

**ROUTING AND ACTION
MEMORANDUM**

ROUTING

TO: (1) Office of the Director - Chief Scientist (Lee, Stephen)

Report is available for review

(2) Proposal Files Proposal No.: 71175-ST-IRP

DESCRIPTION OF MATERIAL

CONTRACT OR GRANT NUMBER: W911NF-17-2-0105

INSTITUTION: Virginia Polytechnic Institute & State University

PRINCIPAL INVESTIGATOR: Stephen Eubank

TYPE REPORT: Monthly Progress Report

DATE RECEIVED: 3/19/20 8:23AM

PERIOD COVERED: 16-Jan-2020 through 15-February-2020

TITLE:

ACTION TAKEN BY DIVISION

(x) Report has been reviewed for technical sufficiency and IS IS NOT satisfactory.

(x) Material has been given an OPSEC review and it has been determined to be non sensitive and, except for manuscripts and progress reports, suitable for public release.

Approved by SSL\STEPHEN.J.LEE on 3/19/20 1:11PM

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA, 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.
PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY) 19-03-2020	2. REPORT TYPE Monthly Progress Report	3. DATES COVERED (From - To) 16-Jan-2020 - 15-Feb-2020
---	---	---

4. TITLE AND SUBTITLE Integrative Genomics Approach to Computational Assessment of Threats (IGACAT)	5a. CONTRACT NUMBER W911NF-17-2-0105
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER

6. AUTHORS Shiv Kale	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES AND ADDRESSES Virginia Polytechnic Institute & State Unive North End Center, Suite 4200 300 Turner Street, NW Blacksburg, VA 24061 -0001	8. PERFORMING ORGANIZATION REPORT NUMBER
---	--

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS (ES) U.S. Army Research Office P.O. Box 12211 Research Triangle Park, NC 27709-2211	10. SPONSOR/MONITOR'S ACRONYM(S) ARO
	11. SPONSOR/MONITOR'S REPORT NUMBER(S) 71175-ST-IRP

12. DISTRIBUTION AVAILABILITY STATEMENT Approved for Public Release; Distribution Unlimited
--

13. SUPPLEMENTARY NOTES The views, opinions and/or findings contained in this report are those of the author(s) and should not contrued as an official Department of the Army position, policy or decision, unless so designated by other documentation.

14. ABSTRACT In February we focused on writing manuscripts and continued developing/finalizing software for dissemination by individual groups under the No Cost Extension.
--

15. SUBJECT TERMS manuscripts, software, methods

16. SECURITY CLASSIFICATION OF:	17. LIMITATION OF ABSTRACT	15. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON Stephen Eubank
a. REPORT UU	b. ABSTRACT UU	c. THIS PAGE UU	19b. TELEPHONE NUMBER 000-000-0000

Report Title

ABSTRACT

In February we focused on writing manuscripts and continued developing/finalizing software for dissemination by individual groups under the No Cost Extension.

REPORT DOCUMENTATION PAGE

*Form Approved
OMB No. 0704-0188*

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
------------------------------------	-----------------------	-------------------------------------

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
---	---

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (Include area code)

Monthly Technical Status Report for Contract W911NF-17-2-0105

Team: Virginia Tech

Period Covered: 01-February-2020 to 29-February-2020

Submitted to:

Contracting Officer's Technical Representative (COTR): Dr. Stephen Lee, ARO

Government Program Manager: Dr. Paul Kolb, IARPA

Contracting Officer (CO): Nneka Iwelu, ACC

Submitted by:

Dr. Shiv D. Kale

Fun GCAT Principal Investigator

Submitted on: 10-March-2020

1. Progress Summary

The Fun GCAT team at Virginia Tech, University of Virginia, Mount Sinai School of Medicine, Purdue University, Iowa State University, and San Diego State University are organizing the world's data about DNA sequences into a coherent knowledge base along with an audit trail describing how to recreate the knowledge base as it existed at any point in the past. We are creating a transparent system for modelers both to access and to add to the knowledge base, also with an automatically generated audit trail. We are assembling the computational hardware, software, and administrative resources to support state-of-the-art model development for our entire, distributed team.

In February, we focused on writing manuscripts, and continued developing/finalizing software for dissemination by individual groups under the No Cost Extension.

