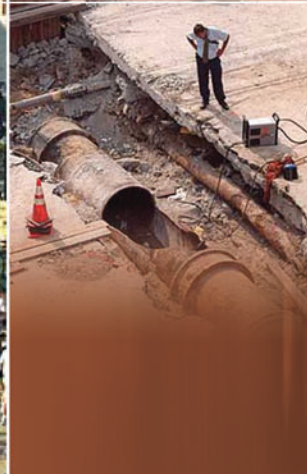


*Draft Report*

# EFFECTS OF CATASTROPHIC EVENTS ON TRANSPORTATION SYSTEM MANAGEMENT AND OPERATIONS

*Baltimore, MD—Howard Street Tunnel Fire—July 18, 2001*



**July 2002**

U.S. Department of Transportation  
ITS Joint Program Office

---

## **Notice**

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

**Technical Report Documentation Page**

1. Report No.		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Effects of Catastrophic Events on Transportation System Management and Operations, Howard Street Tunnel Fire, Baltimore City, Maryland – July 18, 2001				5. Report Date July 2002	
				6. Performing Organization Code	
7. Author(s) Mark R. Carter, Mark P. Howard, Nicholas Owens, David Register, Jason Kennedy, Kelley Pecheux, Aaron Newton				8. Performing Organization Report No.	
9. Performing Organization Name and Address Science Applications International Corporation 7980 Science Applications Court Vienna, VA 22183				10. Work Unit No. (TRAVIS)	
				11. Contract or Grant No.	
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Highway Administration ITS Joint Program Office 400 Seventh Street, SW Washington, DC 20590				13. Type of Report and Period Covered Catastrophic Events Case Study	
				14. Sponsoring Agency Code	
15. Supplementary Notes Contracting Officer's Technical Representative (COTR) – Joseph Peters					
16. Abstract  This report documents the actions taken by transportation agencies in response to the earthquake in Northridge, California on January 17, 1994, and is part of a larger effort to examine the impacts of catastrophic events on transportation system facilities and services. The findings documented in this report are a result of a detailed literature search on Northridge lessons learned. As part of a larger effort, four case studies will be produced:					
17. Key Word Emergency Response, Emergency Preparedness, Transportation System Recovery, Disaster, Catastrophic Event, Fire, Rail Tunnel, Baltimore				18. Distribution Statement No restrictions	
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages	22. Price

# 1.0 Introduction

## 1.1 Regional Context

The City of Baltimore is the principal metropolitan area in the State of Maryland. The City is located in the heart of the state and is a central transportation hub for the Northeast Corridor. I-95, the main north-south interstate highway along the East Coast, runs through the heart of the City, connecting to the Inner Harbor and downtown Baltimore via I-395. I-695, the Baltimore beltway, links I-95 with I-70, a major interstate route that connects the mid-Atlantic region with the Midwest, and I-83, which links Baltimore with York, PA, Harrisburg, PA, and points north. In addition to the above roads, two tunnels passing under the Port connect the interstate system: the Fort McHenry Tunnel, which is part of I-95, and the Baltimore Harbor Tunnel, which is part of I-895 connecting with I-95. The map presented in Figure 1 shows the locations and routes of major interstate and state highways located within and around the City. Average daily traffic on the interstate and state highway system in and around Baltimore is shown in Table 1.

Baltimore is also a major transit point for the movement of freight. The City is served by two major railroads, Norfolk Southern and CSX. The Howard Street Tunnel, which is owned and operated by CSX, represents the only direct rail link between the Northeast, Southeast, and mid-Atlantic regions. The City is also home to the Port of Baltimore and Baltimore-Washington International (BWI) Airport. The Port of Baltimore is one of the largest container ports on the East Coast, and is also one of the leading ports for RO/RO traffic (roll-on/roll-off, including automobile imports into the United States). The Port generates significant freight traffic, both truck and short-line rail (Camden Line), with approximately 80,000 truck trips into and out of the port on an annual basis.



Figure 1. Baltimore City Regional Highway System

**Table 1. Interstate Traffic In and Around Baltimore City**

<b>Interstate</b>	<b>Description</b>	<b>Average Daily Traffic</b>
I-95	Major north-south interstate along the East Coast. Traverses the southern part of Baltimore City, including the Port of Baltimore, and passes under the harbor via the Fort McHenry Tunnel	South Baltimore -170,350 East Baltimore – 91,875
I-895	South Baltimore, connects the Baltimore Harbor Tunnel with I-95.	South Baltimore – 45,225 East Baltimore (near merge point with I-95) – 57,125
I-695	Baltimore beltway system	West of Baltimore – ranges from 160,000 to 180,000 (I-70 juncture) East of Baltimore – ranges from 30,000 (Dundalk) to 120,000 (Parkville) North of Baltimore – ranges from 150,000 to 190,000 South of Baltimore – ranges from 30,000 (Francis Scott Key Bridge) to 160,000 (I-95 juncture)
I-83	South from Pennsylvania border across I-695 into downtown Baltimore (Section from Baltimore Beltway also called the Jones Falls Expressway, or JFX)	Baltimore County–Baltimore City border – 112,325 Mid-town (Cold Spring Lane) – 93,325 End point (Inner Harbor) – 43,425
I-395	Spur from I-95 into Baltimore City; enters the City by Orioles Park at Camden Yards and Convention Center, and merges with Howard Street	From I-95 to Martin Luther King (MLK) Boulevard exit ramp – 99,590 MLK Blvd. to Howard Street – 55,250

Source: Maryland State Highway Administration Traffic Volume Map 2001

An extensive mass transit system is operated within the City and the surrounding region by the Maryland Transit Administration (MTA). The Central Light Rail Line travels a 29-mile corridor extending from Hunt Valley in Baltimore County to Cromwell Station–Glen Burnie in Anne Arundel County, including branches from BWI and Baltimore Penn Station. MTA reports that daily light rail ridership is about 30,000 passengers. MTA also operates the Baltimore Metro subway system, with daily ridership of 45,000 passengers, and a city-wide bus service, with daily ridership of approximately 250,000 people. Commuter rail service (MARC) is operated between Baltimore and Washington, DC, on two lines. The Camden Line operates over CSX tracks, and the Penn Line operates on Amtrak’s Northeast Corridor tracks. A third service operates from Martinsburg, WV, via Brunswick, MD, and Frederick, MD, terminating at Union Station in Washington, DC. Of these three services, the Camden Line, with daily ridership of 3,500 passengers and a terminus at the Camden Yards Station near the stadiums, was the only one impacted by the event on July 18. The location of rail transit systems in the Baltimore region is shown in Figure 2.



Figure 2. Baltimore City Transit System

Baltimore is located approximately 40 miles northeast of Washington, DC, and the Baltimore-Washington corridor that runs along I-95 is one of the more highly urbanized and densely populated corridors in the United States. The two cities combined represent the fifth largest metropolitan area in the United States, and rank among the most congested urbanized areas with respect to vehicular traffic. In 2000, Baltimore ranked in the top 30 of 75 U.S. urban areas in each of the 10 congestion indices developed by the Texas Transportation Institute, and in the top 20 for annual person hours of delay, annual excess fuel consumption, and congestion cost. Even so, Baltimore has a relatively high proportion of mass transit use, with 16% of commuters using transit to get to work.

## 1.2 Howard Street

Howard Street, and the Howard Street Tunnel, are located in the heart of Baltimore City's business and cultural districts, and are adjacent to the core of the City's tourist and sports attractions and the Inner Harbor. The south end of Howard Street is near Oriole Park at Camden Yards and the Baltimore Ravens' football stadium. The south end is also close to the Inner Harbor and the National Aquarium, the heart of Baltimore's tourist area. The north end of Howard Street, near the Mount Royal light rail station, is located close to the Maryland State Government office complex and the City's art district (Meyerhoff Symphony Hall and the Lyric Opera House).

The street runs through the downtown business and entertainment districts and passes directly by or near some of the City's major museums, concert halls, and cultural attractions. Figure 3 shows the locations of both Howard Street and the Howard Street Tunnel within the City of Baltimore. Please note that



Figure 3. Howard Street Corridor

Figure 3, adapted from the Baltimore Sun, also shows street closures that resulted from the incident. Table 2 shows the major cultural and tourism attractions, business districts, hospitals, universities, and other facilities that are located within 2,000 feet of the tunnel.

Howard Street also intersects all major surface transportation systems in Baltimore, including interstate and state highways and city streets. Interstate 395, which links Interstate 95 to downtown Baltimore, terminates at the south end of Howard Street, with an exit ramp for stadium parking and for Martin Luther King Boulevard. I-395 runs almost directly over the south end of the tunnel. The entry points of the Baltimore–Washington Parkway (MD-295), a major north-south commuter route and connector to BWI Airport and US 40, the major east-west route into western Baltimore City, also are located in the vicinity of Howard Street. MD-295 enters the City by the two sports stadiums, and is within 1,000 feet to the west of the tunnel. US-40 crosses Howard Street.

These roadways serve passenger traffic, commercial vehicle traffic in transit, and commercial vehicle traffic with destinations in Baltimore City. Howard Street is also one of the major north-south routes running through the City's central business district, and intersects with all major east-west routes.

Table 3 lists the major routes that intersect Howard Street, and also provides average daily traffic count information for selected streets included in the Baltimore Metropolitan Council Regional Traffic Count Program June 30, 2002, Status Report. Traffic count data were collected over a six-month period from January 1 through June 30, 2002, at locations throughout the City's central business district. Although the data were not collected at the junction of Howard Street and intersecting routes, the data do provide an indication of traffic volumes in and around the section of Howard Street under which the tunnel is located. The cross streets are listed beginning with Pratt Street, located at the south end of Howard Street near the merge point with I-395 and at the south portal of the tunnel. The listing of streets continues up to the northern portal of the tunnel near Mount Royal Avenue. The listing also includes average daily traffic count data for US 40 and MD 295, which include commuter as well as cross-town traffic.

The MTA Central Light Rail Line runs above the tunnel on Howard Street. MTA bus service also runs down Howard Street,

**Table 2. Attractions on Howard Street and in the Surrounding Environs**

<b>Attractions near the Howard Street Tunnel</b>	<b>Description</b>	<b>Proximity to the Tunnel</b>
Baltimore Ravens' Stadium, Oriole Park at Camden Yards	Football and baseball stadiums	Within 1,000 feet west of the south portal of the tunnel
Inner Harbor	Tourist center, includes Harbor Place, Galleria Mall, several hotels	Within 2,000 feet to the east
University of Maryland at Baltimore	Medical school, University Hospital	Within 2,000 feet to the west
Convention Center	Exhibition space and conference center	Adjacent to the tunnel near Oriole Park
Baltimore Arena	Concert, sporting event facility	Adjacent to the tunnel
Edward A. Garmatz Federal Courthouse	United States District Court for the District of Maryland	Within 1,000 feet to the east
Charles Center and Mechanic Theater	Major business district and cultural attraction in downtown Baltimore	Within 2,000 to the west
Lexington Market	Major transit point for Metro, light rail, bus; restaurants, produce, and food stores	Within 1,000 feet to the west
Maryland General Hospital	Medical facilities	Within 1,000 feet to the west
Mercy Hospital	Medical facilities	Within 2,000 feet to the east
Walters Art Gallery and Peabody Conservatory	Cultural attractions	Within 2,000 feet to the east
State Center	Maryland State Government campus	Within 1,000 feet to the east
Lyric Opera House and Meyerhoff	Cultural attractions	Within 1,000 feet to the east/southeast
Symphony Hall		of the north portal
University of Baltimore	Academic institution	Within 1,000 feet to the east/southeast of the north portal
Residential Communities	Federal Hill (south portal), Seton Hill, Mt. Vernon Square, Bolton Hill (north portal)	Within 2,000 feet of the tunnel

as well as on many of the major streets that intersect Howard Street and cross over the tunnel. The MTA's subway system, the Metro, passes below Howard Street and the Howard Street tunnel. The MARC rail system's Camden Line uses the CSX track between Baltimore and Washington, and the MARC track within the City is adjacent to the Howard Street Tunnel.



