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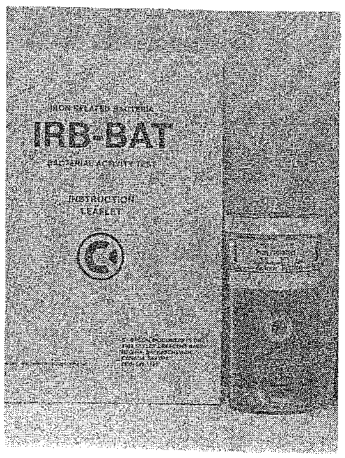
Equipment used in the treatment of relief wells with the ARCC method



Use of New Well Redevelopment Techniques on Relief Wells in Upper Wood River Drainage and Levee District

by
Joseph A. Kissane
US Army Engineeer District, St. Louis

The Upper Wood River Drainage and Levee District is bounded on the upstream end by Lock and Dam 26 at Alton, IL, and on the downstream end by the mouth of the Wood River at the Mississippi River (Figure 1). Relief wells are located along the landside toe of the upstream portion of the levee. Most of these wells were installed in the early to mid-1950's.

The relief wells consist of 8-in.-inside-diameter wood-stave well screens, riser pipes, gravel filter, sand backfill, and concrete upper backfill. The screens are perforated with 3/16-in. vertical slots; the bottom of each screen is closed with wooden plugs. The tops of the relief wells are protected with corrugated metal guards and fitted with backflow valves. A schematic of the well design is shown in Figure 2. The wells were designed with an actual penetration of 60 percent to result in an effective aquifer penetration of 50 percent after well loss considerations.

The aquifer sediments at the site are 60 to 110 ft thick, depending upon surface elevation. Permeabilities of the sands below the floodplain

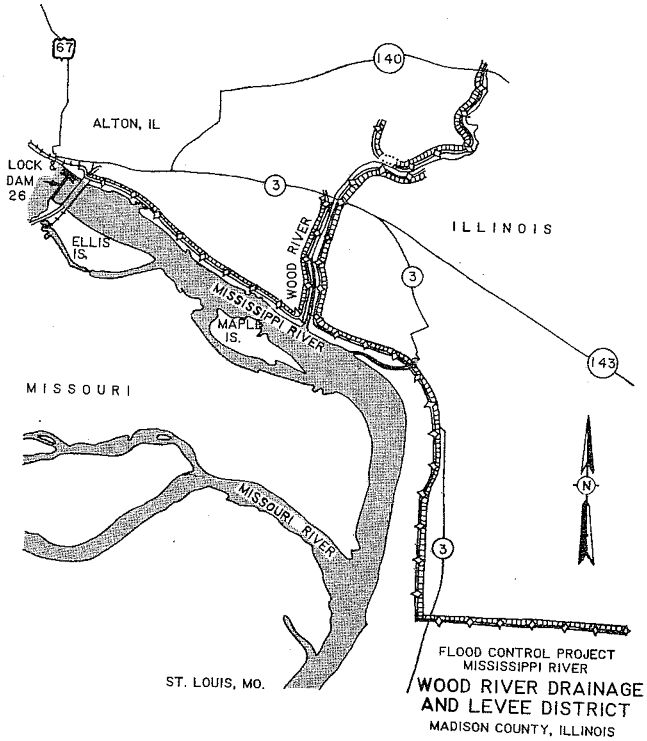


Figure 1. Wood River Drainage and Levee District

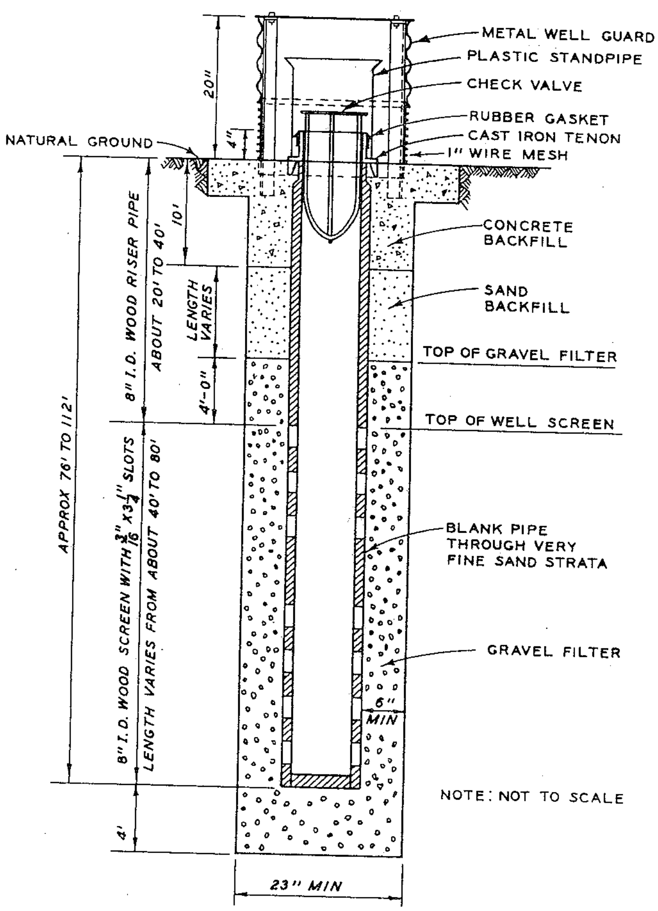


Figure 2. Relief well and appurtenances

deposits range from 1,100 × 10^{-4} to 2,850 × 10^{-4} cm/sec, with an average of 1,650 × 10^{-4} cm/sec. The static ground-water elevation is largely dependent upon river stage and proximity to dewatering activity associated with the construction of Lock and Dam 26 (R). The depth to ground water in the relief wells ranged from 7 to 39 ft with the lower values directly across from the cofferdam and construction area.

