Albuquerque constructed wetlands pilot project: Summary and status of City of Albuquerque project, September 1995

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INTRODUCTION

The Pueblo of Isleta, located five miles downstream from Albuquerque, and the NM Water Quality Control Commission has established strict water quality standards for the Rio Grande, and it has become necessary for the Albuquerque Public Works Department to pursue methods to enhance the purity of treated municipal wastewater effluent produced at the Southside Water Reclamation Plant (SWRP). In response to requirements in a National Pollutant Discharge Elimination System (NPDES) permit, issued in June 1994 by the US Environmental Protection Agency (USEPA), design has begun for additional facilities at SWRP to support biochemical processes that effectively reduce nitrogen during wastewater treatment. However, the NPDES permit, in recognition of State and Pueblo stream standards for the Rio Grande, contains potential discharge limitations for several substances other than nitrogen, including arsenic, silver, aluminum and cyanide. In addition, the permit requires that an interagency evaluation of existing Rio Grande water quality be completed within three years, to provide a foundation for future decisions about the river.

THE CONSTRUCTED WETLANDS STUDY GROUP

The Albuquerque City Council and the Bemalillo County Commission, recognizing the need to explore alternative methods for treating municipal wastewater to higher levels of purity, commissioned the City/County Constructed Wetlands Study Group, in October 1992 and in August 1993, respectively. Goals of the Study Group were to evaluate the status of natural wetlands in the Albuquerque reach of the Rio Grande; to ascertain the impact of new discharge limits on City wastewater treatment operations, including a scoping study of future compliance options and costs; and to examine the applicability and impacts of constructed wetlands for wastewater treatment in Bernalillo County.

In their December, 1993 Final Report to the City Council and County Commission, the Constructed Wetlands Study Group concluded that constructed wetlands represent a proven technology for wastewater treatment that offer added benefits related to wildlife habitat and aesthetic enhancements. Constructed wetlands have been successful in small to medium scale applications for domestic sewage, municipal wastewater, urban stormwater runoff, industrial effluents and mine seepage. However, the Study Group found insufficient available data to establish the efficacy of constructed wetlands for tertiary treatment of large volumes of treated effluent from a municipal wastewater facility. Moreover, no unified system exists for regulating, certifying, operating or monitoring constructed wetlands treating wastewater, which often poses a public health risk. Finally, the Study Group expressed some concern about the effects of evapotranspirative water loss from constructed wetlands on City water rights, and suggested that aquifer recharge feasibility be examined if wastewater effluent could be adequately purified.

The December 1993 final report by the Constructed Wetlands Study Group report contained two major recommendations for further action:

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- Establish and operate a constructed wetlands pilot facility to rigorously evaluate tertiary treatment efficacy for municipal wastewater effluent, and
- Pursue the lease or purchase of properties down-gradient from the SWRP that can be used for full scale constructed wetlands, if the technology proves appropriate for polishing large volumes of treated municipal effluent.

THE CONSTRUCTED WETLANDS PILOT PROJECT PLANNING COMMITTEE

In early 1994, City Councilor Vickie Perea led the City Council in adopting resolutions that appropriated funds to pursue the Study Group recommendations. From the contingency allocation of a multimillion dollar contract to construct nitrogen removal facilities at the Southside Water Reclamation Plant, the Council diverted $10M for the purchase of property that can be converted into constructed wetlands in the future. Negotiations have been initiated toward the purchase of a privately-owned 500-acre parcel south of the treatment plant. It is envisioned that the property, if not converted to a large-scale constructed wetlands for effluent polishing, will be transferred to the City of Albuquerque Open Space Division to provide streamside habitat and recreational potential for the public.

Also based on the Study Group recommendations, the City Council appropriated $500,000 in March 1994 to support the construction of a pilot wetlands facility at SWRP. Discussions about the Study Group recommendation for a pilot constructed wetlands facility led to consideration of two options. A thirteen-acre parcel of land within Southside Plant boundary could be utilized for a constructed wetlands demonstration area. Alternatively, numerous obsolete concrete sludge drying beds were available for potential conversion to constructed wetlands test cells.

