Groundwater in the regional Hueco Bolson aquifer, a source of drinking water for the City of El Paso upgradient of the plant, occurs in both the fluvial deposits and the underlying lacustrine deposits. The primary source of drinking water for the region is extracted from the poorly sorted, irregularly stratified fluvial deposits which outcrop over most of east El Paso and range from 400 feet to 1300 feet thick. The deposits consist of unconsolidated sand lenses alternating with gravel, silt, and clay.

Elevated concentrations of arsenic and other metals in groundwater underlying the Plant were observed during remedial investigation groundwater monitoring events. Arsenic, and in some cases, cadmium, lead, and selenium exceed drinking water MCLs. Dissolved arsenic (the primary constituent of concern), concentrations in the groundwater range from 0.005 mg/l to 315 mg/l. As discussed in Section 2.3, elevated concentrations of metals in the groundwater appear to coincide with areas of elevated metals in soils, pond sediments, and other source areas/materials

Metal concentrations in the groundwater generally decrease by two or more orders of magnitude within a few hundred feet downgradient of the source areas. The rapid decrease in concentrations of metals suggest geochemical attenuation may be controlling horizontal metal migration in the groundwater system.

4.2.2.1 Chemical Treatment of Groundwater (Pump and Treat)

Metals can be removed from groundwater by adjusting the pH to form an insoluble precipitate that settles to the bottom of a treatment vessel. Calcium hydroxide (lime), sodium hydroxide (caustic soda), and to a lesser extent, magnesium hydroxide, are used singly or in combination to achieve the desired pH adjustment. Sulfide polishing is sometimes used as a third step, since the solubility of metal sulfides is substantially less than the solubility of metal hydroxides (Hydrometrics, 1993). Filtration of the treated water is usually required after hydroxide and/or sulfide solution to achieve treatment standards.

To achieve removal of arsenic to low concentrations, one and sometimes two modifications to the hydroxide precipitation step are required. If arsenic is in the insoluble phase (As (V)), it can be precipitated as $FeAsO_4$ and coprecipitated with ferric hydroxide if sufficient ferric ions are added to the treated solutions and the pH is subsequently increased to form an insoluble precipitate. Iron is commonly added, using ferric chloride or ferric sulfate, the correct dosage being determined by laboratory testing. If arsenic exists as the soluble As(III) phase, an oxidizing agent (typically hydrogen peroxide) must be added to oxidize the As(III) to As(V) before the hydroxide precipitation step. Arsenic has been consistently removed to a concentration of 0.015 mg/l in a 100 gpm treatment plant using this process (Hydrometrics, 1996).

Chemical treatment requires the construction and operation of treatment plants. The capital required to construct a plant with a capacity to treat 100 gpm ranges from $4.2 million to $7 million (Modrow, 1995). The cost to operate and maintain a 100 gpm plant ranges from $200,000 to $300,000 per year (Modrow, 1995). Handling, storage and shipping of solid materials range from $200 to $400 per ton.

4.2.2.2 Groundwater Isolation/Containment

Subsurface barriers are designed to isolate or contain contaminated groundwater. A number of different technologies exist, including installation of extraction/injection wells, interception and infiltration trenches, slurry or clay walls, grout curtains, and concrete walls. In a general sense, construction of barriers is extremely costly, and there are numerous technical limitations associated with their effectiveness.

Groundwater Extraction and Injection Wells

Groundwater pumping techniques involve the active manipulation and management of groundwater in order to contain or remove a plume or to adjust groundwater levels to prevent formation of a plume. Extraction and injection wells are often used to manage contaminated groundwater. The selection of the appropriate well type depends on the depth of contamination and on the hydrologic and geologic characteristics of the aquifer.

Extraction wells, or a combination of extraction and injection wells, can be used when the objective is plume containment or removal. Use of extraction wells alone is best suited to situations whereby contaminants are miscible and move readily with water; whereby the hydraulic gradient is steep and hydraulic conductivity high; and where quick removal is not necessary. Extraction wells are frequently used in combination with slurry walls to prevent groundwater from moving over the wall and to minimize leachate contacting and degrading the wall. Slurry walls also reduce the amount of contaminated water that requires removal, so that costs and pumping time are reduced.

A combination of extraction wells and injection wells is frequently used in containment or removal when the hydraulic gradient is relatively flat and hydraulic conductivities are only moderate. One problem with extraction/injection well systems is stagnation zones. The size of the stagnation zone is directly related to the amount of overlap between adjacent radii of influence; the greater the overlaps, the smaller the dead spots will be. Another problem is that injection wells can suffer from many operational problems, including air locks and needs for frequent maintenance and well rehabilitation.

Installation costs for extraction wells and injection wells are approximately $30 per vertical linear foot. Operation and maintenance costs for these wells are typically approximately $120 per day per well.

Interception and Infiltration Trenches

Interception trenches can be excavated to control groundwater gradients and collect contaminated waters for containment or treatment. Application is best suited for low permeability unconsolidated materials. Infiltration trenches can be used in much the same way as infiltration wells. Gradient can be controlled in combination with interception trenches. Infiltration trenches also are potentially useful for disposal of treated waters. Construction costs for an interception or infiltration trench are approximately $8 per square foot.

Slurry Walls

Slurry walls are the most common subsurface barriers because they are a relatively inexpensive means of vastly reducing groundwater flow in unconsolidated materials. The term "slurry wall" can be applied to a variety of barriers. Slurry walls are all constructed in a vertical trench that is excavated under a slurry. This slurry, usually a mixture of bentonite and water, acts essentially like a drilling fluid. It hydraulically shores the trench to prevent collapse, and, at the same time, forms a filter cake on the trench walls to prevent high fluid losses into the surrounding ground.

Slurry wall types are differentiated by the materials used to backfill the slurry trench. Most commonly, an engineered-soil mixture is blended with the bentonite slurry and placed in the trench to form a soil-bentonite (SB) slurry wall. In some cases, the trench is excavated under a slurry of Portland cement, bentonite and water, and this mixture is left in the trench to harden into a cement-bentonite (CB) slurry wall. In the rare case requiring great strength of a subsurface barrier, precast or cast-in-place concrete panels are constructed in the trench to form a diaphragm wall. The construction cost for a slurry wall is approximately $40 per square foot.

Grout Curtains

Grout curtains are subsurface barriers created in unconsolidated materials by pressure injection. Grout barriers can be many times more costly than slurry walls and are generally incapable of attaining truly low permeabilities in unconsolidated materials. Recent field testing of two chemical grouts revealed significant problems in forming a continuous grout barrier due to noncoalescence of grout pods in adjacent holes and grout shrinkage. Furthermore, conventional injection grouting is incapable of forming a reliable barrier in medium sands, and grout curtains are rarely used for groundwater control in unconsolidated materials is desired.

Grout curtains, like other barriers, can be applied to a site in various configurations. Circumferential placement offers the most complete containment but requires that grouting take place in contaminated groundwater downgradient of the source. Chemical reactors in groundwater can cause problems with grout set and durability, and this technique requires extensive compatibility testing during the feasibility study. Another limitation of grout curtains is gaps left in the curtain due to poor grout penetration. Construction costs for a grout curtain are approximately $50 per square foot.

Vibrating Beam

The vibrating beam method is not an injection technique usually used to install grout curtains, but instead is a way of placing grout to generate a wall. In this method, an I-beam is vibrated into the desired depth, then raised at a controlled rate. As the beam is raised, grout is pumped through a set of nozzles mounted in the beam's base, entering the newly formed cavity. When the cavity is completely filled, the beam is moved less than one beam width along the wall, leaving suitable overlap to ensure continuity. The construction cost for placing grout to generate a wall is approximately $14 to $25 per square foot depending on placement depth.

Concrete Walls

Concrete walls can be installed as vertical barriers to groundwater movement. The installation is similar to slurry wall construction, with the exception that concrete is used to displace the mud slurry used to hold the trench open. Concrete has a narrower range of chemical compatibility, and higher permeability than a conventional slurry wall. The construction cost for a concrete wall is approximately $50 per square foot.

Clay Walls

Clay walls can be installed as vertical barriers to groundwater movement. The installation is similar to slurry wall construction, with the exception that clay materials are used to displace the mud slurry used to hold the trench open. Construction costs for clay walls and slurry walls are similar.

4.2.2.3 Source Isolation/Removal

In recent years, attention to groundwater remediation technologies has been drawn away from large-scale manipulation of groundwater, such as pump and treat methods and plume barrier construction, because of the limited effectiveness and high cost of these processes. This is true for dissolved metals, such as arsenic, which are absorbed to aquifer materials and not easily removed from groundwater. If the source of contamination is removed or isolated, natural processes such as geochemical attenuation and dispersion can reduce contaminant concentrations. The time scale for natural processes to occur is highly variable and dependent on a number of site specific factors.

In reviewing options for soil and groundwater treatment, field implementation of physical methods, such as soil flushing or washing, are costly, with numerous technical difficulties being associated with them. Chemical neutralization and deep tilling are effective for surface soils, but smelter sites typically contain enriched metal concentrations at depth. There may be some limited applicability for limestone amendments or deep tilling at the Asarco El Paso site. Thermal destruction of lead and arsenic is not practical for the Asarco El Paso site. The construction of groundwater barriers could present many problems that are site and technique related. Site investigation results suggest that arsenic in the shallow alluvial aquifer is attenuated. Installation of barriers is likely a costly and unnecessary measure for plume containment. Groundwater removal and treatment, such as chemical hydrolysis and co-precipitation is an extremely expensive and difficult procedure. Future consideration of the aforementioned treatment options can probably be eliminated.

Of the methods discussed, source isolation/containment and chemical fixation/stabilization are probably the most rational to implement at the El Paso site in terms of cost, technical feasibility, and success at similar sites. The use of pavement and concrete caps and stormwater improvements that might be constructed in conjunction with site improvement projects could effectively isolate source materials from potential contact with surface water and eliminate leaching of arsenic and metals and percolation to groundwater.

In the case of groundwater, source removal via soil remediation, which either immobilizes arsenic and metals or removes them, thereby preventing their leaching into the groundwater, allows natural dilution and dispersion to occur. Source isolation or removal is by far the most reasonable method of remediating groundwater in terms of cost and implementabilty. In addition, natural processes following source isolation or removal would further reduce the potential for leaching of arsenic and metals, and for off-site impacts. If source materials are removed as part of a corrective action, on-site containment in an appropriately designed solid waste or RCRA compliant landfill would eliminate the need for expensive off-site transport.

4.3 IDENTIFICATION OF CORRECTIVE ACTION ALTERNATIVES

In this section of the report, corrective action technologies and process options reviewed in Section 4.2 are developed into Corrective Action Alternatives based on their potential to be effective and implementable at the Asarco El Paso site. Based on the results of the remedial investigation, and information presented in Section 4.2, groundwater does not appear to adversely impact surface water resources (American Canal and Rio Grande) and treatment of groundwater is not feasible. Therefore, Corrective Action Alternatives do not address groundwater. The following sections identify and describe applicable Corrective Action Alternatives.

4.3.1 Institutional Controls/Deed Restrictions

Institutional controls applicable to corrective action at the Asarco El Paso Smelter site include the following:

- Worker health and safety programs
- Deed restrictions

Through health and safety policies and programs currently in effect at the El Paso smelter, the potential for exposure and health hazards is significantly reduced. The health and safety program includes required OSHA training and medical monitoring of "Contact Intensive" workers. Medical monitoring for lead, cadmium, and arsenic ensures that workers are not at risk.

Deed restrictions are legal mechanisms that prevent specific uses or activities on the property. The Asarco El Paso smelter is currently zoned for industrial use as are adjacent properties. As an operating facility, access to the smelter is controlled. A security system, which controls access at the plant entrance, and a fence enclosing the entire smelter property, limit access to only appropriately trained visitors and workers.

In addition, the Plant has instituted a new contractor Health and Safety program. The program includes specific training regarding health and safety issues, respirator fit tests, and maintaining files regarding biomonitoring of individual contractor employees. The training and file maintenance are updated on an annual basis.

4.3.2 Containment

Containment alternatives applicable to corrective action at the El Paso smelter site include:

- Capping
- Surface control

Capping entails covering source areas with Category II materials with an engineered barrier to prevent the infiltration of surface water through smelter materials, thereby reducing potential impacts to groundwater (Category II materials have not been identified as impacting groundwater, but have the potential to do so), the potential for direct contact by workers, and the potential for wind-blown dust. Capping systems could include clean soil/vegetation, geosynthetic liners (GCL), flexible membrane liners (FML), pavement, and concrete. These may be used as a single application or in combination depending on the type of operations/activities and conditions occurring/existent at a specific source area. For example, a source area subject to heavy traffic would be capped with asphalt or concrete. An open area may be capped with a GCL and/or clean soil and vegetated. The foundation area of an acid plant might require a combination of concrete structures and a FML to contain leaks and eliminate the potential for fluids to infiltrate and percolate through subgrade materials. In come cases, existing buildings and paved or concreted roadways or storage areas currently provide a cap, and simple upgrades could increase their effectiveness as barriers.

