location of sediment/erosion control fences on property edges or limit of construction areas
  - Hay bales in drainage ways
    - staking of bales
    - types of bales - plastic or wire tied
  - Seeding and strawing of soil storage piles
    - seed and straw if going to be unused for greater than 30 days
  - Locate structure to prevent erosion from draining into sensitive ecological areas
    - Detention basins and/or retention basins
      - location
      - size - relative to watershed served by basin
      - depth - depending on amount of water and area available
      - shape - length vs. width
      - top of dam and bottom elevations
    - Direction of drainage flow - with arrows
  - Setbacks from existing streams or wetlands
  - Best management practices required by the National Pollution Discharge Elimination System (NPDES) Construction Activity regulations to meet Clean Water Act
    - 56 states, districts and territories
    - corresponding regulations in Canada
    - Note: See "A Guide to Temporary Erosion-Control Measures for Contractors, Designers and Inspectors" www.ndhealthgov/WQ/Wastewater/pubs/BMPManual
    - This manual is the BMP Manual of the NPDES. It is very concise with excellent graphics. It contains:
      - Bale Ditch and Silt Fence Ditch Checks
      - Triangular Silt Dike Ditch Checks
      - Rock Ditch Checks

        - Bale Slope Barriers
        - Silt Fence Slope Barriers
        - Bale Drop-Inlet and Silt Fence Drop-Inlet Barriers
        - TSD (tm) Drop-Inlet and Block and Gravel Inlet Barrier
        - Drop-Inlet Gravel and Wire Mesh Filter and
        - Drop-Inlet Sediment Trap
        - Temporary Erosion-Control Blankets
        - Seeding

- **Prepare Layout and Materials Plan**
    - Locate building/structure from Point of Beginning (POB) /benchmark
    - Proper layout techniques - order of layout hierarchy
    - Dimensioning - various approaches
    - Types of materials used on a site
        - order of construction
        - reference to details

- **Prepare Grading Plan**
    - Calculating slopes - percentages and use of units rather that feet and inches or metric
        - Difference in elevation
        - Length or distance
        - Slope in percent or ratio
    - Contours
        - existing - dashed lines
        - proposed - sold lines
        - high side - low side
        - intervening spot elevation between like contours
        - distance between contours indicates slope percentage
        - darken every 5th contour
        - Indicate contour number on high side of contour
    - Finish floor elevation (FFE)
        - Always indicates a finished floor surface on interior of a structure
    - Spot elevations on corners of building
        - outside foundation corners
    - Spot elevations (SE)
        - high and low points
        - critical points
    - High point on a swale (HPS)
        - prevent water from flowing toward building or other hardscape
        - direct flow toward drain inlet or stream generally 6 inches lower than FFE
    - Drain Inlet
        - rim elevation
        - invert out elevation
        - invert in elevation

- Step elevations
  - risers are generally 6 inches (.5 ft)
  - require SE at top and bottom of step run
- Slopes of elements - minimum to maximum
  - hardscape - 1% minimum to 5% maximum
  - softscape - 2% generally considered minimum to maximum of 3:1
  - direction of water flow
    - perpendicular to contour
    - centerline of swale
- Locate a dam for retention, detention or storage of water (see "Prepare Erosion and Sediment-Control Plan" section above)
- Roadways
  - slope of roadway
  - crown - height of crown - 3', 4", 6", 9"
  - curb height - generally 6 inches (.5)
  - walkway
    - longitudinal slope generally the same as the slope of the adjacent roadway
    - cross slope - generally 1%
    - most often drains toward the roadway
  - shoulder
    - adjacent to roadway without a curb
    - longitudinal slope same as that of roadway
    - cross slope - generally 2%
  - swales
    - depth - generally 1 foot
    - on up hill side of roadway
  - grading back to existing
    - meet existing on downhill side of roadway
  - roadway alignment
    - horizontal - curve and super elevation relative to design speed of roadway
    - vertical - safety relative to entering and exiting slopes
    - daylight a curve - clear site distance
- Culverts
  - size of pipe
  - cover over pipe
  - invert and top elevations
  - slope of pipe
- Surface drainage and calculations
  - $Q = CIA$
    - C = Runoff coefficient - pervious to impervious
    - I = Intensity of storm
    - A = Area in acres
    - Q = Runoff in cubic feet per sec

- calculate amount of water to detain or store
- slope of land form relative to speed of runoff
- direction of flow perpendicular to contour
- Slope on pipe
- Cover over pipe

- Subsurface drainage and calculations
  - pipe sizing - using nomograph
  - slope of pipe
  - exiting and entering inverts
    - with same size pipe entering and exiting
    - with different size pipes entering and exiting
  - coefficient of friction - on pipe sizing nomograph
  - Freeboard
- Dams and weirs
  - configuration
  - dam - earthen
  - weir - concrete flume
- Visual screening
  - height of object to be screened
  - standard height of viewer
  - standard viewing height from automobile
  - location of mound to effect proper screening
- Pathways
  - slopes and as related to existing situation
- Roadway location as related to minimum and maximum slopes

- **Prepare a stormwater management plan**
  - Identify watersheds relative to stream flow
  - Identify watersheds relative to localized runoff
    - roof runoff
    - pavement
    - turf
    - planting areas
  - Identify direction of drainage
  - Raingardens
    - configuration
    - plant materials
    - drainage
  - Roofgardens
    - identification of basic cross section
    - order of basic construction elements
      - waterproofing
      - geotextile
      - drainage
      - lightweight planting medium for low growing plants
      - point loading for tees and large shrubs with berms

- Protect sensitive wetlands or unique ecological areas or habitats
- Bio-swales -locate drainage structures to prevent drainage from reaching sensitive areas
- Locate dam and size impoundment
  - quantity of storage
  - surface area and pool elevation
  - depth of storage

- **Prepare Planting Plans**
  - Types of plants to use in certain situations (context, performance)
    - Ecological
      - wet to dry conditions
      - soil type variation
    - Safety and welfare
      - overhang
      - thorns
      - fruit drop
      - poisonous characteristics if ingested - berries, leaves
      - sight lines - automobile
        - clear visibility zone at intersection of two streets, at street and access drives
        - generally between 3 feet and 6 feet above grade or relative to driver's eye level
          - 4 feet to 5.5.feet above road surface
      - screening - to not cause a hiding spot for bad guys
    - Health and Comfort
      - Shade from sun
      - Screen from wind and undesirable views
  - Plant ID - there is no need to ID plants by genus and species nomenclature.
    - the requirement is to recognize and match-up functional requirements
    - site context and climate performance to basic plant characteristics
      - evergreen hedge for screening to 10 feet high
      - overhead canopy trees for shade
      - species for arid or wet climates or soils
      - wind attenuation
  - Planting specifications
    - Planting pit
      - size
      - depth
      - backfill
    - Staking and guying
      - Approach
      - Safety of guy wires - flags
    - Time of year to plant

- **Prepare Project Sections and Profiles**
  - This will probably be set up such that a section or profile will be given as a drawing on the screen. The responder will be asked a number of questions about the section in question
    - Is the section or profile properly presented
    - Is it complete
    - What is missing or what is wrong

- **Prepare Construction Details**
  - Will probably be given a construction detail as a drawing on the screen and will then be asked a number of questions relative to that detail
  - Materials
    - Wood
      - Treated
      - Non treated
      - Span of the elements - beams, post, joists, decking
    - Metal
      - Iron
      - Steel
      - Aluminum
    - Concrete
      - Strength
      - Finish
      - Reinforcing
      - Depth
      - Frost depth
    - Masonry units
      - Concrete block
      - Brick
      - Precast retaining units
    - Paving
      - precast
      - cast in place
    - Size of the materials
    - Connection of elements
      - wood to wood
      - wood to concrete

- **Prepare General Contract and Bidding Specifications**
  - Since this is "Construction Documentation" one would presume that it covers the area as it applies to actual construction.
  - Note: Refer to LARE exam Sections 1,2 &3 for lists of basic term of reference. Expect to properly identify the basic proper order of documents needed for construction document packages
    - a public agency bid

- design bid documents
- permit submittal to a local agency
- order of basic components
    - Notice to Bidders
    - Invitation to Bid
    - Bid Instructions
    - General Provisions
    - Special Provisions
    - Supplemental Provisions
    - Technical Specifications - follow CSI order
    - Cover Sheet with Vicinity Map and legal description
    - Existing Conditions Map and Surveys
    - Layout Plans

- **Prepare Technical Specifications**
    - Expect to properly identify the order of technical specifications as outlined by CSI format or order
        - general and procedural items - testing, quality control
        - materials in order found in a typical CSI format set of specifications

Note: If you have questions, I will attempt to answer them.
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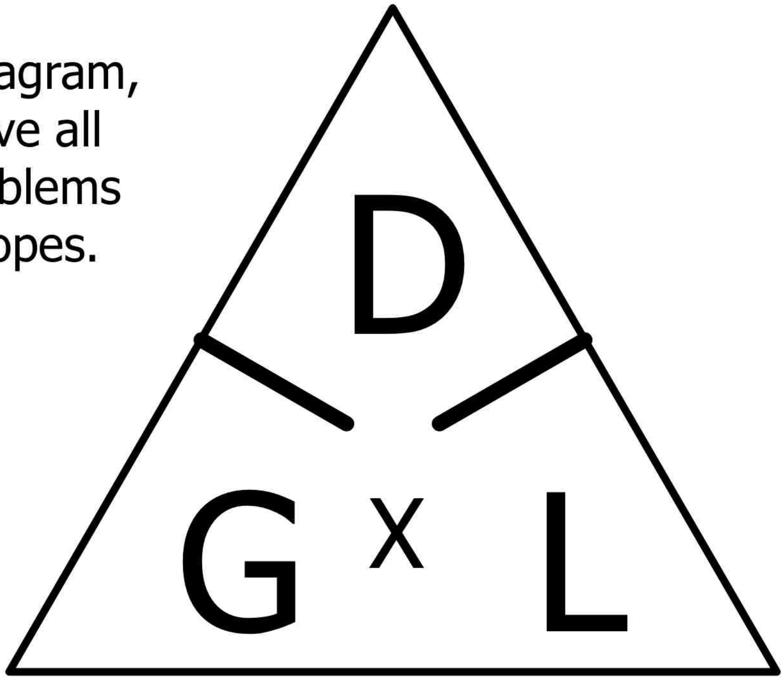
UNIVERSAL SLOPE CALCULATION DIAGRAM

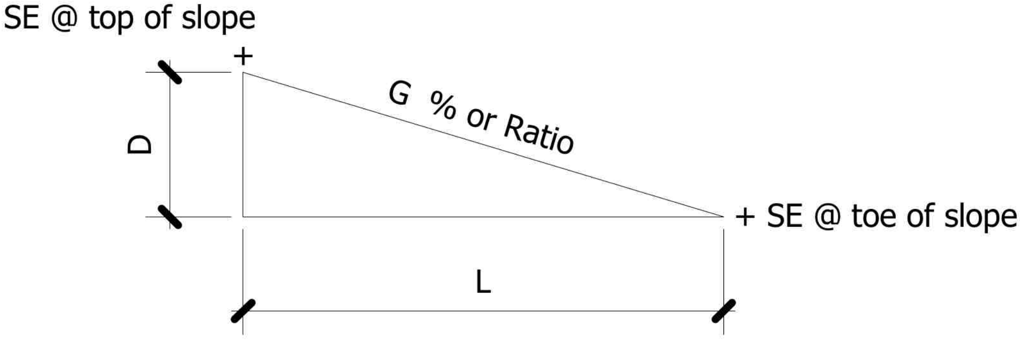
With this diagram, you can solve all grading problems involving slopes.



