APPENDICES
Appendix A

Herbicide Application Treatment Techniques

Broadcast Foliar Applications: Moderate to High Density Stands.

Spray using equipment calibrated to deliver a minimum of 25 gallons per acre. Select coarse nozzle tips that will provide adequate coverage at lower spraying pressures (less than 40 psi) to avoid drift. Use boom-less tips when spraying swaths to the sides to avoid damage to equipment. Adjust nozzle height as recommended by manufacturer. Use blue dye indicator to avoid over-applications and missed plants. Provide for overlap of spray swaths to avoid "banding" or skips. General appearance of foliage should glisten.

Applications using helicopter: Apply 4 pts/acre Imazapy for habitat Herbicide (2-lb a.e. per gal) plus nonionic surfactant in a total spray mix using at a minimum of 15gallons per acre. Follow label precautions.
Applications made adjacent to open water using arsena under 2,4-C label for imazapyr use in New Mexico.

May use imazapyr under aquatic label Habitat™ when approved by New Mexico Department of Agriculture.

*** Public notification prior to aerial pesticide applications required.***

(See-Reclamation Manual/Directives and Standards ENV 01-02)

Individual Foliar Application: Moderate to Low Density Stands

Spraying would occur utilizing backpack sprayers or from hose reel equipped equipment; spray individual plants to glisten or to wet but not to the point of runoff. Insure that all foliage has been sprayed especially terminal tips of branches. Use blue die indicator.

Carpeted Roller Application: Moderate to Low Density Stands

Follow instructions from "Construction and Use of a Carpeted Roller for Weed and Brush Control." Avoid breaking stems and limbs. Do not exceed label rate for active ingredient per acre.

Low Volume Basal Application: Low Density Stands up to waters edge

Use a backpack sprayer or ATV mounted sprayer to treat individual plants. Clear or stomp down any grass or non-target vegetation around plants to avoid interference. Use small orifice nozzle tip (Conejet 5500 X-1 or similar) and direct a low pressure spray to the lower 15-20 inches of plant stems. Ensure that stem surfaces are treated completely around. Spray to wet but not to the point of runoff. Use blue dye indicator.

Cut Stump Treatment: Low Density Stands up to waters edge
These treatments are made immediately after cutting tree. Spray entire exposed stump, particularly the cambium layer next to the bark of the cut surface. Undiluted herbicide may be used if label permits to paint the surface with a brush or wick.

Appendix B

Herbicide Selection for Saltcedar Treatments

Brush or weed controlled	Trade name and product rate/acre	Herbicide common name and active ingredient	Treatment type	Time of application	Remarks
Saltcedar	Arsenal™ or Habitat ½ gal or Tank mix 1 to 1/1/2 qt Arsenal™ with 1 ½ to 2 ½ pt Roundup	imazapyr 1 lb/acre (4 pts/acre) or imazapyr ½ to ¾ lb per/acre + Glyphosate ½ to 1 lb per/acre	Broadcast foliar and individual foliar treatments	July to early September	Use ¼% by volume non-ionic surfactant May use 2pts/acre 90% non-ionic aquatic labeled surfactant
Saltcedar	Garlon 4	trichlopyr 20 to 25 % solution mixed with vegetable oil	low volume basal and cut stump	anytime	wet cambium layer use die indicator
Saltcedar	Arsenal™	imazapyr 12 oz. Mixed with 1 gallon water	cut stump	within 2 weeks of cutting	Use die indicator. Addition of penetrating oil will enhance treatment
Saltcedar	Arsenal™	imazapyr	carpeted roller	growing season	use die indicator. avoid breaking plants

Appendix C

MEMORANDUM OF UNDERSTANDING

Between the

CONSERVATION SOIL AND WATER CONSERVATION DISTRICT

And the

US DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION ALBUQUERQUE AREA OFFICE

On August 1, 2003, the Carlsbad Soil and Water conservation District (hereinafter referred to as CSWCD) and the United States Department of the Interior (USDI), Bureau of Reclamation, Albuquerque Area Office, (hereinafter referred to as Reclamation) entered into a Memorandum of Understanding (MOU) for the purpose of defining the basis of cooperation to perform activities consistent with the Pecos River Saltcedar Control Project. The Pecos River Saltcedar Control Project is part of a special appropriation by the New Mexico State Legislature to fund phreatophyte vegetation control along the Pecos River by soil and water conservation districts.

Federal involvement in the Pecos River Basin began in 1905 with authorization of the Carlsbad Project. Reclamation stores and delivers Carlsbad Project water for the benefit of the Carlsbad Irrigation District (CID). Reclamation's Carlsbad Project facilities on the Pecos River now include Sumner Dam, Brantley Dam, and Avalon Dam. The State of New Mexico has an on going obligation to meet the terms and conditions of the federally approved Pecos River Compact (Public Law 91, Ch. 184) and U.S. Supreme Court Amended Decree with water derived in the Pecos River Basin, New Mexico. New Mexico can meet those obligations only if water is delivered to the New Mexico-Texas state line in appropriate quantities.

The CSWCD, through their efforts to control phreatophytes could improve Carlsbad Project water supply and water deliveries to the Texas state line if net water savings are realized. In addition, authority is given under the Federal Noxious Weed Act- Section 2814 (Management of undesirable plants on Federal lands) for agencies, as appropriate, to enter into cooperative agreements with State agencies to coordinate the management of undesirable plant species on Federal lands.

Therefore, the CSWCD and Reclamation hereby enter into this MOU.

A. The CSWCD will:

1. Provide Reclamation with a written project plan and aerial applications specifications containing the specific details of the aerial application, application

rates, chemical information, and other related pertinent information. Reclamation will utilize this information for obtaining the necessary environmental clearances and a right-of-use permit (Reference Federal Noxious Weed Act, Section 2814, Attachment 1).

2. CSWCD will comply with all Federal laws and regulations related to pesticide use on Federal lands including, but not limited to, the Department of the Interior Pesticide Use Policy (Part 517 Departmental Manual 1.1); Carlson-Foley Act of 1968 (Public Law 90-583), see Attachment 2; and Public Lands Weed Control Program (Part 609 Departmental Manual 1.1), see Attachment 3.