Surface control entails altering the topography and hydrology of the site to control surface water and minimize erosion. A detailed design for stormwater system improvements (Stormwater Collection and Reuse Project) at the Asarco El Paso smelter has been completed (Dames and Moore, 1998). These improvements, which include a lined impoundment, sumps, pumping systems, pipelines, and storage tanks are scheduled for construction beginning in late 1998 or early 1999 and are shown in Figure 4-1. In conjunction with the construction of the stormwater improvements, the existing ponds in Investigation Area 9, which are a potential source of metals to groundwater, will be dried up, their sediments removed, and closed. The new stormwater system will effectively prevent the infiltration of surface water through smelter materials and the potential off-site transport of smelter materials in runoff.

4.3.3 Removal/Disposal

Removal/disposal alternatives applicable to corrective action at the Asarco El Paso smelter site include:

- Excavation
- On-site disposal

Category I materials are typically present in the upper few feet of the surface, but may occur at greater depths in some cases. Excavation will be accomplished by conventional methods using earthmoving equipment, including backhoes, scrapers, front-end loaders, and trucks. The excavation of Category I materials effectively prevents direct exposure and minimizes migration of arsenic and metals from source materials to groundwater, compared to current conditions. Excavated Category I materials will be disposed of in on-site repositories

4.4 CORRECTIVE ACTION MEASURES

As discussed under Section 4.3, Corrective Action Alternatives were selected for the Plant based on effectiveness, implementability, and cost, and include the following:

- Institutional Controls/Deed Restrictions
- Containment (Category II materials)
- Removal/Disposal (Category I materials)
- Conduct Long-Term Monitoring (Groundwater and Surface Water).

Based on an evaluation of initial remedial investigation/site characterization results, fate and transport mechanisms, risk assessment, and the relationship between smelter operations and potential source areas and materials, these Corrective Action Alternatives are expected to adequately address Corrective Action Objectives. As stated in Section 4.1.2 of this report, Corrective Action Objectives for the Plant include:

1. Reduce the potential for exposure to metals by Plant workers and the public.
2. Minimize the potential for transport of metals to the groundwater.
3. Prevent increases in metal concentrations in the American Canal and Rio Grande resulting from the migration of metals in groundwater, surface water, and wind blown dust from the Plant.

This section of the report identifies and defines specific Corrective Action Measures that would be taken to remediate source areas and achieve Corrective Action Objectives. The Corrective Action Measures presented in this section are conceptual only. Additional soil, surface water, and groundwater investigations are required to more accurately define and delineate source areas, materials, and volumes. Accordingly, the costs associated with

Corrective Action Measures, which are presented in Section 4.4.11, are estimates and considered accurate to within plus or minus 25 to 30 percent.

4.4.1 Converter Building/Baghouse Area (Investigation Area 1)

Corrective Action Measures for Investigation Area 1 consist of the following:

- Engineering controls to reduce or eliminate the occurrence of releases from the Acid Plant Mist Precipitator.
- Demolish and replace Medford sump (Stormwater Collection and Reuse Project).
- Excavation of Category I materials.
- Backfill excavated areas with crushed copper slag.
- Grade area to improve surface drainage.
- Construct asphalt pavement/FCL cap over excavated areas.
- Disposal of Category I materials in on-site repositories.

A conceptual illustration of Corrective Action Measures for Investigation Area 1 is in Figure 4-2. Preliminary cost estimates for Investigation Area 1 Corrective Action Measures are summarized in Section 4.4.11. Surface control improvements in this area, which are part of the Stormwater Collection and Reuse Project are illustrated in Figure 4-1.

4.4.2 Boneyard/Slag Storage (Investigation Area 2)

Corrective Action Measures for Investigation Area 2 consist of the following:

- Debris clean-up
- Surface drainage improvements (site grading)
- Excavation of Category I materials
- Disposal of Category I materials in on-site repositories.

Corrective Action Measures have not been defined for potential source materials at depth (below the slag) beneath the boneyard. Additional soil investigations are required to determine the location, extent, and characteristics of source materials in this area before Corrective Action Measures can be formulated. Additional investigations are discussed in Section 4.5. A conceptual illustration of Corrective Action Measures for Investigation Area 2 is in Figure 4-3. Preliminary cost estimates for Investigation Area 2 Corrective Action Measures are summarized in Section 4.4.11.

4.4.3 Acid Plants 1 and 2 (Investigation Area 3)

Corrective Action Measures for Investigation Area 3 consist of the following:

- Engineering controls to reduce or eliminate the occurrence of releases from the acid plants.
- Line and resurface the floor of Acid Plant Mist Precipitator building and construct perimeter sill for secondary containment.
- Construction lined secondary containment around acid plants.
- Excavation of Category I materials (if required as part of secondary containment construction).
- Disposal of Category I materials in on-site repositories.

A conceptual illustration of Corrective Action Measures for Investigation Area 3 is in Figure 4-4. Preliminary cost estimates for Investigation Area 3 Corrective Action Measures are summarized in Section 4.4.11.

4.4.4 Front Slope/Western Plant Boundary (Investigation Area 4)

Corrective Action Measures for Investigation Area 4 consist of the following:

- Debris clean-up

- Excavation of Category I materials
- Backfill excavated areas with clean soil
- Disposal of Category I materials in on-site repositories
- Cap replacement soil area with asphalt or gravel
- Construct drainage collection system.

A conceptual illustration of Corrective Action Measures for Investigation Area 4 is in Figure 4-5. Preliminary cost estimates for Investigation Area 4 Corrective Action Measures are summarized in Section 4.4.11.

4.4.5 Historic Smelter Town (Investigation Area 5)

Corrective Action Measures for Investigation Area 5 consist of the following:

- Deep till soils with elevated metal concentrations in the surface 12 inches.
- Excavate soils where metal concentrations are elevated at depths greater than 12 inches bgs to a total depth of 24 inches.
- Backfill excavated areas with clean soil.
- Haul excavated soils to Plant for use as construction fill.
- Stabilize Investigation Area 5 soils with native vegetation.

A conceptual illustration of Corrective Action Measures for Investigation Area 5 is in Figure 4-6. Preliminary cost estimates for Investigation Area 4 Corrective Action Measures are summarized in Section 4.4.11. Additional Corrective Action Measures for Investigation Area 5 may include redevelopment of the site for commercial or industrial use. In this case, soil remediation would not be necessary. Site grading, stormwater improvements, buildings, and paved parking areas would provide a protective cap to isolate source materials and eliminate transport pathways.

4.4.6 Groundwater (Investigation Area 6)

Corrective Action Measures for Investigation Area 6 consists of long-term groundwater monitoring. Groundwater is not used as a source of drinking water and does not appear to be a source of metals to the American Canal or Rio Grande.

4.4.7 Surface Water (Investigation Area 7)

Corrective Action Measures for Investigation Area 7 consists of long-term surface water monitoring.

4.4.8 Unloading/Bedding Buildings (Investigation Area 8)

Corrective Action Measures for Investigation Area 8 consists of the following:

- Pick up and replace railroad track.
- Construct concrete slab (cap) to replace ballast.
- Construct asphalt/FML cap for other areas.
- Construct drainage control features (drainage collection system).
- Materials excavated (i.e. old ballast) as part of cap construction will be placed under the cap.

Based on the results of the remedial investigation, soils in Investigation Area 8 do not appear to be a source of metals to groundwater. Therefore, they will not be excavated and disposed of in on-site repositories. All Investigation Area 8 soils will be maintained under protective caps. A conceptual illustration of Corrective Action Measures for Investigation Area 8 is in Figure 4-7. Preliminary cost estimates for Investigation Area 8 Corrective Action Measures are summarized in Section 4.4.11.

4.4.9 Ponds 1, 5 and 6 (Investigation Area 9)

Corrective Action Measures for Investigation Area 9 consists of the following:

- Excavate existing sediments.
- Dewater sediments (surface drying pads).
- Recover copper in sediments from Ponds 5 and 6 by recycling through smelter.
- Construct repository in depressional areas of original ponds.
- Reshape ponds for repository configuration.
- Place and compact dried sediments from Pond 1 in on-site repositories.
- Create paved parking/staging area or green spaces on surface of closed repositories.

The copper content in sediments from Ponds 5 and 6 are high enough (greater than 5 percent) to justify smelting to recover copper. Converting the process ponds to lined repositories for disposal of excavated Class I materials makes use of existing depressions and reduces construction costs. In addition, the ponds are well above the groundwater. A conceptual illustration of Corrective Action Measures for Investigation Area 9 is in Figure 4-8 and Figure 4-9. Preliminary cost estimates for Investigation Area 9 Corrective Action Measures are summarized in Section 4.4.11.

4.4.10 Stormwater Drain (Investigation Area 10)

Corrective Action Measures for Investigation Area 10 consists of the following:

- Rebuild the first 200 feet of the plant entrance road.
- Demolish and replace existing sumps.
- Regrade area to divert water away from American canal and to the new sumps.
- Landscape (xeriscape) regraded areas with gravel and native vegetation.

The rebuilding of the plant entrance road, and the demolition and replacement of sumps, is part of the Stormwater Collection and Reuse Project (see Figure 4-1). A conceptual illustration of Corrective Action Measures for Investigation Area 10 is in Figure 4-10. Preliminary cost estimates for Investigation Area 10 Corrective Action Measures are summarized in Section 4.4.11.

4.4.11 Corrective Action Measure Cost Estimates

This section of the report provides preliminary cost estimates for Corrective Action Measures described in the preceding sections for Investigation Areas 1, 2, 3, 4, 5, 8, 9, and 10. The cost estimates are based on the results of initial remedial investigation (site characterization) studies. Additional soil investigations are required to refine quantities (i.e. areas and volumes) and associated costs. Therefore, the costs are feasibility study level (order of magnitude) estimates for Corrective Action Measures accurate to within plus or minus 25 to 30 percent. Estimated costs for Corrective Action Measures are summarized in Table 4-1 for each Investigation Area. Quantities and detailed backup for cost estimates are in Appendix M.

Total construction cost estimates (Corrective Action Measures for Investigation Areas 1,2,3,4,5,8,9 and 10) including base construction, mobilization, sales tax, and a health and safety premium total approximately $6,450,000. Non-construction costs included in the cost estimates total approximately $4,150,000 and include a 25 percent scope contingency (approximately $1,400,000), engineering design and oversite (approximately $1,800,000), monitoring/O&M (approximately $250,000) and other miscellaneous costs (approximately $700,000).

Long-term surface water and groundwater monitoring (Corrective Measures for Investigation Areas 6 and 7) are estimated at approximately $250,000 per year for an assumed period of 15 years.

4.5 PROPOSED ADDITIONAL REMEDIAL INVESTIGATION ACTIVITIES AND AREAS

An additional phase of investigation is recommended to better delineate soil, surface water and groundwater impacts at the Asarco El Paso Copper Smelter. The recommended work expands the original 10 investigation areas designated by the TNRCC to 14 investigation areas. The second phase of investigation will help estimate the location and volume of affected soils in potential source areas and determine whether the four new investigation areas are a source of metals to the groundwater.

The initial remedial investigation included using monitor wells installed specifically as part of the two diesel release investigations. Construction activities during the installation of the wells did not include collection of soil samples for metals concentrations. The wells were located to best monitor diesel releases, but were not able to also act as monitor wells for other source areas. The locations of the 22 monitor wells installed specifically for the Remedial Investigation were selected to monitor potential impacts from facility operations within an investigation area and to investigate hydrogeologic conditions. Many of these locations confirmed that certain plant operations have contributed to the affected groundwater, however, the source(s) of metals in groundwater at several of the locations (i.e., EP-84 and EP-87) have not been identified and require further delineation.

Soil sampling was conducted during the initial Remedial Investigation. The first five feet below ground surface were sampled for most boreholes; however, samples were collected to groundwater in ten boreholes. Additional sampling is proposed to better evaluate the vertical extent of metals in soil.

A summary of proposed additional sampling is presented in Table 4-2, including the four additional investigation areas. Exhibit 2 illustrates the areas that are to be investigated as part of the second phase of the Remedial Investigation. Exhibit 2 also includes the approximate locations of shallow soil borings, deep borings to be advanced to the water table, and locations for additional monitor wells. The locations of all the borings and monitor wells were chosen based on available soil, surface water and groundwater data. The investigation and sampling protocol will be in accordance with those described in the TNRCC approved Remedial Investigation Work Plan (Hydrometrics, 1996). The proposed activities are described below.

Investigation Area 1 - Converter Baghouse - Medford Sump Area

Subsurface soils near the Medford Sump contain concentrations of lead greater than 20,000 mg/kg. It is recommended that a second phase of investigation be conducted in the Medford Sump Area. Three soil borings are proposed for this investigation area. The soil borings will be sampled every five feet to groundwater. Because current soil data indicate increasing concentrations of arsenic and lead with depth, one soil boring will be converted into a monitor well.

Investigation Area 2 - Boneyard/Slag Storage Area

Six additional boreholes are proposed to determine the extent of elevated metal concentrations in soil and to identify the former material storage location underneath the Lead Slag. During drilling, samples will be collected starting at the soils underneath the slag. The borings will be advanced to the water table. The three monitor wells currently located in the Boneyard (EP-53, EP-75 and EP-76) will be sampled quarterly during the next phase of work.