Keywords: manuscripts, software, methods

Administrative

We would like to finalize formatting instructions and specifications for the final report in due course. VT has continued bi-weekly meetings and shared drive access to facilitate communication between team leads.

Data Integration & Acquisition Team (DIA)

Current efforts by the data and acquisition team at the UVA have concluded. Independent efforts are being put forth to conclude manuscript associated with the project.

DIA WORK PLANNED FOR FEBRUARY (from January report)	STATUS
Refine GO annotations in training data using similarity thresholds	FUTURE RESEARCH
Create classifier based on gene sequences found significantly associated with human pathogenesis as a novel threat detection system	FUTURE RESEARCH
Refine virulence factors to isolate those active in human pathogenic bacteria	FUTURE RESEARCH

Computational Framework Team (CF)

Current efforts by the data and acquisition team at the UVA have concluded. Independent efforts are being put forth to conclude manuscript associated with the project.

CF WORK PLANNED FOR FEBRUARY (from January report)	STATUS
Document delivered software (UVA)	IN PROGRESS
Finish manuscripts	IN PROGRESS

Predictive Modeling Team (PM)

In February the Kale Lab worked on finalizing taxonomic analysis associated with Neighborly clusters and concluding the first manuscript. Parth has worked on documenting his ML methods and preparing his thesis for graduation. Parth has also spent effort creating a singularity container for local deployments of Neighborly through web-browsers.

Building on insights gained from experiments and exploration, members of the Heath lab have identified a significant challenge in searching a protein database deriving from the wildly varying lengths of the proteins. We have devised a new strategy for constructing a ball cover for the set of proteins that starts by partitioning the set by approximate protein length. Three computer science students in the Heath lab are working on this new strategy, led by PhD student Yoonjin Kim, assisted by undergraduate students Ben Reidy and James Zhang. We are also working on the EnTrance manuscript.

The Murali group is finalizing the revision of the manuscript on gene function prediction using a multi-bacterial network. We have also continued our efforts to benchmark existing algorithms for HPO term prediction. We are also engaged in a related project to predict genes associated with rare diseases. The intention here is to use the HPO annotations for such diseases as an underlying source of information to link different diseases.

In February, the DAC group continued its work on heterogeneous knowledge graphs for threat identification. We are currently evaluating hypergraph based representation learning methods (<https://arxiv.org/pdf/1906.00137.pdf>) for understanding the relationship between the various nodes in the graph like diseases, kmers, go functions etc.

The Kihara lab has continued to work on the ensemble method for protein gene function prediction. A particular new feature is that the method uses predicted protein tertiary structure features for searching similar proteins from Swiss-Prot database. The method first predicts structure features for a target protein using deep neural network. Then the features are compared with a database of proteins with pre-computed features. Although the structure-based method does not outperform existing sequence-based methods, such as PFP, on average, but there are many examples that the structure-based method performs better than PFP. This happens when a database does not contain homologous proteins. In such cases, the structure-based method can often still identify functionally relevant proteins that lack sequence similarity but have structure similarity. We are further benchmarking and investigating the performance of the structure-based method.

The Friedberg lab has provided code for reverse-engineering the challenge sequences provided. We have developed a multi-class classifier for antibiotic resistance genes, based on the drugs they are resistant to. The first paper in this study has been published in the Machine Learning for Health workshop at NeurIPS 2018. The second paper has been published in *Bioinformatics*. In addition, we have constructed non-redundant AMR gene database using data and metadata from 12 other databases. We are finalizing a manuscript on using transfer learning for prediction of antibiotic resistance, and have submitted a manuscript for using out-of-distribution data for better prediction of antibiotic resistance. We will be using the software (TRAC) to survey several human microbiome data.

The Segall group (including Adrian Cantu and Peter Salamon): We have submitted our PhANNs manuscript to *Bioinformatics*. It was summarily rejected and is being prepared for resubmission. We have adjusted the training and validation databases to have greater similarity cut-offs between sequences in the different protein classes using different amino acid similarity cut-offs, and also investigated the “un-dereplication” of the data after the separation of the training data sets, in order to recover maximum sequence diversity during training. We then re-trained the neural nets and are investigating the performances of the various re-trained ANN ensembles. The paper will be modified and resubmitted soon (next week or two). We are still exploring how to add mutual information to better draw “borders” between categories, i.e., families of viral proteins.

