APPENDIX A: GEOTECHNICHAL REPORT

GENIVAR

BRIEF GEOTECHNICAL REPORT

TO:	SCOTT MINTY	DATE:	September 21, 2010
COMPANY:	GENIVAR C/O CITY OF WINNIPEG	TELEPHONE:	
PROJECT #:	WE 091-15184-00 WE ☐ THE ORIGINAL WILL FOLLOW	FAX:	
SUBJECT:	PROPOSED NAVIN DRAIN CULVERT CROSSING FOR LAGIMODIERE MULTI-USE PATH	NUMBER OF PAGES: (INCLUDING COVER SHEET)	

One testhole was drilled on September 16, 2010 for the proposed Navin Drain (2-1800mm Culvert) Crossing at Lagimodiere Multi- Use Path. The purpose of these testpits was to assess the general subsurface conditions. It was requested that foundation recommendation for the proposed culvert crossing be provided. The testhole drilled to 12.2m depths revealed a general soil profile consisted of 0.6m fill over a thick clay layer, which extended to the depth explored. Detailed description of the soil profile is shown in the attached testhole log. Note that there is about 0.6m of water on top of the based of the drain.

FOUNDATION RECOMMENDATIONS

The foundation recommendations are made on our understanding that the proposed structure is 2-1800mm precast concrete culvert connected with two concrete wing-walls located at the northwest and southeast of the culvert over a concrete apron.

CAST-IN-PLACE FRICTION PILE (CIP)

The preferred foundation is the used of cast-in-place friction pile. Using pile lengths of 7.6m (25 ft), 9.1m (30 ft) and 12.2m (40 ft) below grade, an allowable shaft adhesion value of 15.0 kPa(314 psf), 14.6 kPa(304 psf) and 12.1 kPa(258 psf) applied to the pile circumference within the native clay may be used for the pile design, respectively. A maximum pile length of 9.1m (30 ft) below grade should be used due to considerable low shear strength of the clay below 9.1m depths.

Considering potential long-term soil shrinkage away from the pile face, the upper 1.5m (5 ft) of the piles should be neglected in determining the capacity of all interior piles. For the exterior piles, the upper 3.0m (10 ft) of the piles should be ignored.

Pile spacing should be at least three pile diameters, centre to centre. *Seepage and sloughing will be expected from the base of the drain thus, temporary steel sleeves should be on hand and used during pile installation.* To minimize pile construction difficulties, the total number of pile holes left open at any

From: **Silvestre Urbano, Jr., P. Eng., Geotechnical Engineer**

Winnipeg 10 Prairie Way Winnipeg, Manitoba Canada R3J 3J8
Tel: (204) 477-6650 – **Fax: (204) 474-2864**

given time should not be more than four and the pile holes should be poured with concrete as soon as they are drilled to the design diameters and depths.

Piles located in unheated areas should be provided with full-length reinforcements, a minimum pile length of 7.62m (25 ft) and the top 2.1m (7 ft) of the pile should be cast using with greased sono tube forms to reduce the potential for frost jacking.

Pile installation may be adversely affected by loose backfill and the possible presence of existing concrete slabs. Thus, contract documents should properly cover these potential obstacles during pile installation.

Pile inspection by qualified geotechnical personnel should be employed to ensure a satisfactory foundation installation.

RAFT SLAB ON COMPACTED GRANULAR FILL

Alternatively, the entire structure may be supported on 600mm of compacted granular fill over non-woven geotextile over stiff clay. This system maybe used provided that immediate and long term foundation settlement of less than 25mm is acceptable and frost protection is provided.

To reduce differential foundation settlement, the compacted fill should be prepared as follows:

- Within the proposed structure area and at least 1.2 m beyond the structure perimeter, remove all heterogeneous fill, organic material, peat moss, softened soil and ponded water to expose the underlying clay layer. Depth of site stripping is expected to be 600mm below existing grade. Any additional fill should comprise of either the same material (20mm) or subbase material (50mm down granular fill). Since the anticipated floor is granular fill, the depth of site stripping should cover the entire structure.

