BECC Work Plan, EPA Border 2020 Proposal, RFP SOLTA-C-17-003

Project Sponsor Name: University of California, San Diego

I. Title of Project

Evaluating the 2017 Tijuana River Estuary cross-border wastewater spill sources and coastal impacts

II. Background/Identified Problem

Per square km, the coastline is by far the most economically and ecologically important region of the ocean. Over 500 million annual person-visits by boaters, surfers, and bathers, provide approximately $27 billion economic benefit within the state of California alone. Yet, this region is often impacted by poor water quality. The incidences of US beach closures have significantly increased in the last decade. The San Diego South Bay - Tijuana region specifically is home to California State Parks, a Marine Protected Area, a NOAA National Estuarine Research Reserve, a US National Monument, the iconic Hotel del Coronado, Navy installations, a port, a vibrant border community, and important recreational beaches on both sides of the border. Overall, this coastline is a valuable economic engine for the region due to tourism, boating, shipping, and military. The City of Imperial Beach has over 3 million beach visitors a year, and Silver Strand and Border Field State Parks have 400,000 annual visitors a year. This region can be impacted by poor water quality from pathogen contamination to harmful algal blooms (HABs), often resulting from wastewater disposal in Mexico. The health of this coastal region is of significant concern to local residents, governments, and NGOs (such as Projecto Fronterizo de Educación Ambiental and WiLDCOAST) on both sides of the border. Improved regional prediction capability is desired to provide accurate and timely warning to residents, beach-goers, and surfers; reduce costly beach closures when unnecessary; and help experts on both sides of the border reach long-term binational solutions.

In February 2017, a cross-border wastewater spill contaminated waters in the Tijuana River Estuary and adjacent coastline, closing beaches from Rosarito MX to Coronado CA and emitting strong odors. Conflicting media reports led to confusion regarding the spill magnitude and duration. An investigative report (located at this link) by the International Boundary and Water Commission (IBWC) reported initial information provided by CESPT (Comisión Estatal de Servicios Publicos de Tijuana) that a 4 day (1-4 Feb 2017) of a of wastewater collector line 28 MG (millions of gallons) of wastewater was bypassed into the Tijuana and Alamar Rivers. However, forensic reconstruction of flow records from South Bay International Wastewater Treatment Plant, bacterial data from IBWC, and data from CESPT indicate that the bypassed wastewater volume was around 256 MG during January and Febuary 2017 – although it was acknowledged that the exact volume was difficult to determine. This event spurred a series of recommendations to reduce future contamination events and improve notification when events do occur. This event is just one example of many past and ongoing events that have compromised the water quality in the Tijuana River (TJR) and the adjacent coastlines of Playas Tijuana, Imperial Beach, and Coronado. However, we do not know how severe the impact of this event was or the total wastewater volume released. Here, we will build upon our National Science Foundation (NSF) funded efforts in developing modeling capability by expanding the capability to include the Tijuana River Estuary in the model. We will then simulate the 2017 cross-border wastewater spill in the TJR Estuary and adjacent coastal ocean along the US/Mexico border region using realistic atmospheric, tidal, wave, and oceanic forcing. This will allow us to test the spill

source(s), quantity, and duration; and importantly help outline the spatial region of impact along the coastline in both Mexico and the US. These hindcast simulations will be disseminated through the SCCOOS (Southern California Coastal Ocean Observing System, http://sccoos.org) website.

Figure 1. Tijuana and coastal plume images a & b) The left and middle images demonstrate how a plume travels up the coastline between the surfzone (where waves break) and the inner-shelf (the shallow-region beyond the surfzone). The plume is visualized via a passive pink dye tracer. c) The far right image shows a plume emanating from the Tijuana River.

