Pre-Disaster Planning
for Permanent Housing Recovery

volume three
PLANNING TOOLS

MANUFACTURED

MODULAR

PANELIZED

SITE-BUILT

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

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Pre-Disaster Planning for Permanent Housing Recovery

VOLUME 3: Planning Tools

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Office of Policy Development and Research

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Forest Homes
Louisiana Systems Built Homes
Palm Harbor Homes

About the NAHB Research Center

Located in Upper Marlboro, MD, the NAHB Research Center promotes innovation in housing technology to improve the quality, durability, affordability, and environmental performance of homes and home building products. Created more than 40 years ago as a subsidiary of the National Association of Home Builders (NAHB), the NAHB Research Center has established itself as the source for reliable, objective information and research on housing construction and development issues. Through its various testing and certification services, the Research Center seal is internationally recognized as a mark of product quality and an assurance of product performance.

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Foreword

Since Hurricane Katrina, many lessons have been learned about the importance of disaster preparedness planning and the impact of such planning on permanent residential housing recovery. The U.S. Department of Housing and Urban Development continues to explore new strategies for supporting state and local governments as they prepare and plan for disasters. In cooperation with the Federal Emergency Management Agency and the National Disaster Housing Task Force, we continue to address the temporary, interim, and permanent housing challenges that communities confront in a post-disaster environment.

This report introduces pre-disaster planning tools for permanent housing, with a special emphasis on community involvement in the planning process. We believe that when the community participates, a plan has a greater chance of success because it will reflect the specific housing needs and preferences of the residents. Our national disaster housing strategy recognizes that a "one-size-fits-all" approach is not sufficient for any disaster plan; thus, a flexible approach is encouraged within this report. In fact, the strength of this report is based on its utility and flexibility, which is captured within the electronic tool, worksheets, and checklist.

Planners will be able to use this report to guide the community through the planning process by identifying hazards, housing capabilities, and additional resources needed to implement a pre-disaster housing recovery plan. During the planning process, the community will discover what housing resources are needed to rebuild within a specified time and better understand if it is prepared based on current resources. By considering multiple rebuilding options, the community will be able to weigh the cost and benefits of any given recovery plan.

The planning tools presented in this report are limited to single-family housing needs. This is driven by a desire to keep this volume to a manageable size and not because of a view that other aspects are unimportant. It is vital that communities plan for multifamily and rental housing recovery as well.

Pre-disaster planning can provide a foundation for remaking neighborhoods into dynamic new communities following a disaster. This report provides tools to help make this a reality at the local level. Importantly, it does not direct but rather empowers the planner and community with the tools they need to find the right answer for their circumstance. This approach is aligned with our national disaster preparedness strategy, which emphasizes local involvement in the disaster planning process.

Raphael W. Bostic, Ph.D.
Assistant Secretary for Policy Development and Research

Table of Contents

List of Tables and Figures

Tables

Figures

Executive Summary

Disaster preparedness planning is important to communities and local governments throughout the country, and particularly relevant to those communities located in regions prone to frequent natural disasters. As a result, it is important to develop strategic planning tools that can assist the local communities and governments to prepare before, during, and after a disaster.

The objective of this study is to provide communities and governments with strategic planning tools they can use before a disaster to prepare for rapid reconstruction. These tools are intended to aid with hastening reconstruction of housing during the recovery phase. The planning tools presented within this document are designed to be used by federal, state, or local officials that are responsible for disaster recovery planning. Nonetheless, the authors envision the planners and community working together to develop a permanent housing recovery plan based on the unique needs of the residents and the natural hazards they may experience.

The content is presented in four short volumes. The first volume provides an overview of the permanent housing options, which include manufactured, modular, panelized, and site-built housing. The second volume provides a summary of the national disaster housing strategy, and describes a straightforward planning approach for estimating potential losses and expediting rebuilding. The third volume presents the House Capacity Calculator, which is an easy-to-use application that estimates required rebuilding time based on available house production capacity. The fourth volume describes the basic plant design requirements for manufactured, modular, and panelized housing.

This document serves as both a primer on the subject of permanent housing recovery and a guide to planning for the rebuilding of housing after a disaster. The step-by-step layout of this document allows the reader to progress through the planning process, which makes it ideal for the community participant who is not a disaster management professional. The planning tools have been designed to (1) identify critical planning issues, (2) identify various options available to the community, and (3) compare options in a straightforward manner. The reader is encouraged to use the House Capacity Calculator when considering multiple strategies for the long-term rebuilding of permanent housing. We also have included several worksheets and checklists to facilitate the planning process.

1 Introduction

Volume 3 provides pre-disaster planning tools for considering multiple long-term recovery options. This volume focuses on instruction for using the House Capacity Calculator, an electronic application that estimates the rebuilding time based on housing production capacity. It is also a key resource during the planning process because it allows the planner and community to consider many rebuilding scenarios and select the optimum approach.

The House Capacity Calculator requires five key inputs (i.e., average house size, quantity of houses to rebuild, desired rebuilding time, site-built housing capacity, and the number of factory-built housing plants) in order to determine the resources needed to rebuild permanent housing within a specified time. The planner and community are encouraged to work with local builders and factories to estimate the total house capacity because the better the input is, the more accurate the results will be. The House Capacity Calculator provides the best case results, which means the real outcome will not be better than what has been estimated. Thus, if an estimated rebuilding time is unacceptable to the community, the plan should be revisited to consider other options or approaches.

Although we recommend using the House Capacity Calculator, this volume also provides several worksheets in the Appendix that the planner can use to estimate house capacity and rebuilding time. This manual approach is more time consuming than using the House Capacity Calculator and makes an optimum approach to capacity planning much more difficult.

2 Defining Key Inputs

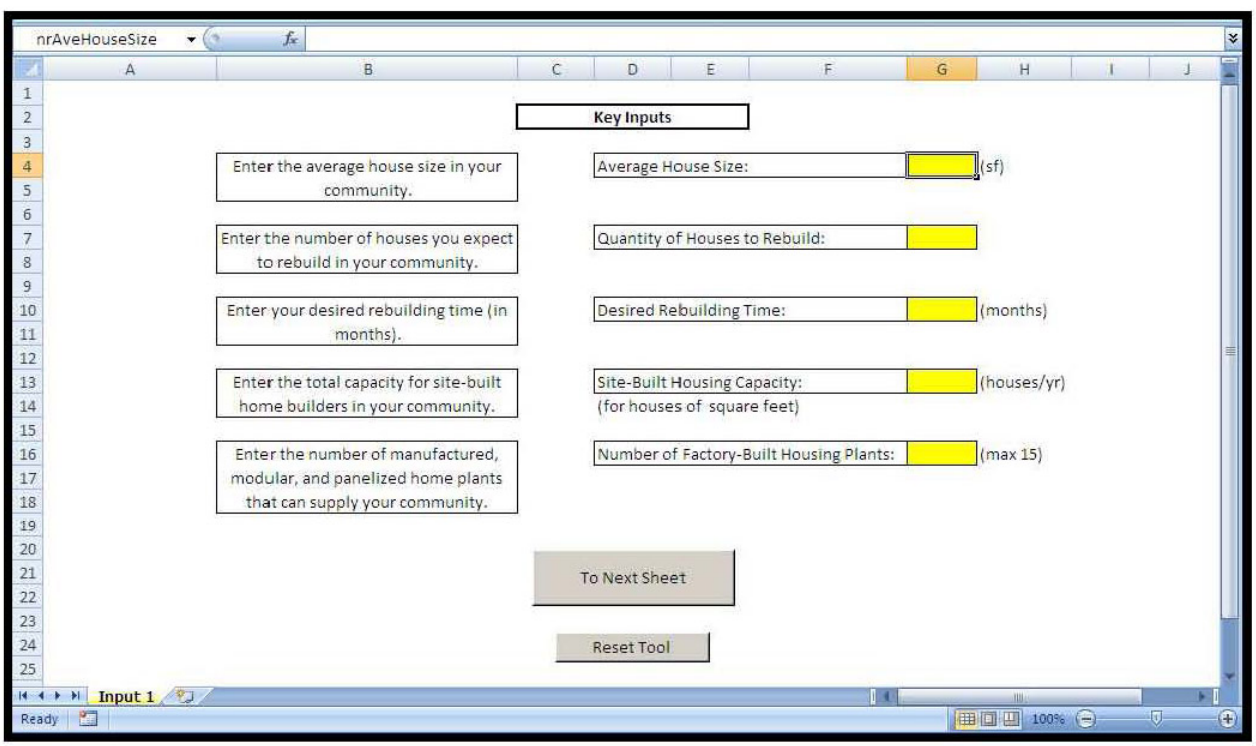
This chapter defines the key inputs for the House Capacity Calculator. The accuracy of the key inputs will depend upon the data available; therefore, we have identified several resources that will assist the planner and community to gather data. Nonetheless, the best information represents a "snapshot" in time; as a result, the planner will need to periodically update the House Capacity Calculator and the pre-disaster plan for permanent housing recovery. The frequency of the updates will depend upon accuracy of the existing inputs, severity of the expected disaster, risk assessments, and the pre-disaster planning process.

Consider the first input page of the House Capacity Calculator, shown in Figure 2-1. Five key inputs are identified; they include *Average House Size, Quantity of Houses to Rebuild, Desired Rebuilding Time, Site-Built Housing Capacity,* and *Number of Factory-Built Housing Plants.*

Average House Size

The first input is the *Average House Size.* It is defined as the median square footage of the existing single-family permanent housing within the community. The "community" can be a neighborhood, city, county, or region (multiple counties) for planning purposes. When defining the community, we recommend that it be the area where the disaster is most likely to occur and representative of the housing that the planner expects to replace permanently. Generally, one would expect to replace existing housing with similar housing in terms of size and architectural design; but, if a different permanent housing size is expected during the disaster recovery phase, this size should be used in the House Capacity Calculator. Local governments can identify their average house size from local tax data, the Census Bureau, and

Figure 2-1: Example Key Inputs for Input 1 of the House Capacity Calculator



residents within the community. Given the preliminary nature of the plan, a moderate level of accuracy will suffice for this input; in other words, it is not necessary to conduct physical appraisals of every house in your community.

Quantity of Houses to Rebuild

The second input is the *Quantity of Houses to Rebuild.* It is defined as the number of single-family houses the planner expects to rebuild permanently after a disaster occurs in the community. This quantity should reflect the severity of the expected disaster and be based on a technical resource, such as FEMA's Methodology for Estimating Potential Losses from Disasters (i.e., HAZUS®).[1] The results from HAZUS are used to estimate a wide range of potential loss estimates from natural disasters including physical damage to residential buildings. We recommend estimating the quantity of houses to rebuild using HAZUS since it is a FEMA-recognized resource for the pre-disaster mitigation planning process.

Desired Rebuilding Time

The third input is the *Desired Rebuilding Time.* It is defined as the desired number of months the planner expects the rebuilding effort to take after a disaster occurs in the community. The desired rebuilding time does *not* include the time to rebuild basic infrastructure (such as roads, utilities, and other public services); it only considers the time it takes to rebuild permanent housing. The desired rebuilding time should be discussed with the community to capture the expectations of the local residents. Although planning experts may know what is reasonable, we recommend developing an initial desired rebuilding time with the local residents because doing so will allow the community to understand what is possible based on the existing housing capacity and various options available to achieve a desired rebuilding time. The iterative nature of the pre-disaster planning process is facilitated by the House Capacity Calculator, which allows for several modifications to inputs including the desired rebuilding time.

Site-Built Housing Capacity

The fourth input is the *Site-Built Housing Capacity.* It is defined as the total number of single-family houses that site-built home builders can provide annually to the community. The total annual capacity must be based on the average house size being used in the House Capacity Calculator. Furthermore, only existing home builders that currently serve the community should be consider as part of the "existing" site-built housing capacity. If neighboring home builders could serve the community, this quantity can be added but only after it is confirmed as part of a pre-disaster recovery plan. To establish existing site-built capacity for a given house size, we recommend using Census Bureau data (i.e., housing starts or building permit data) and contacting the local Home Builder Associations and the National Association of Home Builders to develop a good estimate. Given the preliminary nature of the plan, a moderate level of accuracy will suffice for this input; and it is truly dependent upon the existing housing market, which will vary significantly over time.

Number of Factory-Built Housing Plants

The fifth input is the *Number of Factory-Built Housing Plants.* It is defined as the number of manufactured, modular, and panelized housing plants that can supply the community. The number of potential factory-built housing plants will depend upon whether the community is located within the supply-range of the plant. To identify potential factory-built housing plants within the supply-range of the community, we recommend using HUD's Office of Manufactured Housing Listing,[2] the Manufactured Housing Institute Listing,[3] the Modular Building Systems Association Directory[4], and the National Association of Home Builders' Modular Directory[5] & Panelized Directory.[6]

To further illustrate the function of the House Capacity Calculator, see Figure 2-2. We have entered "example" data into the five key inputs fields.

The example data includes an *Average House Size* of 1900 s.f., a *Quantity of Houses to Rebuild* of 6500, a *Desired Rebuilding Time* of 36 months, a *Site-Built Housing Capacity* of 500 houses per year, and the *Number of Factory-Built Housing Plants* that can supply the community is 5.

Defining Key Inputs

Once this example data is entered and the macro is enabled, the planner must click the "To Next Sheet" button. The House Capacity Calculator will advance to the second input page, where housing capacity details will be entered.

[1] http://www.fema.gov/plan/prevent/hazus/

[2] http://www.hud.gov/offices/hsg/rmra/mhs/mfrlst.cfm (HUD list of Manufactured Housing Plants)

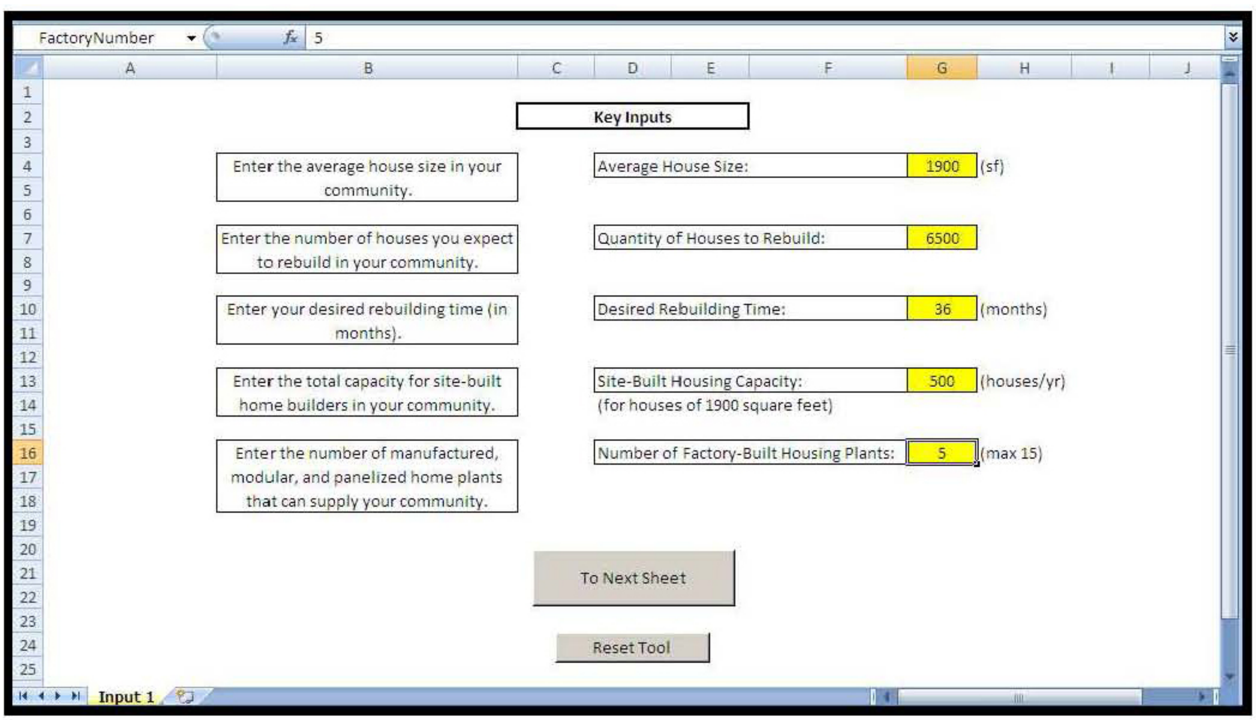
[3] http://www.manufacturedhousing.org/map/ (MHI listing of Manufactured & Modular Housing Plants)

[4] https://netforum.avectra.com/eWeb/DynamicPage.aspx?Site=MBSA&WebCode=OrgSearch (MBSA listing of Modular Housing Plants)

[5] http://www.nahb.org/directory.aspx?sectionID=667&directoryID=340 (NAHB Modular Housing Plant Directory)

[6] http://www.nahb.org/directory.aspx?sectionID=667&directoryID=385 (NAHB Panelized Whole-House Directory)

Figure 2-2: Example Key Inputs for Input 1 of the House Capacity Calculator



3 Defining Housing Capacity Details

This chapter defines the housing capacity details for factory-built housing plants that can supply the community. This information will be entered on the second input page of the House Capacity Calculator, which is illustrated in Figure 3-1.