- Call for subgrade inspection. The exposed subgrade should be compacted with vibratory roller equivalent to 95% Standard Proctor density. *If the exposed subgrade can not be compacted due to saturation, the need for permanent subdrains placed underneath the subgrade should be enforced to attain the required compaction.*

- Once the subgrade is approved, place a 300 mm thickness of 50 to 75mm down granular fill (C-base or subbase) followed by a 300 mm thickness of 20 mm down granular fill (A-base or base course material) across the entire width of the structure area and 1.2 m beyond. Both of the subbase and base course materials should be placed and uniformly compacted with a heavy vibratory roller to at least 98% Standard Proctor density (ASTM D698)

- Call for compaction testing of all the lifts (150m mm thickness) by qualified geotechnical personnel.
- If required, recompact and retest any area of low percent compaction to meet the specified 98% compaction.

For frost protection, raft slab should be provided with a minimum granular soil cover of 1.8m or an equivalent insulation thickness of R20 rigid polystyrene skirt around the perimeter to a depth of 600mm below grade prior to backfilling and extending diagonally outward over the weeping tile a distance of 1.2m.

Final site grading should ensure that all surface runoff is directed away from the any built structure using minimum gradients of 1% and 2% for paved and landscaped areas, respectively.

For winter construction, all bearing surfaces and the newly poured slab should be protected by hoarding and heating to avoid frozen concrete and heaving due to frost penetration below the slab.

To avoid the saturation of the bearing soil and scouring during the spring season, the exposed granular fill beyond the perimeter of the slab should be capped with impermeable clay compacted to at least 95% Standard Proctor density.

Based on the groundwater conditions, the foundation system should be designed to resist an up-lift pressure of about 15 kPa.

For the wing-wall foundation system, the footing may also be designed for an allowable bearing pressure of 72 kPa. A cohesion value of 37.5 kPa with a safety factor of 1.5 against sliding should be used.

The new fill surcharge should be limited to not more than 750 mm above the average ground surface elevation. Raising the existing grade more than 750 mm should not be attempted, without a detailed geotechnical evaluation. On the foregoing basis and contingent upon a minimum depth of 600 mm for the granular pad and a maximum footing width of 750mm(30 in.) is used, an allowable soil bearing pressure of 71.8 kPa(1500 psf) may be used. The associated total soil settlement is estimated to be 25 to 50 mm. Differential settlements of the granular pad are not expected to be significant.

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Winnipeg 10 Prairie Way Winnipeg, Manitoba Canada R2J 3J8
Tel: (204) 477-6650 – **Fax: (204) 474-2864**

LATERAL PRESSURE OF THE WING WALL

The degree of compaction of backfill against the wall, backfill soil type and subdrainage conditions will greatly affect the magnitude and shape of the lateral earth pressure on the structured walls.

Since the walls of the structure will be unyielding (i.e. rigid), the "at-rest" (K_0) earth pressures will be applicable for all cases. Where the backfill behind the wall will be required to provide subgrade support for slabs, pavements, etc., the backfill will need to be compacted. The lateral earth pressures induced by compaction and surcharge loadings will need to be accounted for in design. Where the subgrade support will not be required, the backfill need not be well compacted, and the conventional triangular earth pressure distribution will be appropriate.

As the clay layer is considered impermeable for design purposes, it is anticipated that full hydrostatic pressures will be realized and it is recommended that a water level co-incident with the ground surface be utilized for design. Preferably, a subdrainage system, consisting of filter protected perforated pipes installed at the wall base, would be installed, thus eliminating the requirement to design for full hydrostatic pressures.

