CI 38903

Halifax UG Cable Replacement 1H-403 & 405

REDACTED

September 2, 2010

NOVA SCOTIA POWER
An Emera Company

NOVA SCOTIA POWER
An Emera Company

UARB APPROVAL SHEET

Project Title: **Halifax UG Cable Replacement 1H-403 & 405**

CI Number: 38903

■ Capital Project Authorization
☐ ATO
☐ Final Cost

Head Office Use:
Project Number: D301
Date: August 30, 2010

Location:

Division:

Expenditure Profile

YEAR	Budget Estimate	Project Estimate
2010	592,567	473,599
Total	$592,567	$473,599

Schedule

Start Date	2010-04
Estimated In-Service Date	2010-09
Estimated Close Date	2010-11

COMMENTS

Submitted on behalf of NOVA SCOTIA POWER INCORPORATED

Aug 26/2010

Authorized Signatory DATE
Mark Savory
VP Technical and Construction

Approved on behalf of NOVA SCOTIA UTILITY AND REVIEW BOARD

DATE

CI Number :	38903-D301	- Halifax UG Cable Replacement 1H-403 & 405	Project Number	D301
Parent CI Number :		-		
Cost Centre :	800	- 800-Services - Admin.	Budget Version -	2010 07/05 Forecast

	Forecast
Start :	04/01/2010
Operational :	09/30/2010
Final Cost :	11/30/2010
2010	$473,599.09
Total :	$473,599.09
Original Cost :	$113,032.00

This project is required to replace 2.8 km of 3 phase 25kV underground cable between the Water Street Substation and Scotia Square on circuits 1H-403 and 1H-405.

This project has been activated.

Summary of Related CI's +/- 2 years
No other projects in 2008,2009,2010,2011 and 2012

CI Number : 38903-D301 - Halifax UG Cable Replacement 1H-403 & 405 **Project Number** D301

Parent CI Number : - **Approved Date** 4/20/2010

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2010 07/05 Forecast

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
001		001 - T&D Regular Labour		0	0	0
001		001 - Regular Labour (No AO)		717	0	717
002		002 - T&D Overtime Labour		0	0	0
002		002 - Overtime Labour (No AO)		0	0	0
012		012 - Materials		0	0	0
013		013 - COPS Contracts		0	0	0
092		092-Vehicle T&D OT Labour AO		4,092	0	4,092
092		092-Vehicle T&D Reg. Labour AO		15,102	0	15,102
094		094 - Interest Capitalized		5,841	0	5,841
095		095-COPS Regular Labour AO		49,327	0	49,327
095		095-COPS Overtime Labour AO		14,128	0	14,128
095		095-COPS Contracts AO		9,252	0	9,252
098		098 - Salvage		0	0	0
014	035	014 - Overtime Meals	035 - DP - Wood Poles	201	0	201
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	0	0	0
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	1	0	1
001	046	001 - T&D Regular Labour	046 - DP - U/G Conductor	62,220	0	62,220
001	046	001 - Regular Labour (No AO)	046 - DP - U/G Conductor	3,290	0	3,290
002	046	002 - Overtime Labour (No AO)	046 - DP - U/G Conductor	591	0	591
002	046	002 - T&D Overtime Labour	046 - DP - U/G Conductor	35,462	0	35,462
012	046	012 - Materials	046 - DP - U/G Conductor	1,366	0	1,366
013	046	013 - COPS Contracts	046 - DP - U/G Conductor	26,181	0	26,181
098	046	098 - Salvage	046 - DP - U/G Conductor	(27,500)	0	(27,500)
001	047	001 - T&D Regular Labour	047 - DP - U/G Conductor Devices	42	0	42
002	047	002 - T&D Overtime Labour	047 - DP - U/G Conductor Devices	83	0	83
012	047	012 - Materials	047 - DP - U/G Conductor Devices	272,954	0	272,954
013	047	013 - COPS Contracts	047 - DP - U/G Conductor Devices	0	0	0
001	048	001 - T&D Regular Labour	048 - DP - U/G Line Transf.	9	0	9
002	048	002 - T&D Overtime Labour	048 - DP - U/G Line Transf.	18	0	18
001	049	001 - T&D Regular Labour	049 - DP - U/G Line Transf.Device	75	0	75
002	049	002 - T&D Overtime Labour	049 - DP - U/G Line Transf.Device	146	0	146
001	085	001 - T&D Regular Labour	085 Design	0	0	0
			Total Cost:	473,599	0	473,599
			Original Cost:	113,032		

CI Number	: 38903-D301	- Halifax UG Cable Replacement	**Project Number**	D301
Parent CI Number	:	-	**Approved Date**	4/20/2010
Cost Centre	: 800	- 800-Services - Admin.		

Capital Item Justification

Justification Criteria : DISTRIBUTION SYSTEM
Sub-Criteria : DETERIORATED CONDUCTOR
Name of Report :
Document Location :
Person Responsible :

Why do this project?

This project is required to replace deteriorated underground 25kV cables and accessories in the Halifax Underground System.

Why do this project now?

This project is part of a plan to begin replacing cables that have reached the end of their useful life. Cables installed in the early 1970's have now reached the end of their useful life; estimated at 35 years.

Why do this project this way?

Due to the age of the underground cables, a planned replacement program is scheduled to take place over the next several years.

This work is being completed by NSPI.

CI Number	: 38903-D301	- Halifax UG Cable Replacement	**Project Number**	D301
Parent CI Number	:	-	**Approved Date**	4/20/2010
Cost Centre	: 800	- 800-Services - Admin.		

Reason for Variance / Over Expenditure / Final Costing

14821780

The variance between the current submission and ACE 2010 is primarily due to less NSPI labour along with the applicable overheads than originally estimated. The variance is offset by a decrease in salvage value.

38903 - Halifax UG Cable Replacement 1H-403 & 405

Account	ACE 2010	Current Submission	Variance
001 - Regular Labour (No AO)	-	4,007	4,007
001 - T&D Regular Labour	171,147	62,346	(108,801)
002 - Overtime Labour (No AO)	-	591	591
002 - T&D Overtime Labour	-	35,710	35,710
012 - Materials	275,795	274,320	(1,475)
013 - COPS Contracts	17,419	26,181	8,762
014 - Overtime Meals	-	201	201
092-Vehicle T&D OT Labour AO	-	4,092	4,092
092-Vehicle T&D Reg. Labour AO	39,210	15,102	(24,107)
094 - Interest Capitalized	12,306	5,841	(6,465)
095-COPS Contracts AO	4,261	9,252	4,991
095-COPS Overtime Labour AO	-	14,128	14,128
095-COPS Regular Labour AO	135,429	49,327	(86,101)
098 - Salvage	(63,000)	(27,500)	35,500
	592,567	**473,599**	**(118,967)**

CI 38903 – Halifax UG Cable Replacement 1H-403 & 405

The following is a breakdown of costs associated with the Halifax UG Cable Replacement 1H-403 & 405.

• Administrative Overheads and Interest	$97,743
• Labour	$102,654
• Materials	$274,320
• Contracts	$26,181
• Other	$201
• Salvage	$(27,500)
• Total	$473,599

The main project cost is Materials, which consists of $274,320. This includes the costs for the underground cable.

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Distribution Responses

Request IR-D10:

With respect to page 220, CI# 38903, Halifax UG Cable Replacement 1H-403 &405,

a) Please provide the planning studies and relevant related documents that justify the construction of this project.

b) Is this the start of a continuing cable replacement program? If not indicated in a) above please provide information on the replacement program being planned.

c) Will NSPI be completing any portion of the works utilizing its own forces? If so, please specify those portions of the works that will be assigned to NSPI staff.

d) Provide the breakdown showing the amount budgeted for NSPI labour, contracted labour, consultants, material, interest, and overhead charges.

Response IR-D10:

a) Please refer to Confidential Attachment 1, Distribution Capital Investment Report: Halifax 25kV Underground System. Pages 41 and 42 of this item are considered confidential as these pages contain quotes received from suppliers. NSPI strives to keep the terms and conditions of supplier's pricing and arrangements confidential from their other customers or potential competitors. This prevents competitors from using their information to gain a competitive advantage. This is equally true for NSPI, which desires to protect its ability to acquire capital services and equipment on the most competitive terms. Those "best" terms may not be available if there is a risk that they will be disclosed to the customers or competitors of the supplier.

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Response IR-D10: (cont'd)

b) The 2010 ACE item is based on the following five year plan:

Year 1, 2 and 3 – replace radial sections of the feeders 1H-403, 405, 419 and 431

Year 4 and 5 – replace loops and ties of the feeders 1H-403, 405 and 419

2010

i) 1H-403 – radial section between 1H and 28H-416 Scotia Square (1,400m)

ii) 1H-405 – radial section between 1H and 28H-417 Scotia Square (1,440m)

iii) PILC cable removal between 1H and MH46 on Granville St (1,000m)

2011

i) H-419 – radial section between 1H and L431-401 Proctor Street (2,140m)

ii) 1H-419 – half of the radial section between L431-404 and L431-211 Art Gallery Vault (645m)

2012

i) 1H-431 – radial section between 1H and Art Gallery Vault (2,230m)

ii) 1H-419 – second half of the radial section between L431-404 and L431-211 Art Gallery Vault (645m)

2013

i) 1H-403 – North Loop from 28H-410 to L431-229 Metro Center (2,240m)

ii) 1H-403 – Metro Center Loop from L431-230 to L431-232 (1,700m)

2014

i) 1H-403 – Scotia Square 28H-415 to Grand Parade Vault (380m)

ii) 1H-403 – Scotia Square 28H-411 to Metro Center L431-230 (410m)

iii) 1H-405 – 23kV loop (1,900m)

iv) 1H-419 – Tie to Scotia Square (240m)

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Response IR-D10: (cont'd)

c) All of this work will be performed by internal resources with the exception of traffic control.

d) Table 1- Breakdown of the Halifax UG Cable Replacement Cost Estimate.

Account	Estimate ($)
Labour	171,147
Materials	275,795
Contracts	17,419
Interest	12,306
Overhead	178,900
Salvage	(63,000)
Total	**592,567**

DISTRIBUTION CAPITAL INVESTMENT REPORT
HALIFAX 25 kV UNDERGROUND SYSTEM

Draft
October 05, 2009

TABLE OF CONTENTS

1.0 SUMMARY

Objective

The purpose of this report is to identify the requirements necessary to perform the cable replacement program in Downtown Halifax.

Scope

The scope of the report is limited to 25 kV feeders interconnected around the pole-free area of Downtown Halifax. The main components of the report are: overview of the present system configuration, review of the historic load check, cable inventory and categorization, review of manhole configurations and availability of spare ducts, basic feeder contingency assessment, system improvement proposals, budgeting and timelines. The existing 4 kV underground distribution system, substation contingencies and justifications for new feeder(s) are not covered in the report.

Recommendations

This report recommends that the replacement project be carried out over the next 5 years. The required expenditures have been prioritized. This report has considered the age of plant, the loading of the system from PI data and the reliability to customers connected to the underground system. Consideration has been given to prolonging cable life by injection of chemicals into existing cables.

Also, the report recommends two system improvement options that are necessary to improve the existing switching flexibility by establishing two new tie links. These changes should be made prior to the cable replacement program.

2.0 PRESENT SYSTEM CONFIGURATION

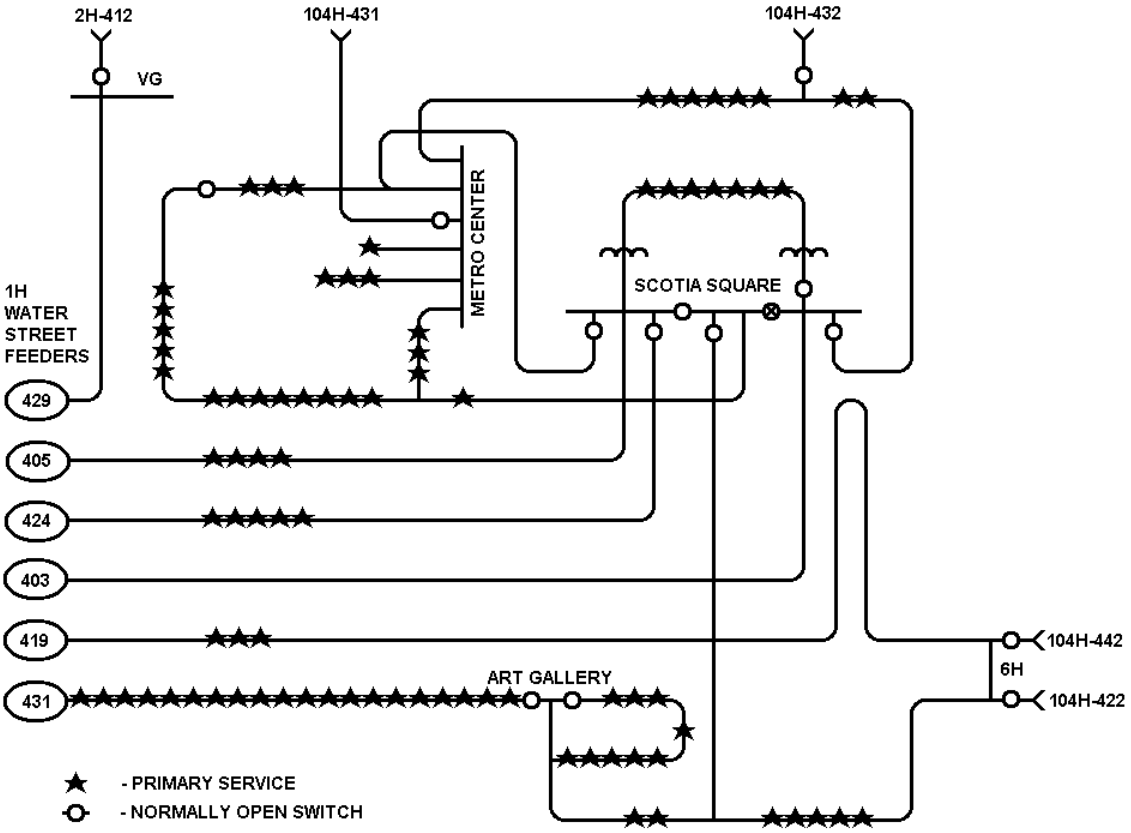


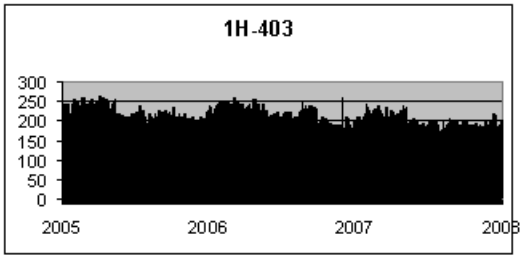
Fig. 2.1 Simplified Feeder Diagram

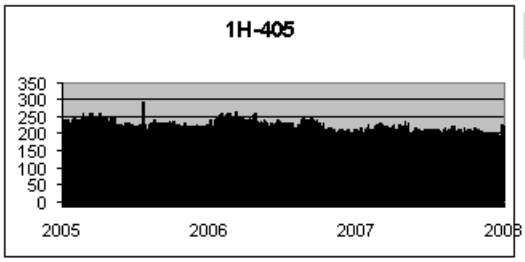
The diagram on Fig. 2.1 is a simplified combination of an electrical single line diagram and a geographical layout of the Halifax UD system. For simplicity, only open points are shown (except for the one at Scotia Square).