**Table 3. Howard Street Cross Streets and Average Daily Traffic**

<b>Streets Crossing Howard Street</b>	<b>CBD Vehicle Occupancy Count Locations</b>	<b>Average Daily Traffic</b>	<b>Location of Count Station with respect to Howard Street</b>
Russell Street – MD 295	Martin Luther King Blvd.	63,758	Southwest
Pratt Street	Martin Luther King Blvd.	9,731	West
	West President Street	37,055	East
Lombard Street	Martin Luther King Blvd.	9,928	West
	West President Street	25,112	East
Baltimore Street	Martin Luther King Blvd.	7,189	West
	West President Street	13,502	East
Fayette Street	Martin Luther King Blvd.	4,185	West
	West Fallsway	12,929	East
Saratoga Street Franklin Street	Martin Luther King Blvd.	5,562	West
	Martin Luther King Blvd.	13,850	West
Orleans Street – US 40	E. Patterson Park Ave.	23,910	West
	E St Paul Street	37,514	East
Mulberry Street	Martin Luther King Blvd.	11,038	West
Madison Street	E. Patterson Park Ave.	15,858	West
Chase Street	E. Guilford Ave.	4,053	East
Preston Street	E. Patterson Park Ave.	4,649	West
	West Fallsway	6,916	East
Mt. Royal Ave	S. Lafayette Street	16,722	Northwest

Source: Baltimore Metropolitan Council

### 1.3 Howard Street Tunnel

The Howard Street Tunnel is the only freight through-route in the Northeast Corridor, from the southern states through Washington and Baltimore and on to New York and Philadelphia. The tunnel, constructed in 1895 out of brick, runs for 1.7 miles through the heart of the City of Baltimore and is said to be the longest underground conduit of freight on the Atlantic seaboard. The south portal of the tunnel is located in the Camden Yards area of Baltimore and the north portal exits in the Mount Royal area, an uphill south-to-north run with a steep 4.8% grade. The tunnel ranges from 60 feet underground at its deepest to 3 feet underground at its shallowest.

Transportation officials have long known that the possibility has existed for a fire or other disaster to cause a significant problem in the Howard Street

Tunnel. An article published in the Baltimore Sun on July 19, 2001<sup>1</sup>, contains a 1985 quote from an unidentified federal transportation safety official who observed "...the problem would be getting in there to fight the fire... If you had an explosion, fire would shoot out of both ends like a bazooka." Notwithstanding this potential for disaster, the tunnel's freight traffic has slowly increased over recent years as CSX and Conrail have sought to divert freight traffic away from Amtrak's former PRR Northeast Corridor. Published reports vary on the number of freight trains that pass through the tunnel on a daily basis, but the most reliable available estimate is contained in an article published in *RailFan and Railroad* magazine in November 2001. The article, titled "Fire in the Hole," estimates that 28 to 32 trains pass through the tunnel each day, carrying a mixture of hotshots (nonstop freight trains), mixed freights, and cross-town transfers.

## 1.4 Description of the Event

At 3:04 p.m. on Wednesday, July 18, 2001, the 60-car CSX freight train L412-16 entered the Howard Street Tunnel in downtown Baltimore. The train, being pulled by three engines, carried 31 loaded and 29 empty cars, with a mix of freight that included empty trash containers, paper products, plywood, soy oil, and several tanker cars. At 3:07 p.m., the engineers heard a grinding noise, saw the air pressure in the brake line drop to nothing, then felt the train lurch and come to a rough stop.

The engineers tried to radio the CSX dispatcher to give notice that the train had stopped in the tunnel, but they were in a dead zone in the tunnel and were not able to get through on the radio. At 3:15 p.m., one of the engineers used his cell phone to reach the train master and told him that the train had come to a stop in the tunnel.

Noticing that the fumes from the diesel engines were growing worse (the engineers did not know at that point that several cars had derailed and a fire had broken out), the engineers shut down the two rear engines, uncoupled all three engines from the train, and exited the tunnel at the north portal. They cleared the tunnel at 3:27 p.m. and were then able to reach the CSX dispatcher in Jacksonville, FL. They notified him that the train had come to an unexpected stop in the tunnel. The engineers had initially planned to reenter the tunnel to determine what the problem was, but noticed that the smoke from the tunnel had not abated and was increasing—evidence of a fire somewhere among the cars (see Figure 4). The engineers then reviewed the bill of lading and saw the words "hazardous materials." They radioed Jacksonville and asked the dispatcher to notify Baltimore City that not only had a train derailed in the tunnel and caught fire, but that the load carried hazardous materials.

---

<sup>1</sup> See Baltimore Sun "Hidden Historical Asset of Baltimore," July 19, 2001, by Scott Calvert.



**Figure 4. Smoke Billows from the Tunnel's South Portal, with the Baltimore City Skyline in the Background.**

Source: *Baltimore Sun*

Baltimore City firefighters received notification of the event somewhere between 3:35 p.m. and 4:15 p.m.<sup>2</sup> and were given the bill of lading upon arrival on site. After reviewing the bill of lading and assessing the scene, it became apparent to the Fire Department crew that the freight train was carrying a variety of hazardous materials (including tripropylene and hydrochloric acid) and that several of the cars carrying these materials were threatened by the fire. At 6:15 p.m., emergency response efforts were further complicated when a break in a 40-inch water main located under the intersection of Howard and Lombard Streets, almost directly above the site of the derailment, spilled water into the tunnel and onto the street. These events occurred as the

City of Baltimore was preparing for both the evening rush hour and the second game of a baseball doubleheader at Oriole Park at Camden Yards. The City thus found itself facing a potentially catastrophic situation at peak demand hours for transportation services.

The exact location of the fire in the tunnel was not determined until about 5:00 a.m. the following morning. It was assumed, and confirmed, that the fire had occurred in the vicinity of the water main break. The water main break was almost directly above the heart of the fire. A manhole on Howard Street approximately 50 feet from the water main break, was found to have a connection to the tunnel. Firefighters entered the manhole and gained access to an alcove in the tunnel near the fire. This became the firefighters' primary access route for fighting the fire. Figure 5, adapted from the *Baltimore Sun*, provides a realistic display of how firefighters used the manhole access to fight the fire.

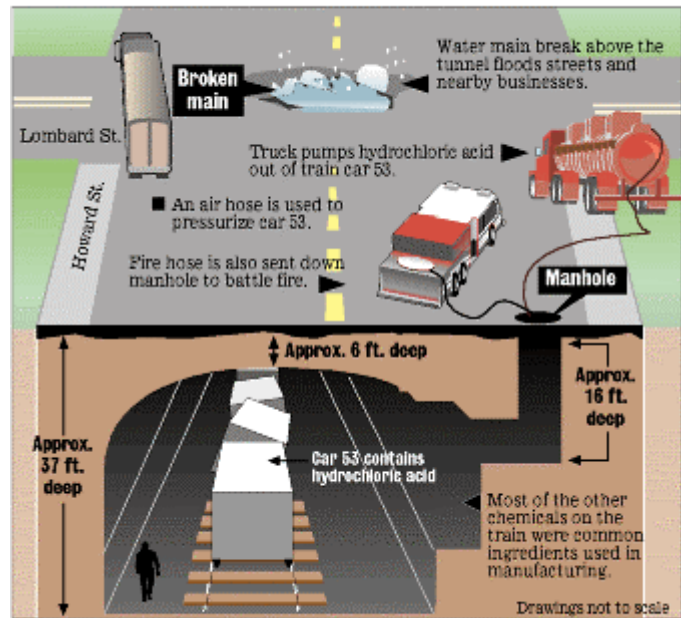
As the fire suppression efforts continued, an assessment was made of the actual situation in the tunnel. As reported *RailFan and Railroad* magazine<sup>3</sup>, "it was determined that a derailment had in fact occurred, with a break of 300 to 400 feet between the 45<sup>th</sup> car, the first car off the track, and the 46<sup>th</sup> through 60<sup>th</sup> car, with cars 46 through 54 derailed. The 52<sup>nd</sup> car, the loaded tank of tripropylene, was the major source of the fire... and the 53<sup>rd</sup> car, a tank car, was slowly leaking its load of hydrochloric acid (HCl). Car 54, another HCl tank, was derailed but not leaking. Car 55, which carried the tank of ethyl hexylphthalate,

<sup>2</sup>Published reports have listed two different times regarding when the Fire Department was notified. CSX records indicate that notification was provided at 3:35 PM, while Fire Department records indicate that notification was received at 4:15 PM. See *RailFan and Railroad*, November 2001, "Fire in the Hole," p. 44.

<sup>3</sup> *Ibid*, page 46.

was still on the rails." Firefighting efforts were hampered by the fact that several carloads of paper, pulpwood, and plywood were also burning, creating intense heat in the tunnel.

Firefighting efforts continued through Saturday, July 21, and three rail cars (boxcars of paper and plywood) were removed from the tunnel on Sunday, July 22. The removal of these three cars, and the extinguishing of their still flaming contents, ended the major fire suppression effort. In addition, the water main break was also finally stopped on 22. At mid-afternoon on the 22<sup>nd</sup>, an inspection of the tunnel revealed no significant structural damage, and on the morning of July 23, the final two cars were removed from the tunnel. At 7:45 a.m. on July 24, the tunnel was cleared for traffic following an additional round of inspections the day before, and at 8:58 a.m., the first post-fire train passed through the tunnel.



SOURCE: LAI Construction

rafael anderson, shirdell medonald, jerald council : sun staff

**Figure 5. Attacking an Underground Fire**

Source: *Baltimore Sun*

## 2.0 Event Response

### 2.1 Pre-Event

Baltimore City and the State of Maryland share responsibility for the operation of transportation facilities located within the City. The Baltimore Department of Public Works has responsibility for all surface roads within the City, including non-interstate routes and I-83, I-295, and MD Highway 40, whereas the Maryland Department of Transportation (MDOT) modal administrations are responsible for most of the interstate network, transit, and the Port of Baltimore.

The Maryland Transit Administration (MTA) operates all transit services in the City, including bus, light rail, heavy rail (Metro), and commuter rail (MARC). The Maryland Port Authority (MPA) is responsible for operating the Port of Baltimore, and the Maryland Aviation Administration (MAA) operates BWI Airport. The Maryland Transportation Authority (MdTA) owns and maintains the I-95 approaches to the Fort McHenry Tunnel, from Caton Avenue on the south side to the northern Baltimore City line, including I-395 into Baltimore's Camden Yards and Inner Harbor areas. (The MdTA is also responsible for other toll facilities in the state, including the Baltimore Harbor Tunnel and its approaches (I-895) and the Francis Scott Key Bridge on the southeastern section of I-695 (the Baltimore Beltway).) Regional and district offices of federal transportation agencies are also located in Baltimore and at BWI Airport.

The City's Office of Emergency Management is responsible for handling emergencies and incident management within Baltimore. State agencies do not have jurisdictional authority within the city but frequently work closely with city agencies in emergency and incident management situations. Both the State and the City maintain emergency response plans and at times have conducted joint practice exercises, in particular in the area of hazardous materials response.

