2010-2011

San Clemente Habitat Restoration & Stormwater Management Project: Annual Monitoring Report

Cheadle Center for Biodiversity & Ecological Restoration

University of California, Santa Barbara

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Executive Summary

The end of 2010-2011 growing season marks the completion of the 5th year in the implementation process of the San Clemente Habitat Restoration and Stormwater Management Project by the Cheadle Center for Biodiversity & Ecological Restoration (CCBER). The implementation phase of the project was due to be completed in the 5th year as stated in the San Clemente Habitat Restoration and Enhancement Plan (SCHREP) written by Morro Group (San Luis Obispo), and approved by the California Coastal Commission (CCC). All implementation and monitoring activities were carried out in accordance with this SCHREP.

In 2010-2011 additional grading occurred on site. CCBER staff used a small skip loader to enhance the existing wetland, one tarplant preservation area, and create one retention wetland. In total, 262 feet of existing wetland were enhanced adding an additional 3,111 square feet of vernal pool habitat to the site. One tarplant area was markedly improved by expanding short term flooding potential by 840 sqft and removing debris. These grading activities mark the completion of all grading activities that are due to occur on the site.

Revegetation of the entire San Clemente site was nearly completed in 2010-2011 with the exception of a few smaller areas and some plant fill in maintenance planned for the winter of 2011-2012. In all, 1 acre of the site was revegetated in 2010-2011. This effort included 64,650 plants comprising 88 different species planted in various habitat types, with 26,070 of them being Purple Needle Grass (*Nassella pulchra)*, representing the completion of our native grassland planting effort. Over 1,749 paid staff hours were utilized in direct planting efforts, while 888 staff hours were utilized preparing plant materials in the greenhouse. An additional 323 hours were utilized sourcing plant seeds in the local area that were then started in the CCBER greenhouse.

Although revegetation was a focus in 2010-2011, exotic weed control is always paramount in the long term sustainability of a restoration project into the future. CCBER staff successfully met the goals laid out in the SCHREP of limiting exotic weed cover to less than 10% of total cover with a total of approximately 5-7% exotic cover in 2010-2011. The exotic weed management approaches utilized in 2010-2011 were greatly reduced relative to previous years and were composed mostly of hand weeding efforts. The total exotic weed control effort in 2010-2011 was 1,147 paid staff hours.

The Southern Tarplant (*Centromadia parryi ssp. australis*) population rebounded nicely in 2010 and 2011 from a slight decline in 2009. All but one of the southern tarplant environmentally-sensitive habitat areas passed the approved performance standards based on the initial baseline conditions in 2005. Population totals in 2010 and 2011 increased to record levels in designated ESHA areas and exploded throughout the rest of the site. Environmental conditions and management strategies coalesced to create optimum conditions for recruitment and survival.

2011 marked the final year of a three year San Clemente bioswale networks stormwater quality improvement assessment. CCBER, working with other campus entities and students, successfully sampled all storm events in the 2010 and 2011 rain season. Results are encouraging and show a reduction of pollutants in the bioswale network over time and longitudinally through the system. CCBER is excited to release a full draft report on the results when full analysis is complete.

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1 INTRODUCTION

1.1 Site Description

The San Clemente graduate housing ecological restoration and stormwater management project occupies a seven-acre portion of an uplifted coastal mesa on the University of California, Santa Barbara campus in southern Santa Barbara County, California **(**Fig. 21, pg. 59**).** The project site lies approximately one half mile from the Pacific Ocean. The project site is characterized by a Mediterranean regional climate influenced by maritime winds and summer fog moisture, consistently mild air temperatures with little seasonal range, and variable rainfall mostly occurring in the months of November through April. Annual precipitation at a weather station in Santa Barbara averaged 45.2 cm for the period of 1867 to 1979 (Ferren and Thomas 1995). The two dominant soil types on the site are a fine beachwood loam and diablo clay formation (Fig. 22, pg. 60**).** Groundwater has been found under the site at varying depths ranging between 8 and 15 feet. Historically, the area was part of Rancho Los Dos Pueblos and was likely used for various forms of ranching activities such as grazing. Uses of the site after it was obtained from Rancho Los Dos Pueblos include the former location of Los Carneros road, which was moved to the west in the early 1970s, and following that, the area was largely used as a dump site for other construction activities elsewhere in the campus vicinity until restoration activities began in 2005. Prior to all previously mentioned historical activities, the site was home to one of many Chumash Native American villages that dotted the campus landscape and Goleta Slough area. Just to the north and west of the San Clemente site extended the most southwestern arm of Goleta Slough, which has now been fragmented into two remnant, diked saltmarshes known as Storke wetlands, which compose the next downstream portion of the watershed. It is the biologically rich slough habitat adjacent to the bountiful Pacific Ocean that likely attracted so many Chumash to the area.

At the start of the restoration project, non-native annual grasses and other exotic vegetation, interspersed with native shrubbery such as coyote brush (*Baccharis pilularis*) and quail bush (*Atriplex lentiformis*), dominated the site. During the rainy winter months, an existing wetland running almost the entire length of the site south to north, supports several native wetland plant species including California bull rush (*Schoenoplectus californicus*), common spikerush (*Eleocharis macrostachya*), and meadow barley (*Hordeum brachyantherum* ssp. *brachyantherum*). On the fringes of low lying wet areas on the site, especially along an abandoned section of old Los Carneros Road, the site's most notable native species, Southern Tarplant (*Centromadia parryi* ssp. *Australis*), is found. This species is listed by the California Native Plant Society (CNPS) as rare, threatened, or endangered in California and elsewhere but currently has no state or federal protection status. For a complete list of all native and non-native species voluntarily occurring on the site see (Tables 12 & 13, pgs. 48-49**).**

1.2 Project Description

The San Clemente ecological restoration project was a collaborative design effort that included landscape and civil architects, engineers, environmental consultants, planners, and biologists. The Cheadle Center for Biodiversity and Ecological Restoration (CCBER) at UCSB assisted with the design process by developing planting palettes, plant inventories, and the project timeline, as well as assisted with on-site plan alterations as needed for ecological success. CCBER is implementing all restoration activities on the project site.

Due to the project's close proximity to the coastline, it falls within the California coastal zone, and, hence, under the regulation of the California Coastal Act established in 1976. Section 30240 of the California Coastal Act states that "existing environmentally sensitive habitat areas shall be protected against any significant disruption of habitat values and that development in areas adjacent to significant habitat areas shall be sited and designed to prevent adverse effects which would degrade such areas."(CCC staff report) The California Coastal Commission and its staff are responsible for administering and ensuring compliance with the act and its regulations regarding coastal resources.

In addition to section 30240 of the coastal act, policy 30231.3 of the UCSB Campus Long Range Development Plan (LRDP) states that "areas surrounding wetlands shall be preserved as open space buffer." ('90 LRDP) As mentioned in the previous section, the San Clemente project site contains an existing wetland. This wetland's 100 foot buffer makes up the majority of the seven-acre area of the restoration project. The 100 foot buffer is consistent with the buffer area provided by most coastal commission decisions regarding wetland protection, and it is reflected in the campus LRDP policies. The San Clemente restoration site also contains a large bioswale system to improve stormwater runoff quality and reduce storm-related flows from the 11.5 acres of new housing and 3 acres of additional roadway from the widening of El Colegio road. This system occupies approximately one acre of the restoration site. As originally proposed, the system was to be constructed within the 100 foot buffer of the delineated wetland, disturbing approximately 1.1 acres of the buffer (or 47,000sq.ft.). A revised plan developed at the request of CCC staff was submitted by UCSB dated June 14, 2005. The plan relocated the entire system further west, reducing the impact on the buffer to approximately 9,000sqft. Due to this disturbance to the wetland buffer, special condition 7 of the CCC staff report requires that "all areas of the site within the 100 foot wetland buffer be restored and enhanced consistent with the habitat restoration plan" (CCC Staff Report). This was mandated to offset the impacts to the buffer from the creation of the stormwater management bioswale system (SMS), and such restoration is not usually required in buffers not impacted by development.

Another key aspect in the initiation of the restoration and conservation effort on the west end of the project site is the presence of a substantial Southern Tarplant population. As mentioned above, the species is CNPS listed, so portions of San Clemente were designated environmentally sensitive habitat areas (ESHA) by the coastal commission's biologist John Dixon. Section 30107.5 of the Coastal Act defines "environmentally sensitive habitat area (ESHA) as any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could easily be disturbed or degraded by human activities and developments" (Coastal Act '76). Areas of ESHA are typically given a minimum 50-foot buffer to protect sensitive plant species, such as Southern Tarplant (CCC Staff Report). The 50-foot buffer for the Tarplant at the project site has also been encroached upon by the SMS by approximately 30-40 feet; this impact is also accounted for by the restoration of the entire 100 foot buffer.

Special condition 7 (A) of the CCC staff report states that "prior to the commencement of development, the university shall submit for the review and approval of the executive director, a final restoration, enhancement and monitoring program prepared by a biologist or qualified environmental resource specialist in substantial conformance with the Habitat Restoration and Enhancement Plan (HREP)," prepared by Morro Group Inc. dated April, 20 2005. Morro group developed a final revised "Habitat Restoration and Enhancement Plan" per the CCC's request for the project dated August 12, 2005. The site also includes other stormwater management BMP's in addition to the one acre constructed vernal marsh mentioned above. Five smaller bioswales drain the surface parking lot on the Southwest end of the project, and one larger swale drains Storke Athletic field. A water quality management plan was written specific to the one acre storm water management system by Fuscoe Engineering and was dated August, 2005. This plan includes information and guidelines on project and site description, best management practices, and inspection and maintenance schedules.

2 RESTORATION ACTIVITIES

2.1 Grading and Construction '05-'08

Grading activities for the San Clemente Restoration Project began in September of 2005. Site topography grading followed the grading plans provided by Fuscoe Engineering (Irvine, Ca). The site was surveyed and delineated with markers and orange fencing by biologists with the Morro Group Inc. to highlight wetland perimeters and tarplant conservation areas so that they were properly avoided. The CCBER project managers, formerly Melanie Powers during year one and currently David Harris, act as environmental monitors for all construction and grading activities on the restoration site and are responsible to notify the Coastal Commission executive director if any breach in permit compliance occurs, if work outside scope of permit occurs, or if any unforeseen habitat issues arise (CCC Staff Report). These actions are consistent with special condition 3(3) of the CCC staff report. Heavy machinery and hand tools were used to excavate and shape all constructed wetland BMP features including the Stormwater Management System (SMS), parking lot bioswales, and the Storke recreation field drainage swale **(**Photos 4-6, pg. 84-85**).** After the BMP's were excavated, the CCBER staff used its own small skip loader and hand tools to adjust final shape and depth **(**Photo 19, pg. 92**).** This fine finish grading was completed by CCBER staff to achieve the proper flow pattern and retention time to allow for the maximum biofiltration efficiency possible given the lengths of swale available. Additionally, it was deemed by CCBER that the original SMS design was not adequate in terms of overall retention time and holding capacity to treat the amount of stormwater flow expected. The SMS was also deemed to be hydrologically insufficient to support wetland vegetation. The CCC was notified in writing by CCBER of its redesign wishes, and this document was accompanied by a letter of support from Fuscoe Engineering. Subsequently, a small redesign and grading effort was completed in the SMS by CCBER staff in conjunction with Damar construction, which created deeper holding basins and a small dam, which would provide adequate holding capacity for stormwater treatment and have complex water depth gradients for a more dynamic and diverse wetland plant community **(**Fig. 40, pg. 78**).** In the existing wetland buffer, heavy grading equipment, operated by contractors from Damar Construction (Ventura, CA) under the supervision of CCBER staff, was used to grade away the existing fill pile topography of the existing wetland buffer, leaving behind a smooth rolling landscape that is much closer to the undisturbed historical condition.

2.1.1 <u>Grading and Construction 2009</u>

As mentioned in the grading and construction section for 2005 through 2008, many of the stormwater BMPs on the restoration site were considered under-designed. This was also the case for the Storke recreation field drainage swale. Storke field is a multipurpose grass (Kikuyu/Bermuda grass) sports field approximately 14 acres in area. The entire field is graded to drain at its northwestern end, where it enters the San Clemente restoration site's 100 foot existing wetland buffer. The swale then flows through the northeastern corner of the restoration site and exits under the access road noted in section 5.2.1 of this document. With the field's relatively large size and drainage pattern, the swale, as constructed in 2005 by ProWest constructors per SCHREP, was easily overwhelmed by even modest rain events (Morro). The shallow swale was not able to contain the flows, so they merged with runoff exiting the SMS systems drainage swale and overwhelmed the drainage system. The combination of these large flows and the bottle neck created by the existence of the access road creates a precarious flooding hazard.

Aware of this issue, along with the great potential for wetland habitat creation and stormwater quality improvement, the swale was redesigned. The existing swale, as graded in 2005, had a volume of approximately 20 cubic feet, but was extremely shallow and, thus, did a poor job of conveying water. The redesign effort was carried out in the month of October by the San Clemente restoration staff using a small skip loader. The redesign effort aimed to increase the swale's retention volume for stormwater quality improvement and increase the swale's conveyance capacity so that it would no longer join with runoff exiting the SMS. This was completed by expanding the upstream half of the swale to create a large pooling area with a maximum depth of 2 feet and a total treatment volume of approximately 5000 cubic feet. A heterogeneous topography was incorporated into the pool area utilizing varied slope angles, underwater shelves, and bottom contours to increase wetland biological diversity and to enhance its natural aesthetic appeal. (Photos 23-25, pgs. 94-95)

The next phase of the redesign was the lower end of the field drainage swale where water was able to jump its bank and mix with the water of the SMS drainage swale to the west. In previous years when runoff did leave this portion of swale mixing with SMS runoff, it cut an erosion gully. Since the majority of this portion of the swale was already planted in 2006, it was decided that rather than re-grade the whole swale, the erosion gully would remain in place with a few minor adjustments to its shape, and a subtle berm would be constructed acting to keep the flows separate. This change has been effective at steering the overflow through the proper drainage pipes. With this effort we have, in effect, doubled our length of bioswale ending up with a braided bioswale network draining the large pool constructed at the top of the swale.

In 2009, San Clemente restoration staff also completed the fifth and final parking lot bioswale, which delivers water to the existing wetland on site (Photos 19-21, pgs. 92-93). Grading occurred in June of 2009 and lasted one week. The swale incorporates two curb cuts entering from the Western portion of the parking lot. The swale has a total length of 73 feet and contains 3 small pooling areas for stormwater treatment and wetland vegetation establishment.

2.1.2 Grading 2010-2011

Grading in 2010 and early 2011 was minimal, as much of the topographic alterations were completed in previous years. A few final alterations to the site's topography were identified by CCBER staff and completed since 2009. Grading efforts included the enhancement of the existing linear wetland in three locations, the enhancement of tarplant area P3, and the creation of one small retention wetland. Most adjustments were made to improve wetland functionality and increase capacity. Excavated soils were not exported and were, instead, used to create topographical features on site.

The existing wetland can be divided into two distinct sections. The first is of high quality composed of a native vernal pool and marsh located at the head of the wetland network. This portion can be seen on aerial imagery from 1928 and is a remnant of a much more extensive wetland system. This more extensive wetland was bisected shortly after 1928 by the building of Los Carneros road directly on its current western edge. This caused water, which would normally flow into a larger expanse of wetlands to the west, to take an immediate right turn to the north along the east side of the new road. This, in essence, created the second, linear portion of the wetland we have today. This new portion of wetland sustained a hydrology sufficient to support mostly non-native facultative-wet wetland species with a few scattered native obligates. The main reason for this was not a lack of water to the wetland area, but a lack of retention time in a basin that was really no more than a road side ditch. Fortunately, the topography surrounding the wetland allowed for relatively easy improvement. These improvements increased retention time and area of inundation of the wetland sections, and they allowed for the expansion of the site's vernal pool habitat. This new vernal pool network's central location within the site provides a dramatic contribution to the entire site's ecological functionality, as evidenced by the use of it by multiple trophic levels. In all, a length of 262 ft of marginal wetland was converted to a network of vernal pools comprising 3,111 sf. (Photos 26-36, pgs. 95-100).

Secondly, a portion of tarplant area P3 was restructured. The northern section of P3 had many historic tire ruts and a large amount of road base at the surface that weren't exactly prohibiting the area from functioning for tarplant, but were definitely decreasing its quality as habitat for the species. It was also recognized that during larger storms a large amount of runoff originating from the existing wetland flowed through P3. This runoff could instead be harnessed to improve its function as tarplant habitat. In early 2011, CCBER completed the redesign which involved removing the road base and tire ruts and replacing them with a shallow basin that would hold more water in the rainy season. During these changes there was also a large amount of asphalt discovered from old Los Carneros road, some of which was removed. (Photos 37-39, pgs. 101-102)

2.2 Erosion Control '06-'08

Special condition 5 (5) of the CCC staff report requires that erosion prone areas have adequate erosion-control materials installed to prevent sedimentation of BMPs and downstream sensitive resources such as the Storke wetland complex and Goleta Slough. It also requires that these materials be checked, maintained, and regularly replaced (CCC Staff Report). After the grading was complete in the Summer of 2006, jute netting, coconut netting, rock check dams, hay bales, and straw wattle were used to effectively control sedimentation and soil erosion in all BMPs and on steep slopes during the first year of the project **(**Photos 9 & 11, pgs. 87-88**).** During all subsequent storm events, CCBER staff monitored potential erosion locations on-site and rectified any erosion control failures. As the CCBER staff monitored water flow on site throughout the winter, additional small drainage channels, sand bags, and rock check dams were strategically placed to better manage potentially erosion-prone areas. In October of 2007, the above mentioned regrade of the SMS took place, and the new contours were also protected with additional erosion control materials. Preventative measures, active monitoring, and adaptive management have successfully reduced erosion on the majority of the site with one exception. The "field drainage" bioswale that drains the entire flow from the remaining 12.4 acres of Storke athletic field and its western field extension (1.6 acres) was not adequately protected from erosion. Right before the last storm event of the year, the western field extension had been fertilized but had not yet been sodded. This storm took a large amount of this high nutrient sediment off of the field extension and deposited it in the field drainage. Between 6 to 12 inches of sediment accumulated in the swale. Fortunately, the upper, deeper portion of the swale captured the largest sediment load. The swale is to be redesigned as soon as possible pending approval from the Coastal Commission and UCSB officials. This should effectively eliminate the above stated impacts.

2.2.1 Erosion Control 2009

In 2009, erosion control was carried out in the new field drainage swale and the new parking lot swale. All exposed slopes were covered in 3,000 square feet of coconut netting. After applying the netting, the restoration staff laid down approximately 2,900 square feet of mulch over the netting to further reduce erosion and help establish conditions conducive to native vegetation. Three large check dams were added in the upper portion of the redesigned field drainage on the slope leading into the swale from the recreational field and two check dams were added to the parking lot swale. Since these efforts took place, we have received two large storm events and the system's held up very well. CCBER restoration staff continues to conduct detailed inspections of all wetland BMPs to ensure their proper performance and integrity before, during, and after storm events.

2.2.2 Erosion Control 2010-2011

In 2010, a minimal amount of erosion control activities were carried out because much of the site's slopes and other erosion prone areas have been stabilized by native vegetation.

The erosion control activities that were carried out included coconut netting the enhanced existing wetland sections and adding one substantial check dam at the inlet of the northern-most enhancement area.

