Golden Gate Bridge Physical Suicide Deterrent System Operations, Maintenance and Emergency Response Report

I. Background & Summary

This report evaluates the impacts of the proposed Golden Gate Bridge Physical Suicide Deterrent System "build" alternatives on bridge operations and maintenance activities. The analysis includes a discussion of how each alternative will impact the Golden Gate Bridge, Highway and Transportation District's (District) maintenance activities including impacts to the efficiencies and access now afforded District forces by the existing railings and maintenance travelers. Any additional equipment or ancillary modifications to the Golden Gate Bridge (Bridge) in order to ameliorate or minimize the impacts of an alternative to ongoing District operations and maintenance activities is also discussed. The information in this Report was developed based on interviews with District bridge management and maintenance staff, discussions with District engineering staff, knowledge of maintenance activities on other similar bridges and field observations.

II. District Criteria

On March 11, 2005, the District's Board of Directors (Board) approved proceeding with environmental studies and preliminary design work for development of a physical suicide deterrent system on the Bridge. The resolution authorizing this action stipulated that suicide deterrent system concepts conform to the following criteria:

1. Must impede the ability of an individual to jump off of the Bridge.
2. Must not cause safety or nuisance hazards to sidewalk users, including pedestrians, bicyclists, District staff, and District contractors/security partners.
3. Must be able to be maintained as a routine part of the District's ongoing Bridge maintenance program and without undue risk of injury to District employees.
4. Must not diminish ability to provide adequate security of the Bridge.
5. Must continue to allow access to the underside of the Bridge for emergency response and maintenance activities.
6. Must not have a negative impact on the wind stability of the Bridge.
7. Must satisfy requirements of State and Federal historic preservation laws.
8. Must have minimal visual and aesthetic impact on the Bridge.
9. Must be cost effective to construct and maintain.
10. Must not, in and of itself, create undue risk of injury to anyone who comes in contact with the Suicide Deterrent System.
11. Must not prevent construction of a moveable median barrier on the Bridge.

Criteria 1, 6, 7 & 8 pertain to the establishment of reasonable standards governing the preliminary engineering and architectural design of proposed physical suicide deterrent systems. Criterion 6 was specifically addressed as part of wind testing performed during Phase I of this study. This wind testing further confirmed that installation of a physical suicide deterrent system would not prevent construction of a moveable median barrier, thus satisfying criteria 11. The remaining criteria – specifically criteria 2, 3, 4, 5, 9 & 10 – pertain to Bridge operations and maintenance, which is the focus of this report.

III. Description of Project Alternatives

Initial wind tunnel testing identified limiting aerodynamic parameters specific to the Bridge that were used in the development of project alternatives.

In addition to defining the wind parameters, the District performed a comprehensive industry review to identify the range of physical suicide deterrent systems considered and implemented on bridges and tall structures throughout the world. The District evaluated these ideas against a set of performance criteria, which were taken from the District adopted criteria, in order to eliminate those ideas that would not likely comply with all eleven adopted criteria, and as a way to identify best practices that could be used to guide the development of alternatives for the project.

Concurrent with this, design criteria and architectural considerations which would serve as guiding principles for developing reasonable alternatives for consideration in the environmental process were identified. For example, the Bridge has symmetry, spacing of elements, shapes of elements and an architectural vocabulary which was considered in the development of alternatives.

Through a collaborative process that considered all of the above factors and the eleven District-defined criteria, numerous alternatives were considered but eliminated from further evaluation. Ultimately, five (5) “build” alternatives were developed for evaluation, along with the no-build alternative, in the draft Environmental Impact Report/Environmental Assessment (EIR/EA). Build alternatives are defined as concepts that, if implemented, will result in the Bridge remaining stable in strong winds, and which comply with all District-adopted criteria. The five build alternatives grew out of the three generic concepts identified during the wind tunnel testing. All alternatives are contemplated to be installed over the full length of the Bridge, on both sides.

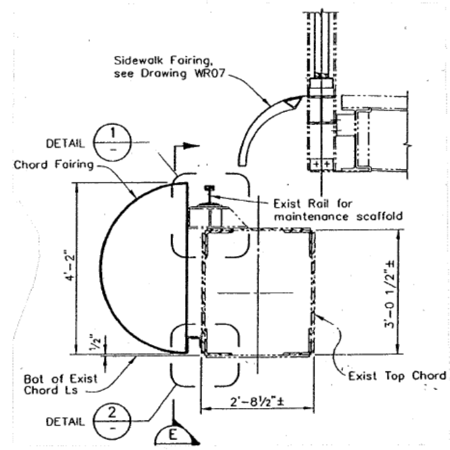
A description of the five Build Alternatives is as follows:

Alternative 1A

Alternative 1A is a new barrier placed on top of the outside hand rail and consists of ½” diameter vertical rods spaced at 6 ½ inches on center, leaving a 6-inch clear space between rods. The new barrier will extend 8 feet vertically from the top of the outside 4 foot high hand rail for a total height of 12 feet. The existing rail posts (W8x28) will be removed and replaced with new posts of the same cross-section, size, material, and color for the 12 foot height. The material to be used for the new portions of the rail will be plain galvanized A36 steel and the color will be International Orange, matching the material and color of the current outside rail.

The top horizontal railing member will consist of a chevron shaped member measuring 8 inches by 4 inches, which is similar to the existing top horizontal railing member. The vertical rods will be threaded at each end and attached to the top and bottom horizontal railing with nuts. This connection point will be hidden behind the bottom railing, which will result in a seamless look.

The outside railing at the west sidewalk between the two main towers will be modified in accordance with the findings of prior wind studies performed on the Bridge as part of the design effort for the District's seismic retrofit program. These studies concluded that the existing 4 inch wide pickets are detrimental to the aerodynamic behavior of the Bridge during high winds. The modified rail will be all new material matching the color of the current rail. The posts will be W8x28 steel posts spaced at 12 ½ feet with a chevron-shaped top horizontal member matching the existing rail. The bottom rail will be a thinner 1 inch by 4 inch member. The pickets will be ⅜ inch thick by 4 inches wide spaced at 5 inches on center for the central 3250 linear feet of the main span. This modified railing is scheduled to be installed as part of the construction contract for Phase 3B of the seismic retrofit project.