### 2.2 Day of the Event

The initial challenges facing the City once the fire was detected were:

- ◆ Identifying the exact location of the fire in the tunnel.
- ◆ Determining the potential environmental impact from the burning cars containing hazardous materials.
- ◆ Determining whether downtown Baltimore would need to be evacuated.

The problem of identifying the potential environmental impact was resolved by the Maryland Department of the Environment's (MDE) Emergency Response Division (ERD). Following a review of the bill of lading provided by the CSX engineers, the ERD personnel contacted members of the South Baltimore Industrial Mutual Aid Plan (SBIMAP). SBIMAP is a voluntary consortium of manufacturers, emergency response personnel, Baltimore City environmental and emergency management personnel, and MDE, focused on

the South Baltimore industrial area. The consortium’s purpose is to plan for and respond to incidents such as the Howard Street Tunnel fire where hazardous materials and potential environmental incidents are involved. SBIMAP was established in 1982 and is largely funded by industry.

SBIMAP member companies provided two chemists, who quickly determined that the hazardous materials involved in the fire would not, in fact, either individually or in combination, present a serious environmental hazard. While MDE immediately initiated air and water quality monitoring in order to detect any leaks or discharges, a determination was made quickly that evacuating the downtown area would not be necessary.

The search for the exact location of the fire was hampered by smoke and the intense heat generated by the conflagration. The tunnel’s 4.8% grade between the south and north portals created a chimney effect that made entry into the tunnel problematic. Initial fire suppression efforts were unable to penetrate very far into the tunnel, but the water main break flooded the tunnel and helped to control the fire. By July 19, firefighters were able to identify the location of the fire.

## 2.3 Summary Time Line – July 18, 2001

Table 4 presents a brief summary of the events of July 18, 2001, involving the Howard Street tunnel train derailment and transportation and emergency management responses. (A more in-depth chronology is included in Appendix A).

**Table 4. July 18, 2001, Time Line**

<b>Time</b>	<b>Elapsed Time</b>	<b>Event/Action Taken</b>
3:07 p.m.	0 hrs. 0 mins.	60-car CSX freight train carrying hazardous materials derails in the Howard Street Tunnel in Baltimore, Maryland.
3:15 p.m.	0 hrs. 8 mins.	Engineers detect fire in 1.7-mile-long tunnel.
3:25 p.m.	0 hrs. 18 mins.	Engineers decouple engines from burning train, exit from tunnel.
4:15 p.m.	1 hr. 8 mins.	Baltimore City Fire Department arrives as first responder, assumes incident command responsibilities. CSX engineers provide bill of lading indicating derailed train is carrying hazardous materials.
4:15 p.m.	1 hr. 8 mins.	CSX Transportation notifies Maryland Department of the Environment, Emergency Response Division (MDE ERD), of the derailment of train cars carrying hazardous materials.
4:20 p.m.	1 hr. 13 mins.	MDE ERD personnel arrive on the scene, contact the National Transportation Safety Board, Baltimore City Fire Department Battalion Chief 6, and Baltimore City Fire Department hazardous materials (HazMat) coordinator. Units begin assisting city personnel with analysis of train documentation and potential hazardous products.
		MARC commuter rail, MTA’s Central Light Rail Line, and rail freight movement are disrupted by the tunnel street fire. MTA initiates a bus bridge to bring MARC passengers from Dorsey Station south of Baltimore to the City.

**Table 4. July 18, 2001, Time Line (continued)**

<b>Time</b>	<b>Elapsed Time</b>	<b>Event/Action Taken</b>
		Chief of the City Fire Department requests that all major roads (I-395, I-83, US-40) into Baltimore City be closed.
4:30 p.m.	1 hr. 23 mins.	Baltimore City Police Department and Department of Public Works start rerouting downtown traffic away from the scene using signs and physical barriers; Howard Street and all streets crossing over the Howard Street Tunnel are closed.  Interstate highways I-395 northbound and I-83 southbound are closed to traffic trying to enter the City.
4:35 p.m.	1 hr. 28 mins.	MDE requests consulting chemist assistance through South Baltimore Industrial Mutual Aid Plan (SBIMAP). MDE advises Baltimore City HazMat of potential hydrogen fluoride (HF) vapor hazard due to thermal degradation of fluorosilicic acid; identifies specialized treatment needed for HF exposures.
4:45 p.m.	1 hr. 38 mins.	Baltimore City Emergency Management contacts MDE to report that city officials are preparing to sound siren system to notify nearby residents to shelter in place. MDE concurs with shelter in place order.
4:53 p.m.	1 hr. 46 mins.	MDE contacts U.S. Coast Guard and requests assistance. MDE and SBIMAP personnel conduct air quality monitoring along Howard Street corridor and in the vicinity of the Mt. Royal Station.
5:00 p.m.	1 hr. 53 mins.	U.S. Coast Guard closes Inner Harbor to boat traffic.  Orioles' office workers are told to leave B & O Warehouse.
5:45 p.m.	2 hrs. 38 mins.	Civil defense warning sirens sound.
6:15 p.m.	3 hrs. 8 mins.	Water from the broken water main located under the Howard and Lombard Street intersections surfaces and floods the street.  MTA closes Metro's State Center station due to smoke entering the station via subway tunnel and station ventilation fans.
8-9:00 p.m.	4 hrs. 53 mins.	Roads and entrance/exit ramps on major thoroughfares into the City reopen sporadically.
11:00 p.m.	7 hrs. 53 mins.	Baltimore City Fire Department Command Staff direct primary Command Post operations to be relocated to the vicinity of Camden Yards stadium complex.  Water is cut off by BCDPW at the point of the water main break.

## **2.4 Agencies Involved with Incident Response**

The response to the Howard Street Tunnel fire involved multiple agencies from the City of Baltimore, the Maryland State Government, and the Federal Government. The Baltimore City Fire Department was the first responder to arrive at the scene of the tunnel fire, and under established incident management procedures, assumed responsibility for incident command. The Baltimore City Fire Department Chief assumed the role of Incident Commander. Additional incident response support was provided by the Baltimore City Police Department, the Baltimore City Department of Public Works, the Maryland Departments of Transportation and Environment, the

Maryland Emergency Management Administration, the U.S. Environmental Protection Agency, and the U.S. Coast Guard. The particular responsibilities of each agency involved in responding to the tunnel fire are summarized in Table 5.

**Table 5. Incident Response and Agency Responsibilities**

<b>Jurisdiction</b>	<b>Modal Administration or Agency</b>	<b>Role in Incident Response</b>	<b>Area of Concern</b>
Baltimore City	Fire Department	Incident command	Fire suppression
	Police Department	Traffic enforcement	Closing of streets crossing over the Howard Street Tunnel.
	Department of Public Works Traffic management	Infrastructure repairs	Repairs to water main and street surface at Howard and Lombard Streets. Traffic control in Baltimore City.
	Office of Emergency Management	Interagency coordination Public information	Media Information
Maryland Department of Transportation	Headquarters	Coordination of DOT response activities	Working with Baltimore Department of Public Works (DPW) to establish a plan on how to repair the infrastructure damage once the fire was extinguished (procurement issues – having a contractor in place to do repairs, developing a plan on how repair work would be implemented once the “green light” would be received, plans for site survey, traffic diversion plan, etc.).
	State Highway Administration	Traffic management on interstate system	Through Coordinated Highways Action Response Team (CHART) system, posted notices on fixed and mobile VMS advising that major routes into the City were closed.
	Mass Transit Administration	Rail and bus transit operations in Baltimore City	Light rail and bus operations. Establishing bus bridge between north and south segments of light rail. MARC operations. METRO subway operations – tunnel inspection.
	Maryland Transportation Authority	Traffic management on I-95 approaches to Fort McHenry Tunnel; I-395	Responsible for ensuring I-395 route into Baltimore was closed off during initial incident response activities.
Maryland Department of the Environment	Emergency Response Division	Air quality Water quality Hazardous materials leaks/discharge	Obtaining information on possible environmental impact of train fire (hazardous materials). Monitoring air and water quality in area around the tunnel and the Inner Harbor. Working with Coast Guard to contain leakag into Inner Harbor. Checking rail cars pulled from tunnel for structural integrity. Coordinating removal and disposal of hazardous materials from the train.
Maryland Emergency Management Agency	N/A	Coordination of state government emergency response and incident management activities	Coordinating activities of state agencies. Media relations and rumor control.
U.S. Coast Guard	US DOT	Supported MDE	Implementing waterway safety measures, including closing of Inner Harbor. Supporting hazardous material detection and containment.
U.S. Environmental Protection Agency	N/A	Supported MDE	Assisting with monitoring of air and water quality.



## 3.0 Event Impacts

In reporting on the impact of the Howard Street Tunnel fire, simply stating statistics on street closings, estimates of traffic diverted, light rail disruptions, and other quantitative indicators does not capture the emotional impact of the event. As noted, it took several hours to identify the exact location of the fire within the tunnel and to determine that the burning chemicals did not pose a significant environmental threat to the City. In the meantime, however, downtown workers were attempting to leave the City only to find all major streets crossing Howard Street closed off, with limited information available initially on alternative routes. Residents were advised to stay indoors and to turn off their air conditioning to avoid smoke intake. The sounding of the civil defense sirens at 5:45 p.m. only added to the confusion. Many residents did not know why the sirens were being sounded, and instead of turning on radios and televisions to obtain information on the crisis (the intent of the exercise), called in to report malfunctioning sirens or to inquire why the sirens had been sounded. The sirens were a relic of the Cold War era and had originally been intended to signal that Baltimore was under attack. All of this occurred while smoke billowed from both ends of the tunnel and the water main break at Howard and Lombard streets flooded the surrounding area, further complicating matters. In reviewing the following information on transportation and other impacts, it is important to remember the context of the event.

### 3.1 Short-Term Transportation Impacts – July 18, 2001

The tunnel fire had an immediate impact on transportation services in Baltimore City. Emergency responders were required to make a number of decisions about how to handle evening rush hour and the evacuation of Oriole Park at Camden Yards. In addition, the tunnel fire and water main break seriously disrupted surface transportation operations within downtown Baltimore. Specific actions that were taken, and specific short-term transportation impacts resulting from the tunnel fire and water main break, included:

- ◆ *A request by the Incident Commander to close the major roadways into the City.* MD DOT contacted Maryland State Highway Administration (MD SHA) State Operations Center, which handled road closures for I-83 southbound, MD-295 (Baltimore-Washington Parkway) northbound, and Route 40 east (inbound); and MdTA, which restricted access to I-395 northbound. In addition to physically barricading entrance ramps to the facilities, the closures included posting variable message signs (VMSs) advising that in-bound routes to Baltimore were closed, as well as highway advisory radio (HAR) messaging. The roadway system was opened to traffic the following morning. Figure 6 shows the road closures on July 18, 2001.




Figure 6. Road Closures into Baltimore City

- ◆ *The closing of city streets in the vicinity of the tunnel, and the rerouting of passenger, bus, and commercial vehicle traffic.* The closing of Howard Street and the surrounding area in essence cut Baltimore's central business district in half, closing off east-west traffic flows. The day of the incident, drivers were trapped on gridlocked streets, and people waited at curbs for buses diverted from their regular routes. However, once traffic management procedures were put in place, the City was cleared of traffic within two hours of normal rush hour times (8:00 p.m. as compared to 6:00 p.m.). The MTA sent supervisors and other staff into the streets to intercept buses and advise passengers of the delays. In-bound buses were rerouted around the incident, or were sent back on the return portion of their routes.
- ◆ *During initial response to the fire, the closing of the Metro subway's State Center station (the station closest to fire) due to smoke accumulation.* Metro officials conducted an inspection of the tunnel running under the Howard Street Tunnel and determined that no damage had been incurred and were able to keep Metro running throughout the event. State Center reopened on July 21, 2001, to help handle the crowds attending the first Orioles game since the day of the incident. MTA reports that there was no other disruption to Metro service during the incident and that the system maintained normal operations.

