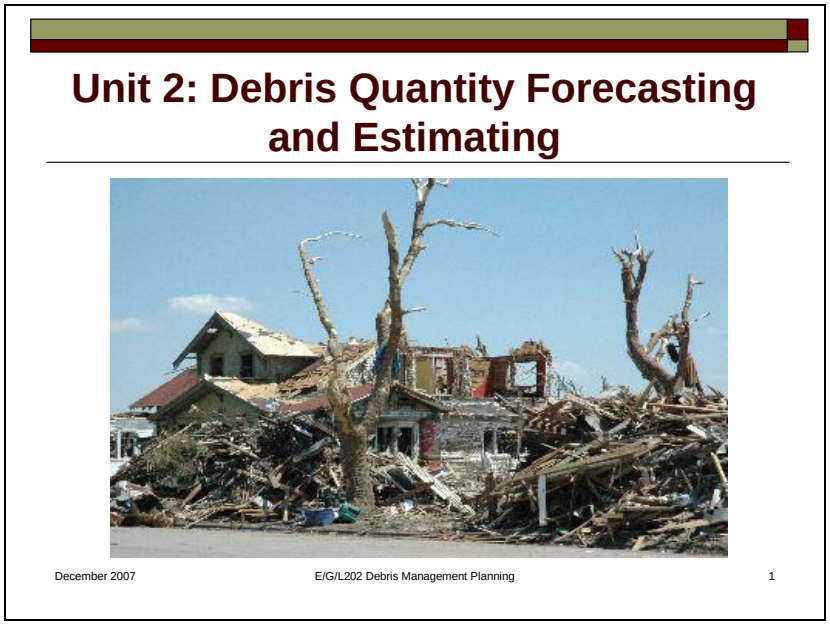
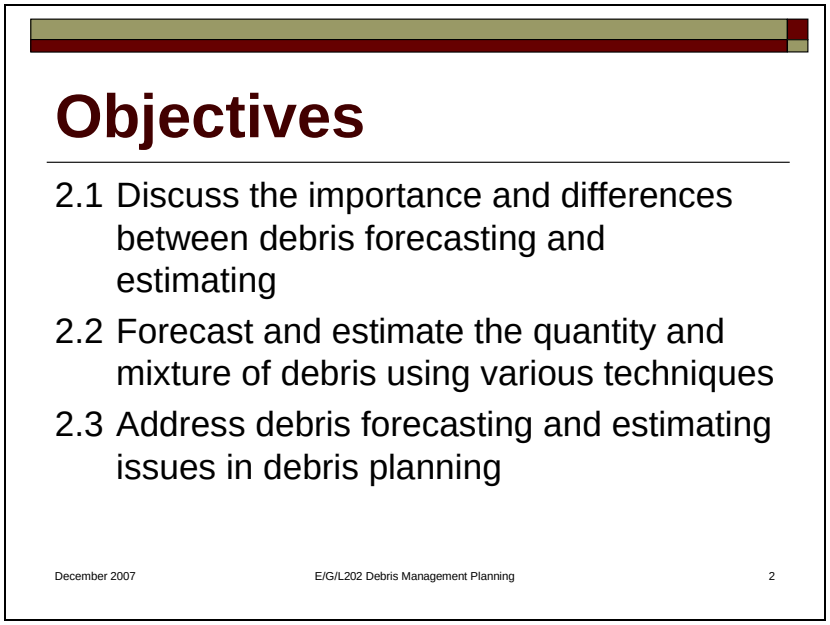


Unit Introduction

- The purpose of this unit is to present various debris forecasting and estimating techniques including various tools and rules of thumb to assist the Debris Manager in planning for large-scale debris operations.

- The determination of the quantity and type of debris is critical to debris management. Debris contracting, the management of Debris Management Sites, and the possible need for State and Federal Resources (covered in following units) will require a reasonably accurate estimate of debris quantities.

Notes:



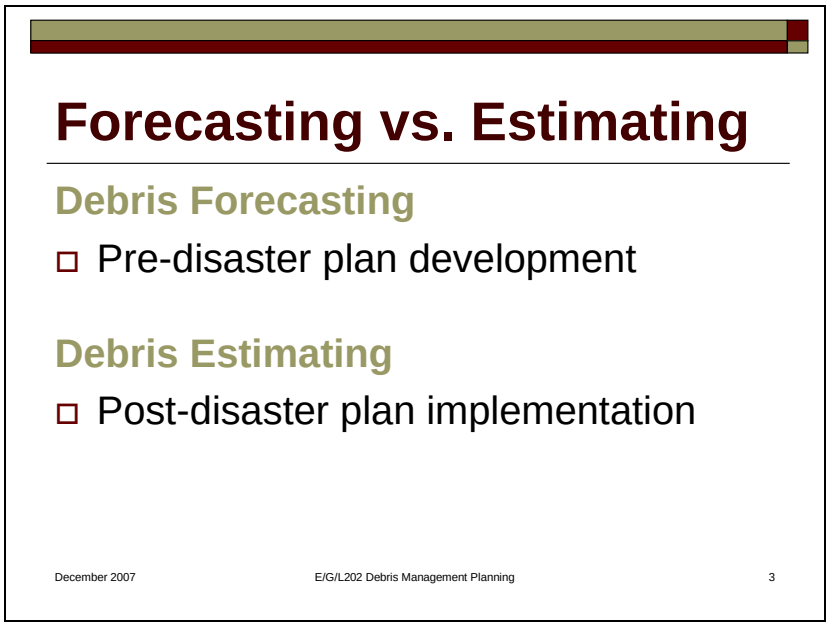
Unit Objectives

At the end of this unit, you will be able to:

- Discuss the importance and differences between debris forecasting and estimating.
- Forecast and estimate the quantity and mixture of debris using various techniques.
- Address debris forecasting and estimating issues in debris planning.