The Slag Storage Area has been designated as Investigation Area 12 and is discussed separately.

Investigation Area 3 - Acid Plants Nos. 1 and 2

An additional eight soil borings advanced to groundwater are recommended for this area. Soil, where present underneath the slag, will be sampled every five feet and analyzed for metals. No additional monitor wells are proposed.

Investigation Area 5 - Smeltertown

During the second phase of investigation, Investigation Area 5 will be expanded. The initial Smeltertown investigation included an area from the American Canal to a fence that paralleled Paisano Drive. This area will be expanded from the American Canal to the Rio Grande. Due to the occurrence of arsenic in several downgradient wells (EP-62 and EP-66), three additional monitor wells will be installed in the area between the American Canal and the Rio Grande.

Investigation Area 6 - Groundwater

For the calendar year August 1998 to May 1999, four quarters of monitoring and sampling are scheduled. All current monitor wells will be included, and the sampling event will begin in the Fall 1998. Wells EP-8 and EP-42 will be monitored and newly constructed wells will be added during the second phase of investigation. During the subsequent year of monitoring, the parameters and the frequency of sampling will be evaluated.

Investigation Area 7 - Surface Water

Surface water locations initially sampled during the Remedial Investigation (i.e., SEP-1, SEP-2, SEP-3, SEP-4, SEP-7, SEP-9, SEP-10, SEP-11, SEP-12, SEP-13 and SEP-14) will continue to be monitored on a quarterly basis. These sites represent locations in the American Canal, Rio Grande and the closed depression area. Sediment samples will also be collected from these locations one time during the monitoring period. Sediments at sample locations in the Rio Grande will be analyzed for metals. Sediment samples will also be collected and analyzed at monitor locations in the American Canal. Sediment samples will only be collected during low or no flow periods in the American Canal due to safety concerns. During the subsequent year of monitoring, the parameters and frequency of sampling will be evaluated.

The two on-site process ponds will be included in the quarterly surface water sampling events as long as there is sufficient water in the ponds.

Investigation Area 8 - Bedding and Unloading Buildings

Soils at the bedding and unloading operations have some of the highest concentrations of arsenic and lead measured at the Plant. An additional nine boreholes will be drilled to groundwater, and soil samples will be collected at five-foot intervals and analyzed for metals. When slag is encountered in boreholes, it will be logged but not sampled.

Investigation Area 9 - Ponds 1, 5 and 6

Ponds 1, 5 and 6 were originally proposed as part of the Remedial Investigation (Hydrometrics, 1996), but were removed from the investigation because of the upcoming Stormwater Control and Water Reuse Project. The pond investigation is expected to begin when the water from each pond is removed, and the bottom sediments allowed to dry. When the bottom sediments are dry enough to safely sample, the investigation of the pond will begin. All three pond investigations are expected to be completed by January 2000.

Investigation Area 10 - Plant Entrance - Stormwater Sump

It is recommended that one monitor well be installed west of the sump area due to elevated concentrations of arsenic in borehole samples (SSENT-8). The well will be sampled after rain events as well as on a quarterly basis to evaluate potential impacts.

Investigation Area 11 - EP-84 (Southern Arroyo)

Monitor well EP-84 was initially installed in the arroyo system located east of the operating plant area to measure background conditions. However, arsenic in groundwater samples from monitor well EP-84 exceeded the MCL. The arroyo is a potential source area because of historical use as a slag storage area and temporary storage area for plant debris.

Thirty additional soil borings are recommended for Investigation Area 11 for the next phase of investigation. Twenty soil borings will be sampled every foot to total depths of five feet, and ten borings will be advanced to groundwater. The borings will be located primarily within the limits of the southern arroyo, with only 10 of the borings being located in the northern arroyo.

Four of the borings advanced to the water table will be converted into monitor wells. The wells will be located upgradient and downgradient of wells EP-84 and EP-87.

Investigation Area 12 – Closed Depression and Pond Sediment Storage Area

The closed depression (SEP-14) and the Pond Sediment Storage Area have been identified as a separate investigation area. These features are located in the northern reaches of the original Investigation Area 2, and may be potential source areas downgradient of the Parker Brothers Arroyo.

The closed depression area north of the No. 9 Bridge is an impoundment created by the railroad track beds that have crossed the expanse of an arroyo. Water accumulates in the impoundment during heavy precipitation events. Since the start of the Remedial Investigation sampling, there has not been sufficient rainfall to collect a sample. It is recommended that five additional borings be drilled laterally and upgradient of well EP-78 to determine the extent of affected soil. One of the borings will be located in the arroyo upgradient of the closed depression and will serve as a background location.

The Pond Sediment Storage Area, located to the south of the No. 9 Bridge, is a bermed impoundment for sediments dredged from Ponds 1, 5 and 6. The Pond Sediment Storage Area is located in the southern branch of an arroyo system that extends to the east towards EP-84. Six additional soil borings are recommended, including one borehole drilled to groundwater and converted to a monitor well. The borehole data will be used to characterize subsurface soils and evaluate potential impacts to adjacent soils. The proposed monitor well will be installed downgradient of the Pond Sediment Storage Area to evaluate groundwater conditions.

Investigation Area 13 - EP-13 (Sample Mill Area)

The area around monitor well EP-13 is the sample mill and blister copper storage area. This area has been previously designated as a feed material process area and a chlorine leach plant.

The chlorine leaching operations may have impacted soil and groundwater in this area. Arsenic concentrations averaged 45 mg/l in well EP-13 during the first four quarters of sampling.

The source of metals in groundwater needs to be further evaluated. Five additional soil borings drilled to groundwater in the vicinity of well EP-13 are recommended. Soil samples will be collected at 5-foot intervals. Any slag encountered will not be sampled. Three of the soil borings will be converted into monitor wells and added to the quarterly groundwater sampling schedule.

Investigation Area 14 - South Terrace Area

The South Terrace Area is located southwest of the Unloading and Bedding Buildings and has historically been an area for storage of ore concentrates, flux materials, plant construction material and demolition debris. Some time ago, the northern portion of the area was formerly used as housing for the Plant staff.

Within the central and western portion of the South Terrace Area is a former arroyo which has been backfilled with slag. Groundwater samples collected from well EP-20, located at the headwaters of the arroyo, have elevated concentrations of arsenic. Further investigation is needed to evaluate if soil in the arroyo is the source of elevated arsenic concentrations downgradient.

Eight additional soil borings in areas of past operations and within the arroyo are proposed. Soil samples will be collected from 5-foot intervals and analyzed for metals. Slag samples will not be collected.

4.6 CORRECTIVE ACTION MEASURES SCHEDULE

A detailed schedule for implementation of Corrective Action Measures is in Exhibit 3.

5.0 SUMMARY AND CONCLUSIONS

- Site characterization activities at the subject Plant for this RI were performed at ten Investigation Areas pursuant to the Agreed Order.

- Surface water bodies located near the Plant are the Rio Grande and the American Canal.

- Groundwater in the project area generally flows west toward the Rio Grande, and occurs at depths ranging from 40 to 60 feet bgs beneath the Plant to about ten feet bgs in wells adjacent to the Rio Grande.

- Groundwater underlying the Plant and in the vicinity of the Plant is not used for drinking water purposes. The nearest domestic well is approximately one-half mile north and upgradient from the Plant.

- Two diesel fuel spills occurred at the Plant (Diesel No. 1 and Diesel No. 2 Remedial Areas) where diesel is present in subsurface materials. Diesel No. 1 is being successfully remediated under a separate Enforcement Order. Diesel No. 2 is being remediated as a voluntary effort.

- Based on borehole sample results from monitor well EP-86 (the most representative background location), elevated concentrations of metals occur in soils at the Plant. Arsenic, cadmium, lead, and selenium are the predominant Constituents of Concern in soil at the Plant and are associated with current and historic smelter operations. No regulatory standards have been established for these constituents in soil.

- Limited occurrences of arsenic, cadmium and selenium above primary drinking water standards were detected in surface water samples collected at two downstream locations in the American Canal during low flow conditions. Arsenic was detected at a maximum concentration of 0.82 mg/l at these locations during the November 1997 and February 1998 sampling events. Cadmium was detected once above its MCL at one location in February 1998. Selenium was detected at both locations during the November 1997 and February 1998 sampling events with a maximum concentration of 0.2 mg/l. Because of reduced flow in the American Canal during the winter months, these samples are not considered to be representative of water in the American Canal.

- No Constituents were detected above MCLs in surface water samples collected from the Rio Grande.

- Primary drinking water standards for arsenic, cadmium and selenium were exceeded in one or more groundwater samples, plus lead exceeded the Federal Action Level. Arsenic was detected above its MCL in 48 groundwater monitor wells. The maximum concentration of arsenic was 464 mg/l in samples from monitor well EP-49. Cadmium was detected above its MCL in 11 groundwater monitor wells with a maximum concentration of 43 mg/l also in monitor well EP-49. Selenium was detected above its MCL in 50 groundwater wells with a maximum concentration of 7 mg/l in a sample from monitor well EP-13. Lead was detected above the action level in nine wells, the maximum concentrations was 0.86 mg/l.

- Arsenic is considered the primary Constituent of Concern in groundwater at the Plant duc to its widespread occurrence above the MCL.

- The strong spatial correlation between arsenic concentrations in near surface soil and arsenic concentrations in groundwater suggests that arsenic migration within the aquifer is minimal.

- Source materials occur primarily in the near surface and are not in direct contact with groundwater. This suggests that arsenic and other metals have been transported to the groundwater through the unsaturated zone in response to precipitation and other sources of recharge.

- Based on an evaluation of water chemistry data, groundwater from the Plant has not impacted water quality in the American Canal and the Rio Grande.

- Fate and transport simulations using site-specific data indicate that impacts to the Rio Grande from arsenic migration may occur if source areas/materials on the Plant are not removed or isolated.

- Materials associated with potential source areas are separated into three Categories (I, II and III) based on metal concentrations, distribution and volume of materials, visual characteristics, impacts to water resources, and degree of potential toxicity.

- Category I materials are residual byproducts from current and past smelter operations and are associated with distinctly elevated concentrations of metals in underlying groundwater. Category I materials include but are not limited to the following:

  - Sulfuric Acid.
  - Acid Plant Scrubber Water/Solids (from leaks, etc.).
  - Acid Plant Water Treatment Plant Filter Cake.
  - Liquid leakage from process gas flues going to the Acid Plants.
  - Leachate from Sulfuric Acid Reacting with Slag Fill Material.
  - Cottrell Dusts (Reverb, Roaster, Converter, ConTop, Sinter Plant).
  - Spray Chamber Dusts (Reverb, Roaster, Converter, ConTop).
  - Converter Building Ventilation Baghouse Dust.

- Baghouse and other dusts from former Lead Plant and Sinter Plant Operations.
- Feed Materials, including lead and copper concentrates, East Helena speiss and matte.
- Fines in the Slag Storage Area.

- Category II materials are large volumes of diluted residual by-products (most of the same materials listed as Category I) and debris from demolition of smelter facilities with residual concentrations of metals. Category II materials do not currently represent a source of metals to the underlying groundwater but could become a potential source in the future if conditions on the surface are not properly managed.

- Category III materials are copper slag and unfumed lead slag.

- The Plant is underlain by arroyos that have been backfilled with soil, slag, and other materials. The arroyos appear to channel and control the flow of groundwater and migration of constituents beneath the plant.

- Groundwater in backfilled arroyos underlying Medford Sump, Acid Plants No. 1 and No. 2, the No. 2 Acid Plant Mist Precipitator, and Ponds 1, 5 and 6 has elevated concentrations of metals. The arroyos appear to have accumulated metals from these source areas.

- Soil associated with the Unloading and Bedding Building facilities, which are not constructed over a backfilled arroyo, have elevated concentrations of metals at the surface but do not appear to have impacted underlying groundwater compared to source areas/facilities constructed over backfilled arroyos.

- Additional soil and groundwater investigations are recommended to better define and evaluate source areas.

- The results of the Risk Evaluation conclude no imminent health threats exist at the Plant because risks are appropriately managed.

- Metal concentrations in surface water (American Canal and Rio Grande) are below health-based levels of concern (MCLs) and Fresh Water Chronic Criteria.

- Corrective Action Objectives include the following:

    1. Reduce the potential for exposure to metals by Plant workers and the public.
    2. Minimize the potential for transport of metals to groundwater.
    3. Prevent increases in metal concentrations in the American Canal and Rio Grande resulting from the migration of metals in groundwater and/or wind blown dust from the Plant.

- Specific Corrective Action Measures to remediate source areas were developed from Corrective Action Alternatives. Corrective Action Alternatives were selected after an evaluation of Corrective Action Technology and Process Options based on effectiveness, implementability, and cost. Corrective Action Alternatives applicable to the Plant include the following:

    1. Institutional controls/deed restrictions (worker health and safety programs).
    2. Containment (capping and surface control).
    3. Removal/disposal (excavation and on-site disposal).
    4. Long-term surface water and groundwater Monitoring.

- Capping and surface control alternatives apply to Category II materials and excavation and on-site disposal alternatives apply to Category I materials.

- Corrective Action Alternatives and Measures do not apply to Category III materials (slag), which will be managed in place or crushed and used as backfill for remedial construction.