- ◆ *The disruption of light rail service in the vicinity of the water main break.* MTA set up a bus bridge between the Patapsco and North Avenue stations to convey passengers around the area in which service had been disrupted. This service was initiated within an hour of the discovery of the water main break, and continued throughout the time needed for repairs to the water main and the light rail track. Two 8-hour shifts were established, with eight buses running on each shift. Buses departed from each terminus at 15-minute intervals. MTA estimated that the bus bridge ridership was about 15,000 passengers per day.
- ◆ *The disruption of MARC commuter rail and Oriole game day service.* MARC trains were stopped at the Dorsey Station near BWI Airport, and a bus bridge was set up by the MTA to bring passengers into the City. The bus bridge was for July 18 only.
- ◆ *The disruption of bus services.* MTA officials indicated that disruptions were systemwide. Bus routes crossing Howard Street were diverted or the buses turned back on the return portion of a route prior to reaching the normal endpoint; buses were pulled off routes to provide the bus bridge services; routes not located in the vicinity of Howard Street experienced delays due to unexpected congestion and traffic patterns caused by the closing of Howard Street.
- ◆ *The closing of the Inner Harbor to boat traffic by the U.S. Coast Guard.* The Maryland Department of the Environment set up booms in the Inner Harbor to minimize the contamination from the chemicals seeping from the leaking rail cars.
- ◆ *The disruption of rail freight movement along the East Coast.* The Howard Street Tunnel is one of only two direct northeast-southeast direct freight lines along the East Coast. Losing access to the tunnel required CSX to divert or delay a significant portion of rail traffic along the eastern seaboard. CSX issued an advisory that freight moving to and from Chicago to Baltimore and Philadelphia had been rerouted through Selkirk and South Kearny, NJ, with expected delays of 18 to 24 hours. Freight moving along the eastern seaboard from the Northeast to Florida and other southern states was advised to expect delays of 24 to 36 hours. CSX was able to reroute six trains a day on Norfolk Southern's Hagerstown-Harrisburg-Reading corridor, including the famous Tropicana "juice train" carrying Florida orange juice to the New York-New Jersey market. However, this Norfolk Southern line is the only other northeast-southeast direct freight line and it is operating at near-full capacity. Freight rail traffic moving to points north of Philadelphia that in normal circumstances would have used the tunnel was instead diverted as far west as Ohio.

Baltimore City's Department of Public Works adjusted traffic lights near the Howard Street corridor and added parking restrictions aimed at improving traffic flow downtown. According to the Baltimore Sun, Doris McGuigan, who serves on the city's emergency planning committee, was quoted as saying, "They (Baltimore City police and other emergency responders) handled the evacuation fine," but communication with people driving into the city was less successful. An example of this comes from a report from a journalist with the Baltimore Sun, who was driving around the Beltway, trying to get back into the city the evening of the incident. With all major roads into the city closed, he reported having to wind through surface streets to make his way home.

Oriole Park at Camden Yards is located at the terminus of the MARC Camden Line, which is also the point where I-395 enters downtown Baltimore streets. Joe Foss, vice chairman and chief operating officer of the Baltimore Orioles baseball team, estimated that 2,500 to 5,000 fans were at or around the stadium, along with 2,000 employees, all of whom were evacuated (see Figure 7). A traffic enforcement officer at Conway and Sharp Streets was assigned to divert traffic and pedestrians away from the stadium.

## 3.2 Medium-Term Transportation Impacts – July 19-23, 2001

Suppression of and initial clean up from the tunnel fire took approximately five days. All cars were removed from the tunnel and inspected for damage, and all hazardous materials were off-loaded and removed. The tunnel was inspected for structural damage, and reopened to rail traffic on July 23. That same Monday morning, when city and state employees returned to work (after many employees took advantage of liberal leave on Thursday and Friday), traffic utilizing I-395 to commute into downtown Baltimore was backed up more than a mile on northbound I-95. Street closures in the vicinity of Howard and Lombard Streets caused MTA officials to divert 23 bus routes. Light rail service continued to rely on buses to transport riders between the Patapsco and North Avenue Station stops around the section of track damaged by the water main break. For five days following the incident, streets in the vicinity of the tunnel and the

water main break remained closed, and all vehicle traffic was diverted. On July 24, nearly all streets were opened to traffic. Only a two-block stretch of Howard Street (around the intersection with Lombard Street) and a portion of Lombard Street from Sharp Street to Eutaw Street remained closed.

Commuters took advantage of Metro services to travel into Baltimore during this time. Metro officials reported that ridership



**Figure 7. Evacuating Orioles Park at the Camden Yards Station on July 18, 2001**

*Source: Baltimore Sun*

on Monday, July 24, was 7,000 higher than normal. Metro officials also provided service on Sunday, July 23 (Metro did not usually operate on Sundays until a service change in September 2, 2001), with ridership of about 6,600 passengers.

While high-priority cargo found ways around Baltimore's Howard Street Tunnel the day of the fire, the East Coast rail network became increasingly constrained with each day that the major north-south artery remained closed. Freight trains were delayed, cancelled, or diverted hundreds of miles throughout the mid-Atlantic states due to the blocked tunnel. In fact, CSX's entire system along the East Coast, and in the Midwest as far away as Ohio, was affected by the bottleneck. The railroad received help from its chief competitor, Norfolk Southern Corp; as some CSX trains were diverted onto Norfolk Southern tracks. Other shipments were sent over alternate CSX tracks. "We cooperate with each other when we have problems like this," said Rob Gould, a spokesman for CSX. Delayed trains were scattered throughout several states. CSX reported that on July 19, eight trains that would have used the tunnel were detouring through Cumberland, MD, and Youngstown, OH, five through Hagerstown, MD and Harrisburg, PA, and five through Cleveland, OH, and Albany, NY. In addition, 12 trains had been stopped in various yards and 3 trains had been cancelled. In addition, freight destined for the Port of Baltimore, only a few miles east of the tunnel's south portal, had to be either held across the harbor from its destination or detoured via Philadelphia. When the tunnel was reopened for traffic on July 24, much of the initial traffic consisted of cross-town traffic. Through trains were diverted for much of the next day.

MARC commuter rail service on the Camden Line was also disrupted until the fire was suppressed. MARC service on the Camden Line was ended at Dorsey Station, but there was not a significant decrease in ridership. Apparently, MARC commuters took advantage of free parking at the Dorsey Station and chose not to switch to other modes of transportation to reach Washington, DC.

### **3.3 Long-Term Transportation Impacts – Days 6 through 55**

The major long-term impact from the tunnel fire was on the Central Light Rail Line. The light rail track in downtown Baltimore runs directly over the Howard Street Tunnel and the water main. When the water main broke and the area around the break collapsed, much of the foundation support for this section of the light rail track was removed. The light rail track is embedded on a concrete slab, but much of the fill underneath the slab was washed away or collapsed (see Figure 8).

In order to gain access to the water main, the light rail track and the supporting concrete slab had to be cut. Once the water main had been repaired, the track itself had to be repaired and shored up, and the new

concrete slab had to cure. MTA also had to determine if the area impacted by the water main break remained solid under the light rail track. MTA used ground-penetrating radar to determine if there were substantial voids (holes or gaps) in the soil below the track bed. Once the slab of concrete with the embedded light rail was replaced, grout was injected to ensure that any small holes were filled. The slab is still being monitored monthly to determine whether there is any shifting or movement of the rail.

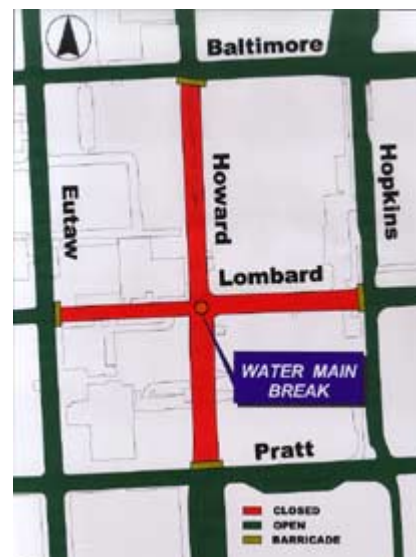
It should be noted that the closure of the Howard Street portion of the Central Light Rail Line had an unexpected, salutary benefit to the MTA. Light rail managers had become increasingly concerned about evidence that the vibration of the light rail tracks against the concrete slab rail bed was loosening the fasteners that affixed the track to the slab. During the shut-down of the Howard Street Corridor while repairs to the concrete slab were effected, MTA's engineering department implemented a fix for the problem with the fasteners: they inserted a resilient rubber boot between the rail and the slab and installed fasteners designed to dampen the vibrations that were causing the problem.

Completing repairs to the water main required 12 days, while reconstruction of the light rail bed and tracks took 53 days. During this time, the two-block area around Howard and Lombard Streets remained closed (see Figure 9). MTA continued to operate the bus bridge linking the north and south segments of the light rail. Maintaining this bus bridge required MTA to utilize close to 100% of available equipment. MTA estimates that at any given time, 17% of its equipment is out of service due to repairs and maintenance. During the incident MTA utilized X% of its available resources<sup>4</sup>. Maintaining 100% use required constant monitoring of schedules and reallocating buses as needed to support the bus bridge from routes where service could be consolidated. The MTA also had to shuffle driver schedules in order to ensure that drivers maintained compliance with hours of service regulations.

An additional impact on MTA operations was that the water main break in essence cut the light rail line in half, and rolling



**Figure 8. The Water Main Break**



**Figure 9. Closing Howard and Lombard Streets**

*Source: Baltimore Sun*

<sup>4</sup>We are waiting for accurate data from MTA.

stock located on the southern segment could not reach maintenance facilities. MTA established a temporary maintenance facility at the Cromwell Street Station. A service pit was dug under a storage rail, and equipment was brought in from the maintenance facility.

Throughout this period, MTA was able to keep all light rail equipment operational and did not have any drop in service levels. The MTA, however, did realize a significant drop in light rail ridership, down about 50% from normal levels to 15,000 passengers per day. MTA officials report that within two months of the reopening of service, ridership was back to pre-tunnel fire levels.

An additional impact resulting from the tunnel fire was the periodic closure of the tunnel over a three-week period for maintenance, repair, and clean-up activities. These closures did result in some delays for freight movement through the tunnel, but were minimal when compared with the impact of the actual event.

## **3.4 Other Impacts**

### **3.4.1 Telecommunications**

On the day of the event, Keynote Systems, an Internet performance company, discovered significant Internet backbone slowdowns. Initially, the "Code Red" virus was thought to be the cause of the problem, but then reports of the Howard Street Tunnel fire were received. The cause of the problem was found by identifying specific backbones experiencing slowdowns. The Howard Street Tunnel houses an Internet pipe serving seven of the biggest US Internet Information Service Providers (ISPs), which were identified as those ISPs experiencing backbone slowdowns. The fire burned through the pipe and severed fiber optic cable used for voice and data transmission, causing backbone slowdowns for ISPs such as Metromedia Fiber Network, Inc.; WorldCom, Inc.; and PSINet, Inc. Reports were received from up and down the East Coast about service disruptions and delays (for example, the Hearst Corporation lost e-mail and its main links to its Web pages on the Internet), and even the U.S. embassy in Lusaka, Zambia, in Africa experienced problems with sending and receiving e-mail.