2.3 Exotic Weed Control '06-'08

Exotic weed control on the San Clemente Ecological Restoration site represents the largest change in CCBER restoration methodology as compared to previous mitigation projects performed by CCBER. It was decided at the project's conception that instead of planting large swaths of area upfront with native vegetation, we would concentrate more on large-scale weeding efforts (grow kills) in attempt to deplete the existing non-native seed bank. These larger scale efforts include solarization (using black plastic), tilling of the soil, and frequent mowing cycles. Solarization is the most effective form of large scale weed control utilized at San Clemente to this point **(**Photo 46, pg. 105**).** It is especially effective over erosion control materials like coconut netting because it does not cause the damage to them that other methods do. Solarization involves laying 6mm 100x20 ft^2 strips of black plastic over areas of exotic vegetation. The plastic subjects plants to high temperatures and prohibits photosynthesis. It has also been suggested that if it becomes hot enough, the seed bank underneath may be sterilized, but we have no evidence of this thus far. Other than killing the above ground vegetation, the plastic covering has been observed to support many species of invertebrates, reptiles, and small mammals for the duration that it is applied. Upon its removal, the resident bird fauna in the area, including western bluebird, western kingbird, black phoebe, and crows feast on the insect smorgasbord. Solarization has proven effective for all species targeted with the exception of rhizomatous or extremely large-rooted species such as Bermuda grass (*Cynodon dactylon*) or Fennel (*Foeniculum vulgare*). This property has actually enabled the spread of native rhizomatous species such as common spike rush along wetland margins**.** Annual invasive species are killed and native species return with vigor, free from competition.

Tilling with CCBER's small skip loader has also proven very effective in larger areas **(**Photo 48, pg. 106). It has been effective on all target exotics as long as enough of the below-ground root material is exposed in the process. An interesting benefit of this activity is that the rare Southern Tarplant that we are trying to preserve and promote is a disturbance follower, and its populations have exploded on site as compared to initial project surveys after such disturbance. Another benefactor of this regulated disturbance is the local killdeer population, which is an open ground nester. They have readily taken to this disturbance, and we had one successful hatching of three chicks on site last year. In the current year, additional nesting activity has been on going, and at least four clutches have hatched with three to four young per nest (Photo 61, pg. 113**).**

Consecutive mowing have also proven extremely effective in keeping back aggressive seeders like annual grasses, black mustard (*Brassica nigra*), and wild radish (*Raphanus sativa*) (Photos 42 & 44, pgs. 103-104**).** This is largely used as a postponement technique to keep seeds down while black plastic or hand-weeding crews are rotated around the site for the final kill off. It is estimated that in annual grasses between 5-25% of those mowed are killed depending on site conditions at the time of mowing. It appears that dryer conditions and waiting for seed to develop before mowing pushes us towards the top end of that estimate. These methods have been effective and produce a clear decline in exotic plant densities in areas where continuous grow kills have taken place. It can also be safely said that these methods are far more economical and time efficient than hand weeding. Once large numbers of natives are planted, large scale exotic weed control must be replaced with very careful use of hand tools.

Another interesting method CCBER has employed on site is flame weeding. Flame weeding involves using a torch-like instrument fueled by a small propane tank, and it is useful on exotic seedlings no larger than about 2 inches. Due to the fact a small flame is used in the process, it may also stimulate the germination of known fire followers such as red maids (*Calandrinia ciliata*), which have been volunteering at the restoration site. At this time though, their presence and this technique cannot be directly correlated.

In areas that have been planted to date, we are employing hand weeding methods with a variety of hand tools (Photo 41, pg. 103**).** These include three types of hula hoes, various shovels, hand weeders, a weed wrench, and hand clippers among others. These methods are very time-consuming compared to the large scale efforts but are the most benign environmentally, and they are much more discriminatory.

When all of the previously mentioned methods fail, which can happen with some real problem species such as Bermuda grass (*Cynodon dactylon*), fennel (*Foeniculum vulgare*), and bindweed (*Convolvulus arvensis*), herbicide is applied. Herbicide is always applied by a formally trained and certified CCBER technician. On all CCBER projects, the health of the ecosystem is paramount. With this in mind, we have researched all herbicide products and methods meticulously and have chosen a product that has proven both effective and safe. Aquamaster™ is an EPA approved herbicide that is safe even for wetland application (*CCBER never applies herbicide in wetlands regardless of the product*). Aquamaster™ does not include the chemical surfactant that most other damaging herbicides contain. The surfactant contained in many herbicides is harmful to amphibians. However we have a thriving population of Pacific Chorus Frog in our flooded areas on site. Regardless of the safety of the product employed, CCBER uses the utmost precaution in application methods as well. The product is applied only in the drier portions of the year (to eliminate any runoff), is never applied under windy conditions (to eliminate drift), and is only applied directly to the target species. Minimal volumes and concentrations are always utilized to complete the objective. Since Aquamaster™ is only applied to a very few problem species we expect its use to be discontinued completely within the next year. On the San Clemente project site nearly three quarters of an acre of thick fennel have been successfully eradicated from the site with this precision method of herbicide application.

In summary, the exotic weed management of the 2007 and 2008 growing season was a complete success. The habitat restoration plan mandates that exotic weed species be reduced to a level below 10% of the total project area, and that has been achieved for the first two growing seasons. Of course, because we are dealing largely with annual populations of exotics, we expect to see their return in the 2009 season, and CCBER will document any change in the overall exotic species composition or change in the seed bank.

2.3.1 Exotic Weed Control 2009

In the 2009 growing season, CCBER's San Clemente restoration staff spent approximately 1,902 hours on exotic weed control activities and met the objectives laid out in the SCHREP as approved by the CCC regarding exotic plant cover. The SCHREP mandates that exotic weeds compose no more than 10% of total cover on site and exotic cover was reduced to approximately 3-5% in 2009. This was accomplished by the use of a broad array of eradication methods detailed in section 2.3 of this report. A map depicting the methods used and where they were used on site was created using ArcGIS (Fig. 36, pg. 74). Accompanying this map is a baseline vegetation map for the 2009 growing season depicting what was present on site both native and non-native before weed eradication methods took place (Fig. 26, pg. 64). Through the comparison of these new maps and their older versions, a succession of our restoration efforts and how the vegetation has evolved on site may be seen.

As mentioned previously the San Clemente restoration site has a few problematic species, which generally only respond to herbicide treatment. These include Bermuda grass (*Cynodon dactylon*), fennel (*Foeniculum vulgare*), and bindweed (*Convolvulus arvensis*). As of 2009, the only species under full control is Fennel which has been completely eradicated except for occasional new recruits. In the 2009 growing season, the San Clemente restoration staff worked diligently to control the other two exotic species listed. Good results were witnessed, but more work is needed. Their eradication will be a focus of 2010. Currently, Bermuda grass alone occupies about 70% of the total cover in our tarplant protection areas. Monitoring of the tarplant areas does not adequately show this high cover because monitoring transects are only a cross section of the total cover present and may repeatedly miss the dominant patches. A plan has been developed to try and address the presence of Bermuda grass. Restoration staff will first remove all viable tarplant seed from the area and store it. Then they will lay black plastic down for two months to kill all non-native annuals and stress out the Bermuda grass. (Amazingly, this length of solarization will not kill the Bermuda grass.) Following this, all the above-ground portions of the plant will be destroyed, but it will re-sprout from its rhizomes. At this time we will spray it with Aquamaster™ and attempt to permanently eliminate it. It is our hope that this procedure will reduce the total amount of herbicide needed to eradicate the species. Following herbicide application, we will redistribute the tarplant seed in the late winter rains so that it may be successfully established again, free of Bermuda grass.

2.3.2 Exotic Weed Control 2010-2011

In the 2010-2011 growing season, CCBER staff spent approximately 1,147 hours on exotic weed control activities. Now that much of the site is planted in native cover, exotic weed control activities are predominantly accomplished through various types of hand weeding using hand weeders, hula hoes, shovels, and other hand tools. The methods used and how they were distributed over the site can be referenced in our exotic weed control map for 2010 (Fig. 37, pg. 75). At the end of the weeding season, exotics once again have been reduced to less than 10% of total plant cover on the site.

The use of large scale weed eradication techniques upfront has proven to be effective over the long term with a clearly visible reduction in exotic cover. For example, where once one may have seen nearly 100% exotic cover by a single species, the species now only occupies the area sparsely. These areas were then planted with natives, which were allowed to flourish with less competition. Also, the highly labor-intensive act of maintenance through hand weeding was reduced substantially. It is important to note that continued exotic weed maintenance is paramount to the project’s long term success because weeds can quickly re-colonize areas of open space that have yet to be filled in with native plants.

Sporadic spraying of Aquamaster™ has also been ongoing as needed for the problematic species listed in above sections. A total of 8 hours were spent spraying by CCBER staff in the past year.

2.4 Revegetation ’06-‘08

As mentioned above, CCBER is taking a “weed heavy upfront” approach to the San Clemente Ecological Restoration Project, but a few areas have been planted and are currently thriving. At the time of this report, CCBER had planted approximately one and a quarter acres of the site with over 17,500 plants. This number does not include direct seeding efforts or naturally occurring volunteers. These plantings included oak woodland (0.42ac)species such as coast live oak (*Quercus agrifolia*), fuchsia-flowered gooseberry (*Ribes speciosum*), Plummer’s Baccharis (*Baccharis plummerae*), and California fuchsia (*Epilobium canum* ssp. *canum*) just to name a few (Photos 59-60, pg. 112) The constructed wetland BMPs are next on the list, while three out of five parking lot bioswales (2058sq.ft.), two other large bioswales (5491sq.ft.), and portions of the storm water management system (0.39ac) have already been completed (Photos 2, 8, 10, 12-16, pgs. 83, 86-90**).** Species in these areas include various sedges (*Schoenoplectus* sp., *Eleocharis* sp., and *Carex* sp.) and rushes (*Juncus* sp.), among other freshwater wetland inhabitants like Yerba Mansa (*Anemopsis californica*) and willow dock (*Rumex salicifolius*). Many of the directly adjacent uplands were planted and seeded with native plants and seeds such as Owl’s clover (*Castilleja densiflora*), meadow barley (*Hordeum brachyantherum* ssp. *brachyantherum*), and blue eyed grass (*Sisyrinchium bellum*). Upland of the existing wetland is a very special community known as vernal meadow (Photos 57 & 58, pg. 111**).** Planting efforts include species such as purple needle grass (*Nassella pulchra*) the California state grass, California poppy (*Eschscholzia californica* var. *californica*) the California state flower, meadow barley (*Hordeum brachyantherum* ssp. *californicum*), and red maids (*Calandrinia ciliata*). Many of the large tree species planned for the site have also already been planted due to the fact that they take the longest amount of time to mature. Some of these species include western sycamore (*Platanus racemosa*), coast live oak (*Quercus agrifolia*), and black cottonwood (*Populus balsamifera* ssp. *trichocarpa*).

Locally native plant species are defined for this project as species naturally occurring within a fifteen-mile radius of Goleta, CA. When plant materials such as seed are collected, it is done so at the closest known source for each individual species within that 15 mile radius. The sources used for collection are typically open spaces and parks in the local area that have substantial naturally occurring (not restored) populations of natives. Many of these sites are under constant threat of development, so their specific genotypes will be preserved in perpetuity on the San Clemente site and on other CCBER sites. A list of these sources will not be provided in this report due to their sensitive nature, but records are kept for future study. Seed collection procedures are taken seriously due to concern for local genotype issues. The standards followed were developed by the California Native Plant Society and are strictly adhered to. All native plants for the project were organically grown using compost produced with the exotic vegetation removed from the project site. All growing, composting, and other plant propagation activities take place at the CCBER native plant nursery and greenhouse, located on the UCSB campus.

2.4.1 <u>Revegetation 2009</u>

In 2009 San Clemente's restoration staff focused on the entire site's revegetation with native plant species. In total, 4.06 acres of the site have been planted and seeded, totaling 51,705 plants representing 88 native species. The approximate time spent by the staff on revegetation efforts in 2009 was 938 hours. Areas planted included the remainder of the SMS, two parking lot bioswales, portions of the vernal meadow, the entire existing wetland edge, additional sections of oak woodland, and approximately one fourth of the grassland. A total of 1.51 acres of vernal marsh, 0.72 acres of grassland, 0.62 acres of coast sage scrub, 0.5 acres of oak woodland, 0.36 acres of tarplant area, 0.18 acres of bioswale, and 0.07 acres of riparian vegetation have been planted as of 2009. These figures do not include 0.7 acres of tarplant preservation areas and existing wetland in which plant communities are already established.

The planting plan for the field drainage swale covers both high and low marsh areas in the upper pool, a riparian transition zone on the banks, and a braided bioswale portion of the swale. The low marsh will contain taller emergent wetland species such as California Bulrush (*Schoenoplectus californicus*), Olney's Bulrush (*Schoenoplectus americanus*), and Three-square Rush (*Schoenoplectus pungens*). The high marsh zone will contain high diversity, including species such as Yerba Mansa (*Anemopsis californica*), Basket Rush (*Juncus textilis*), Bog Rush (*J. effusus*), Brown Headed Rush (*J. phaeocephalus*), and Common Spike Rush (*Eleocharis macrostachya*).

The riparian transition zone includes the banks of the entire field drainage and the lower braided portion of bioswale. It is CCBER's goal to develop a robust riparian habitat here not only to buffer the field swale, but to act as a buffer and shade producer for the section of oak woodland habitat falling directly to the north of the swale. Due to the high volume of water entering the swale and its high nutrient load, it is believed that riparian vegetation, especially trees such as black cottonwood (*Populus balsamifera ssp. trichocarpa*), Western Sycamore (*Platanus racemosa*), White Alder (*Alnus rhombifolia*), Box Elder (*Acer negundo*), and Willow species (*Salix sp.*), will grow vigorously here. These trees will soon begin to cast shade upon the woodland areas directly north. A mix of perennial and annual riparian shrubs and forbs will also be established here to increase overall diversity and quality of habitat.

The last of our parking lot swales were planted this season, and we incorporated two different planting themes. The short swale furthest to the east was planted with mostly a wet meadow mix. This was chosen because species characteristic of this type of community were already present on site in this location including Blue Eyed Grass (*Sisyrinchium bellum*), Meadow barley (*Hordeum brachyantherum ssp. californicum*), and Purple Owl's Clover (*Castilleja exserta*). The farthest west swale has a meandering creek-like design with three modest pools on the outside bends and is fed by two curb cut drains from the parking lot. The planting scheme for this is more representative of what one might find in local creek habitats. The palette here includes Small-Fruited Bulrush (*Scirpus microcarpus*), Bog Rush (*Juncus effusus*), Iris-Leaved Rush (*Juncus xiphioides*), California Wild Rose *(Rosa californica*), Giant Creek Nettle (*Urtica dioica*), and Mule fat (*Baccharis salicifolia*).

So far, 0.72 acres of grassland has been planted. In that 0.72 acres, a total of 26,070 *Nassella pulchra* individuals were planted. This high density is to ensure a dominant presence of our California state grass, and also is intended to help crowd out non native annual grasses. The exact density of planting ranges from 6 inches to 1 foot for Nassella, and the spaces in between are being generously seeded with native wild flowers including Red Maids (*Calandrinia ciliata*), Golden Stars (*Bloomeria crocea*), Blue Dicks (*Dichelostemma capitatum*), Shooting Stars (*Dodecatheon clevelandii*), and various lupine species.(*Lupinus* sp.) Interestingly, we have had the best establishment results when planting in the spring through the summer with the use of irrigation rather than in the typical winter planting season. The reason is that during summer most plant species are doing quite a bit of growing, while annual germination is non-existent. This is largely due to the lack of rainfall and high temperatures. The advantage here is that we can plant and grow the Nassella to a robust size with irrigation without having to contend with large scale weed germination at the same time. By the time the weed season comes around our grasses already dominate the landscape. Conversely, when we plant in the rainy season the weeds are in full germination mode and the native grasses are quickly swamped by exotic annuals, meaning that we have to hand weed our high density planting while they are very fragile and young, which results in a significant loss of Nassella. I would recommend this sort of strategy with grass planting efforts if irrigation is available.

2.4.2 Revegetation 2010-2011

In 2010-2011, CCBER continued to focus on revegetation efforts. In all, CCBER staff spent 1,749 hours planting 1 acre of area. Approximately 64,650 plants were installed in grassland, riparian, coast sage scrub, and wetland habitats (Fig. 34, pg. 72). These numbers show a marked increase in planting density from the previous year. Grassland planting often required up to 12 times more plants per square meter compared to scrub or wetland planting. This is largely due to differences in propagation tendencies between community types. Many wetland plants will quickly spread vegetatively, while bunch grasses require significant seedling recruitment and considerably more time to fill the same area. Grassland sections were, therefore, planted more densely to accelerate establishment of the community. To view the corresponding plant palettes for these differing habitat types see the planting by habitat type table in section 6.0 (Table 14, pgs. 51).

The three enhanced portions of the existing wetland totaling 3,111 sqft were planted with a plant suite characteristic of vernal pools. This palette included Common Spike Rush (*Eleocharis macrostachya*), Parish's Spike Rush (*Eleocharis parishii*), Field Sedge (*Carex praegracilis*), Yerba Mansa (*Anemopsis californica*), and Meadow Barley (*Hordeum brachyantherum ssp. brachyantherum*). 211 cups of vernal pool inoculum was also applied to the newly enhanced vernal pool areas as well. The inoculum material was collected from four different vernal pools in the immediate area, three of which were restored and one naturally occurring. Inoculum was collected once the pools had completely dried out and all plants had gone to seed. Inoculum was taken by scraping one foot square patches of soil and plant material with a garden hoe. Inoculum was harvested from both the inner and outer rings of the pools and labeled as such because very different suites of plant materials and organisms may be found in each. The inoculum was spread evenly throughout the pools in the respective rings according to surveyed elevations and coconut net was applied over the top to help bind the seed and provide erosion control. Coyote Thistle (*Eryngium vaseyi*), and Dwarf Woolly-Heads (*Psilocarphus brevissimus*) have already germinated in the pools.

The created retention wetland and its surrounding transitional habitat totaling 256 sqft were planted in 2010 and also contain a suite of vernal pool plants within the basin as well as a broad array of low growing forbs and grasses in the transitional zones. Plants include Purple Needle Grass (*Nassella pulchra),* Meadow Barley (*Hordeum brachyantherum ssp. brachyantherum*), Wishbone Bush (*Mirabilis californica*), Common Checkerbloom (*Sidalcea malviflora),* and California Buttercup (*Ranunculus californicus).* The low growing, showier palette was selected because it is a highly visible portion of the site and will be the location of the southern tarplant interpretive sign.

The field drain, which was planted in 2009, had to be replanted in early 2011. The reason this had to be done was a high rate of mortality in the plants installed there in 2009. The high rate of mortality was due predominantly to the heavy clay soils, which became saturated in the rainy season and drowned the plants. During the second planting in 2011, a suite of plants was chosen that would be able to better withstand the conditions presented by the heavy clay soils. Some of the plants included were California Wild Rose (*Rosa californica*), Creek Dogwood (*Cornus sericea*), Common Aster (*Symphyotrichum chilense*), Common Rush (*Juncus patens*), and Mugwort (*Artemisia douglasiana*). In all, 0.02 acres were replanted.