Past Modeling Efforts: As part of the NSF funded CSIDE (Cross Surfzone / Inner- shelf Dye Exchange) project, we have been conducting research to improve our fundamental understanding of the physical processes governing the exchange of tracers from the surfzone, through the inner-shelf, and along the coastline. This work includes dye tracer experiments (see Figure 1) and development of numerical simulations that couple wave and ocean circulation models for the San Diego/Tijuana (SDTJ) region from Pt. Loma to the southern end of Playas Tijuana and extending offshore to 120 feet (about 35 m) depth (denoted the 2014 model). This model couples wind forcing, offshore currents, temperature and salinity, and wave predictions from CDIP. The 2014 model was developed to design our 2015 CSIDE dye release experiments. An example of a simulated 30-gallon, 2-hour long dye release from Playas Tijuana in August 2014 is shown in Figure 2. The wave field was moderate south swell with weak winds. In 27 hours, dye makes it northwards past Silver Strand State Park, clearly demonstrating the cross-border connectivity of the US and MX coastal regions. One critical piece that was not included in our 2014 model was the Tijuana River Estuary, which is a critical component to the ecology and water quality in the SDTJ region. Furthermore, the 2014 model does not extend sufficiently south of the US/Mexico border to include Punta Bandera and the San Antonio de los Buenos outfall. The experience developing the 2014 model will be significantly leveraged to develop the 2017 model as many 2014 model components can be reused or modified. We do not have to start from scratch.

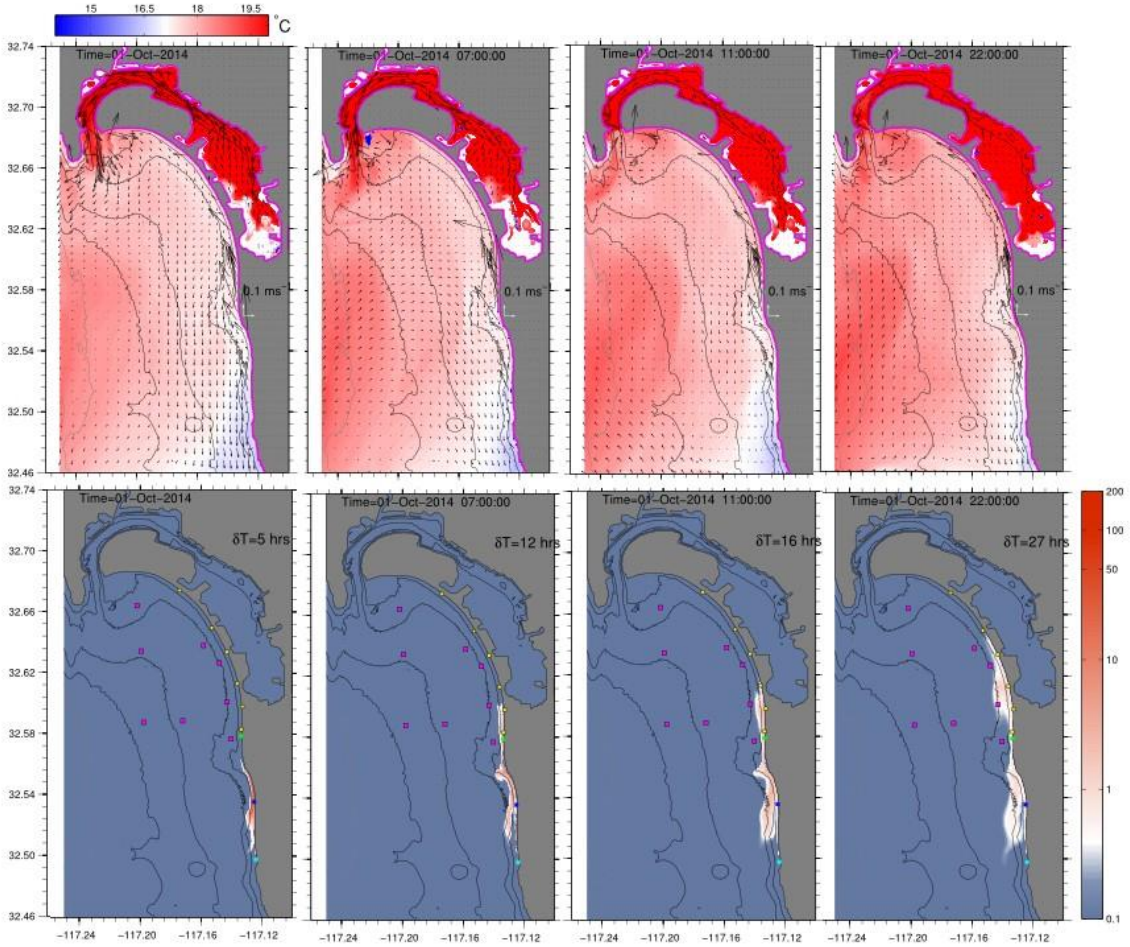


Figure 2: Snapshots of SDTJ model simulated (top) temperature and currents and (bottom) surface dye in ppb at times (left to right) 5 h, 12 h, 16h, and 27 h after the 2-h long, 30-gallon dye release at the Southern end of Playas Tijuana (cyan dot).

