

CLEAN RESOURCES MILESTONE REPORT

Milestone Reports will use this template to capture key results and outcomes from the reporting period. This template represents the minimum information expected

and additional topics relevant to the milestone should be included. The Applicant will work with the AI Project Advisor during the report preparation period to ensure that the final submission of the Milestone Report meets the reporting requirements.

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1. FUNDING AND PARTNERS

List the Contributing Partners and Project Supporters in the tables below. Organization names will be publicly shared in the project summary document discussed below but contribution amounts will be kept confidential.

CONTRIBUTING PARTNERS:

Organization Name	Cash Funding	In-Kind Contribution	Committed?
CanERIC	\$198,100		\$104,779
Canadian Natural Resources Limited (Canadian Natural)		\$198,100	\$198,100

PARTNERS AND SUPPORTERS (OTHER THAN CONTRIBUTING PARTNERS):

Organization Name	Nature of Support
N/A	

2. PROJECT STATUS

Please indicate by check mark if you experienced any of the following changes to the Project. Check all that apply. **Include an explanation for the change.**

RESPOND BELOW

Minor Changes	
<input type="checkbox"/>	A decrease in the total Project Costs and the Investment, where the parties have made provisions for the adjustment and proportional return, where applicable, of the Contribution
<input type="checkbox"/>	A company name change of any Party listed in the Investment Agreement, where no change of corporate control has taken place
<input type="checkbox"/>	A minor change to the work plan which does not change the end goal of the Project
<input type="checkbox"/>	An increase or decrease of the funding on one Milestone, where the Investment to the same Payee will be adjusted by the same increase or decrease at a later Milestone or Milestones with a new MRP
<input type="checkbox"/>	Any one or more of the Expected Milestone Completion Dates is changed by less than 90 days, without changing the original (or legally amended) Project Completion Date by more than 90 days
<input type="checkbox"/>	The Project Completion Date is delayed by less than 90 days
<input type="checkbox"/>	A change to the contact person(s) in the Notices section of the Investment Agreement
<input type="checkbox"/>	Other

Major Changes	
<input type="checkbox"/>	An increase or decrease of the funding on one Milestone, where the Investment will be adjusted by the same increase or decrease at a later Milestone to a different Payee
<input type="checkbox"/>	A substantial change in the nature of the Project which changes the overall intention of the Investment, and which may or may not impact the Project Completion Date
<input type="checkbox"/>	A change to a Milestone Completion Date longer than 90 days, whether or not it affects the Project Completion Date
<input type="checkbox"/>	A change, or cumulative changes to the Project Completion Date resulting in the revised Project Completion Date being later than 90 days from the original date, whether due to delay or suspension
<input type="checkbox"/>	A change of any Party to the Investment Agreement
<input type="checkbox"/>	A Change of Control or name change of any Party (as applicable under a particular Program)
<input type="checkbox"/>	Other

Use the sections below as the executive summary. This summary is an update to what was provided within the *Investment Agreement - Schedule C* and provides only a high-level description of the opportunity, project goals, key results, outcomes and benefits. More in-depth descriptions are expected in the sections that follow. This information will be used to prepare a project summary document that Alberta Innovates will use to communicate the value of funded projects to internal and external stakeholders. The project summary document may be used to inform annual reports, website postings, and learning sessions with Alberta government representatives.

A. EXECUTIVE SUMMARY

CURRENT STATUS (70 WORDS)

Please highlight the significant components of the project that have been completed to date.

Test has concluded. Tri-phase pump was installed at 03-32-004-05W2. Tri-phase pump was installed March 16, 2021. Installation costs, equipment rental, and fuel costs over the 4-month trial were on budget.

The test was a success. Installing the tri-phase pump reduced upstream pipeline pressure by 250 psi. This reduction in pressure is the same as what a Satellite Facility would have achieved, however the tri-phase pump allows conservation of all produced gas volumes, whereby a Satellite Facility would have required volumes to be flared. Conserved gas volumes: 2.8 E3m3/d.