To signify one of the last chapters in the active San Clemente restoration effort, our storage area of five years was dismantled and removed. This effort involved renting a crane to remove the large shed container, which had to be lifted over the permanent fence line. Following this, the area was mulched and planted with an oak woodland palette of vegetation. (Photo 40, pg. 102)

2.5 Southern Tarplant Mitigation

Southern Tarplant (*Centromadia parryi* ssp. *Australis*) is a special-status plant species listed by the California Native Plant Society as rare, threatened, or endangered in California or elsewhere. Southern Tarplant is an annual herb occurring mainly on the margins of marshes and swamps and within valley and foothill annual grassland habitats that contain vernal pools. It ranges from Point Conception to Baja California (Photo 50, pg. 107**)** (CCC Staff Report). A biological survey of the project site was conducted by Morro Group in May of 2005 as part the San Clemente housing EIR process. Morro's biologist identified Southern Tarplant in substantial numbers. Interestingly, the largest congregations of tarplant were discovered along a stretch of abandoned Los Carneros road. The road, although decommissioned, was not destroyed and remains at a shallow depth underneath the soil surface. It is believed that the harsh soil conditions and the perching of water at the surface due to the buried asphalt have created ideal growing conditions for the plant. Although these areas are the largest congregations observed, tarplant also thrives in many other areas the San Clemente site. The San Clemente Graduate Student Housing and El Colegio Road Improvement Project EIR, and CCC ruling required that at least 12,000 square feet (0.28 acre) of habitat area suitable for the preservation and restoration of Southern Tarplant be provided to compensate for proposed tarplant disturbance resulting from SMS construction and buffer zone disturbance.

Approximately 7,361 square feet of tarplant habitat will be preserved within the wetland buffer area. This includes six large congregations of tarplant that were deemed ESHA by the California Coastal Commission’s biologist. Although there were many individuals scattered throughout the project area, only those within these larger congregations were deemed ESHA. The largest contiguous area of ESHA was estimated to have 2,402 individuals, while the other five areas were estimated to have between 30 and 238 individuals each. The baseline tarplant population accounted for in the initial survey by Morro Group (2005) will be used as a measure of success during the mitigation period. As long as the baseline populations in the conservation areas remain steady or increase, they will be considered healthy and self sustaining. (Morro Group 2005)

The California Coastal Commission review of the May 2005 Morro Group tarplant survey indicated that a total of 64 individuals would need to be removed due to construction activities. The CCC then determined that the tarplant would need to be mitigated for at a minimum of a 3 to 1 replacement rate. Therefore, a minimum of 192 tarplant individuals would need to be planted to mitigate for the 64 lost. In accordance with CCC, the project EIR, and the HREP, CCBER was to create another 5,606 square feet of tarplant habitat where mitigation efforts could take place (Morro Group 2005). This created area and the six areas of ESHA sum to 12,967 square feet of tarplant habitat area, exceeding EIR requirements by almost 1,000 square feet (Fig. 28, pg. 66**).** These newly created habitat areas shall use the first year monitoring data as a baseline population, and these numbers will also need to remain steady or increase over the mitigation period to be considered successful.

In accordance with the HREP, CCBER staff began mitigating for the impacts to the tarplant. Southern Tarplant is sometimes weedy where it is found. On the San Clemente restoration site, a large amount of disturbance has taken place due to initial grading activities and on-going weed management. The tarplant, a known disturbance follower, has flourished under this regime. As the tarplant seed ripens in late summer through fall, it is collected from areas within the restoration site, outside those deemed creation or conservation areas. It is then safely stored in large trash cans for future distribution in the creation and preservation areas with the onset of winter rains. The seed from the previous year is distributed throughout each creation/conservation area relative to the overall square footage of the area. After the seed is dropped, it is raked in to create additional disturbance and to cover the seed with a fine layer of soil. Finally, a light watering binds the seed to the soil and promotes germination. At this point, aside from regular hand weeding of the habitat areas, the tarplant is left to its own devices and does extremely well. Due to the success of direct seeding efforts and the disturbed site condition, CCBER has only needed to utilize this form of propagation to date. The most important thing that will be necessary to maintain and bolster these populations in the future is a continued disturbance regime within the population areas. This will ensure minimal competition from other species, while providing ideal growing conditions for the target species.

3 MONITORING METHODS

3.1 Southern Tarplant Monitoring

Southern Tarplant preservation and conservation area monitoring is required for a period of five years. The monitoring is carried out by placing a 1 m^2 quadrat with one hundred 10 cm x 10 cm cells at every third meter starting at 0 along a transect through each preservation/creation area (Fig. 29, pg. 67). Each transect is centered as best as possible through the long axis of each respective tarplant area and runs the entire length of the area. Permanent color-coded stakes were installed to mark the beginning and end of each transect. To account for the random yearly distribution of this weedy annual species, each monitoring position was offset from the center line alternating out to the right and then to the left for the length of the transect. The distance offset at each position was randomly determined and only bound by the extent of the width of the respective tarplant area. The increments used were tenths of a meter and will remain permanent for the duration of the five year monitoring period. Within each tarplant preservation or creation area, estimated tarplant present, percentage of ground surface covered by tarplant, density of tarplant per unit area, percentage and density of competing exotic weed species, and the percent cover of native species is being assessed. In each of the tarplant areas, which are contained in irregularly shaped polygons, an estimate of total individuals is made by counting the tarplant as accurately as possible. Percent cover is determined by estimating how many 10cm by 10cm cells were filled with each species present. Using this method, it is possible to have cover exceeding 100% due to overlapping species strata. Bare ground and thatch are also measured in the percent cover estimate. The density of tarplant per unit area is calculated by counting the tarplant present within each meter square quadrat and averaging this over the entire monitoring transect. The percent cover and density of competing species and other natives are also calculated in the same manner. In addition to the required monitoring techniques of the tarplant preservation and creation areas, CCBER has employed a GIS analysis of the population on the San Clemente site. Although the tarplant is still largely concentrated in the designated preservation and creation areas, it is prevalent in many other areas of the site as well. This is due to the high level of disturbance from grading in the wetland buffer and the construction of various stormwater management BMPs, leading to many more wet areas conducive to tarplant. A GPS unit was used to map all the plants on the entire site and the data was mapped using GIS applications (Figs. 31-32, pgs. 69-70). Each plant was GPS'd, and where there were more than one individual per square meter the center of the congregation was GPS'd, and a value was denoted for the number of individuals within that meter square. For the large congregations, like in the conservation areas, a polygon was GPS'd around the entire congregation and a total number of individuals were assessed. It is believed that this form of monitoring will best show the habits and preferences of this rare, yet very mobile, annual herb. This form of monitoring was first completed in October of 2007 and will be continued annually for the duration of the assigned 5-year period and beyond. The current figure is for 2011. (Fig. 32, pg. 70)

3.2 Vegetation

The required monitoring of the wetland buffers and the SMS basins vegetation is to consist of a qualitative assessment of overall site condition, conducted by walking the entire site and noting native cover, weed cover, and wetland species presence (SCHREP).

This analysis has also been carried out using GPS/GIS technology. The first assessment was conducted in early 2006 **(**Fig. 24, pg. 62**)** to determine the baseline vegetative conditions of the site and was repeated in the spring of 2008, 2009, and 2010. **(**Figs. 25-27, pgs. 63-65). The purpose of this mapping is to show the annual changes in vegetation as CCBER goes through its intensive weed eradication and native revegetation process. The GIS analysis presents the dominant species determined by respective percent cover in all areas of the restoration site. The secondary dominant in each dominant species polygon is part of the GIS database and was not included on the map presented in this report. This form of GIS monitoring will be continued annually throughout the monitoring period. In addition, we maintain an ongoing plant list of all native and non-native species found on the site and their locations within the site **(**Tables 12 & 13, pgs. 48-49**).**

CCBER would also like to initiate a more detailed form of post-restoration monitoring this upcoming year, taking into account the state of the site at when we transition from a more intensive management approach to a site maintenance phase. This would include both quantitative and qualitative variables to synthesize what has been accomplished and to set the stage for "success" monitoring well into the future. The quantitative portion would include, but not be limited to, percent plant cover, plant density, and species richness. This would give us a window into the biological state of the site now and could be repeated in the future to see how the site evolves without intensive management. The more qualitative portion shall include synthesizing all the inputs and management approaches that went into the development of the project so that correlations can be made between the management approach and the patterns that may be seen in the quantitative analysis. This will provide CCBER with an important adaptive management strategy for other projects and will also teach us about the long term sustainability of this project.

3.3 Additional GIS Monitoring

In addition to the required monitoring and the GIS work mentioned, other forms of GPS/GIS based mapping of the San Clemente Habitat Restoration Site have been initiated. The San Clemente Habitat Restoration Plan has been documented and geo-referenced in GIS, designating the various plant community types that will be restored around the site **(**Fig. 28, pg. 66**).**

Detailed "As-Built" planting plans were entered into GIS format for individual areas on site so that there are spatially linked records of all planting activities with respect to species type, distribution, and density. This will make studying the evolution of the site and its success as a self-sustaining ecosystem more feasible. Follow-up mapping and more detailed vegetation surveys will be conducted as mentioned above, and they may be compared to these initial "As-planted" surveys to assess the succession processes at work on the restoration site.

Another important aspect of restoration implementation is exotic weed eradication. GIS mapping of the various eradication methods being utilized on site is being conducted and was initiated in the first season of full scale weed eradication on site, spring/summer 2007 **(**Fig. 35, pg. 73**).** This has been repeated for the spring and summer of 2009 as well as 2011. (Figs. 36 & 37, pgs. 74-75). All eradication methods were documented by area as completed, and a map combining all the various method combinations relative to the exact areas applied was produced. This form of monitoring can give us interesting insight into the effectiveness of each method or combination of methods at eliminating exotic plant communities or specific species. This monitoring will be especially useful when compared (overlaid on) to the yearly existing vegetation profiles, **(**Figs. 24-27, pgs. 62-65**)** also being produced with GIS technology. This may be one of the first attempts to utilize GIS technology on a relatively small scale restoration site.

Along with this GIS data, environmental data that already exists for the area is being compiled to present a full picture of all variables that are at work in regards to the development and long term survivability of the communities being restored. This environmental data includes variables such as topography, aspect, soil type, cloud/fog cover, precipitation, temperature, historical aerial photos, etc. This data will be gathered from various public agencies and data stores that produce or publish this type of data for our specific area. This GIS database of CCBER generated data and environmental data for the site will be useful to determine patterns in the many combinations of variables that will determine the success or failure of individual species, meta-communities within the site, or the restored community as a whole.

It is a goal of the project to even further the library of GIS data being produced by adding additional elements of hydrological analysis. With all the innovative stormwater BMPs being utilized, highlighted by the 1 acre stormwater management system, it is a goal to model the hydrology and water quality characteristics of the system using GIS applications. To accomplish this, a detailed topographical survey was completed using a robotic laser guided survey unit (Fig. 23, pg. 61).

After a suitable amount of data has been collected, CCBER staff would like to begin a full scale GIS analysis, which will make up much of the qualitative information for the post-restoration study mentioned above. This analysis will involve taking all of the environmental data, and the data gathered on restoration activities, and meshing it together to form new data sets that illuminate various patterns in the ecological development of the site as it relates to the way the site was managed. Hopefully this form of analysis will provide insight into the best management strategies to be employed per given environmental conditions. In other words, we may be able to develop a model that can be applied to other restoration sites, streamlining our efforts, while more efficiently achieving the ecological goals set for the given area.

3.4 Photo Documentation

Three types of photo monitoring of the San Clemente Habitat Restoration site are being employed. The first is a landscape photo network that successfully captures the entire site from a more large-scale landscape perspective. This network contains 33 photo points with 76 total photos fringing the outside edge of the site looking in. These are taken around the entire perimeter of the site and down the center line of the site along the existing linear wetland. Each photo point has multiple photo angles to capture everything. The landscape photos are taken seasonally.

Secondly, each habitat type area has its own unique set of photo points to capture in more detail the restoration activities and development of that area. These habitat type photo sets are designed and monitored as sites become planted. (Fig. 39, pg. 77)

Lastly, an archive of miscellaneous photos is being kept to account for all interesting activities and happenings that would not be captured under the formal photo documentation plan. These include, but are not limited to: construction activities, restoration activities, wildlife occurrences, and anything else of ecological importance.

3.5 Hydrology

Currently, the hydrology of the SMS basins, existing wetland, and various bioswales, is being monitored by means of photo documentation and a rain gauge.

During storm events, CCBER staff photographs inundation and flow patterns (Photos 17 & 18, pg. 91). Following the first rains of the season, the stormwater BMPs and the existing wetland are photographed bi-weekly to visually capture the reduction or increase in surface area covered by water. All photos are dated and catalogued.

A rain gauge has been present on site for the previous two years. The rain gauge is checked intermittently throughout each storm event and totals are tallied for the entire event and recorded in the San Clemente water quality field book with the date and time of each observation as well as any other pertinent notes.

Flow gauges could be installed and flow meters could be utilized to record velocity and total discharge for given storm events to and from the basin network and other BMPs. This could help to explain whether our BMP network is functioning effectively at reducing volume and flow-related impacts to downstream wetland resources. Ideally, these impacts would be reduced to pre-housing levels. Another goal would be to construct an overall water budget for the SMS basins. This would take into account inputs and outputs to the system, evaporation, inundation, and evapotranspiration.

3.6 Water Quality

The construction of the 1 acre storm water management system is a progressive step in "low impact development" (LID), and it will be important to document and understand its effect on water quality. Although a stormwater BMP's effect on water quality is important, it is still not fully understood. Therefore it is important that this opportunity is taken to understand the effectiveness of the stormwater management system and the other stormwater BMPs on site. It is one thing to say that you are effectively managing stormwater, and it is a completely different thing to say that you are effectively treating it. The latter requires scientific evidence for validity. A plan for monitoring has been underway and is evolving continuously with the help of four professors at the UCSB campus to monitor water quality for the sites BMP network. The project is fortunate to have the constructive input of Dr. Carla D'Antonio of Ecology, Evolution & Marine Biology, Dr. Arturo Keller of the Bren School of Environmental Science, Dr. Oliver Chadwick of Geography & Environmental Studies, and Dr. Patricia Holden also of the Bren School of Environmental Science. Dr. Keller remains the principal contributor.

From the 2008-2011 rainy seasons, CCBER completed water quality monitoring efforts looking at the San Clemente restoration site. This first season of monitoring was completed with the generous help of an $8000 grant received from UCSB's Coastal Fund. This grant was renewed in 2009, allowing us to continue monitoring through the 2010-2011 season. The monitoring scheme examined all BMPs on site including the SMS, the parking lot bioswales and existing wetland, and the field drainage bioswale, with a total of 30 sampling locations scattered throughout (Fig. 41, pg. 79). During each significant (>0.10 inches) storm, event all sample locations that contain a suitable amount of runoff are sampled once using a clean 250ml Nalgene sample bottle. Samples are taken at the same location each sampling event. Samples are taken using the triple rinse method, and all samples are immediately transported in a cooler to a cold storage room near the lab to await analysis. Lab analysis of these stormwater samples measures total nitrogen, reactive phosphorus, and suspended sediment.

3.6.1 Total Nitrogen

Total nitrogen analysis must be completed within 10 days of sampling to ensure that no nitrogen is consumed or transformed, which would render the tests inaccurate. Total N is reported in units of milligrams per liter. To perform this test we are using Hach total nitrogen test ‘n tube reagent kits which come in low (0-25mg/l) and high (10-150mg/l) level depending on the suspected load of total N in the runoff. These kits cost $103 per 50 samples, and the test which involves multiple reagent, heating, and cooling steps takes approximately 2 hours per 25 samples. Typically our total N results fall below 25mg/l, so the low reagent kit is used.

3.6.2 Reactive Phosphorus

Reactive phosphorus is measured using Hach’s PhosVer 3 reagent pillows which are added to 10 ml of samples to get a value of total reactive phosphorus in milligrams per liter. This test is rather quick and 30 samples can be completely analyzed in just under an hour. Reactive phosphorus tests must be carried out within 48 hours of the time the samples are taken to ensure accurate results. For a more detailed description of our nutrient analysis protocols please see our monitoring protocol document in section 9.0.

3.6.3 Suspended Sediments

The last step in the lab analysis process is to filter the samples for suspended sediment analysis. This involves selecting samples which exhibit a high probability of containing high suspended sediment loads. This is usually easily seen by the level of turbidity observed within the sample bottle. We also systematically filter all inlet and outlet samples to and from the system to assess total import and export of suspended sediment to the system. Filtering is carried out by simply shaking the sample bottle to re-suspend the sediment and then pouring it through Buchner funnel containing a Whatman filter strip. After this is completed, the filter is carefully extracted from the funnel with tweezers and placed in a clean scintillation vile to avoid any contamination of the sample. These viles may be stored in the cold room for up to 6 months without any loss of measurable contaminants. Finally, the volume of filtered water is measured. Due to the complexity of analysis and the high tech equipment needed for our suspended sediment analysis, these samples are sent to the Marine Science Analytical Lab on UCSB’s campus. Currently, CCBER is analyzing the filtered suspended sediment for the presence of 5 heavy metals associated with urban land use. These include Aluminum, Cadmium, Copper, Lead and Zinc molecules. Each of the samples submitted costs approximately $80, and results are typically available within a week.

3.6.4 Wetland Soil Analysis

An additional step in our water quality analysis is the extraction and analysis of bed soil samples from various points within the wetland. Due to the high cost of soil sample analysis, soil sample sites are limited to 15 sites throughout the BMP network (Fig. 41, pg. 79). These sites were chosen because they are representative of the entire BMP network, and occur in pooling areas where low flow velocities and hence greater sedimentation rates and soil contact are likely to occur. Soil samples are taken once a season usually in early summer as the rains have passed and water levels within the wetland begin to recede, giving access to the soils. Samples are extracted using 6 foot long 2 inch diameter PVC pipe with holes cut 6 inches above the sampling end to allow water to be flushed out as the soil sample is forced in. After the sample is successfully extracted from the center of the pool, it is forced out of the sampler with a plunging device. Then, only the top 4-5mm of the 2 inch diameter sample are cut off and deposited in a clean receptacle to be transported to a drying oven. The samples are dried individually at 60 degrees Celsius until they are completely free of any moisture. Then, each sample is pulverized using a clean mortar and pestle. The pulverized samples are then encapsulated in a clean jar and transported to the Marine Science Analytical lab at UCSB for heavy metal analysis. The samples are also analyzed for total carbon, hydrogen, and nitrogen. These samples cost approximately $80 per sample and are also completed in approximately one week.

3.7 Vertebrate/Invertebrate Monitoring

Vertebrate monitoring is currently is on-going and includes observations of birds, mammals, and reptiles. CCBER staff keeps a detailed log of any of these animals occurring on or directly above the site. After a positive identification has been made by knowledgeable staff, an entry in the vertebrate log is made including data such as date, time, associated vegetation type/location, and activity observed. An annotation is also made on a detailed map of the site depicting different habitat zones so that species distribution and preferential habitat can be determined. Mark Holmgren, CCBER's former vertebrate collections manager and a well respected birder in Santa Barbara County, assists with wildlife identification.

Invertebrate monitoring is also underway in a similar fashion, but is minimally effective due to the difficulty in identifying insects without capturing them. Hopefully, through notes and photography we will still be able to show positive rates of colonization by native vertebrates and invertebrates in both constructed wetlands and restored terrestrial habitats. This information can then be used for comparison with both disturbed and natural reference sites to help characterize the success of this restoration effort.

3.8 Staff Utilization Study

A new monitoring effort incorporated in 2009 and repeated through the present is the San Clemente Project staff utilization study. This monitoring effort details all of the work efforts associated with the implementation of the project from 2009 to 2011. Information is recorded daily on the level of staff involved and the various activities that are carried out in specific areas of the site. Data is also included pertaining to office work, monitoring, and other off-site activities carried out for the benefit of project completion (Tables 16 & 17, pgs. 56-57).

