ARVIAT TANK FARM FACILITY TECHNICAL ASSESSMENT STUDY

GN Project:17300-00445

GN Contract:17300-00445-01

WP Project:307031-00048

WorleyParsons

resources & energy

EcoNomics™

ARVIAT TANK FARM FACILITY TECHNICAL ASSESSMENT STUDY

Prepared For:

Government of Nunavut, Canada
Community & Government Services
PO Box 1000 Stn 620, 4th Floor W.G Brown Building
Iqaluit, NU X0A 0H0

Prepared By:

WorleyParsons Canada Services Ltd - Edmonton Operations
Edmonton
120, 5008-86th Street , Edmonton AB T6E 5S2, Canada
Tel: +1 780 440 5300
Fax: +1 780 440 5555

April 2018

PROJECT - ARVIAT TANK FARM TECHNICAL ASSESSMENT STUDY

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
0	Issued for Use	Ozer Ozdemir 02 Apr 2018 O.Ozdemir	Dragan Andrejevic Darcy Mould	Sanjay Khera Sanjay Khera	03 April 2018		
A	Issued for Review	O.Ozdemir	Dragan Andrejevic Darcy Mould	Sanjay Khera	12 Jan 2018		

SYNOPSIS

This report documents technical assessment of Arviat Tank Farm Facility and resupply lines undertaken as part of the ***ARVIAT TANK FARM FACILITY TECHNICAL ASSESSMENT STUDY*** project.

Disclaimer

This Technical Assessment Study report is conceptual in nature and represents the work of WorleyParsons performed to recognize engineering principles and practices appropriate for conceptual engineering work and the terms of reference provided by WorleyParsons' contractual Customer, Government of Nunavut (the "Customer"). This report may not be relied upon for detailed implementation or any other purpose not specifically identified within this report. This report is confidential and prepared solely for the use of the Customer. The contents of this report may not be relied upon by any party other than the Customer, and neither WorleyParsons, its subconsultants nor their respective employees assume any liability for any reason, including, but not limited to, negligence, to any other party for any information or representation herein. The extent of any warranty or guarantee of this report or the information contained therein in favour of the Customer is limited to the warranty or guarantee, if any, contained in the contract between the Customer and WorleyParsons.

PROJECT - ARVIAT TANK FARM TECHNICAL ASSESSMENT STUDY

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
0	Issued for Use	Ozer Ozdemir 02 Apr 2018 O.Ozdemir	Dragan Andrejevic Darcy Mould	Sanjay Khera Sanjay Khera	03 April 2018		
A	Issued for Review	O.Ozdemir	Dragan Andrejevic Darcy Mould	Sanjay Khera	12 Jan 2018		

CONTENTS

1. EXECUTIVE SUMMARY 6
2. INTRODUCTION 9
2.1 GENERAL 9
2.2 COMMUNITY INFORMATION 10
3. EXISTING FUEL FACILITY 13
3.1 SUMMARY 13
3.2 RESUPPLY SYSTEM 14
3.3 TANKAGE AND PIPING 17
3.4 SECONDARY CONTAINMENT AREA 20
3.5 ULSDL/GASOLINE DISPENSER BUILDING 22
3.6 REMOTE DISPENSER ISLAND 24
3.7 OPERATOR SHELTER BUILDING 24
4. PRELIMINARY FACILITY PLANNING 26
4.1 REQUIRED FACILITY ELEMENTS 26
4.1.1 Design Standards 26
4.1.2 Resupply System 26
4.1.3 Tankage and Tank Farm Piping 27
4.1.4 Secondary Containment 29
4.1.5 ULSDL/Gasoline Dispenser Building 29
4.1.6 Remote Dispenser Island 30
4.1.7 Operator Shelter Building 30
4.1.8 General 30
4.1.9 Growth Rates 30
4.1.10 Storage Volumes 31
4.2 PLANNING AND CONSIDERATIONS 31
4.2.1 General 31
4.2.2 Tank Top Elevations 31
4.2.3 Tank Locations 31

4.2.4 Tank Clearances 31
4.2.5 Secondary Containment 32
5. TANK FARM FACILITY OPTIONS 33
5.1 OPTION #1 33
5.1.1 ULSDL Tanks 33
5.1.2 Gasoline Tanks 34
5.1.3 Future Expansion 34
5.2 OPTION #2 34
5.2.1 ULSDL Tanks 35
5.2.2 Gasoline Tanks 35
5.2.3 Future Expansion 35
5.3 OPTION #3 35
5.3.1 ULSDL Tanks 36
5.3.2 Gasoline Tanks 36
5.3.3 Future Expansion 36
6. CONCLUSIONS 37
6.1 GENERAL DISCUSSION 37
6.2 TANK COSTS 38
6.3 COST ESTIMATE 39
6.4 RECOMMENDATIONS 39
6.5 POSSIBLE PROJECT SCHEDULE 39

1. EXECUTIVE SUMMARY

WorleyParsons Canada was awarded a contract to complete a Technical Assessment Study for the expansion of the Arviat Tank Farm, and to provide an opinion on the existing Needs Assessment Study dated 03.Feb.2017 which was completed by the PPD.

Government of Nunavut (GN) Department of Community and Government Services (CGS) through the Petroleum Product Division (PPD) provide bulk fuel storage and distribution of Gasoline and Diesel (ULSDL) petroleum products for the community of Arviat, NU. PPD has identified that the current bulk fuel storage facility at Arviat is in need of expansion and code upgrades.

Two methods are presented in this study for fuel projection for the next 20 years.

- Method A: Fuel projection based on historical fuel sales record provided by the PPD.
- Method B: Fuel projection based on an annual 3% growth rate.

Method B is more conservative than Method A as it projects a higher annual fuel sales growth rate. Based on Method B, the community demand will exceed capacity for ULSDL in 2020-2021 and Gasoline in 2025-2026. On the other hand, based on Method A, demand will exceed capacity for ULSDL in 2022-2023 and Gasoline in 2031-2032.

The Technical Assessment Study re-assessed the three options that were listed in existing Needs Assessment Study completed by the PPD. In addition, an assessment was done on the condition of the Arviat bulk fuel storage facility including the dispenser building, remote dispenser island, operator's shelter, resupply pipeline, and marine spill basin. This assessment was based on the site investigation that was completed in early October, 2017. All applicable current codes and regulations have been taken into consideration in this new study.

Apart from visual inspection, paint samples were taken from all vertical tanks and above ground pipeline by NACE Level III certified paint inspector. Paint lead test results are listed in Appendix E. According to the lab results, lead contents in the paint samples are less than allowable limit defined by WSCC, Guideline for the Management of Waste Lead and Lead Paint. As per WSCC, 600 ppm (0.06% wt) lead content and above is considered as lead amended paint. The highest analysed lead concentration is limited to 158 ppm from the samples taken from the Tank #7.

FUEL DEMAND PROJECTION METHODS	Anticipated ULSDL Demand in 2040-2041 (L)	Anticipated Gasoline Demand in 2040-2041 (L)
METHOD A - Historical Sales Growth by PPD (2.19% for ULSLD and 2.01% for Gasoline)	7,738,221	2,031,121
METHOD B – 3% Annual Population Growth Factor	9,421,908	2,585,825

CURRENT CAPACITY (Including capacity offset by early and late resupply)	5,258,009	1,686,078

OPTIONS	Total Upgraded ULSDL Capacity (L)	Total Upgraded Gasoline Capacity (L)
OPTION 1 – Existing Foot print	7,086,929	1,715,363
OPTION 2 – Expanded Foot print	7,860,929	2,713,363
OPTION 3 – New Tank Farm	9,999,000	3,333,000

Table 1: Summary of fuel capacity for three options with fuel projection methods.

Based on PPD's fuel sales growth projection, anticipated demand for ULSDL and Gasoline in 20 years (until 2040-2041) is 7,738,221L and 2,031,121L respectively which includes 15% safety margin. Current ULSDL and Gasoline capacities are 5,258,009L (not including horizontal tanks) and 1,686,078L respectively including capacity offset by early and late resupply.

Option 1, proposes one new 370,000 L (Dia: 7.14m X Height: 9.25m) capacity Gasoline tank and one new 2,559,000 L (Dia: 18.3m X Height: 9.75m) capacity ULSDL vertical tank without expanding the existing foot print of the facility. This option will not satisfy the Gasoline and ULSDL demand in 20 years (Method A or Method B). Further, the containment area would not be sufficient for future expansion and the existing horizontal tanks will have to be removed. The current dike height needs to be increased from 0.9m to 1.5m.

Option 2, proposes one new 1,368,000 L (Dia: 13.72m X Height: 9.25m) capacity Gasoline and one new 3,333,000 L (Dia: 20.85m X Height: 9.75m) capacity ULSDL vertical tank with containment area expanding to the south east direction by 30m. Option 2 will not satisfy ULSDL demand in 20 years (Method B). Additional a 1,600,000L capacity ULSDL tank would be required. The existing dike height needs to be increased from 0.9m to 1.5m. In addition, the community communication site will have to be relocated due to foot print expansion at the facility.

Option 3, proposes a new tank farm at the east end of Arviat. The location of the new tank farm is shown in Appendix F. It is east of 3rd Ave and south of 8th street; Longitude -94.045230, Latitude 61.107772. Option 3 will satisfy ULSDL and Gasoline demand in 20 years when either Method A or Method B is used for fuel demand projection.

Option 1 and Option 2 will require a new resupply pipeline as the existing resupply line is partially underground with a single-wall pipe installed. There is no leak detection system and therefore it does not comply with SOR/2008-197, 2012 edition. Existing resupply pipeline is approximately 920m from shore manifold to the tank farm facility and is routed through the Arviat community. This arrangement is not ideal due to:

- The existing Resupply pipeline runs through centre of the community and among residential buildings.

- The long distance between existing tank farm and the shore manifold results in decreased operational efficiency.
- Increased duration of resupply operation.
- Increased environmental risk of a hydrocarbon spill.
- Increased health and safety risk for children who play along the pipeline route.

Location of the existing shore manifold is approximately 31 meters from the high water mark and meets SOR/2008-197, 2012 edition. However, water depth in that area is too shallow for the resupply fuel tanker to anchor closer to the manifold. Proposed location of new shore manifold is shown in Figure 24. The location will substantially decrease the fuel tanker supply hose length on water, which will result in:

- Lower pressure drop during resupply operation and
- Lower environmental risk of hydrocarbon spill

Based on pros and cons for all three options, WorleyParsons strongly recommends Option 3 to be considered due to following reasons;

- Provides highest fuel storage capacity which meets ULSDL and Gasoline demand in 20 years with expansion flexibility.
- Provides shortest distance aboveground single wall resupply pipeline from the shore manifold to the tank farm facility.
- Makes a shore manifold location possible that will allow fuel tankers to anchor closer to the shore.
- Convenient location and short distance commute to the tank farm.
- Greenfield construction versus brownfield where unknowns may directly affect project schedule and cost.
- No disruption to community fuel delivery and distribution during the construction phase.
- API 653 allows up to 20 years for the initial service internal inspection for the new constructed tank when release prevention barrier is installed as per API 650, Annex I. On the other hand, existing tanks that are foreseen to be reused require shorter subsequent internal inspection period based on tank bottom plate corrosion rate. There is no guarantee that existing tanks will last without need of any major repair or replacement in 20 years.
- No tie-ins (new to old) are required.

2. INTRODUCTION

2.1 GENERAL

The Government of Nunavut (GN), Department of Community and Government Services (GCS) are obligated to provide fuel distribution to communities and resupply to bulk fuel storage facilities that are not served by private organizations. PPD provides fuel supply and distribution service to the communities, while CGS develops and manages the projects.

Currently CGS through PPD provides bulk fuel storage and distributes petroleum products to Arviat, NU. The products being supplied are ULSDL and Gasoline. PPD identified that the current bulk fuel storage facility of Arviat is in need of expansion and code upgrades.

The objectives of this study are:

- To provide another opinion on the PPD's Needs Assessment Study dated 03.Feb.2017 including re-assessment of the three listed options.
- Evaluation of the current condition of Arviat Tank Farm facility and make recommendations for its expansion and Code upgrade.
- Complete a class 'D' cost estimate for the three listed options.

WorleyParsons Canada was also requested to collect paint samples from all the tanks and aboveground piping. Paint samples were collected in accordance with WSCC guideline by NACE Level III certified paint inspector and results are presented in Appendix E.

The Arviat Tank Farm facility is supplied annually by fuel tankers carrying ULSDL and gasoline fuel. There is no Jet A-1 fuel storage at the bulk fuel facility or at the airport. Based on PPD's historical fuel sales projection (Method A), Arviat community fuel demand will exceed capacity of current bulk fuel storage facility for ULSDL in 2022-2023 and gasoline in 2031-2032.On the other hand, based on 3% annual growth factor projection (Method B), the community demand will exceed capacity for ULSDL in 2020-2021 and Gasoline in 2025-2026.

Following tasks were undertaken during the Technical Assessment Study;

- Review of PPD's Needs Assessment Study dated 03.Feb.2017.
- Site visit to Arviat Tank Farm Facility.
- Review fuel projection methods and storage requirements.
- Preparation of site plan layout and tank storage options.
- Class D cost estimate for all three options.

2.2 COMMUNITY INFORMATION

The Hamlet of Arviat, Nunavut has a population of approximately 2,657 people, based on Statistics Canada 2016 Census. This is a 14.6 % increase from 2011 when the population was recorded as 2,318. Current population of Arviat is approximately listed as 2,851 at airport traveller information boards. Arviat is located at Latitude 61.1N and Longitude 94.1W.

Arviat is within Kivalliq Region and is one of the fastest growing communities in Nunavut . It is projected to have the 2nd highest population in Nunavut by 2024, after Iqaluit.

Table 2 shows community population census data for Arviat from 1981 to 2016.

Nunavut Population Counts by Region and Community, 1981 to 2016 Censuses

	1981	1986	1991	1996	2001	2006	2011	2016
Nunavut	**15,572**	**18,408**	**21,244**	**24,730**	**26,745**	**29,474**	**31,906**	**35,944**
Kivalliq (Keewatin)	**4,327**	**4,986**	**5,834**	**6,868**	**7,557**	**8,348**	**9,266**	**10,413**
Arviat	1,022	1,189	1,323	1,559	1,899	2,060	2,318	2,657
Baker Lake	954	1,009	1,186	1,385	1,507	1,728	1,872	2,069
Chesterfield Inlet	249	294	316	337	345	332	313	437
Coral Harbour	429	477	578	669	712	769	834	891
Keewatin Unorganized[1]	24	13	2	0	0	0	0	0
Naujaat	352	420	488	559	612	748	945	1,082
Rankin Inlet	1,109	1,374	1,706	2,058	2,177	2,358	2,577	2,842
Whale Cove	188	210	235	301	305	353	407	435

Note: 1) Baffin, Keewatin and Kitikmeot unorganized areas include outpost camps.

Sources: Statistics Canada, 1981, 1986, 1991, 1996, 2001, 2006, 2011 and 2016 Censuses of Population, Catalogues #97-550-XWE2006002, #93F0050XDB01003, #98-310-XWE2011002 and #98-402-X2016001

File prepared by Nunavut Bureau of Statistics, February 9, 2017

Table 2, Nunavut Bureau of Statistics, 2016 Census Data

Table 3 shows community population projection data for Arviat from 2014 to 2035.

Kivalliq Community Population Projections, 2014 to 2035

Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Kivalliq	10,467	10,653	10,856	11,057	11,260	11,464	11,673	11,880	12,083	12,288	12,492	12,700	12,912	13,123	13,363	13,585	13,804	14,028	14,252	14,472	14,692	14,908
Arviat	2,611	2,671	2,737	2,804	2,870	2,937	3,006	3,075	3,143	3,210	3,275	3,340	3,405	3,467	3,528	3,590	3,652	3,715	3,780	3,845	3,912	3,980

Notes:

1) The base year of 2014 are population estimates (based on the 2011 Census counts adjusted for net census undercoverage).

2) Community population projections are preliminary and subject to revision.

3) Region totals include Unorganized areas and outpost camps.

4) These projections should be used with some caution, due to the small numbers on which the projections are based.

5) Custom tabulations of the community population projections are available upon request.

Source: Nunavut Bureau of Statistics

Prepared by: Nunavut Bureau of Statistics, December 17, 2014

Table 3: Nunavut Bureau of statistics, December 17, 2014

Table 4 shows Arviat community population projection data for next 20 years starting from 2020.

2020 (Year 0 Population)	2025 (Year 5 Population)	2030 (Year 10 Population)	2035 (Year 15 Population)	2040 (Year 20 Population)
3006	3340	3652	3980	4305

Table 4: Arviat community Population Projections for next 20 years (Assumed construction completion of 2020)

Table 5 is excerpt from the NBC Table C-2 for design weather recommendations for Arviat;

Province and Location	Elev, m	Design Temp				Degree Days Below 18 °C	15 Min. Rain, mm	One Day Rain, 1/50 mm	Ann. Rain, mm	Moist. Index	Ann. Tot. Ppn., mm	Driving Rain Wind Pressures, Pa, 1/5	Snow Load, 1/50		Hourly Wind Pressure, Kpa	
		January		July 2.5%												
		2.5% °C	1% °C	Dry °C	Wet °C								S_s	S_r	1/10	1/50
Arviat	5	-40	-41	22	16	9850	8	65	225	0.85	300	240	3.0	0.2	0.45	0.58

Table 5 : NBC 2015, Table C-2

Table 6 is excerpt from the NBC Table C-3 for Arviat seismic data.

Province and Location	Seismic Data							
	S_a (0.2)	S_a (0.5)	S_a (1.0)	S_a (2.0)	S_a (5.0)	S_a (10.0)	PGA	PGV
Arviat	0.054	0.037	0.022	0.0097	0.0021	0.0011	0.031	0.025

Table 6, NBC 2015, Table C-3

Table 7 and Table 8 shows historical climate data for Arviat from 1981 to 2010.

Canadian Climate Normals 1981-2010 Station Data

Temperature and Precipitation Graph | Normals Data | Station / Element Metadata

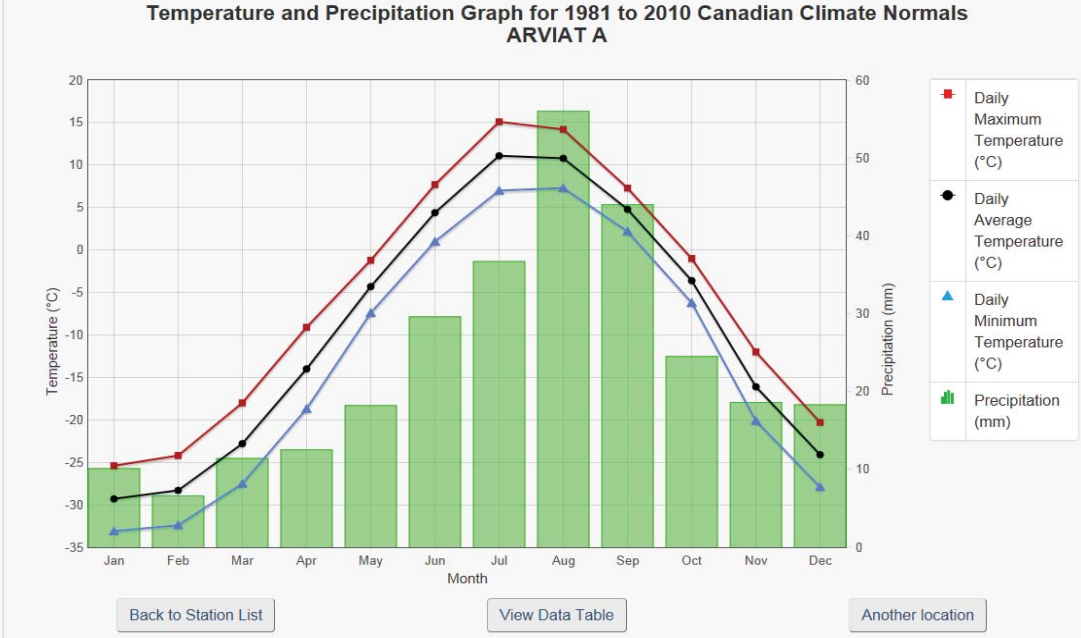


Table 7, Temperature and Precipitation Graph, Government of Canada

▼ Temperature

1981 to 2010 Canadian Climate Normals station data

Temperature

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
Daily Average (°C)	-29.3	-28.3	-22.8	-14.0	-4.3	4.4	11.1	10.8	4.8	-3.6	-16.1	-24.1	-9.3	D
Standard Deviation	3.5	3.1	2.8	2.7	2.3	2.0	1.7	1.0	1.5	2.2	3.2	3.7	2.1	D
Daily Maximum (°C)	-25.4	-24.2	-18.0	-9.1	-1.2	7.7	15.1	14.2	7.3	-1.0	-12.0	-20.3	-5.6	D
Daily Minimum (°C)	-33.1	-32.4	-27.5	-18.7	-7.4	1.0	7.0	7.3	2.2	-6.2	-20.1	-27.9	-13.0	D
Extreme Maximum (°C)	-1.5	-1.5	3.5	4.0	14.5	25.5	**33.9**	30.0	23.0	13.0	1.5	-1.5		
Date (yyyy/dd)	2000/28	1998/17	2004/31	2000/24	2001/26	1999/17	**1973/22**	1991/10	1994/02	1988/08	1997/06	1998/13		
Extreme Minimum (°C)	**-48.3**	-47.0	-41.5	-36.7	-26.7	-11.0	-4.0	-0.6	-8.3	-26.0	-34.0	-42.5		
Date (yyyy/dd)	**1975/19**	2003/28	1995/05	1973/07	1974/02	2002/01	1992/03	1974/18	1974/30	1986/31	1986/11	1996/30		

▼ Precipitation

1981 to 2010 Canadian Climate Normals station data

Table 8, 1981-2010 Canadian Climate Normals Station Data, Government of Canada

3. EXISTING FUEL FACILITY

3.1 SUMMARY

Site visit to the Arviat Tank Farm Facility was conducted on October 4-7, 2017 to assess the facility's bulk storage fuel tanks, tank farm piping system, dikes, liners, fencing, dispenser and operator building, remote dispenser island, resupply pipeline etc.

The north and south boundaries of the facility are surrounded by industrial private development. The area north of the facility includes an aboveground tank facility and a garage that are being operated by Eskimo Point Lumber Supply Ltd. (Eskimo Point) This tank facility has a direct piping connection to the Arviat Tank Farm Facility for resupply purposes. Eskimo Point's garage property boundary encroaches on the resupply piping right-of-way (ROW).

Figure 1: Resupply pipeline ROW encroachment by Eskimo Point's garage property

The area south of Arviat Tank Farm facility includes a garage and is being operated by Panainaaq Construction.

Figure 2: Eskimo Point's tank facility (left) and Panainaaq's garage (right).

3.2 RESUPPLY SYSTEM

The existing resupply pipeline is partially buried underground and partially aboveground. The NPS 6 ULSDL and NPS 4 gasoline pipeline from the shore manifold and marine spill basin (approximately 33 meters from high level water mark) to the main bulk fuel storage facility is approximately 920m.

Figure 3: Shore manifold and marine spill basin. Shore manifold is lacking sea hose valve cover and chain lock on gate valves to prevent accidental spillage or vandalism.

Current location of shore manifold meets federal environmental regulations; set back more than 31m from high water mark, however, water level is too shallow for fuel tankers to approach closer. The long fuel floater hose length results in high pressure drop due to friction and long fuel transfer duration for the resupply operation. This requires an extended period for PPD personnel at site. In addition, the long floater fuel hose length over the water, and extended fuel transfer operation time increases the risk of a fuel spill. Therefore, it is recommended to relocate the shore manifold to the new proposed location.

Figure 4: Resupply fuel tanker and shore manifold shown on top. Fuel floater hose approximate length is 700 meters from fuel tanker to the shore manifold. Fuel tanker anchored by a grader during resupply operation shown on bottom.

The aboveground portions of the existing resupply pipeline are severely rusted where the external coating is scaled off or damaged. Random external thickness measurement by ultrasonic testing is required to determine corrosion rate and remaining life. As per API 570, the recommended maximum inspection interval is 5 years for thickness measurement and external visual inspection.

Figure 5: Aboveground pipeline expansion loops with incorrect pipe guide support practice.

Pipeline thermal expansion loops were not designed properly. All the U-bolts on the first resting support before and after expansion loop have snapped. It's better practice not to guide an expansion loop until the second pipe support from the expansion loop.

Figure 6: Resupply pipeline aboveground pipeline sections. ULSDL piping to QEC power plant (left). ULSDL and gasoline resupply pipe line aboveground section, downstream of 6th street road crossing (centre and right).

The buried underground sections of the resupply pipeline are single wall without a leak detection system, so it does not comply with SOR-2008-197. As per SOR-2008-197, the owner of a single-

walled underground piping system that was installed before the regulation came in effect, must comply with the regulation within 4 years after the day the regulation come into force (June 27, 2012).

Figure 7: Damaged CP test stations along resupply pipeline.