The Deng and Higdon group has conducted some preliminary analysis with promising results. Due to the imbalance on the class labels, currently, student Zihao Hu is also developing a robust approach to address this imbalance issue. Moreover, we have also worked on efficient algorithm to facilitate the computation for such a large-scale analysis. The team expects one or two research papers to be ready by the end of May 2020.

PM WORK PLANNED FOR FEBRUARY (from January report)	STATUS
EnTrance version 2.0 that incorporates ball covering of UniRef90 clusters.	IN PROGRESS

Continued work on parallelizing the EnTrance algorithm, both ball construction and sequence querying, and work on the EnTrance manuscript.	IN PROGRESS
Benchmark existing algorithms to predict HPO annotations. Revise manuscript on gene function prediction using multi-bacterial network.	IN PROGRESS
Addressing the coarse search challenge that has been identified. Continued work on parallelizing the EnTrance algorithm, both ball construction and sequence querying, and work on the EnTrance manuscript. Incorporate EnTrance implementation into the Lunar Lander. Continued testing. Getting new Heath lab member to a point of productivity.	IN PROGRESS
Conclude the neighborly Manuscript for Submission.	IN PROGRESS
Backup the MongoDB containing cluster annotation.	IN PROGRESS
The manuscript describing our current feed forward/back-prop neural nets was submitted (and rejected) to Bioinformatics. We are revising the manuscript as mentioned above. Approval for submission of the manuscript was already obtained last Fall. (The abstract describing this work was presented in a poster at ISMB/ISCB in July.)	IN PROGRESS (manuscript is being revised) COMPLETED (abstract presentation)
Collect training data for eukaryotic viral proteins and align with threat level categories. I now have a new student who will maybe have the chance to continue this project if there are new funds available.	ON HOLD
Antimicrobial resistance discovery web application.	IN PROGRESS
Antimicrobial resistance transfer learning paper.	IN PROGRESS

Ensemble Modeling Team (EM)

In February, Pandey and Murali labs made further progress in their work on heterogeneous ensemble-based data integration, especially to address the limitations of the current version of the framework reported in the MLCB paper. Specifically, they are currently evaluating the framework's performance for GO terms with less than 1000 genes annotated to them, as well as investigating better methods to handle missing data (proteins and edges) in the STRING networks.

PM WORK PLANNED FOR FEBRUARY (from January report)	STATUS
Integrate data through heterogeneous ensembles	IN PROGRESS

2. Planned for Next Reporting Period

Data Integration & Acquisition Team

The main goals of the DIA team for the upcoming reporting period are:

DIA WORK PLANNED FOR MARCH	STATUS
----------------------------	--------

Computational Framework Team

The main goals of the CF team for the upcoming reporting period are:

CF WORK PLANNED FOR MARCH	STATUS
Document delivered software (UVA)	IN PROGRESS
Finish manuscripts	IN PROGRESS

Predictive Modeling Team

The main goals of the PM team for the upcoming reporting period are:

