REPORT

CITY OF WINNIPEG

SEWPCC - Detail Alternative Analysis Review and Reporting

October 2016

Executive Summary

The City of Winnipeg is upgrading the South End Water Pollution Control Centre (SEWPCC) under Environment Act Licence No. 2716 RR. The project is currently under final design, review and phases of construction, but will not be fully complete to meet the timeframes stipulated in the original Licence.

Manitoba Sustainable Development is aware of the project status and has asked the City to prepare a detailed alternative analysis report of the SEWPCC upgrade program to assist in considering a Licence alteration extending the SEWPCC upgrade project. The City engaged Associated Engineering, working collaboratively with City of Winnipeg Sewage Treatment Program (WSTP) staff and CH2M, the SEWPCC upgrade design consultant, to assist in this review as well as to recommend a revised implementation estimate.

The review began in January 2016 and included meetings with the Manitoba Clean Environment Commission and Manitoba Sustainable Development to review progress of the alternative analysis review.

Associated Engineering completed the detailed alternatives review and found no feasible alternatives to improve the schedule of the SEWPCC upgrade program. In terms of the SEWPCC Environment Act Licence, Associated Engineering recommends that the City of Winnipeg, request a Licence alteration modifying the compliance date for implementation of the biological nutrient removal upgrades on or before March 31, 2021. In regards to compliance with chemical addition, February 15, 2020 is recommended.

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1 Introduction

The City of Winnipeg (City) is upgrading the South End Sewage Treatment Plant (SEWPCC) under Environment Act Licence No. 2716 RR. The project is currently under final design, review and phases of construction, but will not be fully complete to meet the timeframes stipulated in the original Licence. The City has requested a time extension to the Licence conditions and has engaged Associated Engineering (AE) to assist in review of alternatives to accelerate completion, as well as to recommend a revised implementation estimate.

As part of the review, a series of meetings and a workshop were held with the City of Winnipeg Sewage Treatment Program (WSTP) staff, CH2M, the design consultant, and AE staff to obtain information on the upgrade program, to review alternatives and to develop implementation estimates. Meetings were also held with individuals from Manitoba Sustainable Development (formerly Manitoba Conservation and Water Stewardship) and the Clean Environment Commission (CEC) to update the progress of the alternative review study and to receive feedback.

This report outlines the alternatives reviewed and proposed Licence completions dates for interim compliance and final compliance for the SEWPCC upgrade.

2 Scope of Review

Manitoba Sustainable Development (MSD) asked the City to prepare a detailed alternative analysis report of the SEWPCC upgrade program, to assist in considering a Licence alteration extending the SEWPCC upgrade completion. The report includes:

- A review of details regarding possible alternatives to expedite the current construction schedule.
- A review of feasible alternatives to conducting activities in parallel rather than sequentially.
- Review of interim implementation options to expedite nutrient removal in advance of construction completion of the final biological nutrient removal (BNR) equipment.
- A review of a revised implementation estimate; including recommendation for accelerating, accepting, or pushing back the licence compliance date based on feasibility analysis.
- Consultation with the CEC on a quarterly basis and receiving input from the CEC on the draft alternative analysis report.

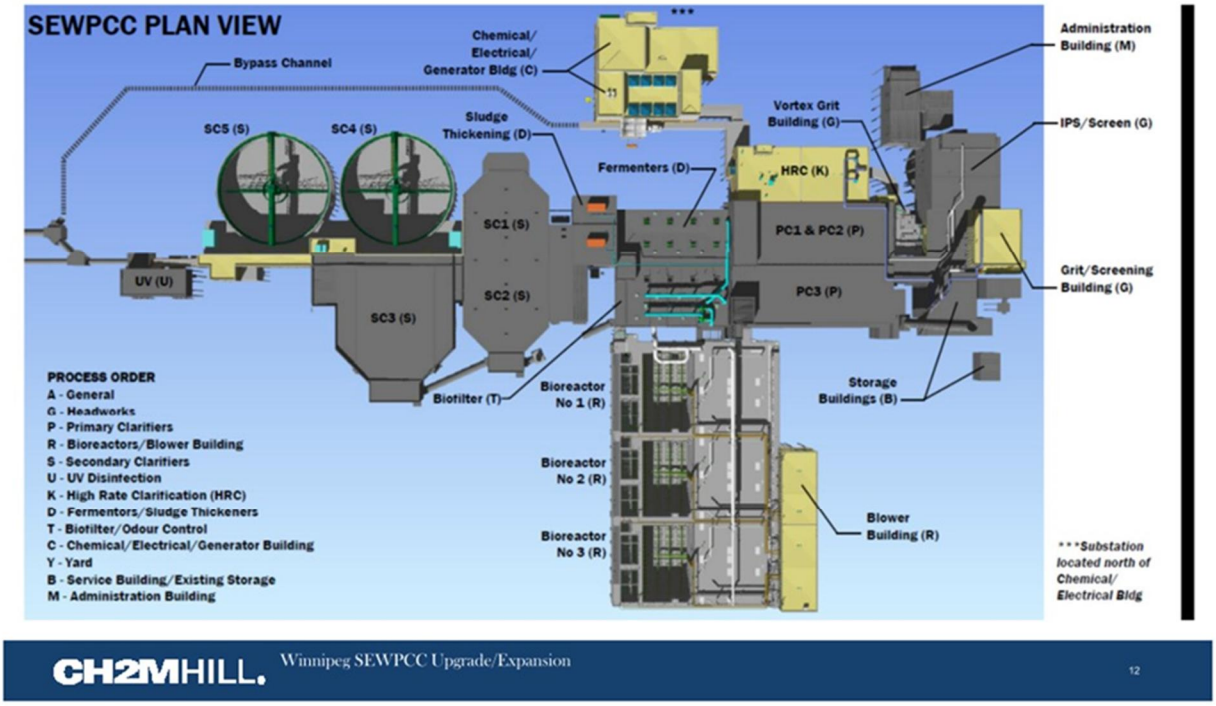
The City engaged AE to prepare the detailed alternative analysis report as per the details above. AE completed the work in collaboration with the WSTP staff and CH2M.

3 SEWPCC Program Overview

3.1 DESIGN AND CONSTRUCTION

The City is expanding and upgrading the SEWPCC to meet the requirements of the Environment Act Licence to remove nitrogen and phosphorous with a BNR process; to accommodate increasing wastewater loadings to the plant; to treat wet weather flow; to replace the existing control system; and, to maintain compliance and operation of existing works through the upgrading program. Figure 1, prepared by CH2M, summarizes the SEWPCC Upgrade / Expansion.

Figure 1: Winnipeg SEWPCC Upgrade



Design and contract administration services are being performed by CH2M. Construction has been broken down into four separate general contracts and two equipment supply contracts to accelerate the schedule:

- Contract 1: Earthworks & Foundation
- Contract 2: High Rate Clarifier (HRC) and Grit Removal Tank Concrete
- Contract 3: Bioreactors and Secondary Clarifier Structural Concrete Works and Miscellaneous
- Contract 4: Facility Wide M&E, Substation, Chemical/Electrical Building, Headworks, Fermenters, Odor Control, Sludge Thickening, Duct Banks and Bypass and System Integration
- High Rate Clarification Equipment Contract
- Integrated Fixed-Film Activated Sludge (IFAS) Media Contract

The SEWPCC Upgrade project is large and complex. It requires upgrading a critical element of the City's existing wastewater infrastructure with new process treatment systems and controls while maintaining full treatment and compliance throughout the construction works. Brownfield projects are more complex to coordinate and execute. They require detail planning, project management and coordination with existing operations exceeding that of a greenfield project. Added to this are the challenges of the winter climate and increasing extreme event and hazards (e.g. flooding, intense rain, intense wind, etc.).

The program must therefore allow for sufficient time for detailed design, review, construction and commissioning to reduce the likelihood of construction issues and cost overruns. Accelerating the project too aggressively will increase risks and potentially create delays that affect meeting Licence timeframes as well as the quality and price of the final works.

3.2 SEWPCC SCHEDULE UPDATE

A project schedule outlining the SEWPCC design and construction activities was provided by CH2M. This schedule, dated February 24, 2016, formed the basis of the project alternative analysis review. In addition, periodic updates on key project milestones were provided throughout the study to assist in the review. As of the time of the report preparation (October 2016), the following dates and trending dates were noted:

Design

- Design and Review Completion - Trending to early 2017

Construction

- Contract 1: Earthworks & Foundation - Complete
- Contract 2: High Rate Clarifier (HRC) and Grit Removal Tank Concrete - In construction
- Contract 3: Bioreactors and Secondary Clarifier Works - In construction
- Contract 4: Facility Wide M&E, Substation, Chemical/Electrical Building, Headworks, Fermenters, Odor Control, Sludge Thickening, Duct Banks and Bypass and System Integration – Tender trending to early 2017

Equipment Supply Contracts

- High Rate Clarification Equipment Contract - Partial delivery of structural items complete. M&E equipment delivery under review.
- IFAS Media Equipment Contract - Delivery trending late 2017/ early 2018

Licence Compliance Dates

- Licence compliance with chemical addition (interim treatment) - Trending to early 2020
- Licence compliance with BNR complete - Trending to mid 2021 with additional construction activities needed to modify and repurpose existing plant facilities.

4 Alternative Analysis Review

4.1 INFORMATION GATHERING

Information related to the alternative analysis review was received though meetings and presentations with the WSTP staff and CH2M, as well from background documents and presentations forwarded by WSTP staff. Additionally, progress update meetings were held with the CEC, MSD, WSTP and AE to receive input on the review. A listing of meetings, the attendees and meeting details are noted below:

Project Initiation Meeting (January 2016): Project initiation, review of scope, schedule and verification of CH2M and WSTP staff associated with the review. Attendees: WSTP and AE.

Progress Review Meeting (February 2016): Progress update meeting with the CEC. The meeting included a presentation by AE on the SEWPCC upgrade program and alternatives analysis review scope. Attendees: CEC, MSD, WSTP and AE.

Site Tour and Information Gathering Meeting (February 2016): Site Tour of the SEWPCC facility. A meeting followed the tour featuring a presentation by CH2M on the SEWPCC upgrade and project schedule. Following the meeting an electronic copy of the project schedule was supplied to AE. Attendees: WSTP, CH2M and AE.

Alternatives Analysis Workshop (May 2016): A collaborative workshop was held to outline AE's draft alternative review findings and draft implementation estimates. The objective of the workshop was to receive feedback and verification on the information presented, identify information gaps, update the progress of work and to discuss the feasibility and risks associated with the alternatives presented. Attendees: WSTP, CH2M and AE.

Progress Review Meeting (June 2016): Progress update meeting with the CEC. The meeting included a presentation by AE on the SEWPCC upgrade program and the alternative review draft findings to date. Attendees: CEC, MSD, WSTP and AE.

4.2 AREAS OF REVIEW

The alternatives analysis review was broken down into three main areas:

1. **Schedule Analysis:** A review of the 'baseline' project schedule based on critical path, remaining activities, the total float, and schedule risk factors; a review of the schedule impacts from trending changes to the schedule; and, a review of impacts related to alternatives or options to improve the schedule.

2. **Alternative Analysis:** A review of alternatives or options to improve the schedule, including: a review of details regarding possible alternatives to expedite the current construction schedule; a review of

feasible alternatives to conducting activities in parallel rather than sequentially; and, a review of interim implementation options to expedite nutrient removal in advance of construction completion of the final BNR equipment.

3. **Licence Compliance Date Analysis:** Based on the schedule and alternatives analysis, revised implementation estimate, including compliance dates are proposed.

These areas are discussed in the following sections of the report.

4.3 SCHEDULE ANALYSIS

4.3.1 Project Schedule

An electronic copy of the project schedule in MS Project prepared by CH2M on February 24, 2016 was provided to AE for analysis related to the alternative options review. AE, with the assistance of Ritter Project Management Inc. (RPMI), analysed the schedule based on:

- A review of the critical path, total float and remaining activities.
- A review of the schedule trend impacts on the February 24, 2016 schedule.
- A review of project risk factors.
- A review of activities that may affect interim compliance and completion, including activities to conducting in parallel rather than sequentially.
- A review of the implementation estimates and Licence compliance dates.

The CH2M schedule was converted from MS Project to Primavera P6 (P6) for analysis purposes. P6 was used based on its functionality in schedule analysis and tends to be used by general contractors on large complex projects. Tasks, task numbering and task information were maintained in the conversion. This converted schedule became the baseline schedule for analysis related to the project.

Critical Path, Total Float and Remaining Activities on Baseline Schedule

Analysis began with a review of critical path, total float and remaining activities.

Critical path activities are the project tasks that must start and finish on time to ensure that the project ends on schedule. A delay in any critical path activity will extend the completion of the project, unless the project plan can be adjusted so that successor tasks finish more quickly than planned.

Float is a measure of schedule flexibility. In a critical path project schedule, starting and ending dates are listed for each activity in the project plan. If the early start date and late start date for an activity are the same, the activity is said to have zero float. Activities that have zero float must start on time to prevent the schedule from slipping. Activities can also have negative float. Negative float occurs when an imposed finish date creates a schedule that is shorter than the duration calculated to complete the activities on the critical path. A project with a total negative float is behind schedule. For the SEWPCC baseline schedule, float can only be reduced by extending task timeframes till the negative float is zero.