Our goals for this period and results:

Task	Goal	Deliverable	Result
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1. Install Tri-phase pump at 03-32-004-05W2.	1. Install the Tri-phase pump on time. 2. Install the Tri-phase pump on budget.	1. Planned On-stream Date: 03/10/2021 2. Budgeted Install Cost: \$52K	1. Actual On-stream Date: 03/16/2021 2. Actual Install Cost: \$57K
2. Optimize Tri-Phase Pump.	Reduce header pressure at 03-32-004-05W2 by 240 psi.	Reduce header pressure at 03-32-004-05W2 by 240 psi.	03-32-004-05W2 header pressure reduced by 250 psi. Pressure at North end of the Field (7 km upstream from pump, 01-09-005-05W2) reduced by 230 psi.
3. Restart wells that had been shut-in due to high line pressure.	Restart wells that had been shut-in due to high line pressure.	Restart 3 wells that had been shut-in due to high line pressure.	Restarted 3 wells that had been shut-in due to high line pressure.
4. Operate Tri-phase pump for 4 month trial, ensuring costs remain on budget.	Operate Tri-phase pump for 4 month trial, ensuring costs remain on budget.	Budgeted Fuel, Rental, and Maintenance Cost: \$178.4K	Actual Fuel, Rental, and Maintenance Cost: \$185.1K

Table 2.1: Tasks, Goals, Deliverables & Results

B. PROJECT UPDATE

This section is focused on the overall project.

3. KNOWLEDGE OR TECHNOLOGY OPPORTUNITY DESCRIPTION

Based on the Project Type, i.e. Knowledge Generation or Technology Development, that was identified the Application, please provide a narrative describing the opportunity the project represents using the following sub-headings.

- **Knowledge or Technology Gaps:** Explain the knowledge or technology gap that is being addressed through this project, along with the context and scope of the knowledge or technical problem.
- **Knowledge or Technology Description:** Include a discussion of the project objectives.
- **Updates to Project Objectives:** Describe any changes that have occurred compared to the original project objectives. Include overall objectives of any testing or simulations to date.

RESPOND BELOW

Knowledge or Technology Gaps:

Common strategy to reduce pipeline pressure in an oil field gathering system is to remove the gas phase from the hydrocarbon stream. To effectively remove the gas from the stream, it needs to be separated at a facility and then subsequently transferred to an offsetting gas network. If an offsetting gas network isn't

nearby, it can be very costly to conserve the gas. Due to this, gas volumes are instead flared or wells are left shut-in. The IJACK XFER tri-phase pump is a cost effective solution to the problem, and gives the ability to move 3-phase fluid (oil, water, and gas) across long distances through pre-existing pipelines, and therefore allows for the conservation of gas volumes.

The tri-phase pump has performed as anticipated. This technology provides the same function as many existing Satellite Facilities with the added benefit of eliminating the need to flare gas. The XFER pump can be manufactured in many sizes depending on the volume of liquid and gas and thus could be used in many applications.

Knowledge or Technology Description:

The XFER pump is a double acting reciprocating pump which pumps and compresses oil, water, gas emulsions and slugs (including sands and paraffin) from wells directly to battery with no facilities in between. Objectives of the trial were to:

- Eliminate requirement for a future flaring satellite facility.
- Reduce pipeline pressure upstream of the XFER pump by 240 psi
- Restart wells that were shut-in due to high line pressure

Updates to Project Objectives:

No changes.

4. PROJECT SCHEDULE

Please provide a narrative describing any updates to the project schedule using the following sub-headings.

- **Project Progress:** Include a discussion of any changes to the schedule and describe any challenges that have been encountered in executing the project as planned.
- **Gantt Chart Update:** Include an updated Gantt chart illustrating the original schedule, the progress of the project and any changes to the schedule for the project.

RESPOND BELOW

- **Project Progress:**
 - The project has concluded.
 - The install of the pump was 5 days behind schedule. This was due to challenges encountered by the pump manufacturer, as delivery of certain pump parts were delayed.
 - Other than missing the install target by 5 days, the trial has adhered to its original timeline.
- **Gantt Chart Update:**
 - See attached.

Please provide a narrative outlining any updates to the budget for this reporting period and the project.

- Summarize the project expenditures in the table below so that the information is current as of the end of the reporting period.