III. Objectives

Proposed Work: As part of this Border 2020 project, we will build a new model (the 2017 model) that will include the TJR estuary and potential pollution sources from the TJR River and the cross-border Canyons as shown in Figure 3. The 2017 model region will also extend farther south and include Punta Bandera and the San Antonio de los Buenos outfall. We will then simulate the 2017 wastewater spill event using both the official reported 28 MG and the unofficial estimated 250 MG by simulating 3 months of 2017 from January through March. During this time period, the model will be driven by the realistic meteorological (wind, precipitation), CDIP modeled waves, and offshore (>10 km) modeled oceanographic conditions. The IBWC flow gauge will be used to constrain the water crossing the border in the river. We will then simulate different sewage spill levels from 25 to 250 MG, by fluxing "model sewage" into the estuary over different time periods corresponding to the official stated and estimated duration of spill. We will then analyze the extent of the impacts on both sides of the border and infer the likely true wastewater spill volume. We will develop a web interface, hosted and maintained by SCCOOS, that will distribute the modeling results as graphs, maps, and animations highlighting the spatial & temporal extent of the wastewater spill and the total region impacted. This web interface will be analogous to the existing HF radar based plume tracker at SCCOOS. The website

will be public. In addition, model codes and grids will be made available for stakeholders wishing to do their own simulations. Specific objectives include:

- Finalize model development
- Test model against in-situ observations
- Simulate Winter (Jan-March) 2017 conditions
- Simulate the 2017 wastewater spill event using various discharge quantities
- Create a web interface through SCCOOS
- Present results to stakeholders such as City of Imperial Beach, State Parks, TJNERR, International Boundary Water Commission, Tijuana River Action Network, WiLDCOAST, Projecto Fronterizo de Educación Ambiental. Many of these stakeholders have seen preliminary modeling results and are excited for the 2017 model.