4 MONITORING RESULTS AND DISCUSSION

4.1 Southern Tarplant Monitoring

The performance standards approved by the California Coastal Commission base the assessment of tarplant success on comparisons of annual monitoring data with the original baseline data collected for the mitigation areas. For existing preservation areas the initial numbers documented by a focused survey during the peak blooming period are used to provide the baseline population data. This baseline population must remain steady or increase over the mitigation period to show establishment of a self-sustaining population in the area. Newly created habitat areas use the first year tarplant population data as the baseline condition. This baseline population must also remain steady or increase over the mitigation period to show the establishment of self-sustaining populations in the area. The monitoring and restoration efforts are to continue for at least a five-year period, and must develop a self-sustaining population as evidenced by survival and natural reproduction of southern tarplant within the mitigation sites. *The enhancement and restoration site shall not be considered successful until it is able to survive without artificial inputs (SCHREP).*

For clarity the site tarplant population fluctuation and success data will be organized in tables below. Values for each transect in *blue* represent the baseline data, which the overall success is based on, and the values for each following year's data will follow with a value colored *green* for populations which have remained steady or increased, and *red* for population areas which have fallen below the baseline performance standard. Discussion will follow for each table. Bar graphs representing the same data types are also included for a visual reference.

4.1.1 Results for Tarplant Preservation Areas

Figure 1. Percent cover for tarplant in preservation areas from 2005-2011

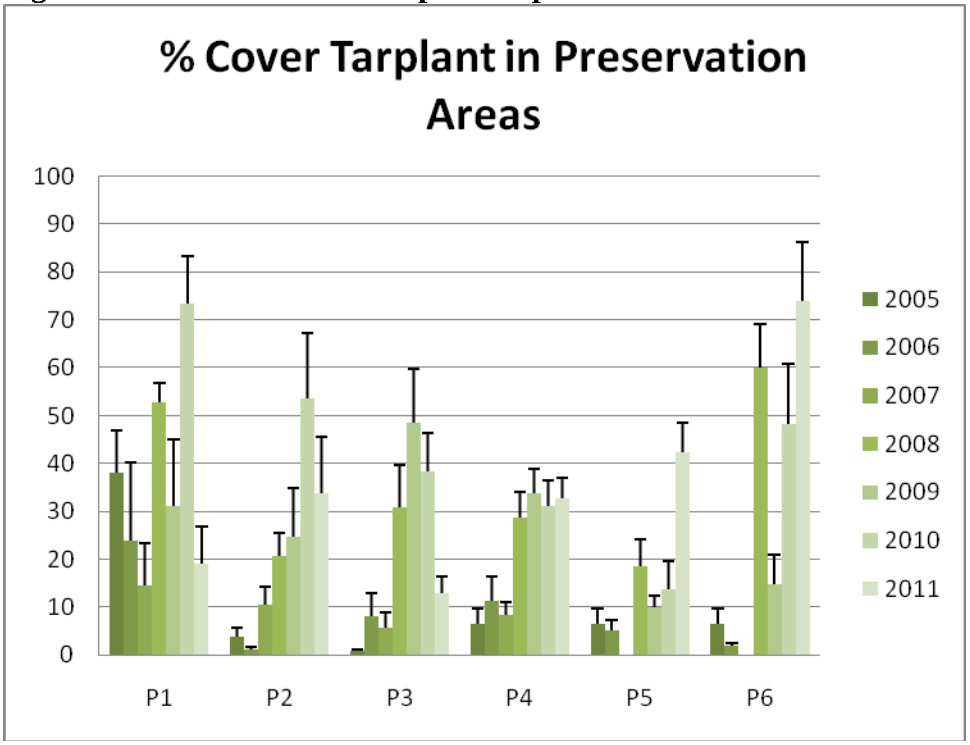


Table 1. % Cover Southern Tarplant

	2005	2006	2007	2008	2009	2010	2011	Pass
P1	38%	23.8%	14.5%	52.8%	31%	73.5%	19%	No
P2	3.7%	1.2%	10.5%	20.8%	24.8%	53.67%	33.8%	Yes
P3	0.8%	8.1%	5.7%	30.8%	48.5%	38.4%	12.8%	Yes
P4	6.5%	11.3%	8.4%	28.7%	33.7%	31.06%	32.7%	Yes
P5	6.5%	5.3%	2.9%	18.5%	10.1%	13.6%	42.3%	Yes
P6	6.5%	1.9%	0%	60%	14.9%	48.3%	73.9%	Yes

In 2011, we had very productive rain year in the area (28.42”), and all but area P1 exceeded baseline population data. Area P1 is the only preservation area that has failed to exceed baseline values in the last four years, but it also has, by far, the highest baseline performance criteria to meet at 38% tarplant cover. The result for P1 in 2011 may also be directly related to a late management approach taken there. While P1 has had some of the highest tarplant cover values in the past, it has also contained some of the higher exotic weed cover. As part of the retention pond wetland creation just north of P1 CCBER staff disced both P1 and P2 somewhat late in the season and reseeded the area afterward in an attempt to reduce exotic cover. This likely lead to the lower value in P1, while P2 didn’t seem to be as affected. The same management induced result may also be seen in P3 where an irregular tire rutted, road base dominated topography was replaced with a broad depression that will surely boost tarplant health in the area into the future, but created a decline in 2011. As for the rest of the preservation areas P4 remained steady while P5 and P6 showed great increases in tarplant cover.

2010 was a prosperous year for San Clemente's tarplant population as all preservation areas exceeded baseline values. Values either remained relatively stable as seen in P3, P4, and P5 or dramatically increased as seen in P1, P2 and P6. These positive results are likely due to an above average rain year totaling 20.72 inches and continued close management.

In 2009 tarplant area P1 fell below 38% to 31% failing the the performance standards. All other areas passed the standards set be the overseeing agency. Three of them(P2,P3,P4) exceeded last years numbers, while areas P5 and P6 passed but dropped off from 2008 levels. As stated in last year's summary found below, a new management strategy has been in effect, but faltered last year due to late seed dispersal, and very uneven coverage of the seed spread throughout the areas. This illustrates the importance of proper seed dispersal methods where seed is spread prior to the last heavy rains of the season. It is also imortant to obtain a good even coverage of seed material throughout all the areas, and germination is also enhanced if the areas receiving treatment are scarafied before dispersal to mimic natural disturbace regimes. It is also pertinent to note that rainfall was lower than normal in 2009, and while storms were somewhat frequent their total output per storm was low creating less short term ponding throughout the tarplant zones over the rainy season.

In 2008 all tarplant preservation areas exceeded the performance standards set by their respective baseline condition. Interestingly though, tarplant percent cover declined for two consecutive years following the baseline data year, but rebounded in 2008. The only logical explanation for this would be the difference in management strategy employed last year. This involved storing excess tarplant seed from areas outside transects on site, and reapplying it into the designated preservation areas coinciding with the coming of winter rains. This additional seed input boosted percent cover figures by more than 50% in all cases. It is also important to note that environmental conditions also play a huge role. For example in 2006-2007 (our worst tarplant year in the monitoring period) rainfall for the water year was only 7.72" nearly nine inches below our average totals. Conversely in 2007-2008 our total rainfall was at 16.92".

Figure 2. Density of Tarplant individuals per meter squared in preservation areas from 2005-2011

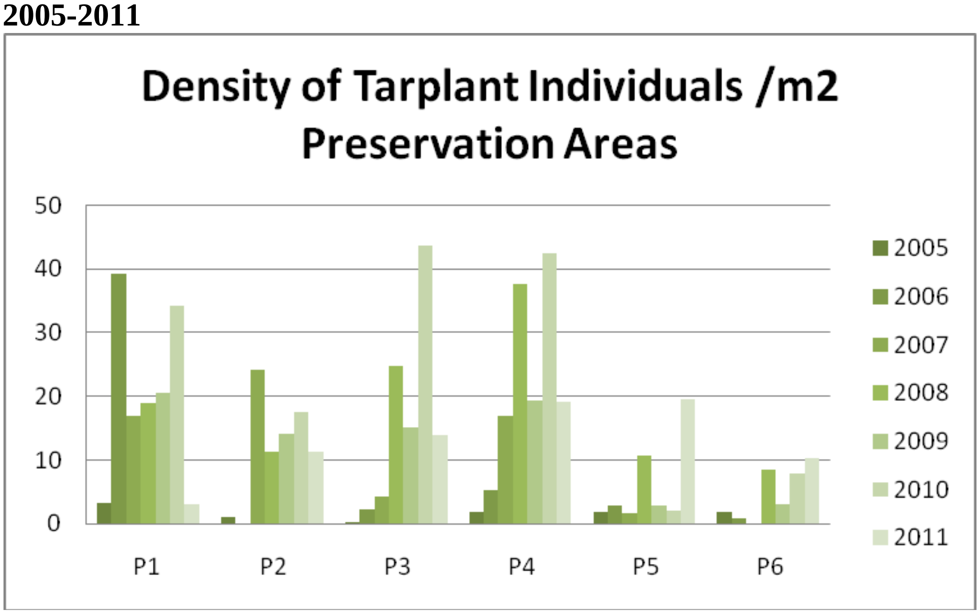


Table 2. Density of Tarplant Individuals/ Meter Square

	2005	2006	2007	2008	2009	2010	2011	Pass
P1	3.3	39.3	17	19	20.6	34.3	3	No
P2	1	0	24.2	11.3	14.2	17.5	11.4	Yes
P3	0.3	2.2	4.2	24.8	15.2	43.7	14	Yes
P4	1.8	5.32	17	37.7	19.3	42.4	19.1	Yes
P5	1.8	2.8	1.7	10.7	2.93	2.13	19.5	Yes
P6	1.8	0.9	0	8.43	3	8	10.4	Yes

In 2010 and 2011 all preservation areas passed their performance standards with the exception of area P1 in 2011, this is likely due to the employed management strategies detailed in the previous paragraph.

All performance standards were met in 2008, and again in 2009 for density of tarplant per meter squared surveys. Although this is promising, on closer inspection of the data you will see that numbers often go up and down year to year even though they may remain above that of the performance standard. One explanation for this is the high variability in this annual herb's distribution within the transects from year to year. These types of species are very mobile. Secondly there is a high level of variability in the size of each individual. A one meter quadrat may have one individual tarplant specimen that covers 100% of the area, but only receives a value of 1 per meter squared, while on the other hand it is possible to have multiple individuals that are smaller than a few centimeters in area. In this case it is possible to have a density value of 50 or more. This makes for very unreliable results in terms of using density alone as a parameter for evaluating tarplant conservation. For an example of this flaw notice that the figure for tarplant density in 2009 for transect P1 rose almost 2 points compared to 2008 numbers, but area P1 also happens to be the only preservation zone that failed in terms of its percent cover dropping from 52.8% in 2008 to 31% in 2009 as seen in the previous graph.

Figure 3. Percent cover of native plant species in preservation areas from 2005-2011 (*includes Tarplant)

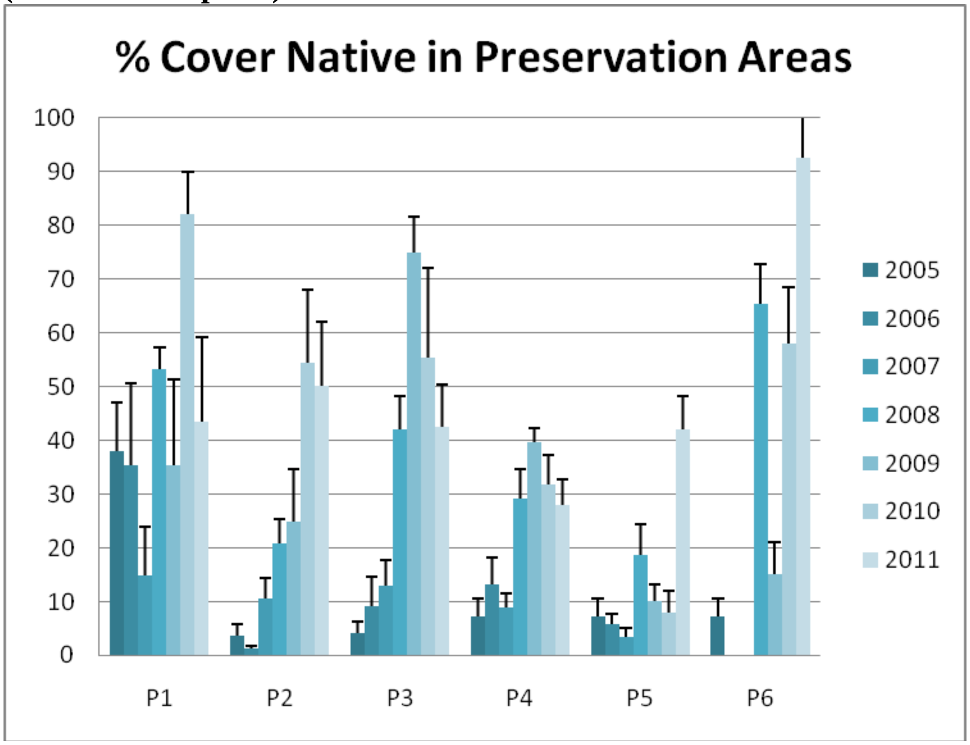


Table 3. % Cover of Native Species

	2005	2006	2007	2008	2009	2010	2011	Pass
P1	38%	35.3%	14.8%	53.3%	35.3%	82%	43.5%	Yes
P2	3.7%	1.2%	10.5%	20.8%	24.8%	54.5%	50.2%	Yes
P3	4.1%	9.2%	13%	42%	75%	55.4%	42.5%	Yes
P4	7.2%	13.2%	8.9%	29.2%	39.6%	31.8%	27.9%	Yes
P5	7.2%	5.7%	3.3%	18.7%	10.1%	7.87%	42.1%	Yes
P6	7.2%	1.9%	0%	65.4%	15%	58.1%	92.6%	Yes

In 2010 and in 2011 native percent cover has remained steady in all areas due mostly to the optimum environmental conditions for tarplant which make up most of the native cover in the preservation areas.

In 2009 three areas (P2,P3,P4) exceeded 2008 native cover percentage passing the performance standards, while tarplant areas P5 and P6 dropped significantly, but still managed to exceed the standards. Tarplant area P1 also dropped significantly falling below 38% failing the standards set.

The figures for native species percent cover all surpassed baseline conditions in 2008. These numbers are relatively close to those you will see above for the tarplant percent cover. This is due to the fact that tarplant is the dominant native in these zones and is included in the overall native species data set.

Figure 4. Percent cover for exotic species in preservation areas from 2005-2011

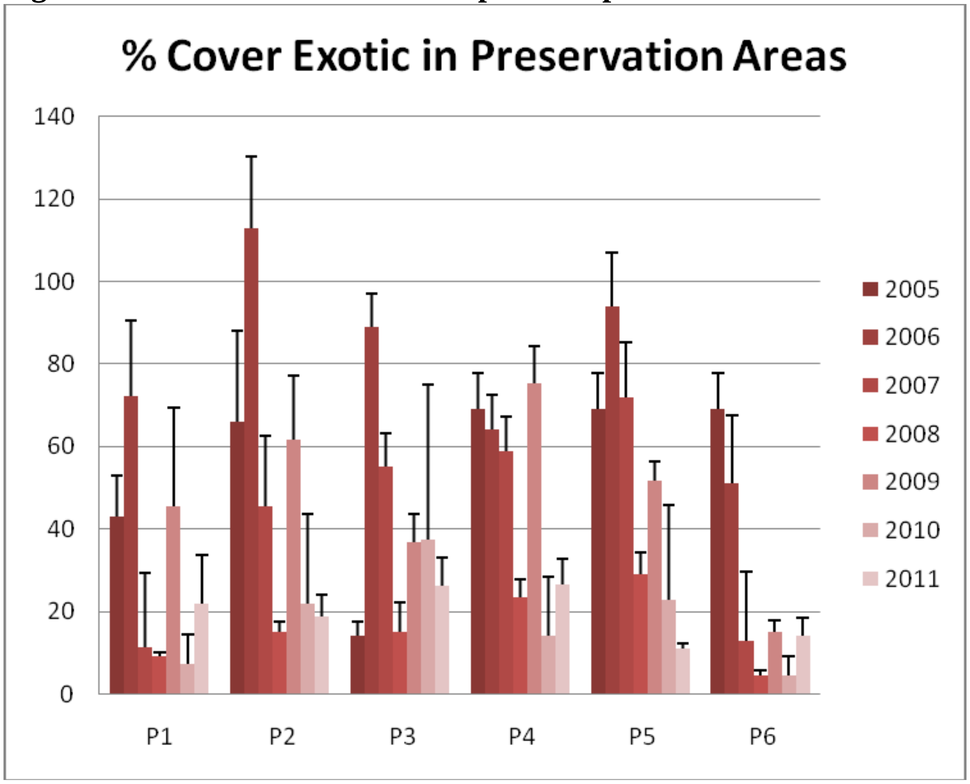


Table 4. % Cover of Exotic Species

	2005	2006	2007	2008	2009	2010	2011	Pass
P1	43%	72.3%	11.3%	9.25%	45.5%	7.25%	21.8%	Yes
P2	66%	113%	45.5%	15.2%	61.8%	21.8%	18.7%	Yes
P3	14%	89%	55%	15.1%	36.9%	37.5%	26.4%	No
P4	69%	64.2%	59%	23.5%	75.2%	14.2%	26.6%	Yes
P5	69%	94%	72%	28.9%	51.8%	22.9%	11.1%	Yes
P6	69%	51%	13%	4.43%	15%	4.57%	14.3%	Yes

In 2011, exotic cover remained relatively the same with some areas increasing around 10% and others dropping about the 10%. Looking at past results it may come as no surprise that area P3 once again failed to pass performance standards, but at least saw an over 10% decline in exotic cover from 2010.

In 2010, all areas showed a decline in exotic cover compared to a less than successful year in 2009, most dropping quite significantly with the exception of P3, which increased slightly and managed to fail performance standards for the 5th consecutive year.

All exotic species percent cover values more than doubled in 2009 relative to 2008 bringing three of the tarplant preservation areas into the red. (P1, P3, P4) from that of baseline conditions, and therefore are deemed unsuccessful. Up until 2009 a decline could be seen in exotic percent cover for each year in the monitoring period to date except for the first year after baseline monitoring. The tarplant areas contain poor growing conditions with weed infested seed banks of small stature weeds such as Bermuda grass, and bur clover. Due to tarplant's late phenology, it is usually present but is very tiny and susceptible to being killed by disturbance when conditions would be ideal for controlling the weeds with large scale efforts. This makes it much more difficult to control the weeds before they set seed.