D=GxL
"D" is the difference in elevation from a spot elevation (SE) at the top of a slope to a SE at the toe of a slope.

G=D/L
"G" is the gradient of a slope and can be presented as a percentage (%) of a ratio e.g. 1:3

L=D/G
"L" is the length of a slope measured horizontally from the top SE to the toe SE



Contours: Some Rules and Basic Considerations

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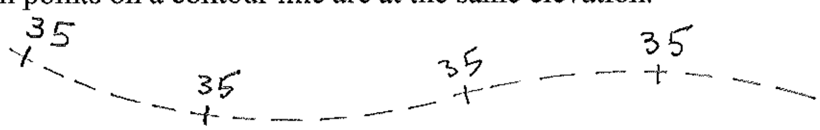
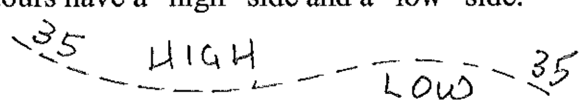
The following is a summary of the basic rules of contours. Each rule is important. Collectively they provide information and considerations necessary for the resolution of any grading and drainage situation. By definition, a contour line is an imaginary line which connects points of equal elevation. In grading and drainage, contours are used to depict topographic relief, where topography is broadly defined as the shape or configuration of the earth's surface.

1. All points on a contour line are at the same elevation.

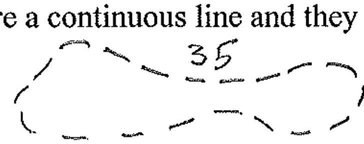


2. All contour lines are derived from a know point of elevation, with the zero elevation point being "Mean Sea Level"
   - Other points of beginning for elevations are Coast and Geodetic Survey Bench Marks which are derived from mean sea level
   - Temporary bench marks can be established in situations where only a difference in elevation within a site is required

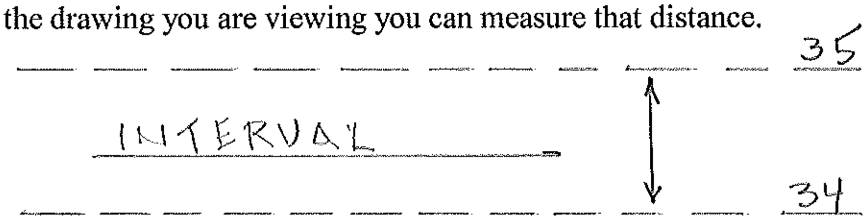
3. All contours have a "high" side and a "low" side.



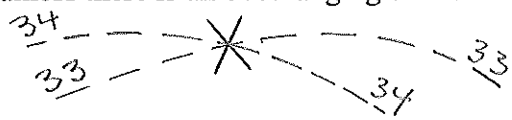
4. All contours are a continuous line and they ultimately close on themselves.



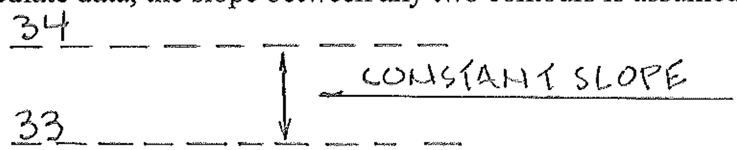
5. The distance between contours is the CONTOUR INTERVAL. If you know the scale of the drawing you are viewing you can measure that distance.



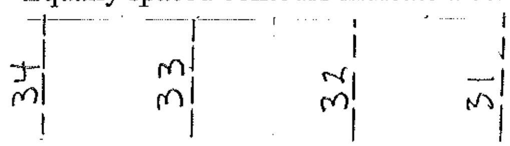
6. Contours never cross. They are always separated by the contour interval (exception to rule: unless there is an overhanging cliff or outcropping of some sort).



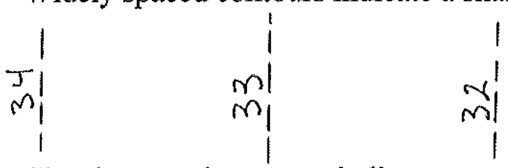
7. With no intermediate data, the slope between any two contours is assumed to be constant or smooth.



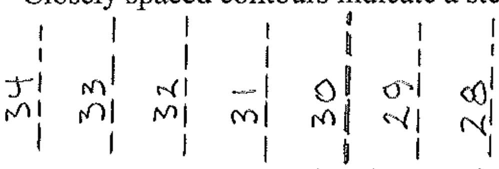
8. Equally spaced contours indicate a constant or uniform slope.



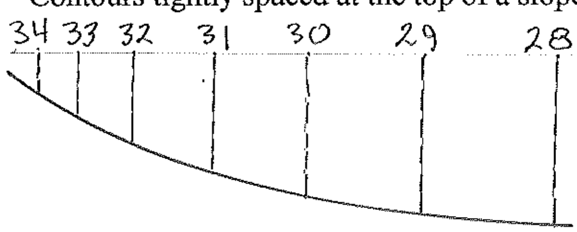
9. Widely spaced contours indicate a shallow slope



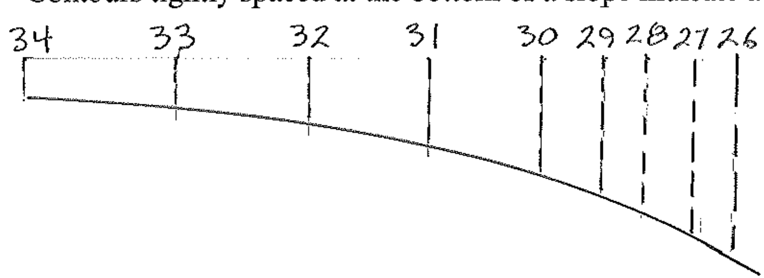
10. Closely spaced contours indicate a steep slope.



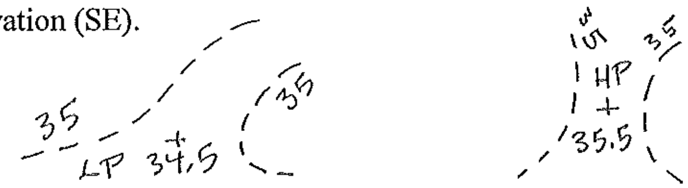
11. Contours tightly spaced at the top of a slope indicated a concave slope profile



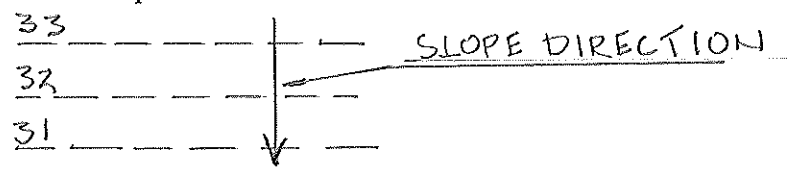
12. Contours tightly spaced at the bottom of a slope indicate a convex slope profile.



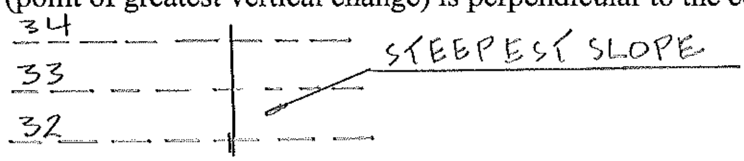
13. No two, like numbered contours can occur adjacent to each other without an intervening Spot Elevation (SE).



14. Two or more contours are required to indicate a three dimensional form and direction of slope.

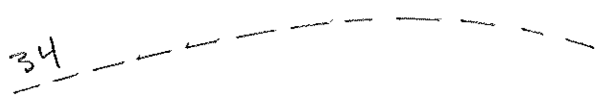


15. The steepest slope (point of greatest vertical change) is perpendicular to the contour lines.

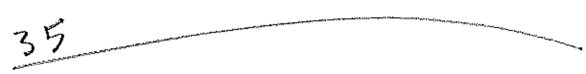


16. Water flows perpendicular to contour lines because that is the steepest vertical change between contours (see 15 above).

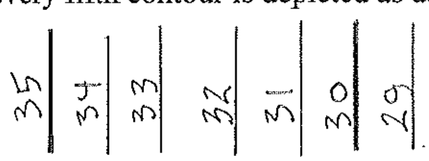
17. Existing contours are depicted by a dashed line.



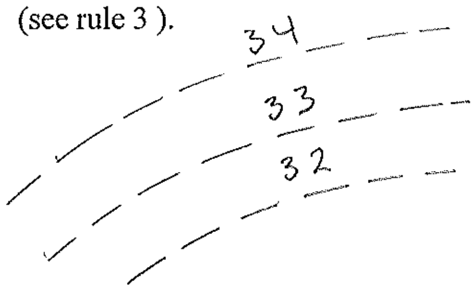
18.. Proposed contours are depicted by solid line.



19. Every fifth contour is depicted as darker than the ones between them

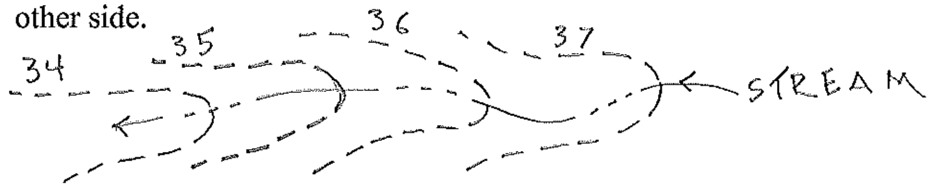


20. When identifying contours, indicate the contour number on the high side of the contour (see rule 3).

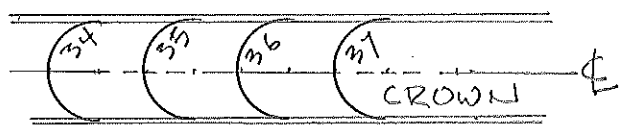


21. Contour signatures:

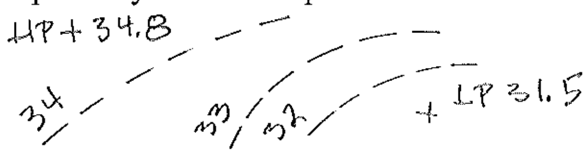
- Contours always point up for valleys, streams, drainage swales, ditches, etc. For example, they run "up" one side of a valley, cross the valley and run "down" the other side.



