Utility Tunnel Evaluation and Repair Study
University of Wisconsin Green Bay
Green Bay, Wisconsin

Division Project No. 08E3N

September 29 2008

FOR

THE STATE OF WISCONSIN
DEPARTMENT OF ADMINISTRATION
DIVISION OF STATE FACILITIES
STATE OF WISCONSIN ADMINISTRATION BUILDING - 7TH FLOOR
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Purpose

The purpose of this study is to evaluate the current condition of the utility tunnel piping systems, areas of water infiltration in the tunnel and overall structural condition of the entire tunnel. Construction and engineering costs will be applied to each item evaluated.

The following are areas of evaluation:

1. Tunnel structural deterioration (Concrete spalling).
2. Tunnel water infiltration through cracks.
3. Chilled water insulation condition.
4. Steam/condensate insulation condition.
5. Expansion joint insulation.
6. Chilled water pipe support integrity.
7. Steam/condensate support integrity.
8. Air pipe support integrity.
9. Expansion joint lubrication extensions.
10. Miscellaneous structural and mechanical repairs.

Tunnel Structure Condition Survey
(Strand evaluation of cracks and spalling)

Site Visit

On June 13, 2008, David Rice, P.E., structural engineer with Strand Associates, Inc. accompanied Chris Hatfield-Director of Facilities Management, Dennis Bailey-Power Plant Superintendent and two representatives from Ring and DuChateau, Inc. Dave Del Ponte, P.E. and Brian Pheifer on a walk-through visual observation of the entire length of utility tunnel from the heating/cooling plant to the tunnel termini at the Phoenix Sports Center, Cofrin Library, Laboratory Sciences building, Student Services building, and Theatre Hall. The purpose of the walk-through was to observe the condition of known defective items in the tunnel. Following the initial walk-through, Ring and DuChateau did another walk-through that day to record more detailed observations. Detailed observations from the walk-through are summarized in the "Existing Utility Tunnel Conditions" Chart (Appendix A).

Background Information

The existing tunnel was constructed in 1970. It extends from the heating/cooling plant south of campus to the four building noted above, and covers a total length of approximately 6100 lineal feet. The main trunk is approximately 4900 feet long and three branches make up the remaining length. The south end of the tunnel passes beneath a service road adjacent to the plant and beneath the eastbound and westbound lanes of state trunk highway (STH) 54/57. It also passes beneath service roads and pedestrian walks beneath the campus grounds.

The tunnel is a cast-in-place reinforced concrete structure with a 7-foot clear ceiling height and a 10-foot clear inside width. According to design drawings dated 1971 and prepared by the Wisconsin Department of Administration Bureau of Engineering, the tunnel walls and floor are 8 inches thick and the roof varies from 10 inches thick at the edges to 12 inches thick at the crown. The drawings indicate that no waterproofing or insulation was provided on the outside faces of walls, roof, and floor. According to the drawings, the depth of earth cover over the tunnel varies from approximately 2 to 8 feet, with a typical average cover of 3 to 5 feet.

According to as-built highway plans for the reconstruction of STH 54/57 dated October 1994, the depth of cover over the tunnel beneath the eastbound lanes STH 54/57 is approximately 6 feet and the depth of cover under the west bound lanes is about 2 to 3 feet. The highway reconstruction project included placement of fill and new concrete pavement construction for the eastbound lanes and placement of an asphaltic overlay over the westbound lanes.
The depth of fill added over the tunnel for the eastbound highway construction was approximately 4.7 feet.

Structural Load Capacity

Strand Associates performed structural calculations and concluded that if the tunnel was constructed in accordance with the record drawings provided to us, the tunnel walls and roof have sufficient load capacity to support the earth loads and HS20 vehicle live loads acting on it. In performing these calculations, it has been conservatively assumed that concrete strength is 3000 psi and reinforcing grade is Grade 40. The drawings indicate the floor slab was reinforced with only a single bottom mat or reinforcing. Calculations indicate the floor slab would be overstressed under the action of earth loads, and should form a longitudinal crack extending down the middle of the tunnel for its full length. This type of crack was in fact observed for a significant portion of the tunnel. With the formation of this crack and lack of any flexural strength in the floor slab, theoretical soil bearing pressures beneath the floor slab under the walls are quite high and differential settlement between the edges and center of the floor would be expected to create a high point in the middle of the floor and a cross slope each side of centerline. Despite what the calculations may indicate, the structure appears in reality to be structurally adequate to resist the earth and live loads, and has done so for almost 40 years.