After identifying the *Number of Factory-Built Housing Plants* that can supply the community, the planner must contact the potential factory-built housing plants to confirm that they are able to provide housing to the community and to establish an annual capacity of housing for each plant. The planner must identify the *Factory Name, Factory Type,* and *Available Capacity.*

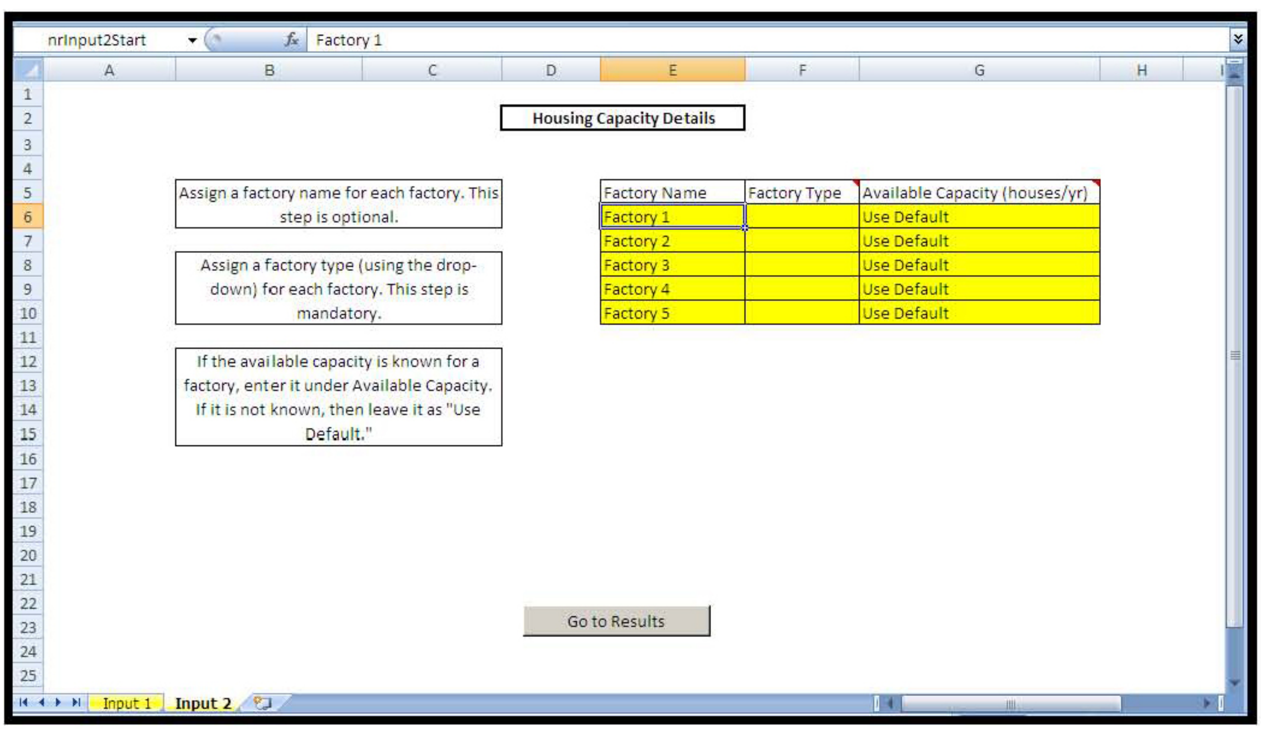
Factory Name

The first input is the *Factory Name.* It is defined as the name of the factory that will supply the community permanent housing after a disaster occurs. This is straightforward information and should come from the list or directory of resources identified in Chapter 2.

Factory Type

The second input is the *Factory Type.* It is defined as manufactured, modular, or panelized housing. This field is mandatory and must be completed for each factory. Some factory-built plants supply only one type of housing, while other plants can supply multiple types of housing. Generally, when a plant can supply multiple factory-built housing types, they will be manufactured and modular housing because both have similar production requirements. In fact, for any given house size, the production capacity of manufactured and modular housing is virtually the same.

Figure 3-1: Input 2 of the House Capacity Calculator



When contacting the plant, the planner must ask what types of housing are produced; then the planner must identify which type of housing is needed by the community. If one plant is supplying two types of housing, and the planner wants both types, the house capacity details must be entered as two separate line items—one entry for each house type. Generally, the planner will only source one factory-built house type from one plant.

Available Capacity

The third input is the *Available Capacity.* It is defined as the total number of single-family houses that the plant can provide annually to the community. The total annual capacity must be based on the average house size being used in the House Capacity Calculator. To establish the available capacity, the planner must disclose to the plant (1) the average house size needed, (2) the quantity of houses that need to be rebuilt, and (3) the desired rebuilding time. The plant may be able to estimate the number of houses that it can provide annually. If the plant cannot offer an estimate because of uncertainty with the future housing need, the House Capacity Calculator assumes a default value that is 20 percent of a benchmark production capacity. The benchmark is calculated by considering the average house size and a baseline production capacity for each factory-built house.[1] Table 3-1 summarizes the baseline information.

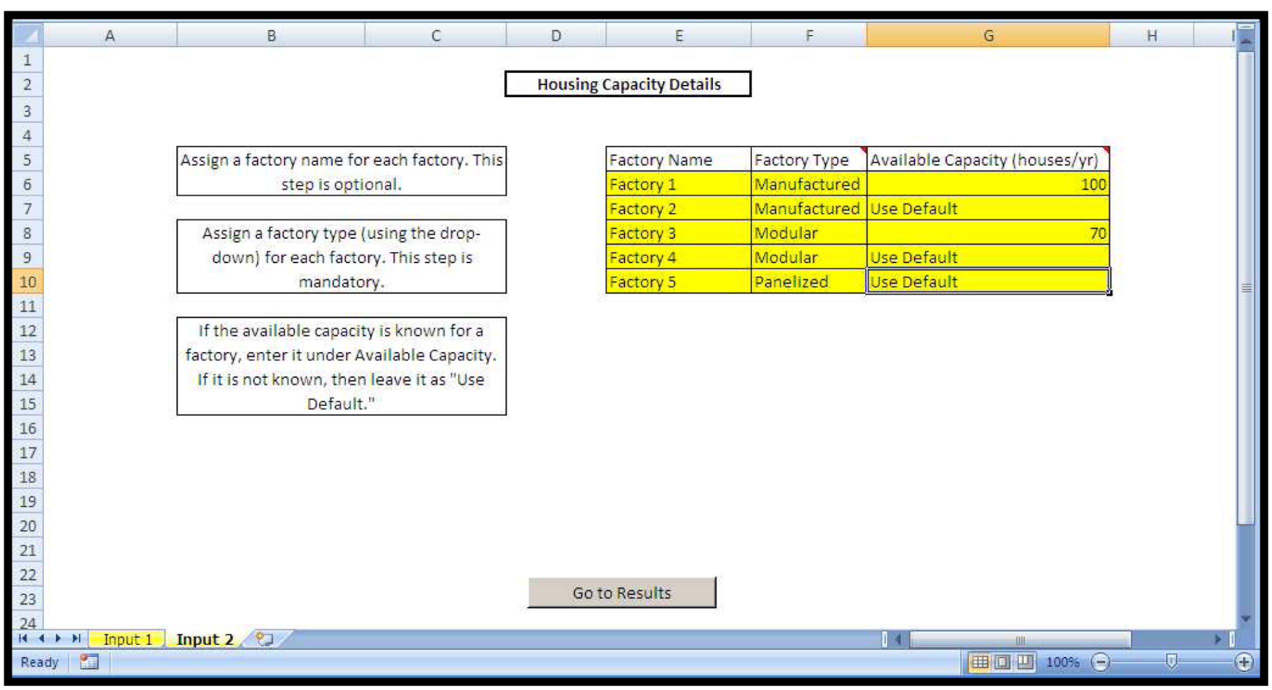
Table 3-1: Summary of Baseline Production Capacity

Housing Type	Plant Size	Number of Houses Produced/Year	Required Labor for 1-shift
Manufactured Housing	100,000 s.f.	350	120
Modular Housing	100,000 s.f.	350	120
Panelized Housing	62,500 s.f.	208	19

To further illustrate the function of the House Capacity Calculator, see Figure 3-2. We have entered "example" data into the housing capacity detail fields.

The example data includes two manufactured plants, two modular plants, and one panelized plant. *Factory 1,* a manufactured plant, has committed to 100 houses per year, while *Factory 2,* a manufactured plant, did not provide an estimate (so the default annual capacity was

Figure 3-2: Example Housing Capacity Details for Input 2



used, which is 70 houses per year in this case). *Factory 3,* a modular plant, has committed to 70 houses per year, while *Factory 4,* a modular plant, did not provide an estimate (so the default annual capacity was used, which is also 70 houses per year in this case). *Factory 5,* a panelized plant, did not provide an estimate (so the default annual capacity was used, which is 35 houses per year in this case).

Once this example data is entered, the planner must click the "Go to Results" button. The House Capacity Calculator will generate (5) standard "Results" pages and (1) "Toggles" page. During the next chapters, we discuss how to interpret results and how to use the Toggles feature.

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1. The baseline condition assumes a 1,600 s.f. house size, a single production shift, and a typical plant size. For manufactured and modular housing, the baseline annual production capacity is estimated to be 350 houses/yr. For panelized housing, the baseline annual production capacity is estimated to be 208 houses/yr. The benchmark production capacity is defined by scaling annual baseline production capacity using the average house size input. See the Worksheet Example in the Appendix for calculation details.

4 Interpreting the Results

This chapter discusses the results and identifies key questions that must be addressed. Ideally, the questions should be considered by the planner, members of the local government, and residents of the community. By doing so, the planner will ensure a pre-disaster recovery plan that incorporates the expectations of the community, while also considering the existing housing capacity and other options to expedite the recovery.

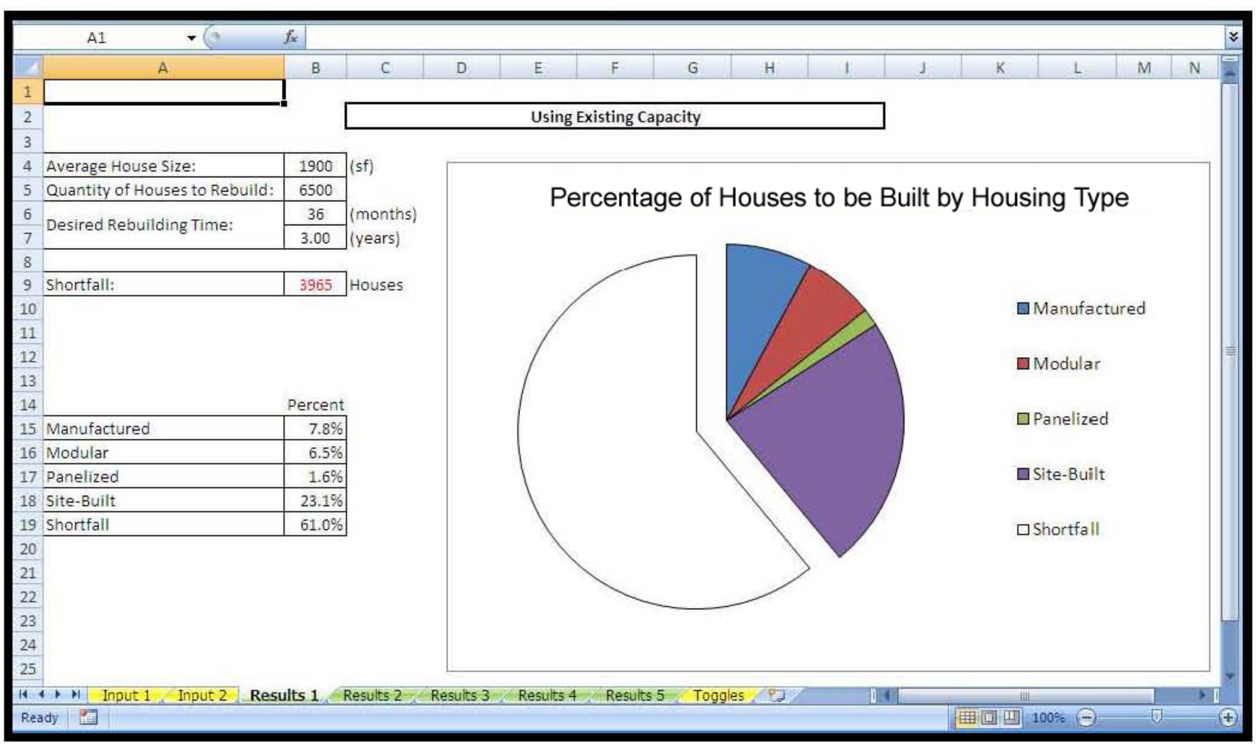
The first results page of the House Capacity Calculator is illustrated in Figure 4-1.

Using Existing Housing Capacity

For our example, Results 1 identifies whether 6,500 houses can be rebuilt within 36 months using the existing housing capacity. The House Capacity Calculator assumes that all houses can be ready for occupancy during the year they are provided. In other words, if 100 houses can be delivered annually, they will also be ready for occupancy during the year. This is a best case scenario assumption. In reality, there may be delays in occupancy due to the building permit process and installation delays due to the weather. In short, the actual results can never be better, but they can be worse for a multitude of reasons. The planner should consider these results as the best case scenario given the existing housing capacity inputs.

Question #1: Can 6,500 houses be rebuilt within 36 months using the existing housing capacity?
Answer #1: No. The existing capacity can only provide 39 percent of the 6,500 houses within 36 months. In fact, the House Capacity Calculator projects a shortfall of 61 percent or 3,965 houses. The housing type distribution

Figure 4-1: Results 1—Using Existing Capacity



over the 36-month desired rebuilding time is shown graphically in the pie chart and quantitatively with the percentages.

The second Results page of the House Capacity Calculator is illustrated in Figure 4-2.

Actual Rebuilding Time

For our example, Results 2 identifies the actual time it takes to rebuild 6,500 houses using the existing housing capacity. Again, the House Capacity Calculator assumes that all houses can be ready for occupancy during the year they are provided. In other words, if 100 houses can be delivered annually, they will also be ready for occupancy during the year. Again, this is a best case scenario assumption. In reality, there may be delays in occupancy due to the building permit process and installation delays due to the weather. In short, the actual results can never be better, but they can be worse for a multitude of reasons. The planner should consider these ideal results given the existing housing capacity inputs.

Question #2: How long does it take to rebuild 6,500 houses using the existing housing capacity?
Answer #2: 7.69 years (or 92.31 months). The housing type distribution over this period is 59.2 percent Site-Built, 20.1 percent Manufactured, 16.6 percent Modular, and 4.1 percent Panelized.

