ONTARIO POWER GENERATION

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OPG-FORM-0076-R006*

Business Case Summary

Project #	16-80126 Capital / 16-38323 OM&A	**Controlled Doc #**	D-BCS-49200-10007
Project Title	DN Emergency Power Generator 1 and 2 Replacement		
Facility	Darlington	**Investment**	Regulatory
Project Level (Scalability)	A	**Financial Classification**	☒ OM&A ☒ Capital ☐ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others: [if applicable]
Release: Gate and Project Phase	☐ Choose an item. G0[ ]: Initiation ☐ Choose an item. G2[ ]: Definition ☐ Choose an item. G1[ ]: Choose an item. ☒ Superseding G3[x]: Execution		
Estimate Class (overall project)	Class 3	**Target Project Completion Date**	JUN-2024

Recommendation

We recommend a release of $17,652 K, including [redacted] of contingency.
This will bring the total released-to-date to $143,648 K *. The total project cost is now estimated at $206,000 K, compared to $178,400 K in the previous release, including contingency. Refer to the total project estimate variance explanation for detail.

*Project 16-80126: Total-to-Date release of $141,486K, as compared to $123,835 K in the previous release.
*Project 16-38323: Total-to-Date release of $2,161 K. as compared to $2,161 K in the previous release.

This release will be used to complete Gate 3A work outlined below, and to prepare for the Gate 3B BCS release which will be brought forward for March 2021 approval:

- Complete the Construction (installation, commissioning and return to service) of EPG2.
- Installation Planning and Non-Long Lead Procurement for EPG1 replacement
- Development of G3B Future Release for EPG1 Replacement and Project Close-out

Investment Cash Flows

$K	LTD	2020	2021	2022	2023	2024	2025	Future	Total
Previous Releases (OM&A)	1,661	500	-	-	-	-	-	-	2,161
Previous Releases (Capital)	90,455	26,229	7,151	-	-	-	-	-	123,835
Current Request (Capital)	-	10,145	7,507	-	-	-	-	-	17,652
Total released to date	**92,116**	**36,874**	**14,658**	-	-	-	-	-	**143,648**
Future Required (Capital)	-	-	See Notes						62,352
Total Project Cost	92,116	36,874	See Notes						**206,000**
Ongoing Costs	-	-	-	-	-	-	-	-	
					Gate:	G3		OAR Approval:	$206,000 K

Notes:

Future Required (Capital):
The previous G3A Release estimated $52,405 K for future release. The future release forecast is $62,352 K, including contingency. Following the completion of EPG2 installation and commissioning, the EPG1 design and construction planning will be updated to incorporate lessons learned, and an updated Class 3 estimate will be developed to support the G3B full execution release for EPG1 construction.

Total Project Cost
The previous G3A Release estimated a total project cost of $178,400 K. The current estimated total project cost is $206,000 K including contingency.

Business Case Summary

Approvals	Signatures	Date
The recommendation, including the identified ongoing costs, if any, represents the best option to meet the validated business need.		
Recommended by: Project Sponsor Sean Granville Chief Operations Officer & CNO		6-Nov-2020
I concur with the business decision as documented in this BCS.		
Finance Approval: John Mauti CFO & SVP Finance		11/18/2020
I confirm that this investment/project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.		
Line Approval per OAR 1.1: Ken Hartwick President & CEO	Dietmar Reiner for Ken Hartwick	11/18/2020

EXECUTIVE SUMMARY – Project Overview

Following a common mode event (e.g. explosion, fire, earthquake) that disables the normal and standby power to the Darlington station, the Emergency Power System (EPS) provides back-up power to specific nuclear safety related systems and essential station loads. This is necessary for the safe shutdown, cooling and monitoring of the Darlington reactor units in the recovery period of a common mode event.

The EPS is comprised of three Emergency Power Generators (EPG's), which are gas turbine-driven generator sets. The EPG 1 and EPG 2 generator sets and auxiliary equipment are degraded and maintenance and repair is impaired due to equipment obsolescence. The reliability and redundancy in the EPS is decreased, risking system impairment or unavailability causing a station shutdown. Replacement of EPG 1 and EPG 2 is required to restore the reliability and redundancy within the Emergency Power System, and ensure its availability to supply back-up power until station end of life.