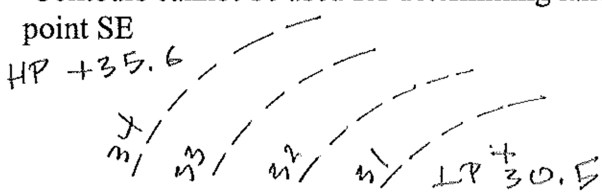
- Contours always point down for ridge lines and roadway crowns.



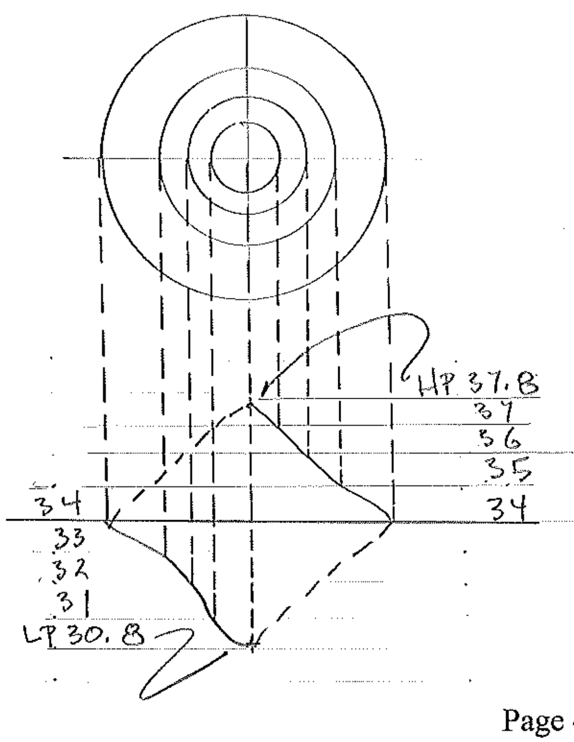
22. Spot Elevations (SE) always take precedent over elevations as depicted by contours. Ses are precisely determined points while contour lines are only representative of an elevation



23. Contours cannot be used for determining land forms without a high point SE and a low point SE



24. Plan and profile of a contour signature



Basic Surveying Terms

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Latitude - angular distance from any part of the earth measured North and South of the equator in degrees

- Latitude lines run horizontally around the earth
- They are parallel to each other
- They are approximately 69 miles apart
- They are numbered from 0º to 90º North and South
- 0º is at the equator
- 90º is at the poles

Longitude - is the angular distance of any point on earth measured east or west of the prime meridian

- Known as the meridians, latitude lines converge at the poles
- 0 º longitude (prime meridian) is at Greenwich, England
- At the equator longitude lines are approximately 69 miles apart
- They continue 180º East and 180º West of Greenwich
- They meet at the international date line in the Pacific Ocean

Degrees of Latitude and Longitude

- Are divided into minutes and seconds with 60" in each degree and 60' in each minute
- 1 degree is approximately 69 miles
- 1 minute is approximately 1.15 miles
- 1 second is approximately 100 ft.
- 1 mile is 5280 ft.- this is accurate
- The US Capital is at 38º 53' 23" N of the equator, 77º 00' 27" W of the prime meridian

Azimuth - is the clockwise angle from the north end of the reference meridian line to the line in question.

- An arc of the horizontal measurement between fixed points
- In measuring angles by the azimuth method, all angles are between 0º and 360º

Magnetic Declination - is the angle between magnetic north and true north. On an east declination magnetic north is greater than true north.

Bearing - is the horizontal angle measured from North to East or North to West, South to East or South to West

- A bearing cannot be greater than 90º, e.g., N 20º 15' 30" E

Northing/Easting - geographic coordinate for a point

- Easting - the eastward measured distance from the x coordinate
- Northing - the northward measured distance from the y coordinate
- Township descriptions are started from horizontal and vertical lines called Northings and Eastings

Land Survey - a land survey is the measurement of boundaries and/or area of a particular place or group of places. It primarily includes:

1. Legal boundary surveys - establishing or recreating property lines
2. Positional accuracy - beginning a survey from an established point
3. Layout and staking to guide construction
4. Field surveys to establish topographic or other land use maps

Plane Surveying - horizontal distances are always measured on a horizontal plane

- Distances recorded on deed restrictions and surveys are horizontal

Traverse - in surveying it is a series of successive lines (often property lines) that are connected together. For example, a calculation which begins at a known plot corner and utilizes the lengths and bearings of the plot description and ends at the point of beginning is known as a traverse.

Layout - location of the main elements of a project on the ground

Point of Beginning (POB) - Is a fixed, existing element in te landscape where surveying begins. It identifies the reference point to which all critical elements of the survey or project must relate and is identified on a drawing as, for example:

- US Coast and Geodetic Survey Marker
- Survey Monument
- Center of roadway intersections
- Property line corner
- Corner of a building

Circles

- Circumference of a circle = π x diameter
- Area of a circle = π x radius^2
- $\pi = 3.1416$

Township - 36 square miles

One square mile - 640 acres

One acre - 43,560 square feet

Right Angles - without the use of a surveying instrument , right angles may be determined with tapes by using the proportion 3, 4, 5

- Pythagorean Theorem - $a^2 + b^2 = c^2$

Vertex - The vertex of an angle is the point where two line segments meet or cross

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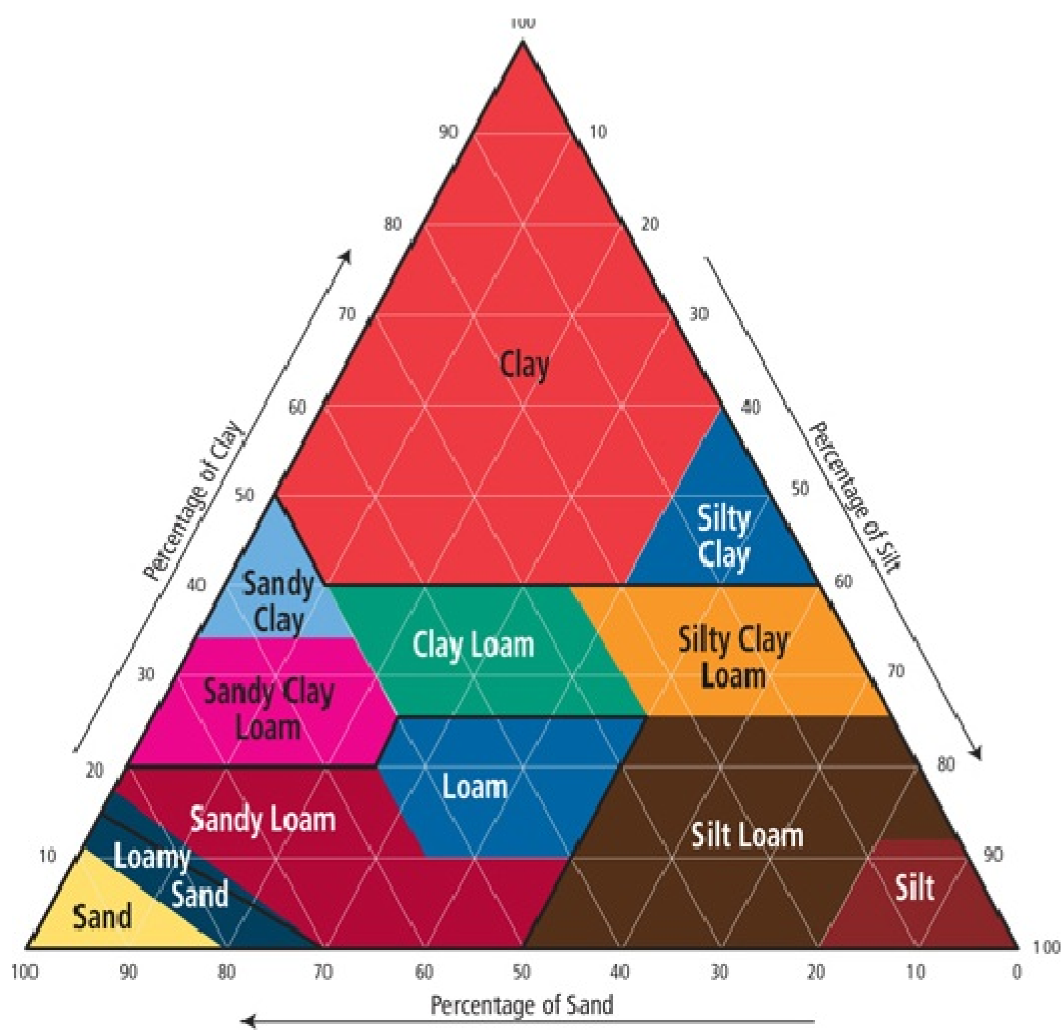
Soil Basics - The following is basic soil information that has traditionally been covered in previous LARE review sessions. You should be familiar with the issues presented here and then expand on the information as you see fit and have time. For all practical purposes everything is on the web. Just GOOGLE the main headings listed here.

- How to read a Soil Texture Triangle Chart
  Example: Classify the texture of a soil that is 30% clay, 20%silt and 50% sand?
  From the Triangle find: 1. the % of clay and follow the line
  2. the % of silt and follow the line
  3. the % of sand and follow the line
  Find where the line intersect, that is the soil texture - Sandy Clay Loam in this case



- The Twelve Soil Orders - listed below in the sequence in which they key out in Soil Taxonomy
  - ☐ Gelisols - soils with permafrost within 2 m of the surface. Limited geographically to high latitude polar regions
  - ☐ Histosols - organic soils. Referred to as peats and mucks. There physical properties restrict their use for engineering purposes
  - ☐ Spodosols - acid forest soils with a subsurface accumulation of metal-humus complexes. Often occur under coniferous forests in cool, moist climates
  - ☐ Andisols - soils formed in volcanic ash
  - ☐ Oxisols - intensely weathered soils of tropical and subtropical environments
  - ☐ Vertisols - clayey soils with high shrink/swell capacity. The shrink/swell actions create serious engineering problems
  - ☐ Aridsols - CaCo3 - containing soils of arid environments with subsurface horizon development. Used mainly for range, wildlife and recreation. Not used for agricultural production unless irrigation water is available
  - ☐ Utisols - strongly leached soils with a subsurface zone of clay accumulation and ≥35% base saturation. The dominant soils of much of the southeastern US. Have subsurface horizon in which yellowish or reddish clay has accumulated
  - ☐ Mollisols - grassland soils with high base status. Some of the most productive soils in the world. Occur in mid-latitudes and prairie regions
  - ☐ Alfisols - moderately leached soils with a subsurface zone of clay accumulation and ≥35% base saturation. Very productive soil and support about 17% of the worlds population
  - ☐ Inceptisols - soils with weakly developed subsurface horizons. Found in mountainous areas and are used for forestry
  - ☐ Entisols - soils with little or no morphological development. Developed in unconsolidated parent material with great diversity in environmental setting and land use
    From: http://soils.cals.uidaho.edu/soliorders/orders

- Podsolization - soil developed in humid, cold to temperate regions where the vegetation produces acidic humus