3. Implement aerial herbicide treatments on Reclamation administered lands only after all necessary environmental clearances have been obtained and a right-of-use permit has been executed by Reclamation for the activity.

4. Properly notify the public as per Department of the Interior requirements associated with aerial pesticide applications (see Attachment 4).

5. Provide technical oversight and inspection of work activities.

6. Provide contract administration and supervision.

B. Reclamation will:

1. Designate aerial herbicide treatment sites on Reclamation administered land.

2. Provide the CSWCD the GPS coordinate locations for the designated aerial herbicide treatment sites, and copy of maps depicting such activities.

3. Complete all necessary environmental clearances prior to the aerial herbicide applications on selected lands administered by Reclamation.

4. Provide a right-of-use permit that will authorize the CSWCD to conduct activities on Reclamation administered land for the purpose of implementing the aerial herbicide application.

5. Perform post-treatment herbicide monitoring on sites located on Reclamation administered land.

6. Provide CSWCD all monitoring and evaluation information gathered on the treated Reclamation sites.

7. Provide technical oversight and review as needed.

C. It is further understood:

1. This MOU may be modified at any time by the joint agreement of the parties or terminated by either party by giving sixty (60) days notice in writing to the other party.

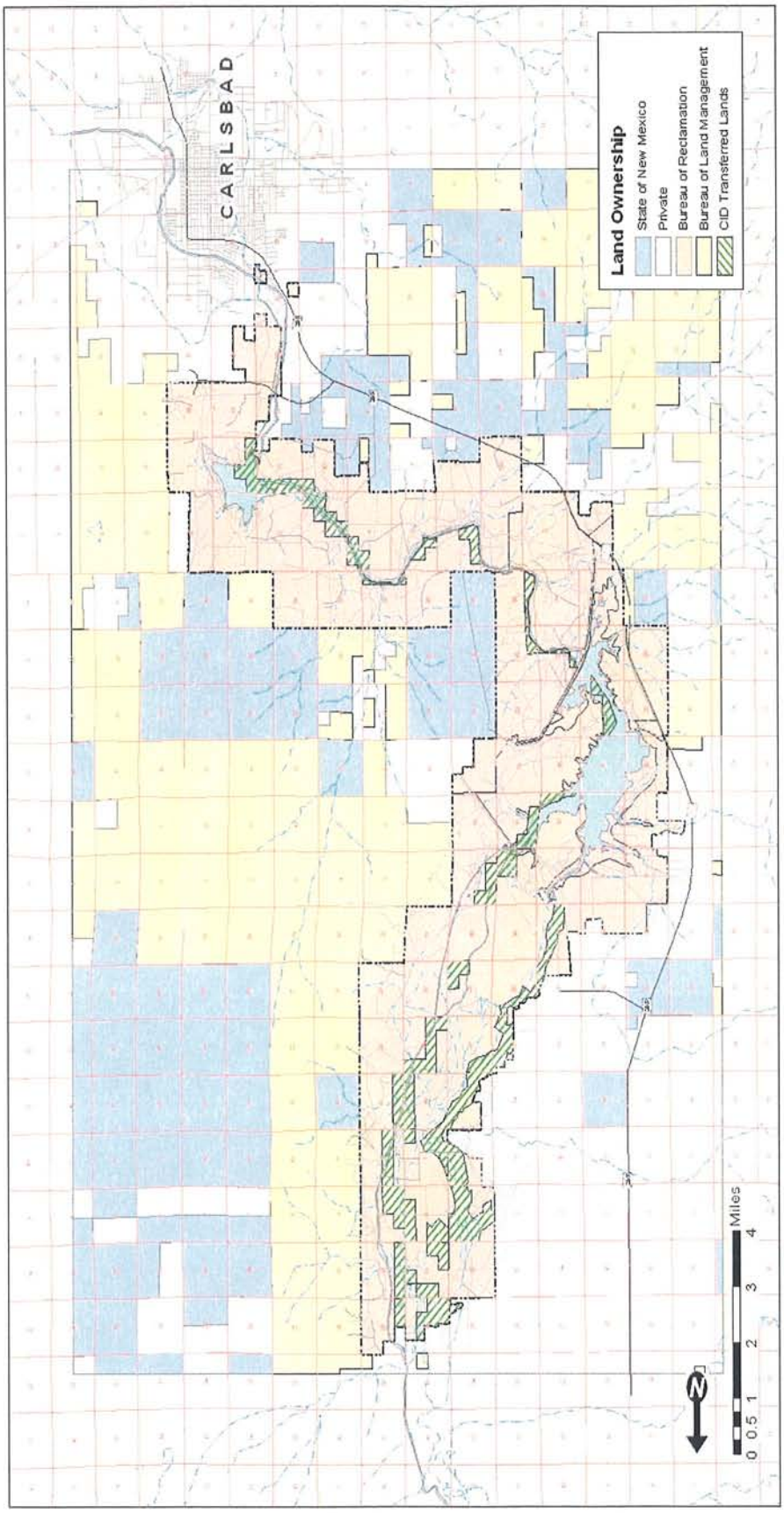
CARLSBAD SOIL AND WATER CONSERVATION DISTRICT

By: _____ Date: 8/1/03
Garth Goody, Chairman

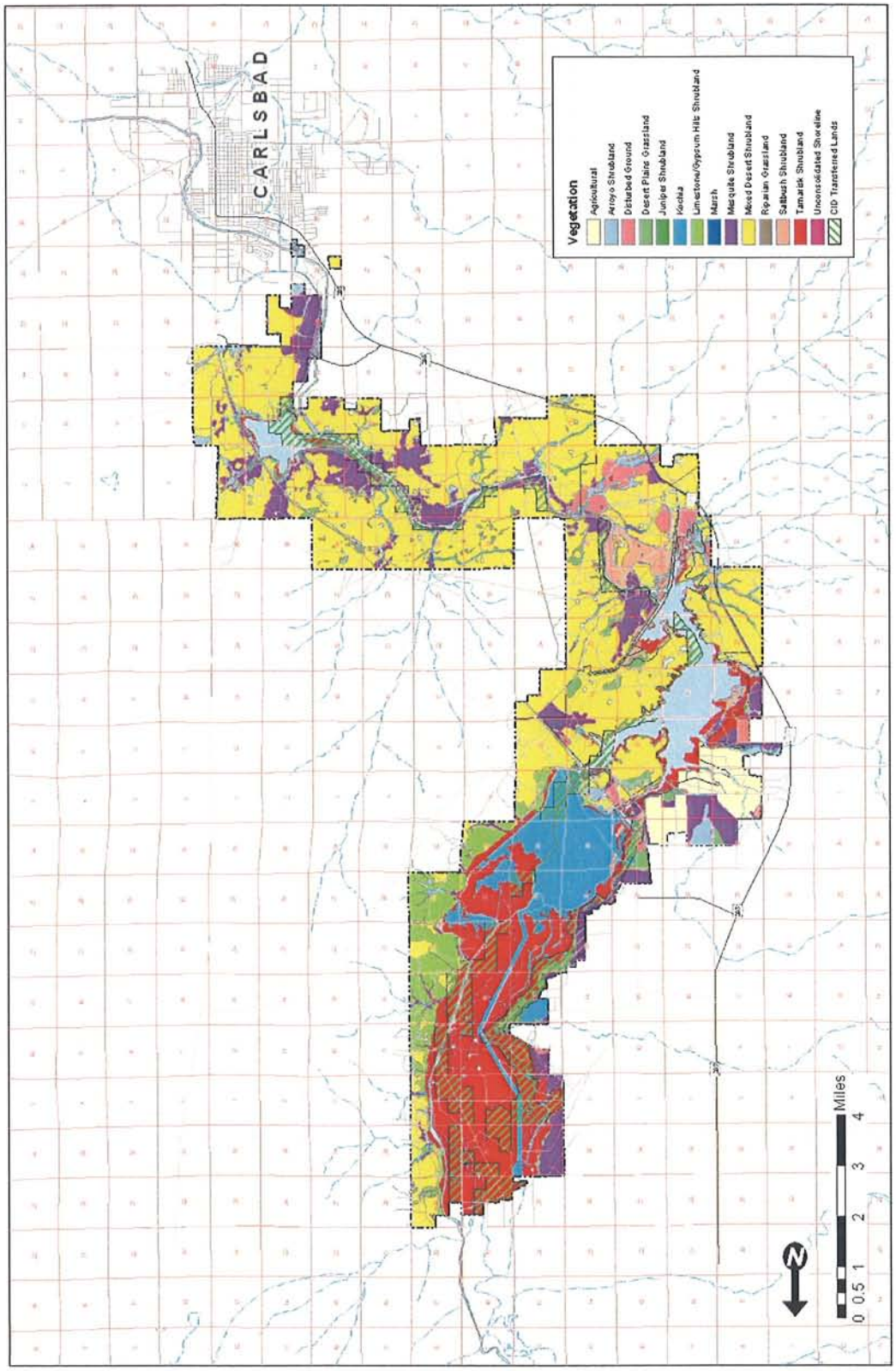
USDI-BUREAU OF RECLAMATION

By: _____ Date: 8/1/03
Ken Maxey, Area Manager

Appendix D
Figure 1



Appendix D
Figure 2



Appendix E –Imazapyr

[redacted]

Herbicide Basics

Chemical formula: (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-3-pyridinecarboxylic acid

Herbicide Family: Imidazolinone

Target Species: grasses, broadleaves, vines, brambles, shrubs and trees, riparian and emerged aquatics

Forms: acid & salt

Formulations: SL, GR

Mode of Action: Amino acid synthesis inhibitor

Water Solubility: 11,272 ppm

Sorption potential: low

Primary degradation mech: Slow microbial metabolism and photolysis

Average Soil Half-life: 25-141 days

Mobility Potential: high

Dermal LD50 for rabbits: >2,000 mg/kg

Oral LD50 for rats: >5,000 mg/kg

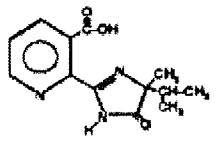
LC50 for bluegill sunfish: >100 mg/L

