

MILWAUKEE WATER WORKS

MEETING OF

WATER PLANTS DIVISION AND WATER ENGINEERING DIVISION  
(Linnwood Tunnel Inspection Project)

Friday, November 7, 1986 - 8:30 a.m.

ATTENDED BY: Messrs. J. Wagner R. Kocol  
R. Stankiewicz W. Powers  
A. Wimes A. Simenc  
L. Dzioba K. Kellen  
G. Gruettner

Mr. Wagner opened the meeting and reported that the swing main was put into high service on October 29, 1986, and that we have been running with Riverside off line since October 31, 1986. We have experienced no problems with North Point and Howard maintaining system demand. Mr. Wagner stated that a meeting was held on November 3, 1986, with Water Engineering, Milwaukee Water Works, Health Department and Safety Commission personnel concerning the Linnwood tunnel inspection procedure. It was decided that the tunnel inspection would be treated as a Level 2 confined space entry. It was further agreed that those people entering the tunnel would receive a physical, a pulmonary test, respirator training, CPR training and first-aid training. Mr. Kocol contacted the Milwaukee Industrial Clinic and arranged for the physicals and pulmonary tests to be administered. Mr. Kocol stated that he would make arrangements for the respirator, CPR, and first-aid training as needed.

Water Engineering met with the Fire Department, and they have agreed to be at Riverside on November 18, 1986, fully equipped. The Fire Department indicated that their personnel would be the first to enter the tunnel.

The next topics were communications and safety equipment. The discussion on communications included use of walkie talkies, FM radios, cordless and hardwired phones. Mr. Simenc stated that the Fire Department preferred the use of mine safety approved communication equipment, but that a hardwire communication system in the tunnel may not be feasible. Water Engineering stated that they would pursue the acquisition of a suitable communication system.

With regard to safety equipment, Water Engineering stated that the Milwaukee Metropolitan Sewerage District will allow us to use one of their large air blower units. It was agreed that the Water Department will arrange for pick-up of this unit on November 13, 1986, and return it to MMSD upon completion of the inspection project.

The Water Works contacted the Fire Department and arranged for the use of a collapsible stretcher. Mr. Simenc reported that the stretcher has been picked up from Engine Co. 5 at 1313 West Reservoir Avenue and delivered to the Riverside Station.

Page Two  
Minutes - Water Plants Division  
and Water Engineering Division  
November 7, 1986

Mr. Wagner stated that the Water Works would arrange to have Distribution deliver a portable generator to the tunnel vent at [REDACTED] on November 17, 1986.

Mr. Wagner said that four back pack one-half hour respirator units will be delivered to Riverside during the week of November 10.

Mr. Simenc stated that the Fire Department will have body harnesses, gas monitors, hard hats with miner lamps and respirator equipment for tunnel entry on November 18, 1986.

The next topic concerned the acquisition of cranes and hoist equipment. After discussion, Mr. Simenc stated he would contact the Bureau of Municipal Equipment to try to obtain one or two cranes to be used for lowering personnel and equipment into the tunnel and as a means of evacuation in the event of an emergency. Mr. Wagner asked that he be contacted if a portable gantry and rental cable hoist will be needed.

The next topic was traffic control. The Water Works will post "no parking" signs and close [REDACTED] during tunnel inspection. As an added precaution and to assist in communications, the Water Works will post an employee and radio equipped vehicle at each of the two tunnel vent locations.

The next topic was tunnel manway accessibility. Plans were reviewed with regard to direct access from the surface manhole in the Riverside roadway to the bottom of the tunnel. Water Engineering requested that a section of the floor be removed from the wood deck level of the tunnel access chamber to eliminate a hatchway offset. Mr. Wagner stated that the Water Works will remove the wood floor as necessary to provide direct access.

Mr. Wagner stated that the Water Works will have rubber boots and walkie talkies available. In addition, the Water Works will fabricate a plywood manhole cover to cover the vent shaft [REDACTED]

The meeting adjourned at 9:45 a.m.

#### STATUS UPDATE NOVEMBER 10, 1986

The rental pump from Engineering was delivered on November 11, 1986.