Field Observations

In general, the June 13, 2008 tunnel walk-through revealed many transverse cracks in the ceiling and walls of the tunnel. Many of the cracks had water dripping steadily through them, and in some cases the drips were connected to form a steady stream of water. The dripping water leaked onto the floor and pipe insulation below. Efflorescence was visible at some of the cracks, where incoming moisture has transported salts from within the concrete ceiling through the cracks and deposited those salts onto the ceiling. In many locations, these migrating salts have the appearance of stalactites.

In some limited areas, primarily beneath STH 54/57, minor to severe spalling in the ceiling was observed. Also, longitudinal cracks were observed running down the middle of the floor over a significant length of the tunnel.

In the days and weeks preceding our June 13, 2008 tunnel walk-through, the Green Bay area had received record rainfalls and an extended period of rain that lasted for weeks. This provided an excellent opportunity to view the extent of cracks and moisture leaking into the tunnel. A campus plant utility employee who accompanied us and who walks the tunnel on a fairly regular basis commented that he did not recall ever seeing that amount of water inflow into the tunnel.
He did say that the tunnel leaks on a regular basis, especially in the Spring after snow melts.

Ring and DuChateau recorded the locations of cracks in tunnel walls and ceiling and rated the leakage through these cracks on a scale of '1' to '5', with '1' representing minor leakage and '5' representing heavy leakage.
Of the total cracks observed, about 50-60 percent were rated a '1' or '2', and about 10 percent or less rated a '4' or '5'. Crack quantities are summarized in "Existing Utility Tunnel Conditions" spreadsheet (Appendix A).

Transverse cracks typically extend across the full width of the ceiling, which is 10 feet wide. The ceiling crack spacing varies, but is on generally on the order of about 8 to 12 feet on center. Wall cracks generally exist in the upper two or three feet of wall. The width of wall and ceiling cracks varied from hairline to about 1/16-inch thick.

Assuming the tunnel structure was constructed in accordance with the details provided on the record drawings, it should have adequate capacity to support the earth loading and vehicle loading from the highway above. It is our opinion that the spalling is not an indication of lack of adequate structural capacity but rather is the result of corrosion of the reinforcing causing the spalling to occur.

Discussion of Structure Defects

The ceiling and wall cracks appear to be temperature and shrinkage cracks which do not affect the structural integrity of the tunnel. They do, however, allow introduction of water and moisture into the tunnel which has saturated the pipe insulation and corroded piping and pipe supports. Shrinkage cracks are to be expected in a structure like this, but the extent and frequency of them is surprising.

It is our opinion that the spalling in the ceiling areas of the tunnel is not indication of a lack of adequate structural capacity but rather is the result of water entering the cracks and corroding the reinforcing bars, which have then expanded and cracked or popped the surface of the concrete off. The corrosion is more prone to occur where chloride ions are carried in the water, as occurs on bridge decks from salting operations in the winter. Given the amount of earth fill over the tunnel beneath the roadways, the affects of salting would seem to be lessened due to the filtering effect of the soil.

The corrosion and spalling is a structural issue only to the extent that the reinforcing bars lose cross sectional area. The concrete on the bottom half of the ceiling is expected to be cracked and spalled and is not counted on for strength as a part of normal practice in design. As long as the reinforcing bars have experienced little or no section loss, the load capacity of the ceiling should remain intact. To the extent the reinforcing lose section due to further corrosion; the load capacity will be directly affected.

Tunnel Repair Options

In order to address spalling on the ceiling of the tunnel, the loose and spalled areas of concrete need to be removed by chipping back to sound concrete. Then, the exposed reinforcing bars should be cleaned, and an epoxy-modified cementitious anti-corrosion coating such as Sika Armatec 110, or equal, should be applied to the exposed reinforcing steel. Following that, a corrosion inhibiting coating such as Sika FerroGard 903, or equal, should be applied to the sound concrete. The coating will penetrate the surface and serve as a protective layer to inhibit further corrosion caused by the presence of chlorides or carbonation within the concrete. An overhead patching should then be applied to repair the spalled area(s).