The construction activities for EPG2 commenced in November 2018, and have been significantly challenged by the realization of first of a kind / first in a while project risks, as identified in the release. Realized risks include challenges installing a new generator set into an existing building, and operational experience from newly installed EPG3 results in late changes to EPG2. The realization of these risks [redacted], and delayed the forecasted completion of EPG2 from November 2019 to June 2020.

The first wave of the Covid-19 pandemic occurred during the construction phase, which resulted in a 3 month fieldwork suspension, and a 3 month extension to the fieldwork critical path for the incorporation of Covid-19 safe work practice considerations. The funding allocated to complete EPG1 procurement and installation planning was spent on Covid-19 pandemic related costs, and there is insufficient funding remaining to cover project support costs until the full execution release is approved.

The completion of EPG 2 replacement is now targeted for December 2020, with a regulatory commitment to the CNSC for March 2021. The delay in the completion of EPG 2 has also delayed the incorporation of lessons learned into EPG 1 design, and the submission of the full execution release for EPG 1 construction.

This release will fund:

- $3.1 M in costs due to the COVID-19 fieldwork suspension ($1.2 M OPG, $1.9 M Vendor)
- $4.8 M in costs due to the COVID-19 safe work practice considerations ($1.5 M OPG, $3.3 M Vendor)
- $1.5 M in advancement of future release costs due to the delay in the G3B release from November 2020 to March 2021.
- $1.2 M of additional interest on EPG1 equipment cost, attributed to a change in accounting policy for the realization of EPG1 equipment cost 18 months earlier.

[redacted]

Note:
This document was prepared based on assumptions from the Business Plan, Generation Plan and station work programs during the recovery stage of the COVID-19 pandemic. A second wave of the COVID-19 pandemic may lead to changes to the assumptions which may impact the overall cost and schedule of this project.

Business Need	For Project Level A or B

The Darlington station assessed the condition of the EPG1 and EPG2 gas turbine-driven generator sets during maintenance outages, and concluded that several critical components are degraded and require repair or replacement. An engine condition assessment in 2010 and 2012 on EPG2 identified degradation of the gas generator and power turbine; high bearing vibrations, cracked combustion outer liner, thermo-erosion on combustion inner liner and gas producer nozzle cracks.

The EPG's have been in service since 1985, and are now past the Original Equipment Manufacturers (OEM) recommended refurbishment period. DNGS cannot perform the required maintenance as there are no spare parts on hand, and components are not commercially available due to outdated technologies and obsolescence. Therefore, the reliability of EPG1 and EPG2 has decreased, and there is a high likelihood that the equipment will become unavailable prior to the end of station service life.

The reliability and availability of the EPG's is critical to station safety, as these provide backup power to specific nuclear safety-related systems and essential station loads required for the safe shutdown, cooling and monitoring of the Darlington reactor units. Such situation could arise when there is a 'common mode event', in which there is widespread incapacitation of normal station control, electrical power or service systems, as could be expected following a major fire, earthquake, or tornado, etc. A common mode event would lead to a sustained loss of Class IV and Class III power, which normally provide power to specific nuclear safety-related systems. In such circumstance, the EPG's would be energized to provide power to the Emergency Power System (EPS), enabling the continued powering of specific nuclear safety-related systems.

OPG has a regulatory commitment as identified in the Darlington Integrated Implementation Plan (IIP) to address EPG2 degradation by the March 2021, and EPG1 degradation by September 2023.

Preferred Alternative:	**Replace obsolete EPG2 and EPG 1 skid with a completely new skid similar to EPG3**

Description of Preferred Alternative

To address the business need of ensuring reliable back-up power to essential station safety systems, the degraded EPG2 and EPG1 gas turbine-driven generator skids and all auxiliary equipment will be replaced (as repair or refurbishment is not an option due to technological obsolescence and component unavailability). New equipment employing current industry technology with proven reliability, will be installed to ensure continued support availability through the end of station service life. Overall system design will also ensure that all sub systems are integrated and provide optimum EPG performance. The new EPG skids will be of similar design to the recently installed EPG3 skid (Solar Mars 100-16000 diesel combustion turbine generator set) that was complete under Project 10-73360. This allows common design, operation and training consistency, spare parts optimization and shared OPEX to apply across EPG1, EPG2 and EPG3.