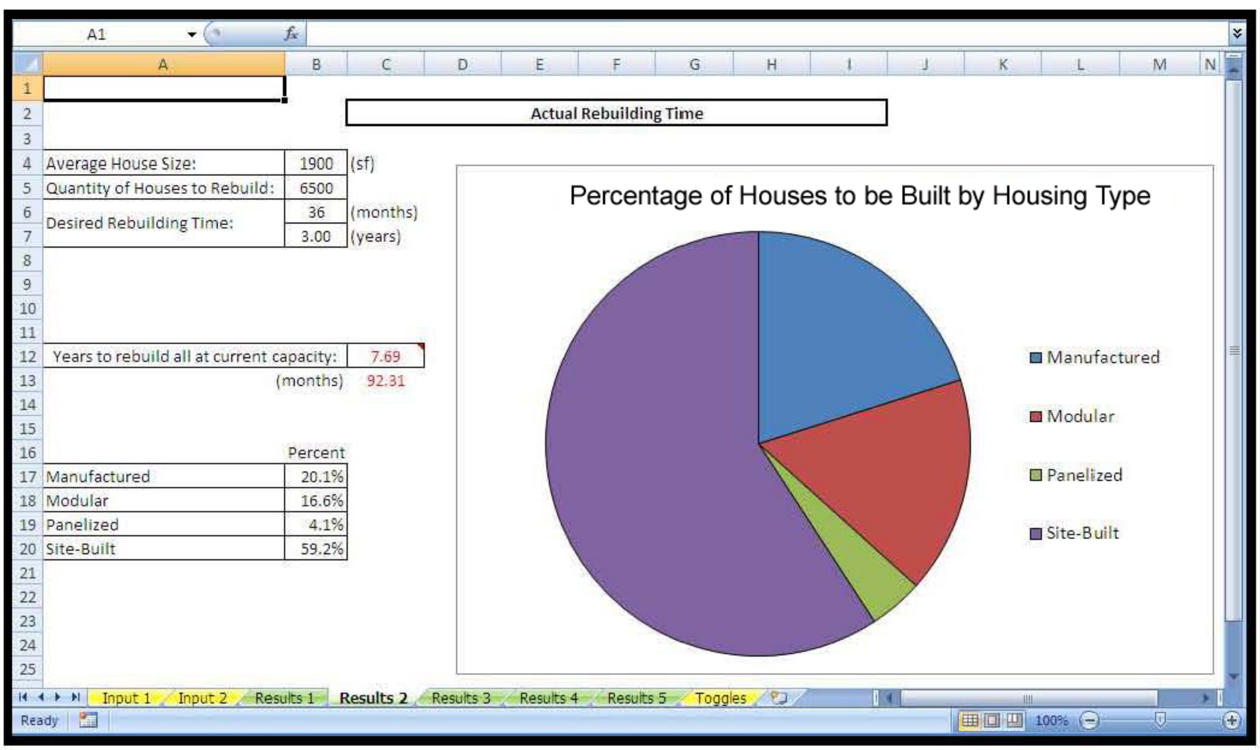
Question #3: Can the community accept the longer rebuilding time based on using the existing housing capacity?
Answer #3: There is no "right" answer to this question. We recommend answering this question with the community. If the answer is "yes," then the new rebuilding time will be 7.69 years (or 92.31 months), instead of 36 months and the preliminary planning exercise is complete. If the answer is "no," because the Actual Rebuilding Time is considered "too long" by the community, then the planner should proceed to Results 3 to consider other options to expedite recovery.

The third Results page of the House Capacity Calculator is illustrated in Figure 4-3.

New House Capacity with Increased Productivity

For our example, Results 3 identifies whether 6,500 houses can be built within 36 months when the existing housing capacity is increased by adding labor, using

Figure 4-2: Results 2—Actual Rebuilding Time

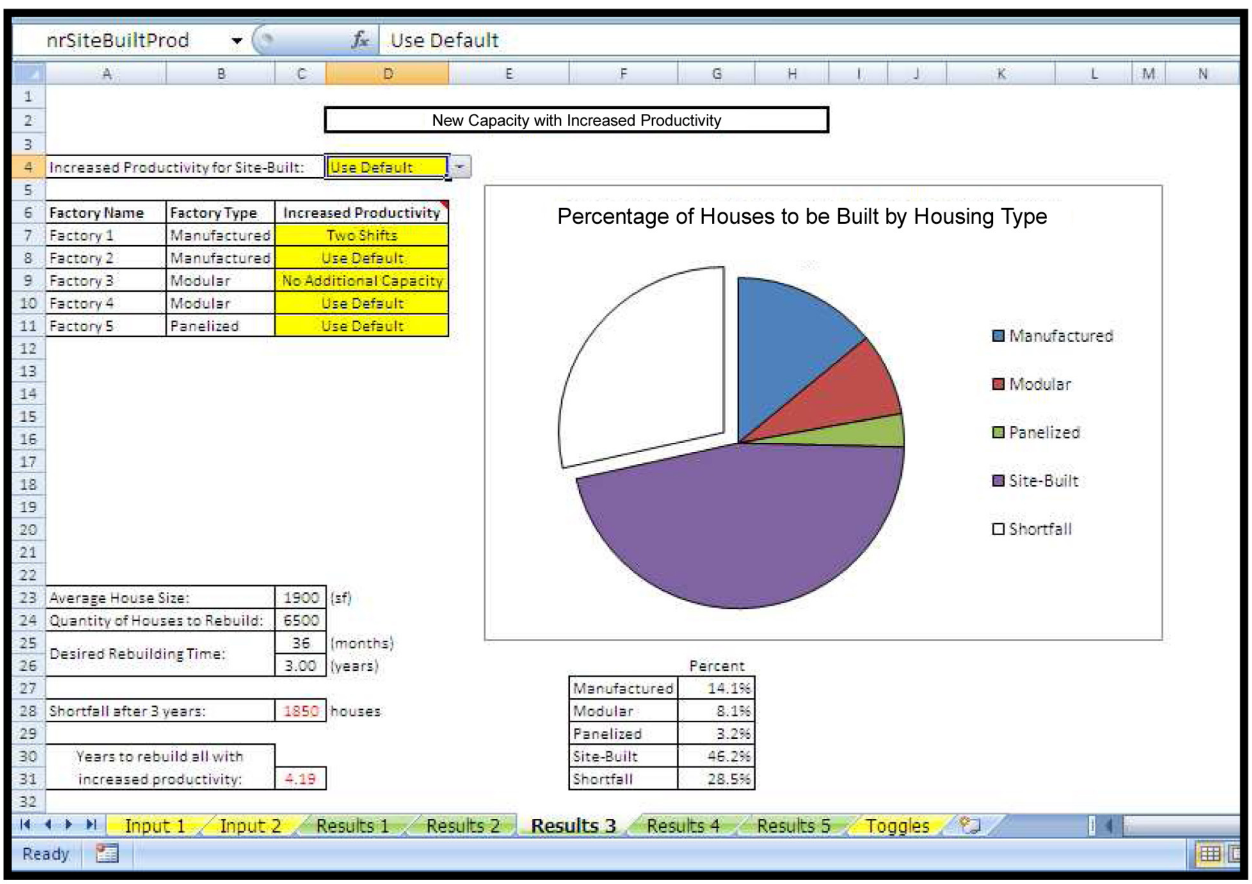


overtime, or adding production shifts. To determine if increased productivity is possible during disaster recovery, the planner must contact existing builders and discuss options. The House Capacity Calculator allows several productivity options to be considered. For site-built housing, productivity can be increased by adding labor. Three options are possible; they include doubling the labor, tripling the labor, and not increasing the labor. The site-built housing default is to double the labor because most areas of the country currently have housing starts that are approximately half of historical averages. For manufactured and modular housing, productivity can be increased by adding overtime or additional shifts. Four options are possible; they include adding overtime, expanding production to create two-shifts, expanding production to create three-shifts, and not increasing production. The manufactured and modular housing default is to add overtime because most factory-built housing plants will add overtime before expanding shifts, which requires adding significant labor (which may or may not be available in the area). For panelized housing, productivity can be increased by adding overtime or additional shifts. Four options are possible; they include adding overtime, expanding production to create two-shifts, expanding production to create three-shifts, and not increasing production. The panelized housing default is to create two-shifts because most panelized plants are highly automated and have a small labor force (which makes adding a second shift more probable than the typical modular or manufactured housing plant).

For our example shown in Figure 4-3, we used the double labor default for site-built housing, *Factory 1* was increased to two-shifts, *Factory 2* was increased by using the overtime default, *Factory 3* was not increased, *Factory 4* was increased by using the overtime default, and *Factory 5* was increased with the two-shift default.

Again, the House Capacity Calculator assumes that all houses can be ready for occupancy during the year they are provided. In other words, if 100 houses can be delivered annually, they will also be ready for occupancy during the year. The House Capacity Calculator also assumes that there will not be a "lag time" associated with adding labor. This is a best case scenario assumption.

Figure 4-3: Results 3—New Capacity with Increased Productivity



In reality, there can be delays because of added labor, building permits, and the weather. In short, the actual results can never be better than these projections, but they can be worse for a multitude of reasons. The planner should consider these results the best case scenario given the underlying assumptions of Results 3.

Question #4: Can existing site-builders and factory-built plants increase productivity?
Answer #4: Yes.

Question #5: Can 6,500 houses be rebuilt within 36 months using the increased housing capacity?
Answer #5: No. The increased capacity can provide 71.5 percent of the 6,500 houses within 36 months. In fact, the House Capacity Calculator projects a shortfall of 28.5 percent or 1,850 houses. The housing type distribution over 36 months is 46.2 percent Site-Built, 14.1 percent Manufactured, 8.1 percent Modular, and 3.2 percent Panelized.

Question #6: With the increased housing capacity, how long does it take to rebuild 6,500 houses?
Answer #6: 4.19 years.

Question #7: Can the community accept the longer rebuilding time based on using the increased housing capacity?

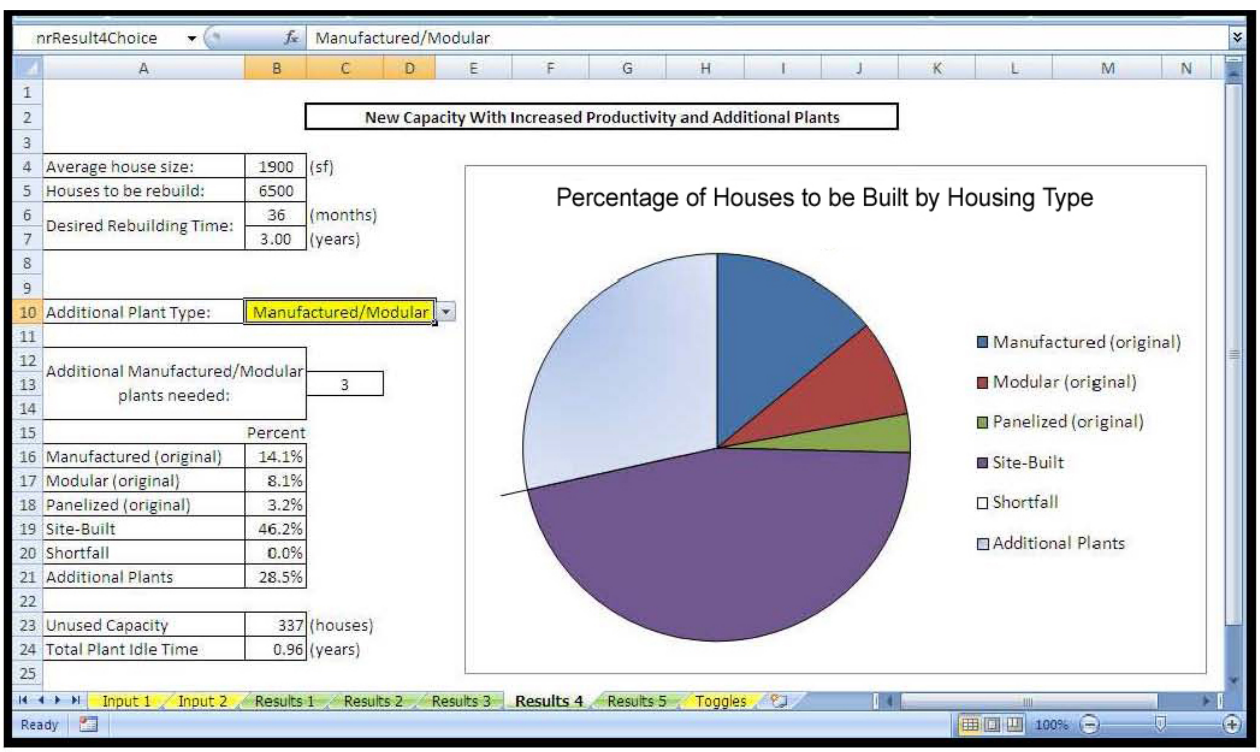
Answer #7: There is no "right" answer to this question. We recommend having this discussion with the community. If the answer is "yes," then the new rebuilding time will be 4.19 years (or 50.28 months), instead of 36 months and the preliminary planning exercise is complete. If the answer is "no" because the new rebuilding time is still considered "too long" by the community, then the planner should proceed to Results 4 to consider other options to expedite recovery.

The fourth Results page of the House Capacity Calculator is illustrated in Figure 4-4.

Increased Productivity and Additional Factory-Built Plants

For our example, Results 4 identifies whether 6,500 houses can be built within 36 months when the existing housing capacity is increased and additional plants are added. To determine if increased productivity is possible during disaster recovery, the planner must contact existing builders and discuss options (this was already done for Results 3 and incorporated into Results 4). To determine

Figure 4-4: Results 4—Increased Productivity and Additional Plants



if plants can be added to increase housing capacity, the planner must determine if vacant facilities exist within the area that can be converted to factory-built housing plants. If qualifying vacant facilities do exist,[1] Results 4 becomes another option to expedite the rebuilding effort.

The vacant facility can be converted into a manufactured, modular, or panelized plant. In either case, the House Capacity Calculator assumes that the new plant will only be operated with one shift. When plants are added, we recognized that some time will be needed to convert vacant facilities into factory-built housing plants. This conversion lag time is included within the House Capacity Calculator. For manufactured and modular housing, the lag time is 11 months. For panelized housing, the lag time is 14 months because of the need to build automated equipment.

Again, the House Capacity Calculator assumes a best case scenario. In reality, there can be delays because of added labor, building permits, the weather, and facility conversion times. In short, the actual results can never be better than these projections, but they can be worse for a multitude of reasons. The planner should consider these results as the best case scenario given the underlying assumptions of Results 4.

For our example shown in Figure 4-4, we selected "Manufactured/Modular" as the additional plant type. Under this option, we will need three vacant facilities to convert. If we had selected "Panelized" as the additional plant type, we would have needed six vacant facilities to convert because we assume a single shift for all new plants.

Question #8: What type of additional plant was selected?
Answer #8: Manufactured or Modular.

Question #9: How many vacant facilities must be converted?
Answer #9: Three.

Question #10: During the desired rebuilding time of 36 months, will the added plants have unused capacity?
Answer #10: Yes. The added facilities will have a total unused capacity of 337 houses, which is equivalent to a total idle time of approximately 0.96 years.

Question #11: What other factors should the planner consider when deciding if plants should be added to increase housing production capacity?

Answer #11: Three critical factors should be considered. First, is the additional rebuilding time really unacceptable? For our example, the increased rebuilding time was 4.19 years instead of 3 years. Second, can you identify existing manufacturers that are willing to convert the vacant facilities during the disaster recovery effort? After the disaster recovery period is complete, what will happen to the added plants? Is there enough factory-built housing demand in the area to support the plants after disaster recovery? Third, if existing factory-built plants have committed to overtime but not additional shifts, can the plant "practically" operate at overtime levels for multiple years? It may not be reasonable to assume a long-term overtime strategy is practical.

Generally, Results 4 will require much discussion and consideration by the planner, local government, and the community. In preparation, the planner will need to identify the existing inventory of vacant buildings within the supply-range of the community. Then, determine if the buildings are suitable for conversion into factory-built plants. If this strategy is selected, the planner must develop a building retrofit process with the local government officials and identify existing factory-built housing suppliers that will operate the new facility.

In some cases, the planner may determine that existing house capacity cannot be increased by adding labor, using overtime, or adding production shifts. The additional site-built housing capacity may be focused on repairing houses that have minor damage, which can be made livable with minimum reconstruction. The existing factory-built housing capacity may not have the labor available locally to increase productivity. When this is the case and the actual rebuilding time with existing housing capacity is regarded as unacceptable by the local government and community, then the planner should proceed to Results 5 to consider one last option to expedite recovery.

The fifth Results page of the House Capacity Calculator is illustrated in Figure 4-5.

Additional Factory-Built Plants

For our example, Results 5 identifies whether 6,500 houses can be built within 36 months when the existing housing capacity and additional plants are added. Results 5 illustrates the original shortfall from the existing housing capacity being fulfilled with additional plants. To determine if plants can be added to increase housing capacity, the planner must determine if vacant facilities exist within the area that can be converted to factory-built housing plants (similar to what was done in Results 4). Since increased productivity is not available in this option, more vacant facilities will need to be converted in Results 5.

The vacant facility can be converted into a manufactured, modular, or panelized plant. In either case, the House Capacity Calculator assumes that the new plant will only be operated with one-shift. When plants are added, we recognized that some time will be needed to convert vacant facilities into factory-built housing plants. This conversion lag time is included within the House Capacity Calculator. For manufactured and modular housing, the lag time is 11 months. For panelized housing, the lag time is 14 months because of the need for automated equipment.