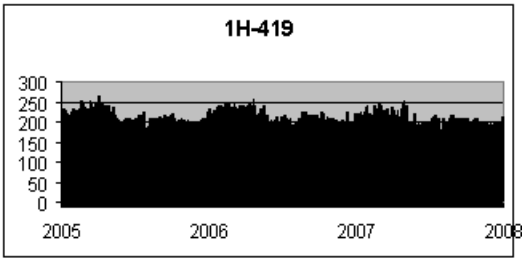
2.1 UNDERGROUND FEEDER PROFILES

The feeder profiles below describe each of the six underground feeders in a uniform format that will allow for easy comparison and quick reference further in the report. The underground feeders are: 1H-403, 1H-405, 1H-419, 1H-424, 1H-429 and 1H-431

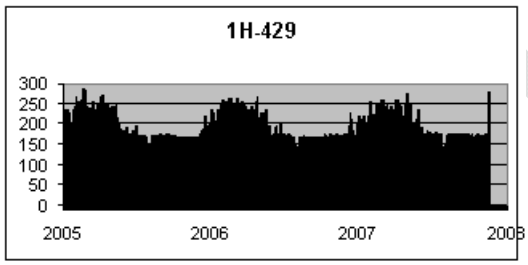
1 of 6

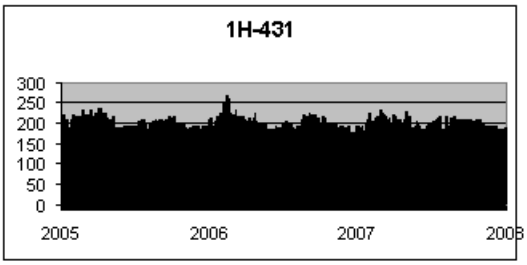
1H-403 FEEDER PROFILE			
Scotia Square / Metro Center			
Total feeder length (including services)	7.8 km		
Built	1970's		
Route	Water, Sackville, Granville, Duke, 28H, Barrington, Agryle, Grafton, Market, Brunswick, Cogswell.		
Installed MVA	23		
Interties with feeders	1H-405, 1H-419, 104H-432, 104H-431		
Loops	Two		
Stepdowns	689H		
Primary services	CS431-048, 170, 139, 197, 184, 185, 198, 487, 510, 428, 036, 429, 637, 531, 430, 150, 227, 211, 162, 154, 001, 182, 270, 426, 046, 144, 143, 265, 216, 244, 573, 402		
Load profile for the last 3 years ending June 1, 2008.			
Underground Cable	Part of feeder	Conductor size [kcmil],[AWG]	Length, 3ph [m]
	Main radial	750	1780
	Loops	750	2240
		500	180
		350	1550
	Ties	750	230
		500	180
	Primary services	750	90
		350	100
		3/0	1110
		1/0	470
		#1	100

1H-405 FEEDER PROFILE			
Scotia Square			
Total feeder length (including services)	3.8 km		
Built	1970's		
Route	Water, Sackville, Granville, Duke, Scotia Square, Market, Cogswell		
Installed MVA	14 (approx.)		
Interties with feeders	1H-403, 1H-424		
Loops	One		
Stepdowns	28H-T26		
Primary services	CS431-007, 427, 005, 012, 507, 508, 481, 506		
Load profile for the last 3 years ending June 1, 2008.			
Underground Cable	Part of feeder	Conductor size [kcmil],[AWG]	Length, 3ph [m]
	Main radial	750	1470
	23 kV loop	750	160
		350	1380
		4/0	180
		#1	340
	Primary services	3/0	170
		#1	10

1H-419 FEEDER PROFILE			
Joseph Howe Bldg./ Proctor Street			
Total feeder length (including services)	5.4 km		
Built	1970's		
Route	Water, Sackville, Granville, Duke, 28H, Hollis, 6H, Upper Water		
Installed MVA	14		
Interties with feeders	1H-403, 1H-431, 104H-422, 104H-442		
Loops	One		
Stepdowns	622H		
Primary services	CS431-351, 138, 196, 053, 268, 183, 272, 140, 004, 142, 047, 279, 011, 141, 169		
Load profile for the last 3 years ending June 1, 2008.			
Underground Cable	Part of feeder	Conductor size [kcmil],[AWG]	Length, 3ph [m]
	Main radial	750	2140
	Loop	750	1290
		4/0	490
		3/0	640
	Tie	750	240
	Primary services	750	30
		3/0	100
		#1	50

1H-424 FEEDER PROFILE			
Water Street/Scotia Square			
Total feeder length (including services)	2.0 km		
Built	2003		
Route	Water, Granville, Duke, 28H		
Installed MVA	3.9		
Interties with feeders	1H-405		
Loops	N/A		
Stepdowns	N/A		
Primary services	CS431-516, 493, 247, 485, 566, 567		
Load profile	No Load Profile Available		
Underground Cable	Part of feeder	Conductor size [kcmil],[AWG]	Length, 3ph [m]
	Main radial	750	1600
	Primary services	350	270
		3/0	350
		#1	150

1H-429 FEEDER PROFILE			
V.G. Hospital			
Total feeder length (including services)	2.2 km		
Built	1990's		
Route	Water, Morris, 10H		
Installed MVA	11.2		
Interties with feeders	2H-412		
Loops	N/A		
Stepdowns	10H-T1 VG - North Bus		
Primary services	N/A		
Load profile for the last 3 years ending June 1, 2008.			
Underground Cable	Part of feeder	Conductor size [kcmil],[AWG]	Length, 3ph [m]
	Main radial	750	2200

1H-431 FEEDER PROFILE			
Downtown U/G			
Total feeder length (including services)	3.9 km		
Built	1970's		
Route	Morris, Hollis, Salter, Water, Bedford Row, Prince		
Installed MVA	17.5		
Interties with feeders	1H-419, 1H-415(o/h), 1H-427(o/h)		
Loops	N/A		
Stepdowns	610H Bedford Row		
Primary services	CS431-205, 345, 554, 002, 497, 498, 148, 580, 674, 165, 049, 261, 217, 220, 271, 401, 608, 450, 054		
Load profile for the last 3 years ending June 1, 2008.			
Underground Cable	Part of feeder	Conductor size [kcmil],[AWG]	Length, 3ph [m]
	Main radial	750	2130
	Primary services	3/0	280
		350	270

2.2 LOAD CHECK SUMMARY

FEEDER PEAK LOAD HISTORY 2004 - 2008											
Halifax peninsular feeders of interest		2008*		2007		2006		2005		2004	
		PI	Load Check	PI	Load Check	PI	Load Check	PI	Load Check	PI	Load Check
Underground feeders	1H- 431	230	213	250	223	270	298	240	286	240	303
	1H-419	220	-	250	196	260	230	260	240	290	258
	1H-403	220	203	240	222	260	273	270	227	270	250
	1H-405	220	210	250	220	270	275	270	283	255	230
	1H-424**	-	60	-	70	-	70	-	70	-	80
	1H-429	180	-	270	184	270	257	280	261	260	247
Overhead Feeders intertied with u/g feeders	1H-415	360	-	375	283	340	326	390	320	350	240
	1H-427	230	230	260	238	260	267	260	220	250	220
	104H-413	250	253	250	330	280	330	250	360	340	350
	104H-431	350	350	260	243	270	271	280	250	340	330
	104H-432	280	343	275	365	280	288	350	351	160	271
	104H-422	230	206	300	253	275	277	275	280	230	267
	104-442	280	284	290	309	240	287	270	253	310	309
	2H-412	350	331	350	345	350	334	350	357	330	332
	2H-413	300	295	300	336	290	242	260	379	300	255
	* - Period ending June 1, 2008 ** - Evaluated based on installed kVA										

3.0 FEEDER CONTINGENCIES

The purpose of this contingency categorization is to help identify feeders with switching limitations and to help draw the line between "Possible" and "Practical" as applied to a planned power outage to a part of the system. In other words even if the power can be restored after a system failure, the same technique may not always be justifiable for a planned outage.

3.1 CONTINGENCY DEFINITIONS

Contingency A – Transferring open point(s) in the loop of the same feeder. This is the preferred way of managing planned and unplanned outages.

Contingency B – Simple switching by transferring open point between two adjacent feeders of the same source (substation). Backup feeder loading is a possible limiting factor.

Contingency C – Transferring open point between two feeders from two independent substations. Limiting factors: feeder loading, substation capacity, temporary abnormal configuration of the backup feeder, possible issues with paralleling, more complicated switching procedures.

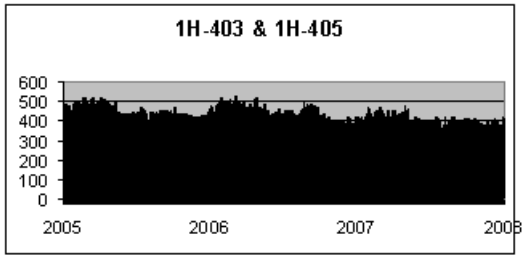
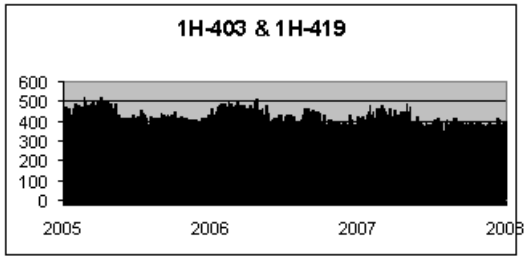
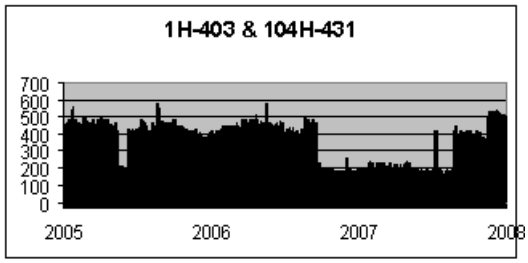
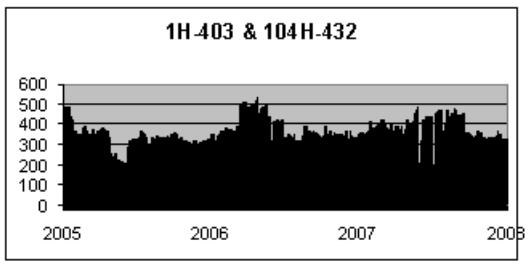
Contingency D – Cascade offloading. (a) Same as Contingency B or C but the backup feeder needs to be offloaded first to a third feeder. (b) Splitting load between two adjacent feeders.

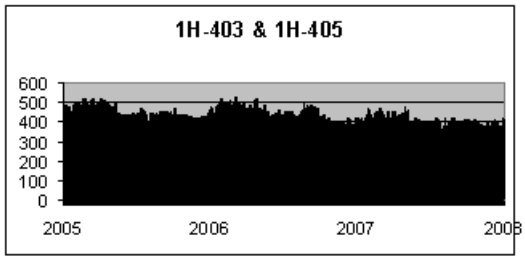
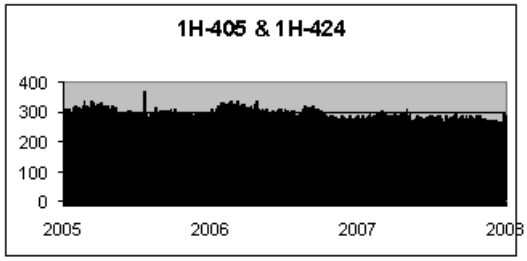
3.2 CONTINGENCY OPTIONS

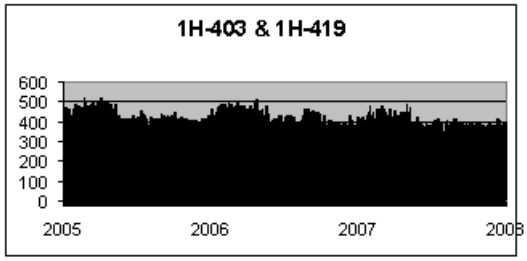
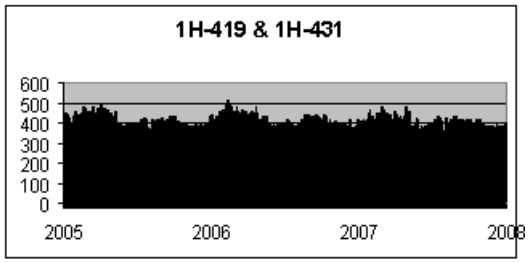
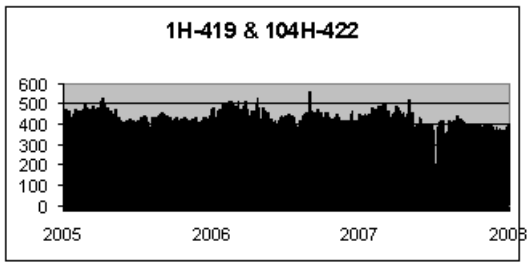
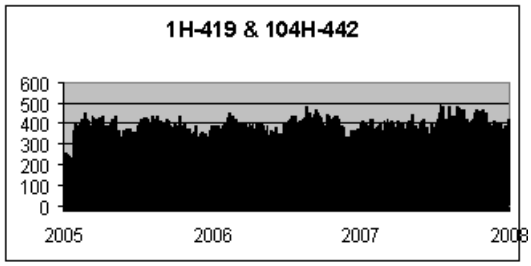
The following summaries are to give an overview of the available switching options. Contingency A options are only available for feeders with loops and only for the loop part of the feeder. This option is not shown in the summaries.

