Appendix I

HABITAT RESTORATION BACKGROUND

PROGRAMMATIC HABITAT RESTORATION AND MANAGEMENT ACTIONS

The following detailed management actions apply to the above management and enhancement areas either individually or combined. The information that follow includes, Wetlands Preservation, Wetlands Creation and Enhancement, Exotic Species Management, Permitting Request, and Regulatory Compliance.

WETLANDS PRESERVATION

Wetlands are important resources, particularly as they pertain to the improvement of water quality in such urbanized environments as Chollas Creek. Although the creek rarely contains valuable wetlands, it is prudent to protect the few wetlands present within the creek environment. It is the resources agencies' highest priority to protect wetlands resources and avoid or minimize impacts to wetlands. Careful review of any planned project along the creek will ensure that wetlands impacts are kept to a minimum. The following guidelines should be employed by City personnel when reviewing project applications:

- Does the project impact Chollas Creek?
- Does the project impact wetlands associated with Chollas Creek?
- What can be done to avoid impacts to wetlands associated with Chollas Creek?
- Could the wetlands be incorporated into the project design?
- If avoidance is not feasible, what can be done to minimize impacts to wetlands associated with Chollas Creek?
- Does the project propose wetlands protection, restoration, enhancement, mitigation or management measures?
- Are the measures proposed in the project consistent with the Chollas Creek Wetlands Management Plan?
- Are mitigation measures and restoration plans likely to be accepted by the resources agencies?
- How will the project affect economic revitalization plans for the area?

The City of San Diego has discretion over accepting projects that include sound and sustainable wetlands protection, planning and management. Wetlands protection benefits the community by providing enhanced water quality, a pleasant ambience that enhances living conditions, increased property value, and potential recreational value.

WETLANDS CREATION AND ENHANCEMENT

The long-term goal of watershed restoration projects is the establishment of a self-sustainable ecosystem that is in equilibrium with the surrounding landscape. The Chollas Creek watershed, after decades of urbanization, is an example of a system in a state of disequilibrium made apparent by the severe stream degradation and channel instability. Restoration is an effective tool for returning a degraded riparian system to, or near, its pre-disturbed condition. It also serves as a tool for preventing environmental degradation provided that the source of the degradation has been corrected. In the context of riverine restoration, mitigation or enhancement projects in the Chollas Creek watershed the specific objectives are:

- Increase the quality and quantity of riparian habitat within the Chollas Creek watershed.
- Increase the abundance of woody vegetation in riparian corridors to improve habitat structure along Chollas Creek.
- Promote revegetation with native species appropriate for the project area.
- Remove concrete where feasible to create permeable soils for aquifer recharge.

Ideally, habitat restoration is intended to restore the habitat value of an area beyond simply "revegetating" or planting vegetation within disturbed areas, but by attempting to create a sustainable and functioning ecosystem. A functioning wetlands ecosystem is not restricted to vegetation, but also includes hydrological, soil, wildlife functions, and the interaction of all natural wetlands components. However, the urbanized nature of Chollas Creek and the fragmented condition of the restoration and enhancement sites along the creek preclude restoration projects that are focused on wildlife and ecological functions; restoration and enhancement in the study area is better suited to benefit the human environment.

Functions of Wetlands Restoration and Enhancement

Wetlands habitat has a wide range of beneficial uses, which should be incorporated into the wetlands creation concept, such as:

- it protects and extends the existing water supply;
- serves as habitat and cover for many wildlife species;
- enhances the recreational value of the human environment;
- provides erosion control;
- enhances nutrient cycling;
- provides a valuable potable water source; and
- recharges the aquifer and reduces flow levels and velocity-associated erosion.

It is likely that wetlands vegetation will require 15 years or longer to approach the general structure and composition of an established and functioning habitat. However, it should be apparent in three to five years whether restoration efforts have been successful.

Restoration and enhancement within Chollas Creek will achieve the following functions:

- instream restoration: improving water quality and associated stream configuration; creek shading; water temperature reduction and re-aeration; realigning meander and sinuosity adding substrate composition and structural complexity; permitting flood waters to percolate and recharge aquifer and reducing discharge and water velocity.

- riparian restoration: preserving and establishing wetlands habitats; enhancing and creating contiguous habitat corridors; adding structural complexity; and improving water quality (natural filters).

- upland restoration: establishing upland buffers and wildlife corridors, controlling nonpoint source inputs from the watershed such as hydrological runoff, and applying urban, agricultural and forestry Best Management Practices.

Site-Specific Baseline Studies

Prior to the formulation of a planting concept, ecological and hydro-geomorphological data, such as hydrology, soils, stream morphology and habitat suitability for certain target species potentially attracted by the restoration project, should be gathered and applied to the site-specific restoration plan. If uplands currently occupy the planned riparian habitat restoration site, it is advisable to conduct a hydrological study through modeling, or at least through soil borings or piezometer readings, to establish a groundwater contour and understand the geomorphology of the site. This facilitates the design of accurate grading plans and allows for potential soil salvaging, amendment or topsoil replacement decisions. Site-specific creek profiles will also need to be developed with the help of hydrological data collected for the entire watershed.

Positioning of different habitat types within the context of the stream represents an important step in the planning process, such as the placement of emergent freshwater marsh versus juvenile riparian scrub or mature willow woodland components. Adjacent habitats would also need to be analyzed to evaluate the compatibility of the plant palette with its surrounding environment. In urban environments such as Chollas Creek, a buffer needs to be planted to facilitate the transition between wetland habitats represented in the plant palettes and their surrounding upland habitat. This buffer may contain recreational elements such as trails, playgrounds and seating areas. Wetland buffers should be provided at a minimum 100 feet in width adjacent to all identified wetlands. The width of the buffer may be either increased or decreased as determined on a case-by-case basis, in consultation with the California Department of Fish and Game, The U.S. Fish and Wildlife Service and the Army Corps of Engineers. Additional definitions and requirements are outlined in the Environmentally Sensitive Lands (ESL) Guidelines of the City of San Diego Land Development Code, Chapter 14, Article 3, Division 1.