4.1.2 Results for Creation Areas

Figure 5. Percent cover Tarplant in creation areas from 2007-2011

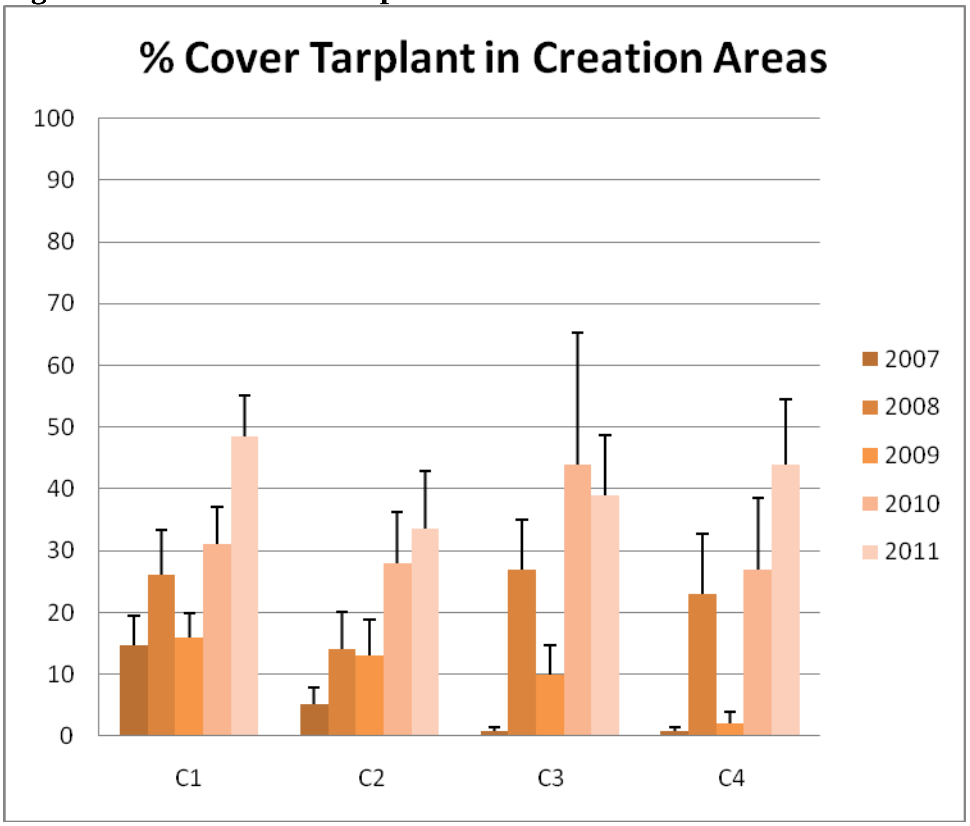


Table 5. % Cover Southern Tarplant

	2007	2008	2009	2010	2011	Pass
C1	14.6%	26%	16%	31%	48.4%	Yes
C2	5.22%	14%	13%	28%	33.6%	Yes
C3	0.7%	27%	9.9%	44%	38.9%	Yes
C4	0.7%	23%	2%	27%	44%	Yes

In 2011 all creation areas continued to increase from a year of decline in 2009 with the exception of C3, which remained relatively steady with a decline of 5 percentage points.

In 2010 populations within the creation areas rebounded with all transects at least doubling their respective tarplant cover. This may be attributed to both positive environmental conditions, and the intensive management strategy.

The percent cover of tarplant in the habitat creation areas in 2009 were all above performance standards set in 2007, but all transects dropped from the quality we saw in 2008. This is due to the same issues with seed dispersal that were detailed in the graph depicting percent cover in the preservation areas.

Figure 6. Density of Tarplant individual per meter squared in creation areas from 2007-2011

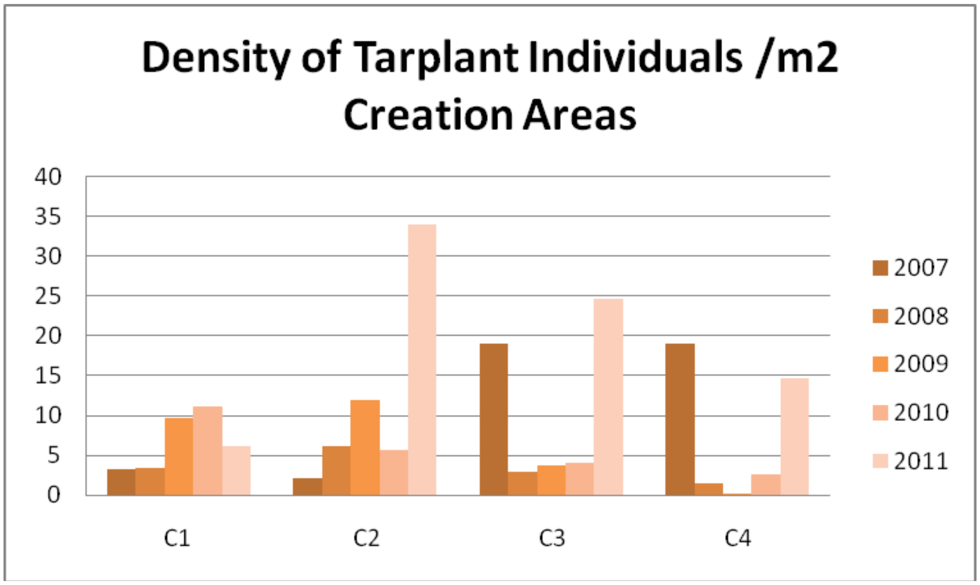


Table 6. Density of Tarplant Individuals/ Meter Square

	2007	2008	2009	2010	2011	Pass
C1	3.31	3.42	9.75	11.12	6.2	Yes
C2	2.11	6.13	12	5.63	34	Yes
C3	19	2.89	3.67	4	24.7	Yes
C4	19	1.57	0.14	2.57	14.6	No

In 2011 areas C2 and C3 dramatically increased while C1 had a small decline. All areas passed performance standards except C4, but it is important to note the over 10% increase seen there.

In 2010 C1, C3, and C4 saw density increases but still only 2 creation areas passed performance standards.

In 2009 three out of four transects saw an increase in density of tarplant but yet again as in 2008 only two of the four transects passed performance standards. As mentioned above the density calculation for this mobile species are misleading, due to size and distribution variability from year to year. Please see comments under table number 2 above. The overall percent cover figures are a more reliable data source in terms of population health.

Figure 7. Percent cover of native species in creation areas from 2007-2011 (*includes Tarplant)

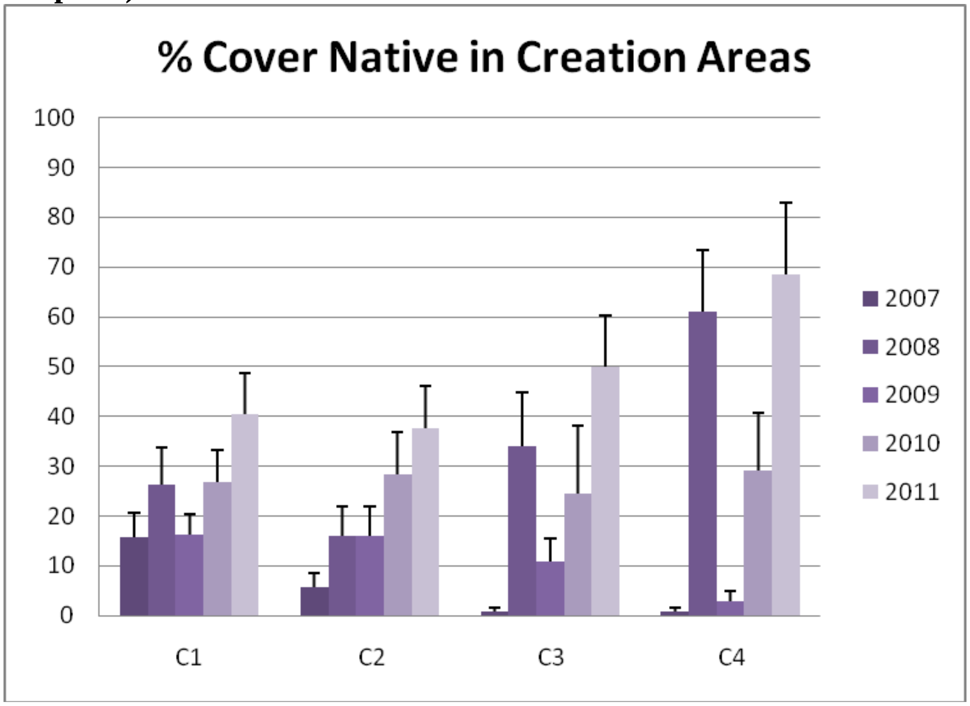


Table 7. Percent cover of native species

	2007	2008	2009	2010	2011	Pass
C1	15.7%	26.4%	16.3%	26.8%	40.5%	Yes
C2	5.67%	16%	15.9%	28.4%	37.6%	Yes
C3	0.8%	34%	10.8%	24.4%	49.9%	Yes
C4	0.8%	61%	2.9%	29%	68.6%	Yes

In 2010 and 2011 the same pattern may be seen as in the above tarplant percent cover graph. After a general down turn in 2009 all areas have steadily rebounded with increases in both 2010 and 2011.

In 2009 the same pattern for native cover in creation areas as seen in the above graphs for the preservation areas is seen. Native cover dropped overall, and in three out of four cases pretty significantly, but still passed the criteria. Being that tarplant is the major contibutor to native coverage in this area their decline is also seen represented in the tarplant percent cover results.

Figure 8. Percent cover of exotics in creation areas from 2007-2011

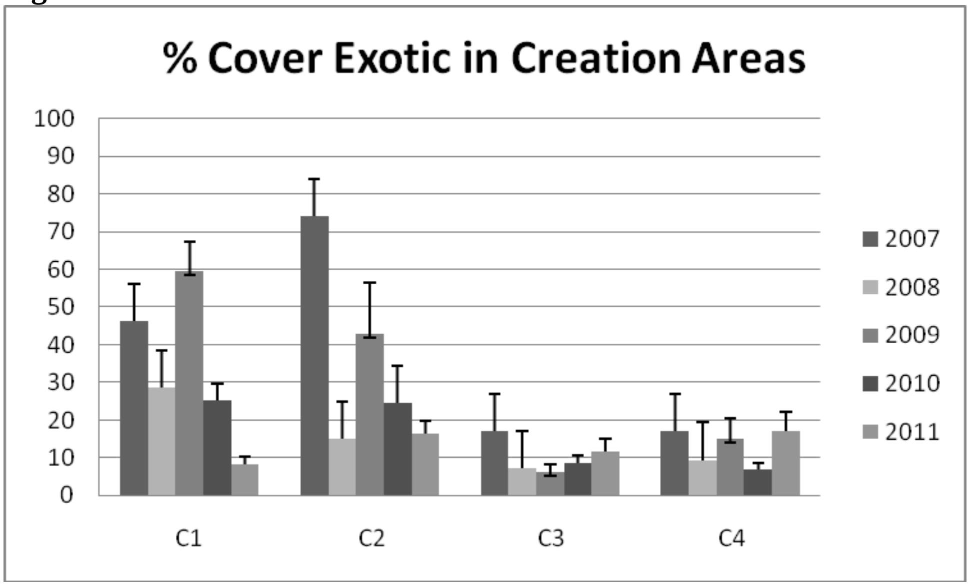


Table 8. % Cover of Exotic Species

	2007	2008	2009	2010	2011	Pass
C1	46.2%	28.6%	59.5%	25.3%	8.1%	Yes
C2	74.1%	15%	42.9%	24.6%	16.4%	Yes
C3	17%	7.22%	6.33%	8.44%	11.8%	Yes
C4	17%	9.4%	15%	7%	17.1%	No

In 2011 areas C1 and C2 continued to decline in exotic cover while C3 and C4 increased. Due to the increase C4 failed to pass performance standards falling just 0.1% over the standard.

In 2010 all transects declined in exotic weed cover with the exception of C3 which increased by a couple percentage points.

Percent cover of exotic weed species in the creation areas increased significantly, once again echoing the results of the neighboring preservation areas. Creation area C1 doubled in exotic cover pushing over the baseline criteria. One reason for this trend is that as tarplant declines in its percent cover the exotic coverage naturally goes up because tarplant is the dominant native representative in the these areas.

4.1.3 Tarplant Population Trends for the Entire San Clemente Site

Figure 9. Trend for the percent cover of Tarplant in all preservation & creation areas by year for 2005-2011

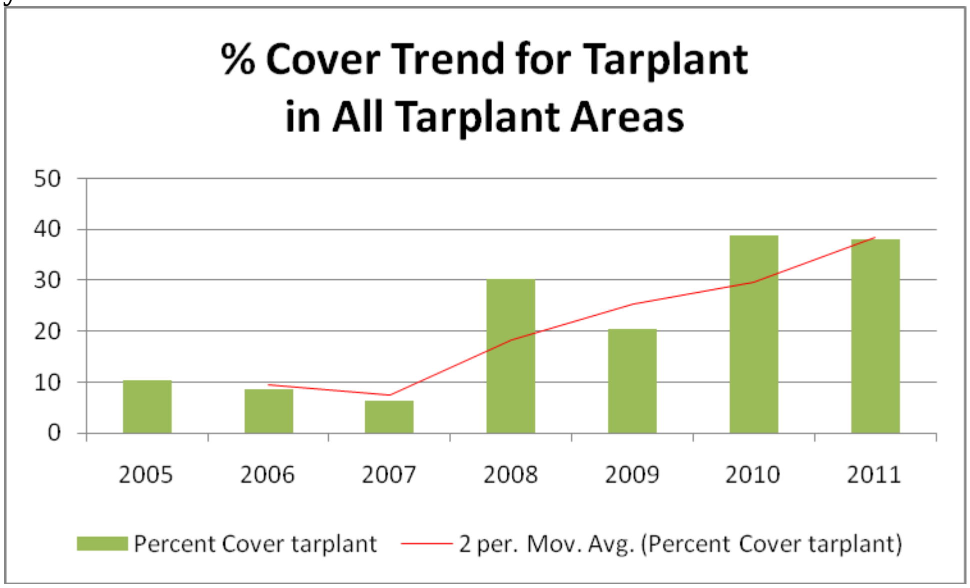


Table 9. Average percent cover of Tarplant in preservation & creation areas across the entire site

	Measured	Standard	Pass
2005	10.33%	10.33%	Base
2006	8.6%	10.33%	No
2007	6.32%	10.33%	No
2008	30.16%	10.33%	Yes
2009	20.39%	10.33%	Yes
2010	38.85%	10.33%	Yes
2011	37.94%	10.33%	Yes

As in most of the individual transect areas the tarplant population as a whole for the San Clemente site declined following the baseline year, but drastically increased in 2008 due to an enhanced management and propagation plan. Yet in 2009 a decrease of 10 percentage points was seen. In 2010 a marked increase in the population was seen and then repeated in 2011. Both a careful management approach and optimum environmental conditions lead to these banner years for the sites tarplant population. It is also important to note that this pioneering disturbance following species is prevalent in many other areas of the site that are not monitored, especially areas close to our numerous constructed wetlands. Because of this one must be careful in judging the health of the entire San Clemente population on these figures alone. Please refer back to section 3.1 for another form of monitoring, which displays a more comprehensive perspective of the entire sites population.

Figure 10. Trend for the percent cover of native species in all preservation & creation areas by year for 2005-2011 (*includes tarplant)

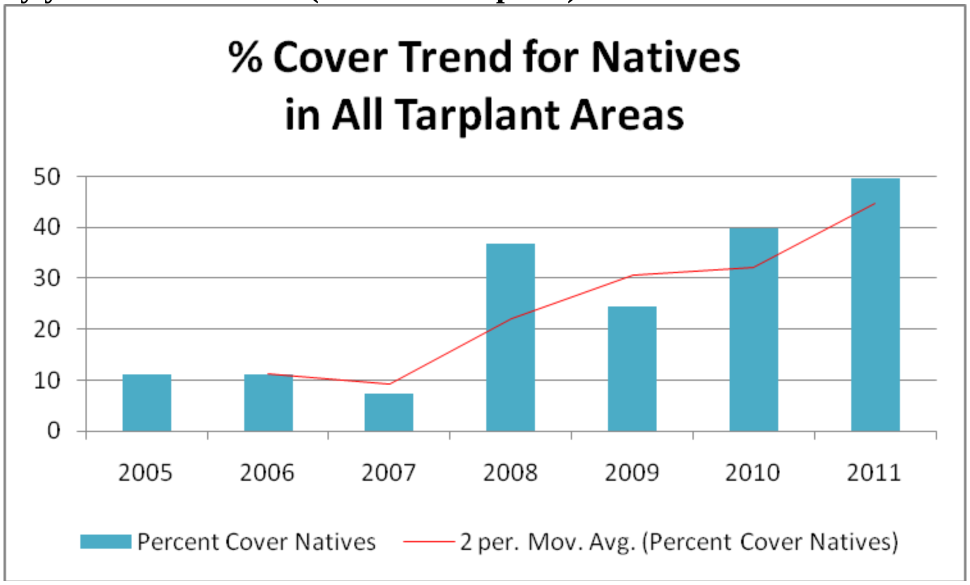


Table 10. Average percent cover of native species in preservation & creation areas across the entire site

	Measured	Standard	Pass
2005	11.23%	11.23%	Base
2006	11.08%	11.23%	Yes
2007	7.34%	11.23%	No
2008	36.68%	11.23%	Yes
2009	24.57%	11.23%	Yes
2010	39.83%	11.23%	Yes
2011	49.54%	11.23%	Yes

The site trend for native percent cover in all tarplant areas very closely follows that of the tarplant percent cover, due to the fact that tarplant dominates the native species assemblage of the tarplant areas.

Figure 11. Trend for the percent cover of exotic species for all preservation & creation areas by year for 2005-2011

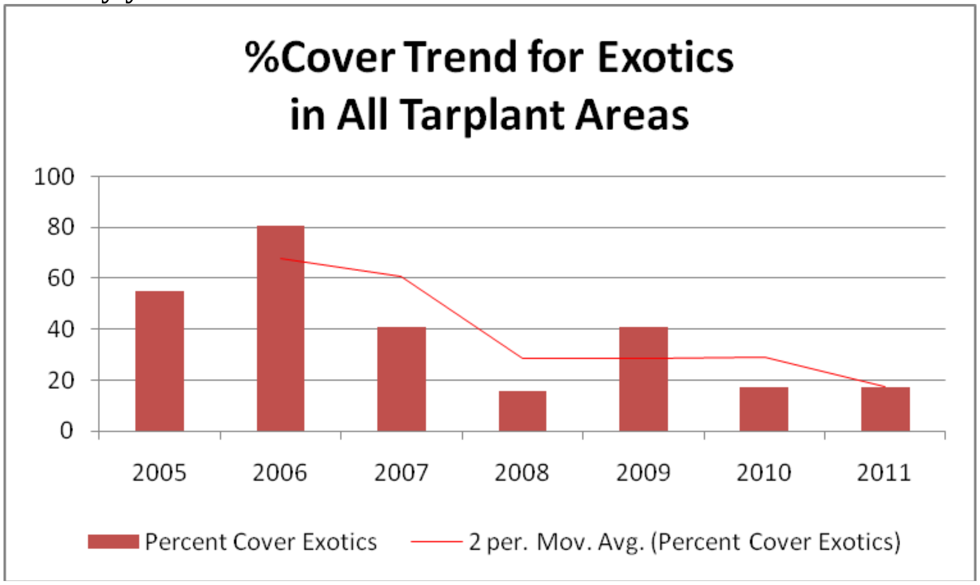


Table 11. Average percent cover of exotic species in preservation & creation areas across the entire site

	Measured	Standard	Pass
2005	55%	55%	Base
2006	80.58%	55%	No
2007	41.01%	55%	Yes
2008	15.66%	55%	Yes
2009	40.99%	55%	Yes
2010	17.36%	55%	Yes
2011	17.23%	55%	Yes

The first year following the baseline data collection year saw a sharp up-turn in the exotic vegetation in the tarplant areas, but since 2006 these figures have dwindled, as a more intensive exotic weed management approach has been employed. Conversely, in 2009 a rebound of exotics is seen that can ultimately be explained by a less intensive weed management strategy in 2009 and marginal results of seed dispersal. In 2010, these factors in management were reversed as shown in the results and continued in 2011.