Water Engineering will coordinate with the Bureau of Municipal Equipment to schedule two cranes for November 18, 1986. Communication equipment for the tunnel inspection will be sound powered hand sets (voice activated) manufactured by David Clark Company - model H-5042. This equipment is being purchased from Wardco Safety, Inc. (251-6730), G units by Water Engineering.

The Linnwood tunnel gate was closed at 9:18 a.m. on Monday, November 10, 1986. The manway covers in Riverside Station will be removed November 11, 1986, and pumps will be set for de-watering.

CITY OF MILWAUKEE, WISCONSIN  
DEPARTMENT OF PUBLIC WORKS

CONTRACT NO. C860314

CONTRACT for LT-10 Sealing of leaks in the Linnwood Tunnel

Location: Below Linnwood Avenue from Riverside Station to the Linnwood Purification Plant.

THIS CONTRACT, Made and entered into this 1st day of December, 1986, by and between - Pukall Co., Inc.

hereinafter called "Contractor", and the City of Milwaukee, a municipal corporation of the State of Wisconsin, hereinafter called "City".

WITNESSETH, That the parties hereto agree as follows:

The CONTRACTOR has made a proposal in writing to the Commissioner of Public Works of the City, hereinafter called "Commissioner", to furnish the material, equipment, labor and everything necessary for the completion of the work herein mentioned for the City, for the price and within the time hereinafter mentioned, and according to the contract documents therefore on file in the Department of Public Works, and the Commissioner has awarded the work to the Contractor according to law;

The CONTRACTOR, in consideration of the payments hereinafter provided, for himself, his heirs, executors and administrators, or for itself and its successors, as the case may be, hereby covenants and agrees to and with the City to well and truly execute and perform the work and furnish the material, under the superintendence of the Commissioner, for the price, and within the time, and according to the contract documents, which include:

Proposal, Dated N/A, See attached Time and Material/Equipment prices for work hereunder.

General Specifications of DPW dated May 1, 1984 and all addendums thereto

Detail Specifications of W.E.D. Project LT-10 Sealing of Leaks in the Linnwood Tunnel

DATED: November 25, 1986

Plans of Linnwood Tunnel (Reference only): T-38-1, 2, 5, 6, & 7,  
R-91-1 & 2

which contract documents are hereby made a part of this contract as though set forth in full at this point, that is to say:

For the Sealing of Leaks of the Linnwood Concrete Tunnel as specified and authorized per CC Res. #86-167a, adopted November 4, 1986.

Work to be done on a cost plus 15% basis for labor and materials. Labor rates to be based on the attached list. Material to be paid for on the basis of invoiced costs. Equipment to be paid for on the basis of the attached list or on the invoiced charge with no mark-up.

All to start on or about December 2, 1986

and the CONTRACTOR hereby agrees to and with the City:

- (1) to complete the work in manner and form aforesaid in the shortest possible time.
- (2) to abide by all statutes of the State of Wisconsin, and all applicable charter provisions and ordinances of the City of Milwaukee, and all amendments thereto, and all provisions of the contract documents;
- (3) to pay not less than the wage scale adopted by the Common Council of the City on March 25, 1969, Resolution File Number 68-1317, and amendments thereto, for all work under this contract.
- (4) to the following schedule of prices for extra work and credits:

N/A

and the CONTRACTOR agrees that he will save and indemnify and keep harmless the City against all liability, judgements, costs and expenses which may in any case come against the City in consequence of granting this contract.

IN WITNESS WHEREOF, the parties hereto have executed this instrument in quadruplicate under their several seals, the day and year first above written, the name and corporate seal of each corporate party hereto affixed and this instrument duly signed by its duly authorized representative.

