APPENDIX 'B'

Pipeline Loading Assessment

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April 25, 2011

Project No. 60197631 (500)

Taran Peters, P.Eng.
Associate
Dillon Consulting Ltd.
895 Waverley Street, Suite 200
Winnipeg, MB R3T 5P4

Dear Mr. Peters:

Regarding: Pipeline Loading Assessment, Murray Avenue Feedermain, Gateside to McPhillips

As per your request, we have reviewed the impact that the proposed road reconstruction along Murray Avenue may have on the Murray Avenue Feedermain. Road work is proposed between Gateside Street to McPhillips Street and involves reconstruction of the roadway from a rural gravel section to a rural oil surfaced cross section. Our report outlines the physical constraints of working above the feedermain and provides both minimum and maximum cover elevations along the pipeline.

As the final design for the roadway has not been completed and our analysis has been undertaken using functional design drawings provided by Dillon Consulting we cannot ascertain the final loading implications of the proposed road works. We have instead identified locations which may be sensitive to increased loads based on the original feedermain Record Drawings. These are locations with excessive or minimal cover.

Dillon Consulting provided us with two options for the design based on different alignments for the road. Option one involved the reconstruction of the road along the same alignment as the existing road. Based on the cross sections provided, this option involved an increase in final cover over the pipeline between 0.5 and 1.0 m. Option two involved moving the roadway overtop of the feedermain and resulted in an increase in final cover over the pipeline of between 1.0 and 1.5 m.

Based on a review of the original pipe designs, and verified using a working stress analysis of the pipe, a maximum cover of 4.72 m (15.5') was determined to keep long term loads within the original design parameters.

This report does not address the existing condition of the Murray Avenue Feedermain to withstand additional loading. All findings within this report assume the existing Feedermain is in acceptable structural condition and capable of withstanding applied loads that are consistent with the original design intent.

When construction is carried out it is critical that the controls noted herein be implemented by your staff and the Contractor (and any Subcontractors) and that all personnel at the site be made cognizant of the significance of working in close proximity to the feedermain. A feedermain failure would be catastrophic (prestressed concrete pipe typically fails in a non-ductile mode) with the

potential to cause extensive consequential damage to infrastructure in the area and adjacent properties.

Data Collection and Review

In our analysis of the Murray Avenue Feedermain we reviewed and referenced the following information:

- Original construction record drawings as provided by the City of Winnipeg WWD (attached in Appendix A)
  - Drawing D1275
  - Drawing D1276
  - Drawing D1277
  - Drawing D1278
- Original pipe specifications/design sheets and laying schedules from Canron (Hyprescon), as provided by the City of Winnipeg WWD (attached in Appendix B)
- Roadway reconstruction options for Murray Avenue between Gateside and McPhillips, as provided by Mr. Taran Peters (attached in Appendix C)
- Murray Avenue survey data, as provided by Mr. Taran Peters
- Canron (Hyprescon) Class 12, 600 mm (24") Prestressed Concrete Cylinder Pipe (Lined Cylinder) pipe design information, North Kildonan Feedermain (1969)
- AWWA Standard C301-64 – Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
- AWWA Standard C301-72 – Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
- AWWA Standard C301-07 – Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
- AWWA Standard C304-07 – Design of Prestressed Concrete Cylinder Pipe
- Miscellaneous ASTM standards as referenced in the above standards pertaining to material properties

The Murray Avenue Feedermain was constructed in approximately 1974. The pipe is a Class 12, 600 mm (24") Prestressed Concrete Cylinder Pipe (PCCP) manufactured by Canron. The pipe is a Lined Core Pipe (LCP). The feedermain was designed in accordance with the Cubic Parabola Design Method found in Appendix A of AWWA C301-64.

Based on record information for the pipe we have determined a maximum pipe invert elevation at McPhillips St. of 747.20' (227.749 m) and a minimum elevation at the proposed McGregor St. Extension (Sta. 74+91', record drawings) of 742.84' (226.420 m). There is a slight discrepancy in the pipeline invert elevations given on the record drawings near McPhillips (discussed below). This elevation should be confirmed during construction.

Loading Analysis

The original design notes, applicable standards for which the pipe was built to, and supplemental design information from other similar feedermains within the City of Winnipeg were used to determine the allowable loading on the pipe.

City of Winnipeg regional water infrastructure typically operates under sustained pressures less than 80 psi, the Murray Avenue Feedermain included. The current AWWA C304 standard requires a minimum transient allowance of the greater of 40 percent of the working pressure or 40 psi which should be an adequate transient allowance in this portion of the feedermain network, based on current operational practices.

Live and dead loads were computed for the maximum and minimum cover conditions. In the original design, dead loads were calculated assuming a trench condition, with trench width equal to pipe outside diameter plus 0.6 m (2'). While this is a commonly used design criterion, experience suggests that control of trench width is difficult to achieve and trenches often exceed these design values, especially with vee'd out trenches. A more conservative criterion is a positive projection embankment load, using a Heger load distribution vertical arching factor of 1.4, which corresponds to a Type 2 ASCE Standard Installation. Live loads were computed using an AASHTO Alternate Tandem and HS20 design vehicle in passing mode.

Original project design notes indicate a Load Factor of 1.5 was used in the design. The Load Factor is used to convert computed pipeline external loading to pipe strengths derived from 3 edge bearing tests. A review of project specifications, trench sections, and considerable experience in test excavations around local feedermains indicate that compacted sand was typically used in the embedment zone. Based on long term research of Heger, McGrath and others[1], a conservative Load Factor for this type of installation would be 1.9, consistent with what is commonly referred to as Class B bedding. Dead loading was calculated based on an assumed soil density of 120 lbs/ft^3 which is consistent with current standard design practice.

Analysis of the 600 mm (24") PCCP Murray Avenue Feedermain was completed using the cubic parabola stress design curves (original design method) as outlined in Appendix A of AWWA C301-72. The pipe design summaries provided to us for this analysis do not include prestressing wire areas or wire specifications, and as such, more sophisticated analysis methods were not employed as the governing design criteria.

A review of working stress analysis method as per Appendix B of AWWA C301-72 was completed as a design check, but prestressing wire areas and wire type was assumed from other projects of similar vintage. As the actual reinforcing properties are unknown, this method was not used in determining limiting conditions, but rather to demonstrate the conservatism of the cubic parabola design method.

The cubic parabola design curves are based on W_o, which is nine tenths of the three edge bearing test load that causes incipient cracking and P_o which is the theoretical (calculated) pressure which will relieve compression in the pipe core induced by prestressing[2]. Based on design information provided, W_o =4,250 lbs/ft and P_o = 150 psi for the Class 12 pipe was utilized on this project.

The Appendix B design method utilizes pipe properties and material strengths to determine acceptable limits for external loading and internal pressure. A combination of the two above mentioned methods are overlain to develop a safe operating envelope for the pipeline as shown in Figure 1.

Figure 1 shows the combined-load diagram for operating conditions at 4.72 m (15.5') of cover. For our analysis 4.72 m (15.5') will be used as an assumed maximum cover for the pipeline as it lies upon the cubic parabola limit (operating condition) for the pipe. Figure 2 shows the combined-load diagram for transient conditions at 4.72 m (15.5') of cover.

[1] *American Concrete Pipe Association, Concrete Pipe Technology Handbook – A Presentation of Historical and Current State-of-the-art Design and Installation Methodology, March 1993*

[2] *AWWA Research Foundation, Failure of Prestressed Concrete Cylinder Pipe, 2008*