4.2 Wetland Buffer Vegetation

The wetland buffer vegetation, monitored by CCBER staff, has surpassed the performance standards. The Coastal Commission approved performance standard for the existing wetland buffers and the SMS basins vegetation consists of a qualitative assessment of overall site condition conducted by walking the entire site and noting native cover, weed cover, wetland species presence and cover. To be deemed successful, the site is to have a dominant cover of native vegetation, with exotic weed percentages constituting less than 10% of the total vegetation. For the restoration and enhancement activities to be deemed successful as a whole, these percentages must be sustained without any artificial input (SCHREP).

At the beginning of each growing season, with the commencement of the winter rains, the project is taken over by many exotic species, predominantly annual grasses. In previous years, the cover of these exotics totaled between 75-80% of all vegetation. In the past two years, this initial exotic cover percentage has fallen to approximately 35-40%. This is a result of an intensive weed management program described in section 2.3 that focuses not just on the exotic vegetation, but on the exotic seed bank itself. For the first four growing seasons, all weeds were reduced to 5% of the total vegetation by the end of each growing season. In this past year, the percent cover of exotics rose slightly, reaching approximately 5-7% at the end of the growing season. This slight increase is due to the difficulty of efficient weeding once native populations are large. That being said, exotic plant removal is still a priority and has been highly effective in promoting the expansion of native cover. Please see the vegetation maps from 2006, 2007-08, 2009, and 2010-2011 (Figs. 24-27, pgs. 62-65**)** to see how the vegetation cover has changed since baseline analysis were performed. With the elimination of exotic species and the introduction of native populations, it is believed that the project shall be self-sustaining by the end of the five year mitigation period. For native and exotic volunteer species list please see tables 12 and 13 respectively.

4.3 Additional GIS Monitoring

For a detailed visual look at the various site activities, please see the figures section for maps produced with ArcGIS software, and Trimble GPS equipment. Maps that are included contain site plans, exotic weed management, yearly baseline vegetation conditions, tarplant distribution, monitoring transects, and photo monitoring locations. This very useful form of spatial monitoring has been successful at providing a visual reference for restoration activities and their progress.

4.4 Photo Monitoring

Photo monitoring has been valuable in showing the progression of various habitat areas and the effectiveness of various restoration methods. For a map of the established photo monitoring points thus far on the restoration site consult (Fig. 39, pg. 77). Please see the sampling of photos from the San Clemente archive in section 8.0**.**

4.5 Hydrology

Site hydrology has to this point been monitored by photo documentation during rain events. Additional monitoring approaches are being explored. These include developing a detailed topography of the site with emphasis on stormwater BMPs taken with highly-accurate total station laser survey equipment (Fig. 23, pg. 61), maintaining staff rain gauges, and maintaining a site rain gauge. If time allows, flow meters, groundwater wells, and various other methods could be employed to paint an accurate picture of the site’s hydrology.

4.6 Water Quality

2008 was the inaugural season in CCBER's attempt to understand water quality in the various constructed wetland systems on the San Clemente site and what effect, if any, these wetland bioswales have on water quality. 2008 was a very successful year in terms of determining what nutrient and heavy metal loads are found in San Clemente's constructed stormwater wetlands. This study's performance standards are based on the EPA criterion continuous concentration (CCC) that are intended to be protective of the vast majority of the aquatic communities in the United States under continuous exposure to the pollutant in question. (www.epa.gov/waterscience/criteria)

Nutrient loads entering the bioswales from various surface sources displayed average levels exceeding EPA criteria by 2 to 5 times what is acceptable for aquatic ecosystems (Fig. 18, pg. 42). EPA CCC standards for total nitrogen are 0.4mg/l and 0.017mg/l for orthophosphate. Below are some preliminary graphs displaying nutrient concentration in the three different types of swales represented on the project. 2008/2009 data for both orthophosphate and total nitrogen is displayed relating storm event concentrations to the concentrations of the same sample sites one week after the respective storm event (Figs. 12-17, pgs. 39-42). In these figures you can see that for orthophosphate levels across all sample sites, there is almost always a reduction in orthophosphate concentrations one week after the initial storm event. This seems to suggest that there are indeed mechanisms occurring in the bioswales that remove orthophosphate from the water column. Total nitrogen on the other hand is a bit more erratic. Eight out of twelve examples of storms and their corresponding week after samplings showed increases in total nitrogen concentrations. This variability in total nitrogen, however, is not a necessary concern. As a measurement of *total* nitrogen, it includes organic forms of nitrogen(c-NH4) as well as inorganic forms like ammonium, nitrate and nitrite and it does not specifically reflect how much nitrogen is biologically available or unavailable in a sample. In addition, this measurement does not discern possible contributions of biological contaminants such as algae or bacteria, in which nitrogen has already been sequestered. Observations of algal blooms in the Stormwater Management System suggest greater availability of organic nitrogen downstream, but still more could be learned by identifying and quantifying these organic forms; a follow up investigation is underway. Further analysis of nutrient inputs during the dry season will also be conducted through 2012 to characterize the influence of San Clemente Housing runoff between sampling events.

Heavy metal analysis of aluminum, cadmium, copper, lead, and zinc also registered high. Aluminum was the most interesting with all samples analyzed exceeding the EPA criteria for aquatic organisms. Aluminum is considered toxic to aquatic communities at continuous exposure levels exceeding 87ug/l. We have yet to discover an explanation for this pattern. The other four metals examined were not as consistently high, and only approximately 10% of samples analyzed exceeded the EPA standards. EPA CCC standards for these four metals are as follows: Cadmium 0.25ug/l, Copper 18ug/l, Lead 2.5ug/l, and Zinc 120ug/l. Combined data from 2008 through 2010 is currently being analyzed.

The fact that in the earlier data set all the metals had samples exceeding EPA levels is of concern because this water runs into Goleta Slough, which is listed on the 2006 list of impaired water bodies. Guidelines for Total Maximum Daily Loads (TMDL) entering Goleta Slough are supposed to be in place by 2015 and 2019 respectively.

Since 2008, monitoring has continued through the winter of 2011. The past 2 years have provided a lot of opportunity to explore our water quality story even further due to two consecutive above average rain years. What we hope to glean from this new portion of our data set is more on what is being exported from our constructed wetland to the downstream watershed. Below are some of the preliminary results from 2008/2009. This season had only five distinct events where water leaving the system was available for analysis (Fig. 19, pg. 43). Understanding more about the water quality levels leaving in comparison with what we know is present in the system will give us better idea of the actual stormwater quality remediation capabilities of the constructed wetlands. When all investigations and analyses are complete, a full report will be created and distributed to the funding agency and the UCSB community as well as all other interested parties. A copy of this report will subsequently be available on CCBER's website.

Figure 12. Orthophospate concentrations for storm events and the corresponding week after events in the Storm Water Management System samples 3-8

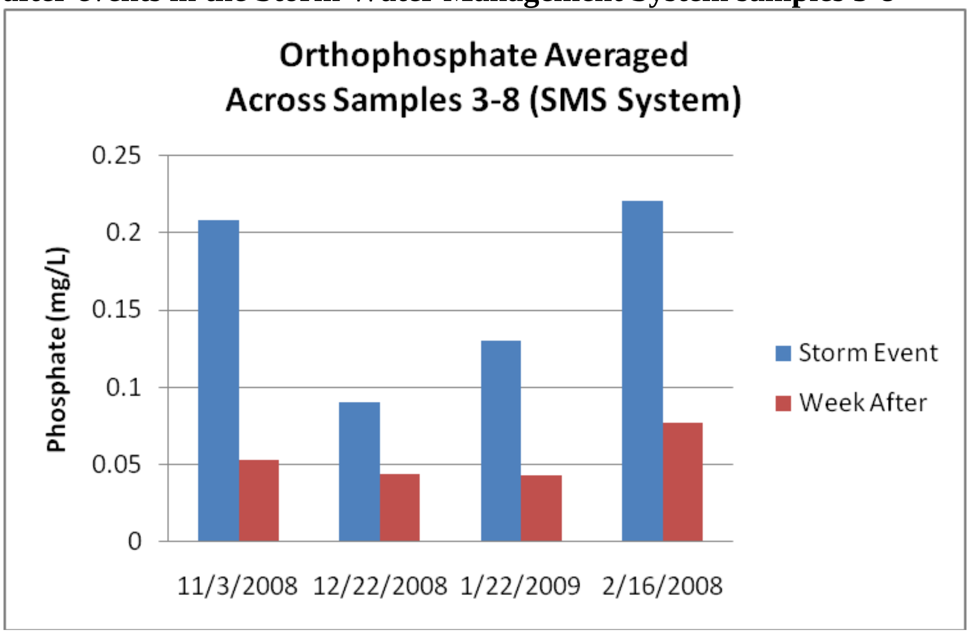


Figure 13. Total Nitrogen concentartions for storm events and the corresponding week after events in the Storm Water Management System samples 3-8

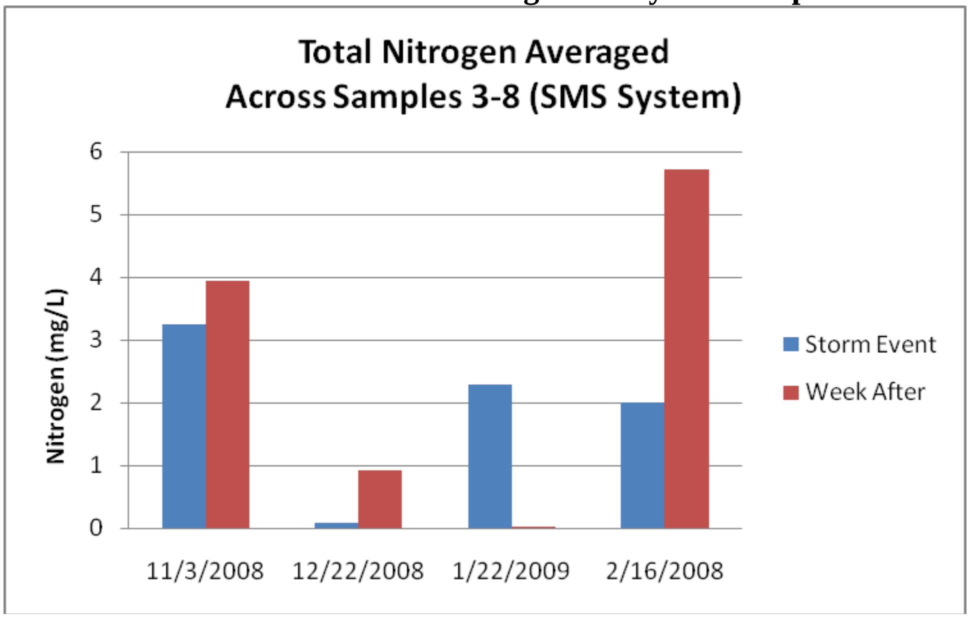


Figure 14. Orthophospate concentrations for storm events and the corresponding week after events in the Parking Lot Bioswales samples 14-19

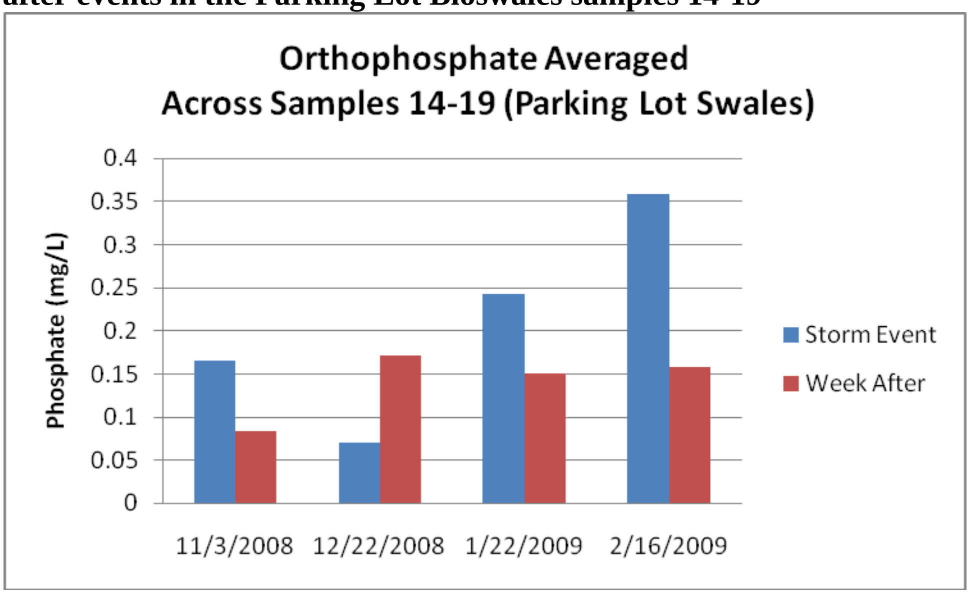


Figure 15. Total Nitrogen concentartions for storm events and the corresponding week after events in the Parking Lot Bioswales samples 14-19

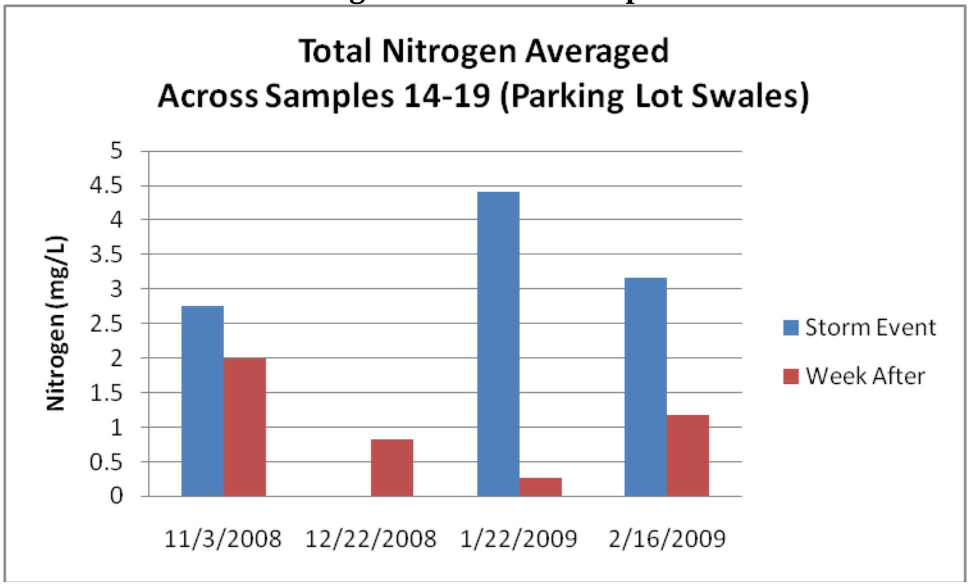


Figure 16. Orthophospate concentrations for storm events and the corresponding week after events in the Field Drainage Bioswale samples 26-28

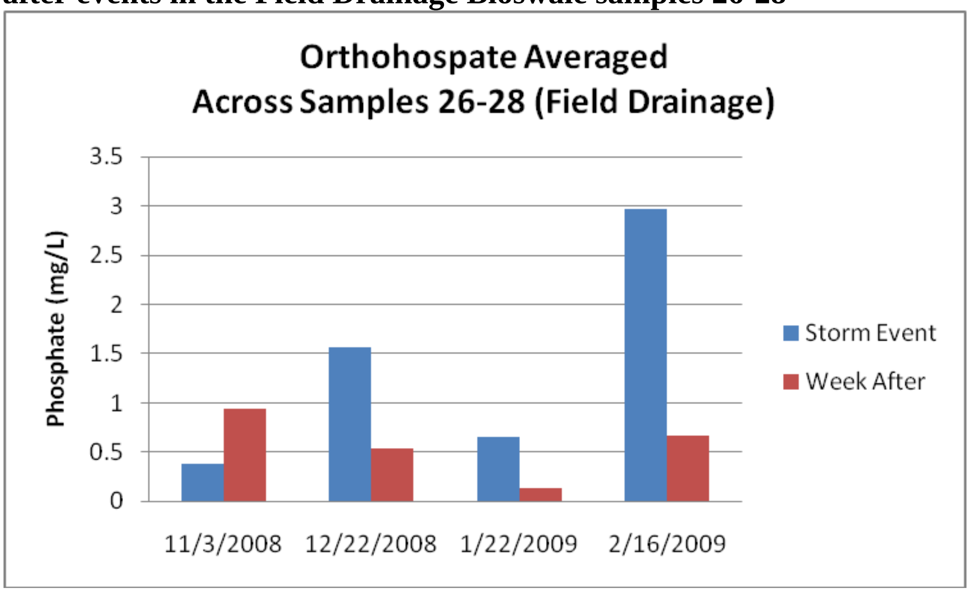


Figure 17. Total Nitrogen concentrations for storm events and the corresponding week after events in the Field Drainage Bioswale samples 26-28

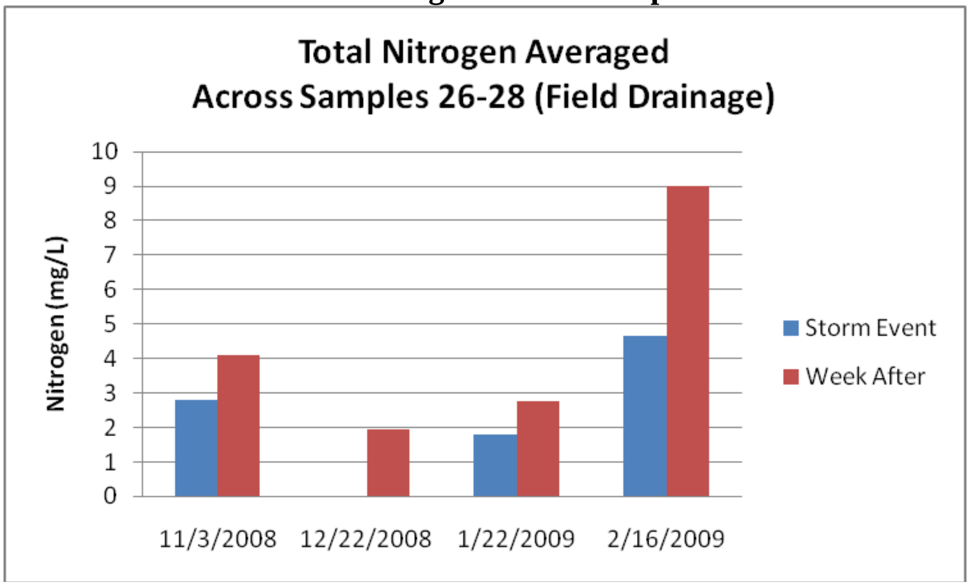


Figure 18. Average influx of dissolved nutrients into three different bioswale types on site

