Rebuilding the World Trade Center

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Abstract: The Construction Institute’s Committee on Social and Environmental Concerns in Construction has examined 24 items of social and environmental concerns in construction that will have to be considered by those who are going to be involved in the reconstruction of the World Trade Center. These topics include the economic aspects of the reconstruction, the planning and design, the environmental issues, the transportation challenges, the contractual problems, the memorial, and the security requirements. During the drafting of this report, the Committee received assistance and guidance from the engineering staff of the Port Authority of New York and New Jersey. Some Committee members visited the World Trade Center site at Ground Zero during the preparation of the report. Also consulted by the Committee were some well-known, highly qualified engineers on various aspects of the report. These contributions from nonmembers of the Committee made the report richer. It is the intent of this report to serve as a starting point for planning and redevelopment.

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Preface

Immediately following the events of September 11, 2001, the Committee on Social and Environmental Concerns in Construction (CSECC) began work on this report. The writers examined many of the social and environmental issues associated with planning and rebuilding the World Trade Center (WTC) site. No attempt was made to solve each of these issues; rather, the intent of this report was to serve as a starting point for planning and redevelopment.

CSECC has been in existence since 1972. It is a standing committee within the Owners’ Directorate of the Construction Institute–American Society of Civil Engineers (CI-ASCE) and was an important committee of the Institute’s predecessor, the Construction Division of the American Society of Civil Engineers (ASCE). The eight members of CSECC who contributed to this report are experts in various specialties of civil engineering. All are members of CI and ASCE. Five authors are academics, one is a construction manager from Illinois, and two are New York residents. The two New Yorkers are very well acquainted with the WTC site. The Chairman who lives in New York City built the North Cove Marina and developed and built the Cove Club Apartments at Battery Park City. His firm also had personnel engaged in the WTC cleanup. The other New Yorker has worked in and around the WTC for 10 years and is familiar with New York City, the WTC, and its environs.

During the development of this report, CSECC received invaluable assistance and guidance from engineering staff at the Port Authority of New York and New Jersey (PANYNJ). Several members of CSECC visited the WTC site on January 31, 2002, escorted by Peter Rinaldi, WTC Site Manager of PANYNJ. Frank Lombardi, Chief Engineer at PANYNJ, also made significant contributions to this report.

The committee also consulted some well-known, highly qualified engineers on various aspects of the report. Although these individuals are not members of the CSECC, their contributions made the report richer.

Introduction

Minoru Yamasaki, the architect of the WTC, is reported to have stated in 1966, “The WTC should, because of its importance, become a living representation of man’s belief in the cooperation of men, and through this cooperation his ability to find greatness.” After the tragedy of September 11, 2001, numerous individuals indicated that their husband, wife, son, or daughter enjoyed working in the WTC towers. For some, it was a dream come true to be associated with a firm working in the buildings.
In fact, it appears that competition and a high density of specialists in close proximity can be invigorating. Employees may have felt that they were involved with important endeavors at work, and this may have been perceived as individual greatness. In some respect, therefore, Minoru Yamasaki’s vision was realized.

It must be remembered that the WTC was not an instant success when it opened. The state of New York rented a large block of space in order to financially assist the PANYNJ, the owner. This has occurred in other large structures. For example, the Empire State Building was nicknamed the “Empty State Building” during the 1930s due to the difficulty of renting space during the Depression. Regardless of a building’s prestige, the marketplace ultimately determines the rental rate.

The WTC towers proved that, even with the Internet and the World Wide Web, the need for compact, contiguous space has not been diminished. Thus, the marketplace should determine how the buildings should be rebuilt. Any artificial subsidies should be avoided in the financial calculations.

On a positive note, the process of removing debris and continuing recovery efforts at the site was conducted in a manner supportive of long-range rebuilding efforts. A bridge/ramp down into the excavation was constructed and visible on January 31, 2002. It was placed specifically to accommodate new construction. The support piers were positioned to allow the underground trains that were destroyed and are currently out of service to be reconstructed without affecting the supports. The ramp will also allow access to below street levels during rebuilding (Fig. 1).

Work on the site cleanup was completed months ahead of schedule, with project participants highly motivated by the desire to show that New York and the United States have not been defeated (Blair 2002b). The highly visible nature of the attacks on the WTC and the desire to quickly rebound means that decisions are likely to be even more accelerated beyond a typical development construction project. Participants in the decision-making process must include the public, engineers, planners, constructors, government officials, families and close associates of the victims, business leaders, and property owners. The following social and environmental issues need to be considered at a minimum: economic, environmental, memorial, transportation, open space, contractual, and security issues. An important additional component of this effort should also include recognition, recording, and dissemination of lessons learned. The effort may need to be coordinated by a single agency focused only on these issues as related to the WTC.