The schedule analysis included a review of the progressions of tasks and confirmation of the critical path. The review was largely based on professional judgement comparing AE's teams experience in construction scheduling, construction administration and wastewater process design on projects of similar scale, size and complexity with our understanding of industry best practices. Based on the analysis, the following details and observations were noted:

- Schedule critical path and the sequence of work activities were confirmed.
- Productivity rates and work hours used in developing construction task durations were consistent with best practices. Some construction tasks will require 24-hour operation for short durations which will require coordination with operations unless other means to complete the work are identified.
- The schedule was developed for project planning and implementation and is not a construction (Constructor) schedule addressing actual resources allocation, resource coordination and resource loading. A Constructors' schedule would typically be more detailed, having more activities broken down into more tasks with shorter durations allowing management of activities, resources and float throughout the project.
- A number of unaccounted project risks were identified that did not generally have allowances built into the schedule. Additional time should be considered for unaccounted project risks.
- Commissioning activities may be compressed. Additional time should be considered for commissioning activities.
- The analysis indicated that there is a negative schedule float of approximately 1.5 months (43 working days) for Contract C4 works related to providing interim compliance with chemical addition and a negative schedule float of approximately 1.0 month (37 working days) for Contract C4 works related to providing compliance with BNR removal achieved. Additional time should be considered in the schedule to reduce the negative float to zero.
- Construction activities will continue to modify and repurpose existing plant facilities after BNR removal is achieved to fully complete all required works.

Based on above analysis, a schedule allowance to reduce negative float to zero (1.5 months for interim completion and 1.0 month for compliance with BNR removal completed) is recommended.

Trending Impacts on Baseline Schedule

The baseline schedule analysis, as noted above, was based on the February 24, 2016 version of the CH2M project schedule. Since February, 2016 the project has continued with several key milestones being met (Contract C1, C2, C3). Other milestones are, however, trending later than the scheduled timeframe.

Contract C4 is the largest trending impact to the schedule. The tender issue date for Contract C4 is currently trending to early 2017, which is later than the original 2016 date due to additional time required for:

- Design and review
- Extended timeframes for tendering (more time allowed to account for the project complexity)
- Longer award timeframes and approval by Council based on the probable contract value

Where in some cases weeks were allocated for these tasks, they are requiring months due to the scale and complexity of the final C4 documents which include approximately:

- 3500 drawings (civil, structural, mechanical, process, electrical, instrumentation and controls)
- 300 pages of commissioning and contract documents

Additionally, some documents (e.g. contract documents) are not yet fully submitted to the City for review and other packages were only received in September 2016.

The review process requires multiple stakeholder inputs (operations, engineering, maintenance groups, consultants etc.) with many iterations of revision. This requires considerable effort and time.

In response the City has increased forces and authorized overtime where possible to accelerate reviews of the C4 contract. Careful and detailed reviews of the documents are necessary to minimize costly mistakes and delays during the construction period.

Considering the foregoing challenges, the C4 contract award will be extended beyond February 2017. This will not allow sufficient time for the successful C4 general contactor to execute Headworks tasks in late 2017 during the required low flow conditions. This low flow condition is only present during the late fall months and winter months. Given the headworks work is on the critical path of the schedule, the work must be deferred to the following year impacting the baseline schedule by approximately 12.0 months. A deferral of work on the schedule critical path generally causes a deferral of all remaining tasks. Additional time should be therefore being considered to account for this impact. Although 12.0 months' impact is noted, this does not infer that the project should be suspended in any way, but rather the works should be tendered as soon as C4 work is complete. This will allow for time to complete non critical path items and possible advance other areas of the schedule that may mitigate against further schedule impacts.

Based on above analysis, a schedule allowance of 12.0 months is recommended to account for trending impacts on the baseline schedule.

Project Risk Factors

In review of the schedule and through discussions in the workshop, a considerable number of unaccounted project risks were identified that did not generally have allowances built into the schedule. As each item has the potential of negatively impacting the schedule by varying amounts, it is recommended to add total allowance or contingency to account for all these risks. Allocating individual factors to each risk and applying them to the schedule will likely be overly conservative as each event has a varying likelihood and impact. Stated more simply, it is foreseeable that some of the impacts could take place but it is very unlikely that all will transpire in the project. The identified unaccounted project risks are listed below:

- The project schedule is aggressive for a project of this complexity and magnitude. It has compressed activities for design and review, construction, verification, testing and commissioning.

- Some critical path tasks are seasonally constrained and if not completed in the appropriate timeframe, may need to be postponed until conditions are suitable. Examples include: Low flow periods required to complete construction and warm temperatures for biological treatment process start-up.
- The schedule was developed for project planning and implementation and is not a construction (Constructor) schedule addressing resources allocation, resource coordination and resource loading.
- Tendering and construction of early construction works (C1, C2, C3) prior to final design and reviews being completed on C4 create the risk of construction and coordination issues.
- Existing plant complexities that could cause delay including tie-ins to existing works, assumptions and irregularities on existing works, accuracy of as-constructed information and unknown and unforeseen site conditions.
- 'Normal' construction challenges for work of this complexity and magnitude affecting schedule.
- Market forces (labour, competing projects, materials).
- General Contractor schedule performance. Risk that the work may extend beyond completion dates based on extensions due to construction issues or performance, even in light of contract penalty provisions.
- Verification, testing and commissioning challenges.
- Weather and hazards (extreme events, river flooding).
- Operational risks of keeping the existing plant operational and compliant during the upgrade works.

Based on the above, it is recommended to include a project risk factor allowance (3.0 months for interim completion and 4.0 months for compliance with BNR removal completed) to the project. In addition, the WSTP staff should compare the above with the existing project risk registry and add any items not noted.

Implementation Estimates and Licence Compliance Dates

- A detailed review of alternates is provided later in the report. Although several alternatives were identified and analysed, no alternative proposed any significant time savings in the schedule for early compliance or for early completion.
- Current timeframes to complete the project are likely unrealistic. Given the factors indicated in the above analysis, it is recommended to allow for additional time in the schedule to account for negative float, current trends, risk factors and compliance timeframes. These allowances are summarized in a later section of this report.

4.4 ALTERNATIVES OVERVIEW

AE completed a review of alternatives or options to improve the schedule, including:

- A review of details regarding possible alternatives to expedite the current construction schedule.
- A review of feasible alternatives to conducting activities in parallel rather than sequentially.
- A review of interim implementation options to expedite nutrient removal in advance of construction completion of the final BNR equipment.

The review looked at the SEWPCC upgrade program and brainstormed activities / options to accelerate the schedule as per the above. Once the process was completed, each option was evaluated for feasibility, risk and schedule impacts. Where an option was found to be feasible, the scenario was analyzed to determine its outcome on the overall schedule.

Risks were broken into four categories:

- Schedule Risks - Risks that may adversely affect the project schedule.
- Quality Risks - Risks that may affect the quality of construction.
- Cost Risks - Risks that may increase the capital or operating cost of the works.
- Operational Risks - Risks that may affect the operations of the existing facility or the proposed upgrade works, including risk to maintaining Licence compliance though construction.

Worksheets were developed for each option summarizing the scenario, risks and an indication whether the option could impact the schedule. A “what-if” schedule analysis was then performed on the baseline to determine if there were any effects on the critical path. A summary of the alternative option worksheets is included in Appendix B.

A collaborative workshop was held to review the alternatives as well as implementation estimates. The workshop provided feedback on the alternatives in terms of feasibility, risk and schedule impact. The outcome of the workshop found the alternatives / actions presented were either not feasible or in many cases, already being considered in the SEWPCC program. Details of the workshop were summarized in a draft workshop report. A summary of the final alternatives / actions is listed below:

Actions currently being implemented or proposed in the SEWPCC Program

- Pre-purchased equipment
  - Integrated Fixed Film Activated Sludge (IFAS) media
  - HRC wet weather flow equipment
- Preselection of “major” equipment and long delivery items
- Preselection / Prequalification of systems controls integrator
- Standardization of equipment
  - PLCs, HMI / Automation
- Contract phasing, strategic tendering, specification conditions
  - Early site work tender (C1)
  - Continuing concrete work activities in winter (C1, C2, C3)
  - Protections of completed foundation works (C1)
  - Scheduling work in beneficial seasons (C1, C2, C3, C4)
  - Staged commission to assist in early compliance (C4)
  - Detailed commission planning (C4)
- Phosphorous removal by chemical addition (interim operation)

In terms of impacts of the above actions on the baseline schedule, no changes are noted as any affects are already factored into the timeframes.

Alternatives / Actions Alternatives to be Considered to Improve Schedule

- Separate tender package for Chemical / Electrical Building Concrete and Electrical Substation Concrete works, in advance of C4 tendering.

The option is not considered feasible as an option to advance the baseline schedule, as the resources required to implement the plan are tied to the critical path delivery of the design and additinal resources are not feasible. In addition, the schedule analysis did not find a reduction in the critical path timeframe for this scenario.

If the trending impacts on baseline schedule, as noted previously, are realized, the C4 Contract could be encouraged to initiate these areas of work earlier and reduce negative, as well as mitigate several other schedule risks.

- Enhanced requirements in Contract C4
  - Early procurement provisions for “major” equipment and long delivery items.
    - Grit Tank Equipment, UV, Fermenter Mixer, Large Transformers, MCCs
  - Critical path based specification requirements with defined milestones.
  - Deferring construction not required for compliance.

The above actions are feasible and will be incorporated into C4 Contract Documents. No additional time saving in terms of schedule were found when analysed but the actions will reduce the schedule risks.

Alternatives Summary

A list of alternatives was identified and analysed by AE as detailed above. No alternative proposed any significant time savings in the schedule for early compliance or for early completion. Furthermore, many of the alternatives / activities have already been implemented in the current SEWPCC upgrade program.

Therefore, no allowances for alternatives have been accounted in the revised implementation estimates.

4.5 LICENCE COMPLIANCE DATE RECOMMENDATIONS

Based on a detail alternatives analysis and project schedule review, it is recommended to modify compliance dates for implementation of the BNR upgrades. A summary of the factors and allowances, as well as recommended dates are listed below and outlined in Table 1.

For **critical path, total float and remaining activities on baseline schedule** a schedule allowance to reduce negative float to zero (1.5 months negative float for interim completion and 1.0-month negative float for compliance with BNR removal completed) is recommended.

For **trending impacts on baseline schedule** a schedule allowance of 12.0 months is recommended.

For **alternatives to expedite the current construction schedule**, no feasible options were found to reduce the baseline schedule for interim or final nutrient removal compliance. Therefore, no schedule allowance is recommended.

For **project risk factors,** a schedule allowance (3.0 months for interim completion and 4.0 months for compliance with BNR removal completed) is recommended.

It is further recommended that an **additional allowance** be added to allow time from the end of construction and commissioning to the Licence compliance date. Although the City is endeavouring to be compliant before the timeframe, activities beyond their control may affect compliance. An additional allowance (2.0 months for interim completion and 3.0 months for compliance with BNR removal completed) is recommended.

Table 1: SEWPCC Upgrade Revised Implementation Estimate
Recommended Schedule Factors

Item	**Licence Compliance with Chemical Addition**	**Licence Compliance with BNR Removal Completed**
	Estimated Factor (month)	**Estimated Factor (month)**
Critical Path, Total Float and Remaining Activities on Baseline Schedule Allowance	1.5	1.0
Trending Impacts on Baseline Schedule Allowance	12.0	12.0
Project Risk Factor Allowance	3.0	4.0
Alternatives to Expedite the Current Construction Schedule	-	-
Additional Allowance	2.0	3.0
Total	**18.5**	**20.0**
Revised Estimated Licence Compliance Dates	(July 31, 2018 + 18.5 months) **February 15, 2020**	(July 31, 2019 + 20.0 months) **March 31, 2021**

4.5.1 Licence Compliance with Chemical Addition

The date provided to Manitoba Sustainable Development in 2015 for interim Licence compliance with chemical addition was estimated to be July 31, 2018. Based on the analysis above, it is estimated that that the date to achieve interim chemical compliance could be approximately 18.5 months later than the current baseline schedule indicates or into the early part of 2020. Given this date and the dates preceding are in winter months, it is highly probable that bioreactor start-up could be further delayed due to weather conditions. No additional allowances for time have been allocated for this scenario.

4.5.2 Licence Compliance with Biological Nutrient Removal (BNR)

The date provided to Manitoba Sustainable Development in 2015 for Licence compliance with BNR removal completed was estimated to be July 31, 2019. Based on the analysis above, it is estimated that the date to achieve compliance with BNR removal could be approximately 20.0 months later than the current baseline schedule indicates or into the first quarter of 2021. Given this date and the dates preceding are in winter months, it is highly probable that full BNR removal could be further delayed due to weather conditions. No additional allowances for time have been allocated for this scenario.

5 Recommendations

Based on a detail alternatives analysis review of the SEWPCC including a detail analysis of the project schedule, it is recommended that the City, request a Licence alteration modifying the compliance date for implementation of the BNR upgrades to on or before March 31, 2021. In regards to compliance with chemical addition, February 15, 2020 is recommended.