Also in keeping with the findings of the prior wind studies, wind fairings will be added to the west side of the Bridge. The wind fairings include a 3800 linear foot section of a 25-inch radius semi circle mounted to the outer vertical face of the west stiffening truss top chord and a 3800 linear foot section of 20-inch radius quarter circle mounted on the outer vertical edge of the west sidewalk (see cross section details above). As with the modified railing, these wind fairings are contemplated as part of the Phase 3B seismic retrofit construction contract. The existing main span traveler operation would be impeded by the installation of the wind fairing. In order for the two main span travelers to traverse those portions of the Bridge where these conflicts exist, the clearance between the inner face of the traveler vertical leg and the outer edge of the stiffening truss must be increased on the west side. This increased clearance can be achieved by modifying the existing traveler, or by installing a new traveler. The cost of the traveler change is included in the project cost estimate.

At the mid span of the Bridge the above-railing treatment will consist of transparent panels, 12 feet wide by 8 foot high. These panels will be placed on top of the outside railing and angled slightly inward (toward the sidewalk) in order to avoid contact with the main span cable and suspender ropes. This mid span transparent panel treatment will be placed at both the east and west outside railings over a total length of approximately 400 feet, centered on the low point of the cable.

Both the east and west sidewalks have 24 widened areas called "belvederes". Each belvedere is 12 ½ feet long. Transparent panels will also be placed above the outside railing at belvedere locations, in order to provide for unobstructed viewing by pedestrians. Transparent panels will also be placed above the outside railing at the tower locations.

Alternative 1B

Alternative 1B is a new barrier placed on top of the outside hand rail and consists of ⅜ inch diameter horizontal cables spaced at 6 inches on center leaving a 5 $^5/_8$ inches clear space between cables. The new barrier will extend 8 feet vertically from the top of the outside 4 foot high hand rail for a total height of 12 feet. The existing rail posts will be replaced with new posts of the same cross-section, size, material, and color for the 12 foot height. These posts will slightly curve forward at the top to support the winglet on top of the barrier. The material to be used for the new portions of the rail will be galvanized A36 steel and galvanized steel cables. The color will be International Orange, matching the material and color of the outside rail.

As is the case for Alternative 1A, the outside railing adjacent to the west sidewalk between the two main towers will be modified in accordance with the findings of prior wind studies performed on the Bridge as part of the design effort for the District's seismic retrofit program. The details of this modified railing are as described for Alternative 1A.

In order to provide for the necessary aerodynamic stability of the bridge, and in lieu of the wind fairings incorporated into Alternative 1A, this alternative features a winglet bolted to the top of the barrier posts. The winglet is a horizontal 1 ¼ inch thick transparent panel measuring 42 inches by 12 ½ feet with a slight downward curvature. The winglet will be positioned to have $^1/_3$ outboard and $^2/_3$ inboard relative to the plane of the barrier. The winglet will be notched at the suspender cables and at the light posts to avoid interference with these elements. While serving a similar purpose as the fairings incorporated into Alternative 1A (stabilization of the Bridge during high wind events), the winglet feature was deemed preferable to fairings for this alternative as its design will impede climbing over the top of the barrier; this climbing deterrent was deemed necessary for this alternative given the ease with which an individual could ascend the barrier using the horizontal cables as a foothold.

Alternative 1B will feature transparent panels at the mid-span, towers and at belvederes, as described for Alternative 1A.

Alternative 2A

Alternative 2A is a new vertical 12 foot tall barrier consisting of ½ inch diameter vertical rods spaced at 4 ½ inches on center, leaving a 4 inch clear space between rods. The outside hand rail will be completely removed. New 12 foot tall W8x28 posts will be installed at 12 ½ feet on center, consisting of the same cross-section, size, material, and color as the original posts. The material to be used for the new barrier posts will be galvanized A36 steel and the color will be International Orange, matching the material and color of the outside rail.

The top horizontal railing member will consist of a chevron shaped member measuring 8 inches by 4 inches by ¼ inch, which is similar to the existing top horizontal railing member. The vertical rods will be threaded at each end and attached to the top and bottom horizontal railing with nuts. This connection point will be hidden behind the bottom railing, which will result in a seamless look. There will be a rub rail consisting of a 2 $^3/_8$ inch diameter steel pipe at a height of 4 ½ feet.

In keeping with the findings of the prior wind studies, wind fairings will be added to the west side of the Bridge. The wind fairings and associated main span traveler modifications are as described for Alternative 1A.

Alternative 2A will feature transparent panels at the mid-span, towers and at belvederes, as previously described for Alternatives 1A and 1B.

Alternative 2B

Alternative 2B is a new 10 foot tall barrier consisting of posts, rub rail and horizontal cables. The cables are 3/8 inch diameter, spaced at 6 $^{3}/_{8}$ inches on center above the rub rail and 4 $^{3}/_{8}$ inches on center below the rub rail. The rub rail consists of a 2 ⅜ inch diameter steel pipe at a height of 4 ½ feet above the sidewalk. The outside hand rail will be completely removed and replaced with this alternative. New 10 foot tall W8x28 posts will be installed at 12 ½ feet on center, matching the cross-section, size, material, and color as the original posts. These posts will slightly curve forward at the top to support the winglet on top of the barrier. The material to be used for the new rail will be galvanized A36 steel and galvanized steel cable painted with International Orange color, matching the material and color of the current rail.

Alternative 2B will feature a transparent winglet attached to the post tops, as previously described for Alternative 1B, and transparent panels at mid-span, the towers and belvedere locations, as previously described.

Alternative 3

Alternative 3 is a horizontal net located near the bottom chord of the Bridge east and west stiffening trusses. The support system will consist of steel beams installed directly to the truss verticals and support cables attached to the ends of the beams and back to the truss top chord. The support system for the netting will include cables that will pre-stress the netting to keep it taut and to prevent the wind from whipping the netting resulting in a propensity for fatigue failures. The net will project 20 feet from the Bridge and be covered with marine-grade stainless steel cable netting with a grid between 4 and 10 inches. The net will be covered with a plastic coating that could match the Bridge color and the steel support system would also be painted to match the Bridge.

The horizontal net will consist of independent 25 foot long sections that can be rotated vertically against the truss so the maintenance travelers can be moved as necessary. The clearance between the inner face of the traveler vertical leg and the outer edge of the stiffening truss must be increased to accommodate the raised net and the wind fairing. This increased clearance can be achieved by modifying the existing traveler, or by installing a new traveler. The cost of the traveler change is included in the project cost estimate.