The extent of rebar corrosion and unsound concrete will not be known until the unsound concrete is removed and the rebar exposed during the repair operation. Even then, rebar corrosion may extend beyond the limits of unsound concrete into areas of sound concrete and thus would not be visible. Hopefully, the depth of unsound concrete will be such that overhead patching as described above will be an appropriate repair. It is our opinion that it should be. If unsound areas extend through a significant portion of the slab or wall thickness, full depth repair might be warranted in those areas. Temporary shoring and forming would then be required. The project structural engineer should have the opportunity to view the repair areas during construction to determine in cooperation with the contractor and Owner the most appropriate methods of repair when the deteriorated areas are fully exposed.

There are several approaches to addressing the cracking in the tunnel. They include (1) Do nothing, (2) Remove earth cover and provide sheet or spray-applied waterproofing to the outside surfaces of the tunnel, (3) Inject cracks with polyurethane foam grout or epoxy from inside the tunnel, and (4) Rout cracks open and apply a crystalline waterproofing product to them from inside the tunnel.

Each of these options is discussed further in the following paragraphs.

(1) Do Nothing - This option will result in continued water migration through cracks into the tunnel, which will cause continued saturation of pipe insulation and corrosion of piping and supports in addition to corroding reinforcing. This corrosion could lead to the need for costly replacement of steam and condensate piping and supports sooner than would otherwise be required plus structural deterioration. While the initial cost would be zero, the costs over time could be higher than other options and offers the risk of compromising the operability, integrity, and safety of the plant piping systems.

(2) Exterior Sheet or Spray-applied Waterproofing - This option provides the best means to protect the reinforcing steel from further corrosion and would provide the most reliable shield against water ingress. However, it would disrupt traffic at locations where the tunnel passes beneath STH 54/57 (both eastbound and west bound lanes) and beneath numerous campus service roads and sidewalks since it

requires open excavation to expose the top of the tunnel for waterproofing. There are also power and signal duct banks installed on top of and adjacent to the tunnel making external waterproofing more difficult and the use of sheet waterproofing potentially less viable. This option would also have the highest initial cost due to the significant amount of excavation and backfill, the cost of the waterproofing itself, the cost of repairing roads and surface restoration, and the costs of traffic control for the portion that passes beneath STH 54/57 and the other service roads. The waterproofing products used could include a sheet product such as Grace Bituthene 4000, or equal, or a spray applied below-grade waterproofing product such as Grace Procor, or equal.

The area from station K through stationing M (Approximately 800 feet) is the portion of the tunnel with the most significant cracks and moisture infiltration. Consideration may want to be given to addressing leak repairs in this area or a portion of this area via this method. We are including an estimated cost for this area as an alternative. The estimated cost for this area is estimated at $500 per foot or $400,000.

(3) Injection of Polyurethane Foam grout – Polyurethane foam grout is a product that has been in existence for at least 25 years and is used to seal cracks in concrete. The product has an advantage over epoxy in that it is flexible and will allow movement without cracking. On the other hand, epoxy is rigid and there is a possibility that new cracks could form adjacent to cracks that have injected with epoxy. One drawback to polyurethane foam grout is that it has a tendency to shrink slightly over time, which could result in sealed cracks leaking again after a number of years. If that occurred, they could be re-injected to correct the leaks. The injection process involves drilling holes and installing injection ports at intervals along the length of a crack. The foam grout or epoxy is then injected into the ports starting from the lowest port and working upward until material oozes out of the adjacent port that has not yet been injected. The injection process has the potential to seal cracks through the full thickness of a wall or slab. That offers the advantage of helping to prevent water from reaching the reinforcing steel from the outside, and thus helps slow or halt the process of corrosion. It is anticipated that all leaks cannot be 100% sealed and that additional cracks will form over time in the tunnel.

(4) Crystalline waterproofing from inside – Crystalline waterproofing is a proprietary cementitious waterproofing product that contains special chemicals that promote the growth of crystals in concrete in the presence of water. This class of product was developed 40-50 years ago in Europe and has been used in the United States for at least 20 years. Manufacturers include Xypex, Hey'di, and Vandex, and others. In a tunnel waterproofing application, a 1-inch square groove would have to be routed in the surface of the concrete along the cracks, and then a dry-pack formulation of the crystalline waterproofing product applied to fill the groove. Any water that enters cracks from outside would theoretically initiate the formation of crystals which would seal out further water ingress. However, since the product would extend 1-inch past the inside face of walls and ceiling, it would not protect the reinforcing steel from exposure to water.