6 Closure

This SEWPCC detail analysis report was prepared for the City of Winnipeg to assist in preparing a Licence alteration extending the SEWPCC upgrade project.

The services provided by Associated Engineering (Sask.) Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering (Sask.) Ltd.

Jeff O'Driscoll, P.Eng. IRP
Division Manager, Winnipeg Infrastructure

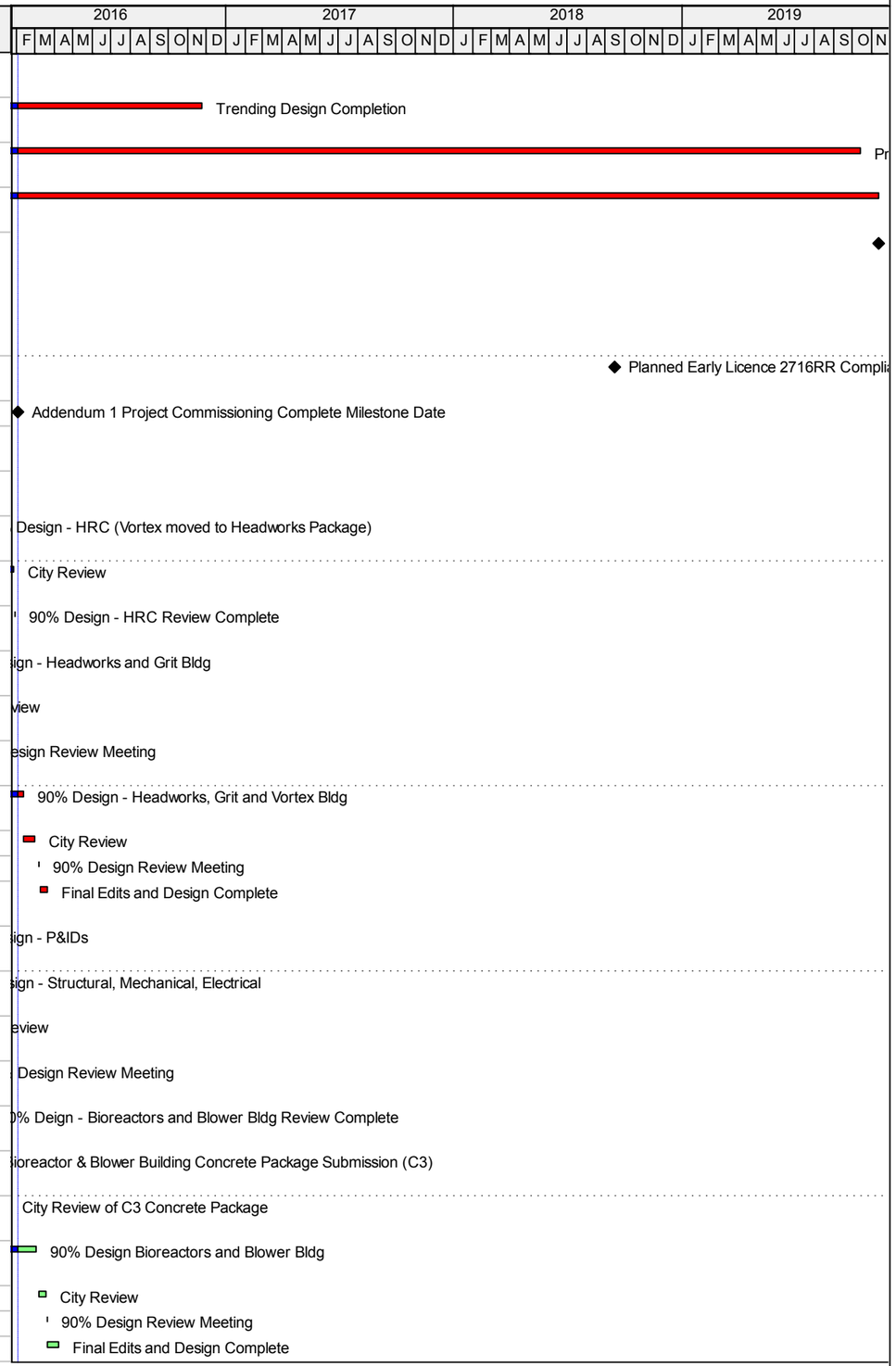
PROVINCE OF MANITOBA
J. P.
O'DRISCOLL
OCT 20/2016
REGISTERED PROFESSIONAL ENGINEER

APEGM
Certificate of Authorization
Associated Engineering Ltd.
No. 396 Date: OCT 20/2016

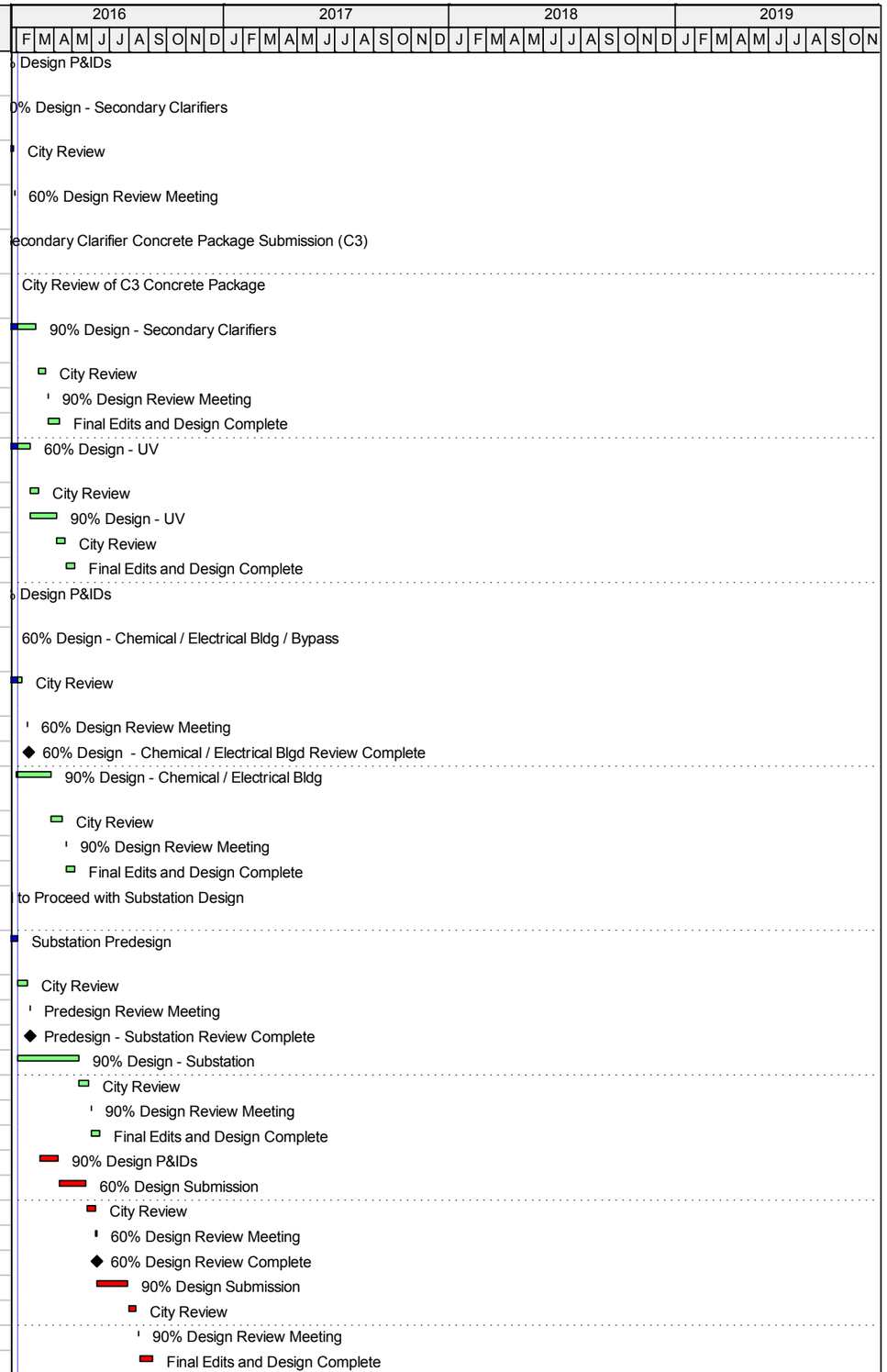
Appendix A – Project Baseline Schedule

SEWPCC	WNP X ACT. ID	04-Feb-16	WNPG 00 - WINNIPEG SEWPCC UPGRADE/EXPANSION ALTERNATIVE ANALYSIS REVIEW

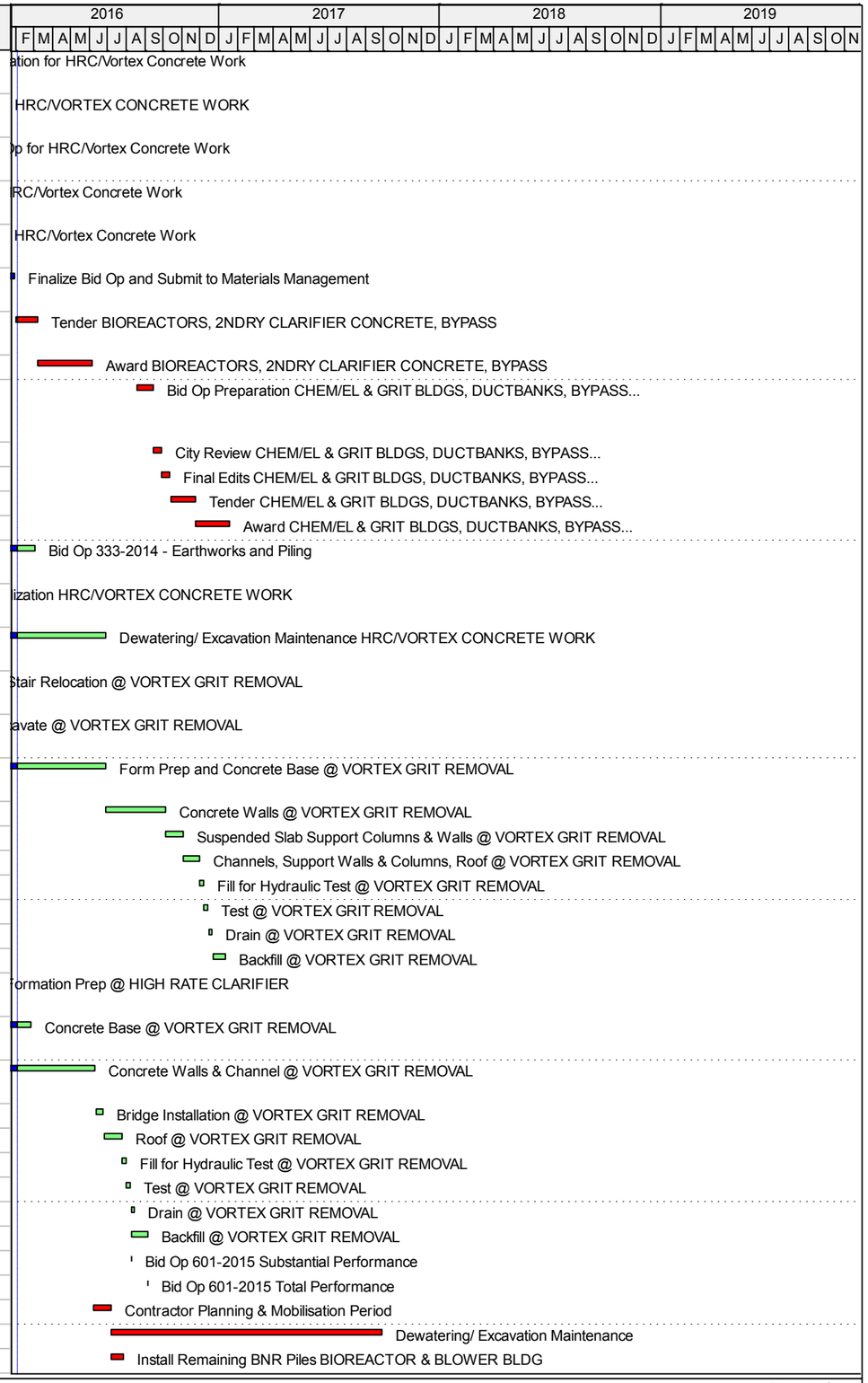
Activity ID	Activity Name	OD	Start	Finish	TF	PRED.	SUCC.
004	Proposed Design Completion	360	02-May-13 A	17-Sep-14 A		003	
005	Trending Design Completion	938	02-May-13 A	23-Nov-16*	-22	127	
006	Proposed Contract Administation Completion	1000	20-Aug-13 A	14-Oct-19	-17		008
007	Trending Contract Administration Completion	1345	04-Sep-14 A	11-Nov-19*	-37	493, 395	008
008	Planned Project License 2716RR Compliance Achieved	0		11-Nov-19*	-37	493, 006, 007, 009, 011, 010, 493, 290, 316, 319, 338, 324, 358, 209, 208, 220, 376	
010	Planned Early Licence 2716RR Compliance Achieved (with Chemical P reduction)	0		14-Sep-18*	-43	469, 472	008
011	Addendum 1 Project Commissioning Complete Milestone Date	0		04-Feb-16*	360		008
016	HRC Tender Award	101	14-Feb-14 A	14-Jul-14 A		015	
022	City Review of Preliminary Design Report	79	17-Jun-14 A	03-Oct-14 A		021	
043	90% Design - HRC (Vortex moved to Headworks Package)	50	04-Sep-15 A	14-Nov-15 A		042, 040	044
044	City Review	50	16-Nov-15 A	28-Jan-16 A		043	045
045	90% Design - HRC Review Complete	1	29-Jan-16 A	29-Jan-16 A		044	053
046	60% Design - Headworks and Grit Bldg	111	27-Apr-15 A	28-Sep-15 A		34, 041	047
047	City Review	10	29-Sep-15 A	13-Oct-15 A		046	048
048	60% Design Review Meeting	1	19-Oct-15 A	19-Oct-15 A		047	049
050	90% Design - Headworks, Grit and Vortex Bldg	77	20-Oct-15 A	11-Feb-16	-43	049	051
051	City Review	10	12-Feb-16	29-Feb-16	-43	050	052
052	90% Design Review Meeting	1	08-Mar-16	08-Mar-16	-43	051	053
053	Final Edits and Design Complete	10	09-Mar-16	22-Mar-16	-43	052, 038, 045	124, 104, 285, 250, 247, 248, 281, 280, 249, 134
055	90% Design - P&IDs	44	29-Jul-15 A	28-Sep-15 A		33, 32	065
056	60% Design - Structural, Mechanical, Electrical	44	29-Jul-15 A	29-Sep-15 A		33, 32	057
057	City Review	20	29-Sep-15 A	26-Oct-15 A		056	058
058	60% Design Review Meeting	1	16-Nov-15 A	17-Nov-15 A		057	059
059	60% Deign - Bioreactors and Blower Bldg Review Complete	1	11-Dec-15 A	12-Dec-15 A		058	060
060	Bioreactor & Blower Building Concrete Package Submission (C3)	1	20-Dec-15 A	20-Dec-15 A		059	061, 062
061	City Review of C3 Concrete Package	10	21-Dec-15 A	19-Jan-16 A		060	120
062	90% Design Bioreactors and Blower Bldg	45	25-Nov-15 A	04-Mar-16	58	060	063
063	City Review	10	07-Mar-16	18-Mar-16	58	062	064
064	90% Design Review Meeting	1	21-Mar-16	21-Mar-16	58	063	065
065	Final Edits and Design Complete	10	22-Mar-16	07-Apr-16	58	064, 055	124



