

Rebuilding the World Trade Center

A report by the
Construction Institute
American Society of Civil Engineers



Committee on Social and Environmental Concerns in Construction

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ASCE

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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 authors 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 is 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 author who lives in New York City built the North Cove Marina and developed/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 ten 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 World Trade Center site on January 31, 2002, escorted by Peter Rinaldi, Staff Engineer at 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 CSECC, their contributions made the report richer.

Introduction

Minoru Yamasaki, 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 Port Authority of New York and New Jersey (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 the prestige associated with a building, the marketplace ultimately determines the rental rate.

The WTC towers proved that even with the Internet and World Wide Web the need for compact, contiguous space has not been diminished. Therefore, 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 is being conducted in a manner supportive of long-range rebuilding efforts. Workers are currently constructing a bridge/ramp into the excavation, which was visible on January 30, 2002. The bridge/ramp 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.

Work on the site, which is months ahead of schedule, continues 24/7, with project participants highly motivated by the desire to show that New York and the United States have not been defeated. The highly visible nature of the attacks on the WTC and the desire to quickly rebound means that decisions are likely to be 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

I. ECONOMIC

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 will represent a significant loss of economic activity in the City. Not only will the City lose the jobs themselves, but also the service providers who support these jobs and the City residents who hold these positions. It is in the best interest of the City to retain this economic activity. The City has already lost 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 previously 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 a recent finding that commercial rents are now approximately 35 percent 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 give New York its leading position.

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 co-workers to be in the same physical location to work together. 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 will be realized by eliminating the amount of time and energy required commuting 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 will 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 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 sentiment for restoring the south end of Greenwich Street, which was occupied by the building.

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 will like to have subtracted from the site (Peter Grant and Jim Vande Hei, 11/2/01).

One thing is certain: Buildings #1 and #2 cannot be reconstructed without approvals from the City, Governor, and Port Authority. But 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 (Robin Finn, 2/15/02).

II. 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 (2/12/02) reported a surge in downtown vacancies, this was a trend that held true for cities other than Manhattan. The American Express Company has agreed to return this spring to its headquarters at the World Financial Center Complex (Richard Lezin Jones); 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, 2/28/02); and, Larry Silverstein, the lessee of Buildings #1 and #2 and the land of Building #7 (which was destroyed), is pushing ahead with plans for reconstruction of Building #7 as soon as possible.

On the negative side, bridge restrictions for crossing into parts of Manhattan are expected to remain in place. No date has been fixed for removing these restrictions (Randy Kennedy, 2/27/02). A hopeful note is that an interim road is presently under

construction to reopen access to the Brooklyn Battery Tunnel from West Street, which has been closed since the disaster (Jennifer Steinhauer, 2/28/02).

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.

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

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.

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 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 make workers more productive. Residences in the vicinity will support neighborhood vitality, particularly in evenings and on weekends. Consequently, 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 will complement and supplement such residential space in Battery Park City and in the lower Manhattan area, and will 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 solutions could be among the following:

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

III. 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 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 workers in buildings in the area (Diane Caldwell, 2/24/02). Eventually, all of the debris in the WTC area will be removed and concerns about air quality during the debris removal phase will abate. Attention will then turn 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 by-products, volatile chemical contaminants and noise 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. 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 negatively 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 conditioning, data, telephone, and other systems will produce greenhouse gases that will negatively affect air quality throughout the life of the buildings. Air quality also can be impacted due to 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 potentially negative air impacts due to the 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 building. Construction equipment equipped with advanced emissions control equipment 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 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.

It must be pointed out that the manufacture of materials and the generation of electricity will be required even if the World Trade Center is not redeveloped, as there will be replacement elsewhere of the space. The replacement buildings will consume presumably an equivalent amount of materials and electricity and produce the same 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 consumption of electricity and have more environmentally sound attributes.

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 rebuilding the WTC are centered on the four life-cycle stages of the building: materials used, construction, operation and maintenance, and end-of-life strategies. In terms of materials, concrete and steel will compete for the structure of the building. Quantitative 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 lifecycle 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 assessed throughout the lifecycle. Finally, the selection of materials and structural systems should take into account the eventual disassembly or demolition of the building, and the need for an increased 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 incorporated and is becoming more widely accepted as a means of evaluating the environmental impacts of development.

Site Contamination

Site contamination after the rubble of the building is removed will be a continuing problem. During the cleanup and removal process now underway, significant quantities of toxic substances have been found at the site. These quantities have at times exceeded the maximum permitted by the EPA and OSHA, 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 is removed, the contamination should be no greater than the site contamination on any construction site elsewhere in New York City, according to Port Authority engineers. However, 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 necessity be used at the site, though the Port Authority 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 approved 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 unquestionably be statements required for altered street plans, roads and 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.

Port Authority engineers point out that the former WTC plan was approved before 1969, which was prior to the enactment of the National Environmental Policy Act (NEPA). Therefore, an environmental 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 configurations, 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.

IV. TRANSPORTATION

Longer Trips to Work

In the aftermath of the September 11 attack on the WTC, a shift in commuting patterns has resulted, in some instances resulting in longer trips to work for many commuters. A major reason for this shift was the imposition of restrictions and rerouting by the City and the Port Authority on autos and rapid transit in lower and midtown Manhattan. One impact has been a diversion of traffic from the lower and midtown crossings to uptown crossings such as the George Washington Bridge and the Triboro Bridge. This diversion from the lower and midtown crossings to these uptown crossings has had a clear effect of increasing commuting time for workers in the midtown and lower Manhattan areas.