In addition to the more severe Internet problems, the flood resulting from the water main break disrupted phone service to two downtown office towers in Baltimore City and caused other temporary communications problems within the City.

Both WorldCom and MFN had fully redundant service restored by July 20. WorldCom used its own crews while MFN contracted its work to LAI Construction Services, with the project managed by Bechtel Telecommunications. Some 24,000 feet of cable were laid to create a fully redundant MFN system, and service was restored within 36 hours.

### 3.4.2 Business Impact

According to an article published in the *Baltimore Sun*, merchants along Howard Street reported that business dropped 80 percent in the five days that Howard Street and east-west streets were closed to cars, buses, and light rail (see Figure 10).

CSX reimbursed businesses for losses, but the burst water main that kept light rail out of service for weeks cut foot traffic at a time when many renovation and new construction projects had been initiated in an effort to revive Howard Street and the western part of downtown Baltimore.<sup>5</sup> In addition, the Baltimore Orioles cancelled three games due to the tunnel fire at an estimated per-game cost of \$1.5 to \$2.0 million in revenues. An additional cost of the cancelled games was the loss of spending by fans at restaurants, parking facilities, and stores in the area surrounding the stadium, as well as the loss to the State of Maryland of sales tax and other tax revenue.



**Figure 10. A Vacant Howard Street in the Days after the Fire**

*Source: Baltimore Sun*

<sup>5</sup> Calvert, Scott "For Howard Street Rough Road", *Baltimore Sun*, July 29, 2001



## 4.0 Findings

### 4.1 Planning and Preparedness

A consistent theme identified in the interview process was that the agencies involved in responding to the Howard Street Tunnel fire had effective plans in place and were prepared to respond to an emergency. Emergency response personnel were on site literally within minutes of the fire being reported, and incident command procedures were established promptly. What complicated efforts was that these agencies had not planned for a situation where both a hazardous materials spill and a fire occurred in the same incident, which created some difficulties with establishing response priorities. For example, the Baltimore City Fire Department's main priority was fire suppression, while MDE's priority was determining the potential health and environmental threat posed by hazardous materials burning in an enclosed area. MDE needed time to determine what the potential hazards were, and what, if any, accommodations would need to be made in fire suppression (e.g., use of particular chemicals, what materials not to use, what type of equipment was needed, etc), while the Fire Department felt it important to commence fire suppression efforts immediately.

The agencies interviewed all stressed the importance of ongoing training and practice as the key to developing and maintaining incident response capabilities.

Notwithstanding the generally positive responses of individuals interviewed with respect to how well existing plans supported the emergency response efforts for the Howard Street Tunnel Fire, Baltimore City officials have acknowledged the need to update and improve the City's hazardous materials incident plan. The major gaps in the existing emergency plan are the lack of any provision on responding to an incident involving chemicals carried by train or truck and the lack of any mention of the Howard Street Tunnel. Baltimore City Mayor Martin O'Malley was quoted in the *Baltimore Sun* as saying, "It is not a question of if but when... Baltimore will again be confronted with comparable challenges" and that the Fire Department needed to answer fundamental questions about the crisis, including, "Were we adequately prepared to respond to the crisis?"<sup>6</sup> Mayor O'Malley has instructed emergency planners to conduct a comprehensive review of the plan, and according to Baltimore City Fire Chief Hector Torres, the City will seek Federal-funding assistance to update the plan and pay for emergency response improvements.

### 4.2 Institutional Coordination

The agencies responding to the incident represented three levels of government—local, state, and Federal. Agencies from Baltimore City, the State of Maryland, and the Federal Government do not typically work together on a single incident, and had not established the informal relationships and

---

<sup>6</sup> See Dewar, Heather and others "Accident Plan Leaves City Unprepared," *Baltimore Sun*, July 26, 2001.

networks that are frequently identified as the key to successful incident response. The number and type of agencies involved also complicated the response efforts.

These circumstances notwithstanding, institutional coordination in general worked well. The State agencies involved in the response efforts had well-established working groups, and proactively sought out counterparts at the City level to offer assistance. An example of this was the effort by MDOT personnel to work with City Department of Public Works staff to plan how the water main break would be repaired once the water flow was stopped—identifying what type of contractor services would be needed, acquiring necessary legal and procurement waivers to obtain services quickly, identifying potential sources of emergency and disaster relief funding, and other similar planning activities. An additional example occurred when the MTA provided the City Fire Department with specialized equipment needed to remove the train cars from the tunnel.

### **4.3 Guiding Priority**

As indicated previously, the tunnel fire created a unique situation where agency functions at times seemed to be at cross-purposes. The initial response to the incident quickly established at least three competing guiding priorities—fire suppression, maintaining transportation mobility, and containment of a potential environmental hazard. With respect to transportation mobility, the priority was to restore transportation infrastructure and services and to ensure movement of people out of the area impacted by the event.

This incident demonstrates the changing nature of incident response – first responders (fire fighters) initially moved into the tunnel, but then had to delay response until MDE, EPA, and CSX identified the chemical contents of trapped cars and determined the appropriate response. The prompt response by MDE in identifying the potential environmental impact of the fire in the cars containing hazardous materials helped to resolve the differences between this priority and the transportation and fire suppression priorities.

### **4.4 Communications**

In general, communications between responding agencies were not as effective as might be desired. This was due in large part to the differences in guiding priorities as well as the fact that the Incident Commander was initially concerned only about fire suppression. The MTA helped to resolve this by providing a mobile command post with state-of-the-art communications capabilities that were used by all parties.

An additional communications area where interviewees identified a need for improvement was in the notification process. Many responding agencies first

heard of the incident via the media, and implemented emergency response plans based on these media reports. Agency to agency notification procedures could have been better managed.

The one area where communications were relatively successful was public information. The City and the State agencies each assigned public information officers (PIOs) to handle all press inquiries, and regular reports were provided to the media. This proved particularly effective in providing information to the public about the absence of a severe environmental hazard due to the fire, and helped significantly with rumor control. The PIOs were able to track down rumors, obtain whatever information was needed to clarify or address a particular rumor, and get this information directly to the media.

The media also provided a valuable service in providing information about the crisis. Local radio and television news teams provided regular reports, and worked cooperatively with the PIOs to distribute information on road closures, alternate routes, and other related information. The MTA cited as examples of the effectiveness of media support the wide-spread reporting that Metro was not closed as a result of the fire and the opening of Metro service on Sunday, July 23.

## 4.5 Role of Advanced Technology

The most significant contribution from advanced technology came in the use of VMS and Highway Advisory Radio (HAR) to provide information to travelers on the closing of roadways into the City on the day of the event. Maryland's CHART is a state-of-the-art system, and the State was able to post messages that covered the portions of the Interstate Highway system impacted by the incident.

Notices about the event were posted on CHART's web site. As can be seen in Figure 11, the web site experienced a significant spike in hits on the day of and the two days immediately following the event.

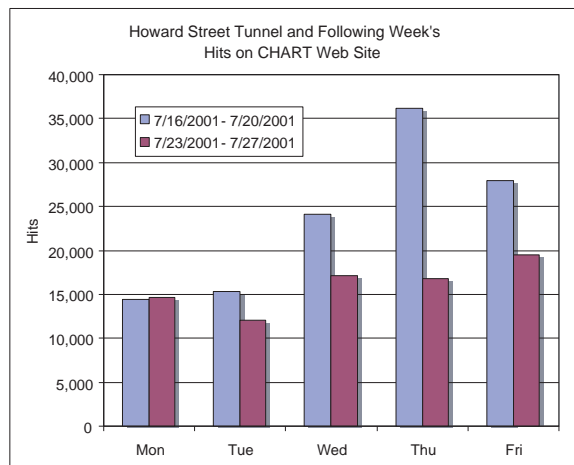


Figure 11. Hits on CHART Web Site

Source: Baltimore Sun

Interviewees stated that NEXTEL Direct Connect (digital two-way radio) was the most effective communications system available at the site. Cellular telephones were not as reliable, in particular on the day of the event, and experienced circuit overload. Many of the State personnel involved in the response had been provided with NEXTEL equipment by their agencies.

## 4.6 System Reliability and Redundancy

The involvement of City and State agency personnel guaranteed some redundancy in systems simply because agencies with similar responsibilities and functions were involved. An example is the presence of both the Baltimore City Office of Emergency Management and the Maryland Emergency Management Agency.

The agencies also proved capable of handling unexpected situations, such as the water main break and the disruption of MARC services. In both instances, MTA was able to establish a bus bridge to keep service operating and to prevent passengers from being stranded.

Where system redundancy was a significant problem was the extensive rerouting of freight traffic along the eastern seaboard due to the closing of the tunnel.

## 4.7 Environmental Considerations

The events of July 18 and the tunnel fire had the potential to be a catastrophic environmental event for the City of Baltimore. While the environmental impact of the tunnel fire in the end was minimal, thanks in part to the prompt response of SBIMAP in determining the potential dangers caused by the mixing of the chemicals on the train, the tunnel fire does highlight the potential for an environmental catastrophe resulting from a rail incident involving hazardous materials. In fact, the Howard Street Tunnel fire has been cited by a number of environmental groups to illustrate the potential dangers involved in the transport of nuclear waste materials to the Yucca Mountain site in Nevada.

A report prepared by Radioactive Waste Management Associates (RWMA)<sup>7</sup> used the Howard Street Tunnel fire to demonstrate, on a hypothetical basis, what might have occurred had nuclear waste been part of the cargo. Under current Nuclear Regulatory Commission regulations, a cask containing nuclear waste (spent nuclear fuel or high-level radioactive waste) must be able to withstand an engulfing fire for 30-minutes at 1,475 degrees Fahrenheit. The Baltimore Sun has reported that the fire reached temperatures as high as 1,500 degrees Fahrenheit, and burned out of control for a period of approximately 24 hours.

---

<sup>7</sup> Lamb, Martin, and Marvin Resnikoff, "Radiological Consequences of Severe Rail Accidents Involving Spent Nuclear Fuel Shipments to Yucca Mountain: Hypothetical Baltimore Rail Tunnel Fire Involving SNF". Radioactive Waste Management Associates, NY, NY, September 2001.

The RWMA study used the Department of Energy's computer models to determine the impact of a severe high-level radioactive waste transport accident based on the Howard Street Tunnel fire. The study estimated that the release of radiation in Baltimore City from such a catastrophic event would cost multiple billions of dollars to clean up and would cause 115 latent cancer fatalities.

The State of Nevada's web site includes a listing of rail transportation routes that are projected by the Department of Energy as possible routes for shipment of nuclear waste to Yucca Mountain. The routes listed for Maryland for shipment of spent nuclear fuel from the Constellation Energy Group's Calvert Cliffs nuclear plant located on the western shore of the Chesapeake Bay in Calvert County include the same CSX railway trackage that experienced the train tunnel fire. Thus, while the RWAA analysis was hypothetical, the analysis, when viewed in the context of an actual tunnel fire and the planned routing of nuclear waste shipments, does demonstrate the potential dangers facing the State of Maryland (and other states) from the shipment of nuclear waste, and other hazardous materials. An additional consideration is that the proposed Western Maryland route is the CSX line used for the MARC Brunswick, MD, to Washington, DC, commuter service.