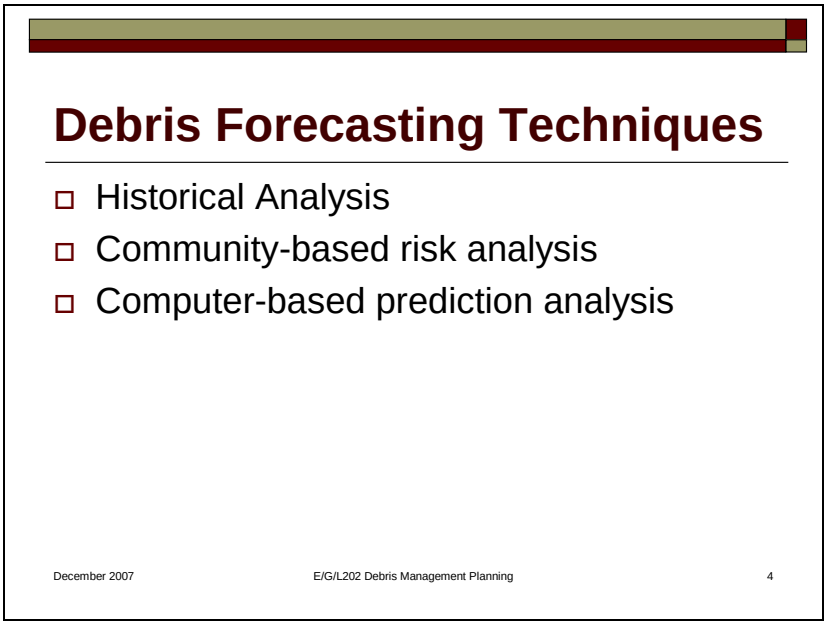
Notes:

Introduction (Cont'd)



- Debris forecasting is normally a pre-disaster technique used to ***predict*** debris quantities.
  - Certain planning assumptions must be made concerning the type and magnitude of debris-generating events.
  - For instance, the plan would assume that a specific type of event, such as a Category 4 hurricane, will affect the community with resulting large quantities of vegetative and construction and demolition debris.
  - Or, the plan may assume a range of debris-generating events from small floods and tornadoes to similar catastrophic events.
  - Debris Forecasting can also be used to determine the type and number of stand-by contracts required to remove and dispose of the predicted debris.
- Debris estimating is normally used in a post-disaster situation to establish a reasonable **estimate** of the actual debris quantities and mix.
  - Debris estimates will be used to determine a community's actual capability to handle the situation.
  - Debris estimates will be used to determine the actual need for Debris Management Sites, contracts, and landfill space requirements.

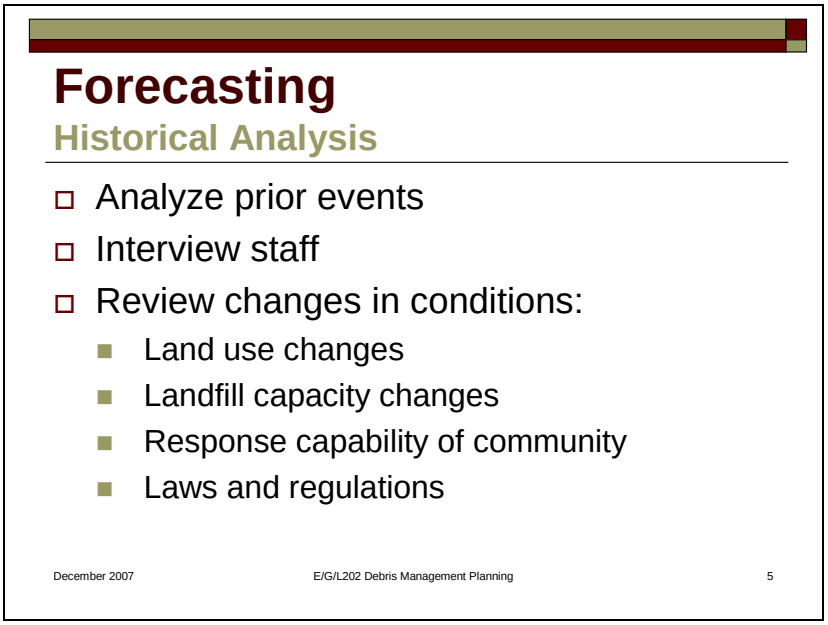
Debris Forecasting Techniques



- There are three basic techniques that are used for debris forecasting:
  - An analysis of prior debris-generating events can be conducted for your community or a similar community. With this analysis completed it may be possible to plan for effective response to similar type events. However, because the event may have been limited in scope or experienced debris staff are no longer available, this method has severe limitations.
  - More commonly, a community-based risk analysis is completed to determine the types and quantities of debris generated by various events. This analysis is then used as a critical component of the debris management plan.
  - Computers can be used for both of the first two techniques to perform calculations and present the analysis. However, there are a range of computer-based prediction models available to perform some of the more routine calculations, use a community's Geographical Information System (GIS) and plan for any number of event scenarios.
  - When these three techniques are combined, a very effective analysis can be completed.

Notes:

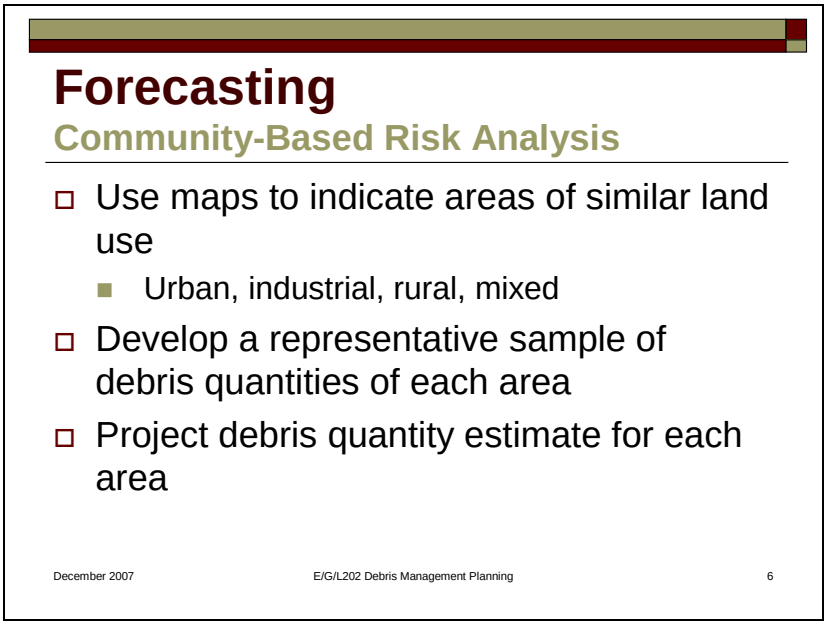
Debris Forecasting Techniques (Cont'd)



- In order to complete an historical analysis of prior debris events, some basic information should be gathered:
  - Prior event(s) should be selected from your community or from communities who have experienced the type of disaster you have forecasted for your community.
  - Key staff members responsible for debris activities should be interviewed to determine procedures that were effective and those that were not.
  - An analysis of any effect in changes to the way your community would be able to respond to such events as:
    - Land use changes that may increase or decrease the types of debris generated.
    - A significant decrease in your landfill capacity or more current landfill regulations may have a very severe impact.
    - A increase or decrease in your community's engineering or solid waste department staff could also make a difference in your response capability.