The construction of Lock and Dam 26 (R) and the subsequent raising of the river stage adjacent to the Upper Wood River District will have a marked impact on local ground-water conditions. Most of the relief wells will likely experience nearly constant flow as a result of the raised river stage.

A program of testing and redevelopment of the existing relief wells was undertaken to optimize the efficiency of existing measures and to assess the number and location of additional wells if needed. The results of these tests are also part of the ongoing periodic evaluation of underseepage control measures in the St. Louis District.

Reports of earlier work indicated that the wells declined in effectiveness after installation, but the rate of decline decreased with time. In addition, studies indicate that the wells improved to nearly their original effectiveness as a result of the prolonged period of flow during the Flood of 1973. Tests in 1976 indicated an overall average of 78 percent of original specific capacity.

Redevelopment Procedures

Measures were undertaken by the St. Louis District to redevelop the relief wells with the expectation that the wells could be brought to an average of 80 percent of their original specific capacity. Prior to treatment the wells were pump tested to determine the extent of well-capacity decline. After the first pump test, the wells were treated with a mixture of trisodium phosphate (TSP) (a dispersing agent) and HTH chlorine (a disinfectant). After 18 to 24 hr, the wells were surged with a specially designed surge block (Figure 3). Surging was performed in units defined as "cycles," each cycle consisting of 15 complete passages of the surge block up and down the extent of the well screen. Surging rates and the number of cycles were varied so that an evaluation of the optimum rate and amount of surging could be made.

Figure 3. Surge block

As work progressed, it became evident that an average of 70 percent of installed specific capacity was a more realistic result of the methods in use. The general conclusion reached was that although the amount of redevelopment was proportional to the amount of surging, the amount of improvement per "cycle" of surging decreased as work continued and that the amount of improvement varied from well to well.

The ARCC Redevelopment Method

On a recommendation from Roy Leach (Principal Investigator on REMR Work Unit 32313, "Restoration of Relief Wells and Drainage Systems," Waterways Experiment Station), plans were made for a demonstration of the Alford Rodgers Cullimore Concept (ARCC), a newly patented redevelopment technology, which had been used recently on relief wells at Grenada, MS.

ARCC procedures include an initial well diagnosis to determine the types of bacterial and chemical agents at work in the wells and a general indication of their concentrations. The initial pH and temperature of the water are also measured. Then a treatment is designed to target the problematic agents with an appropriate set of chemicals.

The ARCC method for redeveloping wells is based upon three principal elements of treatment:

- Disrupt. Chlorine is added to the well and surrounding aquifer to "shock" kill or reduce the impact of deleterious algae and bacteria.
- Disperse. Chemical agents and steam are added to the well and surrounding aquifer, and surging is used to break up organic and mineral clogging in the system.
- Remove. The most effective means available are used to remove whatever material is clogging the well and aquifer.

Two wells (44X and 46) were designated for redevelopment because of their response to the methods already used by the St. Louis District (HTH, TSP, and surging). Well 44X had improved from 52 to 69 percent of its installed specific capacity; well 46, from 52 to 58 percent.

Water samples taken from the wells before the start of the ARCC activities indicated the well water contained high concentrations of pseudomonas bacteria (probably in excess of 1,000,000 per 100 ml), moderate levels of sulfate-reducing bacteria (50,000 to 100,000 per 100 ml), and moderate to high iron bacteria content (greater than 1,000,000 per 100 ml).

The initial treatment was chlorine "shock." Gaseous chlorine was batched with water to a concentration exceeding 800 ppm and then injected in an amount three times that of the volume of the wells. The chlorine was allowed to act on the wells for a minimum of 24 hr.

The next phase of treatment involved heating a chlorine solution to 120° F or higher and then injecting it into the open well to raise the temperature of the well water. (Bacteria die rapidly at a temperature of 120° F.) After the well water was heated, the well was sealed, and a heated mixture of chlorine, sulfamic acid, and a patented acrylic polymer was injected into the well. The results of the chemical and bacterial tests performed at the start of the process determined the concentrations of chlorine and acid and the choice of polymer. The polymer used is ARCC II, a low pH compound designed for use in wells that have potential for bacterial fouling and clogging by clays and silts.

The polymer-acid-chlorine mixture injected at this site has a pH between 1 and 2 and was pumped in at a temperature of approximately 200° F. Approximately 1.5 well-volumes of the heated mixture was injected in each well. Injection was done with a specially designed, low-volume, high-pressure nozzle inserted into the well through the seal. Nozzle pressures were approximately 500 psi; however, with the low injection volumes, this pressure dissipated within the well. The equipment used did not have the capability to measure well pressure. Injection of the heated fluids was followed by a waiting period of approximately 48 hr. Another batch of heated chlorine, acid, and polymer was injected, and then a 24-hr waiting period was observed.

Following the waiting period, the wells were surged with the same surge block configuration as that used in the St. Louis District's redevelopment efforts. Surging consisted of approximately 9 cycles (135 passes) the length of the well screen at a rate of 2.5 ft/sec. This rate, based on St. Louis District's earlier work, reduced the possibility of damaging the wooden screens and limited the amount of filter material brought into the wells to the finer fractions. Surging produced slightly more than 1 ft of infiltrate in each well. The procedure was followed by an approximate 24-hr waiting period.

After the waiting period, an abbreviated pump test was performed to provide a general idea of the effectiveness of the treatment and to remove material brought into the well by surging. Additional surging and pumping were performed. The total amount of surging, chemical treatment, and pumping was identical for the two wells.