There also has been an increase in commuting time for those suburban commuters who have changed their pattern from traveling to Manhattan via automobile 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 or Los Angeles. There can be no question that the traffic congestion during the commuting period in New York 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, 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. Where will the extra capacity come from?

The Long Island Rail Road (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.

As for automobile traffic, there has been a surprising public tolerance of the restrictions on single occupancy autos into Manhattan during the morning commute. However, lengthy delays are still common. To alleviate this, restrictions may have to be increased to include autos with two occupants. Park and ride lots will need to be established in western Nassau County and Queens and the high occupancy vehicle lane on the Long Island Expressway will have to be expanded through Queens. It is only through these actions, and others, that we will be able to start to make a dent on the traffic congestion in the area.

Putting tolls on the bridges across the East River has been suggested in order to discourage automobile traffic into Manhattan. This will 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 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 in the increase of 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 Port Authority of New York and New Jersey 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 percent, from 33,000 to 48,000, since September 11. Smaller, but measurable increases have been reported by the LIRR. Obviously, the shift of commuters from automobiles to rail transit can only improve air quality due to the reduction in carbon monoxide, hydrocarbon, and nitrogen oxide 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.

In addition to a shift in commuting patterns from auto to rail, there has been a shift in automobile commuting. There has been a large increase in the number of autos attempting to enter midtown and lower Manhattan prior to the 6 a.m. start of the restrictions on single occupancy autos. After the 6 a. m. start of the restrictions, there is an increase in the number of autos utilizing facilities north of the single occupancy restrictions, i.e., the Triboro Bridge on the East River side and the Lincoln Tunnel and George Washington Bridge on the New Jersey side. Thus, at least for these drivers, there has been a reluctance to give up their love affair with the auto and turn to the commuter rail alternative.

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 (1/3/02). Before September 11, the PATH took 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 two 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 is only recently that subway service on the E train returned to the World Trade Center 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 (Thomas J. Lueck, 11/29/01, Bob Port, 9/14/01).

The destruction of the PATH station at the World Trade Center 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 Port Authority has reported increases in reverse commuting.

Moving People Efficiently Over New Emerging Commuter Routes

The movement of people in new commuter routes will be based on a re-examination of current methods which, 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, which are becoming more prominent in the lower Manhattan area and which are certainly going to increase in prominence. We can add to these modes of mass transportation other means, such as tramways based on the model of the Roosevelt Island Tramway; elevated highways; and increased use of helicopters to be based at the waterfront. It appears that the technology to move people efficiently around exists. Its viable development must take place.

Environmentally Friendly Transportation

The rebuilding of the WTC must incorporate mass transit over a period extending 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 WTC. If a building 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, mass transit use has increased. This increase in use 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 commuter 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 Port Authority 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 traverse a tunnel. Therefore, lifting restrictions on auto traffic into the area could be beneficial.

Car restrictions and travel into Manhattan have been in effect since September 11. The restrictions on cars that are in effect at present, which consist of a ban on single occupancy vehicles at certain times of the day and days of the week, are currently being studied. There may be gradual relaxation of these restrictions.

The PATH restoration will generate interim methods of transportation 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, which will be considerably larger than the previous station. Improved connections between 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.

V. CONTRACTUAL

A Streamlined Approval Process

The events of September 11, 2001, have affected the lives of many Americans, disrupting normal workdays and causing widespread 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

healing 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 re-construction, the process required for rebuilding should be streamlined. Often, a significant bottleneck on major projects is the approval and permitting 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 process 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 expanding 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 affect 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 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 provide increased motivation to include alternate dispute resolution techniques in rebuilding contracts.

The AIA Form of Contract provides for a 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 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 incorporated in their construction contract.

VI. 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 will 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 their continuing spirit. The placement and style of new buildings should be consistent with the architecture of the monument.

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 Giuliani, is 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, DC. His theory is that tourism will be attracted; thereby bringing about an economic benefit that will equal or perhaps exceed what new buildings might bring. This type of a solution might, of course, be practical because of the proximity of the Statue of Liberty, Ellis Island and the Holocaust Museum in Battery Park City.

The foregoing 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 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 (3/2/02). 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, provides illumination from 6:00 to 11:00 PM every night. It is in the form of columns that generate two luminous tributes generated by 88 powerful searchlights (David W. Dunlap, 3/2/02). Like the Eiffel Tower in Paris, what starts as temporary may well become permanent.

VII. SECURITY

Bioterrorism Preparedness

As long as terrorist cells are in existence, design and construction of replacement 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 this problem and are initiating steps for its prevention.

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 this sort of devastation 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 bioterror expert at the Council of Foreign Relations, positive pressure requires only a modest size blower at the normal air intake to the building. The blower ensures that any leakage of air in the building 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 systems 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 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 will 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 release 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 his biological or chemical substance into the building at the point of entry of the make-up air? Obviously, both of these problems require a great deal of study. Diligent application of engineering controls and passive security, as well as human security, will be needed.

The threat of a terrorist attack using an airborne hazard has moved to the forefront of concerns in the design and retrofit of building 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.

This provides two major benefits: 1) Security against intentional insertion of hazardous materials into the intakes and 2) More likely that the hazardous materials will be diluted if and when they reach the outside air intakes.

In existing construction the relocation of the outside air intake is not always feasible and therefore the existing intakes should be protected by physical security (i.e., 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 with the outside 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 will 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. 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 dilution and control, and preventing the spread of airborne contaminants.

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