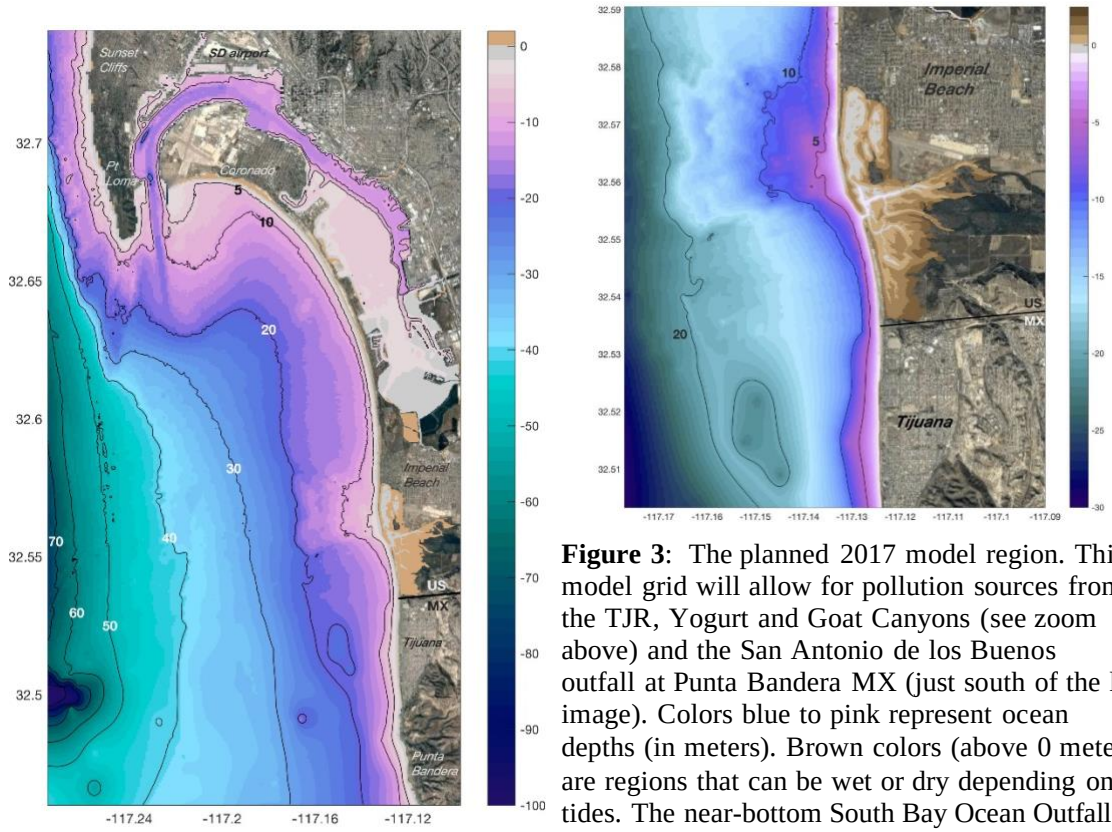


Figure 3: The planned 2017 model region. This model grid will allow for pollution sources from the TJR, Yogurt and Goat Canyons (see zoom above) and the San Antonio de los Buenos outfall at Punta Bandera MX (just south of the left image). Colors blue to pink represent ocean depths (in meters). Brown colors (above 0 meters) are regions that can be wet or dry depending on tides. The near-bottom South Bay Ocean Outfall (SBOO) source can also be included but is not part of this workplan.

This proposal addresses the BECC Priority Area: Produce quantifiable reduction in bacteria, sediment, and/or trash flow into the Tijuana River and New River. The project will accomplish these improvements in water quality along the US/Mexico border coastline through development of improved management tools, physical understanding, and education of affected communities. Although the model cannot change water quality directly, the model will demonstrate the glaring issue and provide an impetus to safeguard water quality. In the future, the model can also be used to help lifeguards in the City of Imperial Beach, Silver Strand State Park, City of Coronado, and Playas Tijuana in making decisions on when to close beaches. Illnesses derived from contact with contaminated water are a significant public health hazard and a drain on the economy. Over 3 million people visit the beaches of this region every year and thus can be impacted by our results and modeling tool.

The Scripps Institution of Oceanography PIs, Feddersen and Giddings, have expertise in estuarine, surfzone, and near-shore physical oceanography observations and modeling. They have collected extensive observations in the region through their CSIDE (Cross Surfzone / Inner-shelf Dye Exchange) experiment. The CSDIE project was funded by the National Science Foundation at a 3-year cost of $997,902 to study the fluid dynamics mechanisms by which pollutants disperse and dilute in the nearshore region. This NSF project also funded the development of the 2014 model (Fig. 2). This BECC project will thus significantly leverage off of exisiting federal funding by applying the knowledge gained from the CSIDE project. Thus the PIs are well poised to achieve the objectives of this project through leveraging the 2014 model to develop the 2017 model, and then using the model to address the objectives. The results will be hosted by SCCOOS who has been providing real-time observations and models output through their website since 2005.

IV. Tasks/Activities of Work Plan

Project Timeline: All work will be performed at Scripps Institution of Oceanography at the University of California San Diego and lead by the PIs. The "SCCOOS Web Interface Tasks" will be performed by a SCCOOS/SIO programmer under PI direction. The project is expected to take 18 months to complete starting 1 December 2017, completing by 1 June 2019 with a timeline as follows (and summarized below in the Gantt Chart in section VI).

Model Development

- Dec 2017-Feb 2018: Finalize the model grid for the San Diego / Tijuana Border region including the Tijuana River Estuary, San Diego Bay, and the San Antonio de los Buenos outfall 10 km south of the border in Mexico
- Feb-Apr 2018: Finalize model forcing fields (winds, precipitation, waves, solar heating, etc.) for the 2015 test period
- Apr-Aug 2018: Run the 2015 simulation on the UCSD Triton Cluster Supercomputer

Model Validation

- Apr-Jun 2018: Compare model tides to NOAA and TJNERR tide gauges
- May-Aug 2018: Compare model waves and currents to CSIDE, SBOO, and City of San Diego (Tim Stebbins) existing observations
- May-Sep 2018: Quantify model skill

Winter 2017 Simulation:

- Jun-Aug 2018: Develop winter (Jan-Mar 2017) model forcing fields
- Jul-Sep 2018: Run winter 2017 simulations
- Jul-Nov 2018: Validate winter 2017 simulation with tide, TJNERR, SBOO, City of San Diego, and other observations
- Sep 2018-Feb 2019: Detailed simulation of the 2017 wastewater spill event spanning 28MG to 250MG total wastewater release.