LIGHT TO MODERATELY COMPACTED BACKFILL

Light to moderately compacted backfill is estimated to correspond to compaction levels of 90 to 95% of standard Proctor. For such degrees of compaction, settlement is expected to be in the range of 2 to 4 percent of the fill height,

Where subdrainage will be provided at the base of the wall, the lateral earth pressures should be determined by:

$$P_h = K_o \bullet H$$

Where: P_h = lateral earth pressure at any depth(kpa)
Ko = earth pressure coefficient
$\bullet$ = total unit weight of the soil(kg/m^3)
H = height of the wall (m)

In the case where subdrainage will not be provided, the design lateral earth pressure acting on the wall may be determined by :

$$P_h = K_o \bullet' H + \bullet_w H$$

Where: P_h = lateral earth pressure at any depth(kpa)
K_o = earth pressure coefficient
$\bullet'$ = buoyant unit weight of the soil(kg/m^3)

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H = height of the wall (m)
•$_w$ = unit weight of water

The recommended soil parameters are presented below in Table 1. Due to the frost susceptibility of a clay material, clay backfill is not recommended for the ramp.

TABLE 1
RECOMMENDED EARTH PRESSURES COEFFICIENTS AND UNIT WEIGHTS FOR LIGHT TO MODERATELY COMPACTED BACKFILL

SOIL TYPE	K_o	TOTAL UNIT WEIGHT(kg/m^3)
Light to Medium Compacted Granular Fill (Pit-run Material: 75 mm down)	0.50	2150

WELL COMPACTED BACKFILL

Where the backfill adjacent to the structured walls will be well compacted, there will be a build-up of lateral compaction stresses and the design earth pressure envelope will be as illustrated in Figure 2. For this case, the design earth pressure for the upper portions of the walls will be dependent on loads imposed by the compactor and includes the centrifugal force in the case of a vibratory compactor. The combined dead weight and centrifugal force for typical compactors is given in Figure 3. It may be necessary to provide temporary bracing during compaction to resist the lateral pressures generated by the compaction equipment.

For the well compacted case, compaction to 98 to 100% of standard Proctor is required and settlement of the fill is expected to be in the range of 0.5 to 1 percent of the fill height. Obviously, the greater degree of compaction achieved, the less settlement will occur. The recommended soil parameters are presented below in Table 2.

TABLE 2
RECOMMENDED EARTH PRESSURES COEFFICIENTS AND UNIT WEIGHTS FOR WELL COMPACTED BACKFILL

SOIL TYPE	K_o	TOTAL UNIT WEIGHT(kg/m^3)
Well Compacted Granular Fill (Pit-run Material: 75 mm down)	0.40	2275

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SURCHARGE

Lateral pressures induced by surcharge loads will need to be included for in the design of some or all of the walls. In the case of uniformly distributed surcharge loads, the lateral pressures should be determined by multiplying the surcharge load intensity by the appropriate K_0 value. For live point or line surcharge loads, the lateral pressures should be determined as shown on Figure 4.

ADDITIONAL CONSIDERATIONS

Concrete should be manufactured with sulphate-resistant (Type 50) cement and air content between 4% and 7%. Any concrete subject to cycles of freezing and thawing should be air entrained in accordance with the latest edition of CSA A23.1, Concrete Materials and Methods of Concrete Construction.

The granular base course and subbase materials should include organic-free, non-frozen, aggregate conforming to the City of Winnipeg gradation limits.

Where soft spots are encountered at the slab level, construction traffic should be restricted. Soft spots should be excavated with a large backhoe fitted with a smooth bucket, to at least 300 mm below the underside of the subbase and replaced with a 300 mm thick layer of 150 mm crushed limestone.

Sieve analysis and compaction testing of the granular base and subgrade materials should be conducted by qualified geotechnical personnel to ensure that the materials supplied and percent compactions are in accordance with design specifications.

CLOSURE

The findings and foundation recommendations provided in this report were prepared in accordance with generally accepted professional engineering principles and practices. The recommendations are based on the results of field investigations. If conditions encountered during construction appear to be different than those shown by the testpit at this site, this office should be notified immediately in order that the recommendations can be reviewed.