Contingency D options are only shown for the feeders with limited switching options B and C.

Not all of the D- options can be shown due to a high number of open/closed switch combinations.

1H-403 CONTINGENCY OPTIONS		
Backup feeder	**1H-405**	
Total load [A]	490/440	
Switching device	L431-412	
Contingency type	B	
Comment	This option can be marginal during summer peaks	
Backup feeder	**1H-419**	
Total load [A]	490/420	
Switching device	28H-413	
Contingency type	B	
Comment	Very similar to 1H-405	
Backup feeder	**104H-431**	
Total load [A]	500/465	
Switching device	L431-233 Metro Center	
Contingency type	C	
Comment	Combined load can be close to 500 A -load check is recommended	
Backup feeder	**104H-432**	
Total load [A]	575/570	
Switching device	D4A15364	
Contingency type	C	
Comment	Available but load check is recommended	
Backup feeder	**1H-419** offloaded to 1H-431 sw# L431-177	No Profile Available
Total load [A]	310/350 estimated	
Switching device	28H-413	
Contingency type	D	
Comment	Limiting factor: 1H-431 peaks at 430/380	
Backup feeder	Split between **104H-431 & 104H-432**	No Profile Available
Total load [A]	TBD as required	
Switching device	TBD as required	
Contingency type	D	
Comment	Available	

1H-405 CONTINGENCY OPTIONS		
Backup feeder	**1H-403**	
Total load [A]	490/440	
Switching device	L431-412	
Contingency type	B	
Comment	This option can be marginal during summer time	
Backup feeder	**1H-424**	
Total load [A]	290/320	
Switching device	28H-447	
Contingency type	B	
Comment	Available. 1H-424 load is estimated to be 70 A.	

1H-419 CONTINGENCY OPTIONS		
Backup feeder	**1H-403**	
Total load [A]	490/320	
Switching device	28H-413	
Contingency type	B	
Comment	Possible but load check is recommended before switching	
Backup feeder	**1H-431**	
Total load [A]	510/440	
Switching device	L431-210 Art Gallery	
Contingency type	B	
Comment	Load check is recommended before switching	
Backup feeder	**104H-422**	
Total load [A]	600/500	
Switching device	6H-410	
Contingency type	C	
Comment	Most of the time >400 A. Marginal	
Backup feeder	**104H-442**	
Total load [A]	560/490	
Switching device	6H-430	
Contingency type	C	
Comment	Available, but load check is recommended before switching	
Backup feeder	Split between 1H-431 & one the above	No Profile Available
Total load [A]	TBD as required	
Switching device	TBD as required	
Contingency type	D	
Comment	Available	

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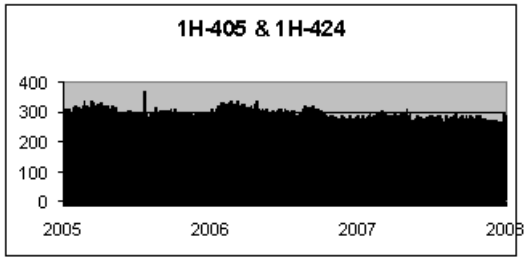
1H-424 CONTINGENCY OPTIONS		
Backup feeder	**1H-405**	
Total load [A]	290/320	
Switching device	28H-447	
Contingency type	B	
Comment	1H-424 load is estimated to be 70 A.	

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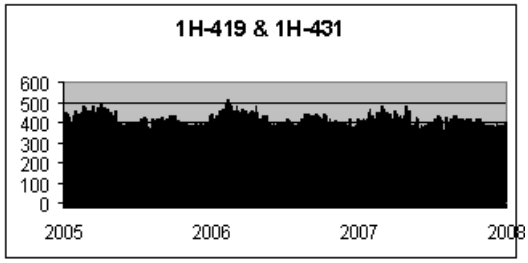
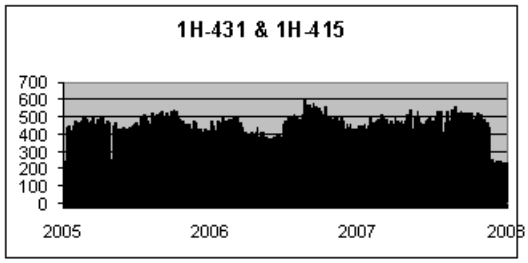
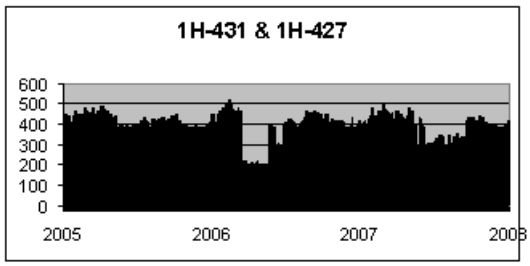
1H-429 CONTINGENCY OPTIONS		
Backup feeder	Split between 2H-412 and 104H-413	1H-429 is an express feeder to the stepdown 10H-T1 North Bus of VG Hospital. At full capacity the load is 260A.
Total load [A]	TBD as required	
Switching device	TBD as required	
Contingency type	D	
Comment	This backup option can be marginal during summer peaks.	

1H-431 CONTINGENCY OPTIONS		
Backup feeder	**1H-419**	
Total load [A]	510/440	
Switching device	L431-210 Art Gallery	
Contingency type	B	
Comment	Load check is recommended before switching	
Backup feeder	**1H-415**	
Total load [A]		
Switching device	D431-184 Hollis/Morris	
Contingency type	B	
Comment	The intertie switch is close to the substation. Very limited backup options for 1H-431	
Backup feeder	**1H-427**	
Total load [A]		
Switching device	D431-266 Hollis/Morris	
Contingency type	B	
Comment	The intertie switch is close to the substation. Very limited backup options for 1H-431	

3.3 OBSERVATIONS

1H-403
There are several switching options but none of them are straightforward. All of the options can be marginal during summer peaks.

1H-405
Feeder 1H-424 is a reliable backup for 1H-405.

1H-419
There are several options. During summer time the simple options become questionable. Splitting the load between 1H-431 and 1H-403 or 104H-422 would be the next option.

1H-424
Feeder 1H-405 is a reliable backup for 1H-424. New feeder.

1H-429
Complicated switching to offload the 10H-T1 transformer between 2H-412 and 104H-413. The load situation at 4 kV is expected to improve and therefore the above offloading should become more reliable. There is a suspicion of a collapsed ductbank on Morris St. The work to clarify on this issue is in progress (Summer 2008). This feeder is relatively new.

1H-431
The only simple backup option for this feeder is 1H-419. This option becomes questionable during summer months. For improved switching flexibility this feeder may require additional intertie. See 4.1 for details. This may be especially important considering the overhead section of the feeder that is exposed at the intersection of Hollis and Morris St.

To summarize the above:
- Feeders 1H-405 and 1H-424 have reliable backup.
- Feeders 1H-403, 1H-419 and 1H-429 have conditional backup options. An effort should be made to improve it.
- Feeder 1H-431 has a questionable backup option. There is a risk of extended outage. Additional backup alternative(s) need to be developed.

4.0 SYSTEM IMPROVEMENTS

4.1 ART GALLERY TIE

To improve the backup options for feeders 1H-431 and 1H-419 a new tie connection is recommended between the Art Gallery vault and feeder 1H-424 in manhole #13 on Lower Water Street. This will create a simple and reliable contingency option for the above two feeders which can also be used for a cable replacement/injection or cable treatment program.

The new feeder configuration will require extending nine 100 mm ducts (3-in, 3-out, 3-spare) from MH56 to the Art Gallery vault. See Fig. 4.2 and Appendix 4 for more details. There are ducts available in the existing ductbank between MH13 and MH56 to install six 750 kcmil cables. The total length of the new cable extension is approximately 60 meters.

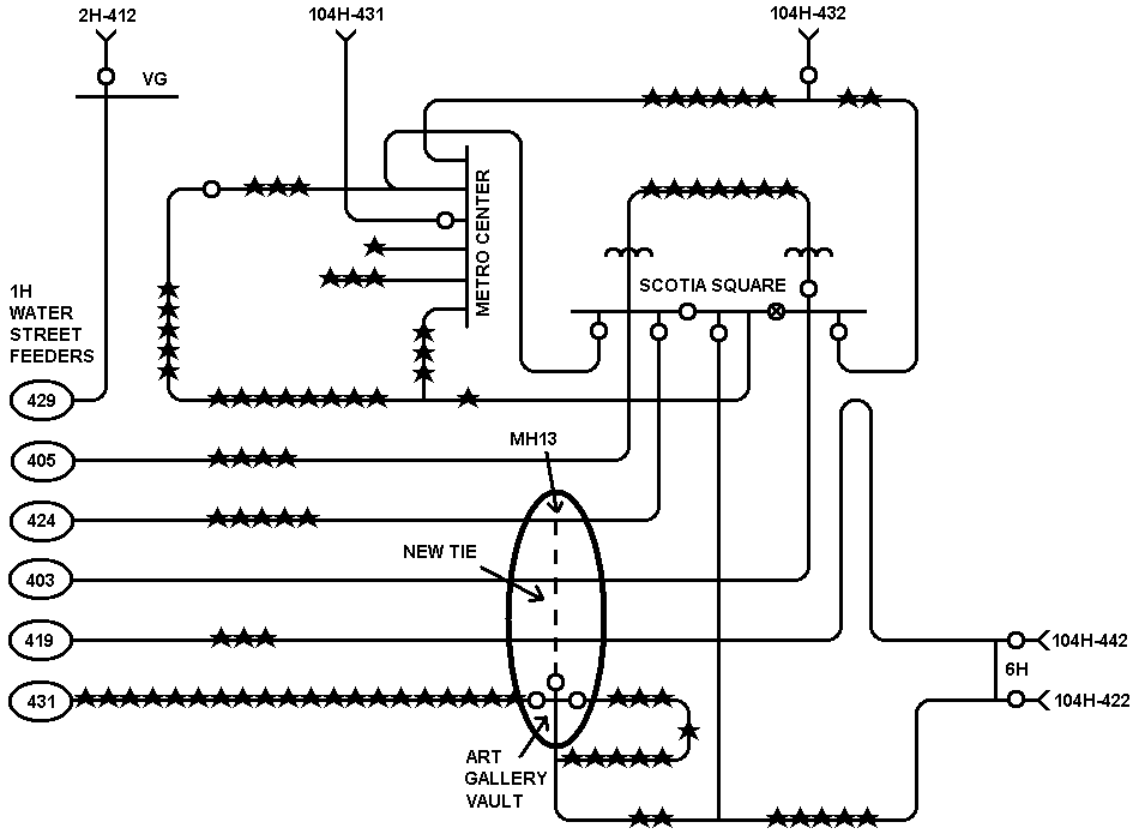


Fig. 4.1 New intertie between Art Gallery vault and MH13

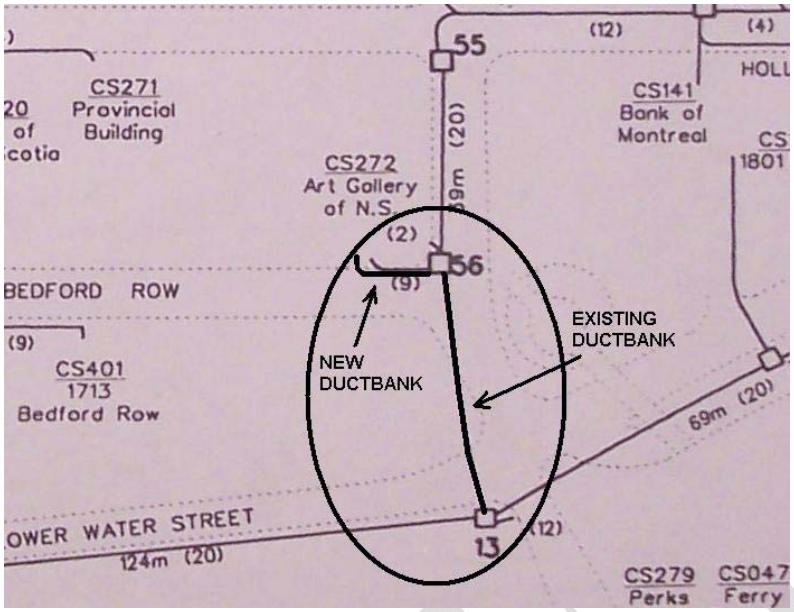


Fig. 4.2 Ductbank Layout

4.2 SCOTIA SQUARE TIE

The main purpose of this proposal is to improve the backup options of the feeder 1H-403. The idea is to use the existing 3-way Vista switch at the Scotia Square vault as a universal tie for 1H-403, 1H-405 and 1H-424 feeders that will allow paralleling them in any combination. At the moment the switch is underutilized and is serving as a connection point between 1H-405 and 1H-424.