## **4.8 Role of the Private Sector**

The assistance provided by SBIMAP volunteers in identifying the chemicals on the train and determining that the fire did not represent a potential environmental catastrophe was one of the key points in responding successfully to the crisis. Once this assessment was made, an appropriate containment strategy was implemented to handle the leaking chemicals. More importantly, the PIOs were in turn able to inform the media that no environmental catastrophe was imminent and to ensure that this information was transmitted to the general public. In addition, CSX offered the services of its contractors to help with fire suppression and removal of cars from the tunnel. This level of private-sector cooperation and support played a critical role in ensuring successful incident response.

## 5.0 Conclusions

The Howard Street Tunnel fire represented a major transportation-related incident that had the potential for catastrophic impacts on the local, regional, and national levels. Major damage to the Howard Street Tunnel could have had substantial adverse effects on freight movement throughout the East Coast and beyond; the MTA's Central Light Rail Line was disrupted for a period of nearly two months; and potentially serious problems could have resulted for a variety of other local and regional transportation facilities. During the incident, the utilization of an integrated Incident Management System approach to the fire and associated occurrences resulted in effective management of the scene, the fire suppression effort, and the containment and mitigation of hazardous materials involved. Furthermore, participants in the incident pointed out the following "lessons learned" that were imparted in the course of the event:

- ◆ Close relationships are essential for building confidence in collective capabilities to do the job right. All interviewees stressed that establishing a network between agencies, so that responders know whom to contact, is critical for ensuring coordinated and effective incident response.
- ◆ Little could be done to improve the transportation situation immediately after the consequences of the water main break became evident. MTA responded promptly and effectively, but the flooding of downtown streets coupled with the closure of cross streets over Howard Street created an impassable situation. The closure of major inbound thoroughfares to allow gridlocked downtown streets to clear was, in retrospect, an effective strategy for managing transportation impacts.
- ◆ The problems with communications were routine. The interviewees indicated that enough experienced personnel who understood the importance of good communications were involved in the response to the fire that appropriate processes for exchanging information were implemented.
- ◆ Once the key issue of potential environmental hazards had been resolved, incident response activities were coordinated and implemented using standard incident response procedures and command structures. This approach allowed responders to operate within a well-understood and well-rehearsed framework that has been tested in a wide variety of situations, with positive results.

The Howard Street Tunnel event does, however, raise a number of difficult yet timely public policy issues that jurisdictions need to consider in planning for incident management and response:

1. *Transportation of Hazardous Materials – Determining the balance between the public's "need to know" and the potential for compromising security*

Officials interviewed for this case study indicated that little information is provided on the movement of hazardous materials by rail, truck, or ship. While hazardous material cars carry warning placards, these indicate the type of threat posed by the hazardous material, not the precise nature of the material being transported. No one has responsibility for monitoring the types and quantities of chemicals passing through Baltimore (or any other urban area).

Balancing this concern about providing information on hazardous materials movement is the issue of not creating unnecessary public panic. Providing this information has the potential to cause extensive public concern as to whether or not such materials should be transported through urban areas, making it difficult or expensive to move materials needed for industry and other end users. Simply shifting hazardous materials shipments to rural areas may actually increase the risk of a major incident, as rural areas often lack the infrastructure and resources needed to respond rapidly and effectively to chemical emergencies.

Providing this information also raises security concerns. In particular, the tragic events of 9/11 have heightened sensitivities to and awareness of the dangers of hazardous materials being used for sabotage and terrorist purposes. Information that is provided on hazardous materials movement needs to be provided in such a way that security is not compromised.

Officials responsible for emergency management and response will need to find the appropriate balance between these competing issues.

## 2. *The Need for Redundant Systems*

The massive tie-ups in freight movement along the East Coast as a result of the fire demonstrated that the rail freight system is at or near capacity and lacks redundancy and back-up systems. This is not an issue that can be easily resolved, but does demonstrate the importance of identifying chokepoints and redundant systems (to the extent feasible) that can be used to compensate for a major transportation system disruption.

Transportation system right-of-ways are increasingly being used for the placement of fiber optic cable. The disruption to the Internet as the result of the fire, however, demonstrates the potential for damage that can result from collocating cable along transportation routes where there is the potential for catastrophic incidents. Planning for redundancy in communications systems is critical to ensure that a transportation-related incident does not in turn disrupt communication systems and infrastructure.

### 3. *The Need for Improved Planning and Communications*

The shortcomings in Baltimore's emergency response plan (the lack of any provision for responding to an accident involving chemicals carried by train or truck, and the absence of any mention of the Howard Street Tunnel) highlight additional concerns that jurisdictions need to address. Jurisdictions need to ensure that such plans identify all potential hazards for their particular area, and that a response is formulated. Jurisdictions should also assess all infrastructure elements to identify potential hazards and plan accordingly.

An additional consideration for jurisdictions is to identify incidents that may require responses from multiple agencies (or jurisdictions) or may have multiple guiding priorities. As has been noted, the emergency response to the Howard Street Tunnel fire at times was hampered by lack of coordination and communication between City and State agencies that did not have well established relationships and also did not have a history of working together in responding to incidents. In addition, the differing guiding priorities of the respondents created some conflict as to what should be done first in managing the incident scene. Jurisdictions would benefit from identifying such possible scenarios, and ensuring that agencies likely to be involved in such a response have a prior agreement on how response priorities will be coordinated, what each agency's responsibilities are, and who the points of contact are for each agency.

### 4. *The Need to Identify All Available Resources – Public and Private*

The roles of SBIMAP and the CSX contractors in identifying the potential environmental hazards and supporting fire suppression efforts were critical in responding to the tunnel fire. Jurisdictions should identify such resources and reach out proactively to plan how assistance might be provided in an emergency. This should include establishing working relationships and obtaining agreements on what types of assistance might be provided, establishing notification procedures, and identifying points of contact.





# Appendix A. Detailed Chronology

## July 18, 2001 – Day 1

- 3:04 p.m. 60-car CSX freight train L412-16 being pulled by three engines, carried 31 loaded and 29 empty cars, with a mix of freight that included empty trash containers, paper products, plywood, soy oil, and several tanker cars enters the Howard Street Tunnel in downtown Baltimore.
- 3:07 p.m. Train unexpectedly comes to stop in tunnel.
- 3:15 p.m. Engineers notify CSX dispatcher via cell phone that train is stopped in tunnel.
- 3:27 p.m. Engineers decouple engines and exit from tunnel. Increasing smoke provides evidence train is burning. CSX dispatcher notified via radio that train is on fire, and that cargo contains hazardous materials.
- 3:35/4:15 p.m. Baltimore City Fire Department arrives as first responder and assumes incident command responsibilities. CSX Engineers provide bill of lading indicating derailed train is carrying hazardous materials.
- 4:11 p.m. CSX Transportation notifies Maryland Department of the Environment-Emergency Response Division (MDE ERD) of the derailment of train cars carrying hazardous materials.
- 4:15 p.m. The Baltimore City Department of Health contacts the Maryland Emergency Management Agency (MEMA).
- 4:20 p.m. MDE ERD personnel arrive on scene, contact National Transportation Safety Board, Baltimore City Fire Department Battalion Chief 6, and Baltimore City Fire Department hazardous materials (HazMat) coordinator. Units begin assisting city personnel with analysis of train documentation and potential hazard products.
- MARC commuter rail, MTA's Central Light Rail Line, and rail freight movement are disrupted by tunnel street fire. MTA initiates bus bridge to bring MARC passengers from Dorsey Station, south of Baltimore, to the City.
- Chief of the City Fire Department requests that all major roads (I-395, I-83, US-40) into Baltimore City be closed.
- 4:30 p.m. Baltimore City Police Department and Department of Public Works start rerouting downtown traffic away from the scene using signs and physical barriers; Howard Street and all streets crossing over the Howard Street tunnel are closed.
- Interstate highways I-395 northbound and I-83 southbound are closed to traffic trying to enter the City.
- 4:35 p.m. MDE requests consulting chemist assistance through South Baltimore Industrial Mutual Aid Plan (SBIMAP). MDE advises Baltimore City HazMat of potential hydrogen fluoride (HF) vapor hazard due to thermal degradation of fluorosilicic acid; identifies specialized treatment needed for HF exposures.

- 4:45 p.m. Baltimore City Emergency Management contacts MDE to report that city officials are preparing to sound siren system to notify nearby residents to shelter in place. MDE concurs with shelter in place order.
- 4:50 p.m. Initial air monitoring by MDE and Baltimore City HAZMAT commences at Mt. Royal using pH paper, photoionization detectors, and multigas instruments. MDE directed to begin air monitoring in the vicinity of Camden Yards.
- 4:53 p.m. MDE contacts U.S. Coast Guard and requests assistance. MDE and SBIMAP personnel conduct air quality monitoring along Howard Street Corridor and in the vicinity of the Mt. Royal Station.
- 5:00 p.m. U.S. Coast Guard closes Inner Harbor to boat traffic.  
Orioles' office workers are told to leave B & O Warehouse.
- 5:45 p.m. Civil Defense warning sirens sound.
- 6:15 p.m. Water from the broken water main located under the Howard and Lombard Street intersections surfaces and floods the street.  
MTA closes Metro's State Center station due to smoke entering the station via subway tunnel and station ventilation fans.
- 7:15 p.m. MTA initiates bus bridge connecting north and south segments of light rail between Patapsco station and North Avenue.  
Exact location of fire is identified (near Howard and Lombard Street intersection).  
MDE, working with SBIMAP, determines that a catastrophic environmental event is not likely to happen because of the train fire and Baltimore City determines that an evacuation of the downtown area is not necessary.
- 8-9:00 p.m. Roads and entrance/exit ramps on major thoroughfares into the City reopen sporadically.
- 8:30 p.m. MDE receives reports of odor and solids emanating from a storm drain outfall near the Harbor Place complex at Pratt and Light Streets. Personnel are dispatched from ERD Field Office with 1,000 feet of containment boom on a trailer.
- 10:30 p.m. Containment boom in place around outfall. Dark solids and pronounced "chemical" odor present. On-site personnel obtain water and product samples and proceed to Mt. Royal office for analysis.
- 10:50 p.m. MDE visual inspection of sample indicates dark particulate/liquid mix floating on the water. Photoionization detector readings are positive for presence of volatile organic compounds.
- 11:00 p.m. Baltimore City Fire Department Command Staff direct primary Command Post operations to be relocated to the vicinity of Camden Yards stadium complex.  
Water is cut off by BCDPW at the point of the water main break.

11:15 p.m. MD DOT, MDE, MEMA, and MD Department of General Services discuss possible closure of state offices near Mt. Royal on July 19. MDE shares results of environmental monitoring and indicates no hazardous materials threat to those facilities. MD DOT and MD GSA tentatively agree to enact liberal leave for state office complex due to road closures and mass transit disruptions. Coordination call between city and state agencies set for 4:00 AM July 19, 2001 so that a final recommendation can be made to the Governor.

## **July 19, 2001 – Day 2**

4:00 a.m. MDE operations shift to Camden Yards command post.

5:00 a.m. MDE confers with CSX and Baltimore City Fire Department incident command staff to discuss incident mitigation strategy. Fire appears to be located under the Howard and Lombard Street intersection and may be accessible from the surface.

Inner Harbor is reopened.

State Personnel assigned to State Center office complex granted liberal leave.

6:30 a.m. Baltimore City Fire Department, U.S. Coast Guard Activities Baltimore, and MDE discuss marine safety zones on Patapsco River and agree to lift same.

9:30 a.m. MDE meets with USCG Activities Baltimore and requests assistance from Activities Baltimore staff in establishing a Hazardous Materials division with the USCG ICS to coordinate monitoring efforts of CSX, MDE, EPA, USCG, and SBIMAP assets.

