1. Market Opportunity

Burge Environmental has identified that the microbial sensor technology has tremendous disruptive potential in real-time process monitoring and control applications. Specifically, this technology is ideal for a Device-as-a-Service model application for the U.S. Water & Wastewater Treatment industry. The unique qualities and characteristics of this novel technology create substantial value for real-time process intelligence in microbial processes.

Burge Environmental has already received considerable interest and traction during beta-site selection within the local wastewater industry in the southwest region of the U.S. (California and Arizona). Currently, this industry relies on model-based microbial processing steps and utilizes Dissolved Oxygen (DO) and Oxygen Reduction Potential (ORP) sensors in addition to high-cost daily or weekly lab sampling procedures for indirect proxy measurements of process conditions. The lack of suitable real-time direct measurement technology requires utilizing these indirect measurement methods (DO, ORP) to confirm processing parameters are meeting the required process model level ranges. The direct and real-time measurement capability of the microbial sensor offers high-value process intelligence that has previously been economically or physically infeasible. Considerable sums are spent within this industry to monitor these processes already as process monitoring is considered a critical need for efficient operations of a highly energy intense part of everyday national infrastructure. Over 50% of the cost and approximately 76 billion kWh/year, of wastewater treatment is from energy[1] to operate primarily aeration pumps in addition to mixing and transfer pump systems used in wastewater treatment.

In discussions with operators of multiple large-scale (6-Million Gallon per Day (MGD) or larger facilities it was discovered that an annual budget exceeding $100,000 is typical for sensor equipment and instrumentation, sensor data subscriptions, and support service contracts. The operators are accustomed to the deficiencies of these kinds of instruments, such as frequent maintenance (weekly cleaning or replacement), high failure rates (ORP), false positives (DO), as well sensor drift issues, and have considerable discretionary spending capability in this category due to the frequency of these problems. These operators conveyed that they typically pay between $8,000 and $12,000 per sensor system and thousands of dollars per year in data subscriptions for web-based access to sensor data, in addition to tens to hundreds of thousands of dollars per year in lab analyses. These large-scale operators were interested in new sensor technologies if they could demonstrate new capabilities, improved value or reliability.

The microbial sensor deployment at the 9 MGD Goleta Sanitary District (Goleta, CA) has already demonstrated that the sensor is impervious to the biofouling that typically requires regular (cleaning) maintenance as it was installed next to an existing DO sensor system that requires weekly cleaning. The microbial signal data correlated strongly to both the existing DO sensor installation as well as daily Mixed Liquor Suspended Solids (MLSS) sampling used for long-term process monitoring. These systems can be installed without reference cell failure and replacement concerns (unlike ORP sensors) and have been able to detect in real-time biocidal chemical contamination events and their impacts to multiple stages of the treatment plant (A novel capability. These capabilities have demonstrated multiple value propositions for the technology:

- Avoid contaminant impact on active microbial communities (process interruption costs).
- Avoid discharge compliance fines (District, County, State, and Federal level).
- Eliminate maintenance and service costs of DO and ORP sensors.
- Improve energy efficiency or process efficiency with real-time microbial monitoring (cost efficiencies).

Each of these value propositions apply to different stages of the wastewater treatment process train. For Goleta Sanitary District, the value of real-time contamination detection is considerably higher than other WWTP facilities as it discharges treated water directly to the ocean and is under heavy regulatory and political scrutiny. Monitoring microbial signal at every step of the process would allow averting substantial (6 and 7-figure) fines at the Goleta Sanitary District in addition to process efficiency gains and improved troubleshooting capabilities.

[1] https://www.nist.gov/sites/default/files/documents/2017/05/09/243_energy_infrastructure2.pdf

Target Market

Half of the 17,000+ wastewater treatment facilities in the U.S. are 6 MGD or more. Discussions with operators of multiple plants in Arizona and California revealed each plant spends over $100,000 annually on sensor technologies and analyses. An estimated $850m niche target market within the water treatment equipment ($9.8bn, 5.90% CAGR[2]) and the life sciences instrumentation ($18.6bn, 8.5% CAGR[3]) submarkets exists serving the Water & Wastewater Industry exists focusing solely on these larger-scale facilities. This technology has applications within the broader global Process Automation & Instrumentation ($88.92bn, 6.24% by 2023[4]) and the Water & Wastewater Products ($96.3bn, 10.2% CAGR by 2019[5]) Markets that extend beyond the U.S. water and wastewater industry.

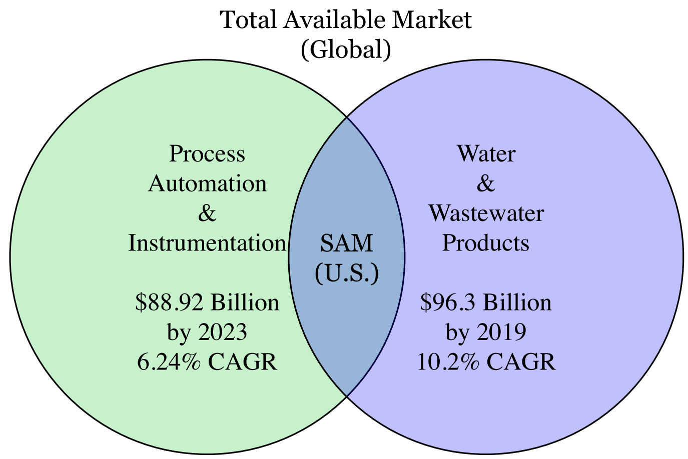

Figure 1 - Serviceable Available Market Intersection Diagram of Global Total Available Market and relevant growth rates.