Again, the House Capacity Calculator assumes a best case scenario assumption. In reality, there can be delays because of added labor, building permits, the weather, and facility conversion times. In short, the actual results can never be better than the projections, but they can be worse for a multitude of reasons. The planner should consider these results the best case scenario given the underlying assumptions of Results 5.

For our example shown in Figure 4-5, we selected "Manufactured/Modular" as the additional plant type. Under this option, we will need six vacant facilities to convert. If we had selected "Panelized" as the additional plant type, we would have needed thirteen vacant facilities to convert because we assume a single shift for all new plants.

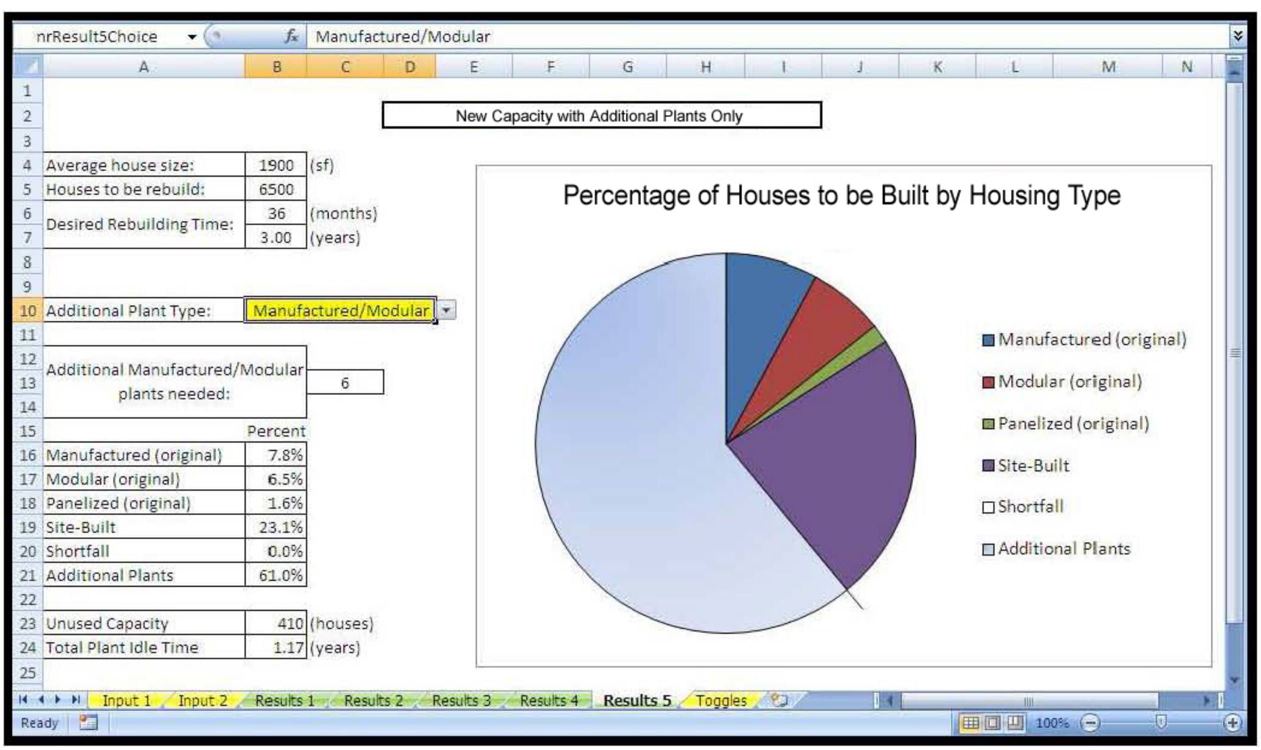
Question #12: What type of additional plant was selected?
Answer #12: Manufactured or modular.

Question #13: How many vacant facilities must be converted?
Answer #13: Six.

Question #14: During the desired rebuilding time of 36 months, will the added plants have unused capacity?
Answer #14: Yes. The added facilities will have a total unused capacity of 410 houses, which is equivalent to a total idle time of approximately 1.17 years.

Question #15: What other factors should the planner consider when deciding if plants should be added to increase housing production capacity?
Answer #15: Three critical factors should be considered. First, is the additional rebuilding time really unacceptable? For our example, the actual rebuilding time was

Figure 4-5: Results 5—Additional Plants



7.69 years instead of 3 years. Second, can you identify existing manufacturers that are willing to convert the vacant facilities during the disaster recovery effort? After the disaster recovery period is complete, what will happen to the added plants? Is there enough factory-built housing demand in the area to support the plants after disaster recovery? Third, can you locate enough vacant facilities?

Generally, Results 5 will require much discussion and consideration by the planner, local government, and the community. In preparation, the planner will need to identify the existing inventory of vacant buildings within the supply-range of the community. Then determine if the buildings are suitable for conversion into factory-built plants. If this strategy is selected, the planner must develop a building retrofit process with the local government officials and identify existing factory-built housing suppliers that will operate the new facility.

The planner, local government, and community may want to investigate other scenarios based on factors that are not explicitly addressed in the five standard results. The "Toggles" page of the House Capacity Calculator allows the planner to consider other factors by altering the *Average House Size, Quantity of Houses to Rebuild,* or the *Desired Rebuilding Time.* When this is the case, the planner should proceed the Toggles page to consider modifications to the original inputs.

[1.] To determine what facility attributes are needed to make them good candidates for conversion into factory-built housing plants, please refer to *Volume 4 – Basic Plant Design* of the **Pre-Disaster Planning for Permanent Housing Recovery** guide.

5 Modifying the Key Inputs

This chapter discusses the Toggles feature, which is located on the last page of the House Capacity Calculator and identifies how the planner can use this feature to consider other scenarios that are not addressed explicitly by the standard results. When using this feature, the planner can ensure a pre-disaster recovery plan that considers a range of possibilities to capture the uncertainty inherent in the pre-disaster planning process.

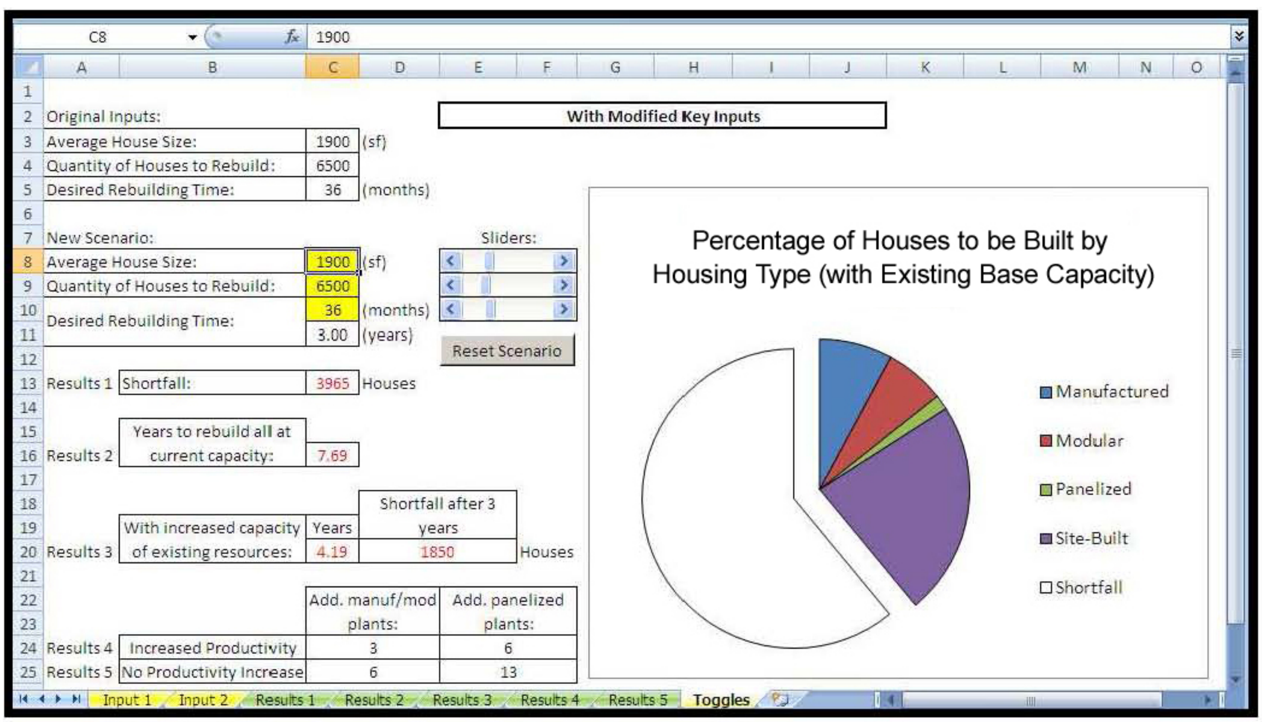
The Toggles page of the House Capacity Calculator is illustrated in Figure 5-1.

Planning for a Range of Possibilities

The Toggles page summarizes the original inputs and allows the planner to dynamically consider other scenarios. Alternative data can be entered into the "New Scenario" section within the *Average House Size, Quantity of Houses to Rebuild,* and *Desired Rebuilding Time* fields. The planner can also manipulate the sliders to the right of the fields to dynamically change the key inputs. The Toggles page uses the original housing capacity and increased productivity housing capacity that was established earlier in the tool. If housing capacity and increased productivity data need to be modified, it must be done on the Input pages or Results 3, respectively.

The planner can use the Toggles page to consider a range of possibilities. Even if the planner has high confidence in the key input data, he or she may want to consider a range because of uncertainty and/or error associated with the key input data. For example, even if the *Quantity of Houses to Rebuild* input is developed using HAZUS, the planner will not truly know the amount of damage that will occur until a disaster actually happens. With this in mind, it may be reasonable to consider a range of houses

Figure 5-1: Toggles Page—Original Key Inputs



to rebuild, such as ±10 percent of the original value. Using our original *Quantity of Houses to Rebuild* value, we have a range of 5,850 to 7,150 houses. Figure 5-2 shows the new scenario results for 5,850 houses to rebuild, while Figure 5-3 shows the new scenario results for 7,150 houses to rebuild. Table 5-1 compares the differences in results between the original value and the ±10 percent range.

Table 5-1: Summary of Results based on Range of Quantity of Houses to Rebuild

	Minimum Quantity 5,850	Nominal Quantity 6,500	Maximum Quantity 7,500
Results 1 (Shortfall)	3,315	3,965	4,615
Results 2 (Years)	6.92	7.69	8.46
Results 3 (Years)	3.77	4.19	4.61
Results 4 (Man/Mod)	2	3	4
Results 5 (Man/Mod)	5	6	7

When considering the range of results in Table 5-1, the planner will notice that *Quantity of Houses to Rebuild* can significantly change the rebuilding scenario, especially if the strategy involves converting vacant facilities. In fact, since the *Quantity of Houses to Rebuild* reflects the severity of the disaster, the planner should expect this variable to be the driving factor for any pre-disaster plan.

If we consider a ±10 percent range for the *Average House Size* input (based on a similar uncertainty with the available data), the planner will notice less variation between the results. The original *Average House Size* value has a range of 1,710 to 2,090 s.f. Figure 5-4 shows the new scenario results for 1,710 s.f., while Figure 5-5 shows the new

Table 5-2: Summary of Results based on Range of Average House Size

	Minimum House Size 1,710 s.f.	Nominal House Size 1,900 s.f.	Maximum House Size 2,010 s.f.
Results 1 (Shortfall)	3,788	3,965	4,112
Results 2 (Years)	7.19	7.69	8.16
Results 3 (Years)	3.90	4.19	4.47
Results 4 (Man/Mod)	3	3	3
Results 5 (Man/Mod)	6	6	6