- Lateritic Soils - associated with North American tropical regions

- Rock types
  - ☐ Metamorphic - any sedimentary or igneous rock created with increase in temperature and pressure - form deep in the earth's crust
  - ☐ Igneous - formed directly from cooling of magma - melted rock that has cooled and solidified - the majority of the earth's crust
  - ☐ Sedimentary - pieces of rock cemented together by chemicals or minerals

- Soil Classification Systems
    - Unified Soil Classification System (USCS) - classification system used in engineering and geology to describe the texture and grain size of a soil
        - Gravel (G) - greater than 50% of material retained on a #4 sieve
        - Sand (S) - soil particles between 0.05 and 2.0 mm - 2.0 is very course sand
        - Silt (M) - soil particles between 0.002 and 0.05 mm
        - Clay (C) - soil particles smaller than 0.002 mm (2 microns)
        - Organic (O) - highly organic - peat
    - Soil components are described as gravel, sand, silt, clay or organic- from larger to smaller grain size
    - ASSHTO soil classification system is used for road construction
    - Atterberg Limits - used to determine a soil"s classification
        - are a basic measure of the nature of a fine grained soil
        - it may appear in four states - solid, semi-solid, plastic and liquid
        - test is used in the preliminary stages of building any structure to ensure that the soil has the correct amount of shear strength

- Liquid Limit - the liquid limit of a soil occurs when a soil passes from a solid state to a liquid state with an increase of moisture

- Sieve Analysis and Particle Analysis - the grain size characteristics of soils that are predominantly coarse grained are evaluated by sieve analysis
    - The higher the sieve number the smaller the grain size
    - A #4 sieve passes grains up to 4.75 mm
    - A#200 sieve passes grains up to 0.075 mm

  used mainly on clayey or silty soil since they expand and shrink due to moisture content

- Soil pH - is a measure of the acidity or basicity of a soil
    - Ranges from 0 to 14
    - 7 is considered neutral
    - Below 7 is acidic while 3.5 is ultra acid
    - Above 7 is basic while 9.0 is ultra alkaline
    - The optimum pH for most plants is between 6.0 and 7.5 but many plants thrive outside this range
    - pH specifically plant nutrient availability

- Soil Gradation - soil or gravel is typically graded as well graded or poorly graded
    - Well Graded - contains particles of a wide range of sizes and a good representation of sizes. A well graded soil will compact better than a poorly graded soil.
    - Poorly Graded - does not have a good representation of particle sizes. If they are uniformly graded most of its particles are of the same size, e.g., sand. A poorly graded soil will have better drainage than a well graded soil

- **Permeability** - is the quality which permits movement of water and air through the most restrictive soil layer in the rooting zone.
  - Slow - permeability in the most restrictive soil layer is 0.06 to 0.60 inches per hour, the most restrictive layer is commonly the lower subsoil
  - Moderate - permeability in the most restrictive soil layer is 0.6 to 2.0 inches per hour, usually loamy subsoils with blocky, subangular blocky, or prismatic soils
  - Rapid - permeability in the most restrictive soil layer is more than 2.0 inches per hour, often loose sandy subsoils with little if any defined structure or restriction to movement of air and water

- **Bearing Capacity** - capacity of the soil to support loads applied to the ground.
  - The maximum load per unit area which the soil or rock can carry without yielding or displacement is termed as the bearing capacity of soils.
  - For example, a point load of 6 tons can be accommodated to soil with a bearing capacity of 2000 lbs. per sq. ft. with a footing of 6 sq. ft.
  - all weight applied to a construction element is transferred to the soil

- **Safe Bearing Capacity** - the maximum intensity of loading that a soil will safely carry without risk of shear failure.
  - the soil must have the capacity to support the weight of the material (dead load) plus the applied weight, either static or dynamic activity on the material (live load).

- **Soil Compaction** - the method of increasing the density of soil. Almost all building sites and construction projects utilize mechanical compaction techniques.
  - Compaction increases load bearing capacity
  - Prevents soil settlement and frost damage
  - Reduces water seepage, swelling and contraction
  - Procter Test - determines the maximum density of a soil
  - Compaction density depends on soil type. Some soils give little bearing capacity at 98% while others are rock hard

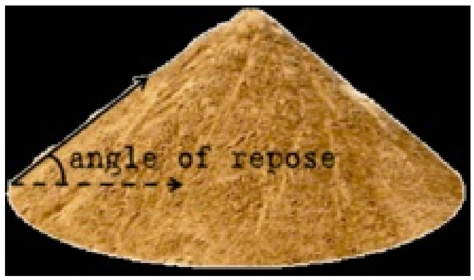
- **Differential Settlement** - structural failure due to unequal settlement. When part of a building is on compressible stratum and the rest of the building is on firm soil strata.

- **Hardpan** - a dense layer of soil usually found below the uppermost topsoil layer
  - impedes drainage and restricts the growth of plants
  - is an issue with foundations - often requires breaking through the hardpan layer as its bearing capacity may not be sufficient to support a foundation

- **Cohesion** - the ability of soils to stick to one another
  - clay soils are cohesive
  - sand soils are not cohesive

- Shear Resistance - the resistance of soil to movement when pressure or impact is applied
  - ☐ occurs from the friction between the soil particles as they slide by one another
  - ☐ he higher the shear resistance the greater the compactive force required
  - ☐ clay has high resistance
  - ☐ sand has low resistance

- Angle of Repose - The angle of repose of soil or a granular material is the steepest angle of descent of the slope relative to the horizontal plane when material on the slope face is on the verge of sliding. The angle varies as soil types vary



- Ericaceous plants - most often require acidic soil. most plant material will not tolerate excessively wet soil because water displaces air

- Littoral Drift - term used for the transport of non-cohesive sediments, mainly sand, along the shore face due to the action of breaking waves.

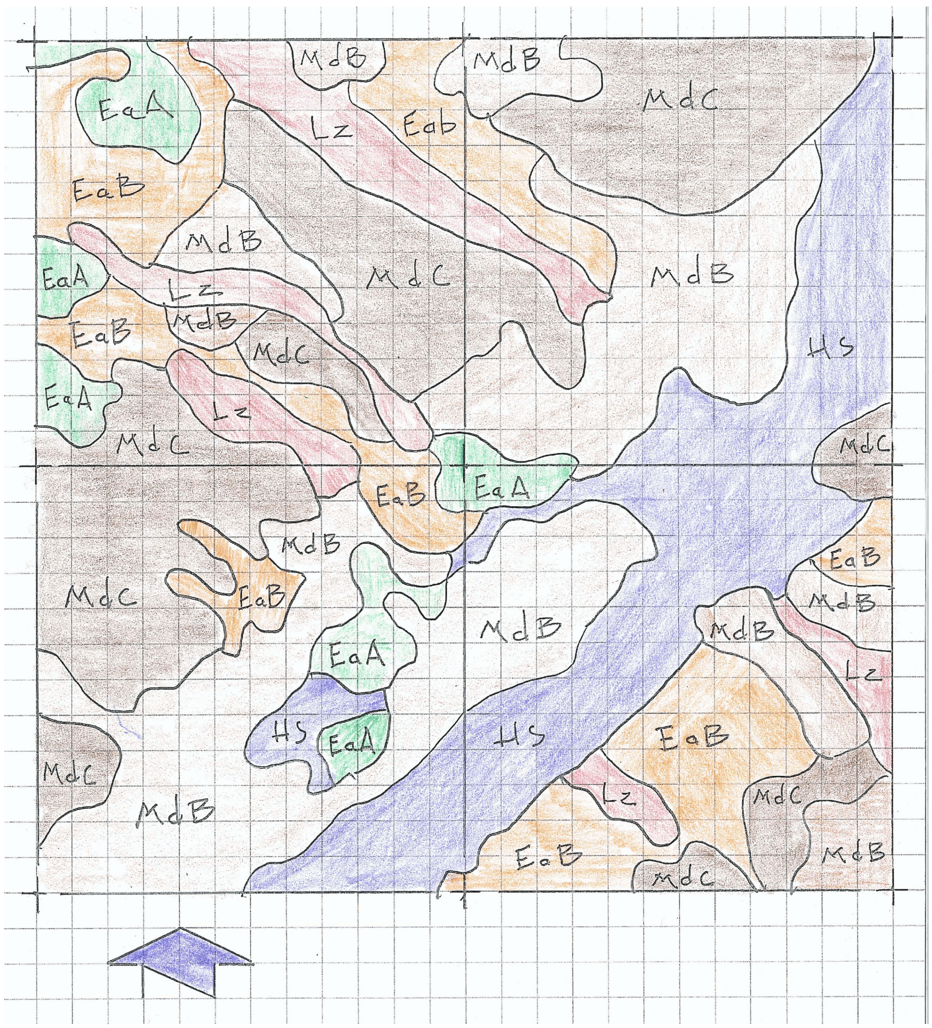
- Aquilude - the impermeable beds above and below the water bearing bed in an artesian system

- Frost Depth - depth to which water freezes in soil.
  - ☐ varies by region of country
  - ☐ frost dept for the sake of construction and code compliance is generally set by state Departments of Transportation
  - ☐ impacts depth of foundations and base of roadways

- Frost Heave - water freezes in soil foundations to the depth of the frost line and causes frost heave on the surface
  - ☐ can destroy surface construction, eg., pavement
  - ☐ need to control water movement under paving which is subject to freezing

Soils Mapping - a soil survey map contains information that can be:

- Applied in managing farms and woodlands
- Used in selecting sites for roadways, ponds, buildings and other structures
- Used in judging the suitability of tracts of land for agriculture, industry, recreation, etc.