The gas turbine-driven generator skid is a completely integrated and operational package consisting of a gas turbine, gearbox, generator, and all accessories and auxiliary systems necessary for normal operation. Installation of the generator sets and auxiliary equipment will take place in the existing EPG1, EPG2, and EPS buildings. Replacement of the skids will entail modification/replacement of the existing interfacing/support systems. This includes but is not limited to: HVAC, fuel delivery system (inside the EPG building), lubrication system, structural, electrical, control system, start-up, and building services. Seismic qualification will comply with current standards.

The condition of EPG2 warrants that it be replaced prior to EPG1. Following removal EPG2 will be stored such that it is available to allow viable components to be salvaged as spares for the existing EPG1; until such time that it is replaced. The EPG Steering Committee endorsed this preferred alternative at its meeting of Dec 5, 2014.

Deliverables:	Associated Milestones (if any):	Target Date:
Previous releases:		
Major Contract awarded for EPG2 Replacement	Contract Award (Construction) – EPG2	Complete
EPG2 Replacement	Start of Installation – EPG2	Complete
	Available for Service Declaration – EPG2	March 26, 2021
Execution Full BCS prepared for EPG1 Replacement	Execution Full BCS Approved	March 30, 2021
Current release:		
N/A	N/A	N/A
Future release:		
EPG1 Replacement	Available for Service Declaration – EPG1	September 01, 2023
Project Completion	Plan Complete	June 13, 2024

Alternative 2:	**Base Case – No Project** For Project Level A, B or Value-Enhancing
This alternative was considered and eliminated in the Definition BCS. Progress-to-date since the previous BCS continues to show validity of all the assumptions used for the elimination of this alternative.	

Alternative 3:	**Delay Work – Replace EPG2 Only, EPG1 Extended to DN End of Life** For Project Level A or B or Value-Enhancing
This alternative was considered and eliminated in the Definition BCS. Progress-to-date since the previous BCS continues to show validity of all the assumptions used for the elimination of this alternative.	

Key Risk Assessment For Project Level A, B or C

Risk Class	Description of Risk	Response Type/ Actions/Final TCD	For Additional Review	Residual Ranking
Schedule	Additional field supervision is in place to monitor the balance of EPG2 installation and commissioning activities, however, there is still a risk that discovery issues arise that result in additional effort for design, construction and/or commissioning to resolve. As a result, both the EPG2 AFS and the approval of the G3B full execution release for EPG1 construction is delayed.	Accept: • [redacted] [redacted]	No	Medium
Financial	This document was prepared based on assumptions from the Business Plan, Generation Plan and station work programs during the recovery stage of the COVID-19 pandemic. A second wave of the COVID-19 pandemic may lead to changes to the assumptions which may impact the overall cost and schedule of this project.	Accept: [redacted]	Yes	High

Additional Risk Analysis For Project Level A or B

N/A

Financial Evaluation					For Project Level A, B (with multiple feasible alternatives) or Value-Enhancing
$M	Preferred Alternative	Base Case (No Project)	Delay work	Alternative 4	Alternative 5
Project Cost	206	N/A	N/A	N/A	N/A
NPV	N/A	N/A	N/A	N/A	N/A
Other: (e.g., IRR)	N/A	N/A	N/A	N/A	N/A

Analysis of Financial Evaluation – Key Assumptions and Key Results:

A financial evaluation is not performed as it does not apply for Regulatory projects. The preferred alternative was selected based on the lowest cost and lowest risk alternative that fully addresses the business need and satisfying qualitative factors/constraints.

Qualitative Factors For Project Level A or B

- Meet regulatory commitment to have EPG2 replaced by March 26, 2021 and EPG1 replaced by September 01, 2023.
- Ensure consistent operation and training, and spares optimization across EPG1, EPG2, and EPG3.