Figure 5-2: Toggles Page—5,850 Houses to Rebuild

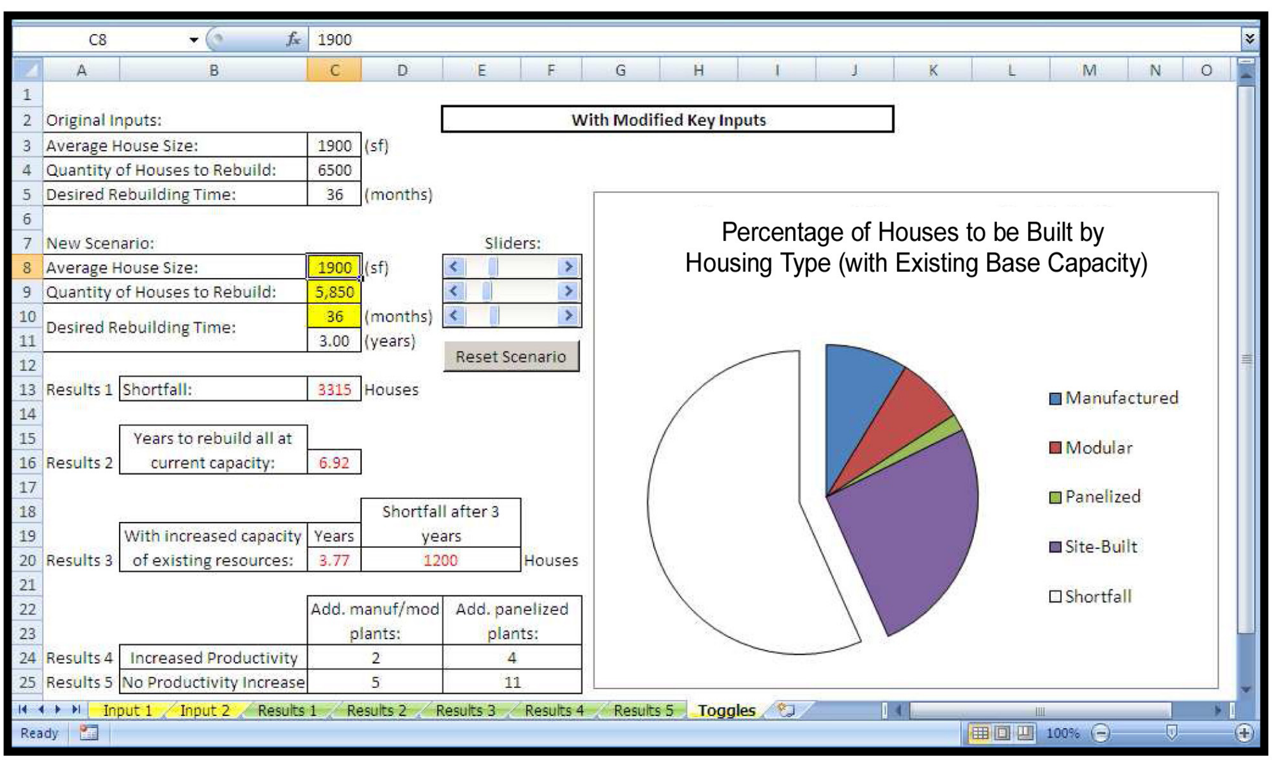


Figure 5-3: Toggles Page—7,150 Houses to Rebuild

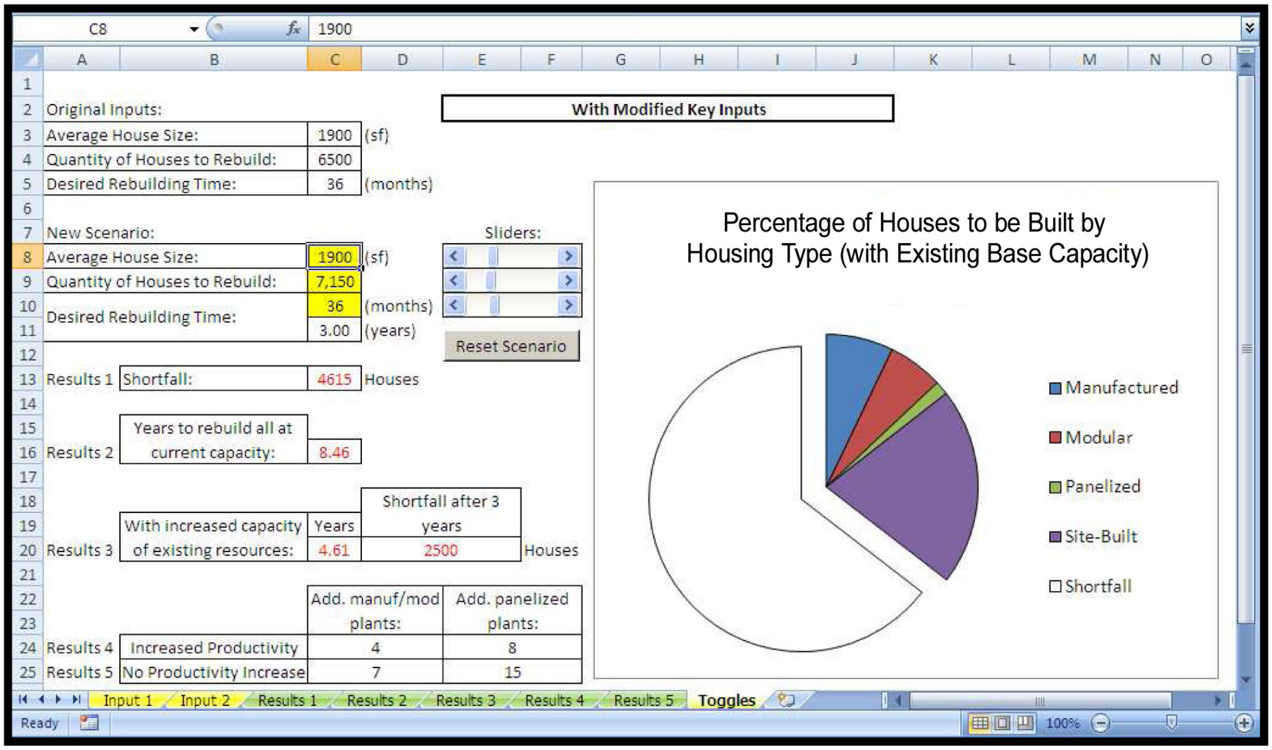
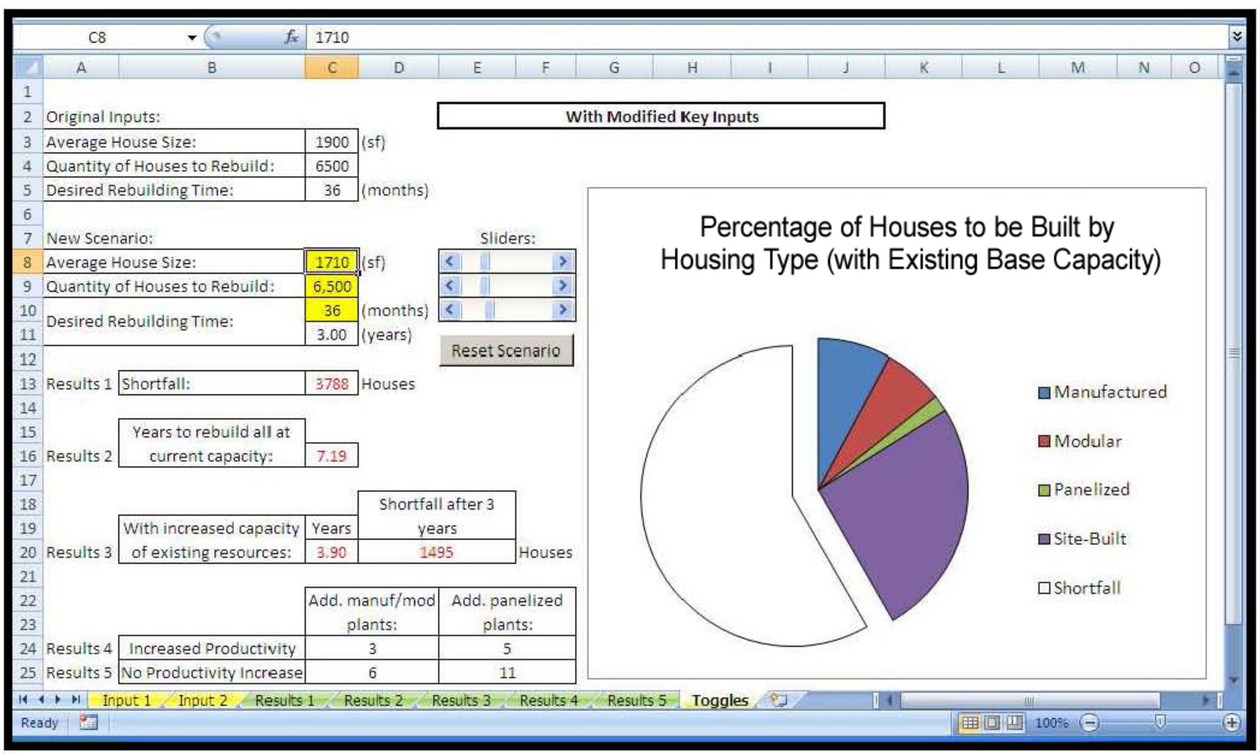


Figure 5-4: Toggles Page—1,710 Average House Size



scenario results for 2,090 s.f. Table 5-2 compares the differences in results between the original value and the ±10 percent range.

When considering the range of results in Table 5-2, the planner will notice that *Average House Size* does change the rebuilding time, but does not change the strategy if it involves converting vacant facilities. In fact, the *Average House Size* must be significantly in error to impact the overall pre-disaster plan.

The original *Desired Rebuilding Time* reflects the expectations of the community, and the standard results provide various options that may achieve the *Desired Rebuilding Time.* After considering these results, the community and planner will realize the actual capability to rebuild using existing housing capacity and will discover some limitations to implementing Results 4 and Results 5. The Toggles feature allows the planner to modify the *Desired Rebuilding Time* based on the actual number of vacant facilities available. For our example, assume that only one vacant facility is available for conversion. The planner will use the slider to increase the *Desired Rebuilding Time* until "1" additional Man/Mod plant is shown in Results 4 as highlighted in Figure 5-6. The new rebuilding time is 3.67 years.

To continue our example, we will now assume that increased productivity is not available and one vacant facility is available for conversion. The planner will use the slider to increase the *Desired Rebuilding Time* until "1" additional Man/Mod plant is shown in Results 5 as highlighted in Figure 5-7. The new rebuilding time is 5.75 years.

The planner can present various rebuilding strategies and times to the community. For our example, the rebuilding

Table 5-3: Considering a Range of Rebuilding Times based on Available Resources

Desired Rebuilding Time	Years
(Results 1) Original Input (Expectation)	3
(Results 2) Actual Time w/Existing Capacity	7.69
(Results 3) New Time w/Increased Productivity	4.19
(Results 4) (Requires 3 Vacant Facilities - Man/Mod)	3
(Results 5) (Requires 6 Vacant Facilities - Man/Mod)	3
New Results 4: 1 Vacant Facility Available – Man/Mod	3.67
New Results 5: 1 Vacant Facility Available – Man/Mod	5.75

Figure 5-5: Toggles Page—2,090 Average House Size

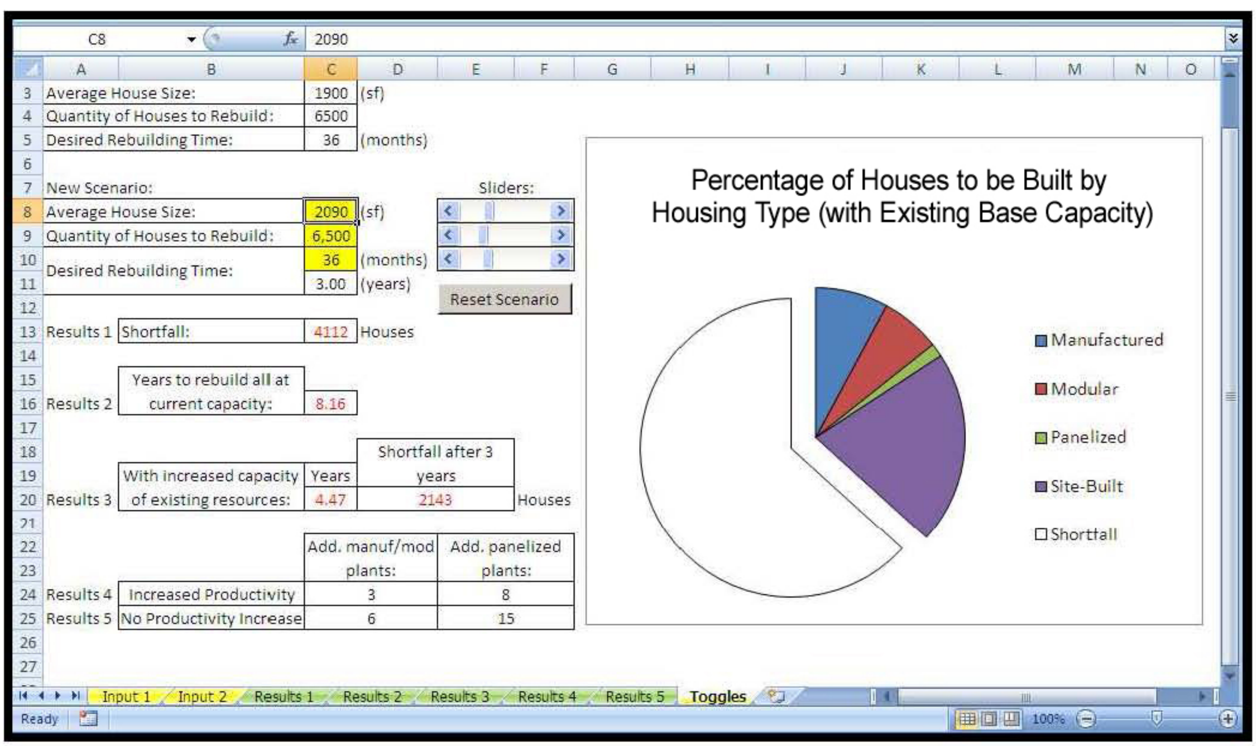


Figure 5-6: Toggles Page—New Rebuilding Time for Results 4

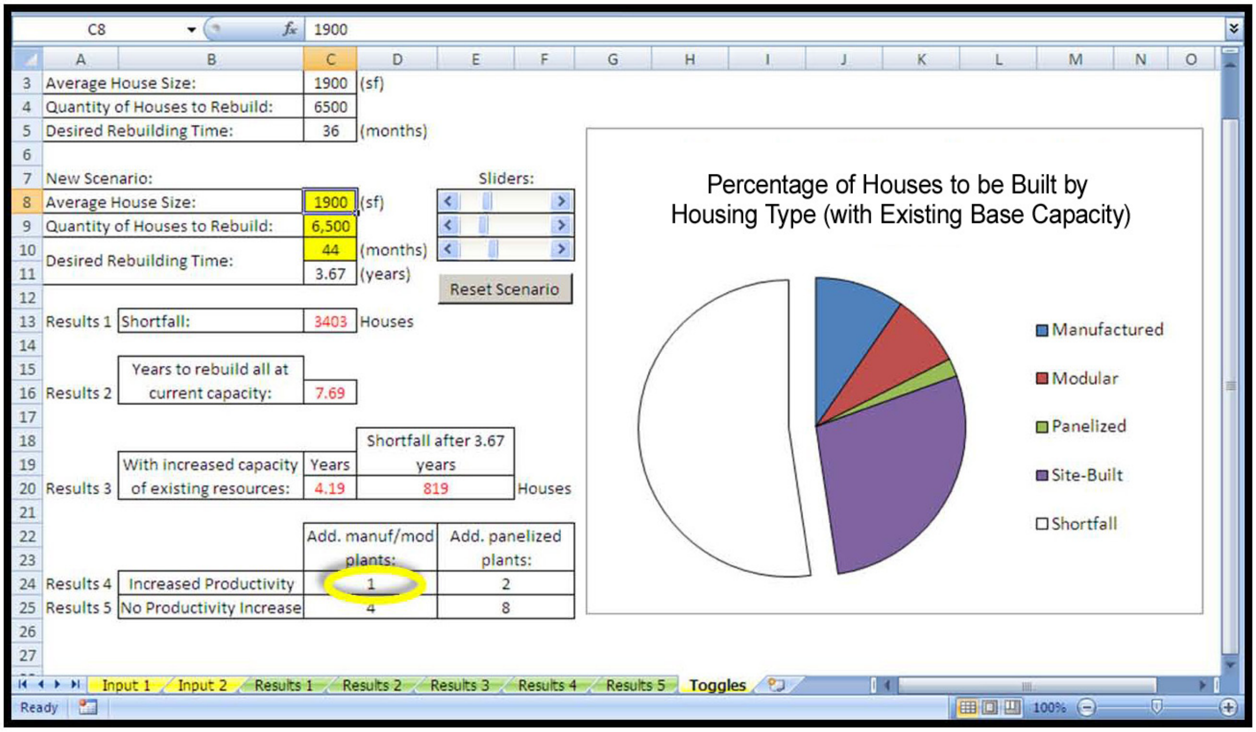
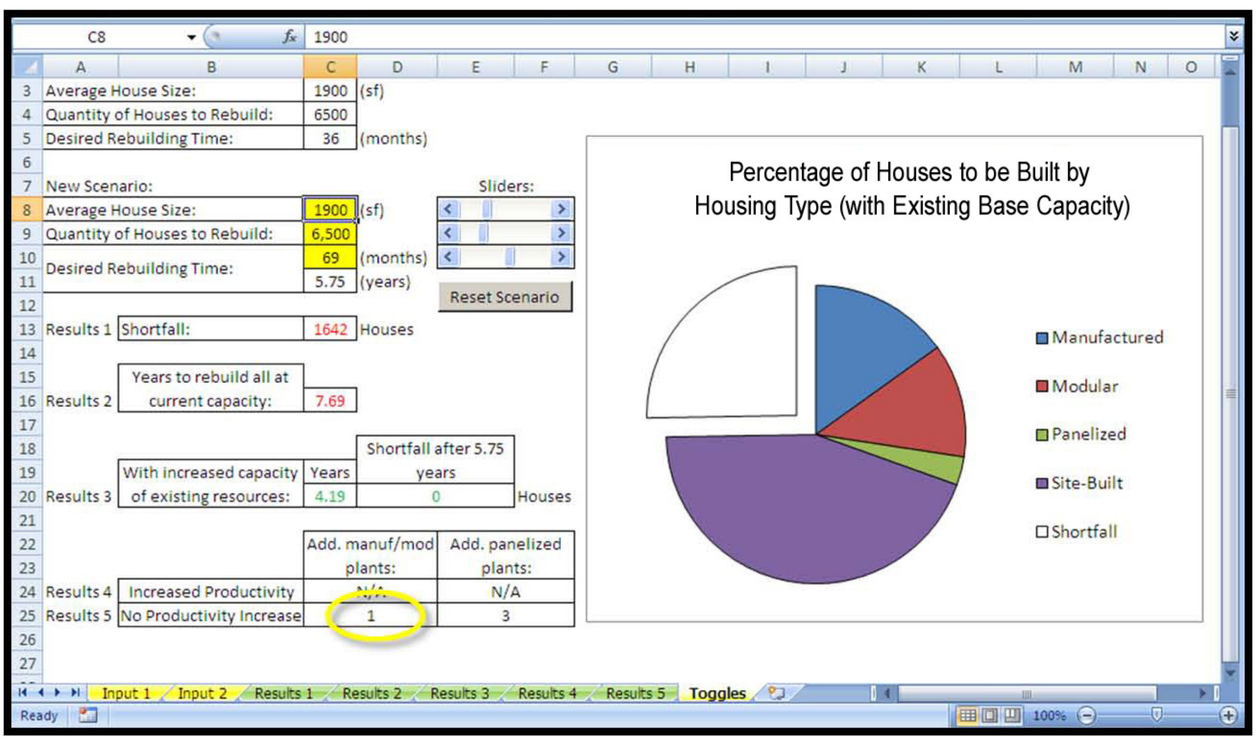


Figure 5-7: Toggles Page—New Rebuilding Time for Results 5



times have been summarized in Table 5-3. The options that have been developed using the Toggles feature are highlighted below.

The House Capacity Calculator is a good tool for preliminary planning and strategy development, but it is equally valuable when considering the facts on the ground after a disaster has occurred. The next section demonstrates how the tool can be updated in a post-disaster environment.

After the Disaster

For our example, assume that the community and local government decided to select the standard planning "Result 3" as the basis for their long-term permanent housing recovery plan. The projected rebuilding time is 4.25 years (to ensure the minimum of 4.19 years is met) and the pre-disaster plan relies on increased productivity from existing home builders (i.e., site-built and factory-built resources).