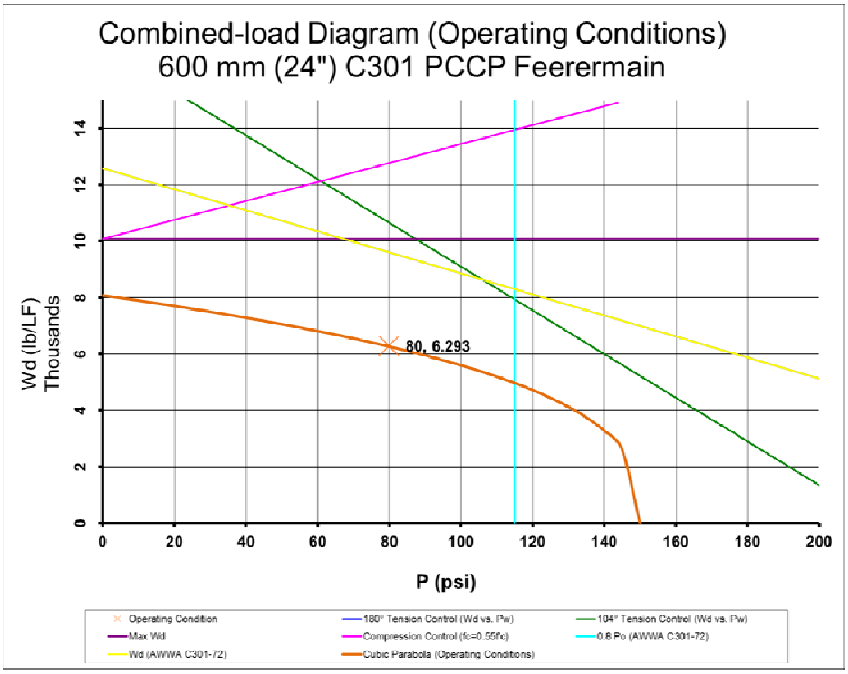

Figure 1 - Combined-Load Diagram - Operating Conditions 15.5' Cover

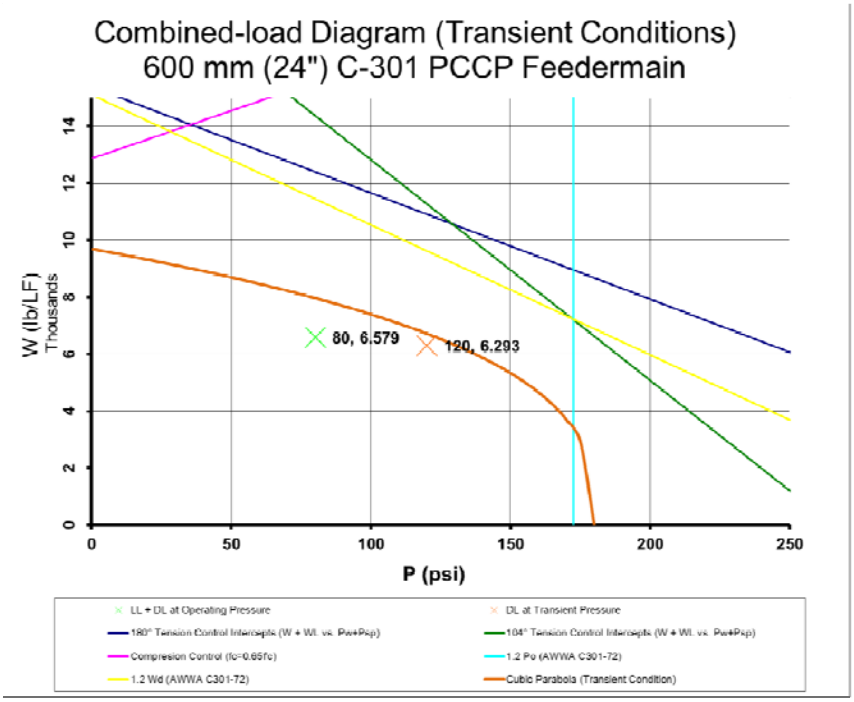

Figure 2 - Combined-Load Diagram - Transient Conditions 15.5' Cover

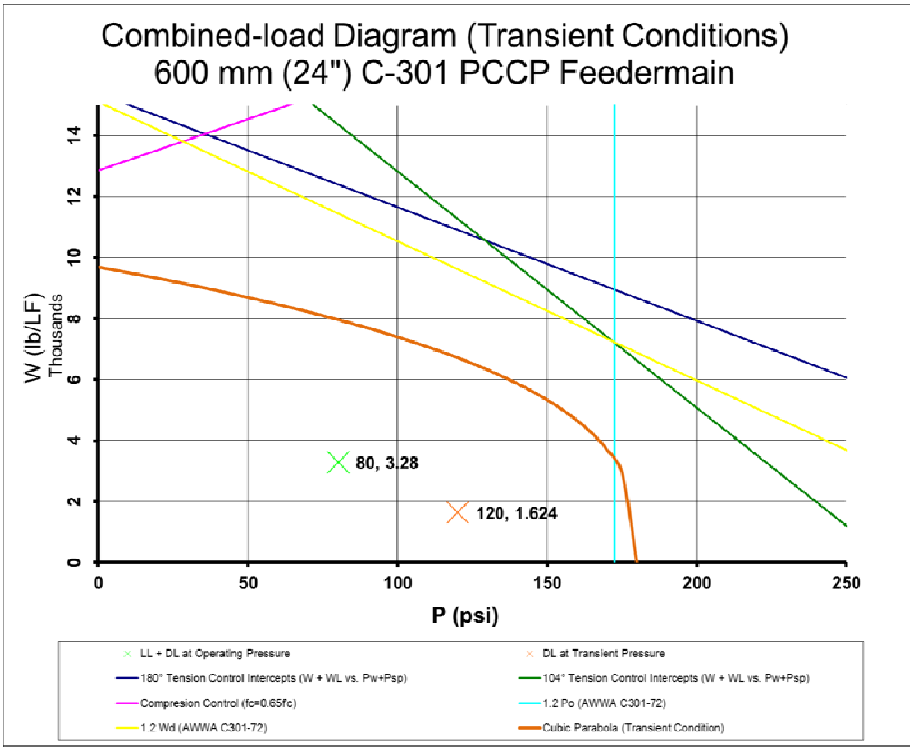

Figure 3 - Combined Load Diagram - Transient Conditions 4' Cover

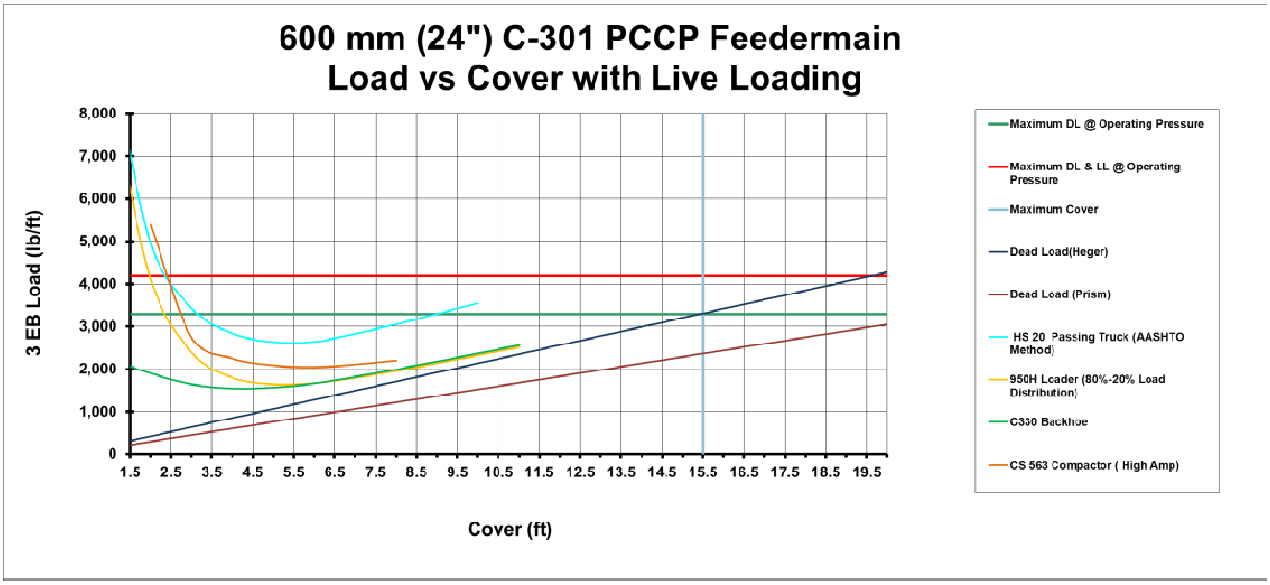

Figure 4 – Cover vs. Live and Dead Loads

Minimum cover for the pipeline was determined to be 1.22 m (4') based on reasonable minimum cover over a Feedermain to prevent damage by construction equipment, excessive loads caused by rutting of the grade and other point loads. As seen in Figure 3 the combined loading for 1.22 m (4') of cover is within the loading limitations described above, however, loads increase sharply at lesser

covers. Based on the roadway design options produced by Dillon Consulting the cover over the feedermain during construction should not be less than 1.22 m (4'). Figure 4 above shows live loads for several pieces of common construction equipment as a means to illustrate the impact live loading can have on a pipeline at low covers and dead load can have on a pipeline at high covers.

Recommendations

As the final design of the roadway has not been determined, we have provided maximum and minimum covers (ground elevations) for over the pipeline based on the pipeline elevation. Chainages given are based on the original City of Winnipeg record drawings for the feedermain construction as no chainages have been provided on the proposed construction drawings.

Table 1 - Feedermain Elevations and Cover Limitations

Feedermain Cover Recommendations					
Chainage	Description	Feedermain Invert Elevation		Recommended Ground Elevations over Feedermain	
				Minimum	Maximum
ft		ft	m	m	m
31+00	Approximate Station at Gateside St.	745.54	227.243	229.136	232.641
40+00		745.80	227.323	229.215	232.720
49+67	Valve Chamber at Ferrier St.	746.20	227.445	229.337	232.842
50+00		746.20	227.445	229.337	232.842
60+00		746.35	227.490	229.382	232.888
70+00		746.49	227.533	229.425	232.930
72+00	Grade Change, High Point	746.52	227.542	229.434	232.940
74+91	Grade Change, Low Point	742.84	226.420	228.313	231.818
76+50	Grade Change	746.58	227.560	229.453	232.958
80+00		746.72	227.603	229.495	233.000
87+00	Grade Change	747.00	227.688	229.581	233.086
90+00		747.07	227.710	229.602	233.107
96+00	Grade Change	747.20	227.749	229.642	233.147
99+00	Grade Change, West Side of McPhillips St.	747.20	227.749	229.642	233.147

As mentioned above there is a discrepancy between the feedermain profile and labelled elevations on D-1277 and D-1278 between Station 87+00 and 101+00. The profile indicates elevations as shown in Table 1, while the profile is labeled with elevations 749.20 at station 96+00 and 99+00. We believe the profile shown on the drawings to be correct based on adjacent pipeline elevations and utility crossings and as such have made an assumption on the pipeline elevation at these locations. Prior to construction at these locations the pipe should be exposed to determine the actual elevation.

