THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

DONCASTER OUTFALL CHAMBER UPGRADE
CONTROL NARRATIVE
PLC-G81

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Engineer's Seal

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1.0 STATEMENT OF LIMITATIONS

This report has been prepared for the City of Winnipeg in accordance with the agreement between KGS Group and the City of Winnipeg (the "Agreement"). This report represents KGS Group's professional judgment and exercising due care consistent with the preparation of similar reports. The information, data, recommendations and conclusions in this report are subject to the constraints and limitations in the Agreement and the qualifications in this report. This report must be read as a whole, and sections or parts should not be read out of context.

2.0 PART 1 - INTRODUCTION

2.1 Overview

This control narrative outlines the process for monitoring the outfall chamber level, gate inclination, and other systems for the Doncaster Outfall Chamber. The purpose of this document is to guide the PLC programmer in developing the station's PLC program. It provides a high-level description of the intended PLC functionality. The control logic shall be implemented using Function Block Diagram (FBD) programming. Any alternate programming languages must receive approval from the Contract Administrator before use.

All I/O mapped into the PLC will be converted to positive logic, where a Boolean value of 1 indicates an alarm condition and a Boolean value of 0 represents the normal (okay) state. Electrical Wiring shall be done is such a way that the associated relays/devices are energized for normal state and de-energized for an alarm state.

Timer settings and initial setpoints provided in this narrative are intended as a starting point for commissioning. These settings shall be adjusted as necessary during commissioning. Any changes to timer settings or setpoints must be communicated to the Engineering Consultant for review, and all changes must be documented in the as-built documentation.

2.2 Reference Drawings

When reviewing this controls narrative refer to the drawings as identified in the table below for supplementary information.

Drawing No.	Title
1-0242G-A0005-001	Automation - PLC C I/O Wiring – CP-G81 - Discrete Input Rack 0 Module 3
1-0242G-A0006-001	Automation - PLC C I/O Wiring – CP-G81 - Analog Input - Rack 0 Module 4
1-0242G-A0013-001	Automation - Process Instrumentation Diagram (P&ID)

2.3 Key Operating Parameters

The chamber is complete with level transmitters and gate inclinometer for monitoring and are set to automatically send alarms to Main SCADA. Key CSO elevations for the outfall chamber are shown below:

Description		Geodetic Elevation (meters above sea level)	Reference Elevation Above Transmitter Zero (meters)
Outfall chamber top elevation		233.981	
Chamber downstream of side gate	Zero Elevation	226.078	
	High Water Level Alarm	TBD	TBD
Chamber immediately upstream of the flap gate	Zero Elevation	226.231	
	High Water Level Alarm	TBD	TBD
Manhole in 2250mm pipe between Willow Avenue and the in-pipe weir	Zero Elevation	226.37	
	High Water Level Alarm	TBD	TBD

3.0 PART 2 - EQUIPMENT AND SYSTEM REQUIREMENTS

3.1 HMI Graphic Displays

Create a graphic (process mimic) display containing a representation of the process as shown on P&ID 1-0242G-A0013-001. All HMI Graphics shall follow City of Winnipeg HMI Animation Guide. HMI colors to be discussed between City E&I, AICG and Operations. Provide access to the Maintenance Screen. Note that all alarms on Graphics Tabs must also display on the Alarms Summary Table Tab. Specific requirements include, but are not limited to:

- Outfall Chamber Window
    - Animate the chamber water level using vertical fill animation. Also display the level value in the center of chamber in relative and absolute units.
    - Include High water level as Red horizontal lines on the Outfall Chamber display.
    - Include the readings of each level transmitter. Include a popup window with HMI buttons for selection of averaging or selecting a particular level transmitter for level monitoring.
    - Include the reading of the flap gate inclination.
- Level Trends Window
    - Display chamber Level trending display.
    - All trending displays shall utilize a Sample Rate of five (5) seconds, Vertical Scale in meters on the left / 0 – 100% on the right and a Horizontal Scale of thirty (30) minutes.
- Settings Window

- Settings can be Read Only and shall be Password Protection for any changes to be made.

- Instrument Calibration Window
  - Display all analog instrument signals to the PLC. Calibration setpoints shall be provided for instrument signal offsets.
  - Calibrations shall only be done from the City's Main SCADA. Calibration settings shall be password protected.