A 1994 joint agreement between the Directors of Planning and Public Works Departments, approved by the Chief Administrative Officer, established the Constructed Wetlands Pilot Project Planning Committee (CWPPPC), representing City, County and public interests. CWPPPC membership initially included representatives of the Albuquerque Public Works Department, Wastewater Utility Division; the Albuquerque Planning Department; the University of New Mexico, Department of Architecture and Planning; the Albuquerque Parks and General Services Department, Open Space Division; the Albuquerque Department of Finance and Management, Real Property Division; the Bernalillo County Environmental Gross Receipts Tax Advisory Board; and the Bernalillo County Environmental Health Department.

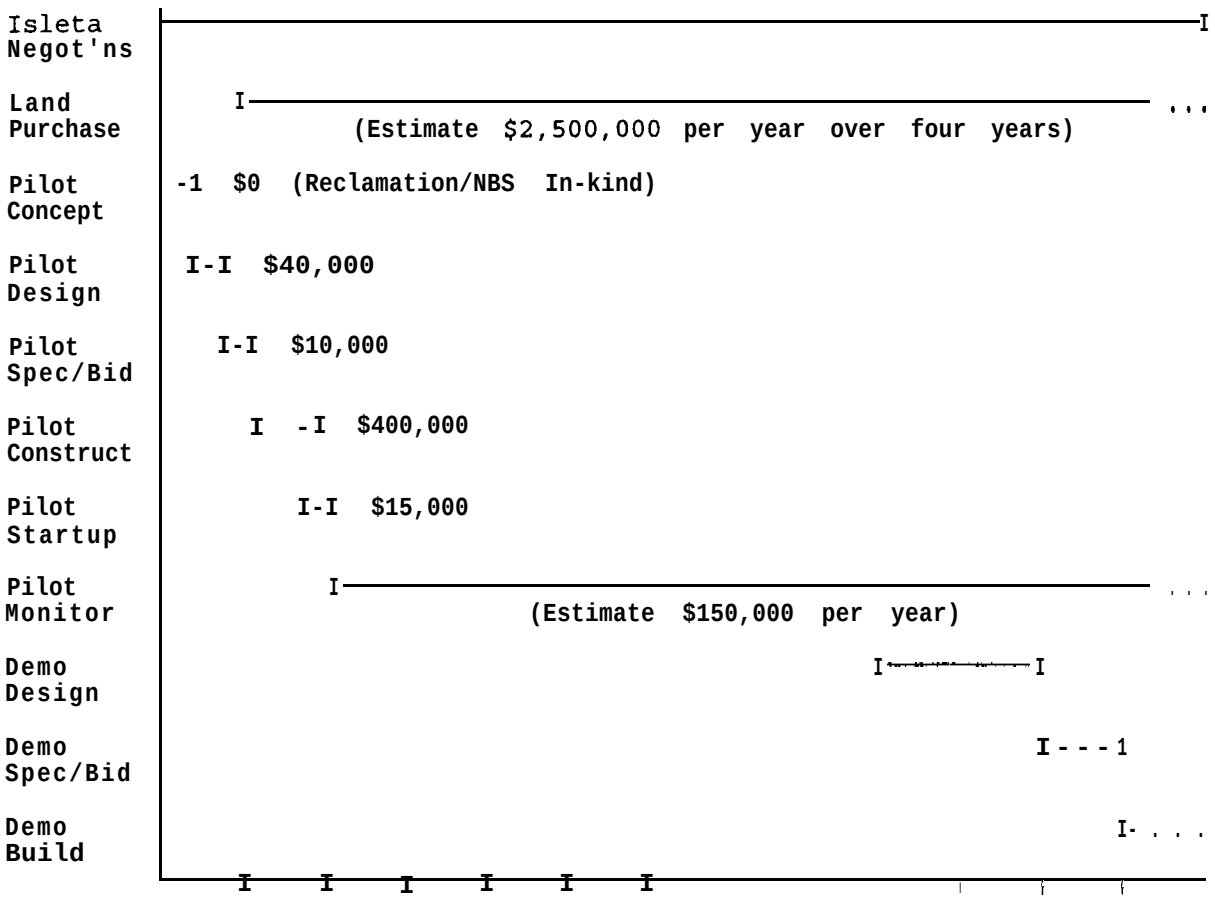
In the early stages of CWPPPC work, efforts were made to encourage financial support for the pilot project from Bernalillo County. Appendix A includes handouts prepared by the Committee for a presentation to the Bernalillo County Environmental Gross Receipts Tax Advisory Board. As CWPPPC efforts progressed, however, personnel changes within the County administration resulted in withdrawal of County representatives from the Committee.