Trade Names: Arsenal®, Habitat®, Chopper®, and Stalker®

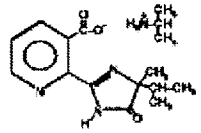
Manufacturer: BASF (previously American Cyanamid Company)

Synopsis

Imazapyr is a non-selective herbicide used for the control of a broad range of weeds including terrestrial annual and perennial grasses and broadleaved herbs, woody species, and riparian and emergent aquatic species. It controls plant growth by preventing the synthesis of branched-chain amino acids. Because imazapyr is a weak acid herbicide, environmental pH will determine its chemical structure, which in turn determines its environmental persistence and mobility. Below pH 5 the adsorption capacity of imazapyr increases and limits its movement in soil. Above pH 5, greater concentrations of imazapyr become negatively charged, fail to bind tightly with soils, and remain available (for plant uptake and/or microbial breakdown). In soils imazapyr is degraded primarily by microbial metabolism. It is not, however, degraded significantly by photolysis or other chemical reactions. The half-life of imazapyr in soil ranges from one to five months. In aqueous solutions, imazapyr may undergo photodegradation with a half-life of two days. Imazapyr is not highly toxic to birds and mammals, but some formulations (for instance, the inert ingredients in Chopper® and Stalker®) can cause severe, irreversible eye damage. Studies indicate imazapyr is excreted by mammalian systems rapidly with no bioaccumulation. It has a low toxicity to fish, and algae and submersed vegetation are not affected. Because imazapyr can affect a wide range of plants and can remain available, care must be taken during application to prevent accidental contact with non-target species. Further, a few studies have reported that imazapyr may be actively exuded from the roots of legumes (such as mesquite), likely as a defense mechanism by those plants. This exudate and the ability of imazapyr to move via intertwined root grafts may therefore adversely affect the surrounding desirable vegetation with little to no control of the target species.



imazapyr acid



imazapyr isopropylamine salt

Weed Control Methods Handbook, The Nature Conservancy. Tu *et al.*
http://tncweeds.ucdavis.edu

Herbicide Details

Chemical Formula: (±)-2-[4,5-dihdro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-3-pyridinecarboxylic acid

Trade Names: Arsenal®, Chopper®, and Stalker®. As of September 2003, imazapyr has received an EPA aquatic registration for Habitat®.