Post Implementation Review (PIR) Plan (refer to OPG-PROC-0056)

Type of PIR Report	Simplified/Standard PIR	**PIR Completion Date**	DEC-2024	
		Target Result	**How to measure?**	**Who will measure?**
Obsolescence	Components are obsolete with no identified replacements	Replacement Components available	System Health Report	SRE
Spare Parts	Component spares for EPG1-2 are not available	Spares complement is available for new EPG1-2	System Health Report	SRE
Start Reliability	98%	98% maintained	SRST	SRE
Unavailability (Planned and Forced)	< 5%	< 5% maintained	SRST	SRE

APPENDICES

Appendix A1-A: Summary of Estimate - Released to date										
Project Number:	**16-80126 (Capital)**									
Project Title:	**Darlington EPG 1 and 2 Replacement**									
$K	**LTD**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Future**	**Total**	**%**
OPG Project Management	3,718	1,971	580	-	-	-	-	-	6,269	4%
OPG Engineering	3,189	1,006	180	-	-	-	-	-	4,374	3%
OPG Procurement	29,663	1,693	125	-	-	-	-	-	31,481	22%
OPG Station Support	1,948	1,181	269	-	-	-	-	-	3,397	2%
Engineering Contracts	[redacted]									
Construction Contract - Procurement										
Construction Contract - Construction										
Other Contracts										
Subtotal										
Contingency										
Subtotal w/ Contingency	87,384	33,444	14,252	-	-	-	-	-	135,081	95%
Interest	3,070	2,930	405	-	-	-	-	-	6,405	5%
Total	**90,455**	**36,374**	**14,657**	-	-	-	-	-	**141,486**	**100%**
Removal Costs (incl. above)	1,473	-	-	-	-	-	-	-	1,473	1%

Appendix A1-B: Summary of Estimate - Future Release										
Project Number:	**16-80126 (Capital)**									
Project Title:	**Darlington EPG 1 and 2 Replacement**									
$K	**LTD**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Future**	**Total**	**%**
OPG Project Management	-	-	1,080	1,440	1,020	300	-	-	3,840	6%
OPG Engineering	-	-	440	540	600	-	-	-	1,580	3%
OPG Procurement	-	-	-	-	-	-	-	-	-	0%
OPG Station Support	-	-	610	1,320	470	-	-	-	2,400	4%
Engineering Contracts	[redacted]									
Construction Contract - Procurement										
Construction Contract - Construction										
Other Contracts										
Subtotal										
Contingency										
Subtotal w/ Contingency	-	-	16,050	31,159	9,511	300	-	-	57,020	91%
Interest	-	-	1,044	2,536	1,741	11	-	-	5,332	9%
Total	-	-	**17,095**	**33,694**	**11,252**	**311**	-	-	**62,353**	**100%**

Appendix A1-C: Summary of Estimate	- Total Project Cost									
Project Number:	**16-80126 (Capital)**									
Project Title:	**Darlington EPG 1 and 2 Replacement**									
$K	**LTD**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Future**	**Total**	**%**
OPG Project Management	3,718	1,971	1,660	1,440	1,020	300	-	-	10,109	5%
OPG Engineering	3,189	1,006	620	540	600	-	-	-	5,954	3%
OPG Procurement	29,663	1,693	125	-	-	-	-	-	31,481	15%
OPG Station Support	1,948	1,181	879	1,320	470	-	-	-	5,797	3%
Engineering Contracts	[redacted]									
Construction Contract - Procurement	[redacted]									
Construction Contract - Construction	[redacted]									
Other Contracts	[redacted]									
Subtotal	[redacted]									
Contingency	[redacted]									
Subtotal w/ Contingency	87,384	33,444	30,303	31,159	9,511	300	-	-	192,101	94%
Interest	3,070	2,930	1,449	2,536	1,741	11	-	-	11,738	6%
Total	**90,455**	**36,374**	**31,752**	**33,694**	**11,252**	**311**	-	-	**203,839**	**100%**
Removal Costs (incl. above)	1,473	-	1,500	-	-	-	-	-	2,973	1%