Once the disaster occurs, the planner will need to update the House Capacity Calculator to reflect the facts on the ground. For our example, the *Average House Size* will remain 1,900 s.f., the *Quantity of Houses to Rebuild* is 6,100 (a little less than the original plan but within the range), the *Desired Rebuilding Time* has been changed to 51 months (or 4.25 years) to reflect the planning strategy approved by the community and local government, the *Site-Built Housing Capacity* will remain 500 (houses/yr), and the *Number of Factory-Built Housing Plants* has decreased to 3 (since one plant went out of business and a second plant was destroyed during the natural disaster). The post-disaster inputs are shown in Figure 5-8.

The planner will now contact the three remaining factory-built housing plants and request annual capacity based on a need for 6,100 houses at an approximate size of 1,900 s.f. The plant, *Factory 1,* that committed to 100 houses/yr during the planning stage is able to meet the commitment. The other plants, *Factory 4* and *Factory 5,* (which could not provide an estimate during the planning stage due to the uncertainty of the disaster plan) have both provided annual quantities of 65 and 50, respectively. This information is entered into the House Capacity Calculator as shown in Figure 5-9.

The planner will review Results 1, which is shown in Figure 5-10. The existing capacity has a shortfall of approximately 50.2 percent.

The planner will review Results 2, which is shown in Figure 5-11. The actual rebuilding time using the existing capacity is 8.53 years (which exceeds the planned years of 4.25 years).

Figure 5-8: After the Disaster—"Key Inputs – Input 1"

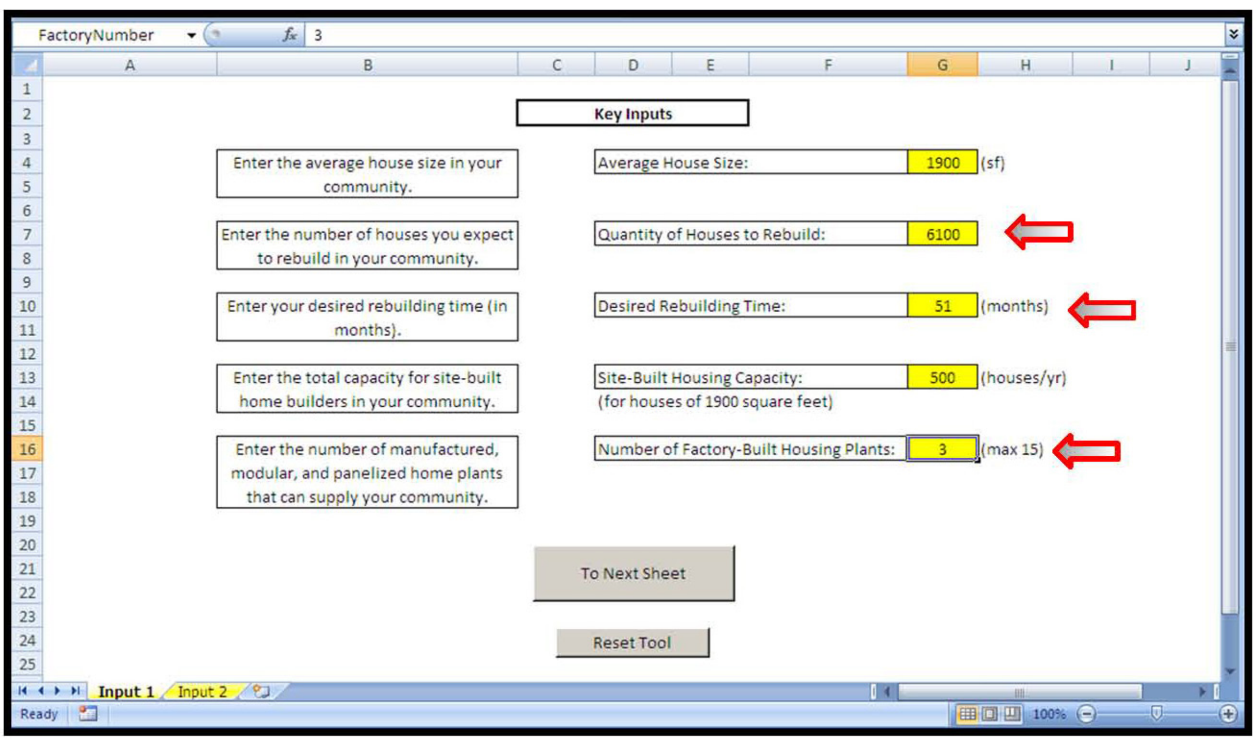


Figure 5-9: After the Disaster—"Housing Capacity Details – Input 2"

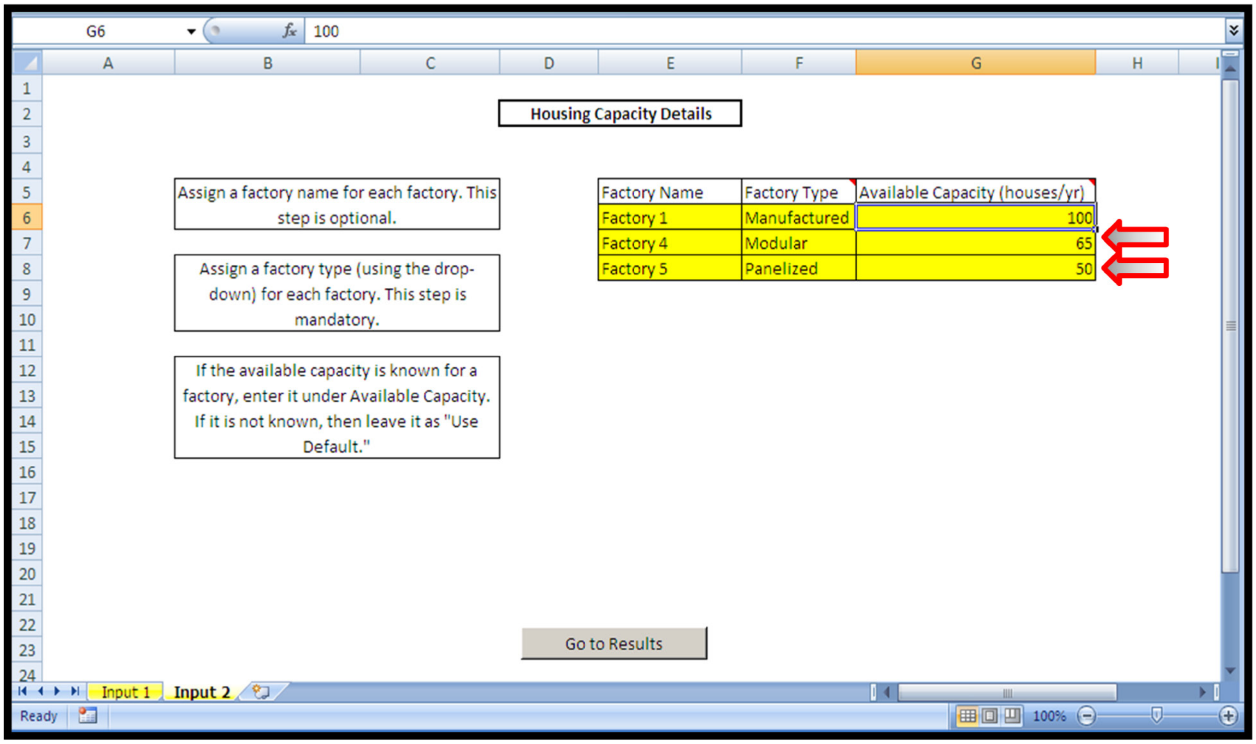
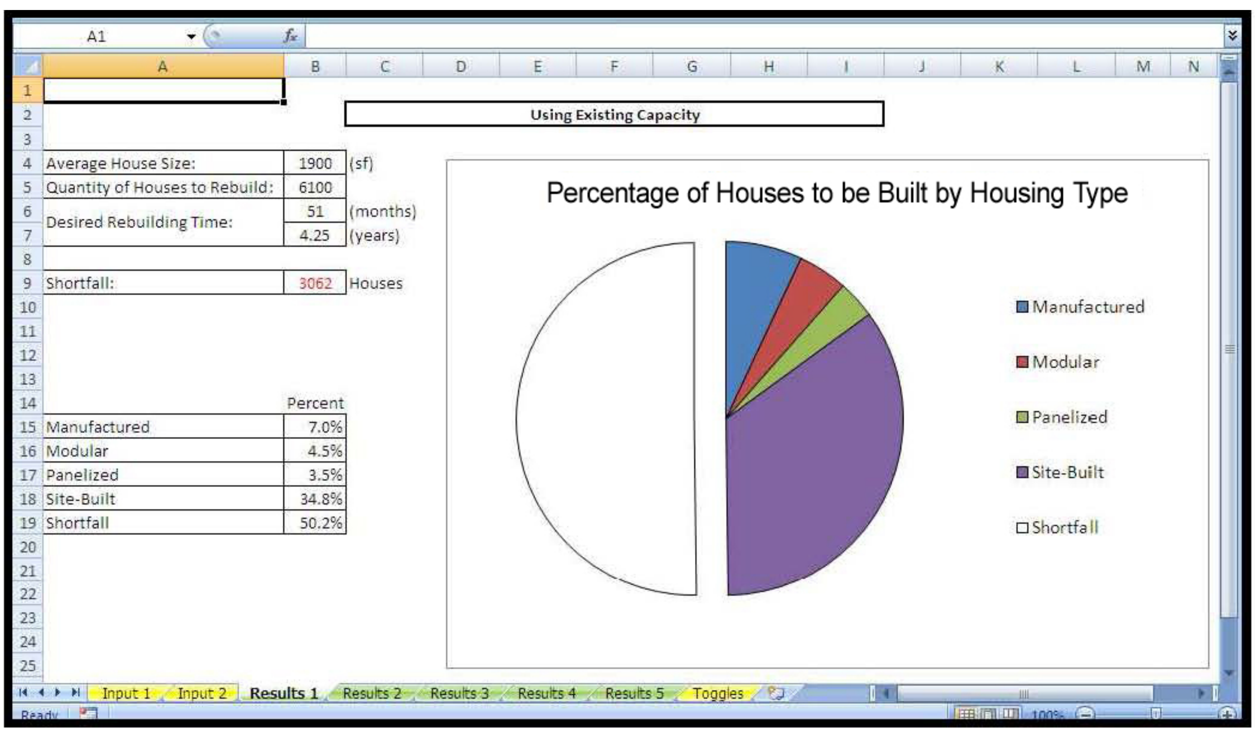


Figure 5-10: After the Disaster—"Using Existing Capacity – Results 1"



The planner will now confirm the planning strategy with the existing house capacity resources. The first plant, *Factory 1,* has confirmed that it will add a second shift as it originally committed during the planning stage. The second plant, *Factory 4,* has agreed to overtime during the rebuilding period. The third plant, *Factory 5,* has agreed to add three shifts.

During the disaster assessment, the planner realizes that many more houses have been damaged but not destroyed. The increase in damaged homes means that additional construction labor is needed; therefore, the site-built housing providers will dedicate more of their labor to repairing existing houses. The impact of shifting the site-built labor to address immediate repair needs is critical to recovery, but it also means that the planner can only count on 500 houses/yr for the permanent housing recovery effort.

Using the updated increased productivity information, the planner determines that the new rebuilding time is 6.44 years (instead of the anticipated 4.25 years) as shown in Figure 5-12. The planner informs the local government, and it decides to revisit the plant conversion options (i.e., Results 4 and Results 5). The planner and local government realize that they now have two vacant facilities: (1) the facility that was originally vacant during the planning stage and (2) the building that became vacant when the factory-built housing supplier went out of business. Figure 5-13 shows Results 4, which utilizes two vacant facilities to achieve the original 4.25-year rebuilding plan.

The planner can ignore Results 5, which are shown in Figure 5-14, because the recovery need is met using two vacant facilities and the existing housing capacity with increased productivity. The planner and local government may consider the rebuilding time if only one of the vacant facilities is used. The planner must use the Toggles feature, which is shown in Figure 5-15.

Again, the House Capacity Calculator assumes a best case scenario assumption even when used during the post-disaster recovery phase. In reality, there can be delays because of added labor, building permits, the weather, and facility conversion times. In short, the actual results can never be better than these projections, but they can be worse for a multitude of reasons. The planner should consider the post-disaster projects the best case scenario given the underlying commitments of the permanent housing resources.

Figure 5-11: After the Disaster—"Actual Rebuilding Time – Results 2"

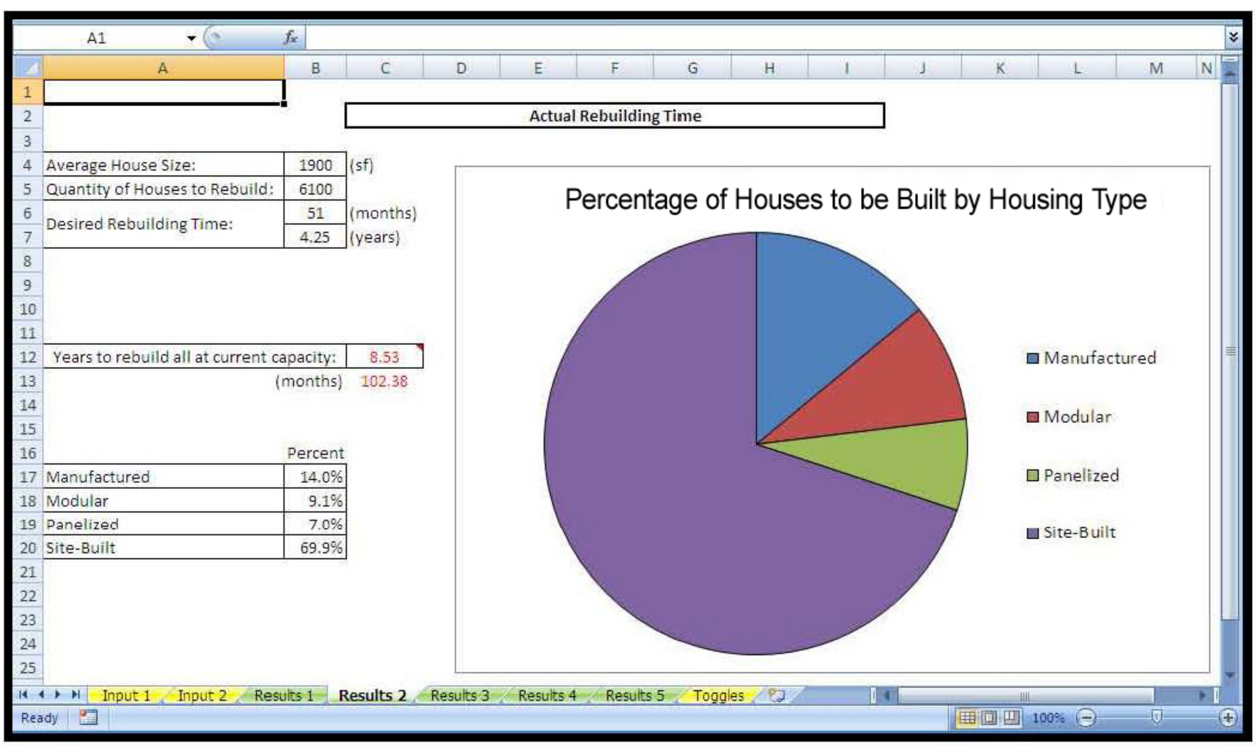


Figure 5-12: After the Disaster—"Increased Productivity – Results 3"