The piping inside the tunnel, particularly along the west wall of the main tunnel occupies about one-third of the tunnel width and is located fairly close to the ceiling. Access to the ceiling above the piping and to the wall behind the piping will make crack repairs using either crystalline waterproofing or injection in those areas difficult or impossible.

Tunnel Repair Costs

According to Jon Downs of Concrete and Masonry Restoration LLC, who has had extensive experience with crack repair using epoxy and polyurethane foam injection as well as crystalline waterproofing applications, rough unit costs for both polyurethane foam injection and the crystalline waterproofing options would be in the $28 to 32 per lineal foot range. According to Jon, rough costs for membrane waterproofing from outside the structure would be in the $4 to $8 per square foot range. The latter would not include any other costs associated with that option such as traffic control, earthwork, pavement reconstruction, and surface restoration.

Applying these unit prices to the crack quantities listed in the table above, and assuming ceiling cracks extend the full width of the tunnel and wall cracks extend 3 feet down each side of tunnel, the total length of observed cracks for the entire tunnel system measures about 4800 lineal feet. At a unit cost of $28 to $32 per square foot, the total cost of crack repairs would be $135,000 to $155,000. The work could be scaled down to address the areas of more active leaks, and could be performed in a phased manner over several years if desired.

For the external waterproofing option, assuming waterproofing was applied over the entire roof slab and for the full height of each wall, and assuming the full 6100 lineal foot length of tunnel is waterproofed, this would result in a total waterproofing area of 173,000 square feet. At a unit price of $4 to $8 per square foot, the cost of waterproofing alone, not including earthwork and other related items mentioned above would be about $700,000 to $1,400,000. This is more than five to ten times the cost of the crack repair options for waterproofing only. Total cost could be in the $400 to $600 per foot range ($2,500,000 to $4,000,000).

Tunnel Non-Structure Condition Survey

Pipe Insulation

The tunnel environment is considered to be extremely wet and humid. Water was 1" to 2" deep in numerous locations during the extremely wet weather. While leaks had subsided during a second visit, moisture in the tunnel was still at a very high level. There were still areas with wet conditions and standing water on the tunnel floor.

Tunnel temperatures were taken at several locations to assess the severity of the environment. Conditions in the tunnel varied significantly depending on location. There were temperature variations of approximately 20 degrees between the floor and ceiling. Based on these measurements is what observed that moisture is condensing on surfaces with temperatures as high as 75 degrees.

Control of moisture penetration to the greatest degree possible as described previously in this report is necessary to protect the insulation integrity.

Tunnel entrance points are vented but they offer little ventilation or air movement for effective drying of the tunnels. Improved ventilation is not considered a solution to the wet conditions in the tunnel although it could provide a slight degree of improvement in those conditions.

Chilled water supply temperature at the time of the survey was recorded at 39.4 degrees.

All of the chilled water pipe examined had 1½" thick insulation. The majority of insulation was glass fiber with an all service jacket. The remaining insulation was polyisocyanurate with a PVC jacket.

Water from ceiling tunnel cracks drips on the chilled water, steam, and pumped condensate insulation. Sheets of tar paper were placed on the pipes under the cracks to protect the insulation. In some case the moisture leaking through the cracks has been so significant that the tar paper is deteriorating. The tarpaper is not placed below all cracks.

Moisture was observed condensing on the bottom one third to two thirds of the chilled water insulation through out the tunnel during both visits. The insulation between the all service jacket and pipe is saturated at the bottom third of the pipe. The ability of the all service jacket to function as a reliable vapor barrier has deteriorated over time due to age, penetrations, moist environment and breeches in the jacket to the point where the barrier is not considered viable. There are also numerous locations of mold formation on the pipe jacketing.

While all of the chilled water insulation has been compromised by moisture the degree varies throughout the length of the system. Certain areas are in worse condition than other locations. Areas could be prioritized if necessary but all the insulation is recommended to be replaced.

Insulation on the steam and condensate piping has been compromised in numerous locations by the dripping water through the cracks. Tarpaper has been draped over some sections of the existing pipe insulation in an effort to protect it from damage. The insulation is considered to be in good condition but a PVC jacket should be considered for long term protection. It should be noted that there is an underlying layer of asbestos insulation on the existing piping.
Expansion joints were observed to be in an un-insulated condition. New removable insulation jackets should be provided.

Pipe Supports
Pipe supports are generally in good condition but there are some areas of concern which should be addressed.