The findings and recommendations provided in this report were prepared by GENIVAR (the Consultant) in accordance with generally accepted professional engineering principles and practices. The recommendations are based on the results of field and laboratory investigations and are reflective only of the actual testhole(s) and/or excavation(s) examined. If conditions encountered during construction appear to be different than those shown by the testhole(s) and/or excavation(s) at this site, the Consultant

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should be notified immediately in order that the recommendations can be reviewed and modified as necessary to address actual site conditions.

This report is limited in scope to only those items that are specifically referenced in this report. There may be existing conditions that were not recorded in this report. Such conditions were not apparent to the Consultant due to the limitations imposed by the scope of work. The Consultant, therefore, accepts no liability for any costs incurred by the Client for subsequent discovery, manifestation or rectification of such conditions.

This report is intended solely for the Client named as a general indication of the visible or reported physical condition of the items addressed in the report at the time of the geotechnical investigation. The material in this report reflects the Consultant's best judgment in light of the information available to it at the time of preparation.

This report and the information and data contained herein are to be treated as confidential and may be used only by the Client and its officers and employees in relation to the specific project that it was prepared for. Any use a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. The Consultant accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The report has been written to be read in its entirety, do not use any part of this report as a separate entity.

All files, notes, source data, test results and master files are retained by the Consultant and remain the property of the Consultant.

PROVINCE OF MANITOBA
S. S
URBANO
SEPT. 22, 2010
REGISTERED PROFESSIONAL ENGINEER

APEGM
Certificate of Authorization
Genivar Consultants Limited Partnership
No. 4318 Date: SEPT. 22, 2010

From: **Silvestre Urbano, Jr., P. Eng., Geotechnical Engineer**

Winnipeg 10 Prairie Way Winnipeg, Manitoba Canada R2J 3J8
Tel: (204) 477-6650 – **Fax: (204) 474-2864**

GENIVAR

Project No: WE-091-15184-00-WE

TH1

Project: Lagimodiere Multi-Use Path

Client: City of Winnipeg

Enclosure:

Location: 2-1800mm Culvert Crossing

Engineer: SSU

SUBSURFACE PROFILE

Depth	Symbol	Description	Elevation, m	Field Vane(m-kg)	Blows/0.3m	Pocket Penetrometer Test kPa (50 150 250 350)	Water Content % (Wp 20 40 60 80 Wl)
0 m (0 ft)		Ground Surface	100				
		FILL 50mm sandy topsoil fill with rootlets over 550mm of CLAY FILL, mixed brown and black, trace of fine gravel	99.5			150	
		CLAY stiff, brown, fissured; SILTY at 1.8 to 1.95m, firm, tan-brown; stiff below 1.95m, trace of sulphate inclusions down to 4.6m; grey at 10m, firm to soft. TESTHOLE WAS DRY AFTER COMPLETION OF DRILLING				100 100 90 90 80 40 40	
12 m (40 ft)		End of Testhole	87.9				

