Reprinted from
RESOURCE RECYCLING

"Unfortunately, at times, it takes a crisis to encourage states to plan"
– Thea McManus

AFTER THE STORM:
DISASTER DEBRIS MANAGEMENT AND RECOVERY

Materials recovery is generally the last thought on anyone's mind after a natural disaster has occurred. However, a disaster debris management plan can help a community identify options for collecting, recycling and disposing of generated debris.

By Justin Gast and Henry Leineweber

They are events no one wants to endure, or after effects anyone wants to observe. Often, without warning, an earthquake, windstorm, fire or flood can strike, and, though the event of a natural disaster can last mere seconds, in some cases, the financial, emotional and environmental impacts from such events can be felt for an extensive period of time.

The landscape of natural disasters in the U.S. varies greatly from region to region. For example, the likelihood of people on the West Coast experiencing an earthquake is much greater than for those living in the Mid-Atlantic, Northeast and South regions. In addition, those taking residence in states that make up the Atlantic and Eastern Seaboards are more likely to confront a hurricane, compared to those living elsewhere. Further, less than 20 percent of the nation is susceptible to severe thunderstorms and violent tornadoes.

When faced with the aftermath of a natural disaster, realistically, materials diversion is the last thought on the minds of community members, emergency response crews and local, state and federal recovery agencies, and rightly so. Responding organizations should always prioritize human safety and welfare over material recovery and management, in order to restore basic services, lines of communication and civil order.

Eventually, materials management will need to occur, and it's always better to be prepared for such a situation than to undertake a post-event task using a fly-by-the-seat-of-your-pants approach. In fact, according to the U.S. Environmental Protection Agency's (EPA) amended 2008 Planning for Natural Disaster Debris (PNDD) report, careful planning can significantly minimize costly mistakes, speed recovery, protect human health and the environment, and prevent the generation of additional waste.

Opportunity in a crisis

"The number of people hit by climate-related disasters is expected to rise by about 50 percent, reaching 375 million a year, globally, by 2015" – *Oxfam International*

Natural disasters represent a persistent, but unpredictable, financial hazard to the U.S. economy. Although the National Science and Technology Council estimates the aforesaid disasters can cost the U.S., as a whole, an average of $52 billion per year in loss of life, property and economic output, this amount can skyrocket in particularly bad years.

In 2005, for example, damage costs from such events as the Evansville Tornado, Hurricanes Dennis, Rita and Wilma, and the costliest hurricane in U.S. history, Hurricane Katrina, totaled over $100.8 billion. Because of Katrina, Louisiana and Mississippi were responsible for more than $79.2 billion – 78.6 percent – of the total damage costs reported that year.

In 2008, Hurricane Ike alone caused more than $29.7 billion in damage, making it the third most destructive hurricane to ever make landfall in the United States. Texas was responsible for a majority of the damage, at over $16 billion, with much of that total associated with debris cleanup, which included structural debris, vegetative and organic material, white goods, scrap vehicles and broad spectrum of material streams. Figure 1 provides a summary of damage costs for the 2008 calendar year, as broken down by region.

Due to the sheer volume of waste generated by any given natural disaster, insufficient processing capacity, in most cases, is the most significant barrier to recycling in debris management and disaster cleanup operations – in many communities, the recycling infrastructure is simply not equipped to be inundated with generated material. After a disaster has occurred, communities are faced with the daunting task of how best to utilize their existing capacity for the handling of natural disaster debris. And, in almost all cases, one component of materials management (e.g., recycling, composting, combustion, etc.) is not sufficient enough to handle the overwhelming amount of debris generated by a disaster.

"After Katrina, we had a difficult time recycling some materials, simply because of the vast volume of debris we were dealing with," says Mark Williams, Solid Waste Policy, Planning and Grants administrator for the Mississippi Department of Environmental Quality (MSDEQ). "There were simply not enough markets or end-uses within reasonable transportation distance to recycle all of the downed trees and vegetative debris, as well as the vast amounts of structural debris, caused by the storm."

It should be noted that, after Hurricanes Katrina and Rita, roughly 950,000 white goods, 26,000 pounds of refrigerant and 12,500 tons of electronics were recycled (combined LA/MS numbers). In addition, vegetative debris, automobiles, scrap metal and boats were also extensively recycled.