Notes:

Debris Forecasting Techniques (Cont'd)

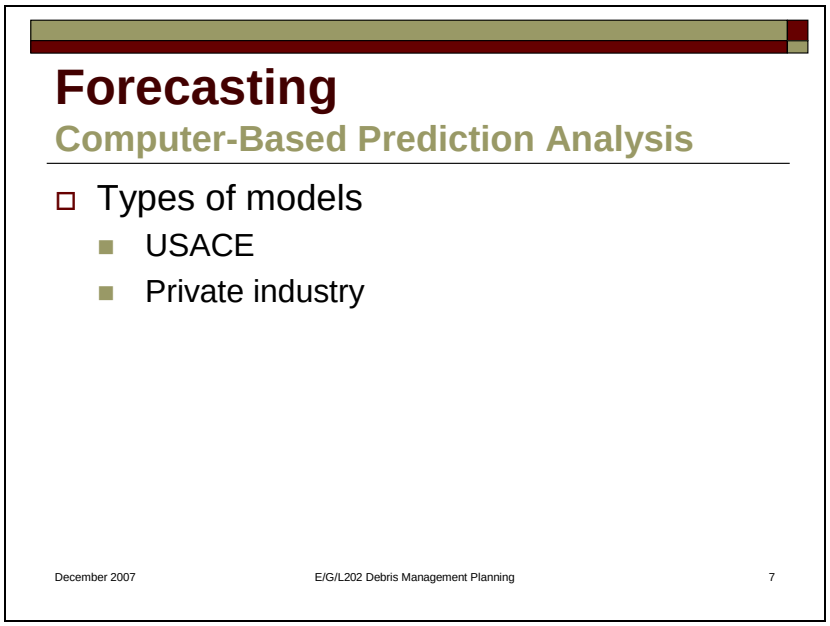


- A simple method can be used to systematically forecast the type and quantity of debris for a community.
  - First, obtain detailed maps of your community and highlight them with an indication of the type of land use in each area, such as urban, industrial, rural, and mixed. This area separation will make your analysis easier as similar land use areas can be assumed to have similar debris types.
- For instance: parks, orchards, groves, nurseries, and tree-lined streets will have similar debris quantities based on an acreage or mileage basis.
- Commercial and industrial areas tend to have heavy amounts of construction and demolition type debris.
- Residential areas can be a combination of vegetative and construction and demolition debris.
- Second, develop a representative sample of the debris in each area.
- Debris quantities can be estimated using the following guidelines:
  - One-story house = Volume in cubic yards times 0.33
  - Volume in cubic yards personal property from flooded home without basement = sq footage of structure times .02
  - Single-wide mobile home = 290 cy.
- The terms light, medium, and heavy are somewhat subjective, but the general guide is: If there is very light vegetation covering the house, yard or driveway, use the light column. If there is a canopy of trees covering the house, use the heavy column. Use the medium column for everything else.

- Third, project the sampling of debris for each area and provide a total of the amount and type of debris for each area. The grand total of all these calculations will provide you with an estimate useful for planning purposes.
- Note that this type of debris forecasting is not an exact science. Broad assumptions and wide-scale projections must be made throughout the process. However, even with its inaccuracies, the resulting quantity estimate can be very useful in completing the next phases of the planning process, such as selecting Debris Management Sites or developing contracts.

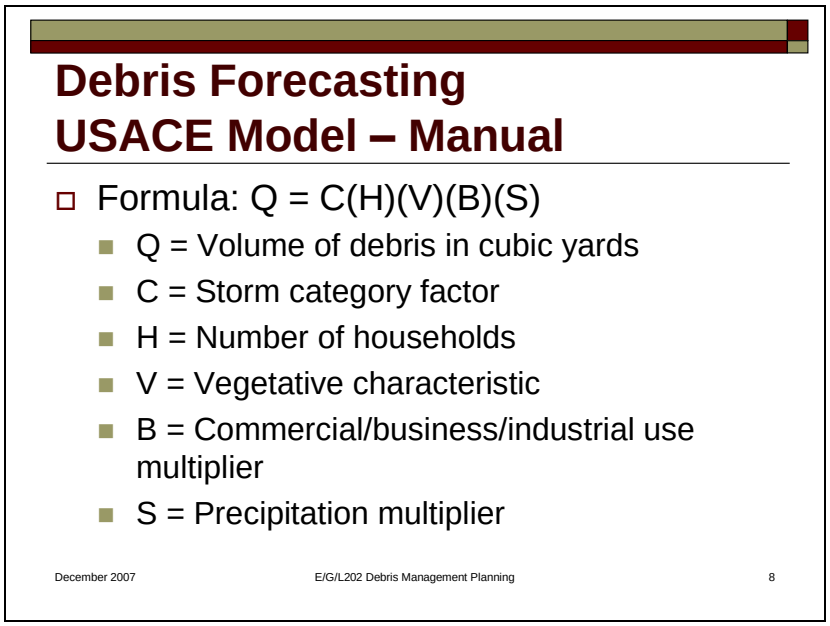
Notes:

Debris Forecasting Techniques (Cont'd)



Computerized modeling programs have been developed to provide reasonable debris predictions for communities under various disaster types.

Notes:



U.S. Army Corps of Engineers (USACE)

Background

- The USACE Emergency Management staff developed a modeling methodology designed to forecast potential amounts of hurricane (and tornado)-generated debris—the first of its kind.
- This model was initially based on actual data from Hurricanes Frederic, Hugo, and Andrew.
- This model considers the category of Hurricane 1 through 5, and assigns a volume of debris based on single-family homes. Multipliers are then used to compensate for other factors, such as tree cover, commercial density, and precipitation. The formula can be put into a spreadsheet and calculations made.
- The model has a predicted accuracy of plus or minus 30 percent.
- However, the model is limited in that it will only generate a gross debris forecast.
  - Since hurricanes do not cause uniform damage over a given area, the USACE model is of little use after an event. It would be very time consuming and difficult to identify the exact areas damaged and the number of homes affected.
  - The USACE has a continuing ongoing effort to improve this model.
- The USACE is considering expanding the model for flood events.