Finally, plant palettes need to be refined and tailored to the site to include spacing/density information and the amount of plants to be planted within a certain habitat context. Removal of exotic species prior to, during, and after restoration efforts should be addressed in the respective restoration plans and/or specifications. Exotic weed control should also be maintained during a post restoration monitoring effort, which should last for at least

three years. (Refer to the "Exotic Species Management " section for weed control guidelines.) Often, regulatory and resource agencies require that certain performance criteria, defined in the restoration plans, will be adhered to and statistically analyzed through sampling methods for the entire duration of the monitoring period, particularly if restoration is being performed as mitigation for project impacts. Reporting at a regular schedule, usually set by the agencies, will assure that performance criteria are met and that the restoration site will be successful and sustainable at a long-term level.

Step By Step Restoration Guidelines

The following schedule outlines steps that may be necessary to restore and create functional wetland systems at the three enhancement sites outlined in this document. Some steps contain information that may be required if the restoration effort is consistent with a Section 404 permit or subject to agency review, which may be ignored if regulatory review is not required.

Determine necessary restoration/revegetation acreage to be created - In consultation with or through conditions set forth by applicable jurisdictions and agencies (such as the ACOE or wildlife resources agencies), determine (or confirm) the site and acreage for restoration/enhancement. This effort could be performed through field visits and review of environmental documents created for the project or adjacent projects. Consult with the respective agencies to verify agency expectations. In addition, confirm the necessity of invasive species removal in association with wetlands creation.

Determine suitability of mitigation land - Conduct site-specific surveys to determine the percentage of uplands versus wetlands available on the site, if applicable or required through a Section 404 permit. This survey will be supported by a wetlands delineation using the ACOE *1987 Wetlands Delineation Manual* to confirm that the wetlands creation site is, indeed, an upland site and does not fall under ACOE jurisdiction. This step is necessary to ensure that a wetlands is being created in upland habitat to conform with the no-net loss policy of wetlands, again, if applicable. In addition, vegetation communities will be identified, including potentially sensitive plants and noxious weed species. If sensitive plants were to occur on the selected wetlands creation site, respective resources agencies, such as

USFWS and CDFG, will be consulted to determine such alternatives as avoiding or salvaging and transplanting these sensitive resources. Noxious, and potentially invasive weeds will be removed prior to wetlands creation.

Determine groundwater availability - There are at least two ways to determine sustainable water sources for the restoration effort: well excavation and piezometer installation. Well excavation constitutes excavating pits using a back hoe to determine the presence of or depth of groundwater. Piezometer installation would acquire groundwater contours and a range of general hydrological and soils information. This information is mandatory to ensure that groundwater will be available to permanently sustain the newly created wetlands site without artificially adding water to the site. Groundwater contours will provide important baseline information for the creation of grading plans.

Determine soil suitability - Soil tests would be helpful during the installation phase of the wetlands creation project to determine soil suitability and prescribe appropriate soil amendments, if necessary, to ensure the establishment of adequate growing conditions.

Determine potential creek alterations - Hydraulic modeling (i.e., HEC 2 models and FEMA overlays) will determine, if an alteration of creek conditions is feasible. If floodplain widening is desired as a restoration and enhancement feature, analyze the flood risk from potential removal of flood walls, wider creek cross section and roughness coefficient from the establishment of vegetation on a site-specific basis.

Determine appropriate plant species composition - In the field, verify the appropriateness of the following recommended native plant palettes for the wetlands restoration and enhancement sites. Freshwater marsh vegetation will be established in the creek invert, riparian scrub vegetation on the creek banks (also surrounding the trail system) and transitional buffer vegetation as a transition between the riparian corridor and the adjacent uplands or developments. Vegetation bandwidths vary from site to site. The following palettes are intended as a guideline only.

Formulate restoration concept - Establish restoration concepts, including: grading contours; topsoil salvage, testing and storage; invasive species removal, if appropriate; soil prepara-

tion requirements; planting specifications, such as plant palettes, growing requirements (e.g., seed distributions or plantings of cuttings and container stock, inoculation requirements); irrigation needs; plant-establishment monitoring; remedial measures; performance standards and long-term monitoring and maintenance. Often, a long-term monitoring program is developed separately, in addition to the concept plan, if required by the resources agencies through the permit process.

Formulate long-term monitoring and maintenance program - Devise performance standards in accordance with standards acceptable to the agencies. Formulate a monitoring and maintenance program to consist of tasks such as irrigation control, removal and replacement of dead vegetation, fencing to avoid trespassing, weed and erosion control and monitoring successful ecosystem establishment according to above performance standards. The goal of monitoring and maintenance is to achieve a self-sustainable wetlands ecosystem similar to natural systems. Therefore, natural scour and deadwood should not be remedied, since these phenomena are typical of the dynamic nature of a wetlands ecosystem. Monitoring will follow a set schedule, which involves site visits conducted monthly between the end of the establishment period and the first month of spring (March), twice per week for the first three months following the first growing season (March, April, May), and monthly for the following six months. Quarterly monitoring visits will be conducted thereafter and for the following two years. If two more monitoring years would be required, visits will be conducted three times per year in March, July, and November. Monitoring typically consists of a field check by the monitoring biologist of plant success (assess percent cover, density, and size of individual plants) using statistically valid sampling methods. Permanent vegetation sampling stations will be established and sampled by using transects and quadrats to determine vegetation success. Statistical data on success are only valuable if compared with data gathered from natural systems. Therefore, sampling results will be compared to data from a control site located in a well-established natural wetlands in the vicinity of the creation site and sampled using the same methods as used for the creation site. In addition, the monitor will also assess the successful establishment of hydrology (e.g., deposition of debris, overbank flows, and evidence of water force), hydric soils (saturated soil in soil pits dug following rain event) and faunal utilization (note evidence of wildlife use and wildlife sightings).