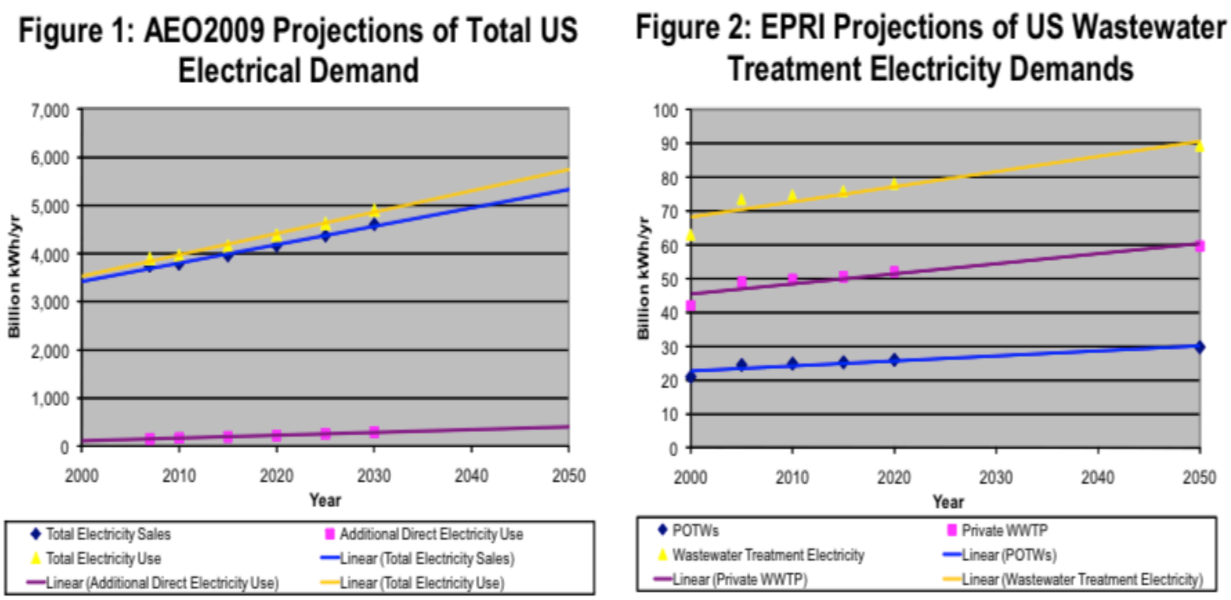

Figure 2 – Figures from NIST Energy and Infrastructure Report U.S. Electrical Demand Projections and U.S. Wastewater Treatment Electricty Demands (Willis, J. 2010)

These wastewater industry sensor technology and lab analysis expenditures are a direct result of the need for both quality assurance and energy efficiency prioritization of wastewater treatment facilities. Wastewater treatment facilities spend approximately $7 billion per year on electricity ($0.10/kWh) to run these processes and

[2] https://www.freedoniagroup.com/industry-study/water-treatment-equipment-3052.htm
[3] https://www.transparencymarketresearch.com/life-science-instrumentation-market.html
[4] https://www.marketsandmarkets.com/Market-Reports/process-automation-market-1172.html
[5] https://www.bccresearch.com/market-research/environment/water-wastewater-treatment-markets-env008c.html

electricity demand for wastewater treatment is expected to continue to grow[6]. Sensors and data acquisition are a small but critical aspect of efficiently monitoring and operating these larger scale plants and improving energy efficiency.

During the first phase of commercialization Burge Environmental will target the southwest region of wastewater treatment plants to demonstrate the technology and grow revenue. In the U.S., we estimate at least $850m is spent annually on sensor instruments, maintenance, sampling, and data acquisition services, offering a robust market where our technology has a tremendous competitive advantage. Licensing or reseller arrangements will be made with companies outside the southwest region or internationally to bring the technology to market as quickly as possible. We anticipate growing to over $10m in annual sales within 5 years of commercialization.

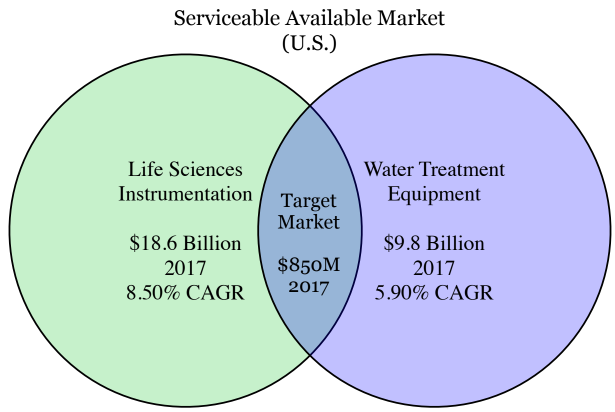

Figure 3 - Target Market Intersection Diagram of Serviceable Available Market and relevant growth rates.

Initially Burge Environmental will target the local wastewater treatment industry within Arizona as well as any organic growth potential through our testing partnership in California. Over 500 MGD of utilized or planned wastewater treatment capacity exists in Maricopa County, Arizona that could benefit from this technology. This submarket already collaborates heavily with our research partners at Arizona State University. In effect this is playing to the homefield advantage of existing collaborative networks between ASU and the local industry, as well as ease of demonstration, and the ability to utilize strong professional referals due to local industry organizations and networks.