Ultimately, the Committee recommended construction of a small-scale pilot wetlands facility to be operated for three years. Design and operations parameters developed from the pilot study could be used for subsequent installation of a demonstration-scale constructed wetlands on a 13-acre parcel of property available at the Southside Water Reclamation Plant. However, certain stipulations in the Albuquerque National Pollutant Discharge Elimination System (NPDES) permit could preclude the demonstration-scale study.

CONSTRUCTED WETLANDS PILOT FACILITY DESIGN PROPOSAL

The CWPPPC was made aware of a technology development support program operated by the US Bureau of Reclamation, and contacted the local Reclamation office. With the assistance of the NM Environment Department Surface Water Quality Bureau, a request for assistance was submitted to Reclamation. As a result, wetlands experts with the National Biological Service (NBS) and the Reclamation Denver Technical Center provided in-kind conceptual design support for the pilot wetlands facility at SWRP, and presented a proposal to the CWPPPC in November 1994. The

City of Albuquerque
Constructed Wetlands for Wastewater Treatment
Proposed Pilot and Demonstration Scale Projects Timeline



designers opted for conversion of the obsolete sludge drying beds at the Southside Water Reclamation Plant into constructed wetlands test cells, but left open the possibility of building a future demonstration wetlands facility on a thirteen-acre parcel south of SWRP. Although the original proposal envisioned the conversion of 21 obsolete sludge drying beds at SWRP into wetlands test cells, time and financial constraints reduced the scale of the final proposed facility by half to 10 test cells, treating only effluent from the Southside Water Reclamation Plant. City Appendix B includes excerpts from the final proposal.

Based on the final conceptual design by the NBS and Reclamation, the following proposed project timeline was developed in November 1994 by the Constructed Wetlands Pilot Project Planning Committee.

Council-sponsored review of the final proposal by local wetlands consultant Ross Coleman of Hydra raised concerns about the balance in the project design between general wetlands research and the specific effluent quality improvement objectives facing the City. Concerns were also expressed by CWPPPC representatives about the apparent lack of emphasis in the final proposal on wetlands use in smaller scale residential applications or wetlands use for urban runoff remediation. Committee members recommended that an effort be made to coordinate the proposed SWRP pilot project with separate ongoing and planned projects, targeted at evaluating constructed wetlands performance for treating residential wastewater and urban runoff. Specific companion programs include the constructed wetlands assessment and demonstration program funded by the Bernalillo County Environmental Gross Receipts Tax; and a constructed wetlands installation at the outfall of an urban stormwater discharge, planned by the Albuquerque Public Works Department Hydrology Division for their Osage la Media project.