Condition of underground section is unknown. Original design documents and cathodic protection (CP) test stations shows that underground piping is being protected by a galvanic anode CP system. CP test stations are not in good conditions due to lack of maintenance. CP test stations are crucial in order to verify effectiveness of CP.

The existing resupply pipeline continues through the core of the Arviat Community amongst traffic areas. One aboveground section runs east of the Hamlet Office where children can be found playing in close proximity to the pipeline, which presents health and safety risks.

Figure 8: Aboveground resupply pipeline (left) and underground section (right) runs parallel to 6th street, centre of community.

3.3 TANKAGE AND PIPING

The existing tankage at the facility is as follows:

Arviat Tank Farm Facility [1]				
Product	**EC Identification Number**	**Tank Number**	**Tank Type**	**Capacity (L)**
ULSDL	EC 00022255	Tank # 6 (9)	Vertical Tank Dome Roof	631,253
		Tank # 11	Vertical Tank Fixed Cone Roof	1,345,363
		Tank # 12	Vertical Tank Fixed Cone Roof	2,551,313
			TOTAL CAPACITY	**4,527,929**
ULSDL (Reserve)	EC 00022273	Tank # 1	Horizontal Tank	92,117
		Tank # 2		91,786
		Tank # 4		91,786
		Tank # 5		92,117
		Tank # 7		91,882
		Tank # 8		91,786
			TOTAL CAPACITY	**551,474**
Gasoline	EC 00022271	Tank # 10	Vertical Tank Fixed Cone Roof	1,345,363
			TOTAL CAPACITY	**1,345,363**

Table 9: Arviat Tank Farm Summary

There are currently six vertical and six horizontal tanks located at the Arviat tank farm facility. Two of the vertical tanks are owned by QEC. Six horizontal tanks are located in the centre of the berm area. During summer 2017, PPD arranged an out-of-service inspection for tank #6(9), tank #11, and the horizontal tanks. The horizontal tanks were tied-in (except tank #4) to the ULSDL tank farm piping.

[1] Tank # 23 and Tank #24, have total of 1,974,000 L ULSDL capacity, are owned by Qulliq Energy Corporation (QEC) and not included in this table.

Figure 9: Horizontal tanks tied-in to ULSDL piping in 2017 summer (top). Overview of horizontal tanks (bottom left). Horizontal tank interconnecting piping (right). Grass and moss growing out from under the tanks.

None of the existing tanks have overfill protection in accordance with API 2350. CCME Section 3.3 requires field-erected tanks be provided with overfill protection. Overfill protection system should include an audible and visible alarm to indicate an abnormal condition to the operation personnel which will require a specific response during resupply operation. It is also recommended level transmitters be installed on the tank roof, configured to alarm on level changes in tanks when no fuel dispensing operations are in progress, to indicate a leakage.

Various appurtenances on the existing vertical storage tanks such as lighting, mechanical level gauges, pressure and vacuum vents were not functioning properly. Mechanical level gauges require calibration or replacement.

Tank venting devices, pressure and vacuum vents, have to be tested and calibrated in accordance with one of the test methods listed in API 2000 in order to verify the flow capacity.

Figure 10: Tank #10 and Tank #11 (left). Tank #6(9), Tank#12, Tank#23 and Tank #24 (right). Water lying around tank foundations.

All the aboveground storage tanks have at least one grounding cable however, the tank connections are rusted. Storage tanks on grade-level foundations are considered inherently grounded for dissipation of electro static charge. Therefore, tanks can be considered adequately grounded for dissipation of the electrostatic charge.

The roof handrails are not continuous all around the roof. As per WSCC and PPD requirements, the roof handrails should be extended to all around the roof perimeter.

Figure 11: Rusted grounding lug and cable (centre). Tank # 11 (right) and Tank#12 (left) partial roof handrails.

Existing stiles (total of 4) over dike are in acceptable condition. Handrails have to be installed on the both sides, so as to meet WSCC and PPD requirements.

The distance between Tank #23 and Tank # 24 was measured as 4.64m from wall to wall. This does not meet the National Fire Code (NFC) requirement for spacing between storage tanks. Tank #23 and Tank# 24 are 10.7m in a diameter. Per NFC paragraph 4.3.2.2, minimum of 0.25 times the sum of tanks diameters (5.35m) is required between tanks. This is a fire hazard and needs to be addressed. In addition, new foundations are required for Tank #23 and Tank #24 where existing foundations have completely eroded and tanks have settled. Other vertical tanks' foundations shall be evaluated by a storage tank engineer considering the plumbness of the shell, shell distortion, and original construction levelness.

Figure 12: Distance between Tank # 23 and Tank #24

During site visit, it was observed that there is no vegetation or weed control measurements in place inside the berm area. Measure shall be taken to ensure that dry vegetation does not pose a threat to successful fire control.

Tank farm piping is mostly in good condition except for piping runs close to the ground level, where external coating is scaled off or damaged. Random external thickness measurement by ultrasonic

testing is required to determine corrosion rate and perform remaining life assessment. As per API 570, recommended maximum inspection interval is 5 years for thickness measurement and external visual inspection.

Figure 13: Tank farm piping coating condition. Isolated blisters and coating damage can be seen.

ULSDL and Gasoline lines have motor operated valves (MOV)upstream of dispenser building. However, this does not meet NFC emergency shut off valve requirement. None of the vertical and horizontal tanks' outlet nozzles have emergency shut-off valves that are remotely controlled from operator building. Individual emergency shut-off valves are required to be located as close as possible to the tank outlets, coupled with actuators (MOV) and remotely controlled from the Operator's Building. Pressure relief valves (thermal case) set to 75 psig and by-pass lines are required for the tank inlet/outlet isolation valves.

Figure 14: Existing non-functional motor operated valve (MOV) on gasoline and ULSDL lines (left and centre). Typical tank inlet & outlet piping nozzle layout (right).

3.4 SECONDARY CONTAINMENT AREA

A granular diked system with a synthetic geomembrane was observed at the Arviat Tank Farm facility. As per the existing drawings, 60 mil (1.5mm) thick HDPE liner were installed when facility had been built in 1994.

In certain high traffic areas, the compacted sand had eroded and exposed the geomembranes that covers the HDPE liner. No specific damage on the HDPE liner was detected.

NFC paragraph 4.3.7.2 requires the liner to provide a permeability of not more than 10^{-6} cm/s to flammable liquids or combustible liquids (ULSDL and Gasoline) contained in the storage tanks. In addition, NFC requires secondary containment liners to be independently evaluated and to comply

with CAN/ULC-S668 , “Liner Used For Secondary Containment of Aboveground Flammable and Combustible Liquid Tanks.” There is no data available for the existing liner to verify conformance to NFC. Permeability of not more than 10^{-6} cm/s allows retention of hydrocarbon contents for a period sufficient for clean-up.

Figure 15: Exposed geomembrane that covers HDPE liner.

There are two light posts around the tank farm that were functioning and these provide ample area lighting. However, replacing the existing light fixtures with LED fixtures can be considered as non-essential upgrade.

The containment volume of the current facility meets NFC paragraph 4.3.7.3. even with the future addition of 2,559 cu.m capacity ULSDL tank. However, the original tank layout for future tanks and spacing does not meet minimum spacing requirement of current edition of the NFC. Therefore, proposed location for the new 2,559 cu.m ULSDL tank has to be the current location of horizontal tanks.

Existing dike height measured as low as 0.9m versus the design height of 1.5m. It is recommended to reinstate original dike height to 1.5m in order to maintain the required secondary containment volume.

It is recommended to verify secondary containment volume by as-built dimensions using survey data. Secondary containment volume calculation should deduct tanks volumes up to the dike height. Further, It is good engineering practice to have a minimum of 150 mm freeboard (vertical distance between the maximum liquid level and top of the dike) to compensate rainwater or run off that may be accumulated in the containment area.

Figure 16: Berm penetration single wall resupply pipeline.

Current dike penetrations are single wall pipe with HDPE pipe boot. Environmental Canada enforces CCME guidelines and interprets berm penetrations as underground piping. Double-wall perma-pipe with leak detection system (vacuum gauge or leak detecting cable) is required for all dike penetrations and underground piping.

3.5 ULSDL/GASOLINE DISPENSER BUILDING

The existing ULSDL/Gasoline dispenser building was in fair to poor condition. Both the building and mechanical dispensing equipment needs replacement or refurbishment to bring them to a fully operable condition.

Figure 17: ULSLD/Gasoline Dispenser Building.

The dispenser building contains ¾ HP ULSDL and Gasoline light vehicle pumps, and a 3 HP ULSDL truck loading pump. The 3 HP ULSDL pump can also transfer product from Arviat Tank Farm to Eskimo Point's tank facility or QEC's power plant when flow direction reversed.

MID: COM 8000-3XP electronic register mounted on Neptune Type 4 size 1 ½" flowmeters c/w strainer and air release vent are provided for the Gasoline and ULSDL light vehicle dispensing system. Accu-Flo calibration sticker shows calibration date. The Arviat Tank Farm facility has a functional remote dispenser island for light vehicles; therefore flowmeters inside the dispenser building are not frequently used.

Solenoid valves for emergency shut off are not operational. None of the pumps have E-stop for shutdown during emergency. It is recommended placing the emergency stop push button on the outside wall of the building.

Figure 18: Gasoline and ULSDL meters inside the dispenser building (left). ¾ HP Gasoline light vehicle pump (right).

There are no drip pans provided for the pumps to contain leakage.

A Neptune type 4 size 3" flowmeter c/w strainer and air release vent is provided for the ULSDL truck loading dispensing system. Auto-stop valve was not functioning.

ULSDL truck loading hose reel assembly contains ½ HP motor and -67°F rated arctic translite® fuel hose. Hose reel assembly was functioning normal during site visit.

Polygas gas detection system, building heating and ventilation system, lighting exterior and interior needs complete replacement.

Existing building roof is flat. It should be sloped and insulated to prevent water leakage and heat loss.

Replacement of existing door complete with new heavy duty spring bumper chain is required.

Figure 19: ULSDL truck loading pump (left) with hose reel assembly (right).

The existing carbon steel ULSDL relaxation chamber is severely rusted and requires replacement with stainless steel complete with top mounted air eliminator.

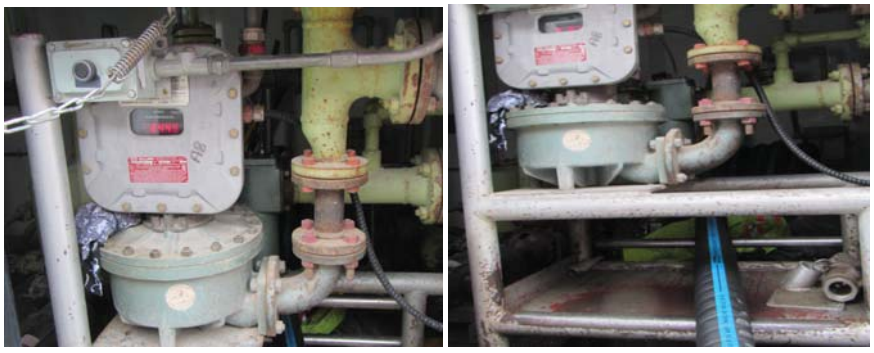


Figure 20: Neptune Type 4 size 3" flowmeter for ULSDL truck loading dispensing system.

Replace dispenser building inlet supply piping including gate valves, pump suction strainers and flexible hoses. Existing thermal relief valves are inline type poppet valves and considered not reliable for outdoor applications. Replace poppet valves with spring loaded vertical upright thermal relief valves set to 75 psig discharge pressure.

Figure 21: ULSDL relaxation chamber (left) and dispenser building inlet piping (right).

Concrete side walk (1.27m wide) in front of dispenser building is acceptable condition and does not require replacement. Existing bollards in front of dispenser building are in satisfactory condition.

3.6 REMOTE DISPENSER ISLAND

The remote dispenser island was functioning at the time of the site visit. Most of the Gasoline and ULSDL supply piping is underground and does not comply with CCME section 5.4.1. Secondary containment is required for all underground piping less than 75mm outside diameter.

Dispenser cabinets are fairly new and were functioning properly. The raised concrete island and concrete apron (3m wide) on each side are in satisfactory condition and do not require replacement. Bollards around the island are in satisfactory condition.

Containment sumps with leak detection systems for monitoring of spills or leaks are required under the dispensing cabinets.

Figure 22: Remote Dispenser Island and dispenser building (left). Gasoline and ULSDL dispenser cabinets located in the remote dispenser island (right).

3.7 OPERATOR SHELTER BUILDING

The operator building has the following deficiencies. Therefore, recommended to be replaced or refurbished to address these and to incorporate new upgrades.

The operator building requires replacement of building lighting (interior and exterior fixtures) and heating system.

Existing building roof is flat, and should be sloped and insulated to prevent water leakage and heat loss.

Due to addition of Motor Operated Valves (MOV) and remote dispenser island leak detection sensor, new control panels c/w pilot lights and an overfill alarm panel are required. Furthermore, polygas control panels are required to be replaced with the new ones.

It is also recommended to replace existing door complete with new heavy duty spring bumper chain

Figure 23: Existing Operator's building.

4. PRELIMINARY FACILITY PLANNING

4.1 REQUIRED FACILITY ELEMENTS

4.1.1 Design Standards

The design and construction of the proposed facility will be in accordance with applicable Codes, revised PPD standard drawings & Design Rationale and applicable API guidelines.

4.1.2 Resupply System

The water level at the current location of shore manifold is too shallow for fuel tankers to anchor. This results in higher fuel spill risk into water and decrease fuel transfer efficiency during resupply operation. Further, resupply pipeline runs through the community which poses a health and safety risk. The new aboveground resupply pipeline will be a comparatively short distance with a more direct routing from the shore manifold to the tank farm.

Location of the new resupply manifold and spill basin is located approximately 950m east of current resupply manifold with a 35m setback from the high level water mark. Gasoline and ULSD piping connection size will remain as NPS 4 and NPS 6 respectively. In order to allow anchoring of fuel tankers, two mooring bollards on piles are required at the shore manifold for safe resupply operation. A winch should be provided at the sea hose connection to facilitate pulling the fuel tanker floater hose up to the manifold connections. Standard signage and a fire extinguisher with sea hose valve cover should be provided as a part of spill basin.

Figure 24: Proposed double-wall, underground resupply pipeline routing for Option 1 and Option 2. Leaving resupply manifold in its current location is not considered.

Resupply manifold should be equipped with permanent lighting fixture to meet Transport Canada requirements.

Option 1 and Option 2 (existing location of tank farm remains same) will require approximately 2,100m long underground, double wall pipeline complete with external coating and cathodic protection, which meet the requirements of SOR – 2008-197. Proper pipeline markers and signage will have to be installed along pipeline route including the three road crossings. Longer underground resupply pipeline is necessary to avoid the town if the current location of Arviat Tank Farm remains as is.

For Option 3 aboveground resupply pipeline is 40m, provided the Arviat Tank Farm facility relocated to the proposed new location. There is no foreseen road or snowmobile/ATV crossing for the Option 3.

The Hamlet and PPD representatives are in agreement with implementation of Option 3 - New tank farm location and resupply piping route.

After the new resupply pipeline and marine manifold are commissioned, the existing resupply pipeline to be purged, decommissioned and demolished as per the SOR-2008-197. Alternatively, this can be executed as a separate project.

4.1.3 Tankage and Tank Farm Piping

All new field erected vertical tanks are required to be designed and fabricated in accordance with API 650 latest edition, PPD standards and regulatory requirements. All electrical components must in compliance with CSA Electrical Code.

New storage tanks are required to provide the necessary bulk fuel storage for 2040-2041(20 years after commissioning of expansion). Existing horizontal tanks are to be removed for Option 1 due to limited spacing. Option 2 can accommodate horizontal tanks, however, addition of MOV on the horizontal tanks outlet manifold is required for NFC Code compliance. Option 3 does not need horizontal tanks for fuel bulk storage purpose. Two of the horizontal tanks can be relocated as a slop tanks for emergency or operation & maintenance tasks. These horizontal tanks are not to be permanently connected with piping.

All the vertical tank handrails must be extended around the full roof perimeter in order to comply with WSCC.

Emergency venting requirements are satisfied if the tanks are equipped with a weak roof-to-shell attachment (frangible joint) in accordance with API 650 paragraph 5.10.2.6, or if the tanks are equipped with pressure relief devices meeting the requirements specified in API 2000 for emergency venting. Since there is no design information or data sheet available for the vertical tanks, it is not possible to verify if the frangible joints rules are met and if they are equipped with frangible roofs. Therefore, a new roof manhole designed for emergency venting (fire case) shall be provided for existing vertical tanks.

None of the existing vertical and horizontal tanks have a high level alarm or overfill protection system. An automatic tank gauging system (ATGS) is required for all vertical tanks which meets API 2350 requirements to prevent spill during resupply operation.

Above mentioned items are to be addressed through repair or replacement by following PDD standards and current Code requirements.

The existing stairs, stiles and platforms require handrails to be placed on the second side to meet WSCC and PPD requirements.

It's recommended that an API 653 inspection be completed on vertical tanks (tank #10, 12, 23 and 24) during construction stage or earlier to verify their integrity, corrosion rate and next inspection interval.

API supports the use of a release prevention system (RPS) to maintain the integrity of the tank bottoms and thus protect the environment. It is recommended for Option 3 to have under tank leak detection system complete with inspection wells (inspection chamber) and drain pipes in accordance with API 650 Annex I. Tank leak detection systems and leak testing are intended to identify, quantify, and/or locate a tank bottom integrity failure that is not detectable visually or through inventory reconciliation.

All yard piping including fittings, valving and pressure relief valves require replacement or refurbishment prior to reuse. The existing pipe supports can be used where appropriate for Option 1 and Option 2. New pipe supports are required for all vertical tanks.

External painting on vertical tanks and yard piping are not satisfactory. Tanks shell walls partially rusted and pitted due to insufficient external paint coverage. New surface preparation, primer and top coat are required for all vertical tanks.

Figure 25: Tank #10 (left), Tank #11 (centre) and Tank # 12 (right) exterior shell wall paint deficiencies.

4.1.4 Secondary Containment

The containment volume of the facility, with the additional tankage and future expansion, shall meet the NFC requirement of: the volume of the largest tank plus 10%, or the volume of the largest tank plus 10% of the aggregated volume of all other tanks, whichever is greater.

Volume of tank foundations and tanks up to dike height should be deducted when determining required secondary containment volume. Deducting tank farm pipe volume inside the containment area is not required.

Existing tank farm secondary containment meets NFC for Option 1. Option 2 needs dike expansion to the south east about 30m for the addition of new vertical tanks. During detail engineering the volume calculation will be verified by using survey data for dike height, length, and slope. The dike dimensions for Option 3 will satisfy NFC for the tankage requirement.

Existing measured dike wall height varies between 0.9m to 1.1m which is less than original design of 1.5m. It is necessity to bring dike height to 1.5m which will allow 150mm freeboard to compensate for rainwater or run off that may accumulate.

The impervious liner, 60 mil thick artic grade HDPE, for all options shall meet CAN/ULC-S668 , “Liner Used For Secondary Containment of Aboveground Flammable and Combustible Liquid Tanks.” Further, NFC paragraph 4.3.7.2 requires liner to provide a permeability of not more than 10-6 cm/s to the flammable liquids or combustible liquids (ULSDL and gasoline) contained in the storage tanks. The liner product data sheet shall state Fire Code compliance.

Existing liner replacement is not required for Option 1 and Option 2. Although damage of the existing liner was not observed, exposed and damaged HDPE liner can be repaired by patching using seaming or bonding procedure.

When Authority Having Jurisdiction (AHJ) requires existing liner compliance with CAN/ULC-S668 (Active since 2012), destructive testing is required to asses permeability of liner.

It is recommended to replace the fence around the tank farm facility.

4.1.5 ULSDL/Gasoline Dispenser Building

A complete new dispenser building is recommended for all the options with the dispensing components for ULSDL and Gasoline systems. The delivery system shall be capable of providing ULSDL to public vehicles and fuel delivery trucks as well as Gasoline to public vehicles. The dispenser building with sloped roof is to follow the PPD standards which require a gas controlled ventilation system. The public vehicle pumps are to provide fuel to the remote dispensing island cabinets and are to include the necessary valves and lockout to immediately stop fuel delivery in emergency situations, including emergency kill switch. ULSDL bulk fuel dispensing hose shall be provided with a hose reel. Stainless steel relaxation chamber is required for ULSDL bulk fuel dispensing in order to dissipate static electricity prior to truck bottom loading operation.

4.1.6 Remote Dispenser Island

The existing remote dispenser island and concrete apron is to be reused for Option 1 and Option 2. Option 3 requires a new remote dispenser island and concrete apron.

The existing cabinets were recently replaced and do can be re-used. Underground supply piping is to be replaced with double wall pipe and extended into the sumps with leak detection sensors for monitoring of leaks.

4.1.7 Operator Shelter Building

A new Operator Shelter Building as per PPD standards and designed to comply with NBC is recommended for all three options. PROJECTED FUEL VOLUMES

4.1.8 General

Following summary includes fuel projection using two separate methods.

- Method A fuel requirements based on a 3% per year growth factor.
- Method B is the projection included in the RFP that was provided by PPD (yearly growth of 2.19% for ULSLD and 2.01% for gasoline)

Both forecasts include a 15% factor of safety as per industry and PPD Standards. Secondly, both forecasts are based on a planning horizon of 20 years assuming completion of construction in 2020. This information will be used in the following sections, in which we provide options for planning the facility into the 20 year demand scenario by 2040-2041.

Based on Method A, the community demand will exceed capacity for ULSDL in 2020-2021 and gasoline in 2025-2026. This is more stringent than Method B where demand will exceed capacity for ULSDL in 2022-2023 and gasoline in 2031-2032.

4.1.9 Growth Rates

The Hamlet of Arviat has seen a 14.6% increase in population from 2011 based on Canada 2016 Census where population was increased from 2,318 to 2,657 people.

Arviat is within Kivalliq Region of Nunavut, Canada and one of the fastest growing communities in Nunavut and projected to have 2nd highest population in Nunavut by 2024 after Iqaluit, ahead of Rankin Inlet the centre of government of Kivalliq.

In both fuel projection methods, ULSLD requires the largest expansion.

It is recommended that Method B be utilized.

Option 3 will satisfy Method A and Method B fuel storage requirements in 20 years.

4.1.10 Storage Volumes

A summary of fuel consumption and volume requirements by Method B over 20 years (until 2040-2041) are as follows;

Fuel Type	2025-2026 (Year 5) (L)	2030-2031 (Year 10) (L)	2035-2036 (Year 15) (L)	2040-2041 (Year 20) (L)
ULSDL	6,047,564	7,010,784	8,127,421	9,421,908
Gasoline	1,659,743	1,924,097	2,230,556	2,585,825

Table 11: Table of fuel consumption demand utilized by Method B projection.

4.2 PLANNING AND CONSIDERATIONS

4.2.1 General

Three (3) options presented in PPD's Technical Needs Assessment Study are re-assessed in this Study. It is concluded that only Option 3 will satisfy Method A and Method B fuel storage requirements in 20 years with proposed tank layouts and tank capacities.

A minimum of two tanks for each fuel type is recommended for redundancy and to assist periodic internal inspection and maintenance. Further, in event of a tank failure, a secondary tank in parallel provides safeguard against losing entire fuel capacity at the facility. However, it is not always economical to provide two tanks. Instead, existing horizontal tanks can function as a slop tank when required.

4.2.2 Tank Top Elevations

In general, it is ideal to arrange tankage in such a way that the top elevations of all tanks are at the same level. This will eliminate the possibility of overflow and spill on lower tanks when equalizing levels on connected tanks.

4.2.3 Tank Locations

In general, it is preferred identical products are stored in adjacent tanks. This also minimizes the amount and cost of the connecting piping required. Relocating existing tanks to address this preference is not warranted for Option 1 and Option 2. Option 3 will meet this preference.

4.2.4 Tank Clearances

The National Fire Code (NFC) requires every combination of 2 aboveground storage tanks to be separated by at least 0.25 times the sum of their diameters and at a minimum 1.0m apart.

No part of a secondary containment wall shall be less than 1.5 m from a storage tank shell as per NFC paragraph 4.3.7.4.

Distance between Tank #23 and Tank # 24 was measured as 4.64m from wall to wall. It does not meet NFC spacing between storage tanks requirement. Tank #23 and Tank# 24 are 10.7m diameter. Per NFC paragraph 4.3.2.2, minimum of 0.25 times the sum of tanks diameters is 5.35m required between tanks. This is identified as a fire hazard and needs to be addressed with Option 1 and Option 2.

4.2.5 Secondary Containment

Existing measured dike wall height varies between 0.9m to 1.1m which is less than original design of 1.5m. It is recommended to bring dike height to 1.5m which will allow 150mm freeboard to compensate rainwater or run off that may accumulate in the berm area.

By definition, freeboard means the vertical distance between the maximum liquid level and the top of the dike.

