Pipeline emplacement: mitigating environmental impacts on wetlands

by Michael A. Krone

Pipeline emplacement on wetlands offers a special challenge because wetlands are environmentally sensitive to the needed labor-intensive activity and use of heavy equipment.

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The value of wetlands

For hundreds of years it was widely assumed that swamps and wetlands had only two uses: to be dredged for lakes and river channels or filled for farms and factory sites. Governmental policy was directed primarily to the elimination of wetlands until about the mid-1900's. It was not until the 1970's that the values of wetlands became widely recognized and documented by the scientific community, and wetlands received governmental protection at both the state and federal level.

Wetlands are among the most productive ecosystems on earth (see figure 1). This productivity nurtures marine commercial and sport fishing, waterfowl, and many furbearing animals — all of which are dependent on wetlands at some point in their life cycle. Consider the following: 1) On the South Atlantic and Gulf Coasts 90% of the commercially important fish and shellfish are dependent on coastal marshes for part or all of their cycle. In 1980 62.7% of the 7 billion pounds of commercial fish caught by American fishermen was dependent on estuarine areas and their associated wetlands, 2) Waterfowl and other waterbirds are extremely dependent on wetlands. Ducks and geese form the base of a multi-million dollar industry through the money spent by more than 2.7 million waterfowl hunters, 3) Many furbearing animals are dependent on wetlands. Muskrat, mink, beaver, otter, raccoon and nutria are almost always associated with water and wetlands. The total harvest of mink, muskrat and nutria exceeded 8 million animals worth more than $33 million in 1975-1976.

Two other important values of wetlands involves flood control and water quality maintenance. The flood control values of wetlands have been documented at numerous sites. Coastal wetlands and those along large lakes are effective at dissipating the energy from wave action created by storms. And in some areas, it has been demonstrated that wetlands can retain 50-79% of the total runoff from most storms. Water quality maintenance and purification of polluted water are valuable functions of most wetlands. Wetlands are actively used to help cleanse effluent waters from sewage treatment processes and some industrial and agricultural practices.

In this context, the natural gas pipeline industry uses a lot of current techniques to minimize construction impacts on wetlands. Installing a pipeline is essentially a balancing act where engineering options are measured against economic considerations, safety and environmental requirements, service and market realities, and other factors which directly affect the pipeline, such as landowner preferences in right-of-way (ROW) treatment. This paper will offer examples of how United Gas Pipe Line Company (United) integrates environmental considerations into new pipeline construction projects.

United's 10,000 miles of interstate natural gas pipe is located throughout the Gulf South including about 4,700 miles of gathering and transmission pipe in Louisiana. Our Louisiana system is part of a major network which transports Louisiana's rich offshore natural gas reserves to onshore distribution networks. Much of this system is located and maintained in brackish marshes and wetlands along Louisiana's coastal zone. The local residents, who are known as cajuns, say that land is too thin to walk on and too thick to drink.

United is not actually in the pipeline construction business but we do own, operate, and maintain our own system. We manage contractors to ensure that pipeline projects are built to our specifications and quality standards. Our 60-plus years of construction management

NET PRIMARY PRODUCTIVITY OF SELECTED ECOSYSTEMS (g/m²/year) adapted from Lieth (1975) and Teal and Teal (1969)