Through this report, our hope is to provide useful information that can serve as a framework for discussion and decision making as the planning and rebuilding of the WTC becomes a reality.

**Topics**

**Economics**

**The City’s Long Term Economic Health**

Employees working in the WTC complex contributed substantially to the economic vitality of New York City. Permanent loss of these jobs to suburban areas or other metropolitan areas would represent a significant loss of economic activity in the City. Not only will the City lose the jobs themselves, but they will also lose the service providers who support these jobs and the city residents holding these positions. It is in the best interest of the City to retain this economic activity. The City has already lost a significant tax base through temporary and likely permanent relocation of companies and residents from the area. Businesses, jobs, and residents who have left may not return. Restaurants and stores have closed, and services that supported the buildings are not currently needed. Additional business moves are being announced as companies relocate, some due to normal business decisions and others due to factors directly related to the events of September 11, 2001. Residents and businesses in the area appear to feel that the area is currently less desirable due to emotions and concerns for long-term safety and air quality. Representative of this feeling is the recent finding that commercial rents are now approximately 35% higher in midtown Manhattan as compared to downtown. It will take time for the impact of these emotions to pass.
A Strong Central City
Many relocated businesses and residents will be disinclined to return. Employees will have bought new homes, their children will be in new schools, and community ties will have been established. Over time, newcomers to the area will be likely. Consideration may be given to providing financial incentives and tax breaks to accelerate their arrival, because leaving the area underutilized will weaken the central city, and severe financial and institutional hardships will result. The strong central city should be maintained because it is the support of financial, cultural, educational, and sports institutions that gave New York its leading position (Blair 2002a; Sollar 2002).

Decentralization Out of Manhattan’s Financial District
Since the construction of the WTC in the early 1970s, many changes have come about in the way the working world operates. The development and proliferation of computer technologies have provided the ability to quickly and efficiently communicate and access information from almost anywhere in the world. Financial and business industries have embraced these technologies and incorporated them into their day-to-day operations. As a result, no longer is it essential for coworkers to be in the same physical location in order to work together. Telework, teleconferencing, E-mail, and electronic chat rooms have reduced the need to schedule face-to-face meetings. Using the Internet, documents can be viewed simultaneously from multiple locations. The information that used to be stored in file cabinets and company libraries is now stored in electronic files that can be accessed at any time and from almost any location.

Rebuilding a WTC at one location to provide a centralized point of operations for businesses may not reflect the way the business world operates today. Current business operations allow for a more decentralized organization that is interconnected by, and conducts its work across, a computer network. This operational structure requires less of a single physical presence in Manhattan’s financial district and permits a greater number of smaller business units to be spread throughout the New York metropolitan area, the country, or even the world. Savings would be realized by eliminating the amount of time and energy required to commute into Manhattan and the high costs of operating in Manhattan’s financial district. In addition, rebuilding the WTC not at one location, but at many throughout the world that are connected by computer networks, will make it truly a “world” trade center.

Such decentralization, however, will have an unfavorable economic impact on the downtown Manhattan area as well as the New York City economy. If there is going to be decentralization, it must be done in a way that the loss of jobs and loss of business in the concentrated downtown area will be replaced by other means. Various means can be used to bring this about, such as a major tourist attraction at the WTC site in the form of a monument or memorial, additional recreational and entertainment facilities, theaters, and restaurants for tourists and residents. The kind of benefit brought to the mid-Manhattan area by the Broadway entertainment district could be an offsetting factor if incorporated in the downtown region. Businesses and tenants that have already moved out of the area may be replaced by new types of users.

It is worth noting that, had the events of September 11, 2001, not occurred, changes in the way businesses operate would still have continued to evolve, probably with little impact on the high occupancy rates in the WTC.

WTC Replacement versus Alternative Suburban Development
The funding of the replacement of the WTC will have to take into account competition from suburban development that is already taking place. Is there room for both? The answer is a definite yes if the economy of New York City can bounce back to where it was before September 11. The answer will be no if suburban development and the replacement of the WTC both occur and compete with one another in a weakened economy. Some degree of forecasting is possible, but for the most part, the marketplace will decide the result.

The role of Larry A. Silverstein, holder of the leasehold on the World Trade Center and the owner of Building 7 is becoming quite clear. He is pushing ahead with the reconstruction of Building 7 and the required space that is needed for the Consolidated Edison transformers that were in the basement of that building. Silverstein has made a great deal of progress on a new design for the building. There is also a great deal of appeal for restoring the south end of Greenwich Street, which was occupied by the building (Cardwell 2002a).

His efforts to reconstruct Buildings 1 and 2 will greatly depend upon the settlement reached with the insurance companies for the value of the buildings and the cost of new construction. Of course, he has to contend with numerous other problems that have arisen from various sources. Environmental groups want the grid of the old city streets restored. There is a great deal of discussion about a large portion of the site being devoted to a memorial, perhaps a larger portion than Mr. Silverstein would like to have subtracted from the site.