- Alarms Summary Table Window
  - Display all alarms in a table format received at the PLC. Include current date in yyyy/mm/dd (i.e. 2023/07/26) format along with time in hh:mm:ss (i.e. 14:23:51) format in the upper right side of the window.
  - Each alarm should include date in yyyy/mm/dd (i.e. 2023/07/26) format along with time in hh:mm:ss (i.e. 14:23:51) format along with description (i.e. Control Panel High Temperature).
  - Alarms shall appear as an entire red row when an alarm is generated. Once alarm has cleared, the entire row shall change to green.

3.2 Outfall Chamber

The chamber structure consists of a conventional three-cell gate chamber, with a slide gate in the upstream cell and a flap gate in the downstream cell. A hydrostatic level transmitter is located immediately upstream of the flap gate and an ultrasonic level transmitter is located downstream of the slide gate. An additional ultrasonic level transmitter is located in the 2250 mm pipe between Willow Avenue and the in-pipe weir upstream of the gate chamber, to monitor water levels. An inclinometer transmitter is provided to monitor the flap gate position. Analog signals from these instruments are sent to the PLC control panel CP-G81 for monitoring and alarm purposes.

3.2.1 PLC INTERFACE INPUTS AND RELATED INSTRUMENTS

PHYSICAL TAG NUMBER	PLC INTERNAL TAG NUMBER	DESCRIPTION	LOCATION
LT-S751	LT_S751	Hydrostatic level transmitter (Between Weir and Immediately Upstream of Flap Gate)	Outfall Chamber
LT-S951	LT_S951	Ultrasonic level transmitter (Downstream of Slide Gate)	Outfall Chamber

PHYSICAL TAG NUMBER	PLC INTERNAL TAG NUMBER	DESCRIPTION	LOCATION
LT-S651	LT_S651	Radar Level transmitter (In Pipe Upstream of Weir)	2250mm pipe
ZT-S851	ZT_S851	Flap gate inclination transmitter	Outfall Chamber

3.2.2 INTERNAL VARIABLES

PLC INTERNAL VARIABLE	DESCRIPTION	RANGE	INITIAL VALUE
LI_S651	Scaled level from LT_S651	0-3 m	-
LI_S951	Scaled level from LT_S951	0-5 m	-
LI_S751	Scaled level from LT_S751	0-3 m	
TI_G681	Scaled temperature from TT-G681	5 – 40 ◦C	-
ZI_S851	Scaled Inclination from ZT-S851	-30°–30°	-

3.2.3 INTERNAL ALARMS/STATUSES

The alarm logic to SET the alarm shall be met for 1 second before setting the alarm. The alarm logic to RESET the alarm shall be met for 3 seconds before resetting the alarm.

PHYSICAL INPUT TAG	INTERNAL TAG	ALARM TAG	DESCRIPTION	FAIL SAFE	ALARM LOGIC	RESET
LI-S751	LI_S751	LAH_S751	Water High Leve Alarm (Between Weir and Immediately Upstream of Flap Gate)		SET (LI_ S651.AlmH) on (LI_ S651.Out >= TBDm) = TRUE SET(LAH_ S751) on LI_ S751.AlmH = TRUE RESET(LI_ S751.AlmH) on (LI_ S751.Out < TBDm) = TRUE RESET(LAH_ S751) on LI_ S751.AlmH = FALSE	Auto
LI-S951	LI_S951	LAH_S951	Water High Level Alarm (Downstream of Slide Gate)		SET (LI_ S951.AlmH) on (LI_ S951.Out >= TBDm) = TRUE SET(LAH_ S951) on LI_ S951.AlmH = TRUE RESET(LI_ S951.AlmH) on (LI_ S951.Out < TBDm) = TRUE RESET(LAH_ S951) on LI_ S951.AlmH = FALSE	Auto