Another major barrier, which unfortunately plays a role in the low diversion rates witnessed throughout much of the South, is culture. A factor also influenced by a lack of infrastructure, in the event of a natural disaster, materials handling can be costly and time consuming, thus, some areas seek alternative, less environmentally-friendly methods of debris management.

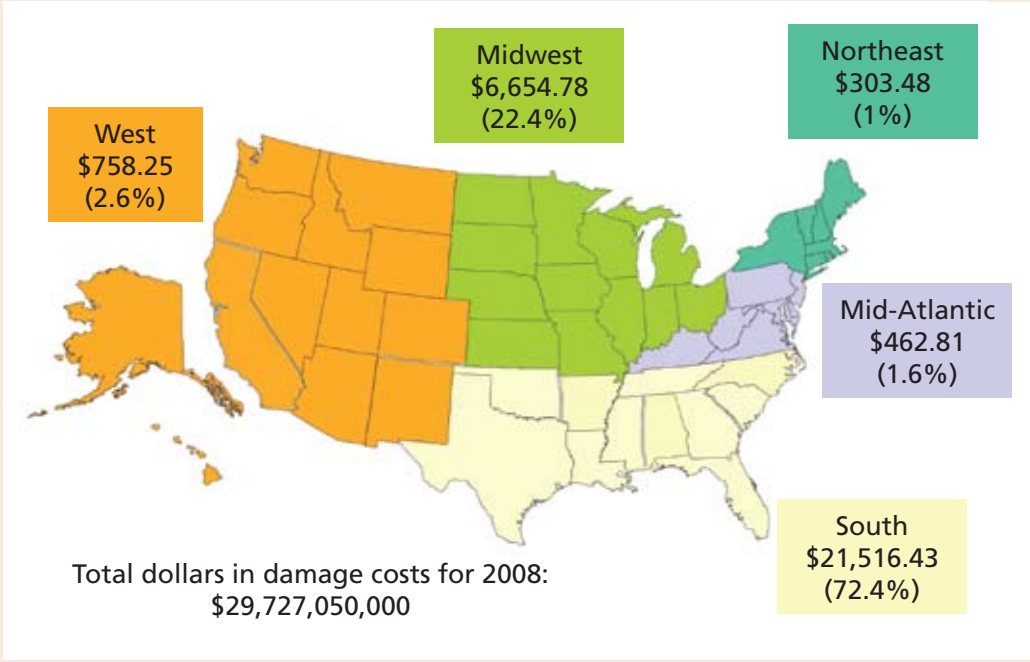
For example, as stated in the State of Louisiana, Office of Homeland Security and Emergency Preparedness' *Debris Management Plan*:

> Debris removed will consist of two broad categories: Clean wood debris and C&D debris. Most common hurricane-generated debris will consist of 30-percent clean woody material and 70-percent C&D. Of the 70-percent mixed C&D, it is estimated that 42 percent of the material will be burnable, but will require sorting, five percent will be soil, 15 percent will be metals and 38 percent landfill.

The plan goes on to state that controlled open burning is a cost-effective method for reducing clean woody debris in rural areas, as burning reduces material volume by 95 percent, leaving only ash residue to be disposed of.

"While I feel our Southern and Southeastern states are starting to make longer strides in re-use and recycling, we are on the upside of the curve concerning a green culture compared to some other sections of the country," says Jerry Hayes, executive director of the Southeast Recycling Development Council. "However, we are now making sure that, when we do it, we

Figure 1 | 2008 summary (in millions of dollars)



Source: National Science and Technology Council, 2009.

do it right."

To be fair, the controlled incineration of material does have its advantages, namely, volume reduction. The magnitude and relative frequency of major storms along the Gulf Coast means that local and regional landfills would quickly be overwhelmed if some form of volume reduction did not occur. This one of the main reasons why the Federal Emergency Management Agency (FEMA) promotes open burning as its processing method of choice, which is ironic, especially since, while providing feedback to Congress in 2008 about a one-year pilot program that involved the agency providing public assistance grant incentives for innovations, such as the development of debris removal plans, FEMA officials acknowledged that recycling disaster-related debris provided financial and environmental advantages to applicants.