Where the average interior height of the walls of the diked area exceeds 1.8m (6 ft), provisions shall be made for normal access; necessary emergency access to tanks, valves, and other equipment; and egress from the diked enclosure. Therefore, it is not recommended that dike height exceed 1.8m.

Earthen walls 0.9 m or more in height shall have a flat section at the top not less than 0.6m wide and shall have a slope that is consistent with the angle of repose of the material of which the wall is constructed.

All options presented satisfies NFC requirement of: the volume of the largest tank plus 10%, or the volume of the largest tank plus 10% of the aggregated volume of all other tanks, whichever is greater.

Aboveground storage tanks that store flammable or combustible liquids are to be located in conformance with NFC Table 4.3.2.1

Maximum Tank Capacity, L	Minimum Distance to a Property Line or to a Building on the Same Property, m
250 000	3
500 000	4.5
2 500 000	9
5 000 000	12

Table 12: NFC Table 4.3.2.1

5. TANK FARM FACILITY OPTIONS

5.1 OPTION #1

This option offers one new vertical ULSDL and one new gasoline storage tank. An expansion of the existing secondary containment and berm area is not required. Existing dike height needs to be increased to 1.5m from 0.9m in order to provide sufficient secondary containment and meet original design.

Spacing between Tank #23 and Tank # 24 does not meet NFC. Tank# 24 needs to be relocated approximately 1 m to the east. New earth foundation complete with crushed stone ringwall is required for Tank #24.

No specific damage on existing HDPE liner was observed. Therefore complete replacement of the existing HDPE liner is not required. A HDPE liner extension is required in order to increase dike height to original design level. A HDPE liner requires to comply with CAN/ULC-S668 , “Liner Used For Secondary Containment of Aboveground Flammable and Combustible Liquid Tanks.

Tank #10, #12, #23 and #24 will need API 653 internal inspection in order to deem suitable for reuse next 5-10 years. Periodic internal inspection is required for existing vertical tanks in accordance with API 653. All existing vertical tanks require refurbishment such as roof handrail extension, additional roof manhole for emergency venting, overfill protection system, and complete repainting.

New tank yard piping would need to be installed on new and existing vertical tank outlets complete with MOV and thermal by pass lines. Single wall buried piping (berm penetrations and supply lines to remote dispenser island) to be replaced with double-wall pipe (perma-pipe).

Existing 920m long resupply pipeline will be demolished and new 2,100m long underground, double wall resupply pipeline complete with external coating and cathodic protection that meets requirement of SOR – 2008-197 will be provided. The resupply pipeline will run outside the residential area.

New ULSDL/Gasoline dispenser and Operator Shelter Buildings will be replaced. The buildings will have a sloped roof and meet the PPD standards and designed to NBC.

5.1.1 ULSDL Tanks

Original Arviat plot plan (Drawing #G4) and existing secondary containment area have allocated locations for future ULSDL (18.5m Dia, 2559 m^3 capacity) and Gasoline (9.14m Dia, 643 m^3 capacity) storage tanks. However, original tank layout for future tanks and spacing does not meet NFC spacing requirement effective today. Proposed location for new ULSDL (18.5m Dia, 2559 m^3 capacity) tank is where currently horizontal tanks located. Therefore, horizontal tanks need to be removed in order to accommodate ULSDL tank.

The forecasted fuel storage requirement for ULSDL (starting from 2020-2021) in 20 years is 7,738,221L including 15% safety margin utilizing Method A and 9,421,908L utilizing Method B.

Additional 2,559,000 L capacity tank will increases total ULSLD storage capacity to 7,086,929L. (Without considering capacity offset by early and late resupply). However, this will not be sufficient to meet demand in 20 years.

5.1.2 Gasoline Tanks

New 370 m^3 capacity gasoline storage tank will be field erected to the area allocated to the ULSDL tank in the original Arviat Tank Farm layout.

The forecasted fuel storage requirement for gasoline (starting from 2020-2021) in 20 years is 2,031,121L including 15% safety margin using Method A, and 2,585,825L using Method B.

Additional 370,000 L capacity tank will increases total gasoline storage capacity to 1,715,363L. (Without considering capacity offset by earl and late resupply). However, this will not be sufficient to meet demand in 20 years.

5.1.3 Future Expansion

Option 1 does not meet demand in 20 years. The secondary containment area cannot accommodate larger size capacity tanks.

5.2 OPTION #2

This option requires an expansion of the existing secondary containment area 30m south east. This would provide spacing and secondary containment for larger capacity storage tanks presented in Option 1. In addition, existing horizontal tanks do not need to be removed. However, community communication site located south of tank farm needs to be relocated.

Two new vertical tanks would need to be constructed; one new ULSLD (20.85m Dia, 3333 m^3 capacity) and one new gasoline (13.72m Dia, 1368 m^3 capacity).

Likewise Option 1, existing dike height needs to be increased to 1.5m from 0.9m and Tank# 24 needs to be relocated approximately 1 m to the east. New earth foundation complete with crushed stone ringwall is required for Tank #24.

No specific damage on existing HDPE liner was observed. Therefore complete replacement of the existing HDPE liner is not required. HDPE liner extension is required in order to increase dike height to original design level and secondary containment expansion to south east.

Tank #10, #12, #23 and #24 will need API 653 internal inspection in order to deem suitable for reuse next 5-10 years. Periodic internal inspection is required for existing vertical tanks in accordance with API 653. All existing vertical tanks require refurbishment such as roof handrail extension, additional roof manhole for emergency venting, overfill protection system, and complete repainting.

New tank yard piping would need to be installed on new and existing vertical tank outlets complete with MOVs and thermal by pass lines. Single wall buried piping (berm penetrations and supply lines to remote dispenser island) will be replaced with double-wall pipe (perma-pipe).

Existing 920m long resupply pipeline will be demolished and new 2,100m long underground, double wall resupply pipeline complete with external coating and cathodic protection that meets requirement of SOR – 2008-197 will be provided. New resupply pipeline will run outside the residential area.

New dispenser and operator shelter building will be replaced. The buildings will have a sloped roof and follow the PPD standards and designed to NBC.

5.2.1 ULSDL Tanks

The forecasted fuel storage requirement for ULSDL (starting from 2020-2021) in 20 years is 7,738,221L including 15% safety margin with utilizing Method A and 9,421,908L with utilizing Method B.

Additional 3,333,000 L capacity tank will increases total ULSLD storage capacity to 7,860,929L. (Without considering capacity offset by earl and late resupply). However, this will not be sufficient to meet demand in 20 years. Additional 1,600,000L capacity ULSDL tank is required to meet forecasted fuel storage requirements with Method B.

5.2.2 Gasoline Tanks

New 1368 m^3 capacity gasoline storage tank will be field erected to the area allocated to the ULSDL tank in the original Arviat Tank Farm layout. In addition, the forecasted fuel storage requirement for Gasoline (starting from 2020-2021) in 20 years is 2,031,121L including 15% safety margin with utilizing Method A and 2,585,825L with Method B.

Additional 1,368,000 L capacity tank will increases total gasoline storage capacity to 2,713,363L. (Without considering capacity offset by earl and late resupply). This will be sufficient to meet demand in 20 years.

5.2.3 Future Expansion

The secondary containment area accommodates space for 3,333 m^3 and 643m^3 capacity future ULSDL and gasoline storage tanks.

5.3 OPTION #3

Option 3 proposes a new tank farm east of Arviat. Location of the new tank farm is shown in Appendix F. Location will be east of 3rd Ave and south of 8th Street; Longitude -94.045230, Latitude 61.107772. This location is different than what was suggested in PPD's Needs Assessment Study.

Option 3 will satisfy ULSDL and gasoline demand in 20 years for both Method A and Method B fuel capacity projection.

Location of the new tank farm will be decided during detail engineering after geotechnical study. 200m long new access road is required from 3rd Ave to the cemetery.

Four vertical tanks would to be constructed; three ULSLD (20.85m Dia, 3333 m^3 capacity) and one new gasoline (20.85m Dia, 3333 m^3 capacity).

Decommission existing 920m long resupply pipeline and Arviat Tank Farm Facility once new resupply and tank farm facility is in operational. No tie-ins to the existing piping or brownfield construction are required.

40 meter long aboveground single wall resupply pipeline from the shore manifold to the Arviat Tank Farm facility property line will be required. Option 3 eliminates direct resupply pipeline connection to the Qulliq Energy Corporation and Eskimo Point lumber storage tanks.

New dispenser and operator shelter building will be required with sloped roof designed in accordance with NBC and PPD standards.

5.3.1 ULSDL Tanks

The forecasted fuel storage requirement for ULSDL (starting from 2020-2021) in 20 years is 7,738,221L including 15% safety margin with utilizing Method A and 9,421,908L with utilizing Method B.

The three ULSDL vertical tanks with individual capacity of 3,333,000L will provide total 9,999,000L storage capacity which will meet and exceed forecasted fuel storage requirements in 20 years.

The vertical tanks complete with appurtenances will be designed and field erected to latest revision of API 650. Overfill protection will be provided.

5.3.2 Gasoline Tanks

The forecasted fuel storage requirement for gasoline (starting from 2020-2021) in 20 years is 2,031,121L including 15% safety margin with utilizing Method A and 2,585,825L with utilizing Method B.

The gasoline vertical tank with capacity of 3,333,000L will meet and exceed forecasted fuel storage requirements in 20 years.

The gasoline vertical tank complete with appurtenances will be designed and field erected to latest revision of API 650. Overfill protection will be provided.

5.3.3 Future Expansion

Option 3 footprint accommodates space for future 3,333 m3 capacity ULSDL and gasoline storage tanks.

6. CONCLUSIONS

6.1 GENERAL DISCUSSION

The most important factors, which lead this work to proceed, are:

- Ensuring the Arviat Tank Farm facility meets GN, regulatory and Code requirements
- Providing sufficient capacity to meet the requirements of the community
- Providing the optimum life cycle cost
- Provide flexibility for facility operations and maintenance, in current and future years
- Provide ideal location for new marine resupply manifold and spill basin
- Provide resupply pipeline that is routed outside the residential area.

Option 1 meets code requirements if only Tank #23 and Tank# 24 are moved to meet NFC minimum spacing requirement. Tank lifting and jacking is not an easy task and requires professional engineering evaluation prior to actual work performed. Option 1 does not provide sufficient capacity to meet projected 20 year fuel demand for the community. In addition, the 2,100m long underground double wall resupply pipeline will extend resupply time etc.

Option 2, like Option 1, meet code requirements if only Tank # 23 and Tank# 24 are moved to meet NFC minimum spacing requirement. The 2,100m long underground double wall resupply pipeline will extend resupply time etc. Unlike Option 1, Option 2 provides sufficient capacity to meet projected 20 year fuel demand for the community when Method A used. Option 2 will not satisfy ULSDL demand in 20 years when Method B used for fuel projection. Additional 1,600,000L capacity ULSDL tank is required to meet forecasted fuel storage requirements when Method B used.

Option 3, new tank farm, meets code and GN requirements. Option 3 satisfies ULSDL and gasoline demand in 20 years when Method A or Method B used. Further, the short distance aboveground single wall resupply pipeline will shorten resupply times and simplify operation.

All options require decommissioning and demolition of the existing resupply pipeline upon commissioning of new resupply pipeline. In addition, Option 3 requires decommissioning and demolition of existing Arviat Tank Farm Facility.

Existing containment area, lined with 60mil(1.524mm) thick HDPE liner. On occasion, rodent (sik sik) damage has limited the life of containment area. That damage depends largely on whether the granular material type in the berm covering is largely sand or if it is largely gravel. Rodent does not burrow in the gravel materials in the same manner as in the sandy materials. There were no signs of damage to the berm or liner areas noted during the site visit.

6.2 TANK COSTS

Below graphs are excerpt from WP's cost data base for A/G Storage Tank pricing.

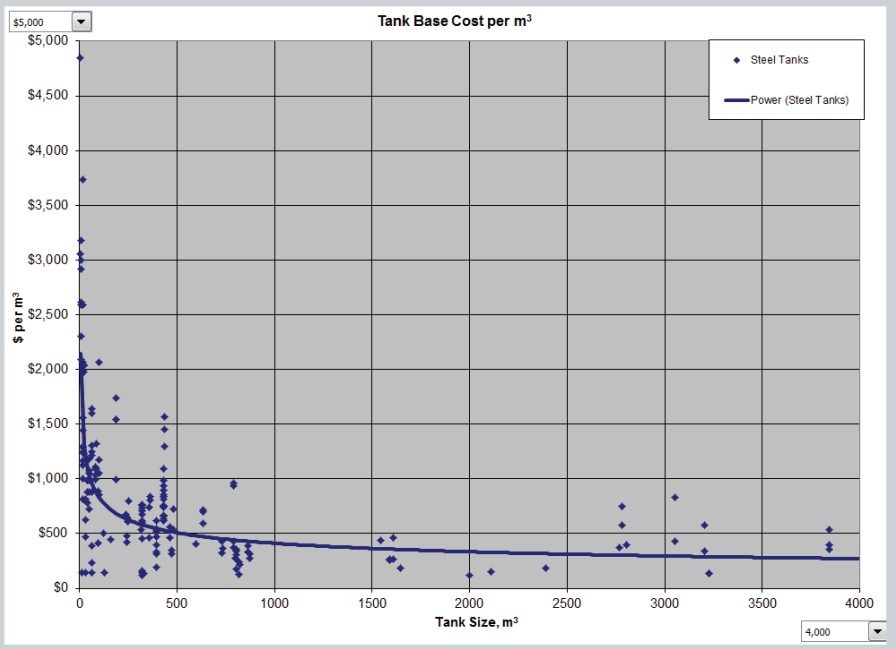


Table 13: Tank base cost pricing per cu.m

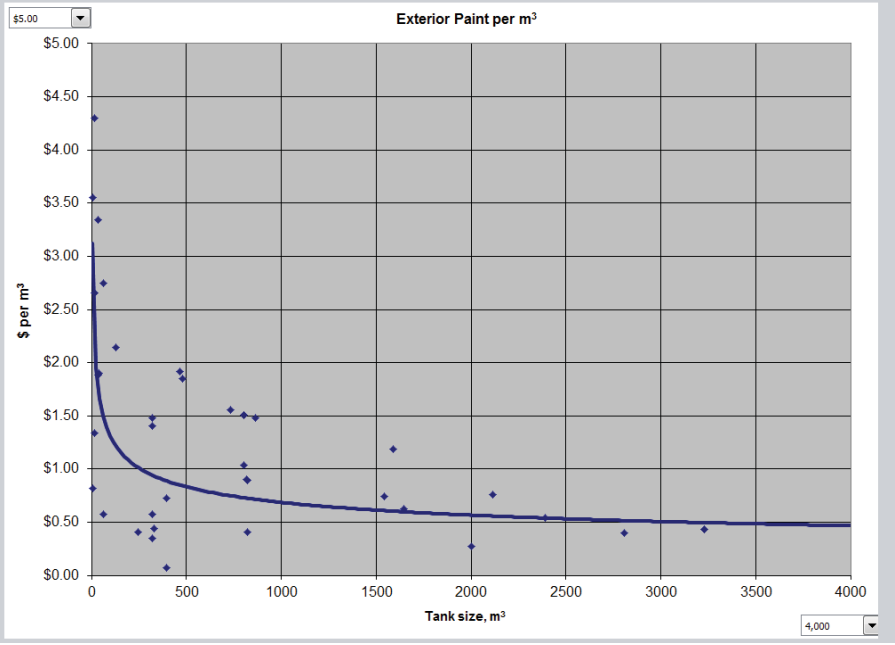


Table 14: Tank exterior coating cost pricing per cu.m

6.3 COST ESTIMATE

A detailed Class D cost estimate prepared by Hanscomb is provided in Appendix C for all 3 options. Taxes are not included.

6.4 RECOMMENDATIONS

WorleyParsons is in agreement with PPD's Needs Assessment Study recommendation and considers Option 3 to be the most desirable option and strongly recommends it for further detailed design.

Alternatively, Option 2 can be considered if Option 3 cost is not feasible. However, there are numerous constraints present in Option 2 that needs to be addressed during detail design and construction phase.

Option 1 is not recommended as it does not provide sufficient capacity to meet projected fuel demand for the community in 20 years.

In Section 6.5, we list the implementation steps that we believe are most practical for this project. It is possible that the successful consultant and contractor might propose a different schedule than what is suggested.

6.5 POSSIBLE PROJECT SCHEDULE

Activity	Duration	Dates
Detail Engineering Design and Geotechnical Study	4 months	April 2018- July 2018
Construction Tender - Call	1 Month	September 2018
Tender Review & Award	1 Month	November 2018
Material and Building Procurement	3 Months	January to May 2019
Site Mobilization	1 month	June 2019
Earthwork	2 Months	June - July 2019
Tank Erection	3 Months	July- September 2019
New Resupply Pipeline	1 to 2 years	June 2019 – August 2020
Substantial Completion	1 week	September, 2020
Painting	1 month	August 2021
Warranty Period Ends	12 months	October 2022

Figure 26: Proposed project schedule

Based on Method B projections, the community demand would exceed storage capacity for ULSDL as early as 2020-2021 approximately 2 years from the issue of this study.

The long lead time to source low temperature steel (ASTM A516 Gr 60/70N) or equivalent tank steel, resupply pipeline and new buildings make the construction award date a priority.

The schedule allows for a construction tender award date of March 2018. Similarly, the engineering design date is critical and should be awarded early 2018.

The presented schedule is highly dependent on availably of contractor and manpower.

A high importance should be given to minimize or eliminate interruption of fuel dispensing to the Community.

APPENDIX A- FUEL PROJECTIONS

Arviat HISTORICAL FUEL SALES AND PROJECTIONS: EXISTING CAPACITY ANALYSIS

To be manually populated — Denotes year at which demand exceeds capacity

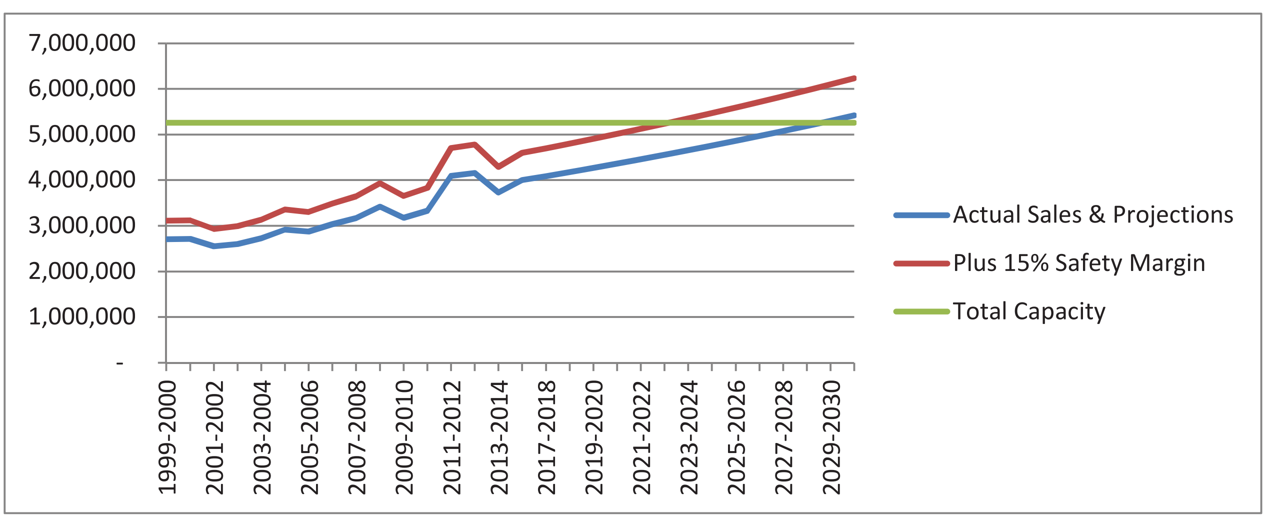
ULTRA LOW SULPHUR DIESEL

Year	Actual Sales	Plus 15%
1999-2000	2,706,550	3,112,533
2000-2001	2,709,627	3,116,071
2001-2002	2,549,014	2,931,366
2002-2003	2,602,728	2,993,137
2003-2004	2,726,790	3,135,809
2004-2005	2,917,558	3,355,192
2005-2006	2,873,172	3,304,148
2006-2007	3,031,083	3,485,745
2007-2008	3,170,993	3,646,642
2008-2009	3,419,334	3,932,234
2009-2010	3,177,527	3,654,156
2010-2011	3,327,601	3,826,741
2011-2012	4,091,033	4,704,688
2012-2013	4,157,221	4,780,804
2013-2014	3,729,153	4,288,526
2014-2015	4,070,371	4,680,927
2015-2016	3,913,005	4,499,956

Historical Compounded Annual Growth Rate
2.19%

Year	Projected Sales	Plus 15%	Current Capacity	
2016-2017	3,998,782	4,598,599	5,258,009	5,258,009
2017-2018	4,086,439	4,699,405	5,258,009	5,258,009
2018-2019	4,176,018	4,802,421	5,258,009	5,258,009
2019-2020	4,267,560	4,907,694	5,258,009	5,258,009
2020-2021	4,361,109	5,015,276	5,258,009	5,258,009
2021-2022	4,456,709	5,125,215	5,258,009	5,258,009
2022-2023	4,554,405	5,237,565	5,258,009	5,258,009
2023-2024	4,654,242	5,352,378	5,258,009	5,258,009
2024-2025	4,756,267	5,469,707	5,258,009	5,258,009
2025-2026	4,860,529	5,589,608	5,258,009	5,258,009
2026-2027	4,967,077	5,712,138	5,258,009	5,258,009
2027-2028	5,075,960	5,837,354	5,258,009	5,258,009
2028-2029	5,187,230	5,965,314	5,258,009	5,258,009
2029-2030	5,300,939	6,096,080	5,258,009	5,258,009
2030-2031	5,417,141	6,229,712	5,258,009	5,258,009
2031-2032	5,535,890	6,366,273	5,258,009	5,258,009
2032-2033	5,657,242	6,505,828	5,258,009	5,258,009
2033-2034	5,781,254	6,648,442	5,258,009	5,258,009
2034-2035	5,907,985	6,794,183	5,258,009	5,258,009
2035-2036	6,037,494	6,943,118	5,258,009	5,258,009
2036-2037	6,169,842	7,095,318	5,258,009	5,258,009
2037-2038	6,305,090	7,250,854	5,258,009	5,258,009
2038-2039	6,443,304	7,409,800	5,258,009	5,258,009
2039-2040	6,584,548	7,572,230	5,258,009	5,258,009
2040-2041	6,728,888	7,738,221	5,258,009	5,258,009
2041-2042	6,876,391	7,907,850	5,258,009	5,258,009
2042-2043	7,027,129	8,081,198	5,258,009	5,258,009