It is also recommended that the physical condition of the feedermain be assessed at a minimum of one location to confirm the assumption that the original structural integrity of the pipeline has not been compromised. This is prudent as the feedermain may be located directly beneath the proposed roadway with covers approaching the physical limitations of the pipeline. This can be accomplished prior to construction by exposing the top 1/3 of the pipeline and inspecting the mortar coating.

Thermal Protection and Frost Loading

The proposed options for reconstruction of Murray Avenue over the Murray Avenue Feedermain all involve increasing cover over the pipeline. As such exposure of the pipeline to frost conditions should not be an issue. With that in mind should the cover over the pipe be reduced to below 2.13 m (7') we recommend the placement of insulation to reduce frost penetration of the pipeline. Insulation installed should be in the form of a 100 mm thick layer of HI-40 rigid polystyrene insulation as per City of Winnipeg Standard Detail SD-018. Notwithstanding SD-018 the total width of the insulation should be 3.65 m (12') and be placed level with the top of the insulation flush with the top of the proposed subgrade (bottom of subbase material).

Feedermain Operational Limitations

We believe that the Feedermain can remain in service during construction, provided that the cover recommendations included in this report are utilized. If cover is reduced below the recommendations for construction of subgrade, or if conditions of unsuitable or soft subgrade are encountered, then consideration for depressurization of the main should be made jointly with the Water and Waste Department.

Construction Limitations and Recommendations

Based on the analysis completed, the proposed road reconstruction should be able to be safely constructed, based on the live loads and earth covers noted above and subject to the following implementation recommendations:

Contractors carrying out repair work or working in close proximity to the Feedermain shall meet the following conditions and technical requirements:

1) Pre-work, Planning and General Execution

   a. No work shall commence at the site until a Construction Method Statement has been accepted and the Feedermain location has been clearly delineated in the field. The Method Statement is a submission from the contractor intended to describe construction sequence and procedures, as well as demonstrate knowledge and conformance to these recommendations.
   b. Contact the City of Winnipeg WWD Department, Construction Services Coordinator (Andy Vincent) prior to construction.
   c. Notify WWD well in advance of construction to coordinate required service interruptions.
   d. Work shall only be carried out with equipment that has been reviewed and quantified in terms of its loading implications by the Contract Administrator.
   e. Vehicular traffic that is compliant to City of Winnipeg load restrictions will be permitted to cross the Feedermain once suitable granular base is in place that will adequately support loads without rutting.
   f. Crossing of the Feedermain is prohibited in the time period from removal of existing roadway structure until the completion of granular base construction. At all times prior to completion of final paving; reduce equipment speeds to levels that minimize the effects of impact loading to the pipe.
   g. For construction work activities either longitudinally or transverse to the alignment of the Feedermain, work only with equipment and in the manner stipulated in the accepted Construction Method Statement and the supplemental requirements noted herein.

h. Where work is in proximity to the Feedermain, utilize construction practices and procedures that do not impart excessive vibration loads on the Feedermain or that would cause settlement of the subgrade below the Feedermain. Only single live loads will be permitted on the Feedermain at any one time until concrete pavements are in place.

2) Excavation

a. Use of pneumatic concrete breakers within 3 metres of the Feedermain is prohibited. Pavement shall be full depth sawcut and carefully removed. Use of hand held jackhammers for pavement removal will be allowed.
b. Where there is less than 1.6 metres of earth cover over the Feedermain and further excavation is required either adjacent to or over the feedermain, utilize only smooth edged excavation buckets, soft excavation or hand excavation techniques. Where there is less than 1 metre of cover over the Feedermain, carefully expose the Feedermain by hand excavation to delineate the location and depth of the main, and provide full time supervision of the excavation.
c. Where there is less than 2.5 m of earth cover over the feedermain, offset backhoe or excavation equipment from Feedermain, a minimum of 3 m from Feedermain centerline, to carry out excavation.
d. Equipment should not be allowed to operate while positioned directly over the Feedermain.
e. If feedermain inspection is required, expose the top 1/3 of the Feedermain by hand excavation, for a minimum length of 1 metre, to allow the City to inspect the condition of the main. Notify the City a minimum of 24 hours in advance of exposure, and allow a minimum of 2 hours for the City to complete inspection works. Backfill test excavation with bedding sand upon completion.

3) Subgrade Construction

a. Subgrade, subbase, and base course construction shall be kept in a rut free condition at all times. Construction equipment is prohibited from crossing pipelines until base is constructed and the grade is sufficient to support the equipment without rutting.
b. Subgrade compaction shall be prohibited within 2 metres of the Feedermain. Subgrade compaction within 3 metres of the Feedermain shall be limited to non vibratory methods only.
c. Stage work activities to minimize the time period that unprotected subgrade is exposed to the environment and protect the subgrade against the impacts of adverse weather if subbase/ base course construction activities are not sequential with excavation.

4) Subbase and Base Course Construction

a. Granular material, construction material, soil or other material shall not be stockpiled on the pipelines or within 5 metres of the pipe centerline.
b. Subbase or base course materials shall not be dumped directly on pipelines but shall be stockpiled outside limits noted in these recommendations and shall be carefully bladed in-place.
c. Subbase compaction within 3 metres of the centreline of the Feedermain shall be either carried out by static methods (without vibration) or with smaller approved equipment such as hand held plate packers or smaller roller equipment.

5) The Contractor shall ensure that all work crew members understand and observe the requirements of this specification. Prior to commencement of on-site work, the Contractor shall jointly conduct an orientation meeting with the Contractor Administrator with all superintendents, foremen and heavy equipment operators to make all workers on site fully cognizant of the limitations of altered loading on the Feedermain, the ramifications of inadvertent damage to the pipelines, the constraints associated with work in close proximity to the Feedermain and the specific details of the Construction Method Statement in instances where a Construction Method Statement is in effect.

6) Employees of the Contractor or any Subcontractor that fail to comply with the conditions for working in close proximity to the Feedermain shall be promptly removed from the Site.

A sample construction specification is included in Appendix D.

We trust this information meets your requirements on this matter. Should you have any queries or require further information or clarification, please do not hesitate to contact either the writer or Marv McDonald, C.E.T. of this office.

Sincerely,

AECOM Canada Ltd.

C.C. Macey, P. Eng.
Senior Technical Director – Water Infrastructure Management
chris.macey@aecom.com

ADB/MGM/gms
Encl.

cc: M. McDonald/A. Braun - AECOM

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("Consultant") for the benefit of the client ("Client") in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations")
- represents Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports
- may be based on information provided to Consultant which has not been independently verified
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued
- must be read as a whole and sections thereof should not be read out of such context
- was prepared for the specific purposes described in the Report and the Agreement
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time

Consultant shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. Consultant accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

Consultant agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but Consultant makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

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- as agreed in writing by Consultant and Client
- as required by law
- for use by governmental reviewing agencies

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This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

Appendix A

Original Record Drawings

D-1274
D-1275
D-1276
D-1277
D-1278

SEE DWG. D-1274

AGREEMENT W290

AREA OF CLOSURE 313'W OF ℄ TRACKS

MURRAY AVENUE

McGREGOR ST.

SUBWAY SUBDIVISION

PUBLIC ROAD

C.P.R. RIGHT OF WAY

24'ø C.M.P. (SMASHED 5 END)

24'ø C.M.P.

TREE LINE 15' HIGH

HYDRO POLE LINE

HYDRO / M.T.S. POLE LINE

24'ø CONC PIPE

24'ø C.M.P.

24'ø FEEDERMAIN

M.T.S POLE LINE

18'ø CONCRETE PIPE

8' CORRUGATED FENCE

CAUTION M.T.S. BURIED CABLES

2'ø GAS

6' CHAIN LINK FENCE

CONCRETE APPROACH

THRUST BLOCK SEE DETAIL ON DWG. NO. D-1283

MAIN LINE VALVE CHAMBER SEE DETAIL ON DWG. NO. D-1280

16"ø FLANGED OFFTAKE STA. 49+51.7

NOTE
1"18. LOCATED AT
5. R. OF NEGREGOR
& N. R. OF MURRAY

SEE DWG. D-1276

DETAILS OF CASING PIPE FOR RAIL CROSSING
N.T.S.

48"ø CORRUGATED GALVANIZED #8 GAUGE METAL CULVERT PIPE

24"ø PRESTRESSED CONC. PIPE

2½"

SAND

℄ C.P.R. MAIN TRACK

MATCH LINE STA. 28+62

MATCH LINE STA. 50+47

760

750

740

730

MUD ACCESS

GROUND PROFILE ℄ OF PIPE

M.T.S. BURIED CABLE

48"ø CORR. GALV. #8 GAUGE METAL CULVERT PIPE- 36' LONG (SEE DETAIL ABOVE)

24'ø CONCRETE PIPE

INV. 745.61
CLOSURE
STA. 35+13.47 TO STA. 35+33.49
PIPE INCLUDES
1-10.00, 1-9.71
WITH 0.51 GAP

CLAY DAM STA. 39+92

16"ø FLANGED OFFTAKE 746.58

INVERT 746.2

℄ VALVE CHAMBER SEE DETAIL ON DWG. NO. D-1280

STA. 49+67

STA. 49+51.7

29+00 30+00 31+00 32+00 33+00 34+00 35+00 36+00 37+00 38+00 39+00 40+00 41+00 42+00 43+00 44+00 45+00 46+00 47+00 48+00 49+00 50+00

MICROFILMED mar77

LEGEND

WATERWORKS, WASTE AND DISPOSAL: UNDERGROUND UTILITIES

- PROPOSED FORCEMAIN, INTERCEPTOR OR SECONDARY SEWER
- EXISTING FORCEMAIN, INTERCEPTOR OR SECONDARY SEWER — W.W.D. 24"ø SEWER
- PROPOSED FEEDERMAIN
- EXISTING FEEDERMAIN — W.W.D. 24"ø W.M.
- W.W.D. — WATERWORKS, WASTE AND DISPOSAL

OTHER UNDERGROUND UTILITIES

- COMMUNITY SEWER
- COMMUNITY WATERMAIN
- GAS
- HYDRO DUCT
- M.T.S. DUCT OR CABLE
- STREET LIGHTING, RAILWAY SIGNAL OR TRAFFIC SIGNAL CABLE

SURFACE UTILITIES

- COMMUNITY BOUNDARY LINE
- FENCE LINE
- POLE LINE
- RAILWAY LINE

MISCELLANEOUS SYMBOLS

- CATCH BASIN
- CULVERT
- HYDRANT
- MANHOLE
- HYDRO OR M.T.S. POLE
- LAMP STANDARD
- RAILWAY OR TRAFFIC SIGNAL STANDARD
- SURVEY BAR
- TREE
- VALVE

NOTES

AS BUILT

D. Sa… SURVEY — W. Dexter ENGINEERING — Nov 25/76 DATE

NO.	DESCRIPTION	DATE	BY
1	AS BUILT	1-11-76	M.S.