PHYSICAL INPUT TAG	INTERNAL TAG	ALARM TAG	DESCRIPTION	FAIL SAFE	ALARM LOGIC	RESET
LI-S651	LI_S651	LAH_S651	Water High Leve Alarm (In Pipe Upstream of Weir)		SET (LI_ S651.AlmH) on (LI_ 651.Out >= TBDm) = TRUE SET(LAH_ S651) on LI_ S651.AlmH = TRUE RESET(LI_ S651.AlmH) on (LI_ S651.Out < TBDm) = TRUE RESET(LAH_ S651) on LI_ S651.AlmH = FALSE	Auto
TI-G681	TI_G681	TAL_ G681	Control Panel low temperature alarm		SET(TT_ G681.AlmL) on (TI_ G681.Out <= 5°C) = TRUE SET(TAL_ G681) on TT_ G681.AlmL = TRUE RESET(TI_ G681.AlmL) on (TI_ G681.Out > 5°C) = TRUE RESET(TAL_ G681) on TT_ G681.AlmL = FALSE	Auto
TI- G681	TI_ G681	TAH_ G681	Control Panel high temperature alarm		SET(TT_ G681.AlmH) on (TI_ G681.Out >= 40°C) = TRUE SET(TAH_ G681) on TT_ G681.AlmH = TRUE RESET(TT_ G681.AlmH) on (TI_ G681.Out < 40°C) = TRUE RESET(TAH_L G681) on TT_ G681.AlmH = FALSE	Auto

3.2.3.1 Alarm Settings

INSTRUMENT TAG	ALARM TAG NUMBER	ALARM LOW-LOW SETTING	ALARM LOW SETTING	ALARM HIGH SETTING	ALARM HIGH-HIGH SETTING
TT_G681	TAL_G681	N/A	5°C	N/A	N/A
TT_ G681	TAH_ G681	N/A	N/A	40°C	N/A
LT_S651	LAH_S651	N/A	N/A	TBD m	N/A
LT_S751	LAH_ S751	N/A	N/A	TBD m	N/A
LT_S951	LAH_ S951	N/A	N/A	TBD m	N/A

3.2.4 CONTROL NARRATIVE

The level in the outfall chamber cells will be monitored by ultrasonic and hydrostatic level transmitters. The level in the 2250 mm pipe upstream of the gate chamber will be monitored by an hydrostatic level transmitter. The position of the flap gate will be monitored by an inclinometer. Alarms will be generated as per section 3.2.3. All alarm level setpoints shall be configurable through the remote SCADA system.

3.3 Miscellaneous Controls – PLC-G81

3.3.1 PLC INTERFACE INPUTS AND RELATED INSTRUMENTS

INSTRUMENT TAG NUMBER	PLC INTERNAL TAG NUMBER	DESCRIPTION	LOCATION
ESL-G713	ESL_G713	Ground Fault Alarm	Control Panel
ESL-G711	ESL_G711	240V Power Fail Alarm	Electrical Enclosure
XS-G712	XS_G712	SPD Alarm Status	Electrical Enclosure
YS-G814-1	YS_G814_1	UPS Battery Mode	Electrical Enclosure
YA-G814	YA_G814	UPS Fault Alarm	Electrical Enclosure
YS-G814-2	YS_G814_2	UPS Battery Charging	Electrical Enclosure
ESL-G812	ESL_G812	120V Power Fail Relay Alarm	Control Panel
ESL -G813	ESL_G813	PS01 24VDC Power Fail Alarm	Control Panel
ESL -G816	ESL _G816	PS02 24VDC Power Fail Alarm	Control Panel
ZS-G600	ZS_G600	Electrical Enclosure Door Open Status	Electrical Enclosure

3.3.2 INTERNAL VARIABLES

PLC INTERNAL VARIABLES	DESCRIPTION	RANGE	INITIAL VALUE
PLC_G81_Rst	PLC Reset (1-Reset, 0 = Not Reset)	-	-
PLC_G81_HB	PLC Heartbeat	0*32767	0