RESPOND BELOW

5. BUDGET

Total Project Budget	Total AI Funding	Total Expenditures for the Reporting Period	AI Payment for the Reporting Period	Total Project Expenditures to Date	AI Total Contribution to Date (including current payment)
\$396,200	\$198,100	\$411,568	\$198,100	\$411,568	\$104,779

Table 5.1: Budget Summary

	Deemed value/Actual cost	Costs paid by others	Costs paid by CanERIC	Actual CTD
Mob, Takedown, Install	\$19,700	\$0	\$19,700	\$21,976
Operator time/testing	\$21,300	\$21,300	\$0	\$32,700
Facility value	\$171,800	\$171,800	\$0	\$171,800
Testing	\$5,000	\$5,000	\$0	\$0
Equipment	\$178,400	\$0	\$178,400	\$185,092
TOTAL	\$396,200	\$198,100	\$198,100	\$411,568

Table 5.2: Cost Details

C. MILESTONE PROGRESS AND LEARNINGS

This section is focused on the current and next milestone.

1. MILESTONE PROGRESS

Please provide a narrative describing the progress made to achieving the objectives within this milestone.

- For each task within the milestone, describe the progress made with respect to the activity's advancement. Please note any variances to the planned activity and discuss the implications of these variances.
- If there are additional project activities that are relevant to the report, please include the details of these results and provide any supporting documents as an appendix to the report as necessary.

RESPOND BELOW

○ Objectives of the test:

1. **Eliminate requirement for a future Flaring Satellite facility:** This result has been achieved. The company no longer intends on constructing a Satellite Facility, because the Tri-phase pump is able to achieve the same result with the significant additional benefit of conserving gas volumes.
2. **Reduce pipeline pressure upstream of the XFER pump by 240 psi:** The pump reduced immediate upstream pipeline pressure by 250 psi, and pressure 7 km upstream of the line by 230 psi.
3. **Restart wells that were shut-in due to high line pressure:** 3 wells were restarted that were previously shut-in due to high line pressure.

2. LEARNINGS DURING MILESTONE

Please discuss the key learnings obtained during this reporting period.

- Discuss the importance of the learnings for the project advancement.
- As appropriate, describe key findings and lessons learned for each task within the milestone, and the importance of those learnings towards the project advancement.

RESPOND BELOW

- **Suction Line:** The main trunk pipeline that runs to the suction of the Tri-phase pump is a 3" pipeline. We added 5 meters of 6" pipeline at the suction of the pump to stabilize inflow. The increased diameter of this added section of pipe slows down the flow of the inlet fluid and helps reduce slug flow. This allows for smoother operation of the pump.

- **Pump Start-up:** When the tri-phase pump is shut down, the percentage of gas volume in the fluid upstream of the pump increases. The tri-phase pump's discharge pressure is very sensitive to gas throughput. As the percentage of gas volume in the fluid stream increases, so does the pressure losses due to friction, and this can cause radical pressure increases on the discharge of the pump. Because of this, it is important to start the pump at a low speed and slowly increase it until the gas percentage in the fluid stream has normalized.

3. EXPECTED ACTIVITIES IN THE NEXT MILESTONE

Please provide a narrative outlining the key tasks for the upcoming reporting period.

- Describe the expected activities for the next reporting period, including any anticipated differences from the project workplan.

RESPOND BELOW

- The project has concluded.

D. METRICS

Please provide a narrative outlining the project's performance metrics. Please use the following sub-headings in your narrative. If this is a mid-project Milestone Report, please comment on significant deviations in this narrative. If this is a Final Milestone Report, please be more specific and comment on all the Metrics that were originally identified for the project. **The Work Plan, Budget and Metrics workbook, Performance Metrics tab requires an update only at the end of the project.**

- **Clean Resources Metrics:** Discuss how current results of the project may impact the Clean Resources Metrics as described in the *Investment Agreement – Schedule C*. Focusing on major deviations from the plan, discuss any changes or updates to these metrics and the driving forces behind the change. Include any mitigation strategies that might be needed if the changes result in negative impacts.
- **Program Specific Metrics:** Discuss how current results of the project impact the Program Metrics as described in the *Investment Agreement – Schedule C*. Discuss any changes or updates to these metrics and the driving forces behind the change. Include any mitigation strategies that might be needed if the changes result in negative impacts.
- **Project Success Metrics:** Discuss the progress of the project strategic metrics and describe the path forward to successfully achieving them.