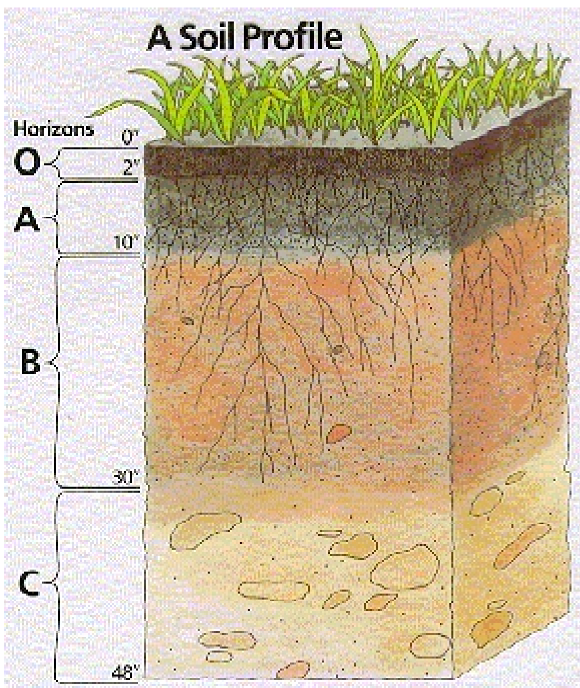
Soil types as indicated on the soils map

HS	Huntington Silt Loam	- deep alluvial soil, well graded sand, subject to periodic flooding, moderate to rapid permeability, slopes 0 - 2%
MdB	Maury Silt Clay	- moderately deep (10 - 15 feet), primarily silt clay, moderate to rapid permeability, slopes 5 - 15%
MdC	Maury Silt Clay	- same as MdB except 15 - 25% slope
Lz	Lowell Silt Clay	- deep sediments, primarily silt-clay with high water table - 6 - 18 inches below surface, moderate to slow permeability, generally unstable, slopes 20 - 45%
EaA	Eden Silt Loam	- deep glacial till, primarily well graded sand - silt - clay, slow permeability, slopes 2 - 8%
EaB	Eden Silt Loam	- same as EaA except slopes 9 - 15%

Possible questions

- Which soil type is most suitable for intensive active recreation as well as the development of commercial and residential development? (MdB)
- Which soil type is most desirable for preservation as a conservation area and not urban development? (Lz)
- Which quadrant on the map is most suitable for a high-density apartment complex? (SW)

- Soil Horizon - a layer to the soil surface whose physical characteristics differ from the layers above and/or beneath. The term horizon describes each of the distintive layers that occur in a soil.
    - O Horizon - Organic matter - plant residue in relatively undecomposed form
    - A Horizon - top layer of the soil horizon or "topsoil" - zone in which most biological activity occurs
    - B Horizon - commonly referred to as "subsoil" - consists of mineral layers which may contain concentrations of clay or minerals
    - C Horizon - little effected by soil forming processes (weathering) - contains parent material and forms the framework of the A and B horizons
    - R Horizons or Layers - hard bedrock - R layers are cemented and excavation is difficult



From: Jim Turenne http://nesoil.com

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D = Difference in Elevation
D = G x L
G = Slope in Percentage or Ratio or Gradient
G = D/L
L = Length (Hor. Dist. between Elev. Points)
L = D/G

GRADING A ROADWAY

This represents many of the components commonly found in day to day site grading and drainage

Definitions

- **Crown** - difference in elevation between the center line and the edge of the roadway
  - Roads are commonly crowned to improve storm runoff from the road surface (**contours at the center of the roadway crown always point down hill**).
  - Crown height is expressed in: inches, tenths of a foot, inches per ft., or slope percentage. For example:
    - The 6 inch crown of a 24 ft wide road is expressed:
    - Roadway Width / 2 = Width of one side of the crown (24'/2 = 12')
      - 6 in.=.5' = ½ inch per foot = 4.17% cross pitch

- **Curb** - is the vertical elevation change at the edge of the roadway.
  - While usually 6 inches high (.5) a curb may range from as low as 3 in. (.25) to as high as 9 in. (.75).
  - Curbs are used to direct and restrict storm run-off and to provide safety for pedestrians along the road edge.

- **Swale** - is a drainage channel having a vegetated surface - usually grass.
  - The depth of swales is measured as the difference in elevation between the centerline of the swale and a point at the edge of the swale on a line taken perpendicular to the centerline.
  - The contour signature of a swale is similar to that of a valley (**contours at the center of a swale always point up hill).**

- **Shoulder** - is the area adjacent to a roadway that does not have a curb or a swale.

- Shoulders are used primarily as a safety mechanism whereby a vehicle can pull off of the road safely.
- They are generally graded (though not always) to drain away from the road, usually at 2% to 3%.

Grading Procedure

- Locate a spot elevation (**SE**), generally given, along the centerline (**CL**) of a road. Then proceed to locate a full contour.
  - Example: Given a SE of 25.42 and a roadway slope of 3% locate the 25' contour
  - Difference in elevation between 25.42 and 25.00 = .42.
  - Distance at 3% = 14 ft. (.42/.03 = 14.0 ft.)
- Given a crown height of 6" (.5) establish the crown of the road.
  - The spot elevation at the edge of the road opposite the 25.0 ft. SE is .5 lower or 24.5 ft.
  - The 25.0 ft. SE is located uphill from this point.
  - A 3% road slope and a difference in elevation of .5 the distance is 16.7 ft. (.5/.03 = 16.7 ft.).
- Given a curb height of 6 in. (.5), means that the elevation at the top of the curb is always .5 ft. above the elevation of the road pavement.
  - Where the edge elevation of the road is 25 ft., the top of the curb is 25.5 ft.
  - Where the edge of the road is 24.5 ft. the top of the curb is 25.0 ft.
  - Therefore, the 25 ft. contour follows the curb from the 25' SE at the bottom of the curb to the 25' SE at the top of the curb
  - distance to the contour at the curb depends on the slope of the roadway.
- Given a sidewalk adjacent to the road that slopes toward the road at 2% while at the same time sloping 3% parallel to the direction of the road.
  - Far edge of the walkway is higher than the road edge.
  - Difference in elevation between the two edges is the width (6 ft.) multiplied by the slope (2%) (6x.02 = .12 ft.).
  - The **SE** on the walk opposite the 25 ft. SE is 25.12 ft.
  - The 25.0 ft. SE on the outside edge of the walk is located down hill from the 25.12 ft SE at a slope of 3% (given) (25.12 - 25.00 = .12) (.12/.03 = 4 ft.).
  - The 25 ft. **SE** is located 4 ft. from the 25.12 SE in the down hill direction.
  - Construct the 25 ft. contour line across the walkway by connecting the 25 ft. **SE**’s.
- Given a swale that is 6 ft. wide and 4 in. deep.
  - The center line (**CL**) of the swale is 4 in. (.33) lower than the two edges.
  - Where the edge of the road is 25.0 ft. SE the swale is 24.67 ft.
  - The 25 ft. **SE** along the **CL** of the swale is located by dividing the difference in elevation (.33 ft.) By the slope of the swale CL (3%) (.33/.03 = 11.0 ft).
  - Measuring up hill along the **CL** from the 24.67 ft. **SE** locates the 25.0 ft. **SE**.
  - The contour representing the bottom of the swale is rounded which reflects the rounded shape of the swale. It is symmetrical about the center line of the swale.
- Construct side slopes as you would in any other grading situation, e.g. 5:1, 10%, etc.

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Procedure for Calculating Q and Sizing Pipe for a Closed Drainage System

These are the directions to fill out the **charts** that are to be used when calculating the flow of storm water and the subsequent sizing of the pipe system.

Flow Calculations (Q = CIA)

ID Drainage Area - designate the area **from** which the drainage begins. For example, if it begins at the top of watershed "A" then write watershed A (**WS A**) in the box. .

Length of Overland Flow (in feet) - is the **longest distance** that water will flow in the watershed as designated above. The rationale is that by the time a drop of water gets from the farthest point on the watershed to the inlet point the entire watershed will be flowing at its peak amount. This figure will be used to determine the **time of concentration (TofC)**as per below.

Slope of Overland Flow (in percentage) -is the percent of slope from the top of the identified watershed to the inlet into which the overland flow will drain. Thee steeper the slope the more rapidly the water will flow to the outlet.

C (Coefficient of Runoff) - the coefficient which determines the **amount of water that will flow from a surface area as opposed to that which will soak in.** Impervious surfaces, such as concrete, allow most of the water to flow from them. Pervious surfaces, such as sandy soil, allow most of the water to soak in with very little running off.

Table of Rational Method Runoff Coefficients(C), is be used to determine the proper **C** for each situation

Ground Cover	Runoff Coefficient, C
Lawns	0.05 - 0.35
Forest	0.05 - 0.25
Cultivated land	0.08-0.41
Meadow	0.1 - 0.5
Parks, cemeteries	0.1 - 0.25
Unimproved areas	0.1 - 0.3
Pasture	0.12 - 0.62

Residential areas	0.3 - 0.75
Business areas	0.5 - 0.95
Industrial areas	0.5 - 0.9
Asphalt streets	0.7 - 0.95
Brick streets	0.7 - 0.85
Roofs	0.75 - 0.95
Concrete streets	0.7 - 0.95

T of C (Time of Concentration in minutes) - is derived from the **Nomograph For Overland Flow Time - See attached Nomograph for Overland Flow Time**

1. First get the longest distance (**Length of Run** - from work sheet) the water will need to flow, e.g, from the top of the watershed in question to the designated inlet .
2. Determine the character of the surface that the water will need to flow over. Use the table of coefficients from above to get **C**
3. Determine the average slope percentage from the top of the watershed to the inlet from the worksheet
4. This will tell how long it will take the first drop of water that alights on the farthest point of the watershed to flow to the designated inlet - that is **T of C**

Warning - if you have variable surfaces (e.g., turf and asphalt) you will need to account for them as this will impact the speed with which the water flows. The most convenient way to do this is calculate the size of each surface type and average it to get a weighted average coefficient

Weighted Average - refers to a weighted arithmetic mean

- ☐ Often used in calculating the average coefficient (C) of land areas with different runoff rates
- ☐ For example, within a watershed are two areas. One is 200 acres with a C of 68 and the other is 100 acres with a C of 44. What is the weighted average of C for the watershed. Answer C=60
- ☐ Hint: 200 is .667 (67%) and 100 is .333 (33%) of the watershed. of the 300 acre watershed

I (Intensity of Rainfall in inches per hour)

Using the **Rainfall Intensity Curves chart**:

1. Determine the Storm event to be considered. For most municipal work a 100 year storm event is the basis for calculating maximum water flows. **In Lexington, KY the standard for a 100 year storm is calculated at 3.3 inches per hour.**
2. Using the **Time of Concentration (Duration of Storm in Minutes)** derived above, apply it to the bottom of the Rainfall Intensity Curve chart. Project up to the storm event in question and then project over to the Rainfall Intensity (in/hr) leg of the chart. This will give you **"I"** in inches of rainfall per hour.

A (Acres) - determine the area of runoff for each specific watershed in **acres**. Keep in mind that some watersheds will have different surfaces and therefore different coefficient types. All of this needs to be considered. So calculate each area separately. An acre contains 43,560 square feet

Q_{sub} (Q = peak runoff in cubic feet per sec (cfs)) - is derived from **C** x **I** x **A** above. The reason for the "sub" is that "Q" must be determined for each sub area independently because the Q's are additive.

Q (cfs) - total **discharge in cubic feet per second** per watershed or drainage unit. This is the volume used to size the pipes in the drainage system.

Pipe Sizing

Utilizing the Q (flow in CFS) that was derived for the watershed in question, apply it to the attached Nomograph for Circular Pipes Flowing Full as follows

n (Roughness Coefficient)
Since the roughness of the interior surface of a pipe is a consideration a Coefficient of Roughness (**n**) must be figured into the pipe sizing equation. For standard concrete pipe this figure is (**n=0.013**).The pipe sizing chart provided accounts for the roughness coefficient so you do not need to deal with it in your calculations.

Diameter of Pipe in Inches

Using the **Nomograph for Circular Pipes Flowing Full** and the "**Q**" from above, determine the size of the pipe needed to carry the discharge. In most municipalities a 12" reinforced concrete pipe (**RCP**)is the minimum used. PVC is also used but it has not yet become an industry standard. In determining pipe size, when the line from Q to Slope is above an indicated pipe size go to the next largest indicated.