Alternative 3 incorporates the west outside hand rail modifications developed in accordance with the findings of prior wind testing. These railing modifications are described under the description for Alternative 1A. Alternative 3 also incorporates the wind fairings and associated traveler changes as previously described.

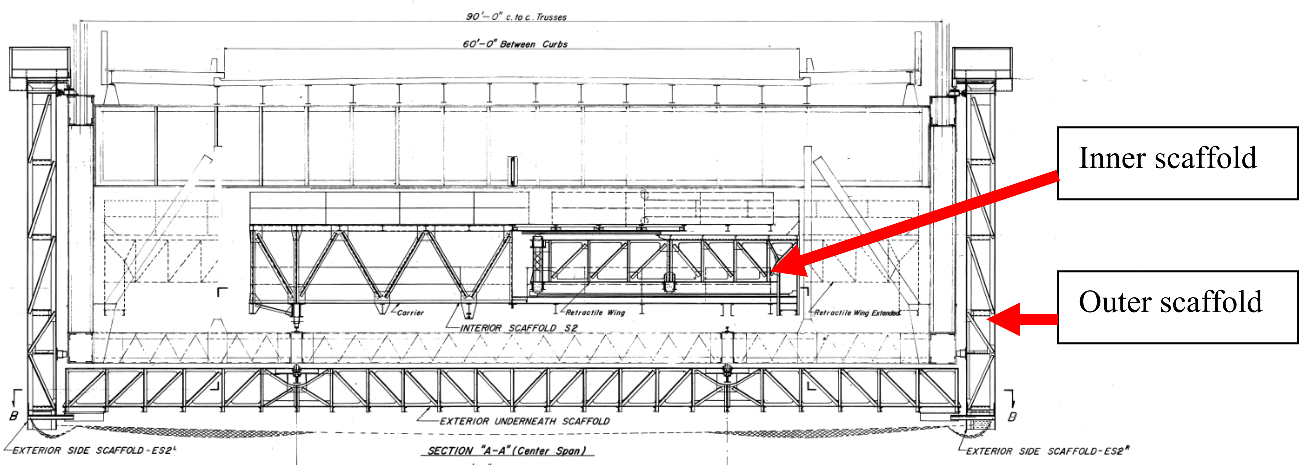
IV. Discussion of Existing Bridge Access Methods

Suspension Spans Maintenance Traveler Operation

Access under the Bridge and access outboard of the stiffening trusses on the suspension bridge portion of the Bridge is provided by four sets of travelling scaffolds (travelers): one in each side span and two within the main span. The travelers, which were installed in the mid-1950s as part of the construction contract for the lower lateral bracing, can be positioned and parked at almost any location along the suspension bridge. Each set of travelers includes an "inner scaffold" and an "outer scaffold." A set of inner and outer scaffolds can move and operate independently.

An outer scaffold is a "U" shaped system attached to the top and bottom chords of the truss and the lower lateral bracing system. The outer scaffold includes the underneath scaffold and exterior side scaffolds on both the east and west sides all of which move as one unit. Currently, access to the outer scaffold is by climbing over the top of the 4-foot tall outside railing from either the west or east sidewalks.

The inner scaffold is a horizontal system located below the floorbeams and attached on top of the existing lower lateral bracing system. The inner scaffolds have "retractable wings" which are extended or retracted as necessary to gain full access to and to allow passage of the inner scaffolds around the upper lateral bracing. The inner scaffolds can be accessed either via the outer scaffold or via a ladder from the extended wing of the inner scaffold to the upper chord of the stiffening truss.



Each traveler is driven by synchronized electric motors powered by a diesel generator. A minimum of three workers are needed in order to move an outer scaffold. The speed at which the outer scaffolds move is a function of many variables. The outer scaffolds can move faster when travelling downhill as opposed to uphill. When climatic conditions result in the rails on the top chord of the stiffening truss being wet the traveler wheels can spin on the rails without moving the traveler, so two additional workers must "sand" the rails so that there is adequate friction between the scaffold wheels and the rail. The east and west exterior side scaffolds can also start to move slightly out of sync which requires correction to avoid twisting or racking the outer scaffold. Depending on these variables it can take 15 to 30 minutes to move an outer scaffold 75 feet.

The inner scaffolds are smaller, lighter and less complex than the outer scaffolds, so movement of the inner scaffolds is easier and less labor intensive. A minimum of 2 workers (operator and spotter) are needed in order to move an inner scaffold and it can take 15 to 20 minutes to move 75 feet.

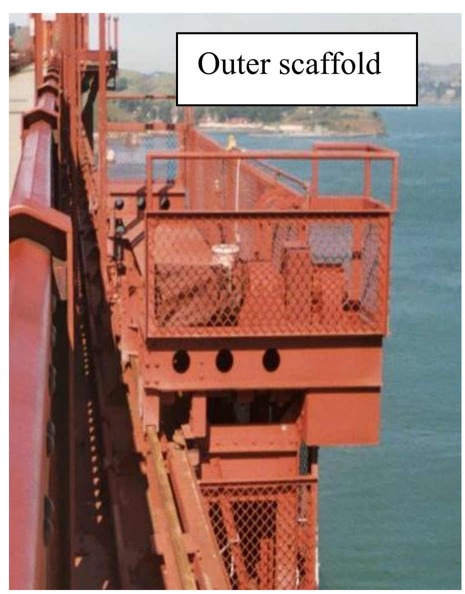
Approach Span Access
Access to the north and south approach truss spans is via a longitudinal maintenance catwalk running the entire length of these spans. The north approach has several “tributary” catwalks offering access to bearings located at the top of each support tower. Catwalks do not exist within the south approach plate girder spans or within the arch span. Traveler rails were recently installed as part of the Phase II seismic retrofit project throughout the south approach for maintenance access platforms, but these platforms have not been deployed. Access to plate girder spans is from the ground or via temporary “job-specific” platforms/scaffolding; temporary platforms/scaffolding are used to access under bridge portions of the arch structure.

Under Bridge Access Equipment
Currently, the District does not have under bridge inspection trucks (UBIT), which are commonly referred to as “snooper trucks”. The practical daytime deployment of the District’s existing crane truck is limited for under bridge inspection and/or maintenance because: the crane does not articulate; it is not routinely equipped with a personnel-basket; and because deployment of this unit requires the closure of two lanes of traffic, which reduces lane capacity to an unacceptable level during normal (daytime) hours.