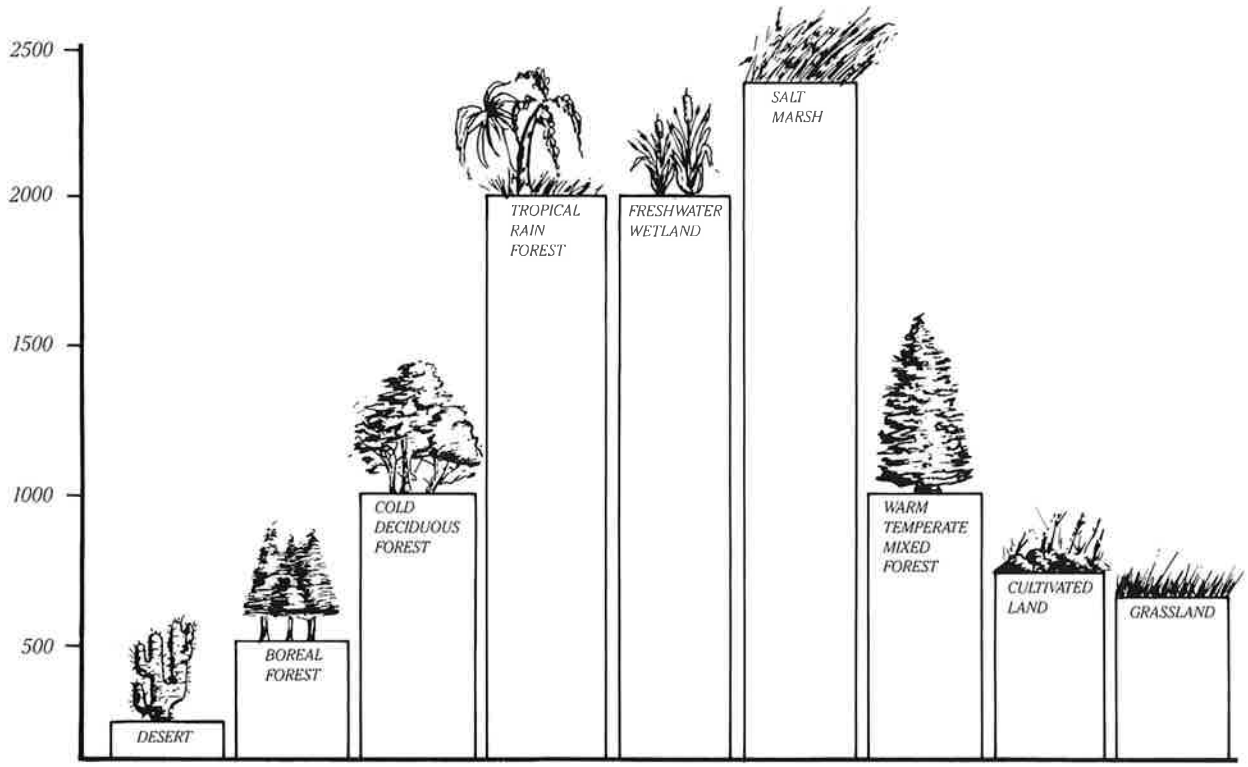

Figure 1. Relative productivity of wetland ecosystems in relation to others. IN: Tiner, Jr. 1984.

experience ensures site specific construction practices which are both environmentally sound and cost-effective.

Wetlands loss and pipeline construction

The increasing rate of wetlands loss is a matter of concern. Most of the coastal wetlands in Louisiana are the result of 5,000 years of Mississippi River delta building. In fact, 40% of coastal wetlands in the contiguous U.S. are found in Louisiana. This long-term deltaic growth process has been reversed in recent history by a complex interaction of physical, chemical, and biological factors. Recent estimates of annual wetlands loss to open water in Louisiana approximate 47 square miles per year (Senate and House Committees on Natural Resources, 1981).

It is currently difficult to predict construction impacts on wetlands because there is very little literature published on the subject. Most literature (Darnell, 1976, MMS, 1983) suggests that *pipeline emplacement impacts are localized and of short duration*. This suggests that either wetlands are more resilient that previously thought or pipeline emplacement activities are compatible in this environment. Whatever combination of reasons is good because pipelines are the safest, most efficient, and most extensive energy distribution system available today. Some researchers suggest that existing pipeline and navigation canals contribute to the total yearly wetlands loss in Louisiana. Estimates vary from 2-4% (Craig et al, 1979, Wicker et al, 1982) and higher. Natural gas pipeline canals represent the old approach to pipeline emplacement and are generally not acceptable under the current regulatory climate because they tend to erode about 2-14% per year and encourage salt water intrusion unless measures have been taken to prohibit boat traffic and control water flow.

Recreational and commercial boat traffic creates a shore wash which erodes and widens the banks where the canals are open to traffic. Pipeline companies cannot control boat traffic but they do have regular maintenance programs to control erosion on their right-of-ways. Where new installations cross existing pipeline canals we can and do, with landowner's permission, minimize the problem.

Louisiana's wetlands are under a lot of pressure. The natural causes of wetlands loss in Louisiana include:

- Subsidence and rising sea levels which enhance salt water intrusion (Adams et al, 1976, Gagliano, 1981)
- Erosion of wetland perimeters and barrier islands (Van Sickle et al, 1976)
- Catastrophic events like hurricanes and fires (Johnson, 1981)
- Changes in the patterns of sediment deposition (Gordon, 1981) and
- Natural succession and biotic factors like overgrazing.