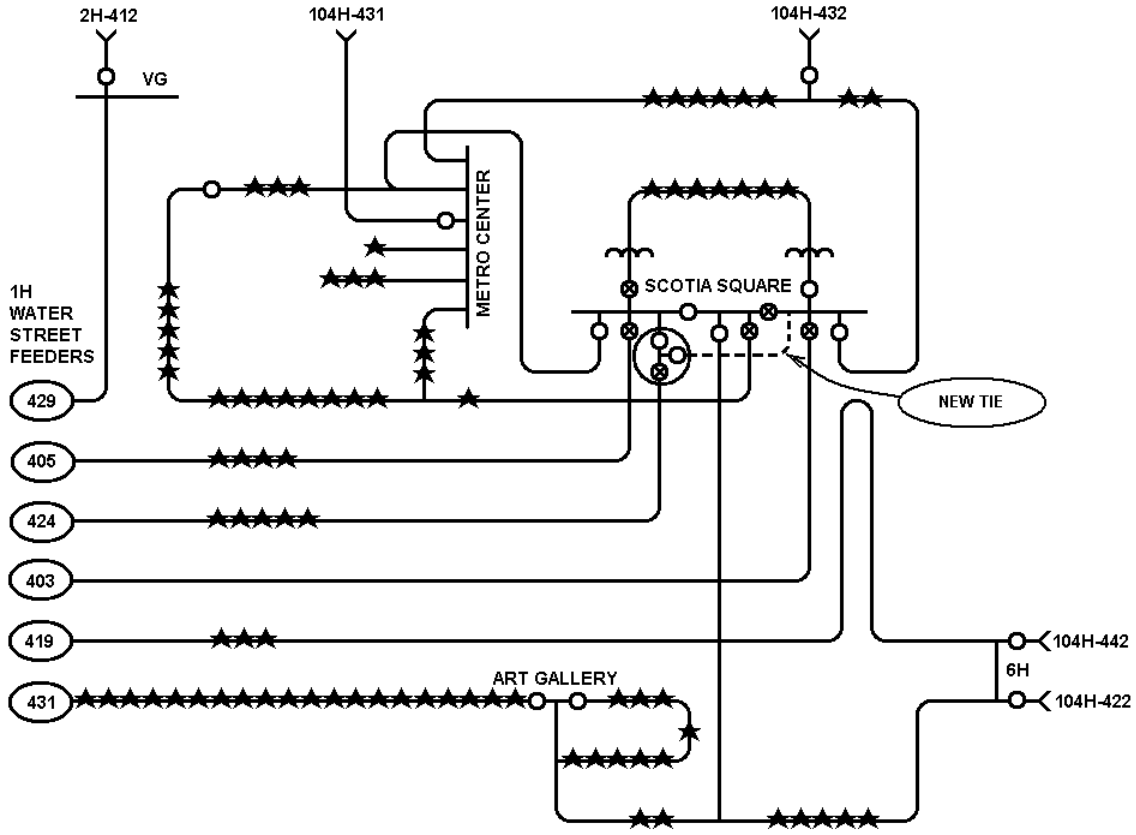


Fig. 4.7 New Connection in the Scotia Square vault

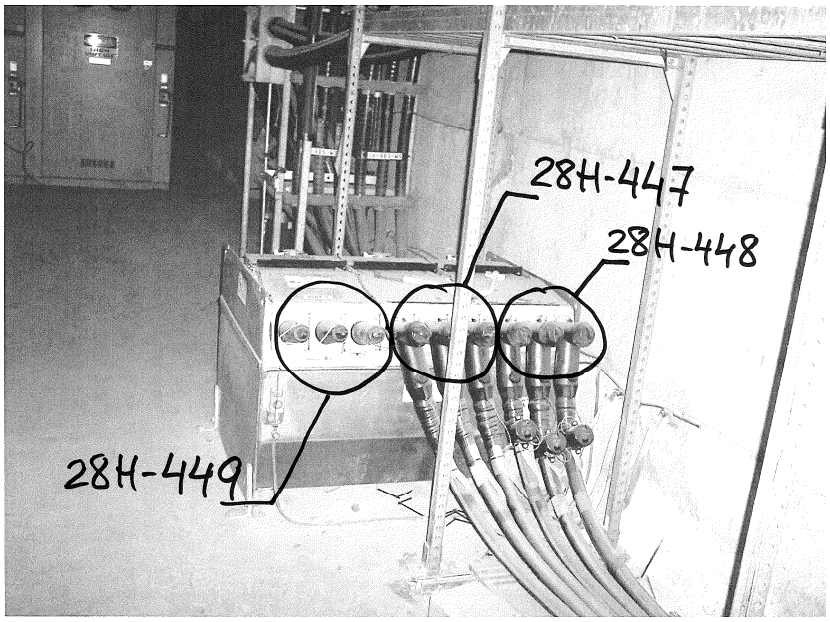


Fig. 4.8

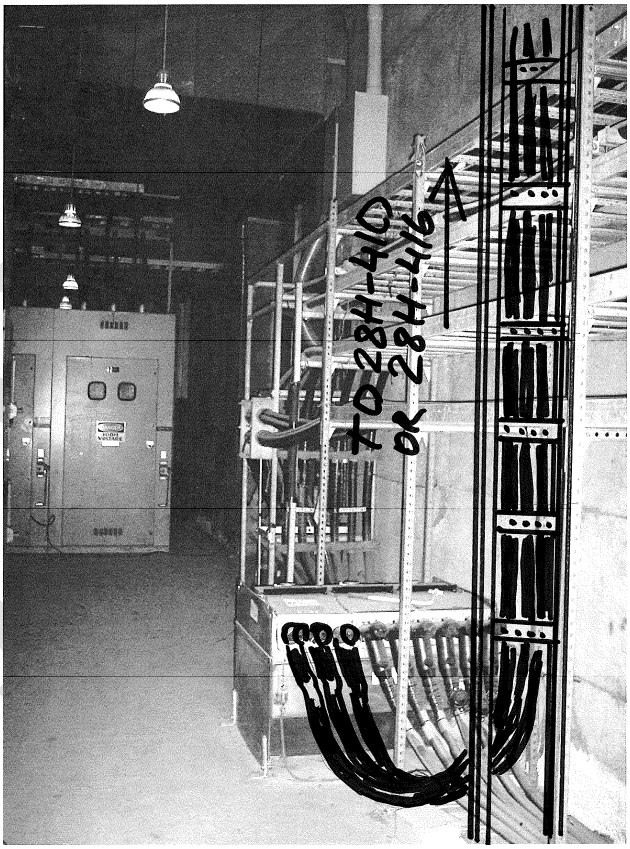


Fig. 4.9

The switch 28H-449 can be connected to one of the following devices that are on the same bus of the 28H substation: 28H-410, 28H-416, 28H-414 or 28H-445
The exact point of connection needs to be determined.

4.3 OTHER SYSTEM IMPROVEMENT OPTIONS

4.3.1 Configuration Improvements of 1H-431

Converting the o/h portion of the feeder 1H-431 would benefit the reliability of the Halifax underground system. There are six riser poles around the intersection of Hollis and Morris Streets that are exposed to traffic and weather. Also, there is a number of flying taps (two sets), quick sleeves, inline switches, communication loops and 4 kV lines sharing the same poles. The top circuits on each of the three poles on Fig. 4.10 are the feeder 1H-431.

Fig. 4.10 Intersection of Hollis and Morris St.

This project would mostly involve extending the ductbank on Hollis Street from manhole #59 (Bushop/Hollis) to #60 (Morris/Hollis) which are approximately 120 meters apart and a new manhole in the middle of the block with a submersible switch in it. The switch is required for two primary services: Waterford Apartments CS431-554 and Prince Matthew's Apartments CS431-480 and also to replace the functionality of the existing set of inline switches D431-394. Two or three overhead services would have to be converted as well.

This part of the feeder is situated within the boundaries of the existing pole-free area. This conversion would have to be supported by the HRM as a continued commitment of the current cost sharing agreement with NSPI. A new development in the area may help to trigger this process.

4.3.2 Cable Upgrades

There are two potential bottlenecks in the existing system that may be considered for an upgrade. The purpose is to increase the conductor size to the full size feeder (750 kcmil) between the Metro Center and Scotia Square and between the riser pole on Cogswell St (feeder 104H-432) and Scotia Square.

See paragraphs 5.3.1 (B) and 5.3.1 (E) further in the text for details. With the existing ductbank configuration only one of the two can be implemented.

5.0 CABLE REPLACEMENT

5.1 Cable Lengths

Table 5.1

Total Feeder Section Lengths [m]							
Part of Feeder	Cable Size	1H Underground Feeders					
		403	405	419	424	429	431
Radial	750	1780	1440	3430	1600	2200	2130
	500	-	-	-	-	-	-
Loop	750	2240	160	-	-	-	-
	500	180	-	-	-	-	-
	350	1550	1380	-	-	-	-
	4/0	-	180	490	-	-	-
	3/0	-	-	640	-	-	-
	#1	-	170	-	-	-	-
Tie	750	230	-	240	-	-	-
	500	-	180	-	-	-	-
Primary Service	350	100	-	-	-	-	-
	3/0	1260	130	100	350	-	270
	#1	-	10	50	-	-	280
Total without/with services		5980/ 7340	3510/ 3650	4800/ 4950	1600/ 1950	2200	2130/ 2680

Note:

1. The above numbers are 3 phase lines, not individual conductors
2. For detailed summary on feeder sections see Appendix A
3. For detailed summary on primary service cables see Appendix B

Summary:
The total length underground feeders including primary services (6 feeders): 22770 m
Same for the feeders over 30 years old (4 feeders) – 18620 m
This includes the feeder sections:

a) Radial – 8780 m
b) Loops – 6990 m
c) Ties – 650 m
d) Primary services – 2200 m

5.2 Cable Accessories

The following cable accessories will be referenced to in tables 5.2, 5.3 and Appendix C:
S – Splice, general.
T – 600 A deadbreak termination
LF – Life front termination
L – 200 A loadbreak elbow
SA – Support arm, 14" multi-mount, Underground Devices Inc, MM14,

Table 5.2

Accessories per Feeder								
Cable Accessory	1H-403		1H-405		1H-419		1H-431	
	Feeder	Service	Feeder	Service	Feeder	Service	Feeder	Service
S	9	-	9	-	9	-	2	-
T	31	27	24	9	20	13	21	14
LF	31	7	36	-	15	4	2	4
L	0	33	-	9	-	11	-	14
SA*	60	-	34	-	60	-	26	-

* - the number of support arms is estimated based on the approximate number of passes through manholes for feeder cables only.

Table 5.3

Total Accessories		
Cable Accessory	Feeder	Service
S	25	-
T	96	67
LF	84	15
L	0	67
SA	180	-
Total	385	149

Note that the accessories are shown here as three phase devices, therefore for the actual number of single phase units needs to be tripled.

5.3 Feeder Sections

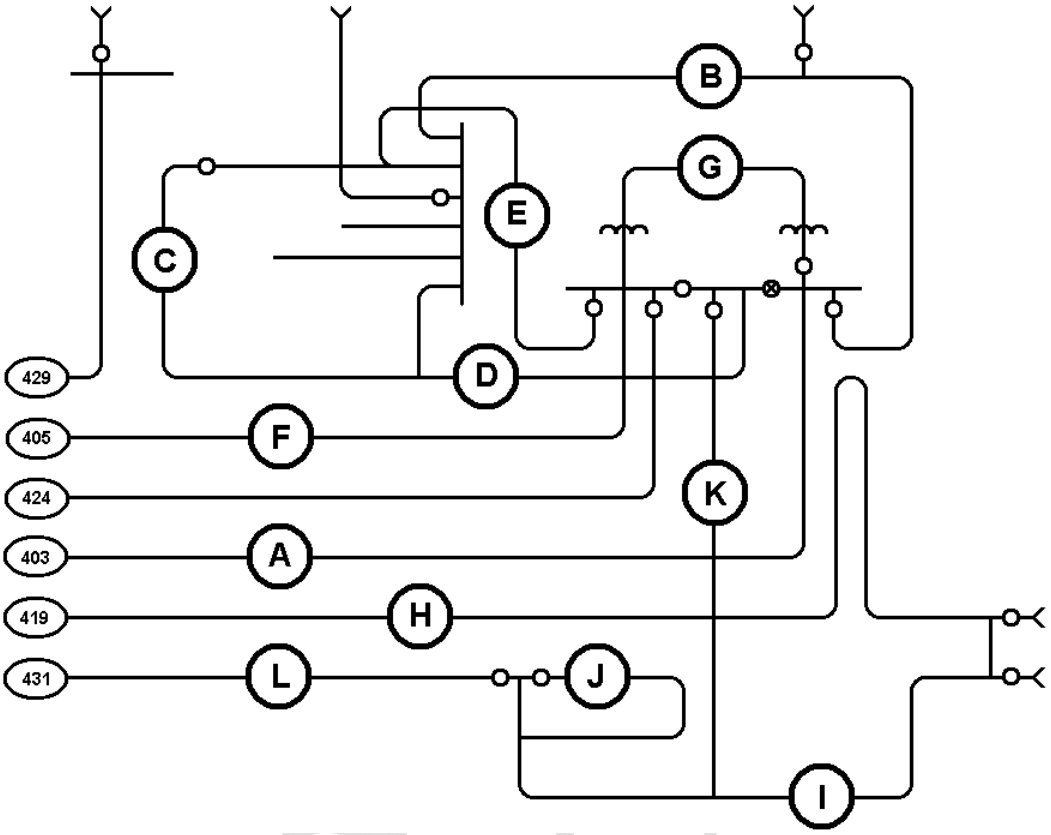


Fig. 5.3 Feeder Sections for Replacement

5.3.1 FEEDER 1H-403 (A, B, C, D, E)

(A) 1H-403 – Main Radial from 1H to 28H-416

The replacement of this part of the feeder can be approached in two ways:

Option 1
Use an alternative supply for 1H-403 (See 3.2 Contingency Options). Deenergize the radial part of the feeder between 1H and 28H-416 (approx. 1.4 km) and replace it.