Formula

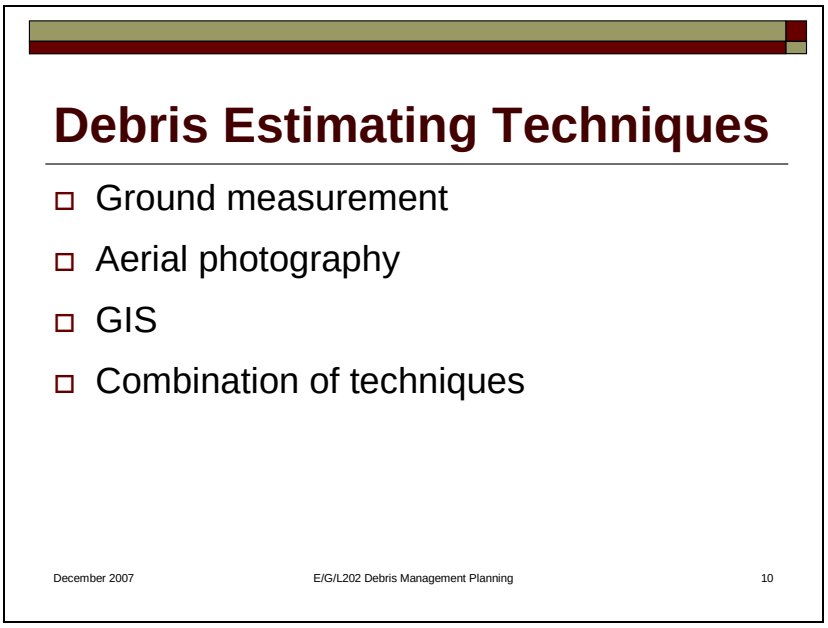
- The following is the formula on which the analysis is based, along with a definition of each. Refer to the Debris Management Guide for a more detailed description of each of these.

Q = C(H)(V)(B)(S)

- Q is the calculated volume of debris in cubic yards.
- C is a factor based on the category of hurricane, 1 through 5.
- H is the number of households involved. If no better information is available, divide the population of the area by 3.
- V is the vegetative characteristic: 1.1 for light, 1.3 for medium, and 1.5 for heavy.
- B is a multiplier that takes into account areas that are not solely single-family residential. Built into this factor is the offsetting commercial insurance requirement.
- S is a storm precipitation multiplier that takes into account the fact that storms that have heavy precipitation will generate more vegetative debris because of the uprooting of complete trees.

Notes:

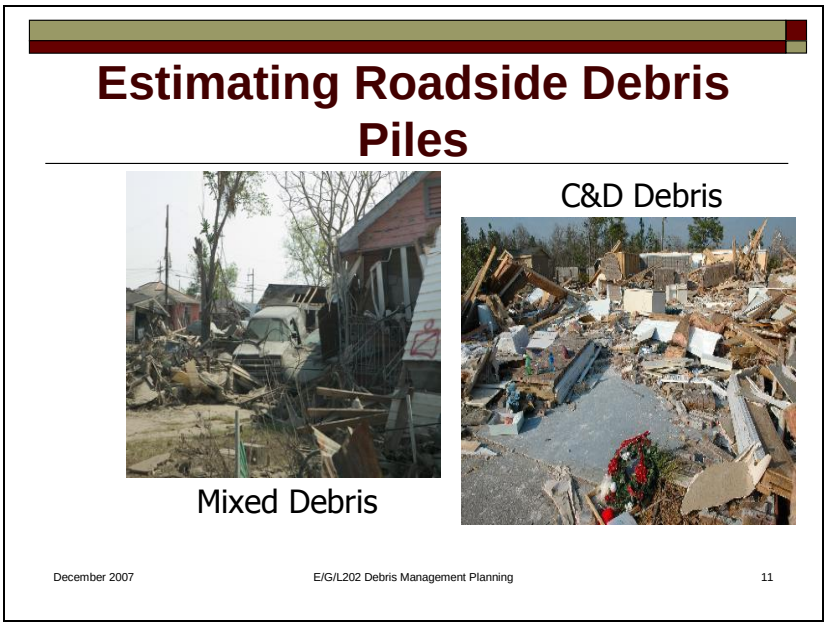
Debris Forecasting Techniques (Cont'd)



- There are many different ways to estimate debris.
- Being creative with the tools, techniques, and information available to you can bring the best results.
- The following slides present various techniques and ways of using them alone and in combination with other techniques to provide the desired product.

Notes:

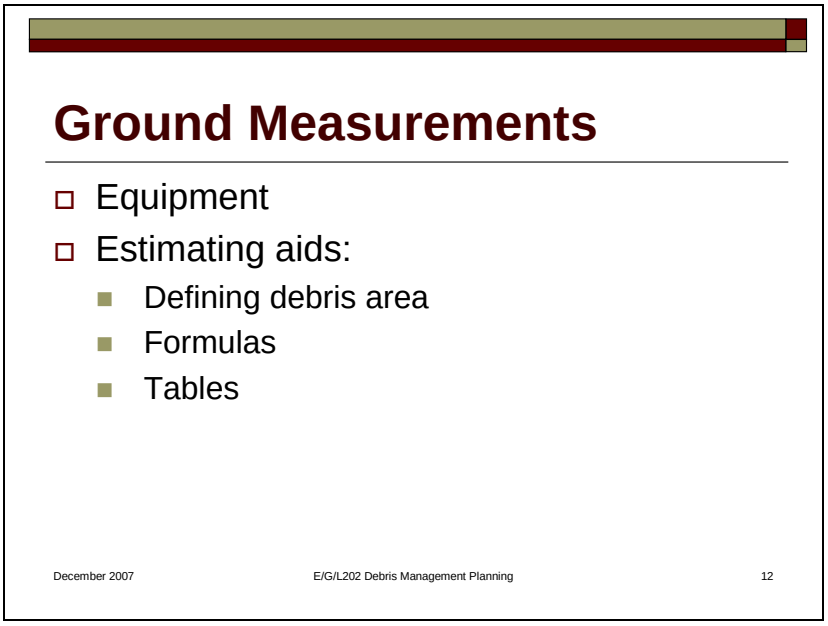
Debris Estimating Techniques (Cont'd)



- There are many things to consider when estimating debris:
  - First consideration: type of debris, for example:
    - vegetative
    - construction and demolition
    - mobile homes
    - a mix of different things
  - Identify handling requirements, for example, if you will need to separate it.
- For FEMA funding, determine if the debris eligible or what portion is eligible.
- From this slide, you can see various ways debris will present itself.