Not all agree with the methods of debris management being sought in such situations. According to a previous statement made by the GreenZone Task Force – a New Orleans-based organization composed of environmental non-profits, local neighborhood organizations and residents of Orleans Parish, among others – regarding the management of material generated by Katrina:

> It seemed to us that the [Army] Corps of Engineers, and others "in charge" of debris removal, were still using 19th century thinking, "dig a hole in the ground and dump the stuff into it," rather than 21st century thinking, where there are many new and creative ideas in operation around the United States that could have been put into operation quickly to less the need for landfill disposal…

With the fact that, on average, debris removal accounts for 27 percent of the total damage cost associated with a natural disaster, according to FEMA, one would think any effort to recover some of the value from materials generated by an event should be undertaken in order to reduce this cost.

Further, open burning is problematic with regard to its effect on air quality and soil toxicity. Granted, a substantial portion of hurricane debris is vegetative or organic, but there are also large amounts of water-damaged household appliances, electronics, cleaning products, plastics, and other items known to release hazardous chemicals if handled improperly or burned. According to the Louisiana Department of Environmental Quality, unsorted and burned mixed debris from Hurricane Betsy in 1965 contributed to the Agriculture Street Landfill in New Orleans being named a Superfund site. At the very least, some degree of sorting must be done on disaster debris to avoid unintentional damage to local air and groundwater health.

Useful online tools

FEMA – National Response Framework	www.fema.gov/emergency/nrf
FEMA – Plan ahead	www.fema.gov/plan/index.shtm
FEMA – Hazards U.S. Multi-Hazard	www.fema.gov/plan/prevent/hazus/index.shtm
FEMA – Regional office information	www.fema.gov/about/regions/index.shtm
Construction Materials Recycling Association	www.cdrecycling.org
Building Materials Reuse Association	www.buildingreuse.org
Construction Industry Compliance Assistance Center	www.cicacenter.org
National Demolition Association	www.demolitionassociation.com
Asphalt Recycling and Reclaiming Association	www.arra.org
EPA – C&D materials	www.epa.gov/cdmaterials
EPA – Disaster debris	http://tinyurl.com/EPAdisasterdebris
EPA – GreenScapes	www.epa.gov/greenscapes
EPA – WasteWise Programs	www.epa.gov/wastewise
U.S. Composting Council	www.compostingcouncil.org

What to expect

As previously stated, different states or regions plan for different types of disasters. Emergency management planners in California, for instance, face a different set of challenges than those in Florida, Mississippi or Texas. And, in the same fashion that types of crises will vary, so, too, will the material streams generated by such disasters. For example, vegetative debris is more of an issue after a hurricane or tornado, than it is following an earthquake. Table 1 lists common debris items associated with a natural disaster, as identified by the Alameda County Waste Management Authority (StopWaste.Org).

Earthquakes can technically happen anywhere, but tend to occur along the West coast. Most new buildings built in California, Oregon and Washington are built to withstand smaller earthquakes; however, historic districts in Seattle and Portland, as well as nearly all of San Francisco, are especially vulnerable. Earthquakes on their own will typically generate large amounts of very specific C&D materials, such as brick, concrete, treated wood, telephone poles and glass, as well as household furniture and appliances. If an earthquake triggers landslides, fires, or other supplemental damage, then the balance of the resulting material stream will be altered to reflect the additional disaster.

Wildfires are the other main type of natural disaster found in the Western United States. Unlike earthquakes, fires do not typically generate large amounts of salvageable wood products. Instead, cleanup crews sorting through wildfire debris can expect to find commingled building and organic char and ash. Significant recycling opportunities, though, do exist for metal reclaimers. Copper pipe, white goods, wiring and fire-damaged vehicles can likely be salvaged for their metal value. Electronics (known as "brown goods" under some management plans), on the other hand, usually cannot, and must be disposed of in accordance with the state's hazardous materials laws.

Flooding is not unique to any particular region and can occur in such geographically disparate states as Louisiana, Minnesota and Washington. Though floods can be caused by a variety of factors, they tend to generate similar types of materials. Water damaged appliances and electronics are very common, necessitating local e-scrap and white goods processing and ruling out landfill disposal. Water damage to vehicles is also common, although whether this effectively totals the vehicle depends on the severity of the flood. Further, organic and vegetative debris volumes are smaller than some other disaster types. Material generated from homes and other structures is also variable, but extreme floods have

been known to wash away houses, bridges and roadways. These instances are rare, and unfortunately, the most common types of waste materials generated by floods are mud, sediment and sandbags used for flood control – all of which have virtually no value for recovery.