Manufacturer: BASF (previously by American Cyanamid Company, which was purchased by BASF in 2000)

Use Against Natural Area Weeds: Imazapyr is a broad-spectrum herbicide that controls terrestrial annual and perennial grasses and broadleaved herbs, woody species, and riparian and emergent aquatic species. It can be used where total vegetation control is desired or in spot applications. Imazapyr is relatively slow acting, does not readily break down in the plant, and is therefore particularly good at killing large woody species. Imazapyr can control saltcedar (*Tamarix ramosissima*), privet (*Ligustrum vulgare*), blackberries (*Rubus* spp.), field bindweed (*Convolvulus arvensis*), bahiagrass (*Paspalum notatum*), and downy brome (*Bromus tectorum*) (American Cyanamid 1986). Caution should be used when applying imazapyr, as a few reports to TNC from the field indicate that imazapyr might be exuded from the roots of target species. Some legume species, such as mesquite, may actively exude imazapyr (J. Vollmer pers. comm.). Imazapyr herbicide can be mobile within roots and transferred between intertwined root systems (root grafts) of many different plants and/or to several species. Movement of imazapyr via root grafts or by exudates (which is a defense mechanism of those plants) may therefore adversely affect the surrounding vegetation. This movement of herbicide may also be compounded when imazapyr is incorrectly overapplied. Movement of soil particles that contains imazapyr can also potentially cause unintended damage to desirable species.

Imazapyr is effective for creating openings for wildlife use. It can be applied pre-emergent, but is most effective when applied as a post-emergent herbicide. Care should be taken in applying it around non-target species, as it is readily adsorbed through foliage and roots, and therefore, could be injurious by drift, runoff, or leaching from the roots of treated plants. To avoid injury to desirable trees, do not apply imazapyr within twice the drip line (tree canopy).

On TNC preserves in Texas, imazapyr provided good control of saltcedar (*Tamarix* spp.) and Chinese tallow tree (*Sapium sebiferum*). In North Carolina preserves, it was effective against oriental bittersweet (*Celastrus orbiculata*), cut-stumps of Chinese privet (*Ligustrum sinese*), and tree-of-heaven (*Ailanthus altissima*). Recent work in California demonstrated that foliar applications of imazapyr effectively controlled jubatagrass and pampasgrass (*Cortaderia jubata* and *C. selloana*) (DiTomaso et al. 1999; Drewitz 2000), and experimental studies in Washington showed that imazapyr provided excellent control of smooth cordgrass (*Spartina alterniflora*) in tidal estuarine habitats (Patten 2002).

Mode of Action: Imazapyr is absorbed quickly through plant tissue and can be taken up by roots. It is translocated in the xylem and phloem to the meristematic tissues, where it inhibits the enzyme

acetohydroxy acid synthase (AHAS), also known as acetolactate synthase (ALS). ALS catalyzes the production of three branched-chain aliphatic amino acids, valine, leucine, and isoleucine, required for protein synthesis and cell growth. The rate of plant death usually is slow (several weeks) and is likely related to the amount of stored amino acids available to the plant. Only plants have ALS and produce these three amino acids, and therefore, imazapyr is of low toxicity to animals (including fish and insects). Animals need these three branched chain aliphatic amino acids, but obtain them by eating plants or other animals.

Dissipation Mechanisms:
Summary: Imazapyr is degraded in soils primarily by microbial metabolism. It will quickly undergo photodegradation in aqueous solutions (photohydrolysis), but there is little to no photodegradation of imazapyr in soil, and it is not readily degraded by other chemical processes. Imazapyr does not bind strongly with soil particles, and depending on soil pH, can be neutral or negatively charged. When negatively charged, imazapyr remains available in the environment.

Volatilization
Imazapyr does not volatilize readily when applied in the field (T. Lanini, pers. obs.). The potential to volatilize, however, increases with increasing temperature, increasing soil moisture, and decreasing clay and organic matter content (Helling et al. 1971).

Photodegradation
Imazapyr is rapidly degraded by sunlight in aquatic solutions. In soils, however, there is little or no photodegradation of imazapyr (WSSA 1994). The half-life of imazapyr due to photodegradation in aqueous solution is approximately two days, and decreases with increasing pH (Mallipudi et al. 1991, Mangels 1991a).

Microbial Degradation
Microbial degradation is the primary mechanism of imazapyr degradation in soils (WSSA 1994). American Cyanamid (1986) reported that the half-life of imazapyr in soils typically ranged from one to seven months, depending on soil type, temperature, and soil moisture (Mangels 1991b). The half-life of imazapyr is shorter at cooler soil temperatures (25° C versus 35° C) and in sandier soils (sandy loam versus clay loam) (American Cyanamid 1986). Degradation rates are decreased in anaerobic soil conditions (WSSA 1994).

In studies of the related compound imazaquin, microbial degradation rates increased with increasing soil moisture content (between 5-75% of field capacity) and increasing soil temperatures (from 15° C to 30° C) (Mangels 1991b). Microbial degradation additionally, was more rapid in soils that did not bind the herbicide strongly. Imazapyr that is bound strongly to soil particles may be unavailable for microbial degradation.