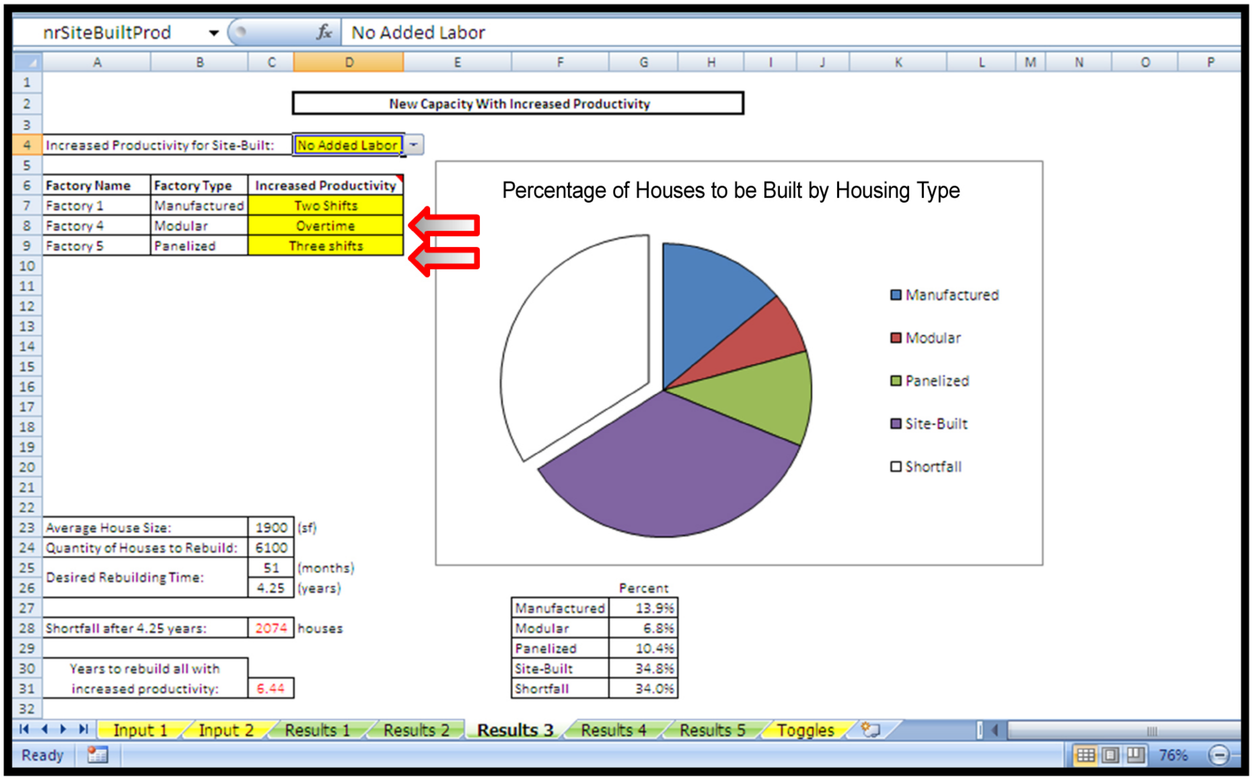
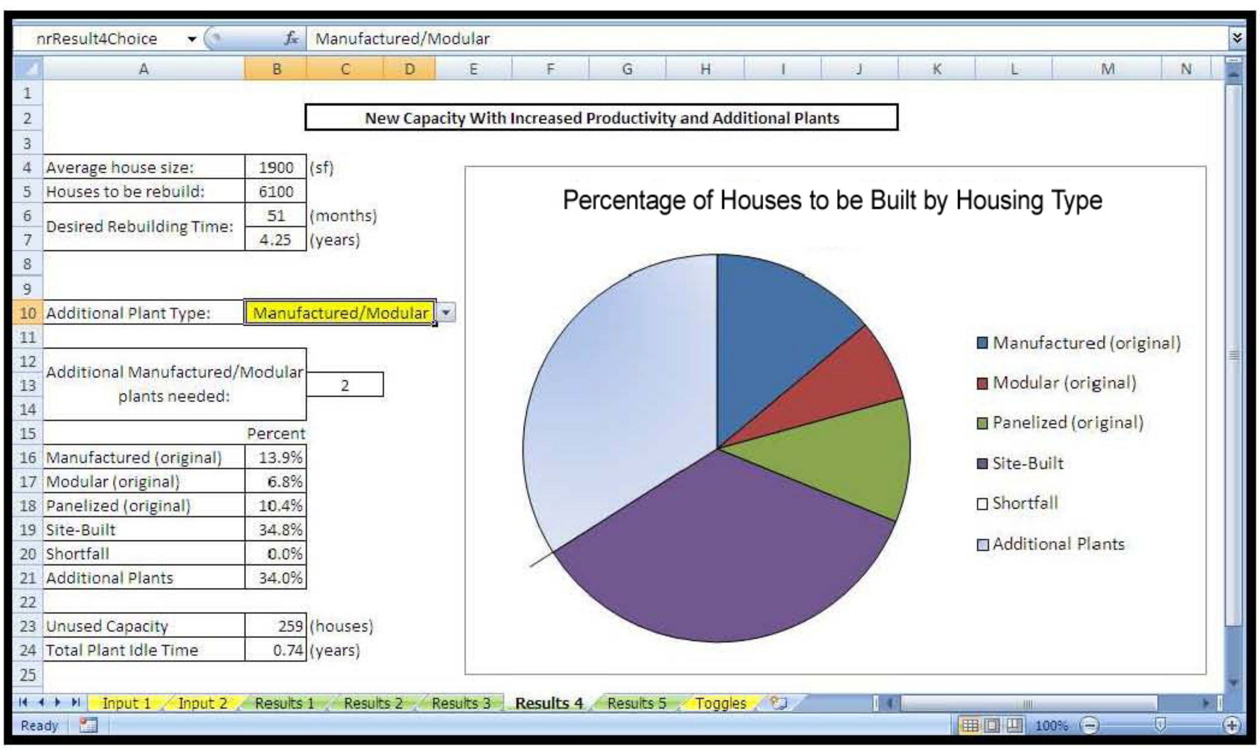


Figure 5-13: After the Disaster—"Increased Productivity/2 Plants – Results 4"



The Appendix includes worksheets that are a manual version of the House Capacity Calculator. Planners are encouraged to attend training seminars, which include several examples to further demonstrate the utility of this planning tool.

Figure 5-14: After the Disaster—"Additional Plants Only – Results 5"

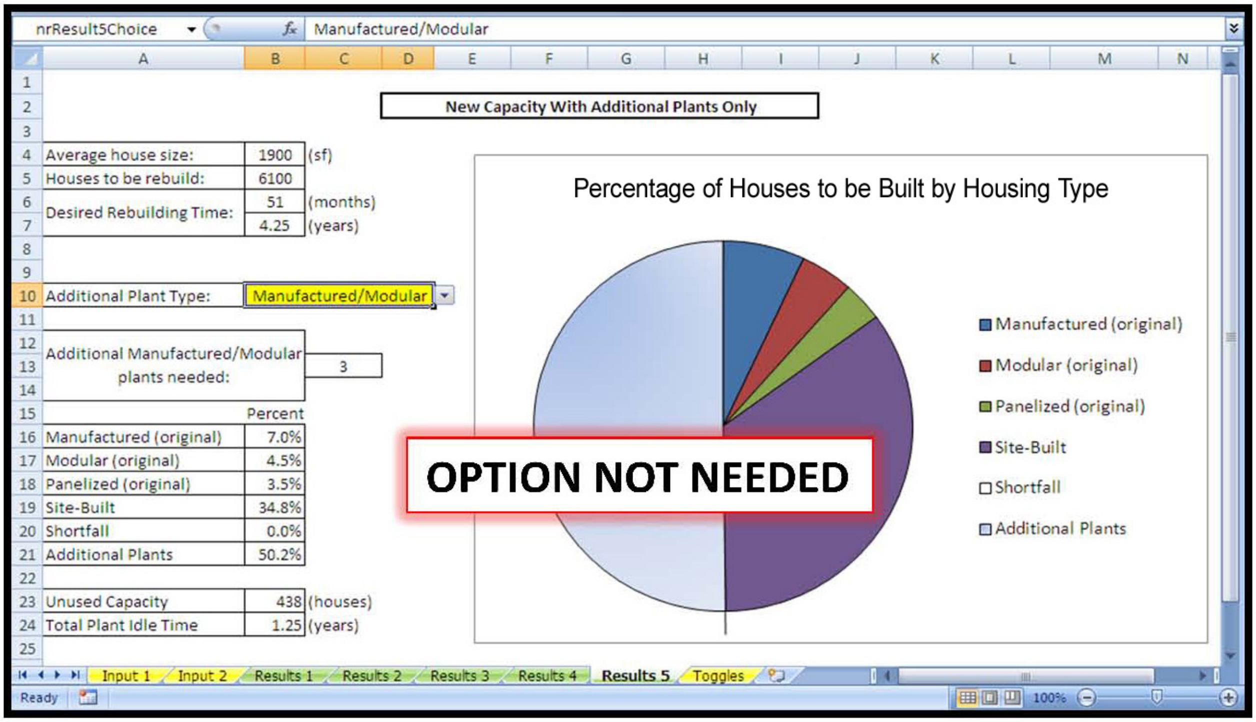
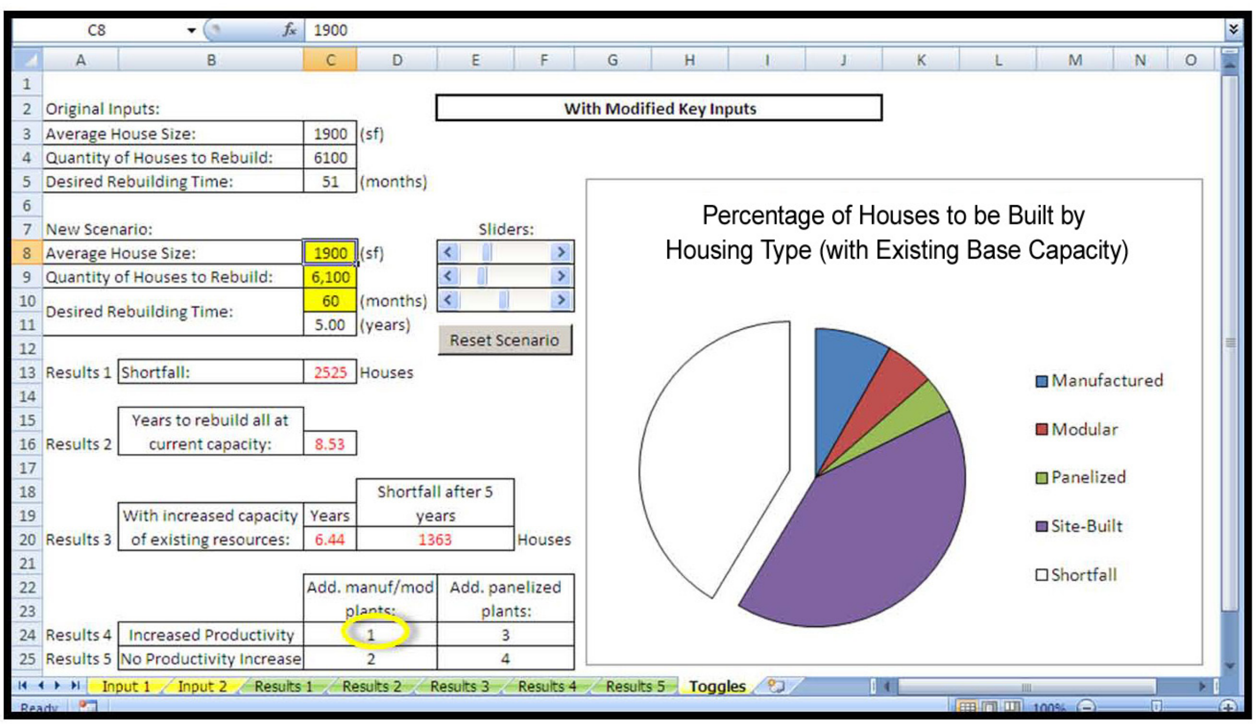


Figure 5-15: After the Disaster—"One Added Plant – Toggles"



Appendix A: Example Worksheets: Preliminary Planning

Example Worksheet: Preliminary Planning (1 of 8)

Identifying What You Need

Provide answers to the following questions (*example "answers"* in red font):

1) What is the average size house you intend to rebuild?
   House Size = 1,900 (s.f.)
2) Identify the number of houses you must rebuild.
   Number of Houses = 6,500
3) Identify how long you expect the rebuilding effort to take.
   Desired Timeframe = 36 (Months)

Step #1: Scale Production Capacity Based on House Size

Typically, the larger the house, the fewer houses that can be produced per year. If your house size is the same as the baseline house, which is 1,600 s.f., the production facility capacity for your chosen housing type will be the same as the baseline production facility capacities listed in Appendix Table 1.

Appendix Table 1: Summary of Baseline Production Capacity

Housing Type	Plant Size	Number of Houses Produced/Year	Required Labor for 1-shift
Manufactured Housing	100,000 s.f.	350	120
Modular Housing	100,000 s.f.	350	120
Panelized Housing	62,500 s.f.	208	19

Scaling Factor$_{House\ Size}$ Equation:

Enter your *House Size (this value can be found in your answer to Question 1 in the "Identifying What You Need" section above)* to determine your *Scaling Factor$_{House\ Size}$*:

$$Scaling\ Factor_{House\ Size} = \frac{House\ Size}{Baseline\ House\ Size}$$

$$Scaling\ Factor_{House\ Size} = \frac{1{,}900}{1{,}600} = 1.1875$$

Note: The decimal portion of the *Scaling Factor$_{House\ Size}$* calculated above must be **rounded** up or down for manufactured and modular housing before it can be applied. For panelized housing, use the actual value for the *Scaling Factor$_{House\ Size}$*, then **truncate** (i.e., delete) the decimal portion of the calculation. Truncation is required because you will not manufacture a partial home. The rules for rounding and truncation are as follows:

Example Worksheet: Preliminary Planning (2 of 8)

Rounding

- Identify the location of the decimal point "." The digit to the left of it is called the "rounding digit." *(Example: 2 is the rounding digit for 12.5)*
- Look at the digit just to the right of the decimal point. If that digit is less than 5, round down by eliminating all digits to the right of the decimal point. *(Example: 1.1875 would become 1)*
- If the digit just to the right of the decimal point is greater than or equal to 5, round up by adding 1 to the rounding digit. *(Example: 12.5 would become 13)*

Special Case

- If 0 is the only digit to the left of the decimal point, and the digit just to the right of the decimal point is less than 5, then use 0.5 for the $\textit{Scaling Factor}_{\textit{House Size}}$. *(Example: 0.4375 would become 0.5)*

Truncation

- Identify the location of the decimal point "."
- Drop all digits to the right of the decimal point. *(Example: 151.2727272727273 would become 151)*

Apply the $\textit{Scaling Factor}_{\textit{House Size}}$ to determine whether the baseline production capacity is increased or reduced.

Manufactured Housing

$$\frac{\textit{Houses Produced}}{\textit{Year}} = \frac{\frac{\textit{Number of Houses Produced}}{\textit{Year}} \textit{(insert value from Table 5-1)}}{\textit{Scaling Factor}_{\textit{House Size}}}$$

$$\frac{\textit{Houses Produced}}{\textit{Year}} = \frac{350}{1} = 350$$

Modular Housing

$$\frac{\textit{Houses Produced}}{\textit{Year}} = \frac{\frac{\textit{Number of Houses Produced}}{\textit{Year}} \textit{(insert value from Table 5-1)}}{\textit{Scaling Factor}_{\textit{House Size}}}$$

$$\frac{\textit{Houses Produced}}{\textit{Year}} = \frac{350}{1} = 350$$

Panelized Housing

$$\frac{\textit{Houses Produced}}{\textit{Year}} = \frac{\frac{\textit{Number of Houses Produced}}{\textit{Year}} \textit{(insert value from Table 5-1)}}{\textit{Scaling Factor}_{\textit{House Size}}}$$

$$\frac{\textit{Houses Produced}}{\textit{Year}} = \frac{208}{1.1875} = 175.158 = 175$$

Example Worksheet: Preliminary Planning (3 of 8)

The new calculated "Houses Produced/Year" is based on the size and type of housing you have tentatively planned to rebuild. Use this value in Step #2, in order to further scale your production capacity. Step #2 assumes that you can increase your production through adding labor capacity and some modest equipment improvements (beyond the baseline example).

Step #2: Increase Production Capacity Based on Labor & Equipment

Typically, the production capacity can be further increased by adding labor and equipment. If your jurisdiction has access to construction labor, then it is reasonable to assume some increased production capacity beyond the baseline example, which is based on one 8-hour production shift. If your jurisdiction lacks the additional labor force, then this increase in production capacity may not apply—unless the additional labor force relocates to your area. Production capacity scaling is defined for each factory-built housing type in Appendix Tables 2 through 4.