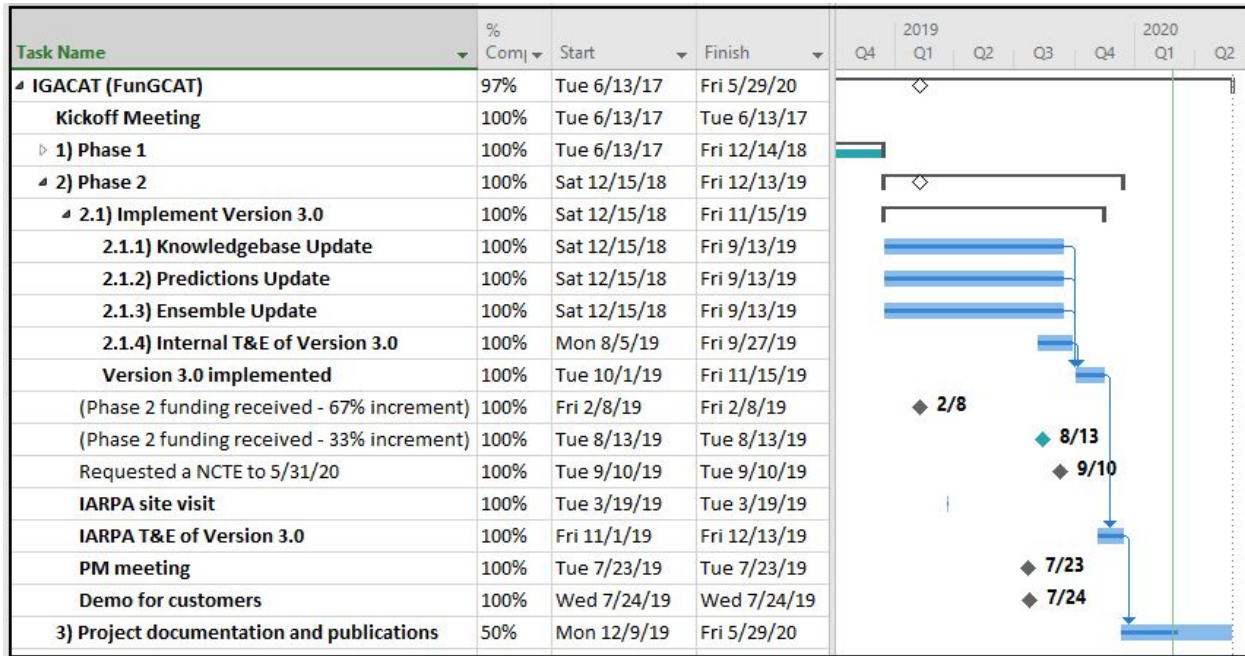
PM WORK PLANNED FOR MARCH	STATUS
Benchmark existing algorithms to predict HPO annotations. Submit manuscript on gene function prediction using multi-bacterial network.	IN PROGRESS IN PROGRESS
Complete and submit Neighborly Manuscript	IN PROGRESS
Revised version of the EnTrance algorithm that addresses the identified challenge in the ball cover for the protein set (Uniref90).	IN PROGRESS
Write a paper for 'Radogest: genome sampler for trees.'	IN PROGRESS
While we wait for manuscript review, we will submit it to <i>bioRxiv</i> and will also use the PhANNs tools to assess predictions and how the predictions fit with other predictive tools incorporated into the Lunar Lander, especially the Plinko tool.	IN PROGRESS
Collect training data for eukaryotic viral structural proteins and training a PhANNs version for eukaryotic viruses.	ON HOLD
Antimicrobial resistance discovery web application	IN PROGRESS
Antimicrobial resistance transfer learning paper	IN PROGRESS

Ensemble Modeling Team

The main goals of the EM team for the upcoming reporting period are:

EM WORK PLANNED FOR MARCH	STATUS
Revisit threat prediction models	IN PROGRESS

3. Progress against Waypoints



4. Material Purchases

None.

5. Key Personnel Changes

None.

6. External Trip Reports

None.

7. Issues and Risks

STANDING ISSUES and RISKS (from earlier reports)	STATUS

None.	
-------	--

8. Requests to IARPA Team

None.

9. Publications & Conference Presentations

Jeffrey Law, Shiv Kale, and T. M. Murali. **Accurate and Efficient Gene Function Prediction using a Multi-Bacterial Network**. Revision in preparation.

Aditya Pratapa, Amogh P. Jalihal, Jeffrey N. Law, Aditya Bharadwaj, and T. M. Murali. **Benchmarking algorithms for gene regulatory network inference from single-cell transcriptomic data**. *Nature Methods* 17, 147–154 (2020).

Parth Vora, Jeffrey Law, Additional Authors, T.M. Murali, Shiv D. Kale. **Neighborly: Platform for gene function prediction via clustering and reduction**. In Preparation.

Vito Adrian Cantu, Peter Salamon, Victor Seguritan, Jackson Redfield, Robert A. Edwards, Anca M. Segall. **PhANNs, a fast and accurate tool and web server to classify phage structural proteins**, Ms. being revised for resubmission.

Linhua Wang, Jeff Law, T. M. Murali and Gaurav Pandey. **Data integration through heterogeneous ensembles for protein function prediction**. In press. Proceedings of MLCB 2019.

Jain A, Kihara D. **NNTox: Gene Ontology-Based Protein Toxicity Prediction Using Neural Network**. *Sci Rep.* 2019 Nov 29;9(1):17923.