Adsorption
The adsorption of imazapyr to soil particles is generally weak, but can vary depending on soil properties (Mangels 1991b). Adsorption is reversible, and desorption occurs readily (WSSA 1994). Because the exact chemical form of the herbicide is determined by environmental pH, the adsorption capacity of imazapyr changes with soil pH. A decline in pH below 5 increases

adsorption of imazapyr to soil particles. Above pH 5, imazapyr becomes ionized, increasing its negative charge, and limiting its ability to bind with soils (Mangels 1991b). Vizantinopoulos and Lolos (1994) found that adsorption decreased with increasing soil temperature, and Dickens and Wehtje (1986) found that adsorption increased with time and decreased soil moisture. In general, imidazolinone herbicides show an increase in soil adsorption capacity with an increase in soil clay content and organic matter, but studies of imazapyr have been conflicting (Dickens and Wehtje 1986, Wehtje et al. 1987, Mangels 1991b, McDowell et al. 1997, Pusino et al. 1997, El Azzouzi et al. 1998).

Chemical Decomposition

Imazapyr changes form readily with changes in pH, but is not necessarily degraded in this process. It does not readily undergo hydrolysis (Mangels 1991a), and no other chemical degradation mechanisms have been reported.

Behavior in the Environment

Summary: Imazapyr is slowly degraded by microbial metabolism and can be relatively persistent in soils. It has an average half-life in soils that range from one to five months. At pH above 5, it does not bind strongly with soil particles and can remain available (for plant uptake) in the environment. In water, imazapyr can be rapidly degraded by photolysis with a half-life averaging two days. There have been a few reports from the field of unintended damage to desirable, native plants when imazapyr has either exuded out of the roots of treated plants into the surrounding soil, or when intertwined roots transfer the herbicide to non-target plants. Make sure to not overapply imazapyr, and also confirm that soil particles with imazapyr are not moved in-contact with desirable species.

Soils

Depending on environmental conditions, imazapyr has an average half-life in soils of several months (Vizantinopoulos and Lolos 1994, El Azzouzi et al. 1998). El Azzouzi et al. (1998) reported half-lives between > 58 to 25 days in two Moroccan soils. In a laboratory study, the half-life of imazapyr ranged from 69-155 days, but factors affecting degradation rates were difficult to identify because the pH varied with temperature and organic content (McDowell et al. 1997). In a more extreme example, Vizantinopoulos and Lolos (1994) found that in loam and clay loam soils with pH 7-8, half-lives ranged up to 50 months. The manufacturer reports that persistence in soils is influenced by soil moisture, and that in drought conditions, imazapyr could persist for more than one year (Peoples 1984).

Lee et al. (1991) reported that imazapyr residues in soil following postemergent application increased eight days after initial application and continued to increase until a peak of 0.23 ppm at day 231 post-treatment. The authors attributed these increases to runoff of residues from plant surfaces following rainfall and to the release of residues from decaying plant matter.

Under most field conditions imazapyr does not bind strongly to soils and can be highly available in the environment. Above pH 5, the herbicide will take on an ionized form, increasing the risk of herbicide runoff. McDowell et al. (1997) found that heavy rainfall caused significant movement

of the herbicide (or more likely, moved the soil particles that the imazapyr was adsorbed to), and leaching up to 50 cm deep in soils have been reported (WSSA 1994).

Water
Despite its potential mobility, imazapyr has not been reported in water runoff, and we found no reports of imazapyr contamination in water. If it enters the water column, imazapyr can be photodegraded by sunlight with an average half-life of two days (Mallipudi et al. 1991).

Vegetation
Because imazapyr kills a wide variety of plants and can be relatively persistent and remain available in soils, damage to desirable non-target plants is possible. When imazapyr is applied in high rates, directly to soil, it can result in season-long soil activity. Plant species that are resistant to imazapyr apparently metabolize it to an immobile form that cannot be translocated to the meristematic tissues (Shaner & Mallipudi 1991).

Environmental Toxicity
Birds and Mammals
Imazapyr is of relatively low toxicity to birds and mammals. The LD50 for rats is > 5,000 mg/kg, and for bobwhite quail and mallard ducks is >2,150 mg/kg (WSSA 1994). American Cyanamid reports that studies with rats indicate that imazapyr was excreted rapidly in the urine and feces with no residues accumulating in the liver, kidney, muscle, fat, or blood (Miller et al. 1991). Imazapyr has not been found to cause mutations or birth defects in animals, and is classified by the U.S. EPA as a Group E compound, indicating that imazapyr shows no evidence of carcinogenicity.

Aquatic Species
Imazapyr is of low toxicity to fish and invertebrates. The LC50s for rainbow trout, bluegill sunfish, channel catfish, and the water flea (*Daphnia magna)* are all >100 mg/L (WSSA 1994). As of September 2003, imazapyr (tradename Habitat®) is registered for use in aquatic areas, including brackish and coastal waters, to control emerged, floating, and riparian/wetland species. A recent study from a tidal estuary in Washington showed that imazapyr, even when supplied at concentrations up to 1600 mg/L, did not affect the osmoregulatory capacity of Chinook salmon smolts (Patten 2003). Similarly, the Washington State Department of Agriculture reported that the 96-hour LC50 for rainbow trout fry to be 77,716 mg/L (ppm) -22,305 ppm of the active ingredient- which represents a greater concentration of imazapyr than found in commercially-sold containers (J. Vollmer, pers. comm.).

Other Non-Target Organisms
Limited information was found on the effects of imazapyr on other non-target organisms such as soil bacteria and fungi. The manufacturers report that Arsenal® is non-mutagenic to bacteria (Peoples 1984).

Application Considerations:
Imazapyr is a slow acting herbicide that is not readily metabolized in plants. It can be very effective against woody species. Due to its persistence in the environment, it may be preferable to

apply imazapyr directly to vegetation (using a low-volume backpack, cut-stump, or basal bark application) instead of using a broadcast spray method. When using a cut-stump application, be careful to avoid overapplication of imazapyr on the stump, as this may lead to excess imazapyr to be transferred between root grafts or movement by soil particles. When completing a cut-stump treatment, apply imazapyr only to the outer cambium layer of the stump (versus applying herbicide to the entire cut-stump), and this should sufficiently kill the tree (J. Vollmer, pers. comm.).