Capacity Offset by Early and Late Resupply	730,080

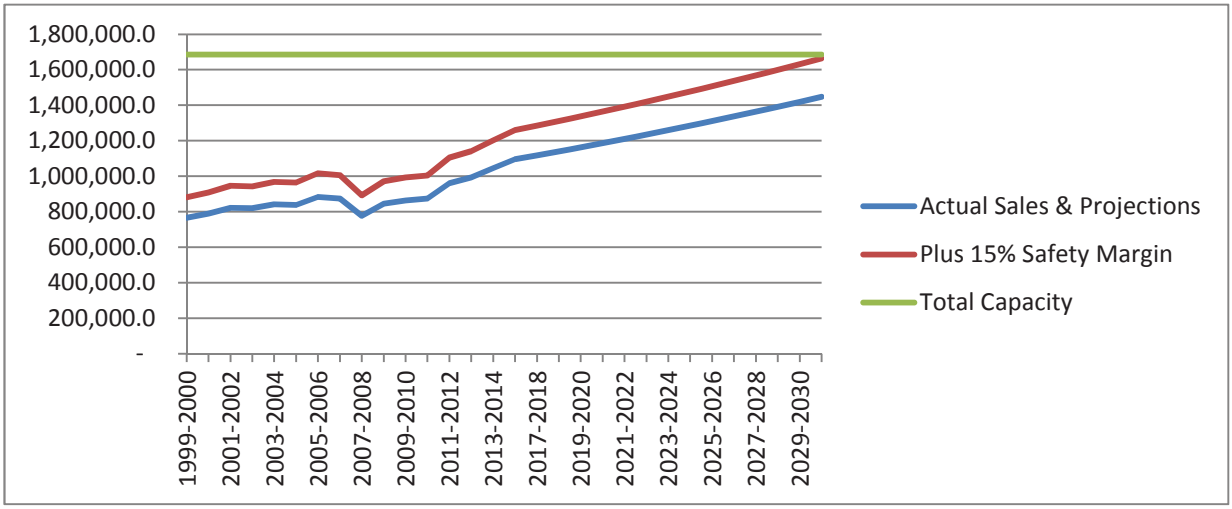


Arviat HISTORICAL FUEL SALES AND PROJECTIONS: EXISTING CAPACITY ANALYSIS

To be manually populated Denotes year at which demand exceeds capacity

GASOLINE							
Year	Actual Sales	Plus 15%	Year	Projected Sales	Plus 15%	Current Capacity	
1999-2000	765,676.0	880,527	2016-2017	1,095,503	1,259,828	1,686,078	1,686,078
2000-2001	789,571.0	908,007	2017-2018	1,117,522	1,285,150	1,686,078	1,686,078
2001-2002	822,168.0	945,493	2018-2019	1,139,984	1,310,982	1,686,078	1,686,078
2002-2003	819,469.0	942,389	2019-2020	1,162,898	1,337,332	1,686,078	1,686,078
2003-2004	841,439.0	967,655	2020-2021	1,186,272	1,364,212	1,686,078	1,686,078
2004-2005	837,702.0	963,357	2021-2022	1,210,116	1,391,633	1,686,078	1,686,078
2005-2006	883,487.0	1,016,010	2022-2023	1,234,439	1,419,605	1,686,078	1,686,078
2006-2007	874,860.0	1,006,089	2023-2024	1,259,251	1,448,138	1,686,078	1,686,078
2007-2008	776,132.0	892,552	2024-2025	1,284,562	1,477,246	1,686,078	1,686,078
2008-2009	844,832.0	971,557	2025-2026	1,310,381	1,506,938	1,686,078	1,686,078
2009-2010	863,916.0	993,503	2026-2027	1,336,719	1,537,227	1,686,078	1,686,078
2010-2011	873,260.0	1,004,249	2027-2028	1,363,587	1,568,125	1,686,078	1,686,078
2011-2012	960,466.0	1,104,536	2028-2029	1,390,995	1,599,645	1,686,078	1,686,078
2012-2013	992,230.0	1,141,065	2029-2030	1,418,954	1,631,797	1,686,078	1,686,078
2013-2014	1,045,620.0	1,202,463	2030-2031	1,447,475	1,664,596	1,686,078	1,686,078
2014-2015	1,028,995.0	1,183,344	2031-2032	1,476,569	1,698,054	1,686,078	1,686,078
2015-2016	1,073,917.0	1,235,005	2032-2033	1,506,248	1,732,185	1,686,078	1,686,078
			2033-2034	1,536,523	1,767,002	1,686,078	1,686,078
Historical Compounded Annual Growth Rate			2034-2035	1,567,407	1,802,518	1,686,078	1,686,078
2.01%			2035-2036	1,598,912	1,838,748	1,686,078	1,686,078
			2036-2037	1,631,050	1,875,707	1,686,078	1,686,078
			2037-2038	1,663,833	1,913,408	1,686,078	1,686,078
			2038-2039	1,697,276	1,951,868	1,686,078	1,686,078
			2039-2040	1,731,391	1,991,100	1,686,078	1,686,078
			2040-2041	1,766,192	2,031,121	1,686,078	1,686,078
			2041-2042	1,801,692	2,071,946	1,686,078	1,686,078
			2042-2043	1,837,906	2,113,592	1,686,078	1,686,078

Capacity Offset by Early and Late Resupply	340,715



Arviat METHOD B: ARVIAT VOLUME PROJECTION (BASED ON PPDs STANDARD 3% GROWTH)

To be manually populated Denotes year at which demand exceeds capacity

ULTRA LOW SULPHUR DIESEL

Year	Actual Sales	Plus 15%
1999-2000	2,706,550	3,112,533
2000-2001	2,709,627	3,116,071
2001-2002	2,549,014	2,931,366
2002-2003	2,602,728	2,993,137
2003-2004	2,726,790	3,135,809
2004-2005	2,917,558	3,355,192
2005-2006	2,873,172	3,304,148
2006-2007	3,031,083	3,485,745
2007-2008	3,170,993	3,646,642
2008-2009	3,419,334	3,932,234
2009-2010	3,117,527	3,585,156
2010-2011	3,327,601	3,826,741
2011-2012	4,091,033	4,704,688
2012-2013	4,157,221	4,780,804
2013-2014	3,729,153	4,288,526
2014-2015	4,070,371	4,680,927
2015-2016	**3,913,005**	4,499,956

Year	Projected Sales	Plus 15%	Current Capacity	
2016-2017	4,030,395	4,634,954	5,258,009	5,258,009
2017-2018	4,151,307	4,774,003	5,258,009	5,258,009
2018-2019	4,275,846	4,917,223	5,258,009	5,258,009
2019-2020	4,404,122	5,064,740	5,258,009	5,258,009
2020-2021	4,536,245	5,216,682	5,258,009	5,258,009
2021-2022	4,672,333	5,373,182	5,258,009	5,258,009
2022-2023	4,812,503	5,534,378	5,258,009	5,258,009
2023-2024	4,956,878	5,700,409	5,258,009	5,258,009
2024-2025	5,105,584	5,871,422	5,258,009	5,258,009
2025-2026	5,258,752	6,047,564	5,258,009	5,258,009
2026-2027	5,416,514	6,228,991	5,258,009	5,258,009
2027-2028	5,579,009	6,415,861	5,258,009	5,258,009
2028-2029	5,746,380	6,608,337	5,258,009	5,258,009
2029-2030	5,918,771	6,806,587	5,258,009	5,258,009
2030-2031	6,096,334	7,010,784	5,258,009	5,258,009
2031-2032	6,279,224	7,221,108	5,258,009	5,258,009
2032-2033	6,467,601	7,437,741	5,258,009	5,258,009
2033-2034	6,661,629	7,660,873		
2034-2035	6,861,478	7,890,700		
2035-2036	7,067,322	8,127,421		
2036-2037	7,279,342	8,371,243		
2037-2038	7,497,722	8,622,381		
2038-2039	7,722,654	8,881,052		
2039-2040	7,954,334	9,147,484		
2040-2041	8,192,964	9,421,908		
2041-2042	8,438,752	9,704,565		
2042-2043	8,691,915	9,995,702		

Historical Compounded Annual Growth Rate (3%)
3.00%

Capacity Offset by Early and Late Resupply: 730,080.00

To be manually populated Denotes year at which demand exceeds capacity

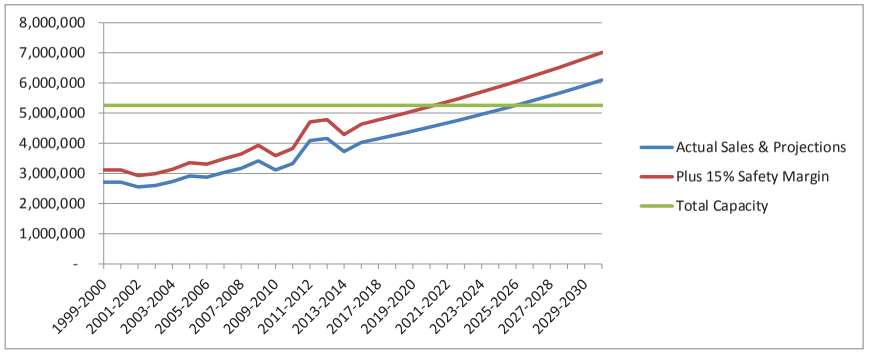
GASOLINE

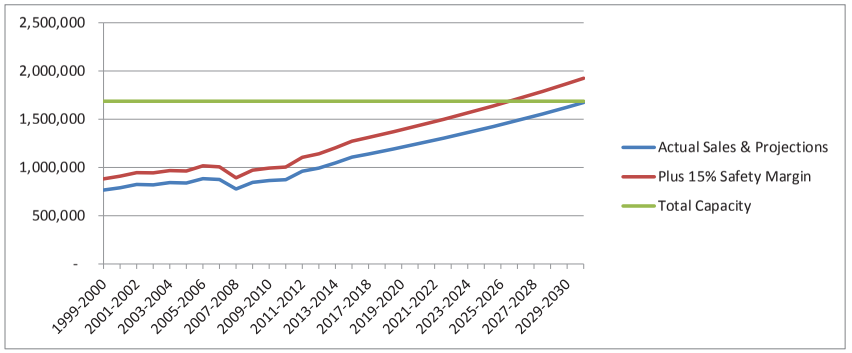
Year	Actual Sales	Plus 15%
1999-2000	765,676	880,527
2000-2001	789,571	908,007
2001-2002	822,168	945,493
2002-2003	819,469	942,389
2003-2004	841,439	967,655
2004-2005	837,702	963,357
2005-2006	883,487	1,016,010
2006-2007	874,860	1,006,089
2007-2008	*776,132*	892,552
2008-2009	*844,832*	971,557
2009-2010	*863,916*	993,503
2010-2011	*873,260*	1,004,249
2011-2012	*960,466*	1,104,536
2012-2013	*992,230*	1,141,065
2013-2014	1,045,620	1,202,463
2014-2015	1,028,995	1,183,344
2015-2016	**1,073,917**	1,235,005

Year	Projected Sales	Plus 15%	Current Capacity	
2016-2017	1,106,135	1,272,055	1,686,078.0	1,686,078
2017-2018	1,139,319	1,310,216	1,686,078	1,686,078
2018-2019	1,173,498	1,349,523	1,686,078	1,686,078
2019-2020	1,208,703	1,390,009	1,686,078	1,686,078
2020-2021	1,244,964	1,431,709	1,686,078	1,686,078
2021-2022	1,282,313	1,474,660	1,686,078	1,686,078
2022-2023	1,320,782	1,518,900	1,686,078	1,686,078
2023-2024	1,360,406	1,564,467	1,686,078	1,686,078
2024-2025	1,401,218	1,611,401	1,686,078	1,686,078
2025-2026	1,443,255	1,659,743	1,686,078	1,686,078
2026-2027	1,486,552	1,709,535	1,686,078	1,686,078
2027-2028	1,531,149	1,760,821	1,686,078	1,686,078
2028-2029	1,577,083	1,813,646	1,686,078	1,686,078
2029-2030	1,624,396	1,868,055	1,686,078	1,686,078
2030-2031	1,673,128	1,924,097	1,686,078	1,686,078
2031-2032	1,723,322	1,981,820	1,686,078	1,686,078
2032-2033	1,775,021	2,041,274	1,686,078	1,686,078
2033-2034	1,828,272	2,102,513		
2034-2035	1,883,120	2,165,588		
2035-2036	1,939,614	2,230,556		
2036-2037	1,997,802	2,297,472		
2037-2038	2,057,736	2,366,396		
2038-2039	2,119,468	2,437,388		
2039-2040	2,183,052	2,510,510		
2040-2041	2,248,544	2,585,825		
2041-2042	2,316,000	2,663,400		
2042-2043	2,385,480	2,743,302		

Historical Compounded Annual Growth Rate (3%)
3.00%

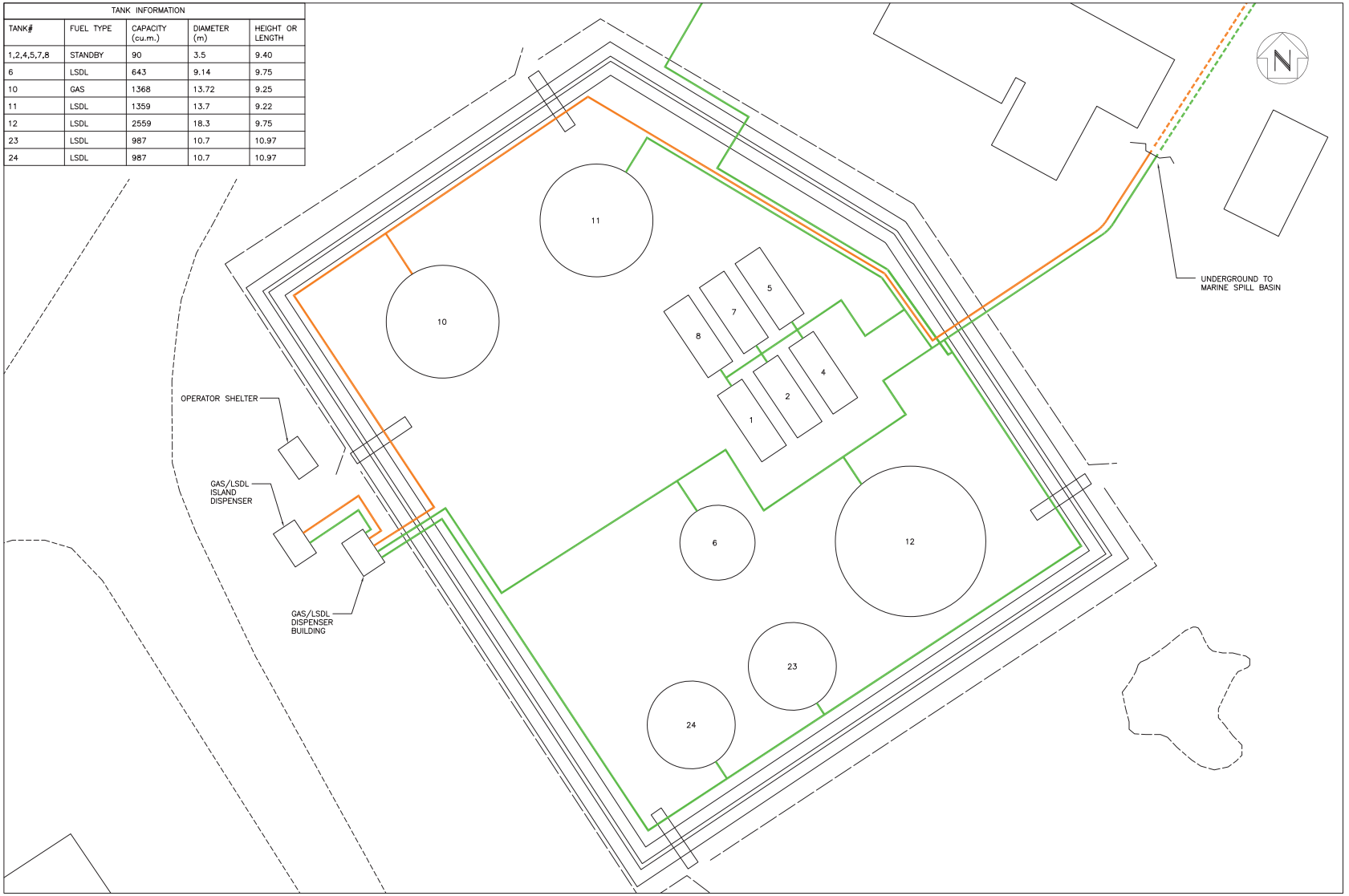
Capacity Offset by Early and Late Resupply: 340715





APPENDIX B- PRELIMINARY DESIGN OPTIONS

TANK INFORMATION				
TANK#	FUEL TYPE	CAPACITY (cu.m.)	DIAMETER (m)	HEIGHT OR LENGTH
1,2,4,5,7,8	STANDBY	90	3.5	9.40
6	LSDL	643	9.14	9.75
10	GAS	1368	13.72	9.25
11	LSDL	1359	13.7	9.22
12	LSDL	2559	18.3	9.75
23	LSDL	987	10.7	10.97
24	LSDL	987	10.7	10.97



NOTES:

LEGEND:

- ULSDL
- GASOLINE
- ROAD
- FENCE
- BERM

FOR INFORMATION ONY
NOT FOR CONSTRUCTION

REV	DATE (DD-MMM-YY)	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
A	17-NOV-17	FOR INFORMATION ONLY	RP	OO/RO	-	-	SK	-		

D SHEET | SCALE AS NOTED

OneWay to zero harm

WORLEYPARSONS PROJECT No.
307031-00048

ENGINEERING AND PERMIT STAMPS (As Required)

CUSTOMER

Nunavut

"This drawing is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. and WorleyParsons Canada Services Ltd. assumes no liability to any other party for any representations contained in this drawing."

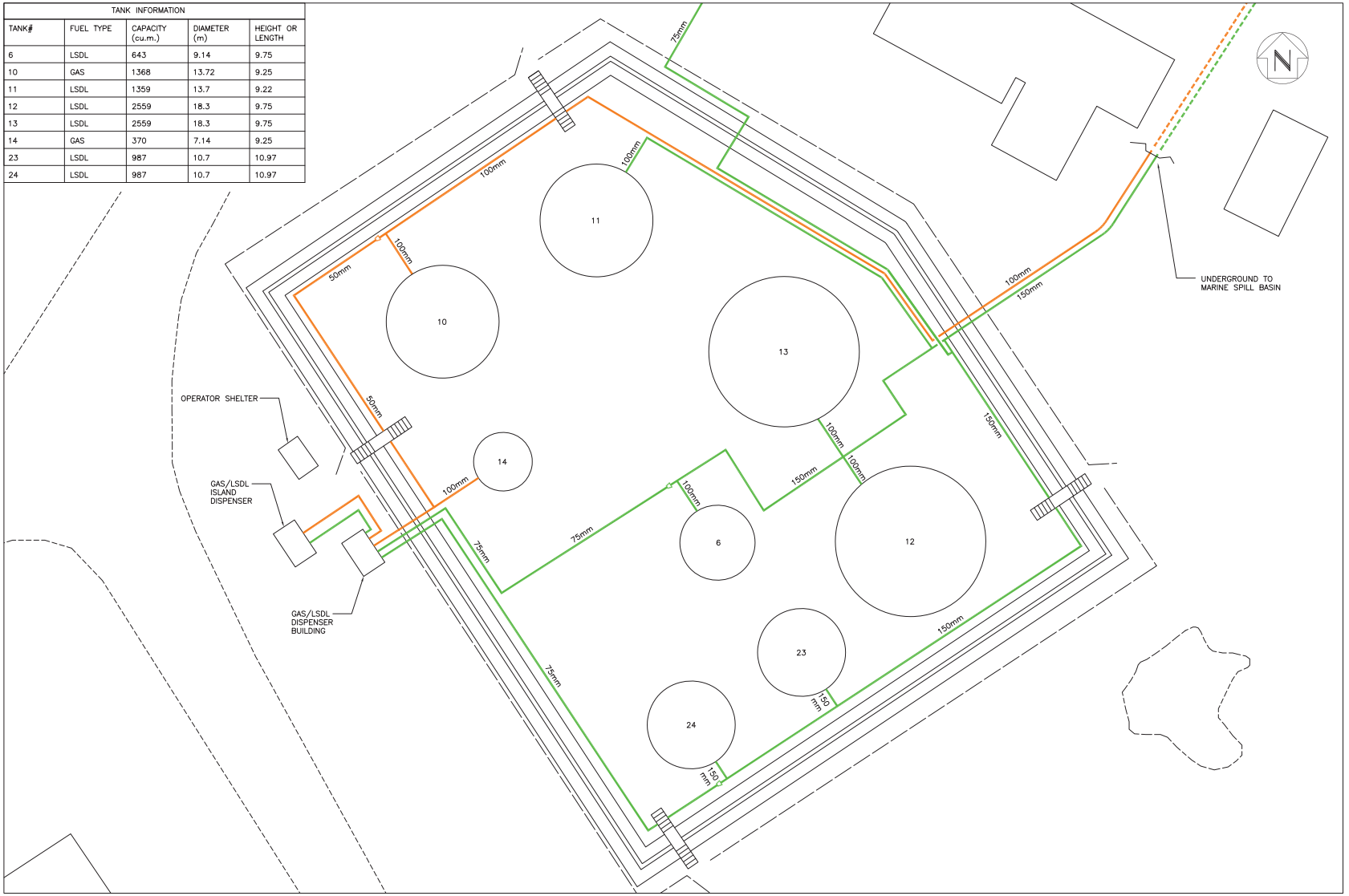
WorleyParsons resources & energy

ARVIAT FUEL FACILITY
SITE PLAN
CURRENT LAYOUT

DRG No 307031-00048-00-PI-DSK-0004

REV A

TANK INFORMATION				
TANK#	FUEL TYPE	CAPACITY (cu.m.)	DIAMETER (m)	HEIGHT OR LENGTH
6	LSDL	643	9.14	9.75
10	GAS	1368	13.72	9.25
11	LSDL	1359	13.7	9.22
12	LSDL	2559	18.3	9.75
13	LSDL	2559	18.3	9.75
14	GAS	370	7.14	9.25
23	LSDL	987	10.7	10.97
24	LSDL	987	10.7	10.97



NOTES:

LEGEND:

- ULSDL
- GASOLINE
- ROAD
- FENCE
- BERM

PRELIMINARY ONLY
NOT FOR CONSTRUCTION

REV	DATE (DD-MMM-YY)	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
A	17-NOV-17	PRELIMINARY	RP	OO/RO	-	-	SK	-		

D SHEET | SCALE AS NOTED

OneWay to zero harm

WORLEYPARSONS PROJECT No. 307031-00048

ENGINEERING AND PERMIT STAMPS (As Required)

CUSTOMER

Nunavut

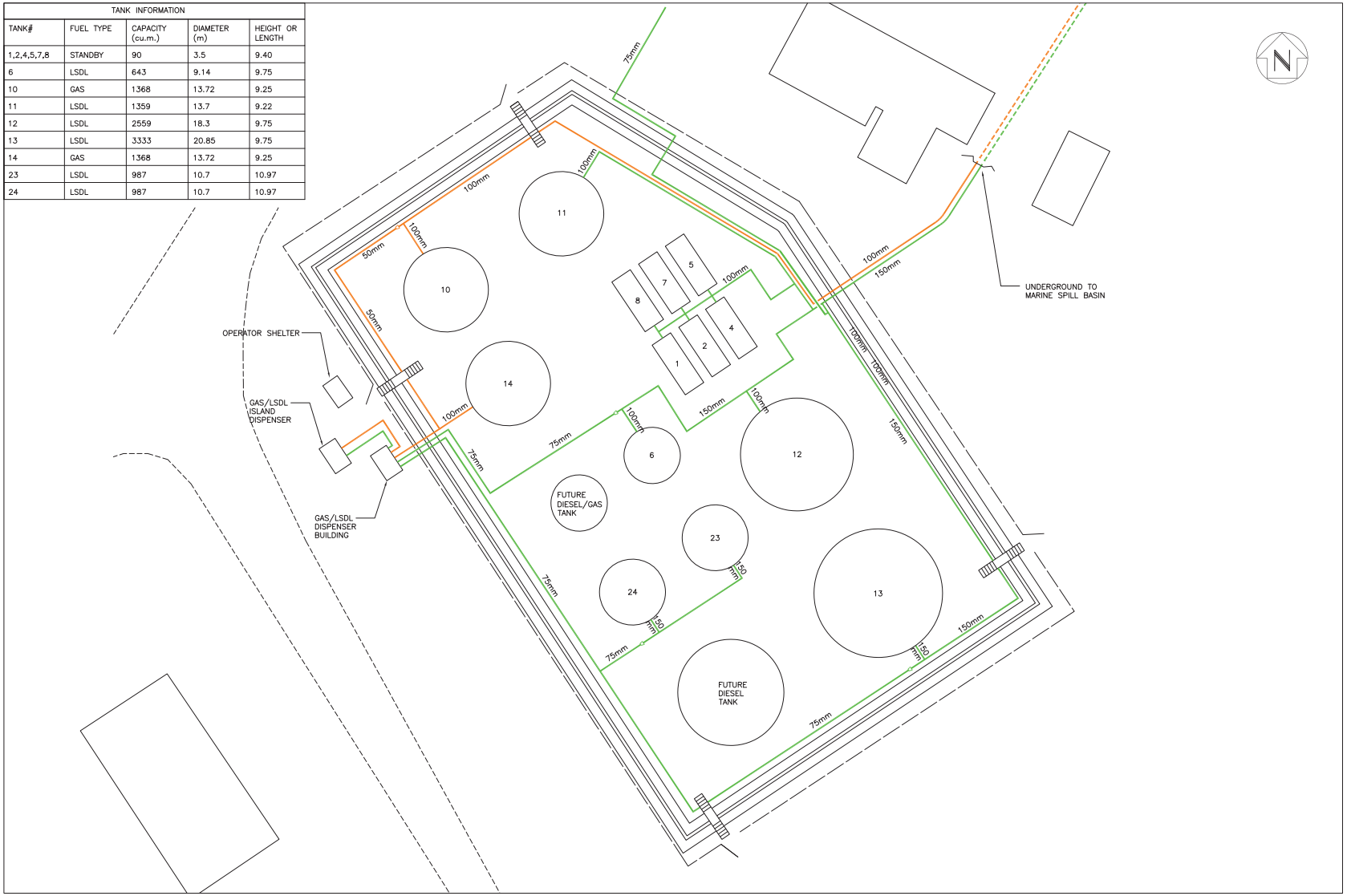
"This drawing is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. and WorleyParsons Canada Services Ltd. assumes no liability to any other party for any representations contained in this drawing."