The final phase of treatment was the removal of infiltrate from the wells with a small centrifugal pump and suction hose. Afterwards, a final pump test was made to determine the amount of improvement.

Costs

The costs of the St. Louis District's efforts included labor and the amount of time spent on the work. St. Louis used personnel of the Geology Section, Core Drill Unit, at an approximate cost of $6,300 per week. The treatment of two wells could be accomplished with allowances for weather and other contingencies in 1 week. Previous work indicated that the methods used by the St. Louis District crew would average 14-percent improvement in specific capacity per well before the methods would become significantly ineffective.

The ARCC work was done on a lump-sum contract basis for $6,500. The work took a total of 11 working days, including considerable delays for equipment repair and extreme-weather related factors. The equipment is in the developmental prototype stage, and improvements are being incorporated into the design as the need is discovered through field experiences such as this program. Downtime for repairs in the field should decline as the company gains experience. Also, mobilization and demobilization costs, included in the lump-sum amount, would not be as significant a cost percentage for a larger project as for just two wells.

The treatment methods of ARCC improved wells 44X and 46 by 14 and 12 percent, respectively. These improvements are comparable to those of the St. Louis District, but they may be more significant when it is considered that they were achieved after the efforts by St. Louis were assumed to have reached the practical and economical limit of effectiveness.

Observations

The relief well development program undertaken by the St. Louis District has resulted in a number of considerations and observations. One consideration is the design of the wells; design factors that have impact on the effectiveness of redevelopment measures are slot size and spacing. The slot size limited the surging rate because excessive rates pull coarse sand and fine gravel through the screen, damaging, rather than developing, the filter. Slot spacing in the wooden screens (historically about 15 percent) is far below conventional wire-wrap screens (30 to 40 percent), and this small open area increases the degree to which clogging by whatever agents are present would impact the well.

An observation based upon the results of installation test data, the test data from the wells in the redevelopment program, and historical data from other relief wells in the St. Louis District is that the variability in specific capacity from well to well is tremendous. This variability occurs in spite of similarity of well design and is not completely attributable to stratigraphic variation within the aquifer. The initial test data within the Wood River District show specific capacities that range from 123 gpm/ft to 324 gpm/ft for wells that are essentially the same in design with little, if any, variation in the aquifer.

Summary

Relief wells in the Upper Wood River District have been treated by various methods to restore lost specific capacity. The methods used by the St. Louis District consisted of an initial pump test, treatment with chlorine and TSP, surging and cleanout, and a final pump test. The St. Louis District's efforts achieved an average increase of 14 percent of the original specific

capacities for 34 wells before the methods used became relatively ineffective.

The ARCC method consists of cycles, including chlorine shock; a treatment of steam generated from a mixture of sulfamic acid, chlorine and an acrylic polymer; surging; cleanout; and a final pump test. The ARCC methods achieved improvements of 12 and 14 percent in specific capacities in two wells that had been treated to the assumed limits of the other methods.

For further information, contact Roy Leach at (601) 634-2727.

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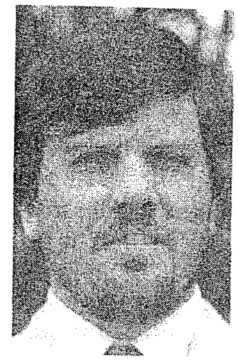


Determination of Relief Well Infestation with the Use of a Bacterial Activity Test (BAT) Kit

by
Roy Leach
US Army Engineer Waterways Experiment Station

The Corps of Engineers (CE) owns 5,000 to 10,000 relief wells located in the toes of levees and embankments and beneath spillways and outlet works. Guidance on how to determine critical flows for the safe operation of these wells is published in CE bulletins and manuals, but the lack of available funds or manpower has sometimes delayed the actual rehabilitation until emergency treatment is required.

The CE levees, dams, and related structures are usually monitored for excess heads with the use of piezometers located nearby, through observation of unusual water flow (increase or decrease), and changed structural conditions. Even if there is a diligent monitoring program, a time lapse can still occur between the observation of a problem and rehabilitation. Any procedure that will shorten the delay, and especially one that will avoid emergency treatment, will benefit the CE.

As a result of initial questionnaires and further discussion with personnel involved with maintenance of relief wells, it was determined that a method was needed to evaluate the actual or potential fouling that can occur in a well as a result of bacteria or their by-products clogging the system. Also, bacterial clogging problems are attributable to the presence of an active bacterial community. If a simple test could be developed as a primary screening tool to determine the presence and abundance of certain bacteria, then the urgency for treatment could be determined and other laboratory tests that involve soil and water chemistry might be eliminated. A test delineating the kind of bacteria present might also help in determining the series of chemicals needed for rehabilitation of the well.

Given the assumption of limited money or manpower, it was necessary to try to develop a procedure for bacterial identification and quantification that would be simple enough that any responsible, untrained employee could use it and get reasonably reliable results. This task was fairly difficult because this is generally a laboratory exercise that requires bacterial field-sampling procedures that are often precise, tedious, and sometimes fruitless. Getting the samples back to the laboratory in their in situ state also requires timely handling and transportation. Since this transfer of field samples provides numerous chances for sampling errors by untrained personnel, the emphasis shifted to developing a field procedure that might not be as precise but that would at least indicate types of bacteria and ranges of infestation. As the REMR work on relief wells progressed, it was learned that a Canadian company, Droycon Bioconcepts Inc., had developed and patented Bacterial Activity Test (BAT) kits that will identify a wide range of bacteria living in water-producing or monitoring wells. The BAT kits were first evaluated in January 1988 in conjunction with a REMR demonstration project on rehabilitation of relief wells for the St. Louis District.