Slope of Pipe in Percentage

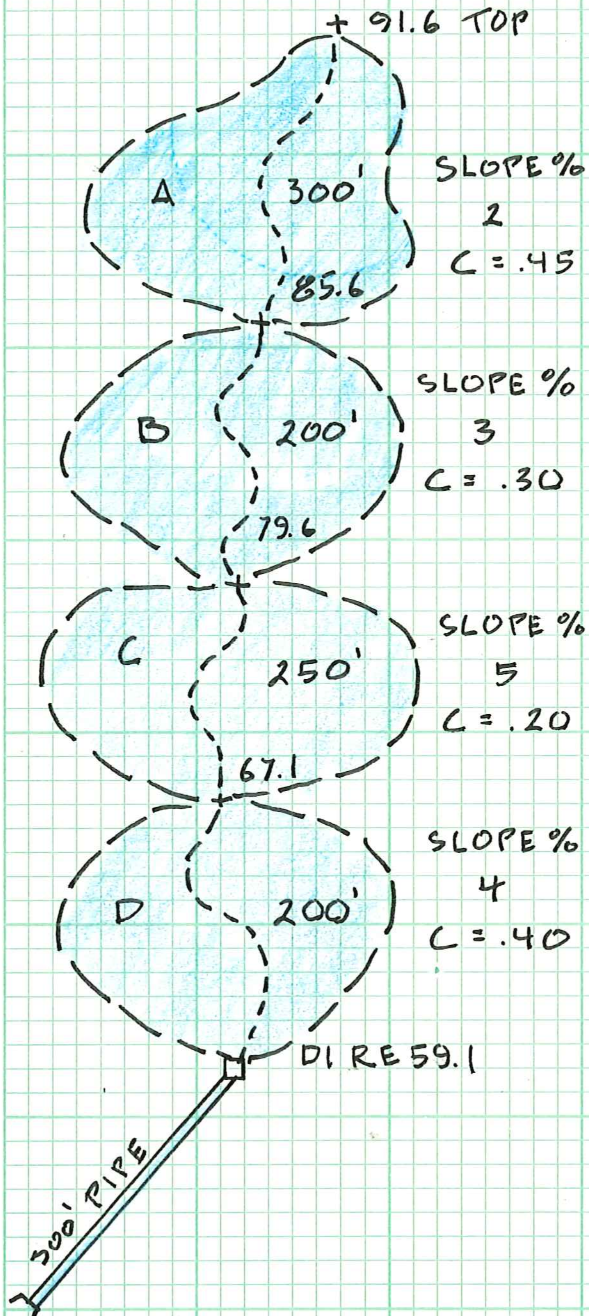
Pipe is generally designed to be placed at a minimum slope of 1%. The is no limit on the maximum side as long as the maximum velocity is not exceeded. For a slope of less than 1% it is required that the pipe be up sized by one size, e.g., a 12" pipe would be up sized to 15", etc.

Length of Pipe in Feet

This is the length of the pipe in feet figured from the center of the inlet to the center of the next inlet or the outlet.

Velocity (fps)

Velocity of flow is another consideration. As a general rule, flow cannot exceed 15 ft per sec or be less than 1.0 ft per sec. - ideal is between 2.0 and 7.0 fps. To increase velocity reduce the size of the pipe or increase the slope. To decrease the velocity, increase the size of the pipe or decrease the slope.



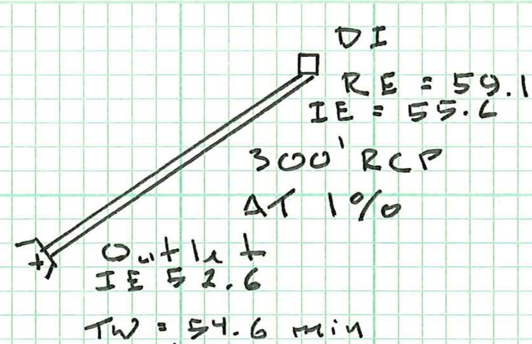
WATERSHED AREA CALCULATIONS TO OBTAIN "Q"

Elevation Change 91.6 - 59.1 = 32.5
Total Length of Run = 950'
Slope % = 3.42
C AVG. = .34 - This would be considered AVG. GRASS

APPLICATION SEE CHARTS 4 & 5

- ☐ Use Length of Drainage Run in ft = 950
- ☐ Use .34 C as Average Grass +/-
- ☐ Use 3.42 % as the Slope
- ☐ Apply to Nomograph For Overland Flow Time
  Resultant = 30 min
- ☐ Apply to Rainfall Intensity Curve Nomograph
  A 100 Yr. Storm Event of 30 min Gives a Rainfall Intensity of 4.5 in HR
- ☐ Calculation
  C = .34
  I = 4.5
  A = 5
  Q = .34 x 4.5 x 5 = 7.65 CFS at DI

PIPE SIZING



- ☐ Overland Flow enters the system at 59.1
- ☐ Flow is 7.65 CFS = Q
- ☐ Using the Pipe Nomograph mark 7.65 on the Flow Line
- ☐ Set Pipe Slope at 1%

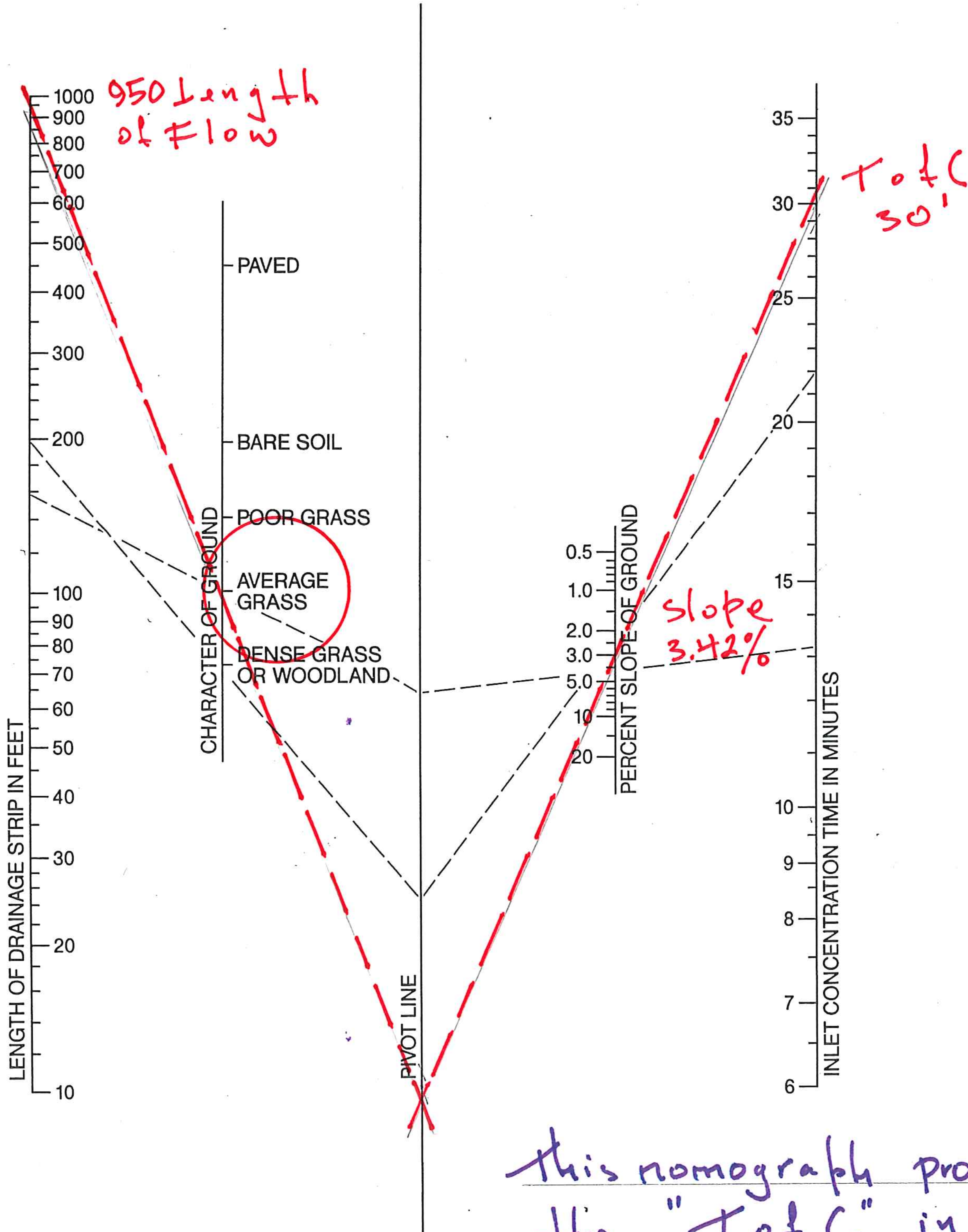
most pipe slopes are set at 1% as a trial to determine if it will drain ok. Slope can be raised or lowered depending on the situation

- ☐ At 1% with a Q of 7.65 an 18" pipe is required since the Nomograph Line crosses above the 15" pipe size.
- ☐ The velocity of flow is approx. 5 fps
  The min. is generally 2.0 fps
  the max. is generally 7.0 fps
- ☐ The Coefficient of friction is n = 0.013 which is built into the nomograph calculations

PIPE ELEVATIONS

- ☐ Entering RE = 59.1
- ☐ Cover over pipe - generall set at 2.0'
- ☐ Pipe size is 18" or 1.5'
- ☐ Invert Elev. (IE) at 59.1 is 59.1 - 2.0 - 1.5 = 55.6
- ☐ 300' Pipe at 1% : 3.0' grade change to outlet
  Invert Elev at Outlet = 55.6 - 3 = 52.6
- ☐ Elev. at Top of Headwall must be at least 54.6 to provide sufficient cover over pipe
- ☐ Make sure there is adequate cover over the entire length of the pipe.