PILOT FACILITY DESIGN CHARETTE

In light of unresolved differences of opinion within the CWPPPC about the most appropriate design for a constructed wetlands pilot project at SWRP, it was determined that independent experts in the field should be assembled for an intensive peer review session, or "charette." Accordingly, representatives of the Albuquerque City Council, City staff, Bernalillo County staff and interested citizens met January 21, 1995 at SWRP with constructed wetlands experts to conduct an intensive peer review of the proposed pilot wetlands facility, using the NBS/Reclamation proposal as a framework for discussion. Two trained facilitators, Rick Mack with the City and Ric Richardson with UNM, were retained by the City to assist charette participants in focusing discussions for maximum effectiveness. Ultimately, charette participants arrived at a consensus for pilot facility design that includes six duplicated constructed wetlands configurations, in which both monoculture and polyculture plant communities are represented. Research objectives were focused on examining heavy metals removal efficiency, nitrogen kinetics and moisture loss rates through evapotranspiration. A summary document, based on facilitators' notes, is attached as Appendix C. The following diagram provides a simplified illustration of the twelve test cell configurations established during charette discussions.

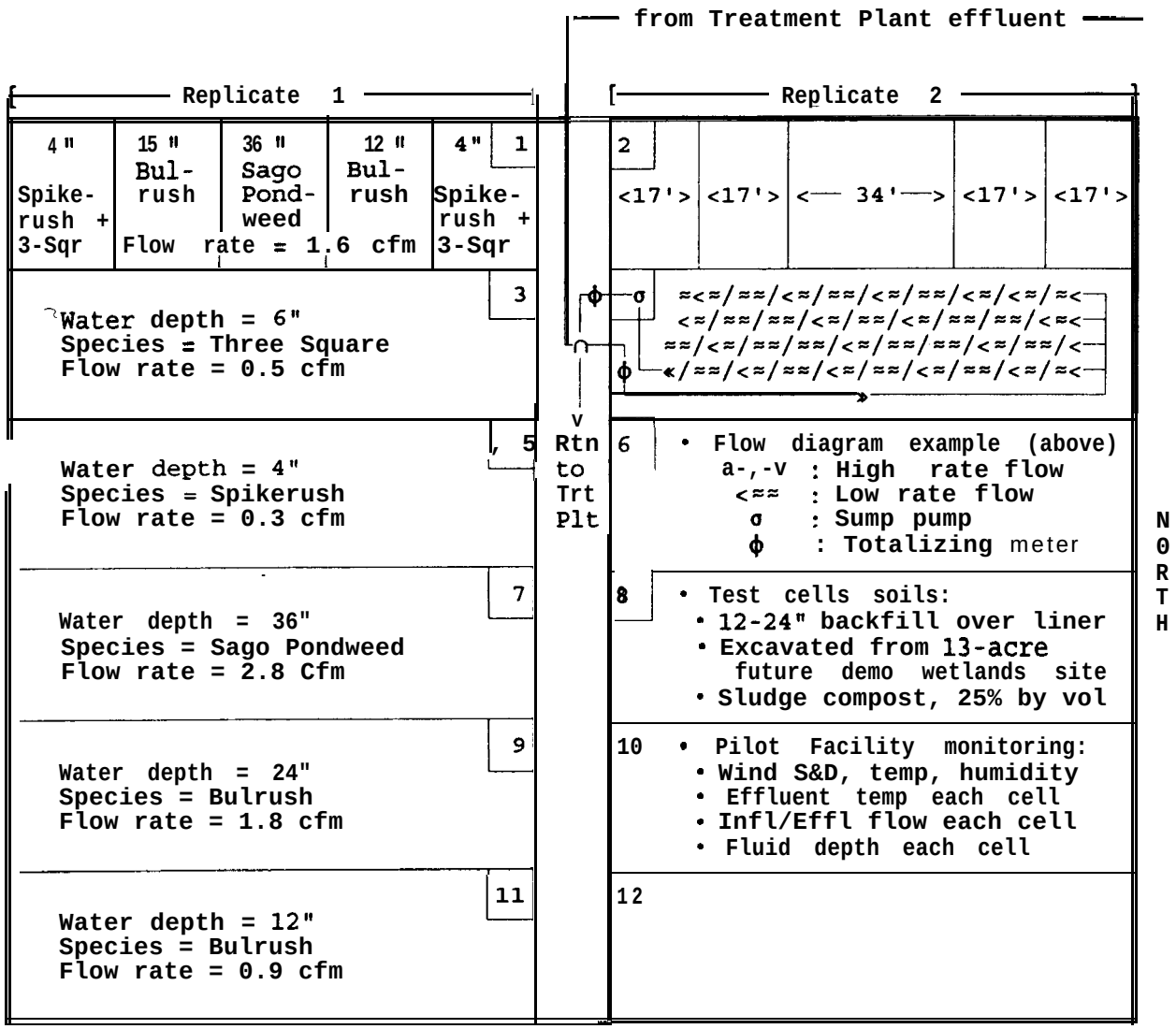
Appendix D includes written opinions about the proposed City program, offered by members of the public and by experts in constructed wetlands technology. Of the experts who provided written opinions, only Sherwood Reed participated in the January 1995 charette.