Although numerous bacteria exist in wells, the BAT kit shown in Figure 1 is the one used to identify the more prevalent iron-reducing bacteria (IRB). The entire kit consists of a small plastic bottle inside a larger plastic bottle, the instruction leaflet, and the autoclaving bag. The small plastic bottle (Figure 2) contains nutrients suitable for growing IRB when a water sample from the well is added. The growth reaction pattern for the IRB-BAT kit is divided into four areas as shown on the "Results Sheet" in Figure 2. After a specified growth time, the pattern that develops can be

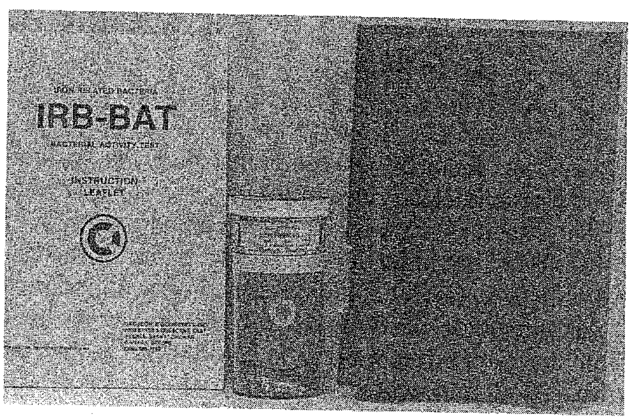


Figure 1. Complete BAT kit

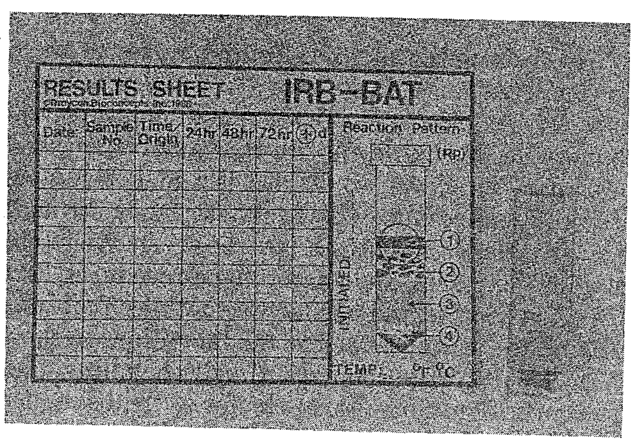


Figure 2. BAT kit sample bottle and data sheet

interpreted with the help of the explanations found in the instruction leaflet. An example of three different patterns of growth (samples from a stratified well) are shown in Figure 3. When the test has been completed, the used bottles should be sterilized before they are discarded.

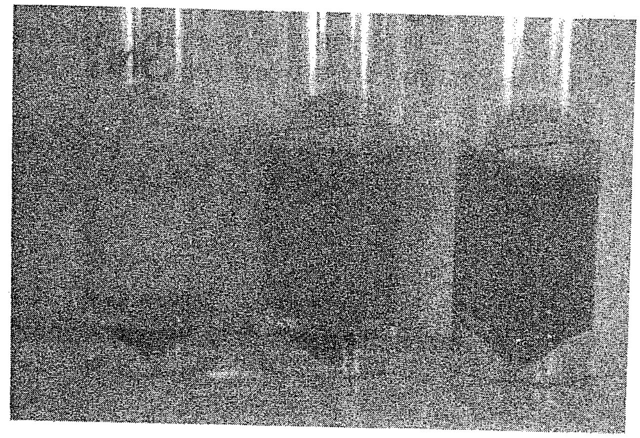
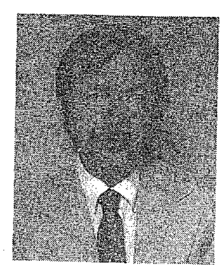


Figure 3. Examples of bacterial growth

The product is not offered as anything more than a primary screening tool for determining the probability of bacterial activity in a water sample, but the demonstration test in the St. Louis District appeared to confirm activity determined through limited laboratory tests on samples from the wells. Other BAT kits will be used on another project later this fiscal year; laboratory tests will be used for confirmation of the results.

The extrapolation, found in the instruction leaflet, for determining bacterial populations should be used only as a guideline to aid in the determination of need for and the development of a rehabilitation procedure. At approximately $7.50, wholesale, the kit can provide a relatively inexpensive method of obtaining data concerning a well's condition, even in cases where no background data are available. The kit can also be used to monitor bacterial regrowth between maintenance periods.

For further information, contact Roy Leach at (601) 634-2727.



Roy Leach is employed as a research civil engineer in the Soil Mechanics Division, Geotechnical Laboratory, WES, and has been with the Corps of Engineers for 23 years. He is currently principal investigator for REMR Work Unit 32313, "Restoration of Relief Wells and Drainage Systems." He received a B.S. degree in civil engineering from Mississippi State University.

Jetty Repair Projects: Potential Beneficial Impacts

by
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US Army Engineer Waterways Experiment Station

Coastal engineering projects entail the gamut of planning, from design to construction, and include economic and environmental considerations. However, once the structures are in place, a need for specific repair, evaluation, maintenance, or rehabilitation may arise, such as the injection of grout into rubble structures to modify their permeability to sediments or the application of epoxy coatings to sea walls or bulkheads to retard their deterioration in seawater. The REMR process may raise questions not addressed during the original planning and construction.

Although few REMR activities are controversial from an environmental standpoint, evaluation must be done on a project-by-project basis. This article describes a REMR activity that presents a unique opportunity to demonstrate beneficial environmental impacts.