V. Discussion of Existing Bridge Operations

The primary Bridge operations which will be impacted by a proposed physical suicide deterrent system relate to: i) access to under-bridge areas for planned maintenance operations; ii) access to under-bridge areas for emergency operations; and iii) cleaning and painting of suspension system components. The following is a discussion of the current operating environment for these areas.

Access to Under-Bridge Areas for Planned Operations
On a daily basis, Monday through Friday, District forces access the under-bridge areas of the Bridge. This typical activity involves painters, ironworkers, operating engineers, and electricians and is performed on two or three of the travelers at any given time. The west sidewalk is exclusively available for District forces to perform maintenance activities during normal daily work hours since it is not open to the public during at this time. Therefore, the west sidewalk is the primary route used for accessing below-deck areas of the Bridge for planned maintenance and repair work. For the majority of planned maintenance activities, workers transport equipment to the work area via light-duty motorized carts (scooters) on the west sidewalk. Equipment, tools and material are also staged on the west sidewalk, since as stated above, there is no public access allowed on the west sidewalk during normal work hours.



For planned activities, the outer scaffold is positioned directly at the work area (see photograph at right). Workers are then able to efficiently access the work area by driving scooters on the sidewalk to the location of the outer scaffold and then climbing over the outside hand rail directly onto the travelers. Since there is a handrail which provides fall protection on the travelers, the workers are not required to wear their safety harnesses and “tie-off” to the outside railing or other such support when accessing the outer scaffold. To aid in the movement of workers over the top of the railing, step ladders designed specifically to attach to the outside hand rail top members are used.

Tools, small pieces of equipment and materials are easily loaded over the top of the outside railing onto the outer scaffolds.

On a less frequent, although still routine, basis, work is performed on the outboard side of the outside hand rail without the use of the travelers. While working on the outboard side of the handrail, District forces stand on the stiffening truss top chord and tie-off to the railing using appropriate fall protection as shown in the photographs above. In certain instances workers tie-off their safety harness lanyards to a temporary safety cable attached to the outside leg of the railing posts as depicted above.

Access for Emergency Operations

Emergency operations are unplanned operations requiring District forces to climb over the outside handrail. This activity typically occurs once or twice per month, and it typically involves two ironworkers for a couple of hours on the outboard side of the outside handrail per event. Access to the outboard side of the outside handrail for emergency response activities is primarily related to “snatch-and-grab” operations involving individuals who have positioned themselves on the outboard side of the railing (usually on top of the stiffening truss top chord). In these instances, Bridge Patrol or California Highway Patrol (CHP) officers position themselves on the sidewalk and attempt to dissuade the individual from jumping. Meanwhile, two ironworkers are dispatched to climb over the outside hand rail, and onto the top chord, at an appropriate distance on either side of the individual. Currently, Bridge forces are able to climb over the top of the railing onto the top chord at any point along the longitudinal continuum of the outside railing. Responding ironworkers are then able to move along the top chord of the stiffening truss toward the individual, maintaining appropriate fall-protection via double lanyards attached to the railing. Access for other emergency response situations is similar.

Cleaning & Painting of Suspender Ropes

While this is a current project, it is not a common maintenance activity. Once the current painting cycle is complete, it is anticipated the suspender ropes will not be repainted again for 15 years. However, repainting the suspender ropes is a significant undertaking requiring multiple crews and two years to complete, so it is discussed herein.

This activity includes cleaning and painting the suspender ropes and associated hardware which connect the suspension bridge roadway and sidewalk to the main cables. The suspender ropes are a group of 4 steel cables located every 50 feet along the length of the suspension spans at both the east and west sidewalks.

Cleaning and painting of the suspension system elements involves access from both the sidewalk and traveler platforms and requires access from both the east and west sidewalks. When this work activity is ongoing on the east side, temporary barriers are used to separate the work activity from the general public.

The vertical suspender ropes are painted using a combination of a “cable master” device and self-hoisting platforms (cable box). The cable-master device is an unmanned motor-driven unit which has been designed for the District to perform cleaning and painting of individual suspender ropes; the cable box (see photograph above) is a tethered, self-hoisting platform manned by two workers that allows for the cleaning and painting of four suspender ropes in an enclosed environment.

The painting devices are rigged and tethered to the existing outside railing via fabricated connections and pulleys as depicted in the photograph to the right. The cable boxes are brought to the work site on both the east and west sidewalks via work carts and are then manually lifted over the outside handrail into place around a group of suspenders using a rope and pulley system. Workers enter the cable box after it is installed by climbing step ladders from the sidewalk level.

VI. Operations & Maintenance Impacts

Access for Planned Maintenance Operations with Taller Railings (Alternatives 1A, 1B, 2A and 2B)

The installation of any physical suicide deterrent system that provide a taller railing (Alternatives 1A, 1B, 2A and 2B) will inhibit access to under-bridge areas for planned maintenance activities using the current access techniques. In order to mitigate this impact, access gates are proposed. The gates will be located at a spacing of 150-feet on center to match the spacing of existing light posts and the bicycle safety rail gates.

Gates will consist of two 4-foot wide swinging sections with a common hinged post, and will be constructed of rods to match the appropriate deterrent system design. The frame for each gate door will be constructed of 2 inch by 2 inch steel tube members. As with the fixed sections of each alternative, the rods will connect to the gate framing members with nuts which will be shielded from view, resulting in a seamless look.

The gates will be locked at all times to restrict access by other than Bridge personnel. For Alternatives 1A and 1B (vertical systems extending on top of the outside hand rail), the gates will be 8 foot tall and be positioned on top of the existing outside railing; for Alternatives 2A and 2B, the gates will be the entire height of the replacement fence (12 foot for Alternative 2A, 10 foot for Alternative 2B).

Each sidewalk has 24 belvederes. At these locations the belvedere extends out over the upper chord of the stiffening truss, blocking workers from walking along the truss top chord. The spacing of the belvederes presents several locations where District forces will have to carefully walk along the small traveler rail as shown in the photo below. Fortunately gates can be located such that this will only occur at a few locations on each sidewalk.

Fall protection will be required when walking from the gates to the travelers. It is proposed that a permanent stainless steel safety cable be installed on the outboard side of the east and west outside handrail or new barrier, along the entire length of the Bridge, for workers to "tie-off" to when walking along the stiffening truss upper chord or traveler rail. The cable will be on the outer face of the outside hand rail posts to minimize its visibility.