Contractor Witnesses

\_\_\_\_\_  
CONTRACTOR (Seal)

\_\_\_\_\_  
Business Address

By \_\_\_\_\_  
Name Title President

\_\_\_\_\_  
Name Title Secretary

CITY OF MILWAUKEE

THIS CONTRACT WAS  
DRAFTED BY THE OFFICE  
OF THE CITY ATTORNEY

Countersigned:

*E/S* By \_\_\_\_\_  
Commissioner of Public Works

\_\_\_\_\_  
Comptroller

*MS*

PROJECT: LT-10 LINNWOOD TUNNEL  
REPAIRS

Time & Material Rates

Supervisor	\$34.78/hr (As required) 4 hrs./day max.
Cement Mason Foreman	\$27.99/hr.
Cement Mason	\$26.79/hr.
Laborer	\$24.64/hr.

Rental Equipment

Air Blower	\$22.00 per day
Air Heater	\$40.00 per day
Generator	\$40.00 per day
Hoist	\$40.00 per day
Material Cart	\$20.00 per day
Working Platform	\$50.00 per day
Construction Trailer	\$30.00 per day
Trucking	\$30.00 per day
Self Rescuers	\$10.00 each per day
Miners' Lamps	\$12.00 each per day
Chipping Hammers	\$17.00 each per day
Respirators, small tools, and other miscellaneous equipment	\$30.00 per day

Labor & Materials at Contractor's Cost plus 15% markup.

Pukall Co., Inc.  
Donald Pukall

130  
WPL

City  
of  
Milwaukee

Koccol

Department of Public Works  
Bureau of Engineers

January 23, 1987

B-19-2 LT-General  
Linnwood Tunnel

David A. Kuemmel  
Commissioner of Public Works  
John A. Erickson  
Deputy Commissioner of Public Works  
Edwin J. Laszewski, P.E.  
City Engineer  
Gerald J. Dew  
Assistant City Engineer

Department of Natural Resources  
P.O. Box 12436  
Milwaukee, WI 53212

Attention: Mr. Mark R. Ishihara

The inspection of the Linnwood Tunnel and any required repairs were mandated by your letter of September 20, 1985.

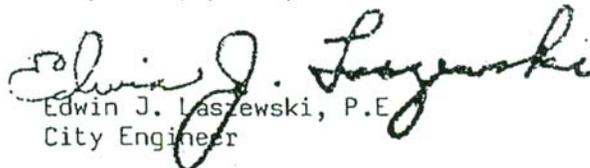
Our letter of October 31, 1986, informed you of our intent to inspect the tunnel during the week of November 17, 1986. Our letter of December 26, 1986, invited D.N.R. to inspect the tunnel before it was restored to service.

Since that date, the tunnel has been filled and chlorinated. Following a confirmation of a stable chlorine residual, the tunnel was dewatered and filled with water from the distribution system. After water samples are confirmed to be bacteriologically safe, the tunnel will be restored to service which is expected to be on or about Monday, January 26.

We are attaching one copy of the "Report of the Condition of the Linnwood Tunnel". The report concludes that the tunnel is in very good condition and has less leakage than would be expected of a new structure.

Please call Mr. Kenneth Kellen at 278-2421 if you have any questions with regard to the tunnel.

Very truly yours,

  
Edwin J. Laszewski, P.E.  
City Engineer

EJL:RJK:mal  
cc: D.A. Kuemmel  
H.J. Balconi

278-87  
1-27

REPORT ON THE CONDITION OF THE LINNWOOD TUNNEL

The Linnwood Tunnel Conveys water from the Linnwood Purification Plant to Riverside Pumping Station, along a route within the street lines of Linnwood Avenue. The shape is circular and the diameter is uniform at 9 feet throughout. The tunnel was constructed in 1921 and placed in service in 1924. Flow is controlled by a sluice gate located at the gate chamber at the Linnwood Plant. The tunnel terminates at Riverside Station in a gate chamber from which the station suction tunnel extends in a "T" shape. The tunnel and each side of the gate chamber is constructed with a sluice gate which, in combination with a sluice gate in the middle of the station, can isolate any of the sections. There ~~is~~ are manholes and an air vent at Lake Drive and at Oakland Avenue. The tunnel slopes downward from the Linnwood Plant to Riverside Station. See attached Drawings T-38-1, T-38-6, and WP-36-1. in the tunnel

After the sluice gate at the Linnwood Plant was closed, the tunnel was dewatered by pumps located in the sump at the gate chamber at Riverside.