Sathappan Muthiah, Debanjan Datta, Mohammad Raihanul Islam, Patrick Butler, Andrew Warren, Naren Ramakrishnan. **ProtTox: Toxin Identification from Protein Sequences**. Accepted as a Poster at MLCB 2019.

Prathyush Sambaturu, Aparna Gupta, Ian Davidson, S. S. Ravi, Anil Vullikanti, Andrew Warren. **Efficient Algorithms for Generating Provably Near-Optimal Cluster Descriptors for Explainability**, Accepted at AAAI 2020.

Md Nafiz Hamid, Iddo Friedberg **Identifying Antimicrobial Peptides using Word Embedding with Deep Recurrent Neural Networks** (2019) *Bioinformatics* 35:12 2009-2016

Preprints:

Md Nafiz Hamid, Iddo Friedberg **Self-Attention based model for de-novo antibiotic resistant gene classification with enhanced reliability for out of distribution data detection** (2019) *bioRxiv* <https://doi.org/10.1101/543272>

Md Nafiz Hamid, Iddo Friedberg **Transfer learning improves antibiotic resistance class prediction** (in preparation)

Vito Adrian Cantu, Peter Salamon, Victor Seguritan, Jackson Redfield, Robert A. Edwards, Anca M. Segall **PhANNs, a fast and accurate tool and web server to predict and classify bacteriophage structural proteins** Revised manuscript will be submitted to *bioRxiv*.

IGACAT
MONTHLY CONTRACT STATUS REPORT - Completion
Date Submitted 3/10/2020
Reporting Month February-20

1. NAME OF CONTRACTOR: **Virginia Polytechnic Institute and State University**
2. CONTRACT NO: W911NF-17-2-0105
3. TYPE: Cooperative Agreement COST
4. PERIOD OF PERFORMANCE: 6/16/2017-5/31/2020
5. REPORTING PERIOD: 02/1/2020-02/29/2020
6. CORRESPONDING INVOICE NUMBER:

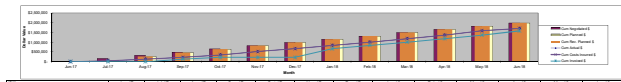
7. CONTRACT SUMMARY:		DATE	COST/PRICE	FEE	TOTAL
Action	Description				
Phase 1	\$3,000,000	6/16/2017-12/14/2018	\$ 3,000,000.00	\$ -	\$ 3,000,000.00
Phase 2	\$2,600,000	12/15/2018-5/31/2020	\$ 2,600,000.00	\$ -	\$ 2,600,000.00
Phase 3			\$ -	\$ -	\$ -
MOD 3			\$ -	\$ -	\$ -
TOTALS:			\$ 5,600,000.00	\$ -	\$ 5,600,000.00
Current Variance (Plan v. Actual)		0.00%			
% Expended To Date:		95.85%	Can the contract/work be completed within the available funding		YES
and on schedule? YES/NO If not, explain in Comment section below.					

8. EXPENDITURES AND COMMITMENTS:		DATE	COST/PRICE	FEE	TOTAL
EXPENDITURES THIS PERIOD:			\$ 5,367,431.98	\$ -	\$ 5,367,431.98
TOTAL EXP. CONTRACT PERIOD OF PERF			\$ 5,367,431.98	\$ -	\$ 5,367,431.98
TOTAL EXP. GOVERNMENT FISCAL YEAR 2018			\$ 2,081,147.19	\$ -	\$ 2,081,147.19
TOTAL EXP. GOVERNMENT FISCAL YEAR 2019			\$ 2,147,771.80	\$ -	\$ 2,147,771.80
TOTAL EXP. GOVERNMENT FISCAL YEAR 2020			\$ 915,683.20	\$ -	\$ 915,683.20
Costs Incurred, but not yet invoiced:					
Iowa State	estimated Jan 2019	02/01/20-02/29/20	\$ -	\$ -	\$ -
Mt. Sinai School of Medicine	actual Mar 2020	03/01/20-03/31/20	\$ 20,018.57	\$ -	\$ 20,018.57
Purdue University	estimated Jan 2019	02/01/20-02/29/20	\$ -	\$ -	\$ -
San Diego State University	actual Jan 2019	02/01/20-02/29/20	\$ -	\$ -	\$ -
University of Virginia	estimated Jan 2020	02/01/20-02/29/20	\$ -	\$ -	\$ -
			\$ 20,018.57	\$ -	\$ 20,018.57
			\$ -	\$ -	\$ -
ITD EXPENDITURES AND COMMITMENTS:			\$ 5,387,450.55	\$ -	\$ 5,387,450.55
ESTIMATE TO COMPLETE:			\$ 212,549.45	\$ -	\$ 212,549.45
ESTIMATE AT COMPLETION:			\$ 5,600,000.00	\$ -	\$ 5,600,000.00