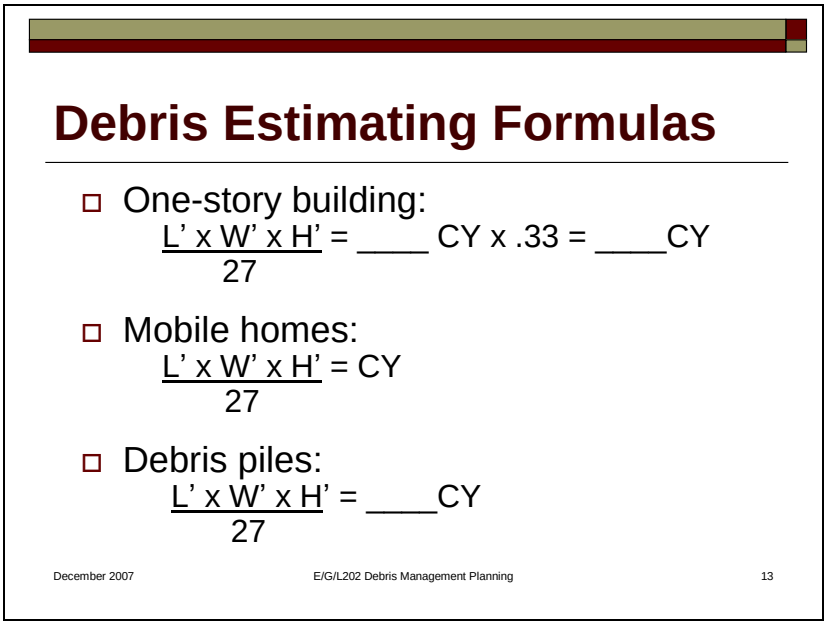
Notes:

Debris Estimating Techniques (Cont'd)



- It is important to have the correct tools, aids, and information in place when doing estimates. Debris estimates are only as good as the basic information used to create them.
- Ensure that necessary equipment is available, including:
  - Digital (preferred) or Polaroid camera
  - 100-foot tape or roll-off wheel
  - Calculator, notepad, sketchpad
  - Maps of area
  - Aerial photographs (preferably before and after the disaster)
  - Dedicated vehicle and mobile communications
- Once the equipment is in place, consider the area to be estimated and the manner in which the area should be divided (sectors). Debris estimating can be expedited by dividing the community into sectors based on any of the following:
  - Type of debris: woody, mixed, or construction material
  - Location of debris: residential, commercial, or industrial
  - Land use: rural or urban
- Remember that however you define your area, you must be consistent with your system and keep detailed notes on how, where, and what method you used for your estimates. These notes must be well documented and maintained for future reference.
- Further discussion on estimating formulas and tables is provided in the following slides.

Debris Estimating Techniques (Cont'd)



- Estimating Aids—Buildings: The following information will assist you in determining the amount of debris from destroyed buildings, homes, and debris piles:

  - One-story building formula:
    L'xW'xH' = ___ CY x .33 = ___ CY
    27
  - One-story house formula:
    L'xW'x8' = ____ cubic yards x 0.33 = ____ cubic yards of debris
    27' per cy
    (The 0.33 factor accounts for the "air space" in the house)
  - Mobile homes formula:
    L'xW'xH' = CY
    27
    (The 0.33 factor is not applied to mobile home calculations due to their compact construction)
  - Debris piles:
    L'xW'xH' = ___ CY
    27

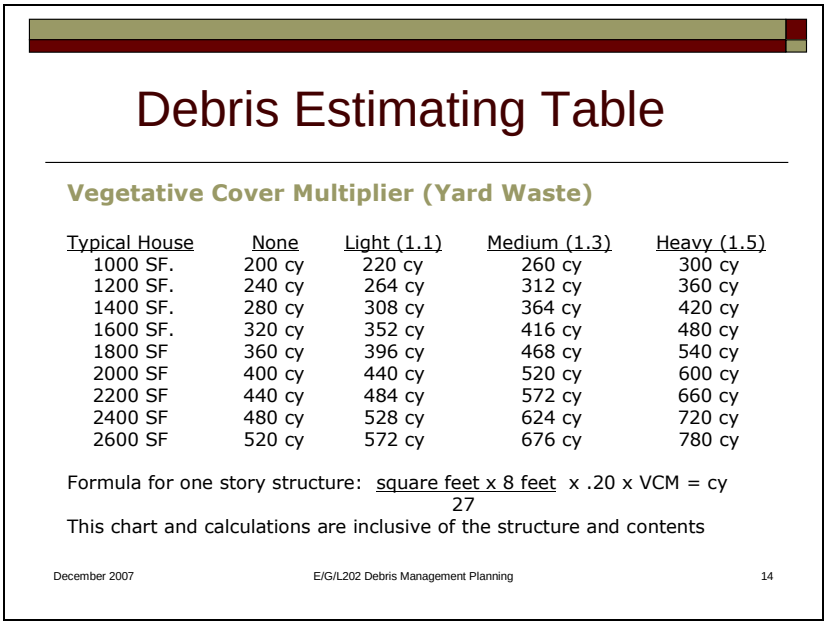
- Reminders: The following reminders may be of assistance when performing debris estimates:

  - Look beyond the curb into side and backyards and at the condition of the homes. Most debris in these areas will eventually move to the curb.

- Wet storms will produce more personal property debris (household furnishings, clothing, rugs, etc.) if roofs are blown away.
- Look for hanging debris such as broken limbs after an ice storm.
- Flood-deposited sediment may be compacted in place. Volume may increase as debris is picked up and moved.
- Using aerial photographs in combination with ground measurements will help determine if there are any voids in the middle of large debris piles.
- Treat debris pile as a cube, not a cone, when performing estimates.