The man-induced causes of wetlands loss in Louisiana include:

- Land reclamation due to farming, housing, and landfill (Craig et al, 1979, Gagliano, 1973)
- Flood control (Keown et al, 1981) and reservoir construction
- Dredging for navigation channels
- Canals associated with oil and gas extraction
- Strip mining and peat mining
- Groundwater extraction and waste disposal.

Regional variations in subsidence and sea level make it difficult to isolate the

impact of natural and man-induced factors. It is clear that the predictability of wetland environmental impacts is not well defined at this time and further research on ecosystem structure, function, and response needs to occur. There is also a critical need to learn how to restore and manipulate degraded wetland environments. Both are areas where the natural gas industry can take and is taking a leadership role.

Compensatory mitigation or the 'banking concept" is a new approach to environmental impact which is somewhat controversial. Compensatory mitigation can serve as a positive tool in environmental planning when it is used to balance the unavoidable impacts of development against the need for maintaining a relatively pristine coastal environment. Compensatory strategies can take the form of habitat restoration, creation or enhancement as a means of replacing projected losses of habitat, resources and/or habitat functions.

Numerous laws, including the Fish and Wildlife Coordination Act and the Clean Water Act require that the adverse ecological impacts of a development project be mitigated by the developing agency or individual. The banking concept offers a unique approach to satisfying those requirements because it puts mitigation up front in the permit process rather than at the end. As a result it should reduce delay often associated with the permit process. From an environmental standpoint, the "banking concept" can maintain and in some instances enhance the environment (Helvey, 1984, Zagata, 1984).

Short-term impacts and mitigative planning

United attempts to minimize construction impacts on all construction projects because: 1) we believe in the "good neighbor" policy, 2) we comply with federal and state environmental regulations, and 3) it is cost-effective to address environmental issues in planning stages. Pipeline emplacement in wetlands offers a special challenge because they are considered sensitive and the environment itself is hostile to a labor intensive activity which uses heavy equipment.

The regulatory arena is also sensitive to wetlands issues. Here are some examples of federal programs which impact wetlands although no specific legislation exists to date:

- Rivers and Harbors Act (1899)
- Federal Water Pollution Control Act (Clean Water 1972)
- Migratory Birds Act (1918, 1929, 1934)
- Wetlands Loan Act (1961)
- Land and Water Conservation Act (1965)
- Water Bank Act (1970)
- Fish and Wildlife Coordination Act (1965)
- Coastal Zone Management Act (1972)
- Endangered Species Act (1972), and
- Executive Order 11990 (1977)

The intent of this federal legislation is good but there still exists federal legislation which encourages wetlands conversions like the Swamp Lands Act and the Agriculture Conservation Program.

At United, we make it a point to be aware of, understand, and comply with all appropriate regulations. We plan for

this compliance and communicate this attitude to our construction crews. But even given a positive approach and modern construction techniques, *pipeline emplacement does have some short-term environmental impacts.* Pipeline emplacement has the potential to impact wetlands in the following ways:

- Changes in drainage patterns and tidal flow
- Increased turbidity
- Changes in soil and soil-water chemistry
- Changes in nutrient flow
- Damage to archaeological resources
- Reduction in esthetic qualities and recreation opportunities, and
- Disturbances of plant and animal community structure.

Short-term impacts like turbidity are minimized by planning and rapidly disappear after the construction crew completes their right-of-way (ROW) treatment to our specifications. United evaluates a number of siting and construction guidelines for every potential route to minimize short-term impacts. These include:

- Avoiding wetlands where possible
- Minimizing clearing on the ROW
- Utilizing existing ROW when possible and attempting to cross wetlands at their narrowest point
- Timing the construction period with an awareness of wildlife breeding activities and low-water levels to reduce turbidity loads and species impacts (especially oysters)
- Implementing stream bank repair immediately following construction to control erosion and salt water intrusion
- Contouring to reestablish drainage patterns using bulkheads, culverts, earthen dams, wiers, or other aids
- Crossing streams at right angles at the narrowest point in areas of shallow stream banks to minimize riparian construction staging impacts. The higher the stream bands the more bank has to be cut away so that the pipe has the cover required by safety regulations or by permitting agencies and construction personnel are working with a safe grade (2:1)
- Minimizing the number of construction vehicles and their frequency of passes to control soil compaction and reduce plant community impacts

- Backfilling trench in a timely manner to avoid canalization and restore contours
- Consider double ditching where circumstances call for it. Double ditching is a construction technique where the topsoil is segregated from the trench spoil and then replaced sequentially. This technique has been used in some agricultural situations where it is felt that the trench spoil has a different nutrient profile or acidity.
- Revegetating high-energy sites like barrier islands or consider directional drilling, and
- Using the push-pull method of construction or other construction techniques to minimize turbidity loads and construction impacts.