RESPOND BELOW

- Note: See APPENDIX B and C for plots
- **Clean Resources Metrics:**
 - **Emission Reduction:** The project has reduced future emissions of 2.8 E3m3/d or 3,301 T CO2/year.
- **Program Specific Metrics:**

1. Upstream Well Production:

	Before Pump Install	After Pump Install	Delta
Oil (m3/d)	7.6	10.4	2.8
Water (m3/d)	93.7	124.0	30.3
Gas (E3m3/d)	1.6	2.8	1.2

2. Pipeline Pressures:

Header Location	Distance from Tri-Phase Pump (km)	Pressure Before install (psi)	Pressure After Install (psi)
03-32-004-05W2	0	340	100
01-09-004-05W2	7	410	180

E. REPORT SIGNATURES

Publication of Non-Confidential and Aggregate Information by Alberta Innovates

Alberta Innovates may (1) publish and/or disseminate in the public domain certain information contained within this Milestone Report as a way to promote success stories about innovation in the Province of Alberta and/or (2) use certain information contained within this Milestone Report as a way to verify information contained herein. On these bases, Alberta Innovates deems the following information in this Milestone Report to be non-confidential and subject to disclosure by Alberta Innovates in its sole discretion at any time: The information captured in the Applicant and Project Summary Tables, including but not limited to Applicant and Applicant Representative Contact Information, Project Title, Project Start and End Dates, Project Start and End TRLs, Total Project Cost, Alberta Innovates Funding Amount, the Names of Contributing Partners, and Section A: Executive Summary.

Alberta Innovates will also aggregate certain information contained within this Milestone Report for the purposes of reporting or dissemination in the public domain. For clarity, 'aggregate' means removal of personal identifiers such as names, locations and addresses of the Applicant and employees, and combining such information with that of other Applicant submissions.

Consent and Declaration of Applicant

By submitting this Milestone Report, including any supporting documentation, I, in my capacity as the authorized representative of the Applicant, legally represent for and on behalf of the Applicant that:

- The Applicant acknowledges, understands and agrees to the disclosure of non-confidential information and aggregate information as identified above, by Alberta Innovates in its sole discretion;
- The Applicant Representative is legally authorized to submit this for and on behalf of the Applicant;

- All information contained in this Milestone Report, is true and accurate;