A study of wipe-on applications to the reed *Phragmites australis*, however, found that this method provided some suppression of reeds in the short-term, but failed to control them in the long term (Kay 1995). Malefyt and Quakenbush (1991) reported better results when imazapyr was applied at 21° C rather than 32° C. Rainfall is considered important for good activity following soil application (Malefyt and Quakenbush 1991) but can increase movement of imazapyr in the soil column. A non-ionic surfactant can improve the efficacy of imazapyr.

Safety Measures:
Some formulations of imazapyr can cause severe irreversible eye damage. Care should be taken to prevent accidental splashing or other exposure of eyes to the herbicide.

Human Toxicology
Imazapyr is of relatively low toxicity to mammals, and shows no mutagenic or teratogenic potential. It can be an eye and skin irritant, but is not a dermal sensitizer (American Cyanamid 1986; Cyanamid Ltd. 1997).

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Date Authored: April 2001
Updated: June 2004

Appendix F – Revegetation Studies

Treatments for Pecos Revegetation Studies

Revised 05/25/2004

(From Sarah Wynn)

Non-Irrigated	**1**	**5**	**2**	**7**	**6**	**4**	**3**
4 Replications	**4**	**6**	**7**	**3**	**5**	**2**	**1**
	6	**1**	**2**	**7**	**3**	**5**	**4**
	5	**7**	**1**	**4**	**2**	**6**	**3**
Irrigated							
Demonstration	**4**	**1**	**3**	**7**	**5**	**6**	**2**

Dryland studies: North and South Sites on the Seven Rivers Farm
These treatments will be replicated 4 times using one seed mix on the clay south site and one seed mix on the more gravelly north site.

1. **Broadcast seed before subsoiler treatment**
2. **Broadcast seed before imprinter treatment**
3. **Broadcast seed before roller/chopper treatment**
4. **Seed with deep-furrow drill**
5. **Seed with Pitter-seeder**
6. **Seed with no-till seeder**
7. **Control: No Seeding**

Factor 1 = Seeding Method
Factor 2 = Mycorrhizal Inoculation (Each ½ plot will be treated with broadcast mychorrizae)

Irrigated Demonstration
Each of the treatments will be laid out one time and irrigated to match average monthly rainfall.

Individual plots are 50' x 100'.

Each dry land study with irrigated demonstration will be 800 feet wide by 340 deep or 272,000 square feet = 6.244 acres. This includes 10 foot lanes between plots, a 20 foot east-west land between the non-irrigated study and irrigated demonstration area, and a 20 foot lane around each study area. Each study area will be fenced.

Preliminary species list for use at Restoration Project on the Pecos River 04/13/2004
***Seed known to be available for 2004 from Curtis & Curtis Seed**

Shrubs: To be seeded in FY 2005 or 2006 using pitter-seeder or plot drill

**Four-Wing Salt Bush*	*Atriplex canescens*
**Quail Bush*	*Atriplex lentiformis*
***Desert willow*	*Chilopsis linearis*

***questionable on clay site*

Grasses for Clay Site: To be seeded in FY 2004*

05	**Desert Saltgrass*	*Distichlis spicata*
25	**Alkali sacaton*	*Sporobolus airoides*
	**Giant sacaton*	*Sporobolus gigantea*
05	*Bush muhly*	*Muhlenbergia porteri*
10	**Vine mesquite*	*Panicum obtusum*
25	**Switch gras*	*Panicum virgatum*
05	**Blue grama*	*Bouteloua gracilis*
10	**Sideoats Grama*	*B. curtipendula*
15	**Galleta Grass*	*Pleuraphis jamesii*
	Tobosa Grass	*Pleuraphis (Hilaria) mutica*

Grasses for Non-Clay Site: To be seeded in FY 2004*

	**Desert Saltgrass*	*Distichlis spicata*
20	**Alkali sacaton*	*Sporobolus airoides*
05	**Giant sacaton*	*Sporobolus gigantea*
	Bush muhly	*Muhlenbergia porteri*
	**Vine mesquite*	*Panicum obtusum*
25	**Switch gras*	*Panicum virgatum*
10	**Blue grama*	*Bouteloua gracilis*
25	**Sideoats Grama*	*B. curtipendula*
10	**Galleta Grass*	*Pleuraphis jamesii*
05	*Tobosa Grass*	*Pleuraphis (Hilaria) mutica*

Revegetation Plots
Site Locations

Homogeneity

The southern site we originally stood on was south of the major power line running east/west. This area is dissected by a number of small drainage channels. I located the southern site just north of the major power line on a relatively flat surface. However, there is a drainage channel cutting through the northern half of the plot. If we shifted the northern half 300 ft. to the north, both would be on a relatively flat surface. We could shift the whole plot to the north keeping them together. Kochia dominates the low areas in this site. As of 3/29/04, the Kochia was 1 to 2 inches tall for the most part with maybe 10% being 3 inches tall.

The northern site has a drainage channel at the very end of the southern boundary. I don't see where it will interfere with the plot. The northern site has a hummocky microrelief. The alkali sacaton occurs in the low areas, apparently where water collects. Kochia has not started growing at this site to any great extent.

It follows that any control efforts especially those requiring soil disturbance will most likely result in the same early seral species occupying the sites. It is important for these sites to progress toward more stable perennial species for long-term stability. It is proposed that strategies be developed to accomplish this task without the necessity of incorporating control efforts on sites still occupied by salt cedar. These strategies should include the testing of soils to insure relative similarities in physical and chemical properties for a given site and to predict which methods will be most effective given soil type and texture, organic matter content and moisture availability. The major differences between cleared sites and those still occupied by salt cedar should be described as well, e.g., presence/absence of surface salinity, mulch type and depth to water table.

One possible strategy may be to roughen the soil surface via disking, pitting, imprinting, etc., to create micro-catchments. This may also be desirable in mulch management. Mulch presence, type and depth may be critical to the success of perennial species establishment either positive by increasing moisture availability or negative by raindrop interception or shading. In some areas it may be necessary to provide control efforts, to limit weedy competition. This may be accomplished through nitrogen sequestration, herbicides or other means.