Notes:

Debris Estimating Techniques (Cont'd)



Debris Estimating Table

Vegetative Cover Multiplier (Yard Waste)

Typical House	None	Light (1.1)	Medium (1.3)	Heavy (1.5)
1000 SF.	200 cy	220 cy	260 cy	300 cy
1200 SF.	240 cy	264 cy	312 cy	360 cy
1400 SF.	280 cy	308 cy	364 cy	420 cy
1600 SF.	320 cy	352 cy	416 cy	480 cy
1800 SF	360 cy	396 cy	468 cy	540 cy
2000 SF	400 cy	440 cy	520 cy	600 cy
2200 SF	440 cy	484 cy	572 cy	660 cy
2400 SF	480 cy	528 cy	624 cy	720 cy
2600 SF	520 cy	572 cy	676 cy	780 cy

Formula for one story structure: $\frac{\text{square feet x 8 feet}}{27}$ x .20 x VCM = cy

This chart and calculations are inclusive of the structure and contents

- The table in the slide can be used to estimate debris quantities for a totally destroyed typical home.
- A vegetative debris multiplier is also included.
- Amount of personal property (as debris) from average flooded residence without a basement: 25-30 cy.
- Amount of personal property (as debris) from average flooded residence with a basement: 45-50 cy.
- Remember, these values are for a single-story home (please note the height used in the formula is 8 feet).
- If the structure had blown away or you did not know the square footage of the building, measure the area of the floor slab if still in-place and then use the table. Similarly, once a square footage has been generated from a floor slab, multiply by the number of floors, if that can be determined, from the homes in the surrounding neighborhood.
- As far as the vegetative cover multiplier goes, one just has to develop a sense of what heavy vegetation is. A new home could be considered to have had little or no vegetative cover, for instance.

NOTE: For multiple-story buildings, multiply the debris from one story by the number of stories; however, the vegetative cover should be determined by using the multiplier from a one-story facility.

Debris Estimating Techniques (Cont'd)

Debris Forecasting
USACE Flood Debris Model

- Used to calculate debris quantity from a flood event only when the structure is not destroyed.
- Formula: Square footage x .02 = cubic yards of debris
- 2400 sq. ft. x .02 = 48 cubic yards

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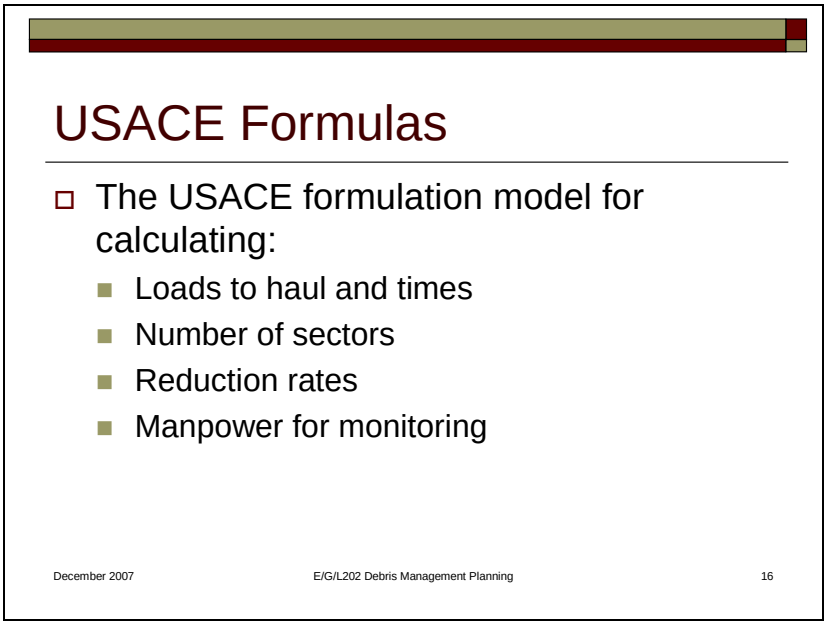
Notes:

Debris Estimating Techniques (Cont'd)



1. The USACE has a formulation guideline used to calculate.
   - The reduction time and volume
   - Area needed for a sector
   - Loads moved within the sector
   - The number of trucks it takes to haul a given number of cubic yards to a landfill or Debris Management Site
2. The following slides (2.17-2.21) will briefly cover the application of the USAC formulation guidelines.

Notes:

USACE Formulas - Loads to haul and times

- 120-Day mission (Example)
- 2,000,000 cy per sector and one TDSR per sector
- A 4 C.Y. loader will load a 20 C.Y. truck in 10 min.
- Average haul distance is 15 miles
- 12-hour work day

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USACE Formulas - Loads to haul and times

- Calculations:
- Loading = 60min / 10min/load = 6 loads per hour
- Assuming 1 hr for lunch and 1 hour down time,
- 12 -2 = 10 hrs x 6 = 60 loads per day per loader
- 60 loads x 20 cy per load = 1200 cy per day per loader
- Truck time, 15-mile haul
- = 30 min travel, 15 unloading, 25 min return = 70 min, 70/10 min/load = 7 trucks, use 8
- = 8 trucks per loader

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USACE Formulas - Loads to haul and times

- Calculations:
- Loading = 60min / 10min/load = 6 loads per hour
- Assuming 1 hr for lunch and 1 hour down time,
- 12 -2 = 10 hrs x 6 = 60 loads per day per loader
- 60 loads x 20 cy per load = 1200 cy per day per loader
- Truck time, 30-mile haul
- = 50 min travel, 15 unloading, 45 min return = 110 min, 110/10 min/load = 11 trucks,
- Use 12 = 12 trucks per loader

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USACE Formulas - Loads to haul and times

- Calculations:
- 1200 cy per day per loader
- 8 trucks per loader
- 2,000,000 C.Y. / 120 days for mission = 16,666 C.Y./day
- 16,666 C.Y./1200 = 13.8 or 14 loaders
- 14 loaders x 8 trucks/loader = 112 trucks

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USACE Formulas – Reduction Rates

- 12-hour work day
- Incineration rate = 160 C.Y. per hour, 24-hour operation
  - 160 x (24-5)19 hrs/day = 3000 C.Y./day
- Grinding rate = 180 C.Y. per hour, 10-hour operation
  - 180 x 10 = 1800 C.Y./day

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USACE Formulas – Monitoring Manpower

Manpower:

- One inspector per loading operation = 14
- Six inspectors per TDSR
  - One - Site Team Leader
  - Two - Tower Operations
  - One - Reduction Operations
  - Two - Night Shift = 6