Option 2
Remove the old 4 kV cables 1H-243, 1H-246 and 1H-247 (#500, 3 phase PILC) along the Lower Water, Sackville and Granville Streets between 1H and MH46 (1 km). Install new cables in the freed-up ducts while the existing feeder cables are still in service. Then extend the new cables from MH46 to MH47 and further to MH125 and MH26. This is approximately 90 % of the radial section of the feeder. The remaining short run from MH26 – MH28 – MH32 to 28H does not have enough free ducts. Therefore, one of the alternative supplies will be used for the duration of the cable replacement.

Advantages of this option: a) minimizes the use of alternative supply b) one kilometer of ducts becomes available for cascade replacement of two more feeders c) old equipment is removed and salvaged.

This cable may contain PCB. Federal and provincial legislation and regulations regulate the management of PCBs. Refer to the Environmental Management Strategy for Oil-Filled Equipment ENV-2.05 (Environmental Binder) for proper procedures.

(B) 1H-403 – North Loop from 28H-410 to L431-229 Metro Center
There are three sizes of conductors in the loop: 350, 500 and 750 kcmil. It may be beneficial to upgrade a part of the loop between MH102 on Cogswell St and 28H to 750 kcmil to create a full size tie between feeder 104H-422 (SW# D4A15363) and 28H-410 in Scotia Square. There are two conditions for this upgrade:
1) Some cables would have to be swapped in MH43 to make this tie "service free". This will transfer the cs431-265 service to another shoulder of the same loop that has multiple primary services and will remain 350 kcmil.
2) There are only two free ducts available between 28H and MH32. The upgrade is still possible but this option needs to be further investigated.

(C) 1H-403 –Metro Center Loop from L431-230 to L431-232
This part of the feeder has enough spare ducts to pre-install the new switch-to-switch sections while the old cable remains in service. The switching between the old and new cable can be done without taking outages to the customers.

(D) 1H-403 – 28H-415 to Grand Parade Vault
This is a normal feed for the Metro Center loop. There are not enough spare ducts to install the replacement cable ahead of time. One of the two available backup options has to be used for the duration of the cable replacement or injection.

(E) 1H-403 – 28H-411 to L431-230 Metro Center – Tie with 1H-405
There are two sizes of conductors (500 and 750 kcmil) used in this tie. The 500 kcmil section should be upgraded to the standard 750 kcmil size. There are only two free ducts available between 28H and MH32 to exit the Scotia Square vault. The cable upgrade is possible but this option needs to be further investigated.

With the existing ductbank configuration, the two cable upgrades (B) and (E) are mutually exclusive therefore:
a) Only one of the two may be selected
b) Possibility of adding more ducts between 28H vault and MH32 to be explored

5.3.2 FEEDER 1H-405 (F, G)

(F) 1H-405 – Main Radial from 1H to 28H-417
This part of the feeder is very similar to 1H-403 (A) and can be approached in the same way. See section (A) options for details. The removal of the old 4 kV feeder cables will also benefit the 1H-405 feeder replacement.

(G) 1H-405 – 23 kV Loop
The old multi-loop configuration was recently changed. The exact configuration of the present system may need to be updated on the single line diagrams. The upcoming cable replacement may also be used as an opportunity to further optimize the existing 23 kV loop system.

5.3.3 FEEDER 1H-419 (H, I, J)

(H) 1H-419 – to L431-401 Proctor Street
The replacement of this section can be combined with the removal of the old 4 kV cables (See 5.1 Option 2). This section can be backfeed from 104H-422 or 104H-442.

(I) 1H-419 – L431-404 Proctor Street to L431-211 Art Gallery Vault
The layouts of manholes MH90, MH91 and MH92 need to be verified and completed.

(J) 1H-419 Loop from L431-211 to L431-209 Art Gallery Vault
This is a normal underground loop. There is no foreseeable reason for cable size upgrades or configuration change.

(K) 1H-419 MH22 to 28H-413
This is a normally open tie with the feeder 1H-403. There are no primary services on this feeder section. The replacement should be straightforward.

5.3.4 FEEDER 1H-431 (L)
(L) 1H-431 to Art Gallery Vault
The records on the available spare ducts are inconsistent. A detailed scoping is required. The system improvement option 4.1 is recommended for better contingency arrangements.

5.4 Budgeting for Cable Replacement

5.4.1 Estimates and Assumptions

Labour:

- One underground crew includes 3 technicians.
- A basic length of 3 phase cable would normally consist of 1, 2 or 3 runs between two electrically adjacent cable accessories. The cable runs can be: manhole-to-manhole, manhole-to-vault, vault-to-vault and in some cases riser pole to manhole.
- One crew can install in one normal day:
  a) one basic length of three 750 kcmil cables, no terminations.
  b) 2 basic lengths of triplexed cable, no terminations.
  c) 1 basic length of triplexed cable and terminate one end.
  d) 6 cable terminations
  e) one primary service loop (one basic length), terminate both ends reconnect.
- One crew can remove in one normal day:
  a) three old PILC cables from three manhole-to-manhole lengths. Four manholes to be entered. This is mostly applicable to the three old feeders between 1H and MH46.
  b) switch from old to new pre-installed and pre-terminated length of cable, remove the old cable. Phase the cable.
- For simplicity the above installation steps can be further combined into mandays per basic length of cable (installation + termination + switching + removal):
  a) 750 kcmil three 1 phase cables: 3md + 3md + 3md = 9 mandays
  b) <750 kcmil 3 phase cable installation: 1.5md +3md + 3md = 7.5 mandays

- One eight hour manday (2010) with overhead is calculated as follows:
  315 + 315 x 0.7913(AO internal) + 315 x 0.22(vehicle) = $634

- One eight hour overtime manday is calculated:
  2 x 315 + 2 x 315 x 0.3957 + 2 x 315 x 0.22 = $949

- Unless specified, no overtime rates have been used for calculations.

Materials:

- Primary cable:	750 kcmil Al, 28 kV	- $25/m
	350 kcmil Al, 28 kV, 3 phase	- $40/m
	3/0 Al, 28 kV, 3 phase	- $35/m
	#1 Al, 28 kV, 3 phase	- $30/m
- Splice	750/750	- $200 each
- T-Connector 600 A	(See Appendix E for details)	- $239 each
- Loadbreak elbow 200 A		- $55 each
- Synthetic terminator	-	$170 each
- Support arm 14” complete with masonry fasteners and tie wraps for cable		- $50 each

5.4.2 Feeder Replacement Estimates

Table 5.4

Materials and Labour for Cable Replacement Option Excluding Primary Services			
Feeder	Cable (refer to feeder profiles 2.2)	Accessories (refer to 5.2)	Labour (refer to 5.4.1)
1H-403	750 kcmil: 4250 x 1.1* x 25 x 3 = $325,625 350 kcmil: 1550 x 1.1 x 40 = $68,200 Other sizes: 360 x 1.1 x 35 = $13,860 **Total: $407,685**	S: 9 x 6**x 239 = $12,906 T: 31 x 3 x 239 = $22,227 LF: 31 x 3 x 170 = $15,810 SA: 60 x 50 = $3,000 **Total: $53,943**	750 kcmil: 19 runs = 171md <750 kcmil***: 13 runs =97.5md **Total: 268.5md $170,229**
1H-405	750 kcmil: 1630 x 1.1 x 25 x 3 = $134,475 350 kcmil: 1380 x 1.1 x 40 = $60,720 Other sizes: 520 x 1.1 x 35 = $20,020 **Total: $215,215**	S: 9 x 6 x 239 = $12,906 T: 24 x 3 x 239 = $17,208 LF: 36 x 3 x 170 = $18,360 SA: 34 x 50 = $1,700 **Total: $50,174**	750 kcmil: 7 runs = 63md <750 kcmil: 6 runs = 45md **Total: 108 md $68,472**
1H-419	750 kcmil: 3430 x 1.1 x 25 x 3 = $302,775 Other sizes: 1130 x 1.1 x 35 = $43,505 **Total: $346,280**	S: 9 x 6 x 239 = $12,906 T: 20 x 3 x 239 = $14,340 LF: 15 x 3 x 170 = $7,650 SA: 60 x 50 = $3,000 **Total: $37,896**	750 kcmil: 17 runs = 153md <750 kcmil: 8 runs = 60 md **Total: 213 md $135,042**
1H-431	750 kcmil: 2130 x 1.1 x 25 x 3 = $175,725 **Total : $175,725**	S: 2 x 6 x 239 = $2,868 T: 21 x 3 x 239 = $15,057 LF: 2 x 3 x 170 = $1,020 SA: 26 x 50 = $1,300 **Total: $20,245**	750 kcmil cable: 14 runs = **126md** **Total: $79,884**

* - 10% of length is added for splicing loops and waste.
** - 600 A deadbreak elbows are used for splicing cables.
*** - In this context: 3 phase cable size between #1 and 350 kcmil
Total: 716 mandays, $1,760,790

Note that the system improvement items (4.0), old 4 kV cable removals (5.3.1 A) and proposed conductor upgrades for 1H-403 (5.3.1 B, E) are not included in the above estimate.

5.4.3 Service Replacement Estimates

Table 5.5

Materials and Labour for Replacing Primary Service Cables			
Feeder	Cable (refer to feeder profiles 2.2)	Accessories (refer to 5.2)	Labour (refer to 5.4.1)
1H-403	750 kcmil: 100 x 1.1* x 25 x 3 = $8,250 350 kcmil: 100 x 1.1 x 40 = $4,400 Other sizes: 1680 x 1.1 x 35 = $64,680 **Total: 72,930**	T: 27 x 3 x 239 = $19,359 LF: 7 x 3 x 170 = $3,570 L: 33 x 3 x 55 = $5,445 **Total: $28,374**	32 services = **96md** **Total: $60,864**
1H-405	3/0: 170 x 1.1 x 35 = **$6,545**	T: 9 x 3 x 239 = $6,453 L: 9 x 3 x 55 = $1,485 **Total: $7,938**	8 services = **24md** **Total: $15,216**
1H-419	750 kcmil: 30 x 1.1 x 25 x 3 = $2,475 3/0 & #1: 140 x 1.1 x 35 = $5,390 **Total: $7,865**	T: 13 x 3 x 239 = $9,321 LF: 4 x 3 x 170 = $2,040 L: 11 x 3 x 55 = $1,815 **Total: $13,176**	15 services = **45md** **Total: $28,530**
1H-431	350 kcmil: 270 x 1.1 x 40 = $11,880 3/0 & #1: 480 x 1.1 x 35 = $18,480 **Total: $30,360**	T: 14 x 3 x 239 = $10,038 LF: 4 x 3 x 170 = $2,040 L: 14 x 3 x 55 = $2,310 **Total: $14,388**	19 services = **57md** **Total: $36,138**

* - 10% of length is added for splicing loops and waste.

Total: 222 mandays, $322,324

Table 5.6

Materials and Labour for Replacing Primary Service Cables 50% Overtime			
Feeder	Cable (refer to feeder profiles 2.2)	Accessories (refer to 5.2)	Labour (refer to 5.4.1)
1H-403	750 kcmil: 100 x 1.1* x 25 x 3 = $8,250 350 kcmil: 100 x 1.1 x 40 = $4,400 Other sizes: 1680 x 1.1 x 35 = $64,680 **Total: 72,930**	T: 27 x 3 x 239 = $19,359 LF: 7 x 3 x 170 = $3,570 L: 33 x 3 x 55 = $5,445 **Total: $28,374**	32 services = **96md** **Total: $75,984**
1H-405	3/0: 170 x 1.1 x 35 = **$6,545**	T: 9 x 3 x 239 = $6,453 L: 9 x 3 x 55 = $1,485 **Total: $7,938**	8 services = **24md** **Total: $17,413**
1H-419	750 kcmil: 30 x 1.1 x 25 x 3 = $2,475 3/0 & #1: 140 x 1.1 x 35 = $5,390 **Total: $7,865**	T: 13 x 3 x 239 = $9,321 LF: 4 x 3 x 170 = $2,040 L: 11 x 3 x 55 = $1,815 **Total: $13,176**	15 services = **45md** **Total: $35,618**
1H-431	350 kcmil: 270 x 1.1 x 40 = $11,880 3/0 & #1: 480 x 1.1 x 35 = $18,480 **Total: $30,360**	T: 14 x 3 x 239 = $10,038 LF: 4 x 3 x 170 = $2,040 L: 14 x 3 x 55 = $2,310 **Total: $14,388**	19 services = **57md** **Total: $45,116**

* - 10% of length is added for splicing loops and waste.

Total: 222 mandays, $355,707

5.5 Salvage

Aluminum

Table 5.7

Theoretical Weight of Aluminum Wire			
Wire size	Diameter [mm]	Cross-section [mm2]	Weight [kg/km]
750	22	380	1026
500	18	253	683
350	15	177	478
4/0	11.7	107	289
3/0	10.4	85	230
#1	7.4	42	113

Table 5.8

Aluminum Salvage Weight by Feeder [kg]					
	Cable Size	1H-403	1H-405	1H-419	1H-431
Feeder	750	13,080	4,926	11,295	6,555
	500	369	369	-	-
	350	2,223	1,977	-	-
	4/0	-	156	426	-
	3/0	-	-	441	-
	#1	-	57	-	-
Service	350	144	-	-	-
	3/0	849	90	69	186
	#1	-	-	18	96

Note: concentric neutral material is not accounted for

Salvage value of aluminum: $1.5/kg:

a) Feeder cables 750 kcmil = $54,000
b) Feeder cables <750 kcmil = $9,000
c) Services, all sizes = $2,200

Copper

The salvage value of copper: $5.00/kg. The removal of 3 km of 3 ph 500 kcmil PILC cable (5.3.1 Option 2) should produce 10 tons of salvageable copper, which is approximately $50,000.