For Alternatives 1A, 1B, 2A and 2B, worker access for planned maintenance activities on the outer scaffold will be as follows:

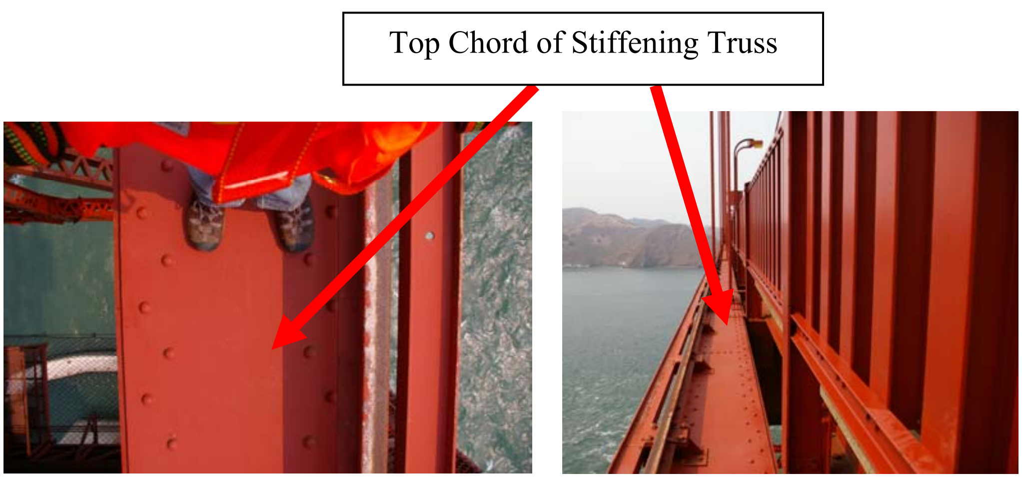
- drive a scooter on the sidewalk to the location of the gate closest to the traveler;
- don a safety harness for fall protection;
- for Alternatives 1A and 1B, climb over the outside hand rail and through the gate while "tied-off" with fall protection;
- for Alternatives 2A and 2B, walk through the full height gate;
- close and lock the gate; and
- while "tied-off" walk along the top chord of the stiffening truss (a maximum of 75 feet) to the outer scaffold.

For planned maintenance activities on the inner scaffold, workers will access the scaffold as follows:

- drive a scooter on the sidewalk to the location of the gate closest to the traveler;
- don a safety harness for fall protection;
- for Alternatives 1A and 1B, climb over the outside hand rail and through the gate while "tied-off" with fall protection;
- for Alternatives 2A and 2B, walk through the full height gate;
- close and lock the gate; and
- while "tied-off" walk along the top chord of the stiffening truss (a maximum of 75 feet) to access outer scaffold and access the inner scaffold from the outer scaffold.

or,

- drive a scooter on the sidewalk to the location of the gate closest to the traveler;
- don a safety harness for fall protection;
- for Alternatives 1A and 1B, climb over the outside hand rail and through the gate while "tied-off" with fall protection;
- for Alternatives 2A and 2B, walk through the full height gate;
- close and lock the gate; and
- while "tied-off" walk along the top chord of the stiffening truss (a maximum of 75 feet) to the location of the inner scaffold and then climb down a ladder that extends from the extended wing of the inner scaffold to the upper chord of the stiffening truss.



The maximum distance that personnel will have to walk along the truss top chord is 75 feet, since the gates are spaced 150 feet apart. The suspender ropes are spaced 50 feet apart, so there will be instances where workers will need to climb around the outside of the suspender ropes as they walk along the top chord to the travelers. There will also be instances where workers will need to climb around the belvederes on the traveler rail as discussed above.

Thus, for Alternatives 1A, 1B, 2A and 2B it will take longer for Bridge forces working at under-bridge locations to reach the work locations. The time it takes to don a safety harness, unlock the gate, tie-off, climb or walk through the gate, and walk along the truss top chord to reach the traveler location represents a decrease in productive time as compared to the existing situation. This decreased production corresponds to an increased annual operating cost. It is anticipated that it will take an extra seven minutes each time a worker travels between the sidewalk and a traveler. Bridge workers travel back to the shop for one coffee break and for lunch each day. This corresponds to six one-way trips through a gate and walking on the upper chord of the truss per worker per day, or 42 minutes of lost productivity per day for each worker engaged in planned maintenance activities below the deck.

A typical paint crew has eight workers, so this represents 336 minutes of lost productivity per paint crew per day as compared to the existing condition. (42 minutes per worker per day * 8 workers per crew = 336 minutes of lost productivity per crew per day)

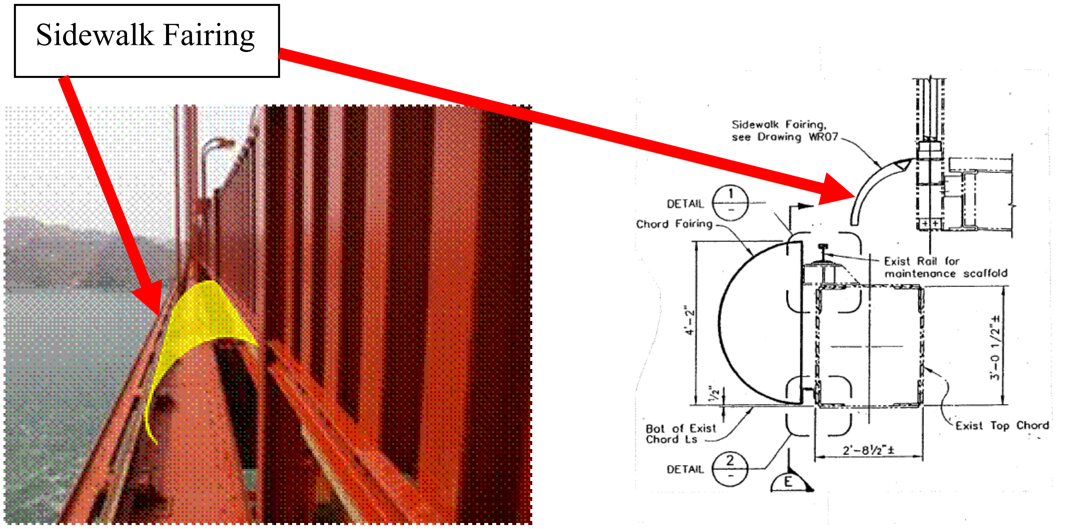
If, on average, two crews are working on the travelers, this would correspond to 672 minutes of lost productivity per day associated with Alternatives 1A, 1B, 2A or 2B, but does not apply to Alternative 3.

