Incidents
Tuscaloosa, AL, September 2008

This is a recent incident, and no final reports from NTSB, ADEM, or local authorities are yet available. EPA information is sketchy at best. Newspaper accounts have been collected, and telephone interviews with some principals have been conducted.

On 18 September 2008, mercury was found at the former Riverview Water Treatment plant in Tuscaloosa, AL. Additional mercury was found at the site of the ST Bunn Construction office on 24 September and, on that same day, and informant led investigators to two additional spill sites (Taylor, 2008). The treatment plant had long been abandoned, having been shut down in 1994, and had been sold to a private developer in 2006 (Taylor, 2008a). At the time of the incident, the facility was undergoing demolition for eventual construction of condominiums (Taylor, 2008b).

The original discovery was by a worker for the current owner (Ellis-Trick, Inc) of the treatment plant, which was determined to be the source of the mercury. Mercury-filled gauges within the plant had apparently not been removed at the time of decommissioning (Taylor, 2008b). After its abandonment, the plant had become a favorite “hangout” for local teens, who frequently played paintball there (Taylor, 2008a). News reports indicate that the private developer arranged for environmental testing of the property at the time of sale, and that no mercury had been found (Taylor, 2008b).

The 24 September discovery at Bunn was by a computer technician there, who recognized mercury beads in the grass and driveway around the site. Another employee there reported seeing the mercury as much as a week earlier but had not recognized its significance (Taylor, 2008). The informant led investigators to two other sites: a wooded area behind the Broad Street apartment complex (near Bunn), where a pickle jar of mercury was found; and a wooded area near Guildswood Apartments (Jack Warner Parkway, near the former treatment plant) that revealed two 20-ounce soda bottles full (Taylor, 2008a). News reports (and interviews) provide some confidence that indoor contamination was absent at all sites except the plant itself, though one report (Taylor, 2008c) states that the informant found Gatorade bottles filled with mercury near the plant and carried them home with him/her.

Mercury and its compounds, almost without exception, are toxic. Inhalation of vapors or powders must be avoided, and skin contact with the metal provides a potential pathway for contamination (Mercury, 1976). All common environmental forms of the element (metallic, salts, and organics) are highly poisonous. Inhalation of vapors is the most common acute exposure pathway. Upon inhalation, the bulk of the metal (~80%) sorbs to bloodstream where, because of fat solubility, it readily crosses the “blood-brain barrier,” and can accumulate in kidneys, bone marrow, liver and spleen. Half-life in the body is about 60 days. Acute exposure effects are largely pulmonary, and can include pneumonitis and pulmonary edema. High-level exposures can also cause coughs, chest pains, vomiting and diarrhea, and are often signaled by metallic taste in the mouth. Chronic exposures more often present as central-nervous system maladies, and include tremors, psychological changes, and memory loss. Dermal exposure, even to vapors, can cause severe dermatitis or acrodynia (Boyd, 2008). Sax and Lewis (1986) list
mercury as a potential tumorogenic agent, and cite potential violent reactions with many substances.

At all sites, phase-partitioning models in our text (1.8) would be useful in determining fates with respect to pure-phase vs solid-sorption, and possibly for skin absorption by paintball-playing teenagers in the plant (though thermodynamic parameters for mercury would have to be acquired elsewhere). Vaporization of the mercury, however, is unlikely to have been an equilibrium process at any of the sites (outdoors, or abandoned building with broken windows), and would be better examined as volatilization from pure phase liquids (2.3.4); potential exposure by inhalation is likely of limited spatial scope. Releases to water, either at the riverside plant or through storm drainage, would be complicated by bacteria action – organic complexation (methylation/phenylation) of the mercury which profoundly affects its solubility; our text provides no guidance concerning this fate/pathway, but information is available elsewhere (Atlas, 1984). Mercury oxidizes very slowly at ambient temperatures, does not wet glass, alloys with some metals (amalgams) but not iron. Liquid, metallic mercury readily forms finely divided (inhalable) metal powders when rubbed with many organics (greases, sugars, ether, ref. Mercury, 1976).