SCCOOS Web Interface Development

- Sep 2018-Feb 2019: create and test SCCOOS web interface for visualizing the extent of the modeled wastewater plume
- Dec 2018: host model output from the 2017 simulations, web interface becomes public

- Feb 2019: post final products of the 2017 simulation

Stakeholders Engagement

- Dec 2017-Mar 2018: reach out to stakeholders including the EPA, TJNERR, City of Imperial Beach, City of Coronado, the Regional Water Quality Control Board, International Boundary Water Commission, Proyecto Fronterizo de Educación Ambiental, City of San Diego, and other governmental and non-governmental organizations about our work and include any inputs they may have.
- Through 2018: provide quarterly updates to stakeholders on progress
- Sep-Oct 2018: provide updates to stakeholders on progress and ask for additional input at that stage (after 2015 simulations are complete)
- Jan-Mar 2019: Prepare reports and presentations
- Feb-May 2019: Outreach to stakeholders through presentation of results and follow-up discussions

V. Measurable Results (outputs and outcomes)

Project Outputs include:

1. Hindcast simulations of the 2017 wastewater spill event testing the point source location(s) and duration. This will include cross-border flows entering the TJR Estuary but also include estimated inputs at the San Antonio de los Buenos outfall within Mexico
2. Maps of likely extent of impact derived from the hindcast simulations of wastewater concentration. No bacterial decay will be included in this version of the model, these maps will be based on mixing and dilution of a model dye field
3. These outputs will be delivered via a SCCOOS real-time web interface
4. Presentations and reports to the Border 2020 Task Force, regional water quality control board, the IBWC, the EPA, and other stakeholders on both sides of the border such as City of Imperial Beach, State Parks, TJNERR, International Boundary Water Commision, Tijuana River Action Network, WiLDCOAST, Projecto Fronterizo de Educación Ambiental.

Project outcomes include:

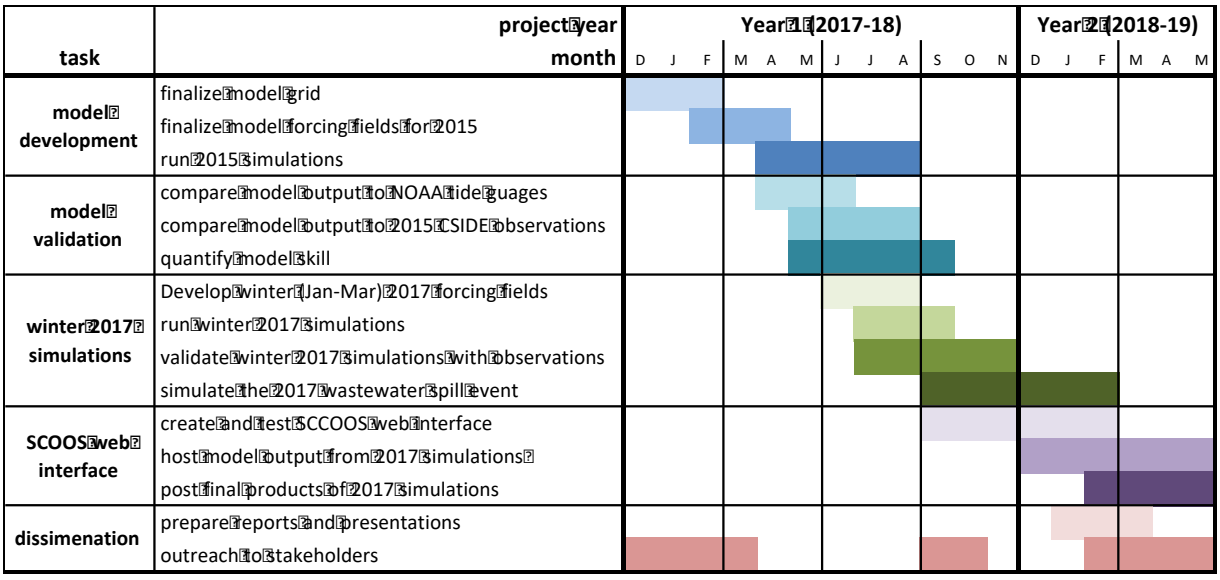
1. Better understanding of the 2017 spill event, including its magnitude, and extent of influence.
2. Improved prediction capability of wastewater spill events in the region leading to deeper understanding of the extent and impacts of these events on both sides of the border. The long-term goal (beyond the scope of this project period) is to turn this model development into a real-time predictive system for the region with results distributed through SCCOOS. All the required inputs exist to allow for such development, including forecasts of meteorlogical and wave forcings (discussed in the QA/QC section). The NSF-funded CSIDE project and this project can be significantly leveraged in development of a real-time forecast system. No enhancements to the underlying software are required. However, new software must be developed to automate the acquisition and formatting of the model forcing fields. Additional ongoing maintenance costs for the web site, disk space, supercomputer time to do the real-time simulations would be required.
3. Improved management tools. The work proposed here will develop a tool (the 2017 model) which can be used by managers to study historical spill impacts. In addition, the existence of this 2017 model will allow for future meta-analysis of varying