The tunnel was inspected by Messrs. K. P. Kellen and R. J. Kocol of the Water Engineering Division on November 18, 1986. The inspection disclosed that the tunnel was in excellent to good condition. By sections, the tunnel condition was as follows:

A. <sup>#1</sup> The section ~~between Riverside Station and Lake Drive~~ a distance of 1450 feet, was in excellent condition. This section includes the segment under the river. The leakage observed was virtually zero.

B. <sup>#2</sup> The section ~~between Riverside Station and Lake Drive~~ a distance of 4210 feet, varied in condition. The section between ~~Riverside Station~~ and a point about 2/3 of the distance to ~~Lake Drive~~, about 2807 feet, was in very good condition. While it contained some pinhole leaks, the amount of leakage appeared to be very low. Between the 2/3 point and ~~Lake Drive~~ there were several longitudinal cracks in the top element and one crack at the spring line. There were a number of pinhole leaks in this section, all of which were small. the start of section #2

the end of the section

the end of the section

<sup>#3</sup> END of section 2

C. The section between ~~Riverside Station~~ and the sluice gate at the Linnwood Plant, a length of about 1341 feet, was in excellent condition. This section had a few pinhole leaks. There was a large stream of water emanating from the ceiling of the "Y" chamber at the sluice gates. Detailed plan review disclosed that this was a 2" pipe venting the "Y" gate chamber which was connected to the filtered water gatewell on the opposite side of the sluice gate. This vent was subsequently temporarily plugged in the gate well and at the outlet on the tunnel side during the repair period. The nine foot plus diameter sluice gate was relatively tight with an estimated leakage of 15 gallons per minute. The other sluice gate has a drained dry well behind it and it had no leakage.

A contractor specializing in sealing leaks was engaged to seal the leaks that existed. The work was completed on December 30, 1986. On December 30, the total leakage from the tunnel was then measured using a five gallon container and a stop watch. In five trials, the leakage was determined to be about 25 gallons per minute.

Assuming the leakage at the Linnwood Plant sluice gate to be 10 gallons per minute, the net tunnel leakage was 15 gallons per minute. This leakage occurs with no water in the tunnel. Under operating conditions, the internal pressure at the centerline varies between 10.5 p.s.i. at the sluice gate and 15.7 psi at Riverside Station with the Linnwood Clearwell at a normal level during minimum flow. This internal pressure will further diminish the inflow.

The tunnel was subsequently disinfected with chlorine and is expected to be restored to operation after safe water samples are confirmed, which is expected to be on or about January 23, 1987.

#### Evaluation Of The Final Leakage

In order to evaluate the magnitude of the leakage in the tunnel, a comparison between the leakage in the tunnel and that permitted in a new concrete containment structure such as the Howard Purification Clearwell has been made. The leakage is based on the leakage per square foot of wetted surface area and is as follows:

Howard Sta. West Clearwell = 0.35 gal. per sq. ft. per day

Tunnel:  $15 \text{ gpm} \times 60 \text{ min./hr.} \times 24 \text{ hr./ day} \div$   
 $(7,001 \text{ ft.} \times 9.0 \text{ ft.} \times 3.1416) = 0.1090 \text{ gal. per sq. ft. per day}$   
 This is less than 1/3 that permitted for the clearwell.

The leakage, expressed as a fraction of the flow in the tunnel when the flow is minimum and assuming the leakage is reduced by 30 percent due to internal pressure, results in the following data:

Leakage under operating conditions =  $15 \text{ gpm} \times .70 = 10.5 \text{ gpm}$

The minimum flow with the smallest pump operating at Riverside Station is 33 M.G.D.

Leakage as a ratio of the minimum flow =  $10.5 \text{ gpm} \div (33 \text{ mgd} \times 694 \text{ gpm/mgd})$   
 = 0.000458 which is 0.046% of tunnel flow.

Based on the average flow of 62.22 M.G.D., the ratio of leakage is 0.000243 or 0.024% of tunnel flow.