PILOT FACILITY DESIGN AND CONSTRUCTION

Immediately following the charette, final pilot facility design services were secured from Molzen-Corbin and Associates via a change order to an existing contract with the Albuquerque Public Works Department. Drawings were completed and approved for construction in late March 1995.

Two construction companies, each with existing contracts at the Southside Water Reclamation Plant, were provided final facility drawings and asked to provide quotes for pilot facility construction if completed under change order. After opening sealed quotes April 19, the Wastewater Division Facilities Engineering Section awarded the

City of Albuquerque
Constructed Wetlands Pilot Facility
Schematic Diagram



Note (06/30/95): Flow rates subject to confirmation by CWPPPC. Flow rates shown assume 72 hour detention time in each cell.

construction work to RMCI. Excavation of twelve former sludge drying beds at the west edge of the SWRP property began April 20, 1995.

In mid-June 1995, RMCI finished excavating the twelve former sludge drying beds. Ground water was encountered at a depth of 4.5 feet below grade, forcing some redesign of the four test cells for which deep water trials are planned. Consultation between the City, RMCI, Ross Coleman (Hydra) and Joan Thullen (National Biological Service) established that maximum water depths in the deeper cells could be limited to 36 inches, accomplished by reducing soil backfill from 24 inches to 12 inches depth. Both Coleman and Thullen are confident that the reduced depth will not materially affect the value of the constructed wetlands trials.

Excavated test cells were lined with polypropylene, and plumbing to deliver SWRP effluent to the test cells was installed. Soil, augmented with compost produced at the City biosolids composting facility, was used to fill lined cells in preparation for planting procedures. Compost augmentation is intended to simulate accumulated decaying plant detritus in the soil, allowing more rapid attainment of a mature, equilibrium state for ecosystems represented in the test cells.

The original change order to RMCI, under which the wetlands pilot facility was constructed, included an allocation for purchase of wetlands plants in numbers and of species defined by the Constructed Wetlands Pilot Project Planning Committee, in consultation with the National Biological Service. RMCI selected local supplier Hydra to provide the necessary plant materials. Under the planting subcontract with RMCI, Hydra was required to obtain a performance bond for the vitality of plant materials provided for constructed wetlands use. To ensure the survival of plants in the wetlands test cells, it was deemed vital that installation of the plants be accomplished by a few small teams of 4-6 competent individuals following strict planting procedures.