One thing is certain: Buildings 1 and 2 cannot be reconstructed without approval from the City, the governor, and the PANYNJ. However, Silverstein is quick to point out that not rebuilding will result in $47 billion in gross wages being lost, which will decimate the region financially (Finn 2002).

Planning and Design
Sprawled Office Development in the Metro Area
The rate of office development in the suburbs will no doubt be accelerated by the absence of the WTC. Replacement space must be provided and the 10–12 million square feet of missing space can be partially provided by suburban development. Established builders in those areas with ready access to vacant space are willing and anxious to take up the slack. At the same time, the social impact of replacing WTC office space with suburban office developments will mean a dislocation of jobholders from Manhattan to the suburbs and a loss of taxes and revenue for the city of New York. There is no practical way, under our free market system, for this to be regulated. Some means must be provided, however, to foresee the extent of this impact, and some provisions—social and environmental—must be made before it happens.

While Bloomberg News (February 12, 2002) reported a surge in downtown vacancies (Bloomberg News 2002), this was a trend that held true for cities other than Manhattan. The American Express Company returned this spring to its headquarters at the World Financial Center Complex; the New York City Opera is currently looking for possible partners for a move into a new opera house to be built at Ground Zero (Pogrebin 2002); and Larry Silverstein, the leasee of Buildings 1 and 2 and the owner of Building 7 (which was destroyed) is pushing ahead with reconstruction of Building 7 as soon as possible.
On the negative side, some bridge restrictions for crossing into parts of Manhattan are expected to remain in place. No date has been fixed for removing these restrictions (Kennedy 2002).

Loss of Open Space
Will there be a loss of open space with the WTC rebuilding? Obviously, if the buildings are shorter and the same amount of floor space is provided, then a greater amount of footprint will be required of the site for occupancy by buildings. By definition, this means a loss of open space. But does this necessarily have to take place? It may be possible to construct shorter buildings and greater footprints occupied by those buildings and still have as much open space. Elevated terraces, aboveground parks, and roof landscaping may be used. Easy pedestrian access from the WTC site across West Street should be accommodated in future development. Some additional open space will likely be incorporated into any memorial component of the rebuilding. It will be a challenge for planners and developers to bring this about.

Sudden Surge in Suburban Development
Besides the surge in suburban commercial and office development, a related surge in suburban residential and infrastructure development is likely. With new offices, there will be a need for new homes for the workers and new infrastructure such as schools, places of worship, recreation, and shopping to be built.

There has been a substantial amount of suburban development surrounding New York City in the last 50 years. This has resulted in unplanned and unwise development in certain locations. If this takes place elsewhere or is added to, it could have a negative impact on the region around New York City. Planning should begin now to deal with this problem (Eaton 2002).

Building Heights
The primary reason for not rebuilding the WTC to the previous heights is that, economically, it may not be as efficient as a 50- to 70-story building. Large cores, columns, and greater occupant evacuation times work against it. Many private developers find approximately 50 stories efficient. This may approximate the new heights.

Lower buildings would have almost the same views. The Windows on the World (penthouse restaurant) could still find a home there. Employees in the building would not have the psychological fear that a 100-story building may trigger (Bagli 2001).

The environmental implications of building heights have not yet been systematically studied. Effects due to tall buildings (like changing wind patterns, creating heat islands, etc.) may be significant. For example, there have been concerns about wind power stations altering wind-flow patterns in some regions, although no conclusive results have been published to date (Wyatt 2002).

Blockage of Sunlight to Nearby Areas
There was a blockage of sunlight by the WTC prior to September 11. This affected the residential and office buildings that are presently located at Battery Park City immediately to the west of the WTC site. If a development of similar square footage is placed at the site, the footprint of the future buildings will have to be small relative to the height of the building, just as with the former WTC. Building anything on the site above the average height of the existing neighboring buildings will result in blockage of sunlight. The reduction in height of future buildings will be a benefit to those existing and new buildings in the area and no doubt will increase the amount of sunlight available in the morning hours. Size of the building, height, and open space will result in tradeoffs having to be made.

Mix of Residential and Commercial Tenants
The original WTC complex was devoted primarily to office and retail space. In a new complex, some provision for residential space could be desirable. Locating residential space near work locations can reduce travel times and congestion as well as making workers more productive. Residences in the vicinity will support neighborhood vitality, particularly in the evenings and on weekends. As a result, the local infrastructure will receive more extensive use.

The residential area immediately to the west of the WTC site, namely, Battery Park City, has a good deal of night and weekend impact on the liveliness of the neighborhoods. Additional provision for residential space in the new complex and nearby would complement and supplement such residential space in Battery Park City and in the lower Manhattan area, and would be of benefit to both entities.