WorleyParsons resources & energy

ARVIAT FUEL FACILITY
SITE PLAN
OPTION 1

DRG No 307031-00048-00-PI-DSK-0001 | REV A

TANK INFORMATION				
TANK#	FUEL TYPE	CAPACITY (cu.m.)	DIAMETER (m)	HEIGHT OR LENGTH
1,2,4,5,7,8	STANDBY	90	3.5	9.40
6	LSDL	643	9.14	9.75
10	GAS	1368	13.72	9.25
11	LSDL	1359	13.7	9.22
12	LSDL	2559	18.3	9.75
13	LSDL	3333	20.85	9.75
14	GAS	1368	13.72	9.25
23	LSDL	987	10.7	10.97
24	LSDL	987	10.7	10.97



NOTES:

LEGEND:

- ULSDL
- GASOLINE
- ROAD
- FENCE
- BERM

PRELIMINARY ONLY
NOT FOR CONSTRUCTION

REV	DATE (DD-MMM-YY)	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
A	17-NOV-17	PRELIMINARY	RP	OO/RO	-	-	SK	-		

D SHEET SCALE AS NOTED

WORLEYPARSONS PROJECT No.
307031-00048

ENGINEERING AND PERMIT STAMPS (As Required)

CUSTOMER

Nunavut

"This drawing is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. and WorleyParsons Canada Services Ltd. assumes no liability to any other party for any representations contained in this drawing."

WorleyParsons resources & energy

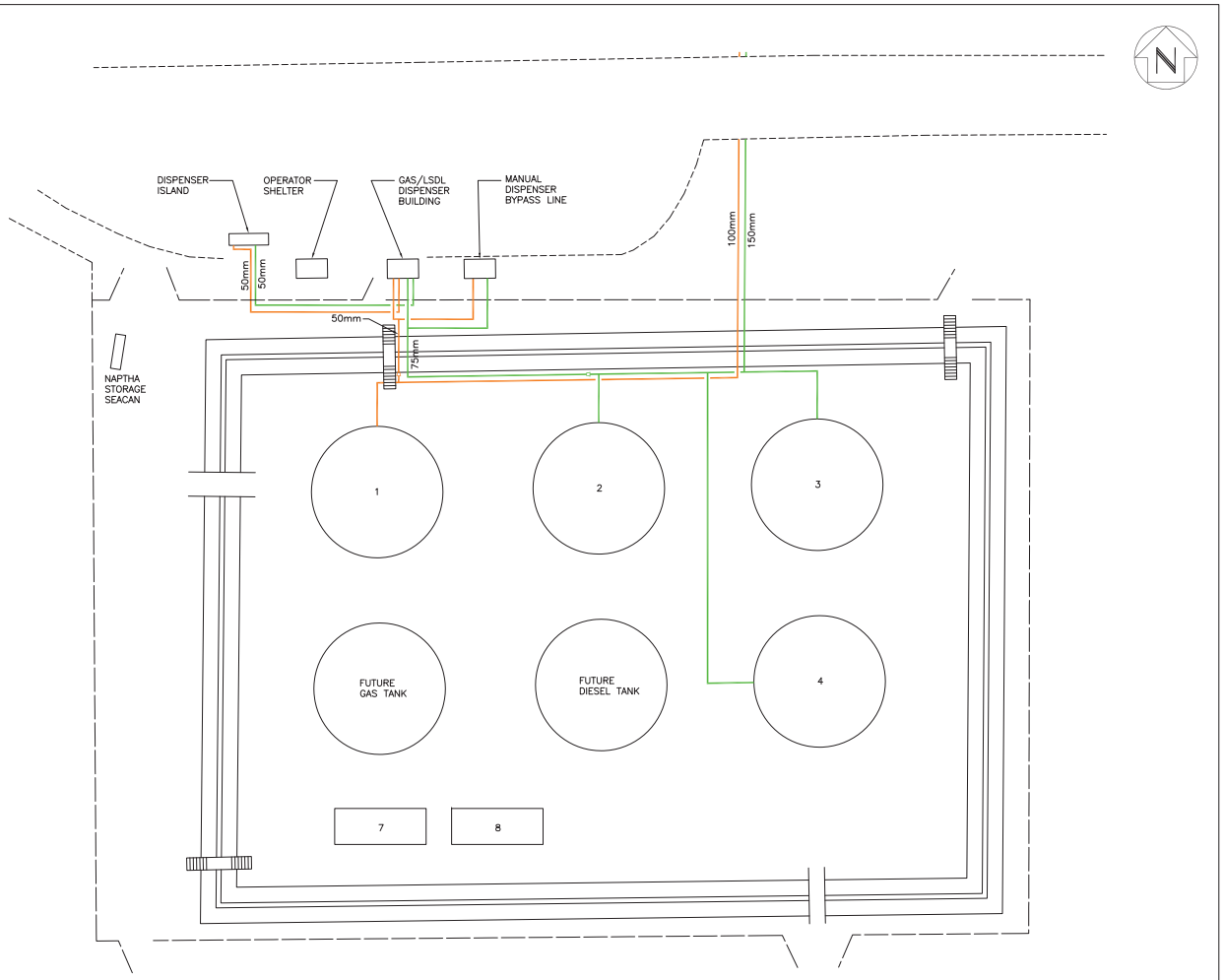
ARVIAT FUEL FACILITY
SITE PLAN
OPTION 2

DRG No 307031-00048-00-PI-DSK-0002

REV A

TANK INFORMATION				
TANK#	FUEL TYPE	CAPACITY (cu.m.)	DIAMETER (m)	HEIGHT OR LENGTH
7	STANDBY	90	3.5	9.50
8	STANDBY	90	3.5	9.50
1	GAS	3333	20.85	9.76
2	LSDL	3333	20.85	9.76
3	LSDL	3333	20.85	9.76
4	LSDL	3333	20.85	9.76

RESUPPLY LINE INFORMATION		
FUEL TYPE (MM)	LENGTH (M) (L)	PIPE DIAMETER
LSDL	40	150
GAS	40	100



NOTES:

LEGEND:

- ULSDL
- GASOLINE
- ROAD
- FENCE
- BERM

PRELIMINARY ONLY
NOT FOR CONSTRUCTION

REV	DATE (DD-MMM-YY)	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
A	17-NOV-17	PRELIMINARY	RP	-	OO/RP	OO	SK	-		

D SHEET SCALE AS NOTED

OneWay to zero harm

WORLEYPARSONS PROJECT No.
307031-00048

ENGINEERING AND PERMIT STAMPS (As Required)

CUSTOMER

Nunavut

"This drawing is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. and WorleyParsons Canada Services Ltd. assumes no liability to any other party for any representations contained in this drawing."

WorleyParsons resources & energy

ARVIAT FUEL FACILITY
SITE PLAN
OPTION 3

DRG No 307031-00048-00-PI-DSK-0003

REV A

APPENDIX C- COSTING

ARVIAT TANK FARM FACILITY EXPANSION AND UPGRADES ARVIAT, NUNAVUT

CLASS 'D' ESTIMATE

December 12, 2017
Revised: April 17, 2018

Hanscomb

ARVIAT TANK FARM FACILITY EXPANSION AND UPGRADES ARVIAT, NUNAVUT

CLASS 'D' ESTIMATE

Prepared For:

WORLEY PARSONS CANADA
4803 - 87 STREET
EDMONTON, ALBERTA
T6E 0V3

TEL: **(780) 440-5458**
FAX: **(780) 440-5555**
EMAIL: **sanjay.khera@worleyparsons.com**

Prepared by:

HANSCOMB LIMITED
151 SLATER ST., SUITE 605
OTTAWA, ONTARIO
K1P 5H3

TEL: **(613) 234-8089**
FAX: **(613) 234-4578**
EMAIL: **ottawa@hanscomb.com**

December 12, 2017
Revised: April 17, 2018
PROJECT NUMBER: Ott-5373

TABLE OF CONTENTS

1.	Introduction	2
2.	Documentation	4
3.	Cost Considerations	5
4.	Gross Floor and Site Developed Areas	7
5.	Construction Cost Estimate Summary	8

Appendices

· A - Detailed Elemental Cost Estimate: Option 1
· B - Detailed Elemental Cost Estimate: Option 2
· C - Detailed Elemental Cost Estimate: Option 3
· D - Drawing List

1. INTRODUCTION

1.1 Purpose:

This Class 'D' Estimate is intended to provide a realistic allocation of direct and indirect construction costs for the Arviat Tank Farm Facility , Expansion and Upgrades , located in Arviat, Nunavut , with exceptions of items listed in 1.5 below.

1.2 Description:

This is the code upgrade and expansion to the Arviat Tank Farm. The following three options are being considered for the project.

. Option 1: One new gasoline tank and one new ULSDL vertical without expanding the existing footprint. The current dyke height needs to be increased from 0.9 to 1.5m.

Option 2: One new gasoline tank and one new ULSDL vertical tank with containment area expanding to the south east direction by 30m. The existing dike height needs to be increased from 0.9m to 1.5m.

Option 3: A new tank farm at the east end of Arviat.

1.3 Methodology:

From the documentation and information provided, quantities of all major elements were assessed or measured where possible and priced at rates considered competitive for a project of this type under a stipulated lump sum form of contract in Arviat, Nunavut .

Pricing shown reflects probable construction costs obtainable in the Arviat, Nunavut area on the effective date of this report. This estimate is a determination of fair market value for the construction of this project. It is not a prediction of low bid. Pricing assumes competitive bidding for every portion of the work.

1.4 Specifications:

For building components and systems where specifications and design details are not available, quality standards have been established based on discussions with the design team.

1. INTRODUCTION

1.5 Exclusions: This Class 'D' Estimate does not provide for the following, if required:

- Land acquisition costs and impost charges
- Development charges
- Legal fees and expenses
- Right of way charges
- Easement costs
- Financing or fund raising costs
- Owner's staff and associated management
- Relocation of existing facilities, including furniture and equipment
- Professional fees and expenses
- Maintenance equipment
- Premium for local labour and material use
- Special audio, visual, security equipment or installation other than provision of empty conduit systems carried in electrical division
- Loose furniture, furnishings and equipment
- Winter construction
- Overtime and restrictive working hours allowance
- Cash allowances
- Phased construction premiums
- Escalation contingency
- Construction contingency
- Preventative maintenance contracts
- Building permit
- Goods and Services Tax

2. DOCUMENTATION

This Class 'D' Estimate has been prepared from the documentation included in Appendix D of this report.

- All of the above documentation was received from Worley Parsons Canada and was supplemented with information gathered in meeting(s) and telephone conversations with the design team, as applicable.

Design changes and/or additions made subsequent to this issuance of the documentation noted above have not been incorporated in this report.

3. COST CONSIDERATIONS

3.1 Cost Base:

All costs are estimated on the basis of competitive bids (a minimum of four (4) general contractor bids and at least three (3) sub-contractor bids for each trade) being received in January 2018 from general contractors and all major sub-contractors and suppliers based on a stipulated lump sum form of contract.

If the minimum contractor/sub-contractor conditions are not met, the bids received could exceed the estimate.

3.2 Escalation:

No contingency has been included for construction cost escalation that may occur between January 2018 and the anticipated bid date for the project. Escalation during the construction period is included in the unit rates used in the estimate.

3.3 Contingencies:

A contingency of 25.0% has been included to cover design and pricing unknowns. This contingency is not intended to cover any program space modifications but rather to provide some flexibility for the designers and cost planners during the remaining contract document stages.

No contingency has been included to cover construction (post contract) unknowns. It is recommended that a provision for this item be included in the overall program budget.

3.4 Unit Rates:

The unit rates in the preparation of this Class 'D' Estimate include labour and material, equipment, subcontractor's overheads and profits.

3.5 Taxes:

No provision has been made for the Goods and Services Tax. It is recommended that the owner make separate provision for GST in the project budget.

3.6 Statement of Probable Costs:

Hanscomb has no control over the cost of labour and materials, the contractor's method of determining prices, or competitive bidding and market conditions. This opinion of probable cost of construction is made on the basis of experience, qualifications and best judgment of the professional consultant familiar with the construction industry. Hanscomb cannot and does not guarantee that proposals, bids or actual construction costs will not vary from this or subsequent cost estimates.

Hanscomb has prepared this estimate in accordance with generally accepted principles and practices. Hanscomb's staff is available to discuss its contents with any interested party.

3.7 Ongoing Cost Control:

Hanscomb recommends that the Owner and design team carefully review this document, including line item description, unit prices, clarifications, exclusions, inclusions and assumptions, contingencies, escalation and mark-ups. If the project is over budget, or if there are unresolved budgeting issues, alternative systems/schemes should be evaluated before proceeding into the next design phase.

Requests for modifications of any apparent errors or omissions to this document must be made to Hanscomb within ten (10) days of receipt of this estimate. Otherwise, it will be understood that the contents have been concurred with and accepted.

It is recommended that a final update estimate be produced by Hanscomb using Bid Documents to determine overall cost changes which may have occurred since the preparation of this estimate. The final updated estimate will address changes and additions to the documents, as well as addenda issued during the bidding process. Hanscomb cannot reconcile bid results to any estimate not produced from bid documents including all addenda.

4. SITE DEVELOPED AREAS

SITE DEVELOPED AREA:

Description	Option 1	Option 2	Option 3
Area of Site	989	1,736	14,976
Site Developed Area	**989**	**1,736**	**14,976**

Site Developed Area is the area of the site less the footprint area of the building.

The above areas have been measured in accordance with the third edition of the Canadian Institute of Quantity Surveyors' "Measurement of Buildings by Area and Volume".

5. CONSTRUCTION COST ESTIMATE SUMMARY

COST SUMMARY:

	Option 1	Option 2	Option 3
- Site Development	$11,161,400	$12,447,600	$10,618,600
- Decommissioning and Disposal	$915,600	$720,600	$4,049,600
- Lead Abatement	$200,000	$200,000	$250,000
Total- Including Site	**$12,277,000**	**$13,368,200**	**$14,918,200**
- General Requirements & Fee	$3,069,300	$3,342,100	$3,729,600
- Freight and Accommodations	$3,069,300	$3,342,100	$3,729,600
Total- Excluding Contingencies	**$18,415,600**	**$20,052,400**	**$22,377,400**
- Design and Pricing Allowance	$4,603,900	$5,013,100	$5,594,400
- Escalation Allowance	$0	$0	$0
- Construction Allowance	$0	$0	$0
Total- Including Contingencies	**$23,019,500**	**$25,065,500**	**$27,971,800**
- Goods and Service Tax	$0	$0	$0
Total Construction Estimate	**$23,019,500**	**$25,065,500**	**$27,971,800**

Appendix
A - Detailed Elemental Cost Estimate: Option 1

Project	: **Arviat Tank Farm Facility**		Report date : 17 Apr 2018
	: **Expansion and Upgrades - Option 1**		Page No. : 1
Location	: **Arviat, Nunavut**	**ELEMENTAL COST SUMMARY**	Bldg Type : 180
Owner	: **Government of Nunavut, Canada**		C.T. Index : 0.0
Consultant	: **WorleyParsons Canada Services Ltd**		GFA : 989 m2

Element	Ratio to GFA	Elemental Cost Quantity	Elemental Cost Unit rate	Elemental Amount Sub-Total	Elemental Amount Total	Rate per m2 Sub-Total	Rate per m2 Total	%
A SHELL		989 m2			0		0.00	0.0
A1 SUBSTRUCTURE					0		0.00	0.0
A11 Foundations				0		0.00		
A12 Basement Excavation				0		0.00		
A13 Special Conditions				0		0.00		
A2 STRUCTURE					0		0.00	0.0
A21 Lowest Floor Construction				0		0.00		
A22 Upper Floor Construction				0		0.00		
A23 Roof Construction				0		0.00		
A3 EXTERIOR ENCLOSURE					0		0.00	0.0
A31 Walls Below Grade				0		0.00		
A32 Walls Above Grade				0		0.00		
A33 Windows & Entrances				0		0.00		
A34 Roof Coverings				0		0.00		
A35 Projections				0		0.00		
B INTERIORS		989 m2			0		0.00	0.0
B1 PARTITIONS & DOORS					0		0.00	0.0
B11 Partitions				0		0.00		
B12 Doors				0		0.00		
B2 FINISHES					0		0.00	0.0
B21 Floor Finishes				0		0.00		
B22 Ceiling Finishes				0		0.00		
B23 Wall Finishes				0		0.00		
B3 FITTINGS & EQUIPMENT					0		0.00	0.0
B31 Fittings & Fixtures				0		0.00		
B32 Equipment				0		0.00		
B33 Elevators				0		0.00		
B34 Escalators				0		0.00		
C SERVICES		989 m2			0		0.00	0.0
C1 MECHANICAL					0		0.00	0.0
C11 Plumbing & Drainage				0		0.00		
C12 Fire Protection				0		0.00		
C13 HVAC				0		0.00		
C14 Controls				0		0.00		
C2 ELECTRICAL					0		0.00	0.0
C21 Service & Distribution				0		0.00		
C22 Lighting, Devices & Heating				0		0.00		
C23 Systems & Ancillaries				0		0.00		
NET BUILDING COST - EXCLUDING SITE				**$**	**0**		0.00	0.0
D SITE & ANCILLARY WORK		989 m2			12,277,000		12,413.55	66.7
D1 SITE WORK					11,161,400		11,285.54	60.6
D11 Site Development	0.001	1 Sum	819,300.00	819,300		828.41		
D12 Mechanical Site Services	0.001	1 Sum	9,877,100.00	9,877,100		9,986.96		
D13 Electrical Site Services	0.001	1 Sum	465,000.00	465,000		470.17		
D2 ANCILLARY WORK					1,115,600		1,128.01	6.1
D21 Decommissioning	0.001	1 sum	1,115,600.00	1,115,600		1,128.01		
D22 Alterations				0		0.00		
NET BUILDING COST - INCLUDING SITE				**$**	**12,277,000**		12,413.55	66.7
Z1 GENERAL REQUIREMENTS & FEE					6,138,600		6,206.88	33.3
Z11 General Requirements + Fee		25.0 %		3,069,300		3,103.44		
Z12 Freight and Accomodations		20.0 %		3,069,300		3,103.44		
TOTAL CONSTRUCTION ESTIMATE - EXCLUDING ALLOWANCES				**$**	**18,415,600**		18,620.42	100.0
Z2 ALLOWANCES					4,603,900		4,655.11	
Z21 Design & Pricing Allowance		25.0 %		4,603,900		4,655.11		
Z22 Escalation Allowance		0.0 %		0		0.00		
Z23 Construction Allowance		0.0 %		0		0.00		
TOTAL CONSTRUCTION ESTIMATE - INCLUDING ALLOWANCES				**$**	**23,019,500**		23,275.53	
VALUE ADDED TAX (GST/HST)					0		0.00	
Value Added Tax (GST/HST)		0.0 %		0		0.00		
TOTAL CONSTRUCTION ESTIMATE				**$**	**23,019,500**	**$**	**23,275.53**	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D11 Site Development				
1 Clearing for existing containment pad	598 m2	25.00	15,000	
2 Compact existing tank foundation	598 m2	30.00	17,900	
3 New tank foundation	1,500 m3	110.00	165,000	
4 Raise berm from .9m to 1.5m	1 sum	211,400.00	211,400	
- Prepare existing top of berm area for berm raise	172 m2	20.00	3,400	
- Liner	1,050 m2	30.00	31,500	
- Geotextile material (double layer)	2,100 m2	15.00	31,500	
- Structural fill to raise berm height (hand laid)	580 m3	250.00	145,000	
5 Allowance for modifications to existing stairs and stiles		allow	20,000	
6 Allowance for road diversions in 3 areas		allow	100,000	
7 Allowance for road closures for 2 weeks		allow	20,000	
8 New operator building c/w foundations and structure. Mechanical and electrical services included elsewhere.	12 m2	5,000.00	60,000	
9 Allowance for fence repairs		allow	10,000	
10 Marine spill basin relocation	1 sum	25,000.00	25,000	
- Install	1 sum	20,000.00	20,000	
- Demolition	1 sum	5,000.00	5,000	
11 Allowance for modifications to existing fuel dispenser island for new supply piping being installed		allow	3,000	
12 Concrete supports for expansion loop	12 no.	1,000.00	12,000	
		Carried Forward :	659,300	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D11 Site Development (Continued)		**Brought Forward :**	659,300	
13 New dispenser building c/w foundations, structural. Demolition of existing dispenser building included. Mechanical and electrical services included elsewhere	1 sum	160,000.00	160,000	
D11 Site Development **TOTAL : $**	1 Sum	819,300.00	819,300	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D12 Mechanical Site Services				
1 New field erected, vertical fuel tanks to API design standard & guidelines	1 sum	1,827,000.00	1,827,000	
- 7.14m dia. x 9.25m high vertical gasoline tank, 370,000L	1 no.	550,000.00	550,000	
- 18.3m dia. x 9.75m high vertical ULSDL tank, 2,559,000L	1 no.	1,100,000.00	1,100,000	
- Steel stairs, roof handrail, manholes, gauges etc. included in above price		incl.		
- Exterior paint on above 2 tanks	800 m2	140.00	112,000	
- Strapping and calibrating above tanks	1 sum	30,000.00	30,000	
- Hydro testing above tanks	1 sum	20,000.00	20,000	
- Allow for tank overfill alarm system	1 sum	15,000.00	15,000	
- Tank foundations - included elsewhere		nil		
2 New above ground FO piping in tank farm	1 sum	57,300.00	57,300	
- 100mm pipe connection from new Gasoline tank #14 to existing GAS/LSDL dispenser building	5 m	380.00	1,900	
- Allow for new 100mm gasoline resupply line connection to new tank #14	20 m	380.00	7,600	
- Allow for new 150mm LSDL resupply line connection to new tank #13	20 m	420.00	8,400	
- 150mm pipe connection from new LSDL tank #13 to existing delivery piping	20 m	420.00	8,400	
- Allow for pipe supports, painting etc.	1 sum	15,000.00	15,000	
- Allow for miscellaneous valves, drain connections etc.	1 sum	10,000.00	10,000	
- Allow for testing complete pipe installation	1 sum	6,000.00	6,000	
3 Improvements to existing tanks & piping in tank farm	1 sum	945,800.00	945,800	
- Re-locate existing vertical LSDL tank #23, 10.7m dia. x 10.97m high	1 sum	160,000.00	160,000	
- Extend all around tank#6 roof handrail	1 sum	12,000.00	12,000	
- Extend all around tanks #23 & #24 roof handrail	1 sum	26,000.00	26,000	
- Extend all around tanks #10 & #11 roof handrail	1 sum	32,000.00	32,000	
- Extend all around tank#12 roof handrail	1 sum	22,000.00	22,000	
- New 24" manhole on exting tank roof	6 no.	2,800.00	16,800	
- Sand blast and repaint existing tanks #6, 10, 11, 12, 23 & 24 (external surface)	2,400 m2	160.00	384,000	
(Continued)				
		Carried Forward :	2,830,100	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D12 Mechanical Site Services (Continued)		**Brought Forward :**	2,830,100	
3 Improvements to existing tanks & piping in tank farm (Continued)				
- Replace existing tank level gauges	6 no	3,000.00	18,000	
- Test & calibrate tank venting devices, pressure & vacuum vents	1 sum	20,000.00	20,000	
- Overfill protection system for existing vertical tanks c/w HL alarm with LV wiring	1 sum	30,000.00	30,000	
- Replace defective thermal relief and other valves & accessories	1 sum	25,000.00	25,000	
- Wire brush and repaint existing tank farm above ground piping	1 allow	50,000.00	50,000	
- Complete API inspection to verify condition of tanks #10, 12,23 & 24	1 sum	150,000.00	150,000	
4 New LSDL/Gasoline dispenser building and equipment	1 sum	226,000.00	226,000	
- Allow for building heating and ventilation system, fire extinguishers etc.	1 sum	35,000.00	35,000	
- Allow for dispensing/truck loading equipment c/w pumps, piping & valves	1 sum	180,000.00	180,000	
- Allow for polygas detection system	1 sum	6,000.00	6,000	
- Allow for drip pans for pumps	1 sum	5,000.00	5,000	
5 Improvements to Gasoline/LSDL remote dispenser island	1 sum	40,000.00	40,000	
- FO supply piping(double wall Perma pipes) to existing cabinets and leak detection in new sump	1 sum	30,000.00	30,000	
- New dispenser sump c/w fittings, corrugated ducting, entry boot, shear valve etc.	2 no.	5,000.00	10,000	
6 Mechanical services in new operator's shelter building (prefabricated)	1 sum	11,000.00	11,000	
- Mechanical requirements such as fire extinguisher, electrical heater - included in cabin price		nil		
- Polygas detection system c/w control panel	1 allow	6,000.00	6,000	
- Motor operated valves (MOV) & remote despenser island leak detection sensor & control panels	1 allow	5,000.00	5,000	
		Carried Forward :	3,107,100	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D12 Mechanical Site Services (Continued)		**Brought Forward :**	3,107,100	
7 New resupply lines from shore manifold to tank farm	1 sum	6,730,000.00	6,730,000	
- 100mm Gasoline resupply line PermAlert Ultra FS prefabricated conduit c/w fittings & supports	2,100 m	1,200.00	2,520,000	
- 150mm Diesel resupply line PermAlert Ultra FS prefabricated conduit c/w fittings & supports	2,100 m	1,600.00	3,360,000	
- Combined trench for fuel pipes c/w excavation, sand bed & backfilling , remove surplus materials etc.	2,100 m	160.00	336,000	
- Allow for markers and signage for above pipeline	1 sum	20,000.00	20,000	
- Alow for pipe sleeves through existing dike wall	1 sum	4,000.00	4,000	
- Allow for RT examination	1 sum	30,000.00	30,000	
- Allow for cathodic protection system	1 sum	200,000.00	200,000	
- Allow for leak detection system for pipelines c/w sensor cable, alarm units, monitoring panel etc.	1 sum	80,000.00	80,000	
- Allow for hydrostatic testing etc.	1 sum	30,000.00	30,000	
- Premium for 3 road crossings additional requirements	1 sum	150,000.00	150,000	
8 New shore manifold and marine spill basin	1 sum	40,000.00	40,000	
- Allow for shore manifold c/w sch 40 steel piping, valves & fittings as shown on NT-P02	1 sum	40,000.00	40,000	
- Concrete spill basin as per dwg NT-S11 included elsewhere		nil		
D12 Mechanical Site Services **TOTAL : $**	1 Sum	9,877,100.00	9,877,100	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D13 Electrical Site Services				
1 Electrical services/instrumentation/controls/ grounding / grid bonding etc	1 sum	465,100.00	465,100	
- Incoming power & communications, no new work required		nil.		
- Replace ex. light fixture type C on ex. vertical tanks	7 no.	2,500.00	17,500	
- Replace ex. light fixture type D on ex. vertical tanks	7 no.	2,500.00	17,500	
- Replace ex. area light fixture type A on ex. service pole, 1 x 3	3 no.	2,500.00	7,500	
- Replace ex. area light fixture type B on ex. poles, 4 x 3	12 no.	2,500.00	30,000	
- New area light fixture type A c/w one new pole, 1 x 3	1 set	15,000.00	15,000	
- New area light fixture type B c/w one new pole, 1 x 2	1 set	10,000.00	10,000	
- New light fixture type C on new vertical tanks, 1 x 1	1 no.	1,250.00	1,300	
- New light fixture type D on new vertical tanks, 1 x 1	1 no.	1,250.00	1,300	
- Power & control wiring for MOVs - RGS conduits/wiring from control panel in operator's shelter	8 no.	8,250.00	66,000	
- Wiring in RGS conduits from OS to overfill alarm sy LSs, strobes at vertical tanks & horn on tank 1	1 sum	125,000.00	125,000	
- Power & control wiring from OS to remote island dispensers	1 sum	8,000.00	8,000	
- LSDL/gasoline dispenser building - power & conrols c/w connections to 2 pumps, HVAC eqt etc + polygas	1 sum	20,000.00	20,000	
- New bonding & grounding on new vertical tanks, piping & stiles, 1no.	1 sum	4,000.00	4,000	
- Ground grid at new LSDL/gasoline dispenser building & remote island dispensers	1 sum	8,500.00	8,500	
- Replacement of bonding & grounding on vertical tanks, 7no.	1 sum	7,000.00	7,000	
- Operator shelter - possibe elect. work due to building controls, displays, panels etc replacement	1 sum	5,000.00	5,000	
- Operator shelter -18CCT sub-panel, MOV CP etc, overfill alarm panel, replacing 3 lights/switches etc	1 sum	7,000.00	7,000	
- Operator shelter - replace existing heater	1 sum	2,000.00	2,000	
(Continued)				
		Carried Forward :	465,100	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D13 Electrical Site Services (Continued)		**Brought Forward :**	465,100	
1 Electrical services/instrumentation/controls/ grounding / grid bonding etc (Continued)				
- Replace conduits to existing tankage	1 sum	20,000.00	20,000	
- Trenching (teck cables in trench, 130m trench outside berm + 70m inside berm)	200 m	225.00	45,000	
- Misc. standard requirements, site conditions etc		allow	22,000	
- Electrical work required for demolition of ex. 6 horizontal tanks		allow	25,500	
- Cathodic protection system - included in mechanical site services		nil.		
D13 Electrical Site Services **TOTAL : $**	1 Sum	465,100.00	465,100	