It should also be noted that the recycling and re-use of woody material, and wooden structural material, generated by a hurricane or flood, can be affected by several factors, such as the Formosan Subterranean Termite. Though this is more of an issue for those living in the southern states, especially those bordering the Gulf of Mexico, this invasive species can consume up to 13 ounces of wood per day, and played a key role in halting the re-use (e.g., as mulch or building materials) of wooden material recovered from homes and trees destroyed by Hurricane Katrina.

Tornadoes effect much of the Midwest and Great Plains states and generate high volumes of C&D materials and vegetative debris. Mixed into C&D streams generated by destroyed buildings will likely be crushed or broken electronics and white goods, as well as organic materials. Automobiles and other scrap vehicles could theoretically be produced by tornadoes, but many survive encounters with tornadoes and are salvaged and repaired.

Hurricanes incorporate elements of several aforementioned disasters and consequently, are among the most costly and complicated emergencies to manage. Following Hurricane Katrina, cleanup crews in New Orleans quickly learned that the material generated was not purely C&D, as predicted. Instead, the raw destructive power of hurricanes create an amalgamated waste stream of demolition debris, household hazardous waste, organic, and vegetative material, which requires significant sorting and processing to be managed responsibly. For example, the Louisiana DEQ estimated that as much as five million gallons of chlorine bleach, drain cleaners and other chemicals were present in the debris generated by Katrina. Larger items that survive a storm, like vehicles and household appliances, are easier to separate from the waste stream, at the point of collection; however, these items often suffer water damage and are rendered inoperable, necessitating responsible disposal for recovery. A useful tool in predicting the volume of material generated by hurricanes has been developed by the Army Corps of Engineers (Figure 2).

For a more broad approach, FEMA and the National Institute of Building Sciences developed a software program that covers all disaster types. Dubbed Hazards U.S. Multi-Hazard (HAZUS-MH), the program uses updated area maps, as well as hazard data garnered from past events, to produce economic loss estimates for buildings, infrastructure and populations. An accompanying box lists online information regarding the program, along with other useful association and government links.

Table 1 | Typical disaster debris

Asphalt
Bricks
Brown goods (e.g., microwave ovens and televisions)
Concrete
Drywall
Furniture
Glass
Household hazardous waste
Metals
Personal belongings
Plastics (including sheeting and water containers)
Sandbags
Soil and rock
White goods (e.g., refrigerators, washers and dryers)
Wood
Yard waste

Source: Alameda County Waste Management Authority, 1998

Planning for the worst

Despite its infrequent use, the EPA recommends that communities and states have a disaster debris management plan in place, so as to lay the groundwork for a community's preparedness and response to a natural disaster, particularly one of a large-scale magnitude. The EPA also encourages states to develop or update their disaster management plan to incorporate the re-use, recycling and composting of waste materials generated.

Next to identifying potential disasters and their corresponding material streams, knowing whether the respective city, or state for that matter, has an existing recycling infrastructure to work within will be a key component toward implementing a recycling strategy for disaster waste management. Advance implementation of a municipal recycling system will ensure that permitting, compliance, collection, processing and marketing issues are already addressed. Additionally, a healthy and functional recycling program can more easily accommodate a rapid, but temporary, surge in material volumes. Trying to design and implement a new recycling program specifically to process disaster debris is considerably more difficult.

That said, much of the planning process for recycling disaster debris can be easily incorporated into a broader emergency management plan, once the decision is made to do so. Pre-planning activities primarily revolve around the determination of FEMA public assistance eligibility requirements and the selection of a planning team.

Regarding the latter, FEMA recommends that the composition of a planning team reflect the type of disaster likely to be faced, and the state or municipality's current waste management strategy. During the planning phase, this group should be kept relatively small, but should also be able to accommodate additional members and coordinating personnel following a major disaster. Prospective members should include representatives from state, and possibly federal, emergency management agencies; the National Guard; the U.S. Coast Guard; a state's departments of transportation and environmental quality; law enforcement and first responders; and, waste haulers and material recovery professionals.