The Question of Open Space and Public Areas
The new buildings may be shorter. To achieve the same area, they may be bulkier. This will raise an architectural and planning challenge for open space and public access while also addressing public and private security issues. The solutions are not readily apparent. Some possible solutions include the following:

- Setbacks with landscaped terraces,
- Moving outdoor sidewalks,
- Two- or three-level roads,
- Light rail between buildings,
- Staggered work hours,
- Working in shifts, and
- Additional underground offices and shops plus cultural and entertainment facilities.

Environmental
Worsened Air Quality
Since the destruction of the World Trade Center complex on September 11, there have been many conflicting reports on the quality of the air in the area. While some agencies have reported that the air quality is within acceptable limits, others have indicated the presence of dangerous ultra-fine particles and chemical compounds. This uncertainty may affect the residents of Battery Park City and the workers in buildings in the area (Cardwell 2002b).

Eventually, concerns about air quality during the debris removal phase abated. Attention will be paid to possible air-quality impacts in the future. There are two primary time periods to be considered when evaluating air-quality impacts of the reconstruction of the WTC: (1) during construction; and (2) throughout the life of the building.

Air quality will be impacted adversely during construction unless mitigation measures are implemented. Construction typically results in the generation of dust, fuel-combustion byproducts, and volatile chemical contaminants during the construction period. In addition to air-quality degradation in the construction area, air quality will be impacted overall through the manufacturing and transportation of the construction materials. Most products incorporated into a new building will require the use of precious raw materials and energy. Even the use of recycled products requires the use of energy. The majority of power generated in the United States is still produced using fossil fuel combustion that produces...
greenhouse gas emissions. Air quality will also likely be nega-
tively impacted depending on the wall and floor coverings used.
Paints and solvents can be significant contributors to poor air
quality if selected and utilized indiscriminately.

The power generated to operate the buildings' heating, air condi-
tioning, data, telephone, and other systems will produce green-
house gases that will negatively affect air quality throughout the
life of the buildings. Air quality can also be impacted by micro
weather pattern influences and the urban heat island effect noted
in urban areas due to the diminished green space and increased
heat-absorbing pavement, roofs, and building walls.

Despite the potential negative air impacts of construction and
operation of a replacement to the WTC, these impacts can be
reduced—although not eliminated altogether—by appropriate
specification of methods, equipment, and materials in the build-
ing. Construction equipment equipped with advanced emissions
control can be utilized. Recycled materials can be used, as well as
materials produced relatively locally to minimize transportation-
related air-quality impacts. Materials designed to minimize the
urban heat island effect can be used, including living vegetated
roofs or those designed to minimize solar heat gain. Site solar
power features can be incorporated into the building. None of the
air-quality impacts are substantially different from those of the
old WTC and in fact should be mitigated more effectively due to
improved technologies and awareness (Herbert 2002).

It must be pointed out that the manufacture of materials and
the generation of electricity would be required even if the World
Trade Center was not redeveloped, as there would be replacement
of the space elsewhere. The replacement buildings will consume
presumably a similar amount of materials and energy and may
produce similar impacts. In any event, any new buildings should
be designed so as to take into account the knowledge that has
been developed in green building design and construction. Such
buildings will be more efficient in their construction, operation
(consumption of electricity), and maintenance, and will have more environmentally sound attributes overall.

**Elements of Green Building Design**

Whatever is rebuilt on the site of the WTC, it will likely have to
be a greener building than the original WTC. Today there are
considerable pressures from tenants to occupy an environmentally
friendlier facility. The issues that should be raised when rebuild-
ing the WTC are centered on the four life-cycle stages of the
building: materials used, construction, operation and mainte-
nance, and end-of-life strategies. In terms of materials, concrete
and steel will compete for the structure of the building. Quantita-
tive studies are appearing that compare the environmental effects
of manufacturing the two structural systems. It is also important
to take into account the construction effects. What fraction of the
total life-cycle impacts will construction effects account for? How
can they be mitigated? What are the most important factors that
could be reduced? A considerable amount of research and practice
is being conducted concerning the energy use of operating a
building. Maintenance and renovation needs should also be as-
essed throughout the life cycle. Finally, the selection of materials
and structural systems should take into account the eventual dis-
assembly or demolition of the building and the need for an in-
creased reuse or recycling of the embedded materials. Green
building rating systems (such as the LEED scoring system from
the U.S. Green Building Council) could be applied. The LEED
scoring system applies credits to the design and construction of a
building for various environmentally friendly components incor-
orated and is becoming more widely accepted as a means of
evaluating the environmental impacts of development (Jezer
2002).