The total salvage value of the cables proposed for removal under this project is expected to be $110,000.

6.0 CABLE INJECTION

6.1 Description

The cable injection option will be calculated for 750 kcmil cable only. The smaller conductor sizes for both feeder and services are considered for replacement. See Table 6.1 for summaries.

Table 6.1

Three phase line to be injected/replaced [m]			
	Feeder Injection 750 kcmil	Feeder Replacement <750 kcmil	Service Cable Replacement
1H-403	4,250	1,730	1,360
1H-405	1,680	1,910	140
1H-419	3,650	1,130	150
1H-431	2,130	0	550
Total	**11,710**	**4,770**	**2,200**

For feeder cables the injection will have to be done with de-energized cables. The injection and material installation crew would normally include 3 technicians. Time to inject will be dependent on the characteristics of the cable and type of conductors. The first draft work schedule implies up to 10 hours/day and 7 days/week. Labour fees for cable testing (TDR and pressure test) and cable injection are included in the injection price. The actual cable length is to be confirmed with TDR. Once injected the cables are protected by a 20 year warranty.

6.2 Scope

Following is a planned scope of injection work grouped by feeder# and section# (see Fig. 5.3). The sections will be (a) terminated at switching devices using livefront or deadfront terminations and (b) spliced using 600A deadbreak T-body, therefore each section will require 6 terminations. All terminations are in manholes and vaults. Some of the basic section lengths below are assumed to be equal for simplicity, but the total lengths should be fairly accurate.

Feeder 1H-403 (4250 m)
Section A: 230+230+230+230+230+230=1400 m
Section B: 160+150+230=540 m
Section C: 210+220+160+220+140+80+280+120+120+150=1700 m
Section D: 190+190=380 m
Section E: 230 m
Three phase cable sections: **22**
Terminations: 22 x 6 = **132**

Feeder 1H-405 (1680 m)
Section F: 230+230+230+230+230+270=1440
Section G: 240

Three phase cable sections: **7**
Terminations: **42**

Feeder 1H-419 (3670 m)
Section H: 228+228+228+228+228+200+200+200+200+200=1140 m
Section I: 156+156+156+110+190+240+190=1290 m
Section K: 240 m
Three phase cable sections: **18**
Terminations: **108**

Feeder 1H-431 (2130 m)
Section L: 190+190+150+90+100+160+170+170+190+110+100+180+160+160=2130 m
Three phase cable sections: **14**
Terminations: **84**

Summary:
Three phase cable sections: **61** (183 1ph 750 kcmil cables)
Total 3 ph. length: **11,710 m**
Terminations: **366** (306 T-bodies + 60 misc. live front terminations)

6.3 Cable Replacement Part of the Cable Injection Option

The cables other than 750 kcmil will be replaced as follows

Table 6.2

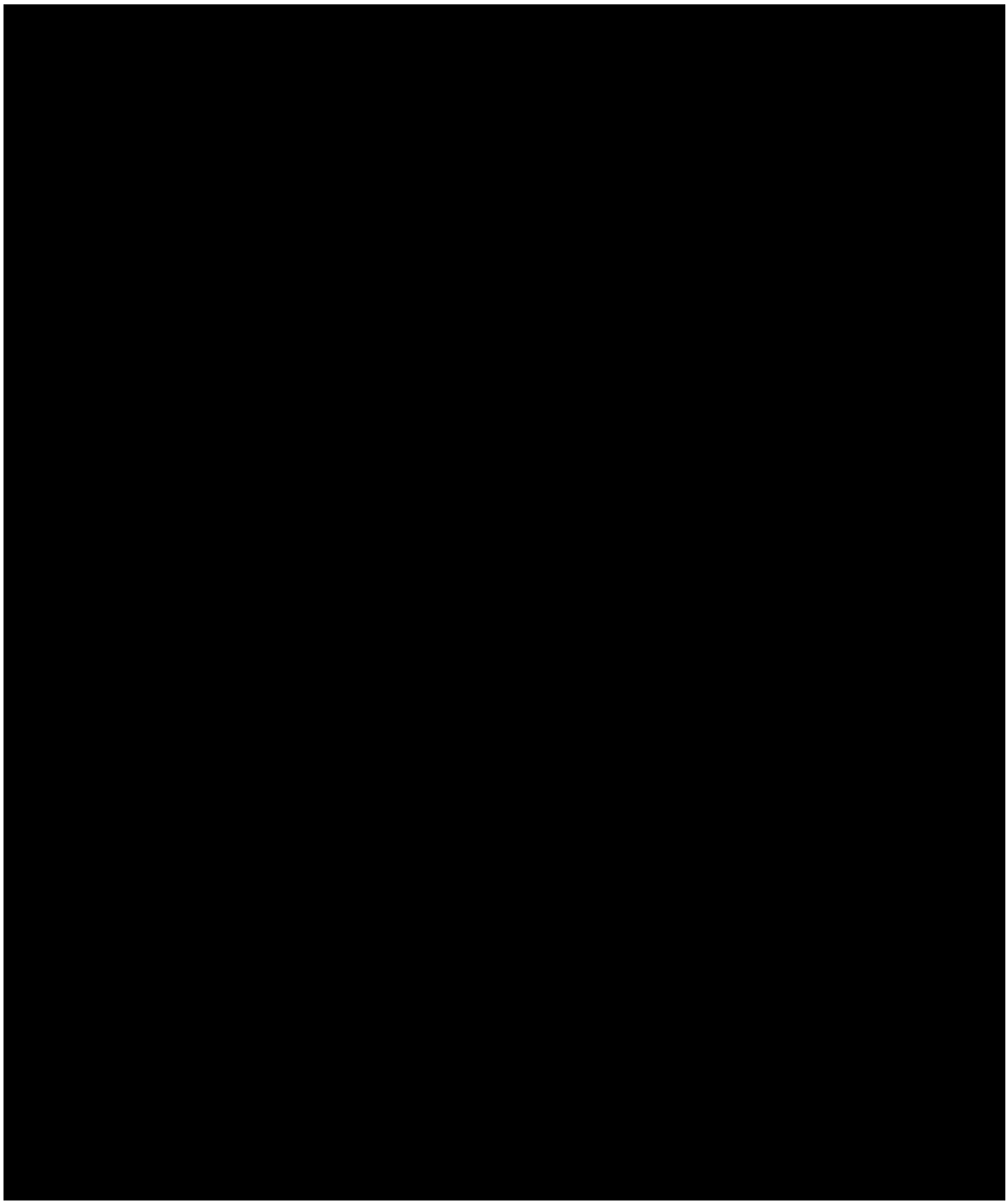
Materials and Labour for Cable Replacement Excluding 750 kcmil Feeder Cables and Primary Services			
Feeder	Cable (refer to feeder profiles 2.2)	Accessories (refer to 5.2)	Labour (refer to 5.4.1)
1H-403	350 kcmil: 1550 x 1.1* x 40 = $68,200 Other sizes: 360 x 1.1 x 35 = $13,860 **Total: $82,060**	T: 13 x 3 x 239 = $9,321 LF: 23 x 3 x 170 = $11,730 SA: 60 x 50 = $3,000 **Total: $24,051**	<750 kcmil**: 13 runs =97.5md **Total: $61,815**
1H-405	350 kcmil: 1380 x 1.1 x 40 = $60,720 Other sizes: 520 x 1.1 x 35 = $20,020 **Total: $80,740**	T: 32 x 3 x 239 = $22,944 LF: 32 x 3 x 170 = $16,320 SA: 34 x 50 = $1,700 **Total: $40,964**	<750 kcmil: 6 runs = 45md **Total: $28,530**
1H-419	Other than 750 kcmil sizes: 1130 x 1.1 x 35 = **$43,505**	T: 7 x 3 x 239 = $5,019 LF: 10 x 3 x 170 = $5,100 SA: 60 x 50 = $3,000 **Total: $13,119**	<750 kcmil: 8 runs = 60 md **Total: $38,040**
1H-431	N/A	N/A	N/A

* - 10% of length is added for splicing loops and waste.

** - In this context: 3 phase cable size from #1 to 350 kcmil

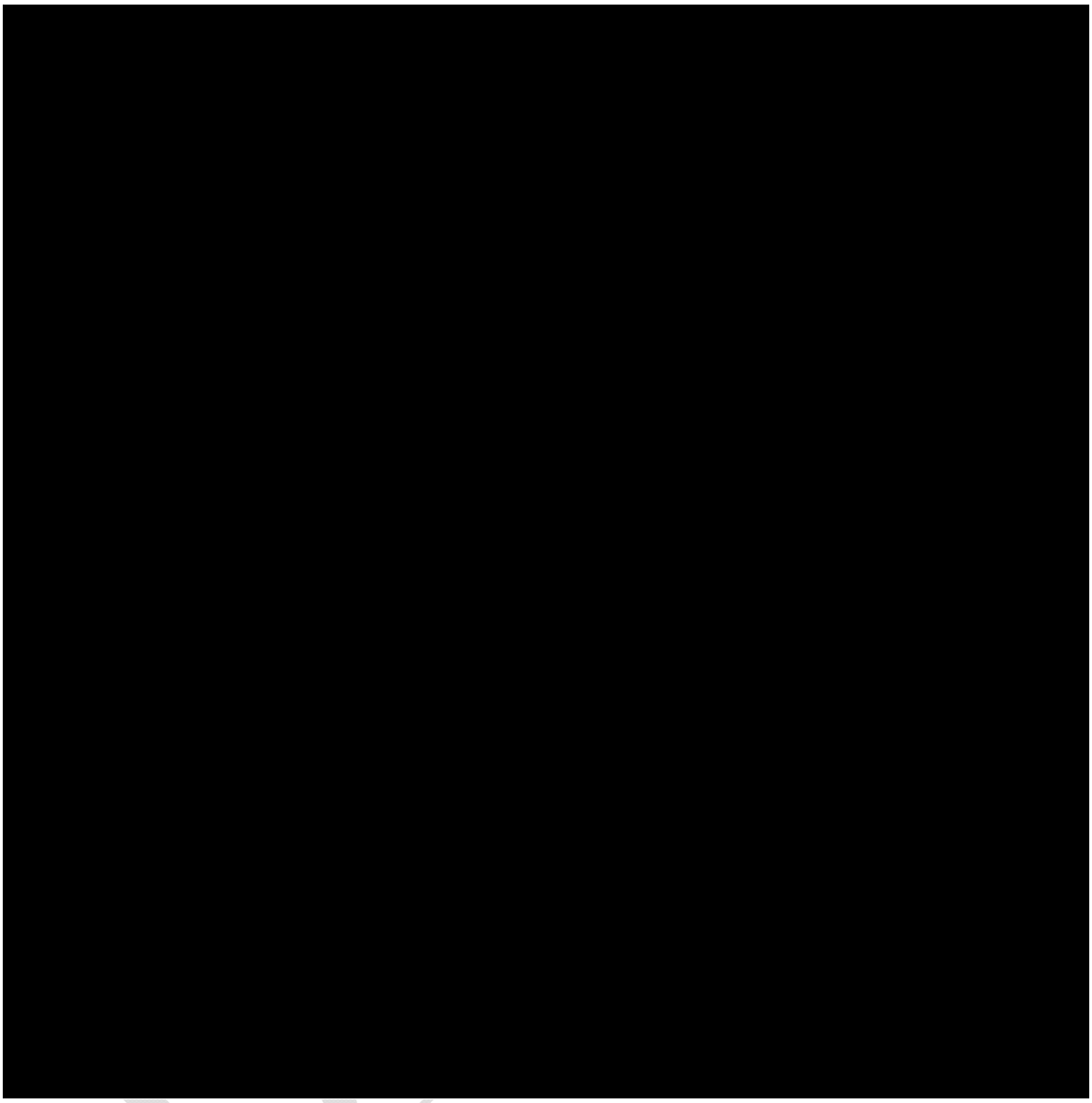
Total: 203 mandays, $412,824

6.4 Injection Estimates



The Total price with 24.46% of contractor's overhead: [redacted]

One of the NSPI underground crews will be involved with the contractor for the duration of the project which is estimated to be 8 weeks.



The Total contractor's price:
Same with 24.42% of contractor's overhead:

7.0 Cable Replacement vs. Cable Injection

Table 7.1

Replacement of 750 kcmil Cable Only			
Feeder	Cable (Table 5.4)	Accessoties	Labour
1H-403	**$325,625**	Splices:19x1,432=$27,208 Brackets:19x50=$950 Total: **$28,158**	171md **$108,414**
1H-405	**$130,475**	Splices:7x1,432=$10,024 Brackets: 7x50=$350 Total: **$10,374**	63md **$39,942**
1H-419	**$302,775**	Splices: 17x1,432=$24,344 Brackets: 17x50=$850 Total: **$25,194**	153md **$97,002**
1H-431	**$175,725**	Splices: 14x1,432=$20,048 Brackets: 14x50=$700 Total: **$20,748**	126md **$79,884**
Total:	**$934,600**	**$84,474**	**$325,242**

Table 7.2

Cable Replacement vs. Cable Injection Budget Summaries 750 kcmil only						
	Cable Replacement (Table 7.1)		CableCure (TCI)		Cable Injection (Novinium)	
	$	Comment	$	Comment	$	Comment
NSPI Labour	325,242	replace radial feeder cables	114,120	working with TCI	114,120*	working with Novinium
Materials	1,019,074	750 kcmil cables	N/A	N/A	N/A	N/A
Cable Injection with OH 25%	N/A	N/A	927,582	Injecting cables, 3x12km	709,194	Injecting cables, 3x12km
Salvage	+60,000	Al	N/A		N/A	
	+50,000	Cu	N/A		N/A	
Total:	**$1,234,316**		**$1,041,702**		**$823,314**	

* -3 technicians, 60 mandays, regular time (three calendar months).

Calculating net present values for projects with different life spans can lead to incorrect decisions unless adjustments are made. One of the accepted techniques for dealing with this problem is the Replacement Chain Method which transforms the decision variable (NPV) into a common metric for projects of different life spans. NPV in itself does not accomplish this.