- When completed, the Stormwater Collection and Reuse Project, along with other secondary spill containment, stormwater management, best management practices and discharge control technology elements currently in place, will effectively reduce transport of metals to groundwater and surface water.

- Sediments from Ponds 5 and 6 are sufficiently high in copper to warrant smelting to recover the copper. It is recommended that Ponds 1, 5 and 6 be reworked and converted to lined on-site repositories for the disposal of Category I and other materials as appropriate.

- Order-of-magnitude (plus or minus 25 to 30 percent) Corrective Action Measures costs for Investigation Areas 1, 2, 3, 4, 5, 8, 9, and 10 are approximately $6,450,000 for construction items and an additional $4,150,000 for non-construction items, including a 25 percent scope contingency, engineering design and oversight, O&M, and other miscellaneous costs.

- Corrective Action Measures costs for Investigation Areas 6 and 7 (long-term monitoring) are estimated at approximately $250,000 per year for a total of 15 years.

- The Corrective Action Measures implementation schedule for the 10 Investigation Areas has a total duration of 424 days and starts in June 1999.

- Additional soil, groundwater, surface water and other types of data may be warranted to identify other potential source areas, better define the nature and extent of known source areas and better evaluate off-site risks.

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TABLES

TABLES

TABLE 1-1. SUMMARY OF HISTORIC OPERATIONS, ACTIONS AND REPORTS

Date	Action/Report
1887	Lead plant founded.
1910's	Copper smelter added.
1930's	Godfrey roaster for cadmium added.
1948	Zinc fuming furnace added.
1972	Acid Plant 1 constructed.
1976	Antimony plant added.
1978	Acid Plant 2 constructed.
1979	Sinter plant and unloading/bedding systems added.
1985	Lead plant closed. Currently being removed.
1985, August	Asarco/TNRCC compliance agreement to investigate potential leakage of Ponds 1 and 6.
1985, September 27	Hydro-Search, Inc. Report: Regional and Local Hydrology at the El Paso Plant. Prepared to comply with compliance agreement.
1985, October 10	Hydro-Search, Inc. Report: Groundwater Monitoring Plan, Asarco, Inc., El Paso Plant. Prepared to comply with compliance agreement.
1985, November 15	Hydro-Search, Inc. Report: Liner Investigation, ASARCO, Inc. El Paso Plant. Prepared to comply with compliance agreement.
1986	Antimony plant closed. Building has been remodeled.
1990, February 7	International Boundary and Water Commission workers noticed petroleum hydrocarbons seeping into the American Canal. Hydrometrics, Raba-Kistner Consultants and Applied Earth Science enlisted to investigate spill.
1990, March 14	State of Texas provides Asarco with Notice to Proceed regarding investigations of metals down gradient of Ponds 1 and 6.
1990, March 30	Hydrometrics began investigation activities for Diesel 2 spill.
1990, May 19	Nine monitoring wells were installed down gradient of Ponds 1 and 6, and quarterly monitoring began.
1992	Design and construction of Diesel Number 1 recovery system. Cadmium plant closed. Currently being removed. Zinc furnace closed. Currently being removed.
1993	CONTOP copper process added.
1994	Design and construction of Diesel Number 2 recovery system.
1996	Began design of storm water improvements.
1996, August 29	TNRCC issues Agreed Order requiring remedial investigation.
1997-1998	Remedial Investigation field activities conducted.

TABLE 1-2. FACILITY REGULATORY PERMIT INFORMATION

Permit No.	Permit Type	Issuing Agency	Facility
20345	Air	TNRCC	Primary Copper Smelter (CONTOP Project)
4151	Air	TNRCC	Ore Unloading and Storage Facility
WQO2321	Water	TNRCC	Industrial Wastewater
TXR05A301	Water	EPA	Plant Storm Water
31235[(1)]	Solid Waste	TNRCC	Solid Waste Generator

Notes: (1) TNRCC Notice of Registration Number

TABLE 1-3. ACTIVE SOLID WASTE MANAGEMENT UNITS

Unit Number	Unit Description
011	Bulk Pneumatic Trailer for Resource Conservation Company (RCC) Spray Dryer Solids (Acid Plant water treatment system)
012	Drum Management Area - fenced area used to accumulate miscellaneous storage containers
013	Paint shop satellite accumulation/storage area
014	Auto shop satellite accumulation storage area
015	Acid Plant accumulation area
016	Unloading/Bedding Wastewater Treatment Plant
017	PCB Storage Building
018	Container storage area for miscellaneous refuse containers
019	Container storage area - Security Building Bunker
020	Bulk Hopper for Spray Dryer Solids
021	Container Storage Area in Laboratory
022	Container Storage Area in Health Clinic
023	21 Hazardous trash hoppers in miscellaneous areas of plant site
024	55-gallon drum used at Laboratory for satellite accumulation of organic and inorganic lab waste liquids
025	Spent Anode/Converter brick piles located on paved concrete area west of the Unloading Building and Concrete Bunkers/paved concrete south of the Unloading Building
026	Concrete Bunker north of Medford Sump
027	55 gallon drum, auto, machine, paint and old electric shops, powerhouse north and south of converters
028	Auto shop metal container < 55 gallon

TABLE 1-4. GENERAL DESCRIPTION OF INVESTIGATION AREAS

Area	Description	Agreed Order Reference[1]	Status	Site Use
1	Adjacent to Converter Building Ventilation Baghouse	3(b) & 9(b),(c)	Active	Baghouse spill containment and abandoned, spent scrubber saddles noted by TNRCC.
2	Boneyard /Slag	3(d) & 9(d)	Active	Deposited slag, with equipment and debris storage on some slag areas.
3	Acid Plants 1 & 2	3(e)	Active	Sulfuric acid production.
4	Front Slope (plant boundary)	3(h)	Inactive	No particular use; historic stormwater runoff area.
5	Historic Smeltertown	Not specifically identified	Inactive	Diesel 2 recovery system.
6	Groundwater	8	Inactive	Resource not used for domestic water supply.
7	Surface Water	Not specifically identified	Inactive	Off-site downgradient water bodies include the American Canal and the Rio Grande. On-site ponding exists in slag area.
8[2]	Bedding and Unloading Buildings	From TNRCC Response to Comments	Active	Receiving, Handling and Storage Area for Incoming Feed Material.
9[2]	On-site Process Ponds	From TNRCC Response to Comments	Active	Three ponds used for fresh water supply, process makeup water and firewater storage.
10[2]	Plant Entrance	From TNRCC Response to Comments	Active	Plant entrance and potential outfall of stormwater and spills to the American Canal.

Notes:

(1) TNRCC, 1996.

(2) Includes areas added per TNRCC review of the Remedial Investigation Work Plan (TNRCC, 1997).

TABLE 2-1. SUMMARY OF INVESTIGATION AREAS

Investigation Area	Description
1	Adjacent to Converter Building Ventilation Baghousc
2	Slag/Boneyard
3	Acid Plants 1 and 2
4	Front Slope (Plant western boundary)
5	Historic Smeltertown
8	Bedding and Unloading Plant
10	Plant Entrance

Notes: See Table 1-4 For descriptions of the Investigation Areas.
See Exhibit 2 for the Investigation Area locations.

TABLE 2-2. SUMMARY OF SOIL SAMPLE RESULTS (mg/kg)

	pH	As	Cd	Cr	Cu	Fe	Pb	Se	Zn
Min	5	<20	<10	<30	<20	5,000	<10	<10	<10
Max	10.2	22,000	2,100	1,500	190,000	260,000	71,000	1,800	110,000
Ave(1)	8.5	616	124	86	4,362	30,524	2,447	22	2,695
Ave(2)	NA	7.2	NA	54	25	26,000	19	0.39	60

mg/kg = Milligrams per kilogram.
NA = Not Analyzed.
(<) = Less than; concentration is less than the detection limit indicated.
(1) = Investigation average, calculated from all soil samples.
(2) = Average concentration of soils in United States (USGS, 1984).

TABLE 2-3. REFERENCE LIST OF ANALYTICAL PARAMETERS

Analytical Parameter	Unit of Measurement	Abbreviation
Biochemical Oxygen Demand	mg/l	BOD
Fecal Coliform	colony-forming units per 100 ml	cfu/100 ml
Ammonia	mg/l	NH_3
Total Hardness	mg/l	Tot Hardness
Turbidity	Nephelometric Turbidity Units (NTUs)	Turb
Temperature	°F or °C	Temp
Dissolved Oxygen	mg/l	O_2 or DO
pH	units	pH
Specific Conductivity	Microsiemens per centimeter (µS/cm)	SC
Total Dissolved Solids	mg/l	TDS
Total suspended solids	mg/l	TSS
Calcium	mg/l	Ca
Magnesium	mg/l	Mg
Sodium	mg/l	Na
Potassium	mg/l	K
Total Alkalinity as $CaCO_3$	mg/l	
Bicarbonate	mg/l	HCO_3^-
Carbonate	mg/l	CO_3^{2-}
Sulfate	mg/l	SO_4^{2-}
Chloride	mg/l	Cl
Fluoride	mg/l	F
Nitrate and Nitrite as Nitrogen	mg/l	$NO_3 + NO_2$ as N
Arsenic	mg/l	As
Barium	mg/l	Ba
Cadmium	mg/l	Cd
Chromium	mg/l	Cr
Copper	mg/l	Cu
Iron	mg/l	Fe
Lead	mg/l	Pb
Manganese	mg/l	Mn
Mercury	mg/l	Hg
Selenium	mg/l	Se
Silver	mg/l	Ag
Zinc	mg/l	Zn

Note: mg/l = milligrams per liter

TABLE 2-4.

RIO GRANDE WATER QUALITY DATA, 1997 THROUGH 1998 AT COURCHESNE BRIDGE[1]

DATE	D.O.	pH	BOD	FECAL COLIFORM	CHLORIDE	TDS	SULFATE	EC	TOTAL HARDNESS	AMMONIA	TURBIDITY	TEMP (F)
1/9/97	12.0	8.0	3	160	360	1,564	489	2,450	468	0.19	19	35
1/16/97	11.4	8.3	3	100	335	1,538	464	2,320	468	0.30	19	38
1/23/97	10.0	8.1	3	100	305	1,436	501	2,220	436	0.13	19	46
2/6/97	10.0	8.3	3	170	245	1,114	307	1,835	368	0.11	23	47
2/13/97	10.0	8.2	5	130	240	1,216	403	1,911	416	0.13	19	49
2/20/97	10.0	8.2	4	140	200	720	184	1,190	256	0.23	36	50
2/27/97	10.3	8.1	3	320	125	656	167	1,040	240	0.21	123	45
3/6/97	10.0	8.3	3	180	110	634	249	992	240	0.09	143	48
3/13/97	9.0	7.9	7	190	150	544	167	930	208	0.29	160	58
3/20/97	8.8	8.0	3	230	95	566	155	923	236	0.07	166	59
3/27/97	9.0	8.1	2	NR	90	552	158	906	212	0.07	102	56
4/3/97	9.0	8.2	2	110	90	610	198	1,015	248	0.07	57	58
4/10/97	9.0	8.1	3	310	110	646	214	1,089	248	0.07	46	58
4/17/97	8.6	8.1	3	230	105	708	235	1,114	268	0.03	54	61
4/24/97	8.8	8.1	2	210	230	684	223	1,081	240	0.07	57	60
5/1/97	8.6	8.1	3	140	110	758	243	1,156	268	0.52	42	62
5/8/97	8.1	8.1	2	990	120	776	223	1,186	272	0.15	43	68
5/22/97	7.9	8.0	5	830	135	822	274	1,264	292	0.05	67	68
5/29/97	7.6	8.2	3	220	155	800	288	1,333	296	0.02	48	71
6/5/97	7.6	8.2	5	190	95	644	187	1,016	248	0.11	85	73
6/12/97	7.4	8.0	2	200	165	540	146	935	220	0.10	89	74
6/19/97	7.4	8.3	5	580	95	596	247	1,053	256	0.07	92	75
6/26/97	7.6	8.0	3	220	80	578	159	994	248	0.09	67	73
7/3/97	7.3	8.2	3	200	85	556	168	982	240	0.05	70	76
7/10/97	7.3	8.0	5	580	105	558	198	1,079	282	0.07	79	76
7/17/97	7.3	8.1	3	220	85	558	238	1,038	248	0.13	65	77
7/24/97	7.2	8.1	4	430	70	558	217	954	252	0.04	154	79
7/31/97	7.2	7.8	3	120	95	512	253	1,020	244	0.07	94	78
8/7/97	7.4	8.0	4	600	130	592	237	1,099	264	0.06	171	76
8/14/97	7.3	8.1	4	880	100	596	242	1,085	252	0.09	144	76
8/21/97	7.2	7.8	3	240	85	552	235	1,061	260	0.09	82	78
8/28/97	7.3	7.9	5	500	110	474	211	1,021	260	0.07	85	77
9/4/97	7.6	7.8	3	430	NR	556	234	1,053	NR	0.09	59	73
9/11/97	7.4	7.9	6	NR	105	654	139	1,041	260	0.09	157	75
9/18/97	9.7	7.8	3	1,160	100	770	180	1,206	296	0.08	223	77
9/25/97	8.1	7.9	2	570	100	630	216	1,084	288	0.17	2,259	67
10/2/97	7.7	7.8	4	650	190	876	299	1,386	320	0.12	112	71
10/9/97	7.7	8.0	2	690	125	872	189	1,393	336	0.09	83	65
10/16/97	9.0	7.9	4	830	125	612	144	1,193	288	0.08	236	57
10/23/97	8.8	7.8	3	890	170	968	189	1,514	328	0.04	62	59
10/30/97	9.2	8.0	1	320	185	1,056	357	1,740	404	0.12	37	55
11/6/97	9.4	7.9	2	270	160	1,232	368	1,885	384	0.12	19	53
11/13/97	9.6	8.1	2	620	200	902	277	1,776	372	0.12	27	52
11/20/97	9.8	8.2	1	220	225	1,196	390	1,975	424	0.13	21	50
12/4/97	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
12/11/97	11.1	8.3	5	150	250	1,182	363	1,970	308	0.13	14	40
12/18/97	10.5	8.2	2	50	300	1,152	496	2,350	480	0.25	15	44
12/25/97	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1/8/98	14.1	8.2	2	590	240	1192	412	2030	440	0.15	11	40
1/15/98	11.1	8.2	3	280	245	1,204	396	2,020	420	0.22	22	42
1/22/98	10.3	7.9	3	430	150	730	233	1,305	308	0.08	38	46
1/29/98	10.5	7.6	2	170	165	762	265	1,330	308	0.04	57	45
2/5/98	10.5	8.0	3	180	150	774	242	1,294	328	0.15	53	44
2/12/98	10.3	7.8	3	130	155	726	251	1,309	240	0.11	98	46
2/19/98	10.8	8.1	3	930	150	756	268	1,338	308	0.12	63	44
2/26/98	10.8	7.7	4	240	135	586	243	1,157	300	0.13	203	43
3/5/98	9.6	7.7	3	250	100	608	234	1,109	268	0.10	157	51
3/12/98	10.3	7.8	4	70	113	714	212	981	244	0.09	217	47
3/19/98	9.6	7.8	5	130	95	618	204	897	240	0.10	175	52
3/26/98	8.4	7.7	3	380	70	424	221	951	228	0.07	106	62
4/2/98	9.4	7.8	3	180	75	618	251	1,021	260	0.07	84	53
4/9/98	9.5	7.4	4	250	75	588	225	1,051	260	0.12	63	61
4/16/98	9.4	7.6	4	80	75	594	239	1,004	260	0.09	59	54
4/23/98	9.3	7.8	2	180	100	646	244	1,093	268	0.04	82	61
4/30/98	8.2	7.9	3	140	80	654	246	1,035	248	0.12	59	62
5/7/98	8.4	7.5	2	180	120	776	287	1,224	292	0.11	49	63
5/14/98	9.0	6.9	2	110	95	670	264	1,127	280	0.07	51	65
5/21/98	10.2	7.9	4	210	95	730	261	1,143	264	0.09	55	70
5/28/98	9.8	7.5	4	180	45	718	266	1,137	276	0.12	31	69
AVERAGE	9.0	7.9	3	340	141	761	254	1,279	293	0.1	115	59
MAXIMUM	12.0	8.3	7	1,160	360	1,564	501	2,450	480	0.5	2,259	79
MINIMUM	7.2	6.9	1	70	45	424	139	897	208	0.0	14	35