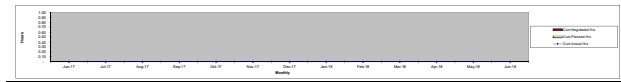
9. Invoicing				COST/PRICE	FEE	TOTAL Paid By Agent
Invoice Number	Invoice Date	Invoice Paid Date	Lag Time			
Invoice Number 1	9/8/2017	9/26/2017		\$ 134,574.00	\$ -	\$ 134,574.00
Invoice Number 2	10/22/2017	11/6/2017	15	\$ 88,255.79	\$ -	\$ 222,829.79
Invoice Number 3	1/15/2018	2/14/2018	30	\$ 448,228.29	\$ -	\$ 671,058.08
Invoice Number 4	2/22/2018	3/22/2018	28	\$ 166,918.29	\$ -	\$ 837,976.37
Invoice Number 5	3/6/2018	3/22/2018	16	\$ 169,474.07	\$ -	\$ 1,007,450.44
Invoice Number 6	4/17/2018	4/30/2018	13	\$ 176,820.04	\$ -	\$ 1,184,270.48
Invoice Number 7	5/19/2018	6/22/2018	34	\$ 184,324.87	\$ -	\$ 1,368,595.35
Invoice Number 8	6/13/2018	6/21/2018	8	\$ 214,710.22	\$ -	\$ 1,583,305.57
Invoice Number 9	7/2/2018	7/11/2018	9	\$ 123,040.37	\$ -	\$ 1,706,345.94
Invoice Number 10	9/5/2018	11/15/2018	71	\$ 431,297.59	\$ -	\$ 2,137,643.53
Invoice Number 11	10/16/2018	11/15/2018	30	\$ 166,333.45	\$ -	\$ 2,303,976.98
Invoice Number 12	12/7/2018	1/14/2019	38	\$ 341,118.25	\$ -	\$ 2,645,095.23
Invoice Number 13	3/11/2019	4/2/2019	22	\$ 208,692.88	\$ -	\$ 2,853,788.11
Invoice Number 14	4/14/2019	7/15/2019	92	\$ 160,484.37	\$ -	\$ 3,014,272.48
Invoice Number 15	5/15/2019	7/15/2019	61	\$ 76,031.71	\$ -	\$ 3,090,304.19
Invoice Number 16	6/2/2019	7/15/2019	43	\$ 121,834.69	\$ -	\$ 3,212,138.88
Invoice Number 17	7/1/2019	7/15/2019	14	\$ 120,526.94	\$ -	\$ 3,332,665.82
Invoice Number 18	7/31/2019	8/22/2019	22	\$ 584,470.44	\$ -	\$ 3,917,136.26
Invoice Number 19	8/31/2019	9/25/2019	25	\$ 307,039.78	\$ -	\$ 4,224,176.04
Invoice Number 20	10/15/2019	1/2/2020	79	\$ 227,572.74	\$ -	\$ 4,451,748.78
Invoice Number 21	11/11/2019	1/24/2020	74	\$ 178,654.87	\$ -	\$ 4,630,403.65
Invoice Number 22	12/9/2019	2/21/2020	74	\$ 209,988.59	\$ -	\$ 4,840,392.24
Invoice Number 23	1/28/2020	2/25/2020	28	\$ 213,660.76	\$ -	\$ 5,054,053.00
Invoice Number 24	2/7/2020			\$ 78,447.60	\$ -	
Invoice Number 25	3/2/2020			\$ 234,931.38	\$ -	
				\$ 5,367,431.98	\$ -	\$ 5,054,053.00