10:30 a.m. Fire personnel are able to access the tunnel via a manhole at the Howard and Lombard Street intersection and begin fighting the fire at that location. Small leaks reported in one tank car of hydrochloric acid (HCl). CSX, MDE, and Baltimore City fire personnel begin planning acid transfer operations along with CSX contractors.

1:00 p.m. MDE deploy to Lombard/Howard intersection to assist with product transfer operations and monitor air and liquids for presence of HCl.

7:00 p.m. MDE personnel escort first tank truck of transferred hydrochloric acid to Sasol facility in South Baltimore. Transfer and escort operations continue until approximately 3:00 a.m. on July 20, 2001.

## **July 20, 2001 – Day 3**

6:00 a.m. CSX personnel consult with MDE regarding construction of dike around leaking HCl car. Initial suggestion by contractor staff was to use soda ash bags as diking material; this action changed after MDE staff express serious safety reservations about the reaction with soda ash should the tank car suddenly fail.

8:00 a.m. USCG Activities Baltimore develops written site safety plan; MDE adopts plan and is covered by it in order to ensure unity of operations and safety purposes.

1:30 p.m. MDE, SBIMAP consultant, and two CSX personnel enter north end of tunnel via high-rail vehicle to assess tank cars. SBIMAP consultant is overcome by fatigue

and exhausts air supply. Personnel begin to evacuate the tunnel and contact intervention team for assistance per existing safety plan. MDE and SBIMAP consultant transported to University of MD medical center for observation and released.

4:00 p.m. Multi-agency incident strategy meeting held, led by Baltimore City Office of Emergency Management.

### **July 21, 2001 – Day 4**

State Center Metro station is reopened.

Camden Yards Central Light rail line station is reopened; however, bus bridge continues to operate between Patapsco and North Avenue stations due to presence of emergency equipment near Camden station.

4:00 a.m. MDE personnel are provided with status update on all cars. Tank cars at northern end of tunnel are removed and assessed. All are reported intact. Remaining tank cars are being removed from south end of tunnel.

5:45 a.m. Undamaged HCl tank is removed from tunnel's south portal.

7:00 a.m. Undamaged HCl tank car is inspected visually by MDE staff. Small amount of vapor is visible near manway. Vapor is confirmed to be acidic and CSX is notified.

11:30 a.m. Damaged HCl tank car is removed from south end of tunnel.

11:45 a.m. MDE confers with CSX, USCG, EPA, and Baltimore City Fire Department regarding need for continued MDE presence. Monitoring and long-term clean-up efforts are discussed.

1:30 p.m. MDE personnel depart scene as emergency operations have concluded. Work plan is established for follow-on monitoring and assessment during clean-up operations.

7:05 p.m. First Orioles game is played at Orioles' Park at Camden Yards since the day of the incident.

### **July 23, 2001 – Day 6**

Broken valve is repaired near water main break and water flow stops.

Howard Street is reopened to traffic, except in vicinity of water main break.

Cross streets intersecting Howard Street reopen except streets between Baltimore Street and Pratt Street.

MTA continues bus bridge between north and south light rail branches.

Liberal leave for state employees ends and regular work hours resume.

7:10 a.m. Final rail car is removed from tunnel and remaining fires are extinguished.

4:45 p.m. CSX bridge maintenance engineers, Federal Railroad Administration officials, Baltimore City engineers, and Baltimore Mass Transit Administration officials enter the tunnel for the first time to inspect the damage.

### **July 24, 2001 – Day 7**

MARC's Camden Line resumes service from Washington, DC, to Camden Yards station in time for morning commute.

CSX's test run through the Howard Street tunnel with two locomotives and 50 loaded cars at reduced speed is successful; CSX resumes freight service through the Howard Street tunnel at limited speeds.

### **July 29, 2001 – Day 12**

Water main repairs are completed.

### **August 11, 2001 – Day 25**

Manhole covers fly four feet into the air and traffic signals are disrupted in small area downtown due to the ignition of tripropylene by electrical sparks. Approximately 2,000 gallons of tripropylene are recovered from storm drain system and nearby conduit vaults.

### **September 4, 2001 – Day 49**

Intersection of Howard Street and Lombard Street is reopened to traffic.

Central Light Rail line is repaired.

### **September 8, 2001 – Day 53**

Central Light Rail Line is reopened, bus bridge is discontinued.

### **September 10, 2001 – Day 55**

Baltimore City completes repairs to road surfaces.

# Appendix B. Information Sources and Documents Reviewed

## Baltimore Sun ([www.sunspot.net](http://www.sunspot.net))

### July 19, 2001

'Hidden historical asset of Baltimore' was born of necessity; Possibility of a fire in 1.7-mile rail tunnel did not go unconsidered

<http://www.sunspot.net/news/local/bal-te.md.tunnel19jul19.story>

Baseball fans and commuters held hostage by road closings; Rush-hour timing aggravates widespread gridlock, frustration

<http://www.sunspot.net/news/local/bal-te.md.scene19jul19.story>

Train fire, toxic cargo shut city; Firefighters stymied as CSX freight burns in Howard Street Tunnel; Civil defense sirens wail; I-395, Inner Harbor closed; water main break cuts power

<http://www.sunspot.net/news/local/bal-te.md.train19jul19.story>

Firefighters battle unknown dangers; Dangers: The chemical fire presented unusual dangers for firefighters who, with limited oxygen supplies, were unsure of what they would face

<http://www.sunspot.net/news/local/bal-te.md.fire19jul19.story>

Freight carried dangerous cargo; Chemicals listed on the train's manifest

<http://www.sunspot.net/news/local/bal-te.md.chemicals19jul19.htmlstory>

Morning transit; Information for commuters

<http://www.sunspot.net/news/local/bal-te.md.transit19jul19.story>

### July 20, 2001

Tunnel fire choking East Coast rail freight; Cargo being rerouted, but customers nervous

<http://www.sunspot.net/news/local/bal-te.bz.freight20jul20.story?coll=bal%2Dhome%2Dheadlines>

Train derailment severs communications—Fiber optic cables in tunnel damaged; Flood knocks out phone service

<http://www.sunspot.net/news/local/bal-te.bz.fiber20jul20.story?coll=bal%2Dhome%2Dheadlines>

Hazardous materials pass daily—and no one knows; On land, sea, and air, potential for disaster

<http://www.sunspot.net/news/local/bal-te.md.hazard20jul20.story?coll=bal%2Dhome%2Dheadlines>

Burning cars in rail tunnel resist control; Crews use manhole to approach blaze with cooling water; 'Like walking into an oven'; 5 of 60 cars removed; Heat makes cleanup of acid leak difficult

<http://www.sunspot.net/news/local/bal-te.md.train20jul20.story?coll=bal%2Dhome%2Dheadlines>

There when you need them; Without warning; Emergency responses were generally good, but luck was better; The worst did not happen.

<http://www.sunspot.net/news/local/bal-ed.siren20jul20.story>

Aging infrastructure invites other disasters; Baltimore: City was lucky the freight train derailment and fire produced only a big scare.

<http://www.sunspot.net/news/local/bal-ed.tunnel20jul20.story>

An all-nighter for O'Malley; Response: The mayor acts quickly to defuse a tense situation, tracking emergency efforts and putting people at ease.

<http://www.sunspot.net/news/local/bal-te.md.mayor20jul20.story>

Rail accident linked to water main break; New valve to be installed today; Pipe repairs might take days, official says

<http://www.sunspot.net/news/local/bal-te.md.water20jul20.story>

Orioles at loss if makeups missed; Backlog of games could cost O's dearly; Ripken 'finale' sought

<http://www.sunspot.net/news/local/bal-sp.orioles20jul20.story>

Duck and Cover? No, find the remote; Emergency: Many in the city were puzzled when the Civil Defense sirens sounded – and it wasn't Monday

<http://www.sunspot.net/news/local/bal-to.siren20jul20.story>

Downtown stores, workers struggle after fire, flood; Buildings drenched, firms inconvenienced, and business slows for some

<http://www.sunspot.net/news/bal-te.bz.downtown20jul20.story>

Morning transit; Information for commuters

<http://www.sunspot.net/news/local/bal-te.md.transit20jul20.story>

## July 21, 2001

Chronology: With a rumble, chaos

<http://www.sunspot.net/news/local/bal-te.md.accident21jul21.story>

These events leave a cloud over our city

<http://www.sunspot.net/news/local/bal-to.kasper21jul21.column>

CSX train fire sparks debate of stay or go; Reaction: Clear messages from reliable sources help people figure out what to do when facing possible disaster

<http://www.sunspot.net/news/local/bal-to.disaster21jul21.story>

'It's a little bit of hell'; 22 smoldering cars pulled out; those with toxic cargo next; Heat, smoke slow battle; Fire, water rupture keep downtown in turmoil for 3rd day

<http://www.sunspot.net/news/local/bal-te.md.train21jul21.story>

Waiting game is only one O's play; Rail cleanup keeps schedule in flux; O's tell of evacuation fears

<http://www.sunspot.net/news/local/bal-sp.orioles21jul21.story>



Plans to repair water main hit another snag; Pipe embedded in arch of tunnel; Work stopped for safety of firefighters; 'We're in a holding pattern'

<http://www.sunspot.net/news/local/bal-te.water21jul21.story>

Firms find way around major Internet artery; Downed data lines on key route cause delays across country

<http://www.sunspot.net/news/local/bal-te.bz.fiber21jul21.story>

Weekend transit

<http://www.sunspot.net/news/local/bal-te.transitbox21jul21.story>

## **July 22, 2001**

Fire, flood and gridlock: Mayor's reputation at stake

<http://www.sunspot.net/news/local/bal-md.olesker22jul22.column>

Crews remove riskiest cars; Tankers carrying acid, other liquid out of tunnel; Burning boxcars remain; Danger delays full probe; Officials hope to open more streets in time for morning rush hour

<http://www.sunspot.net/news/local/bal-te.md.train22jul22.story>

O's fans get to game despite shut streets, reduced light rail; Normal downtown traffic still may be days away

<http://www.sunspot.net/local/bal-te.md.traffic22jul22.story>

## **July 23, 2001**

Disaster experts to the rescue; Emergencies: Containing deadly chemicals in dangerous situations is all in a day's work for specialized crews

<http://www.sunspot.net/news/local/bal-te.md.wrecks23jul23.story?coll=bal%2Dhome%2Dheadlines>

Firefighters deserve high-fives and another fete

<http://www.sunspot.net/news/local/bal-md.rodicks23jul23.column>

'The hardest part is over'; Firefighters declare triumph over blaze in Howard Street Tunnel; Nearly 100 hours of work; Investigation begins, could take months to determine cause

<http://www.sunspot.net/news/local/bal-te.md.train23jul23.story>

Commuters still face city snarls; Drivers urged to use Metro, avoid going through downtown

<http://www.sunspot.net/news/local/bal-te.md.downtown23jul23.story>

Today's transit; Information for commuters

<http://www.sunspot.net/news/local/bal-te.transitbox23jul23.story>

## **July 24, 2001**

Howard Street, tunnel reopen; Broken water main eyed as cause of CSX derailment, fire; 'City is back in business'

<http://www.sunspot.net/news/local/bal-te.md.train24jul24.story>

Makeup plan set for O's, Rangers; Texas doubleheader slated tomorrow, plus 1 game here Monday

<http://www.sunspot.net/news/local/bal-sp.ossider24jul24.story>

Firefighters' heroism; Fearless work: With little regard for own safety, city firefighters did a great job with blazing train wreck

<http://www.sunspot.net/news/local/bal-ed.fire24jul24.story>

Mass transit's weakness; Commuting: Last week's events show that the region badly needs a system that works