Notes: NR = Not Reported

Chemical concentrations in mg/l.

(1) 9.5 Miles above Haskell R. Street Wastewater Treatment Plant.

TABLE 2-5.
RIO GRANDE WATER QUALITY, 1997 THROUGH 1998 AT 1.5 MILES ABOVE HASKELL R. STREET WASTE WATER TREATMENT PLANT
(ACROSS FROM BOWIE HIGH SCHOOL FOOTBALL FIELD)

DATE	D.O.	pH	BOD	FECAL COLIFORM	CHLORIDE	TDS	SULFATE	EC	TOTAL HARDNESS	AMMONIA	TURBIDITY	TEMP (F)
1/9/97	12.0	8.2	3	130	325	1,484	475	2,340	448	0.22	20	35
1/16/97	11.1	8.5	3	260	320	1,506	478	2,290	476	0.36	16	41
1/23/97	10.0	8.1	3	320	310	1,470	525	2,300	444	0.28	16	48
2/6/97	10.0	8.4	3	130	265	1,138	317	1,896	372	0.15	17	49
2/13/97	10.0	8.3	3	700	270	1,386	440	2,060	400	0.21	14	49
2/20/97	10.0	8.3	4	310	205	714	182	1,208	248	0.08	40	51
2/27/97	10.3	8.2	3	290	125	638	156	1,036	240	0.13	87	47
3/6/97	10.0	8.4	2	90	120	622	160	997	236	0.08	80	49
3/13/97	9.0	8.0	8	120	100	520	163	920	212	0.13	178	58
3/20/97	8.8	8.2	3	360	90	536	147	909	232	0.04	154	60
3/27/97	9.2	8.2	2	380	75	482	141	833	208	0.08	123	56
4/3/97	8.8	8.2	2	810	85	550	185	960	236	0.05	77	60
4/10/97	8.8	8.2	2	200	100	588	201	1,042	244	0.06	42	59
4/17/97	8.6	8.2	3	160	100	688	225	1,094	260	0.03	38	60
4/24/97	8.6	8.2	2	510	210	664	219	1,072	256	0.06	57	60
5/1/97	8.6	8.1	2	340	115	744	227	1,133	264	0.21	41	62
5/8/97	8.1	8.2	2	770	125	742	229	1,143	256	0.22	36	68
5/22/97	7.7	8.2	3	90	105	708	223	1,126	264	0.03	77	70
5/29/97	7.6	8.4	4	220	120	656	223	1,132	260	0.03	40	72
6/5/97	7.4	8.3	6	600	75	552	156	901	232	0.09	95	74
6/12/97	7.4	8.0	4	610	170	520	144	890	230	0.11	99	75
6/19/97	7.3	8.5	5	440	85	564	172	989	240	0.07	92	76
6/26/97	7.4	8.2	3	330	80	624	147	967	232	0.07	72	74
7/3/97	7.2	8.4	4	180	85	554	144	930	224	0.05	71	77
7/10/97	7.3	8.2	6	480	95	510	151	943	240	0.05	86	76
7/17/97	7.2	8.3	3	170	80	598	153	995	236	0.10	61	78
7/11/96	7.0	8.1	2	720	70	546	129	898	228	0.04	163	80
7/31/97	7.2	8.2	3	300	85	592	194	950	240	0.06	153	78
8/7/97	7.3	8.1	2	NR	85	628	197	1,004	268	0.05	145	76
8/14/97	7.2	8.2	3	1090	85	562	142	957	236	0.08	121	78
8/21/97	7.2	8.0	2	800	85	552	136	994	228	0.08	70	79
8/28/97	7.2	8.0	5	330	100	532	161	949	240	0.06	84	78
9/4/97	7.4	8.1	3	370	NR	600	140	980	NR	0.08	63	74
9/11/97	7.4	7.8	8	NR	85	576	53	928	236	0.10	644	75
9/18/97	9.6	7.9	3	1120	105	688	123	1,078	272	0.08	290	77
9/25/97	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
10/2/97	7.7	7.9	2	740	175	842	291	1,398	316	0.11	101	71
10/9/97	7.4	7.8	4	600	110	804	104	1,293	280	0.07	88	71
10/16/97	9.0	7.9	3	180	120	580	127	1,077	272	0.09	265	58
10/23/97	8.8	8.0	3	600	165	946	176	1,451	324	0.05	67	59
10/30/97	9.2	8.1	1	290	200	1,042	305	1,780	400	0.13	43	57
11/6/97	9.4	8.0	2	370	220	1,160	321	1,943	388	0.13	19	54
11/13/97	9.6	8.2	3	1900	200	802	275	1,768	368	0.12	38	52
11/20/97	9.8	8.3	1	NR	245	1,268	375	2,070	556	0.14	14	51
12/4/98	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
12/11/98	11.1	8.3	5	150	250	1,182	363	1,970	308	0.13	14	40
12/18/98	10.5	8.2	2	50	300	1,552	496	2,350	480	0.25	15	44
1/8/98	10.8	8.2	2	280	245	1,272	419	2,090	424	0.24	15	42
1/15/98	10.8	8.3	4	110	265	1,268	408	2,070	396	0.27	15	44
1/22/98	10.3	7.8	3	480	150	748	250	1,338	312	0.09	27	47
1/29/98	10.3	7.9	8	160	165	792	255	1,336	304	0.06	63	47
2/5/98	10.5	7.9	2	150	145	786	240	1,309	308	0.10	61	45
2/12/98	10.3	7.9	3	160	175	752	272	1,365	316	0.12	102	47
2/19/98	10.5	8.0	3	300	160	824	291	1,395	316	0.10	53	45
2/26/98	10.8	8.0	3	140	140	722	258	1,205	284	0.11	105	44
2/5/98	9.6	7.8	4	420	95	638	200	1,016	256	0.06	168	53
3/12/98	10.3	7.8	4	350	93	770	190	915	220	0.08	200	47
3/19/98	9.4	7.9	3	200	90	598	202	885	224	0.07	172	53
3/26/98	8.4	7.9	3	420	70	436	194	863	228	0.06	123	63
4/2/98	9.2	7.9	3	240	70	560	226	952	240	0.06	82	54
4/9/98	9.8	8.0	3	150	85	624	238	1,104	256	0.09	63	72
4/16/98	9.2	7.8	2	220	70	594	232	988	252	0.07	57	56
4/23/98	9.2	8.2	2	210	100	662	247	1,087	256	0.03	48	62
4/30/98	8.2	8.1	2	520	80	446	235	1,018	252	0.11	58	63
5/7/98	8.6	7.2	16	0	170	920	301	1,588	284	10.2	19	63
5/14/98	9.2	7.7	4	490	95	636	249	1,075	256	0.07	51	65
5/21/98	9.6	8.0	5	810	100	702	270	1,144	264	0.07	30	68
5/28/98	9.6	7.8	6	420	60	690	274	1,142	260	0.11	18	67
AVERAGE	9.0	8.1	4	394	141	767	235	1,270	288	0.3	86	60
MAXIMUM	12.0	8.5	16	1,900	325	1,552	525	2,350	556	10.2	644	80
MINIMUM	7.0	7.2	1	0	60	436	53	833	208	0.0	14	35

Note: NR = Not Reported
Chemical Concentrations in mg/l.

TABLE 2-6. AVERAGE CONCENTRATIONS OF RIO GRANDE SURFACE WATER SAMPLES, JANUARY 1997 - MAY 1998

Parameter	Courchesne Bridge	Bowie High School
DO (mg/l)	9.0	9.0
pH	7.9	8.1
BOD (mg/l)	3	4
Fecal Coliform (cfu/ 100 ml)	340	394
Chloride (mg/l)	141	141
TDS (mg/l)	761	767
Sulfate (mg/l)	254	235
SC (µS/cm)	1,279	1,270
Total Hardness (mg/l)	293	288
Ammonia (mg/l)	0.1	0.3
Turbidity (NTUs)	115	86
Temperature (°F)	59	60

mg/l = milligrams per liter.

Source: Tables 2-4 and 2-5 contain additional information. Average concentrations derived from weekly sampling efforts.

TABLE 2-7. SUMMARY OF ANALYTICAL RESULTS, AUGUST 1997 - MAY 1998
SURFACE WATER SAMPLES

Parameter	Rio Grande			American Canal			On-site Ponds		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Avc
DO	6.1	7.64	6.76	4.97	12.4	7.52	5.29	8.33	7.19
pH	7.9	8.5	8.34	7.6	8.5	8.18	7.20	9.10	7.92
EC	814	1,993	1,317	896	5,410	2,445	975	50,100	13,369
TDS	526	1,337	856	594	3,979	1,729	644	53,664	13,002
TSS	16	432	128	13	275	101	1.8	41	15
Ca	60	107	79	62	225	119	35	526	225
Mg	14	27	18	15	94	40	3.2	274	74
Na	100	286	181	114	965	390	154	16,140	3,861
K	7.4	14	9	6.9	67	25	6.3	715	169
Total Alkalinity	162	235	197	172	388	244	73	154	106
HCO_3	178	299	225	205	381	243	61	256	143
CO_3	0.5	17	4.4	0.5	11	1.6	0.5	25	5.8
SO_4	131	436	259	156	1,839	736	193	36,326	8,053
Cl	67	255	150	75	679	265	137	2,853	762
F	0.57	0.82	0.69	0.65	2.3	1.1	0.91	30	11.2
$NO_3 + NO_2$	0.21	6.5	1.5	0.21	12	3.0	0.025	34	8.9

TABLE 2-7. - Continued

Parameter	Rio Grande			American Canal			On-site Ponds		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
Dissolved Metals									
As	<0.005	0.011	0.005	<0.005	0.82	0.24	0.064	3.7	1.03
Cd	<0.005	<0.005	<0.005	<0.005	0.13	0.01	0.021	22	5.93
Cr	<0.005	<0.005	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cu	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.2	1	0.59
Fe	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.76	0.21
Pb	<0.003	<0.003	<0.003	<0.003	0.004	<0.003	0.004	0.26	0.15
Se	<0.005	0.005	<0.005	<0.005	0.2	0.052	0.005	1.7	.041
Zn	<0.02	0.035	<0.02	<0.02	0.022	<0.02	0.16	137	38
Total Recoverable Metals									
As	<0.005	0.015	0.007	0.005	1.6	0.296	NA	NA	NA
Cd	<0.005	0.008	0.003	<0.005	0.019	<0.005	NA	NA	NA
Cr	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	NA	NA	NA
Cu	<0.025	0.026	<0.025	<0.025	0.043	<0.017	NA	NA	NA
Fe	0.15	5.9	2.25	<0.1	4.7	1.77	NA	NA	NA
Pb	<0.003	0.014	0.005	<0.003	0.021	0.007	NA	NA	NA
Se	<0.005	0.006	<0.005	<0.005	0.36	0.063	NA	NA	NA
Zn	<0.02	0.042	0.027	<0.02	0.068	0.032	NA	NA	NA

Notes:

(<) = Result is less than value indicated, which is the detection limit for the method.