20/zone

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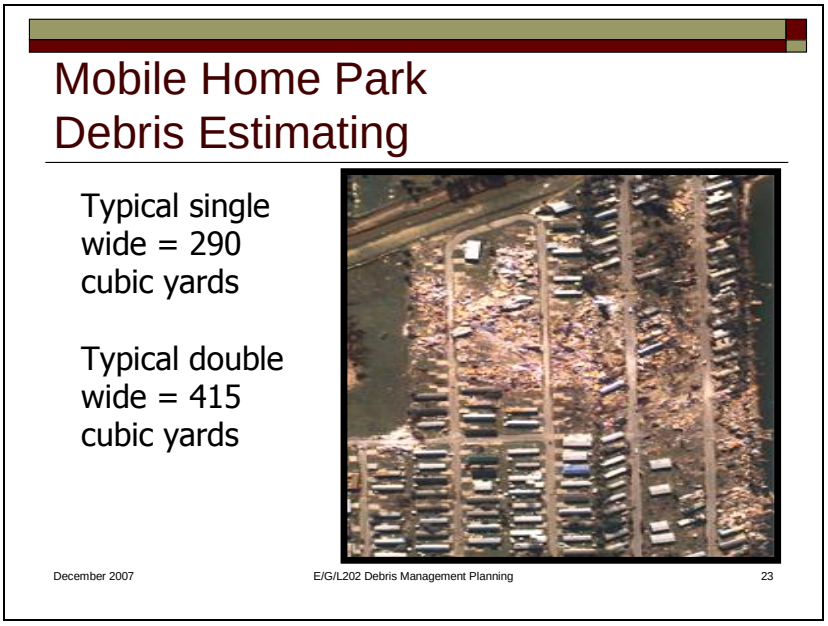
Debris Estimating Techniques (Cont'd)

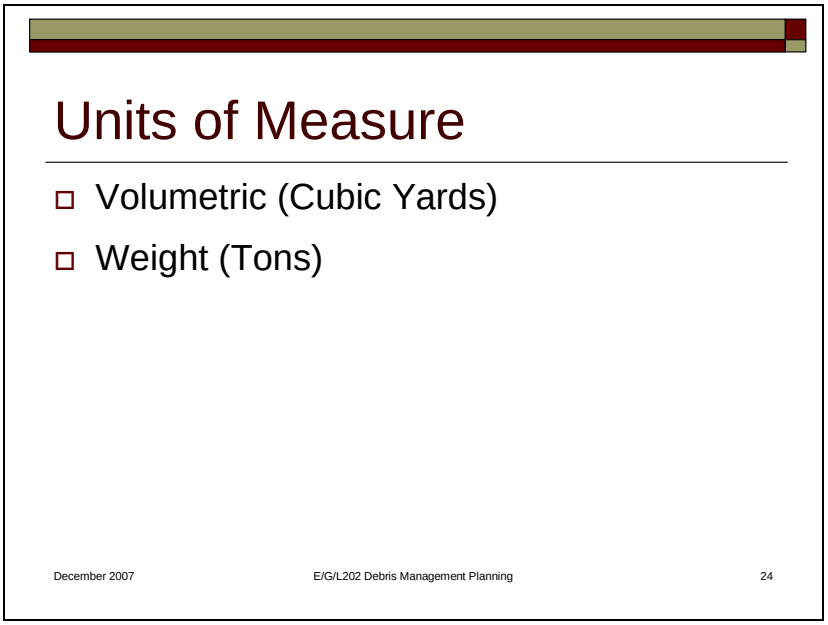


Typical quantities for mobile homes:

- Single-wide mobile home = 290 cy of debris
- Double-wide mobile home = 415 cy of debris

Notes:

Debris Estimating Techniques (Cont'd)

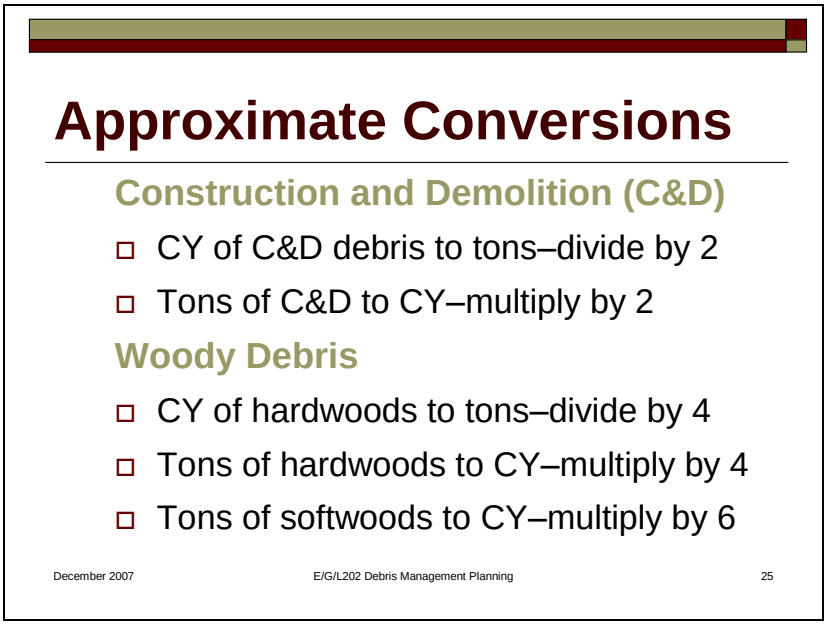


Units of measure can be done in many ways. In most cases, measurements are made by volume (cubic yards) or weight (tons).

- **Volumetric (cubic yard):** Cubic Yard (cy) measurements are used to determine the unit price of debris (woody, mixed, or C&D) transported to a Debris Management Site or permanent landfill.
- **Weight (tons):** All trucks must have a certified tare weight (empty) established if payments are going to be made based on certified scale net weight receipts. Field Debris Monitors will be required to spot check trucks after dumping to see if they are still at their tare weight.
  - Note: Gross weight – tare weight = net weight.

Notes:

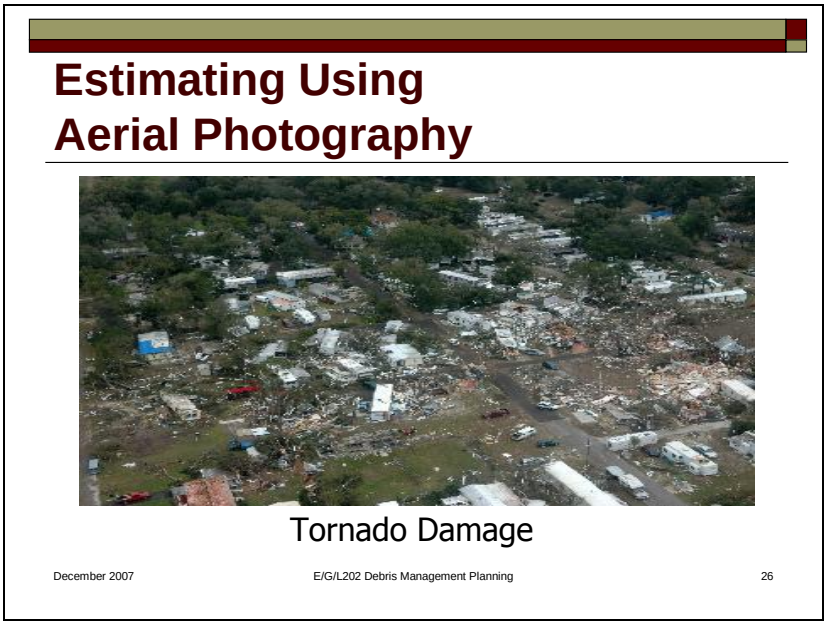
Debris Estimating Techniques (Cont'd)