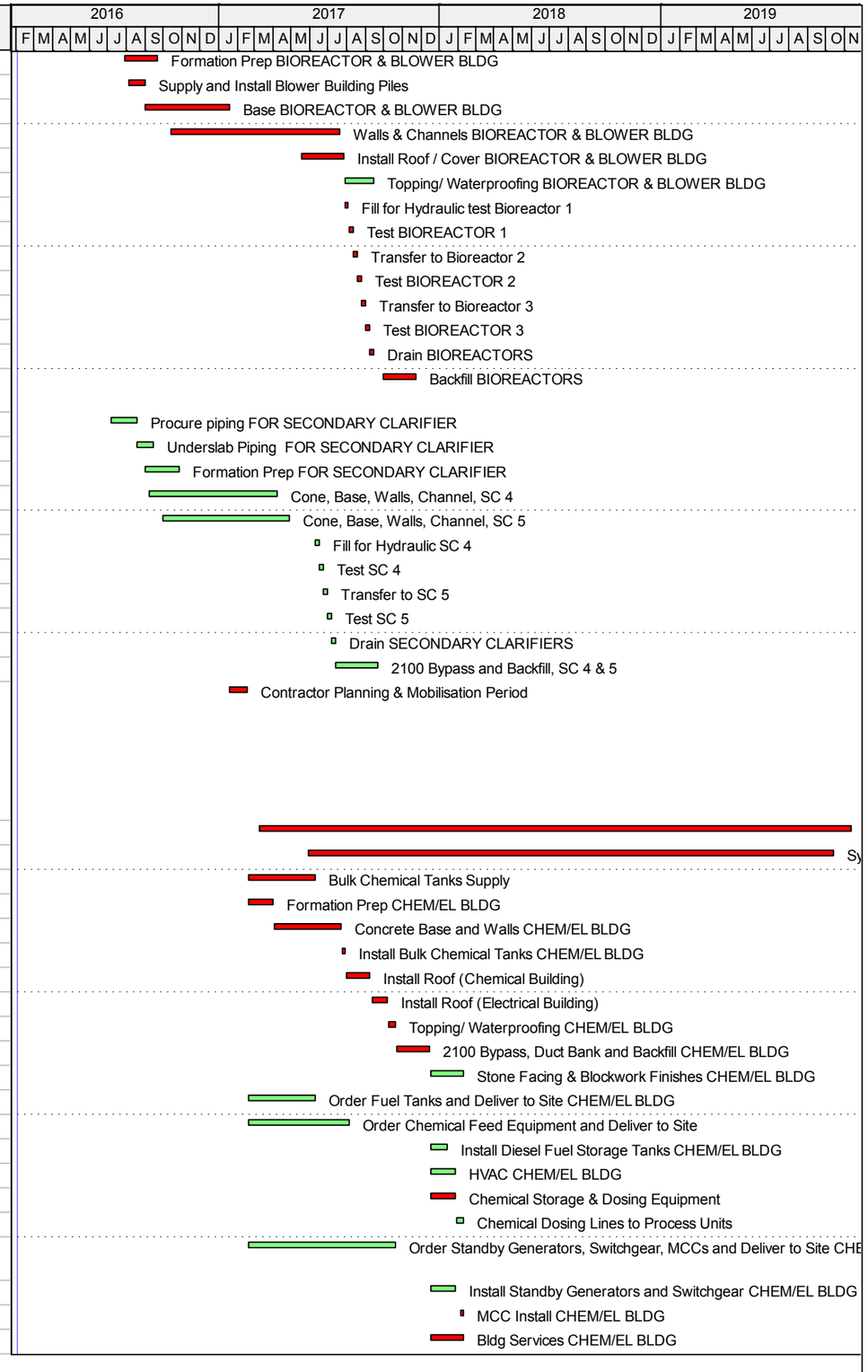
Activity ID	Activity Name	OD	Start	Finish	TF	PRED.	SUCC.
067	90% Design P&IDs	30	09-Oct-15 A	21-Nov-15 A		33, 32	068
068	60% Design - Secondary Clarifiers	40	02-Oct-15 A	15-Dec-15 A		33, 32, 067	069
069	City Review	20	16-Dec-15 A	28-Jan-16 A		068	070
070	60% Design Review Meeting	1	29-Jan-16 A	29-Jan-16 A		069	071
072	Secondary Clarifier Concrete Package Submission (C3)	1	18-Dec-15 A	18-Dec-15 A			073
073	City Review of C3 Concrete Package	10	21-Dec-15 A	18-Jan-16 A		072	120
074	90% Design - Secondary Clarifiers	40	18-Jan-16 A	04-Mar-16	56	071	075
075	City Review	10	07-Mar-16	18-Mar-16	56	074	076
076	90% Design Review Meeting	1	23-Mar-16	23-Mar-16	56	075	077
077	Final Edits and Design Complete	10	24-Mar-16	11-Apr-16	56	076	124
078	60% Design - UV	50	07-Dec-15 A	22-Feb-16	68		079, 080
079	City Review	10	23-Feb-16	07-Mar-16	68	078	124
080	90% Design - UV	29	23-Feb-16	06-Apr-16	111	078	081
081	City Review	10	07-Apr-16	20-Apr-16	111	080	082
082	Final Edits and Design Complete	10	21-Apr-16	04-May-16	111	081	191
084	90% Design P&IDs	40	25-Sep-15 A	21-Nov-15 A		36, 35	091
085	60% Design - Chemical / Electrical Bldg / Bypass	70	07-Oct-15 A	19-Jan-16 A		36, 35	086
086	City Review	10	20-Jan-16 A	10-Feb-16	31	085	087
087	60% Design Review Meeting	1	19-Feb-16	19-Feb-16	31	086	088
088	60% Design - Chemical / Electrical Blgd Review Complete	0	22-Feb-16		31	087	089
089	90% Design - Chemical / Electrical Bldg	38	02-Feb-16 A	28-Mar-16	28	088	090
090	City Review	10	29-Mar-16	14-Apr-16	28	089	091
091	90% Design Review Meeting	1	21-Apr-16	21-Apr-16	28	090, 084	092
092	Final Edits and Design Complete	10	22-Apr-16	05-May-16	28	091	124, 213
094	City Approval to Proceed with Substation Design	1	18-Aug-15 A	18-Aug-15 A			095
095	Substation Predesign	116	19-Aug-15 A	03-Feb-16 A		094	096, 099
096	City Review	10	04-Feb-16	19-Feb-16	66	095	097
097	Predesign Review Meeting	1	23-Feb-16	23-Feb-16	66	096	098
098	Predesign - Substation Review Complete	0	24-Feb-16		66	097	101
099	90% Design - Substation	65	04-Feb-16	11-May-16	1	095	100
100	City Review	10	12-May-16	27-May-16	1	099	101
101	90% Design Review Meeting	1	01-Jun-16	01-Jun-16	1	100, 098	102
102	Final Edits and Design Complete	10	02-Jun-16	15-Jun-16	1	101	124
104	90% Design P&IDs	20	09-Mar-16	08-Apr-16	-43	053	105
105	60% Design Submission	30	11-Apr-16	24-May-16	-43	104	106
106	City Review	10	25-May-16	07-Jun-16	-43	105	107
107	60% Design Review Meeting	1	09-Jun-16	09-Jun-16	-43	106	108
108	60% Design Review Complete	0	10-Jun-16		-43	107	109
109	90% Design Submission	35	10-Jun-16	29-Jul-16	-43	108	110
110	City Review	10	01-Aug-16	12-Aug-16	-43	109	111
111	90% Design Review Meeting	1	17-Aug-16	17-Aug-16	-43	110	112
112	Final Edits and Design Complete	15	18-Aug-16	07-Sep-16	-43	111	124



Activity ID	Activity Name	OD	Start	Finish	TF	PRED.	SUCC.
114	Bid Op Preparation for HRC/Vortex Concrete Work	17	06-Jul-15 A	28-Jul-15 A			115
115	City Review - HRC/VORTEX CONCRETE WORK	11	28-Jul-15 A	11-Aug-15 A		114	116
116	Finalize Bid Op for HRC/Vortex Concrete Work	4	11-Aug-15 A	14-Aug-15 A		115	117
117	Tender HRC/Vortex Concrete Work	30	14-Aug-15 A	24-Sep-15 A		116	118
118	Award HRC/Vortex Concrete Work	1	22-Oct-15 A	22-Oct-15 A		117	133
120	Finalize Bid Op and Submit to Materials Management	9	19-Jan-16 A	29-Jan-16 A		073, 061	121
121	Tender BIOREACTORS, 2NDRY CLARIFIER CONCRETE, BYPASS	29	01-Feb-16 A	07-Mar-16	-27	120	122
122	Award BIOREACTORS, 2NDRY CLARIFIER CONCRETE, BYPASS	60	08-Mar-16	06-Jun-16	-27	121	166
124	Bid Op Preparation CHEM/EL & GRIT BLDGS, DUCTBANKS, BYPASS...	20	18-Aug-16	14-Sep-16	-43	053, 065, 077, 112, 092, 102, 079	125
125	City Review CHEM/EL & GRIT BLDGS, DUCTBANKS, BYPASS...	10	15-Sep-16	28-Sep-16	-43	124	126
126	Final Edits CHEM/EL & GRIT BLDGS, DUCTBANKS, BYPASS...	10	29-Sep-16	12-Oct-16	-43	125	127
127	Tender CHEM/EL & GRIT BLDGS, DUCTBANKS, BYPASS...	30	13-Oct-16	23-Nov-16	-43	126	005, 128
128	Award CHEM/EL & GRIT BLDGS, DUCTBANKS, BYPASS...	40	24-Nov-16	18-Jan-17	-43	127	207
130	Bid Op 333-2014 - Earthworks and Piling	386	04-Sep-14 A	04-Mar-16	86		172
133	Mobilization HRC/VORTEX CONCRETE WORK	15	21-Oct-15 A	10-Nov-15 A		118	137, 150
134	Dewatering/ Excavation Maintenance HRC/VORTEX CONCRETE WORK	200	21-Oct-15 A	28-Jun-16	159	053	139
137	Stair Relocation @ VORTEX GRIT REMOVAL	30	12-Nov-15 A	24-Dec-15 A		133	139
138	Excavate @ VORTEX GRIT REMOVAL	10	12-Nov-15 A	25-Nov-15 A			147
139	Form Prep and Concrete Base @ VORTEX GRIT REMOVAL	30	29-Dec-15 A	28-Jun-16	159	137, 134	140
140	Concrete Walls @ VORTEX GRIT REMOVAL	70	29-Jun-16	05-Oct-16	159	139	141
141	Suspended Slab Support Columns & Walls @ VORTEX GRIT REMOVAL	20	06-Oct-16	02-Nov-16	159	140	142
142	Channels, Support Walls & Columns, Roof @ VORTEX GRIT REMOVAL	20	03-Nov-16	30-Nov-16	159	141	144
144	Fill for Hydraulic Test @ VORTEX GRIT REMOVAL	5	01-Dec-16	07-Dec-16	159	142	145
145	Test @ VORTEX GRIT REMOVAL	5	08-Dec-16	14-Dec-16	159	144	146
146	Drain @ VORTEX GRIT REMOVAL	5	15-Dec-16	21-Dec-16	159	145	147
147	Backfill @ VORTEX GRIT REMOVAL	15	22-Dec-16	11-Jan-17	159	146, 138	316, 186
150	Formation Prep @ HIGH RATE CLARIFIER	30	12-Nov-15 A	23-Dec-15 A		133	152
152	Concrete Base @ VORTEX GRIT REMOVAL	60	26-Nov-15 A	26-Feb-16	19	150	153
153	Concrete Walls & Channel @ VORTEX GRIT REMOVAL	120	07-Dec-15 A	10-Jun-16	19	152	154
154	Bridge Installation @ VORTEX GRIT REMOVAL	10	13-Jun-16	24-Jun-16	19	153	155
155	Roof @ VORTEX GRIT REMOVAL	20	27-Jun-16	25-Jul-16	19	154	157
157	Fill for Hydraulic Test @ VORTEX GRIT REMOVAL	5	26-Jul-16	01-Aug-16	19	155	158
158	Test @ VORTEX GRIT REMOVAL	5	02-Aug-16	08-Aug-16	19	157	159, 160, 161
159	Drain @ VORTEX GRIT REMOVAL	5	09-Aug-16	15-Aug-16	29	158	160
160	Backfill @ VORTEX GRIT REMOVAL	20	09-Aug-16	05-Sep-16	29	158, 159	162
161	Bid Op 601-2015 Substantial Performance	1	09-Aug-16	09-Aug-16*	19	158	162
162	Bid Op 601-2015 Total Performance	1	06-Sep-16	06-Sep-16*	29	160, 161	299, 300, 305, 312, 316, 318, 213
166	Contractor Planning & Mobilisation Period	22	07-Jun-16	07-Jul-16	-27	122	167, 170, 172, 189
167	Dewatering/ Excavation Maintenance	320	08-Jul-16	28-Sep-17	-27	166	391, 186
170	Install Remaining BNR Piles BIOREACTOR & BLOWER BLDG	15	08-Jul-16	28-Jul-16	-7	166	171