Of the above short-term impacts, disruption of plant communities is probably the most obvious environmental impact attributed to pipeline emplacement. The ROW has to be kept free of woody shrubs and trees for safety considerations and access. In most wetland situations although, available studies (Farnworth, 1979, Odegard et al, 1982) indicate that *rapid recovery, in terms of vegetative cover, occurs within two growing seasons after a pipeline is installed.* The natural gas industry is currently sponsoring further research to document the resilience which wetlands exhibit to current pipeline emplacement techniques. New construction techniques which appear to enhance plant recruitment and are cost-effective are incorporated into our mitigative planning measures.

Mitigative planning is the process of siting and regulatory consultation which precedes construction in an attempt to minimize short-term and long-term impacts to the environment. The process at United involves:

- Establishing baseline conditions from available in-house resources. United employs environmental analysts to evaluate potential environmental impacts for route alternatives using resources like the MMS Regional Environmental Assessments and Bio-Atlas, Louisiana Wildlife and Fisheries Gulf Coast Ecological Inventories, and the DNR Louisiana Coastal Resources Atlas. Aerial overflights are helpful in this regard. The route selection process occurs between essentially two fixed points (i.e. the production or processing platform and a pipeline point of connection). If engineering considerations permit, the direct line approach is evaluated to minimize materials and wetlands impacts. We relay on agency insights during the route selection process to avoid sensitive areas.
- Company personnel routinely visit the work site before meeting with permit agencies (e.g., MMS, COE, CUP, W&F, SHPO). Pre-application meetings are used to discuss the project, various route considerations and construction methods, and the type and the quality of the terrain to be traversed. The sit-

ing guidelines which have already been mentioned are discussed and evaluated for each route.

- Then applications are made for construction, ROW, and environmental permits. Interstate natural gas companies have the power of eminent domain to ensure that an environmentally compatible route can be secured should such action be required.
- Bids go out to various preselected construction companies with proven wetlands construction expertise. An up-to-date referral system is employed to assure that the bidder has the equipment, expertise, and the financial strength to complete the job and his track record for previous projects is good. The bids incorporate the mitigative planning measures as construction specifications including the type of equipment desired for use and the various permit requirements. Construction bids are opened at a predetermined date and evaluated for cost, construction plan, task comparison, and resources the company plans to use in terms of equipment and manpower.
- Part of the mitigative planning sequence is implementation. Our onsite construction inspectors monitor for specification compliance. These United field personnel have the hand's-on responsibility to complete the job in full accordance with the plans, specifications, laws and regulations and most importantly in a safe, workmanlike manner. The real success of a wetlands project rests upon the experience and expertise of these project supervisors, field engineers, construction representatives and inspectors.

Construction sequence

Current pipeline construction practices in wetlands is a repeatable operation which requires digging ditches into which the pipe is floated and subsequently lowered to the bottom of the ditch. This construction method is known as the push method because all welding operations and pipe storage is done at a central staging area to reduce ROW impacts. The push-pull method is another variation where the pipe is pulled as it is floated. The material

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How to save a marsh by creating one

A unique project in San Diego gives Caltrans the chance to build back a coastal natural resource.

by Gene Berthelsen

Gene Berthelsen is Chief of Communications for Caltrans. This article first appeared in the official Caltrans' publication 'Going Places,' Sept.-Oct. 1984 issue.

A staff of talented Caltrans scientists in San Diego is hard at work turning a heretofore unloved piece of real estate on the southeastern shore of San Diego Bay into a thriving habitat where lightfooted clapper rails, California least terns, and other birds, wildlife, and plants can once again begin to weave their complex set of environmental relationships.

At the same time, work can proceed on a much needed interchange on Interstate 5 and State Route 54, and related projects.

The conservation work involves Sweetwater Marsh, a tidal area unprepossessing in looks, but one of the last remaining saline marshes in San Diego Bay. Like so much California marshland, this area in the 1920s and 30s was thought to have no particular purpose, and so was adorned with a landfill dump.