REVISIONS

FIELD BOOK(S) NO. F-387, F-394, F-408, F426

LAND SURVEY PLAN(S) NO.

B.M.

SURVEYED BY D.M. GALKA

DATE MAY 14, 1974

The City of Winnipeg

Waterworks, Waste and Disposal Division

Branch
Operations (Waterworks)

-MURRAY AVENUE FEEDERMAIN- MAIN ST. TO MANITOBA HYDRO RIGHT OF WAY

PLAN - PROFILE

STA. 28+62 TO STA. 50+47

DESIGNED BY Rob

DRAWN BY F. kolbert

CHECKED BY

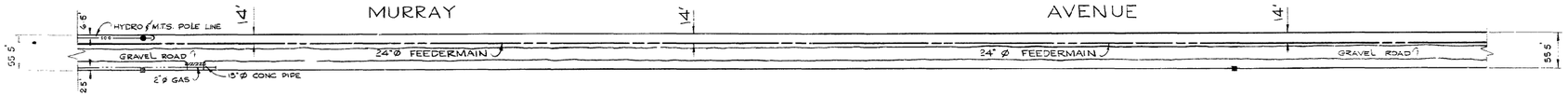
APPROVED BY

DATE SEPT. 10-74

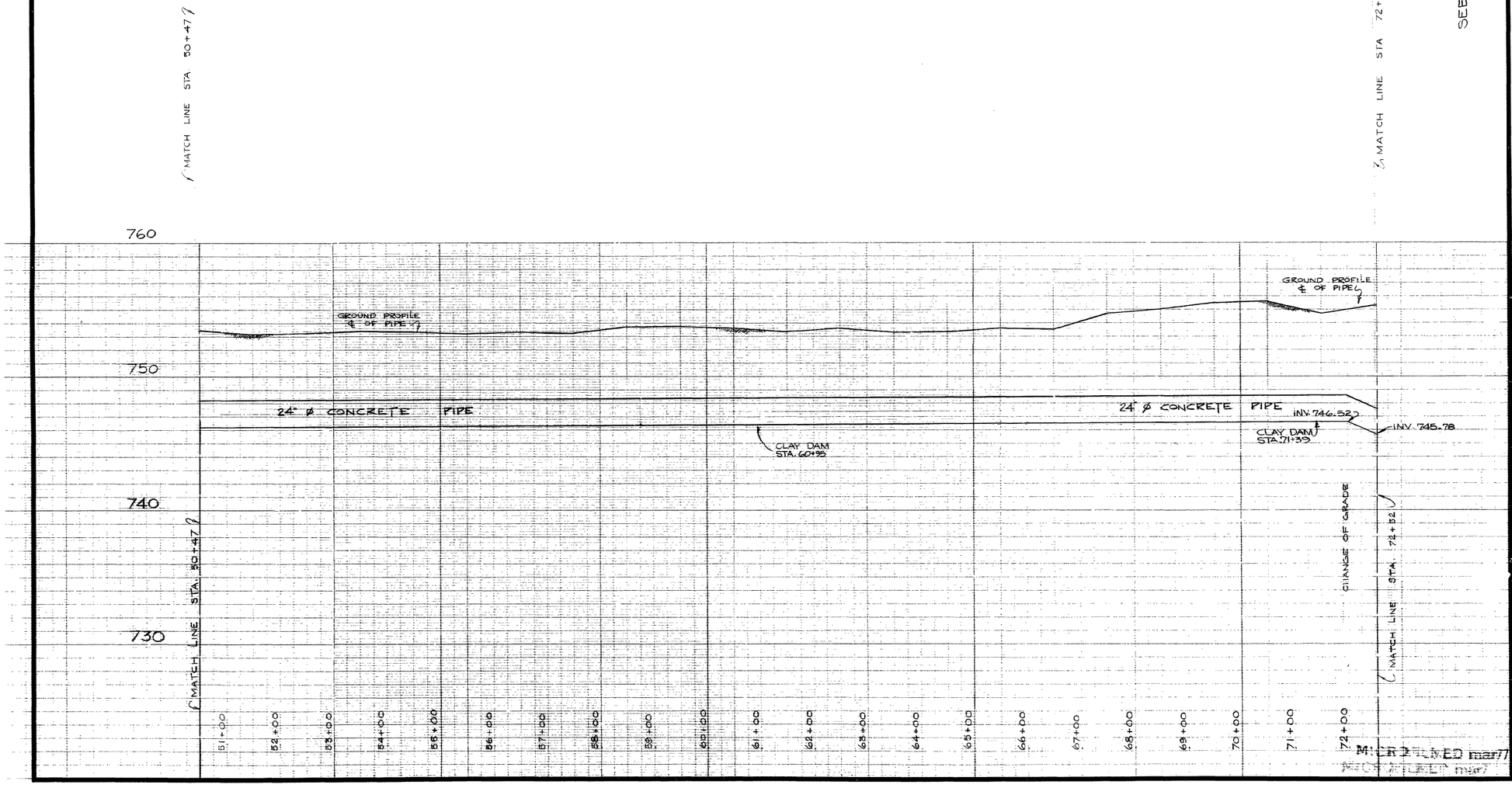
SCALE HOR. - 1" = 100' VERT. - 1" = 4'-0"

DRAWING NO. D-1275

SEE DWG. D-1275



SEE DWG. D-1277



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- SURVEY BAR
- TREE
- VALVE

NOTES

AS BUILT

D.S.&K. Wdexlivers Nov.25/76

SURVEY ENGINEERING DATE

NO.	DESCRIPTION	DATE	BY
1	AS BUILT	1-11-76	M.S.

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DATE MAY 14, 1974

The City of Winnipeg

Waterworks, Waste and Disposal Division

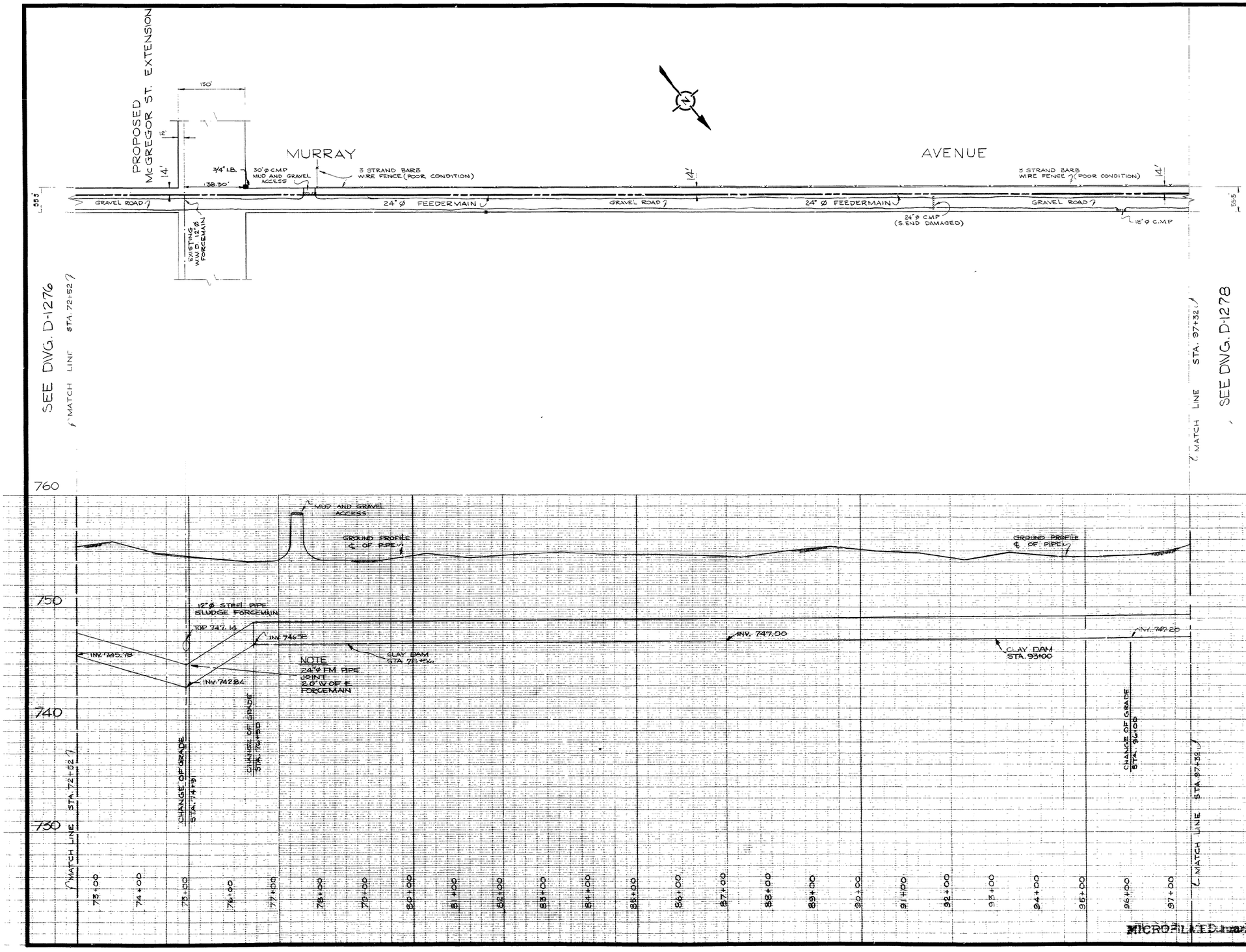
Branch Operations (Waterworks)