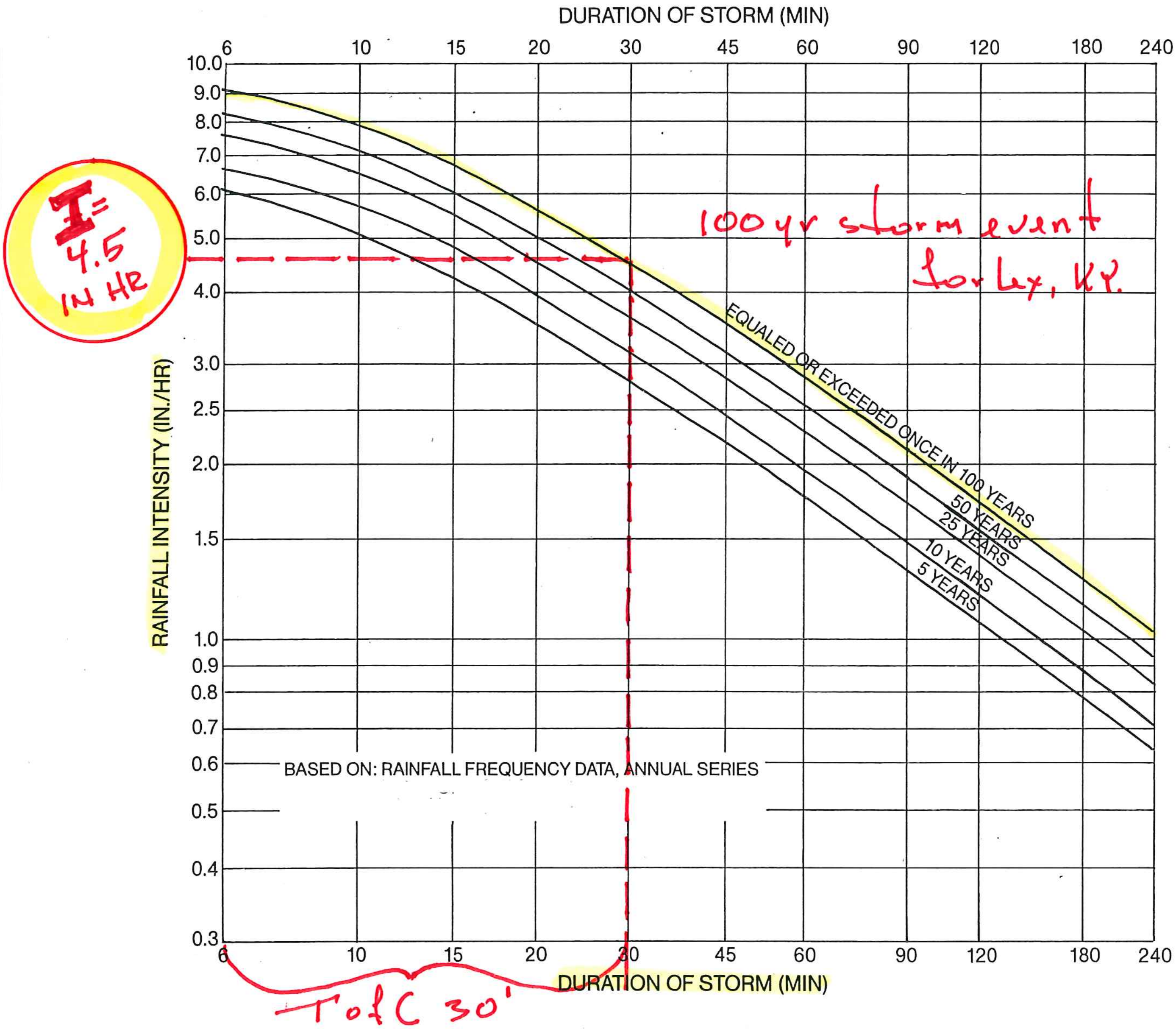
4



NOMOGRAPH FOR OVERLAND FLOW TIME

this nomograph provides the "T of C" in minutes for the Duration Chart

DURATION OF STORM

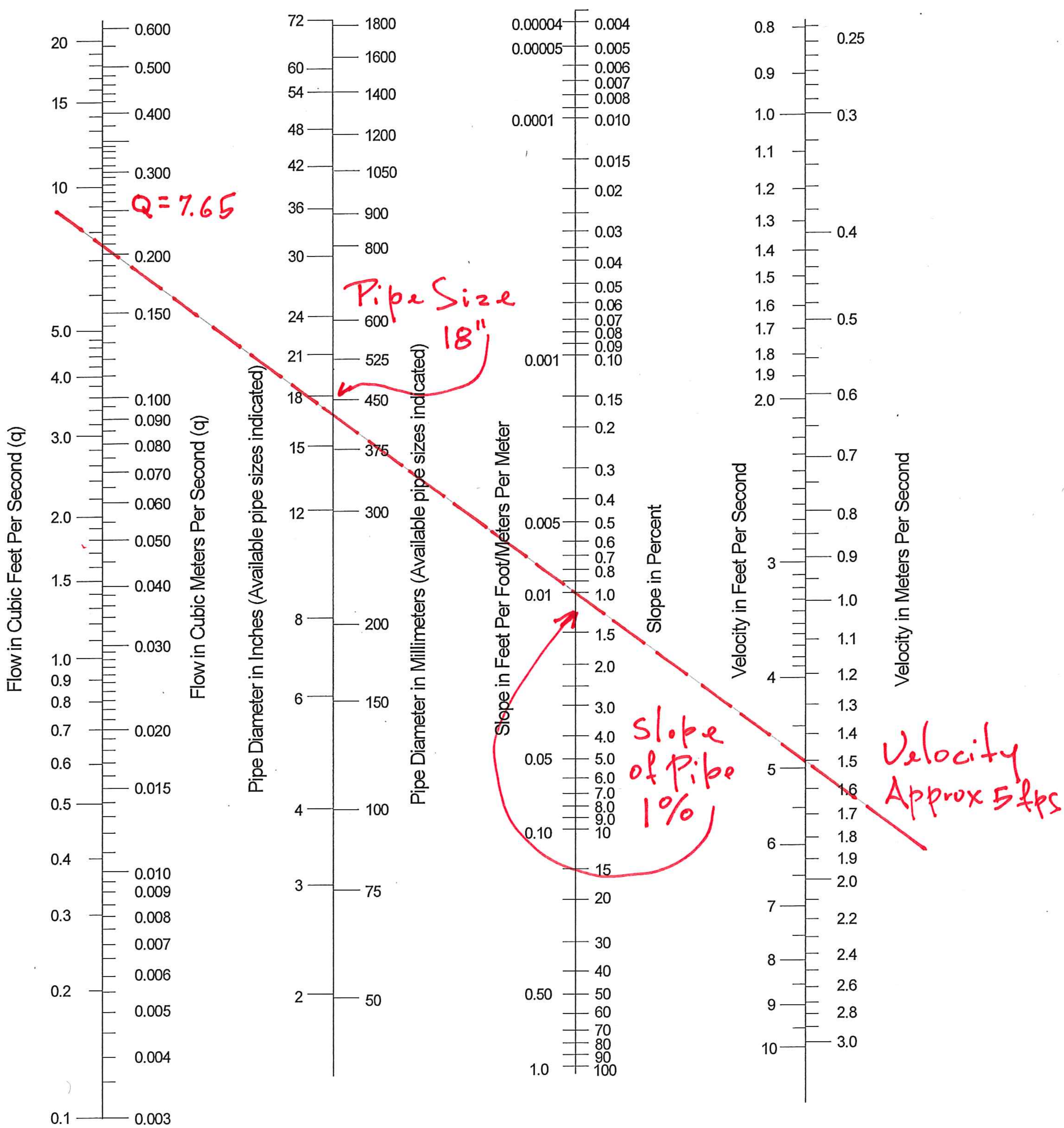


RAINFALL INTENSITY CURVES

In Lexington the standard is "3.3 inches per hr" - 100 yr.

1. Duration of storm is 60 min.
2. From previous chart get time of C. & follow up to 100yr storm line
3. Go over to Intensity on left - this gives the "I" for the chart. - formula.

Nomograph for Circular Pipes Flowing Full (Manning's Equation - Concrete Pipe *n*=0.013) (for Section 4)



PROCEDURE FOR SIZING & LAYING OUT A CLOSED DRAINAGE SYSTEM

Name:

FLOW CALCULATIONS Q=CIA

ID Drainage Area	SIZE OF AREA IN ACRES						Length of Overland Flow in feet	Slope of Overland Flow %	T of C (min)	I (iph)	Q (cfs)
	Pervious	C	Impervious	C	Total Acres	Avg C					

ID Drainage area = Describe area where drainage begins (e.g., Area A)
C = Coefficient of runoff - see table
T of C = Time of Concentration - use charts
I = Inches of rainfall per hour - use chart
Q_{sub} = Runoff in cubic feet per second for each subarea
Q = Total runoff per drainage unit

n = Coefficient of roughness
RIM Elev = Elevation at grade for drainage structure
Entering INV = Entering invert elevation
Exiting INV = Exiting invert elevation

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SHEET **OF**

PROCEDURE FOR SIZING & LAYING OUT A CLOSED DRAINAGE SYSTEM

Name:

PIPE SIZING										INLET DATA		
Begin Inlet Q	Beginning Inlet	TO Inlet	Qsub	Q	n	Diam Pipe (in)	Slope of Pipe (%)	Length of Pipe (ft)	Velocity (cfps)	Rim Elevation	Entering Inv	Exiting Inv

ID Drainage Area = Describe area where drainage begins
C = Coefficient of runoff - see table
T of C = Time of Concentration - use charts
I = Inches of rainfall per hour - use chart
Q_{sub} = Runoff in cubic feet per second for each subarea
Q = Total runoff per drainage unit

n = Coefficient of roughness
RIM Elev = Elevation at grade for drainage structure
Entering INV = Entering invert elevation
Exiting INV = Exiting invert elevation

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SHEET **OF**

2010 ADA Standards for Accessible Design

The following was excerpted from the 2010 ADA Standards to provide basic knowledge requirements for Sections 3 and 4 of the LARE - it is not comprehensive.

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Chapter 4 Accessible Routes

403.3 The running slope of walking surfaces shall not be steeper than 1:20. The cross slope of walking surfaces shall not be steeper than 1:48

403.5.1 The clear width of walking surfaces shall be 36 inches minimum.

403.5.2 Where the accessible route makes a 180 degree turn

- Clear width shall be 42 inches minimum approaching the turn
- 48 inches minimum at the turn
- 42 inches minimum leaving the turn

403.5.3 An accessible route with a clear width less than 60 inches shall provide passing spaces at intervals of 200 feet

- a space 60 inches minimum by 60 inches minimum
- or an intersection

405.2 Ramp runs shall have a running slope not steeper than 1:12

405.3 Cross slope of ramps shall not be steeper than 1:48

405.5 The clear width of a ramp run and, where handrails are provides, the clear width between handrails shall be 36 inches minimum.