NA = Not Analyzed.

See Table 2-3 for explanations of analytical parameters, including measurement units.

See Tables E-1 through E-3, Appendix E, for a full tabulation of analytical results, including detection limits.

See Exhibit 1 for sample locations.

All results in milligrams per liter.

TABLE 2 - 8. SUMMARY OF ON-SITE POND SEDIMENT SAMPLING RESULTS (mg/kg)

	Pond 1			Pond 5			Pond 6		
Parameters	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Arsenic	4,541	5,693	768	4,065	2,049	1,253	1,120	4,391	2,399
Barium	284	225	154	627	326	375	326	535	446
Cadmium	1,269	1,257	257	1,158	597	212	462	1,522	1,129
Chromium	185	326	251	63	63	62	45	154	79
Copper	10,450	13,840	2,573	72,520	42,070	58,680	27,800	55,160	55,370
Lead	6,964	9,695	1,790	63,330	32,430	5,416	4,296	12,290	7,421
Mercury	1.3	26	7.4	4.5	6.1	3.5	85	7	5.4
Selenium	119	189	37	247	101	59	89	247	269
Silver	52	71	19	385	335	117	88	181	176

Notes: mg/kg = milligrams per kilogram
Samples collected on July 15, 1996.
See Figure 3-8 for sample locations.

TABLE 2-9. ON-SITE POND AND SURFACE WATER SAMPLING RESULTS, NOVEMBER AND DECEMBER 1997

Sample Location	pH	SC (µS/cm)	TDS (mg/l)	Temp (degrees C)	Sulfate (mg/l)	Chloride (mg/l)
Pond 1	7.5	27,200	25,974	9.1	16,043	1,002
Pond 5	7.2	975	644	21.5	193	137
Pond 6	7.7	5,330	3,912	16.4	1,874	497
SEP-1	8	4,660	3,424	19.4	1,616	438
SEP-2	8.3	1,950	1,289	11.8	415	248
SEP-3	7.6	5,250	3,954	21.3	1,839	597
SEP-4	7.9	1,952	1,289	10	424	249
SEP-6	8.4	961	643	26	176	85
SEP-7	8.3	1,924	1,290	16.3	412	249
SEP-8	8.3	958	677	26	190	85
SEP-9	8.3	1,886	1,225	15.7	401	248
SEP-10	8.5	1,970	1,337	16	436	255
SEP-11	8.3	1,933	1,258	14.3	415	246
SEP-12	8.3	1,970	1,323	11.4	427	254
SEP-13	8.3	1,993	1,304	10.5	422	249
Rio Grande	8.2	1,768	802	11.1	275	200

Notes: Locations shown on Figure 2-2.
mg/l = milligrams per liter
µS/cm = microsiemens per centimeter

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
1/1/95	0.10	3.88	3.36
1/2/95	0.09	3.88	3.25
1/3/95	0.09	3.74	2.92
1/4/95	0.09	3.96	3.45
1/5/95	0.09	3.99	3.79
1/6/95	0.09	4.33	4.3
1/7/95	0.09	4.28	4.39
1/8/95	0.09	3.94	4.02
1/9/95	0.09	4.53	4.57
1/10/95	0.09	4.28	4.43
1/11/95	0.09	3.85	4.07
1/12/95	0.09	3.65	3.94
1/13/95	0.09	3.46	3.74
1/14/95	0.09	3.4	3.66
1/15/95	0.09	3.31	3.64
1/16/95	0.09	3.34	3.72
1/17/95	0.09	3.17	3.41
1/18/95	0.09	3.12	3.31
1/19/95	0.09	3.09	3.21
1/20/95	0.09	3.2	3.34
1/21/95	0.09	6.91	8.07
1/22/95	0.09	8.35	8.98
1/23/95	0.09	9.2	9.33
1/24/95	0.10	9.52	9.47
1/25/95	0.10	9.91	9.65
1/26/95	0.10	10.4	10.3
1/27/95	0.10	11.2	11.5
1/28/95	0.10	10.1	10.4
1/29/95	0.11	10	10.1
1/30/95	0.11	8.75	8.51
1/31/95	0.10	7.87	7.55
2/1/95	0.10	7.59	7.06
2/2/95	0.11	7.42	7.16
2/3/95	0.10	7.28	6.97
2/4/95	0.10	6.74	6.49
2/5/95	0.10	6.57	6.37
2/6/95	0.11	6.32	6.11
2/7/95	0.11	6.03	5.63
2/8/95	0.12	6.4	6.16
2/9/95	0.10	7.82	7.7
2/10/95	0.11	10.2	10.4
2/11/95	0.10	7.25	7.09
2/12/95	0.10	6.85	6.4
2/13/95	0.10	6.97	6.42
2/14/95	0.09	6.17	5.46
2/15/95	0.10	7.33	6.58
2/16/95	0.10	11.7	11.2
2/17/95	0.10	10.3	10.1

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
2/18/95	0.09	7.5	7.19
2/19/95	0.10	7.11	6.37
2/20/95	0.10	8.01	7.12
2/21/95	0.10	10.2	9.3
2/22/95	0.10	8.44	7.87
2/23/95	0.09	7.76	7.11
2/24/95	0.10	7.67	6.4
2/25/95	0.10	7.79	6.84
2/26/95	0.09	7	6.22
2/27/95	0.09	8.52	7.43
2/28/95	0.10	8.35	7.21
3/1/95	0.10	8.55	7.39
3/2/95	0.10	7.11	6.29
3/3/95	0.10	12.3	11.5
3/4/95	0.10	12.7	12.6
3/5/95	0.10	13.5	13.5
3/6/95	0.11	15.2	14.8
3/7/95	0.13	16.2	15.1
3/8/95	0.22	17.3	15.4
3/9/95	0.32	19.7	17.9
3/10/95	0.33	18.4	16.6
3/11/95	0.36	18.1	15.9
3/12/95	0.39	23.7	19.9
3/13/95	0.48	26.3	23.4
3/14/95	0.55	27.4	23.9
3/15/95	2.71	28.6	22.2
3/16/95	3.72	32.9	25
3/17/95	4.74	34.3	25.4
3/18/95	3.99	32.6	25.6
3/19/95	5.81	36.8	24.8
3/20/95	10.60	39.4	25
3/21/95	7.68	38.2	26.7
3/22/95	5.76	38.2	28.2
3/23/95	5.29	37.7	28.5
3/24/95	5.31	36	27.8
3/25/95	5.43	36	27.4
3/26/95	5.40	33.1	25.5
3/27/95	5.39	32.6	24.5
3/28/95	5.40	32.6	24.3
3/29/95	5.51	33.7	25.2
3/30/95	5.38	28.6	21.8
3/31/95	5.44	26.6	19.7
4/1/95	5.37	27.2	20
4/2/95	5.34	24.4	18.5
4/3/95	5.27	22.6	16.6
4/4/95	5.22	21.4	15.5
4/5/95	5.32	22.9	16.4
4/6/95	5.32	21.7	15.3

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
4/7/95	5.31	19.7	13.2
4/8/95	5.43	20.8	14.2
4/9/95	5.40	21.3	15.1
4/10/95	5.39	18.5	12.3
4/11/95	5.43	18.1	11.5
4/12/95	5.50	18	11.1
4/13/95	5.58	18.7	11.8
4/14/95	5.49	22.2	15.5
4/15/95	5.25	21.4	15.5
4/16/95	5.27	23	17
4/17/95	5.15	24.8	19
4/18/95	5.09	24.5	18.9
4/19/95	5.04	23.3	17.7
4/20/95	5.01	21.9	16.6
4/21/95	5.10	26.3	20.3
4/22/95	5.25	25.8	19.7
4/23/95	5.28	26.5	20.3
4/24/95	5.34	25.7	19.7
4/25/95	5.40	25.3	19.3
4/26/95	5.37	24	18.2
4/27/95	5.28	22.6	16.7
4/28/95	5.21	20.2	14.6
4/29/95	5.28	23.3	17.4
4/30/95	5.29	25.1	18.8
5/1/95	5.44	31.2	24.2
5/2/95	5.37	32.9	25.9
5/3/95	5.33	32.3	25.4
5/4/95	5.32	31.2	24.1
5/5/95	5.31	30.3	23
5/6/95	5.33	29.7	22.6
5/7/95	5.26	31.7	24.5
5/8/95	5.20	29.2	22.9
5/9/95	5.23	26.7	20.8
5/10/95	5.32	26.2	20
5/11/95	5.38	27.4	20.6
5/12/95	5.34	28.3	21.4
5/13/95	5.39	26.9	20
5/14/95	5.42	25.5	18.5
5/15/95	5.46	26.9	19.5
5/16/95	5.31	29.2	21.6
5/17/95	5.22	27.7	20.6
5/18/95	5.27	33.4	25.8
5/19/95	5.14	38.2	30.1
5/20/95	5.19	39.6	31
5/21/95	8.35	51	31.7
5/22/95	12.60	61.2	30.6
5/23/95	9.98	42.8	29
5/24/95	12.40	40.8	25.6

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
5/25/95	13.30	39.9	24.3
5/26/95	13.40	40.8	25
5/27/95	13.40	40.5	25.3
5/28/95	11.60	37.9	25
5/29/95	11.40	39.4	26.6
5/30/95	14.00	37.9	24.1
5/31/95	14.50	34	20.4
6/1/95	12.90	30.3	18.4
6/2/95	16.10	60.3	30.1
6/3/95	21.30	71.6	32.7
6/4/95	20.40	53.8	32.6
6/5/95	24.10	55.2	31
6/6/95	26.70	49.6	28.5
6/7/95	25.30	41.3	25
6/8/95	21.60	39.9	25.7
6/9/95	20.30	41.6	28.5
6/10/95	20.40	43.3	29.2
6/11/95	22.10	52.1	29.6
6/12/95	23.80	56.6	30
6/13/95	26.10	53	27.3
6/14/95	27.00	49.8	24.9
6/15/95	23.50	42.5	24.5
6/16/95	21.90	41.9	26
6/17/95	22.40	47.3	27.6
6/18/95	23.50	54.7	28.3
6/19/95	23.20	54.9	28.7
6/20/95	23.30	56.4	28.7
6/21/95	24.10	49	26.9
6/22/95	24.30	43	23.5
6/23/95	22.80	42.8	25.9
6/24/95	22.00	47.6	28.8
6/25/95	25.60	60.3	28.9
6/26/95	30.40	71.1	28.6
6/27/95	34.00	70	26.3
6/28/95	33.70	60.3	24.5
6/29/95	35.70	70.2	26.7
6/30/95	37.90	75.6	27
7/1/95	47.80	106	30.7
7/2/95	53.20	110	32.3
7/3/95	47.70	67.7	31.4
7/4/95	41.40	65.1	32.7
7/5/95	52.80	73.1	31.7
7/6/95	50.50	72.2	28.5
7/7/95	56.00	64.9	30.3
7/8/95	59.30	71.4	30.8
7/9/95	62.10	88.9	31.1
7/10/95	57.20	101	30.9
7/11/95	53.30	89.8	28.7

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
7/12/95	50.40	69.7	29.1
7/13/95	46.70	46.2	27.7
7/14/95	51.10	50.4	28.3
7/15/95	57.70	68.5	30.4
7/16/95	62.10	85.8	30.6
7/17/95	66.60	91.8	31
7/18/95	72.70	94	30.4
7/19/95	70.10	74.5	28.8
7/20/95	58.00	65.7	28.6
7/21/95	56.10	65.1	30.2
7/22/95	56.90	65.4	30.3
7/23/95	56.60	67.4	30.1
7/24/95	54.30	71.9	30.4
7/25/95	49.70	80.4	30.8
7/26/95	47.10	79.3	29.5
7/27/95	43.70	77.9	28.4
7/28/95	42.70	80.7	28.4
7/29/95	42.70	69.7	27.8
7/30/95	44.00	62.3	28
7/31/95	42.50	59.8	28.2
8/1/95	39.00	47.9	26.8
8/2/95	26.70	46.2	27
8/3/95	19.40	49	31.2
8/4/95	10.50	44.7	34.5
8/5/95	8.00	37.1	29.1
8/6/95	8.99	41.1	32
8/7/95	9.15	43.6	32.9
8/8/95	9.02	39.4	31.4
8/9/95	8.60	37.4	29.5
8/10/95	7.78	32.3	26.7
8/11/95	6.50	29.5	25.9
8/12/95	6.59	28.2	25.1
8/13/95	7.55	37.7	32.8
8/14/95	10.30	41.9	34.5
8/15/95	14.70	44.5	33.1
8/16/95	18.00	50.7	33.3
8/17/95	14.20	43.6	32.7
8/18/95	14.10	52.1	33.5
8/19/95	14.90	62	33.7
8/20/95	8.90	44.7	32.5
8/21/95	6.71	39.9	31.7
8/22/95	5.90	37.9	30.3
8/23/95	5.19	34.8	27.7
8/24/95	5.38	34.3	27.4
8/25/95	5.58	33.1	26.4
8/26/95	5.73	33.4	26.8
8/27/95	5.67	36.8	29
8/28/95	5.61	41.3	32.7

