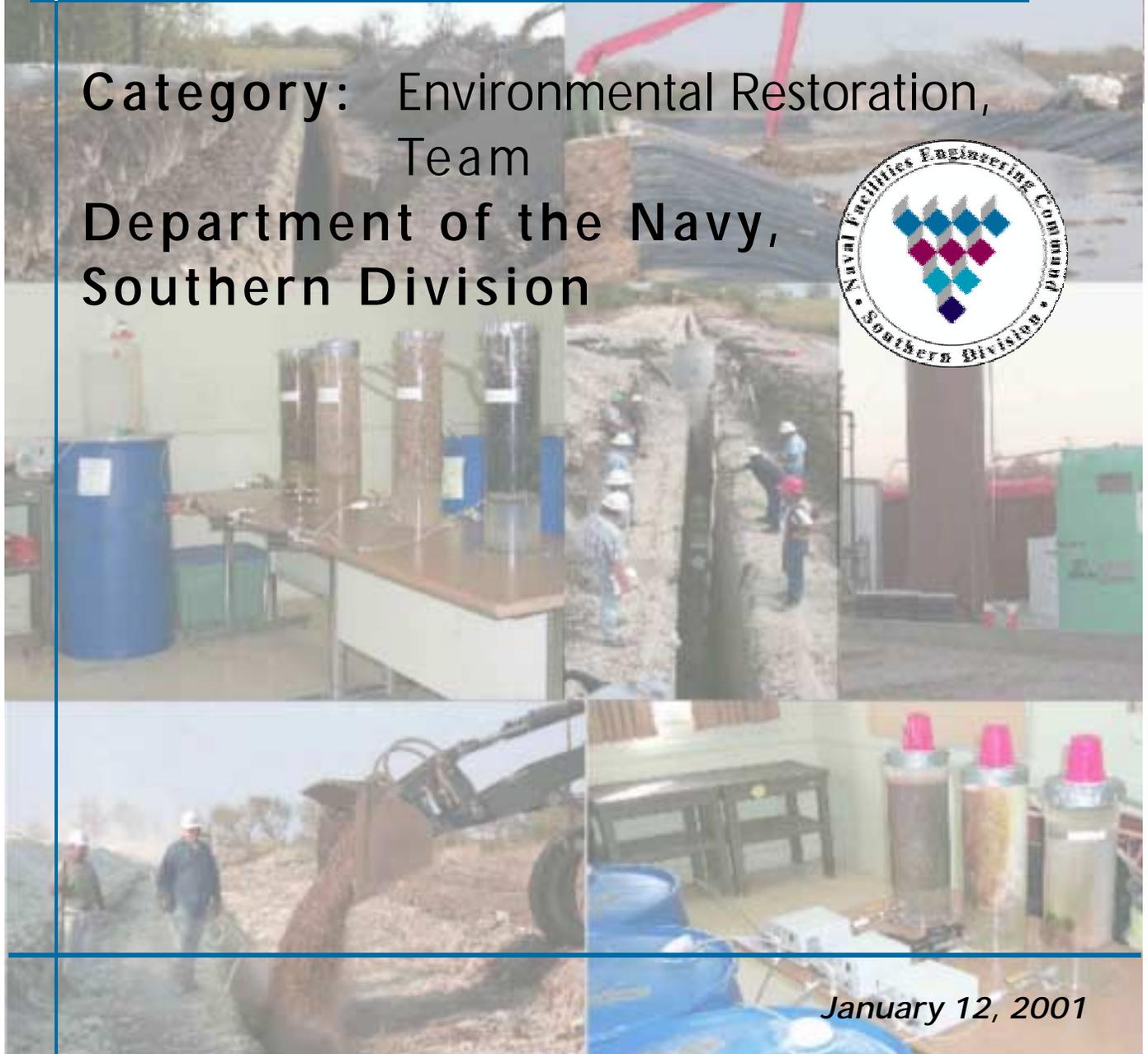


Remediation of Perchlorate Contamination in Soil and Groundwater

NWIRP McGregor, Texas

Category: Environmental Restoration,
Team
Department of the Navy,
Southern Division