Finalize restoration and monitoring plans - Have restoration and monitoring plans approved by the appropriate jurisdiction and regulatory agencies and finalize the restoration plan.

Select project biologist - Retaining a project biologist to oversee the restoration efforts would be of value to the restoration process. If the project biologist is different from the biologist that formulates the restoration concept, the best time to retain a project biologist is prior to initiating contract growing of plant material. The project biologist will be responsible for the successful implementation of the wetlands creation project. The project biologist must be able to provide records of past successful native wetlands creation experience.

Initiate contract growing of plant material - It takes time to establish appropriate plant material for wetlands creation, particularly if a structurally diverse canopy cover is desired. Native plant nurseries typically do not hold a stock of appropriate plant materials large enough to satisfy the creation of even the smallest wetlands. Therefore, advanced notice must be given to the nurseries to prepare plant materials at least six months prior to the desired planting date. If large plant stock is required (e.g., 5-gallon containers and larger), a nursery will often request advanced notice in excess of six months. In addition, it is important to verify that the contract grower is experienced in native plants for restoration purposes and is knowledgeable in plant inoculation methods. Another component of the plant acquisition includes the collection of plant material by an experienced collector. Plant material such as seeds and cuttings should be collected within the immediate vicinity of the creation area and within the appropriate plant communities. This may not be feasible due to the scarcity of riparian habitat within Chollas Creek and the relatively low species diversity of these habitats. The project biologist should confirm the growing success of plant materials at least once prior to plant delivery to ensure that the plant material conforms with specifications. If unsatisfactory plant material is delivered to the site, the project biologist retains the right to refuse the delivery and acquire appropriate plants at the contracting nursery's expense.

Develop landscape specifications - Formulate restoration specifications to detail contractor responsibilities according to, but more detailed than, the restoration concept plan. In addition, develop landscape plans (signed by a California licenced landscape architect), including grading plans, irrigation plans

and planting plans. Planting plans would include the species composition and spacing. Grading plans will be developed according to the groundwater contours that were established during hydrological studies. Depending on the type of wetlands to be created, surface contours should be no more that 12 feet above the groundwater contour and should, as best as possible, model contours found in natural wetlands ecosystems. Irrigation should be designed to be temporary and removable following two to four years of plant establishment. If available and permissible by law, reclaimed water constitutes an appropriate irrigation source for the establishment of a riparian wetlands system.

Retain landscape contractor - Based on contractor specifications, acquire bids from landscape contractors knowledgeable and experienced in native wetlands creation.

Initial site visit - Schedule a field visit with all responsible parties, including installation contractor(s), project biologist, representatives of the jurisdiction, and, potentially, resources agencies. This field visit is intended to describe the project, project responsibilities, reporting procedures, educate the contractor regarding the presence of potentially sensitive resources, and discuss potential foreseeable problems.

Initiate site preparation - Site preparation, according to the concept plan and specifications, typically include such measures as site fencing and flagging, clearing and grubbing (including removal of exotic weeds), topsoil salvage and storage, soil testing, grading and installation of a temporary irrigation system.

Prepare planting - Planting preparation includes such measures as inspection and lay-out of plant material by the project biologist. In addition, the project biologist will also supervise the application of soil amendments, if specified or deemed appropriate, as well as the planting or seeding of plant materials by the installation contractor. Container stock should be planted prior to seed applications to keep seed beds free of disturbance.

Monitor plant establishment - During the plant establishment period (typically 120 days), the project biologist will monitor the site and complete remediation measures, such as replacing dead plant material, fixing irrigation systems, removing weeds and trash, and repairing erosion damage, as necessary. Reporting procedures to the applicable jurisdiction and agencies will be adhered to as established in previous documents (e.g., permits, restoration concept).

Initiate long-term monitoring, maintenance and reporting procedures - According to the restoration concept and monitoring program, retain a monitoring biologist (if different from the project biologist) and maintenance contractor to perform long-term monitoring of the wetlands creation project. Both the monitoring biologist and the maintenance contractor need to be knowledgeable in the identification of native plants versus exotic weeds and need to demonstrate past experience in native vegetation monitoring. Following the restoration implementation period, the site would ideally be monitored and maintained for three to five years (or longer) at a schedule determined in the monitoring program. The monitoring or project biologist would brief the applicable jurisdiction and resource agency on the site's success by biannual or annual monitoring reports. A final monitoring report and subsequent site visit with the agencies would conclude the project, provided the agencies find that the site fulfills required performance standards to their satisfaction. If subject to a Section 404 permit, the ACOE often requests a final wetlands delineation to confirm that the created wetlands indeed conforms to the ACOE's definition of wetlands by at least showing the successful establishment of hydrophytic vegetation and hydrology [hydric soils, the third parameter the ACOE requires as wetlands parameter often need more time to establish themselves than the monitoring period allows.