D2 ANCILLARY WORK	Quantity	Unit rate	Amount	Trade
D21 Decommissioning				
1 Removal of contaminated soils & dispose. This includes disposal but not treatment.	2,600 m3	75.00	195,000	
2 Demolition of existing operator building including foundations	1 Sum	150,000.00	150,000	
3 Decommissioning (mechanical works) and disposal(ship out of community)	1 sum	570,600.00	570,600	
- Decommission and remove existing horizontal FO tank, 3.5m dia. x 9.4m long (Tanks #1,2,4,5,7,8)	6 no.	30,000.00	180,000	
- Disconnect and remove fill line to above 6 tanks and cap	1 sum	15,000.00	15,000	
- Excavate, expose, disconnect and remove existing U/G 100mm gasoline resupply line	500 m	200.00	100,000	
- Disconnect and remove existing A/G 100mm gasoline resupply line with pipe supports	420 m	180.00	75,600	
- Excavate, expose, disconnect and remove existing U/G 150mm ULSDL resupply line	500 m	220.00	110,000	
- Disconnect and remove existing A/G 150mm ULSDL resupply line with pipe supports	420 m	200.00	84,000	
- Disconnect and remove existing piping to Gasoline/LSDL dispensers from dispenser building	1 sum	5,000.00	5,000	
- Disconnect all services prior to remove existing operator's shelter	1 sum	1,000.00	1,000	
4 Lead abatement (w)	1 sum	200,000.00	200,000	
- Additional works due to lead abatement	1 sum	200,000.00	200,000	
D21 Decommissioning **TOTAL : $**	1 sum	1,115,600.00	1,115,600	

Appendix
B - Detailed Elemental Cost Estimate: Option 2

Project	: **Arviat Tank Farm Facility**		Report date : 17 Apr 2018
	: **Expansion and Upgrades - Option 2**		Page No. : 1
Location	: **Arviat, Nunavut**	**ELEMENTAL COST SUMMARY**	Bldg Type : 180
Owner	: **Government of Nunavut, Canada**		C.T. Index : 0.0
Consultant	: **WorleyParsons Canada Services Ltd**		GFA : 1,763 m2

Element	Ratio to GFA	Elemental Cost Quantity	Elemental Cost Unit rate	Elemental Amount Sub-Total	Elemental Amount Total	Rate per m2 Sub-Total	Rate per m2 Total	%
A SHELL		1,763 m2			0		0.00	0.0
A1 SUBSTRUCTURE					0		0.00	0.0
A11 Foundations				0		0.00		
A12 Basement Excavation				0		0.00		
A13 Special Conditions				0		0.00		
A2 STRUCTURE					0		0.00	0.0
A21 Lowest Floor Construction				0		0.00		
A22 Upper Floor Construction				0		0.00		
A23 Roof Construction				0		0.00		
A3 EXTERIOR ENCLOSURE					0		0.00	0.0
A31 Walls Below Grade				0		0.00		
A32 Walls Above Grade				0		0.00		
A33 Windows & Entrances				0		0.00		
A34 Roof Coverings				0		0.00		
A35 Projections				0		0.00		
B INTERIORS		1,763 m2			0		0.00	0.0
B1 PARTITIONS & DOORS					0		0.00	0.0
B11 Partitions				0		0.00		
B12 Doors				0		0.00		
B2 FINISHES					0		0.00	0.0
B21 Floor Finishes				0		0.00		
B22 Ceiling Finishes				0		0.00		
B23 Wall Finishes				0		0.00		
B3 FITTINGS & EQUIPMENT					0		0.00	0.0
B31 Fittings & Fixtures				0		0.00		
B32 Equipment				0		0.00		
B33 Elevators				0		0.00		
B34 Escalators				0		0.00		
C SERVICES		1,763 m2			0		0.00	0.0
C1 MECHANICAL					0		0.00	0.0
C11 Plumbing & Drainage				0		0.00		
C12 Fire Protection				0		0.00		
C13 HVAC				0		0.00		
C14 Controls				0		0.00		
C2 ELECTRICAL					0		0.00	0.0
C21 Service & Distribution				0		0.00		
C22 Lighting, Devices & Heating				0		0.00		
C23 Systems & Ancillaries				0		0.00		
NET BUILDING COST - EXCLUDING SITE				**$**	**0**		0.00	0.0
D SITE & ANCILLARY WORK		1,763 m2			13,368,200		7,582.64	66.7
D1 SITE WORK					12,447,600		7,060.47	62.1
D11 Site Development	0.001	1 Sum	1,310,900.00	1,310,900		743.56		
D12 Mechanical Site Services	0.001	1 Sum	10,601,700.00	10,601,700		6,013.44		
D13 Electrical Site Services	0.001	1 Sum	535,000.00	535,000		303.46		
D2 ANCILLARY WORK					920,600		522.18	4.6
D21 Decommissioning	0.001	1 sum	920,600.00	920,600		522.18		
D22 Alterations				0		0.00		
NET BUILDING COST - INCLUDING SITE				**$**	**13,368,200**		7,582.64	66.7
Z1 GENERAL REQUIREMENTS & FEE					6,684,200		3,791.38	33.3
Z11 General Requirements + Fee		25.0 %		3,342,100		1,895.69		
Z12 Freight and Accommodations		20.0 %		3,342,100		1,895.69		
TOTAL CONSTRUCTION ESTIMATE - EXCLUDING ALLOWANCES				**$**	**20,052,400**		11,374.02	100.0
Z2 ALLOWANCES					5,013,100		2,843.51	
Z21 Design & Pricing Allowance		25.0 %		5,013,100		2,843.51		
Z22 Escalation Allowance		0.0 %		0		0.00		
Z23 Construction Allowance		0.0 %		0		0.00		
TOTAL CONSTRUCTION ESTIMATE - INCLUDING ALLOWANCES				**$**	**25,065,500**		14,217.53	
VALUE ADDED TAX (GST/HST)					0		0.00	
Value Added Tax (GST/HST)		0.0 %		0		0.00		
TOTAL CONSTRUCTION ESTIMATE				**$**	**25,065,500**	**$**	**14,217.53**	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D11 Site Development				
1 Clearing for existing containment pad	598 m2	25.00	15,000	
2 Compact existing tank foundation	598 m2	30.00	17,900	
3 Removal of existing berm	609 m3	60.00	36,500	
4 Remove existing fence c/w foundations	74 m	50.00	3,700	
5 New tank foundation	1,500 m3	150.00	225,000	
6 Raise berm from .9m to 1.5m	1 sum	218,800.00	218,800	
- Prepare existing top of berm area for berm raise	540 m2	20.00	10,800	
- Liner	1,050 m2	30.00	31,500	
- Geotextile material (double layer)	2,100 m2	15.00	31,500	
- Structural fill to raise berm height (hand laid)	580 m3	250.00	145,000	
7 New berm	1 sum	365,000.00	365,000	
- Liner	1,750 m2	20.00	35,000	
- Geotextile (double layer)	3,500 m2	30.00	105,000	
- Structural fill (hand laid)	900 m3	250.00	225,000	
8 New chainlink fencing c/w gate	120 m	200.00	24,000	
9 Allowance to remove and replace stile over berm		allow	5,000	
10 Allowance for modifications to existing stairs and stile		allow	20,000	
11 Allowance for road diversions in 3 areas		allow	100,000	
12 Allowance for road closures for 2 weeks		allow	20,000	
13 New operator building c/w foundations, steel structural. Mechanical and eletrical services included elsewhere.	12 m2	5,000.00	60,000	
14 Relocation of marine spill basin	1 sum	25,000.00	25,000	
- Demolition	1 sum	5,000.00	5,000	
(Continued)				
		Carried Forward :	1,135,900	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D11 Site Development (Continued)		**Brought Forward :**	1,135,900	
14 Relocation of marine spill basin (Continued)				
- Install	1 sum	20,000.00	20,000	
15 Allowance for modifications to existing fuel dispenser island for new supply piping being installed		allow	3,000	
16 Concrete supports for expansion loop	12 no.	1,000.00	12,000	
17 New dispenser building c/w foundations and structural. Demolition of existing dispenser building included. Mechanical and electrical services included elsewhere - Optional price	1 sum	160,000.00	160,000	
D11 Site Development **TOTAL : $**	1 Sum	1,310,900.00	1,310,900	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D12 Mechanical Site Services				
1 New field erected, vertical fuel tanks to API design standard & guidelines	1 sum	2,295,000.00	2,295,000	
- 13.72m dia. x 9.25m high vertical gasoline tank, 1,368,000L	1 no.	820,000.00	820,000	
- 20.85m dia. x 9.75m high vertical ULSDL tank, 3,333,000L	1 no.	1,250,000.00	1,250,000	
- Steel stairs, roof handrail, manholes, gauges etc. included in above price		incl.		
- Exterior paint on above 2 tanks	1,000 m2	140.00	140,000	
- Strapping and calibrating above tanks	1 sum	40,000.00	40,000	
- Hydro testing above tanks	1 sum	30,000.00	30,000	
- Allow for tank overfill alarm system	1 sum	15,000.00	15,000	
- Tank foundations - included elsewhere		nil		
2 New above ground FO piping in tank farm	1 sum	107,900.00	107,900	
- 100mm pipe connection from new Gasoline tank #14 to existing GAS/LSDL dispenser building	5 m	380.00	1,900	
- Allow for new 100mm gasoline resupply line connection to new tank #14	20 m	380.00	7,600	
- Allow for new 150mm LSDL resupply line connection to new tank #13	60 m	420.00	25,200	
- 150mm pipe connection from new LSDL tank #13 to existing delivery piping	60 m	420.00	25,200	
- Allow for pipe supports, painting etc.	1 sum	30,000.00	30,000	
- Allow for miscellaneous valves, drain connections etc.	1 sum	10,000.00	10,000	
- Allow for testing complete pipe installation	1 sum	8,000.00	8,000	
3 Improvements to existing tanks & piping in tank farm	1 sum	1,091,800.00	1,091,800	
- Re-locate existing vertical LSDL tank #23, 10.7m dia. x 10.97m high	1 sum	160,000.00	160,000	
- Extend all around tank#6 roof handrail	1 sum	12,000.00	12,000	
- Extend all around tanks #23 & #24 roof handrail	1 sum	26,000.00	26,000	
- Extend all around tanks #10 & #11 roof handrail	1 sum	32,000.00	32,000	
- Extend all around tank#12 roof handrail	1 sum	22,000.00	22,000	
- New 24" manhole on exting tank roof	6 no.	2,800.00	16,800	
- Sand blast and repaint existing tanks #6, 10, 11, 12, 23 & 24 (external surface)	2,400 m2	160.00	384,000	
(Continued)				
		Carried Forward :	3,494,700	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D12 Mechanical Site Services (Continued)		**Brought Forward :**	3,494,700	
3 Improvements to existing tanks & piping in tank farm (Continued)				
- Sand blast and repaint existing tanks #1, 2, 4, 5, 7 & 8 (external surface)	600 m2	160.00	96,000	
- Replace existing tank level gauges	6 no	3,000.00	18,000	
- Test & calibrate tank venting devices, pressure & vacuum vents	1 sum	20,000.00	20,000	
- Overfill protection system for existing vertical tanks c/w HL alarm with LV wiring	1 sum	30,000.00	30,000	
- Replace defective thermal relief and other valves & accessories	1 sum	25,000.00	25,000	
- Wire brush and repaint existing tank farm above ground piping	1 allow	50,000.00	50,000	
- Complete API inspection to verify condition of tanks #10, 12,23,24 and 1,2,4,5,7,8 standby tanks	1 sum	200,000.00	200,000	
4 New LSDL/Gasoline dispenser building and equipment	1 sum	226,000.00	226,000	
- Allow for building heating and ventilation system, fire extinguishers etc.	1 sum	35,000.00	35,000	
- Allow for dispensing/truck loading equipment c/w pumps, piping & valves	1 sum	180,000.00	180,000	
- Allow for polygas detection system	1 sum	6,000.00	6,000	
- Allow for drip pans for pumps	1 sum	5,000.00	5,000	
5 Improvements to Gasoline/LSDL remote dispenser island	1 sum	40,000.00	40,000	
- FO supply piping(double wall Perma pipes) to existing cabinets and leak detection in new sump	1 sum	30,000.00	30,000	
- New dispenser sump c/w fittings, corrugated ducting, entry boot, shear valve etc.	2 no.	5,000.00	10,000	
- Note:- new concrete island and apron included elsewhere		nil		
6 Mechanical services in new operator's shelter building (prefabricated)	1 sum	11,000.00	11,000	
- Mechanical requirements such as fire extinguisher, electrical heater - included in cabin price (Continued)		nil		
		Carried Forward :	3,771,700	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D12 Mechanical Site Services (Continued)		**Brought Forward :**	3,771,700	
6 Mechanical services in new operator's shelter building (prefabricated) (Continued)				
- Polygas detection system c/w control panel	1 allow	6,000.00	6,000	
- Motor operated valves (MOV) & remote despenser island leak detection sensor & control panels	1 allow	5,000.00	5,000	
7 New resupply lines from shore manifold to tank farm	1 sum	6,730,000.00	6,730,000	
- 100mm Gasoline resupply line PermAlert Ultra FS prefabricated conduit c/w fittings & supports	2,100 m	1,200.00	2,520,000	
- 150mm Diesel resupply line PermAlert Ultra FS prefabricated conduit c/w fittings & supports	2,100 m	1,600.00	3,360,000	
- Combined trench for fuel pipes c/w excavation, sand bed & backfilling , remove surplus materials etc.	2,100 m	160.00	336,000	
- Allow for markers and signage for above pipeline	1 sum	20,000.00	20,000	
- Alow for pipe sleeves through existing dike wall	1 sum	4,000.00	4,000	
- Allow for RT examination	1 sum	30,000.00	30,000	
- Allow for cathodic protection system	1 sum	200,000.00	200,000	
- Allow for leak detection system for pipelines c/w sensor cable, alarm units, monitoring panel etc.	1 sum	80,000.00	80,000	
- Allow for hydrostatic testing etc.	1 sum	30,000.00	30,000	
- Premium for 3 road crossings additional requirements	1 sum	150,000.00	150,000	
8 New shore manifold and marine spill basin	1 sum	40,000.00	40,000	
- Allow for shore manifold c/w sch 40 steel piping, valves & fittings as shown on NT-P02	1 sum	40,000.00	40,000	
- Concrete spill basin as per dwg NT-S11 included elsewhere		nil		
9 Allow for new sump, sump pump and pumpout line for extended dyke wall	1 sum	60,000.00	60,000	
D12 Mechanical Site Services **TOTAL : $**	1 Sum	10,601,700.00	10,601,700	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D13 Electrical Site Services				
1 Electrical services/instrumentation/controls/ grounding / grid bonding etc	1 sum	535,000.00	535,000	
- Incoming power & communications, no new work required		nil.		
- Replace ex. light fixture type C on ex. vertical tanks	6 no.	2,500.00	15,000	
- Replace ex. light fixture type D on ex. vertical tanks	6 no.	2,500.00	15,000	
- Replace ex. light fixture type D on ex. horizontal tanks	5 no.	2,000.00	10,000	
- Replace ex. area light fixture type A on ex. service pole, 1 x 3	3 no.	2,500.00	7,500	
- Replace ex. area light fixture type B on ex. poles, 4 x 3	12 no.	2,500.00	30,000	
- New area light fixture type A c/w one new pole, 1 x 3	1 set	15,000.00	15,000	
- New area light fixture type B c/w one new pole, 3 x 2	1 set	30,000.00	30,000	
- New light fixture type C on new vertical tanks, 1 x 2	2 no.	1,250.00	2,500	
- New light fixture type D on new vertical tanks, 1 x 2	2 no.	1,250.00	2,500	
- Power & control wiring for MOVs - RGS conduits/wiring from control panel in operator's shelter	14 no.	8,250.00	115,500	
- Wiring in RGS conduits from OS to overfill alarm sy LSs, strobes at vertical tanks & horn on tank 1	1 sum	125,000.00	125,000	
- Power & control wiring from OS to remote island dispensers	1 sum	8,000.00	8,000	
- LSDL/gasoline dispenser building - power & conrols c/w connections to 2 pumps, HVAC eqt etc + polygas	1 sum	20,000.00	20,000	
- New bonding & grounding on new vertical tanks, piping & stiles, 1no.	1 sum	4,000.00	4,000	
- Ground grid at new LSDL/gasoline dispenser building & remote island dispensers	1 sum	8,500.00	8,500	
- Replacement of bonding & grounding on vertical tanks, 6no.	1 sum	7,000.00	7,000	
- Operator shelter - possibe elect. work due to building controls, displays, panels etc replacement	1 sum	5,000.00	5,000	
- Operator shelter -18CCT sub-panel, MOV CP etc, overfill alarm panel, replacing 3 lights/switches etc	1 sum	7,000.00	7,000	
(Continued)				
		Carried Forward :	535,000	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D13 Electrical Site Services (Continued)		**Brought Forward :**	535,000	
1 Electrical services/instrumentation/controls/ grounding / grid bonding etc (Continued)				
- Operator shelter - replace existing heater	1 sum	2,000.00	2,000	
- Replace conduits to existing tankage	1 sum	20,000.00	20,000	
- Trenching (teck cables in trench, 130m trench outside berm + 70m inside berm)	200 m	225.00	45,000	
- Misc. standard requirements, site conditions etc		allow	40,500	
- Cathodic protection system - included in mechanical site services		nil.		
D13 Electrical Site Services **TOTAL : $**	1 Sum	535,000.00	535,000	

D2 ANCILLARY WORK	Quantity	Unit rate	Amount	Trade
D21 Decommissioning				
1 Removal of contaminated soils & dispose. This includes disposal but not treatment of the soil.	2,600 m3	75.00	195,000	
2 Demolition of existing operator building including foundations	1 Sum	150,000.00	150,000	
3 Decommissioning (mechanical works) and disposal(ship out of community)	1 sum	375,600.00	375,600	
- Excavate, expose, disconnect and remove existing U/G 100mm gasoline resupply line	500 m	200.00	100,000	
- Disconnect and remove existing A/G 100mm gasoline resupply line with pipe supports	420 m	180.00	75,600	
- Excavate, expose, disconnect and remove existing U/G 150mm ULSDL resupply line	500 m	220.00	110,000	
- Disconnect and remove existing A/G 150mm ULSDL resupply line with pipe supports	420 m	200.00	84,000	
- Disconnect and remove existing piping to Gasoline/LSDL dispensers from dispenser building	1 sum	5,000.00	5,000	
- Disconnect all services prior to remove existing operator's shelter	1 sum	1,000.00	1,000	
4 Lead abatement	1 sum	200,000.00	200,000	
- Additional works due to lead abatement	1 sum	200,000.00	200,000	
D21 Decommissioning **TOTAL : $**	1 sum	920,600.00	920,600	

Appendix
C - Detailed Elemental Cost Estimate: Option 3

Project	: **Arviat Tank Farm Facility**		Report date : 17 Apr 2018
	: **Expansion and Upgrades - Option 3**		Page No. : 1
Location	: **Arviat, Nunavut**	**ELEMENTAL COST SUMMARY**	Bldg Type : 180
Owner	: **Government of Nunavut, Canada**		C.T. Index : 0.0
Consultant	: **WorleyParsons Canada Services Ltd**		GFA : 14,976 m2