The planning board should be headed by a debris project manager, who oversees all operations, planning, logistics and costs associated with debris management operations, and has a broad knowledge of debris and waste management, emergency response and interagency communication.

The actual activities that need to be completed in the planning process (Figure 3) do not have a specific order, with the exception of the identification of debris types and predicted amounts. This should be undertaken first and can be accomplished using either of the aforementioned tools, waste audits from past disasters, correspon-

dence with neighboring or partnering communities or debris management guidance plans developed by FEMA and the EPA.

Other tasks can be undertaken simultaneously, such as ensuring compliance with local environmental rules, taking inventory of waste management capacity, preselecting primary, secondary and temporary debris management sites and the development of an inter-agency communication plan. The ultimate goal is to draft a debris removal strategy that addresses the hazardous waste concerns associated with disaster debris, a strategy for reclaiming or processing as much material as possible, and collection and disposal logistics. Remember, natural disasters often affect a broad area and can damage local waste management and transportation infrastructure.

The biggest component of a disaster debris plan, though, involves communication. During the recovery stage, a municipality must communicate with the debris management team, all relevant governmental agencies, local major commercial and industrial enterprises and residential waste haulers, in addition to the general public, regarding the materials handling/removal process.

Of course, notifying the public beforehand will help make dealing with the aftermath that much easier. For example, the City of Los Angeles provides its residents with "Recycle Earthquake Debris" door hangers, which offer precautions in the event of an earthquake (e.g. bolting a water heater to the ground to prevent tipping or snapping of gas lines). Informing residents of a community's designated plan, via such outlets as radio and television announcements, flyers and door hangers, telephone hotlines and Web sites, will also lessen the likelihood of residents taking actions into their own hands, including resorting to illegal burning, dumping and other improper management methods.

According to the *Alameda County Disaster Waste Management Plan*, it is recommended that government officials inform the community when, where and how debris collection will commence, when normal collection is likely to resume, and provide special instructions for reporting and separating disaster debris at the curb. In addition, all communication should be timely, consistent, updated, and use language that is not overly technical.

Figure 2 | USACE Hurricane debris Prediction model

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

Q = Estimated debris total generated in cubic yards
Note: The predicted accuracy of the model is ± 30 percent

H = Number of households, or population / 3 (household = population divided by 3)
C = Hurricane category factor (cat1 = 2, cat2 = 8, cat3 = 26, cat4 = 50 and cat5 = 80)
V = Density of vegetation (1.1 for light, 1.3 for medium and 1.5 for heavy)
B = Percentage of commercial structures = (1.0 for light, 1.2 for medium and 1.3 for heavy)
S = Precipitation factor (1.0 for none to light and 1.4 for medium to heavy)

Source: U.S. Environmental Protection Agency, 2008

Tips and success stories

During the early morning on January 17, 1994, a 6.7 magnitude earthquake rocked the Los Angeles area, injuring more than 9,000 people and causing over $20 billion in damages. Although the city did not have a plan to deal with disaster debris prior to the Northridge Earthquake (the most expensive earthquake in U.S. history) occurring, it quickly worked to make sure that as much of the material as possible was recycled. Within a day, Los Angeles had instituted a curbside debris collection program and rapidly updated the list of licensed, insured debris removal contractors.

Before the quake, C&D materials had made up less than 15 percent of the area's total waste stream, or, about 150 tons per day. In the aftermath of the quake, the volume rocketed to over 10,000 tons per day. But, thanks to quick work on the part of city officials and a healthy collection and processing infrastructure in the area, by mid summer, 56 percent of the 1.5 million tons generated (i.e., wood, metal, soil, concrete, asphalt pavement and brick) had been recycled – this includes an approximate 80-percent recycling rate for mixed debris.

The lesson here, is that speed and effective coordination of local resources are essential to recycling disaster debris. By acting quickly and mobilizing the local collection infrastructure, Los Angeles officials were able to set the agenda for what happened with the earthquake waste. Even though they did not use one, a debris management plan is intended to simplify and ease this process.

Other regions have their own success stories to tell:

"Based on our following of the flow of scrap from [Hurricane Katrina], over 50,000 appliances worked their way into the recycling stream out of the Louisiana-Mississippi area," said Bill Heenan, president of the Steel Recycling Institute. "Additionally, thousands of vehicles were scrapped, as a result of flood damage, and moved through the dismantler/shredder scrap industry, with the steel eventually ending up in steel mills."