In addition to the loss in productivity, the District’s workers compensation experience may change with the taller railing alternatives due to workers accessing the travelers via walking on the top chord of the stiffening truss. Currently, workers do perform some tasks from the top chord, away from the travelers; however, it is not an everyday occurrence.

Loading tools, equipment and supplies will also be less efficient, and thus costlier. Currently tools, equipment and supplies are loaded over the existing rail directly onto the traveler on a daily basis. The installation of Alternatives 1A, 1B, 2A or 2B will necessitate either: travelers must be moved to the gate locations on a daily basis in order to load tools, equipment and supplies through the access gates and then the travelers would then be relocated back to the work location after the loading and transfer operations were completed; or the travelers would remain parked at the work locations and a boom would lift supplies over the taller railings avoiding the additional frequent traveler moves.

Access for Planned Maintenance Operations with Fairings (Alternatives 1A and 2A)
Alternatives 1A, 2A and 3 include fairings on the west side of the main suspension span between the north and south towers. The fairings will be located on the truss top chord and sidewalk as shown on the next page for approximately 3800 feet centered about mid span. This represents approximately 42 percent of the length of the Bridge.

As stated above, Alternatives 1A and 2A will include access gates and with either of these alternatives, District workers will access the scaffolds by opening a gate, climbing over the outside handrail through a gate or just passing through a gate and walking along the upper chord of the stiffening truss. However, the introduction of the fairing will preclude walking along the west stiffening truss top chord for the 3800 feet length between the north and south towers where the fairings are to be installed. Therefore, for Alternatives 1A and 2A, District workers will be required to access the outer scaffolds for this 3800 foot length of the main span from the east sidewalk, as opposed to the current situation where they access it from the west sidewalk.



As stated previously, District workers utilize the west sidewalk to access the travelers since the west sidewalk is closed to the public during the District's normal work hours. The east sidewalk is open to the public during the District's normal work hours and is occupied with pedestrians and bicyclists. It is estimated that 10 million visitors come to the Bridge each year enjoying the sidewalks. On a summer day the sidewalks are crowded with bicycles and pedestrians. For example, over 5,000 bicyclists may use the Bridge sidewalks on a summer day. Thus, the scooters traveling on the east sidewalk move much more slowly than the scooters on the west sidewalk. On average, a scooter on the west sidewalk travels at approximately 15 miles per hour, while on the east sidewalk a scooter travels at approximately 5 miles per hour.

The minimum trip length on the east sidewalk to reach one of the two main span travelers is approximately 1100 feet, while the maximum trip length is approximately 5200 feet. Thus the average trip length would be 3150 feet [(1100 + 5200) / 2 = 3150]. The average increased travel time per scooter trip would then be:

[3100 feet / 5280 feet per mile / 5mph * 60 minutes per hour] –
[3100 feet / 5280 feet per mile / 15 mph * 60 minutes per hour] = 4.7 minutes per scooter trip (one-way)

District workers travel back to the shop for one coffee break and for lunch each day. This corresponds to six one-way trips per day. Assuming that one of the two main span travelers are in use, on average, each day; and assuming that one paint crew is working on the traveler, then this corresponds to:

4.7 minutes per trip * 6 trips * 8 workers (one paint crew) = 226 minutes of lost productivity per day

The 226 minutes of lost productivity for Alternatives 1A and 2A due to scooters on the east sidewalk is in addition to the 672 minutes due to the taller railing which was discussed on pages 11, 12 and 13.

In addition to the loss in productivity, mixing intensive maintenance activities with bicycle and pedestrian traffic on a long-term basis is less desirable from a risk management perspective; since it introduces greater opportunity for conflicts between maintenance activities and the public's recreational use of the same sidewalk.

One possible alternative to avoid these impacts would be to move all bicycle and pedestrian access to the west sidewalk and then stage all maintenance activities from the east sidewalk away from bicycle and pedestrian conflicts. Bicyclists could use the east sidewalk during non-working hours. This is essentially a reversal of the current maintenance and public access situation. The tradeoff is that pedestrians and bicyclists would not have the view corridors that they currently enjoy from the east sidewalk; so all things considered, this is not recommended.

Alternative 3 does not require access gates so walking on the stiffening truss top chord in order to access the outer scaffolds does not apply. Workers will be able to climb over the rail directly onto the traveler as is done today.

Access for Planned Maintenance Operations with Horizontal Nets (Alternative 3)

Alternative 3, the installation of a horizontal net system, will not require workers to pass through gates and then walk on the upper chord of the stiffening truss in order to reach the outer scaffolds, so the above inefficiencies are not applicable. However, Alternative 3 would introduce other inefficiencies. Specifically, it will affect the staff resources necessary to move the outer scaffolds.

The horizontal extension of the net will interfere with the current operations of the outer scaffold. To mitigate this impact, it is proposed that the net be designed to rotate, in 25-foot long segments, to a vertical position such that the maintenance traveler can pass without the vertical exterior side scaffolds of the traveler interfering with the net. This rotation will be achieved through the use of a pinned connection detail between the net structure and the stiffening truss, and by using a portable winch device that will attach to and pull on the outer net framing to move it into a vertical position.

Currently, a minimum of three workers are needed to move an outer scaffold. Two additional workers, one on the west sidewalk and one on the east sidewalk, would be required to rotate the net sections up and down as the outer scaffold moves. This represents a decrease in productive time as compared to the existing situation. This impact would be particularly noticeable for those less frequent, but longer scaffold moves.

The frequency and length of outer scaffold moves varies with the activity underway. Bridge inspection typically requires daily moves of 25 feet for two scaffolds, while routine maintenance may require only weekly moves for a scaffold. Long scaffold moves of multiple bays are less frequent. Typically, there are 1.5 outer scaffold moves per day, and each move takes 20 minutes (assuming the scaffold moves are only one bay which is 25 feet) and requires two additional workers, this corresponds to 60 minutes of lost productivity per day.

1.5 moves per day * 20 minutes per move * 2 additional workers = 60 minutes of lost productivity per day.

Access for Emergency Operations with Taller Railings (Alternatives 1A, 1B, 2A and 2B)
The installation of any physical suicide deterrent systems will impede individuals from jumping off of the Bridge. However, it is possible that a few individuals may still attempt to defeat a physical suicide deterrent system and jump from the Bridge, so it is appropriate to contemplate the requisite emergency operations.