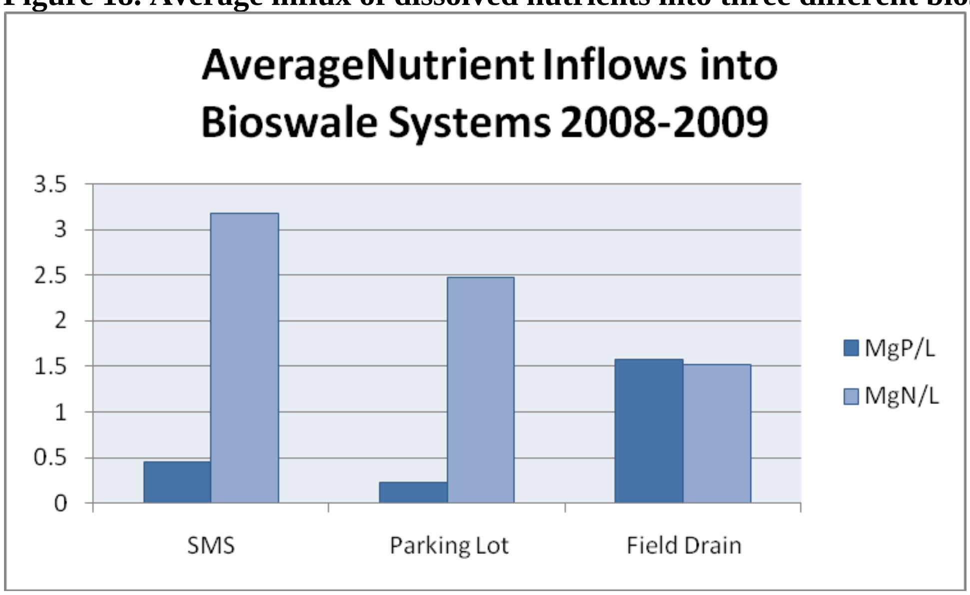
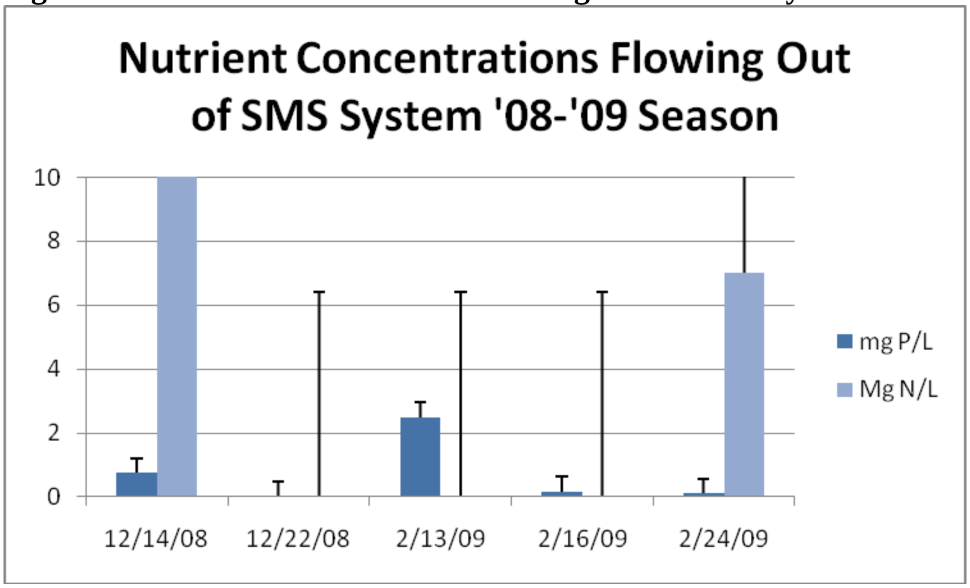


Figure 19. Nutrient Concentration Flowing Out of SMS System '08-'09



4.7 Vertebrate/ Invertebrate Monitoring

Vertebrate monitoring is underway in the form of an observed species list (Table 15 pg. 51). CCBER has also initiated a formal bird survey conducted by Mark Holmgren and his trained assistants. Mr. Holmgren was CCBER's vertebrate collections manager and is a well respected birding expert. Currently, there have been 56 bird species reported on site. This includes various raptors, songbirds, flycatchers, as well as resident and migratory shorebirds among others. Some species have begun nesting on site, most notably the Red-winged Blackbirds that have taken residence in the Stormwater Management System basins. The annual flush of tarplant attracts many foraging species during summer, and the perennial presence of raptors is indicative of a stable and productive food web. The vertebrate record also includes 8 mammal and 7 herptile species, which have likewise maintained a consistent presence. In contrast, the adjacent sports field receives little animal use outside the rainy season. Please see some photos of our regular visitors towards the back of this report (Photos 61-66, pgs. 113-115).

5 SUMMARY AND PROJECT UPDATES

5.1 Report Summary

The San Clemente Habitat Restoration & Stormwater management Project success is a testament to the value and feasibility of smaller scale restoration efforts conducted in conjunction with development. While the project site is located in a relatively developed area, it has a high level of biodiversity and adds natural value to an area, which is known for its natural resources and beauty. At this point in the mitigation period, it seems likely that the project will be largely self-sustaining within the next three years if the same amount of effort and care are afforded to it for that remaining period of time. It is also of monumental importance that the site's connectivity to other open space areas remains preserved. It is wonderful to protect any size or type of habitat when the opportunity presents itself, but the most important thing that can be done to ensure an area's ecological viability and function is to assess where it fits within the greater context of regional ecological resources. Once a context and relationship has been established, the most effective way to ensure species movement and communication is to have unbroken, passable corridors for species movement and communication. That being said, the last challenge left in preserving this project's value is a smart solution for the "access" road that UCSB developed simultaneously with the San Clemente dorm construction in 2005. Smart solutions to preserve the habitat viability of the San Clemente site range from leaving the "access" road area as is, being only a rarely used fire access road, to removing the access road all together.

5.2 Project Amendments & Changes

This section was created to notify the overseeing agency of changes to the project plan that have occurred in the first four years of work. Many of these changes are not consistent with coastal commission policies, and the approved habitat restoration plan, but were deemed necessary for safety or other reasons.

5.2.1 Pedestrian Trail Change

The trail originally designed to run through the northern quarter of the site from west to east was eliminated from the plan due to the need for various swale crossings. A new trail was built further to the north through a section of restored oak woodland habitat (Fig. 38. pg. 76).

5.2.2 Change in Outlet design for SMS

The original SMS design had an underground outlet pipe situated at the end of the open basin network. This pipe was designed to take the water from the SMS in a northward direction about 150 meters where it would daylight again in the head swale of East Storke wetlands. Prior to the start of grading, it was realized that the underground outflow would not be feasible due to the presence of a buried gas line directly in the path of the proposed pipe. A new plan was submitted by Fuscoe Engineering with an above-ground swale that accomplished the same goals. This addition to the plan was a positive one in that an above ground swale is more valuable in terms of water quality and habitat creation. The problem with this change is that the surface swales elevation was almost identical to that of Los Carneros Rd. directly to the west. This created a potential for flooding of the roadway. Upon noticing this flaw the project manager notified ProWest constructors and a solution was obtained by continuing an already elevated berm on the western end of the project further to the north. This change was completed in the summer of 2007. This change averted modest to large-scale flooding in one large storm event in February of 2008. Although this change was considered successful, this swale will not be flood-proof until the drainage issue of the access road is resolved.

5.2.3 Fencing Change

On the eastern edge of the project site, the western Storke playing field extension was installed in late 2007. It was deemed necessary for safety reasons to change the mandated post and cable fence type to a 6 foot black vinyl coated chain link fence in that area. This portion of chain link fence is approximately 410 feet long. The fields are often utilized by small children, and it was a concern that the youngsters might wander the 250 feet to the stormwater management system ponds and drown. The new fence has no space for animal passage because such a space would enable small children to pass. The fence was also created with gated openings that will remain unlocked so that stray sporting equipment may be retrieved from the restoration site. It is of concern that these entry points may encourage unauthorized access through the habitat area. The remainder of the site features post and cable fencing, which will allow sufficient animal passage. Installation was completed on February 12, 2010.

5.2.4 Additional inflow to the SMS added

In November of 2008, a new inflow to the Storm Water Management System was added with Coastal Commission approval. This new input drains the new westbound lanes of El Colegio Rd. The drainage area of approximately three acres is composed entirely of new road surface. Penfield & Smith did a study on how this large new input will affect the flood control capacity of the basin network and the storm flows leaving the site as compared to pre-construction flows.

Penfield & Smith recommended removing 6 inches of rocks from the Southern basin overflow area. This should ease the ability of large flows to move through the system, but the additional source of water will undoubtedly increase the volume of runoff leaving the site as compared to pre-project flow conditions. As originally designed, the SMS is supposed to reduce flows to a level close to that of pre-development conditions.

The university did add a stormwater filter designed to capture oil and other floatables as well as sediment that may enter the constructed wetland from the new roadway. The unit produced by ADS Water Management Company has been installed, and will be cleaned as needed using a vacuum truck. The addition of this unit, as long as it is properly maintained, will pre-treat runoff coming from the roadway before it reaches the wetland. With the help of graduate students on campus we will assess how this source of stormwater will affect the water quality improving ability of the basin network and how the downstream watershed of Storke wetlands and Goleta Slough will be affected in terms of water quality. Target pollutants expected from this type of surface include mostly heavy metal and hydrocarbons. This input will be monitored for hydrology and water quality as well; data will be presented in the upcoming water quality report.

5.2.5 Tarplant Areas P1 & P2 in County Right of Way (ROW)

Tarplant areas P1 and P2, which lie on the north western portion of the restoration site fall in the right of way of the County of Santa Barbara along Los Carneros Rd (see tarplant locations on Fig.28, pg.61). As of late January 2010, the University has received an easement from the County of Santa Barbara, for that portion of the project site. With this easement in place not only will protection be ensured for the threatened tarplant, but a modest amount of space for additional restoration will be obtained.

Since the 2008 report, a decision on fencing in this area was made. The county of Santa Barbara declined to have any fencing for the project occur in the County ROW easement area due to issues with the possible liability to the county if a drowning occurred in the adjacent stormwater management basins. The solution was to keep the post and cable fence on UCSB property. Due to this, tarplant preservation areas 1 and 2 have not been fenced in with the rest of the project. The current solution for this is to fence these relatively small areas separately with an aesthetically pleasing wood post and rope fence design and some signage. It is our hope that this will alert the public to the presence of a rare plant species in this area.

5.2.6 Transition Area

At the southeastern end of the site near the surface parking lot, there is a significant amount of open area that does not fall within the 100 foot buffer of the existing wetland on site. Under the original plan, the area was to be maintained by UCSB Housing staff and was slated to be planted with a mix of ornamental vegetation and native but non-local genotypes. CCBER proposed that UCSB Housing plant this area in local native vegetation to fit the scheme of the restoration site directly adjacent to it. The Housing and Residential Services at UCSB agreed to this proposal and granted the restoration project the area as a transition zone, which may be planted with natives and maintained along with the rest of the restoration site. Planting natives in the transition area will surely benefit the habitat congruity of the whole restoration site.

Unfortunately the plan for this area has changed as of ’09-‘10. Housing and Residential Services at UCSB has notified CCBER that there are 2 reasons that the above solution will be nullified. First, all areas outside of the existing buffer fall within the building envelope of the San Clemente Graduate Housing addition, which will eventually occur on the surface parking lot located there. The concern is if native habitat establishes outside the buffer within the new building envelope, then issues may arise with the development as planned. Secondly, Housing and Residential Services would like to have areas where representatives from the U.S. Green Building Council can come and view the restoration site and its activities.

As of this writing the final layout for this transition zone has been worked out (Fig. 42, pg. 80), and will include restoration viewing areas and an array of native plants consistent with those occurring on the restoration site. Signage will also be installed to educate the public and USGBC members of the activities going on at the restoration site. The post and cable fence has been located just on the outer edge of the existing wetland’s 100 foot buffer line surveyed by Penfield and Smith per the original habitat area maps produced by Morro group. A current photo may be viewed in the appendix. (Photo 67, pg. 116)

5.2.7 Western Habitat Buffer/ SB County ROW

CCBER, in conjunction with campus planning, has created a habitat transition/buffer zone via a County easement on the entire western portion of the site. CCBER believes that this large area has a great potential to provide additional habitat value to the restoration site. The area, which falls in the county right of way along Los Carneros road, extends along the entire Western edge of the restoration site and varies from 2 feet wide to over 20 feet in some sections. The plan for the area incorporates the use of native shrubs and forbs along with eight Western Sycamores to create additional habitat and provide a buffer from the roadway for the stormwater management wetlands directly to the east. Usually areas like these become weedy and can lead to the spread of invasive weeds into the restoration site. Under the new easement agreement, the county is relieved of its maintenance obligations, and CCBER is able to eliminate exotic weed issues while adding value to the restoration site.

The plan was finalized and approved in January of 2010, and the planting of the area is complete. Included are some photos of this shrub border. (Photos 68 & 69, pgs. 116-117)

6 TABLES

Table 12. Native plant species naturally occurring on the San Clemente restoration site

Native Species	Common Name
Amaranthus blitoides	Prostrate Amaranth
Ambrosia chammisonis	Beach Bur
Ambrosia psilostachya	Western Ragweed
Artemisia californica	California Sagebrush
Artemisia douglasiana	Mugwort
Asclepias fascicularis	Narrow-Leaved Milkweed
Aster subulatus	Slender Aster
Atriplex lentiformis	Quail Bush
Atriplex triangularis	Fat Hen
Baccharis pilularis	Coyotebush
Baccharis salicifolia	Mule-fat
Bolboschoenus maritimus	Sea-Club Rush
Bromus carinatus	California Brome
Calandrinia ciliata	Red Maids
Calystegia macrostegia ssp. cyclostegia	Coastal Morning Glory
Camissonia micrantha	Miniature Suncup
Cardamine oligosperma	Little Western Bittercress
Castilleja densiflora	Dense Flower Owl's Clover
Ceanothus cuneatus	Buckbrush
Centromadia parryi ssp. australis	Southern Tarplant
Conyza canadensis	Horseweed
Conyza coulteri	Coulter's Conyza
Croton setigerus	Doveweed
Cyperus eragrostis	Tall Flatsedge
Cyperus esculentus	Yellow Nut Sedge
Datura wrightii	Toloache
Deinandra fasciculata	Fascicled Tarplant
Eleocharis acicularis	Needle Spikerush
Eleocharis macrostachya	Spike Rush
Eleocharis parishii	Parish's Spike Rush
Epilobium brachycarpum	Panicled Willow Herb
Epilobium ciliatum	Common Willow-herb
Euthamia occidentalis	Western Goldenrod
Filago californica	California Cottonrose
Gnaphalium bicolor	Bicolored Everlasting
Gnaphalium palustre	Western Marsh Cudweed
Grindelia camporum	Gum Plant
Heterotheca grandiflora	Telegraph Weed
Hordeum brachyantherum ssp. brachyantherum	California Barley
Isocoma menziesii	Coast Goldenbush
Juncus acutus	Spiny Rush
Juncus bufonius	Toad Rush
Juncus patens	Common Rush
Lepechinia calycina	Pitcher Sage
Linaria canadensis	Toad Flax

Lupinus bicolor	Miniature Lupine
Lupinus succulentus	Succlulent Lupine
Malvella leprosa	Alkali Mallow
Platanus sp.	Plane sp.
Quercus agrifolia	Coast Live Oak
Salix lasiolepis	Arroyo Willow
Salix sp.	Willow
Sarcocornia pacifica	Pickleweed
Schoenoplectus californicus	California Bulrush
Sisyrinchium bellum	Blue-eyed Grass
Solanum douglasii	Douglas' Nightshade
Suaeda calceoliformis	Horned Sea Blite
Toxicodendron diversilobum	Poison Oak
Typha domingensis	Cat-tail
Verbena lasiostachys	Western Vervain
Xanthium strumarium	Cockleburr
Zeltnera muehlenbergii	Muehlenberg's Centaury

Table 13. Exotic plant species observed on the San Clemente restoration site

Non-Native Species	**Common Name**
Acacia longifolia	Sydney Golden Wattle
Amaranthus hybridis	Green Amaranth
Amaranthus albus	Pigweed
Amaranthus retroflexus	Rough Pigweed
Anagalis arvensis	Scarlet Pimpernel
Antirrhinum sp.	? Snapdragon
Asphodelus fistulosus	Onionweed
Atriplex semibaccata	Australian Saltbush
Avena barbata	Slender Oat
Avena fatua	Wild Oat
Beta vulgaris	Beet
Brachypodium distachyon	False Brome
Brassica nigra	Black Mustard
Brassica ssp.	Mustard
Bromus catharticus	Rescue Grass
Bromus diandrus	Rip-gut Brome
Bromus hordaceus	Soft Brome
Capsella bursa-pastoris	Shephard’s Purse
Carduus pycnocephalus	Italian Thistle
Carpobrotus edulis	Sea Fig
Chamaesyce maculata	Spotted Spurge
Chamaesyce prostrata	Prostrate Spurge
Chenopodium album	Pigweed
Chenopodium ambrosioides	Mexican Tea
Chenopodium murale	Nettle-leaved Goosefoot
Convolvulus arvensis	Field Bind Weed
Conyza bonariensis	Flax-Leaved Fleabane
Conyza floribunda	Asthmaweed
Coronopus didymus	Stinkweed

Cortaderia selloana	Pampas Grass
Cotula australis	Australian Brass Buttons
Cotula coronopifolia	Brass Buttons
Crypsis schoenoides	Swamp Grass
Cynodon dactylon	Bermuda Grass
Cyperus sp.	Nut Sedge
Dichondra ssp.	Asian Pony-foot
Echinochloa crus-galli	Barnyard Millet
Echium candicans	Pride of Madeira
Erodium botrys	Long Beak Stork's Bill
Erodium cicutarium	Redstem Filaree
Eucalyptus sp.	Red Eucalyptus
Eucalyptus globulus	Bluegum Eucalyptus
Euphorbia peplus	Petty Spurge
Festuca pratensis	Meadow Fescue
Filago gallica	Narrow-leaved Filago
Foeniculum vulgare	Sweet Fennel
Geranium dissectum	Cutleaf Geranium
Gnaphalium luteo-album	Weedy Cudweed
Hirschfeldia incana	Short-podded Mustard
Hordeum marinum	Seaside Barley
Hordeum murinum	Mouse Barley
Kickxia spuria	Fluellin
Lactuca serriola	Prickly Lettuce
Lolium multiflorum	Italian Ryegrass
Lotus corniculatus	Bird's-foot Trefoil
Lythrum hyssopifolium	Loosestrife
Malva parviflora	Cheeseweed
Marrubium vulgare	White Horehound
Medicago polymorpha	Burr Clover
Melilotus albus	White Sweet Clover
Melilotus indicus	Yellow Sweet Clover
Myoporum sp.	Myoporum
Nicotiana glauca	Tree Tobacco
Oxalis pes-caprae	Bermuda Buttercup
Pennisetum clandestinum	Kikuyu Grass
Phalaris aquatica	Harding Grass
Picris echioides	Bristly Ox Tounge
Pinus sp.	Pine
Piptatherum miliaceum	Smilo Grass
Plantago coronopus	Cut-Leaved Plantain
Plantago lanceolata	English Plantain
Poa annua	Annual Bluegrass
Polycarpon tetraphyllum	Four-leaved Allseed
Polygonum arenastrum	Oval-leafed Knotweed
Polypogon interruptus	Beard Grass
Polypogon monspeliensis	Rabbit's Foot Grass
Portulaca oleracea	Purslane
Raphanus sativus	Wild Radish
Ricinus communis	Castor Bean

Rumex acetosella	Sheep Sorrel
Rumex crispus	Curly Dock
Rumex sp.	Dock sp.
Salsola kali	Russian Thistle
Silene gallica	Windmill Pink
Solanum lycopersicum	Cherry Tomato
Sonchus oleraceus	Common Sow Thistle
Spergularia arvensis(?)	Corn Spurry
Spergularia bocconii	Sandspurry
Spergularia villosa	Hairy Sandspurry
Trifolium hirtum	Rose Clover
Triflolium pratense	Red Clover
Urtica urens	Dwarf Nettle
Vicia benghalensis	Purple Vetch
Vicia sativa	Common Vetch
Vicia villosa	Winter Vetch
Vulpia bromoides	Brome Fescue
Washingtonia robusta	Mexican Fan Palm