#### Conclusion

Based on the above data, the Linnwood Tunnel is in very good condition and has less leakage than what would be expected of a new structure.

Water Engineering Division  
 January 19, 1987

Inspection of Tunnel between Linnwood  
and Riverside - Nov. 18, 1986

Enter at 10:50 A.M.

Exit at 2:45 P.M.

B. J. Kocol

S. P. Hellen

2 members of M.F.D. Mine Rescue Team

Sta 0+00 Gate at Riverside

Sta 0+50 3" dia. hole in top - old  $Cl_2$  feed from  
Gate House

Sta 1+00 Dripping from small spot in top

Sta 2+25 Small spalled area on bottom

Sta 14+50 (Shaft at Oakland) Const. Jt. between  
shaft and tunnel - west side - small  
amount of leakage

Small amount of leakage from crack  
on west side of shaft 30'± above  
the top of the tunnel.

Sta 17+50 Small stream ( $\frac{1}{4}$  gpm ±) from hole south  
side of tunnel.

Sta 18+50 Crack in bottom

Sta 18+70 Small stream ( $\frac{1}{4}$  gpm ±) from hole south  
side of tunnel

Sta 19+20 Small hole - south side

Sta 19+70 Crack on north side

- Sta 22+70 Small hole in top - 1/2 gpm
- Sta 23+70 Small stream (1/4 gpm) from hole north side of tunnel
- Sta 24+20 Cracks on north & south sides
- Sta 25+20 Crack on top and north side
- Sta 25+70 Small hole in top
- Sta 26+20 Small stream, cracks tops and sides
- Sta 40+00 Small stream - hole in north side
- Sta 44+50 Horiz. crack south side
- 45+00 Crack south side
- 45+10 Crack south side, hole in top
- 46+10 } Crack around
- 46+35 } Crack in top
- 46+35 } Crack around
- 46+60 } Crack in top
- 46+60 } Crack around, Conc. spalling bottom
- 47+10 } Crack around
- 47+60 } Crack in top
- 47+60 } Crack around
- 48+10 Conc. spalling bottom, hole in top (2 gpm)
- 48+60 Crack around
- 49+10 Crack around
- 49+60 } Crack around
- 50+10 } Crack Top
- 50+10 } Crack ...