**Site Contamination**

Site contamination after the rubble of the building was removed
may be a continuing problem. During the cleanup and removal
process, significant quantities of toxic substances were found at
the site. These quantities had at times exceeded the maximum
permitted by the EPA and Occupational Safety and Health Ad-
ministration, creating concerns for the health and safety of the
recovery and debris removal workers and others in the vicinity.
Continuous monitoring of air, water, and soil at the site will be
required, and is currently being performed, to protect people’s
health and safety.

After all of the rubble was removed, the contamination was no
greater than the site contamination on any construction site else-
where in New York City, according to PANYNJ engineers. How-
ever, the question of the fine particles of dust that seem to be
lingering on the site and its immediate vicinity still has to be
resolved.

**Environmental Impact Statements**

Environmental impacts statements will be required as a normal
course under the New York State and New York City Building
Codes. The continuation of this established process will of neces-
sity be used at the site, though the PANYNJ may choose to
modify this process. Because of the numerous competing and
worthy interests of various sectors of the public, industry, and the
government, an environmental impact statement that will be ap-
proved without challenge will be a challenge indeed. No doubt, if
there are multiple buildings, there will be a statement for each
building component in the reconstruction. There will also unques-
tionably be studies required for altered street plans, roads, parks,
and other public facilities. The proposed monument or memorial
will also be the subject of an environmental impact statement, and
it will be part of the long and no doubt contentious process that
will bring forth different points of view.

PANYNJ engineers point out that the former WTC plan was
approved before 1969, the year of the enactment of the National
Environmental Protection Act (NEPA). Therefore, an environ-
mental impact statement was not required at the time of original
construction.

They do concede, however, that it will likely be necessary to
evaluate the net impact of new traffic patterns, building configu-
rations, new streets that may be planned at the site, and different
types of buildings and uses, relative to the WTC site prior to
September 11.

**Transportation**

**Longer Trips to Work**

In the aftermath of the September 11 attack on the WTC, a shift in
commuting patterns has emerged, in some instances resulting in
longer trips to work for many commuters. There also has been an
increase in commuting time for those suburban commuters who
have changed their pattern from traveling to Manhattan via auto-
mobile to mass transit. Although this switch is environmentally
more acceptable, the resulting shift to mass transit may result in
an increase in commuting time. Instead of driving to Manhattan
and parking the car near a place of employment, the shift to mass
transit for a typical suburban commuter means a drive to the train
station, a wait for the train, a transfer to the subway, and a walk
from the subway station to work. The shift from the automobile to mass transit also results in less flexibility for a commuter. When traveling by automobile, the commuter can leave work whenever it is convenient. When using mass transit, the commuter is a captive of the train schedule. If there are significant time lags between trains to their destination, the commuter may find a need to leave work earlier than desirable in order to catch the earlier train. The alternative is to work longer than may be necessary or to sit and wait at the train station for the later train.

Another shift in automobile commuting has resulted in the relocation of companies from downtown Manhattan to New Jersey. The result of this shift has been an increase in both rail and automobile traffic in the reverse direction of the predominant commuter flow. As companies eventually return to their downtown Manhattan locations, the next year or so should provide an indication as to whether this will be a permanent shift or is merely a temporary response to the September 11 attacks.

Nightmarish Traffic Congestion

What constitutes congestion is certainly a matter subject to interpretation depending upon one’s place of residence. For example, what a resident of Louisville, Kentucky, would characterize as severe congestion would be considered nothing more than a minor inconvenience to a resident of New York City or Los Angeles. There can be no question that the traffic congestion during the commuting period in New York City is severe.

A problem facing the New York City area is the ability of the transportation system to handle the automobile and transit traffic into Manhattan. For hours every morning, the inbound tunnels and bridges experience significant backups. The Long Island Rail Road (LIRR), New Jersey Transit, PATH, and Metro North trains are frequently standing room only during the morning and afternoon rush. In addition, the East River railroad tunnels are at capacity during the peak commuting periods. Many of the subway lines, e.g., the Lexington Avenue line, have commuters resembling sardines instead of passengers (Kennedy 2002). Where will the extra capacity come from?

The LIRR is seeking to establish service to Grand Central terminal. While this will reduce some of the passenger load into Penn Station, it will place more load on an already overburdened East Side subway system. The long-debated and planned Second Avenue subway should become a reality before the LIRR’s East Side access is built.

Putting tolls on the bridges across the East River has been suggested in order to discourage automobile traffic into Manhattan. This would perhaps cause some reduction in automobile traffic, but not at a level sufficient to decrease the amount of congestion in that borough. Past increases of tolls have not resulted in a substantial reduction in traffic. In fact, tolls could create a hardship for those who cannot afford the additional money. This particularly is a factor in the increase in taxicab fare into Manhattan and the cost of commercial traffic into Manhattan.

Altered Commuter Flow

The aftershocks of the September 11, 2001, attack on the WTC have included significant changes in the commuter flow into New York City. Shortly after the attacks, the City and the PANYNJ placed restrictions on single-occupancy automobiles entering lower and midtown Manhattan. What were the ramifications of these restrictions?