With over 100 water & wastewater treatment facilities, water reclamation facilities, and smaller private treatment infastructure, the Maricopa County, Arizona market itself is a $1 million to $3 million in potential annual subscription revenue for this technology. This assumes 1 or more microbial sensor deployments per facility alone. This is not to illustrate an estimated sales within Maricopa County, but that the industry and market we're targetting is extremely large and supports 8+ figure annualized revenues in relatively short time frames. Figure 4 maps the geographic distribution of target facilities that leads have already been established from beta-site selection work and ASU research collaboration. Burge Environmental has full contact details and direct referal capabilities for each of the highlighted sites. Size, shape and color indicate processing capacity, facility type, and lead status (e.g., existing relationship in green, discussions and interest in yellow, referral opportunity in orange, etc.). The research into finding suitable beta-sites for testing the technology for the SBIR proposal revealed the

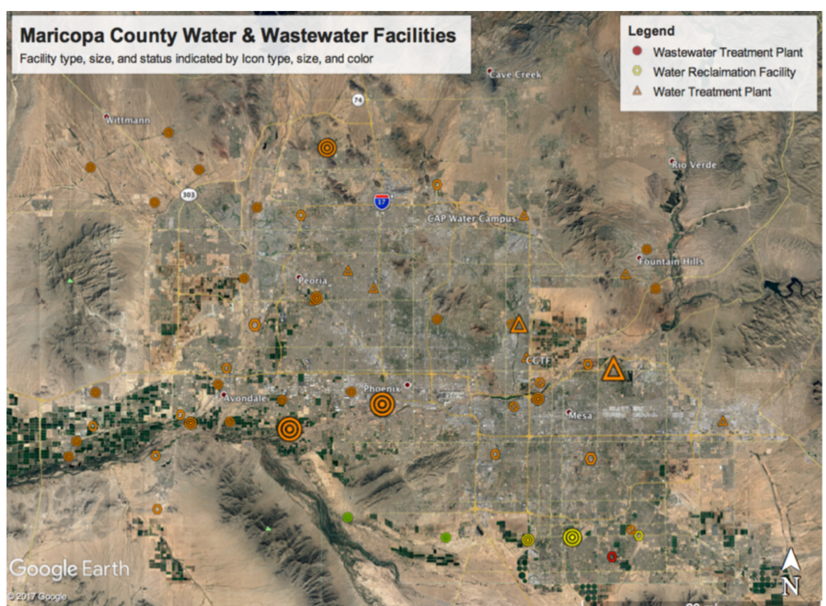

Figure 4 – Maricopa County, Arizona Water & Wastewater Facilities and beta-site leads map.

[6] https://www.nist.gov/sites/default/files/documents/2017/05/09/243_energy_infrastructure2.pdf

shear size of the wastewater industry. The strong interest and beta-site traction in the microbial sensor established this industry as the primary target for the first commercialization stages.

Hazardous waste and environmental monitor well markets (the original direction of the SBIR R&D grant) do not offer the same scalability. Limited sites, environmental consultant gatekeepers, and the high risk and confidentiality associated with environmental cleanups inihibit new technology adoption. This contrasts significantly with the numerous sites, strong customer and consultant interest in trying new technologies, and best practices collaboartion characteristics of the water & wastewater industry. For example, as new technologies are applied to water and wastewater facilities, industry white papers and conference presentations are given to promote best practices that result in reduced costs and/or improved efficiencies. This drastically lowered the customer aquistion cost (CAC) estimates in a significantly higher customer lifetime value (CLV) industry by switching focus to the water & wastewater industry. Design, manufacturing, and deployment efficiencies were also gained due to the similar nature of wastewater facilities in contrast with the individual nature and remote deployment characteristics of environmental monitoring sites (e.g., Two of our hazardous waste environmental monitoring beta-sites required either specialized corrosion resistant materials, or custom-made cabling for deep well deployments, drastically increasing COGS.).

Market Trends

The sensor and instrumentation market is going through a major sea change due to innovations in "Internet-of-Things" and inexpensive wireless connectivity. Automated sensor systems, process control, and remote monitoring have been major drivers for both product adoption and company acquisitions for the last few years. Furthermore, these trends are expected to continue. While these key market drivers are supportive of fast adoption of this technology, it will be critical to provide a partnership program for existing industry vendors and suppliers to perceive the technology as a new, complimentary product.

Vendors in this industry are developing and marketing equipment to improve process efficiency (e.g., energy intensity, residence time) due to energy being over 50% of wastewater treatment cost[7] or residence time being the limit on capacity. Marketing the microbial sensor technology as a method of confirming these improvements will aid with adoption. The sensor technology will provide a valuable tool to consulting engineering firms to both qualify and quantify improved process efficiency from equipment or operational improvements, better demonstrating the value their products and services provide. Marketing the technology as an inexpensive tool for proving equipment or services value-propositions for existing firms in the industry will accelerate adoption of the microbial sensor technology through positive mindshare of existing industry experts.

[7] https://www.nist.gov/sites/default/files/documents/2017/05/09/243_energy_infrastructure2.pdf

Channel Strategy

We will target organic growth of sales with existing business networks and through beta-site relationships initially and then focus on developing regional channel partners of existing consultants and vendors in the wastewater industry. It will be important to create channel partnerships which establish this product as non-competitive with the existing engineering and consulting market for the water & wastewater industry to spur adoption through utilizing these existing expertise and reputations in the market.

Burge Environmental will exclusively focus sales and financial resources on the Water & Wastewater industry, where the opportunity is largest and the traction and sales cycles are fastest. Licensing or reseller opportunities in other major markets such as the U.S. Bioreactor ($600m, 18% 2024 CAGR[8]), U.S. Precision Agriculture (Variable Rate Technologies, $2bn, 6% 2017 CAGR[9]), and the non-wastewater U.S. Life Sciences Instrumentation ($18.6bn, 8.5% CAGR[10]) submarkets will be further pursued as a method of raising licensing revenue in addition to traditional capital sources.

Table 1 – Channel Timeline

Channel Timeline	2018	2019	2020	2021	2022
Water & Wastewater					
Subsurface Environmental Monitoring					
Bioreactor					
Precision Agriculture					
Life Sciences Instrumentation					

Table 2 - Market / Channel Commercialization Strategy Matrix

Market or Channel	Water & Wastewater	Subsurface Environmental Monitoring	Bioreactor	Precision Agriculture	Life Sciences Instrumentation
Regional	Burge Environmental	Reseller or Licensor/JV	Reseller or Licensor/JV	Licensor/JV	Licensor
National	Reseller	Reseller or Licensor/JV	Reseller or Licensor/JV	Licensor/JV	Licensor
International	Reseller or Licensor	Reseller or Licensor	Reseller or Licensor	Licensor	Licensor

In addition to licensing and reseller agreements for outside the initial target market region, channel partnerships will have to be developed with some of the national players for this technology. This will both bolster the credibility of the new technology to potential customers, and accelerate overall adoption. Early discussions with large-scale national industrial equipment companies have been initiated for the environmental monitoring and bioreactor markets as partners, resellers or licensors of the technology after successful completion of this proposal. These discussions are the result of existing business history and relationships between the principles of Burge Environmental and senior management & executives of Danaher Corporation, Xylem Inc., Graco Inc., CH_2M Hill, Carollo Engineers, and Geosyntec Consultants. Some of these companies expressed interest in Phase III SBIR partnerships.