Steel chilled water supports at main takeoffs have severe corrosion which should be removed to bare metal and painted.

Deterioration of steam strut supports and air pipe supports has occurred due to either high humidity levels in the tunnel or leakage through ceiling cracks directly above the supports. Some supports will need to be replaced, repaired or repainted depending on the severity of the deterioration. Repair of the tunnel leaks should be done prior to support repair to minimize further impacts. There are some supports which should also be raised onto concrete pads.

Miscellaneous Items
Currently expansion joint points of lubrication are difficult to get to and pose the problem of an individual getting burned in order to lubricate. For safety reasons extension of the lubrication points should be provided.

Water was also discharging into the tunnel through drains from the adjacent power and signal vaults. This further exacerbates the wet conditions in the tunnel. It is recommended that these be plugged and piped to sump pumps.

Sump pump gratings are corroded and in a deteriorating condition and should be replaced.

Ladders are generally in good condition but are showing signs of corrosion and should be repainted.

There is a Manhole at the end of the tunnel near Environmental Sciences that leaks and shows signs of significant roof deterioration. This should be rebuilt.

There is a condensate pipe anchor near Environmental Sciences that has failed and needs to be rebuilt. This is not considered to be an immediate safety risk.

The compressed air pipe is corroded in several locations where moisture is leaking in through cracks. The rust should be removed and the pipe painted. A portion of the pipe (Estimated at 25%) has already been painted by plant personal over the years. It is suggested that the entire remaining length of air pipe be painted to prevent any further corrosion.

There is an existing secondary pump at station 2080 which is no longer used. Jumper piping has been installed but the pump is not physically disconnected from the system. Prior to any re-insulation the piping should be physically disconnected from the active system so as to minimize insulation of abandoned piping.

Due to the extensive moisture infiltration there is considerable sediment accumulation/deposits in the tunnel. It is suggested that the tunnel be cleaned upon completion.

Re-Insulation Energy/Dew Point Evaluation

Based on the observations of the conditions in the tunnel we would classify the tunnel as a severe environment for controlling condensation on the insulation of chilled water piping.

Mold, surface condensation, moisture dripping onto insulation and breeches of the vapor barrier the chilled water jackets have all contributed to compromising the insulation.

Replacement of the insulation with an appropriate insulation and jacket is recommended to prevent corrosion of the chilled water piping, maintain system energy efficiency, protect insulation from incoming moisture, and control mold growth.

An elastomeric insulation with a 20 mil PVC jacket should be considered along with a fiberglass insulation system similar to Owens-Corning "VaporWick". Further evaluation of appropriate materials should be done. A test of performance on 20 foot lengths of pipe is suggested to better evaluate the long term performance of the insulation in this environment.

Increasing the thickness of the insulation from 1½" to 2" is recommended primarily to raise surface temperatures to help reduce surface condensation. The premium cost for the additional ½" of insulation is approximately $120,000- $240,000 depending on the type of insulation used.

A secondary benefit of the increased thickness is an improvement in energy efficiency. The energy savings for increasing the thickness of the insulation from 1½" to 2" is estimated at approximately $2000 per year.

There is also energy savings when replacing the existing 1 ½" of moisture laden insulation with new 1 ½" of non moisture laden insulation. It would be extremely difficult to come up with an accurate estimate of this savings but it would be considered very significant due to the current saturated condition of the existing insulation.

Executive Summary

The long term viability of a utility tunnel is significantly dependent upon the ability to prevent external moisture migration into the tunnel. Moisture migration is considered very severe in this tunnel and needs to be addressed in the near future to avoid long term major deterioration of the structure. Tunnel repairs would be considered the highest priority. Repairs at this time are estimated to run in the $70 to $80 per foot of tunnel. Structural replacement of the tunnel or portions of the tunnel would cost well over $1000/foot and could be several thousand dollars per foot in today's dollars.

Damage to the chilled water pipe insulation is very significant and should also be addressed to avoid pipe corrosion and energy loss.

The projected cost for re-insulation and noted other non structural tunnel repairs is approximately $350 to $400/foot. Replacement of the chilled water pipe alone is estimated to be approximately $1500 per foot in today's dollars.