New Jersey Transit reported, in a recent edition of Engineering News Record, that its daily rail ridership into Manhattan has increased by 45%, from 33,000 to 48,000, since September 11. Smaller, but still measurable increases have been reported by the LIRR. Obviously, the shift of these individuals from automobiles to rail transit can only lead to improved air quality due to the reduction in carbon dioxide, nitrogen oxide, particulate matter, and hydrocarbon emissions.

An additional change in commuting patterns has resulted in ferry service use picking up significantly. Helicopter “ferry-like” service may not be far from reality, although security concerns are readily apparent.

There has been a significant impact due to the loss of the PATH system. This impact is graphically illustrated in a map that accompanies the article by Randy Kennedy in the New York Times (January 3, 2002). Before September 11, 2001, the PATH had a total number of passenger trips of 260,523 daily; as of Thursday, December 20, 2001, the number of total passenger trips was only 191,842. But the Christopher Street Station, which once handled an average of 3,700 passengers a day, now handles 8,000. The busiest PATH station of the system was the one at the WTC, which is now out of commission for at least 2 years. Efforts are now underway to rebuild and reopen the PATH station at Ground Zero.

Lastly, the devastation at the WTC has interrupted PATH and subway service in the immediate area. It was only recently that subway service on the E-train returned to the WTC stop. Service on the 1 train, which passed directly beneath the WTC on its way to the Battery, has shifted its operation so that it no longer offers service south of Chambers Street in Manhattan. Instead, the 1 train continues into Brooklyn from that point. Service on the 9 train, which also traveled under the WTC on the way to the Battery, has been discontinued. It is presently estimated that it will be at least three more years before the 1 train services the WTC and the station south of it (Lueck 2001; Port 2001; Chartock 2002).

The destruction of the PATH station at the WTC has meant that PATH commuters with a downtown Manhattan destination must travel into Manhattan and transfer to the subway at either the Christopher Street or the 9th Street and 6th Avenue stations in order to reach their downtown destinations. This may have contributed to companies shifting their operations from downtown Manhattan to New Jersey, as the PANYNJ has reported increases in reverse commuting (Fig. 2).

Moving People Efficiently over New Emerging Commuter Routes

The movement of people in new commuter routes will be based on a reexamination of current methods that, for the most part, are based on 20th century and earlier methods. Twenty-first century engineers must develop additional means of moving people efficiently. This may encompass such mechanical means as moving walkways; light rail systems in, around, and into the WTC site; trackless trolleys that have the ability to carry masses of people with flexibility of hours and routes; and ferries (Cardwell 2002d), which are becoming more prominent in transportation in the lower Manhattan area and which are certainly going to increase in prominence. We can add to these modes other means of mass transportation, such as trams based on the model of the Roosevelt Island Tramway, and elevated highways. It appears that the technology to efficiently move people around exists. Its viable development must take place.
Environmentally Friendly Transportation
The rebuilding of the WTC must incorporate mass transit facili-
ties that will have an extended life of at least the next 50 years.
The buildings will last at least that long and likely much longer.
The use of public transportation was a critical component of the
previous WTC and must be included in the new plans. If a build-
ing of similar size and population is constructed, it must be one
that includes environmentally friendly mass transit. Given the
large number of people that will commute daily to the buildings
and conduct life, the effective and convenient movement of
people and materials into and out of the area is critical. Since
September 11, 2001, mass transit use has increased, and this will
likely continue in the future. The actual reasons for the increase
are not clear and may be related to concern about traffic jams,
restrictions on single-occupancy vehicle usage, or concern about
being impacted by a potential terrorist attack on a primary com-
muter bridge or tunnel. It is to be expected that mass transit use
will increase over time, both to improve the effective movement
of the same number of people as in the past and to accommodate
increased numbers of people in the future.

It has been pointed out by the PANYNJ engineers that auto
traffic into the City might be less of a target for terrorist attack
than mass transportation, which also has to cross a bridge or
tunnel. Therefore, lifting restrictions on auto traffic into the area
could be beneficial.

PATH restoration will generate interim methods of transporta-
tion, as evidenced by the temporary rerouting of the passenger
traffic. Permanent solutions, for which there are plans underway,
include a hub PATH station at the WTC site that will be consid-
erably larger than the previous station. Improved connections be-
tween the various transit facilities are a must, and connections
between PATH and the subways will undoubtedly be high on the
list of matters considered as transportation is restored.

Contractual
Streamlined Approval Process
The events of September 11, 2001, have affected the lives of
many Americans, disrupting normal workdays and causing wide-
spread concern for personal safety and welfare. Much effort has
been expended to encourage those affected by the collapse of the
WTC, especially those in Manhattan’s financial district, to return
to work and resume their normal daily activities. Part of the heal-
ning process will be the rebuilding of the WTC. Consequently,
quickly rebuilding the WTC—or rather its replacement—will
help the country return to normalcy.