January 12, 2001

Environmental Restoration

Team

1.0 INTRODUCTION

The Naval Weapons Industrial Reserve Plant (NWIRP) McGregor project team has achieved remarkable results while simultaneously coordinating a multitask perchlorate groundwater investigation for 9,600 acres onsite and 22,000 acres offsite. At the same time the team has transferred ownership of approximately 3,500 acres of the facility to the City of McGregor to satisfy U.S. Rep. Chet Edwards' 1996 special legislation. Due to the high visibility of this work at the national and congressional level, members of the team worked with senior military officials (including Elsie Munsell, Admirals Baucom, Brewer, and Grunuzzo); U.S. Rep. Chet Edwards and Senators Phil Gramm and Kay Bailey Hutchison while facilitating relationships between two System Commands and multiple Southern Division Naval Facilities Engineering Command (SOUTHDIV) departments.

Despite the tremendous challenges faced by the team, dramatic cost savings were achieved during 2000. This was made possible by the implementation of *in situ* bioremediation of contaminants at the facility. The use of *in situ* technologies, successfully demonstrated during simultaneous bench-scale studies, eliminated the need for currently existing *ex situ* units, alternate *ex situ* treatment technologies, and their associated permitting costs. This decision alone saved SOUTHDIV more than \$6.5 million of ER,N funding in FY-00, an amount roughly equivalent to 17% of the entire SOUTHDIV ER,N budget.

The McGregor project team was recognized and won the Grand Award from the Consulting Engineers of Tennessee in association with the American Consulting Engineers Council (ACEC) for the innovative and low-cost remediation of perchlorate contaminated groundwater through an *in situ* system.

Further, the Navy's project manager, Mr. Mark Craig, has received additional commendations for his work on the project. In recognition of his leadership, which has exceeded the normal expertise and requirements of his position, he received letters of commendation from the City of McGregor and the Naval Air Systems Command. In addition, he received Special Act awards, was selected as the Southern Division Environmental Restoration Employee of the Year for 1999, Southern Division Associate of the Year for 2000, and the Federal Employee of the Year for the Greater Charleston Area for 2000.

2.0 ENVIRONMENTAL BACKGROUND

NWIRP McGregor is a government-owned, contractor-operated facility in McGregor, Texas, approximately 20 miles southwest of Waco. The U.S. Army Ordnance Corps originally established it in 1942 as the Bluebonnet Ordnance Plant. Over the facility's 50-year history, owners included the U.S. Army, U.S. Air Force, and its current owner, the U.S. Navy's Naval Air Systems Command (NAVAIR). Industrial activities at the site included weapons and solid-fuel rocket propulsion systems manufacturing.

During its prime, NWIRP McGregor utilized 1,400 workers and was the largest employer in the area. Revenues from the facility supported the economies of many local communities, such as the cities of McGregor, Waco, Temple, Killeen, and Belton.

At the time of the facility's closure in 1995, the 625 people still employed at NWIRP McGregor were released. The closure created an economic hardship for the surrounding communities and, as a result, U.S. Rep. Chet Edwards sponsored special legislation to help turn the property over to the city of McGregor for economic redevelopment. Since 1999, 3,500 of 9,600 acres have been transferred to the City of McGregor. Because of the collaboration between the Navy, the City of McGregor, the USEPA, and the Texas Natural Resource Conservation Commission (TNRCC), the City of McGregor was given with the Community Economic Development Award sponsored by the Texas Department of Economic Development.

Prior to facility shutdown, a multi-phased Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) was initiated in 1992 at NWIRP McGregor targeting soil, surface water, and groundwater. The RFI responded to environmental issues raised in the RCRA Facility Assessment completed by the TNRCC.

