Executive Summary

1000 Connecticut Avenue is a 12 story, 565, 000 GSF commercial office building located at the corner of K Street and Connecticut Avenue in Washington D.C. The building is used primarily for office space, but also contains retail space on the first level, commercial office space on levels 3-12, a roof-top terrace with a green roof, and four levels of underground parking.

For this thesis report, 1000 Connecticut Avenue was re-located to Arlington, Virginia and the existing two-way flat slab floor system with lateral resisting concrete moment frames was re-designed as a composite steel floor gravity floor system with lateral resisting moment and braced frames. Before re-locating the building to Arlington, VA it was found that Washington D.C. has a zoning height limit of 130 ft. With the existing structure having a height of 130 ft., it was found that to use the new steel system the building would either need to be designed for a reduced number of stories or relocated to a region that does not have a height limit since the new steel system will increase the floor structural depth. To use the new steel structural system in Washington D.C., the structure would need to be re-designed for a reduced number of stories to maintain a minimum floor-to-ceiling height of 8'-6" and to remain within the restricted 130 ft. height limit. Reducing the number of stories from 12 to 11 was undesirable, therefore to create a fair comparison between the two systems the building was relocated to Arlington, VA, which does not have a height limit. The goal of the re-design was to

- increase the bay sizes to open the floor plan layout;
- increase floor-to-floor height to increase the openness of the space;
- Reduce the construction schedule;
- Reduce the structural system cost;
- Increase the annual revenue by increasing the rental value of the space and increasing the amount of rentable space

When designing the steel framing layout, a uniform layout was created to reduce the number of required skewed members and wider bays were created by removing certain existing column lines and relocating columns. Wider bays were created to open the floor plan and to increase the rental value of the space with reduced column obstructions and more rentable space. Maintaining an open floor layout was an important aspect of the re-design, therefore for the lateral system moment frames were used to avoid obstructions in the in the floor plan layout and braced frames were located around the elevator shafts and stairwell cores. The gravity system was designed as a composite steel system to achieve long spans while maintaining minimal structural depth. AISC 14th edition was used to design the gravity frame members. ETABS was used to analyze and design the lateral system. The lateral system design and analysis was based on the wind and seismic lateral loads calculated according to ASCE 7-10. The wind loads were determined by using Analytical Procedure (method 2) outlined in ASCE 7-10 and the seismic loads were determined by using the Equivalent Lateral Force Procedure outlined in ASCE 7-10. After designing the gravity and lateral systems, typical member connections were designed. The typical connections designed were orthogonal and skewed shear connections and a moment frame connection.

After designing the gravity and lateral systems, two breadth studies were conducted to determine how the new structural system will affect other aspects of the building. The first breath study was construction management impact. This breadth analyzed the impact of the structural system redesign on the superstructure cost; construction sequence of the existing system to the proposed construction sequence of the new structural system; site logistics of steel versus concrete; building LEED certification; and the anticipated revenue increase from the use of the new structural system. First the cost of the current structural system was compared to the cost estimate of the new structural system. In this portion of the analysis it was found that the new structural system will cost $5,994,630 more than the existing structural system. Second, the new structural system construction schedule was compared to the existing system construction schedule. It was found that the new structural system was erected 18 days earlier than the existing structural system, thus representing the use of the new system reduced the construction schedule. Third, how the construction site will have to be managed differently for steel compared to concrete was be evaluated. Using the existing 1000 Connecticut Avenue existing site for analysis, it was found that the site will be managed similarly for both materials. Fourth, the building LEED certification with the use of the new structural system was be compared to the existing building LEED certification and it after the analysis it was found that the building will maintain LEED Gold Certification. Last, the revenue obtained from the new structural system with wider bays and higher floor-to-ceiling heights was compared to the existing structural system's revenue. Wider bays and higher floor-to-ceiling heights increased the rental value of the floor space and therefore the building owner will be able charge higher rent which increased the revenue. The additional revenue obtained from using the new structural system is $3,705,450. This shows that even though the structural system costs more than the existing system, the amount of additional revenue obtained from using the new system is far more beneficial than using the existing system. Therefore the re-designed structural system with wider bays and floor-to-ceiling heights results in an overall very successful design with a reduced construction schedule and increased rental value. The proposed steel structural system is a viable alternative system to use in Arlington, VA since the new system has many additional benefits compared to the existing concrete structural system.

The second breadth studied was acoustics and lighting impact. This breadth involved determining the sound treatments required for a typical office space located in the new structural system. The analysis began by determining the level of speech privacy the common wall barrier between offices provided. It was shown that a 54 STC rated 8" partition wall with 2-layers of ½" thick gypsum wall board on both sides, staggered electrical boxes isolated with insulation, and 2 ½" metal studs spaced 24" o.c. and is very adequate for providing speech privacy for the offices housed in the new steel structural system. In addition, since the new structural system was designed for higher floor-to-ceiling heights, lighting illuminance applied to the work plane surfaces were affected. As a result, a lighting breadth was conducted by designing the lighting system for a typical office space using the existing floor-to-ceiling height of 8'-6" and checking to determine if the same lighting system can be used for the new floor-to-ceiling height of 10'-6". AGI was be used to design the lighting system for the space and the average illuminance in the space was compared to the target illuminance of the space. The IESNA Handbook 10th edition was used to determine the target illuminance and maximum power density for a private office space. It was found that the lighting system designed for the space with a floor-to-ceiling height of 8’-6” also achieved the target lighting illuminance for the space with a floor-to-ceiling height of 10’-6”.