Scaling for Labor & Equipment:

Appendix Table 2: Production Capacity Increases for Manufactured Housing

Strategy	Direct Labor	Equipment/ Automation Level	Production Capacity	Labor & Equipment Scaling Factor
Baseline (1 Shift)	120	Low	7 houses/week 350 houses/year	1
Baseline (1 Shift w/OT)	120	Low	10 houses/week 500 houses/year	1.5
Increase labor size (2 Shifts)	200	Low	14 houses/week 700 houses/year	2

Appendix Table 3: Production Capacity Increases for Modular Housing

Strategy	Direct Labor	Equipment/ Automation Level	Production Capacity	Labor & Equipment Scaling Factor
Baseline (1 Shift)	116	Low	7 houses/week 350 houses/year	1
Baseline (1 Shift w/OT)	116	Low	10 houses/week 500 houses/year	1.5
Increase labor size (2 Shifts)	195	Low	14 houses/week 700 houses/year	2

Appendix Table 4: Production Capacity Increase for Panelized Whole-House Units

Strategy	Direct Labor	Equipment/ Automation Level	Production Capacity	Labor & Equipment Scaling Factor
Baseline (1 Shift)	19	Medium	330,000 s.f./year 208 houses/year	1
Increase labor size (2 Shifts)	38	Medium	660,000 s.f./year 416 houses/year	2
Increase labor size (3 Shifts)	57	Medium	1,000,000 s.f./year 625 houses/year	3

Example Worksheet: Preliminary Planning (4 of 8)

Scaling Factor$_{Labor\ \&\ Equipment}$ Equation:

Example of increased production capacity based on the labor and equipment

Select your production capacity strategy, and then apply the corresponding *Scaling Factor$_{Labor\ \&\ Equipment}$* from Appendix Tables 2, 3 or 4 to determine your maximum production capacity.

You can select any scaling factor listed in the tables, but for this example assume that construction labor is available and that you will add one more shift to increase the overall production capacity for each factory-built option listed in Appendix Tables 2 through 4. Round up your answer to the nearest whole-number value.

Manufactured Housing

$$\frac{\textit{Final House Production}}{\textit{Year}} = \frac{\textit{Houses Produced}}{\textit{Year}} \times \textit{Scaling Factor}_{\textit{Labor \& Equipment}}$$

$$\frac{\textit{Final House Production}}{\textit{Year}} = 350 \times 2 = 700$$

Modular Housing

$$\frac{\textit{Final House Production}}{\textit{Year}} = \frac{\textit{Houses Produced}}{\textit{Year}} \times \textit{Scaling Factor}_{\textit{Labor \& Equipment}}$$

$$\frac{\textit{Final House Production}}{\textit{Year}} = 350 \times 2 = 700$$

Panelized Housing

$$\frac{\textit{Final House Production}}{\textit{Year}} = \frac{\textit{Houses Produced}}{\textit{Year}} \times \textit{Scaling Factor}_{\textit{Labor \& Equipment}}$$

$$\frac{\textit{Final House Production}}{\textit{Year}} = 175 \times 2 = 350$$

The "Final House Production/Year" represents the estimated maximum production for your chosen factory-built housing type. Use this value in Step #3 to determine how many production facilities you will need to rebuild in your desired timeframe.

Example Worksheet: Preliminary Planning (5 of 8)

Step #3: Estimated Time to Rebuild Based on the Production Facility Capacity

Using the number of houses that you must rebuild and your annual production capacity calculated in Step #2, determine the number of production facilities you need in order to rebuild within your desired timeframe.

Example of estimated time to rebuild based on the Production Facility Capacity

Basic Planning Equation:

Assume 6,500 houses need to be rebuilt within a desired timeframe of three years. When calculating the number of production facilities, round up to the nearest number of production facilities.

Manufactured Housing

$$\textit{Number of Years for One Production Facility} = \frac{\textit{Number of Houses}}{\textit{Final House Production/Year (calculated in Step \#2)}}$$

$$\textit{Number of Years for One Production Facility} = \frac{6{,}500}{700} = 9.3$$

Now, determine how many production facilities you will need in order to rebuild in your desired timeframe:

$$\textit{Number of Production Facilities} = \frac{\textit{Number of Years for One Production Facility}}{\textit{Desired Timeframe (in years)}}$$

$$\textit{Number of Production Facilities} = \frac{9.3}{3} = 3.1 = 4$$

Modular Housing

$$\textit{Number of Years for One Production Facility} = \frac{\textit{Number of Houses}}{\textit{Final House Production/Year (calculated in Step \#2)}}$$

$$\textit{Number of Years for One Production Facility} = \frac{6{,}500}{700} = 9.3$$

Now, determine how many production facilities you will need in order to rebuild in your desired timeframe:

$$\textit{Number of Production Facilities} = \frac{\textit{Number of Years for One Production Facility}}{\textit{Desired Timeframe (in years)}}$$

$$\textit{Number of Production Facilities} = \frac{9.3}{3} = 3.1 = 4$$

Example Worksheet: Preliminary Planning (6 of 8)

Panelized Housing

Number of Years for One Production Facility = $\frac{\textit{Number of Houses}}{\textit{Final House Production/Year (calculated in Step \#2)}}$

Number of Years for One Production Facility = $\frac{6,500}{350} = 18.6$

Now, determine how many production facilities you will need in order to rebuild in your desired timeframe:

Number of Production Facilities = $\frac{\textit{Number of Years for One Production Facility}}{\textit{Desired Timeframe (in years)}}$

Number of Production Facilities = $\frac{18.6}{3} = 6.2 = 7$

Step #4: Adjusting Production Facility Capacity based on the Implementation Option

The planning results from Step #3 assume that the production facility is producing at 100 percent capacity. This is possible with an existing production facility, but it is unlikely that an existing production facility will dedicate all of its production capacity to a single customer for multiple years. At most, an existing production facility may be willing to dedicate 20 percent of its total capacity to a single new customer, provided the existing customer base needs can be met. If a vacant facility is converted with the primary objective of rebuilding houses for a community affected by a natural disaster, then one can plan for 100 percent of the production capacity being dedicated to the rebuilding effort. Appendix Table 5 illustrates how available capacity must be considered for long-term recovery planning.

Appendix Table 5: Production Capacity based on the Implementation Option

Implementation Option	Production Capacity Available	Lead-Time to Implement		
		Manufactured Housing	Modular Housing	Panelized Housing
Use Existing Manufacturing/ Factory	50%	Now	Now	Now
Convert Existing Facility	100%	11-Month	11-Month	14-Month

Example of adjusting production facility capacity based on the implementation option when using existing production facilities:

Assume the best case scenario: 20 percent of the existing capacity will be available.

Manufactured Housing

Number of Production Facilities = $\frac{\textit{Number of Production Facilities (calculated in Step \#3)}}{20\%}$

Number of Production Facilities = $\frac{4}{0.20} = 20$

Example Worksheet: Preliminary Planning (7 of 8)

Modular Housing

$$\textit{Number of Production Facilities} = \frac{\textit{Number of Production Facilities (calculated in Step \#3)}}{20\%}$$

$$\textit{Number of Production Facilities} = \frac{4}{0.20} = 20$$

Panelized Housing

$$\textit{Number of Production Facilities} = \frac{\textit{Number of Production Facilities (calculated in Step \#3)}}{20\%}$$

$$\textit{Number of Production Facilities} = \frac{7}{0.20} = 35$$

When converting a vacant facility:

Manufactured Housing

$$\textit{Number of Production Facilities} = \frac{\textit{Number of Production Facilities (calculated in Step \#3)}}{100\%}$$

$$\textit{Number of Production Facilities} = \frac{4}{1} = 4$$

Modular Housing

$$\textit{Number of Production Facilities} = \frac{\textit{Number of Production Facilities (calculated in Step \#3)}}{100\%}$$

$$\textit{Number of Production Facilities} = \frac{4}{1} = 4$$

Panelized Housing

$$\textit{Number of Production Facilities} = \frac{\textit{Number of Production Facilities (calculated in Step \#3)}}{100\%}$$

$$\textit{Number of Production Facilities} = \frac{7}{1} = 7$$

We have selected 20 percent as a default maximum value for existing manufacturing facilities. The available capacity will vary with each existing manufacturer of factory-built housing. As a result, it is better to solicit the available capacity from the manufacturer, which may change the number of production facilities needed significantly.

If you decide to use existing manufacturers of factory-built housing, it is important to discuss backlog, logistics, and other possible strategies for increasing production capacity. For some rebuilding efforts, it might be prudent to implement a strategy that includes both existing production facilities and converted facilities to meet the desired timeframe and fulfill the house quantity needed.

Is the desired timeframe and number of production facilities needed “reasonable”?

Example Worksheet: Preliminary Planning (8 of 8)

Are there enough existing production facilities in your area to supply your rebuilding needs within the desired timeframe? Can you adjust your desired timeframe such that you can use existing production facilities? Do you have enough existing vacant facilities in your area to supply your rebuilding needs within the desired timeframe? Can you adjust your desired timeframe such that you can use existing vacant facilities?

To find the best fit for your jurisdiction, try a few scenarios using the blank Preliminary Planning Worksheets. But before doing so, review the summarized ramp-up times for implementing different rebuilding options in Appendix Tables 6 through 8:

Appendix Table 6: Ramp-up Timeframe for Manufactured Housing

Implementation Strategy	Plant Setup	Timeframe to Full Production
Using existing manufacturers	Now	Depends on each manufacturer's backlog and production capacity
Converting existing facility	6 months	18 weeks (a total of about 11 months)

Appendix Table 7: Ramp-up Timeframe for Modular Housing

Implementation Strategy	Plant Setup	Timeframe to Full Production
Using existing manufacturers	Now	Depends on each manufacturer's backlog and production capacity
Converting existing facility	6 months	18 weeks (a total of about 11 months)

Appendix Table 8: Ramp-up Timeframe for Panelized Housing

Implementation Strategy	Plant Setup	Timeframe to Full Production
Using existing manufacturers	Now	Depends on each manufacturer's backlog and production capacity
Converting existing facility	9 months	20 weeks (a total of about 14 months)

Appendix B: **Worksheets: Preliminary Planning**

Worksheet: Preliminary Planning (1 of 4)

Identifying What You Need

Provide answers to the following questions:

1) What is the average size house you intend to rebuild?
House Size = ______________________________ (s.f.)

2) Identify the number of houses you must rebuild.
Number of Houses = ____________________________

3) Identify how long you expect the rebuilding effort to take.
Desired Timeframe = ____________________ (Months)

Step #1: Scale Production Capacity Based on House Size

Typically, the larger the house, the fewer houses that can be produced per year. If your house size is the same as the baseline house, which is 1,600 s.f., the production facility capacity for your chosen housing type will be the same as the baseline production facility capacities listed in Appendix Table 1 (see page 26).

Scaling Factor$_{House\ Size}$ Equation:

Enter your *House Size* to determine your *Scaling Factor$_{House\ Size}$*:

$$\text{Scaling Factor}_{House\ Size} = \frac{\text{House Size}}{\text{Baseline House Size}} = \frac{\quad}{\quad} = \_\_\_\_\_\_\_\_$$

Manufactured Housing

$$\frac{\text{Houses Produced}}{\text{Year}} = \frac{350}{\text{Scaling Factor}_{House\ Size}} = \frac{350}{\quad} = \_\_\_\_\_\_\_\_$$

Modular Housing

$$\frac{\text{Houses Produced}}{\text{Year}} = \frac{350}{\text{Scaling Factor}_{House\ Size}} = \frac{350}{\quad} = \_\_\_\_\_\_\_\_$$

Panelized Housing

$$\frac{\text{Houses Produced}}{\text{Year}} = \frac{208}{\text{Scaling Factor}_{House\ Size}} = \frac{208}{\quad} = \_\_\_\_\_\_\_\_$$

The newly calculated "Houses Produced/Year" is based on the size and type of housing you have tentatively planned to rebuild. Use this value in Step #2 in order to further scale your production capacity. Step #2 assumes that you can increase your production through adding labor capacity and some modest equipment improvements (beyond the baseline example).

Worksheet: Preliminary Planning (2 of 4)

Step #2: Increase Production Capacity Based on Labor & Equipment

Typically, the production capacity can be further increased by adding labor and equipment. If your jurisdiction has access to construction labor, then it is reasonable to assume some increased production capacity beyond the baseline example, which is based on one 8-hour production shift. If your jurisdiction lacks the additional labor force, then this increase in production capacity may not apply—unless the additional labor force relocates to your area. Production capacity scaling is defined for each factory-built housing type in Appendix Table 9.

Scaling for Labor & Equipment:

Appendix Table 9: Production Capacity Increases for All Factory-Built Housing Types

Strategy	Manufactured Housing Labor & Equipment Scaling Factor	Modular Housing Labor & Equipment Scaling Factor	Panelized Housing Labor & Equipment Scaling Factor
Baseline (1 Shift)	1	1	1
Increase labor (OT or 2 Shifts)	1.5	1.5	2
Increase labor (2 or 3 Shifts)	2	2	3

Scaling Factor$_{\text{Labor \& Equipment}}$ Equation:

Select your production capacity strategy, and then apply the corresponding *Scaling Factor$_{\text{Labor \& Equipment}}$* from Table 5-9 to determine your maximum production capacity.

$$\frac{\textit{Final House Production}}{\textit{Year}} = \frac{\textit{Houses Produced}}{\textit{Year}} \times \textit{Scaling Factor}_{\textit{Labor \& Equipment}}$$

$$\frac{\textit{Final House Production}}{\textit{Year}} = \underline{\qquad\qquad} \times \underline{\qquad\qquad} = \underline{\qquad\qquad}$$

The "Final House Production/Year" represents the estimated maximum production for your chosen factory-built housing type. Use this value in Step #3 to determine how many production facilities you will need to rebuild in your desired timeframe.

Worksheet: Preliminary Planning (3 of 4)

Step #3: Estimated Time to Rebuild Based on the Production Facility Capacity

Using the number of houses that you must rebuild and your annual production capacity calculated in Step #2, determine the number of production facilities you need in order to rebuild within your desired timeframe.

Basic Planning Equation:

When calculating the number of production facilities, round up to the nearest number of production facilities.

$$\text{Number of Years for One Production Facility} = \frac{\text{Number of Houses}}{\text{Final House Production/Year (calculated in Step \#2)}}$$

$$\text{Number of Years for One Production Facility} = \frac{\qquad}{\qquad} = \underline{\qquad\qquad}$$

Now, determine how many production facilities you will need in order to rebuild in your desired timeframe:

$$\text{Number of Production Facilities} = \frac{\text{Number of Years for One Production Facility}}{\text{Desired Timeframe (in years)}}$$

$$\text{Number of Production Facilities} = \frac{\qquad}{\qquad} = \underline{\qquad\qquad}$$

Worksheet: Preliminary Planning (4 of 4)

Step #4: Adjusting Production Facility Capacity based on the Implementation Option

The planning results from Step #3 assume that the production facility is producing at 100 percent capacity. This is possible with an existing production facility, but it is unlikely that an existing production facility will dedicate all of its production capacity to a single customer for multiple years. At most, an existing production facility may be willing to dedicate 20 percent of its total capacity to a single new customer, provided the existing customer base needs can be met. If a vacant facility is converted with the primary objective of rebuilding houses for a community affected by a natural disaster, then one can plan for 100 percent of the production capacity being dedicated to the rebuilding effort. Appendix Table 5 (see page 31) illustrates how available capacity must be considered for long-term recovery planning.

When using existing production facilities:

$$\textit{Number of Production Facilities} = \frac{\textit{Number of Production Facilities (calculated in Step \#3)}}{\textit{Available Capacity (\%)}} = \frac{\qquad}{\qquad} = \underline{\qquad\qquad}$$

When converting a vacant facility:

$$\textit{Number of Production Facilities} = \frac{\textit{Number of Production Facilities (calculated in Step \#3)}}{100\%}$$

$$\textit{Number of Production Facilities} = \frac{\qquad}{1} = \underline{\qquad\qquad}$$

We have recommended 20 percent as a default maximum available capacity for existing manufacturing facilities. The available capacity will vary with each existing manufacturer of factory-built housing. As a result, it is better to solicit the available capacity from the manufacturer, which may change the number of production facilities needed significantly.

Resources

Census Bureau Data

New Residential Construction: Building Permits, Housing Starts, & Housing Completions
http://www.census.gov/const/www/newresconstindex.html

Federal, State, or Local Governments

There are several resources that support disaster recovery for permanent housing.

U.S. Department of Housing and Urban Development
http://www.hud.gov

Federal Emergency Management Agency
http://www.fema.gov/

List of State Governments
http://www.usa.gov/Agencies/State_and_Territories.shtml

Associations

There are several resources that support permanent housing.

National Association of Home Builders
http://www.nahb.org/

Manufactured Housing Institute
http://www.factorybuilthousing.com/Default.asp

Modular Building Systems Association
http://www.modularhousing.com/

Structural Insulated Panel Association
http://www.sips.org/

U.S. Department of Housing and Urban Development
Office of Policy Development and Research
Washington, DC 20410-6000

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

EQUAL HOUSING OPPORTUNITY

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