Sta 51+10 Crack-N. Side, spalling conc. bottom

52+10 Crack around

52+60 Crack around

52+85 Crack Around

53+05 Horiz. Crack, south side

53+55 Hole in top

54+55 Hole, south side

54+80 Spalling conc, bottom

55+80 Hole in top

55+90 Hole in top

56+25 Crack around

56+50 (Shaft at ~~Gate D~~) Crack around,  
ups Jt. between MH and Tunnel

58+50 Hole top, 1/2 gpm

60+50 Hole, south side

61+50 Hole, north side

62+50 Hole, north side

63+00 Crack, south side

63+10 Hole, south side

63+60 Hole, south side

Sta 63+70 Hole, north side

64+20 Crack around

64+40 Crack around

66+40 Crack, south side

66+65 Crack, top

66+75 Crack, around

69+00 Crack, north side

70+00 Gate at Linnwood - Flow from 2"  $\phi$   
vent pipe estimated at 250 gpm

SPECIFICATIONS FOR THE  
SEALING OF LEAKS IN THE  
LINNWOOD TUNNEL

- LT-1 Scope of work The work consists of furnishing all labor, material and equipment for sealing leaks in the Linnwood Tunnel as directed and noted by the City Field Engineer. This may include spurting leaks, cracks, or may include concrete surface repair. Waterproofing materials shall be as manufactured by the Xypex Corporation and installed in accordance to their recommendations. Other proven materials may be used after being approved by the City. All materials must be E.P.A. approved for contact with potable water.
- LT-2 Tunnel Layout Contractor shall view the plans and make field inspections to familiarize himself with the general layout of the tunnel, including the distances between manholes, the depths of manholes, and surface condition at each manhole. The City has removed the sealed covers at the ~~Oakland Avenue and Lake Drive~~ manholes and will put them in storage. The contractor must remove and replace the manhole covers at the ~~Oakland Ave. and Lake Drive~~ manholes each night.
- LT-3 Pumping The City will continue to pump water at Riverside Station to prevent water buildup in the tunnel.
- LT-4 Safety Equipment The contractor is required to provide safety equipment for his personnel and shall be totally responsible for their safety. Contractor shall view the work site to assure he is familiar with hazards on the job. As a minimum requirement, the contractor shall maintain a blower to force outside air into the tunnel all of the time any men are in the tunnel.
- LT-5 Electric Power and Lighting Contractor shall furnish his own electric power and lighting except power is available at Riverside Station.
- LT-6 Communication The City will furnish headphones and wire for a voice driven telephone communication system. There is sufficient wire for the full length of the tunnel. Contractor shall use care to assure that the system is not damaged.

LT-7 Specialized Equipment Furnished by the Contractor Contractor shall purchase the following equipment:

1. 2 - 1/2 hour Back Pac Respirators as specified.
2. 1 - Electric Hoist 2 Ton Capacity with not less than 130 feet of cable.
3. 2 - Gas Detection Units as specified.

Contractor shall use this equipment wherever required. After completion of the job, this equipment with all auxiliary articles and instruction manuals shall become the property of the City.

LT-8 Payment Contractor will be paid on a cost plus 15% basis for labor and materials. Labor will be paid for in accordance with the attached list. Materials will be paid for on the basis of invoiced prices.

Equipment will be paid for on the basis of the attached list with no markup.

WATER ENGINEERING DIVISION

November 3, 1986

583  
RUB ✓  
BTR ✓  
547

INSPECTION OF THE LINNWOOD TUNNEL

The following procedure will be used to inspect the tunnel initially, and subsequently during the period in which the contractor is working.

I. Preparation of the tunnel.

After the tunnel is dewatered, preparation work on the tunnel will consist of the following:

- a. Remove the plugs at the top of the manholes at Lake Drive and ~~Oakland Avenue.~~
- b. Install forced air ventilation at Lake Drive. Cover the manhole at ~~Oakland Avenue~~ with an easily removable cover so that the fresh air will sweep the entire tunnel and not short circuit at ~~Oakland Avenue.~~
- c. Install a communication system in the tunnel so that a communication system is available continuously.
- d. Install a winch to remove personnel if required.

II. Initial Inspection by personnel

The initial inspection will be made by two or three men. All entering and exiting will be done at one of the openings at Riverside Station. Each of the persons will be required to have the following qualifications:

- a. Be in good health
- b. Have instruction on the use of the self contained breathing equipment.
- c. Be familiar with the use of the gas detecting equipment.
- d. Be familiar with the use of the communication system.
- e. Be familiar with an evacuating plan in the event of a problem.
- f. Be certified in CPR as of that date.

Each person entering the tunnel will be equipped with the following equipment:

- a. A gas detection unit.
- b. Self contained breathing apparatus, 15 to 30 minute size.
- c. Safety harnesses
- d. Hard hats with lights

Inspection Linnwood Tunnel

- e. Separate flashlights.
- f. Boots
- g. Tape recorders (one unit)
- h. One rolling cart if possible to be used to carry equipment.

One person will be required to be at the surface at the entry point at all times. That person will be required to monitor the air exiting from the tunnel and have the same qualifications as the persons entering the tunnel.

He should also be equipped with the same equipment as the personnel entering the tunnel.

III. Inspection of work done by the Contractor

After the initial inspection, a contractor may be required to work in the tunnel. All of the time the contractor's personnel will be in the tunnel, all of the tunnel preparations will be in place including forced air and communications equipment. The contractor will be required to provide his own safety equipment which is expected to be similar to that required by City personnel. The City will send an inspector in the tunnel from time to time to inspect the contractors work.

The inspection team will consist of two persons. One person going into the tunnel and one person remaining at the entrance. Before descending, the inspector will contact the contractors personnel informing them that he is descending. He will also be in constant contact with the top man. Each of these two persons will also be trained and equipped as the original inspection team.

This procedure will be followed until all of the work is complete.