The most difficult information to find, so far, is localized spill quantities. News reports provide bulk totals and only sketchy (sometimes contradictory) amounts for the four individual sites. The EPA incidence report (Buerki, 2008) is notoriously uninformative. No final report by ADEM is yet in evidence, and the ADEM representative (Bruce Friedman, Field Operations) on the scene is out of his office until 3 November. Kenny Owing of US Environmental Services (Alabaster, the cleanup contractor) provided the approximate quantities (he didn’t have his notes at hand) actually recovered at each site, as well as surface area of the spills by phone interview. His compatriot (Ryan Boon, Mobile office) also has access to vapor concentrations monitored at the various sites. That latter, together with a research into the workings of their detector (Lumex Light) may allow me to reconstruct unrecovered mercury quantities.

New Brighton, PA, October 2006

This two-year old incident is well documented in an NTSB Accident Report (NTSB 2008), which provides the bulk (all, unless otherwise specified) of the information presented here.

On 20 October 2006, a Norfolk Southern train, en route from Chicago to New Jersey, derailed while crossing the Beaver River, in New Brighton, PA. The train, pulled by three locomotives, carried three empty freight cars and 83 tank cars, the latter all filled with denatured (with natural gasoline) ethanol, a flammable liquid. 23 tanks cars derailed, 20 of which spilled ethanol (~485000 gallons released, 176000gallons recovered), which caught fire and burned for two days. The locomotives, and the first 23 cars did not derail, so fuel release was not an issue. Unburned ethanol entered both local soils and the river, and combustion products entered the atmosphere. A seven-block area was evacuated for the duration of the fire. No injuries resulted. Monetary damages were estimated at $5.8 million. Proximate cause of the accident was a rail defect. NTSB found root causes to include Norfolk Southern’s rail inspection practices and rail-defect management.

A cited (January) 2007 report by ENSR concluded that “most” of the released ethanol (and denaturant?) was consumed by the fire, but was unable to quantify burned/unburned partitioning. No fish kills or surface sheens were in evidence after the event, and no downstream treatment intakes were negatively affected.
Ethanol, while rapidly oxidized in the body without accumulation, is listed as a moderate irritant by oral, inhalation, intravenous and skin exposure. Sax and Lewis (1986) also cite potential for carcinogenesis and mutagenesis. Large and repeated doses can give rise to addictions, liver cirrhosis, and alcohol poisoning. Ethanol’s major potential hazard is that of flammability. Benzene, a trace component of the denaturant used here, is a known human carcinogen and is toxic on inhalation or skin absorption. It is also an acute central-nervous system narcotic and a skin irritant, and a dangerous fire hazard.

Ethanol is highly volatile (vapor pressure = 40 mm Hg at 19°C) and soluble (completely miscible in water). Explosive limits are 3.3-19% in air (Sax and Lewis, 1986). Except for some small partitioning to soil, all fates are expected to be dominated by kinetic (non-equilibrium) processes. Even segregation into organisms is expected to be of short residence time.

The most worrisome lack of available information at this stage is the quantity of the release that was burned vs not burned. While I suspect that the ethanol would burn pretty completely, incomplete combustion products of the denaturant (5%, including benzene at .25%) may be an additional worry. I intend to acquire and review the aforementioned ENSR report, a PA Department of Environmental Protection Review (that was also cited here), and to search for any water sampling results available subsequent to and downstream of the wreck. Ethanol, the denaturant, and weather conditions are all well characterized in the NTSB report.

West Cote Blanch Bay, LA, October 2006

This two-year old incident is well documented in an NTSB Accident Report (NTSB 2007), which provides the bulk (all, unless otherwise specified) of the information presented here.

On 12 October 2006, the towboat Miss Megan was transporting two barges in the West Cote Blanche Bay oil field in Louisiana for pile-driving work. The construction barge, Athena 106, carried a crane and its fuel-supply tank, a generator and compressor, and oxygen/acetylene bottles. The deck barge IBR 234 was used as a storage platform for (creosote, by photograph) pilings installed or extracted in the operation. While underway, the “aft spud” (described as 5-ton, steel mooring shaft) of the Athena 106 was released from it raised position, dropping to the bottom where it struck and ruptured a natural gas pipeline. The released gas ignited, creating a fireball that engulfed all three vessels. Five crew members were killed, one escaped, and one was listed as missing at the time of the report. A SCADA system, sensing the pressure drop (from 700 psig to 400) automatically shut a downstream check valve 15 minutes after the rupture (preventing backflow of gas into the failure). An upstream valve was shut manually one-minute subsequent to the downstream shutoff, and gas loss was estimated at 973000 scf. Cargo and equipment on the construction barge was lost, though the fuel tank survived, and the towing vessel was deemed a total constructive loss. The structure of the deck barge remained largely intact, but the pilings were burned. Total monetary losses in the incident (including lost gas and pipeline repair) were estimated by Chevron oil at ~$1.6 million.