wind/wave/oceanographic conditions to be tested, quantified, and summarized as to their impact on plume spreading to allow for rapid response management to particular situations.

This hindcast will be a critical test case of our regional modeling system and its applicability for historical and future water quality investigations. For example, the model predictions can be tested against satellite plume observations or historical shoreline fecal indicator bacteria data. As mentioned above, we plan to continue to seek funds to maintain this modeling tool, continually improve it, and maintain its presence as a SCCOOS web interface. Long term we plan to transform this into a predictive modeling system for the region, which should provide improved management/ predictive tools over those currently available due to the incorporation of critical physical processes within the estuary and the surfzone. This will benefit both the public and environment in the US and Mexico as it will improve water quality along the US/Mexico border coastline via improved management tools, education of the affected communities, and provide an impetus for improving infrastructure to safeguard water quality.

VI. Gantt Schedule

Details regarding the objectives, sub-tasks, and timeline are outlined below in the Gantt Chart timeline (and described in further detail in section IV above). The bulk of the tasks will be completed by SIO PIs and postdoctoral researcher. Note that the "SCCOOS web interface" tasks will be completed by SCCOOS programmer, under SIO PI direction. Quarterly reporting periods are indicated with vertical lines.



VII. Quality Assurance/Quality Control (QA/QC) as applicable

The 2017 model will be implemented with standard open-source codes such as the Regional Ocean Modeling System (ROMS – http://myroms.org) and the wave model Simulating Waves in the Nearshore (SWAN - http://swanmodel.sourceforge.net/). The bathymetry and topography for the region will utilize 1/3 arc second digital elevation model developed by NOAA for Tsunami hazard evaluation (https://www.ngdc.noaa.gov/dem/squareCellGrid/download/3542). The input wind and

atmospheric forcing fields will be derived from NOAA North American Model (NAM - https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/north-american-mesoscale-forecast-system-nam) analysis fields. These analysis products will be tested against local winds and precipitation measured locally at the TJNERR. The wave boundary conditions will be provided by the CDIP MOP version 2.0 – see https://cdip.ucsd.edu/?nav=documents&sub=faq&xitem=models which are highly accurate for this region of Southern California. Offshore current, temperature, and salinity model boundary conditions will be obtained from larger-scale data-assimilated solutions for the Southern California Bight and the California Current provided by Bruce Cornuelle of Scripps Institution of Oceanography. Model wastewater inputs into the TJRE and at Punta Bandera will be derived from the best information available. It is estimated that 20-24 millions of gallons per day of wastewater are released at Punta Bandera with some limited chlorination. The IBWC maintains a flow gauge into the Tijuana River (https://www.ibwc.gov/wad/013300_a.txt) providing flow rates into the estuary although this is not all wastewater. Statistically combining flow gauge with precipitation data can give forensic insight into additional wastewater released during the Jan-March 2017 time period.

We will utilize the April 2017 IBWC "Report of Transboundary Bypass Flows into the Tijuana River" (and any subsequent reports) to set wastewater release amounts. CESPT has stated that 28 million gallons of wastewater were released over 4 days (1-4 Feb) at a rate of 300 Lps. However, flow records, IBWC data, and CESPT data indicate that about 256 MG of wastewater was released into the estuary during Jan-Feb 2017. We will simulate both of these scenarios using the IBWC flow rate gauge to quantify temporal variations in the wastewater release together with the statistical relationship with rainfall.