In the normal course of the investigations, a suite of contaminants of concern was identified during the RFI. However, in March 1998, the TNRCC notified the Navy of USEPA documentation stating that NWIRP McGregor used, stored, and disposed of ammonium perchlorate (AP), which had become an environmental groundwater issue nationally. This revelation had the potential of slowing down the property transfer that was already in progress.

AP is an oxidizing agent used in solid-rocket propellant. Because AP is a salt, it dissolves rapidly in water, becomes mobile in groundwater, and persists for many decades under typical ground and surface water conditions. Perchlorate affects the thyroid hormone function by competitively inhibiting iodide anion uptake reducing thyroid hormone production.

In 1997, an American Water Works Association Research Foundation panel resolved there was no proven process for treating drinking water containing low perchlorate concentrations. That same year, when improved chemical analytical methods lowered perchlorate's detection limit from 400 to 4 micrograms per liter ($\mu\text{g/L}$), it was identified in many water supply systems, particularly in western states where rocket motors were manufactured. As a result, in March 1998, USEPA placed perchlorate on its Contaminant Candidate List for evaluation and potential regulation under the Safe Drinking Water Act. Various states, including Texas, established action levels for perchlorate in drinking water, ranging from 18 to 32 $\mu\text{g/L}$.

In August 1998, after reviewing all recent perchlorate sampling results, a comprehensive Groundwater Investigation (GWI) work plan was developed to unify all site groundwater investigations and continue them offsite. With increased precipitation from November 1998 to February 1999 (compared to the dry summer), groundwater monitoring wells were installed and sampled, and onsite and offsite surface water sampling continued. This investigation identified migration of perchlorate from onsite source areas at concentrations that exceeded Texas' drinking water standard of 22 $\mu\text{g/L}$.

In February 1999, the TNRCC requested that interim stabilization measures (ISMs) be implemented to abate offsite migration of perchlorate from NWIRP McGregor. The Navy responded in March to the TNRCC's request identifying source areas where interim corrective measures could be implemented immediately to remove, stabilize, or control perchlorate contamination. The TNRCC approved the response letter. In June 1999, an ISM evaluation plan was submitted to the TNRCC and the USEPA for review. The plan recognized that contaminated groundwater was exfiltrating to surface water at concentrations exceeding TNRCC action levels during the wet season. The groundwater subsequently contaminated the surface water (via natural springs and seeps) then flowed toward Lake Belton, a primary drinking water source in central Texas. TNRCC and USEPA quickly approved the recommendations contained in the ISM evaluation.

SOUTHDIV, along with its CLEAN II contractor, EnSafe Inc., and its design-build contractor, CH2M Hill, was tasked to manage the contaminant investigation, evaluate remedial alternatives, prepare a conceptual design, and oversee final design and construction as part of NWIRP McGregor's Environmental Restoration program.

3.0 AWARDS AND SERVICES

In addition to the aforementioned ACEC honor, the team developed and coordinated the Central Texas Perchlorate Conference held in Temple, Texas, in May 1999. The conference was designed to educate stakeholders, community leaders, and local and federal politicians on perchlorate issues and describe the environmental efforts that were being conducted at NWIRP McGregor as well as on a national level. In addition, the Interagency Perchlorate Steering Committee used this venue to conduct a community outreach program.

The local community is updated on NWIRP McGregor field and property transfer activities at quarterly Restoration Advisory Board (RAB) meetings. In addition, local stakeholders are provided detailed site activity information during a more comprehensive meeting. U.S. Rep. Chet Edwards, along with staffers from Senators Kay Bailey Hutchison and Phil Gramm, have routinely been updated on NWIRP McGregor's progress.

Publications and Presentations

During the last year, several papers and articles were published based on the achievements at NWIRP McGregor. The team was also invited to present in support of these papers at numerous conferences.