It is proposed that two revegetation sites differing in soil type be developed: one within the old McMillan lakebed (lacustrine soils) and the other to the north with soils deposited primarily through historic flooding events. A component of each site will receive limited irrigation to simulate annual rainfall.

The irrigated component will provide moisture to simulate typical monsoon rainfall events and may incorporate rainfall simulation to insure timing and total expected rainfall. Ideally monsoon rains typical for the area will be the norm; however it will be expedient to have irrigated sites to show what is possible in the event that rainfall is below normal.

Appendix G. Selected Wildlife Species reported from Brantley and Avalon Reservoirs, New Mexico[a].

COMMON NAME	SCIENTIFIC NAME
BIRDS	
American Coot	*Fulica americana*
American Avocet	*Recurvirostra americana*
American White Pelican	*Pelecanus erythrorhynchos*
Bank Swallow	*Riparia riparia*
Barn Swallow	*Hirundo rustica*
Belted Kingfisher	*Ceryle alcyon*
Black-Necked Stilt	*Himantopus mexicanus*
Brown Pelican	*Pelecanus occidentalis carolinensus*[b]
Burrowing Owl	*Athene cunicularia*
Canyon Wren	*Catherpes mexicanus*
Cliff Swallow	*Hirundo pyrrhonota*
Common Loon	*Gavia immer*
Common Nighthawk	*Chordeiles minor*
Double-Crested Cormorant	*Phalacrocorax auritus*
Eared Grebe	*Podiceps nigricollis*
Gambel's Quail	*Callipepla gambelii*
Greater Roadrunner	*Geococcyx californianus*
Great Blue Heron	*Ardea herodias*
Great-Horned Owl	*Bubo virginianus*
Green Heron	*Butorides virescens*
Herring Gull	*Larus argentatus*
House Sparrow	*Passer domesticus*
Interior Least Tern	*Sterna antillarum*[b]
Kill Deer	*Charadrius vociferus*
Mallard	*Anas platyrhynchos*
Mourning Dove	*Zenaida macroura*
Northern Harrier	*Circus cyaneus*
Northern Shoveler	*Anas clypeata*
Red-Winged Blackbird	*Agelaius phoeniceus*
Ring-Necked Pheasant	*Phasianus colchicus*
Snowy Egret	*Egretta thula*
Turkey Vulture	*Cathartes aura*
Western Kingbird	*Tyrannus verticalis*

Western Meadowlark	*Sturnella neglecta*
White-Winged Dove	*Zenaida asiatica*
Wilson's Phalarope	*Phalaropus tricolor*
Yellow-billed Cuckoo	*Coccyzus americanus*[c]
MAMMALS	
Blacktail Jackrabbit	*Lepus californicus*
Coyote	*Canis latrans*
Raccoon	*Procyon lotor* (sign observed)
Mule Deer	*Odocoileus hemionus*
HERPETOFAUNA	
Little Striped Whiptail	*Cnemidophorus inornatus*
Turtle	Unidentified
Western Whiptail	*Cnemidophorus inornatus*

[a] Brantley and Avalon Reservoirs RMP Environmental Assessment, December 2003
[b] Federally listed species
[c] Also known to occur on the Pecos River (USBR 1996)

Appendix H. Fish species reported from Brantley Reservoir (BR), Avalon Reservoir (AR), and the Pecos River (PR) within the Project Area.

COMMON NAME (*SCIENTIFIC NAME*)	BR	AR	PR
Family Atherinidae – silversides			
Inland Silverside (*Menidia beryllina*)	X	X	X
Family Catostomidae - suckers			
Blue Sucker (*Cycleptus elongates)*			X
Gray Redhorse (*Moxostoma congestum*)		X	
River Carpsucker (*Carpiodes carpio)*	X	X	X
Smallmouth Buffalo (*Ictiobus bubalus)*	X	X	X
Family Centrarchidae - sunfishes			
Black Crappie (*Pomoxis nigromaculatus*)	X	X	X
Bluegill (*Lepomis macrochirus)*	X	X	X
Green Sunfish (*Lepomis cyanellus*)	X	X	X
Largemouth Bass (*Micropterus salmoides)*	X	X	X
Longear Sunfish (*Lepomis megalotis*)	X	X	X
Spotted Bass (*Micropterus punctulatus*)	X	X	X
Warmouth (*Lepomis gulosus)*	X	X	X
White crappie (*Pomoxis annularis)*	X	X	X
Family Clupeidae - herrings			
Gizzard Shad (*Dorosoma cepedianum*)	X	X	X
Threadfin Shad (*Dorosoma petenense)*	X	X	
Family Cyprinidae - carp and minnow			
Common Carp (*Cyprinus carpio*)	X	X	X
Fathead Minnow (*Pimephales promelas)*	X	X	X
Red Shiner (*Cyprinella lutrensis)*	X	X	X
Family Fundulidae - killifishes			
Plains Killifish (*Fundulus zebrinus*)	X	X	X
Family Ictaluridae - catfishes			
Black Bullhead (*Ameiurus melas)*	X	X	X
Channel Catfish (*Ictalurus punctatus*)	X	X	X
Flathead Ccatfish (*Pylodictis olivaris)*	X	X	X
Family Lepisosteidae - gars			
Longnose Aar (*Lepisosteus osseus)*	X	X	X
Family Percichthyidae - temperate basses			
White Bass (*Morone chrysops)*	X	X	
Family Percidae – perches			
Bigscale Logperch (*Percina macrolepida*)	X	X	X
Walleye (*Stizostedion vitreum)*	X	X	

Family Poeciliidae – livebearers			
Western Mosquitofish (*Gambusia affinis*)	X	X	X

Appendix I. Other federally listed threatened and endangered species found in Eddy County, New Mexico.

