Impact of Produced Water Discharges on the Hypoxic Zone

Argonne's Environmental Science Division (EVS) planned and conducted a study of produced water discharges from 50 offshore oil and gas platforms located in the hypoxic zone of the Gulf of Mexico. The study was required by a 2004 permit issued by the U.S. Environmental Protection Agency (EPA). It involved coordination among numerous companies, three federal agencies, and other interested parties.

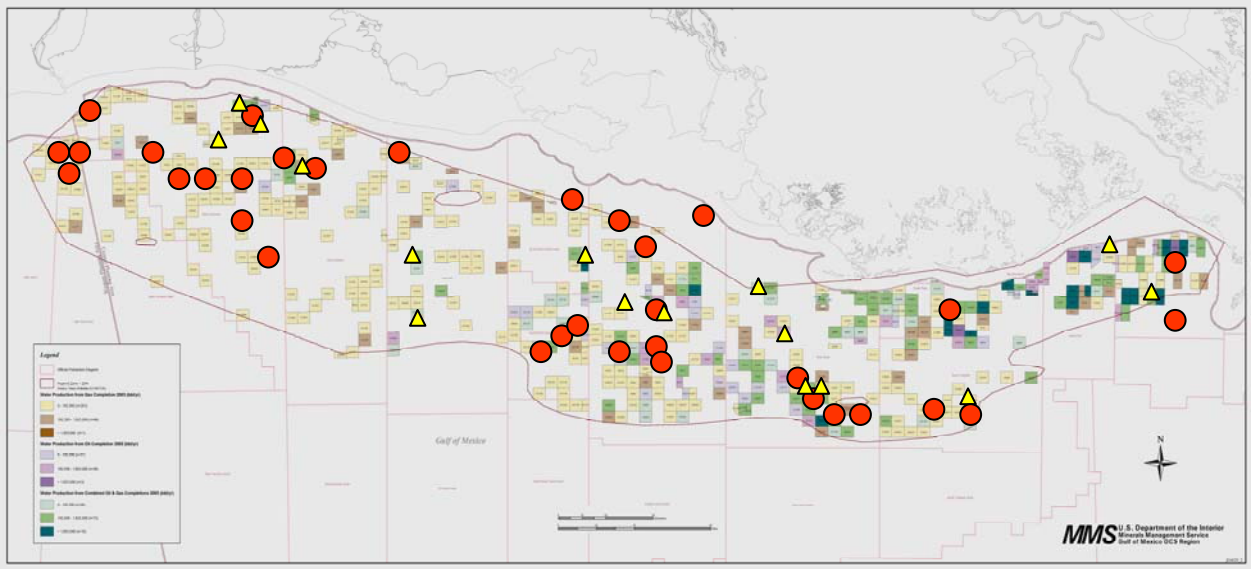
PROBLEM/OPPORTUNITY

Shallow water areas of the northern Gulf of Mexico continental shelf off the coast of Louisiana experience low dissolved oxygen (hypoxia) each summer. This hypoxic zone is thought to be primarily caused by input of nutrients from the Mississippi and Atchafalaya Rivers. The nutrients stimulate the growth of phytoplankton, which leads to depletion of most of the oxygen in water near the sea floor. During the renewal of an offshore discharge permit used by the oil and gas industry in the Gulf of Mexico, the EPA identified a need to study discharges of produced water from oil and gas facilities in or near the hypoxic zone in order to evaluate the oxygen demand resulting from the discharges. The final EPA permit (November 2004) required either all platforms in the hypoxic zone to submit samples or the industry to conduct a joint study. The U.S. Department of Energy (DOE) asked Argonne to design the study.

APPROACH

EVS developed a sampling plan that was approved by the EPA, DOE, Minerals Management Service (MMS), the American Petroleum Institute (API), the Offshore Operators Committee, and individual oil and gas companies. Sampling began in January 2005. Sixteen platforms were sampled three times each at approximately one-month intervals to give an estimate of temporal variability; an additional 34 platforms were sampled one time. The 50 sampled platforms were scattered throughout the hypoxic zone to give an estimate of spatial variability.

Each platform was sampled for discharges of biochemical oxygen demand , total organic carbon, nitrogen (ammonia, nitrate, nitrite, and total Kjeldahl nitrogen [TKN]), and phosphorus (total phosphorus and orthophosphate). In addition to these parameters, each



Platforms sampled one time and selected at random.

Platforms sampled three times and selected based on discharge volume and type of hydrocarbon produced.

sample was monitored for pH, conductivity, salinity, and temperature. Samples were collected by platform personnel and placed in coolers. The coolers were then transported by helicopter or boat to company shore bases, where they were later collected by couriers and driven to a laboratory in the New Orleans area for testing. The sampling program incorporated comprehensive field and laboratory QA/QC measures.

RESULTS

The final Argonne report, which includes the most comprehensive set of data ever developed on the oxygen-demanding properties of offshore produced water, was provided to EPA in August 2005, to comply with permit deadlines. The data show that the offshore oil and gas contribution to the hypoxic zone is minimal when compared to the riverine inputs. This information is important in that it provides the first accurate quantification of the contribution to the hypoxic zone by offshore oil and gas discharges.

EPA engaged several expert water quality modelers to use the data collected by EVS as inputs to their models, which are used by EPA in setting limits in discharge permits for the offshore platforms. In May 2006, the modelers submitted their findings, which mirrored the findings of the EVS sampling study – the produced water discharges have a very small effect on the hypoxic zone when compared to other inputs, particularly the river contributions. The subsequent draft National Pollutant Discharge Elimination System discharge permit for offshore Gulf of Mexico released by the EPA indicated that EPA was convinced that the produced water discharges were not making a significant contribution to the hypoxic zone and noted that no additional permit actions would be required at this time.

COMMUNICATION OF RESULTS

EVS published its report in August 2005 and has presented papers at several U.S. and international conferences since then. The report has received wide distribution and is available on the EVS website.

Nutrient	Mean Flux (lb/yr) from Mississippi and Atchafalaya Rivers[a]	Estimated Annual Mass Loading (lb/yr) from Produced Water Discharges to the Hypoxic Zone	Ratio of Produced Water Loading to Riverine Loading
Ammonia	68,355,000	5,030,000	[b]
Organic Nitrogen	1,278,900,000	389,000 (calculated as TKN – ammonia)	[b]
Nitrate	2,100,000,000	71,900	[b]
Nitrite	0	3,285	[b]
Total Nitrogen	3,460,000,000	5,500,000	0.00159
Orthophosphate	92,100,000	23,700	[b]
Particulate phosphate	209,000,000	0	[b]
Total Phosphorous	301,000,000	39,800	0.00013

[a] Goolsby et al. 1999

[b] The key ratios are total nitrogen and total phosphorus. Ratios for the other component comparisons are not shown.