Hurricanes Frances and Jeanne, which battered both the Atlantic and Eastern Seaboards in 2004, posed a different set of challenges. In the four weeks after the storms, local haulers and contractors cleared nearly two million cubic yards of vegetative debris from roads and neighborhoods in affected areas. By consolidating the waste into nine temporary collection sites, a total of three plus million cubic yards of material was eventually chipped and mulched, with 25 percent of the resulting material being used in West Palm Beach County agricultural land projects.

But, perhaps the most unique challenges hoisted upon debris management crews are due to wildfires. For instance, in October of 2003, Southern California was ravaged by 15 wildfires, with as many as a dozen occurring at the same time. The most notable of those blazes, the Pines and Cedar Fires – Cedar being the second largest fire in California history – destroyed over 400,000 acres of vegetation, nearly 6,000 structures and some 4,000 vehicles throughout much of unincorporated San Diego County.

Yet, even in areas ravaged by fire, approximately 74,000 tons of concrete, metal and vegetative debris were recycled, resulting in a recycling rate of nearly 60 percent in the affected area and preserving more than 185,000 cubic yards of landfill space. Debris management coordinators

facilitated this by providing 1,500 30- to 40-gallon rollcarts to citizens to remove fire-damaged debris from their property. In addition to the 10,000 tons of debris collected through the bin program, San Diego County collected more than 82,000 pounds of household hazardous waste at special events, 13,000 pounds of which came from fire victims.

