Male: Managing evacuations involves the use of traffic control strategies, being prepared for spontaneous evacuation, routing traffic effectively and monitoring traffic flows to control bottlenecks. Where people are located varies over the course of the day and will help determine how quickly vehicles load onto transportation networks. Census data only provides reasonable approximations of locations of nighttime populations. Special census and surveys may be needed to provide detailed data for daytime populations and to identify geographical features or physical infrastructure that could constrain evacuation flow. Tom Kovo, from the Geography Department at the University of Utah.

Male: If was charged with emergency planning and evacuation planning in my jurisdiction or community, I'd look at a variety of scenarios for fire, fire possibly from one of eight different directions, historic winds, seasonal winds. I'd look at the type of fuel and map the fuel in the area. I'd map the houses. I'd try to enlist as many people in the community as possible at helping in the emergency planning effort so which homes are defensible, which are not.

Where are the shelters, where are the potential safe zones, what are the primary evacuation routes for each neighborhood, what are the alternatives if that evacuation route or routes are not available? How will the community be notified? How many message channels will I have available to me? Who's likely to be in charge of ordering an evacuation? What options do they have, mandatory, voluntary, recommended? When is shelter the best recommendation? How many vehicles, what's the vehicle ownership in some of these canyons? How does that vary by time of day?

So is there a canyon that is employing a lot of people in construction, a lot of transients who aren't familiar with necessarily all the ways out. How would they be notified? What is the working pattern of – working, you know, daily pattern of some of these people that work in these areas? What's the estimate of a canyon's population say at noon versus at 7:00 p.m. versus 8:00 a.m.? And then, yeah, how can I educate people in those areas about the options that they might have available to them and the scenarios they might have to deal with so that I'm not trying to march an army that doesn't know it's in the army.

The better trained the citizens are, the easier it's gonna be for me to tell them what to do. Ideally I could say we're dealing with scenario number four. You lost your primary exit. Proceed to the

golf course in an orderly fashion and wait there until we can tell you what to do.

Male: Traffic control may include adjusted signaling, traffic guides, signs, roadblocks and lane reversal or expansion. Multiple methods can be employed to facilitate evacuation movement. If bottlenecks occur at intersections, signals can be adjusted to favor major egress grounds. Options to use when signals constrain traffic include dispatching a controller to manually operate the signal or disabling and using the control with or without a traffic guide. Traffic guides can be people, signs or roadblocks.

Official personnel are the most effective. Directional or instructional signs the least effective. Sometimes traffic guides materialize without official sanction as people often assume this role if the need is apparent. Roadblocks may or may not be staffed. Staff at roadblocks are the most effective since unmanned stations may be ignored if counterintuitive to public perception of routing efficiency. Other control methods such as tape and portable barriers or cones are not very effective because they are easily moved if not manned. Contraflow lanes traffic lane reversal have been used with some success during large urban evacuations.

One issue with contraflow lanes is maintaining lanes for emergency vehicles such as keeping shoulders of roads open. The lanes must be manned to remain effective, especially in mass evacuations where slow moving traffic may cause vehicle breakdowns. Other issues associated with lane reversal include decisions on timing and closure of reversed lanes. Brian Wilshon, a transportation engineer at Louisiana State University.

Male: People often look at contraflow as being the silver bullet, the magical solution to all that evacuation problems because it seems so simple. All you do is reverse the flow in the inbound lanes and get people moving in the outbound direction. And the concept is simple. But there are some very complicating issues that accompany that.

Number one, we look at – when we're using the inbound lanes for outbound flow, we're not able to get, say, emergency services vehicles back into that area and we're not able to get the type of circulation that we would normally get using those routes so people aren't able to come into the threat area, say, to pick up relatives or to close properties or to secure buildings and things like that.

Another problem is from an operational standpoint can be the safety issues where you have to go and close down the inbound lanes and make sure it's clear and make sure that you're keeping state police or some kind of enforcement presence to keep people from coming into those inbound lanes. Some of the more subtle things that people are not aware of and should be is that the contraflow segments are only as good as the design or the initiation configuration and the termination configuration. And what I mean by that, if you look at a contraflow segment as a big pipe, if you cannot fully fill that pipe with evacuation stream of traffic, then what happens is you cause congestion prior to that contraflow segment.

That's what we saw in New Orleans where we didn't get a full utilization of the contraflow segment because it wasn't able to load properly. Then if we look on the downstream end at the termination point, we don't get a split or a decrease in traffic such that we can bring those lanes together. Then what happens is we end up causing more congestion throughout the segment.

So the congestion would either happen prior to without a flow utilization or on the downstream end, we would get congestion caused by an improper, let's say, departure of that traffic from the contraflow segment. And that's an issue that we've seen through research modeling. We've been able to identify that and because of that, a number of plans around the – or states around the southeast United States and the gulf coast have been changed, which was good to see.