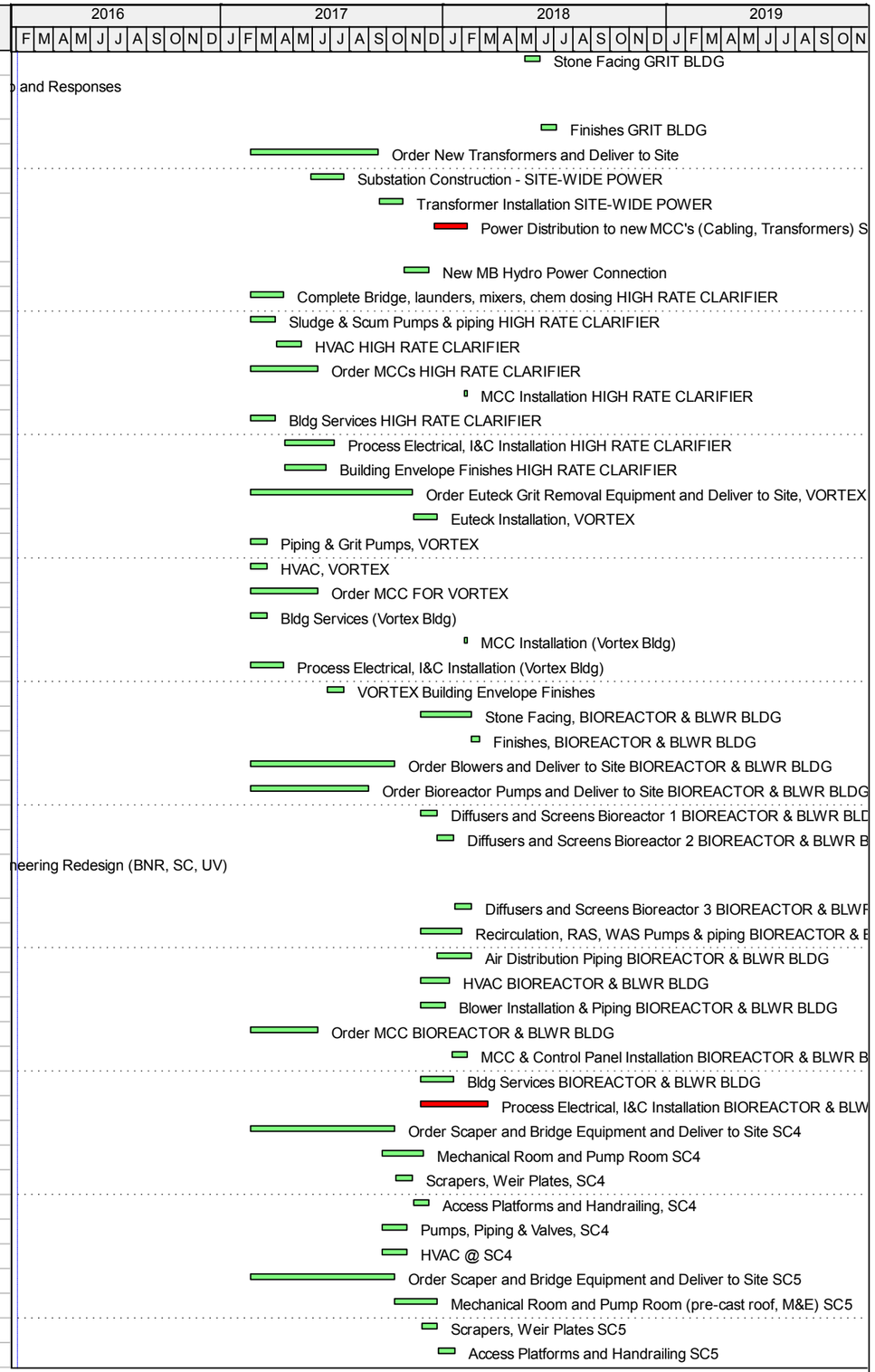


Activity ID	Activity Name	OD	Start	Finish	TF	PRED.	SUCC.
171	Formation Prep BIOREACTOR & BLOWER BLDG	40	29-Jul-16	22-Sep-16	-7	170	174
172	Supply and Install Blower Building Piles	20	05-Aug-16	01-Sep-16	-17	166, 130	174
174	Base BIOREACTOR & BLOWER BLDG	100	02-Sep-16	19-Jan-17	-17	171, 172	175
175	Walls & Channels BIOREACTOR & BLOWER BLDG	200	14-Oct-16	20-Jul-17	-17	174	176
176	Install Roof / Cover BIOREACTOR & BLOWER BLDG	50	19-May-17	27-Jul-17	-17	175	177, 179
177	Topping/ Waterproofing BIOREACTOR & BLOWER BLDG	35	28-Jul-17	14-Sep-17	23	176	186
179	Fill for Hydraulic test Bioreactor 1	5	28-Jul-17	03-Aug-17	-17	176	180
180	Test BIOREACTOR 1	5	04-Aug-17	10-Aug-17	-17	179	181, 186
181	Transfer to Bioreactor 2	5	11-Aug-17	17-Aug-17	-17	180	182
182	Test BIOREACTOR 2	5	18-Aug-17	24-Aug-17	-17	181	183
183	Transfer to Bioreactor 3	5	25-Aug-17	31-Aug-17	-17	182	184
184	Test BIOREACTOR 3	5	01-Sep-17	07-Sep-17	-17	183	185
185	Drain BIOREACTORS	5	08-Sep-17	14-Sep-17	-17	184	186
186	Backfill BIOREACTORS	40	29-Sep-17	23-Nov-17	-27	180, 185, 177, 167, 147	295, 323, 328, 331, 333, 334, 337, 338, 339
189	Procure piping FOR SECONDARY CLARIFIER	30	08-Jul-16	18-Aug-16	28	166	190
190	Underslab Piping FOR SECONDARY CLARIFIER	20	19-Aug-16	15-Sep-16	28	189	191
191	Formation Prep FOR SECONDARY CLARIFIER	40	02-Sep-16	27-Oct-16	28	190, 082	194
194	Cone, Base, Walls, Channel, SC 4	150	09-Sep-16	06-Apr-17	28	191	196
196	Cone, Base, Walls, Channel, SC 5	150	30-Sep-16	27-Apr-17	28	194	200, 198
198	Fill for Hydraulic SC 4	5	09-Jun-17	15-Jun-17	28	196	199
199	Test SC 4	5	16-Jun-17	22-Jun-17	28	198	200, 203
200	Transfer to SC 5	5	23-Jun-17	29-Jun-17	28	196, 199	201
201	Test SC 5	5	30-Jun-17	06-Jul-17	28	200	202, 203
202	Drain SECONDARY CLARIFIERS	5	07-Jul-17	13-Jul-17	28	201	203
203	2100 Bypass and Backfill, SC 4 & 5	50	14-Jul-17	21-Sep-17	28	199, 202, 201	343, 344, 347
207	Contractor Planning & Mobilisation Period	22	19-Jan-17	17-Feb-17	-43	128	209, 212, 220, 222, 223, 225, 229, 232, 236, 247, 248, 249, 250, 258, 259, 280, 281, 285, 292, 293, 299, 300, 303, 305, 310, 312, 315, 316, 318, 323, 326, 327, 328, 331, 333, 334, 336, 338, 339, 342, 343, 347, 349, 356, 362, 366, 372, 373, 213
208	Dewatering/ Excavation Maintenance	697	10-Mar-17	11-Nov-19	-37	395	008
209	Systems Integrator	620	30-May-17	14-Oct-19	-17	493, 207	008
212	Bulk Chemical Tanks Supply	80	20-Feb-17	09-Jun-17	-13	207	215
213	Formation Prep CHEM/EL BLDG	30	20-Feb-17*	31-Mar-17	-43	162, 207, 092	214
214	Concrete Base and Walls CHEM/EL BLDG	80	03-Apr-17	21-Jul-17	-43	213	215
215	Install Bulk Chemical Tanks CHEM/EL BLDG	5	24-Jul-17	28-Jul-17	-43	214, 212	216
216	Install Roof (Chemical Building)	30	31-Jul-17	08-Sep-17	-43	215	217
217	Install Roof (Electrical Building)	20	11-Sep-17	06-Oct-17	-43	216	218
218	Topping/ Waterproofing CHEM/EL BLDG	10	09-Oct-17	20-Oct-17	-43	217	219
219	2100 Bypass, Duct Bank and Backfill CHEM/EL BLDG	40	23-Oct-17	15-Dec-17	-43	218	220, 224, 225, 226, 230, 232, 295
220	Stone Facing & Blockwork Finishes CHEM/EL BLDG	40	18-Dec-17	09-Feb-18	119	219, 207	008
222	Order Fuel Tanks and Deliver to Site CHEM/EL BLDG	80	20-Feb-17	09-Jun-17	188	207	224
223	Order Chemical Feed Equipment and Deliver to Site	120	20-Feb-17	04-Aug-17	62	207	226
224	Install Diesel Fuel Storage Tanks CHEM/EL BLDG	20	18-Dec-17	12-Jan-18	53	219, 222	395, 438, 441
225	HVAC CHEM/EL BLDG	30	18-Dec-17	26-Jan-18	62	219, 207	432
226	Chemical Storage & Dosing Equipment	30	18-Dec-17	26-Jan-18	-33	219, 223	227, 233
227	Chemical Dosing Lines to Process Units	10	29-Jan-18	09-Feb-18	92	226	434
229	Order Standby Generators, Switchgear, MCCs and Deliver to Site CHEM/EL BLDG	175	20-Feb-17	20-Oct-17	32	207	230, 231
230	Install Standby Generators and Switchgear CHEM/EL BLDG	30	18-Dec-17	26-Jan-18	7	229, 219	403
231	MCC Install CHEM/EL BLDG	5	05-Feb-18	09-Feb-18	-43	229, 295	233, 431
232	Bldg Services CHEM/EL BLDG	40	18-Dec-17	09-Feb-18	-43	219, 207	233