[8] https://www.gminsights.com/industry-analysis/bioreactor-market
[9] https://www.ibisworld.com/industry-trends/specialized-market-research-reports/technology/scientific-systems-devices/precision-agriculture-systems-services.html
[10] https://www.transparencymarketresearch.com/life-science-instrumentation-market.html

Due to significant interest by Geosyntec Consultants for major long-term remediation projects and Graco, Inc. for their landfill bioreactor business, licensing and reselling agreements will be pursued. Carollo Engineers, has expressed significant interest in wastewater industry partnerships as the technology is commercialized. These agreements will take time to prove out due to the "bleeding edge" state of the technology. These companies are keenly awaiting research publication and summaries of the technology in these wastewater treatment applications, and discussions have moved forward with other organizations for potential partnerships in their primary markets outside of water & wastewater.

Table 3 - Channel Partnership Discussion Areas

Channel Partner Interest					
Channel Partner	Water &	Subsurface Environmental	Bioreactor	Precision Agriculture	Life Sciences Instrumentation
[redacted]	X				X
[redacted]	X		X		
[redacted]	X	X			X
[redacted]		X			
[redacted]	X				

Business Model

Due to the low cost of goods sold for the technology and high-value of the real-time data, a compelling service-model-based pricing structure has been identified that is well within the budget ranges of WWTP Operators. We estimate $1,000 per month per unit as a low-friction price point, and intend to offer high-value data service upgrades through big-data analyses, and multiple operational modes for sensor data acquisition (e.g., kinetic measurement, a more complex and data demanding method of sensor operation). The in-situ real-time technology lends itself to this application structure as the sensor probe does not suffer from the same failure and replacement constraints as existing technologies (i.e., it can be reliably deployed for long periods of time). Also, the real-time microbial response sensor data is a new analytical tool for process monitoring and operations where customers will want curated data and analysis guidance. The technology does not lend itself to handheld meters or other single-use lab instrument applications.

Customers in this segment already pay separate service contracts and automated data acquisition service fees, and can more easily fit smaller monthly fees into budgets than large capital outlays for specific monitoring systems. Investors prefer lower-risk subscription revenue business models, and the easier ability to up-sell customers through advanced data analytics and software unlocked features of a standard piece of equipment. This results in a high-margin Device-as-a-Service business model that is attractive to customers as well as investors.

At the early adoption stage the technology will be manufactured in-house for direct sales to the wastewater industry and any channel partner or licensor sales for other industries. This is to capture valuable design and customer feedback cycles for design-for-manufacturing activities and develop workflow automation strategy that will be part of scaling the company. Sales will be completely in-house for this initial period to assist in capturing this vital information.

Other Benefits

A real-time method for measuring microbial activity in biological processes will have a tremendous impact on the scientific understanding of microbes and their electrochemical metabolic interactions. New instrumentation technologies will emerge based on the principles of this technology and provide new insights into the intersection of microbial life and the physical world. However, the time-scale for such academic discovery will be considerably longer and require considerably more research than the scope of this proposal and is not in line with the purpose of this SBIR or Burge Environmental. For 24 years, Burge Environmental has been a business focused on environmental innovation, remediation, and protection; it is paramount that this technology be developed further for successful commercialization within the water & wastewater industry as the societal benefit of improving water treatment energy efficiency and reducing economic and environmental impacts of water infrastructure are becoming more critical every day. **At the time of this writing, Cape Town, South Africa has less than 100 days of water.**

2. Company & Team

Burge Environmental, Inc. is an analytical instrumentation company located in Tempe, Arizona. The company was founded in 1990 by [redacted] The company has performed research and development of the instrumentation and has marketed some of the instrumentation (TCE, organics and hexavalent chromium automated sensor technologies). [redacted] is the current president of the company and holds a Ph.D. in analytical chemistry (1982). The company has developed analytical sensor systems and accompanying real-time monitoring systems for trichloroethene, carbon tetrachloride, hexavalent chromium, Sr-90, TC-99, I-129, U(VI) and tritium. The funding for these systems were provided by SBIR and STTR through DOE and DOE SBIR grants. Burge & Associates, Inc. is a related environmental consulting company which maintains appropriate insurances and business licenses for equipment mobilizations and installation of technologies developed by Burge Environmental, Inc.

Revenue History (in 000s's)

Entity	2015	2016	2017
Burge Environmental, Inc.	223.8	390.1	503.8
Burge & Associates, Inc.	685.6	259.7	106.6

These two associated companies have a combined headcount of 6 employees, and a [redacted], and research partnership with Arizona State University make up the balance of the Sales & Marketing and Research & Development Teams for the spinout company. The spinout company team is made up of experienced industry professionals who have all collaborated with [redacted] for at least 9 years in the environmental remediation, biotechnology development, or research fields.

Management Structure & Team

David Hoffman will direct and manage the Sales & Marketing team made up of experienced product development and sales professionals. [redacted] are experienced serial entrepreneurs in the biotechnology, subsurface geosciences, and software technology sectors respectively. They have each exited from or currently are CEO of their respective ventures, and will be the core of the product development and commercialization team of the new venture. [redacted] will be providing the real-time cloud dashboard expertise based off the real-time sensor telemetry analytical dashboard tools of [redacted] with the Burge Environmental team. [redacted] have experience in commercializing sensor telemetry software, web-based software development, and real-time software dashboard technologies respectively.