Drill Method: S/S Auger

Drill Date: 09/16/10

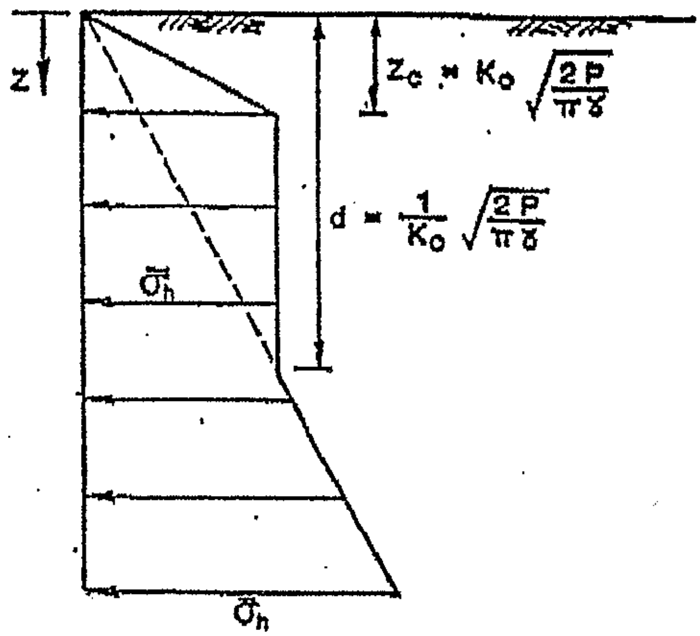
Hole Size: 125mm

GENIVAR
#10 Prairie Way
Winnipeg, Mb.
R2J 3J8

Datum:

Checked by: SSU

Sheet: 1 of 1



FOR $Z_c \leq Z \leq d$

$\bar{\sigma}_h = \sqrt{\frac{2P\gamma}{\pi}}$

FOR $Z > d$

$\bar{\sigma}_h = K_o \cdot \gamma \cdot Z$

P (ROLLER LOAD) = $\frac{\text{DEAD WT. OF ROLLER + CENTRIFUGAL FORCE}}{\text{WIDTH OF ROLLER}}$

L : LENGTH OF ROLLER

SOIL PARAMETERS ARE GIVEN IN THE TEXT OF REPORT

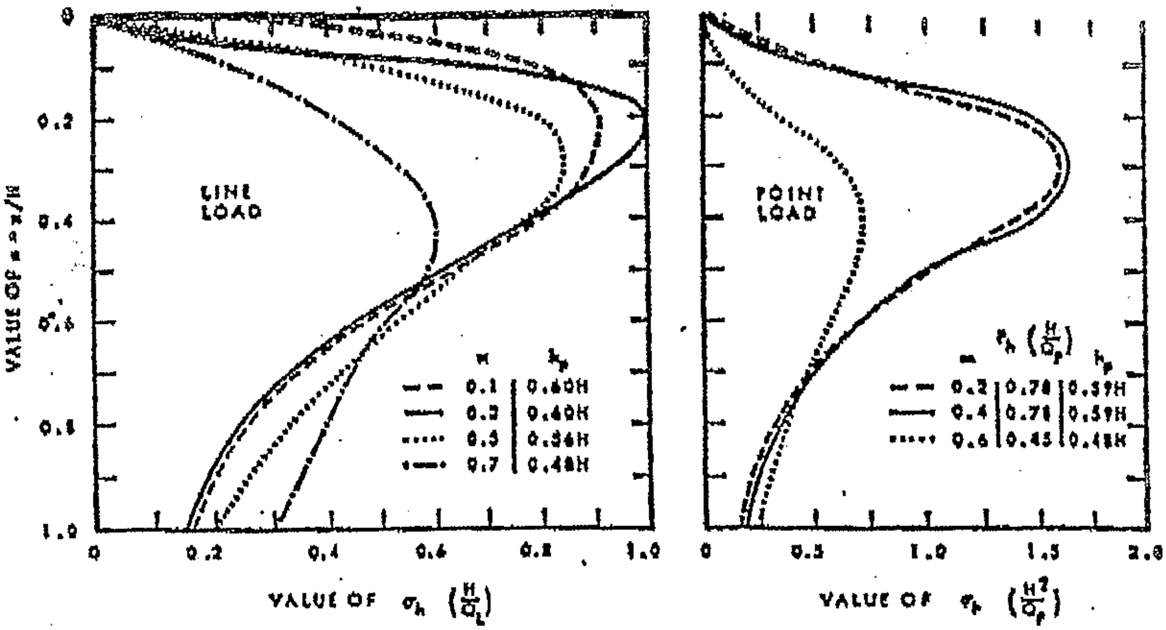
REF: INGOLD (1980), INTERNATIONAL CONFERENCE ON COMPACTION

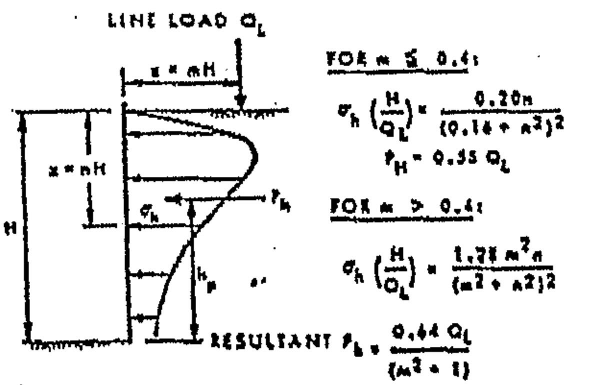
DRAWN BY :	CLIENT :
PROJECT No :	PROJECT :
DATE :	DESCRIPTION : HORIZONTAL PRESS. ON WALLS DUE TO COMPACTION EFFORT
SCALE : NOT TO SCALE	DRAWING : FIGURE 2

TYPICAL COMPACTOR LOADS (P)

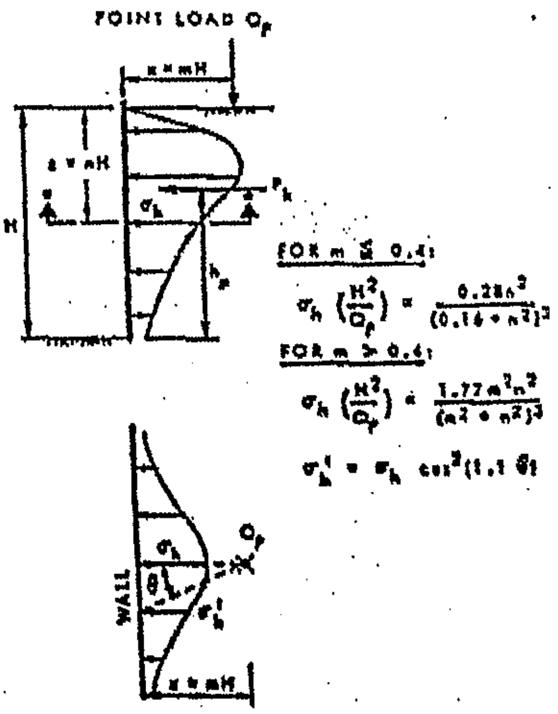
Compactor	Load (P) kN/m
Bowmag TSE	31.3
Bowmag 60S	31.8
Bowmag 65S	22.7
Bowmag 75S	32.5
Bowmag 90S	39.3
Bowmag 75AD	19.6
Bowmag 100AD	20.3
Bowmag 120AD	33.5
Bowmag 130AD	36.1
Bowmag BW122D	30.4
Bowmag BW122PD	35.8
Dynapac LR100	41.7
Dynapac 2100V	92.9
Bowmag 142PDB	46.6
Bowmag 172PDB	92.9
Dynapac CA121D	53.2
Dynapac CA121PD	53.7
Dynapac CA151	79.9
Dynapac CA151D	80.2
Dynapac CA151PD	96.2

DRAWN BY :	CLIENT :
PROJECT No :	PROJECT :
DATE :	DESCRIPTION : COMPACTOR LOADS
SCALE : NOT TO SCALE	DRAWING : FIGURE 3





PRESSURES FROM LINE LOAD Q_L
(BOUSSINESQ EQUATION MODIFIED BY EXPERIMENT)



SECTION a - a
PRESSURES FROM POINT LOAD Q_p
(BOUSSINESQ EQUATION MODIFIED BY EXPERIMENT)

REFERENCE:
CANADIAN FOUNDATION ENGINEERING MANUAL, 2nd EDITION, 1985

	DRAWN BY :	CLIENT :
	PROJECT No :	PROJECT :
	DATE :	DESCRIPTION : LATERAL PRESSURE ON WALLS DUE TO POINT & LINE LOADS
	SCALE : NOT TO SCALE	DRAWING : FIGURE 4