- *Bioremediation of Perchlorate-Contaminated Groundwater at Naval Weapons Reserve Plant McGregor, Texas*, National Defense Industrial Association Proceedings, 26th Environmental Symposium and Exhibition, Long Beach, California, March 27-30, 2000.
- *Enhancement and Optimization of Perchlorate Treatment in Soil and Groundwater*, Remediation of Chlorinated and Recalcitrant Compounds, Battelle, Monterrey, California, May 22-25, 2000.

- (1) *Concept to Pilot-Scale: Ex Situ Biotreatment of Perchlorate-Contaminated Soil and Groundwater* and (2) *Innovative Technology: In Situ Biotreatment of Perchlorate-Contaminated Groundwater*, Air and Waste Management Association, 93rd Annual Conference and Exhibition, Salt Lake City, Utah, June 18-22, 2000.
- *Mechanisms of Perchlorate Degradation: An Overview*, (2) *In Situ Perchlorate Bioremediation for Soil and Groundwater*, and (3) *Implementation of Innovative In Situ Biotreatment Technology at NWIRP McGregor, Texas*, 5th Annual Joint Services Pollution Prevention and Hazardous Waste Management Conference and Exhibition, San Antonio, Texas, August 23, 2000.
- *Bioremediation of Perchlorate-Contaminated Groundwater and Soil at NWIRP McGregor, Texas*, Society of American Military Engineers, Fort Worth, Texas Post, October 3, 2000.
- *Abating and Remediating Perchlorate*, The Military Engineer, Society of American military Engineers, November-December 2000, Vol. 92, No. 608.

4.0 ACCOMPLISHMENTS

Over an *eight-month period*, the Navy generated a conceptual design, evaluated several bench- and pilot-scale studies, and then implemented multiple pilot- and full-scale remedial systems in the process of saving millions of dollars. The groundbreaking approach to remediation at NWIRP McGregor has earned the Navy and EnSafe recognition as leaders in perchlorate remediation technology.

A series of bench-scale studies was completed to develop a biological treatment system for the site. Based on the bench-scale studies' successful results, a pilot-scale, fixed-bed bioreactor was designed and evaluated. Based on site conditions, perchlorate concentrations, and operation and maintenance issues a series of cutoff and collection trenches and an *ex situ* fixed-bed anaerobic bioreactor were initially recommended to address perchlorate-contaminated groundwater.



Concurrent to the *ex situ* pilot-scale evaluation, new bench-scale studies were conducted to develop *an in situ* biological treatment technology. Early favorable *in situ* bench-scale study results encouraged SOUTHDIV to incorporate the concept into groundwater recovery trenches being installed for the *ex situ* pilot-scale study. The cost of incorporating the *in situ* technology into the ongoing recovery trench construction was less than 1% of the remediation construction cost. As a result, the *in situ* system was implemented as the primary stabilization measure. The *ex situ* system was still evaluated, but has been supplanted as the selected treatment alternative.

The *in situ* treatment technology effectively created a permeable reactive barrier (PRB). Within three weeks of trench construction completion, perchlorate concentrations in trench groundwater decreased from 27,000 µg/L to below laboratory detection limits of 20 µg/L. Perchlorate-contaminated groundwater, once migrating offsite, is now intercepted and treated by the PRB.



After 12 months of operation, the *in situ* system is still treating perchlorate-contaminated groundwater to below detection levels. Furthermore, there is analytical evidence that downgradient perchlorate concentrations are being influenced (i.e., reduced) by the *in situ* system. Because it is still considered a pilot-scale system, effectiveness monitoring continues.

Offsite *In Situ* Treatment

Perchlorate-contaminated groundwater on Texas A&M property, which is directly downgradient (south) of NWIRP McGregor, migrated offsite before the *onsite in situ* system was constructed. As a result, the contaminant plume continues to be a surface water and (further) downgradient groundwater contamination source.