[redacted] will direct and manage the Research & Development team made up of experienced wastewater industry experts, biotechnology and electronics inventors. [redacted] will be providing the technical R&D expertise for development of the microbial sensor technology invented by Burge Environmental. [redacted] have developed remote automated sensor technologies based on Burge Environmental R&D for over 20 years. [redacted] was founder and CEO of a bioreactor technology company that developed microbial biofertilizers and later worked with [redacted] as Chief Science Officer and [redacted] as technical advisor for sensor technology integration.

Burge Environmental has recruited a team of experience biotechnology, web software sensor telemetry and analytics, and electronics product development professionals and entrepreneurs. [redacted] have all gone through 7+ figure venture funding rounds as original founders and CEOs of their previous ventures and were recruited to bring these fundraising and industry experiences to ensure the success of the microbial sensor commercialization efforts.

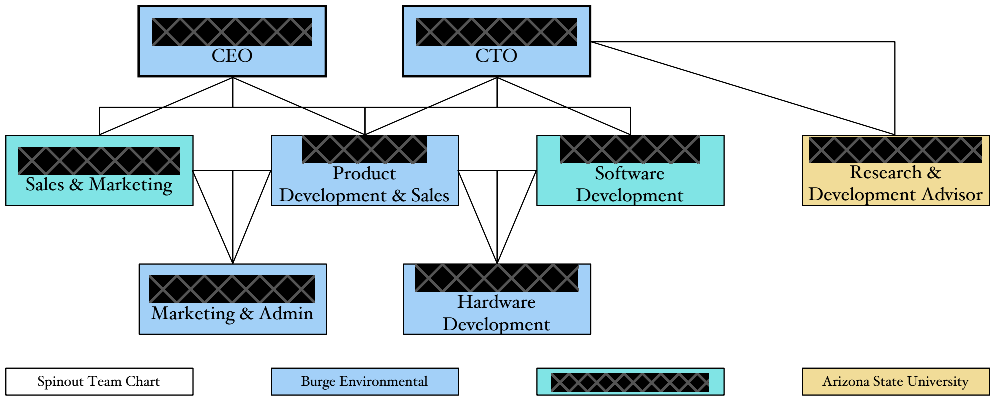

Figure 5 – Burge Environmental Commercialization Team

Team Credentials

[redacted]
Managed Business Operations of Burge Environmental and Burge & Associates for over 20 years. 30 Year background in sales and business operations. Patents for development of sensor technologies.

[redacted], Ph. D. Analytical Chemistry, J.D. Law, B.S. Chemistry
Managed Technical Operations of Burge Environmental and Burge & Associates for over 20 years. Multiple publications and patents for novel sensor technologies for environmental monitoring and remediation applications.

[redacted]
B.S.E. Electrical Engineering
Over 20 years' product development & manufacturing expertise, and multiple innovative electronics patents.

[redacted]
B.S. Sustainability
Inventor, Founder and CEO, of 15+ person bioreactor technology company. Multiple patents pending for bioreactor technology and real-time microbial process technology.

[redacted]
Ph.D. Civil and Environmental Engineering, M.S. Environmental Technology, B.S. Chemical Engineering.
Wastewater industry expert and former Chief Science Officer of microbial bioreactor technology company.

[redacted]
Ph.D. Environmental Science & Management M.S. Geology, B.S. Chemistry
[redacted]

[redacted]
MBA
[redacted]

Other necessary expertise includes the need for developing an industry expert advisory board, and legal counsel for advancing licensing and reseller contracts. These gaps will be filled during the scope of this proposal and will include the operations managers of existing beta-sites for the initial technical advisory board as well is retaining corporate counsel as the licensor, reseller, and investor discussions accelerate.

3. Competition

The process automation, scientific instrument, and lab analysis markets that this technology will be going into are robust with hundreds of competitors ranging from small businesses to major conglomerates. These competitors produce automated sensor systems, manual biochemical assay kits, or provide expensive lab analyses serving a combined global market size larger than $100bn today[11,12]. These competing technologies frequently enter the market serving either the water & wastewater industry before switching to environmental or agricultural industries or vice versa to grow sales.

The competitors which produce automated sensor systems capable of real-time dissolved oxygen or oxygen reduction potential measurement have high up-front and high maintenance, replacement, and service costs. Many of these technologies cannot be installed in various process chambers due to the maintenance and replacement requirements of the sensor technology. These competitors are releasing self-cleaning dissolved oxygen probes to partially resolve these issues, but have not been able to develop solutions to the reference cell replacement issues associated with electrode-based technologies. The self-cleaning dissolved oxygen probes have limited applications as many of the process chamber systems are anaerobic environments, this adaptation is mainly to reduce maintenance costs. Neither of these technologies are capable of, now will they ever capable of, detecting biocidal contamination events or substrate concentration levels.

The competitors which produce various biochemical assay (e.g., ATP testing) kits or provide mixed liquor suspended solids testing which can be utilized for estimates substrate concentration levels rely on expensive single use methods that are not economically feasible to use for process control activities. These methods are used for assessing plant performance issues such as confirming biocidal impacts or as daily quality control samples for long-term monitoring. The costs of these manual methods prevent utilizing them in any real-time system.

There are dozens of handheld instrumentation meters on the market that are used for troubleshooting and regular process monitoring (i.e., daily or weekly). These tools are similar in limitation to the biochemical assay or MLSS testing and cannot be utilized for real-time process monitoring. Handheld instrumentation meters are not a directly comparable product and the microbial sensor is unlikely to compete with these specialized devices.