If an individual were to climb over Alternatives 1A, 1B, 2A or 2B and stand on the top chord of the stiffening truss (on the outside of the railing) the Bridge Patrol or California Highway Patrol (CHP) officers would position themselves on the sidewalk and attempt to dissuade the individual from jumping similar to today. Meanwhile, Bridge ironworkers would be dispatched who would access the stiffening truss upper chord, on the outside of the railing, via a gate at an appropriate distance from the individual. Responding ironworkers would then move along the truss top chord toward the individual, maintaining appropriate fall-protection via safety harness lanyards attached to the new steel safety cable. The ironworkers would then escort the individual along the truss chord to the nearest gate. It is anticipated that with the taller railing this operation would be a rare occurrence, so the associated cost would be negligible.

Access for Emergency Operations with Nets (Alternative 3)
If an individual were to jump into Alternative 3, the net, the District would need to rescue the individual from the net which would introduce a significant new operational challenge. In order to provide for the safe retrieval of such an individual, it is recommended that the District purchase an under bridge inspection truck (UBIT), which are some times referred to as "snooper trucks" (see photograph to the right). The snooper truck would be used to access and facilitate retrieval of jumpers from the horizontal netting along most of the length of the Bridge. Snooper trucks have a truck-mounted bucket-controlled basket that can be used for access beneath a bridge from the roadway. The District would purchase a snooper truck which operates within a single lane closure and that has a reach to span over the sidewalk and reach down to the net. Several manufactures make such a unit. One example is the Aspen A-62, manufactured by Aspen Aerials, Inc.

It is anticipated that the rescue operation discussed above would be a rare occurrence based on the history of other net applications; however the cost and operational impacts of being prepared for such an operation would not be negligible. The equipment and procedures involved are quite complex and the District would have to periodically practice retrieval operations in order to be adequately prepared to retrieve someone if necessary. Assuming retrieval operations are practiced once a month, require six staff (2 ironworkers, 2 operating engineers and 2 Bridge Patrol personnel) and last two hours, this corresponds to 12 hours or 720 minutes of lost productivity per month which corresponds to 32.8 minutes of lost productivity per day (720 minutes/month / 22 days/month).

The cost to maintain snooper trucks would also be an additional cost. It is estimated that 1 mechanic would spend 6 days per year on mandated inspections and the annual certification of the snooper trucks, plus 1 mechanic would spend 6 days per year maintaining the snooper trucks.

This corresponds to 12 days per year or 8 hours per month or 22 minutes per day (8 hours/month * 60 minutes/hour / 22 days/month) of required additional resources.

It is important to note that the use of snooper trucks would be limited within approximately 300 feet of either side of mid-span. Rescue of victims from this area would require specialized and highly technical "suspended rescue" techniques. Operation of snooper trucks would also be prohibited during severe wind conditions.

Although not a cost to the District, traffic congestion and motorist delays are a possibility associated with a net rescue. The deployment of the snooper truck would require the closure of a traffic lane, reducing vehicular capacity on the Bridge during the incident. Depending on the time of day (lane configuration in place and traffic demand) this may result in significant delay to the motoring public. In addition, the Bridge sidewalk would need to be closed in the vicinity of the snooper truck during such an operation.

The normal working hours for operating engineers and ironworkers, who would participate in a response, is from 7:00 a.m. to 3:30 p.m., Monday through Friday. Any rescue operation outside normal work hours, such as on weekends, would require that operating engineers and ironworkers be contacted and travel to the Bridge in order to participate in a response. These employees reside in locations at varying distances from the Bridge, so call-out and response times on weekends or after-hours could be several hours.

Maintenance of Suicide Deterrent System – Steel Components

The steel components for Alternatives 1A, 1B, 2A and 2B will be fabricated then hot-dipped galvanized and painted in order to protect the steel from corrosion (or rust). Minor painting "touch-up" would be an ongoing minor effort. It is anticipated that an entire repainting (over-coating) would need to occur in 15 to 20 years. The support beams for Alternative 3 would be similarly galvanized and painted. The netting for Alternative 3 would be marine-grade stainless steel with a colored plastic coating; this will provide a long service life with minimal maintenance of the netting material.

Cleaning of Suicide Deterrent System – Transparent Panels (Alternatives 1A, 1B, 2A & 2B)

The transparent panels and winglets introduce new materials and new maintenance requirements. The very purpose of the transparent panels at mid span, the towers and at the belvederes is to provide an opportunity for photographs to be taken with people on the Bridge with the un-obscured landscape as the backdrop for the photograph. This will create expectations that these transparent panels be sufficiently clean for this purpose, necessitating regular cleaning. The climactic conditions at the Bridge (e.g. fog and drizzle) would increase the frequency of cleaning necessary to maintain adequate clarity for photographic purposes, perhaps two or three times per week.

It is anticipated that the transparent panels can be cleaned using pressure washers and hand cleaning tools with extension capability. Water is not available on the span, so water will have to be delivered to the sidewalks via tanks towed by scooters. Access to the outer face of these panels would be through the access gates via the traveler or top chord (while tying off to the proposed permanent safety cable).

Access to the outer face of the transparent panels at tower locations can not be achieved using the traveler or truss top chord. For these locations, one of two methods is proposed. The first method would be to install a temporary work platform, using rigging attached to the transparent panel framing and/or sidewalk support framing. An alternative method would be to access the outer face via a traveling vertical scissor lift device such as those manufactured by Genie, Inc (see photograph at right). This device is self-driven and would travel on the sidewalk, allowing access to the top of the panels. Once at the top, a worker could use a fully-extended hand cleaning tool to reach the transparent panel outer surface. This technique could also be used to clean the outside of the transparent panels at the belvederes.

If possible, to simplify cleaning the outside face of the transparent panels, the panels would be designed to either rotate about a horizontal axis or hinge, or swing into the sidewalk. This would allow the outside surface to be cleaned directly from the sidewalk.

It is anticipated that cleaning the transparent panels at mid span, the towers and the belvederes would require two full-time equivalent positions which corresponds to 960 minutes per day (16 hours * 60 minutes/hour) of required additional resources.

Cleaning of Suicide Deterrent System – Winglets (Alternatives 1B and 2B)
Winglets would not need to be cleaned as frequently as the transparent panels at mid span, the towers and belvederes, since they serve a different function.