Element	Ratio to GFA	Elemental Cost Quantity	Elemental Cost Unit rate	Elemental Amount Sub-Total	Elemental Amount Total	Rate per m2 Sub-Total	Rate per m2 Total	%
A SHELL		14,976 m2			0		0.00	0.0
A1 SUBSTRUCTURE					0		0.00	0.0
A11 Foundations				0		0.00		
A12 Basement Excavation				0		0.00		
A13 Special Conditions				0		0.00		
A2 STRUCTURE					0		0.00	0.0
A21 Lowest Floor Construction				0		0.00		
A22 Upper Floor Construction				0		0.00		
A23 Roof Construction				0		0.00		
A3 EXTERIOR ENCLOSURE					0		0.00	0.0
A31 Walls Below Grade				0		0.00		
A32 Walls Above Grade				0		0.00		
A33 Windows & Entrances				0		0.00		
A34 Roof Coverings				0		0.00		
A35 Projections				0		0.00		
B INTERIORS		14,976 m2			0		0.00	0.0
B1 PARTITIONS & DOORS					0		0.00	0.0
B11 Partitions				0		0.00		
B12 Doors				0		0.00		
B2 FINISHES					0		0.00	0.0
B21 Floor Finishes				0		0.00		
B22 Ceiling Finishes				0		0.00		
B23 Wall Finishes				0		0.00		
B3 FITTINGS & EQUIPMENT					0		0.00	0.0
B31 Fittings & Fixtures				0		0.00		
B32 Equipment				0		0.00		
B33 Elevators				0		0.00		
B34 Escalators				0		0.00		
C SERVICES		14,976 m2			0		0.00	0.0
C1 MECHANICAL					0		0.00	0.0
C11 Plumbing & Drainage				0		0.00		
C12 Fire Protection				0		0.00		
C13 HVAC				0		0.00		
C14 Controls				0		0.00		
C2 ELECTRICAL					0		0.00	0.0
C21 Service & Distribution				0		0.00		
C22 Lighting, Devices & Heating				0		0.00		
C23 Systems & Ancillaries				0		0.00		
NET BUILDING COST - EXCLUDING SITE				**$**	**0**		0.00	0.0
D SITE & ANCILLARY WORK		14,976 m2			14,918,200		996.14	66.7
D1 SITE WORK					10,618,600		709.04	47.5
D11 Site Development	0.000	1 Sum	2,876,000.00	2,876,000		192.04		
D12 Mechanical Site Services	0.000	1 Sum	6,985,000.00	6,985,000		466.41		
D13 Electrical Site Services	0.000	1 Sum	757,600.00	757,600		50.59		
D2 ANCILLARY WORK					4,299,600		287.10	19.2
D21 Decommissioning	0.000	1 Sum	4,299,600.00	4,299,600		287.10		
D22 Alterations				0		0.00		
NET BUILDING COST - INCLUDING SITE				**$**	**14,918,200**		996.14	66.7
Z1 GENERAL REQUIREMENTS & FEE					7,459,200		498.08	33.3
Z11 General Requirements + Fee		25.0 %		3,729,600		249.04		
Z12 Freight and Accommodations		20.0 %		3,729,600		249.04		
TOTAL CONSTRUCTION ESTIMATE - EXCLUDING ALLOWANCES				**$**	**22,377,400**		1,494.22	100.0
Z2 ALLOWANCES					5,594,400		373.56	
Z21 Design & Pricing Allowance		25.0 %		5,594,400		373.56		
Z22 Escalation Allowance		0.0 %		0		0.00		
Z23 Construction Allowance		0.0 %		0		0.00		
TOTAL CONSTRUCTION ESTIMATE - INCLUDING ALLOWANCES				**$**	**27,971,800**		1,867.78	
VALUE ADDED TAX (GST/HST)					0		0.00	
Value Added Tax (GST/HST)		0.0 %		0		0.00		
TOTAL CONSTRUCTION ESTIMATE				**$**	**27,971,800**	**$**	**1,867.78**	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D11 Site Development				
1 Allowance for clearing, grubbing and compaction of site	8,000 m3	30.00	240,000	
2 Fill for tank laydown area c/w grading and compacting	7,000 m3	100.00	700,000	
3 New tank foundation	1,553 m2	253.20	393,200	
- Tank pads (granular)	3,000 m3	100.00	300,000	
- HDPE liner	1,553 m3	30.00	46,600	
- Geotextile (double layer)	3,106 m2	15.00	46,600	
4 New berm	1 sum	782,300.00	782,300	
- Liner	8,447 m2	20.00	168,900	
- Geotextile (double layer)	15,894 m2	15.00	238,400	
- Structural fill (hand laid)	1,500 m3	250.00	375,000	
5 New chainlink fencing c/w gate	500 m	200.00	100,000	
6 New operator building c/w foundations, steel structural. Concrete sidewalks included. Mechanical and electrical services included elsewhere.	12 m2	5,000.00	60,000	
7 New marine spill basin	1 sum	20,000.00	20,000	
- Install	1 sum	20,000.00	20,000	
8 New dispenser building c/w foundations, structural, sidewalks and bollards. Mechanical and electrical services included elsewhere	1 sum	160,000.00	160,000	
9 Allowance for new dispenser island foundation	1 sum	1,500.00	1,500	
10 New stiles to berm	3 no.	5,000.00	15,000	
11 Access ramp	32 m	687.50	22,000	
- Structural fill for access ramp	200 m3	110.00	22,000	
12 Access road	200 m	1,810.00	362,000	
- Clearing and grubbing	1,600 m2	20.00	32,000	
- structural fill	2,200 m3	110.00	242,000	
- Gravel	1,100 m3	80.00	88,000	
		Carried Forward :	2,856,000	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D11 Site Development (Continued)		**Brought Forward :**	2,856,000	
13 Allowance for miscellaneous site work		allow	20,000	
14 Geo-technical report was not recieved and has been excluded		nil		
D11 Site Development **TOTAL : $**	1 Sum	2,876,000.00	2,876,000	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D12 Mechanical Site Services				
1 New field erected, vertical fuel tanks to API design standard & guidelines	1 sum	5,529,000.00	5,529,000	
- 20.85m dia. x 9.75m high vertical gasoline tank, 3,333,000L	1 no.	1,250,000.00	1,250,000	
- 20.85m dia. x 9.75m high vertical ULSDL tank, 3,333,000L	3 no.	1,250,000.00	3,750,000	
- Steel stairs, roof handrail, manholes, gauges etc. included in above price		incl.		
- Exterior paint on above 4 tanks	2,600 m2	140.00	364,000	
- Strapping and calibrating above tanks	1 sum	80,000.00	80,000	
- Hydro testing above tanks	1 sum	60,000.00	60,000	
- Allow for tank overfill alarm system	1 sum	25,000.00	25,000	
- Tank foundations - included elsewhere		nil		
2 Relocate horizontal fuel tanks from existing location to new location	1 sum	80,000.00	80,000	
- Relocate 3.5m dia. x 9.5m long horizontal standby tank, 90,000L (for slop purpose)	2 no.	40,000.00	80,000	
- Tank foundations - included elsewhere		nil		
3 New above ground FO piping in tank farm	1 sum	850,000.00	850,000	
- Allow for new GAS/LSDL piping in tank farm	1 sum	600,000.00	600,000	
- Allow for pipe supports, painting etc.	1 sum	60,000.00	60,000	
- Allow for miscellaneous valves, drain connections etc.	1 sum	150,000.00	150,000	
- Allow for testing complete pipe installation	1 sum	40,000.00	40,000	
4 New LSDL/Gasoline dispenser building and equipment	1 sum	226,000.00	226,000	
- Allow for building heating and ventilation system, fire extinguishers etc.	1 sum	35,000.00	35,000	
- Allow for despensing/truck loading equipment c/w pumps, piping & valves	1 sum	180,000.00	180,000	
- Allow for polygas detection system	1 sum	6,000.00	6,000	
- Allow for drip pans for pumps	1 sum	5,000.00	5,000	
5 New Gasoline/LSDL remote dispenser island	1 sum	80,000.00	80,000	
- Dispenser cabinet	2 no.	25,000.00	50,000	
(Continued)				
		Carried Forward :	6,765,000	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D12 Mechanical Site Services (Continued)		**Brought Forward :**	6,765,000	
5 New Gasoline/LSDL remote dispenser island (Continued)				
- FO supply piping to cabinets and leak detection in sump	1 no.	20,000.00	20,000	
- Dispenser sump c/w fittings, corrugated ducting, entry boot, shear valve etc.	2 no.	5,000.00	10,000	
- Note:- concrete island and apron included elsewhere		nil		
6 New operator's shelter building	1 sum	25,000.00	25,000	
- Allow for building heating and ventilation system, fire extinguishers etc.	1 sum	14,000.00	14,000	
- Allow for polygas detection system c/w control panel	1 sum	6,000.00	6,000	
- Allow for motor operated valves, remote despenser island leak detection sensor & control panels	1 sum	5,000.00	5,000	
7 New resupply lines from shore manifold to tank farm (aboveground)	1 sum	55,000.00	55,000	
- 100mm single wall CS-Sch STD A106 Gr B Gasoline resupply line c/w fittings	40 m	420.00	16,800	
- 150mm single wall CS-Sch STD A106 Gr B Diesel resupply line c/w fittings	40 m	480.00	19,200	
- Pipe supports etc.	1 sum	15,000.00	15,000	
- Allow for signage along pipeline	1 sum	1,000.00	1,000	
- Allow for hydrostatic testing etc.	1 sum	3,000.00	3,000	
8 New shore manifold and marine spill basin	1 sum	40,000.00	40,000	
- Allow for shore manifold c/w sch 40 steel piping, valves & fittings as shown on NT-P02	1 sum	40,000.00	40,000	
- Concrete spill basin as per dwg NT-S11 included elsewhere		nil		
9 Allow for sump, sump pump and pumpout line for new dyke wall	1 sum	100,000.00	100,000	
D12 Mechanical Site Services **TOTAL : $**	1 Sum	6,985,000.00	6,985,000	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D13 Electrical Site Services				
1 Electrical services/instrumentation /controls / lightning protection /grounding grid bonding etc	1 sum	757,600.00	757,600	
- Cash Allowance for incoming power & communications, Signage as per Div 1 - Section 01020	1 sum	50,000.00	50,000	
- Contractor's costs for work to be covered under above cash allowance		allow	20,000	
- U/G power service to operator's shelter from new Utility pole, 3C #500mcm Teck 90 + #4/0 gnd, allow	25 m	600.00	15,000	
- Power service in buried conduit to two fuel dispensing buildings, allow	60 m	250.00	15,000	
- Utility service entrance pole mount tank farm area single light, type E	1 no.	5,000.00	5,000	
- Pole mount HPS tank farm area twin lights type E	2 no.	20,000.00	40,000	
- Pole mount HPS tank farm area three lights type E	2 no.	25,000.00	50,000	
- 150W ceiling mount HPS light, type C	4 no.	1,140.00	4,600	
- 150W stanchion mount HPS light, type D	4 no.	1,300.00	5,200	
- 150W stanchion mount HPS light, type D, temporary horizontal tank	2 no.	1,250.00	2,500	
- Instrument field junction box	1 no.	1,300.00	1,300	
- 2.63x4.67m Gasoline/LSDL dispenser building - electrical	1 sum	80,000.00	80,000	
- 5.00x9.60m Operator shelter bldg. c/w store, service, office, wash room & M/E room - electrical	1 sum	170,000.00	170,000	
- Site grounding	1 sum	60,000.00	60,000	
- 2 #8 Feeders + gnd in 27mm RPVC conduits for lighting	400 m	60.00	24,000	
- 5x2 #8 Feeders + gnd in 50mm RPVC common conduits for lighting	150 m	100.00	15,000	
- 2 #8 Teck 90 feeders direct buried outside containment area for pole mount lights	500 m	70.00	35,000	
- Design & install rectifier type cathodic protection system, 4 new tanks & 2 future tanks	1 sum	35,000.00	35,000	
- Design & install rectifier type cathodic protection system, allow for future expansion	1 sum	2,500.00	2,500	
- Fuel tank overfill alarm system, 4 tanks	1 sum	75,000.00	75,000	
- Fuel tank overfill alarm system, allow for future expansion	1 sum	2,500.00	2,500	
(Continued)				
		Carried Forward :	757,600	

D1 SITE WORK	Quantity	Unit rate	Amount	Trade
D13 Electrical Site Services (Continued)		**Brought Forward :**	757,600	
1 Electrical services/instrumentation /controls / lightning protection /grounding grid bonding etc (Continued)				
- Misc. standard requirements, site conditions etc		allow	50,000	
D13 Electrical Site Services **TOTAL : $**	1 Sum	757,600.00	757,600	

D2 ANCILLARY WORK	Quantity	Unit rate	Amount	Trade
D21 Decommissioning				
1 Decommissioning existing tank farm(mechanical works) and disposal (ship out of community)	1 sum	2,619,600.00	2,619,600	
- Empty, disconnet, dismantle and remove existing horizontal tank, 3.5m dia. x 9.4m long	6 no.	30,000.00	180,000	
- Empty, disconnet, dismantle and remove existing vertical tank, 9.14m dia. x 9.25m high	1 no.	150,000.00	150,000	
- Empty, disconnet, dismantle and remove existing vertical tank, 10.7m dia. x 10.97m high	2 no.	250,000.00	500,000	
- Empty, disconnet, dismantle and remove existing vertical tank, 13.7m dia. x 9.25m high	2 no.	350,000.00	700,000	
- Empty, disconnet, dismantle and remove existing vertical tank, 18.3m dia. x 9.75m high	1 no.	600,000.00	600,000	
- Disconnect and remove existing tank farm Gasoline/LSDL A/G piping c/w pipe suppors	1 sum	100,000.00	100,000	
- Excavate, expose, disconnect and remove existing U/G 100mm gasoline resupply line	500 m	200.00	100,000	
- Disconnect and remove existing A/G 100mm gasoline resupply line with pipe supports	420 m	180.00	75,600	
- Excavate, expose, disconnect and remove existing U/G 150mm ULSDL resupply line	500 m	220.00	110,000	
- Disconnect and remove existing A/G 150mm ULSDL resupply line with pipe supports	420 m	200.00	84,000	
- Disconnect all services prior to remove existing operator's shelter , dispenser building & island	1 sum	20,000.00	20,000	
2 Decommissioning existing tank farm (electrical works) and disposal (ship out of community)	1 sum	300,000.00	300,000	
- Allow for disconnect and remove all power feeders, panels, lighting, grounding etc.	1 sum	300,000.00	300,000	
3 Lead abatement	1 sum	250,000.00	250,000	
- Additional works due to lead abatement	1 sum	250,000.00	250,000	
		Carried Forward :	3,169,600	

D2 ANCILLARY WORK	Quantity	Unit rate	Amount	Trade
D21 Decommissioning (Continued)		**Brought Forward :**	3,169,600	
4 Decommissoning existing tank farm site works (ship out of community) and reclamation of old land/site	1 sum	1,130,000.00	1,130,000	
- Remove existing dispenser building	1 sum	100,000.00	100,000	
- Remove existing operator building	1 sum	150,000.00	150,000	
- Removal of existing dispenser island	1 sum	50,000.00	50,000	
- Remove existing berm	1 sum	150,000.00	150,000	
- Remove existing chainlink fence	320 m	250.00	80,000	
- Allowance for removal of any contaminated soils from existing site	1 sum	600,000.00	600,000	
D21 Decommissioning **TOTAL : $**	1 Sum	4,299,600.00	4,299,600	

Appendix
D - Drawing List

APPENDIX D - DRAWING LIST

DOCUMENT

Title	Dated	Received
Existing Layout	17 Nov. 2017	22 Nov. 2017
Option 1 Layout	17 Nov. 2017	22 Nov. 2017
Option 2 Layout	17 Nov. 2017	22 Nov. 2017
Option 3 Layout	17 Nov. 2017	22 Nov. 2017
Option 1 Scope of Work	Nov. 2017	22 Nov. 2017
Option 2 Scope of Work	Nov. 2017	22 Nov. 2017
Option 3 Scope of Work	Nov. 2017	22 Nov. 2017
Schedule A: Request for Proposal	20 July 2017	22 Nov. 2017
Environmental Assessment	Nov. 2017	4 Dec. 2017
Arviat Tank Farm Facility Needs Assessment Study	Oct. 2017	22 Nov. 2017

APPENDIX D – POPULATION PROJECTIONS

Nunavut Census Total Population by Age Group, Region and Community, 2006, 2011 and 2016 Censuses

	2006				2011				2016			
	Total Population	0 to 14	15 to 64	65 and over	Total Population	0 to 14	15 to 64	65 and over	Total Population	0 to 14	15 to 64	65 and over
Nunavut	**29,475**	**9,995**	**18,670**	**815**	**31,905**	**10,425**	**20,425**	**1,060**	**35,945**	**11,690**	**22,900**	**1,360**
Qikiqtaaluk (Baffin)	**15,765**	**5,080**	**10,310**	**370**	**16,940**	**5,195**	**11,215**	**525**	**18,985**	**5,975**	**12,330**	**695**
Arctic Bay	690	240	430	10	825	300	485	40	870	330	505	35
Cape Dorset	1,235	430	775	25	1,365	455	850	50	1,440	520	860	60
Clyde River	820	315	480	10	935	340	570	25	1,050	370	645	30
Grise Fiord	140	65	80	0	130	40	90	5	125	25	100	10
Hall Beach	655	250	375	15	540	200	325	25	850	335	485	30
Igloolik	1,540	635	880	20	1,455	555	855	35	1,685	660	970	55
Iqaluit	6,185	1,565	4,490	115	6,700	1,600	4,940	165	7,740	1,925	5,580	240
Kimmirut	410	145	270	5	455	155	285	15	390	130	245	15
Pangnirtung	1,325	470	800	50	1,425	495	860	70	1,480	500	890	90
Pond Inlet	1,315	480	810	30	1,550	545	955	45	1,615	585	975	60
Qikiqtarjuaq	475	145	305	30	520	150	345	20	595	190	380	20
Resolute	225	90	160	5	215	65	135	15	195	60	130	5
Sanikiluaq	745	295	430	25	810	290	495	30	880	315	535	30
Kivalliq (Keewatin)	**8,350**	**3,055**	**5,045**	**240**	**8,955**	**3,180**	**5,465**	**300**	**10,415**	**3,540**	**6,485**	**390**
Arviat	2,060	825	1,210	35	2,320	890	1,350	75	2,660	955	1,600	95
Baker Lake	1,725	620	1,050	65	1,875	595	1,195	80	2,070	650	1,310	105
Chesterfield Inlet	330	110	200	10	310	105	195	20	435	150	275	20
Coral Harbour	770	305	440	25	835	300	495	35	890	340	525	35
Rankin Inlet	2,360	775	1,490	75	2,270	710	1,495	60	2,840	820	1,925	90
Naujaat	745	295	440	5	945	425	495	15	1,085	465	590	30
Whale Cove	355	140	190	10	..	..	..	..	435	165	255	30
Kitikmeot	**5,360**	**1,855**	**3,325**	**180**	**6,010**	**2,050**	**3,730**	**230**	**6,545**	**2,170**	**4,090**	**300**
Cambridge Bay	1,475	455	965	65	1,610	455	1,095	60	1,770	475	1,205	80
Gjoa Haven	1,065	400	625	20	1,280	470	760	55	1,325	485	790	50
Kugaaruk	685	285	380	15	770	320	425	20	935	365	550	30
Kugluktuk	1,300	410	850	65	1,450	465	930	60	1,490	465	945	80
Taloyoak	810	300	470	35	900	340	520	25	1,025	390	595	45

Notes: *1) Data may not add to totals due to random rounding.*

2) .. Whale Cove, data has been suppressed for data quality due to a global non-response higher than or equal to 25%.

Sources: Statistics Canada, 2006, 2011 and 2016 Censuses of Population, Catalogues #94-575-XCB2006001, #98-311-XCB2011026 and #98-400-X2016003

File prepared by Nunavut Bureau of Statistics, May 5, 2017

Kivalliq Community Population Projections, 2014 to 2035

Total	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Kivalliq	**10,467**	**10,653**	**10,856**	**11,057**	**11,260**	**11,464**	**11,673**	**11,880**	**12,083**	**12,288**	**12,492**	**12,700**	**12,912**	**13,123**	**13,363**	**13,585**	**13,804**	**14,028**	**14,252**	**14,472**	**14,692**	**14,908**
Arviat	2,611	2,671	2,737	2,804	2,870	2,937	3,006	3,075	3,143	3,210	3,275	3,340	3,405	3,467	3,528	3,590	3,652	3,715	3,780	3,845	3,912	3,980
Baker Lake	2,164	2,194	2,229	2,264	2,299	2,333	2,369	2,404	2,435	2,468	2,499	2,532	2,565	2,597	2,632	2,667	2,700	2,736	2,767	2,800	2,829	2,861
Chesterfield Inlet	387	392	398	402	407	413	418	423	428	433	438	442	447	452	460	465	471	477	483	489	495	501
Coral Harbour	961	979	998	1,016	1,034	1,053	1,073	1,093	1,112	1,131	1,150	1,174	1,197	1,220	1,247	1,274	1,300	1,326	1,353	1,379	1,405	1,429
Rankin Inlet	2,820	2,864	2,908	2,953	2,998	3,046	3,093	3,139	3,185	3,228	3,274	3,318	3,365	3,411	3,470	3,520	3,566	3,615	3,664	3,710	3,754	3,794
Repulse Bay	1,068	1,091	1,118	1,144	1,170	1,195	1,220	1,244	1,272	1,302	1,334	1,364	1,396	1,430	1,470	1,507	1,544	1,581	1,620	1,658	1,696	1,736
Whale Cove	456	461	468	474	481	488	494	502	509	515	522	529	538	546	555	563	571	578	585	592	600	606
Male	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Kivalliq	**5,449**	**5,537**	**5,634**	**5,731**	**5,828**	**5,928**	**6,030**	**6,131**	**6,228**	**6,327**	**6,425**	**6,525**	**6,629**	**6,733**	**6,862**	**6,967**	**7,071**	**7,176**	**7,278**	**7,378**	**7,478**	**7,575**
Arviat	1,278	1,307	1,339	1,371	1,404	1,436	1,470	1,505	1,539	1,573	1,606	1,639	1,672	1,703	1,734	1,764	1,794	1,825	1,855	1,886	1,919	1,951
Baker Lake	1,163	1,178	1,196	1,214	1,231	1,249	1,268	1,286	1,301	1,318	1,333	1,350	1,367	1,384	1,402	1,420	1,438	1,455	1,470	1,484	1,497	1,511
Chesterfield Inlet	211	214	216	218	220	222	225	227	229	231	233	235	237	239	243	245	248	250	252	255	258	260
Coral Harbour	518	526	536	545	554	563	572	581	591	600	609	620	631	642	658	670	683	696	709	721	733	745
Rankin Inlet	1,459	1,479	1,499	1,520	1,541	1,564	1,586	1,608	1,629	1,649	1,669	1,689	1,711	1,733	1,767	1,790	1,811	1,832	1,853	1,873	1,891	1,907
Repulse Bay	568	579	591	604	616	627	639	651	664	679	693	708	723	739	760	776	793	811	828	846	864	883
Whale Cove	252	254	257	260	263	266	269	272	276	278	282	285	289	293	298	301	304	307	310	313	316	319
Female	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**
Kivalliq	**5,018**	**5,116**	**5,221**	**5,326**	**5,432**	**5,536**	**5,643**	**5,749**	**5,855**	**5,961**	**6,067**	**6,175**	**6,283**	**6,391**	**6,501**	**6,618**	**6,733**	**6,852**	**6,974**	**7,094**	**7,214**	**7,333**
Arviat	1,333	1,364	1,398	1,433	1,467	1,501	1,536	1,570	1,604	1,637	1,669	1,701	1,733	1,764	1,794	1,826	1,858	1,890	1,924	1,959	1,993	2,029
Baker Lake	1,001	1,017	1,033	1,050	1,068	1,084	1,101	1,118	1,134	1,150	1,166	1,182	1,198	1,214	1,230	1,247	1,262	1,280	1,298	1,316	1,332	1,350
Chesterfield Inlet	176	179	182	184	187	190	193	196	199	202	205	208	210	213	217	220	224	227	231	234	238	241
Coral Harbour	443	453	462	471	480	490	501	511	521	531	541	554	566	578	590	603	617	630	644	658	671	684
Rankin Inlet	1,361	1,385	1,409	1,433	1,458	1,482	1,507	1,531	1,556	1,580	1,605	1,629	1,654	1,678	1,703	1,729	1,755	1,783	1,811	1,837	1,863	1,888
Repulse Bay	500	512	526	540	554	567	580	593	608	624	640	657	674	691	710	730	750	771	791	812	833	854
Whale Cove	204	207	211	215	218	222	225	229	233	236	240	244	249	253	257	262	266	270	275	278	283	287

Notes:

1) The base year of 2014 are population estimates (based on the 2011 Census counts adjusted for net census undercoverage).

2) Community population projections are preliminary and subject to revision.

3) Region totals include Unorganized areas and outpost camps.

4) These projections should be used with some caution, due to the small numbers on which the projections are based.

5) Custom tabulations of the community population projections are available upon request.

Source: Nunavut Bureau of Statistics

Prepared by: Nunavut Bureau of Statistics, December 17, 2014

APPENDIX E – PAINT LEAD TEST RESULTS

Viper Inspection Report Arviat Tank Farm

To: Sanjay Khera of Worley Parsons Canada

Written By: Steven Holmes NACE certified coating inspector.

Date: January 8, 2018

Location: Arviat Tank Farm

Re: Coating inspection of Tanks and Pipeline – Arviat Tank Farm Facility.

Steven Holmes

Nace Certified # 37165

A. **EXECUTIVE SUMMARY**

Viper Inspection was requested by Worley Parsons Canada to conduct coating inspection and assessment of the external surface/paint of the tanks & the above ground pipeline at the Arviat Tank Farm Facility.

The scope of work included:

1. Visual inspection of the external surfaces of the tanks and above-ground pipeline;
2. Collection of paint samples of all the coatings down to the substrate on the external surface of the tanks and above-ground pipeline;
3. Testing of the paint samples for any lead content at an accredited laboratory;
4. Analyzing the laboratory test report and recommend whether lead abatement will be necessary, and
5. Document the findings in a brief report.

The site visit was completed in early January, 2018 and the samples collected from the Arviat Tank Farm site were sent to the laboratory for testing.

According to the laboratory test results (Appendix E), lead content in the paint samples is less than allowable limit defined by WSCC, Guideline for the Management of Waste Lead and Lead Paint. As per WSCC, 600 ppm (0.06% wt.) lead content and above is considered as lead amended paint. The highest analyzed lead concentration was limited to 158 ppm from the samples taken from the Tank #7.

B. **SITE INSPECTION DETAILS**

1. Visual inspection showed that the tanks were coated with a gray primer which looked like a Zinc primer. The white coating on top looked like an epoxy coating which was failing in several areas. (See Figures 1 & 2)

Figure1. Coating failure - gray primer.

Figure 2. Coating failure.