Instead of another series of cutoff and collection trenches, a passive amendment delivery system to foster *in situ* biotreatment conditions was proposed for an offsite pilot study. The delivery system, which is *less intrusive and expensive* than the already cost-effective trench system, comprises approximately 200 boreholes (15 to 20 rows of 11 boreholes) along the narrow perchlorate plume. The boreholes were backfilled with a natural organic carbon source and aggregate blend, and supplemented with sodium acetate and perchlorate-reducing microorganisms (PRMs) to promote a quick start to the biotreatment process. The effectiveness-monitoring program for the encouraging pilot-study is in progress.



Soil Treatment

In October, following a successful bench-scale study, perchlorate-contaminated site soil was transported to an onsite, engineered treatment cell that was lined with a 30-mil HDPE liner. Before the soil was placed into the treatment cell, it was mixed with a carbon source (to foster anaerobic conditions), nitrogen and phosphorus fertilizer (micronutrients), soda ash (buffer), and water in designed quantities and ratios developed during the bench-scale study. Additional water was added to maintain at least 2 inches of water above the soil to promote and sustain anaerobic conditions. Finally, the cell was covered with a 6-mil HDPE liner.



After six months, soil was sampled at six random locations and analyzed for perchlorate. All six samples were below the regulatory target cleanup level of 270 $\mu\text{g}/\text{kg}$. Furthermore, the perchlorate concentration in the water used to flood the cell was below its detection limit of 4 $\mu\text{g}/\text{L}$.

Key Environmental Restoration Challenges

The key environmental restoration challenges included the following:

- Assure that the selected remediation technology would operate reliably and at low cost without the benefit of prior field applications for guidance.
- Complete the development, evaluation, and implementation of the new technology under a compressed schedule to meet the TNRCC's ISM deadlines for the site.
- Create an avenue to educate and distribute information to the community and stakeholders on perchlorate remedial technologies and site cleanup status.

Accelerating Cleanup/Risk Reduction to Human Health and the Environment

The rapid implementation of the innovative *in situ* groundwater system stopped the offsite migration of perchlorate. As a result, concentrations in surface water entering drinking water reservoirs serving more than 400,000 residences have decreased from more than 200 $\mu\text{g}/\text{L}$ to below detection limits.

In addition, rapid implementation of key investigation tasks has helped defuse any concerns the public may have had concerning private and public drinking water supplies. The investigation tasks included monthly sampling of raw water intakes from pump stations on area lakes and a water quality assessment of area lakes during which more than 950 water samples and 222 sediment samples were collected. These tasks demonstrated that the drinking water supplies were safe.

Stakeholder Involvement

Community leaders and local, state, and federal officials have been updated on the project's successes through the RAB. Throughout the project, the Navy responded to community concerns through regular public meetings and hearings to present the steps being taken to address offsite contaminant migration. Under the effective partnership between the Navy and its contractors, the TNRCC, and the USEPA, the project proceeded rapidly from investigation to interim remediation. Key community-related achievements included the following:

- The Navy established public confidence in its commitment to protect the environment and provide corrective action for site releases.
- The Navy quickly and proactively responded to TNRCC's directive to address offsite migration of perchlorate.
- The Navy worked in close cooperation with the TNRCC and the USEPA for the first investigation and remediation of perchlorate in the State of Texas.
- Due to the uniqueness of the project, in which the CLEAN II and the design-build contractors, the regulatory agencies, and the community had significant input, the Navy had to remain flexible with regard to ISM design and implementation.
- The Navy created an avenue for educating and disseminating perchlorate information to the community and stakeholders on both the local and national levels.
- The Navy met its social obligation by improving water quality in a timely manner while developing a cost-competitive innovative biotreatment technology.
- The Navy collaborated with Texas A&M and Baylor Universities on academic pursuits.
- The Navy responded quickly by helping the local communities achieve economic redevelopment goals.

Regulatory Coordination

This remediation project was successfully executed with the full support and input of the TNRCC and the USEPA. Because of this project's rapid evolution, the regulators had to be flexible and patient. Both goal-oriented agencies often reacted quickly while providing guidance to ensure that all proposed remedial actions were within all state and federal guidelines. This is further demonstrated as the regulators have routinely streamlined document review by communicating questions and concerns early in the evaluation process.