-MURRAY AVENUE FEEDERMAIN- MAIN ST. TO MANITOBA HYDRO RIGHT OF WAY

PLAN - PROFILE

STA. 50 + 47 TO STA. 72 + 52

DESIGNED BY R.W.G.	DRAWN BY T. Kolbert
CHECKED BY	DATE SEPT-10-74
APPROVED BY	
SCALE HOR. 1"=100' VERT. 1"=4-0"	DRAWING NO. D-1276



LEGEND

WATERWORKS, WASTE AND DISPOSAL: UNDERGROUND UTILITIES

- PROPOSED FORCEMAIN, INTERCEPTOR OR SECONDARY SEWER
- EXISTING FORCEMAIN, INTERCEPTOR OR SECONDARY SEWER — W.W.D. 24"ø SEWER
- PROPOSED FEEDERMAIN
- EXISTING FEEDERMAIN — W.W.D. 24"ø W.M.
- W.W.D. — WATERWORKS, WASTE AND DISPOSAL

OTHER UNDERGROUND UTILITIES

- COMMUNITY SEWER
- COMMUNITY WATERMAIN
- GAS
- HYDRO DUCT
- M.T.S. DUCT OR CABLE
- STREET LIGHTING, RAILWAY SIGNAL OR TRAFFIC SIGNAL CABLE

SURFACE UTILITIES

- COMMUNITY BOUNDARY LINE
- FENCE LINE
- POLE LINE
- RAILWAY LINE

MISCELLANEOUS SYMBOLS

- CATCH BASIN
- CULVERT
- HYDRANT
- MANHOLE
- HYDRO OR M.T.S. POLE
- LAMP STANDARD
- RAILWAY OR TRAFFIC SIGNAL STANDARD
- SURVEY BAR
- TREE
- VALVE

NOTES

AS BUILT

SURVEY — ENGINEERING — Nov 25/76 DATE

NO.	DESCRIPTION	DATE	BY
1	AS BUILT	3-11-76	M.S.

REVISIONS

FIELD BOOK(S) NO. F-387, F-394, F-408, F-426

LAND SURVEY PLAN(S) NO.

B. M.

SURVEYED BY D.M. GALKA

DATE MAY 14, 1974

The City of Winnipeg

Waterworks, Waste and Disposal Division

Branch
Operations (Waterworks)

- MURRAY AVENUE FEEDERMAIN - MAIN ST. TO MANITOBA HYDRO RIGHT OF WAY

PLAN - PROFILE

STA. 72+52 TO STA. 97+32

DESIGNED BY R.W.G.

DRAWN BY F. kolbert

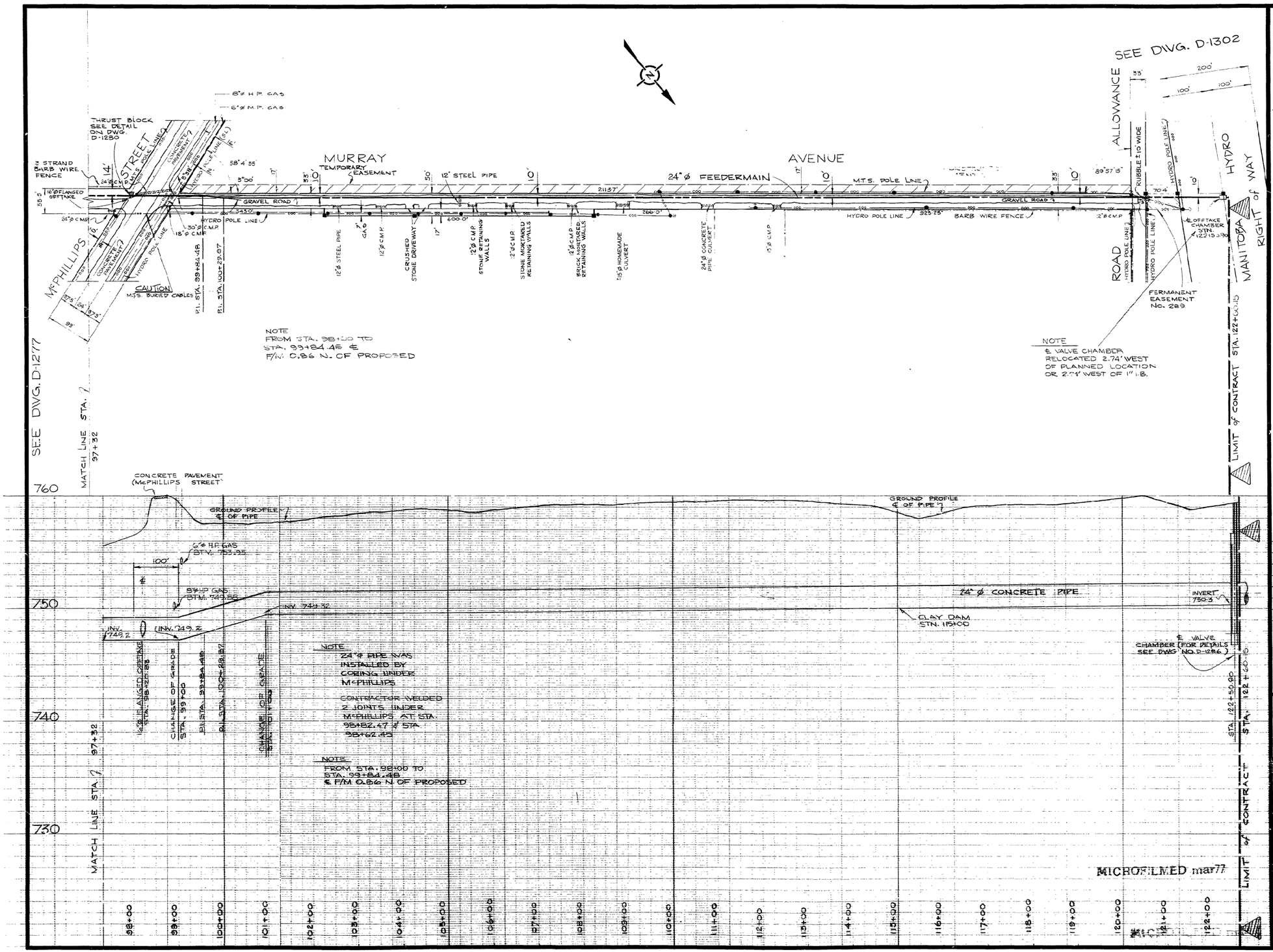
CHECKED BY

DATE SEPT. 10. 74

APPROVED BY

SCALE HOR. - 1"=100' VERT. - 1"= 4'-0"

DRAWING NO. D-1277



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LEGEND

WATERWORKS, WASTE AND DISPOSAL; UNDERGROUND UTILITIES

- PROPOSED FORCEMAIN, INTERCEPTOR OR SECONDARY SEWER
- EXISTING FORCEMAIN, INTERCEPTOR OR SECONDARY SEWER — W.W.D. 24"ø SEWER
- PROPOSED FEEDERMAIN
- EXISTING FEEDERMAIN — W.W.D. 24"ø W.M.
- W.W.D. — WATERWORKS, WASTE AND DISPOSAL

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- RAILWAY OR TRAFFIC SIGNAL STANDARD
- SURVEY BAR
- TREE
- VALVE

NOTES

AS BUILT

D.S. SURVEY — W. Alexander ENGINEERING — Nov 25/76 DATE

NO.	DESCRIPTION	DATE	BY
1	AS BUILT	9-11-76	M.S

REVISIONS

FIELD BOOK(S) NO. F-387, F-384, F-408, F-426
LAND SURVEY PLAN(S) NO.
B. M.