Table 7.3

Cable Replacement vs. Cable Injection – Compare the Options of Different Life 750 kcmil only			
	Cable Replacement	CableCure (TCI)	Cable Injection (Novinium)
Expected Life, years	40	20	40**
NPV	$1,238,000	$1,041,702	$823,314
Replacement Chain Method * (i = 8%)	$1,238,000	$1,265,197	$823,314

* Method: Determine the lowest common denominator of all the "project lives". Calculate the Net Present Value for the project repeated "n" times. Compare the projects; choose that project with highest NPV or less negative in our case.
** The 40-year cable life extension is supported by the Novinium warranty.

Risks associated with cable injection:

a. A variety of first generation polyethylene insulation cable will remain in service.
b. After removing of the old terminations and splices some of the cables may be too short for a quality splice.
c. Some of the cable sections may not be injectable due to physical (loss of pressure) or electrical parameters and therefore will have to be replaced.
d. Need to trace another parameter of the injected cable section and having to manage the cable injection records for warranty purposes.
e. The cable injection warranty will only cover the cost of injection for the affected section. The cost of associated NSPI labour and cost of restoration will not be covered.
f. Introduction of non-standard hardware to the system. All of the new terminations have features for cable injection (e.g. reticular flash preventer)
g. Working with contractor will require additional coordination effort.
h. Unforeseeable cost plus items

Novinium Warranty – An Alternative Perspective

The cost of cable injection per basic length of three phase section (typ. Switch-to-switch) today is:
$823,314 / 57 (Table 7.2) = $14,444

When one of the three cables of the injected section fails in 20 years, NSPI will be reimbursed with:
$570,000 / (57x3) = $3,333

The present value of the future warranty payment is:
PV=3,333(P/F,8%,20)= $715

8.0 BUDGETARY TIMELINES

Year 1, 2 and 3 – replace radial sections of the feeders 1H-403, 405, 419 and 431
Year 4 and 5 – replace loops and ties of the feeders 1H-403, 405 and 419

2010: a) 1H-403 – radial section between 1H and 28H-416 Scotia Square (1,400m)
b) 1H-405 – radial section between 1H and 28H-417 Scotia Square (1,440m)
c) PILC cable removal between 1H and MH46 on Granville St (1,000m)
2011: a) 1H-419 – radial section between 1H and L431-401 Proctor Street (2,140m)
b) 1H-419 – half of the radial section between L431-404 and L431-211 Art Gallery Vault (645m)
2012: a) 1H-431 – radial section between 1H and Art Gallery Vault (2,230m)
b) 1H-419 – second half of the radial section between L431-404 and L431-211 Art Gallery Vault (645m)
2013: a) 1H-403 – North Loop from 28H-410 to L431-229 Metro Center (2,240m)
b) 1H-403 – Metro Center Loop from L431-230 to L431-232 (1,700m)
2014: a) 1H-403 – Scotia Square 28H-415 to Grand Parade Vault (380m)
b) 1H-403 – Scotia Square 28H-411 to Metro Center L431-230 (410m)
c) 1H-405 – 23kV loop (1,900m)
d) 1H-419 – Tie to Scotia Square (240m)

Budgetary Item for 2010

The underground work units and cost of materials are described in Section 5.4.1 of the Report. The RT labour is calculated as: 315 + 315 x 0.7913 + 315 x 0.2446 = $641/day

1. Cable NSPI# 6548-0400
   (1400 + 1440) x 1.1 x $25 x 3 = **$234,300**
2. Accessories
   Separable cable connectors as per Appendix E: 28 x $1,432 = **$40,095**
   Support arms – 28 x $50 = **$1,400**
3. Labour
   Cable installation (28 basic runs) 28 x 9 = 252 mandays: **$161,532**
   PILC cable removal 15 mandays: **$9,615**
4. Contracting
   Traffic control - $500/day: 28 x 500 x 1.2442 = **$17,419**
5. Salvage
   3 x 3 x 1 km of copper PILC 500 kcmil cable = 10,000 kg of salvageable copper
   Assume salvage value is $5.00/kg, the total value is **$50,000**
   3 x 2.84 km of 750 kcmil al cable = 8,740 kg of salvageable aluminum
   Assume the salvage value is $1.5/kg the total value is **$13,000**

Total: $401,419

APPENDIX A – Cable Lengths and Available Ducts

(A) 1H-403 – Main Radial 1H to 28H-416 – 1400 m of 750 kcmil		
From	To	Available Ducts
1H Substation	MH2	9A (A- available), Remove: 243, 246, 247
MH2	MH4	1A* Removals: 243, 246, 247
MH4	MH5	
MH5	MH6	
MH6	MH9	
MH9	MH10	2A* Removals: 243, 246, 247
MH10	MH48	
MH48	MH46	
MH46	MH26	0A, 1 cemented over,
MH26	MH28	0A
MH28	MH32	3A
MH32	28H-416 Scotia Square	2A*

(B) 1H-403 – North Loop from 28H-410 to L431-229 Metro Center			
From	To	Cable	Available Ducts
28H-410	MH32	500, 180 m	2A
MH32	MH39		5A
MH39	MH41	350, 530 m	4A*
MH41	MH42		4A*
MH42	MH43		5A
MH43	MH126		2A
	MH102	350, 400 m	3A*
MH102	MH103		0A
MH103	Police Station Vault		0A
Police Station Vault	Citadel Inn Vault	350, 70 m	0A
Citadel Inn Vault	MH103	350, 550 m	0A
MH103	MH102		0A
MH102	MH43		3A*
MH43	MH42		5A
MH42	MH41		4A*
MH41	MH39		4A*
MH39	MH38	750, 160 m	3A*
MH38	MH40		5A
MH40	MH38	750, 150 m	5A
MH38	MH116		5A
MH116	MH38	750, 230 m	5A
MH38	MH37		9A
MH37	MH36		9A
MH36	L431-229 MetroCtr		8A

(C) 1H-403 –Metro Center Loop from L431-230 to L431-232			
From	To	Cable	Available Ducts
Metro Venter Vault	MH36	750, 210 m	11A
MH36	MH110		4A
MH110	MH114		
MH114	Prince George Vault		
Prince George Vault	MH114	750, 220 m	
MH114	MH124		
MH124	Cambridge Vault		
Cambridge Vault	MH124	750, 160 m	
MH124	MH87		
MH87	MH131		
MH131	MH132	750, 220 m	
MH132	MH117	750, 140 m	
MH117	MH115	750, 80 m	
MH115	MH109	750, 280 m	
MH109	Grand Parade Vault		
Grand Parade Vault	MH33	750, 120 m	
MH33	MH34		
MH34	MH35	750, 120 m	
MH35	MH123		
MH123	MH35	750, 150 m	
MH35	MH36		
MH36	L431-232 Metro Ctr		

(D) 1H-403 – 28H-415 to Grand Parade Vault			
From	To	Cable	Available Ducts
28H-415	MH30	750, 190 m	2A
MH30	MH31		2A
MH31	L431-187 Barrington Place		0A
L431-186	MH31	750, 190 m	0A
MH31	MH30		2A
MH30	MH33		12A
MH33	L431-227 Grand Parade Vault		9A

(E) 1H-403 – 28H-411 to L431-230 Metro Center – Tie with 1H-405			
From	To	Cable	Available Ducts
28H-411	MH32	500, 180 m	A2, Upgrade?
MH32	MH39		A5, Upgrade?
MH39	MH38	750, 230 m	A3*
MH38	MH37		A9
MH37	MH36		A9

MH36	L431-230 Metro Center		A11

(F) 1H-405 – Main Radial 1H to 28H-417			
From	To	Cable	Available Ducts
1H-405	MH2	750, 1050 m	9A
MH2	MH4		1A
MH4	MH5		1A
MH5	NH6		1A
MH6	MH9		1A
MH9	MH10		2A
MH10	MH48		2A
MH48	MH46		2A
MH46	MH47		3A
MH47	MH133		13A
MH133	MH47	750, 390 m	13A
MH47	MH46		3A
MH46	MH26		0A
MH26	MH28		1A
MH28	MH32		3A
MH32	28H-417		2A, may be used for 1H-403 upgrades

(G) 1H-405 – 23 kV Loop			
From	To	Cable	Available Ducts
28H-408	MH32	350, 390 m	2A
MH32	MH39		5A
MH39	MH41		4A
28H-409	MH32	350, 390 m	2A
MH32	MH39		5A
MH39	MH41		4A
28H-408	28H-424 Center Pad	350, 110 m	
28H-409	28H-423 Center Pad	350, 110 m	
MH41	28H-419 Scotia Tower	350, 20 m	
MH41	28H-418 Scotia Tower	350, 20 m	
MH41	MH42	350, 120 m	4A
MH41	MH42	350, 120 m	4A
MH42	28H-427 North Pad	4/0, 90 m	1A
MH42	28H-428 North Pad	4/0, 90 m	1A
MH42	28H-433 MacKeen Tower	350, 50 m	0A
MH42	28H-432 MacKeen Tower	350, 50 m	0A

28H-433	MH43	#1, 170 m	
MH43	28H-442		
28H-432	MH43	#1, 170 m	
MH43	28H-441		

(H) 1H-419 – to L431-401 Proctor Street			
From	To	Cable	Available Ducts
1H-405	MH2	750, 1140 m	9A
MH2	MH4		1A
MH4	MH5		1A
MH5	MH6		1A
MH6	MH9		1A
MH9	MH10		2A
MH10	MH48		2A
MH48	MH46		2A
MH46	MH47		3A
MH47	MH125		3A
MH125	MH26	750, 1000 m	1A
MH26	MH28		1A
MH28	MH32		3A
MH32	28H		2A*
28H	MH30		2A
MH30	MH23		6A
MH23	MH22		7A
MH22	MH21		9A
MH21	MH90		0A
MH90	MH91		0A
MH91	MH92		
MH92	6H-401 Proctor St		

(I) 1H-419 – L431-404 Proctor Street to L431-211 Art Gallery Vault			
From	To	Cable	Available Ducts
L431-404	MH92	750, 560 m	
MH92	MH91		
MH91	MH90		0A
MH90	MH21		0A
MH21	MH20		5A
MH20	MH19		7A
MH19	L431-257 Xerox Building		4A
L431-256	MH19	750, 110 m	4A
MH19	L431-259 Sheraton Vault		5A
L431-258 Sheraton Vault	MH19	750, 190 m	5A

MH19	MH18		15A
MH18	MH22		9A
MH22	MH18	750, 240 m	9A
MH18	MH16		14A
MH16	MH14		14A
MH14	1801 Hollis St		4A
1801 Hollis St	MH14	750, 190 m	4A
MH14	MH13		14A
MJH13	MH56		12A
MH56	L431-211 Art Gallery Vault		0A

(J) 1H-419 Loop from L431-211 to L431-209 Art Gallery Vault			
From	To	Cable	Available Ducts
L431-211 Art Gallery Vault	MH56	3/0, 140 m	0A
MH56	MH55		13A
NH55	MH25		1A
MH25	L431-236 Royal Bank Vault		4A
L431-237 Royal Bank Vault	MH25	3/0, 210 m	4A
MH25	MH24		4A
MH24	MH15		
MH15	MH17		2A
MH17	L431-238 Historic Properties Vault		0A
L431-239 Historic Properties Vault	MH7	4/0, 160 m	
MH7	MH15		
MH15	L431-240 Law Courts Vault		
Law Courts Vault	MH111	3/0, 50 m, NB radial	
MH111	Ferry Term. Vault		
Ferry Term. Vault	MH13		
MH13	Riser Pole		
L431-241 Law Courts Vault	MH15	4/0, 140 m	
MH15	MH24		4A
MH24	L431-242 Hist. Prop. Prom. Vault		
L431-243 Hist. Prop. Prom. Vault	MH24	4/0, 190 m	
MH24	MH25		4A
MH25	Royal Bank Vault		4A

Royal Bank Vault	MH25		4A
MH25	L431-244 Bank of Montreal		2A
L431-245 Bank of Montreal	MH25	3/0, 70 m	2A
MH25	MH105		0A
MH105	MH25	3/0, 170 m	0A
MH25	MH55		1A
MH55	MH56		12A
MH56	L431-209 Art Gallery Vault		0A

(K) 1H-419 MH22 to 28H-413			
From	To	Cable	Available Ducts
L431-176 MH22	MH23	750, 240 m	
MH23	MH30		6A
MH30	28H-413 Scotia Square		2A

(L) 1H-431 to Art Gallery Vault			
From	To	Cable	Available Ducts
1H-431	MH2	750, 380 m	12A
MH2	MH3		2A
MH3	MH60		2A
MH60	Riser D431-001		0A
Riser D431-354	MH59	750, 150 m	0A
MH59	MH58		9A
MH58	MH57	750, 90 m	9A
MH57	MH148		
MH148	Ralston Vault	750, 100 m	
Ralston Vault	MH57	750, 160 m	
MH57	MH7		8A
MH7	Keith's Brewery Vault		1A
Keith's Brewery	MH7	750, 170 m	1A
MH7	Harbour Walk Vault		5A
Harbour Walk Vault	MH7	750, 180 m	5A
MH7	MH8		15A
MH8	Summit Place Vault		
Summit Place Vault	MH89	750, 190 m	
MH89	MH49		5A
MH49	MH51		9A
MH51	Founder's Square Vault		0A
Founder's Square	MH51	750, 110 m	0A

Vault			
MH51	MH52		5A
MH52	Bedford Row Vault		
Bedford Row Vault	MH52	750, 100 m	3A
MH52	MH53		12A
MH53	Public Works Vault		
Public Works Vault	MH53	750, 180 m	
MH53	MH12		
MH12	MH88		
MH88	Maritime Museum Vault		
Maritime Museum Vault	MH88	750, 320 m	
MH88	MH12		
MH12	MH13		
MH13	MH56		
MH56	Art Gallery Vault		

APPENDIX B – Primary Service Cables

Note: Due to short cable length, the primary services located in the same with the switch vault or manhole may not be shown in the list.