A rubble-mound jetty at the entrance to Mission Bay, California, suffered wave-induced damage along its ocean-exposed face near its seaward end. Typically, repair of this jetty would have involved removal of displaced stone from the damaged section to some offsite location prior to placement of new, appropriately sized stone in the bedding, intermediate, and armor layers of the structure. Debris removal might have occurred via barge or, if an access road were present, by truck at some appreciable cost. At Mission Bay, rather than move this material offsite, an option to place the debris adjacent to the structure to create a habitat for biological resources is being exercised.

Description of the Repair Project

The jetty system at Mission Bay consists of three structures (Figure 1). The outlet of the San Diego River flows between the middle and south jetties. A navigation channel into Mission Bay property is maintained between the middle and north jetties. The repair project involved the north jetty (Figure 2), which is periodically subjected to high-energy wave attack. The actual repair work was performed during September-October 1987. Stone removal and replacement were confined to an approximate 125-ft section that appeared as a notch almost bisecting the structure immediately before its seaward terminus. Staging areas where stone was stockpiled for the repair were located in a parking lot adjacent to the landward base of the jetty and on property near Mariners Basin. These areas were selected to minimally disturb the seasonal use of Mission Beach by the public. Not surprisingly, Mission Beach, which runs northward from the north jetty, is a popular surfing area, and some individuals were concerned that the existing wave regime would be altered. Because this repair would be a relatively small-scale operation, these concerns were alleviated.

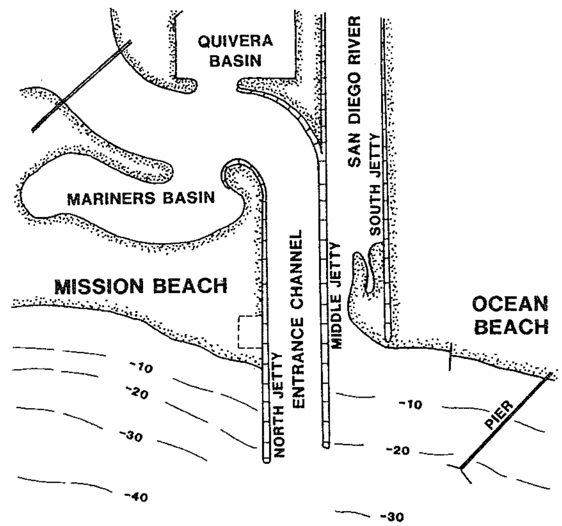

Figure 1. Mission Bay jetty repair project area. Repair involves the north jetty only. Depth contours are in feet

To place stone debris in discrete mounds directly north of the jetty, the repair contractor used a barge. This method allowed placement of the material at a greater distance from the toe of the structure than would have been possible with a crane mounted on the jetty itself. Consequently, the stone mounds were positioned in a line roughly parallel to and approximately 100 to 125 ft away from the structure.

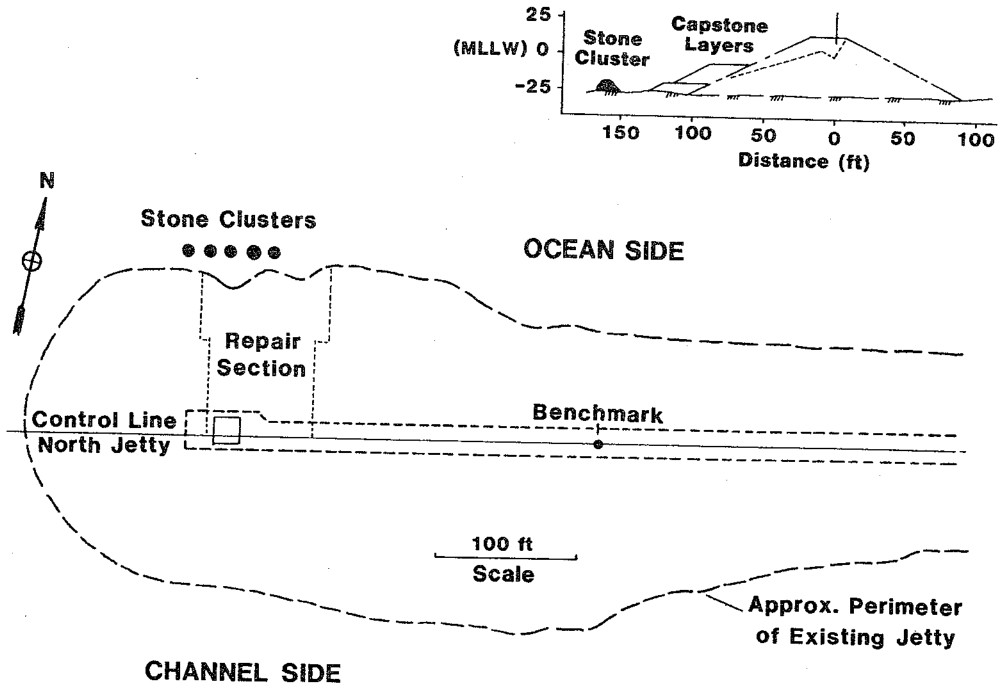

Figure 2. Plan and cross section of the jetty repair project at Mission Bay, California. Positions of the stone clusters in relation to the jetty structure are not to scale

Objectives of the Study

This study tests the feasibility of this option for future repair projects. In addition to saving the cost of having to transport debris offsite, the formation of artificial reef habitats provides other benefits. The popularity of rubble-mound jetties as recreational fishing spots is evidence that these structures provide habitat for numerous fish and shellfish species. Jetties, breakwaters, and similar structures have been shown to function as valuable artificial reef habitat, especially along otherwise "barren" stretches of sandy coastline (Hurme 1979). Rocky substrate with numerous surficial crevices and interstitial spaces (rubble mound) is rapidly colonized by diverse assemblages of both flora and fauna (Johnson and others 1979; Stephens and Zerba 1981; Van Dolah, Knott, and Calder 1984). Although public access to jetties raises questions related to safety and liability, the sociological benefits of creating access to marine resources for shore anglers otherwise denied this use is substantial, particularly in urban areas. An additional benefit is the formation of new habitat for target biological resources, such as lobsters, crabs, and various reef fishes. Also, the formation of artificial reef habitat could serve as mitigation for impacts of other Corps projects in the future.