SURVEYED BY P.M. GALKA
DATE MAY 4, 1974

The City of Winnipeg
Waterworks, Waste and Disposal Division

Branch
Operations (Waterworks)

-MURRAY AVENUE FEEDERMAIN- MAIN ST. TO MANITOBA HYDRO RIGHT OF WAY

PLAN - PROFILE

STA. 97+32 TO STA. 122+60.15

DESIGNED BY	DRAWN BY P. kolbert
CHECKED BY	DATE SEPT. 10-74
APPROVED BY	
SCALE HOR. - 1"=100' VERT. - 1"=40'-0"	DRAWING NO. D-1278

Appendix B

Original Pipe Specifications and Laying Schedules

CANRON LIMITED

MURRAY F/M – W 237
O. KILDONAN F/M – W 239
W. 238

OWNER / PROPRIÉTAIRE: CITY OF WINNIPEG
LOCATION / EMPLOI:
PROJECT NO. / NO PROJET:
CUSTOMER / CLIENT:
ATTENTION OF / COMPTE CE DE:
SHEET / PAGE 1 OF / DE
SUBJECT / SUJET: 24" DIA. WATERMAIN
DATE AUG. 14/7.

24" DIA. A.W.W.A C-301 (L) CYLINDER PIPE (1" THICK COATING)

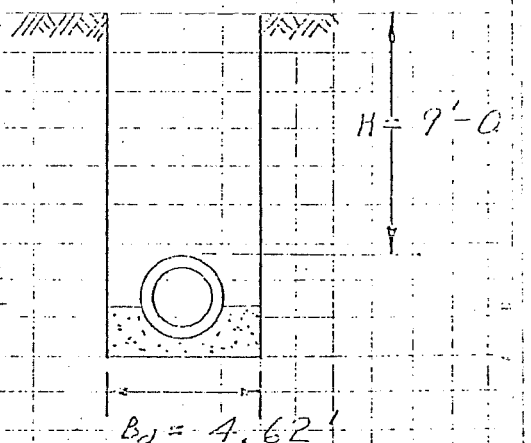
$P_w = 100$ psi
$P_{wh} = 50$ psi

Width of Trench = O.D. + 2' = 2.62' + 2' = 4.62'
Unit weight of backfill = 110 lb/cu.ft.
$K_\mu = 0.130$
Bedding : Type 'C'
Load factor; L.F. = 1.5
Depth of Fill = 9'-0" MIN.
Live Load = H 20 – S 16

1) Calculation of External Loadings :

$\frac{H}{B_d} = \frac{9.00'}{4.62'} = 1.95$

$\therefore C_d = 1.53$



Earth Load, $W_d = C_d \cdot w \cdot B_d^2$
$W_d = 1.53 \times 110 \times 4.62^2$
$W_d = 3592$ lb/ft
$\frac{W_d}{L.F.} = \frac{3592}{1.5} = 2395$ lb/ft

Live Load, $W_L = C_L \cdot P (1 + I_f)$
$W_L = 0.026 \times 16000 \times 1$
$W_L = 416$ lb/ft

2) Select C301 (L) CLASS 12
$P_o = 150$ psi
$W_o = 4250$ lb/ft.

3) Combined Analysis : (see Graph at page 2)

i) $\frac{P_w}{P_o} = \frac{100}{150} = 0.67$; $\frac{W_d/L.F.}{W_o} = \frac{2395}{4250} = 0.564 < 0.69$ O.K

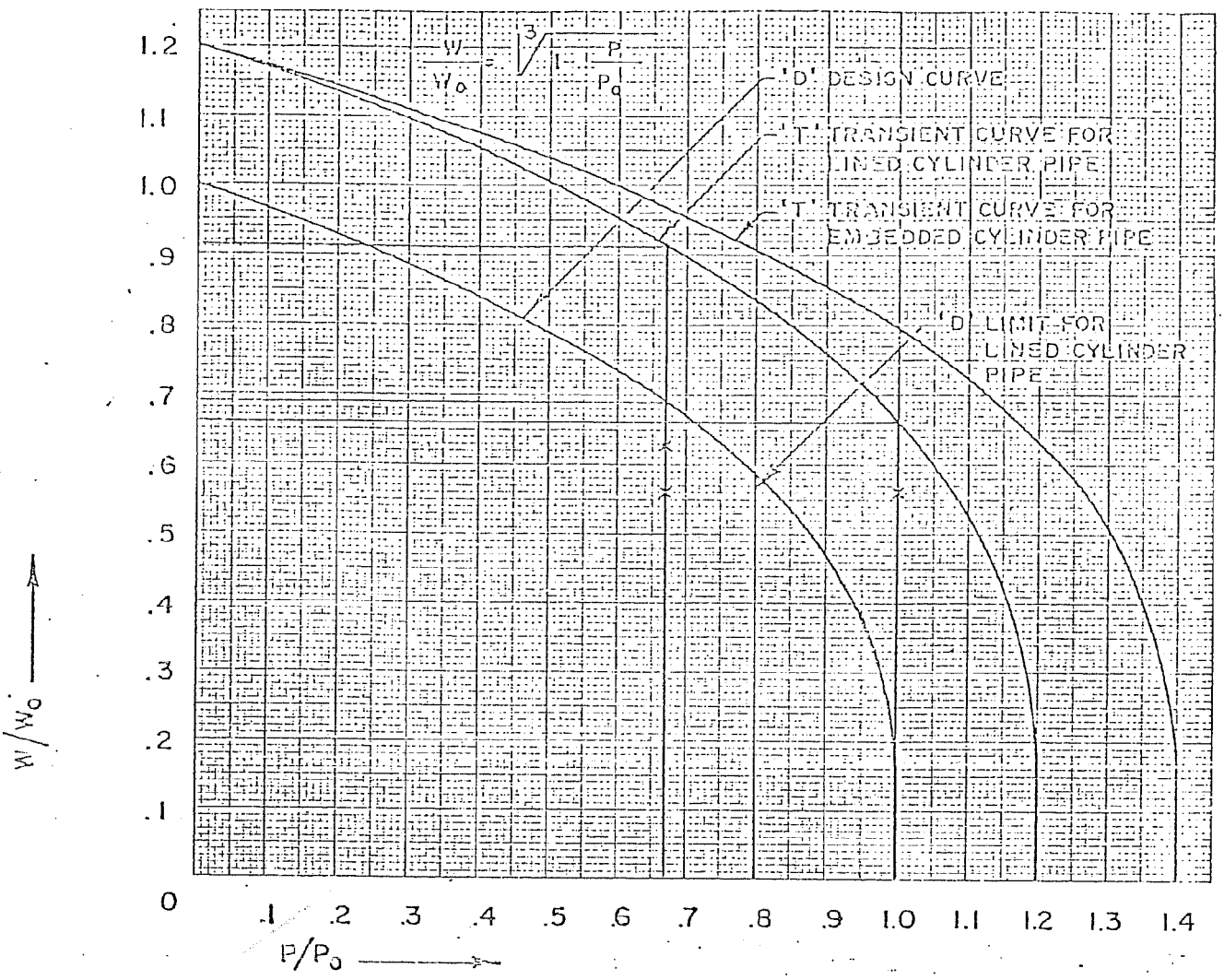
ii) $\frac{P_w + P_{wh}}{P_o} = \frac{150}{150} = 1.00$; $\frac{W_d/L.F.}{W_o} = \frac{2395}{4250} = 0.564 < 0.66$ O.K

iii) $\frac{P_w}{P_o} = \frac{100}{150} = 0.67$; $\frac{W_d/L.F. + W_L/1.5}{W_o} = \frac{2672}{4250} = 0.629 < 0.91$ O.K

$\therefore$ C301 (L) CLASS 12 IS O.K.

09

COMBINED INTERNAL-EXTERNAL LOADING ANALYSIS



DATAS

WIRE AREA $in.^2/ft.$		
P_o	p.s.i.	150
W_o	lbs/ft.	4250
P_w	p.s.i.	100
P_{wh}	p.s.i.	50
W_d	lbs/ft.	3592
W_1	lbs/ft.	416
L.F.		1.5

COMBINATION LOADING

UNDER 'D' CURVE	$\frac{P_w}{P_o} = 0.67$	$\frac{W_d/L.F.}{W_o} = 0.564$
UNDER 'T' CURVE	$\frac{P_w + P_{wh}}{P_o} = 1.00$	$\frac{W_d/L.F.}{W_o} = 0.564$
UNDER 'T' CURVE	$\frac{P_w}{P_o} = 0.67$	$\frac{W_d/L.F. + W_1/1.5}{W_o} = 0.629$

NOM. PIPE DIAMETER – 24 inches
CLASS – C-301(L) CLASS 12.