Applicant Representative Name and Title	Applicant (Organization)
Signature	Date

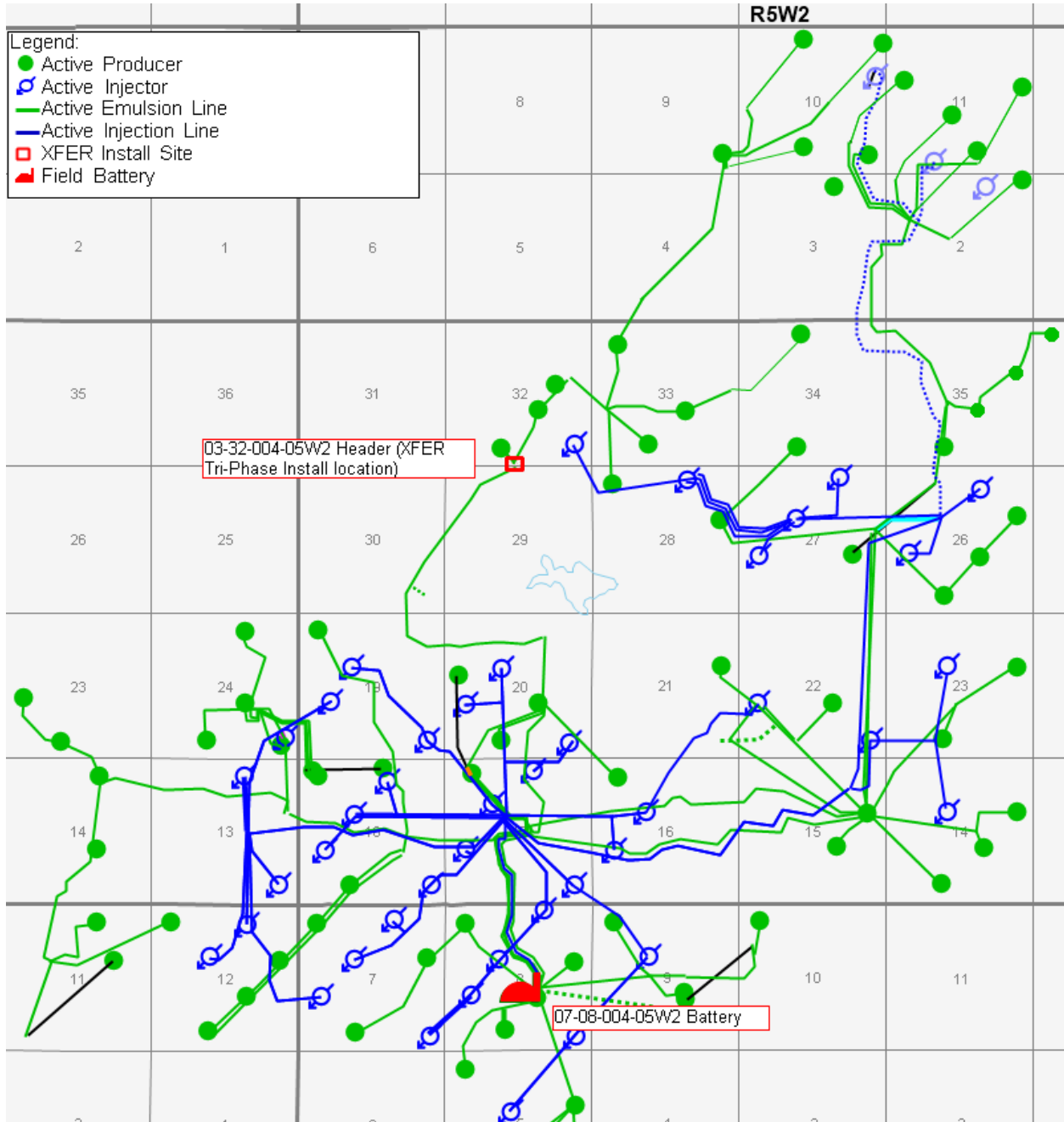
F. ATTACHMENTS

Please include all relevant attachments which may include but not limited to:

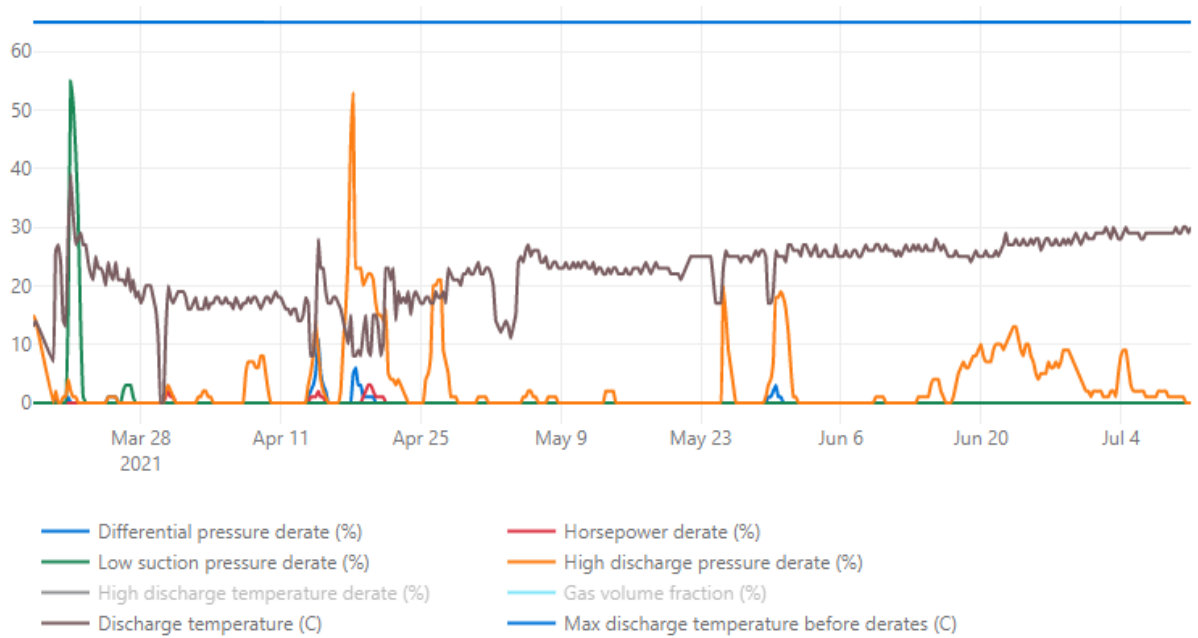
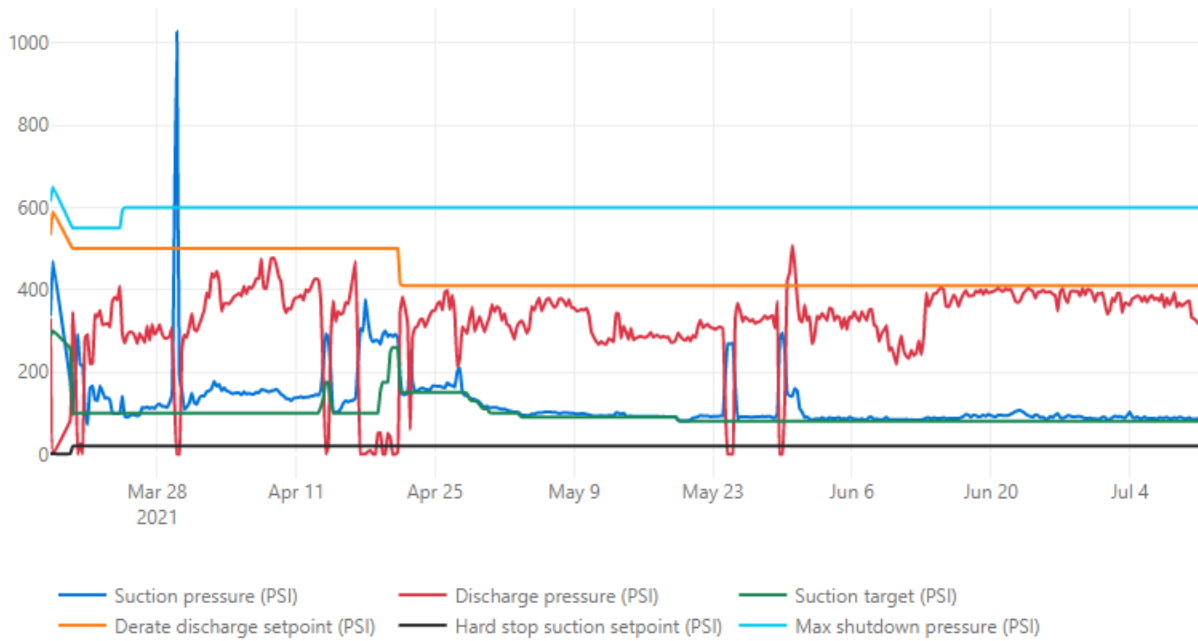
- Updated Gantt chart
- *Work Plan, Budget and Metrics* workbook updated to reflect completed milestone
- List of all communication exercises from this milestone
- Final Milestone Report: List of all academic papers, publications and conference presentations for the entire project