Male: In determining where to route traffic, planners should designate evacuation routes that reflect everyday traffic patterns. Such routes should not be counterintuitive or place people at increased risk. Although analyses using evacuation models can help identify optimum routing, there still may be a need for traffic control to achieve that routing. Monitoring traffic movement during the evacuation either visually by spotters or remote video cameras at critical intersections or through automated real-time road sensors is essential to prevent unforeseen bottlenecks. Usually evacuation planning begins with a risk vulnerability analysis and then developing an evacuation time estimate or ETE.

An ETE can first be used to determine the time it takes to evacuate an area or clearance time. An ETE developed with the assistance of the evacuation simulation model can be used to determine the feasibility of evacuation without detailed route and control

planning. The model can also identify potential bottlenecks and assess the effects of different control and evacuation strategies.

Finally, a model-based ETE can be used to estimate traffic speed and queuing times on different evacuation routes. Evacuation strategies may include phased or sector evacuation, keyhole evacuation and selective evacuation. Phased evacuation is defined as the sequential movement of people from defined zones. It is often used after sheltering in place. Officials may choose to evacuate zones nearest the hazard first and expand the evacuation zone as the event progresses. Or evacuate only nearby zones and shelter the more distant zones or shelter nearby zones and evacuate the more distant zones. Betty Hearne Morrow.

Female: The real fear is the total bottleneck where, you know, no one gets out or very few. And so most of those communities have gone to what – at least in their planning – a phased evacuation system, which there's debate in the community how much this is going to really work. But I know for example in the Keys, Florida Keys, it has seemed to work. We've studied several like Hurricane George, for example, in the Keys. There was a good phased evacuation. They _____ the people the furthest away down in Key West, they're given a time block when they are supposed to leave. If they don't leave in that time block, that road is closed off for them so that the next group can go and so forth.

And so the Keys are very experienced evacuators. And so consequently that seems to work pretty well there. But it requires a great deal of organization and most of our evacuations today are regional evacuations so it requires several different jurisdictions to be able to work together in planning this and a regional approach to it. It's complex.

Male: Sector, keyhole and selective evacuation strategies involve only portions of the public. Criteria for defining the zones can be risk or hazard based determined by geographic features or geometrically defined such as using quadrants or concentric circles. Some emergency planning zones around fixed chemical facilities divide their planning zones into subzones using major highways and streets as well as geographical features such as streams or rivers.

When an emergency involves a release of chemicals or other hazardous substances, officials may consider weather conditions in evacuating people. In a wedge evacuation strategy, a 30 to 45-degree arc is overlaid on a map based on wind direction and all

subzones touching the wedge are evacuated. Jerry Mitchell, geographer from the University of South Carolina.

Male: Graniteville was a chlorine release resulting from a train accident in Graniteville, South Carolina which is about 10 miles from the South Carolina/Georgia border January 6, 2005. And as a result of that release, there were nine fatalities. And some of those fatalities were people operating the train, etc. They weren't directly from the chlorine release but there nine fatalities and about 500 or so people who sought medical treatment as a result of the spill. The majority of the spill took place and was released within two hours.

Sixty tons of chlorine was dissipated within about two or three hours at the time so the evacuation came much later. But that notice as well just simply told people if you are within one mile of the accident, evacuate. It still did not tell you where the accident was so how do you know one mile from what, how am I going to determine that? People are notoriously bad at estimating distances. So even if you did tell them exactly what the spot is, do I know if I'm within one mile or not? And we have people tell us that.

We had one family, for example, that sat literally at the kitchen table with a map and rule and was trying to figure out whether or not they should stay or go. And in the threat of a potential chlorine cloud, you don't need to be making that type of decision. You should be able to decide immediately.

So if some simple geography was put into those messages that all those people within one mile within this street, this street, this street, adding in some of that local knowledge that people would have latched onto, people could have made a better decision on how it applied to them or not and then been able to go from there.

In terms of ordering evacuations, whether it be from a fixed chemical release or mobile one, there are some significant geographical issues one has to deal with which significantly clouds up and muddies the issue here. For the example of Graniteville, dealing with that, in terms of the evacuation, if you want to base it upon risk, you're calling for a one mile evacuation, a perfectly circular buffer around that site which is contrary to the physical realities of the plume itself which is going to be wind-based and going a particular direction.

The fact that it was a certain chemical chlorine which was heavier than ambient air meant that lower lying areas were going to deal

with that issue differently than higher areas. So you have to take topography into consideration.

Male: Keyhole evacuation is similar but an area upwind of the facility is evacuated as well. In general, all people within a specified radius, usually two miles in the case of a nuclear power plant are evacuated and only those in the wedge further out are evacuated. It is critical that local and state jurisdictions including adjacent states coordinate their evacuation transportation plans to ensure evacuees understand the reasons for phasing evacuations and how public officials are coordinating traffic flows to enhance the evacuation process.

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