Because of the potential for habitat enhancement afforded by this type of project, the National Marine Fisheries Service and the Los Angeles District of the US Army Corps of Engineers have coordinated a plan to evaluate the short-term fate of the created rubble mounds. With support from the US Army Engineer Waterways Experiment Station under the environmental problem area of the REMR Program, physical and biological monitoring of the rubble mounds will continue through September 1988. Specific objectives of the monitoring efforts include: (1) evaluation of the relative stability of the artificial habitat in this high-energy environment, (2) estimation of the rate of colonization of the mounds by target fishes and shellfishes, (3) measurement of localized changes in the benthos (bottom-dwelling organisms such as clams and marine worms) attributable to the presence of the mounds, and (4) determination of the patterns of utilization of the artificial habitat by key fish species. Regardless of the small-scale nature of this project, these objectives present several challenges to the personnel involved.

Parameters to Measure and Methods

Ideally, artificial reef habitat should mimic its natural counterpart. Because the habitat represented by the jetty itself has been present for some time, the biological resources using the jetty can be expected to have established an equilibrium; that is, the community will be dynamic but predictable over the long term. Thus, the newly created rubble mounds, having a source of recruits of species preadapted to rocky substrate, should experience rapid colonization. The "value" of a given unit of habitat space or volume depends on a number of variables. In the present example, the size and spacing of the rubble mounds might influence the total number of desirable fish supported, especially if the target species is territorial. Target species for this project include shiner and black surfperches, garibaldi, blacksmith (these latter two species are damselfishes), barred sand bass, and several species of rockfishes. Spiny lobsters might also be expected to inhabit both the jetty and the rubble mounds.

Physical features of the habitat will largely determine the extent of utilization by biological resources. For example, the success achieved by the contractor in placing the stone in discrete mounds will be an important factor. Stones scattered on the bottom in such a manner that interstitial spaces are not created and vertical relief is low will limit their effectiveness in attracting and sheltering fishes. Determining the actual dispersion pattern of the mounds with respect to one another and to the jetty will be the initial objective of the field efforts. This determination will be accomplished by divers using simple survey techniques. As a follow-up, the short-term stability of the mounds will be assessed, particularly after storm events. Another important aspect of their stability would be evidence of subsidence into the underlying sandy substrate. Shifting caused by wave surge and scouring along the base of the mounds by localized water currents could conceivably lead to gradual settling of individual mounds and reduction of their habitat value.

Rates of colonization of the mounds by target species will be assessed by seasonal sampling. As mentioned previously, colonization should proceed rapidly because of the proximity of potential recruits to the jetty. Sampling will involve several techniques. The most quantitative methodology, given the logistical and funding constraints of the study, will be visual observations by divers taken along fixed transects parallel and perpendicular to the axis of the rubble mounds. Traditional transect and point-count methods, adapted for use underwater, are both rapid and nondestructive (visual observations do not require removal of the catch, as do netting and trapping techniques). As a reference for comparison, identical transects will be established over open bottom at an equivalent distance from the jetty but away from the influence of the rubble mounds. (Advantages and disadvantages of visual censusing have been reviewed by Clarke (1986).) In this study a video record of the observations for each sampling period will be obtained as water clarity conditions permit. To augment the visual counts, an array of traps will also be deployed during each sampling period. Because visual counts are biased toward inclusion of larger, active fishes, trap data can provide insight into the relative numbers of smaller, cryptic forms present. During periods of extended low visibility, traps and gill nets may be used to follow the colonization process.

To examine changes in the benthic community surrounding the rubble mounds, divers will take benthic core samples at fixed stations along transects parallel and perpendicular to the axis of rubble mounds. As specified for the visual transects, identical stations will be established and sampled in the predetermined reference area. Scouring or other processes that affect the composition of the benthos could result in alterations relative to the value of the habitat (Davis, VanBlaricom, and Dayton 1982), such as for foraging by fishes. If necessary, the benthic samples could be obtained by conventional bottom-grabs from a small boat.

An assessment of utilization patterns of the created habitat by target species will require integration of all of the physical and biological information gathered. The fish censuses will be used to estimate the total numbers of given species per unit of artificial habitat. Visual observations and video records will provide insight into the behavioral associations between species and the mounds. For example, some species may be resident, limiting their movements to the immediate vicinity of the artificial habitat, whereas other species may be transient.

Tangible and Intangible Benefits

At the conclusion of this study, the Corps will be better able to decide whether to use this option of debris removal in future repair projects. Tangible benefits alone, in the form of cost savings over the offsite disposal alternative, may justify the habitat enhancement option. In addition, several types of intangible benefits may be accrued. If this project does demonstrate that habitat value is enhanced, the Corps will benefit from cooperating with environmental resource agencies on similar coastal REMR projects, as well as reaping positive public relations.

The study should also produce recommendations on how to most effectively achieve habitat enhancement on repair projects of various sizes.

The possibilities are basically limited only by the amount of stone debris that can be placed on the bottom. On a project-by-project basis, specific configurations and spacing patterns of rubble mounds can be optimized in accordance with the intended target species and use of the created habitat. For example, when access can be controlled, artificial habitat can be used to improve recreational fishing and to provide a sanctuary for valuable resources.