EXOTIC SPECIES MANAGEMENT

As discussed in the existing conditions section, the vegetation surrounding Chollas Creek within the study area is dominated by exotic, often weedy and invasive, plant species. Exotic plant species are those plants that arrived in an area through human actions. Once introduced, exotic plants are considered "invasive weeds" when they colonize natural areas and dominate or displace natural communities. Some potential impacts resulting from exotic plant infestation include:

- alteration of ecosystem processes, such as nutrient cycling, erosion, and fire frequency;
- suppression of native plant recruitment and growth; and
- reduction of wildlife resources, such as food, cover, and nesting habitat

Exotic plants considered invasive weeds often have several characteristics that permit them to successfully compete with

native plants by rapidly becoming established and precluding the growth of other plants. Generally, invasive weeds have more than one method of reproduction. Many species can reproduce vegetatively through the sprouting of stem and root segments, as well as sexually through seed production. Often, invasive weeds reach reproductive maturity quickly and produce large amounts of readily dispersed seeds that remain viable for long periods, even when stored in the soil. In addition, invasive weeds tolerate a wide variety of habitat conditions and, in many cases, are favored by repeated disturbance.

Many of the exotic plant species that occur in the Chollas Creek watershed have been introduced to the area during the past 200 years (i.e., since establishment of the first European settlement). Wetlands that are typically common along the banks of undisturbed creeks such as Chollas Creek have been replaced by patches of disturbed and most weedy vegetation, which is largely attributable to disturbance such as development, frequent urban use (trampling, mowing, etc.) and flood control.

General Considerations

Development of strategies to control exotic plant infestations includes more than deciding which control measure to use on which target species with current infestations in the watershed. This section discusses weed management as a component of other project types and general elements that should be considered as part of both species-specific and watershed-level exotic vegetation control programs.

Prior to initiating species- and site-specific weed control activities, a broader, watershed-level strategy toward exotic species control should be considered to eradicate weeds more efficiently. Activities proposed as a component of reducing current infestations of giant reed, for example, should be evaluated for potential impacts on other exotic plant infestations and on currently un-infested areas. This broader strategy should incorporate aspects of all proposed weed control activities so that an action with potential negative impacts to other proposed actions can be resolved prior to implementation. Watershed-level planning must address the on-going dispersal and recruitment of weeds into infested areas through natural and human-induced events that open up new ground to potential infestation, such as landslides, tree falls, trail establishment, streambank stabilization, and recreational use.

Implementation of a Weed Management Program

Comprehensive Management

Management of exotic plant species involves more than merely controlling certain plant species at selected sites within the watershed. Projects and actions along the creek, for example bank stabilization, flood control, landscaping, plant community restoration, and trail maintenance, must consider the project's potential to:

- create new sites for weed colonization;
- spread existing weed species to un-infested areas;
- expand the extent of existing weed populations, and
- introduce new weed species to the watershed.

The following factors need to be considered in the assessment of each project's effect on exotic plants:

- areas to be disturbed by the project, including the particular site of the project action, existing desirable vegetation, and known weed occurrences (identifying all noxious weeds potentially impacted by the project and their invasive habit—for example, do they spread vegetatively, sexually, or both?);

- means in which project staff and equipment will access the site (e.g., will they travel through an existing weed infestation?);

- type of ground disturbance associated with project actions (e.g., depth, type, and means of ground disturbance such as overland travel by vehicles on soil surface, trenching by hand-digging to three feet deep, or discing top several inches with a tractor)

- potential removal of existing vegetation; and

- method and time frame for remediating the ground disturbance (e.g., revegetation, mulching, or swamp mat installation).

After assessing the project's potential effect on weeds, means of mitigating these effects must be designed. These may include defining Best Management Practices or other project- and site-specific mitigation measures suitable for the particular activity (such as restoration or revegetation using desirable, native vegetation).

Best Management Practices

Best Management Practices may be defined generally for application to a range of project types and activities or may focus on a particular type of impact, such as erosion and sedimentation control or weed control. General principles applicable to weed control are cited below and include means of preventing weed propagule dispersal within the project area, obstructing or limiting the germination and growth of weed propagules, and preventing the introduction of new weed taxa. The following Best Management Practices shall be applied to any project within a 500-foot corridor of Chollas Creek:

- Avoidance of weed plants and seed sources shall be accomplished through project design (e.g., work area placement is one manner in which weed populations can be avoided).

- All seeds and straw material used shall be certified as weed-free by the California Department of Food and Agriculture seed laboratory.

- All gravel and fill materials used during the project shall be certified as weed-free by the local County Agriculture Commissioner's office.

- The removal site for fill materials shall be examined for presence of noxious weeds and approved.

- Materials will not be stockpiled in a noxious weed location unless they are to be used at that location.

- Equipment must be cleaned after use in a designated noxious weed infested area and prior to moving to a new (un-infested) area. This may involve the use of wash stations or air compressors to clean vehicle tires and underbodies of seeds and other plant material, or may be as simple as cleaning shoes and tools after working in an infested area.

- Signs must be posted in all weed infested construction areas indicating a noxious weed area and inspected daily to ensure that signs remain in place.

Other considerations to prevent weed spread that may be appropriate to a particular project include:

- timing activities such that sensitive periods for a weed species are avoided (e.g., during seed production and dispersal); and

- scheduling activities to ensure that final actions do not adversely affect areas previously completed (e.g., beginning work in the upper portion of the watershed and continuing downstream).

Weed Management Planning

Planning for the management of exotic vegetation should occur prior to implementing control measures. An exotic species management plan should be prepared for Chollas Creek, because this creek is located in a highly urbanized area that lacks native vegetation and is plagued by an exotic species problem. Such an exotic species management plan would include the following components:

- Objectives and goals;

- Priorities (particular weed species and/or locales);

- Current extent of the weed species and rate and type of expansion (e.g., many small occurrences scattered throughout the watershed or one large infestation; slow expansion through increasing size of existing occurrence or rapid expansion through establishment of newly infested sites);

- Vegetation and animals associated with or present adjacent to the infested area (desirable vegetation to be retained, potential impacts on plants and animals as a consequence of weed control);

- Treatment options (primary treatment method and alternatives, conditions under which alternative treatments will be applied);

- Specific actions (what treatments, where, when, using what materials and equipment, who will implement treatments, estimated costs);

- Monitoring methodology and evaluation of success/failure of achieving goals;

- Remedial measures; and
- Documentation.

Clear objectives for the site and the watershed must be established. In some cases, eradication of a particular exotic plant species may not be practicable within a few years and other, short-term goals should be identified. These may include control of seed production by removing inflorescenses, limiting the spread of an existing population by controlling new recruits, and reducing the percent cover of a particular species by increments over many years. The objectives should be measurable so that monitoring activities can evaluate success or failure of the actions.

The Nature Conservancy has produced a Weed Management Plan Template available through their Internet site. This template includes the components cited above and provides additional guidance in evaluating needs and developing information to complete a management plan.

Weed Control Implementation

A contractor knowledgable of the local weed species and their biology should be retained by the City of San Diego to implement the weed management plan. The contractor must hold a current pesticide and herbicide application license and must document thorough experience with similar project. Since the contractor is working in a populated area surrounded by parks and playgrounds, the contractor must document safe operating procedures, including an emergency clean-up plan.

A qualified project biologist would be retained by the City to oversee exotic removal procedures and compliance with wetlands permits requirements. The biologist would mark access routes such that the process of removing exotics would avoid impacting native woody riparian vegetation. Prior to the initial removal of exotic species, the biologist would coordinate with the City and maintenance contractor in the field to review the weed control areas, access flagging, disposal methods, and any other specifications in the weed management plan. The biologist will then monitor the initial removal effort and provide documentation to the City upon completion.

Weed Management Monitoring

Monitoring the effectiveness of treatments and assessing the weed management actions relative to the programs goals and objectives is a necessary component of weed management.

The following weed species were detected along Chollas Creek. Weed removal would be applicable for all areas. Control measures are also identified in the table below.

Summary of Exotic Plant Species

Description					Control Methods		
Species	**Lifeform**	**Growth Habit**	**Reproduction**	**Invasive Habitat**	**Biological**	**Chemical**	**Physical**
Arundo donax (giant cane)	perennial grass	erect to >20 feet tall (rhizomatous)	roots and rhizomes	rapid growth (can spread outside existing locales	no	yes	yes (with limitations)
Centaurea solstitialis (yellow starthistle)	annual herb	erect 2 to 3 feet tall	seed	highly competitive and invasive	yes	yes	yes
Cirsium arvense (Canada thistle)	perennial herb	erect; colony-forming (creeping rootstalks)	seed (wind dispersed) vegetative (lateral roots and root fragments)	aggressive, colony-forming	no	yes	yes
Cirsium vulgare (bull thistle)	biennial herb	erect 2 to 5 feet with spreading branches	seed (wind dispersed)	aggressive	yes	yes	yes
Cortaderia spp. (pampas grass)	perennial grass	erect	seed (root crown resprouts)	rapid growth	no	yes	yes (with limitations)
Cynara cardunculus (artichoke thistle)	perennial	erect 1.5 to 2 feet freely branched	seed (root crown resprouts)	aggressive and invasive	no	yes	no
Eucalyptus globulus (eucalyptus tree; Tasmanian blue gum)	evergreen tree	tree	seed	rapid (fast-growing)	no	yes (with limitations)	yes
Nicotiana glauca (tree tobacco)	evergreen shrub	erect shrub 6 to 15 feet tall	seed	aggressive	no data	no data	yes
Ricinus communis (castor bean)	annual herb	erect 4 to 6 feet	seed	(low temperature kills)	no data	no data	no data
Salsola tragus (Russian thistle)	annual	erect to 3 feet	seed	invades disturbed sites	yes	yes	no
Schinus terebinthi-folius (Brazilian pepper tree)	deciduous tree	shrub or small tree	seed	rapid	under study	yes	no
Tamarix spp. (tamarisk)	deciduous tree	shrub or small tree	seed vegetative (stems and stem fragments)	aggressive and invasive	yes	yes	no
Vinca major (periwinkle)	perennial herb	trailing vine	vegetative (stolons root at tip)	spreads from existing plantings in shade	no	yes	yes
Washingtonia sp. (palm)	evergreen tree	tall tree	seed	invasive, particularly in sandy creek inverts	yes	yes	yes

In many cases, alternative treatments must be included in the schedule of activities and the decision on when to implement alternatives should be based upon an evaluation of previous actions. Information gained from monitoring is needed to modify and improve control techniques, to evaluate priorities (including allocation of available labor and budgets), and to measure success/failure of the program.

TREATMENT COSTS

The general cost for restoration and enhancement measures are generated by adding land acquisition costs, restoration and enhancement costs, monitoring costs and an administration fee. These costs vary for different habitats to be restored and whether the project is a result of a mitigation requirement. The following list illustrates general weed control and habitat restoration costs per unit:

Treatment Costs

Treatment	Minimum Range	Maximum Range
Exotic Species Removal (per acre)	Herbaceous Species: $4,000	Tree Removal: $15,000
Clearing and Grubbing (per acre)	Surface Clearing: $1,500	incl. stumps, asphalt: $4,000
Grading , incl. disposal fees (per cubic yard)	Simple grading: $14	Grading for structures: $23
Hydroseeding (per acre)	Basic native mix: $6,000	Special mix + mulch: $10,000
Planting - 1 gal. containers (installed)	Shrubs: $7	Trees: $12
Planting - 5 gal. containers (installed)	Basic trees: $20	Specialty trees: $30
Irrigation Simple (optional)	Overhead: $5,000	Overhead plus drip: $15,000
Five-year maintenance /monitoring (per acre)	Low maintenance: $30,000	High Maintenance: $60,000

Generally, wetlands restoration and enhancement projects may be calculated between $30,000 and $60,000 per acre, depending on the complexity of the project. However, treatment costs may vary by project size and accessibility, and by project features (e.g., concrete berm removal, installation of flood control features, etc.). Accurate cost estimates should be based on detailed restoration and construction specifications.

POTENTIAL FUNDING SOURCES

Potential funding sources are available for restoration projects, including exotic vegetation removal. Not all funding sources are available in a given year (many are dependent on state legislature or congressional appropriation of funds). The potential funding sources are not generally geared exclusively toward the removal of invasive exotic species; rather, funding applicants would be required to show how an exotic species removal program would be consistent with a particular program's priorities (e.g., restoring the natural resource value of a stream). Additionally, many of the potential funding sources require some form of matching contribution from local governments or local citizen groups. In some programs, however, matching contributions can include in-kind services, such as the value of donated (volunteer) labor.

Appendix II

CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN

CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN:

CONCEPTS AND MEASURES FOR USE IN LAND DEVELOPMENT IN SAN DIEGO

A Guide for Architects, Designers, Developers, and Urban Planners

San Diego Police Department
Neighborhood Policing Resource Team
March 2001

The San Diego Police Department's philosophy of Neighborhood Policing recognizes the need for partnerships with other elements of the community to identify and solve neighborhood crime and disorder problems, and where practical, to create an environment in which problems do not arise. In land development, the SDPD would like to see a variety of crime prevention measures incorporated in the initial design of new projects. These measures are intended to complement and reinforce other efforts in the City to improve public safety and security through community planning, redevelopment, urban design, transit-oriented design, Livable Neighborhoods, and code enforcement, and be consistent with the urban design principles found in the City's *Progress Guide and General Plan,* community plans, and related documents.

Examples of such measures are outlined in this paper under the four basic concepts of Crime Prevention Through Environmental Design (CPTED). Some caveats regarding CPTED and a list of references are also included.

In addition to distributing this paper widely to people and organizations involved in land development, the SDPD is actively involved in the City of San Diego's project management process where it participates in preliminary project reviews and suggests alternative design measures that will help to prevent crime in the future. Questions about the application of these CPTED concepts and measures to land development in the City should be directed to the Neighborhood Policing Resource Team at (619) 533-5757.

CPTED CONCEPTS AND MEASURES

CPTED is based on a set of four design and usage concepts that can lead to a reduction in the incidence and fear of crime, and an improvement in the quality of life. These concepts are defined briefly as follows:

1. Surveillance. Involves the location and use of physical features, electrical and mechanical devices, activities, and people to maximize visibility. Creates a risk of detection for intruders and offenders, and a perception of safety for legitimate users.

2. Access control. Employs people, electrical and mechanical devices, and natural measures to create a perception of risk to offenders and deny them access to targets. Also guides legitimate users safely through the environment.

3. Territoriality. Uses physical features and activities to express ownership and control of the environment. Promotes neighborhood pride. Discourages presence of outsiders by delineating private and semi-private spaces, controlling the movement of people and vehicles, and making someone responsible for maintaining all spaces in the neighborhood.

4. Maintenance. Allows the continued use of space for its intended purposes. Maintains the effectiveness of measures employed for surveillance, access control, and territoriality.

Measures to implement these concepts are of three types: organized/formal, electrical/mechanical, and natural/informal. Measures can be implemented in the initial design, as additions or modifications to the initial design, or in maintaining the initial design. Many measures support more than one concept.

Organized/formal measures are labor intensive and can be very expensive if people have to be hired specifically for them. However, they need not be expensive if they can be carried out by volunteers or by workers hired primarily for other purposes. Electrical/mechanical and natural/informal measures tend to have low personnel and capital costs, especially if they are included in the initial design. Some examples of these two types of measures are outlined in the following sections to provide design guidelines for architects, designers, developers, and urban planners involved in land development.

1. Surveillance

Surveillance measures include (1) the design and location of physical features and electrical/mechanical devices to enhance visibility by people during normal/everyday activities, and (2) the location of people and activities to facilitate surveillance. These measures create a risk of detection for intruders and offenders, and a perception of safety for legitimate users.

a. Lighting

- Provide exterior lighting for visibility at night on streets, parking areas, sidewalks, pedestrian paths, possible entrapment spots, etc., to enable people to see where they are going and identify others along their route. Light should be consistent to reduce contrast between shadows and illuminated areas.
- Avoid lighting isolated areas that people should not use at night.
- Provide interior lighting and stain or paint walls white to enable people to see well indoors, e.g. in parking garages.
- Make sure that light is not blocked by trees or other landscaping.

b. Windows and Doors

- Provide two-way visibility in areas open to the public. Windows and doors should not be obstructed by signs, displays, plants, etc.
- Provide one-way visibility (from inside to outside) in areas not open to the public. Use mirrored glass or see-through curtains to maintain inside privacy. Use glare-proof glass to enable occupants of a lighted building to see out at night.
- Install peepholes for viewing people seeking entrance to secure areas.

c. Unobstructed Sight Lines

- Maintain tree canopies at least 8 ft above the ground.
- Keep shrubs trimmed to less than 3 ft except where privacy or environmental noise mitigation is a primary concern.
- Grade land where practical without substantially altering the natural terrain to provide unobstructed sight lines within the project and from adjacent streets and developed areas.
- Use open landscaping and see-through fences instead of

solid walls or hedges for boundaries where privacy or environmental noise mitigation is not needed.
- Orient buildings in a complex for good visibility of the streets, parking lots, and other buildings in the complex.
- Orient parking spaces to provide good visibility between cars.
- Maintain continuous front setbacks for buildings along a street.
- Orient houses in a neighborhood for clear visibility of the streets and the sides of nearby houses.
- Place garages even with or set back from front of homes.
- Use open or see-through structures for exterior stairways, walkways, porches, sitting areas, patios, parking spaces, etc.
- Use open structures for interior walls, e.g., in parking structures and garages.
- Eliminate possible hiding or entrapment spots along pedestrian paths.
- Install closed-circuit television (CCTV) cameras or mirrors where sight lines are obstructed.
- Provide a clear view of room interiors from room entry points.
- Install mirrors where sight lines are obstructed.
- Use straight short cul-de-sacs instead of curved, angled, or long ones where practical without substantially altering the natural terrain to enable the end of the cul-de-sac to be seen from the cross street.
- Use streets as buffers between housing and parks, playgrounds, commercial and industrial sites, etc.

d. Communications Systems

- Install emergency phones, alarms, or intercoms in convenient places for people to use to report intruders or suspicious activities, or to call for help.
- Post signs to show locations of emergency communications systems.

e. Indoor Facilities and Activities

- Locate high-activity rooms and areas so they face public and semi-public areas. These include kitchens and family rooms in homes, lobbies with guards or receptionists in buildings, offices of property managers in multi-family residences, offices of administrators and supervisors in businesses and other establishments, cashiers in stores and restaurants, etc. Provide large, unobstructed windows for good visibility of outside areas.

- Locate facilities for activities that involve a few people at a time in areas of high usage and good visibility so they can benefit from the natural surveillance already in the area. These include rest rooms, elevators, stairs, ATMs, pay phones, laundry rooms, trash containers, etc.

f. Outdoor Facilities and Activities

- Include front porches and benches to provide places where people can sit and observe activities on streets, sidewalks, open spaces, etc.
- Locate facilities for activities that attract large numbers of people in areas of low usage and poor visibility so that users can provide surveillance of the area. These include basketball courts, ball fields, eating establishments, etc.
- Locate facilities for activities that involve a few people at a time in areas of high usage and good visibility so they can benefit from the natural surveillance in the area. These include pay phones, ATMs, bus stops, bike racks, parking lots, hiking or jogging trails, etc.
- Locate activities within a facility to reduce potential causes of conflict and confusion, and make individual activities easier to supervise.
- Locate paths to and from entrances and exits of building through areas that need surveillance. Use the most direct route where possible.
- Mix compatible residential, commercial, and other land usages permitted by zoning regulations to provide round-the-clock presence and surveillance opportunities.
- Locate parking lots where non-conflicting users, e.g., church goers on weekends and office workers on weekdays, can share the spaces to expand the times that people are in the area.

2. Access Control

Access control measures include design features and target hardening that create a perception of risk to offenders and deny them access to targets. They also guide legitimate users safely through the environment. Controls should also be established on exits to deny offenders escape opportunities.

a. Security Systems

- Consider installation of alarms, cameras, intrusion detectors, metal detectors, activity decoys, intercoms, etc, to protect and control of all entrances and exits,

including garage, basement, service, loading and unloading doors, fire, roof, and attic. Make systems visible to potential intruders.
- Provide special protection for ground floor units.
- Install alarmed, self-locking emergency exits.
- Provide keys, entry cards, or access codes to residents or occupants.
- Provide safes or other secure facilities for storing cash and other valuables.

b. Doors and Windows

- Use strong locks and construction materials on all doors and windows. Avoid use of bars, if possible.
- Limit numbers of entrances and exits to buildings, parking lots, etc.
- Locate entrances and exits in areas that are under surveillance or direct supervision.
- Locate windows next to doors on hinge side, not on lock side.
- Eliminate rear-yard gates to alleys, pedestrian paths, open areas, etc.

c. Walls and Fences

- Make walls and fences attractive as well as durable.
- Use open fences, e.g., vertical wrought iron or decorative iron. They are preferred because they are easier to see through, harder to climb, and less susceptible to graffiti.
- Use vines, thorny plants, and other landscaping along walls to make access more difficult and prevent graffiti.

d. Signs

- Make signs legible and unambiguous. Use symbol signs where possible.
- Locate signs in strategic places.
- Use signs to:
  - Discourage access to dangerous areas
  - Indicate opening and closing times
  - Indicate minimal cash on hand
  - Direct people to safe paths, exits, assistance, means of calling for help, etc.
  - Inform people how to report maintenance problems
  - Inform intruders of access control measures

e. Safe Paths and Common Areas

- Provide adequate light for nighttime use of paths to and from the entrances and exits of buildings, and throughout the project or neighborhood.
- Close or discourage nighttime use of certain paths where adequate lighting, visibility, and surveillance cannot be provided.
- Eliminate entrapment spots, e.g., dense shrubs, high walls or hedges, or alcoves, along pedestrian paths.
- Locate amenities and activities at or near entrances, exits, and major circulation paths to increase risk of detection for intruders.
- Place common areas within the building complex.
- Group common areas for increased surveillance.
- Locate common mail boxes in secure, controlled-access areas.

f. Restraints

- Install barriers or other devices to prevent misuse of public facilities or areas, e.g., bathing in fountains, camping overnight under bridges, or violating protected open space.
- Design public amenities to discourage misuse, e.g., shape benches to be comfortable for sitting but not for sleeping, and roughen or install breaks in low walls, curbs, steps, railings, and smooth surfaces to discourage skateboarding.
- Install barriers to prevent trespassing on private property.
- Locate homes along borders of open space to prevent uncontrolled street access to the open space. Provide designated access points on streets or in parks for controlled access.
- Limit numbers of entrances and exits to buildings, parking lots, etc., to those that can be kept under direct surveillance, supervision, or control.