Responding to the emphasis placed on public information and participation during the Wetlands Pilot Project Charette in January 1995, both the City and Hydra thoroughly explored alternatives that would allow public assistance in planting the test cells. While members of the general public are unlikely to possess the necessary horticultural skills, the Albuquerque Area Master Gardeners' Association were considered likely candidates for planting volunteers. However, after consulting with the Master Gardeners' coordinator at the Bernalillo County Cooperative Extension Service office, it was determined that the degree of exposure and rigor of the planting work is excessive for most Master Gardeners, who tend to be elderly retired citizens. It was ultimately decided that Hydra should assume primary responsibility for installing plants in the constructed wetlands test cells, with assistance as needed from staff from RMCI, the City and the National Biological Service. Test cells planting was completed between June 19 and June 22, except that the deepest cells (7 and 8) were not planted because Sago Pondweed tubers were not available.

Sago Pondweed, specified during the Charette for the deep test cells and for the polyculture test cells was found to be unavailable from suppliers in the United States at the time of pilot facility planting. Sago Pondweed must be shipped in the tuber form, which cannot be harvested after the plants germinate, and the June planting schedule for the Albuquerque pilot facility postdated the annual germination period for pondweed. The NBS recommended an *Elodea* species as a substitute species, and Hydra initially concurred. However, after further consideration it was mutually determined that Elodea requires a cooler climate and clearer water, and would not thrive in secondary effluent. A decision was therefore reached to postpone planting Sago Pondweed in the deeper pilot facility test cells until April 1996. The deep cells (7 and 8) will be operated essentially as typical wastewater oxidation ponds, and the effects of volunteer algae growth will provide useful data for comparison with subsequent information gathered after pondweed is planted. In multiple depth cells, the planned polyculture plant community will be minimally affected by the temporary delay in the pondweed planting schedule.

Wastewater Division instrumentation technicians, with financial assistance from the National Biological Service, acquired equipment and hardware necessary for monitoring test cell effluent temperatures, solar energy, wind speed and direction, air temperature, humidity and precipitation at the pilot facility. Numerous opportunities to redeploy idle instrumentation from other Waste-

water Division applications have been exploited to reduce costs, and the NBS is funding the purchase of most new equipment needed.

DESIGN, CONSTRUCTION AND OPERATIONS COST ESTIMATES

Original facility construction estimates were provided by Reclamation in their project proposal. Costs to convert 10 obsolete sludge drying beds into wetlands test cells were estimated at $400,000, or $40,000 per cell. During charette discussions, a decision was made to substitute less expensive 40-mil polypropylene liners for the Hypalon liners specified in the proposal. From discussions with a local liner supplier, savings were estimated at $14,000 for twelve test cells, or $1167 per cell, bringing the construction costs estimate to $38,833 per cell.

No funds were allocated to final design costs in the original proposal. The design consultant quoted a cost of $40,000, increasing facility implementation costs to $42,166 per test cell.

Costs for acquiring and installing wetlands plants in the test cells were included in the NBS proposal, and were estimated at $13,100 for 10 test cells. The actual bid from Hydra under its subcontract with RMCI for plant materials to install twelve test cells is $22,820, which increased to $42,000 when RMCI markup and support labor were included. Some potential savings in planting costs were proposed during charette discussions, such as harvesting plants from local ditch-banks and using volunteer labor to plant the test cells. For purposes of these estimates, however, a cost of $3500 per cell was assumed for planting. Including planting, pilot facility implementation costs are estimated at $45,666 per test cell, or $547,992 for the entire 12-cell pilot facility.

It is estimated that operational support for the pilot facility will entail two visits per shift, two shifts per day, seven days per week by an Wastewater Operator II, for purposes of data collection, flow adjustments, minor maintenance and sample collection. A duration of one and one-half hour per visit seems adequate, with occasional longer times for more significant equipment repairs. Therefore, operational support for the facility will require 6 operator hours spread over two shifts per day, or 2190 operator hours per year. Average Operator time spent per wetlands test cell computes to 182.5 hours/cell/year. Including benefits, the hourly cost for a Wastewater Operator II is $12.86, or approximately $2347/cell/year, or $28,165 per year for a 12-cell facility.