Appendix A1-D: Summary of Estimate	- Released to date									
Project Number:	**16-38323 (OM&A)**									
Project Title:	**Darlington EPG 1 and 2 Replacement**									
$K	**LTD**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Future**	**Total**	**%**
OPG Project Management	781	-	-	-	-	-	-	-	781	36%
OPG Engineering	880	-	-	-	-	-	-	-	880	41%
OPG Procurement	-	-	-	-	-	-	-	-	-	0%
OPG Station Support	[redacted]									
Engineering Contracts	[redacted]									
Construction Contract - Procurement	[redacted]									
Construction Contract - Construction	[redacted]									
Other Contracts	[redacted]									
Subtotal	[redacted]									
Contingency	[redacted]									
Subtotal w/ Contingency	1,661	500	-	-	-	-	-	-	2,161	100%
Interest	-	-	-	-	-	-	-	-	-	0%
Total	**1,661**	**500**	-	-	-	-	-	-	**2,161**	**100%**

Project #: 16-38323 OM&A, 16-80126 Capital
Project Title: DN Emergency Power Generator 1 and 2 Replacement
Document #: D-BCS-49200-10007

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Business Case Summary

Appendix A1-E: Summary of Estimate - Total Project Cost										
Project Number:	**16-80126 (Capital) and 16-38323 (OM&A)**									
Project Title:	**Darlington EPG 1 and 2 Replacement**									
$K	**LTD**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Future**	**Total**	**%**
OPG Project Management	4,499	1,971	1,660	1,440	1,020	300	-	-	10,890	5%
OPG Engineering	4,069	1,006	620	540	600	-	-	-	6,834	3%
OPG Procurement	29,663	1,693	125	-	-	-	-	-	31,481	15%
OPG Station Support	1,948	1,181	879	1,320	470	-	-	-	5,797	3%
Engineering Contracts	[redacted]									
Construction Contract - Procurement										
Construction Contract - Construction										
Other Contracts										
Subtotal										
Contingency										
Subtotal w/ Contingency	89,045	33,944	30,303	31,159	9,511	300	-	-	194,262	94%
Interest	3,070	2,930	1,449	2,536	1,741	11	-	-	11,738	6%
Total	**92,116**	**36,874**	**31,752**	**33,694**	**11,252**	**311**	-	-	**206,000**	**100%**

Appendix A2: Summary of Estimate – Notes			
Escalation Rate	2 %	**Interest Rate (going-forward)**	4.3 %

Appendix A3: Summary of Estimate – In-Service Estimates				
$K	Only applicable to capital projects. In-Service amount shall include interest but exclude removal costs.			
Project #	**Date (YYYY-MM-DD)**	**Description**	**Amount**	**%**
16-80126	3/26/2021	EPG2 - Return to Service	[redacted]	56%
16-80126	9/1/2023	EPG1 - Return to Service*	[redacted]	43%
16-80126	6/13/2024	Project Close-out	[redacted]	1%
Total			[redacted]	100%

[redacted]

Prepared by:		Reviewed and Endorsed by:	
James Philipps Project Leader, Nuclear Projects	Oct 16, 2020 Date	B. Graham for Marc Clemente Section Manager, Nuclear Projects	02 Nov·2020 Date

*Associated with OPG-STD-0076, Developing And Documenting Business Cases

Appendix B: Total Project Estimate Variance Analysis

Project #	16-38323 and 16-80126								
$K	**LTD**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Future**	**Total**
G3A EXEP	86,654	19,142	44,532	25,520	2,532	20	-	-	178,400
G3A EXEP Superseding*	92,116	36,874	31,752	33,694	11,252	311	-	-	206,000

Notes *:
See Project Estimate Variance Explanation below.

Total Project Estimate Variance Explanation (delete if not required)

The total estimated project cost has increased due to the following:

G3A – Partial Execution Release

- [redacted]
- **$17,652 K Over Variance (this release)** - The COVID-19 pandemic first wave resulted in a 6 month delay to the construction completion and in-service of EPG2, and a change in accounting policy resulted in additional interest costs for EPG1 material.