1 of 4

1H-403 Primary Service Cables		
CS Number	Cable Size [AWG], [kcmil]	Cable Length [m]
CS431-139	3/0	70
CS431-170-T2	#1	160
CS431-150	750	10
CS431-221	3/0	10
CS431-227	3/0	40
CS431-265	350	60
CS431-426	350	40
CS431-046	3/0	50
CS431-182	3/0	150
CS431-270	750	80
CS431-001	3/0	50
CS431-211	3/0	80
CS431-162	3/0	100
CS431-154	3/0	40
CS431-402	3/0	50
CS431-430	3/0	150
CS431- 531	#1	100
CS431-036	3/0	50
CS231-012	1/0	200
CS231-038	1/0	270
CS431-428	3/0	10
CS431-197	3/0	130
CS431-137	3/0	100
CS431-185	3/0	20
CS431-184	3/0	10

2 of 4

1H-405 Primary Service Cables		
CS Number	Cable Size [AWG], [kcmil]	Cable Length [m]
CS431-007	3/0	50
CS431-012	3/0	70
CS431-005	3/0	50
CS431-504	-	-
CS431-505	-	-
CS431-506	-	-
CS431-507	-	-
CS431-508	-	-

3 of 4

1H-419 Primary Service Cables		
CS Number	Cable Size [AWG], [kcmil]	Cable Length [m]
CS431-351	3/0	10
CS431-138	3/0	70
CS431-196-T2	750	30
CS431-268	#1	50
CS431-279	3/0	10

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1H-431 Primary Service Cables		
CS Number	Cable Size [AWG], [kcmil]	Cable Length [m]
CS431-205	#1	55
CS431-002	3/0	50
CS431-345	#1	50
CS431-247	#1	30
CS431-049	#1	10
CS431-217	3/0	10
CS431-220	3/0	220
CS431-271	3/0	50
CS431-450	350	270

APPENDIX C – Splices and Terminations

The allocation of the cable accessories below is assumed based on single line diagrams and may not be an exact representation of the actual type or quantity. For accessory legend see 5.2.

Splices and Terminations									
MH# /Vault	Equip. in MH	1H-403		1H-405		1H-419		1H-431	
		Feeder	Service	Feeder	Service	Feeder	Service	Feeder	Service
001									
002									
003								s	
004		s		s		s			
005									
006		s		s		s			
007									
008									
009									
010		s		s		s			
011									
012								s	
013									
014									
015									
016									
017									
018									
019									
020						s			
021									
022	TX+SW					3T	2T+2L		
023						s			
024									
025									
026				s					
027									
028		s							
029									
030									
031									
032						s			
033									
034	SW	2T	T+L						
035									
036		T							
037									
038									
039		2s							
040	SW	2T	T+L						
041				2s					
042		s		2s					
043		s							

044									
045									
046		s				s			
047				s					
048									
049									
050									
051									
052	TX+SW								
053									
054									
055									
056									
057									
058								T	
059									
060									
061									
062									
063									
064									
065									
066									
067									
068									
069									
070									
071									
072									
073									
074									
075									
076									
077									
078									
079									
080									
081									
082									
083									
084									
085									
086									
087									
088									
089									
090						2s			
091A									
091B									
092									
093									
094									
095									

096									
097									
098									
099									
100									
101									
102		s							
103									
104									
105	TX+SW					2T	T+L		
106									
107									
108	TX		L						
109									
110									
111									
112									
113									
114									
115	TX+SW	2T	4T+4L						
116		2T	2T+2L						
117	TX+SW	2T	T+L						
118									
119									
120	SW								
121									
122	TX								
123	TX+SW	2T	2T+2L						
124	TX								
125	TX+SW					2T	2T+2L		
126	Adj Sw	2LF	2LF+2 L						
127									
128									
129									
130									
131	TX+SW	5T	5T+5L						
132	TX+SW	2T	2T+L						
133	TX+SW			4T	4T+4L				
134									
135									
136									
137									
138									
139									
140									
141									
142									
143									
144									
145									
146									
147									
148	TX+SW							2T	2T+2L

149									
150									
151									
152									
153									
154	SW								
155									
156									
157									
158									
159	TX	2T	2T+2L						
160									
161									
162									
163									
164									
165									
166									
167									
168									
169									
170									
171									
200									
B01	TX+SW								
B02	TX+SW								
D01									
D02	TX								
D03	SW								
D04									
D05									
D06									
D07									
D08									
D09									
D10	SW								
D11	SW								
D12									
D13	TX+SW								
D14	TX+SW								
D15									
D16	TX+SW								
D17									
D18	TX+SW								
D19									
D2	TX								
D20	TX								
D21	TX+SW								
D22									
D23	TX+SW								
D24									
D25									
D26									

D27									
D28									
D29									
D30									
D31									
D32									
D33									
D34									
D35									
D36A									
D36B									
D37									
D38									
D39									
D40									
D41									
D42									
D43									
D44A									
D44B									
D44C									
D44D									
D44E									
D44F									
D44G									
D44H									
D44I									
D44J									
D6									
Police Station		4LF	LF						
Citadel Hotel		4LF	LF						
Plaza 1881									
Blue Cross									
Metro Center		11LF	3LF						
Prince George		2T	T+L						
Cambridge Suites		2T	2T+2L						
Canada Trust									
City Hall									
Grand Parade		3T	3T+3L						
Proctor Street									
Xerox Bldg						2T	2T+2L		
Sherato						2T	T+L		

n									
Hollis 1801						2T	T+L		
Art Gallery						3T	T+L	T	
Royal Bank						2LF	LF		
Historic Prop. Warerfront						2LF	LF		
Ferry Terminal						2LF			
Law Courts						2T	2T+3LF		
Hist Prop. Promenade						2T	T+L		
Bank of Montreal						2LF	LF		
Ralston Building								2T	T+L
Summit Place								2T	T+L
Founder's Square								3T	T+L
Bedford Row								2T	2T+2L
Public Works Canada								2T	2T+2L
Barrington Place		2T	T+L						
Market St 1770			4L						
6H Proctor Street						6LF			
O/H section								2LF	4LF
Keith's Brewery								2T	2T+2L
Harbour Walk								2T	T+L
Maritime Museum								2T	2T+2L
28H South Pad Vault		10LF		36LF+2T		LF			
Center Pad Vault				4T	T+L				

Scotia Tower Vault				4T	T+L				
North Pad Vault				4T	T+L				
MacKeen Pad Vault				4T	T+L				
Trade Mart Vault				2T	T+L				

APPENDIX D – Art Gallery Tie (Details)

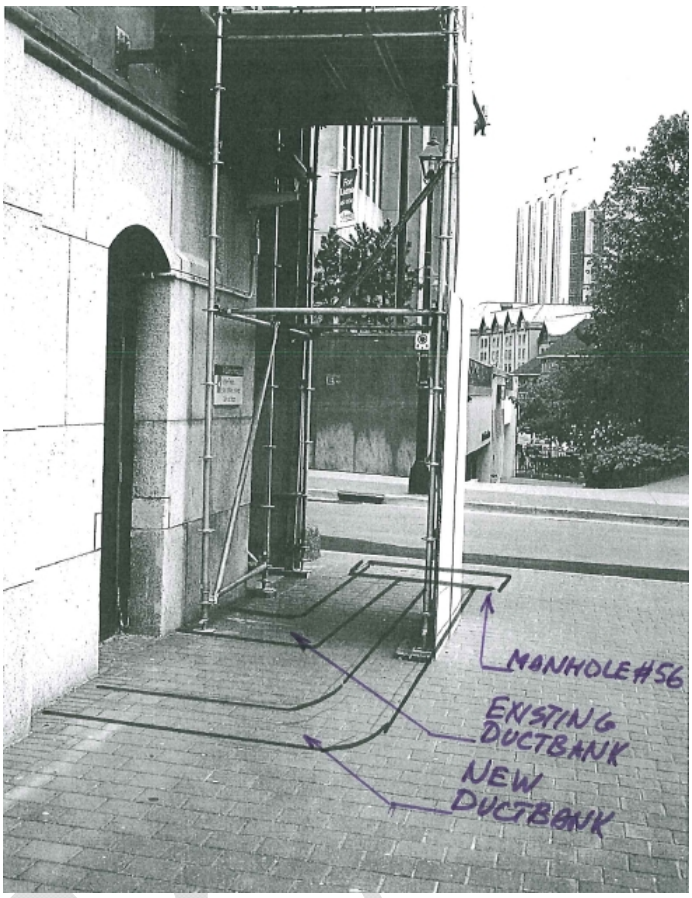

Fig. 4.3 Art Gallery Ductbank Extension

The inlaid brick manhole cover should be replaced with a different type of cover that can be quickly removed and reinstalled as required.

Fig. 4.4 Manhole MH56

The electrical connections in the vault will have to be modified to allow for a new switch. One of the options would be to install a new two-way 200 A VacPac switch and relocate the CS431-272 primary service from the existing four-way VacPac switch to the new switch. The source side of the new switch will be piggybacked at L431-209. See Fig. 4.5 and 4.6 for details. This will free up one of the 600 A switches on the existing VacPac which will be used to tie-in the feeder 1H-424.

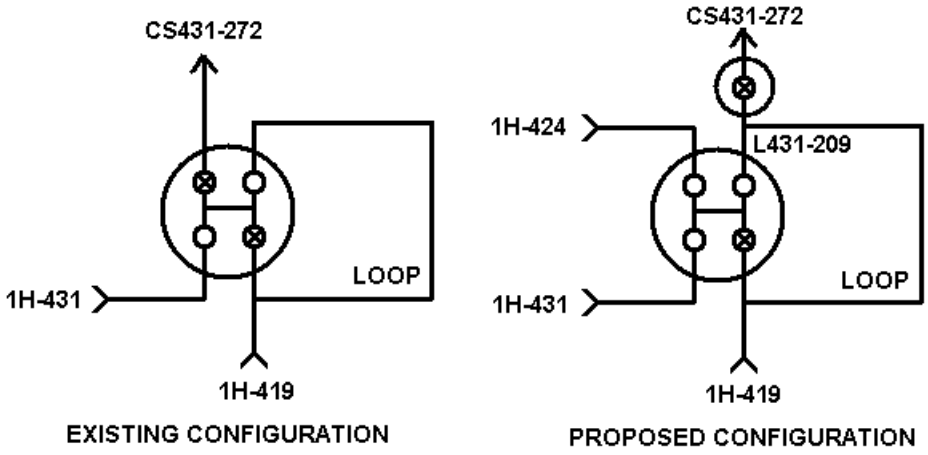

Fig. 4.5 Electrical Connections Before and After

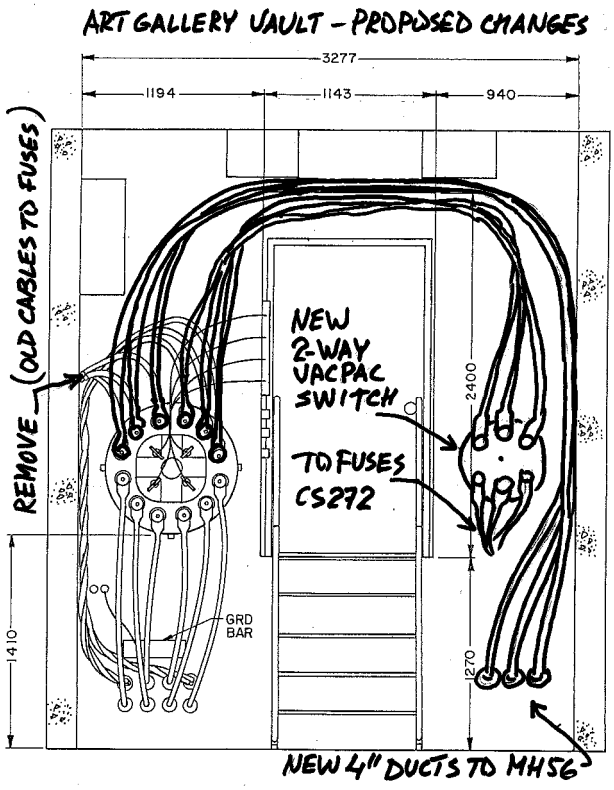

Fig. 4.6 New Two-Way Switch in the Vault

The following is the list of basic jobs for the project:

1. Install nine 100 mm ducts (3 spare) between the Art Gallery vault and MH56 (approx. 8 m).
2. Repair or replace manhole cover MH56
3. Install six 750 kcmil Al cables from MH13 through MH56 to Art Gallery vault (60 – 70 m)
4. Install new 2-way 200 A VacPac switch in the vault. Cooper model # 21VP125-22. The SMD-20 fuse mounts in the vault may need to be slightly moved to allow for proper clearance.
5. Transfer cs431-272 from four-way to two-way VacPac switch. The source side of the new switch connects to L431-209.
6. Terminate and connect the new cables to L431-212 -the freed-up switch.
7. Splice-in the other end of the cable to the feeder 1H-424 in MH13 using 600A deadbreak terminations.
8. Consider installing barriers in front of the fuses in the vault.

APPENDIX E – Deadfront Splice Specifications for 750 kcmil Cable

One three phase separable deadfront splice on the full size feeder cable will require the following materials:

#	**Description**	**NSPI Code**	**QTY**	**Price**
1	Basic Shielded Elbow 25 kV	5465-2370	6	$76.87/ea
2	Cable Adapter #750, Compact	5465-0189	6	$15.84/ea
3	Connecting Plug 25 kV	5465-7400	3	$79.26/ea
4	Basic Insulating Plug	5465-7350	6	$46.29/ea
5	Conductor Contact, #750 Compact	5465-1320	6	$33.17/ea
6	Constant Force Spring	5465-0655	6	$13.56/ea
7	Braid Flexible Tinned	5465-0650	3 m	$7.98 per ft