Model validity will be addressed through model validation using existing observations (see section IV) and standard quantification of model skill relative to observations using published metrics including correlation coefficients, Willmott Skill Scores [e.g., *Willmott, Bulletin American Meterological Society*,1982], and the standard Skill Score [*Murphy, Monthly Weather Review*,1988].

VIII. Staff and Sub-consultant Capabilities

The PIs (Feddersen and Giddings) are faculty at Scripps Institution of Oceanography and world-recognized experts in coastal ocean and estuary modeling. SCCOOS has been providing real-time observations and models output through their website since 2005.

The PIs will be hiring a qualified postdoctoral scholar to help with model development. The UCSD Triton cluster supercomputer is a world-class resource for performing numerical simulations of the coastal ocean.

IX. Cost Breakdown Budget

This proposal requests $87,556 that is broken down in the following categories (see budget table on the following page):

Salaries: $47,170 is requested in salaries for five months of postdoctoral researcher (create the 2017 model grids, forcings, and run simulations), one month of SCCOOS programmer (Darren Wright - develop web interface), 0.5 months summer salary of Prof. Giddings and 0.1 month summer salary for Prof. Feddersen. Salaries are for productive time only and include

employee benefits. Prof. Giddings and Feddersen will contribute additional time to the project utilizing their 9-month faculty appointment.

Equipment: $5000 is requested to purchase a 24 CPU node at the UCSD Triton Shared Computing Cluster. This item is essential to performing the proposed numerical simulations, and is the most cost effective solution.

Material and Supplies: $6092 is requested in supplies to purchase 15 TB of disk drive space to archive the model results and serve the results through the SCCOOS web site.

Indirect Costs: $29,294: The University of California San Diego indirect cost rate of 55% MTDC is applied to all costs requested except for equipment. The current federally negotiated F&A Rate Agreement is dated May 12, 2010. Cognizant agency is DHHS.

Categories	Number Item(s)	Cost Each	Total BECC/EPA Funds	Leverage Amount	TOTAL
Salary and Benefits (# months)					
Feddersen, Falk	0.1	$ 19,460.00	$ 1,946.00	$ 28,369.40	$ 30,315.40
Giddings, Sarah	0.5	$ 11,312.00	$ 5,656.00	$ 11,023.74	$ 16,679.74
Wright, Darren	1	$ 13,788.00	$ 13,788.00		$ 13,788.00
TBD Postdoctoral Scholar	5	$ 5,156.00	$ 25,780.00		
Supplies				$ -	$ -
10 TB disk space	1 ea.	$ 4,600.00	$ 4,600.00		$ 4,600.00
Equipment				$ -	$ -
24 CPU node at the UCSD Triton Shared Computing Cluster	1 ea	$ 5,000.00	$ 5,000.00	$ -	$ 5,000.00
Other					
Project Specific Supplies	includes phone, fax, postage, etc.	$ 1,492.00	$ 1,492.00	$ 276.00	$ 1,768.00
Subtotal			$ 58,262.00	$ 39,669.14	$ 72,151.14
Indirect Cost					
55% Indirect Charges			$ 29,294.10	$ 21,818.03	$ 51,112.13
TOTAL			$ 87,556.10	$ 61,487.17	$ 123,263.27

With respect to the following comment:
1) While not a requirement, please consider lowering your indirect rate to make more funds available for the project.

The indirect cost reimbursement the University receives for this project will cover research expenses incurred by the University that allow this project to take place. While it may appear that lowering the indirect cost rate will make more funds available for a single project, in the long run, reducing the contribution to the cost of supporting the infrastructure and environment necessary to keep labs running negatively impacts the ability of the university to perform research on behalf of federal agencies.

The federally negotiated rate establishes a reasonable level of recovery of the indirect costs the University incurs in conducting extramural projects. As a public institution of the State, the University has a responsibility to cover the expenses it incurs in undertaking sponsored research projects.

A further point, the University of California San Diego has not had an increase in its indirect cost recovery rate in five years. During this time though, the cost of conducting federally-sponsored research has gone up.

X. Reporting Schedule to BECC/EPA

Quarterly progress reports in electronic format will be submitted to the BECC and EPA within 25 days after the end of each quarter. Final report to be presented 30 days after project completion to the BECC in electronic file with required backup documents included. In the quarterly reports, the accomplishments relative to the objectives will be detailed, the outputs and outcomes will be quantified, reasons for any deviation from the work plan will be established, and any additional pertinent information will be provided, including explanation of cost overruns or high unit costs.