Cost Avoidance Measures

The expedited, innovative perchlorate treatment technologies have saved the Navy millions of dollars in pilot-scale testing and full-scale operations. Cost avoidance measures included:

- Advancement of technologies reduced treatment system capital costs by more than \$3 million when compared to existing technologies.
- Selection of a collection trench reduced installation and operational costs by 50% when compared to traditional extraction wells.
- The *in situ* system's O&M costs are approximately \$5,000 per year. Comparatively, other treatment systems have been estimated at more than \$100,000 per year.
- Innovative anaerobic landfarming of onsite perchlorate-contaminated soil lowered remediation costs by \$100,000 when compared to excavation and offsite transportation and disposal.
- The Navy negotiated a favorable interpretation of a new "Consistency Document" with TNRCC, thereby significantly reducing laboratory costs.
- Use of innovative investigation techniques, such as Ground-Penetrating Radar (GPR), reduced the number of groundwater monitoring wells that had to be installed.
- Eliminated report duplication by combining data from multiple investigations.

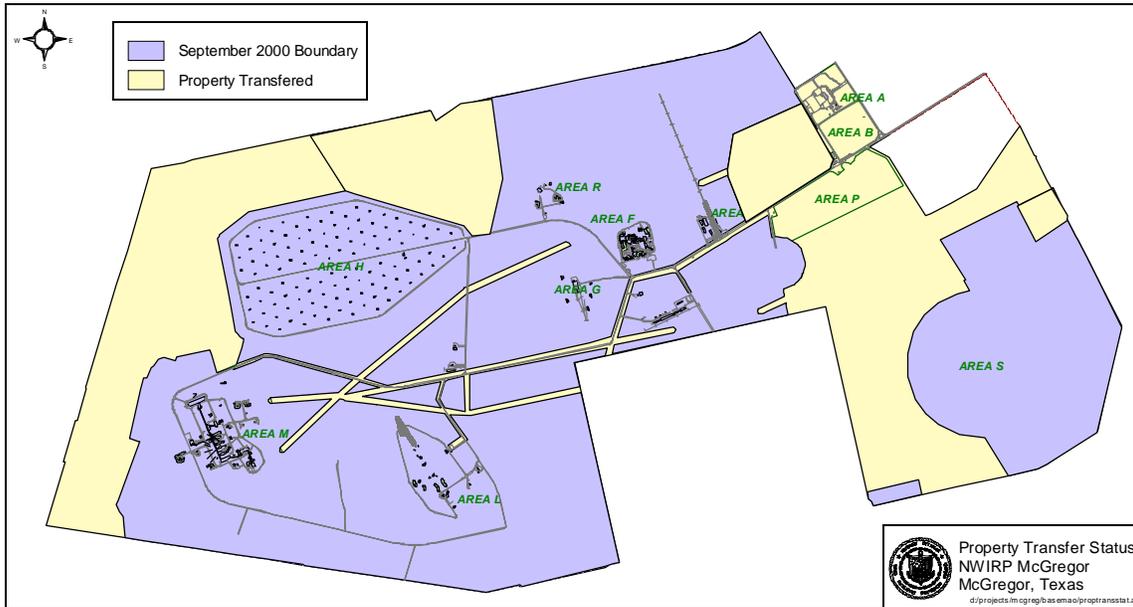
Other Benefits

The Navy successfully fostered a synergistic relationship between regulatory agencies and local communities, which has allowed it to complete the transfer of almost 3,500 acres to the City of McGregor for economic redevelopment.

Open communication and routine collaboration helped establish trust among the partners. This relationship has maintained the project's rapid schedule despite perchlorate's impact on the project.

Through the partnering and team efforts, stakeholders and community leaders know that the Navy is committed to evaluate and correct environmental issues in a timely manner at NWIRP McGregor. This brings positive benefits for local communities in their recovery efforts from the loss of this facility.





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