<http://www.sunspot.net/news/local/bal-ed.transit24jul24.story>

## **July 25, 2001**

After early morning trial run, freight traffic resumes in tunnel; CSX employee recalls how bad passage looked hours after fire began

<http://www.sunspot.net/news/local/bal-te.ride25jul25.story?coll=bal%2Dhome%2Dheadlines>

NTSB, city sifting clues to accident; U.S. investigators find 'earthy material' atop derailed train; 'Fire came first,' city says; One week afterward, Baltimore almost back to normal

<http://www.sunspot.net/news/local/bal-te.md.train25jul25.story>

## **July 26, 2001**

Accident plan leaves city unprepared; Its 440 pages fail to consider tunnel, deal with toxic spills

<http://www.sunspot.net/news/local/bal-te.md.plan26jul26.story?coll=bal%2Dhome%2Dheadlines>

Officials discuss costs of train fire; City tallies expenses of \$1.3 million; CSX agrees to pay bulk; 'Exchange of information'

<http://www.sunspot.net/news/local/bal-md.train26jul26.story?coll=bal%2Dhome%2Dheadlines>

## **July 27, 2001**

Tunnel blame drama begins; City, CSX, others have much at stake in the placing of fault

<http://www.sunspot.net/news/local/bal-bz.legal27jul27.story>

Officials to improve city emergency plan; Spokesman says firefighters prepared for chemical spills

<http://www.sunspot.net/news/local/bal-md.fire27jul27.story>

## **July 29, 2001**

For Howard Street, it's been rough road; Troubles: The train derailment, fire and water main break that stifled retail trade are just the latest in a long line of misfortunes and setbacks

<http://www.sunspot.net/news/local/bal-te.md.howard29jul29.story>

NTSB probe of tunnel derailment could take 9 months; Agency started investigation immediately after accident

<http://www.sunspot.net/news/local/bal-te.md.train29jul29.story>

## **July 31, 2001**

Avoiding tunnel is impractical, costly, CSX says; Federal law limits local authority over hazardous freight; Bypasses create delays

<http://www.sunspot.net/news/local/bal-te.md.train31jul31.story?coll=bal%2Dhome%2Dheadlines>

Howard repairs could take 5 weeks; Water main fixed Sunday, but extensive damage, light-rail work noted; Project could begin Thursday

<http://www.sunspot.net/news/local/bal-md.main31jul31.story?coll=bal%2Dlocal%2Dheadlines>

## **August 13, 2001**

Sewers, Howard tunnel connect; CSX reveals link, but manhole blasts still called a mystery

<http://www.sunspot.net/news/local/bal-te.md.hazmat13aug13.story>

## **August 14, 2001**

Explosions in city still a mystery; City, state, CSX call six downtown blasts 'baffling,' 'puzzling'; 'Just spinning our wheels'; Investigators continue to look for a link to rail tanker car leak

<http://www.sunspot.net/news/local/bal-md.explode14aug14.story>

## **August 15, 2001**

Tests to seek chemical source; Officials aim to learn whether explosions, CSX train fire linked

<http://www.sunspot.net/news/local/bal-md.explode15aug15story>

## **August 16, 2001**

Howard Street repair in high gear; Crews try to correct water main damage in about 5 weeks; 'Challenge for everybody'

<http://www.sunspot.net/news/local/bal-te.md.main16aug16.story>

## **August 17, 2001**

Mystery of train accident unsolved; Evidence in tunnel obliterated during 5 days fighting blaze

<http://www.sunspot.net/news/local/bal-md.nts17aug17story>

## **August 29, 2001**

Intersection repair work almost done; Officials tell legislators about wreck aftermath

<http://www.sunspot.net/news/local/bal-md.derail29aug29.story>

## **September 5, 2001**

Howard, Lombard junction reopens; Traffic able to flow freely for first time since break of water main

<http://www.sunspot.net/news/local/bal-md.howard05sep05.story>

## **September 8, 2001**

Derailed train linked to chemical in sewers; Sample from storm drain matched to CSX load supplied by La. Company

<http://www.sunspot.net/news/local/bal-md.train08sep08.story>

## **Washington Post (www.washingtonpost.com)**

### **July 19, 2001**

Train Sets Tunnel Afire, Shuts Down Baltimore; Hazardous Smoke Closes Roads, Cancels Ballgame

<http://www.washingtonpost.com/ac2/wp-dyn?pagename=article&node=&contentId=A17542-2001Jul18&notFound=true>

### **July 8, 2002**

In Nuclear Waste Site Debate, Visions of Transport Disaster

<http://www.washingtonpost.com/wp-dyn/articles/A36463-2002Jul7.html>

## **Baltimore City Paper Online (www.citypaper.com)**

### **September 12, 2001**

The Feds Are Considering Shipping Spent Nuclear Fuel Through the Howard Street Tunnel. Are They Playing with Fire?

<http://www.citypaper.com/2001-09-12/feature.html>

### **February 20, 2002**

Baltimore Tunnel Fire, Aberdeen Missile Test Targets in National Nuke-Transport Debate

<http://www.citypaper.com/2002-02-20/mobs.html>

## **WBAL-TV (www.thewbalchannel.com)**

### **July 19, 2001**

Progress Made in Tunnel Fire

<http://www.thewbalchannel.com/news/879713/index.html>

Train Derails; Hazardous Chemicals Onboard; Two Cars Carrying Hydrochloric Acid

<http://www.thewbalchannel.com/news/878827/index.html>

### **July 23, 2001**

Inspectors Assess Rail Tunnel Damage; Repairs Set to Begin to Aging Tunnel System

<http://www.thewbalchannel.com/news/883994/index.html>

### **July 24, 2002**

Most Downtown Roads Reopen After Tunnel Fire

<http://www.thewbalchannel.com/news/886604/detail.html>

## **UTU Daily News Digest (www.utu.org)**

### **July 20, 2001**

Chemicals Drained from Baltimore Train; Tunnel Fire Slows Internet Service  
<http://www.utu.org/News/NewsDgst/2001/July/0720/010720.htm>

### **July 24, 2001**

Way Cleared for Baltimore Tunnel Reopening; NTSB Wonders if Flooding Caused Baltimore Train Wreck  
<http://www.utu.org/News/NewsDgst/2001/July/0724/010724fr.htm>

### **November 5, 2001**

Leak temporarily closes Baltimore rail tunnel  
<http://www.utu.org/News/NewsDgst/2001/November/1105/1105fr2.htm>

## **Constellation (http://www.nab.usace.army.mil)**

### **September 2001**

Accident Causes Interruption of Light Rail Service  
<http://www.nab.usace.army.mil/publications/Constellation/2001/index.htm>

## **CSX Corporation (www.csx.com)**

### **July 24, 2001**

Press Release: Howard Street Tunnel Operations to Resume  
<http://www.csx.com/aboutus/news/press/pressview.cfm?ID=6621>

## **CSX Intermodal (www.csxi.com)**

### **July 19, 2001**

CSX Intermodal Advisories: Line Disruption in Baltimore  
<http://www.csxi.com/advisories/index.cfm?fuseAction=Detail&id=6601>

### **July 25, 2001**

CSX Intermodal Advisories: Line Interruption in Baltimore – Update  
<http://www.csxi.com/advisories/index.cfm?fuseAction=Detail&id=6680>

### **August 17, 2001**

CSX Intermodal Advisories: Howard Street Tunnel Re-Routs Have Ended  
<http://www.csxi.com/advisories/index.cfm?fuseAction=Detail&id=6826>

## **NIRS (www.nirs.org)**

**July 21, 2001**

Press Release: What if the Baltimore Train Tunnel Fire Had Involved High-Level Nuclear Waste?

<http://www.nirs.org/newsreleases/PRwhatifbaltimore0701.htm>

## **Common Dreams (www.commondreams.org)**

**February 11, 2002**

Last Summer's Tunnel Fire Would Have Ruptured Containers, Contaminating Baltimore, a Report Says

<http://www.commondreams.org/headlines02/0211-01.htm>

## **Baltimore City Government (www.ci.baltimore.md.us)**

**July 18, 2001**

Press Advisory: Traffic Advisory – Most Major Arteries Reopened Detours to be Posted for Rush Hour

<http://www.ci.baltimore.md.us/government/dpw/press/010718.html>

## **Baltimore Transit Archives (www.btco.net/index2.html)**

**June 18, 2002**

Howard Street – The Aftermath

<http://www.btco.net/Howard/Howardst.html>

## **ZDNET UK (http://news.zdnet.co.uk)**

**August 3, 2001**

Train Crash Could be to Blame for Internet Derailment

<http://news.zdnet.co.uk/story/0,,t274-s2092503,00.html>

## **Global Beat Syndicate (http://www.nyu.edu/globalbeat/syndicate)**

**July 26, 2001**

A Train Tunnel Fire in Baltimore Exposes the Dangers of Nuclear Waste Transportation

<http://www.nyu.edu/globalbeat/syndicate/kamps072601.html>

## **Emergency.com (www.emergency.com)**

**July 18-23, 2001**

Train Fire Declared Under Control by Incident Commander  
<http://www.emergency.com/2001/Balt-hzmt-0718.htm>

## **Maryland Department of the Environment (www.mde.state.md.us)**

**September 7, 2001**

Chemical Links Baltimore's Manhole Explosions to CSX Train Derailment  
[http://www.mde.state.md.us/press/nr\\_mde-010907.html](http://www.mde.state.md.us/press/nr_mde-010907.html)

## **The WHIR (http://thewhir.com)**

**July 21, 2001**

Metromedia Rebuilds Fire Damaged Network in 36 Hours  
<http://thewhir.com/marketwatch/metromedia722.cfm>

## **FindArticles.COM (www.findarticles.com)**

**September 19, 2001**

Industry Shares Credit for Baltimore Response  
[http://www.findarticles.com/m3066/35\\_163/78932032/p1/article.jhtml?cf=0](http://www.findarticles.com/m3066/35_163/78932032/p1/article.jhtml?cf=0)

**Fall 2001**

Peering Into The Abyss  
[http://www.findarticles.com/cf\\_0/m3870/12\\_17/78805350/p1/article.jhtml](http://www.findarticles.com/cf_0/m3870/12_17/78805350/p1/article.jhtml)

## **RAILSERVE (www.railserve.com)**

**July 19, 2001**

Baltimore Train Accident: News, Photos, and Links.  
<http://www.railserve.com/baltimore.html>

## **Interviews**

<b>January 28, 2002</b>	Maryland Department of Transportation
<b>April 15, 2002</b>	Maryland Emergency Management Agency
<b>May 6, 2002</b>	Maryland Transit Administration
<b>May 7, 2002</b>	Baltimore City Office of Transportation
<b>June 10, 2002</b>	Maryland Transit Administration

## Additional Information Sources

Maryland State Highway Administration

State of Nevada Agency for Nuclear Projects

<http://www.state.nv.us/nucwaste/states/maryland.htm>

HMHTTC Response Incorporated

[http://www.hmhttc.com/baltimore\\_csx.htm](http://www.hmhttc.com/baltimore_csx.htm)

Radioactive Waste Management Associates

Lamb, Matthew and Marvin Resnikoff. "Radiological Consequences of Severe Rail Accidents Involving Spent Nuclear Fuel Shipments to Yucca Mountain: Hypothetical Baltimore Rail Tunnel Fire Involving SNF," September 2001, p. 20.

University of Maryland, Baltimore Campus

<http://www.umbc.edu>

Mitchell, Alexander D., IV. "Fire In the Hole," *Railfan & Railroad*. November 2001. pp. 42-49