Depending on the wastewater process, the microbial sensor technology offers either previously unavailable capabilities such as real-time biocide detection, or complimentary capabilities such as real-time microbial process monitoring in relation to dissolved oxygen level (i.e., ability to optimize energy and oxygenation inputs). In many wastewater processes the microbial sensor can be a direct replacement of oxygen reduction potential probes. Additionally, process stages that previously could not be monitored due to sensor fouling or inaccessibility for maintenance purposes are now able to be measured utilizing this technology.

There are several existing technologies for which the microbial sensor is a substitute. Most of these technologies are indirect measurements or some form of lab sample analysis. While this demonstrates a substantial amount of market competition, it also demonstrates a robust and healthy market for innovation where new products and technologies are frequently developed.

These technologies are manufactured and sold by companies such as Hach, Xylem, Veolia, Danaher, ATI, Zaps Technologies, YSI, Rockwell Automation, Johnson Controls, Red Lion Controls, Sigma Aldrich, CH_2M Hill, Graco, Geosyntec Consultants, and countless others. These larger companies have been aggressively acquiring new technology entrants to the market. We anticipate healthy competition, partnership or joint-venture potential, as well as strategic investment opportunities to be available as we commercialize. The size and robust nature of the market has confirmed and encouraged that the initial niche of wastewater treatment is the correct product/market fit for the technology.

[11] https://www.marketsandmarkets.com/Market-Reports/process-automation-market-1172.html
[12] https://www.bccresearch.com/market-research/environment/water-wastewater-treatment-markets-env008c.html

IP

The technology is currently patent-pending with numerous provisional patents filed. The unique capabilities of this novel technology are allowing a substantial patent portfolio to be developed and it is expected that more provisional and full filings will be submitted before the completion of this proposal. There are similar concepts for using microbial fuel cell technologies to measure current as an analytical sensor, however none utilize voltage potential and few can operate without specific microbe communities. Additionally, this method suffers from substantial sensor-drift problems and has not been able to transition outside the lab and into functional field deployments or commercialization. The microbial sensor technology has absolute freedom to operate, and upon successful patent award will have considerable defensibility.

No other IP is necessary to make use of or sell this technology to the previously described market opportunity.

4. Finance and Revenue Model

Commercialization will begin during the Phase IIB period, as the microbial signal characteristics are tested across multiple stages of wastewater treatment plants and findings are published in industry recognized scientific journals. These steps will be critical to being able to secure both paying customers and capital investment as new instrumentation technology requires both a reliable method of interpretation for customers (e.g., signal characterization), and scientific community review (e.g., peer review).

Table 4 - Partnership Discussion Meeting Contacts

Name	Title	Organization	Partnerhip Channel
[redacted]	Technology Development Manager	[redacted]	Water & Wastewater, Life Sciences Instrumentation
[redacted]	VP Sales	[redacted]	Water & Wastewater, Landfill Bioreactor
[redacted]	President	[redacted]	Water & Wastewater, Landfill Bioreactor
[redacted]	Director, Business Development, Process Division	[redacted]	Water & Wastewater, Landfill Bioreactor
[redacted]	Sales Manager, Global Water	[redacted]	Water & Wastewater, Life Sciences Instrumentation
[redacted]	Senior Consultant	[redacted]	Subsurface Environmental Monitoring
[redacted]	Senior Consultant	[redacted]	Subsurface Environmental Monitoring
[redacted]	Process Engineer	[redacted]	Water & Wastewater
[redacted]	Principle	[redacted]	Subsurface Environmental Monitoring
[redacted]	CEO	[redacted]	Life Sciences Instrumentation, Precision Agriculture
[redacted]	Fellow	[redacted]	Life Sciences Instrumentation, Precision Agriculture
[redacted]	Director	[redacted]	Life Sciences Instrumentation, Subsurface Environmental Monitoring

The initial stage of commercialization will begin with expanded beta sites to characterize the microbial signals across multiple stages and wastewater treatment facilities, the goal will be to convert these beta-sites into paying customers after satisfactory results from the characterization studies and device performance are proven. This stage is expected to take place during the last half of the Phase IIB activities.

The results of these characterization studies, major milestones in the form of journal article publications, and early adopter revenue will be necessary for securing either strategic investment or regular venture funding (angel or VC). The proposed use of funds of $993,688 of this Phase IIB will be utilized to satisfy the final stage of pre-investment R&D. Follow-on capital of up to $2,000,000 over 3 years sourced through a combination of outside investment, non-dilutive financing, or potentially from customer revenue will be necessary to establish enough runway to reach profitability. The primary cost drivers are sales & marketing expenses associated with growing into a large sales-based organization for the technology.

Burge Environmental and related Burge & Associates have enough resources to attempt boot-strapping revenue after completion of the Phase IIB until outside investment, secondary market licensing agreements, or non-equity financing can be secured as the technology itself is inexpensive to manufacture and the objectives of the Phase IIB should satisfy key customer. A Year 3 break-even target of 24 customers is wholly attainable with the team and resources Burge Environmental will have through the completion of the Phase IIB. Early discussions have begun with potential channel partners as sources of licensing revenue or strategic investment as sources of working capital. These agreements can take upwards of 18 to 24 months complete. It has been critical to begin these discussions before completion of the SBIR program to prevent any gaps in funding if sales revenue is not enough to bootstrap working capital. See Table 4 for detailed list of partnership meeting participants, Table 5 for summary Revenue, Cost, and Capital Source projections and Figure 7 for full 5-year pro-forma projections based on bootstrapping revenue.