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
8/29/95	5.39	38.8	31.3
8/30/95	5.30	36.2	30.2
8/31/95	3.47	30.9	27.7
9/1/95	2.85	28.9	26.3
9/2/95	3.37	28.6	25.7
9/3/95	3.47	30.9	26.9
9/4/95	4.65	39.1	32.1
9/5/95	4.38	38.8	32.3
9/6/95	2.85	35.4	31.4
9/7/95	1.70	30	28.2
9/8/95	1.37	26.1	25.5
9/9/95	4.18	26	25.2
9/10/95	10.90	34.3	23.4
9/11/95	10.90	54.7	31.2
9/12/95	15.50	80.4	32.5
9/13/95	1.98	40.5	31.5
9/14/95	1.46	32.9	30.1
9/15/95	5.01	32.9	30.1
9/16/95	3.44	38.2	31.9
9/17/95	2.43	39.4	31.4
9/18/95	1.43	30.9	27.7
9/19/95	1.29	31.2	27.6
9/20/95	1.19	28.6	25.8
9/21/95	1.08	26.2	24.1
9/22/95	0.98	23.6	22.4
9/23/95	0.89	23	22.8
9/24/95	0.77	22.1	23
9/25/95	0.72	21.6	22.4
9/26/95	0.72	21.1	20.2
9/27/95	0.66	19.5	18.8
9/28/95	0.35	17.9	17.7
9/29/95	0.22	18.4	18.3
9/30/95	0.23	23.3	22.7
10/1/95	1.49	23	21.4
10/2/95	0.77	24	22.5
10/3/95	0.56	22.9	21.4
10/4/95	0.53	21.6	20.5
10/5/95	0.41	19.7	18.6
10/6/95	0.32	19.2	17.8
10/7/95	0.28	18.6	17.4
10/8/95	0.28	19.9	18.5
10/9/95	0.26	20.9	18.6
10/10/95	0.25	20.3	18.2
10/11/95	0.23	19.5	16.9
10/12/95	0.21	17.8	17.6
10/13/95	0.20	19	18.3
10/14/95	0.17	19.1	18.4
10/15/95	0.16	19.3	19.3

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
10/16/95	0.14	20.7	20.4
10/17/95	0.15	20.4	19.9
10/18/95	0.16	20.5	20.7
10/19/95	0.15	19.3	20.8
10/20/95	0.15	23.1	21.7
10/21/95	0.14	25.8	25.3
10/22/95	0.12	25.5	26.1
10/23/95	0.09	20.2	24.9
10/24/95	0.09	17.8	22.5
10/25/95	0.08	17.1	21.9
10/26/95	0.08	16.8	21.8
10/27/95	0.07	16.3	21.7
10/28/95	0.07	16.1	21.4
10/29/95	0.07	15.9	15.9
10/30/95	0.06	13.7	13.8
10/31/95	0.05	11.2	11.7
11/1/95	0.05	10	10.9
11/2/95	0.04	8.89	9.55
11/3/95	0.04	8.61	8.68
11/4/95	0.04	8.33	8.21
11/5/95	0.04	8.01	8.08
11/6/95	0.04	8.52	8.53
11/7/95	0.04	8.01	8.1
11/8/95	0.39	7.7	7.81
11/9/95	0.09	7.39	7.22
11/10/95	0.09	7.05	6.85
11/11/95	0.09	6.77	6.72
11/12/95	0.09	6.6	6.45
11/13/95	0.09	6.6	6.23
11/14/95	0.09	6.49	6.2
11/15/95	0.09	6.4	5.85
11/16/95	0.09	6.09	5.59
11/17/95	0.09	5.89	5.54
11/18/95	0.09	5.83	5.48
11/19/95	0.09	5.72	5.44
11/20/95	0.09	5.61	5.52
11/21/95	0.09	5.61	5.27
11/22/95	0.09	5.55	5.26
11/23/95	0.08	5.55	5.28
11/24/95	0.08	5.35	3.99
11/25/95	0.08	5.3	3.4
11/26/95	0.08	5.32	5.16
11/27/95	0.08	5.35	5.16
11/28/95	0.08	5.38	4.9
11/29/95	3.07	5.44	1.64
11/30/95	4.94	5.47	0.09
12/1/95	4.96	5.41	0.09
12/2/95	4.97	5.35	0.09

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
12/3/95	4.94	5.35	0.09
12/4/95	4.91	5.27	0.08
12/5/95	4.90	5.15	0.08
12/6/95	4.89	5.07	0.08
12/7/95	4.87	4.96	0.07
12/8/95	5.04	5.18	0.07
12/9/95	5.00	5.01	0.07
12/10/95	4.85	4.76	0.07
12/11/95	4.81	4.64	0.07
12/12/95	4.84	4.73	0.07
12/13/95	4.85	4.67	0.07
12/14/95	4.77	4.67	0.07
12/15/95	4.71	4.56	0.07
12/16/95	4.70	4.5	0.07
12/17/95	4.73	4.53	0.07
12/18/95	5.10	4.79	0.07
12/19/95	4.90	4.79	0.07
12/20/95	4.77	4.59	0.07
12/21/95	4.88	4.64	0.07
12/22/95	4.93	4.84	0.07
12/23/95	4.76	4.7	0.07
12/24/95	4.73	4.56	0.07
12/25/95	4.56	4.33	0.07
12/26/95	4.57	4.28	0.07
12/27/95	4.62	4.22	0.07
12/28/95	4.53	4.19	0.07
12/29/95	4.53	4.11	0.07
12/30/95	4.43	4.02	0.07
12/31/95	4.38	3.96	0.07
1/1/96	4.42	3.97	0.07
1/2/96	4.49	4.21	0.07
1/3/96	2.23	4.09	2.58
1/4/96	0.44	4.08	3.56
1/5/96	0.39	4.14	3.35
1/6/96	0.35	4.1	3.23
1/7/96	0.34	4.02	3.24
1/8/96	0.36	3.84	3.26
1/9/96	0.38	3.63	3.29
1/10/96	0.37	3.65	3.28
1/11/96	0.58	3.42	2.53
1/12/96	1.61	3.07	1.67
1/13/96	3.43	3.56	0.07
1/14/96	3.42	4.69	0.07
1/15/96	3.88	5.4	0.07
1/16/96	8.18	8.76	0.07
1/17/96	8.46	9.38	0.13
1/18/96	3.75	8.94	5.3
1/19/96	0.76	8.85	8.42

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
1/20/96	0.69	8.94	9.61
1/21/96	0.64	9.21	9.63
1/22/96	0.60	9.57	9.71
1/23/96	0.53	9.96	9.96
1/24/96	0.50	10	9.86
1/25/96	0.47	9.91	10
1/26/96	0.43	10.2	10.2
1/27/96	0.45	11.2	9.95
1/28/96	0.41	12.2	10.2
1/29/96	0.39	11.4	12.8
1/30/96	0.35	9.75	11.4
1/31/96	0.33	12.2	12
2/1/96	0.32	13.8	12.3
2/2/96	0.32	15.2	14.3
2/3/96	0.32	14.9	15.6
2/4/96	0.30	14.4	14
2/5/96	0.29	13.8	13.6
2/6/96	0.31	13.2	13.4
2/7/96	0.32	12.9	13.2
2/8/96	0.31	12.2	12.3
2/9/96	0.30	11.7	11.9
2/10/96	0.31	10.8	11.1
2/11/96	0.34	9.71	10.6
2/12/96	0.30	8.47	7.83
2/13/96	0.28	6.22	5.71
2/14/96	0.26	5.49	5.33
2/15/96	0.26	4.35	4.45
2/16/96	0.28	6.77	5.78
2/17/96	0.27	6.09	5.86
2/18/96	0.24	5.23	5.34
2/19/96	0.25	5.37	5.41
2/20/96	0.25	5.86	5.92
2/21/96	0.26	6.26	6.15
2/22/96	0.25	6.37	6.43
2/23/96	0.24	6.56	6.56
2/24/96	0.24	5.75	5.75
2/25/96	0.25	12.8	11.3
2/26/96	0.24	15	13.5
2/27/96	1.37	14.7	12.9
2/28/96	0.82	14	11.9
2/29/96	0.69	12.2	11.1
3/1/96	0.60	12.3	11.7
3/2/96	0.59	12.1	11.5
3/3/96	0.58	15.9	14.4
3/4/96	0.54	20.7	19.3
3/5/96	0.56	20.2	18.7
3/6/96	0.57	19.7	18.1
3/7/96	0.64	21	18.8

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
3/8/96	0.68	24.5	21.5
3/9/96	0.69	24.3	22.3
3/10/96	0.76	27.3	24.9
3/11/96	0.81	28.9	26.9
3/12/96	0.86	29.5	27.3
3/13/96	0.89	29.6	27.3
3/14/96	0.92	31.4	28.4
3/15/96	2.73	29.8	25.8
3/16/96	3.24	28.9	24.8
3/17/96	3.15	27.3	24
3/18/96	3.19	26.9	23.7
3/19/96	4.57	28.1	23.2
3/20/96	5.43	30.4	24.2
3/21/96	5.42	30	24.2
3/22/96	5.41	29.6	23.6
3/23/96	5.44	30.7	24
3/24/96	5.34	29.8	23.5
3/25/96	5.30	28	21.4
3/26/96	5.61	28.7	21.4
3/27/96	5.64	27.7	20.8
3/28/96	5.68	28.1	20.8
3/29/96	5.52	25.8	19.1
3/30/96	5.26	26	19.6
3/31/96	5.17	26	19.6
4/1/96	5.17	26.8	20.1
4/2/96	5.28	25.1	18.5
4/3/96	5.40	25.8	18.6
4/4/96	5.43	24.1	17.2
4/5/96	5.55	22	15.1
4/6/96	5.55	28.8	20.5
4/7/96	5.35	28.5	21.4
4/8/96	5.26	20	14.5
4/9/96	5.25	16.7	11.4
4/10/96	5.31	16	10.5
4/11/96	5.36	13.6	8.13
4/12/96	5.41	19.9	13.5
4/13/96	5.29	18.8	13.7
4/14/96	5.24	18.5	13.6
4/15/96	5.23	20.8	15.6
4/16/96	5.36	19.3	14.1
4/17/96	5.37	19.8	14.4
4/18/96	5.62	22.3	16.2
4/19/96	5.26	27.4	21
4/20/96	5.22	22.2	16.6
4/21/96	4.94	23.1	17.1
4/22/96	5.14	22.3	16.4
4/23/96	5.17	21.4	15.5
4/24/96	5.34	22.3	16.2

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
4/25/96	5.36	21.7	15.6
4/26/96	5.28	18.7	13.1
4/27/96	5.28	19.3	13.5
4/28/96	5.24	22	15.5
4/29/96	5.28	22	15.3
4/30/96	5.43	21.6	14.8
5/1/96	5.51	22.3	15.4
5/2/96	3.86	20.6	15.6
5/3/96	3.21	21.8	17.2
5/4/96	3.26	22.3	17.8
5/5/96	3.21	21.8	18.1
5/6/96	3.27	24.4	19.2
5/7/96	3.34	25	19.6
5/8/96	3.26	23.9	19.2
5/9/96	3.18	22	17.8
5/10/96	3.29	22.4	17.9
5/11/96	3.46	20	15.7
5/12/96	3.42	20.5	16.1
5/13/96	3.40	18.4	14.5
5/14/96	3.50	16.8	13.2
5/15/96	3.53	14.2	11
5/16/96	3.61	14	10.9
5/17/96	3.50	18	14.7
5/18/96	3.24	18.1	15.3
5/19/96	3.19	19.6	16.6
5/20/96	3.18	23.1	19.7
5/21/96	3.22	22.3	19.3
5/22/96	3.23	23	19.6
5/23/96	3.27	21.3	18.4
5/24/96	3.25	18.4	16.3
5/25/96	3.12	16	14.4
5/26/96	3.17	17.5	13.6
5/27/96	3.11	21.9	16.8
5/28/96	3.09	22.8	19.1
5/29/96	3.14	20.8	18.1
5/30/96	3.13	21.3	17.4
5/31/96	3.14	21.3	18
6/1/96	5.37	22	16.4
6/2/96	6.50	24.7	16.3
6/3/96	6.38	27.5	19
6/4/96	6.02	27.3	19.6
6/5/96	6.02	28.6	20.1
6/6/96	6.20	29.2	19.9
6/7/96	6.25	29	19.3
6/8/96	6.46	29.9	19.8
6/9/96	6.56	30.5	20.5
6/10/96	6.51	31.6	21.2
6/11/96	6.42	29.9	20.9