405.6 The rise of a ramp shall be 30 inches maximum. Maximum ramp length is 30 feet @ 1:12

405.7 Ramps shall have landings at the top and the bottom of each ramp

- A level landing is needed at the accessible door to permit maneuvering and simultaneously door operation. Slopes not steeper tan 1:48 shall be permitted

405.7.4 Ramps that change direction between runs at landings shall have a clear landing 60 inches minimum by 60 inches minimum

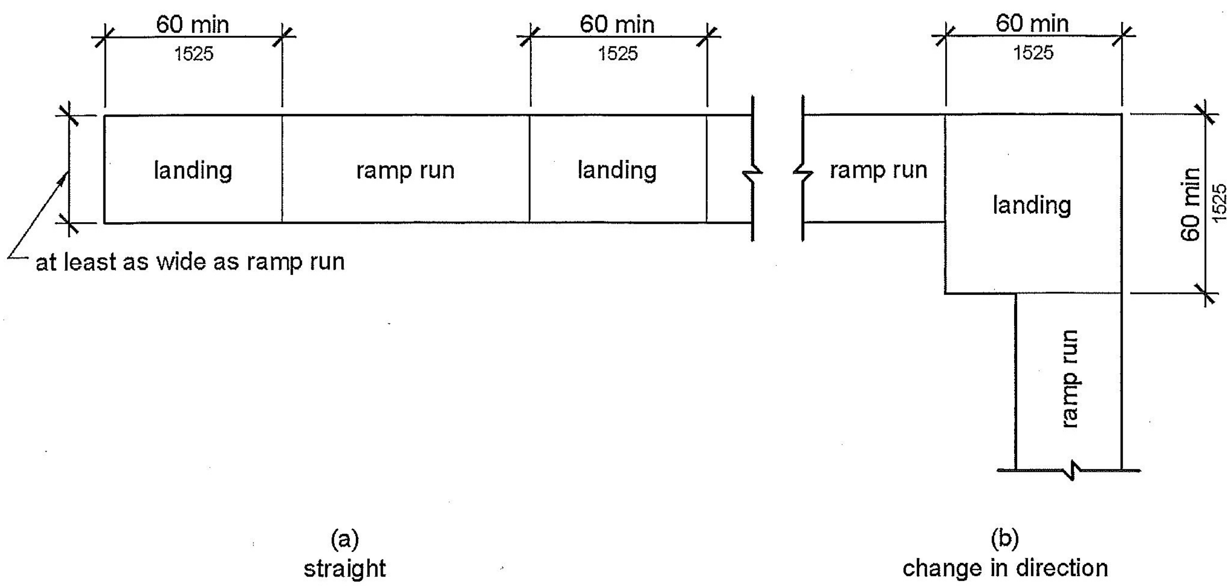

Figure 405.7
Ramp Landings

405.8 Ramps with a rise greater than 6 inches shall have handrails

405.9 Edge protection shall be provided on each side of ramp runs and at landings

405.9.1 The floor or ground surface of the ramp run or landing shall extend 12 inches minimum beyond the inside face of a handrail

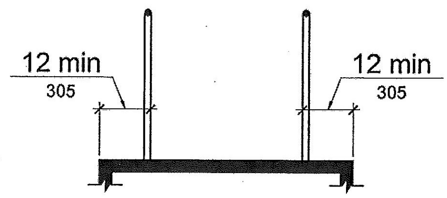

Figure 405.9.1
Extended Floor or Ground Surface Edge Protection

405.9.2 Curb or Barrier. A curb or barrier shall be provided that prevents the passage of a 4 inch (100 mm) diameter sphere, where any portion of the sphere is within 4 inches (100 mm) of the finish floor or ground surface.

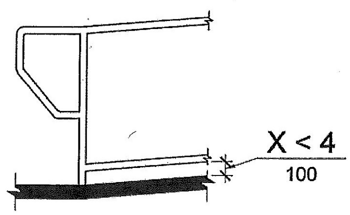

Figure 405.9.2
Curb or Barrier Edge Protection

405.10 Wet Conditions. Landings subject to wet conditions shall be designed to prevent the accumulation of water.

Chapter 5: General Site and Building Elements

502 Parking Spaces

502.1 Where parking spaces are marked with lines, width measurements of parking spaces and access aisles shall be made form centerline of the markings

502.2 Car spaces shall be 96 inches wide minimum

502.2 Van spaces shall be 132 inches wide minimum

Van spaces can be 96 inches where the access aisle is 96 inches wide minimum

- One of eight accessible spaces, but at least one, must be van accessible

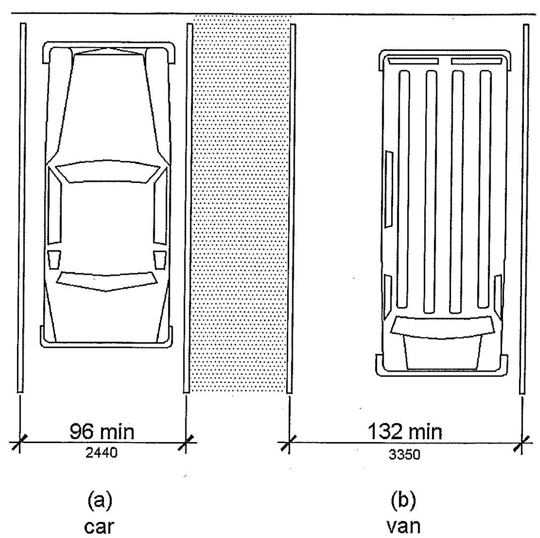

Figure 502.2
Vehicle Parking Spaces

502.3 Accessible aisles shall adjoin an accessible route. Two parking spaces shall be permitted to share a common access aisle

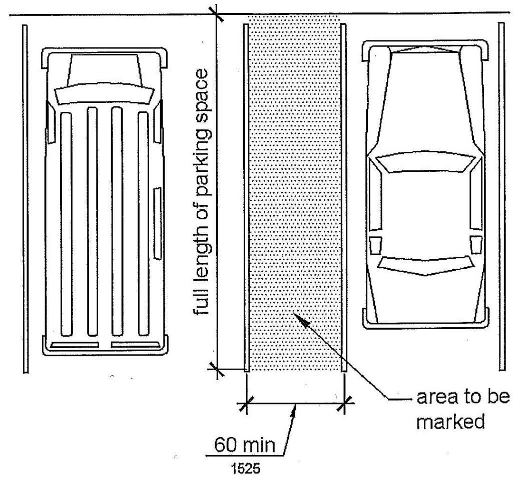

Figure 502.3
Parking Space Access Aisle

502.3.1 Accessible aisles, car and van, shall be 60 inches minimum wide

502.3.2 Access aisles shall extend the full length of the parking they serve

502.3.4 Access aisles can be placed on either side of the parking space. For angled van parking spaces the access aisle shall have the access aisle located on the passenger side of the parking space

502.4 Access aisles shall be at the same level as the parking spaces the serve. Changes in level are not permitted

502.6 Parking space identification signs shall include the International Symbol of Accessibility

Minimum Number of Accessible Parking Spaces

Minimum Number of Accessible Parking Spaces
ADA Standards for Accessible Design 4.1.2 (5)

Total Number of Parking spaces Provided (per lot)	Total Minimum Number of Accessible Parking Spaces (60" & 96" aisles)	Van Accessible Parking Spaces with min. 96" wide access aisle	Accessible Parking Spaces with min. 60" wide access aisle
	Column A		
1 to 25	1	1	0
26 to 50	2	1	1
51 to 75	3	1	2
76 to 100	4	1	3
101 to 150	5	1	4
151 to 200	6	1	5
201 to 300	7	1	6
301 to 400	8	1	7
401 to 500	9	2	7
501 to 1000	2% of total parking provided in each lot	1/8 of Column A*	7/8 of Column A**
1001 and over	20 plus 1 for each 100 over 1000	1/8 of Column A*	7/8 of Column A**

* one out of every 8 accessible spaces ** 7 out of every 8 accessible parking spaces

505 Handrails

505.2 Handrails shall be provided on both sides of stairs and ramps

505.3 Handrails shall be continuous within the full length of each stair flight or ramp r
505.4 Top gripping surfaces of handrails shall be 34 inches minimum and 38 inches maximum vertically above the walking surfaces

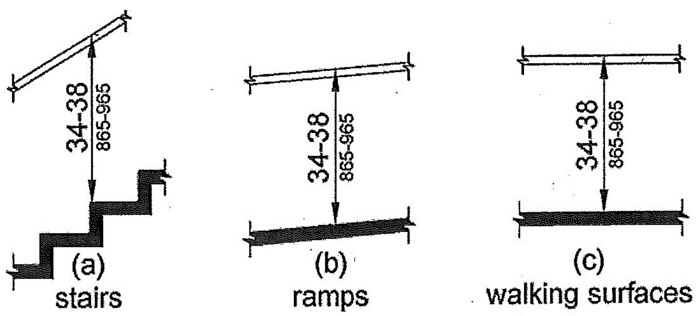

Figure 505.4
Handrail Height

LARE Review Section 4 – Construction Materials
Session Notes - Matt Mathes, ASLA
September 28, 2012 8AM

- **Prepare Project Sections and Profiles**
  - Probable set up: a section or profile will be given as a drawing on the screen. The responder will be asked a number of questions about the section:
    - Section or profile properly presented?
    - Is it complete?
    - What is missing?
- **Prepare Construction Details**
  - Probable set up: given a construction detail as a drawing on the screen and responder will be asked a number of questions relative to that detail
  - Graphical problems - illustrate the various details that relate to construction materials utilized in specific situations.
- **Materials**
  - Wood
    - Treated
    - Non treated
    - Spans of elements - beams, post, joists, decking
  - Metal
    - Iron
    - Steel
    - Aluminum
  - Concrete
    - Strength
    - Finish
    - Reinforcing
    - Depth
    - Frost depth
  - Masonry units
    - Concrete block
    - Brick
    - Precast retaining units

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- Paving
  - precast
  - cast in place
- Size of the materials
- Connection of elements
  - wood to wood
  - wood to concrete
- Wood & Wood Substitutes (Recycled)
  - Treated – needed ground contact and weather exposure
  - Non treated – covered from weather, not contacting ground
  - Span of the elements :
    - Beams – shear, deflection limit to 8' to 10' (wood)
    - Posts – slenderness ratio limits to 8' to 10' (wood)
    - Joists – shear, deflection limits span from 8' to 25'+ (laminated)
    - Decking – typically 10" to 24" max. (wood or recycled extruded Trex Deck etc.)
- Metal
  - Iron – strong for posts or spans
  - Steel - strong for compression or spans
  - Aluminum – light weight, brittle, limited spans
  - Mesh & Cable – composite metals or steel
- Concrete
  - Strength – 2,000 to 4,500 poured, higher for precast or extruded
  - Finish – sack rubbed, broom, scored, towel smooth
  - Reinforcing – fiber, fiberglass, WWM, rebars

        - Depth – typical cross sections for walks, drives, patio uses.
        - Frost depth – foundation and footing below frost depth by 1 foot.
    - Masonry units
        - Concrete block – 8”x8”x16”
        - Brick – typical sizes, non-standard sizes
        - Precast retaining units – segmental retaining wall (SRW), interlocking units with geotextile option for tieback or moisture control
    - Paving
        - precast – many sizes, shapes and types, best for geometric and rectilinear designs.
        - cast in place – poured concrete, many textures, surfaces and colors, fluid designs, curvilinear or free form designs.
    - Size, shape and recognition of basic materials – go to a home improvement store & look at all the shelves
    - Connection of elements
        - wood to wood – joists to decking, joists to beams, beams to posts
        - wood to concrete – deck to foundation, trellis to wall, post to ground via concrete base unit
- **Section 4 Problem Types:**
    - Identify right or wrong components
    - Match the application of a use or need with the correct system (wood, metals, concrete, recycled)
    - Discern between 2+ similar systems for meeting a need
    - Knowledge of materials
    - Show knowledge of:
        - Assemblies

- Tolerances (min. or max.)
- Typical sizes relative to generic units
- Background knowledge not provided in the problem

Section 4 Content:

- Cross Sections
- Preparing Construction Details
- Materials

Section 4 Style of Problems:

- Multiple choice (Most)
- Multiple response (A few)
- Drag & Drop graphic (A few)
  - Plan
  - Section
  - Photo or diagram