For additional information on environmental aspects of this REMR project, contact Dr. Douglas Clarke at (601) 634-3770 or Mr. John Cullinane at (601) 634-3723.

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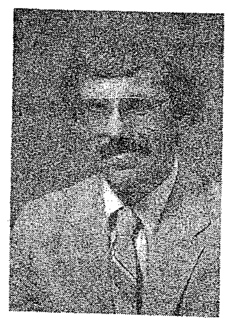

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Maintenance and Repair Materials Data Base for Concrete and Steel Structures

The REMR Maintenance and Repair Materials Data Base is online. It is intended to provide the user with a means to (a) identify products for use in concrete and steel structures that may be applicable for specific types of repairs and (b) obtain supplemental information from the manufacturer, the Corps of Engineers, and other sources regarding the use, application, limitations, and technical properties of the products. The data base is located and maintained at the Waterways Experiment Station, Vicksburg, MS. It can be accessed by dialing (601) 634-4223 through a remote personal computer and modem with the use of a telecommunication package, such as Crosstalk.

Products in the data base are identified as either end-use or additive. An end-use product is a material that is used as purchased to make a repair, whereas an additive product is a material used in an end-use product. Help options provide definitions of product categories and uses for end-use and additive products.

In using the data base, the user must first select the type of product to search, either end-use or additive. The user can then search for product records having a specific manufacturer's name, product name, product category, product use, or both product category and use.

Point of Contact:
Mr. Roy L. Campbell
Data Base Manager
US Army Engineer Waterways Experiment Station
PO Box 631
Vicksburg, MS 39181-0631
Telephone (601) 634-2814

Request for Articles

The REMR Bulletin is actively soliciting articles in any of the areas being addressed by the REMR Research Program. Articles by individuals outside the Corps will be considered if relevant to REMR activities of the Corps.

To submit an article, write to: Commander and Director, US Army Engineer Waterways Experiment Station, ATTN: CEWES-SC-A, PO Box 631, Vicksburg, MS 39181-0631. Guidelines are available upon request.

When submitting photographs with articles, please provide glossy prints or film rather than prescreened negatives.

REMRNET Update

A few Corps of Engineers OnTyme users have seen ID syntax changes as a result of the new office symbols. The log in procedures for REMRNET, however, remain unchanged. REMRNET is accessed by entering the OnTyme system and using the following ID and Key:

ID? CORPS.DAENRNBB

KEY? 8-YOURKEY

The Research and Development Bulletin Board will appear. Choosing item number 5 on the main menu will access the REMR Network System.

REMRNET remains organized into four major areas: available REMR products, scheduled field tests and demonstrations, upcoming REMR program events, and an interactive problem/solution discussion. Soon-to-be-published products are now included under the "available products" area.

REMRNET is available to anyone with a computer or terminal that is capable of communicating with the Corps' OnTyme Electronic Mail System. Information about OnTyme can be obtained from a local OnTyme coordinator. Problems or recommendations concerning REMRNET should be addressed to the REMRNET monitor (CPT Greg May) at (601) 634-3243 or by leaving a message for OnTyme I.D. CORPS.WESSCA.

REMR Research Program

KEY PERSONNEL

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Jerry S. Huie (Geotechnical—Rock)	Geotechnical Laboratory, WES	CEWES-GR-M	601-634-2613
Glenn A. Pickering (Hydraulics)	Hydraulics Laboratory, WES	CEWES-HS-L	601-634-3344
D. D. Davidson (Coastal)	Coastal Engineering Research Center, WES	CEWES-CW-R	601-634-2722
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Henry Nakashima	Pacific Ocean Division	CEPOD-ED-PH	808-438-7013
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REMR Reports Published to Date

Number	*Date*	*Title*	*AD Number*
Unnumbered	Feb 1983	REMR Research Program Development Report, by J. M. Scanlon, Jr., J. E. McDonald, C. L. McAnear, E. D. Hart, R. W. Whalin, G. R. Williamson, and J. L. Mahloch	AD A125 998
Unnumbered	Sep 1985	The REMR Notebook	
Unnumbered	Jan 1987	Proceedings of REMR Workshop on Assessment of the Stability of Concrete Structures on Rock, 10-12 September 1985, compiled by W. F. McCleese	
TR REMR-CS-1	Sep 1984	Engineering Condition Survey of Concrete in Service, by R. L. Stowe and H. T. Thornton, Jr.	AD A148 893
TR REMR-CS-2	Apr 1985	The Condition of Corps of Engineers Civil Works Concrete Structures, by J. E. McDonald and R. L. Campbell, Jr.	AD A157 992
TR REMR-CS-3	Jul 1986	Latex Admixtures for Portland Cement Concrete and Mortar, by D. L. Bean and T. B. Husbands	AD A171 352
TR REMR-CS-4	Nov 1986	Repair of Waterstop Failures: Case Histories, by J. E. McDonald	AD A176 937
TR REMR-CS-5		Instrumentation Automation for Concrete Structures	
	Dec 1986	Report 1 Instrumentation Automation Techniques, by John Lindsey, David Edwards, Aubrey Keeter, Tom Payne, and Roger Malloy	AD A178 139
	Jun 1987	Report 2 Automation Hardware and Retrofitting Techniques, by Aubrey Keeter, Byron Stonecypher, Tom Payne, Mathew Skerl, Jim Burton, and James Jennings	
	Jun 1987	Report 3 Available Data Collection and Reduction Software, by Brian Currier and Marta H. Fenn	
TR REMR-CS-6	May 1987	In Situ Repair of Deteriorated Concrete in Hydraulic Structures: Feasibility Studies, by R. P. Webster and L. E. Kukacka	
TR REMR-CS-7	Jul 1987	Design of a Precast Concrete Stay-In-Place Forming System for Lockwall Rehabilitation, ABAM Engineers	AD A185 081
TR REMR-CS-8	Nov 1987	Procedures and Devices for Underwater Cleaning of Civil Works Structures, by Carmela A. Keeney	
TR REMR-CS-10	Dec 1987	Development of Nondestructive Testing Systems for In Situ Evaluation of Concrete Structures, by Henry T. Thornton, Jr. and A. Michel Alexander	
TR-REMR-CS-11	Jan 1988	In Situ Repair of Deteriorated Concrete in Hydraulic Structures: Laboratory Study, by R. P. Webster and L. E. Kukacka	
TR REMR-CS-12	Mar 1988	Factors Related to the Performance of Concrete Repair Materials, by Lawrence I. Knab	
TR REMR-CS-13	Dec 1987	Rehabilitation of Navigation Lock Walls: Case Histories, by James E. McDonald	
TR REMR-CS-14	Dec 1987	A Demonstration of the Constructibility of a Precast Concrete Stay-in-Place Forming System for Lock Wall Rehabilitation, by ABAM Engineers	