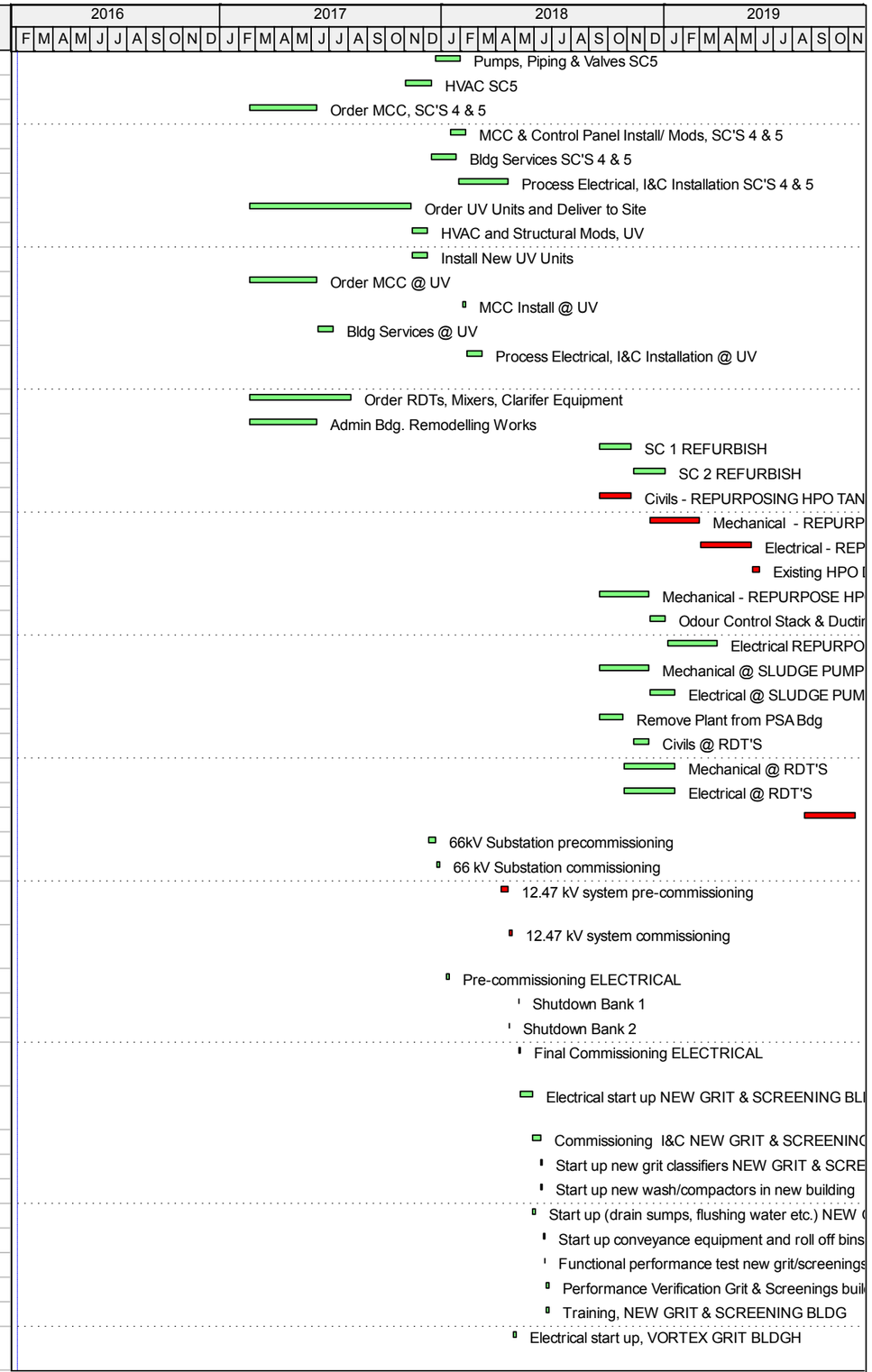


Activity ID	Activity Name	OD	Start	Finish	TF	PRED.	SUCC.
233	Process Electrical, I&C Installation CHEM/EL BLDG	40	12-Feb-18	06-Apr-18	-43	232, 226, 231	403, 431, 438
236	Overhead Door HDWRKS/GRIT/SCREENING	20	20-Feb-17	17-Mar-17	-28	207	237
237	Earthworks HDWRKS/GRIT/SCREENING	10	20-Mar-17	31-Mar-17	-28	236	238
238	Piling HDWRKS/GRIT/SCREENING	10	03-Apr-17	14-Apr-17	-28	237	239
239	Concrete Bases HDWRKS/GRIT/SCREENING	30	17-Apr-17	26-May-17	-28	238	240
240	Suspended Slab Support Columns & Walls HDWRKS/GRIT/SCREENING	50	29-May-17	04-Aug-17	-28	239	241
241	Suspended Slab HDWRKS/GRIT/SCREENING	20	07-Aug-17	01-Sep-17	-28	240	242
242	Install Roof HDWRKS/GRIT/SCREENING	20	04-Sep-17	29-Sep-17	-28	241	243
243	Topping/ Waterproofing HDWRKS/GRIT/SCREENING	10	02-Oct-17	13-Oct-17	-28	242	244
244	Duct Bank and Backfill HDWRKS/GRIT/SCREENING	30	16-Oct-17	24-Nov-17	-28	243, 258	282, 283, 286, 289, 295, 251, 261
247	Order New Raw Sewage Pump and Deliver to Site HDWRKS/GRIT/SCREENING	250	20-Feb-17	02-Feb-18	41	207, 053	263
248	Order New Screens and Deliver to Site HDWRKS/GRIT/SCREENING	150	20-Feb-17	15-Sep-17	-9	207, 053	253
249	Order Wash Compactor Equipment and Deliver to Site HDWRKS/GRIT/SCREENING	100	20-Feb-17	07-Jul-17	196	207, 053	257
250	Order Gates and Deliver to Site HDWRKS/GRIT/SCREENING	100	20-Feb-17	07-Jul-17	21	207, 053	251
251	Inlet Channel Gates and Benching HDWRKS/GRIT/SCREENING	20	27-Nov-17	22-Dec-17	11	250, 244	252
252	Channel Construction / Modifications HDWRKS/GRIT/SCREENING	80	25-Dec-17	13-Apr-18	11	251	282
253	New 6mm Screens Installation HDWRKS/GRIT/SCREENING	80	11-Dec-17	30-Mar-18	-9	248	254, 263, 261, 262, 268, 271, 269, 270
254	Grit Channel Modifications HDWRKS/GRIT/SCREENING	30	02-Apr-18	11-May-18	-9	253, 262	282
255	Existing Conveyor Removal HDWRKS/GRIT/SCREENING	5	25-Dec-17	29-Dec-17	71	261	256, 257
256	Install Temporary Bins HDWRKS/GRIT/SCREENING	5	01-Jan-18	05-Jan-18	81	255, 281	282
257	Temporary Wash Compactor Instalation HDWRKS/GRIT/SCREENING	15	01-Jan-18	19-Jan-18	71	255, 249	282
258	Covers for Wetwell and Grit Tanks (supply and install)	150	20-Feb-17	15-Sep-17	-8	207	282, 244
259	HVAC Improvements (supply & install AHU's, fans, ducts) HDWRKS/GRIT/SCREENING	130	20-Feb-17	18-Aug-17	181	207	282
261	Temporary Electrical (Remove conduit @ conveyor & re-wire) HDWRKS/GRIT/SCREENING	20	27-Nov-17	22-Dec-17	71	253, 244	255, 266
262	Temporary Electrical (For New Screens & One Wash Compactor) HDWRKS/GRIT/SCREENING	50	01-Jan-18	09-Mar-18	6	253	254
263	DCS Conversion HDWRKS/GRIT/SCREENING	20	02-Apr-18	27-Apr-18	1	253, 247	282
266	Existing screens operation with temp wiring PERF PLATE SCREENS	5	25-Dec-17	29-Dec-17	126	261	267
267	Individual screenings and grit bins in place PERF PLATE SCREENS	0	01-Jan-18		126	266	268
268	Start up screen 1 plus sluice section PERF PLATE SCREENS	4	09-Jul-18	12-Jul-18	-9	253, 267, 282	272, 273
269	Start up screen 2 plus sluice section PERF PLATE SCREENS	4	05-Feb-18	08-Feb-18	102	253	274
270	Start up screen 3 plus sluice section PERF PLATE SCREENS	4	05-Mar-18	08-Mar-18	82	253	275
271	Start up screen 4 plus sluice section PERF PLATE SCREENS	4	02-Apr-18	05-Apr-18	62	253	276
272	Start up temporary wash/compactor PERF PLATE SCREENS	2	13-Jul-18	16-Jul-18	-9	268	277
273	Functional performance test screen 1 PERF PLATE SCREENS	2	13-Jul-18	16-Jul-18	-9	268	277
274	Functional performance test screen 2 PERF PLATE SCREENS	1	09-Feb-18	09-Feb-18	102	269	277
275	Functional performance test screen 3 PERF PLATE SCREENS	1	09-Mar-18	09-Mar-18	82	270	277
276	Functional performance test screen 4 PERF PLATE SCREENS	1	06-Apr-18	06-Apr-18	62	271	277
277	Performance Verification PERF PLATE SCREENS	1	17-Jul-18	17-Jul-18	-9	276, 272, 273, 274, 275	278, 472
278	Training	5	17-Jul-18	23-Jul-18	-9	277	493, 452
280	Order Classifiers and Sluice and Deliver to Site GRIT BLDG	100	20-Feb-17	07-Jul-17	211	207, 053	282
281	Order Bins and Deliver to Site GRIT BLDG	50	20-Feb-17	28-Apr-17	256	207, 053	256
282	Install grit handling systems GRIT BLDG	40	14-May-18	06-Jul-18	-9	244, 280, 258, 252, 254, 263, 259, 256, 257	268
283	Bldg Services (Grit and Screenings Bldg)	20	18-Dec-17	12-Jan-18	354	244	412, 290
285	Order MCC GRIT BLDG	80	20-Feb-17	09-Jun-17	132	207, 053	286
286	MCC Installation (Grit and Screenings Bldg)	10	29-Jan-18	09-Feb-18	-33	285, 244, 295	287, 288
287	Process Electrical, I&C Installation (Grit and Screenings Bldg)	60	12-Feb-18	04-May-18	274	286	412
288	Transfer Existing Grit Equipment to new MCC	40	12-Feb-18	06-Apr-18	-33	286	404