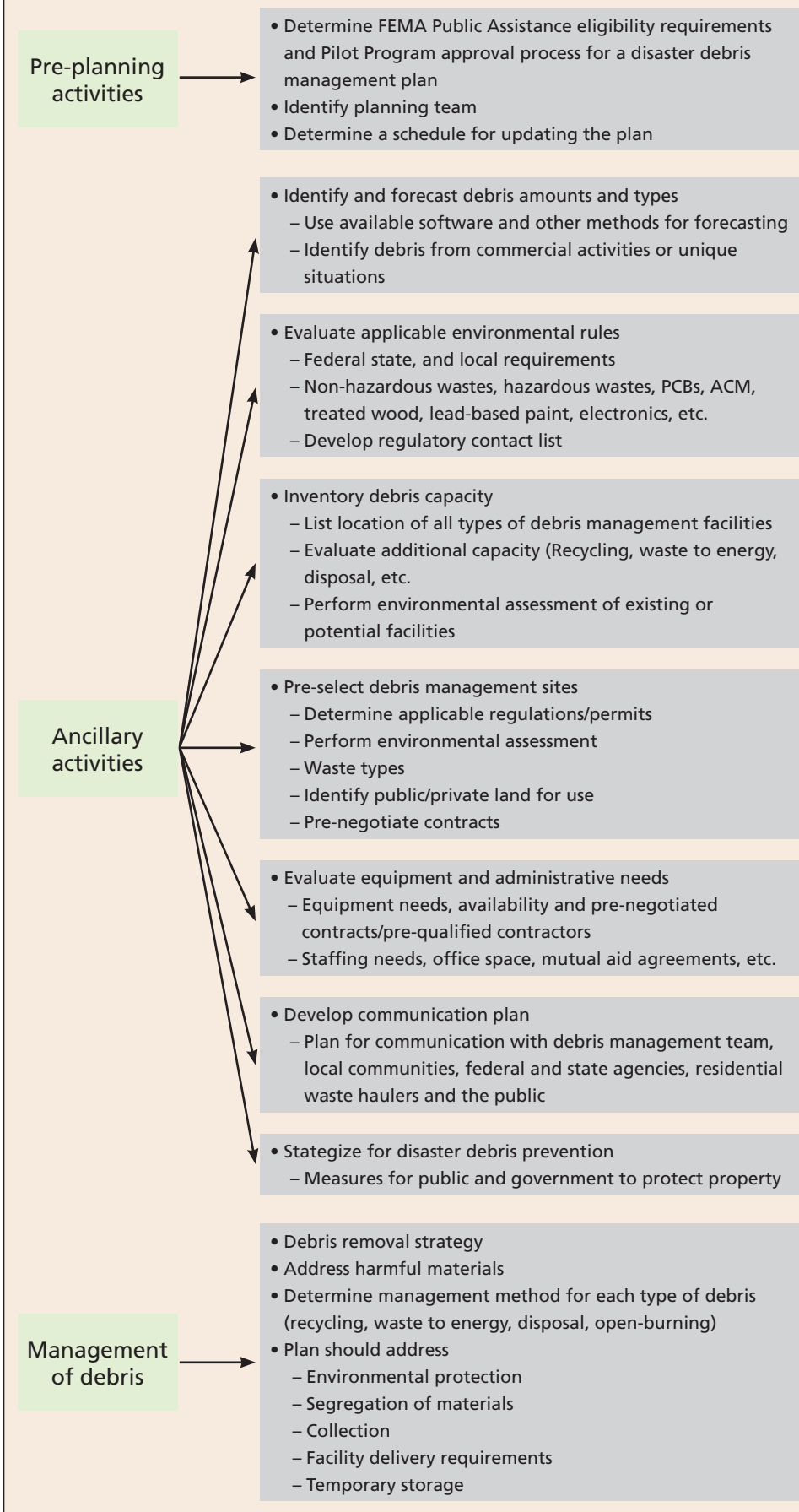
Don't get burned again

Unfortunately, many barriers still exist for states wishving to incorporate recycling into their disaster debris management plans. The biggest obstacle, for instance, appears to be an institutional disagreement between the EPA, which seems to support recycling options for disaster debris, and FEMA, which actively pushes open burning as the quickest and easiest form of cleanup.

When asked about the agency's position regarding the matter, Bradley Carroll, FEMA's deputy press secretary, stated, "When drafting management plans, we [FEMA] strongly encourage applicants to establish a recycling program prior to a disaster. However, it's a local, rather than federal, decision as to whether jurisdictions choose to recycle and/or reuse disaster generated materials." Though FEMA may look like the bad guy in this battle, the EPA says that's no so. "For FEMA, the term 'debris removal' is so broad that it encompasses handling, recycling, demolition, burning, etc. There is no specific definition," says Thea McManus, associate division director of the EPA's Office of Resource Conservation and Recovery. "It's this reason that state and local governments are in a better position for identifying and thinking through for their particular situation."

According to McManus, Subtitle D of the Resource Conservation and Recovery Act requires that states have the primary responsibility for handling municipal solid waste, while the EPA claims responsibility for enforcing the handling of hazardous waste. Said McManus, "The EPA simply does not have the authority to enforce all wastes." In addition, the Robert T. Stafford Disaster Relief and Emergency Assistance Act, last amended in June 2007, also establishes which

Figure 3 | Flowchart of disaster debris management planning activities



Source: U.S. Evironmental Protection Agency, 2008.

federal agency will do what in the event of a natural disaster. It's almost as if everyone knows their roles, and their hands are tied.

"Nonetheless, if FEMA pushed and helped with recycling more, or at least got comfortable with the higher costs of recycling versus the other options, then it could help lead states in that direction," says Scott Mouw, chief of the Community and Business Assistance Section of the North Carolina Division of Pollution Prevention and Environmental Assistance.

An example of FEMA's position regarding the recycle/incinerate debate was expressed by MSDEQ Administrator Mark Williams. "In April of 2008, 150,000 to 200,000 cubic yards of vegetative type debris was generated by a storm that hit the metropolitan area of Jackson, Mississippi. Even though our state did not allow any open burning of this debris, as a management option after this storm event, we were still pressed by FEMA representatives to allow it." Williams continued, "The bulk of the debris from these storms was chipped for boiler fuel, mulch and re-use purposes."

Incorporating debris recycling into natural disaster plans offers communities the opportunity to recycle or reuse many of the materials that would otherwise go to waste. And, alternatives to conventional trash and burn debris management practices do exist for communities, and states, looking to explore recycling. If your area doesn't have a disaster debris management plan, now would be the time to develop one, because the next natural disaster won't wait and neither should your plan. RR

Reprinted with permission from Resource Recycling, *P.O. Box 42270, Portland, OR 97242-0270; (503) 233-1305, (503) 233-1356 (fax); www.resource-recycling.com.*