In order to stimulate quick and efficient reconstruction, the
process required for rebuilding should be streamlined. Often, a
significant bottleneck on major projects is the approval and per-
mitting process. The process involves the submittal of many
documents and can include long response and approval times,
which directly delay the construction process. A streamlined pro-
cess is needed that does not impede the progress of the project
and perhaps allows for work to continue on the jobsite while
approvals are being sought. Consideration should be given to ex-
panding a system of electronic submittal and tracking of permit
applications and approvals, as is now being done in some other
cities around the country. Innovative approaches to streamline
the submittal and approval process could also serve as a model to be
employed on other projects. An approvals process that takes into
consideration the need for timely rebuilding will positively effect
the healing and return to normalcy.

Alternate Dispute Resolution Techniques
The mechanism for alternate dispute resolution in construction is
quite sophisticated and developed to the point where it can be
incorporated into all of the design and construction contracts for
the WTC construction. The American Institute of Architects (AIA) Form of Contract between Contractors and Subcontractors is now sufficiently tried so that the method being used for this practice will continue to be applicable. Firms involved in potential rebuilding efforts may be motivated by a combination of profits, public relations, and patriotic expression. This may result in increased efforts to avoid public disputes and increased motivation to include alternate dispute resolution techniques in rebuilding contracts.

The AIA Form of Contract provides for mediation of disputes as a condition to bringing a demand for arbitration. When the contract is used, the settlement of disputes will take place without resort to the courts and the costly legal process. This should be continued in any work that is done for the WTC reconstruction for subcontracts between general contractors and their subcontractors. Whether the Port Authority chooses to avail itself of mediation and arbitration is a matter of policy that it will have to decide.

Other means of dispute resolution and prevention, such as dispute review boards and partnering, should also be made a part of any construction that is undertaken.

The role of the Port Authority in any effort to bring about alternate dispute resolution does not involve them directly, per se. Most of the questions of contractual efforts to avoid litigation will be between developers and their contractors, and between contractors and their subcontractors and suppliers. Nevertheless, encouragement from the Port Authority of the use of alternate dispute techniques such as dispute review boards, partnering, mediation, and arbitration will help in bringing these results about, particularly if this is incorporated in their construction contract.

Memorial

Monument to the Victims of the September 11, 2001, Tragedy

In any redevelopment plan, provision for a suitable memorial to the victims of the September 11, 2001, tragedy should be a priority. The psychological scars of this immense tragedy would be somewhat alleviated and the memory of the tragedy—and the resulting resolve to prevent similar events—prolonged. A memorial could take many forms. It might be freestanding or incorporated into new buildings. The new buildings themselves should also be viewed as a memorial to the victims and an affirmation of the continuation of their spirit. The placement and style of new buildings should be consistent with the architecture of the monument (Haberman and Neuman 2002).

No other aspect of the rebuilding of the WTC is receiving more ideas and debate than the idea of a monument or memorial. The entire spectrum of those who were affected by the tragedy and those who are residents, not only of the City and State, but of the entire world, are contributing ideas as to what would be a proper memorial or monument. Needless to say, this will not be an easy matter to be solved with the agreement of all of the constituencies involved.

One interesting idea, given by former Mayor Rudolf Giuliani, was that no rebuilding should take place on the site at all, but that the entire site should be devoted to parks and memorials similar to the Mall in Washington, D.C. His theory was that the tourism that would be attracted thereby would bring about an economic benefit that would equal or perhaps exceed what new buildings might bring. This is just one example of the kind of debate (albeit for a solution less likely to occur) that is now beginning to be generated and that will no doubt increase in intensity.

As time goes on, the question of the monument becomes more an issue that will not be easily resolved. One example of this is a series of Letters to the Editor that were published in the New York Times (March 2, 2002). The four letters each argue for a monument, but each of the monuments being advocated is diametrically opposed to the others. It’s as if they were from the four points of the compass. Obviously, not everyone is going to be satisfied on the monument issue and it is going to be a very long process before this monument is in place. The temporary memorial, which became reality on March 11, 2002, provided illumination from 6:00 to 11:00 P.M. every night. It was in the form of columns, two luminous tributes generated by 88 powerful searchlights (Dunlap 2002). This memorial has since been extinguished (Cardwell 2002c; Dunlap 2002).

Security

Bioterrorism Preparedness

The design and construction of buildings throughout the country should include specific measures for the prevention of bioterrorism. Federal, city, and state governments have started to realize the enormity of the problem and are initiating steps for bioterrorism prevention (Holusha 2002).

The anthrax spread, an example of the complex and tedious task of dealing with bioterrorism, is still in the investigative stage. Forthcoming results of studies and government/medical efforts to bring about a measure of prevention and security from bioterrorist threats are undergoing continuing development.