Methane is not listed as a hazardous chemical in Sax and Lewis, though it obviously represents a flammability hazard. Furthermore, though I need to explore further, I would expect it to burn fairly cleanly, with few incomplete-combustion products here. MSDS for methane lists the flammability hazard, lists carbon monoxide/dioxide as combustion products, and further characterizes methane as a simple asphyxiant. The NTSB report provides sufficient information to estimated dissolution of methane in the water column.

Fuel losses would need to be addressed, and in a marine accident with active fire suppression, all losses would be expected to be released, either to air or water. No information
concerning the fuel status is included in the NTSB report, and loss-estimation might require some assumptions based on similar vessels.

Most uncertainty lies in the burned creosote pilings. A distillate of crude coke oven tar, and a suspected carcinogen, the wood preservative is an undefined mixture containing PAHs, cresols, and phenols (Creosote). MSDS lists combustion products as CO and NO\textsubscript{x}, but specifies the toxic nature of smoke and ashes. In a marine accident with active fire suppression, releases would be expected to both air and water.

**Early-Warning System**

I believe that I initially misunderstood this part of the assignment. I reviewed the two examples given that were still available (the yosemite.epa example has apparently been pulled or relocated), and then proceeded to look for similar systems in place at our local facilities. None was in evidence at either Tuscaloosa or Northport. A fairly thorough internet search on both yielded no real-time monitoring of intake waters. Though I have not yet been able to reach the appropriate contact at Northport, I did call the Ed Love Plant at Tuscaloosa. Intake monitoring there is of the parameters likely to affect the treatment system itself (i.e., pH, turbidity, alkalinity, etc.), and is lab-based (with associated delay in results).

I then re-read the question and (with considerable hope that I’ve now got it right) assumed you were talking about “some” local authority, rather than “our” local authority.

Your examples, along with most systems reviewed, were focused on species-specific tests, and were sited on river systems. The former limits their usefulness in recognizing unanticipated threats. The latter makes things “easier” in that there is a time lag between discovery of a plume and its arrival at the intake.

One developmental paper I reviewed (VonderHaar, et al, “Drinking Water Early Warning Detection and Monitoring Technology Evaluation and Demonstration,” date unknown, downloaded from acwi.gov/monitoring/conference/2002/PapersAlphabetical%20by%20FirstName%20LastName/Rajib%20Sinha%20Ea... , the website of Advisory Committee on Water Information) focused on real-time (or nearly so) monitoring of whole water toxicity.

The authors proposed, and began testing (for, so far, only a limited number of toxicant species), a series of rapid, “automate-able” tests based on responses of various sensitive organisms (“coal-mine canaries?”). An algae toximeter, based on the differential chlorophyll light-absorbance characteristics (measured in 10 minutes by fluorescent exposure and response) of two algal cultures (one exposed to raw source water, the other to clean water) showed rapid response to the introduction of atrazine (an herbicide) without any need to tune the instrument to that particular toxicant. A Daphnia toximeter uses continuous, computerized image analysis to detect differences in swimming patterns of these sensitive arthropods to infer toxic exposure. Tests in which cadmium, gasoline, and dieldrin were introduced, all showed rapid and sensitive response by the system.

The authors also proposed a clam toximeter (based on shell-gap response), and a fish monitor (in which “coughs” in measured bioelectric potential indicate stress), but had not yet tested them. This approach has the potential to give warning signals to plant operators for unanticipated pollutants entering the treatment train. Moreover, the these systems shows promise to be of sufficiently rapid response time to be of use in plants of little flow in the source waters (i.e., lakes - the intake monitoring could give a signal before the measured influent leaves the plant).
References