3. Territoriality

Territoriality measures involve the use of physical features to express ownership and control of the environment, and promote neighborhood pride. They discourage the presence of outsiders by delineating private and semi-private spaces, and controlling the movement of people and vehicles.

a. Streets

- Locate and design streets into and out of a neighborhood or development to reduce safety and security problems associated with through traffic.
- Employ measures to reduce the amount and speed of vehicular traffic. These include narrow road widths, two-way traffic, on-street parking, speed limits, bumps/humps, signs, traffic signals, curb indentations, bollards, cul-de-sacs, etc.
- Build sidewalks and seating to promote walking through the neighborhood or project.

b. Boundaries

- Define clear boundaries between public, semi-public/private, and private spaces. Boundaries are needed at entrances to courtyards, yards, patios, terraces, storage areas, play areas, parking lots/garages, etc. They can be established by signs, walls and fences, gates, landscaping, sidewalks, curbs (vertical instead of rolled), and pavement treatment like tiles and cobblestones.
- Use boundaries to prevent conflicts between different groups, e.g., teens and seniors, so all user groups will be able to enjoy an area or facility and maintain an ownership interest in it.
- Place address numbers where they are clearly visible from the street.

c. Public Spaces

- Create display and performance areas for local artists. A beautiful environment attracts people while a barren one repels legitimate users.
- Design neighborhood facilities to meet the needs of the people living in the neighborhood.
- Define uses for all areas in the neighborhood to prevent "no man's lands" from existing.

d. Public and Low-Income Multi-Family Housing

- Units with separate entrances are preferred. Smaller is better for number of units per building.
- For buildings with common entrances, smaller is better for numbers of units and floors per building, and units per corridor/entrance/stairway.
- Limit numbers of parking spaces per parking lot/garage. Several parking areas are preferred to one large one.
- Cluster buildings around common areas, amenities, and parking.

4. Maintenance

Maintenance measures permit continued use of the space for the intended purposes. They help maintain the effectiveness of the measures employed for surveillance, access control, and territoriality.

a. Low-Maintenance Landscaping

- Use low-maintenance designs and irrigation systems, and drought-resistant plants to facilitate upkeep over time.
- Avoid use of loose rocks.

b. Hardening against Vandalism

- Employ design features and materials that cannot easily be vandalized, stolen or used to damage the property.
- Use graffiti-resistant paint or anti-graffiti coatings on walls, benches, light poles, signs, etc.
- Avoid blank facades at street level.
- Use screens, wired glass, or other protection for light fixtures and bulbs.
- Use shiny aluminum or shatter-resistant glass for mirrors.

CAVEATS

CPTED measures employ three elements — people, devices, and design features — to deter crimes of opportunity by making it more difficult for an offender to commit a crime and escape without being stopped or detected.

Although devices and design features are important, the human element is the critical one. People in the environment must:

- Take advantage of the visibility provided to observe and question intruders,
- Report suspicious behavior and criminal activities,
- Use the access control measures provided to keep intruders out,
- Use the security measures provided to protect themselves and their property,
- Exercise control over their environment,
- Maintain the effectiveness of the various measures provided for surveillance, access control, and territoriality, and

- Be willing to testify in court to help convict the criminals.

But even all of this will not stop many types of offenders. Other concepts and strategies will also be needed to deal with offenders who are:

- Determined and skillful in defeating surveillance and access control measures,
- Irrational in their behavior,
- Acting as a member of an organized gang,
- Under the influence of drugs or alcohol,
- Reckless or undeterred by the risks of detection and apprehension,
- Unconcerned about possible punishment, or
- Residents and others legitimately in the area.

The need for the community, police, and other agencies and organizations to work together as partners to employ other concepts and strategies is especially critical in dealing with gangs. This is because organized gangs can use many of the same surveillance, access control, and territoriality measures outlined in this paper, along with terror and intimidation, to make an environment safe for their criminal activities.
Finally, CPTED measures do not deal with many types of crimes that occur in social, home, and business environments. For example, they do not help to prevent crimes in which the victim knows or provides access to the offender, i.e., domestic violence, child abuse, acquaintance rape, substance abuse, workplace violence, fraud, and forgery. Counseling, education, enforcement, and other measures are needed to deal with these situations.

REFERENCES

Crime Prevention Through Environmental Design: Guidelines to "Design Out Crime," City of Los Angeles, July 8, 1995.

Crime Prevention Through Environmental Design: Applications of Architectural Design and Space Management Concepts, Timothy D. Crowe, National Crime Prevention Institute, Butterworth-Heinemann, 1991.

Defensible Space: Deterring Crime and Building Community, Henry G. Cisneros, Secretary, U.S. Department of Housing and Urban Development, February 1995.

Defensible Space: Crime Prevention Through Urban Design, Oscar Newman, The Macmillan Co., 1972.

A Working Guide for Planning and Designing Safer Urban Environments, Planning and Development Department, City of Toronto, October 1992.

Physical Environment and Crime, Ralph B. Taylor and Adele V. Harrell, National Institute of Justice, U.S. Department of Justice, May 1996.

Design for Public Safety Saint Paul, Department of Planning and Economic Development, City of Saint Paul, December 1993.

Crime Prevention Through Environmental Design and Community Planning, Dan Fleissner and Fred Heinzelmann, National Institute of Justice Research in Action, August 1996.

Designing Safer Communities: A Crime Prevention Through Environmental Design Handbook, National Crime Prevention Council, July 1997.