G3B – Future Full Execution Release

- **$ 9,948 K increase for EPG1 Construction** - The previous G3A release identified a future release requirement of $52,405 K including contingency. Based on the interim lessons learned on EPG2 installation and commissioning, the forecasted cost for the EPG1 construction is $62,353 K, including contingency.
- Upon completion of EPG2 installation and commissioning, the lessons learned will be incorporated in the EPG1 design and EPG1 construction planning. An updated Class 3 estimate for the future release scope will be prepared, and the G3B full release BCS will be submitted for March 2021 OAR approval.

APPENDICES (Continued)

Appendix C: Financial Evaluation Assumptions	For Project Level A, B (with multiple feasible alternatives) or Value-Enhancing
Key assumptions used in the financial model of the project are:	
N/A	

References	For Project Level A or B
N/A	

ONTARIO POWER GENERATION

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Project Over-Variance Approval

Project #	13-83072	**Controlled Doc #**	P-BCS-36110-0709109
Project Title	Pickering Buried Boiler Blowdown Pipe Replacement		
Facility	Pickering	**Investment Classification**	Sustaining
Project Level (Scalability)	C	**Financial Classification**	☐ OM&A ☒ Capital ☐ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others: [if applicable]
Release: Gate and Project Phase	☐ Over-variance G0 : Initiation ☐ Over-variance G1 : Choose an item.		☐ Over-variance G2 : Definition ☒ Over-variance G3 B: Execution
Estimate Class (overall project)	Class 3	**Target Project Completion Date**	June 2021

Recommendation

We recommend a release of $910K, including [redacted] f contingency. This will bring the total released-to-date to $21,648K.

Total project cost is estimated at $21,858K, including [redacted] contingency, compared to $20,948K in the previous release including contingency.

This project is for the replacement of Boiler Blowdown (BBD) pipes in U1, U4, U5 and U6. This is the final funding request for this project to account for incurred cost due to new legacy/discovery issues with existing systems. This release is to fund close out activities and open items.

This document was prepared based on assumptions from the Business Plan, Generation Plan and station work programs during the recovery stage from the first wave of the COVID-19 pandemic. A second wave of the COVID-19 pandemic may lead to changes to the assumptions which may impact the overall cost and schedule of this project.

Investment Cash Flows

$K	LTD	2020	2021	2022	2023	2024	2025	Future	Total
Previous releases	11,682	9,266							20,948
Current request	-		910						910
Total released to date	**11,682**	**9,266**	**910**	**-**	**-**	**-**	**-**	**-**	**21,858**
Future required	-								-
Total Project Cost	**11,682**	**9,266**	**910**	**-**	**-**	**-**	**-**	**-**	**21,858**
Ongoing Costs	-								
					Gate:	**G3**	**OAR Approval:**		$21,858 K

Project Overview

The Buried Boiler Blowdown (BBD) carbon steel piping at Pickering Nuclear Generating Station (PNGS) requires replacement due to known degradation detected during recent inspections. The desired outcome is to maintain unit operation and address potential steam safety hazards. The benefit in replacing buried Boiler Blowdown piping is to reduce the risk of blowdown failures that can take the Units out of service for approximately 40 days for repairs, resulting in a generation loss of $20 M per system failure. If buried Boiler Blowdown piping line failure occurs in multiple units, this could result in approximately >$50M loss of generation revenue.

The preferred alternative is to replace one of the two 6 inch carbon steel buried Boiler Blowdown pipes in U1, U4, U5 and U6 between north and south pits along with concrete transite pipe at the excavation location. The tie-in to merge 2 pipes into one will be completed up stream of the north pit and splitting of pipe will be completed in the south pit or down stream. Removal and replacement of the 6 inch piping will be carried out by having two open pits at the 45 degree pipe anchor, near the middle of the 260 feet pipe run, between the two open manholes at the reactor buildings and the screenhouses.