Table 5 - Pro Forma Revenue and Cost Summary & Other Capital Source Summary Table

Bootstrap Projections	2018	2019	2020	2021	2022
SBIR & Sales Revenue	$587,096	$687,592	$721,250	$2,327,212	$7,509,013
Product COGS	$20,295	$35,196	$156,311	$477,474	$1,567,508
Operations Costs	$37,000	$187,000	$560,000	$1,800,000	$4,480,000
Other Sources of Capital					
Licensing Revenue			$400,000	$400,000	$400,000
Non-Equity Funding			$500,000		
Equity Investment			$500,000	$1,500,000	

Revenue Model Metrics, Assumptions, and Review

It is estimated that the NPV for the DOE will be an $9.18 million-dollar Project NPV within the first 10 years of commercialization with a DOE investment multiple of 6.4. First revenues are expected by Q4 of 2018, and break even by Q2 of 2020. Please see Figure 6 and Figure 7 which are modified DOE SBIR templates to factor in original Phase I, Phase II, and Phase IIB funding as well as the Device-as-a-Service business model. Multiple sources of market analysis were utilized to identify the Total Addressable Market, Serviceable Available Market, and the Target Market Niche of the Water & Wastewater Industry, with weighted-average compound annual growth rates utilized to estimate annual grown for this specific niche. Operating margins are consistent with conservative Software-as-a-Service and Device-as-a-Service projections for customer segments requiring more Professional Services and Customer Support due to the technical nature of the offering and the novel characteristics of a direct measurement microbial sensor.

DOE SBIR Funding: Years 0 - 4

		PH I	PHII - Year 1	PHII - Year 2	PHIIB - Year 1	PHIIB - Year 2
		0	1	2	3	4
($ in1000s)	Year	2015	2016	2017	2018	2019
SBIR Funding		$224	$497	$497	$491	$491
	Discount Rate		15%	15%	15%	15%
	Discount factor		0.928174876	0.799630638	0.688888672	0.593483516
Net Present Value (NPV)		$224	$461	$397	$338	$291

Ten Year Revenue Projection: Years 3 - 12

		3	4	5	6	7	8	9	10	11	12
($ in1000s)	Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
	Market Size	$ 32,941,465,530	$35,436,319,507	$38,120,123,681	$41,007,188,377	$44,112,907,731	$47,453,841,765	$51,047,804,692	$54,913,959,902	$59,072,922,142	$63,546,867,439
	Market growth rate	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%	7.6%
	Market Share	0.00000027%	0.00000054%	0.00000189%	0.00000567%	0.00001702%	0.00003830%	0.00006703%	0.00010054%	0.00012567%	0.00013824%
Gross Revenues mfg/licensee		$89	$191	$721	$2,327	$7,509	$18,175	$34,216	$55,210	$74,240	$87,849
	Royalty rate	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Gross Revenues Licensing		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Operating Margin	3.24%	-2.60%	0.63%	2.12%	19.46%	18.00%	17.00%	17.00%	17.00%	17.00%
Operating Profits		$3	-$5	$5	$49	$1,461	$3,272	$5,817	$9,386	$12,621	$14,934
	Discount Rate	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
	Discount factor	0.69	0.59	0.51	0.44	0.38	0.33	0.28	0.24	0.21	0.18
Net Present Value (NPV)		$2	-$3	$2	$22	$554	$1,070	$1,638	$2,277	$2,638	$2,689

Project NPV and Investment Multiple

Cumulative NPV 10yr Profits:		$10,890
Cumulative NPV SBIR funding		$1,712
Project NPV	$	9,178
DOE Investment Multiple		6.4

Figure 6 – DOE SBIR NPV Worksheet

Market Assumptions

Expanded Beta-site testing confirmed that microbial sensor technology has potential across multiple major (multi-billion dollar annual sales) U.S. industries and markets. At no point in this 5 y5-yearojection is it projected that the company will achieve more than 7/10ths of 1% of market penetration into our $850m estimated U.S. target market niche of the Water & Wastewater Industry facilities larger than 6 MGD processing capacity. The actual Serviceable Available Market is much larger at approximately $33 billion dollars with a weighted average 7.6% CAGR in 2017 dollars (See Market Research Appendices). This would require significant licensing and reseller arrangements to approach 1/10th of 1% of the U.S. SAM (see Figure 6) that were not modelled for conservative estimation purposes.

Revenue & Business Model Assumptions

The business model is based off a Device-as-a-Service model for real-time data acquisition and analytics. Similarly, Software-as-a-Service subscription models, a 75%-95% gross margin is the industry norm for investment viability[13]. The sensor technology's low Cost-of-Goods-Sold and unique characteristics make it an ideal fit for this Device-as-a-Service model.

The annual cost per automated system is already in line with the $8,000 to $25,000+ spent per year by beta-site customers on individual sensor apparatus (Automated Dissolved Oxygen or Oxygen Reduction Potential monitoring systems on a single process stage), and considerably less expensive than more complex systems available for upwards of $80,000 in instrumentation costs alone. It is assumed each wastewater treatment plant will utilize an average of 2.5 systems from facilities as small as <10,000 population town aeration ditches (1 system) to 6+ million gallon per day treatment plants (anywhere from 3-10+ systems on a single site). A 15% annual churn rate is modeled in year 3 onward to conservatively model lost customer subscriptions. This appears to be significantly higher than the instrumentation data acquisition and automated instrumentation churn rate as customer lifetime is typically 3-5 years at minimum in this industry.

Cost Assumptions

Each Sensor System is comprised of a $350 custom Microbial Signal Processor board, a 4G communications board, and 3 individual microbial sensor anodes and microbial reference cathode manufactured in-house using a combination off-the-shelf parts and custom integrated circuit systems. Currently each system includes $300 of solar cell and backup batteries for a total part cost of approximately $650. Additionally, 10 person-hours at a $40 per hour rate is assumed in labor costs of $400 per unit. Approximately $45/month per customer estimated Cloud Platform Hosting Cost and 4G Cellular Data Service Costs. This is based on Amazon Cloud Hosting Costs per month and data usage estimations using beta-site deployed system usage for estimation. 4G Cellular Data Service is under $5 per system due low bandwidth and data needs (less than kilobyte every 30 minutes per system). Currently hosting data from 11 systems costs almost $65 per month in Cloud System and Cellular System costs, or less then $6 per month per system or $15 per month per average customer (1/3rd the modelled figure). While these costs are anticipated to go down significantly, for estimating purposes no economies of scale are assumed for manufacturing.