JOB ORDER NO. –
REVISION –

CANRON LIMITED
PIPE DIVISION

SPECIFICATION: A.W.W.A. C-301-64 APPENDIX 'A'

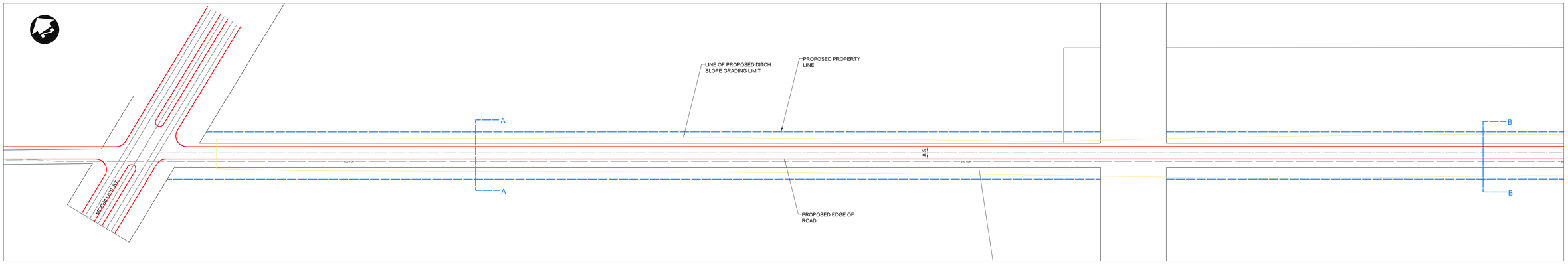
PREP. BY K. HARTL | DATE: AUG. 14/13 | DWG. NO. A-5-D-56

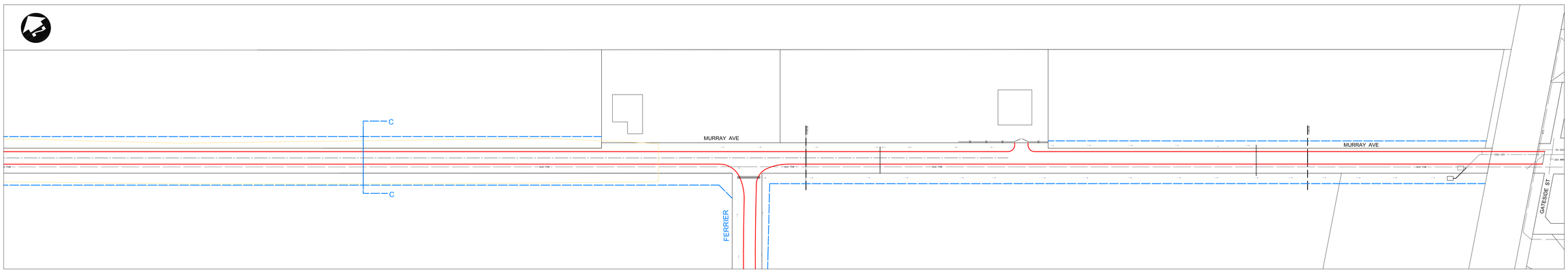
APPROVED BY

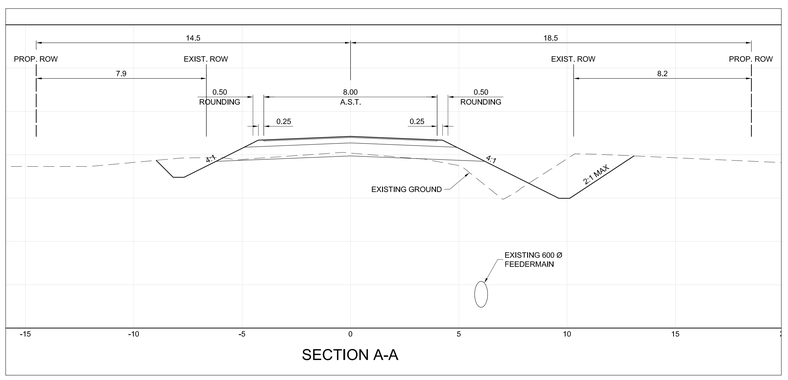
P-3-0-1

Appendix C

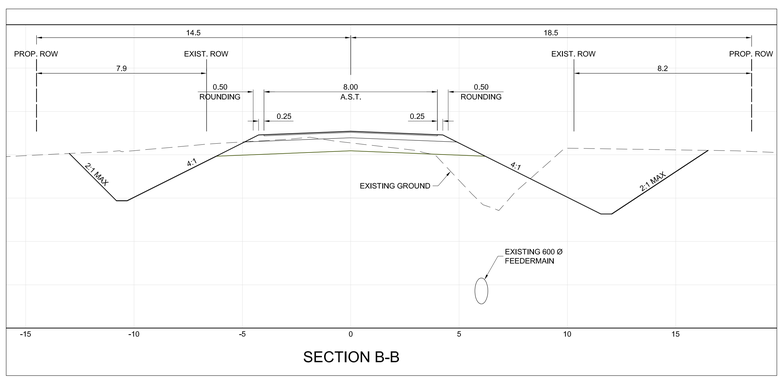
Roadway Reconstruction Options







SECTION A-A



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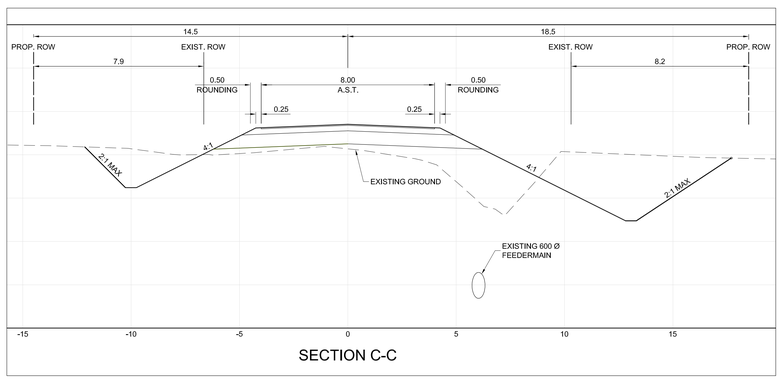

SECTION C-C

DILLON CONSULTING

SCALE 1:1000

TITLE

MURRAY ROAD- FUNCTIONAL DESIGN
OPTION 1 - ONLINE

DRAWING NO.

REF-03

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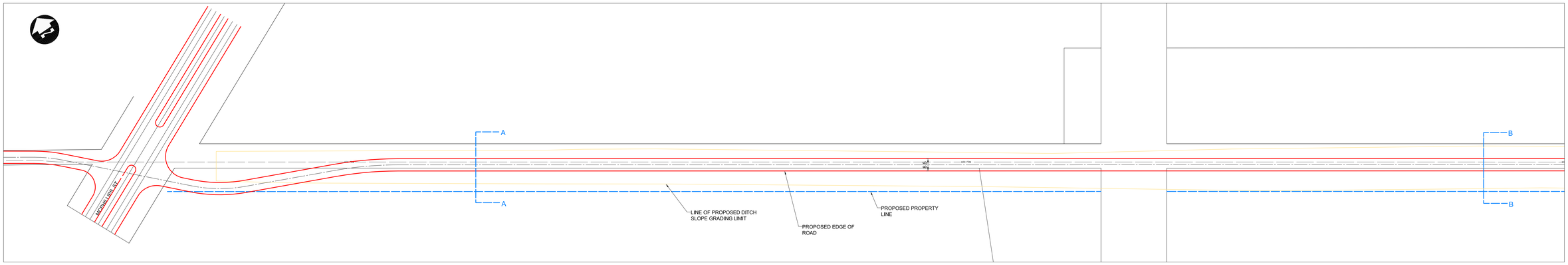

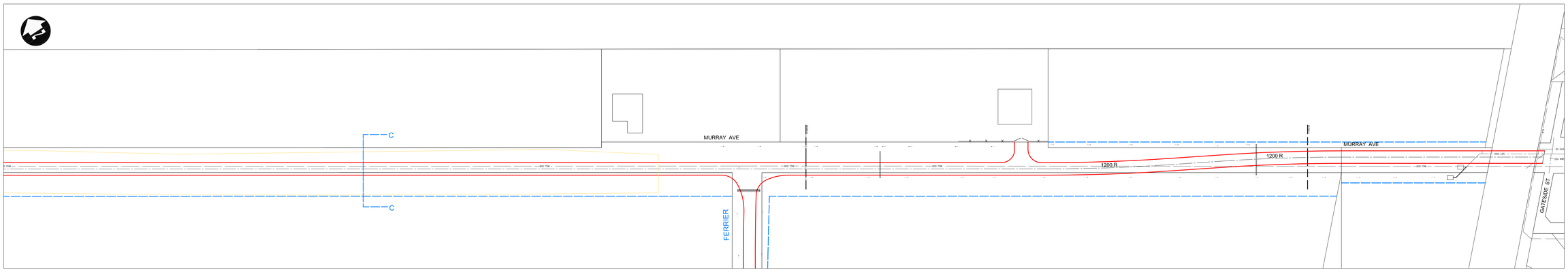

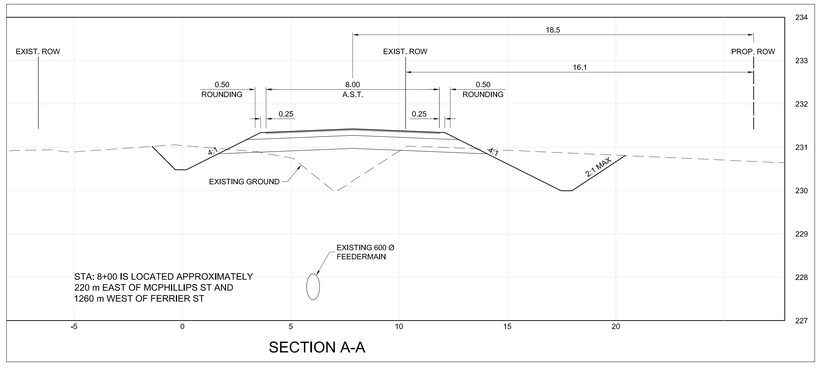

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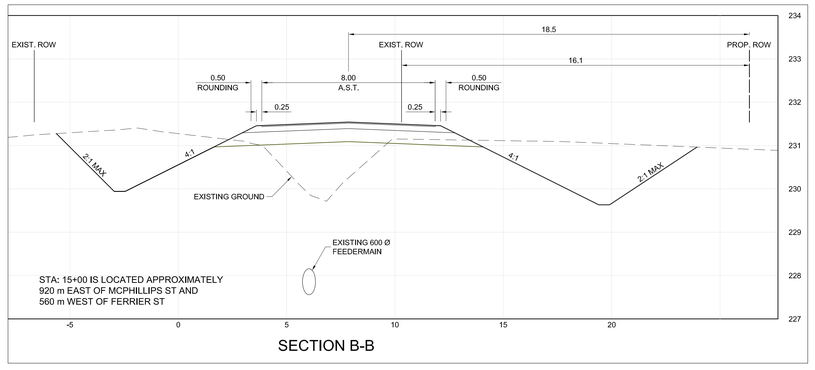