- The following are rules of thumb. It will be necessary to do a field test to verify the makeup of the debris for your area and disaster type.
- When developing cubic yard (cy) measurements, divide cubic feet by 27.
- When converting from cy to tons, remember to use the correct factor:
  - Use 2 if converting for C&D material.
  - Use 4 if converting for woody material.
- Rules of thumb:
  - 15 trees, 8 inches in diameter = 40 cy (average)
  - Root system (8'-10' diameter) = may require one flatbed trailer to move
  - To convert cy of C&D debris to tons, divide by 2
  - To convert tons of C&D debris to cy, multiply by 2

Notes:

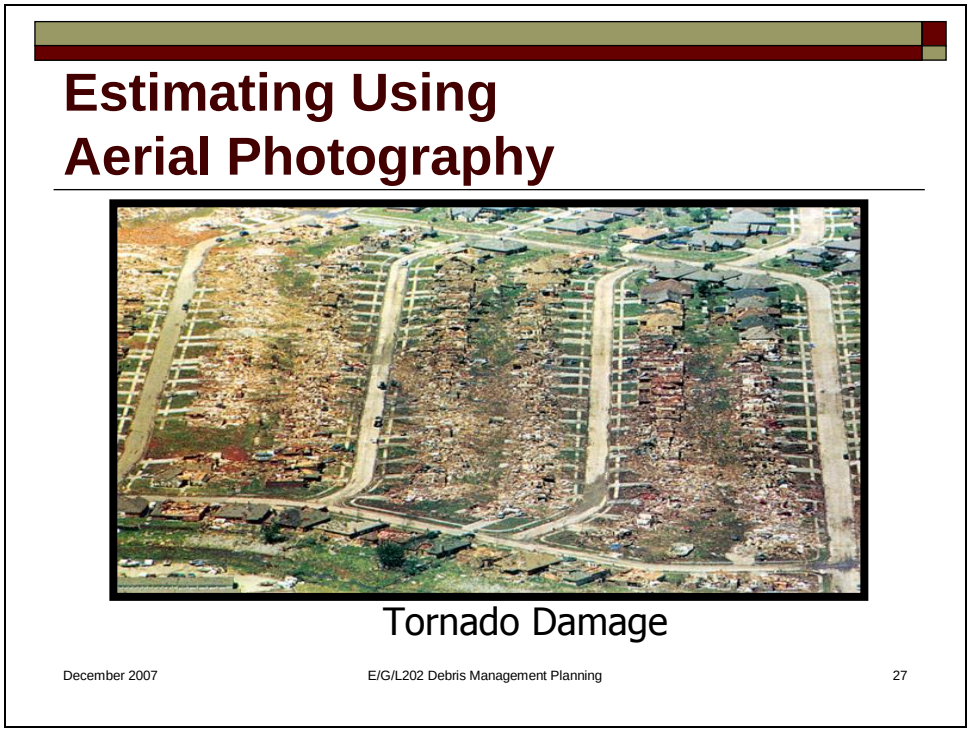
Debris Estimating Techniques (Cont'd)



- Damage estimates can be made from available aerial photographs. The local newspaper supplied the above photograph.
- To estimate debris using a photograph such as this:
  1. Select an object in the photograph for which the length can be reasonably estimated, such as the truck.
  2. Measure the truck in the foreground and estimate its length at 25 feet.
  3. Apply that length to the intact houses to estimate the approximate length and width of each house. Calculate the approximate square footage by multiplying the length times the width. If you have houses of differing sizes, measure several and then calculate an average square footage.

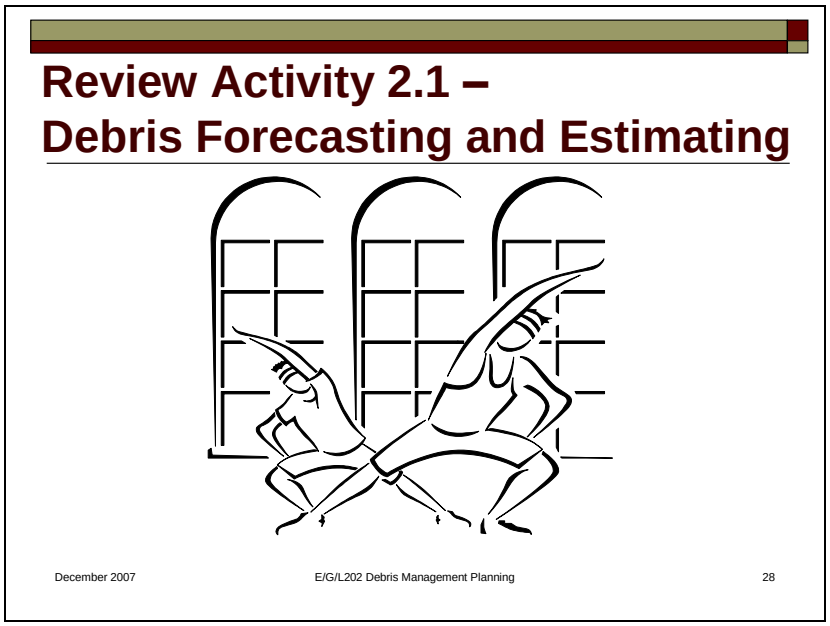
Notes:

Debris Estimating Techniques (Cont'd)



- This is an example of high altitude aerial photography.
- If you know the approximate square footage of the homes in the picture, you can count the driveways and compute the estimated cubic yards of mixed debris using a tornado debris conversion table.

Notes:



Activity 2.1: Debris Forecasting and Estimating

- Turn to Activity 2.1 in your Student Manual, Volume II (Group Activity Materials).

Notes: