

DUNE HABITAT RESTORATION PLAN MARINA DUNES PRESERVE MARINA, CALIFORNIA



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Introduction

The following Dune Habitat Restoration Plan has been prepared for the Monterey Peninsula Regional Parks District (MPRPD) to guide the restoration and preservation of sand dune habitat at Marina Dunes Preserve in Marina, California. The 62 acre parcel is located adjacent to the Monterey Bay on Dunes Drive in Monterey County (**Fig. 1**). Ten acres of the Marina Dunes Preserve has been owned and managed by the MPRPD as a public access corridor since 1990. Fifty-two acres of the Marina Dunes Preserve were acquired in 1998 from Granite Rock, a sand mining company. The Big Sur Land Trust provided interim ownership until conveyance to MPRPD. The entire parcel is now zoned as open space preserve. No development or construction is planned, only the fencing of walking paths and installation of educational signage.

The site is located within an environmentally sensitive area known as the Marina Dunes, which includes approximately 626 acres west of Highway One within the city limits of Marina. The Marina Dunes are part of the more extensive Monterey Dunes, which extend from Monterey harbor north to the Salinas River mouth in Monterey County, California. The different geologic histories of these dunes give rise to an unusual mosaic of vegetation found nowhere else along the Pacific Coast of North America (Pavlik and Zoger, 1990). The Monterey Dunes contain a unique blend of coastal species from northern and southern California and a large number of endemic species (native species of restricted distribution), resulting in areas of remarkable plant diversity.

At one time, sand was carried south from the Salinas River in longshore currents that followed the coastline, piling dunes to considerable heights along the southern half of Monterey Bay. After diversion of the Salinas River mouth north to Moss Landing Harbor, alluvial sand is no longer deposited along the shoreline, resulting in a substantial loss of sand for the Monterey Dunes (Thornton, 1994). Sand mining, development, and recreational use have also severely impacted the coastal dunes. The Monterey Dunes once contained over 50 native plant species, but are now much reduced by the above factors as well as the encroachment of non-native (exotic) species planted for erosion control, such as iceplant (*Carpobrotus edulis*) and Holland dune grass (*Ammophila arenaria*).

The Marina Dunes Preserve contains scattered pockets of pristine dune vegetation among disturbed dunes covered by non-native species. Iceplant (*Carpobrotus edulis*) has monopolized most of the site, reducing the cover of native species and habitat quality. Introduced cypress and eucalyptus trees dominate the southeastern portion of the parcel. The encroachment of iceplant, subsequent loss of native vegetation, and the orientation of the dunes have resulted in uncontrolled sand erosion and sand blowouts (moving sand sheets) at the Preserve. Fortunately, a broad diversity of coastal dune species is still present, and there is likely a substantial seed bank of native species remaining in the soil.

Surveys have documented several threatened or endangered (special status) species at the Marina Dunes Preserve and to the north in the Marina Dunes (Thomas Reid Associates, 1999, **Fig. 2**). Recovery objectives for special status species include protecting existing populations from development, invasive weeds, predators, and

recreational degradation. Preservation and restoration of potential habitat is encouraged for maintenance and increase of these populations. Special status plant species at the Marina Dunes Preserve include sand gilia (*Gilia tenuiflora* ssp. *arenaria*), Monterey spineflower (*Chorizanthe pungens* var. *pungens*), and Yadon's wallflower (*Erysimum menziesii* ssp. *yadonii*). Special status animal species include the Smith's Blue butterfly (*Euphilotes enoptes smithi*) and the black legless lizard (*Anniella pulchra nigra*). The western snowy plover (*Charadrius alexandrinus nivosus*) is documented north of the Preserve in the dunes owned by CEMEX, formerly RMC Lonestar.

Successful restoration of the Marina Dunes Preserve will provide limited public access to an extraordinary showcase of coastal dune habitat. Restoration provides an opportunity to connect the southern corridor of sand dunes (Marina State Beach and Fort Ord Dunes State Park, over 1000 acres in various stages of restoration), with quality dune habitat all the way north to the Salinas River (**Fig. 2**). The Marina Dunes Resort is the immediate neighbor to the south. Built on an abandoned sand mine in 1999, the Resort includes 6 acres of restored dune habitat surrounding 13 acres of development. To the north of the Marina Dunes Preserve is the largest undeveloped dune acreage along the Monterey Bay coastline. The CEMEX dunes contain a large, operating sand mine surrounded by semi-disturbed, vegetated dunes. The Martin Dunes include 120 acres of mostly pristine dune habitat and are privately owned in partnership with the Big Sur Land Trust. Connection with and preservation of these restored and mostly undeveloped dunes is extremely important for the sustainability of coastal dune habitat along the Monterey Bay.

Successful dune restoration at Marina Dunes Preserve requires weed eradication, the containment of non-native trees, sand stabilization, and the planting of appropriate native coastal species to augment the existing dune community. Native plant species stabilize the sand with deep, extensive root systems, as well as enhance habitat quality. Plant restoration supports native wildlife populations (especially special status species) by providing a variety of species-specific food and shelter.

The goal of this restoration plan is to describe existing biological resources at Marina Dunes Preserve and to define procedures and standards for restoration of the native coastal landscape. If the plan is implemented and monitored according to the plan, any adverse effects to existing native species or potential habitat can be avoided. The restoration program will significantly improve habitat value by increasing the quantity and diversity of native species, as well as expanding the corridor of restored dunes around the Monterey Bay. By designating the Marina Dunes Preserve as an open space preserve, the Monterey Peninsula Regional Parks District assures permanent protection of the restored area.

Biological Survey

The Marina Dunes Preserve is a 62 acre parcel that contains coastal strand and bluff, dune scrub, and maritime chaparral species (**Fig. 2**). Non-native species include the invasive iceplant widely planted for erosion control, weedy annual grasses, and introduced forest species. According to Cooper (1967) and Pavlik (1990), the soils of the Monterey Dunes include recent dune soils (formed from “recent” alluvial depositions of the Salinas and Pajaro rivers) and Flandrian dunes formed and stabilized during the Wisconsin glaciation (**Fig. 2**). Though much of the Marina Dunes Preserve is covered by iceplant, the sand appears to be high quality, judging from the diversity and quality of native dune vegetation growing in pockets throughout the parcel.

Sand movement at the Marina Dunes Preserve is considerable and appears to be caused by several factors: 1) the predominance of non-native iceplant, a shallow-rooted, heavy plant that smothers the native vegetation, changing the natural patterns of sand accretion and often sloughing off dune faces 2) historic sand mining and current recreational activity that prevents the native vegetation from establishing and stabilizing the sand 3) the perpendicular direction of the foredune and coastal bluffs to the ocean. Foredune orientation in the southern Monterey Bay is often parallel with the ocean and provides an important barrier to high winds and storm waves. The perpendicular orientation at the Preserve has resulted in considerable sand erosion along the coastal strand and sand movement to the inland side of the parcel, particularly in un-vegetated areas. The largest sand sheet measures 1,000,000 square feet and has existed since at least 1949 according to aerial photos. This sand sheet has buried the fencing along the eastern boundary of the Preserve and threatens to spill onto Dunes Drive, the frontage street of the parcel (**Fig. 1**).

A survey at Marina Dunes Preserve on June 15, 2005 recorded 30 native species, providing approximately 25-40% vegetative cover over the whole parcel (**Table 1a**). Coastal strand species include hardy, low-growing plants that have adapted to the exposed conditions next to the ocean, such as wind and salt spray. At Marina Dunes Preserve, coastal strand species are characterized by beach burr (*Ambrosia chamissonis*), sea rocket (*Cakile maritima*, non-native), beach morning glory (*Calystegia soldanella*) and beach primrose (*Camissonia cheiranthifolia*). Coastal bluff species at the Preserve include sparse, semi-woody shrubs perched along the edges of the ocean bluffs, such as coast buckwheat (*Eriogonum latifolium*) and lizardtail (*Eriophyllum staechadifolium*), as well as wind-tolerant, sand stabilizing species such as yellow sand verbena (*Abronia latifolia*) and sand dune bluegrass (*Poa douglasii*). Coastal scrub species are taller, shrubby species, well adapted to the dry, low nutrient soils of the mid-to-rear dunes. Dune scrub species on the site include beach sagewort (*Artemisia pycnocephala*), mock heather (*Ericameria ericoides*), and silver beach lupine (*Lupinus chamissonis*). Lower growing species such as bluff lettuce (*Dudleya caespitosa*), deerweed (*Lotus scoparius*), beach aster (*Lessingia filiginifolia*) and beach poppy (*Eschscholzia californica* var. *maritima*) thrive between the shrubby species in this dune scrub ecotype. A pocket of maritime chaparral contains dense, tall shrubs tucked behind the rear dunes including coyote bush (*Baccharis pilularis*) and mock heather (*Ericameria ericoides*).

A large area of the Marina Dunes Preserve is disturbed due to the cover of 12 non-native species that have monopolized the available habitat and reduced native species diversity (**Table 1b**). This non-native cover consists primarily of patches of iceplant (*Carpobrotus edulis*) that range from 25% to 100% cover, with the densest cover in the dune swales and on the coastal bluffs overlooking the ocean. An introduced forest covers ~8% of the parcel, and contains non-native gum trees (*Eucalyptus globulus*) and Monterey Cypress (*Cupressus macrocarpa*), that are native to Pebble Beach, but not the Marina Dunes. Ripgut grass (*Bromus diandrus*) and other weedy annuals occupy ~5% cover in the disturbed soils near the central gate and introduced forest (**Fig. 1**).

There was evidence of a sizeable rodent population throughout the weedy areas of the parcel. In particular, the introduced forest area had numerous squirrel holes, gopher tailings and other signs of herbivore presence, such as rabbit and deer scat. A grey fox and an owl are often observed onsite, according to a frequent visitor.

From the northern gate, an access corridor leads to the beach (the original 10 acre corridor owned by MPRPD). This northern path is 10-15 feet wide and provides vehicular access for maintenance. It is spread with decomposed granite along its eastern half, for stability and potential handicapped access. An interpretive kiosk is displayed at the entrance from Dunes Drive and ocean safety signs are posted at the ocean end of the trail. Along the ocean bluff, concrete pads and coarse sands remain from the surf zone mining that occurred many years ago.

A central gate leads to a short road and staging area next to the introduced forest. This area appears to have been graded and is compacted with fill soils, judging from the surrounding vegetation (**Fig. 1**). A high number of annual weeds occur here, adjacent to and within the introduced forest. From this central gate and road, numerous paths are scattered throughout the parcel. These unconsolidated pathways and the roads cover up to 10% of the Preserve.

According to the Marina Dunes Species Management Guidelines compiled by Thomas Reid Associates (1999), several special status species exist at the Marina Dunes Preserve and on nearby properties. Surveys of the parcel in 1987 and 2005 documented sand gilia (*Gilia tenuiflora* ssp. *arenaria*, state threatened, federally endangered), Monterey spineflower (*Chorizanthe pungens* var. *pungens*, federally threatened), and Yadon's wallflower (*Erysimum menziesii* ssp. *yadonii*, state and federally endangered, **Fig. 2**). Animal surveys in 1987 and 1997 found the Smith's Blue butterfly (*Euphilotes enoptes smithii*, federally endangered, **Fig. 3**) and black legless lizard (*Anniella pulchra nigra*, state species of concern, **Fig. 4**) on the Preserve, and the western snowy plover (*Charadrius alexandrinus nivosus*, federally threatened) just to the north in the RMC Lonestar Dunes (**Fig. 5**).

The small colony of **sand gilia** (*Gilia tenuiflora* ssp. *arenaria*) occurs next to the introduced forest on the ocean side and included ~150 individuals in this prolific rain year (late survey may have underestimated numbers, **Fig. 2**). The individuals ranged from 3 to 10 inches in diameter. A previous survey in 1993 counted 350 sand gilia onsite (Dorrell-Canepa, 1994). Sand gilia prefers open sands in mid-to-rear dune areas, protected from the exposed winds and salt spray of the foredunes. Associated native vegetative cover rarely exceeds 50%. After iceplant eradication, there will be many rear

dune areas suitable for expansion of the sand gilia colony at the Marina Dunes Preserve.

Monterey spineflower (*Chorizanthe pungens* var. *pungens*) was found scattered throughout the mid-to-rear dunes of the parcel. The species is relatively abundant onsite, with ample suitable habitat available for expansion (**Fig. 2**).

Yadon's wallflower (*Erysimum menziesii* ssp. *yadonii*) was planted in the foredunes of the Marina Dunes Preserve from site-specific collection at RMC Lonestar Dunes immediately north of the parcel (300 seedlings, **Fig. 2**). This endangered species is known only from the Marina Dunes. It was likely more abundant along the coastal bluffs of Marina at one time, but the colonies "migrate" considerably due to storm and bluff erosion (Thomas Reid Associates, 1999). Yadon's wallflower thrives in open areas free of other plant competition and tolerates moderate sand burial. Suitable habitat exists on the parcel for expansion of the population; however establishment is often difficult due to the windy, unpredictable nature of the foredunes.

The **Smith's Blue Butterfly** (*Euphilotes enoptes smithi*) was documented at Marina Dunes Preserve in 1987 and in the RMC Lonestar and Martin Dunes in 1997 (no surveys were conducted onsite that year, Thomas Reid Associates, 1999, **Fig. 3**). The butterfly has also been documented to the south at Marina State Beach (Arnold, 1986). The Smith's Blue Butterfly only associates with coast buckwheat (*Eriogonum latifolium*) and dune buckwheat (*Eriogonum parvifolium*), the two host plants. The butterfly spends its entire life cycle associated with buckwheat, utilizing the nectar as a food source, laying eggs, and overwintering beneath the plant. A decrease in dune buckwheat (*E. parvifolium*) at the Marina Dunes Preserve has led to a documented shift in Smith's Blue colonization patterns to coast buckwheat (*E. latifolium*), now the dominant species onsite. Smith's Blue butterfly is thought to have a "stepping-stone" dispersal pattern, which allows gene flow between adjacent colonies throughout the population's distribution. Any interruption to suitable habitat areas wider than 50 feet may act as a barrier to butterfly dispersal (Thomas Reid Associates, 1999). Sheltered rear dune areas tend to support more butterflies than the more exposed foredunes and mid-dunes.

The Marina Dunes Preserve contains abundant habitat suitable for the expansion of coast and dune buckwheat populations with a likely increase in the Smith's Blue Butterfly population. Only the introduced forest area on the site provides a substantial barrier to butterfly flight. An increase in buckwheat cover is especially important at the Preserve to link the substantial butterfly populations of the northern Marina Dunes (Lonestar and Martin Dunes) to butterfly populations in the southern Marina Dunes, including the restored dune habitat at Marina Dunes Resort and Marina State Beach.

The **black legless lizard** (*Anniella pulchra nigra*) was originally proposed for federal listing in 1995, but was withdrawn in 1998 because its range was considerably more extensive than originally thought. Over much of its range, the black legless lizard is found in the habitats occupied by the Smith's Blue butterfly. Thus, the lizard benefits from the same habitat restoration and preservation efforts that support the Smith's Blue Butterfly (removal of exotic vegetation, restoration of native plant communities).

Black legless lizards were found at the Marina Dunes Preserve in 1987 in areas primarily covered with native vegetation (Thomas Reid Associates, 1999, **Fig. 4**). The lizards are generally observed in sandy washes or native vegetated dunes on all slope aspects and habitat types, except bare sand. The lizards prefer large woody shrubs such as mock heather (*Ericameria ericoides*) and silver beach lupine (*Lupinus chamissonis*), which provide a shady cover and cool, deep sand that is easily penetrable. They forage for insects and spiders in leaf litter in the daytime and come to the surface around dusk.

Western snowy plovers (*Charadrius alexandrinus nivosus*) are known to nest at Marina State Beach and from the RMC Lonestar Dunes (CEMEX) north to Elkhorn Slough (U.S. Fish and Wildlife Service, 1993, **Fig. 5**). The species has not been reported to nest at the Marina Dunes Preserve. Preferred habitats for nesting in the Marina Dunes include dune backed beaches and un-vegetated beach strands. Nest sites typically occur in flat, open areas with sandy substrate, with vegetation and driftwood sparse or absent. Most plovers are site-faithful, returning to the same breeding site in subsequent breeding seasons. Their nesting habitat is unstable due to high winds, storms, wave action and plant colonization. Poor reproductive success, resulting from human disturbance, urban development, predation, and inclement weather, combined with the loss of nesting habitat to the introduced European beachgrass (*Ammophila arenaria*), has led to a decline in active nesting colonies, as well as an overall decline in the population of the western snowy plover along the Pacific Coast of the United States. The relatively successful nesting population of snowy plovers in the northern Marina Dunes appears to be related to the low level of human disturbance away from developed beach access areas (Thomas Reid Associates, 1999). Restoration of the foredune at the Marina Dunes Preserve should be planned around the potential presence of roosting or nesting plovers, allowing un-vegetated areas to remain in between planted areas.

Restoration Plan

The primary goal of the restoration plan is to restore 62 acres with a diversified palette of native dune strand and coastal scrub species that are surviving, growing and reproducing within five years of installation. Non-native species shall be eradicated and controlled throughout the restoration area. Drifting sand shall be controlled with sand stabilization techniques and re-vegetation efforts. Revegetation of the native species shall include the collection of site-specific seed, broadcast seeding, hydroseeding, and the outplanting of propagated seedlings. Special status plant species and their habitat shall be enhanced through native re-vegetation efforts, and by seed collection and increase from the existing populations on site. Structural improvements shall include fencing to protect restored areas and delineate pathways. Interpretive signage shall educate about the native dune habitat and inform passersby that restored areas are off limits. Once restored, maintenance and monitoring to specific performance criteria shall ensure a continued progression towards a diverse and sustainable dune community. Figures and tables list existing species and biological features, proposed species for the restoration effort and detail specific areas for recommended procedures. A schedule and estimated budget allow efficient planning of the restoration effort.

The success of dune restoration depends on proper timing of sand stabilization, weed control, seeding, and planting. Working outside the “restoration window” for native species is a waste of time, effort, and materials. Native plants in the Monterey Dunes are specifically adapted to a rainy winter and dry summer/ fall. Dune species usually germinate after the first rains of winter, increasing in size and flowering as spring progresses. Therefore, broadcasted seed must be in place when rains start, and planting from containers must be done early in the rainy season. When rainfall ceases in May-June, the plants slow their growth, usually producing seed by the end of summer or fall. Throughout the dry summer and fall, the perennial dune species may appear brown and desiccated, but their deep roots keep them alive. During this dormant summer period, native species survive by absorbing moisture and nutrients from the fog that blankets the coastline. Seed dispersed by the native species awaits the arrival of winter rainfall in November or December to begin the cycle of germination and growth once again.

Rapid plant establishment in disturbed sand dunes is important for sand stabilization as well as aesthetic reasons. Every site varies considerably with respect to the microhabitats available for plant establishment. Important factors that affect establishment include soil moisture and quality, the presence of existing vegetation, wind patterns, and herbivore presence. After elimination of exotic species, a variety of stabilization and re-vegetation techniques may be chosen for the treatment area, including broadcast seeding, hydroseeding (native seed sprayed in a water-based slurry with wood fiber mulch, tackifier and fertilizer), straw planting (vertical bunches of straw, with or without broadcasted seed), and straw crimping by machine over broadcasted seed. Transplantation of container seedlings (outplanting) is an important final step for increasing diversity in sensitive or problem areas, and for providing larger plants with greater reproductive output. The proposed plant list includes native species found in

undisturbed areas on the site, and from un-restored areas of the RMC Lonestar Dunes (CEMEX) and Marina State Beach, adjacent sites with high natural diversity (**Table 2**).

Restoration at the Marina Dunes Preserve should be staged over three to five years, with 15-20 acres treated each year. Experimental stabilization and re-vegetation treatments in the first two years shall guide the complete treatment of the un-vegetated sand blowouts and exposed foredunes in the third year. Multi-year staging increases establishment success by allowing adaptive management of the site, which includes a continuous assessment of the treated areas and modification of restoration techniques as needed. Weed control is most efficient if followed by immediate re-vegetation efforts (broadcast seeding, outplanting) the following rainy season. Twenty acres is a reasonable acreage for implementing restoration efforts when winter rainfall rarely lasts more than three months, providing a narrow window for plant germination and establishment. Restoration occurring over several years optimizes plant establishment and seed collection efforts. Each year, the winter rainfall, temperature and wind patterns vary considerably. Different native species establish and thrive under the different weather conditions. Likewise, seed collection spread over several years takes advantage of cyclical differences in seed production and viability. Some native species actually produce more seed in dry years.

1. Restoration Goals and Objectives

- Eradicate and control non-native vegetation and gophers/ ground squirrels as needed.
- Remove construction debris.
- Re-contour sand blowout and augment degraded areas with the excavated sand.
- Stabilize sand to prevent wind erosion.
- Install fencing to delineate walking trails and protect restored areas.
- Revegetate with site specific, native species that are representative of the Marina Dunes coastal community.
- Enhance potential and existing habitat for endangered species.
- Implement a monitoring program based on qualitative and quantitative standards.
- Establish a long term management program for maintaining and preserving the restoration areas.
- Enhance visitor appreciation through interpretive signage.

2. Restoration Procedures

Restoration activities shall be implemented according to this plan by a qualified restoration biologist and contractor, who shall be onsite for all activities. The timing of implementation shall adhere to the restoration schedule for optimal plant establishment and erosion control (Table 4), but adaptive management shall be practiced. For

instance, if early rains occur and the extended forecast is favorable, then revegetation methods can begin early. If broadcasted seed or hydroseeding efforts fail to germinate, then the outplanting of container stock shall be adjusted for optimal plant coverage. Analysis of unsuccessful areas shall guide changes in plant species, stabilization technique(s), or herbivore and weed control.

3. Multi-Year Restoration Schedule

Year One: 20 acres (southern section)

- Eradicate iceplant on southern third of property, in deep swales, Ammophila (foredune)
- Clean up forest area, remove dead trees, control saplings, gophers, squirrels
- Excavate buffer area for sand sheet, add sand to central gate area
- Re-fence eastern boundary, fence central path, repair northern path as needed
- Begin pathway reclamation, monitor use patterns
- Seed collect, propagate 15000 seedlings
- Broadcast seed and outplant southern third of property
- Experimentally treat origin of sand sheet (western edges) & foredune areas:
(Straw planting, drift fencing, broadcasting, straw crimping over seed?)
- Add endangered spp. to outskirts of sand gilia colony, Yadon's colony, spineflower
- Spray annuals

Year Two: 20 acres (middle section)

- Eradicate iceplant, spot treat previously sprayed, monitor Ammophila
- Control forest escapes, gophers, squirrels
- RE-excavate sand sheet as needed, add to central area
- Fence off pathways, revegetate
- Seed collect, propagate 15000 seedlings
- Broadcast and outplant middle third of property
- Continue sand stabilization experiments, moving inland on sand sheet, foredune
- Add gilia, Yadon's, spineflower to suitable areas restored in Year One
- Spray annuals

Year Three: 20 acres (northern section)

- Eradicate rest of iceplant, spot treat previously sprayed, monitor *Ammophila*
- Control forest escapes, gophers, squirrels
- Continue pathway reclamation
- Seed collect, propagate 15000 seedlings
- Broadcast and outplant northern third of property
- Continue sand stabilization, moving back on sand sheet, foredune
- Treat large area of sand sheet with drift fencing, straw crimping over seed, hydroseeding,
- Add gilia, Yadon's, spineflower
- Spray annuals
- Add interpretive signs

4. Weed Eradication and Control:

- To eradicate exotic (non-native) species before restoration efforts begin.
- To control weeds at less than 10% cover in subsequent years.

Invasive, exotic species monopolize available dune habitat, reduce diversity, and prevent germination of the desired native species. *Carpobrotus edulis* (iceplant) and other exotic grasses are the most significant invasive weeds on the parcel (**Table 1b**). Their control is essential for long term restoration success. Because these non-native species exist on adjacent properties, it is difficult to achieve complete eradication. However, a well-timed weed control program can keep the non-native species to a minimum.

The project area shall be sprayed before restoration begins with Roundup herbicide at 2% concentration, leaving a buffer zone around any native plants, where the weeds should be hand-pulled. The herbicide shall be sprayed by a certified pesticide applicator on non-windy days to prevent chemical drift. Once restoration efforts have commenced, herbicide application must be done by an applicator experienced at identifying native and non-native species in juvenile and adult stage. If hand-pulling becomes necessary, it shall be done in the spring before the weed seed ripens. Proper disposal of all herbicide containers is required.

Depending on thickness, iceplant spraying shall occur at least 6-12 months before re-vegetation efforts begin, so that the iceplant decomposes enough for efficient container planting. In areas with very thick iceplant, re-vegetation may need to be delayed until the second year of treatment. However, planting in the decomposed iceplant mats or seeding between the mats shall be done as soon as possible to prevent annual grasses from colonizing the iceplant mulch. This mulch becomes a magnet for invading weeds being richer in nutrients than the surrounding sands.

In areas with a substantial cover of native species, iceplant should be sprayed in late fall when the natives are essentially dormant and germinating native seedlings are at a minimum. In weedy, disturbed areas, iceplant should be sprayed in early to late spring so that the annual weeds and grasses are also eliminated before their seed is dispersed. Before re-vegetation with native species in these weedy areas with degraded soils, the bank of undesirable seed needs to be eliminated over several years of germination and eradication. To prevent re-colonization of the iceplant, it is essential to spray any re-growth of the mats and to pull small seedlings.

For budget reasons, the planted eucalyptus and cypress trees on the parcel need not be removed until they die of natural causes, although the shaded grove prevents complete restoration of the rear dune habitat. However, young saplings and dead trees shall be sprayed or removed to prevent further spread of the introduced stand. A lone acacia in the rear dunes near the forested area shall be removed.

A 400 sq. ft. stand of European beachgrass (*Ammophila arenaria*) on the parcel shall be sprayed and carefully monitored for reinvasion (**Fig. 1**). This highly invasive dune grass forms a dense plant cover and has monopolized many acres of valuable coastal dune habitat to the north, reducing native species diversity while changing beach topography (Weidemann and Pickart, 1996). European beach grass requires repeat spraying in the spring when shoot growth is most active. Herbicide applications of 4% or 10% Glyphosate (Roundup) with 0.5 % added surfactant have been shown to be effective at reducing cover by 90% or more (Bossard et al, 2000).

In severely degraded areas, gopher and ground squirrel eradication with phos-toxin gas (Weevil-cide) or non-secondary rodent bait is recommended prior to planting (Fig. 1). This gas may inadvertently harm black legless lizards and other beneficial soil dwellers as it permeates the rodent burrows and tunnels. However, lizard presence is probably low to non-existent in degraded areas that lack the loose sands and established native vegetation that lizards prefer (Thomas Reid Associates, 1999). Gophers proliferate in areas with depleted soil, where weed cover also prevents the establishment of native plant species. Where possible, augmentation with quality sand from another part of the site shall be preferred to chemical controls for rodents.

5. Removal of Construction Debris:

- To remove any sand mining or construction debris for public safety.

Large, rusting debris presents a liability hazard for public use of the Marina Dunes Preserve (**Fig. 1**). Before restoration begins, the debris shall be removed to a certified landfill. To access the debris along the ocean bluff, appropriate equipment may need to drive by permission onto Marina State Beach from the Reservation Road parking lot. The remaining debris is in the forested area, accessible from Dunes Drive. Coordination with California Department of Parks and Recreation and the Marina Dunes Resort could result in a joint effort to rid the ocean bluffs of other unsightly and dangerous debris left from sand mining operations.

6. Sand Recontouring and Augmentation:

- To prevent sand burial of city property along Dunes Drive.
- To increase plant establishment by adding clean sand to degraded areas.

Un-vegetated sand along the eastern boundary of the Marina Dunes Preserve shall be removed to avoid encroachment onto the City of Marina's right of way along Dunes Drive. The sand sheet in this area has accumulated to almost 25 feet and buries the boundary fencing. Machinery shall create a buffer zone on MPRPD property to catch moving sands until the sand sheet is (hopefully) stabilized after several years of treatment. It is unlikely that any black legless lizards will be disturbed by sand excavation, because unconsolidated sand sheets do not support the native shrubby vegetation required for shelter and support of the lizard's food sources (Thomas Reid Associates, 1999).

The excavated sand shall be used to increase planting success on degraded areas of the site. Under supervision of the restoration biologist, sand shall be added inside the introduced forest and along the compacted road leading from the central gate (**Fig. 1**). Before augmentation, the central road should be narrowed to 10 or 15 feet depending on desired use (vehicular or pedestrian). The sand shall be added to a depth of one to three feet along both sides of the roadway, preferably with some prior loosening of the compacted soils. The sand shall be spread into mounds by rake or mechanical means, mimicking natural dune topography, but allowing the wind to do the final sculpting. Vehicles carrying the sand shall travel along the designated roadway wherever possible to prevent unnecessary compaction of the restored areas.

7. Sand Stabilization:

- To hold bare sand in place for increased establishment of native vegetation;
- To provide wind protection for transplanted seedlings in barren areas;
- To stabilize large sand blowouts, preventing erosion and sand drift.

Most native dune species have deep roots that increase survival and stabilize the sand, preventing erosion. These roots provide a physical structure, and attract a "web" of fungal associations that serve to increase nutrient uptake. In un-vegetated areas, or after the addition of fresh sand, stabilization techniques hold the sand in place and protect young plants from wind while the root system develops. Various stabilization techniques include the installation of straw bunches (straw planting), drift fencing, mechanical straw crimping, and hydroseeding. Sand stabilization should occur within 48 hours of recontouring or sand augmentation. Stabilization should not be necessary in areas interspersed with existing native vegetation or in dead iceplant.

Small areas of bare sand in exposed areas or surrounded by only minimal native vegetation may require straw planting for stabilization (**Fig. 6**). Hand-sized bunches of sterile straw are "planted" on 18-24 inch centers to a depth of three inches, leaving 6-10 inches protruding vertically from the sand. Seedlings planted on the leeward side of the upright

straw bunches are protected from wind, and moisture retention is improved next to the straw. The open sand between bunches allows effective native seed dispersal and germination. Straw bunches usually persist for several years until they decompose or are buried by sand. Approximately 2000 pounds of straw and 320 man hours are needed per acre of bare sand (Ferreira and Gray, 1986). Native seed may be broadcasted and raked in or naturally worked into the sand as crews install the straw bunches. Any straw planting in the foredunes at the Preserve shall occur in pods to allow open areas for the potential presence of roosting or nesting snowy plovers (*Charadrius alexandrinus nivosus*).

Fast moving sand needs a combination of techniques to provide barriers to wind movement, such as **drift fencing** and/or straw planting, with secondary treatments to increase plant cover such as broadcast seeding, mechanical straw crimping and/or hydroseeding (**Fig. 6**). Drift fencing can provide an effective physical barrier to moving sands, giving vegetation a chance to establish in the unconsolidated sands. Lath and wire “snow-fencing” is typically erected in parallel rows of 100-200 feet, approximately twenty feet apart, perpendicular to the prevailing wind. The sections of fencing should be routinely lifted and maintained to prevent broken slats and loose wire. Drift fencing is not appropriate in foredune areas that are potential habitat for the western snowy plover, as the fencing may provide a significant barrier to roosting and nesting efforts.

For large un-vegetated areas with gentle slopes, **mechanical straw crimping** is an effective method of sand stabilization (**Fig. 6**). Sterile straw is blown by machine onto the surface of the sand after broadcasting native seed at ~15#/ acre, and the sand surface is rolled with a tractor-drawn straw crimper, which punches the straw into the sand over top of broadcasted native seed. Approximately 4000# of straw is used per acre. The straw blows around and may provide more sand coverage than is optimal for the germination of native dune species. However, straw crimping creates a roughened surface with ample crevices for seed protection and germination.

Hydroseeding at the proper time of year (November-December) is an economical treatment for stabilization and an even dispersal of a variety of native species (**Fig. 6**). Hydroseeding uses a custom blend of native seed with mulch, tackifier, and small doses of fertilizer, mixed into slurry that is extruded onto the sand. The slurry usually holds the seed in place on the sand, and the seeds germinate after sufficient rainfall (or irrigation). Hydroseeding is an effective option for steep un-vegetated areas which are difficult to treat with other methods, but is not as effective over unconsolidated sand sheets. See the Hydroseeding section for technical specifications.

8. Protective Fencing:

- **To protect restored areas from human and pet impacts and to delineate public access corridors to the beach.**

Guideline fencing shall be installed or upgraded along the designated pathways, separating the fragile dune habitat and restored areas from pedestrian use (**Fig. 7**). Boundary fencing along Dunes Drive should be more substantial than guideline fencing as a visual deterrent to trespass. The southern boundary is currently unfenced and

blends into restored dune habitat at the Marina Dunes Resort. If pedestrian use increases at this border, then guideline fencing may need to be installed to protect the habitat. The central and northern gates should be updated and signage coordinated to unify the two entrances.

Symbolic guideline fencing strung with black cable is recommended for a non-obtrusive look along the pathways. Anchor rods (eye rods) can be placed every 10-12 feet and strung with cable connected with furrrels. Nuts screwed on the bottom of the rods rust into the sand and make the rods difficult to remove. Guideline fencing requires proper construction and routine maintenance to keep the anchor rods straight and the cable evenly stretched with only a slight curve between anchor rods.

To prevent damage to germinating seedlings and fragile areas, fencing should be installed before sand stabilization and re-vegetation efforts begin. **Fig. 6** shows the main pathways to the beach. Other connecting pathways may remain, depending on user trends, if the majority of criss-crossing pathways are re-vegetated. The reclamation of old pathways may require temporary slat fencing with signage blocking the path until pedestrians learn to use the designated pathways. Signage stating "Restoration in progress, please do not enter" is informational, while requesting compliance. Routine monitoring of the fenced areas will indicate problem areas, such as shortcuts through sensitive habitat or areas with high recreational use. Fencing may need to be redesigned to accommodate some of these problem areas, or the density of native vegetation increased to discourage trespass.

At this time, the Marina Dunes Preserve has relatively few visitors per acre. Pedestrians use the northern corridor, but often walk along the ridgetops for the freedom of being "on top of the world". While this ridge walking can be damaging, it may be acceptable if use level remains low. Pedestrian use of the ridgetops should be monitored and perhaps used to plan a ridgeline pathway with minimal impacts. At this site, it is likely that iceplant encroachment has done more to reduce habitat quality and increase sand erosion than any amount of pedestrian impact.

9. Seed Collection:

- **To collect site-specific seed for seeding and propagation efforts.**

To preserve genetic integrity, all native species used shall be collected from the nearest source, or no more than three miles from the site. Adequate quantities of seed for increase of the special status species is available onsite (sand gilia, Monterey spineflower, Yaden's wallflower). Plant species adapt to changes in their immediate environment, leading to evolutionary changes that increase survival for the species. This genetic variation is often very specific to microhabitat and locale. The plants grown from nearby, site-specific seed will contain the adaptive traits needed to ensure long term survival at the site.

The proposed plant list includes native species found in undisturbed areas on the parcel, and from pristine areas with high natural diversity at Marina State Beach and CEMEX dunes. Seed shall be collected under the supervision of a restoration biologist by permission from the California Department of Parks and Recreation and CEMEX.

Maximum genetic diversity shall be assured by collecting seed from un-restored sections of the nearby dune areas, and by gathering from as many different plants of the same species as possible. No more than 10% of the seed from any one plant shall be collected. From special status species onsite, less than 5% of the seed shall be collected to prevent any negative impacts to the endangered populations. Seed shall be collected from May through October, stored in paper bags, and used within several months of collection for maximum viability. Therefore, seed must be collected each year for re-vegetation efforts in the fall-winter season. Seed collection shall occur over at least three years for optimal species diversity and establishment. Native dune species often have fluctuating seed yields and viability, related to winter rainfall and temperatures.

Table 2 contains a list of suggested species and quantities for seed collection. The amount of seed and plant numbers may be modified by the project biologist if permit issuance or site preparation prevents planting in early winter (December through January). **Fig. 2** shows the general location for the different vegetation ecotypes found on the site. Table 3 lists which native species are appropriate for each ecotype. Low-growing, coastal strand species that are resistant to wind, such as *Ambrosia chamissonis* (beach burr) and *Abronia latifolia* (yellow sand verbena), and *Poa douglasii* (dune blue grass) will be used in the most exposed areas on the foredunes and coastal bluffs. Taller coastal scrub species, such as *Lupinus chamissonis* (silver beach lupine), *Eriophyllum staechadifolium* (lizardtail), and coast buckwheat (*Eriogonum latifolium*), will be used in the more protected dune swales and ridges of the mid to rear dunes to hold the sand in place and improve habitat values.

10. Broadcast Seeding:

- To broadcast a mixture of site-specific, native dune seed over unvegetated areas to enhance species diversity and cover and ultimately stabilize the sand.

The most economical method to increase native species cover is broadcast seeding and raking of site-specific seed, because machinery is unnecessary. Broadcasting seed can broaden the diversity of species compared to natural wind dispersal, and the improved seed to soil contact after raking increases germination. The method works best in relatively small areas (<1 acre) where the sand is relatively stable with some existing native vegetation. It is effective for the reclamation of pathways and on foredunes before or after straw planting for stabilization. Seeding over iceplant mats is not effective unless decomposition is sufficient to allow good seed to soil contact (one to three years). Germination from broadcast seeding increases with consistent rainfall/irrigation but it is not required because the seed will often remain dormant until there is sufficient moisture, sometimes even germinating the following year (i.e. deerweed, *Lotus scoparius*).

Broadcast seeding shall occur in October-November, before winter rainfall begins, and after all late ripening seed has been collected. Seed shall be spread by hand onto the sand or fully decomposed iceplant litter and raked in lightly. Two seed mixes shall be

created, corresponding to the two general ecotypes (coastal strand or scrub) and their appropriate location in the fore or mid-to-rear dunes. **Table 2** lists suggestions for native species to be used for broadcasting and seed quantities. Several foredune species, such as beach burr (*Ambrosia chamissonis*) and the sand verbenas (*Abronia* spp.), require burial of at least one inch for germination. Therefore, they should be broadcasted and raked in with no further treatment (with the exception of straw planting) to avoid wasting the seed, which is difficult to collect in quantity.

11. Hydroseeding:

- To disperse a mixture of site-specific native dune seed in a slurry over un-vegetated areas to stabilize the sand and enhance native species diversity and cover.

Hydroseeding is efficient and economical for large barren areas, because it uniformly distributes a diverse mixture of seed. Soil moisture is conserved, promoting seed germination, and the slurry prevents (slight to moderate) sand movement during plant establishment. For most effective treatment of sand blowout areas, hydroseeding should be combined with drift fencing and possibly corridors of straw planting. Hydroseeding over dead iceplant is ineffective, as the slurry containing the native seed must have good contact with the sand surface for germination to occur. Hydroseeding depends on consistent rainfall or irrigation for optimal success.

Hydroseeding shall be done in November-December at the beginning of the rainy season for optimal seed germination. Any large scale sand augmentation shall be immediately followed with hydroseeding, so that the loose sand is stabilized by the extruded slurry.

The following hydroseeding specifications are recommended for sand dunes. Wood fiber mulch shall be applied at a rate of 2000 pounds per acre. Tackifier (M-binder or equivalent) shall be applied at a rate of 80 pounds per acre. Fertilizer shall be applied at a reduced rate (compared to other habitats) of 100 pounds per acre using Nutricote or Osmacote (14-14-14) controlled release fertilizer, Type 180. A rear dune/ coastal scrub seed mix shall be included in the slurry at 15#/ acre. Any dune areas with diverse native vegetation, especially special status species, shall be completely avoided with the hydroseeding slurry.

12. Propagation:

- To grow site-specific seedlings in containers and maintain them in optimal condition for outplanting in early winter (December-January).

Table 2 contains a list of suggested native species and plant numbers. Container plants shall be grown by a local nursery that specializes in growing native sand dune plants, and has a proven track record of satisfied customers. Propagation of the seed shall be done in sterile media designed for germination (i.e. McCalif's Germination Mix #3) in "stubby" cells manufactured by Stuewe and Sons, Inc. (Corvallis, Oregon). The germination mix shall be used in a 3:1 ratio with sand from nearby vegetated areas to

provide site-specific mycorrhizae that will facilitate plant establishment. Approximately two ounces of pelleted fertilizer shall be added to the soil mix per tray of 98 cells (Osmacote or similar brand, 90 day timed release, NPK 14-14-14).

The native, site-specific seed shall be made available to the nursery in time to allow propagation to occur in late August or early September. Propagation should take approximately three months for seedling growth, preferably with a hardening-off period before outplanting. At least some of the seedlings should be ready for outplanting (with a well-developed root system) by mid-December to take advantage of early rainfall should it occur. Consistent watering, thinning to one seedling per cell, and the prevention of herbivory are all essential for the survival and health of the dune seedlings.

13. Outplanting:

- To plant specified numbers of container seedlings in the appropriate locations, augmenting broadcast seeding/ hydroseeding efforts;
- To optimize seedling establishment by timing installation with winter rains;
- To improve diversity of the existing native community and encourage rapid plant establishment in barren areas.

Transplanting or outplanting seedlings from containers provides fast growth for improved sand stability and maximum reproductive efficiency. Plant establishment is usually successful from container stock, particularly in areas with existing vegetation or when combined with straw planting for sand stabilization. Container plants grow larger and reproduce more quickly than plants that germinate from seed after the first rains of winter. Container seedlings can be planted into dead iceplant where broadcasted seed or hydroseeding would be ineffective. However, compared to plants that germinate from seed onsite, container plants are often more affected by inconsistent rainfall, high winds, and grazing by herbivores. Native plants from seed germinate after finding a suitable microniche and sufficient water, thus they often have an advantage over seedlings planted at a specified density with no possible knowledge of the microhabitat.

The suggested plant numbers will supplement broadcast seeding and/or hydro-seeding efforts with the outplanting of approximately 1000 seedlings per acre. Survival of the seedlings depends on careful planting by trained staff. The plant shall be firmly tamped into the sand and the root mass completely buried with a shallow well 2-3 inches deep created around each seedling to conserve rainwater. Plant spacing and location vary according to species and existing vegetation, and shall be under the supervision of the restoration biologist, using **Fig. 2** and **Table 3** as a guide. The biologist may need to adjust plant numbers according to seed viability and germination success.

Planting of the seedlings shall occur after the first storms of the winter season have thoroughly soaked the sand. Around the Monterey Bay, planting conditions are usually optimal by late December or early January when at least 2 inches of rain has fallen and more rainfall is expected within the week. Planting should not occur on unseasonably hot or windy days, as young seedlings may suffer on the exposed sand dunes. Planting

should occur in stages, so that herbivory and other unforeseen conditions can be controlled before all the plant material is compromised.

Thick iceplant must be given time to decompose, or planting efforts will be inefficient and tiresome. The decomposing litter of the iceplant will hold the sand in place and act as a protective windbreak for the out-planted seedlings. Seedlings can be planted directly into 12 inch clearings in the iceplant or along the edges of the mats, allowing the iceplant to act as mulch, preventing weed growth while it decomposes. In more exposed areas, dead iceplant can be formed into a circle around each young seedling, providing valuable wind protection.

In areas with straw planting for stabilization the seedlings shall be planted in the lee of the straw bunches where there is maximal wind protection and moisture conservation. In areas with no stabilization treatment, new seedlings shall be installed using the existing vegetation as a buffer wherever possible.

14. Special Status Species:

- To create and enhance appropriate habitat for six special status species: sand gilia (*Gilia tenuiflora* ssp. *arenaria*), Monterey spineflower (*Chorizanthe pungens* var. *pungens*), Yadon's wallflower (*Erysimum menziesii* ssp. *yadonii*);
- To increase each special status plant species to a "sustainable" level of 1000 individuals each;
- To plant *Eriogonum parvifolium* and *latifolium* in support of Smith's blue butterfly;
- To restore native coastal scrub species and eliminate non-native species to support black legless lizard expansion;
- To restore foredunes in a manner that creates suitable snowy plover habitat.

Sand gilia, Monterey spineflower, and Yadon's wallflower are all found at the Marina Dunes Preserve in limited quantities. Increase of these special status species will be naturally encouraged by restoring the parcel to native species and eliminating the iceplant, leaving the patches of open sand that naturally occur between existing dune vegetation. Both sand gilia and Monterey spineflower are usually found in open sands associated with sparse, low-growing native vegetation in the mid-to-rear dunes. Yadon's wallflower occurs in the open sands of the exposed foredune, where growing conditions are tough and there is little plant competition.

Sand gilia: There is ample opportunity for sand gilia enhancement after habitat improvement in the mid-to-rear dunes of the Marina Dunes Preserve. The presence of a designated pathway bordering the existing gilia population provides a unique opportunity for interpretive signage showing the sand gilia in its natural habitat (**Fig. 6**).

This annual, self-pollinating species disperses ample seed when growing in quality sands, free of herbivory and protected from winds. Onsite seed collection shall occur in late April-May, with weekly monitoring for seed readiness, as the seed capsules dehisce rapidly and completely. Seed shall be collected from as many individuals as possible, with no more than 5% of the seed harvested from any one plant. Nursery propagation of

the seed is recommended since broadcasting is difficult due to the tiny, sand grain-like seed. Seedlings shall be grown in cells using the same techniques and timing described in the Propagation section. Outplanting shall occur in open sand between existing low-growing vegetation occupying less than 25-50% cover. Swales, flat areas, and low dunes are preferred receiver sites over steep or south-facing slopes. Several plantings should be sequenced over the winter season with frequent survival monitoring to modify any unforeseen conditions, such as herbivory or erosion. Individuals should be planted in “colonies” of 25-50 individuals with 1 foot spacing. First year monitoring of survival is greatly facilitated by planting in a series of lines, but these lines can wind between and slightly under existing vegetation for increased protection.

Monterey spineflower: Broadcast seeding of the annual Monterey spineflower is a effective and economical way to increase population numbers. Seed is easily collected July through August, when plants are thoroughly desiccated, and the accompanying plant debris need not be separated from the seed. Because of its clumping spines, spineflower is most effectively broadcasted after mixing with other dune seed before winter rains begin in October-November. Seed shall be dispersed and lightly raked in between existing vegetation of the mid-to-rear dunes. Monterey spineflower efficiently colonizes unwanted pathways, sparse or un-vegetated areas, and disturbed soils. Herbivory is rarely a problem for this species. Broadcast seeding followed by even moderate rainfall will result in hundreds of new seedlings from the highly viable seed, ensuring natural regeneration for years to come. Monterey spineflower grows rapidly in nursery containers, but top growth is horizontal, so seedlings must be used promptly or become difficult to separate.

Yadon’s wallflower: This species was grown from seed from the nearest (and largest) source, RMC Lonestar Dunes (Cemex) in 1999-2000 (~300 seedlings) and has continued to increase in the exposed foredunes of the site. Seed of this often perennial species shall be collected July through August, from as many individuals as possible, with no more than 5% of the seed harvested from any one plant. If ample seed is collected, some can be broadcasted in foredune areas un-colonized by the species. A portion or all of the seed (if limited) should be propagated in cells for outplanting in early winter. Straw planting in exposed foredune areas increases the survival and establishment of the wallflower seedlings. However, any straw planting or outplanting in the Marina foredunes shall be done in pods to facilitate co-existence with the western snowy plover, which prefers un-vegetated beaches for nesting and winter roosting. Wallflower seedlings can also be planted behind other species such as sea rocket (*Cakile maritime*) for protection from the unpredictable and strong winds of the foredune.

The establishment of the special status plant species shall be monitored annually by counting or estimating (if numbers are high) all reproductive individuals on the parcel: sand gilia (April-May), spineflower (May-June), Yadon’s wallflower (June-August). The desired five year goal of at least 1000 individuals per species shall be indexed to surrounding natural populations, as numbers of the annual species (particularly sand gilia) fluctuate substantially each year, probably tied to rainfall levels. If any species’ numbers fall below 250 individuals, then replanting shall occur the following winter season after the reason(s) for mortality is carefully analyzed and remedied.

Smith's Blue Butterfly: Restoration efforts at the Marina Dunes Preserve will substantially improve potential and existing habitat for the Smith's Blue Butterfly. In addition to the eradication of non-native species and sand stabilization efforts, it is recommended that dune buckwheat (*Eriogonum parvifolium*) be planted at the site to restore the species to the site. Because dune and coast buckwheat (*Eriogonum latifolium*) flower at separate times, they should be planted in large colonies, rather than interspersed, to avoid confusion to the butterfly population that has evolved to use the coast buckwheat.

Black legless lizard: Restoration at the Marina Dunes Preserve will enhance existing poor quality habitat, stabilize and vegetate the sand sheets, and naturally increase black legless lizard populations. The entire parcel will eventually become a habitat corridor for the lizard, allowing movement between lizard populations to the north and south. Lizards disturbed during sand excavation (see Sand Recontouring and Augmentation) will be relocated to established vegetation on site.

Western snowy plover: Any sand stabilization and re-vegetation in the foredune of the Marina Dunes Preserve shall be done in sections with un-vegetated areas in between, to allow potential habitat for the snowy plover. Interpretive signs about the plover and a "dogs on leash" policy are important efforts. If any nesting activity is observed, exclusionary fencing around the nest may be recommended, after contact with local experts. MPRPD may wish to contribute to the regional effort to control the non-native red foxes that prey on the snowy plover.

15. Irrigation:

- To supplement inconsistent rainfall and ensure plant establishment if hydroseeding or outplanting do not occur during December and January.

Because restoration at the Preserve is not dependent on construction schedules, supplemental irrigation should not be necessary. The lack of an irrigation system substantially reduces costs, annual weed proliferation and uncontrolled leaks (Ferreira and Gray, 1987). Instead, a multi-year seeding and planting effort within the appropriate restoration timing window should balance any years of lean rainfall.

The local weather conditions shall be used to best advantage. If broadcast seeding occurs October-November, hydroseeding or straw crimping by end November, and outplanting of seedlings from January through mid-February, the average winter rainfall is usually adequate for successful plant establishment. Hand or truck watering of outplanted seedlings is inconvenient but increases survival if there are rain-free periods of more than two to three weeks in the winter, or sustained high winds unaccompanied by rainfall.

Temporary irrigation may be advisable when the largest areas of the moving sand sheet are stabilized and seeded/ planted in Years Two and Three. Depending on the success of the early experimental treatments at the origin of the sand sheets, it may be deemed

advantageous to extend the native species establishment window with irrigation from December through May.

16. Monitoring:

- To monitor implementation of the restoration plan.
- To ensure that minimum performance criteria are met.

The restoration goal is to create a diversified palette of coastal strand and scrub species that are surviving, growing, and reproducing within five years (i.e. self-sustaining). A project biologist shall oversee all restoration activities to ensure compliance with the restoration plan. The biologist shall also routinely inspect the restoration areas to notice any developing problems, such as increased herbivory, lack of water, or water and wind erosion. Changes to the restoration plan due to adaptive management shall be agreed to by MPRPD and the City of Marina, unless they involve special status species. If special status species are involved, the California Department of Fish and Game and the U.S. Fish and Wildlife Service shall be consulted.

Monitoring standards provide a means for assessing the success of the restoration and for identifying maintenance needs. Annual monitoring shall include quantitative measures to ensure adequate establishment of the native species, including vegetative cover and density (the number of native plants per square meter). The number of species in a given area (species composition or “richness”) shall be calculated to ensure adequate species diversity. Qualitative evaluations shall assess the health and vigor of the vegetation and indicate any erosion or problem areas. Photos taken from permanent photopoints will provide documentation of the progress of restoration. The condition of physical structures such as fences, gates and signs will be evaluated.

Quantitative measurements shall include percent vegetative cover from 30 line transects of 25 meters each (15 permanent, 15 random). There shall be 10 transects per foredune (primarily coastal strand and bluffs), 10 transects per mid-dune (coastal scrub, swales) and 10 transects per reardune areas (primarily coastal scrub and sand blowout areas). Percent cover will be calculated by measuring the distance covered (basal measurement) by any species along 10 randomly placed meter sticks placed perpendicularly to the transect line. The data will be used to estimate the mean percent cover for native and non-native species. The goal of the permanent transects is to monitor the change in percent cover of all native and non-native species over time. The goal of the random transects is to estimate the mean percent cover for native and non-native species with a 95% confidence interval no greater than 25 % of the mean.

Plant density and species richness will be determined from 30 random quadrats, 5*5 meters each, divided evenly between foredune, mid-dune, and reardune areas. Plant density will be figured by presence or absence of a native species (measuring at least 10 cm. basal diameter) for each square meter within the quadrat. Using the same quadrats, species richness shall be assessed for the foredune, mid-dune and reardune areas by recording the number of different native species per 25 square meters and combining the 10 quadrats for richness per 250 square meters.

Monitoring shall occur annually for five years for each 20 acre section following complete restoration. Because of multi-year restoration efforts, the first restoration area may be monitored for 2 years before the final stage is complete. Data shall be collected in May - June when all plant species are at peak growth. Results from the data shall be presented in an Annual Monitoring Report due by September 1 to MPRPD and the City of Marina.

The restored habitat areas shall be maintained and managed to meet the following performance criteria. If an area fails to meet the stated requirements, remedial actions shall be described in the annual report and completed prior to monitoring the following year. The determination of the success of the restoration goals and objectives shall be made by MPRPD, the City of Marina, the California Department of Fish and Game and the U. S. Fish and Wildlife Service.

17. Native Species Performance Criteria:

		Foredune	Mid-to-Reardune
% native cover:	1 year:	>5%	>10%
	2 years:	>10%	>20%
	3 years:	>15%	>25%
	4 years:	>20%	>30%
	5 years:	>25%	>35%
% non-native cover:	All Years	<10%	<10%
Density:	5 years	1 plant greater than 10cm diameter/sq. meter	
Diversity:	5 years	30/250m ²	40/250m ² (mid) 50/250m ² (rear)
Special status species:	1000 each: sand gilia, Monterey spineflower, Yadon's wallflower		
Health and vigor:	normal		
Erosion/disturbance:	minimal or nonexistent, repaired in timely manner		
Fences, gates, signs:	in good repair		

18. Contingency Measures:

By the third year, replanting shall occur in deficient areas where native vegetation falls below 15% (foredune) or 25% cover (mid-to-reardune). Reseeding/replanting shall also occur in bare sand areas exceeding 250 square meters, or if species composition falls below 25 species by the third year. Plant failure should trigger careful consideration of the reason(s) for mortality and the appropriate location for the species. If certain species will not survive in exposed areas of the parcel, than any successfully established species from that area shall be increased in number.

The moving sand sheet at the Marina Dunes Preserve has been unvegetated for many years, according to aerial photos. It is likely that stabilization and seeding/ planting treatments will be difficult to impossible as the sands are unconsolidated, with little to no mycorrhizae or nutrients available to plant roots. The sand sheet areas may need to be monitored separately from the other dune restoration areas, and assessed more realistic performance standards.

19. Maintenance:

- To ensure that the goals and objectives of the restoration plan are achieved.
- To ensure that performance criteria are sustained in perpetuity.

Maintenance activities include weed and rodent control, prevention and repair of any disturbance including erosion, replanting of deficient plant areas, fence, gate, or sign adjustment or replacement, and trash collection. Maintenance activities shall be performed by trained staff familiar with native species and the fragility of coastal dune habitat.

Herbicide treatment of non-native species at the proper time can eliminate hours of hand labor. Hand weeding shall be timed to occur before seed is dispersed, with extra weeding labor scheduled for the spring. The removal of iceplant seedlings is important to prevent re-colonization of the species. Ripgut brome is highly invasive in disturbed areas (particularly dead iceplant) and must be thoroughly eliminated before the seed disperses for many years. European beach grass requires constant vigilance to prevent reinvasion. Excessive gopher or squirrel populations should be controlled to prevent loss of the re-vegetation effort.

Eroded or disturbed areas larger than 250 square meters shall be stabilized and replanted. Smaller areas should regenerate from natural seed dispersal. Damaged fencing or signage shall be immediately repaired or replaced. Trash collection in areas without walkways may only need to be performed on a quarterly or semi-annual basis.

In the future, surface or underground improvements may require maintenance or repair in the restoration areas. MPRPD shall approve any work that disturbs the restored habitat areas under the conditions that the dune habitat be protected and any disturbance restored to its original condition. All work is subject to the restoration, maintenance and monitoring provisions in this document.

20. Interpretive Signage:

- To educate about the fragile nature and features of coastal dune habitat;
- To educate about the flora and fauna of the Marina Dunes;
- To guide pedestrians to the beach and discourage entry into restored areas.

To enhance visitor appreciation and enjoyment of the Marina Dunes and the Monterey Bay, educational information about the coastal dune habitat shall be displayed and updated on several kiosks placed at each gate along Dunes Drive **(Fig. 7)**. The interpretive text shall discuss habitat restoration on the site, with information about the Marina Dunes and its inhabitants, including illustrations of several common and endangered dune species. Ocean safety information is already posted at a central location above the beach. If this sign does not include information about the western snowy plover and its beach habitat, then it should be updated. Additional ocean safety signs are suggested at the end of the central pathway to the beach **(Fig. 6)**. All interpretive signs shall be made of a material that resists damage by vandals and the weather, and the posts secured by concrete footings. No signs should be installed on the beach.

As budget permits, additional interpretive signs might identify various dune species along the access trails to the beach by picture and brief description. In particular, all three special status species (sand gilia, Monterey spineflower, and Yadon's wallflower) should be identified along the central pathway to the ocean, which passes alongside suitable or existing habitat for each of the species **(Fig. 7)**.

Signs prohibiting entry might say "Sensitive Habitat–Please Do Not Enter" or "Restoration in progress- Please Do Not Enter" should be placed at the edges of the restoration areas. In the appropriate areas, signs reading "Please do not disturb, restoration by volunteers" seem to be most effective. Strategically placed "Beach Access" signage shall direct pedestrians to the walkways to prevent shortcuts through the restoration areas.

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12. Weidemann, A.M. and A. Pickart, 1996. The *Ammophila* problem on the northwest coast of North America. Landscape and Urban Planning. 34:287-99

Table 1a. Native Species

Scientific Name	Common Name	06/15/05
<i>Abronia latifolia</i>	yellow sand verbena	x
<i>Abronia umbellata</i>	pink sand verbena	x
<i>Achillea millefolium</i>	yarrow	x
<i>Agoseris apargioides</i> var. <i>eastwoodiae</i>	Eastwood's agoseris	x
<i>Ambrosia chamissonis</i>	beach burr	x
<i>Armeria maritima</i>	sea thrift	x
<i>Artemisia californica</i>	CA. Sagebrush	
<i>Artemisia pycnocephala</i>	sagewort	x
<i>Astragalus nuttallii</i>	rattleweed	
<i>Atriplex leucophylla</i>	saltbush	
<i>Baccharis pilularis</i>	coyote bush	x
<i>Cakile maritima</i>	sea rocket	x
<i>Calystegia soldanella</i>	beach morning glory	x
<i>Camissonia cheiranthifolia</i>	beach primrose	x
<i>Cardionema ramossissimum</i>	sand mat	x
<i>Castilleja latifolia</i>	Indian paintbrush	x
<i>Chorizanthe pungens</i> FT*	Monterey spineflower	x
<i>Crassula connata</i>	sand pgymy	x
<i>Croton californicus</i>	croton	x
<i>Cryptantha leiocarpa</i>	coast cryptantha	
<i>Cupressus macrocarpa</i>	Monterey cypress	15
<i>Dudleya caespitosa</i>	liveforever	x
<i>Ericameria ericoides</i>	mock heather	x
<i>Erigeron glaucus</i>	seaside daisy	
<i>Eriogonum latifolium</i>	coast buckwheat	x
<i>Eriogonum parvifolium</i>	dune buckwheat	
<i>Erysimum ammophilum</i>	coast wallflower	x
<i>Erysimum menziesii</i> ssp. <i>yadonii</i> CE, FE*	Yadon's wallflower	x
<i>Eriophyllum staechadifolium</i>	lizardtail	x
<i>Eschscholzia californica</i> var. <i>maritima</i>	CA. poppy	x
<i>Gilia tenuiflora</i> ssp. <i>arenaria</i> CT, FE*	sand gilia	151
<i>Heterotheca grandiflora</i>	telegraph weed	x
<i>Lessingia filaginifolia</i>	CA. beach aster	x
<i>Leymus mollis</i>	American dune grass	
<i>Linaria canadensis</i>	blue toad-flax	
<i>Lotus scoparius</i>	deerweed	x
<i>Lupinus chamissonis</i>	silver beach lupine	x
<i>Phacelia ramosissima</i>	branching phacelia	x
<i>Poa douglasii</i>	sand dune bluegrass	x
<i>Polygonum paronychia</i>	knotweed	x
TOTAL	Species	30
*CE/CT = CA Endangered/Threatened FE/FT = Federally Endangered/Threatened		

Table 1b. Non-Native Species

Non-Native Species Scientific Name	Common Name	Present 06/15/05
Acacia spp.	acacia	1
Ammophila arenaria	Holland dune grass	x
Anagallis arvensis	scarlet pimpernel	x
Avena fatua	wild oat	x
Brassica nigra	black mustard	x
Bromus diandrus	ripgut grass	x
Carpobrotus edulis	iceplant	30-100%
Chamomilla suaveolens	pineapple weed	
Centaurea melitensis	totalote	x
Conicosia pugioniformis	conicosia	
Conyza canadensis	horseweed	x
Erodium cicutarium	redstem storksbill	x
Eucalyptus globulus	blue gum	30
Gnaphalium luteo-album.	weedy cudweed	
Hordeum murinum	barnyard foxtail	
Hypochaeris glabra	smooth cat's ears	
Medicago polymorpha	California burr-clover	
Melilotus indica	Indian melilot	
Pennisetum clandestinum	kikuyu grass	
Plantago coronopsis	cut-leaved plantain	
Poa annua	annual bluegrass	
Polypogon monspeliensis	rabbitfoot grass	
Raphanus sativa	wild radish	
Rumex acetosella	sheep sorrell	
Senecio vulgaris	common butterweed	
Silene multinervis	many-nerved catchfly	
Solanum umbelliferum	nightshade	
Sonchus oleraceus	common sowthistle	
Spergularia bocconii	sand-spurrey	
Stellaria media	shiny chickweed	
Tetragonia tetragonioides	New Zealand spinach	x
Vulpia myuros	rattail fescue	
TOTAL	Species	12

Table 2. Proposed Native Species and Seed Requirements

Scientific Name	Common Name	Spp %	Contain.	Pounds of Seed				TOTAL
				Seed/Cont	Broadcast	Hydro-	Crimp.	
<i>Abronia latifolia</i>	yellow sand verbena	5%	2000	15	50	Mid-Rear		65
<i>Abronia umbellata</i>	pink sand verbena	3%	1400	8	40		20	68
<i>Achillea millefolium</i>	yarrow	2%	900	2	13	5	6	26
<i>Agoseris apar. var. eastwoodiae</i>	Eastwood's agoseris	1%	500	1	8	2	3	13
<i>Ambrosia chamissonis</i>	beach burr	5%	2300	13	75		20	108
<i>Armeria maritima</i>	sea thrift	2%	900	3	12	5	6	26
<i>Artemisia californica</i>	CA. Sagebrush	3%	1200	2	23	5	9	38
<i>Artemisia pycnocephala</i>	sagewort	14%	6000	14	150	25	50	239
<i>Astragalus nuttallii</i>	rattleweed	3%	1400	3	23	5	9	39
<i>Atriplex leucophylla</i>	saltbush							
<i>Baccharis pilularis</i>	coyote bush	2%	900	2	15	3	6	26
<i>Cakile maritima*</i>	sea rocket	Non-inv.						
<i>Calystegia soldanella</i>	beach morning glory							
<i>Camissonia cheiranthifolia</i>	beach primrose	3%	500	1	25	6	10	42
<i>Cardionema ramossissimum</i>	sand mat							
<i>Castilleja latifolia</i>	Indian paintbrush	1%	500	1	8	2	3	13
<i>Chorizanthe pungens (FT)</i>	Monterey spineflower	4%	1000	2	50	8	15	75
<i>Crassula connata</i>	sand pgymy							
<i>Croton californicus</i>	croton							
<i>Cryptantha leiocarpa</i>	coast cryptantha							
<i>Cupressus macrocarpa</i>	Monterey cypress	PB End.						
<i>Dudleya caespitosa</i>	liveforever	2%	900	1	4	1	2	8
<i>Ericameria ericoides</i>	mock heather	7%	3000	7	53	11	22	92
<i>Erigeron glaucus</i>	seaside daisy	2%	900	3	14	3	6	26
<i>Eriogonum latifolium</i>	coast buckwheat	6%	2400	10	50	20	40	120
<i>Eriogonum parvifolium</i>	dune buckwheat	4%	1800	4	26			30
<i>Erysimum ammophilum</i>	coast wallflower	3%	1400	3	24	5	10	42
<i>Erysimum m. ssp. yadonii (CE, FE)</i>	Yadon's wallflower	5%	3000	3	10			13
<i>Eriophyllum staechadifolium</i>	lizardtail	6%	2500	6	50	14	30	100
<i>Eschscholzia cal. var. maritima</i>	CA. poppy	3%	1400	1	15	8	12	36
<i>Gilia ten. ssp. arenaria (CT, FE)</i>	sand gilia	2%	3000	0.5				1
<i>Heterotheca grandiflora</i>	telegraph weed							0
<i>Lessingia filaginifolia</i>	CA. beach aster	3%	1400	2	10	2	4	18
<i>Leymus mollis</i>	American dune grass							
<i>Linaria canadensis</i>	blue toad-flax							
<i>Lotus scoparius</i>	deerweed	2%	900	5	40	10	20	75
<i>Lupinus chamissonis</i>	silver beach lupine	3%	1200	1	8	4	6	19
<i>Phacelia ramosissima</i>	branching phacelia	1%	300	1	8	2	3	13
<i>Poa douglasii</i>	sand dune bluegrass	3%	1400	rhizomes				30
<i>Polygonum paronychia</i>	knotweed							
TOTAL	Species	100%	45,000	100	750	150	300	1400

Table 3. Appropriate Ecotype for Seeding/ Outplanting

Scientific Name	Common Name	strand	bluff	scrub	Rear ridges	Sand sheets	Maritime chaparral	paths
<i>Abronia latifolia</i>	yellow sand verbena	X	X		X			
<i>Abronia umbellata</i>	pink sand verbena			X				
<i>Achillea millefolium</i>	yarrow		X	X	X			
<i>Agoseris apargioides</i> var. <i>eastwoodiae</i>	Eastwood's agoseris	X						
<i>Ambrosia chamissonis</i>	beach burr	X		X	X	X		
<i>Armeria maritima</i>	sea thrift	X		X				
<i>Artemisia californica</i>	CA. Sagebrush						X	
<i>Artemisia pycnocephala</i>	sagewort	X	X	X	X	X		X
<i>Astragalus nuttallii</i>	rattleweed		X	X	X			
<i>Atriplex leucophylla</i>	saltbush	X						
<i>Baccharis pilularis</i>	coyote bush						X	
<i>Cakile maritima</i>	sea rocket				X	X		
<i>Calystegia soldanella</i>	beach morning glory	X						
<i>Camissonia cheiranthifolia</i>	beach primrose	X		X	X			X
<i>Cardionema ramossissimum</i>	sand mat			X				X
<i>Castilleja latifolia</i>	Indian paintbrush		X	X	X			
<i>Chorizanthe pungens</i> (FT)	Monterey spineflower	X		X				X
<i>Crassula connata</i>	sand pgymy							
<i>Croton californicus</i>	croton			X				
<i>Cryptantha leiocarpa</i>	coast cryptantha			X				
<i>Cupressus macrocarpa</i>	Monterey cypress							
<i>Dudleya caespitosa</i>	liveforever		X	X	X			
<i>Ericameria ericoides</i>	mock heather		X	X	X	X	X	
<i>Erigeron glaucus</i>	seaside daisy			X				
<i>Eriogonum latifolium</i>	coast buckwheat		X	X	X	X	X	X
<i>Eriogonum parvifolium</i>	dune buckwheat			X	X	X	X	X
<i>Erysimum ammophilum</i>	coast wallflower			X				
<i>Erysimum menziesii</i> ssp. <i>yadonii</i> (CE, FE)	Yadon's wallflower	X						
<i>Eriophyllum staechadifolium</i>	lizardtail		X	X	X	X		X
<i>Eschscholzia californica</i> var. <i>maritima</i>	CA. poppy	X	X	X				X
<i>Gilia tenuiflora</i> ssp. <i>arenaria</i> (CT, FE)	sand gilia			X				
<i>Heterotheca grandiflora</i>	telegraph weed							
<i>Lessingia filaginifolia</i>	CA. beach aster	X		X	X			X
<i>Leymus mollis</i>	American dune grass							
<i>Linaria canadensis</i>	blue toad-flax			X				
<i>Lotus scoparius</i>	deerweed			X		X		X
<i>Lupinus chamissonis</i>	silver beach lupine		X	X	X	X		X
<i>Phacelia ramosissima</i>	branching phacelia			X				X
<i>Poa douglasii</i>	sand dune bluegrass	X	X	X	X	X		X
<i>Polygonum paronychia</i>	knotweed			X	X	X		
TOTAL	Species							

Table 5. Multi-Year Budget

										MPRPD	Trust Fund
	Material	Quantity	Units	Notes	Cost	Hours	Rate	Cost	TOTAL	FY06-09	FY08-09
Project Plan				Report	\$10,000				\$10,000	\$5,000	
Construction Debris Removal		100	tons	crew + disposal		60	\$750		\$45,000		\$25,000
Sand Recontouring/ Augment		500	cy	Equip+Operator		40	\$100		\$4,000		\$1,400
Sand Stabilization	30 ac. highly disturbed + 20 ac. sand sheet + 12 ac. moderately disturbed										
Straw planting (by hand)	Straw	2000	lbs	3-acres	\$250	900	\$35	\$31,500	\$31,750	\$1,600	\$11,113
Straw crimping (by machine)	Straw	40000	lbs	20-acres	\$5,000	40	\$1,375	\$55,000	\$60,000		\$21,000
Hydroseeding	Hydroseed	150	lbs	10-acres	\$5,250	40	\$250	\$10,000	\$15,250		\$5,338
Drift fencing	Fencing	6000	ft	incl delivery	\$1,500	60	\$35	\$2,100	\$3,600	\$2,400	\$1,200
Protective Fencing	Fencing	3000	ft	incl delivery	\$16,000	60	\$80	\$4,800	\$20,800	\$1,000	\$7,280
Herbicide spraying	Chemical	incl	gal	62-acres	incl	440	\$80	\$35,200	\$35,200	\$10,000	\$12,320
Interpretive Signage	Sign/Kiosk	4	ea	Time/Material	\$10,000	24	\$60	\$1,440	\$11,440		\$4,004
Seed Collection	Seed	810	lbs	incl	incl	810	\$35	\$28,350	\$28,350		\$9,923
Propagation	Cells	65000	ea	1000/acre	\$65,000	400	\$35	incl	\$65,000	\$40,000	\$22,750
Broadcast seeding	Seed	760	lbs	40-acres	incl	76	\$35	\$2,660	\$2,660	\$1,200	\$931
Outplanting	Cells	45000	ea	45-acres	incl	1000	\$35	\$35,000	\$35,000	\$21,000	\$12,250
Irrigation	Unknown - Depends on Rainfall & Timing and could double planting costs										
Project Management	Contract					620	\$55	\$34,100	\$34,100	\$3,500	\$11,935
	Salaried					200	85	\$17,000	\$17,000	\$8,500	
Total Installation Costs	Less any Irrigation Costs and Contingencies								\$419,150	\$94,200	\$146,443
Annual monitoring & reporting				5-years		500	\$55	\$27,500	\$27,500		
Annual weed control	Chemical	incl	gal	5-years	incl	1100	\$80	\$88,000	\$88,000		
TOTAL from PROJECT ESTIMATE									\$534,650	\$94,200	\$146,443
TOTAL from DISTRICT and TRUST FUND									\$240,643		

Figure 1.

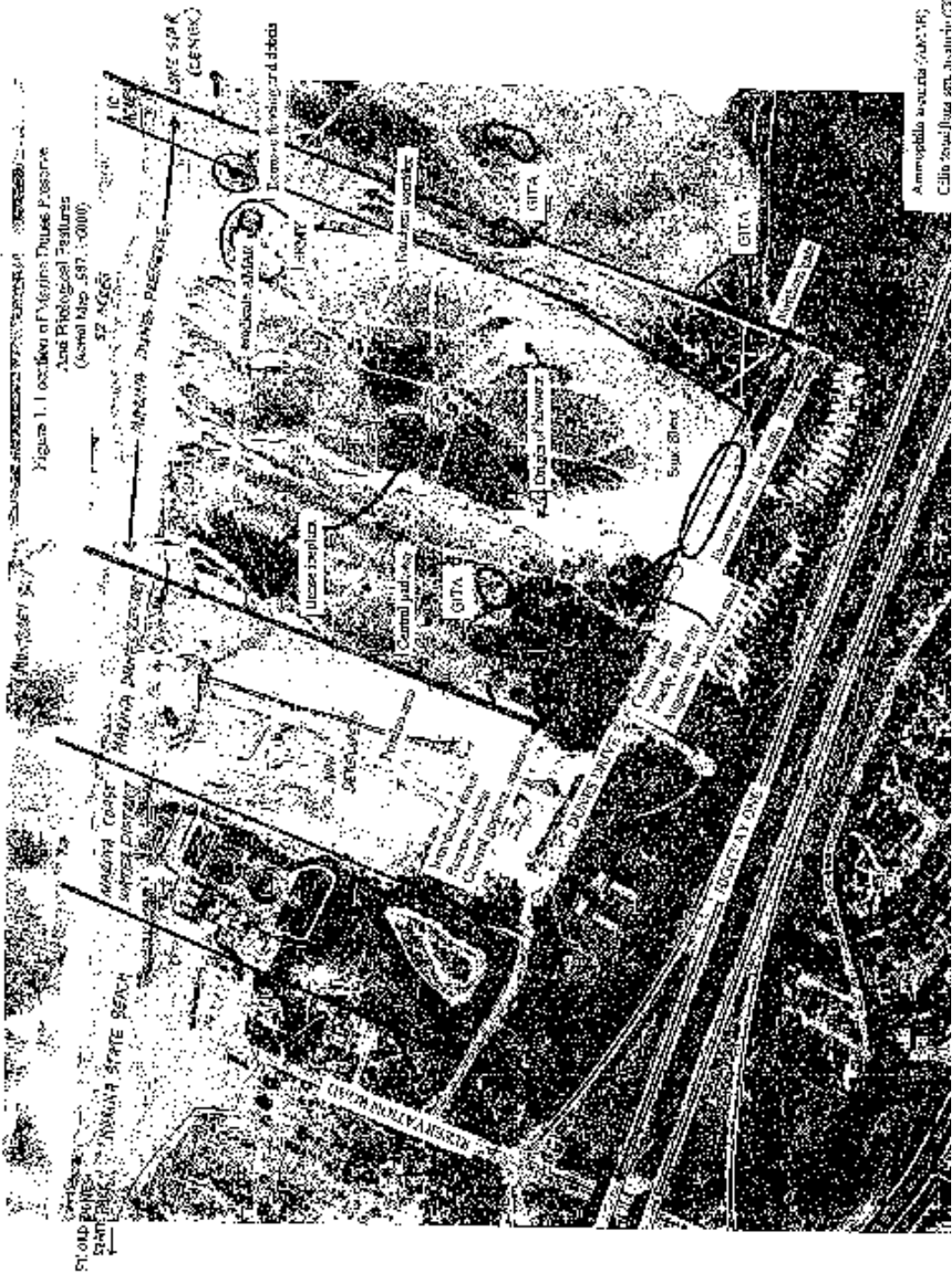


Figure 2. Plant Communities and Rare Species

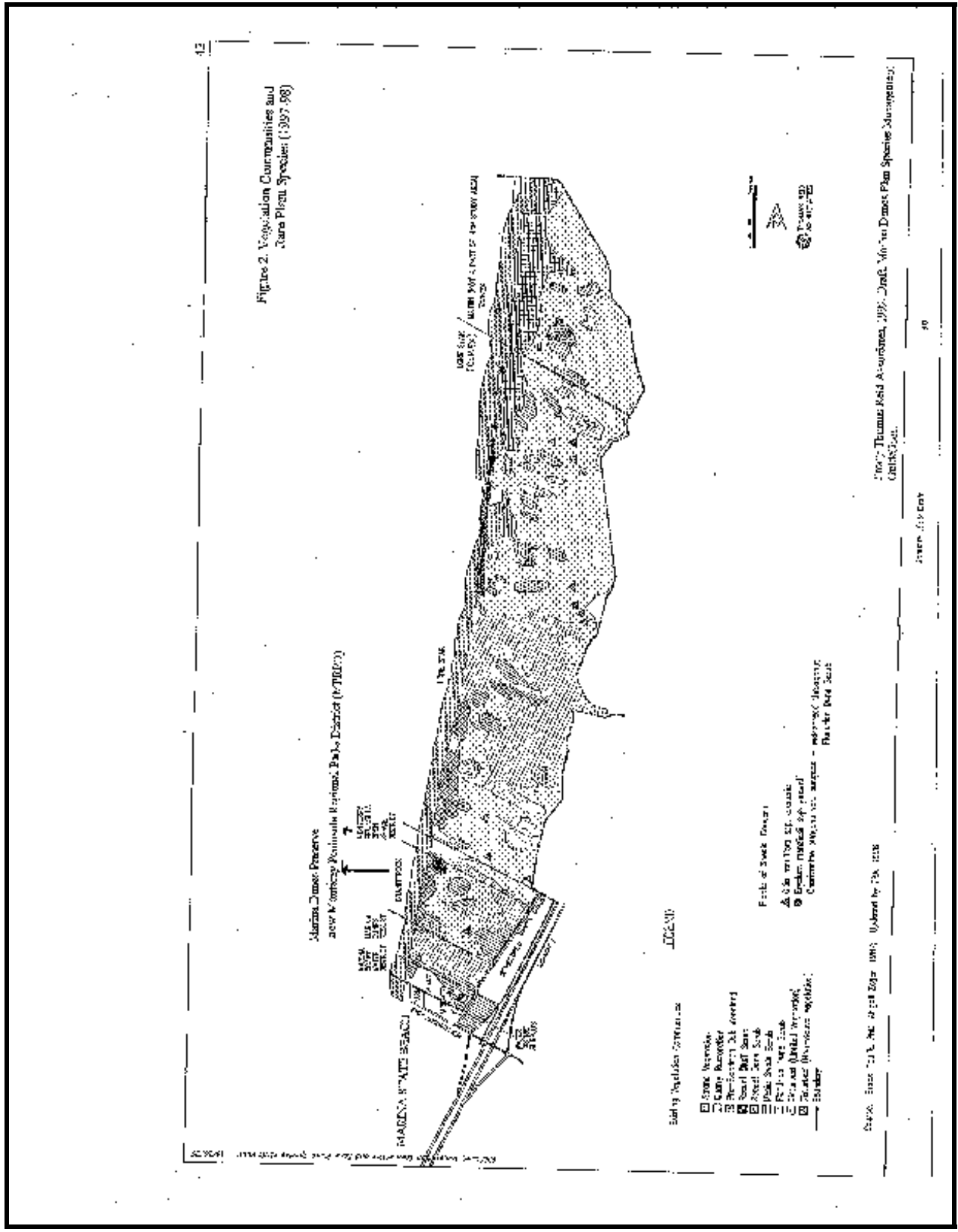


Figure 3. Smith's Blue Butterfly Habitat

Figure 3. Smith's Blue Butterfly Habitat
(1997 Data)

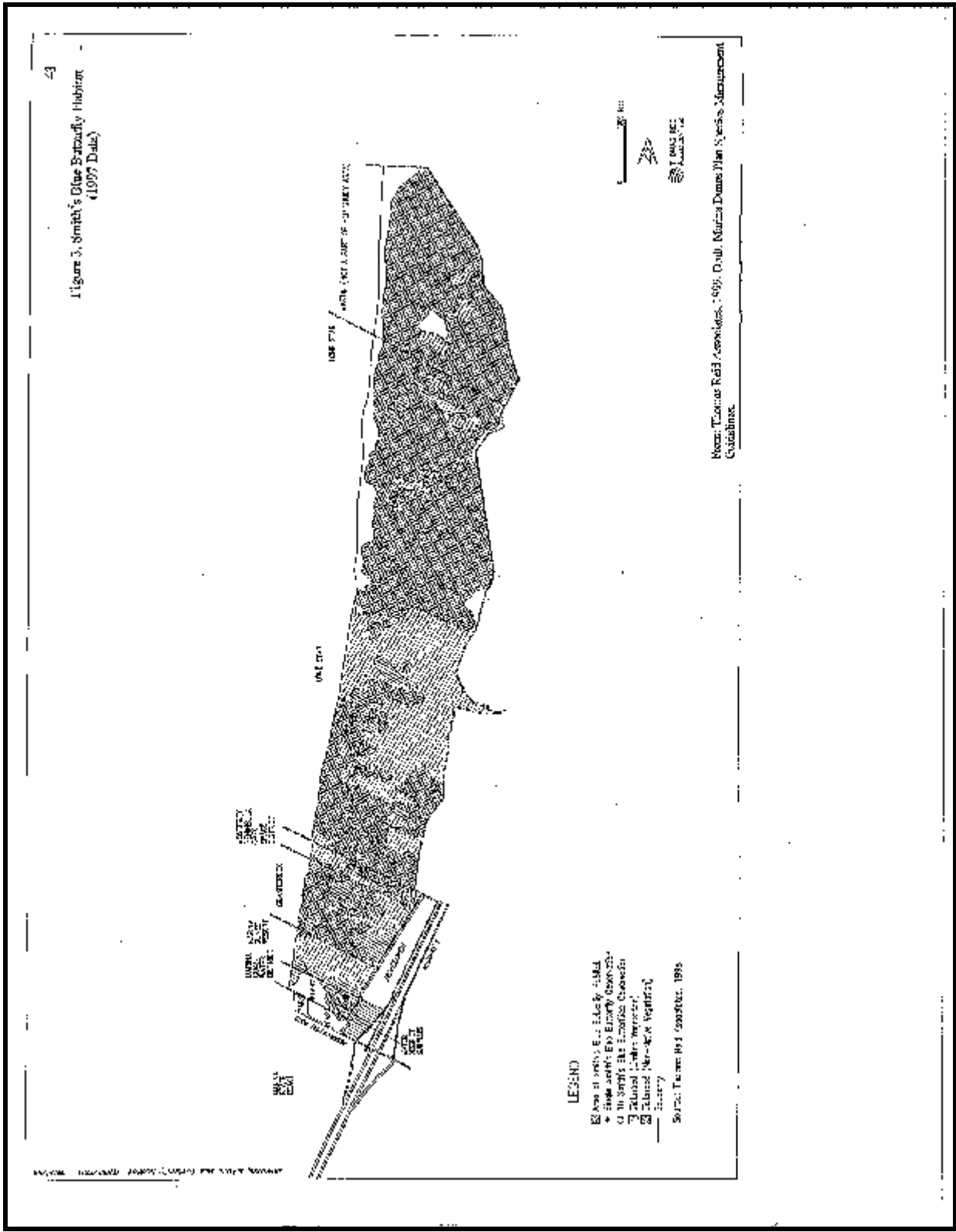
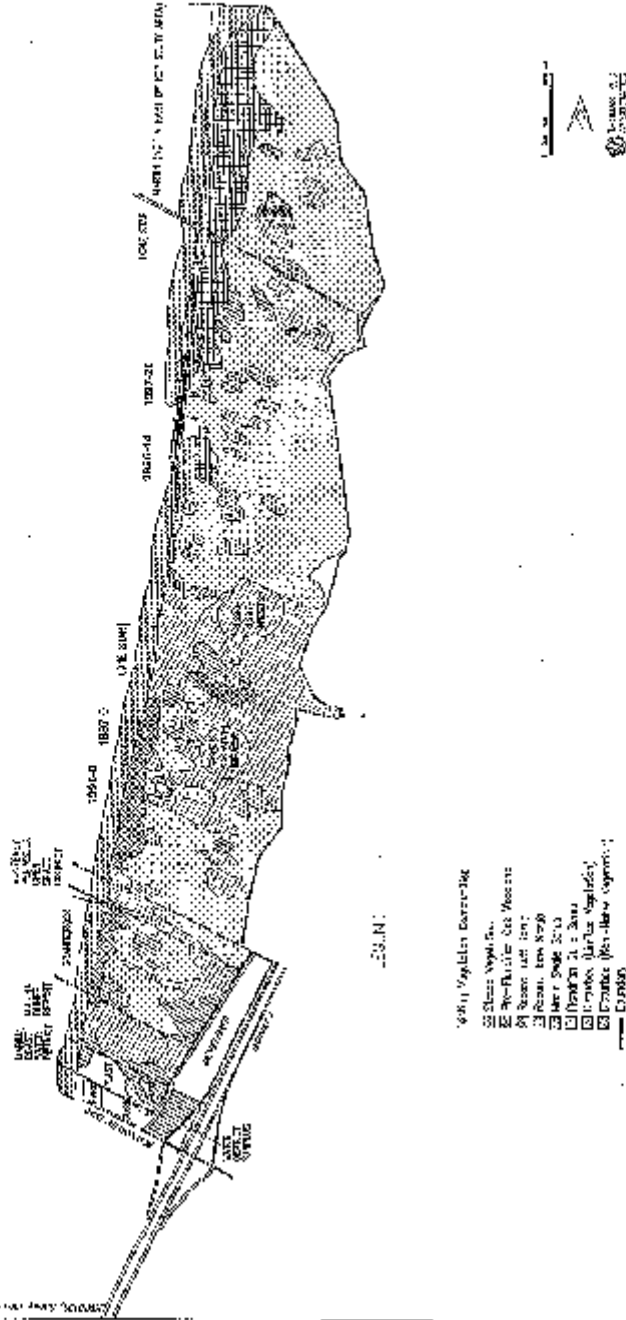


Figure 4. Black Legless Lizard Habitat

Figure 5. Snowy Plover Nesting Sites

Figure 5. Snowy Plover Nesting Sites
(1996-97 Data)



Source: University of California, Santa Cruz, Marine Invertebrate Research Group
 (1996-97 Data)

Scale: 1:25,000 (1 inch = 250 meters)

Figure 6. Stabilization and Treatment Areas

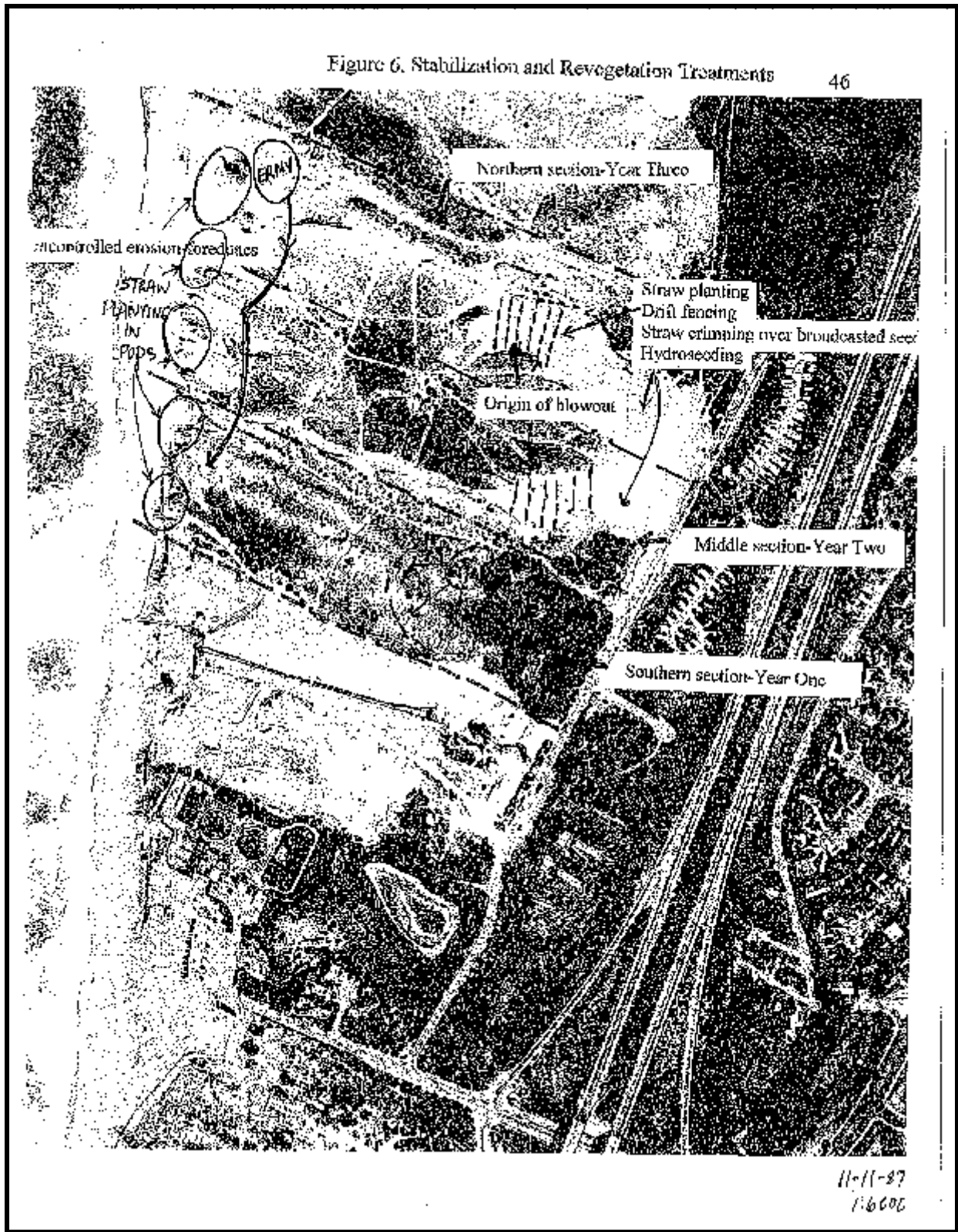


Figure 7. Fencing, Paths, and Signage

Figure 7. Fencing, Pathways and Signage

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