Sweetwater Marsh is part of a complex land swap involving the old dump, old dredge spoils, and 200 acres of marshy land to be preserved by the U.S. Corps of Engineers. Most of the land is currently owned by the Santa Fe Railroad.

Caltrans is restoring 25 acres of the wetlands and adding 10 acres of new marsh in exchange for the use of 10 acres for the freeway. By doing so, Caltrans can expand Interstate 5 and build its east-west Route 54, just south of San Diego. Groundbreaking was held last May. Santa Fe will have an opportunity to develop its residential and coastal-oriented Gunpowder Point project, and Caltrans will complete its Sweetwater Flood Control Project for the Corps of Engineers.

As with so many Caltrans projects, the Route 5/54 Interchange was planned during a period of dynamic change in state and federal environmental law. Agreements for the route's location were signed in 1964. By 1969, the project was already awaiting funding. The project was to involve a lane addition to the existing Route 5 between E Street in Chula Vista and 24th Street in National City, and an 8-lane freeway between Routes 5 and 805. One of the main features of the project was a freeway-to-freeway interchange of routes 5 and 54.

Integrated with the project was a Corps of Engineers flood control project on the Sweetwater Channel to control periodic flooding (even though a serious flood had not occurred since 1916, when a wildly effective rainmaker named Hatfield had succeeded in flushing much of San Diego into the Bay — and had to flee to Mexico).

Caltrans' first action was to go ahead by filing a notice of negative declaration, even though almost 30 acres of marshland were slated to be used for structures and fill. Next came an environmental report and a thorough review by local, state, and federal agencies.

It was the Endangered Species Act and the Fish and Wildlife Service which prompted the decision to regenerate the marshland. Two species of endangered birds, the light-footed clapper rail and the California least tern, had nesting areas within project limits.

To mitigate the impact on these areas, the conservation agencies and Caltrans recommended eliminating some off-ramps and relocating others, eliminating dredging associated with the project, removing hiking and recreational trails, assuring fresh water flushing of the area,

and other measures. Construction work in the birds' nesting sites was prohibited during the birds' critical breeding season of May 1 to August 15.

But the recommendation that brought the Caltrans environmental scientists into the project was that the lost marsh must be compensated with restored marsh in another area, and that other areas should be preserved.

California's marsh destruction was no small matter. In fact, the U.S. Army Corps of Engineers had named the state as having the "dubious distinction of being the nation's leader in the destruction of marshes and wetlands."

In the late 1700s, when Europeans began to arrive at San Diego Bay, there had been extensive estuarine and salt marsh ecosystems. But the bay's natural harbor and balmy climate subjected it to intensive use for shipping, U.S. naval operations, fishing, and a host of marine-related recreational activities.

By the time Caltrans had started planning for the Route 5/54 Interchange, the Sweetwater-Paradise marsh complex contained 300 of the last 420 acres of marsh left in the San Diego Bay area. Small wonder it was highly sensitive.

A long series of compromises was struck. The area lost to ramps and structures was reduced to fewer than 10 acres.

Mark Moore is one of several Caltrans and other government biologists who have been associated with the project. A graduate from Humboldt State University in Arcata, CA, he makes it clear that his job is to figure out how to keep Caltrans projects from putting any more of Mother Nature's creatures out of business.

"Sure, Caltrans was only going to take 30 acres for this project. But we've already lost forever 90% of all saltmarsh wetlands in California to development, bit by bit. Continual losses of 10 acres here and 10 acres there will degrade or eliminate almost every coastal saltmarsh in California," says Moore.

Nowhere is the complex interrelationship of species more dramatic than in the fragile salt marsh Moore is so busy working with. Here, thousands of tiny creatures ebb and flow with the tides, feeding on each other, living lifecycles that may be as short as a few hours.

There is low marsh, middle marsh, and high marsh. Low marsh means mud flats, areas under water most of the time, which appear only when the tides are well out. Below the low marsh are mudflats and tidal channels, which grade into areas thick with cordgrass, saltwort, and pickleweed. (Pickleweed is so named because early settlers used the plant's salty, succulent stems as a pickle substitute.) The low marsh areas dominated by cordgrass are preferred for nesting by the endangered lightfooted clapper rail.

Low marsh areas are flooded and exposed with each high and low tide. Tidal channels near the low marsh are critical spawning and rearing grounds for numerous fish species including smelt, turbot, queenfish, and killifish. These fish in the tidal channels are foder for the terns, nesting on nearby open, sandy expanses.

Mudflats bordering tidal channels and low marsh plants are also critical as producers of small molluscs and crustaceans which are food for many birds. Here, too, feeding on algae, are colonies of shore crabs — seas of them that look like the opening valves on some Disney-esque musical instrument, until we arrive on the scene and they dive into pencil-sized holes in the sand.

Middle marsh habitats, just a couple of feet higher, are periodically submerged but are exposed for more time at low tide. Several feet higher is high marsh, washed only by the highest of tides, and as you walk across it, it looks oddly juxtaposed, like a desert, here so close to the ocean. Here are found such plant species as saltgrass, lovegrass, sea lavender, and sea-blite. An endangered plant called saltmarsh bird's beak is also found in the high marsh.

The marshes must be supplied with natural barriers to civilization encroaching in the form of cats, dogs, and curious boys and girls. The new marsh will be protected from its surrounding urban environment by a deeper marsh — a water barrier.

The marsh environment is so delicate that a change in elevation of just a few feet can destroy it. Pile on a layer of topsoil for a landfill dump, and even the hardy pickleweed turns sparse, to be

(See Marsh, page 10)

removed from the ditch, namely marsh substrate, mud, and vegetation, is placed alongside the ditch and then the ditch is backfilled using this material to cover the pipeline. Frequently, there is inadequate material to backfill due to losses of plastic or liquid marsh substrates. The very fluid soil may spread into the adjacent marsh or be reduced in volume by drying and compaction (Farnworth, 1979). The construction crews compensate for this by reducing the number of equipment passes to minimize compaction and backfilling as soon as possible.

Trench backfill methods vary depending on the type and quality of marsh. Cost-benefit analysis is employed at this point to determine the appropriate method of reclamation. Although pipeline companies are willing to prioritize environmental considerations, our experience suggests that typical construction costs when comparing farmland and wetland indicates that environmental reclamation techniques tend to be much more expensive in wetlands (about 10% of pipeline emplacement costs) with no quarantees of plant recruitment success. In addition, reclamation techniques are either labor intensive (e.g., revegetation) or use heavy equipment (e.g., double ditching). These reclamation techniques have their own adverse impacts which should be balanced in the mitigative planning process.

Post construction monitoring also occurs to ensure that mitigative measures are working and maintained. Pipelines are very expensive propositions and it is in our rate payers interest that they are environmentally compatible and that they are maintained in excellent condition. Pipelines are built using new corrosion resistant materials and coatings and are built to last for decades to minimize the need for maintenance work during its useful life. Once pipelines are no longer needed they are capped, filled with water, and abandoned in place to minimize the environmental impact of removal, unless their removal is required by the permitting agencies or the property owners.

Summary

In summary, the available literature suggests that the new construction tech-

(See Summary, page 10)

Marsh *(from page 9)*

replaced by a brilliant spray of chrysanthemums.

"Junk plants," snorts Moore. "They go, first thing."

There must be just the right balance of flushing from fresh water to allow some species to reestablish themselves periodically. But if too little sea water is available, the delicate plants of the saltwater marsh will die to be replaced by freshwater cattails and bullrushes. So this problem is being solved by construction of a barrier with "shunts" — holes in the flood control channel which will allow only so much water to get into the estuary.

How do you create such a world?

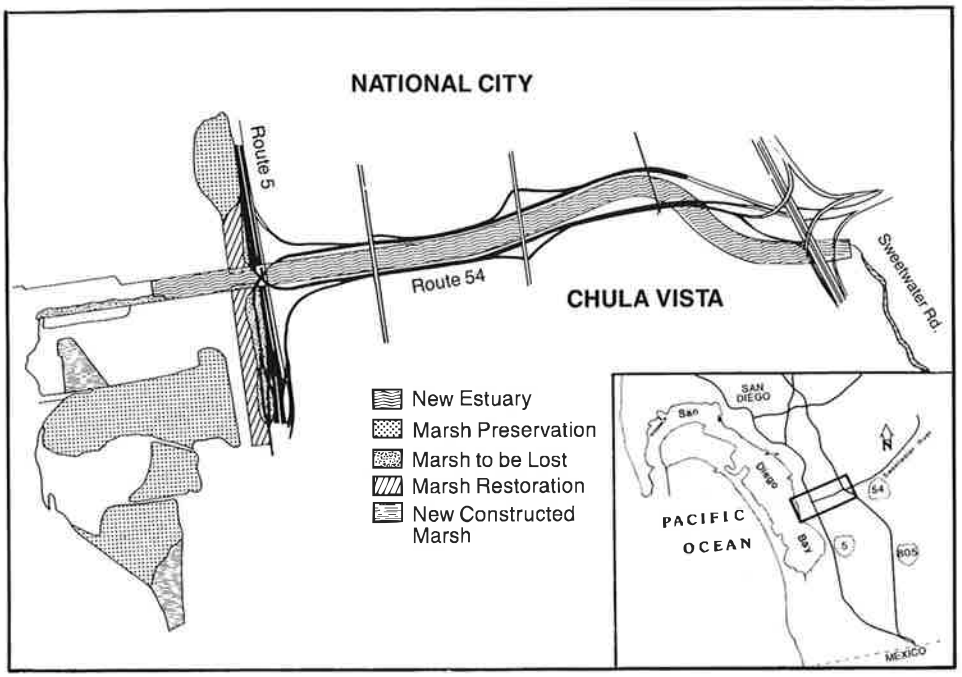
"You use a natural marsh for a template, try to troubleshoot the problems in advance — and keep your fingers crossed," Moore responds. "You can see where things lie, where they flourish, and where they die just by looking at a natural marsh."

It won't be necessary to introduce any plants or animals except for *Spartina Foliosa*, or cord grass, which has so many characteristics of crabgrass you wonder why it isn't flourishing there already. Two nurseries of cord grass are already planted against the day when it will be transplanted, a fistfull at a time, to become a sea of nutritious, protective grasses for a myriad of tiny creatures.

Moore is hesitant about a question on Caltrans "doing enough" for the environment. Once a student who viewed Caltrans as anathema, Moore today is plainly heartened with his effort in San Diego.

"But we're a long way from being sensitive enough," says Moore. "We have a long way to go." And from the determination in his eyes, it is obvious that he intends to move Caltrans toward more conservation, more preservation, more replacement of species already crowded out by highways and other accoutrements of California civilization.

The freeway and flood control projects should be finished by 1988. As for the wetlands of Sweetwater Marsh, they should be intact for many years to come.



Map by Bob Puckey

The least tern is among the wildlife being preserved by Caltrans in this highway project.

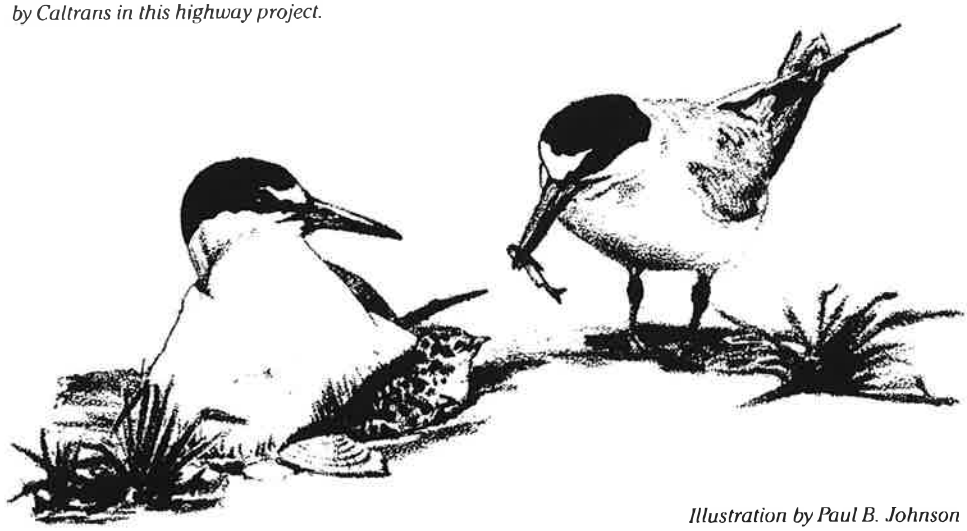


Illustration by Paul B. Johnson

Summary *(from page 9)*

niques employed by the natural gas pipeline industry are compatible in a wetlands environment. United is concerned about wetlands loss and is willing to employ cost-effective measures to ensure the environmental considerations are prioritized. Pipeline emplacement does have the potential to impact wetlands in several ways but mitigative planning and siting guidelines reduces or avoids the localized and short-term impacts. These short-term impacts are minimal when compared to other factors like rising sea levels and coastal subsidence.