Appendix

i. Tunnel Plan

ii Tunnel Section

iii. Existing Utility Tunnel Conditions

iv Probable Construction Costs

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Existing Utility Tunnel Conditions									
		TUNNEL LEG (Station)							
Item	Description	A-H (0'-1805')	H-L (1805'-2730')	L-P (2730'-3625')	P-U (3625'-4884')	Sports Branch (0'-495')	Branch I-I2 (0'-540')	Library Branch (0'-166')	***Total***
1A	Tunnel Spalling-Large	3	0	0	0	0	0	0	***3***
1B	Tunnel Spalling-Medium	3	0	0	0	0	0	0	***3***
1C	Tunnel Spalling-Small	5	0	2	4	0	3	1	***15***
2A	Tunnel Leaks-Ceiling	88	59	26	57	85	0	1	***316***
2B	Tunnel Leaks-Wall	1	7	3	8	0	23	0	***42***
2C	Tunnel Leaks-Ceiling & Wall	31	16	27	20	6	0	0	***100***
3	Chilled Water Insulation	3610 LF	1850 LF	1790 LF	1259 LF	990 LF	1080 LF	332 LF	***10911***
4	Steam/Condensate Jacket	3610 LF	1850 LF	1790 LF	1259 LF	990 LF	1080 LF	332 LF	***10911***
5	Expansion Joint Insulation	14	10	6	14	4	4	4	***56***
6	Chilled Water Support-Paint	4	2	4	4	2	0	0	***16***
7A	Steam Support-Concrete Base	1	0	0	44	0	0	16	***61***
7B	Steam Support-Paint	11	10	5	45	32	60	16	***179***
8	Air Supports	8	1	9	0	0	0	0	***18***
9	Exp Joint Lube Extension	14	10	6	14	4	4	4	***56***
10A	Vault Drain	14	8	16	0	0	0	0	***38***
10B	Sump Grate-Replace	2	2	1	4	0	0	0	***9***
10C	Ladder-Paint	1	2	1	1	0	0	0	***5***
10D	Not Used								
10E	Anchor Repair	0	0	0	0	0	1	0	***1***
10F	Paint Air Pipe	1805	925	895	630	495	540	166	***5456***
10G	Disconnect Pump Piping	0	1	0	0	0	0	0	***1***

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Probable Construction Costs					
Item	Description	Quantity	Total Lin. Ft.	Unit Cost	Total Cost
1A	Tunnel Spalling-Large	3	0	$ 15,000.00	$ 45,000.00
1B	Tunnel Spalling-Medium	3	0	$ 10,000.00	$ 30,000.00
1C	Tunnel Spalling-Small	15	0	$ 5,000.00	$ 75,000.00
2A	Tunnel Leaks-Ceiling	316	3200	$32	$ 102,400.00
2B	Tunnel Leaks-Wall	42	250	$32	$ 8,000.00
2C	Tunnel Leaks-Ceiling & Wall	100	1600	$32	$ 51,200.00
3	Chilled Water Insulation	0	10911		$ 945,000.00
4	Steam/Condensate Jacket	0	10911		$ 94,800.00
5	Expansion Joint Insulation	56	0	$ 1,200.00	$ 67,200.00
6	Chilled Water Support-Paint	16	0	$ 1,000.00	$ 16,000.00
7A	Steam Support-Concrete Base	61	0	$ 400.00	$ 24,400.00
7B	Steam Support-Paint/Repair	179	0	$ 1,000.00	$ 179,000.00
8	Air Supports	18	0	$ 300.00	$ 5,400.00
9	Exp Joint Lube Extension	56	0	$ 300.00	$ 16,800.00
10A	Vault Drain	38	0	$ 5,000.00	$ 190,000.00
10B	Sump Grate-Replace	9	0	$ 300.00	$ 2,700.00
10C	Ladder-Paint	5	0	$ 300.00	$ 1,500.00
10D	Not Used				$ -
10E	Anchor Repair	1	0	$ 1,000.00	$ 1,000.00
10F	Paint Air Pipe	0	5500	$ 2.00	$ 11,000.00
10G	Disconnect Pump Piping	1	0	$ 20,000.00	$ 20,000.00
10H	Miscellaneous (Tunnel Cleanup)				$ 50,000.00

Total Construction		**$ 1,936,400.00**
OH & P	**15%**	**$ 290,600.00**
		$ 2,227,000.00
AE Fee	**8%**	**$ 178,000.00**
DSF Fee	**4%**	**$ 96,000.00**
Contingency	**8%**	**$ 178,000.00**
Total Project		**$ 2,679,000.00**