Costs information for electrical power to operate facility sump pumps, and for materials and labor to repair or replace failed equipment, has not been developed by the consultant as of this writing. For purposes of this summary, electromechanical costs will be conservatively estimated as equal to personnel costs. Total estimated operations costs, then, are $4694/cell/year, or $56,328 per year for the planned 12-cell pilot facility.

Based on analytes and monitoring schedule proposed during charette discussions, along with others listed in the SWRP NPDES permit, the following draft wetlands facility monitoring protocol was prepared by City Public Works Department Technical Programs staff in conjunction with experts at the NBS and Reclamation in Denver. Analytical costs are based on the Albuquerque Water Quality Laboratory FY95 price list, assuming that one influent sample plus one sample per cell will be required for each sampling event. It should be noted that estimates have not been made for analyses of wetlands plant tissues, as recommended by charette participants.

The following table summarizes estimated facility costs for the 12-cell Constructed Wetlands Pilot Facility at the Albuquerque Southside Water Reclamation Plant.

	Design/Construct	Operations	Monitoring	Total Costs
Year 1	$547,992	$56,328	$149,904	$754,224
Year 2	--	$60,000	$170,000	$230,000
Year 3	--	$60,000	$170,000	$230,000

City of Albuquerque
Constructed Wetlands Pilot Facility
Draft Monitoring Schedule and Costs

Analyte Set	Cost/ Cell	Cost/ Series	Start Up (Jul)	Interim (Aug-Sep)	Stabilized (Oct-Jun)	Total costs
Operating Parameters: Flow rate, H20 temp	N/A	N/A	Continuous	Continuous	Continuous	N/A
Water Chemistry: pH, DO (Eff)	$17	$204	l/week [$1768]	2/week [$3536]	2/week [$15,912]	$21,216
Solids: TSS (Inf, Eff)	$20	$240	4/month [$9601	2/month [$9601	Z/month [$4320]	$6,240
Oxygen Demand: BOD (Inf, Eff)	$24	$288	4/month [$1152]	Z/month [$1152]	Z/month [$5184]	$7,488
Nitrogen: TEN, NH3+, NO2/NO3 (Inf, Eff)	$112	$1344	I/month [$5376]	2/month [$5376]	Z/month [$24,192]	$34,944
Fecal Coli, Fecal Strep (Inf, Eff)	$114	$1368	N/A	N/A	l/month [$12,312]	$12,312
Hvy Metals: Al, Ag, As + 10 other (Inf, Eff)	$468	$5616	N/A	N/A	l/month [$50,544]	$50,544
Cyanide (Inf, Eff)	$90	$1080	N/A	N/A	l/month [$9,720]	$9,720
Sediment: 13 heavy metals + Cyanide	$310	$3720	1 Series [$3720]	N/A	1 Series [$3720]	$7,440
Total analytical costs			$12,976	$11,024	$125,904	$149,904

PILOT FACILITY PUBLICITY

Media coverage of the constructed wetlands pilot study began with a dedication ceremony and press conference June 21, hosted by Albuquerque Chief Administrative Officer Lawrence Rael and City Councilor Vickie Perea. Also attending was State Representative Pauline Gubbels who, during her tenure as an Albuquerque City Councilor, initiated the Constructed Wetlands Study Group. Considerable interest in the pilot facility has been expressed by NM State University, Los Alamos National Laboratories, the NM Waste Management Education and Research Consortium, and by out of state constructed wetlands firms. During the first two months of pilot facility operation, tours were conducted for groups from the Dona Ana Community College Water and Wastewater Program, the Public Works Finance Division and Sandia Pueblo.

PILOT FACILITY START-UP

Initial experimentation will be conducted in accordance with goals established during the January 1995 charette, under a memorandum of understanding currently being drafted between the City and the NBS. A monitoring plan, directed at evaluating pilot wetlands performance for metals removal and nitrogen kinetics, has been developed jointly between the two agencies (see draft monitoring schedule above). It is anticipated that the Albuquerque Water Quality Laboratory, located at the Southside Water Reclamation Plant, will provide analytical support for the project.