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TR REMR-CS-15	Aug 1988	Analysis of Concrete Cracking in Lock Wall Resurfacing, by C. Dean Norman, Roy L. Campbell, Sr., and Sharon Garner	
TR REMR-CS-16	Jan 1988	Repair of Dam Intake Structures and Conduits: Case Histories, by Roy Campbell	
TR REMR-CS-17		Surface Treatments to Minimize Concrete Deterioration	
	Apr 1987	Report 1 Survey of Field and Laboratory Application and Available Products, by Dennis L. Bean	
TR REMR-CS-18	Apr 1988	Evaluation of Concrete Mixtures for Use in Underwater Repairs, by Billy D. Neeley	
TR REMR-EI-1	Nov 1986	Applicability of Environmental Laws to REMR Activities, by J. E. Henderson and L. D. Peyman	AD A177 322
TR REMR-EI-2	Nov 1986	Bibliography of Environmental Research Related to REMR, by N. R. Nunnally	AD A177 069
TR REMR-EI-4	Aug 1988	Seasonal Regulation of Repair, Evaluation, Maintenance, and Rehabilitation (REMR) Activities, by Mark W. LaSalle, John Nestler, and Andrew C. Miller	
Unnumbered	Jan 1988	Proceedings of REMR Workshop on Seepage Control	
TR REMR-GT-1	Sep 1984	Mathematical Analyses of Landside Seepage Berms, by R. A. Barron	AD A150 014
TR REMR-GT-2	Aug 1985	Improvement of Liquefiable Foundation Conditions Beneath Existing Structures, by R. H. Ledbetter	AD A160 695
TR REMR-GT-3	Aug 1986	Geotechnical Aspects of Rock Erosion in Emergency Spillway Channels, by C. P. Cameron, K. D. Cato, C. C. McAneny, and J. H. May (Report 1 of a Series)	AD A173 163
TR REMR-GT-4	Nov 1987	State of the Art for Design and Construction of Sand Compaction Piles, by R. D. Barksdale	
TR-REMR-GT-5	Sep 1987	Inspection and Control of Levee Underseepage During Flood Fights, by R. W. Cunny	
TR-REMR-GT-6		Geotechnical Applications of the Self Potential (SP) Method	
	Mar 1988	Report 1 The Use of Self Potential in the Detection of Subsurface Flow Patterns in and Around Sinkholes, by Ronald A. Erchul	
TR REMR-GT-7	Dec 1987	Application of the State of the Art of Stone Columns-Liquefaction, Local Bearing Failure, and Example Calculations, by R. D. Barksdale	
TR REMR-GT-8	Jul 1988	Review of Consolidation Grouting of Rock Masses and Methods for Evaluation, by R. Morgan Dickinson	
TR REMR-GT-9	Mar 1988	A Survey of Engineering Geophysics Capability and Practice in the Corps of Engineers, by Dwain K. Butler	
TR REMR-HY-1	Jul 1984	Annotated Bibliography for Navigation Training Structures, Compiled by W. E. Pankow and R. F. Athow, Jr.	AD A173 303
TR REMR-HY-2	Jun 1987	Floating Debris Control; A Literature Review, by R. E. Perham	AD A184 033
TR REMR-OM-1	May 1986	Evaluation of Existing Condition Rating Procedures for Civil Works Structures and Facilities, by Enno Koehn and A. M. Kao	AD A170 391

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TR REMR-CO-3		Case Histories of Corps Breakwater and Jetty Structures	
	Jun 1988	Report 1 South Pacific Division, by Robert R. Bottin, Jr.	
TR REMR-CO-4	Feb 1988	Stability of Dolos and Tribar Overlays for Rehabilitation of Stone-Armored Rubble-Mound Breakwater and Jetty Trunks Subjected to Breaking Waves, by Robert D. Caver and Brenda J. Wright	
TR REMR-CO-5	Feb 1988	Stability of Dolos Overlays for Rehabilitation of Dolos-Armored Rubble-Mound Breakwater and Trunks Subjected to Breaking Waves, by Robert D. Carver and Brenda J. Wright	
TR REMR-CO-6	Aug 1988	Stability of Dolos Overlays for Rehabilitation of Tribar-Armored Rubble-Mound Breakwater and Jetty Trunks Subjected to Breaking Waves, by Robert D. Carver and Brenda J. Wright	
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DWAYNE G. LEE
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