The design of buildings to make them less susceptible to attacks of bioterrorism involves ventilation and filtering systems, as well as surveillance and emergency planning. Experts distinguish between attacks that originate outside a building and migrate inside versus those that start inside. The most important measure that can be taken for building protection where the attack begins outside the building is “positive pressure” in a ventilation system. According to Dr. Richard Garwin, physicist and bioterrorism expert at the Council of Foreign Relations, positive pressure requires only a modest size blower at the air intake of the building. The blower ensures that any leakage of air is out rather than in. (The foregoing information is by James Glanz of the New York Times, in his article titled “Buildings: Air Pressure and Fine Filters.”) Biological material that may be released from a package or letter inside a building must be compartmentalized within the building. Otherwise, the material may spread throughout the building and perhaps even to the surrounding area outside the building. Ventilation system and filtering modifications will need to consider various scenarios in an effective and cost-efficient manner.

The Port Authority engineers point out that almost every building of modern design incorporates a positive pressure in the ventilation and air conditioning system. Nevertheless, with the positive pressure come certain problems.

Marvin Mass, Senior Partner of Cosentini Associates, a well-known mechanical engineering firm, is presently working on a number of designs for building replacements and refitting in the area. In a discussion with the CSECC, he made it clear that positive pressure in a building will not prevent a disgruntled employee or terrorist from releasing a biological substance within the building. The problem then would be to detect it in time to prevent its spread. Unfortunately, according to Mass, there is no quick detection system for such an event. Consequently, the re-
lease of a terrorist substance within a building that has its air conditioning and ventilation systems operating will result in spreading the substance throughout the building before it is even known that a foreign substance is present.

With the use of positive pressure in a building, there has to be a means of providing make-up air into the building to replace the air expelled from the building by the positive pressure. Here, again, a problem arises. How can we prevent a terrorist attacker from injecting biological or chemical substances into the building at the point of entry of the make-up air? Both of these problems will require a great deal of study. Diligent application of engineering controls and passive security, as well as human security, will be needed (Glanz and Lipton 2002).

The threat of a terrorist attack using an airborne hazard has moved to the forefront of concerns in the design and retrofit of building heating, ventilation, and air-conditioning (HVAC) systems. Airborne hazards can be classified into two types. The first is in the form of particulate matter (as in the case of anthrax), which is of a finite size. The second type of hazard is a gaseous or chemical hazard that cannot be controlled with a particulate filter. Examples of this include Sarin gas. The concern with both types of hazards is that there are presently no real-time monitors that can detect their presence and allow time to react.

Regardless of the type of hazard, the release can be categorized as emanating from either an external or an internal source. How we design modern HVAC to protect against hazards and—more importantly—react to their release is directly related to the source of the contaminant. For protection against an external release, be it accidental or malicious, the outside air intakes should be located as high as reasonably possible above ground level (Glanz and Lipton 2002). This provides two major benefits: (1) security against intentional insertion of hazardous materials into the intakes; and (2) greater likelihood that the hazardous materials will be diluted in and when they reach the outside air intakes.

In existing construction, relocation of the outside air intake is not always feasible and thus the existing intakes should be protected by physical security (e.g., fencing, cameras, etc.) The mechanical equipment rooms housing the air handlers, filters, and intake plenums should be secured as well.

New building design should include a relative positive pressurization to minimize the amount of air that enters the building through infiltration.

An internal release of a hazard is an even trickier problem in controlling its spread. Buildings that have floor-by-floor air handling units are not as likely to circulate hazards to other zones as a large central system air handler would do. How different zones are designed needs to take this into consideration.

Filtering of the outside air is an effective means of controlling airborne particulate matter but is not the panacea in solving the threat of biohazards. Engineering and operational controls are an important component in maintaining a safe environment. An open window, air bypassing an improperly installed filter, drafts, infiltration, etc., are all means in which contaminants can enter a building and render the most efficient filters useless.

As engineers, we attempt to strike a balance in choosing the right filter for every application. There is a cause and effect to the selection of filters. Higher efficiencies equate to higher pressure drops, dirtier filters also equate to higher efficiencies. Higher pressure drops also equate to higher energy costs. In attempting to strike this balance, a hierarchy of priorities is used. Of primary concern is the safety of the occupants. A secondary concern is what is dictated by code, while the third concern is the cost of the various filters.

Finally, as part of an operational plan there should be a means in place to immediately shut down all fans (supply, exhaust, air handlers) if a hazard is detected and conditions warrant. “Kill switches” should be installed to allow building fans to be immediately shut down in reaction to a hazard release. These switches should operate in conjunction with a building management system that can quickly purge zones within a building, thereby allowing for the dilution and control, and preventing the spread, of airborne contaminants.

References