Sales Cost Assumptions

A 12% sales commission and extensive technical sales force are anticipated to be required to scale this business. The sales teams will be made up of both technical and semi-technical individuals due to the nature of the product and market. This substantial commission rate is used to target an average annual compensation for sales associates of approximately $140,000 with an additional $43,000 of marketing budget per sales associate by year 5. Each full-time sales associate is projected to manage approximately 1 new customer per month on average due to the technical nature of the sale and to maintain conservative estimation.

[13] https://www.lightercapital.com/blog/calculating-gross-margin-for-your-saas-business/

Pro Forma Income Statement

Burge Environmental, Inc.
2018 to 2022

Total Addressable Market (U.S. Only)	Phase IIB (2018)	Phase IIB (2019)	2020	2021	2022
Serviceable addressable Market (U.S. Only)	$ 32,941,465,530	$ 35,443,572,126	$ 38,143,742,364	$ 41,058,488,817	$ 44,205,806,069
1 Water Treatment Equipment (5.9% CAGR)	$ 10,378,200,000	$ 10,990,513,800	$ 11,638,954,114	$ 12,325,652,407	$ 13,052,865,899
2 Life Science Instrumentation Market (8.5% CAGR)	$ 20,181,000,000	$ 21,896,385,000	$ 23,757,577,725	$ 25,776,971,832	$ 27,968,014,437
3 Precision Agriculture Market - VRT (6% CAGR)	$ 2,120,000,000	$ 2,247,200,000	$ 2,382,032,000	$ 2,524,953,920	$ 2,676,451,155
4 Bioreactor Market (18% CAGR)	$ 262,265,530	$ 309,473,326	$ 365,178,524	$ 430,910,659	$ 508,474,577
Target Market Niche					
Estimated Wastewater Industry Equipment and Instrumentation (Markets 1 and 2 only)	$ 850,000,000	$ 914,600,000	$ 984,109,600	$ 1,058,901,930	$ 1,139,378,476
Rate Market growth (Weighted Average)	7.60%	7.60%	7.60%	7.60%	7.60%
Production Revenue (Sales - Device as a Service Subscription)					
Cumulative Subscriptions (Customers)	3.0	6.4	24.0	77.6	250.3
Churt Rate (After 2 Years)	NA	NA	15%	15%	15%
$ Average Revenue per Subscription (Monthly)	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500
New product Subscriptions	3.0	3.4	21.6	59.6	202.4
Total Production sales (Revenue)	$90,000	$191,000	$721,250	$2,327,212	$7,509,013
% of Total Addressable Market (U.S. Only)	0.000273%	0.000539%	0.001891%	0.005668%	0.016986%
% of Target Market Niche	0.010588%	0.020883%	0.073290%	0.219776%	0.659045%
SBIR/STTR Contract R&D	$ 497,086	$ 496,592			
Total revenue	$ 587,086	$ 687,592	$ 721,250	$ 2,327,212	$ 7,509,013
Cost of Goods Sold (COGS)					
Material	$ 4,875	$ 5,471	$ 35,149	$ 96,769	$ 328,878
Manufacturing	$ 3,000	$ 3,367	$ 21,630	$ 59,550	$ 202,387
Cloud Platform Operating Costs	$ 1,620	$ 3,438	$ 12,983	$ 41,890	$ 135,162
Sales Commissions	$ 10,800	$ 22,920	$ 86,550	$ 279,265	$ 901,082
Total COGS new product	$20,295	$35,196	$156,311	$477,474	$1,567,508
COGS Material (per unit)	$ 650	$ 650	$ 650	$ 650	$ 650
COGS Manufacturing (per unit)	$ 400	$ 400	$ 400	$ 400	$ 400
COGS Monthly Cloud Hosting (per Customer)	$ 45	$ 45	$ 45	$ 45	$ 45
Direct SBIR/STTR Contract Expenses	$ 510,402	$ 482,876			
Total COGS	$ 531,097	$ 518,472	$ 156,711	$ 477,874	$ 1,567,908
Gross Margin					
Total GM$	$ 55,989	$ 169,121	$ 564,539	$ 1,849,338	$ 5,941,105
Total Gross Margin %	10%	25%	78%	79%	79%
Operating Expenses					
Sales		$ 140,000	$ 225,000	$ 600,000	$ 1,340,000
Marketing		$ 10,000	$ 150,000	$ 250,000	$ 700,000
Administrative (G&A)	$ 25,000	$ 25,000	$ 110,000	$ 450,000	$ 900,000
Legal & Accounting	$ 12,000	$ 12,000	$ 35,000	$ 270,000	$ 400,000
Facilities			$ 40,000	$ 80,000	$ 140,000
Total Selling General and Administrative	$37,000	$187,000	$560,000	$1,650,000	$3,480,000
Internal R&D			$ -	$ 150,000	$ 1,000,000
Total Operating Expenses	$ 37,000	$ 187,000	$ 560,000	$ 1,800,000	$ 4,480,000
Operating Profit (EBIT)	$ 18,989	$ (17,879)	$ 4,539	$ 49,338	$ 1,461,105
EBIT Margin %	3.2%	-2.6%	0.6%	2.1%	19.5%
Income before tax (EBT)	$ 18,989	$ (17,879)	$ 4,539	$ 49,338	$ 1,461,105
Tax rate	28.0%	28.0%	28.0%	28.0%	28.0%
Taxes	$5,311	$0	$1,269	$13,799	$408,642
Net income	$ 13,678	$ (17,879)	$ 3,269	$ 35,539	$ 1,052,463
Net income as %/sales	2.3%	-2.6%	0.5%	1.5%	14.0%
Year-End Cash	$ 18,989	$ 1,110	$ 5,648	$ 54,987	$ 1,516,092

Figure 7 – DOE SBIR 5 Year Pro Forma Income Statement