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
6/12/96	6.35	28.3	19.6
6/13/96	6.44	28.2	18.5
6/14/96	6.38	27	17.4
6/15/96	6.39	27	17.7
6/16/96	6.56	29.3	19.9
6/17/96	6.58	32.9	23.4
6/18/96	6.26	31.6	23.2
6/19/96	6.23	29.3	21.5
6/20/96	6.17	27.2	20
6/21/96	6.33	26.8	19.6
6/22/96	6.54	26.1	19.1
6/23/96	6.49	27	20.2
6/24/96	6.51	28.2	21.5
6/25/96	6.49	28.1	22.1
6/26/96	6.57	27.2	21.5
6/27/96	6.74	34.2	26.6
6/28/96	6.52	37.1	28.9
6/29/96	9.60	41.1	27.8
6/30/96	7.36	32.4	24
7/1/96	6.68	36	27
7/2/96	6.26	27.5	19.9
7/3/96	6.46	23.3	15.9
7/4/96	6.35	20.6	13.5
7/5/96	6.37	24.4	16.5
7/6/96	6.23	23.7	15.8
7/7/96	6.30	25	17.4
7/8/96	6.45	30.7	21.7
7/9/96	6.24	28.6	21.2
7/10/96	6.26	27.2	20.2
7/11/96	6.28	29.2	22.5
7/12/96	6.38	30.7	23.3
7/13/96	6.41	26.1	18.8
7/14/96	6.51	28.4	21.8
7/15/96	6.57	34.6	27
7/16/96	10.90	45.2	29.9
7/17/96	10.70	40.2	26.6
7/18/96	6.75	23.5	17.6
7/19/96	6.81	25	18
7/20/96	6.42	28.9	22
7/21/96	6.30	28.8	22.4
7/22/96	6.64	32.2	24.4
7/23/96	6.52	28.7	21.9
7/24/96	6.62	25.7	19.3
7/25/96	6.72	24.1	17.6
7/26/96	6.52	23.6	17.1
7/27/96	6.38	24.7	17.7
7/28/96	6.51	29.8	21.5
7/29/96	6.51	31.8	23.2

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
7/30/96	6.43	29.9	21.9
7/31/96	5.86	29.3	22
8/1/96	5.44	31.5	24.1
8/2/96	5.54	37.2	28.2
8/3/96	5.99	35.5	26.9
8/4/96	6.09	35.9	28.4
8/5/96	5.66	35	27.1
8/6/96	5.02	29.7	24.7
8/7/96	5.11	26.7	20.6
8/8/96	5.46	27.2	20.3
8/9/96	5.45	24.7	18.5
8/10/96	5.37	25.2	18.3
8/11/96	5.32	29.2	20.5
8/12/96	5.21	27.7	22.2
8/13/96	5.18	24.9	19.8
8/14/96	5.30	24.1	18.9
8/15/96	5.39	22	16.9
8/16/96	5.37	21.1	15.8
8/17/96	5.34	20.4	15
8/18/96	5.41	21.6	15.8
8/19/96	5.56	27.6	20.9
8/20/96	5.50	25.4	19.7
8/21/96	5.57	27.5	21.3
8/22/96	5.49	26.1	20.1
8/23/96	5.58	29.3	22.2
8/24/96	5.56	30.3	22.8
8/25/96	5.42	28.9	21.4
8/26/96	5.31	23.2	16.8
8/27/96	5.49	21.7	15.1
8/28/96	5.65	22.4	15.7
8/29/96	5.62	21.8	15.1
8/30/96	5.67	23.6	16.5
8/31/96	4.14	23.1	17.6
9/1/96	3.67	21.1	16.4
9/2/96	3.52	25.8	19.3
9/3/96	3.23	23	21.2
9/4/96	3.48	22.1	17.1
9/5/96	3.56	20.4	15.2
9/6/96	3.63	20	14.9
9/7/96	2.06	20.1	16.8
9/8/96	0.50	20.5	18.5
9/9/96	0.51	18.2	17
9/10/96	0.42	17	16
9/11/96	0.49	18.7	17.1
9/12/96	0.60	24.2	21.2
9/13/96	32.90	41.9	25.3
9/14/96	14.30	40.7	24.8
9/15/96	16.00	33.9	15.9

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
9/16/96	5.15	28.8	20
9/17/96	0.50	23.3	22.1
9/18/96	0.87	22	21.2
9/19/96	1.06	19.2	19.1
9/20/96	1.06	15.8	16
9/21/96	1.01	13.2	15
9/22/96	0.98	11.6	13.6
9/23/96	0.98	14.4	14.1
9/24/96	0.99	12.8	11.4
9/25/96	0.93	11.8	10.5
9/26/96	0.88	14.8	12.9
9/27/96	0.87	17.2	15.4
9/28/96	0.86	18.5	16
9/29/96	0.86	22.9	20.1
9/30/96	0.82	22.1	19.1
10/1/96	8.55	48.3	24.7
10/2/96	4.97	37	22.7
10/3/96	1.09	18.3	15.5
10/4/96	1.00	15.2	12.1
10/5/96	0.97	13.9	11
10/6/96	0.99	13	11.1
10/7/96	1.00	12.7	11
10/8/96	1.01	11.4	10.5
10/9/96	1.03	10.2	9.38
10/10/96	1.07	9.81	8.85
10/11/96	1.08	8.93	8.13
10/12/96	1.10	8.52	7.85
10/13/96	1.12	8.09	7.64
10/14/96	1.11	8.01	7.67
10/15/96	5.18	8.09	2.97
10/16/96	8.45	7.62	0.03
10/17/96	7.84	7.25	0.03
10/18/96	7.28	6.74	0.03
10/19/96	7.01	6.6	0.03
10/20/96	6.89	7.28	0.03
10/21/96	6.71	6.31	0.03
10/22/96	6.44	6.03	0.03
10/23/96	6.41	6.01	0.03
10/24/96	6.43	6.05	0.03
10/25/96	6.28	5.91	0.03
10/26/96	6.16	5.74	0.03
10/27/96	6.02	5.64	0.03
10/28/96	6.18	6.13	0.03
10/29/96	6.18	6.22	0.03
10/30/96	6.05	6.18	0.03
10/31/96	6.02	5.93	0.03
11/1/96	5.78	5.58	0.03
11/2/96	5.37	5	0.03

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
11/3/96	5.26	4.91	0.03
11/4/96	5.26	4.78	0.03
11/5/96	5.20	4.78	0.03
11/6/96	5.11	4.76	0.03
11/7/96	4.98	4.64	0.03
11/8/96	4.82	4.58	0.03
11/9/96	4.88	4.83	0.03
11/10/96	4.81	4.79	0.03
11/11/96	4.72	4.74	0.02
11/12/96	4.64	4.68	0.02
11/13/96	4.64	4.7	0.02
11/14/96	4.57	4.63	0.02
11/15/96	4.53	4.61	0.02
11/16/96	4.44	4.51	0.02
11/17/96	4.22	4.1	0.02
11/18/96	4.24	4.21	0.02
11/19/96	4.23	4.11	0.02
11/20/96	4.18	4.16	0.02
11/21/96	4.16	4.23	0.02
11/22/96	4.13	4.21	0.02
11/23/96	4.17	4.11	0.02
11/24/96	4.07	3.98	0.02
11/25/96	3.91	3.84	0.02
11/26/96	4.07	3.94	0.02
11/27/96	4.10	3.99	0.02
11/28/96	4.08	3.85	0.02
11/29/96	4.21	3.97	0.02
11/30/96	4.10	3.76	0.02
12/1/96	4.07	3.63	0.02
12/2/96	4.06	3.71	0.02
12/3/96	4.03	3.52	0.02
12/4/96	3.92	3.37	0.02
12/5/96	3.87	3.3	0.02
12/6/96	3.77	3.14	0.02
12/7/96	3.80	3.09	0.02
12/8/96	3.76	3.04	0.02
12/9/96	3.79	3.07	0.02
12/10/96	3.76	3.01	0.02
12/11/96	3.68	2.8	0.02
12/12/96	3.67	2.67	0.02
12/13/96	3.81	2.82	0.02
12/14/96	3.75	2.7	0.02
12/15/96	3.75	2.6	0.02
12/16/96	3.47	2.54	0.02
12/17/96	3.53	2.72	0.02
12/18/96	3.23	2.37	0.02
12/19/96	3.27	2.24	0.02
12/20/96	3.44	2.51	0.02

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
12/21/96	3.39	2.58	0.02
12/22/96	3.24	2.6	0.02
12/23/96	3.16	2.43	0.02
12/24/96	3.12	2.32	0.02
12/25/96	3.12	2.28	0.02
12/26/96	3.09	2.26	0.02
12/27/96	2.99	2.14	0.02
12/28/96	2.95	2.11	0.02
12/29/96	2.99	2.05	0.02
12/30/96	2.98	2.02	0.02
12/31/96	3.12	2.15	0.02
1/1/97	3.02	2.16	0.02
1/2/97	2.99	2.04	0.02
1/3/97	3.04	2	0.02
1/4/97	3.04	2.23	0.02
1/5/97	3.03	2.17	0.02
1/6/97	3.02	2.4	0.02
1/7/97	3.03	1.78	0.02
1/8/97	3.23	2.74	0.02
1/9/97	3.36	2.81	0.02
1/10/97	3.15	2.86	0.02
1/11/97	3.13	2.83	0.02
1/12/97	3.01	2.88	0.02
1/13/97	2.89	2.67	0.02
1/14/97	2.73	2.24	0.02
1/15/97	2.80	2.45	0.02
1/16/97	3.03	2.55	0.03
1/17/97	2.82	2.37	0.03
1/18/97	2.68	2.32	0.03
1/19/97	2.66	2.28	0.03
1/20/97	2.70	2.28	0.03
1/21/97	2.72	2.27	0.03
1/22/97	2.72	2.22	0.03
1/23/97	2.75	2.3	0.03
1/24/97	2.54	2.1	0.03
1/25/97	7.23	6.59	0.03
1/26/97	10.30	8.76	0.03
1/27/97	11.00	8.74	0.03
1/28/97	11.00	9.16	0.03
1/29/97	11.10	9.54	0.04
1/30/97	10.70	9.14	0.04
1/31/97	10.70	9.23	0.04
2/1/97	10.80	9.36	0.04
2/2/97	10.40	9.39	0.04
2/3/97	8.12	7.18	0.04
2/4/97	5.60	4.42	0.04
2/5/97	4.84	3.6	0.04
2/6/97	4.38	3.21	0.04

TABLE 2-10.
RIO GRANDE DAILY MEAN DISCHARGE RATES, CUBIC METERS PER SECOND

Date Measured	Pump House Below American Dam	Courchesne Bridge	Diversion at American Canal
2/7/97	3.91	2.96	0.04
2/8/97	3.62	2.69	0.04
2/9/97	3.44	2.52	0.04
2/10/97	3.23	2.29	0.04
2/11/97	3.21	2.24	0.04
2/12/97	3.06	2.15	0.04
2/13/97	2.97	2.08	0.04
2/14/97	3.62	3.02	0.04
2/15/97	4.55	4.14	0.04
2/16/97	3.98	3.4	0.04
2/17/97	4.11	3.96	0.04
2/18/97	3.46	9.3	4.86
2/19/97	1.22	11	8.74
2/20/97	1.04	9.45	7.56
2/21/97	0.97	11.9	9.69
2/22/97	0.93	13.9	11.1
2/23/97	0.86	13.7	10.8
2/24/97	0.84	14.1	11.1
2/25/97	0.80	13.8	10.9
2/26/97	0.73	14.2	11.5
2/27/97	0.72	15.4	12.2
2/28/97	0.65	11.2	9.17
3/1/97	0.62	12.6	10
3/2/97	0.60	14.5	11.9
3/3/97	0.60	22.2	17.2
3/4/97	0.54	21.1	17.8
3/5/97	0.51	20.5	17.1
3/6/97	0.47	17.9	14.9
3/7/97	0.45	17.6	14.9
3/8/97	0.48	19.6	16.6
3/9/97	0.49	22.5	19
3/10/97	0.51	24.4	21.1
3/11/97	0.58	29.1	24.7
3/12/97	0.55	28.6	24
3/13/97	0.50	27.8	23.4
3/14/97	0.53	24.6	21.9
3/15/97	0.53	28.5	21.3
3/16/97	0.57	28.6	22.1
3/17/97	2.74	31.2	23.9
3/18/97	3.77	32.3	23.9
3/19/97	4.98	31.1	22.1
3/20/97	5.45	34.7	24.5
3/21/97	5.53	36	25.5
3/22/97	5.62	35.1	24.7
3/23/97	5.56	33.7	23.9
3/24/97	5.61	35.5	25.4
3/25/97	5.37	36.9	27.4
3/26/97	6.26	38.6	28.4