The City took possession of the Constructed Wetlands Pilot Facility June 30, 1995 and immediately introduced treated municipal wastewater effluent to the freshly planted test cells. Cells 7 and 8, in which no plants had been introduced, were temporarily left dry.

Plant Operations staff immediately encountered significant difficulties maintaining consistent flow rates to any of the 10 active test cells. Problems were initially attributed to clogging in the perforated PVC pipes that serve as influent distributors for each cell. While influent distributor clogging is a definite continuing problem, continued observation established that the primary facility feed pump, which pressurizes the main trunk of the test cells influent network, was operating outside its optimum range and regularly tripped its circuit breaker. Discussions with the design engineer established that higher flow rates were necessary to prevent automatic shutdown of the primary influent pump. To increase flow rates, influent was introduced to test cells 7 and 8, and an influent overflow valve was partially opened at the end of the primary influent line. Some improvements were observed in flow rate consistency, although the variable pipe diameters designed to provide differing influent flows to the test cells continued to create unpredictable interdependent flow rate effects.

Additional problems were encountered with test cell effluent sumps and pumps. In two deeper test cells (9 and 10), cell drain plug gaskets failed, allowing cell contents to enter the cell effluent sump without passing through the gravel bed and perforated PVC pipe collection system. A solution was developed, and repairs were accomplished by the Wastewater Division Maintenance Group, although it was necessary to completely drain the cells. Another problem was discovered when test cells 7 and 8 were brought online to correct influent flow rate inconsistencies. Effluent sumps for cells 7 and 8 each contain two parallel sump pumps, needed to evacuate the higher flow rates intended for these deeper cells. Unfortunately, check valves were omitted from the plumbing between the parallel pumps, causing one pump to force cell effluent backwards through the second pump. Consequently, one sump pump in each test cell was destroyed within 48 hours after cells 7 and 8 were brought on line. Further complicating the problems with test cell effluent discharge, it was discovered that the flow meters specified for effluent lines are extremely sensitive to clogging, and malfunction regularly. Plans were developed to retrofit fine mesh screens at test cell discharge pipes, in an attempt to exclude particulate material that might clog effluent meters.

Despite the mechanical difficulties described above, plants thrived in the pilot facility test cells. Monocultures planted in cells 3, 4, 5, 6, 9, 10, 11 and 12 were maintained by regular removal of sparse weeds, although nearly confluent growth of volunteer duckweed in most cells was tolerated. Joan Thullen, Research Botanist with the National Biological Service, visited the facility August 8-10,

1995 to collect initial plant density and health data. Ms. Thullen noted that plant communities in the test cells were much further developed than she had anticipated, based on her previous experiences with constructed wetlands in California and Colorado. In six weeks, Spikerush tufts had grown to over 100 stems per square foot and Bulrush had reached nearly 6 feet in height. Moreover, habitat components of the pilot facility had become evident, with such indicators as a burgeoning dragonfly population, a diversity of subsurface insect life and regular visits by ducks and their broods. In anticipation of an eventual need to suppress mosquito breeding, the introduction of indigenous species of minnows and bats is being explored with local experts with the U.S. Fish and Wildlife Service and the National Biological Service.

APPENDIX A

Albuquerque Constructed Wetlands Pilot Facility Handouts Prepared for BCESGRT Advisory Board, November, 1994--Not included here.

APPENDIX B

Albuquerque Constructed Wetlands Pilot Facility National Biological Service/US Bureau of Reclamation Final Conceptual Design Proposal, November, 1994--Not included here.

APPENDIX C

Albuquerque Constructed Wetlands Pilot Facility Charette January 21, 1995, Summary--Not included here.

APPENDIX D

Albuquerque Constructed Wetlands Pilot Facility Written Opinions Received--Not included here.