Common Name (Scientific Name)	Federal Status	Typical Habitat
Mexican Spotted Owl (*Strix occidentalis lucida*)	Threatened	Old-growth conifer forest in mountainous terrain.
Northern Aplomado Falcon (*Falco femoralis septentrionalis*)	Endangered	Yucca or mesquite desert grasslands with scattered prominent woody vegetation.
Black-footed Ferret (*Mustela frenata neomexicana*)	Endangered (Experimental Pop.)	Prairie dog towns in prairie grasslands up to 10,500 feet elevation.
Pecos Gambusia (*Gambusia nobilis*)	Endangered	Restricted to a few springs and gypsum sinkholes.
Kuenzler Hedgehog Cactus (*Echinocereus fendleri* var. *kuenzleri*)	Endangered	Occurs in woodland between 5800 and 7000 feet on gentle south-facing slopes having limestone influenced soil.
Lee's Pincushion Cactus (*Coryphantha sneedii* var. *leei*)	Threatened	Restricted to cracks and ledges of steep limestone outcrops above 4000 feet.

Appendix J. Additional Invasives Treatments

Dominant Vegetative Species Present and Recommended Treatments

A Field Review Conducted 08/03-05/04) by Nancy Umbreit (Bureau of Reclamation) And Doug Parker (U.S. Forest Service)

The following low-impact methods are recommended for controlling unwanted vegetation on three dams (Sumner, Brantley, and Avalon Dams) located along the Pecos River, New Mexico. These methods will provide excellent control results at a minimal cost. Many of the herbicide applications can be done in the fall or early winter, which is a distinct advantage when temperatures are more favorable for such work. "Restricted Use" herbicides were not selected for recommendation (since they require applicator certification which is not necessary for the proposed control) nor herbicides that are mobile and could have the potential for water contamination. As much as possible, we have recommended the use of selective herbicides and selective application methods to limit affects to desirable plants. The recommended treatments at all three dams are similar which is beneficial to contracting the work under one contract.

Introduction

The vegetative control work is necessary for the following reasons (Ref: Guidelines for Removal of Trees and other vegetative growth from Earth Dams, Dikes, and Conveyance Features, Bureau of Reclamation, April 26, 1989):

1) To allow proper surveillance and inspection of the structures and adjacent areas for seepage, cracking, sinkholes, settlement, deflection, and other signs of distress.
2) To allow adequate access for normal and emergency Operation and Maintenance (O&M) activities.
3) To prevent damage to the structures due to root growth, such as shortened seepage paths through embankments; voids in embankments from decayed roots or toppled trees; expansion of cracks or joints of concrete walls, canal lining, or pipes; and plugging of perforated or open-jointed drainage pipes.
4) To discourage animal/rodent activity (by eliminating their food source and habitat), thereby preventing avoids within embankments and possible shortened seepage paths.
5) To allow adequate flow-carrying capability of water conveyance channels (e.g., spillway inlet an outlet channels; open canals, laterals, and drains).

The vegetative growth of trees and potentially detrimental vegetation should be prevented during its early states as part of the normal O&M program. Early control is generally the most cost effective means of avoiding potential adverse effects on these structures.

Brantley Dam

1) **Vegetation Location: On upstream and downstream faces of Brantley Dam (major two species present are honey mesquite and yerba-de-pasmo).**

a) Treat the following seven species using triclopyr (product name = Garlon 4 or Tahoe 4) and Oil: Treatments will involve the oil basal approach as previously described. The 25% herbicide mixture (one part herbicide to three parts

vegetable oil) needs to be applied to the stems from the ground up for about a foot. All sides of the stems need to be covered with the spray. Application is best done in the fall or early winter. Follow instructions in the earlier mentioned guides.

Whitethorn (*Acacia constricta*)
Catclaw acacia (*Acacia greggii*)
Feather dalea (*Dalea formosa*)
Cooper golden bush (*Ericameria cooperi*)
Baccharis (*Baccharis sp.*)
Honey mesquite (*Prosopsis glandulosa*)
Yerba-de-pasmo (*Baccharis pteronioides*)

b) Grub the individual narrowleaf yucca plants

Narrowleaf yucca (*Yucca glauca*)

Avalon Dam

1) **Vegetation Location: On upstream and downstream faces of Avalon Dam (mix of species, no particular species dominating).**

a) Treat the following seven species using triclopyr (product name = Garlon 4 or Tahoe 4) and Oil (oil basal technique). Treat the following seven species using triclopyr and Oil: Treatments will involve the oil basal approach as previously described. The 25% herbicide mixture (one part herbicide to three parts vegetable oil) needs to be applied to the stems from the ground up for about a foot. All sides of the stems need to be covered with the spray. Application is best done in the fall or early winter. Follow instructions in the earlier mentioned guides.

Catclaw acacia (*Acacia greggii*)
Honey mesquite (*Prosopsis glandulosa*)
Saltcedar (*Tamarisk sp.*)
Creosotebush (*Larrea tridentata*)
Ash (*Fraxinus sp.*)
Mulberry (*Morus sp.*)
Net-leaf Hackberry (*Celtis reticulata*)

b) Cut tree as low to the ground as possible. This species will not sprout.

Juniper (*Juniperus monosperma*)

a) Spot treatment using imazapyr (product name = Arsenal). Mix two ounces of the concentrate in a gallon of water and apply the solution to the foliage of actively growing plants. Since imazapyr is a broad spectrum herbicide that is soil active, some nearby plants will be killed.

Silverleaf nightshade (*Solanum elaeagnifolium*)

b) Grub the individual following plants.

Prickly Pear (*Opuntia sp.*)
Yucca (*Yucca spp.*)

c) Pull individual plants before seed production (annual plant). Also, glyphosate (2% solution in water) or imazapyr (1% solution in water) can to applied to foliage prior to seed set.

Buffalo bur (*Solanum rostratum*)

d) Pull prior to plants seeding or control plants with an herbicide. Glyphosate (2% solution in water) or imazapyr (1% solution in water) can to applied to foliage prior to seed set.

Sandburs (*Cenchrus longispinus*)

Appendix K – Map of Treatment and Research Areas