3.3.3 INTERNAL ALARMS

PHYSICAL INPUT TAG	INTERNAL TAG	ALARM TAG	DESCRIPTION	FAIL SAFE	ALARM LOGIC	RESET
ESL- G713	ESL_ G713.In	EAL_ G713	Ground Fault Alarm	F/S	SET(EAL_ G713) on ESL_ G713.In = TRUE for 1sec RESET(EAL_ G713) on ESL_ G713.In = FALSE for 3sec	Auto
ESL- G711	ESL_ G711.In	EAL_ G711	240V Power Fail Alarm	F/S	SET(EAL_ G711)on ESL_G711.In = TRUE for 1sec RESET(EAL_G711) on ESL_G711.In = FALSE for 3sec	Auto
XS-G712	XS_ G712.In	XA_ G712	SPD Alarm	F/S	SET(XA_G712) on YA_G712.In = TRUE for 1sec RESET(XA_G712) on YA_G712.In = FALSE for 3sec	Auto
YA-G814	YA_G814.In	YA_G814	UPS Fault Alarm	F/S	SET(YA_G814) on YA_G814.In = TRUE for 1sec RESET(YA_G814) on YA_G814.In = FALSE for 3sec	Auto
YA- G814-1	YA_ G814_1.In	YA_ G814_1	UPS Battery Mode	F/S	SET(YA_ G814_1) on YA_ G814_1.In = TRUE for 1sec RESET(YA_ G814_1) on YA_ G814_1.In = FALSE for 3sec	Auto
YA- G814-2	YA_ G814_2.In	YA_ G814_2	UPS Battery Charging	F/S	SET(YA_ G814_2) on YA_ G814_2.In = TRUE for 1sec RESET(YA_ G814_2) on YA_ G814_2.In = FALSE for 3sec	Auto
YA- G813	YA- G813.In	YA_G813	PS01 24VDC Power Fail Alarm	F/S	SET(YA_ G813) on YA_ G813.In = TRUE for 1sec RESET(YA_ G813) on YA_ G813.In = FALSE for 3sec	Auto
YA- G816	YA- G816.In	YA_G816	PS02 24VDC Power Fail Alarm	F/S	SET(YA_ G816) on YA_ G816.In = TRUE for 1sec RESET(YA_ G816) on YA_ G816.In = FALSE for 3sec	Auto

PHYSICAL INPUT TAG	INTERNAL TAG	ALARM TAG	DESCRIPTION	FAIL SAFE	ALARM LOGIC	RESET
ESL- G812	ESL_ G812.In	EAL_ G812	120V Power Fail Alarm	F/S	SET(EAL_ G812)on ESL_G812.In = TRUE for 1sec RESET(EAL_G812) on ESL_G812.In = FALSE for 3sec	Auto
ZS-G600	ZS_G600.In	ZA_G600	Electrical Enclosure Door Open Alarm		SET(ZA_ G600)on ZS_G600.In = TRUE for 1sec RESET(ZA_G600) on ZS_G600.In = FALSE for 3sec	Auto

3.3.4 CONTROL NARRATIVE

The PLC shall monitor the following instruments:

1. PLC panel UPS fault status
2. PLC panel UPS battery mode status
3. PLC panel UPS charging mode status
6. PLC panel 24VDC PS01 fault status
7. Panel Cooler 24VDC PS02 fault status
8. 24V Power Fail Relay Alarm
9. SPD Status Alarm
10. Ground Fault Monitor Alarm
11. 240V power Fail Relay alarm
12. Electrical Enclosure Door Open Alarm

3.3.5 TIME DELAYS

When the PLC receives a digital command from the SCADA, the PLC shall have a time delay between receiving the command and changing it back to zero so it can be detected on SCADA.

DNP3 binary outputs shall be a pulse in the PLC program. The mapped input shall be a 5 second pulse. This time shall be adjusted as necessary during commissioning.

3.3.6 ON DEMAND EVENTS

On demand events for analog points shall be generated by the NOR card periodically as required by the city

3.3.7 DEADBAND

During commissioning, the Contractor shall set the threshold (deadband) to 2% within the NOR card. The City will review the data coming into SCADA and provide instructions for the Contractor to adjust the deadband accordingly.

3.3.8 DNP3 DIGITAL OUTPUT MAPPING

Each DNP3 output point will need to be mapped (mirrored) to a DNP3 input point of the same type (while keeping the output point). This mapped DNP3 input point will be used in SCADA to detect change of state.

3.3.9 GENERAL I/O MAPPING & TESTING

All I/O's, Alarms and any necessary points shall be sent to the city SCADA using DNP3.

Provide testing and confirmation of the DNP3 mapping list to the city SCADA system (functional test whenever possible).

Provide testing and verification of instrument readings, alarm conditions and control logic with the city SCADA system.

3.3.10 PLC HEARTBEAT

A heartbeat is to be implemented in the PLC-G81 named as "PLC_G81_HB" so that the station's PLC can be monitored on SCADA (i.e. a DNP3 analog input point that is incremented every one second by the PLC until it reaches 32767, reset to zero and continue incrementing).

The heartbeat shall be configured as Class 0 so SCADA receives the heartbeat by polling Class 0.

3.3.11 ADDING ADDITIONAL TAGS

Any and all additional tags or alarm points shall be added before/during commissioning as identified by the contract administrator.

END OF CONTROL NARRATIVE