A traveling vertical scissors lift device is recommended for use in cleaning transparent winglets for Alternatives 1B and 2B. The lift device would be a benefit to other maintenance activities, including providing access to the cable boxes or "Spider" platforms (see discussion under "Cleaning and Painting Operation" below). Water is not available on the span, so water will have to be delivered to the sidewalks via tanks towed by scooters. The nature of this activity would require that it occur when the sidewalks are closed to bicyclists and pedestrians.

The proposed total length of the winglets on the east and west sides is 3.5 miles. It is anticipated that it would require 2 workers for 3 days per month to clean the winglets. This corresponds to 48 hours per month or 130 minutes per day (48 hours/month * 60 minutes/hour / 22 days/month) of required additional resources.

Cleaning of Suicide Deterrent System – Nets (alternative 3)
Alternative 3, the horizontal netting system, will introduce a new debris removal activity. The net will incorporate a grid between 4 and 10 inches, the actual size to be determined during final design. The larger size would allow many common items, such as cameras, to pass through the net and fall to the water similar to what happens if a camera is dropped today. A smaller grid would capture more debris.

In addition to pedestrians dropping items into the net, debris from the roadway may accumulate in the horizontal net system. The Bridge is located at a windy site and lightweight debris may be blown onto the net. However, this lightweight debris which has been transported into the net by wind may similarly be removed from the net by the wind.

The net is most visible from the sidewalks at the towers (see photograph at right). Thus, along the majority of the length of the net, where it is not readily visible to the public, a once every three month cleaning interval would likely be adequate. However, the approximately 200 foot long length nearest the towers would be very visible, necessitating that this area be more regularly cleaned. The required frequency of cleaning to satisfy public expectations of cleanliness is unknown at this time, since we do not have any basis to estimate how quickly trash will accumulate in these segments of the net. However, it will require that manpower resources be allocated to this task. It is anticipated that it would require 2 workers for 5 days per month to clean the nets. This corresponds to 80 hours per month or 218 minutes per day (80 hours/month * 60 minutes/hour / 22 days/month) of required additional resources.

The snooper truck which would be used for emergency operations with the net can be used to clean debris from the net. However, the snooper for emergency operations requires a single lane closure. In order to avoid traffic impacts associated with trash removal the District should purchase a second, smaller sidewalk-sized snooper (see photographs above) for debris removal operations. The cost of the smaller snooper truck is also included in the project cost estimate. As previously discussed the use of snooper trucks near mid-span is limited. Alternate methods will be used for cleaning the nets at these locations.

Cleaning and Painting of Suspender Ropes

As previously discussed, District workers currently rig the cable boxes and Cable Master from the sidewalk and the outer traveler, and workers access the cable box via a step ladder from the sidewalk (see photograph at bottom left). The construction of Alternatives 1A, 1B, 2A or 2B will impact the installation and utilization of the cable boxes and Cable Master currently used to paint suspender ropes (see photograph at bottom right). Access to and attachment of these devices will be at an elevation 10 feet or 12 feet above the sidewalk. Current attachment and rigging devices and techniques will need to be modified accordingly, and access will need to be via the portable scissors lift unit previously described.

While these impacts will have a negative effect on productivity, the cleaning and painting of the suspension system is not a regular daily maintenance activity, so the cost impact is not significant.

VII. Summary

The introduction of any of the physical suicide deterrent system alternatives will impact Bridge maintenance and operations. These impacts can be minimized through a combination of new equipment and staff resources. The purchase of the equipment can be included in the capital budget for the project, while the additional staff costs will require an increase to the annual operating budget.

The table on the following page summarizes the operations and maintenance impacts as measured in lost productivity and additional required resources as compared to the existing situation.

		Alternative 1A	Alternative 1B	Alternative 2A	Alternative 2B	Alternative 3
A	**Planned Maint. with Taller Railings**	672 minutes per work day	672 minutes per work day	672 minutes per work day	672 minutes per work day	
B	**Planned Maint. With Fairings**	226 minutes per work day		226 minutes per work day		
C	**Planned Maint. With Nets**					60 minutes per work day
D	**Emergency Operations**					33 minutes per work day
E	**Maintain Snooper Trucks**					22 minutes per work day
F	**Clean Transparent Panels**	960 minutes per work day	960 minutes per work day	960 minutes per work day	960 minutes per work day	
G	**Clean Winglets**		130 minutes per work day		130 minutes per work day	
H	**Clean Nets**					218 minutes per work day
	Total	1,858 minutes per work day	1,762 minutes per work day	1,858 minutes per work day	1,762 minutes per work day	333 minutes per work day

The table below summarizes the annual cost of these operations and maintenance impacts based on current salary and benefit rates for the specific job classifications impacted.

		ALTERNATIVES				
	Description	***1A***	***1B***	***2A***	***2B***	***3***
A	**Planned Maintenance w/Taller Railings** **15.23 Hrs/Month/FTE** **# FTE affected: 16 FTE** Salaries & Benefits	$ 194,471	$ 194,471	$ 194,471	$ 194,471	
B	**Planned Maintenance w/Fairings** **10.25 Hrs/Month/FTE** **# FTE affected: 8 FTE** Salaries & Benefits	$ 65,287		$ 65,287		
C	**Planned Maintenance w/Nets** **10.92 Hrs/Month/FTE** **# FTE affected: 2 FTE** Salaries & Benefits					$ 16,526
D	**Emergency Operations** **2 hrs/Month/FTE** **# FTE affected: 6 FTE** Salaries & Benefits					$ 8,514
E	**Maintain Snooper Trucks** **8 Hrs/Month/FTE** **# FTE affected: 1 FTE** Salaries & Benefits					$ 5,658
F	**Clean Transparent Panels** **174 Hrs/ Month/FTE** **# FTE affected: 2 FTE** Salaries & Benefits	$ 205,832	$ 205,832	$ 205,832	$ 205,832	
G	**Clean Winglets** **24 Hrs/Month/FTE** **# FTE affected: 2 FTE** Salaries & Benefits		$ 28,391		$ 28,391	
H	**Clean Nets** **40 Hrs/Month/FTE** **# FTE affected: 2 FTE** Salaries & Benefits					$ 47,318
	TOTAL COST	**$ 465,589**	**$ 428,693**	**$ 465,589**	**$ 428,693**	**$ 78,016**