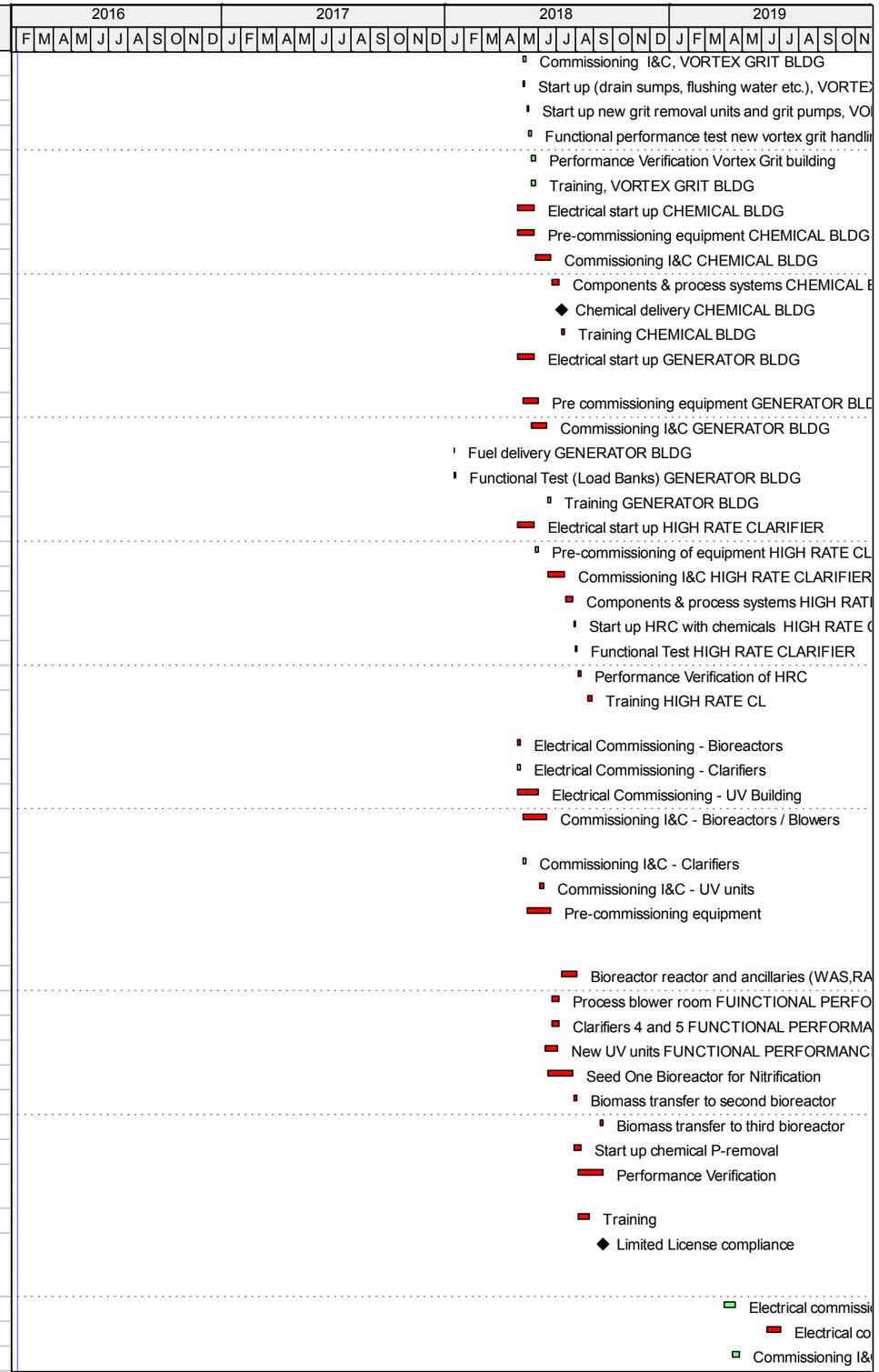
Activity ID	Activity Name	OD	Start	Finish	TF	PRED.	SUCC.
289	Stone Facing GRIT BLDG	20	14-May-18	08-Jun-18	314	244	290
29	Value Engineering Workshop and Responses	147	11-Aug-14 A	04-Mar-15 A			30
290	Finishes GRIT BLDG	20	11-Jun-18	06-Jul-18	314	289, 283	008
292	Order New Transformers and Deliver to Site	150	20-Feb-17	15-Sep-17	17	207	294
293	Substation Construction - SITE-WIDE POWER	40	29-May-17	21-Jul-17	57	207	294
294	Transformer Installation SITE-WIDE POWER	30	18-Sep-17	27-Oct-17	17	292, 293	296
295	Power Distribution to new MCC's (Cabling, Transformers) SITE-WIDE POWER	40	18-Dec-17	09-Feb-18	-43	186, 244, 219	409, 317, 231, 286, 304, 337, 357, 367
296	New MB Hydro Power Connection	30	30-Oct-17	08-Dec-17	17	294	400
299	Complete Bridge, launders, mixers, chem dosing HIGH RATE CLARIFIER	40	20-Feb-17	14-Apr-17	207	162, 207	306, 307
300	Sludge & Scum Pumps & piping HIGH RATE CLARIFIER	30	20-Feb-17	31-Mar-17	217	162, 207	301, 306
301	HVAC HIGH RATE CLARIFIER	30	03-Apr-17	12-May-17	292	300	446
303	Order MCCs HIGH RATE CLARIFIER	80	20-Feb-17	09-Jun-17	237	207	304
304	MCC Installation HIGH RATE CLARIFIER	5	05-Feb-18	09-Feb-18	67	303, 295	458
305	Bldg Services HIGH RATE CLARIFIER	30	20-Feb-17	31-Mar-17	217	162, 207	306
306	Process Electrical, I&C Installation HIGH RATE CLARIFIER	60	17-Apr-17	07-Jul-17	207	299, 300, 305	445
307	Building Envelope Finishes HIGH RATE CLARIFIER	50	17-Apr-17	23-Jun-17	364	299	319
310	Order Euteck Grit Removal Equipment and Deliver to Site, VORTEX	190	20-Feb-17	10-Nov-17	111	207	311
311	Euteck Installation, VORTEX	30	13-Nov-17	22-Dec-17	111	310	422
312	Piping & Grit Pumps, VORTEX	20	20-Feb-17	17-Mar-17	311	162, 207	313
313	HVAC, VORTEX	20	20-Feb-17	17-Mar-17	311	312	422
315	Order MCC FOR VORTEX	80	20-Feb-17	09-Jun-17	246	207	317
316	Bldg Services (Vortex Bldg)	20	20-Feb-17	17-Mar-17	354	162, 207, 147	008
317	MCC Installation (Vortex Bldg)	5	05-Feb-18	09-Feb-18	76	315, 295	422
318	Process Electrical, I&C Installation (Vortex Bldg)	40	20-Feb-17	14-Apr-17	291	162, 207	422
319	VORTEX Building Envelope Finishes	20	26-Jun-17	21-Jul-17	364	307	008
323	Stone Facing, BIOREACTOR & BLWR BLDG	60	24-Nov-17	15-Feb-18	105	186, 207	324
324	Finishes, BIOREACTOR & BLWR BLDG	10	16-Feb-18	01-Mar-18	105	323	008
326	Order Blowers and Deliver to Site BIOREACTOR & BLWR BLDG	170	20-Feb-17	13-Oct-17	72	207	334
327	Order Bioreactor Pumps and Deliver to Site BIOREACTOR & BLWR BLDG	140	20-Feb-17	01-Sep-17	87	207	331
328	Diffusers and Screens Bioreactor 1 BIOREACTOR & BLWR BLDG	20	24-Nov-17	21-Dec-17	13	186, 207	329, 332
329	Diffusers and Screens Bioreactor 2 BIOREACTOR & BLWR BLDG	20	22-Dec-17	18-Jan-18	18	328	330
33	Value Engineering Redesign (BNR, SC, UV)	70	03-Jun-15 A	08-Sep-15 A		32	055, 056, 067, 068
330	Diffusers and Screens Bioreactor 3 BIOREACTOR & BLWR BLDG	20	19-Jan-18	15-Feb-18	18	329	460
331	Recirculation, RAS, WAS Pumps & piping BIOREACTOR & BLWR BLDG	50	24-Nov-17	01-Feb-18	28	186, 207, 327	460
332	Air Distribution Piping BIOREACTOR & BLWR BLDG	40	22-Dec-17	15-Feb-18	13	328	457
333	HVAC BIOREACTOR & BLWR BLDG	35	24-Nov-17	11-Jan-18	33	186, 207	454
334	Blower Installation & Piping BIOREACTOR & BLWR BLDG	30	24-Nov-17	04-Jan-18	43	186, 207, 326	457
336	Order MCC BIOREACTOR & BLWR BLDG	80	20-Feb-17	09-Jun-17	172	207	337
337	MCC & Control Panel Installation BIOREACTOR & BLWR BLDG	20	15-Jan-18	09-Feb-18	17	186, 336, 295	457
338	Bldg Services BIOREACTOR & BLWR BLDG	40	24-Nov-17	18-Jan-18	135	186, 207	008
339	Process Electrical, I&C Installation BIOREACTOR & BLWR BLDG	80	24-Nov-17	15-Mar-18	-12	186, 207	454
342	Order Scaper and Bridge Equipment and Deliver to Site SC4	170	20-Feb-17	13-Oct-17	37	207	344, 344
343	Mechanical Room and Pump Room SC4	50	22-Sep-17	30-Nov-17	28	203, 207	346, 350, 357, 358
344	Scrapers, Weir Plates, SC4	20	16-Oct-17	10-Nov-17	37	203, 342, 342	345, 351
345	Access Platforms and Handrailing, SC4	20	13-Nov-17	08-Dec-17	107	344	455
346	Pumps, Piping & Valves, SC4	30	22-Sep-17	02-Nov-17	93	343	460
347	HVAC @ SC4	30	22-Sep-17	02-Nov-17	63	203, 207	354
349	Order Scaper and Bridge Equipment and Deliver to Site SC5	170	20-Feb-17	13-Oct-17	67	207	351
350	Mechanical Room and Pump Room (pre-cast roof, M&E) SC5	50	13-Oct-17	21-Dec-17	28	343	353
351	Scrapers, Weir Plates SC5	20	27-Nov-17	22-Dec-17	37	344, 349	352
352	Access Platforms and Handrailing SC5	20	25-Dec-17	19-Jan-18	37	351	460



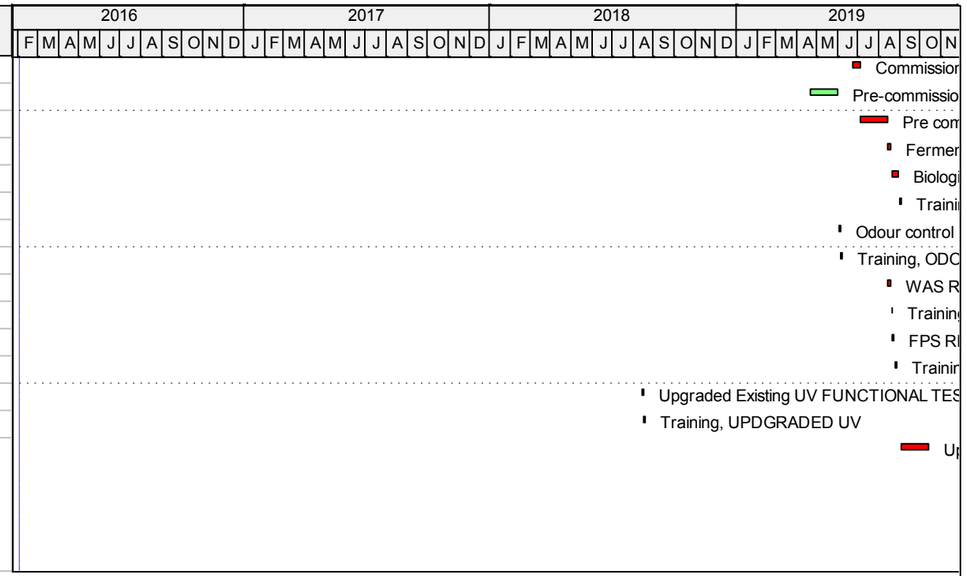
Activity ID	Activity Name	OD	Start	Finish	TF	PRED.	SUCC.
353	Pumps, Piping & Valves SC5	30	22-Dec-17	01-Feb-18	28	350	460
354	HVAC SC5	30	03-Nov-17	14-Dec-17	63	347	460
356	Order MCC, SC'S 4 & 5	80	20-Feb-17	09-Jun-17	167	207	357
357	MCC & Control Panel Install/ Mods, SC'S 4 & 5	20	15-Jan-18	09-Feb-18	12	343, 356, 295	359
358	Bldg Services SC'S 4 & 5	30	15-Dec-17	25-Jan-18	130	343	008
359	Process Electrical, I&C Installation SC'S 4 & 5	60	29-Jan-18	20-Apr-18	12	357	455
362	Order UV Units and Deliver to Site	190	20-Feb-17	10-Nov-17	51	207	363, 364
363	HVAC and Structural Mods, UV	20	13-Nov-17	08-Dec-17	51	362	369
364	Install New UV Units	20	13-Nov-17	08-Dec-17	51	362	369, 490
366	Order MCC @ UV	80	20-Feb-17	09-Jun-17	161	207	367, 368
367	MCC Install @ UV	5	05-Feb-18	09-Feb-18	6	366, 295	369
368	Bldg Services @ UV	20	12-Jun-17	07-Jul-17	161	366	369
369	Process Electrical, I&C Installation @ UV	20	12-Feb-18	09-Mar-18	6	367, 364, 368, 363	456, 490
372	Order RDTs, Mixers, Clarifer Equipment	120	20-Feb-17	04-Aug-17	139	207	392, 393
373	Admin Bdg. Remodelling Works	80	20-Feb-17	09-Jun-17	344	207	493
375	SC 1 REFURBISH	40	17-Sep-18	09-Nov-18	184	472	376
376	SC 2 REFURBISH	40	12-Nov-18	04-Jan-19	184	375	008
378	Civils - REPURPOSING HPO TANKS 1&2	40	17-Sep-18	09-Nov-18	-37	472	379, 391
379	Mechanical - REPURPOSING HPO TANKS 1&2	60	10-Dec-18	01-Mar-19	-37	378	380
380	Electrical - REPURPOSING HPO TANKS 1&2	60	04-Mar-19	24-May-19	-37	379	381
381	Existing HPO DCS Migration / Demolition Acceptance Test & Shutdown	10	27-May-19	07-Jun-19	-37	380, 385	475
383	Mechanical - REPURPOSE HPO TANK 4	60	17-Sep-18	07-Dec-18	3	472	384
384	Odour Control Stack & Ducting - REPURPOSE HPO TANK 4	20	10-Dec-18	04-Jan-19	3	383	385
385	Electrical REPURPOSE HPO TANK 4	60	07-Jan-19	29-Mar-19	3	384	381, 474
387	Mechanical @ SLUDGE PUMP & PIPING	60	17-Sep-18	07-Dec-18	74	472	388
388	Electrical @ SLUDGE PUMP & PIPING	30	10-Dec-18	18-Jan-19	74	387	474
390	Remove Plant from PSA Bdg	30	17-Sep-18	26-Oct-18	119	472	392, 393
391	Civils @ RDT'S	20	12-Nov-18	07-Dec-18	144	378, 167	395
392	Mechanical @ RDT'S	60	29-Oct-18	18-Jan-19	119	390, 372, 393	488
393	Electrical @ RDT'S	60	29-Oct-18	18-Jan-19	119	390, 372	392
395	Access Roads, Final Grading, Landscaping, and Fencing	60	20-Aug-19	11-Nov-19	-37	493, 224, 391	007, 208
400	66kV Substation precommissioning	10	11-Dec-17	22-Dec-17	17	296	401, 407
401	66 kV Substation commissioning	5	25-Dec-17	29-Dec-17	17	400	403, 406
403	12.47 kV system pre-commissioning	10	09-Apr-18	20-Apr-18	-43	401, 230, 233, 406	404, 408
404	12.47 kV system commissioning	5	23-Apr-18	27-Apr-18	-43	403, 288	407, 409, 412, 422, 431, 438, 445, 454, 455, 456, 474, 475
406	Pre-commissioning ELECTRICAL	5	08-Jan-18	12-Jan-18	17	401	409, 403
407	Shutdown Bank 1	1	07-May-18	07-May-18	-18	400, 404, 408	439, 409
408	Shutdown Bank 2	1	23-Apr-18	23-Apr-18	-9	403	407
409	Final Commissioning ELECTRICAL	2	08-May-18	09-May-18	49	404, 406, 295, 407	412, 472
412	Electrical start up NEW GRIT & SCREENING BLDG	15	10-May-18	30-May-18	271	287, 404, 409, 283	413, 416
413	Commissioning I&C NEW GRIT & SCREENING BLDG	10	31-May-18	13-Jun-18	271	412	414, 415
414	Start up new grit classifiers NEW GRIT & SCREENING BLDG	2	14-Jun-18	15-Jun-18	271	413	417
415	Start up new wash/compactors in new building	2	14-Jun-18	15-Jun-18	271	413	417
416	Start up (drain sumps, flushing water etc.) NEW GRIT & SCREENING BLDG	3	31-May-18	04-Jun-18	282	412	418
417	Start up conveyance equipment and roll off bins NEW GRIT & SCREENING BLDG	2	18-Jun-18	19-Jun-18	271	415, 414	418
418	Functional performance test new grit/screenings handling	1	20-Jun-18	20-Jun-18	271	417, 416	419
419	Performance Verification Grit & Screenings building	5	21-Jun-18	27-Jun-18	271	418	420
420	Training, NEW GRIT & SCREENING BLDG	5	21-Jun-18	27-Jun-18	271	419	493
422	Electrical start up, VORTEX GRIT BLDGH	5	30-Apr-18	04-May-18	21	318, 404, 317, 313, 311	423, 424