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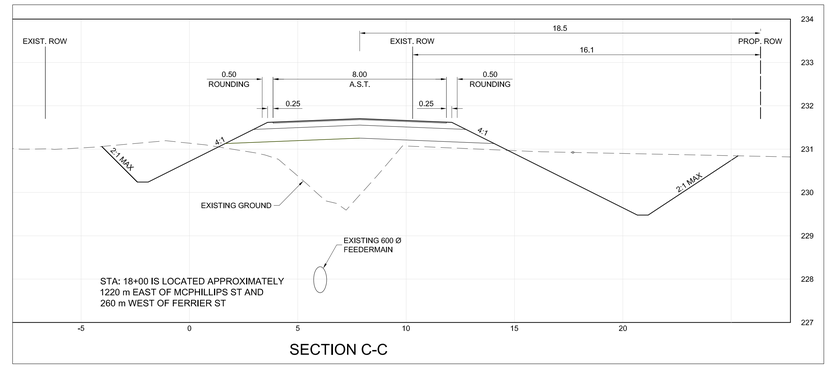

SECTION C-C

DILLON CONSULTING

SCALE 1:1000

TITLE

MURRAY ROAD- FUNCTIONAL DESIGN
OPTION 2 - SOUTH ALIGNMENT

DRAWING NO.

REF-04

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Appendix D

Sample Specifications

B1. OPERATING CONSTRAINTS FOR WORK IN CLOSE PROXIMITY TO THE MURRAY AVENUE FEEDERMAIN

B1.1 Description

B1.1.1 This Section details operating constraints for all work to be carried out in close proximity to the Murray Avenue Feedermain. Close proximity shall be deemed to be any construction activity within a 5 m offset from the centreline of the feedermain.

B1.2 General Considerations for Work in Close Proximity to the Murray Avenue Feedermain

B1.2.1 The Murray Avenue Feedermain is a critical component of the City of Winnipeg Regional Water Supply System and work in close proximity to the pipeline shall be undertaken with an abundance of caution. The pipe cannot be taken out of service for extended periods to facilitate construction and inadvertent damage caused to the pipe would likely have catastrophic consequences.

Work around the Feedermain shall be planned and implemented to minimize the time period that work is carried out in close proximity to the pipe and to ensure that the pipeline is not subjected to excessive construction related loads, including excessive vibrations and/or concentrated or asymmetrical lateral loads during backfill placement.

B1.2.2 The Murray Avenue Feedermain is constructed of Prestressed Concrete Cylinder Pipe (Lined Core) conforming to AWWA Standard C301. The Murray Avenue Feedermain was manufactured and installed in 1974.

AWWA C301 pipe has limited ability to withstand increased earth and live loading. Therefore, every precaution must be undertaken to ensure that applied loading during all phases of construction is within accepted loading parameters.

Loading limitations and calculated loads associated with typical construction equipment is attached to this specification as Appendix A for illustrative purposes. The loading calculations shall be interpreted with caution, however, as many factors can cause applied loads to increase considerably, such as unbalanced loading, variations in wheel base or track width, payload, impact factors due to excessive speed or vibration, etc.

B1.3 Submittals

B1.3.1 Submit proposed construction equipment specifications to the Contract Administrator for review seven (7) days prior to construction. The submissions need to include sufficient data on operational weights, dimensions, and payloads to facilitate assessment that the proposed construction equipment is not in excess of the typical construction loading that this assessment was based on. Submittal shall include:

(a) Equipment operating weight and dimensions including wheel or track base, track length or axle spacing, track widths or wheel configurations

(b) Payload weights

(c) Load distributions in the intended operating configuration

B1.3.2 Submit a Construction Method Statement with proposed construction plan including haul routes, excavation equipment locations, loading positioning and base construction sequencing, to the Contract Administrator for review seven (7) days prior to construction. Do not commence construction until the Construction Method Statement has been reviewed and accepted by the Contract Administrator.

B1.4 Protection of the Murray Avenue Feedermain During Construction

B1.4.1 The section of the Feedermain affected by construction runs parallel to Murray Avenue between Gateside Street and McPhillips Street.

B1.4.2 Contractors carrying out repair work or working in close proximity to the Feedermain shall meet the following conditions and technical requirements:

(a) Pre-Work, Planning and General Execution

(i) No work shall commence at the site until the Equipment Specifications and Construction Method Statement have been submitted and accepted, and the Feedermain location has been clearly delineated in the field. Work over the feedermain shall only be carried out with equipment that has been reviewed and quantified in terms of its loading implications on the pipe. All proposed construction equipment must be submitted to Contract Administrator for review prior to construction. Work in areas in close proximity to the Feedermain shall only be carried out with equipment that has been reviewed and quantified in terms of its loading implications by the Contract Administrator.

(ii) Contact the City of Winnipeg WWD Department, Construction Services Coordinator (Andy Vincent) prior to construction.

(iii) Notify WWD well in advance of construction to coordinate required service interuptions

(iv) Where work is in close proximity to the Feedermain, utilize construction practices and procedures that do not impart excessive vibration loads on the feedermain or that would cause settlement of the subgrade below the feedermain.

(v) Crossings of the Feedermain is prohibited in the time period from removal of existing roadway structure until the completion of granular base construction. At all times prior to completion of final paving; reduce equipment speeds to levels that minimize the effects of impact loading to the pipe

(vi) For construction work activities either longitudinally or transverse to the alignment of the Feedermain, work only with equipment and in the manner stipulated in the accepted Construction Method Statement and the supplemental requirements noted herein.

(vii) Where work is in proximity to the Feedermain, utilize construction practices and procedures that do not impart excessive vibration loads on the Feedermain or that would cause settlement of the subgrade below the Feedermain.

(viii) The pipeline elevation datum relative to the proposed roadway shall be adequately verified. Deviations from the elevations noted herein shall be reported to Contract Administrator for review prior to construction of the subgrade.

(ix) Construction operations should be staged in such a manner as to limit multiple construction loads at one time, (e.g. offset crossings sufficiently from each other, rollers should remain a sufficient distance behind spreaders to limit loads. A reasonable offset distance is 3m between loads).

(x) The contractor and all site supervisory personnel and equipment operators have to be formally briefed to ensure that they are fully cognizant of the associated restrictions, constraints, and risks associated with working adjacent to and over this pipeline. New personnel introduced after commencement of the project need to be formally orientated as to the significance and constraints associated with working over the feedermain.

(b) Demolition and Excavation

(i) Use of pneumatic concrete breakers within 3 metres of the Feedermain is prohibited. Pavement shall be full depth sawcut and carefully removed. Use of hand held jackhammers for pavement removal will be allowed.

(ii) Where there is less than 1.6 metres of earth cover over the Feedermain and further excavation is required either adjacent to or over the feedermain, utilize only smooth edged excavation buckets, soft excavation or hand excavation techniques. Where there is less than 1 metre of cover over the Feedermain, carefully expose the Feedermain by hand excavation to delineate the location and depth of the main, and provide full time supervision of the excavation.

(iii) Where there is less than 2.5 m of earth cover over the feedermains, offset backhoe or excavation equipment from Feedermain, a minimum of 3 m from Feedermain centerline, to carry out excavation.

(iv) Equipment should not be allowed to operate while positioned directly over the Feedermain.

(v) For feedermain inspection, expose the top 1/3 of the Feedermain by hand excavation, for a minimum length of 1 metre, to allow City to inspect condition of the main. Notify City a minimum of 24 hours in advance of exposure, and allow a minimum of 2 hours for City to complete inspection works. Backfill test excavation with bedding sand upon completion.

(c) Subgrade Construction

(i) Subgrade compaction shall be prohibited within 2 metres of the feedermain. Subgrade compaction within 3 metres of the Feedermain shall be limited to non vibratory methods only.

(ii) Subgrade, sub-base and base course construction shall be kept in a rut free condition at all times. Construction equipment is prohibited from crossing pipelines if the grade is insufficient to support the equipment without rutting.

(iii) Subgrade conditions should be inspected by personnel with competent geotechnical experience (e.g. ability to adequately visually classify soils and competency of subgrade, subbase, and base course materials). In the event of encountering unsuitable subgrade materials above the feedermain, proposed design revisions shall be submitted to this office for review to obtain approval from the Water and Waste Department relative to any change in conditions.

(iv) Construction operations shall be staged to minimize the time period between excavation to subgrade and placement of granular subbase materials. Should bare subgrade be left overnight, measures shall be implemented to protect the subgrade against inadvertent travel over it and to minimize the impact of wet weather.

(d) Subbase and Base Course Construction

(i) Granular material, construction material, soil or other material shall not be stockpiled on the pipelines or within 5 metres of the pipe centerline.

(ii) Subbase or base course materials shall not be dumped directly on pipelines but shall be stockpiled outside limits noted in these recommendation and shall be carefully bladed in-place.

(iii) Subbase compaction within 3 metres of the centreline of the Feedermain shall be either carried out by static methods (without vibration) or with smaller approved equipment such as hand held plate packers or smaller roller equipment.

Appendix A

Figure 1: AWWA C301 - 600 mm Class 12 Loading Curves