2. The inspector saw the epoxy laminating and there was no sign of any polyurethane coating to protect the epoxy from UV light of the sun. Rust bleeding through the zinc primmer was also observed. (See Figure 3)

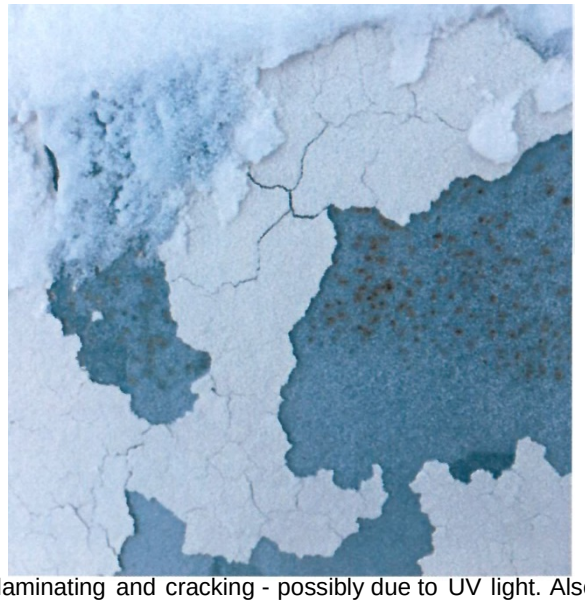


Figure3. Coating laminating and cracking - possibly due to UV light. Also rust bleeding.

3. The above ground pipeline looked like it was an epoxy only. There was total coating failure on the bottom half of the pipeline in some areas. (See Figure 4)

Figure 4. The underside of the of the pipeline showing total coating failure.

4. A total of 16 coating samples were taken from the tanks and the pipeline.

5. The stairs are welded onto the side of the tanks, and it was observed that the coating had failed on the welds connecting each step to the tank.

6. The handrails also showed signs of coating failure.

7. The weather was very cold and temperatures of -47°C kept freezing up the inspector's camera. Hence there are only a few photos in this report.

8. The zinc primer has adhered well to the tanks with isolated areas of rust bleeding through.

9. With the top coat failing the zinc will start sacrificing itself to protect the steel tanks.

10. It appears that the coating failure is occurring due to the inadequate coating system.

11. Some portions of the pipeline were buried under snow and samples could not be taken from those portions.

12. The nuts & bolts on the manway doors on the tanks had very little coating or no coating.

C. CONCLUSION AND RECOMMENDATIONS

1. Paint lead test results are listed in Appendix E. According to the laboratory results, lead content in the paint samples are less than allowable limit defined by WSCC, Guideline for the Management of Waste Lead and Lead Paint. As per WSCC, 600 ppm (0.06% wt.) lead content and above is considered as lead amended paint. The highest analysed lead concentration is limited to 158 ppm from the samples taken from the Tank #7.

2. All tanks and above-ground pipelines should be coated with a suitable coating system.

3. It is advisable to check the welding on the steps attached to the tanks, to determine if there have not been weakened from the rust observed during the site inspection. I

4. A schedule to check the internal condition of the tanks should be developed to determine if there are any issues that need to be addressed

Guideline for the Management of Waste Lead and Lead Paint

1 Introduction

1.1 Definitions
1.2 Potential Effects
1.3 Common Sources of Lead

2 Roles and Responsibilities

2.1 Environmental Protection Service
2.2 Occupational Health and Safety
2.3 Public Health and Safety
2.4 Generators
2.5 Sand Blasting Contractors

3 Waste Management

3.1 Pollution Prevention
Containment of Paint and Abrasive Debris
3.3 Recovery of Paint and Abrasive Debris
3.4 Storage
3.5 Transportation
3.6 Disposal

4 Agency Information

4.1 Key to Acronyms
4.2 Agency Contacts

5 Bibliography

April 2004

Guideline for the Management of Waste Lead and Lead Paint

1 Introduction

Waste products that contain lead are considered contaminants under the Northwest Territories' *Environmental Protection Act* (EPA) and must be managed as a hazardous waste. This guideline presents a brief introduction into the management of waste lead and lead containing products. It is intended as a source of basic information and does not replace the existing legislation, which is referenced throughout.

Historically, lead was used in many commercial products including: paint, gasoline, insecticides and batteries, to name a few. We now know that products and structures painted with leaded paint are a source of health and environmental contaminants. Lead in gasoline and household paints is now restricted by federal legislation, as are lead pellet shotgun shells used for hunting migratory birds.

Lead is toxic to living organisms and if released into the environment can bioaccumulate and enter the food chain. Products that contain lead in excess of 600 parts per million (0.06% by weight) are considered hazardous waste and shall be managed in accordance with this guideline.

This document should be read in conjunction with the Guideline for the General Management of Hazardous Waste In The NWT (referred to as the General Guideline), and, the Guideline for the Management of Waste Institutional/Commercial and Industrial Chemicals. Management of lead acid batteries is addressed under the Guideline for the Management of Waste Batteries.

Section 2.2 of the EPA gives the Minister of Resources, Wildlife and Economic Development the authority to develop, coordinate and administer these guidelines. Other Acts and Regulations are also in place to protect workers and the public from the effects of lead exposure. Please contact the appropriate agency before proceeding on projects involving waste lead and lead paint.

1.1 Definitions

Controlled product Any product, material or substance specified under paragraph 15(1)(a) of *the Hazardous Products Act* (Canada) and its regulations.

Fume	The smoke-like vapour given off from heated metals.
Generator	The owner or person in charge, management or control of a hazardous waste at the time it was generated, or a facility that generates hazardous waste.
Lead amended paint	Structural coatings containing greater than 600 parts per million (0.06% by weight) lead.
Metallic lead	The solid metal form of lead, bluish-white or silvery-gray in colour. By weight, it is heavy and is also soft, which makes it ductile and malleable. Other desirable properties are that it is a poor conductor of electricity, it has a low melting point and it is resistant to corrosion. Uses include: ammunition, electrical storage batteries (lead acid batteries), lead solder, pipes, sheaths for electrical cable and radiation shields.
Organic lead	In general, lead combined with a chemical compound containing carbon. These chemical compounds are usually in powder, crystal, paste or liquid form, depending on the compound. Uses include tetraethyl lead (used as an anti-knock agent in gasoline), tetramethyl lead, lead naphthanate, stearate and oleate.
Inorganic lead	In general, lead substances that <u>do not</u> contain compounds of carbon, hydrocarbons or derivatives. These chemical compounds are usually found in powder or crystal form, but some are liquid. Uses include: frits, glasses, insecticides, wood preservatives, specific paints, pigments, plastics and rubber compounds.
Transport authority	The regulations controlling the management of hazardous waste under specified modes of transport. They include:

<u>Road and rail</u>	*Transportation of Dangerous Goods Act* (TDGA) and *Regulations* (TDGR)
<u>Air</u>	*International Civil Aviation Organization* (ICAO) *Technical Instructions*
<u>Marine</u>	*International Maritime Dangerous Goods Code* (IMDG)

1.2 Potential Effects

Metallic lead

Fumes – Lead fumes inhaled during melting operations pose an acute health risk to people. They can also be an accumulative poison and if exposure continues, chronic health symptoms and disability occur. The major areas affected are the nervous system, blood system and kidneys.

Dust – Metallic lead can also enter the body through breathing dust from activities such as sandblasting of lead paint. If inhaled, lead particles smaller than 10 microns (one-millionth meter) can move directly into the bloodstream through the lungs.

Another source of occupational lead exposure is by accidental ingestion as workers handle cigarettes or food when their hands are contaminated with lead dust.

Contact with Water – Metallic lead is not water soluble between the pH range of 5 and 12. If prevented from contacting water or water vapor, it will not leach into the environment.

Organic lead

These chemical compounds are generally toxic by inhalation, ingestion and skin absorption. With skin absorption being the primary route of exposure, it readily penetrates the skin directly or is dissolved in oils, which can penetrate the skin. Many organic lead compounds are also flammable or carcinogenic. Ingestion of leaded paint dust and chips has been shown to retard mental and physical growth in children.

Inorganic lead

These chemical compounds are generally toxic by inhalation or ingestion. Skin absorption is generally insignificant for both metallic and inorganic lead.

Hazardous Effect Ratings

	inhalation	**ingestion**	**skin absorption**
Metallic lead	High (extreme when heated)	Medium	Low
Organic lead	Medium	High	High
Inorganic lead	Low	High	Low

1.3 Common Sources of Lead

Metallic lead

Automotive industry:	wheel weights, bearings, friction additive in clutch facings and brakes, storage batteries
Construction industry:	flashing, pipe, sheeting, counterweights, paint additives
Electronic industry:	cathode-ray tubes, radiation shielding, solder
Resource industry:	fishing sinkers, rifle bullets, backstops at rifle and pistol ranges
Printing industry:	letter blocks

Organic lead

Miscellaneous:	paint, insecticides, fungicides, chemical reagents, gasoline additives, pigments, dyes
Automotive industry:	spent glycol solution removed from cooling systems with heat exchangers made from alloys containing lead as an adhesive

Inorganic lead

Oil field construction:	joining compound (pipe dope)
Automotive industry:	ceramic products, paints, rubbers, dyes, corrosion inhibiting pigment in paints and primers
Miscellaneous:	manufacture of explosives, blasting caps, matches and pyrotechnics, chemical reagents, pigments, dyes

2 Roles and Responsibilities

2.1 Environmental Protection

The **Environmental Protection Service** (EPS) is part of the Government of the Northwest Territories' (GNWT) Department of Resources, Wildlife and Economic Development. EPS is the agency responsible for control of how contaminants are discharged and their impact on the natural environment. It is responsible for ensuring environmentally acceptable management procedures, emission levels and disposal methods are maintained in the NWT.

EPS programs are applied primarily to Commissioner's Land, municipal lands or lands involving GNWT activities. Legislative authority is provided by the *Environmental Protection Act* (EPA) and *Pesticide Act*. Contact EPS for a listing of relevant regulations and guidelines or visit the web site at www.gov.nt.ca/RWED/eps/leg.htm.

2.2 Occupational Health and Safety

The **Prevention Services Division of the Workers' Compensation Board** regulates worker protection from air-borne lead and other toxic materials. The *General Safety Regulations*, under the *Northwest Territories Safety Act*, require that employee exposure to hazardous air-borne dust be maintained below specified levels. The specified exposure levels correspond to the type of materials in use and are listed in the Schedule to the regulations.

Contact the Prevention Services Division for regulations and procedures to prevent worker exposure to toxic materials. This includes lead abatement projects (leaded paint removal), handling products containing lead or the grinding, cutting or welding of products coated in leaded paint. Also included are worker protection measures for use during clean up of backstops at rifle and pistol ranges.

2.3 Public Health and Safety

The **Department of Health and Social Services** has the authority for public health and safety. The *General Sanitation Regulations,* under the authority of the *Public Health Act,* is the legislation used to protect the public from materials or activities that are injurious to public health. As an example, lead abatement projects, which use sand or abrasive blasting to remove leaded paint from steel structures, have the potential to adversely impact on public health. Responsible management of such projects means consulting with an Environmental Health Officer.

2.4 Generators

The responsibility for proper waste management rests with the generator and should be considered part of the "cost of doing business".

Identification of lead in organic and inorganic lead-based chemicals is accomplished by review of the Material Safety Data Sheets (MSDS), which must accompany all controlled products distributed in Canada. Manufacturers or their product distributors are required to provide an MSDS with their products.

Alternate resources may be required to identify older products suspected of containing lead. Analysis by an accredited laboratory is one option. Laboratories can be contacted through their associations listed in the General Guideline, Appendix II.

Management options for lead-containing chemicals (organic or inorganic) are addressed in the Guideline for the Management of Waste Institutional - Commercial and Industrial Chemicals. The General Guideline should also be consulted for generator responsibilities.

Wastes Further Addressed

For the purpose of this guideline, only the following wastes containing lead and their management are further addressed:

- lead amended paint
- sand or soils used as backstops at rifle and pistol ranges
- soils containing lead at steel structure manufacturing/construction or repair yards

It is the owner's responsibility to identify the presence of lead. Common examples of where lead amended paint is found include:

- barges and ships, heavy equipment
- steel fabrication/painting facilities
- pipelines
- fuel storage tanks
- steel bridges
- steel towers
- grain storage bins
- rail cars

The owner is responsible for evaluating painted steel structures or fabrication/ demolition sites for the presence of lead. Painted tanks or other steel structures should be sampled for confirmation of lead amended paint and lead concentration prior to sandblasting or other maintenance activities.

In addition to lead, industrial or steel coatings such as paint and paint primer, may contain other contaminants to be aware of such as arsenic, polychlorinated biphenyls (PCBs), cadmium, chromium, copper, magnesium and mercury. These are toxic substances if inhaled or ingested.

Paint Samples

A paint sample should be collected from tightly adhered paint and comprised of all layers of paint, from a one square inch area (2.5 cm). Make sure to scrape down to the metal, being careful not to include any metal in the sample. A plastic bag is an adequate container. The paint should then be analyzed, at the owner's expense, at an accredited laboratory. The analytical data should then be forwarded to EPS.

Rifle Range Backstop Samples
Sample collection from rifle range backstops should be done by following the procedures provided by an accredited analytical laboratory to ensure representative samples are obtained. Personal protective equipment may be required, consult WCB Safety Officers.

Soil Samples
Information on the procedures for sampling lead in soil are available from accredited analytical laboratories.

Important Analysis Note
Due to the complex chemical relationship of lead and iron, the Toxic Characteristic Leaching Procedure (TCLP) is not acceptable for lead analysis. Iron masks TCLP detection of lead. The only accepted lead analysis is called “Total Lead”.

2.5 Sandblasting Contractors

Repainting of steel structures for rust protection usually involves sandblasting of the deteriorated paint, in preparation for a new coating of primer and paint. Painted tanks or other steel structures should be sampled for confirmation of lead and lead concentration prior to sandblasting or other maintenance activities. Consultation with the appropriate regulatory agencies prior to starting lead abatement projects is the responsible work strategy to prevent public, worker and environmental impairment.

Sandblasting Media Hazards
The International Agency for Research on Cancer, established by the World Health Organization in 1995, classified crystalline (free) silica as carcinogenic to humans when inhaled in the form of quartz or cristobalite from occupational sources. Selection of a non-hazardous sandblasting medium will reduce the hazard dust levels that need to be controlled and managed as hazardous wastes.

Non-carcinogenic sand types should be specified for sandblasting. Alternately, products like nutshells, solid carbon dioxide or baking soda-based abrasives should be used to remove deteriorated paint. Ultra-high pressure water jetting of leaded paint is recommended as paint and abrasive dusts are not produced. Names of alternate blasting media suppliers are available by contacting the paint associations listed in this document under section 4 Agency Contacts.

3 Waste Management

> **Minimizing or avoiding the creation of pollutants and wastes can be more effective in protecting the environment than treating or cleaning them up after they have been created.** -- Canadian Council of Ministers of the Environment

3.1 Pollution Prevention

"Pollution prevention" methods eliminate the creation of environmental contaminants by preventing the waste from being created in the first place. "Pollution control" methods are geared towards treating the waste after it's created.

Scientific advances in the paint and coatings industry have resulted in the development of superior paints and coatings that provide corrosion resistance on steel and other structures. Leaded paints are no longer required.

Approximately 500 protective coatings and linings are available to provide protection, without lead, for commercial and industrial structures. These coatings have been developed for five general exposure environments (categories) and special purpose materials i.e. exterior service, flooring, immersion service, buried pipe, buried structures and specialty function.

Coating subcategories that list more detailed exposure conditions; types of structures, heat resistance etc., as well as the generic coatings types (e.g. Acrylic, Epoxy, Zinc-rich, Polyurethane. etc.); and the recommended uses, are available in The Journal of Protective Coatings and Linings (ISSN 8755-1985).

Technology Publishing Company in cooperation with the Steel Structures Painting Council publishes the Journal of Protective Coatings and Linings on a monthly basis. The RWED Library has available, for viewing, all monthly issues of the journal from 1994. Coating manufacturers, coating consultants and new technologies are also listed.

Pollution prevention methods for structures with leaded paint include:

- repainting without complete paint removal
- spot painting, overcoating, zone coating, or deferring painting entirely
- alternatives to sandblasting such as cleaning with ultra-high pressure water jets, vacuum power tools, rotary power tools, vacuum head needle guns, and chemical strippers

Because of potential health and environmental hazards, sandblasting should only be considered after a thorough evaluation of the structure and the pollution prevention options.

Containment of Paint and Abrasive Debris

Regardless of the leaded paint removal method, total containment of the leaded paint and abrasive debris or paint strippers is a requirement of the *Environmental Protection Act*.

A containment system must be used to enclose an entire work area or paint removal tool. It includes cover panels, screens, scaffolds, supports and shrouds. The purpose of such a system is to minimize and prevent any generated debris from entering the environment, and to facilitate the controlled collection of the debris for disposal. Containment systems may also employ the use of ground covers or water booms.

Containment devices include:
- drop sheets or tarps
- shrouding or free-hanging enclosures
- total structure enclosures
- negative pressure containment

In general, high-pressure water jetting for paint removal is fast, less expensive than other methods and generates minimal waste. Also, worker safety is increased, as lead paint dust is not created. However, the water must be filtered to remove all paint residues and it must be tested for lead prior to discharge.

Filter fabric is used to remove the paint from the water. The filter fabric and paint residues require containment and managed as hazardous waste. The remaining water requires testing to ensure no more than 5 mg/l (ppm) of total lead remain prior to discharge to the environment or sewage lagoon (Guideline for Industrial Waste Discharges in the NWT). Water analysis is required by EPS prior to receiving discharge authorization.

3.3 Recovery of Abrasive and Paint Debris

Collection of paint residues must be undertaken frequently to prevent dispersal by wind or by sandblasting operations. A vacuum is recommended as a rapid on-site collection method. Sweeping and shoveling are also used for cleaning abrasives from the ground covers.

Collection containers must not allow sandblasting wastes to spill or leak into the environment. Open-top drums or strong plastic bags are examples of materials that can be used for waste collection and storage, pending disposal. Debris collection techniques include:
- capture from surface at point of cleaning (vacuum blasting)
- capture from containment enclosures (sweeping, vacuuming)

- capture from ground or over water (tarps, barges)
- channeling debris to specified collection points

3.4 Storage

Lead compounds or materials contaminated with lead must be stored in a safe and secure manner. They should be in leakproof containers to prevent release into the environment. Depending on the material, the packaging should be designed to prevent contact with precipitation or it should be stored indoors.

3.5 Transportation

Lead waste transported to a recycling, treatment, disposal or management facility must be properly classified, packaged, labelled and manifested, as required by the transport authority (air, road, rail, marine), as the case may be. Specific requirements for waste generators, carriers and receivers are detailed in the General Guideline.

Registration numbers, waste manifests and registered hazardous waste carrier lists are available from EPS. Waste management contacts are listed in the General Guideline.

For road transportation purposes, dry leaded paint waste or lead contaminated soils/materials from pistol and rifle range backstops can be classified as shown below.

Shipping Name:	**Leachable Toxic Waste (L17)** **Classification: 9.3** **P.I.N.: UN9500** **Packing Group: III**

Chemical stripping of lead paint generates both a corrosive waste and a lead leachable waste. The disposal options are the same as that for the dry wastes generated by mechanical means. However, the shipping requirements must reflect the additional hazards of being corrosive.

The shipping requirements will be based on the chemical characteristics of the chemical stripper used to remove the paint. Consultation with the TDGR, IATA or IMDG is recommended.

3.6 Disposal

Metallic Lead
Disposal of metallic lead, such as wheel weights or sheeting, can be done by shipping to a lead or metals foundry, or a metals recycler (metallic lead is not listed in the *Transportation of Dangerous Goods Act* or regulations).

Inorganic and Organic Lead Chemical Waste
Management is addressed in the Guideline for the Management of Waste Institution - Commercial and Industrial Chemicals.

Leaded Paint/Soils
Disposal options for leaded paint and sandblast residue, and lead contaminated soils/materials from pistol and rifle range backstops include transport to a registered hazardous waste disposal facility, or a lead or metals foundry. The receiving facility must be registered in the receiving province or territory and approved to manage that waste.

Names of recycling or disposal companies are available by contacting the waste management associations listed in Appendix II of the General Guideline. Generator registration numbers, waste manifests and registered hazardous waste carrier lists are available from the Environmental Protection Service.

Scientific advances in waste product stabilization and solidification utilizing cement, flyash, zeolites, etc., which chemically bind the lead and prevent environmental release are presently under review. EPS may approve the method, subject to conditions, if leachate test results are in accordance with the Guideline for Industrial Waste Discharges in the NWT and amendments.

If sandblast medium contains iron, the Toxic Characteristic Leaching Procedure (TCLP) cannot be used to meet requirements of the Guideline for Industrial Waste Discharges in the NWT.

Consideration will be given to proposals for alternate management methods that provide a level of environmental protection equivalent to those discussed in this guideline.

4 Agency Information

4.1 Key to Acronyms

EPA	Environmental Protection Act
EPS	Environmental Protection Service
GNWT	Government of the Northwest Territories
IATA	International Air Transportation Association
ICAO	International Civil Aviation Organization
IMDG	International Maritime Dangerous Goods Code
MSDS	Material Safety Data Sheets
SSPC	Steel Structures Painting Council
TCLP	Toxic Characteristic Leaching Procedure
TDGA	Transportation of Dangerous Goods Act
TDGR	Transportation of Dangerous Goods Regulations
General Guideline	Guideline for the General Management of Hazardous Waste in the NWT

4.2 Agency Contacts

Contact these agencies for further information on the proper management of waste lead and lead paint:

Government Departments

- Environmental Protection Service
  Department of Resources, Wildlife and Economic Development
  Government of the Northwest Territories
  600, 5102 - 50 Avenue
  Yellowknife, NT X1A 3S8

  Phone: (867) 873-7654 Fax: (867) 873-0221
  www.gov.nt.ca/RWED/eps/leg.htm

- Motor Vehicles
  Department of Transportation
  Government of the Northwest Territories
  76 Capital Drive, Suite 201
  Hay River, NT X0E 1G2

  Phone: (867) 874-5000 Fax: (867) 874-6088

- Workers' Compensation Board
  Box 8888, Yellowknife, NT, X1A 2R3

  Phone: (867) 920-3888 or 1-800-661-0792
  Fax: (867) 873-0262 or 1-866-277-3677

- Health Protection
  Department of Health and Social Services
  Government of the Northwest Territories
  Box 1320, Yellowknife, NT, X1A 2L9

  Phone: (867) 920-8646 Fax: (867) 873-0122
  www.gov.nt.ca/HLTHSS

Paint and Environmental Associations

- Canadian Paint & Coating Association
  9900 Cavendish Blvd., Suite 103
  St-Laurent, Quebec H4M 2V2

  Phone: (514) 745-2611 Fax: (514) 745-2031

- Environmental Services Association of Alberta
  10303 Jasper Ave. N.W.
  Edmonton, Alberta T6E 3N6

  Phone: (780) 429-6363 Fax: (780) 429-4249
  www.essa.org

- Steel Structure Painting Council of Canada
  (Northern Alberta & Northwest Territories)
  c/o Barry Grundy, Regional Manager
  Sil Industrial Minerals
  P.O. Box 6100 Station C
  Edmonton, Alberta T5B 4K5

Phone: (780) 478-7171 Fax: (780) 472-6984

- The Society for Protective Coatings
  40 - 24th Street, 6th Floor
  Pittsburgh, PA 15222-4656
  USA

  Phone: (412) 281-2331 Fax: (412) 281-9992
  www.sspc.org

5 Bibliography

Canadian Council of Ministers of the Environment (CCME), 1997 Recommended Guidelines - Canadian Soil Quality Guidelines for Lead; (EC 1996; HC1996).

Animal Health Division of Alberta Agriculture; Lead Poisoning in Cattle; 1998 Government of Alberta.

Journal of Occupational and Environmental Medicine 1999; 41:3-10.
Lead exposure linked to mental distress.

N. Irving Sax, Richard J. Lewis (1989), Dangerous Properties of Industrial Materials, Seventh Edition, Van Nostrand Reinhold, Publishers, New York, NY.

Kenneth A. Timber, Daniel P. Adley, (1994), Project Design Industrial Lead Paint Removal Handbook Volume ll. Technology Publishing Company, Pittsburgh, PA.

Kenneth A. Timber, (1993), Industrial Lead Paint Removal Handbook 2nd Edition, Published by KTA-Tator, Inc. Pittsburgh, PA, A Steel Structures Painting Council Text.

Weast, R. C., ed., Handbook of Chemistry and Physics 70th Edition, CRC Press, Inc., Boca Raton, Florida, 1989-90.

Richard J. Lewis, Hawley's Condensed Chemical Dictionary, 13th Edition, John Wiley & Sons, Inc., New York, NY.

Canadian Council of Ministers of the Environment (CCME), 1999 Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health.
ISBN 1-896997-34-1 Publication No. 1299.

APPENDIX F – OPTION 3, NEW TANK FARM LOCATION

APPENDIX F – OPTION 3, NEW TANK FARM LOCATION