HOURS by Cost Element		Jan-17	Jan-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	TOTAL		
LABOR	\$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
TRAVEL	\$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COLL	\$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MATERIALS	\$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SUBCONTRACTS	\$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRAVEL/COPIES	\$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
TOTAL HOURS	\$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Dollars by Cost Element		Jan-17	Jan-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	TOTAL		
LABOR	\$	-	\$ 31,179.87	\$ 49,164.43	\$ 53,329.28	\$ 64,072.45	\$ 89,649.42	\$ 86,840.16	\$ 81,687.42	\$ 86,473.64	\$ 95,085.21	\$ 79,488.67	\$ 61,227.28	\$ 40,971.01	\$ 121,852.14	\$ 89,390.20	\$ 101,879.20	\$ 70,524.71	\$ 56,000.68	\$ 43,910.81	\$ 22,027.74	\$ 18,004.65	\$ 24,833.50	\$ 26,100.38	\$ 48,424.11	\$ 28,754.78	\$ 102,649.93	\$ 83,683.74	\$ 77,842.04	\$ 69,159.82	\$ 65,440.64	\$ 58,230.31	\$ 16,387.68	\$ 8,942.99	\$ -	\$ -	\$ -	\$ 1,907,853.31		
TRAVEL	\$	489.42	\$ 538.40	\$ 2,192.56	\$ -	\$ 962.40	\$ 2,131.50	\$ 1,164.41	\$ 552.94	\$ -	\$ -	\$ -	\$ 598.24	\$ -	\$ 1,959.28	\$ 87.60	\$ 2,060.73	\$ 885.10	\$ 3,157.98	\$ 569.96	\$ 620.24	\$ 557.65	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 18,046.82
COLL	\$	-	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
MATERIALS	\$	-	\$ -	\$ -	\$ 1,487.98	\$ 1,786.00	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 11,881.10
SUBCONTRACTS	\$	-	\$ -	\$ -	\$ 24,363.17	\$ 7,511.05	\$ 10,809.02	\$ -	\$ 9,747.91	\$ 7,511.05	\$ 3,670.29	\$ 3,674.94	\$ -	\$ -	\$ 87,948.06	\$ -	\$ 83,707.91	\$ 8,276.14	\$ 4,186.64	\$ 26,263.62	\$ 3,668.91	\$ 77,707.79	\$ 26,749.00	\$ 32,348.27	\$ 72,581.05	\$ 393,330.31	\$ 189,841.98	\$ 85,712.87	\$ 51,419.42	\$ 37,343.94	\$ 136,201.89	\$ 95,382.62	\$ 226,079.16	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 1,719,033.71	
TRAVEL/COPIES	\$	-	\$ -	\$ -	\$ 1,487.98	\$ 1,786.00	\$ 28,248.13	\$ 7,511.05	\$ 10,809.02	\$ -	\$ 9,747.91	\$ 7,511.05	\$ 3,670.29	\$ 3,674.94	\$ 87,948.06	\$ -	\$ 83,707.91	\$ 8,276.14	\$ 4,186.64	\$ 26,263.62	\$ 3,668.91	\$ 77,707.79	\$ 26,749.00	\$ 32,348.27	\$ 72,581.05	\$ 393,330.31	\$ 189,841.98	\$ 85,712.87	\$ 51,419.42	\$ 37,343.94	\$ 136,201.89	\$ 95,382.62	\$ 226,079.16	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 1,728,614.88	
LABOR/TRAVEL/COPIES	\$	489.42	\$ 31,718.27	\$ 51,356.99	\$ 54,817.28	\$ 66,858.45	\$ 91,149.51	\$ 88,349.31	\$ 83,435.34	\$ 88,621.55	\$ 104,832.76	\$ 87,100.24	\$ 64,868.27	\$ 44,642.01	\$ 133,824.34	\$ 90,380.40	\$ 104,947.10	\$ 71,350.81	\$ 59,167.32	\$ 46,027.62	\$ 25,055.74	\$ 18,004.65	\$ 26,100.38	\$ 48,424.11	\$ 28,754.78	\$ 102,649.93	\$ 83,683.74	\$ 77,842.04	\$ 69,159.82	\$ 65,440.64	\$ 58,230.31	\$ 16,387.68	\$ 8,942.99	\$ -	\$ -	\$ -	\$ 1,925,644.09			
TRAVEL	\$	489.42	\$ 538.40	\$ 2,192.56	\$ -	\$ 962.40	\$ 2,131.50	\$ 1,164.41	\$ 552.94	\$ -	\$ -	\$ -	\$ 598.24	\$ -	\$ 1,959.28	\$ 87.60	\$ 2,060.73	\$ 885.10	\$ 3,157.98	\$ 569.96	\$ 620.24	\$ 557.65	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 18,046.82	
LABOR	\$	305.12	\$ 19,348.14	\$ 31,346.06	\$ 33,438.03	\$ 40,788.05	\$ 62,465.77	\$ 64,779.47	\$ 61,644.38	\$ 60,989.07	\$ 64,854.72	\$ 53,703.39	\$ 61,241.11	\$ 29,088.08	\$ 75,461.76	\$ 70,638.79	\$ 83,000.71	\$ 60,779.50	\$ 37,660.01	\$ 33,791.36	\$ 4,381.29	\$ 25,692.26	\$ 17,981.96	\$ 18,672.30	\$ 31,122.81	\$ 18,177.19	\$ 81,453.48	\$ 50,367.14	\$ 33,740.33	\$ 42,870.97	\$ 40,208.24	\$ 18,578.90	\$ 2,378.29	\$ 2,230.46	\$ -	\$ -	\$ -	\$ 1,312,169.68		
LABOR/COPIES	\$	305.12	\$ 19,348.14	\$ 31,346.06	\$ 33,438.03	\$ 40,788.05	\$ 62,465.77	\$ 64,779.47	\$ 61,644.38	\$ 60,989.07	\$ 64,854.72	\$ 53,703.39	\$ 61,241.11	\$ 29,088.08	\$ 75,461.76	\$ 70,638.79	\$ 83,000.71	\$ 60,779.50	\$ 37,660.01	\$ 33,791.36	\$ 4,381.29	\$ 25,692.26	\$ 17,981.96	\$ 18,672.30	\$ 31,122.81	\$ 18,177.19	\$ 81,453.48	\$ 50,367.14	\$ 33,740.33	\$ 42,870.97	\$ 40,208.24	\$ 18,578.90	\$ 2,378.29	\$ 2,230.46	\$ -	\$ -	\$ -	\$ 1,314,189.68		
TRAVEL/COPIES	\$	489.42	\$ 538.40	\$ 2,192.56	\$ -	\$ 962.40	\$ 2,131.50	\$ 1,164.41	\$ 552.94	\$ -	\$ -	\$ -	\$ 598.24	\$ -	\$ 1,959.28	\$ 87.60	\$ 2,060.73	\$ 885.10	\$ 3,157.98	\$ 569.96	\$ 620.24	\$ 557.65	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 18,046.82	