The following scope is complete on the BBD Project:

- **U1:** Available for Service (AFS) is completed in 2020.
- **U5:** AFS completed in 2020.
- **U4:** Installation and tie-in completed. Commissioning/AFS to be completed by Dec 31 2020.
- **U6:** Installation and tie-in completed. Commissioning/AFS to be completed by Dec 31 2020.

Project Over-Variance Approval

Project Overview

BBD project anticipated discovery issues/risks and allocated contingencies to address them. [redacted] his release is required to fund cost increases due to the following legacy/discovery issues with existing systems:

- Damaged U5/U6 transite between thrust block (TB) and south pit requiring new design and installation.
- Design and installation of temporary ramp and cable duct support over U5/U6 transite pipe replacement.
- Additional soil/asphalt/concrete disposal due to the larger excavation in U5/U6.
- Configuration management issues with existing U5/U6 supports requiring new design and installation.
- Repair legacy damaged heat trace (HT).
- Installation of temporary heating system to prevent U5/U6 BBD piping from freezing during winter to support damaged HT cable repair.

Total Project Estimate Variance Explanation

The total project cost has increased by 4% or $910K to $21,858K from $20,948K approved in the previous Gate 3B full execution release. The additional funding is required to address cost increase due to the legacy/discovery issues.

The legacy/discovery issues described above were not known in advance of construction due to following reasons:

- Damaged concrete transite pipes were discovered during construction via video inspections. This was not known during design stage as pipes were buried. Additional design, excavation and construction efforts were needed to repair damaged pipes.
- Additional excavation and installation of temporary ramp and cable duct support were required to repair damaged transite pipe. The excavation generated larger amount of soil, asphalt, and concrete waste which required proper offsite disposal.
- Configuration management issues with existing U5/6 supports were discovered during installation, and required additional design and installation efforts. This could not have been foreseen during design stage as the supports were covered by insulation.
- Temporary heating system was installed on U5/U6 BBD piping to provide freeze protection while addressing discovery issues during cold temperatures/winter months.

Project #: 13-83072
Project Title: Pickering Buried Boiler Blowdown Pipe Replacement
Document #: P-BCS-36110-0709109

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Project Over-Variance Approval

Appendix A1: Summary of Estimate - Total Project Cost										
Project Number:	**13-83072**									
Project Title:	**Pickering Buried Boilder Blowdown Pipe Replacement**									
$K	**LTD**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**Future**	**Total**	**%**
Project Mgmt	1,166	434							1,600	7%
Inspection										
Engineering									1	
Procurement									4	
Construction	[redacted]									
Commissioning										
Closeout										
Subtotal										
Outside WBS										
Contingency										
Subtotal w/ Contingency										
Interest									5	
Other	508	665							1,173	5%
Total	**11,682**	**9,266**	**910**	**-**	**-**	**-**	**-**	**-**	**21,858**	**100%**
Removal Costs (incl. above)		300							300	1%

Appendix A3: Summary of Estimate – In-Service Estimates				
$K	Only applicable to capital projects. In-Service amount shall include interest but exclude s.			
Project #	**Date (YYYY-MM-DD)**	**Description**	**A**	**%**
13-83072	2020-06-12	U1 BBD Piping	[redacted]	28%
13-83072	2020-09-21	U4 BBD Piping		21%
13-83072	2020-11-30	U6 BBD Piping		32%
13-83072	2020-12-31	U5 BBD Piping		15%
13-83072	2021-06-30	Open Items, Project Close-out		4%
Total				100%

Prepared by:	**Reviewed and Endorsed by:**
Kamran Malik PNGS Projects & Modifications Project Manager Date Dec 17, 2020	Ahmed Smaili PNGS Projects & Modifications 17Dec2020 Section Manager Date

Approvals	Signatures	Date
Recommended by: Project Sponsor David Rogalski, Director - Central Engineering ~~Sr Manager Comp & Control Design~~		18 Dec 2020
Finance Approval: Melissa Hannon for Director, Controllership, Pickering	Melissa Hannon	Jan 5, 2021
Line Approval per OAR 1.1: Jon Franke SVP, Pickering		06-Jan-2021

*Associated with OPG-STD-0076, Developing And Documenting Business Cases