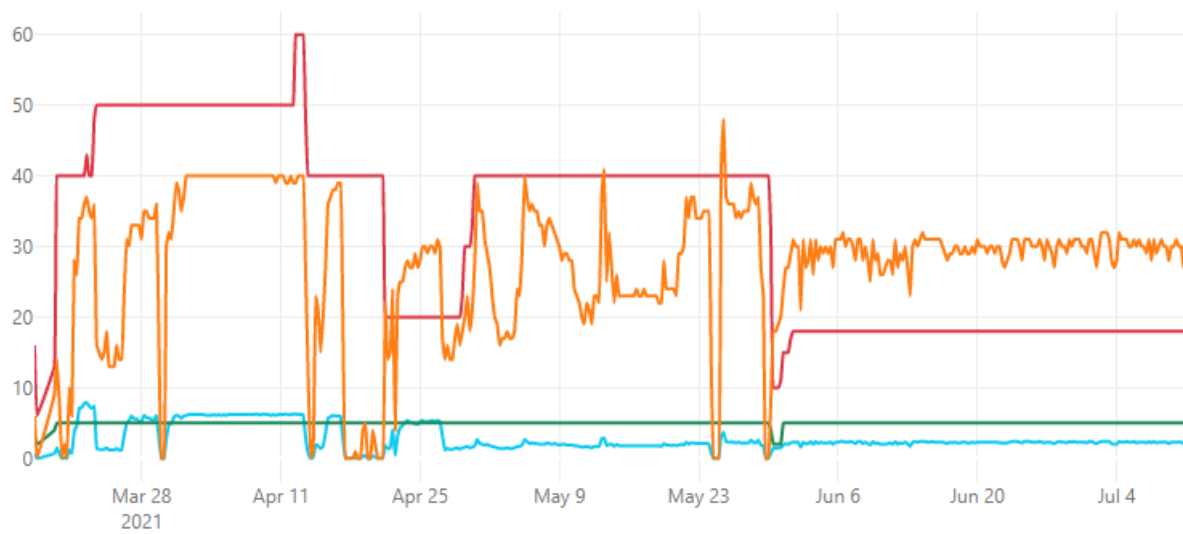
G. APPENDIX

APPENDIX A: MAP

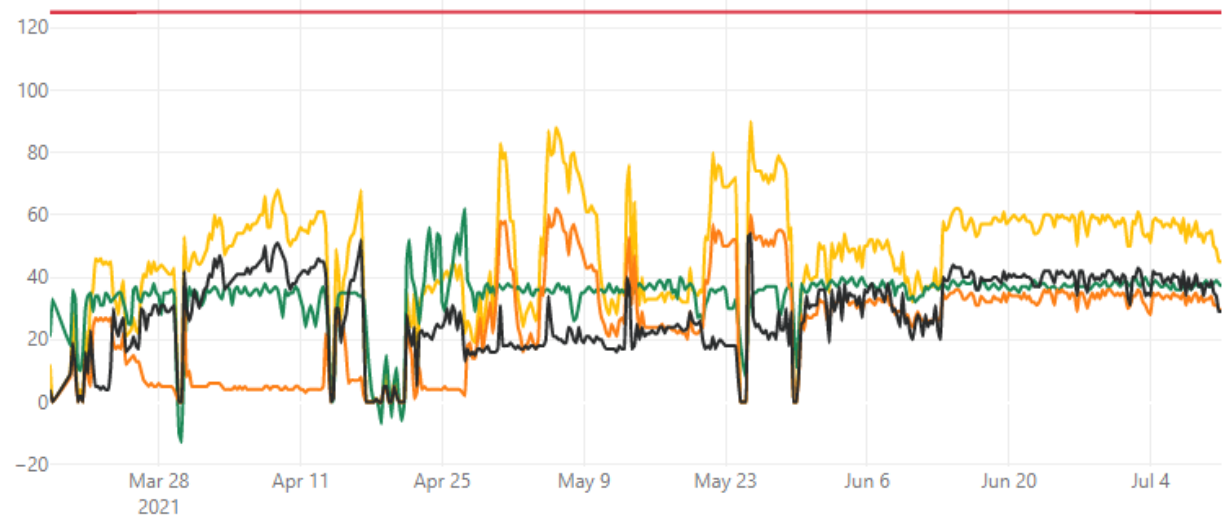


APPENDIX B: IJACK XFER TRI-PHASE PUMP DATA OUTPUT





— Strokes per Minute
 — Max speed setpoint (%)
 — Min speed setpoint (%)
 — Stroke speed average (%)
— Stroke up time (s)
— Stroke down time (s)



— Horsepower
— Horsepower limit
— Hydraulic temp (C)
— Horsepower on downstroke
— Horsepower on upstroke

APPENDIX C: UP-STREAM WELL PRODUCTION GROUP PLOT