Financial Summary



Month	Total Payments	Total Payments	Total Payments	Total Payments
Jan 17	100000	100000	100000	100000
Feb 17	150000	150000	150000	150000
Mar 17	200000	200000	200000	200000
Apr 17	250000	250000	250000	250000
May 17	300000	300000	300000	300000
Jun 17	350000	350000	350000	350000
Jul 17	400000	400000	400000	400000
Aug 17	450000	450000	450000	450000
Sep 17	500000	500000	500000	500000
Oct 17	550000	550000	550000	550000
Nov 17	600000	600000	600000	600000
Dec 17	650000	650000	650000	650000
Jan 18	700000	700000	700000	700000
Feb 18	750000	750000	750000	750000
Mar 18	800000	800000	800000	800000
Apr 18	850000	850000	850000	850000
May 18	900000	900000	900000	900000
Jun 18	950000	950000	950000	950000



Month	Total Payments	Total Payments	Total Payments	Total Payments
Jan 17	100000	100000	100000	100000
Feb 17	150000	150000	150000	150000
Mar 17	200000	200000	200000	200000
Apr 17	250000	250000	250000	250000
May 17	300000	300000	300000	300000
Jun 17	350000	350000	350000	350000
Jul 17	400000	400000	400000	400000
Aug 17	450000	450000	450000	450000
Sep 17	500000	500000	500000	500000
Oct 17	550000	550000	550000	550000
Nov 17	600000	600000	600000	600000
Dec 17	650000	650000	650000	650000
Jan 18	700000	700000	700000	700000
Feb 18	750000	750000	750000	750000
Mar 18	800000	800000	800000	800000
Apr 18	850000	850000	850000	850000
May 18	900000	900000	900000	900000
Jun 18	950000	950000	950000	950000