Activity ID	Activity Name	OD	Start	Finish	TF	PRED.	SUCC.
423	Commissioning I&C, VORTEX GRIT BLDG	5	07-May-18	11-May-18	21	422	425
424	Start up (drain sumps, flushing water etc.), VORTEX GRIT BLDG	3	07-May-18	09-May-18	26	422	426
425	Start up new grit removal units and grit pumps, VORTEX GRIT BLDG	3	14-May-18	16-May-18	21	423	426
426	Functional performance test new vortex grit handling	3	17-May-18	21-May-18	21	425, 424	427, 448
427	Performance Verification Vortex Grit building	5	22-May-18	28-May-18	293	426	428
428	Training, VORTEX GRIT BLDG	5	22-May-18	28-May-18	293	427	493
431	Electrical start up CHEMICAL BLDG	20	30-Apr-18	25-May-18	-3	233, 404, 231	432, 433
432	Pre-commissioning equipment CHEMICAL BLDG	20	30-Apr-18	25-May-18	-3	431, 225	433
433	Commissioning I&C CHEMICAL BLDG	20	28-May-18	22-Jun-18	-3	431, 432	434
434	Components & process systems CHEMICAL BLDG	10	25-Jun-18	06-Jul-18	-3	433, 227	435
435	Chemical delivery CHEMICAL BLDG	0	09-Jul-18		-3	434	436, 449
436	Training CHEMICAL BLDG	5	09-Jul-18	13-Jul-18	-3	435, 443	493, 452
438	Electrical start up GENERATOR BLDG	20	30-Apr-18	25-May-18	-18	233, 404, 224, 442	439
439	Pre commissioning equipment GENERATOR BLDG	20	07-May-18	01-Jun-18	-18	438, 407	440
440	Commissioning I&C GENERATOR BLDG	20	21-May-18	15-Jun-18	-18	439	443, 447
441	Fuel delivery GENERATOR BLDG	1	15-Jan-18	15-Jan-18	53	224	442
442	Functional Test (Load Banks) GENERATOR BLDG	3	16-Jan-18	18-Jan-18	53	441	443, 438
443	Training GENERATOR BLDG	5	18-Jun-18	22-Jun-18	7	442, 440	493, 436
445	Electrical start up HIGH RATE CLARIFIER	20	30-Apr-18	25-May-18	-3	306, 404	446, 447
446	Pre-commissioning of equipment HIGH RATE CLARIFIER	5	28-May-18	01-Jun-18	22	445, 301	449
447	Commissioning I&C HIGH RATE CLARIFIER	20	18-Jun-18	13-Jul-18	-18	445, 440	448
448	Components & process systems HIGH RATE CLARIFIER	10	16-Jul-18	27-Jul-18	-18	447, 426	449
449	Start up HRC with chemicals HIGH RATE CL	2	30-Jul-18	31-Jul-18	-18	448, 435, 446	450
450	Functional Test HIGH RATE CLARIFIER	3	01-Aug-18	03-Aug-18	-18	449	451
451	Performance Verification of HRC	5	06-Aug-18	10-Aug-18*	-18	450	452
452	Training HIGH RATE CL	5	21-Aug-18	27-Aug-18	-29	451, 491, 436, 278	493, 472
454	Electrical Commissioning - Bioreactors	5	30-Apr-18	04-May-18	-43	404, 339, 333	457, 460
455	Electrical Commissioning - Clarifiers	5	30-Apr-18	04-May-18	7	404, 359, 345	458
456	Electrical Commissioning - UV Building	25	30-Apr-18	01-Jun-18	-29	369, 404	459, 465
457	Commissioning I&C - Bioreactors / Blowers	30	07-May-18	15-Jun-18	-43	454, 337, 334, 332	466
458	Commissioning I&C - Clarifiers	5	07-May-18	11-May-18	7	455, 304	464
459	Commissioning I&C - UV units	6	04-Jun-18	11-Jun-18	-29	456	465
460	Pre-commissioning equipment	30	14-May-18	22-Jun-18	-43	454, 331, 330, 346, 354, 353, 352	462, 463, 464
462	Bioreactor reactor and ancillaries (WAS,RAS, Internals) FUNCT PERF	20	09-Jul-18	03-Aug-18	-43	460, 463	470, 472
463	Process blower room FUINCTIONAL PERFORMANCE	10	25-Jun-18	06-Jul-18	-43	460	462, 470
464	Clarifiers 4 and 5 FUNCTIONAL PERFORMANCE	10	25-Jun-18	06-Jul-18	-23	460, 458	470
465	New UV units FUNCTIONAL PERFORMANCE	15	12-Jun-18	02-Jul-18	-29	456, 459	470, 490
466	Seed One Bioreactor for Nitrification	30	18-Jun-18	27-Jul-18	-43	457	467, 468, 469
467	Biomass transfer to second bioreactor	5	30-Jul-18	03-Aug-18	-13	466	472
468	Biomass transfer to third bioreactor	5	10-Sep-18	14-Sep-18	-43	466	472
469	Start up chemical P-removal	10	30-Jul-18	10-Aug-18	-18	466	472, 010
470	Performance Verification	30	06-Aug-18	14-Sep-18	-43	462, 463, 464, 465	471, 472
471	Training	15	06-Aug-18	24-Aug-18	-28	470	472
472	Limited License compliance	0		14-Sep-18	-43	462, 470, 471, 469, 468, 467, 452, 277, 409	375, 378, 383, 387, 390, 010
474	Electrical commissioning - Odour control	15	01-Apr-19	19-Apr-19	24	385, 404, 388	476, 478
475	Electrical commissioning - Fermenters - RDTs	18	10-Jun-19	03-Jul-19	-37	381, 404	477, 479
476	Commissioning I&C - Odour control	10	15-Apr-19	26-Apr-19	49	474	484



Activity ID	Activity Name	OD	Start	Finish	TF	PRED.	SUCC.
477	Commissioning - I&C - Fermenters - RDTs	10	24-Jun-19	05-Jul-19	-9	475	481
478	Pre-commissioning - Odour Control	30	22-Apr-19	31-May-19	24	474	484
479	Pre commissioning - Fermenters - RDTs	30	04-Jul-19	14-Aug-19	-37	475	481, 486
481	Fermentation (mixers) FUNCTIONAL TESTING	3	15-Aug-19	19-Aug-19	-37	479, 477	482, 488, 493
482	Biological P removal FUNCTIONAL TESTING	9	20-Aug-19	30-Aug-19	-37	481	483, 493
483	Training FERMENTATION	1	02-Sep-19	02-Sep-19	-37	482	493
484	Odour control FUNCTIONAL TESTING	3	03-Jun-19	05-Jun-19	24	478, 476	485, 493
485	Training, ODOUR CONTROL	2	06-Jun-19	07-Jun-19	24	484	493
486	WAS RDTs FUNCTIONAL TESTING	3	15-Aug-19	19-Aug-19	-28	479	487, 493
487	Training WAS RDT'S	1	20-Aug-19	20-Aug-19	-28	486	493
488	FPS RDTs FUNCTIONAL TESTING	4	20-Aug-19	23-Aug-19	-32	481, 392	489, 493
489	Training FPS RDT'S	1	26-Aug-19	26-Aug-19	-32	488, 491	493
490	Upgraded Existing UV FUNCTIONAL TESTING	3	14-Aug-18	16-Aug-18	-29	465, 369, 364	491, 493
491	Training, UPDGRADED UV	2	17-Aug-18	20-Aug-18	-29	490	493, 489, 452
493	Upgraded Plant Full Operation and Complete Licence Compliance	30	03-Sep-19	14-Oct-19	-37	481, 482, 484, 486, 488, 490, 491, 489, 487, 485, 483, 452, 443, 436, 428, 420, 278, 373	008, 007, 209, 395, 008



Appendix B – Alternative Options Worksheets

Alternative 1	**Risks**
Advance the tender date of Critical Path Systems – Separate Contract or negotiate with existing GC • Chemical / Electrical Building Concrete Works • Electrical Substation Concrete Works	Schedule Cost
Risk Comments: Reduction of Schedule Risk – Advance Critical Path Task Additional Contracts – Increased coordination between Contracts. May be difficult to implement with City's current procurement policies.	
Schedule Impacts: May not advance schedule but will remove tasks off of critical path and reduce slippage risk. May only realize 2 - 3 months of gain assuming current timeframes with lesser impact on compliance date (New Critical Path)	
Quality Impacts: Low risk of affecting quality	
Cost Impacts: Minor risk of increased cost related to coordination with other contracts. Increased contract administration and engineering costs (tender packages).	
Operation Impacts: Minor	
Scenario for Schedule Analysis - Yes **Further Review** - Yes - Scenario will be reviewed for impacts to schedule	

Alternative 2	Risks
Procurement or Preselection of “Major” Equipment and Long Delivery Items - Additional Items • Grit Tank Equipment, UV (Hard Spec’d) • Fermenter Mixer • Large Transformers, MCCs • Other (Process Blowers, Programming)	Schedule Cost
Risk Comments: Reduction of Schedule Risk	
Schedule Impacts: Risk Mitigation - May not advance schedule but will reduce schedule risk.	
Quality Impacts:	
Cost Impacts: Engineering costs (tender packages), novation agreements and GC costs	
Operation Impacts:	
Scenario for Schedule Analysis - No **Further Review** - Yes	

Alternative 3	**Risks**
Contract 4 - More rigorous schedule requirements in Contract Documents (several items are already being considered to lesser or larger degree): • Critical Path Based Specification, Milestones Schedule for compliance and not completion. • Additional Forces to allow for overlapping area of construction (concrete works). • Tender Based on Overtime vs. Standard Hours.	Schedule Cost Operation
Risk Comments: Reduced Risk of schedule slippage. More control and monitoring of actual impacts.	
Schedule Impacts: Greater oversight of critical path. May mitigate schedule slippage by GC.	
Quality Impacts:	
Cost Impacts: Some additional contract administration, GC Costs (minor)	
Operation Impacts: Better coordination of City resources. May impact hours of operation, increased contract administration.	
Scenario for Schedule Analysis - No **Further Review** - Yes. The option is being considered in the existing work program.	

Alternative 4	Risks
Contract 4 - Completion Incentives • Site Occupancy or other incentives	Schedule Cost
Risk Comments: May not help with schedule. Needs to be a meaningful incentive.	
Schedule Impacts: May not help. Not typical for Municipal Utilities. Unproven. Do you want to implement on such a large, significant project?	
Quality Impacts:	
Cost Impacts: Could work either way. High saving or risk of significant costs.	
Operation Impacts:	
Scenario for Schedule Analysis - No **Further Review** - No	

Alternative 5	**Risks**
Contract 4 - Commissioning and Training - (Already being considered in project commission plan) • Optimize schedule milestones based on availability of staff for training, availability of lab and facilities. • Early coordination and verification by City.	Schedule Cost Operation
Risk Comments: Risk reduction	
Schedule Impacts: Will extend schedule (months)	
Quality Impacts:	
Cost Impacts: Increase time, GC Costs. Contract administration costs	
Operation Impacts: Lesser impact with more coordination. Assist in proving and reliability for ongoing compliance	
Scenario for Schedule Analysis - No **Further Review** - Yes. The option is being considered in the existing work program.	

Alternative 6	Risks
Defer process items based on capacity (only) and optimize schedule for compliance: *(Several Items already being considered to lesser or larger degree with staged commissioning) (Similar to previous option)* • New raw water pump • One of four grit removal units • One of two grit removal units • One of two high rate clarifiers • One of three BNR trains (first basin will be commissioned before other two basins are complete) • One of two secondary clarifiers • One of two UV reactors	Schedule Quality Cost Operation
Risk Comments: May not be possible on all systems. Should not apply to Heavy Civil Works.	
Schedule Impacts: May improve early compliance. Could extend final completion.	
Quality Impacts: May increase work in non-hazardous locations.	
Cost Impacts: Increase GC cost, safety costs, increase engineering and contract administration. Increased City Resources.	
Operation Impacts: Much more disruptive to operations.	
Scenario for Schedule Analysis - No **Further Review** - Yes. The option is being considered in the existing work program.	