Table 14. Planting Palette by Habitat Type (*some species listed may not be planted depending on local seed availability**)**

COASTAL SAGE SCRUB	
Artemisia californica	California Sage Brush
Atriplex lentiformis	Quail Bush
Baccharis pilularis	Coyote Bush
Calystegia macrostegia	Morning Glory
Corethrogyne filaginifolia	California Aster
Encelia californica	Bush Sunflower
Epilobium canum	Fuschia
Eriogonum parviflorum	Sea Cliff Buckwheat
Eriophyllum confertifolium	Golden Yarrow
Gnaphalium bicolor	Bicolored Everlasting
Gnaphalium californica	Green Everlasting
Hazardia squarrosa	Saw-Toothed Goldenbush
Isocoma menziesii	Golden Bush
Leymus condensatus	Giant wild Rye
Lotus scoparius	Deer Weed
Malacothrix saxatilis	Sea Cliff Daisy
Marah fabaceus	Wild Cucumber
Mimulus aurantiacus	Bush Monkey flower
Phacelia ramosissima	Rambling Phacelia
Rhus integrifolia	Lemonade Berry
Salvia leucophylla	Purple Sage
Salvia mellifera	Black sage
Scrophularia californica	California figwort
Solidago californica	California Goldenrod
Symphyotrichum chilense	Common Aster
Verbena lasiostachys	Western Vervain

WOODLAND	
Artemisia douglasiana	Mugwort
Astragalus trichopodus	Coast Locoweed
Baccharis plummerae	Plummer's Baccharis
Bromus carinatus	California Brome
Chenopodium californicum	Pigweed or Goosefoot
Conyza coulteri	Coulter's Conyza
Dudleya lanceolata	Live-forever
Elymus glaucus	Blue Wild Rye
Encelia californica	Bush Sunflower
Galium nuttallii	Santa Barbara Bedstraw
Heteromeles arbutifolia	Toyon
Juglans californica	Southern Black Walnut
Juncus occidentalis	Yard Rush
Juncus patens	Common Rush
Juncus textilis	Basket Rush
Keckiella cordifolia	Honeysuckle Penstemon
Leymus condensatus	Giant Wild Rye
Leymus tritichoides	Alkali Rye
Lonicera subspicata ssp subspicata	Santa Barbara Honeysuckle
Lotus scoparius	Deer Weed
Mimulus aurantiacus	Bush Monkey Flower
Paeonia californica	Peony
Pholistoma auritum	Fiesta Flower
Prunus ilicifolia	Holly-Leaved Cherry
Quercus agrifolia	Coast Live Oak
Ranunculus californica	California Buttercup
Rhamnus californica	Coffeeberry
Rhamnus crocea	Redberry
Ribes amarum	Bitter Gooseberry
Ribes speciosum	Fuchsia-Flowered Gooseberry
Rosa californica	California Wild Rose
Salix lasiolepis	Arroyo Willow
Salvia spathacea	Hummingbird sage
Sambucus mexicanus	Blue Elderberry
Scrophularia californica	California Figwort
Sidalcea malviflora	Common Checker Bloom
Solanum douglasii	Douglas' Nightshade
Stacchys bullata	Common Wood Mint
Symphoricarpos alba	Snow Berry
Toxicodendron diversilobum	Poison Oak
Venegasia carpesoides	Canyon Sunflower
Verbena lasiostachys	Western Vervain
GRASSLAND	
Amsinckia sp.	Fiddleneck
Antirrhinum nuttallianum ssp. *subsessile*	Nuttal's Snapdragon
Asclepias fascicularis	Narrow-Leaved Milkweed
Atriplex coulteri	Coulter's Saltbush
Bromus carinatus var. *carinatus*	California Brome
Calandrinia ciliata	Red Maids

Calystegia macrostegia	Morning Glory
Camissonia micrantha	Small Primrose
Cardionema ramosissimum	Sand Mat
Castilleja exserta	Purple Owl's Clover
Centromadia parryi ssp australis	Southern tarplant
Chlorogalum pomeridianum	Soap Plant
Croton setigerus	Dove Weed
Datura wrightii	Jimson weed
Deinandra fasciculata	Fascicled Tarplant
Deinandra increscens ssp. *increscens*	Tarplant
Ericameria ericoides	Mock Heather
Eschscholzia californica	California poppy
Gnaphalium canescens	Fragrant Everlasting
Gnaphalium stramineum	Cotton-Batting Plant
Grindelia camporum	Gum Plant
Hordeum brachyantherum ssp californicum	Meadow Barley
Hordeum depressum	Alkali Barley
Juncus occidentalis	Yard Rush
Juncus patens	Common Rush
Lotus salsuginosus	Coastal Lotus
Lotus strigosus	Bishop's Lotus
Lupinus bicolor	Bicolored Lupine
Lupinus succulentus	Succulent lupine
Malvella leprosa	Alkali Mallow
Nassella cernua	Nodding Needle Grass
Nassela pulchra	Purple Needle Grass
Plantago elongata	Bigelow's Plantain
Sisyrinchium bellum	Blue Eyed Grass
Spergularia macrotheca	Large-flowered Sand Spurry
Stacchys ajugoides	Ajuga Mint
Zeltnera muehlenbergii	Muehlenberg's Centaury
VERNAL MARSH	
Anemopsis californica	Yerba Mansa
Bolboschoenous maritimus	Prairie bulrush
Bolboschoenous robustus	Field Sedge
Carex praegracilis	Bull Tule
Distichlis spicata	Salt Grass
Eleocharis macrostachya	Common spikerush
Eleocharis parrishii	Parish's Spikerush
Euthamia occidentalis	Golden Rod
Hordeum brachyantherum ssp brachyantherum	Meadow Barley
Juncus acutus	Spiny Rush
Juncus bufonius	Toad Rush
Juncus mexicanus	Mexican rush
Juncus patens	Common Rush
Juncus phaeocephalus	Brown-Headed rush
Juncus xiphioides	Iris-leaved Rush
Lemna gibba	Gibbous Duckweed
Rumex salicifolius	Willow Dock
Schoenoplectus americanus	Olney's Bulrush

Schoenoplectus californica	California Bulrush
Schoenoplectus pungens	common Three-square
Scirpus microcarpus	Small-fruited Bulrush
Sparganium eurycarpum	Broad-Fruited Bur-Reed
Typha domingensis	Southern cattail
Typha latifolia	Broad-leaved Cattail
VERNAL POOL	
Brodiaea jolonensis	Dwarf Brodiaea
Centunculus minimus	False Pimpernel
Crassula aquatica	Water Pygmy Weed
Elatine brachysperma	Short-seeded Waterwort
Eleocharis ascicularis	Needle Spikerush
Eleocharis macrostachya	Common spikerush
Eryngium armatum	Prickly Coyote Thistle
Eryngium vaseyi	Vasey's Coyote Thistle
Isolepis cernua	Low Club Rush
Phalaris lemmonii	Lemmon's Canary Grass
Plagiobothrys undulatus	Popcorn Flower
Psilocarphus brevissimus	Dwarf Wooly-heads
RIPARIAN	
Acer negundo	Box Elder
Alnus rhombifolia	White Alder
Artemisia douglasiana	Mugwort
Baccharis douglasii	Salt Marsh Baccharis
Baccharis salicifolia	Mule fat
Clematis ligusticifolia	Creek Clematis
Cornus sericea	Creek Dogwood
Cressa truxillensis	Alkali Morning-glory
Helenium puberulum	Sneezeweed
Juglans californica	Southern Black Walnut
Juncus patens	common Rush
Leymus x *multiflorus*	Hybrid Rye
Leymus tritichoides	Alkali Rye
Lotus purshianus	Spanish Clover
Malvella leprosa	Alkali Mallow
Oenothera elata	Hooker's Evening Primrose
Pilularia americana	American Pilwort
Platanus racemosa	Western Sycamore
Pluchea odorata	Marsh fleabane
Populus balsamifera	Black cottonwood
Rosa californica	Castillian Rose
Salix exigua	Sand Bar Willow
Salix lasiolepis	Arroyo Willow
Salix laevigata	Red Willow
Urtica dioica	Creek Nettle

Table 15. Vertebrate species list for species observed on the San Clemente restoration site

MAMMALS	
Canis latrans	Coyote
Lynx rufus	Bobcat
Mephitis mephitis	Striped Skunk
Microtus agrestis	Field Mouse
Microtus californicus	California Vole
Procyon lotor	Raccoon
Spermophilus beechyi	Ground Squirrel
Sylvilagus bachmani	Brush Rabbit
*Ursus americanus**	Black Bear*
BIRDS	
Accipiter cooperi	Cooper's Hawk
Agelaios phoeniceus	Red-winged Blackbird
Aimophila ruficeps	Rufous-crowned Sparrow
Anas platyrhynchos	Mallard
Anthus rubescens	American Pipit
Aphelacoma californica	Western Scrub Jay
Ardea alba	Great Egret
Ardea herodias	Great Blue Heron
Branta canadensis	Canadian Goose
Buteo jamaicensis	Red-tailed Hawk
Buteo lineatus	Red-shouldered Hawk
Calypte anna	Anna's Hummingbird
Carduelis psaltria	Lesser Goldfinch
Carduelis tristis	American Goldfinch
Carpodacus mexicanus	House Finch
Cathartes aura	Turkey Vulture
Charadrius vociferus	Killdeer
Circus cyaneus	Northern Harrier
Cistothorus palustris	Marsh Wren
Corvus brachyrhynchos	American Crow
Dendroica coronata	Yellow-rumped Warbler
Egretta thula	Snowy Egret
Elanus leucurus	White-Tailed Kite
Euphagus cyanocephalus	Brewer's Blackbird
Falco sparverius	American Kestrel
Falco peregrinus	Peregrine Falcon
Geothlypis trichas	Common Yellowthroat
Himantopus mexicanus	Black-necked Stilt
Hirundo rusticans	Barn Swallow
Icterus bullockii	Bullock's Oriole
Icterus cucullatus	Hooded Oriole
Larus occidentalis	Western Gull
Limnodromus griseus	Short-billed Dowitcher
Megaceryle alcyon	Belted Kingfisher
Melospiza lincolnii	Lincoln's Sparrow
Melospiza melodia	Song Sparrow
Mimus polyglottos	Northern Mockingbird

Pelecanus occidentalis	Brown Pelican
Petrochelidon pyrrhonota	Cliff Swallow
Picoides pubescens	Downey Woodpecker
Pipilo crissalis	California Towhee
Polioptila caerulea	Blue Grey Gnatcatcher
Psaltriparus minimus	Bushtit
Sayornis nigricans	Black Phoebe
Sayornis saya	Say's Phoebe
Sialia mexicana	Western Bluebird
Setophaga coronata	Yellow-rumped Warbler
Sturnella neglecta	Western Meadowlark
Sturnus vulgaris	European Starling
Tringa flavipes	Lesser Yellowlegs
Tringa melanoleuca	Greater Yellowlegs
Troglodytes aedon	House Wren
Tyto alba	Barn Owl
Tyrannus vociferans	Western Kingbird
Zenaida macroura	Mourning Dove
Zonotrichia leucophrys	White-crowned Sparrow
HERPTILES	
Diadophis punctatus	Ring-necked Snake
Elgaria multicarinata	Southern Alligator Lizard
Eumeces skiltonianus	Western Skink
Hyla regilla	Pacific Tree Frog
Lampropeltis getula californiae	California King Snake
Pituophis catenifer	Gopher Snake
Sceloporus occidentalis	Western Fence Lizard

* Black Bear was seen 50 meters directly North of the site in a thicket of willow in the summer of 2008.

Table 16. Staff Utilization Study 2010-2011(01/04/2010 - 05/31/2011)

- Total Hours Worked in 2010-2011 = 5445
  - Total Hours Spent Weeding in 2010-2011 = 1147
    - LA3 Hours Spent Weeding in 2010-2011 = 465
    - LA1 Hours Spent Weeding in 2010-2011 = 165
    - SR1 Hours Spent Weeding in 2010-2011 = 393
    - SR3 Hours Spent Weeding in 2010-2011 = 127
    - Hours Spent Weeding Grassland =304
    - Hours Spent Weeding Vernal Meadow = 159
    - Hours Spent Weeding Oak Woodland = 19
    - Hours Spent Weeding Storm Water Management System = 476
      - North Basin =205
      - Mid Basin = 48
      - South Basin = 219
    - Hours Spent Weeding Existing Wetland = 57
    - Hours Spent Weeding Tarplant Area = 126
    - Hours Spent Weeding Other Areas = 114

- Hours Spent Working at the Greenhouse in 2010-2011 = 888
- Total Hours Spent Planting in 2010-2011 = 1749
  - Existing Wetland = 202
  - Grassland = 941
  - Vernal Meadow = 253
  - Tarplant Area = 87
  - Oak Woodland = 89
  - Storm Water Management System = 131
    - South Basin = 69
    - Mid Basin = 19
    - North Basin = 43
- Hours Spent on Miscellaneous Site Maintenance (incl. Mowing) = 566
- Total Hours of Monitoring = 93
  - Water Quality Monitoring = 69
- Hours Spent Spreading Mulch = 96
- Hours Spent Working in the Office = 845
  - SR3 = 418
  - SR1 = 120
  - LA3 = 116
- Tractor Hours = 44
- Hours Seed Collecting = 323
  - Ellwood = 49
  - More Mesa = 31
  - San Clemente = 12
  - San Marcos = 213
  - Other = 18
- Hours Spraying = 8
- Hours Watering (most watering now included in “Maintenance”) = 4

Table 17. Staff Utilization Study Summary 2009

- Total Hours Worked in 2009 = 5809
  - Total Hours Spent Weeding in 2009 = 1902.5
    - LA3 Hours Spent Weeding in 2009 = 1306
    - LA1 Hours Spent Weeding in 2009 = 81
    - SR1 Hours Spent Weeding in 2009 = 209
    - SR3 Hours Spent Weeding in 2009 = 147
    - Hours Spent Weeding Grassland = 455.5
    - Hours Spent Weeding Vernal Meadow = 554.5
    - Hours Spent Weeding Oak Woodland = 117
    - Hours Spent Weeding Storm water Management System = 518
      - North Basin =147
      - Mid Basin = 97
      - South Basin = 242
      - General SMS = 28
    - Hours Spent Weeding Existing Wetland = 70

        - Hours Spent Weeding Tarplant Area = 63
        - Hours Spent Weeding San Clemente = 104
    - Hours Spent Working at the Greenhouse in 2009 = 633
    - Total Hours Spent Planting in 2009 = 938
        - Existing Wetland = 172
        - Grassland = 247.5
        - Vernal Meadow = 273.5
        - Tarplant Area = 23.5
        - Oak Woodland = 10.5
        - Storm Water Management System = 134
            - South Basin = 78
            - Mid Basin = 14
            - North Basin = 30
    - Hours Spent on Miscellaneous Site Maintenance = 296
    - Total Hours of Monitoring = 184.5
        - Water Quality Monitoring = 107
    - Hours Spent Spreading Mulch = 233
    - Hours Spent Working in the Office = 940
        - SR3 = 663
        - SR1 = 38
        - LA3 = 176
    - Tractor Hours = 137
    - Hours Seed Collecting = 221

7 FIGURES

Figure 21. San Clemente site location & surrounding resources

Figure 22. San Clemente site soils

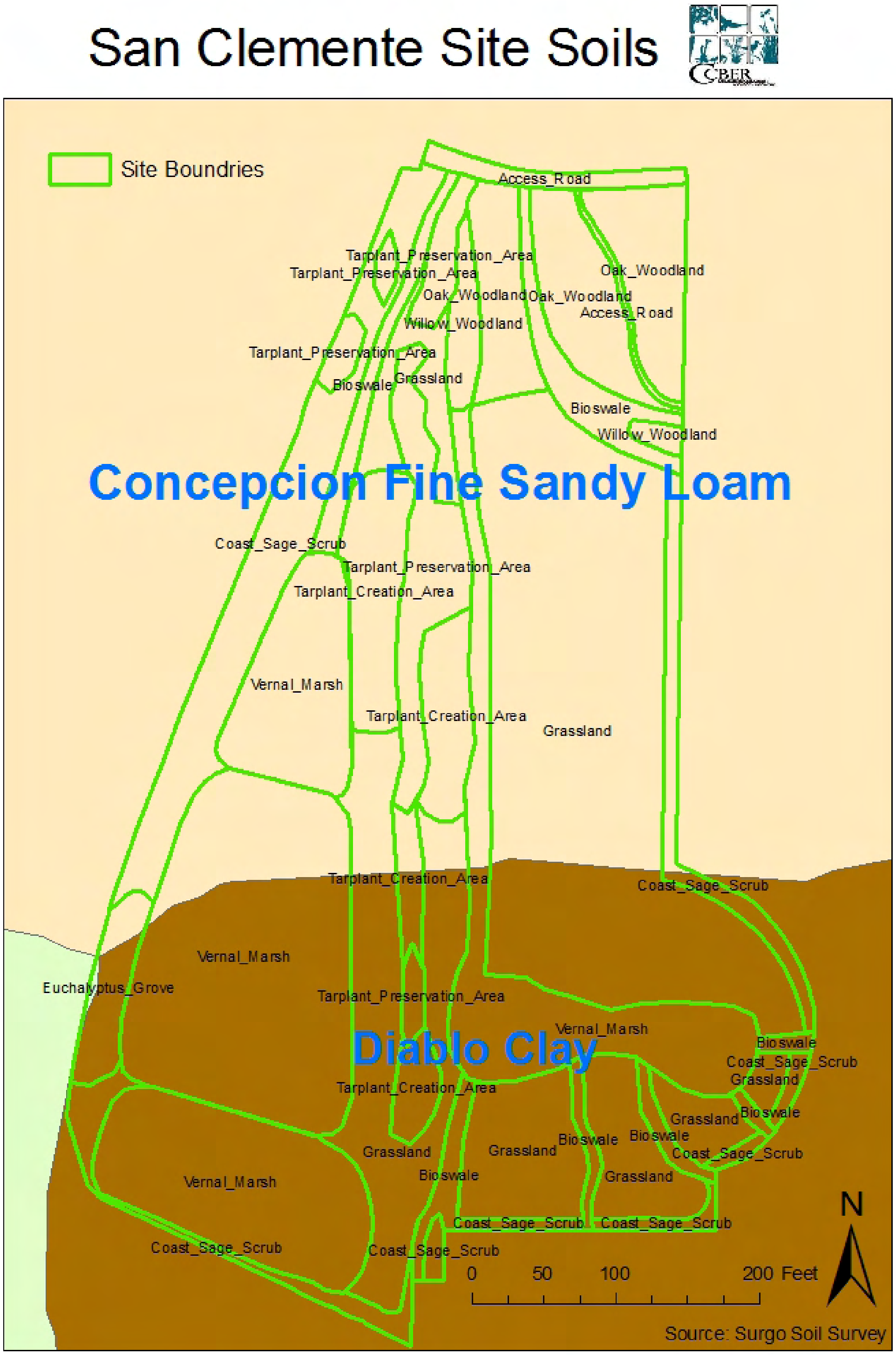


Figure 23. San Clemente Topographical Layout

Figure 24. San Clemente baseline vegetation in 2006

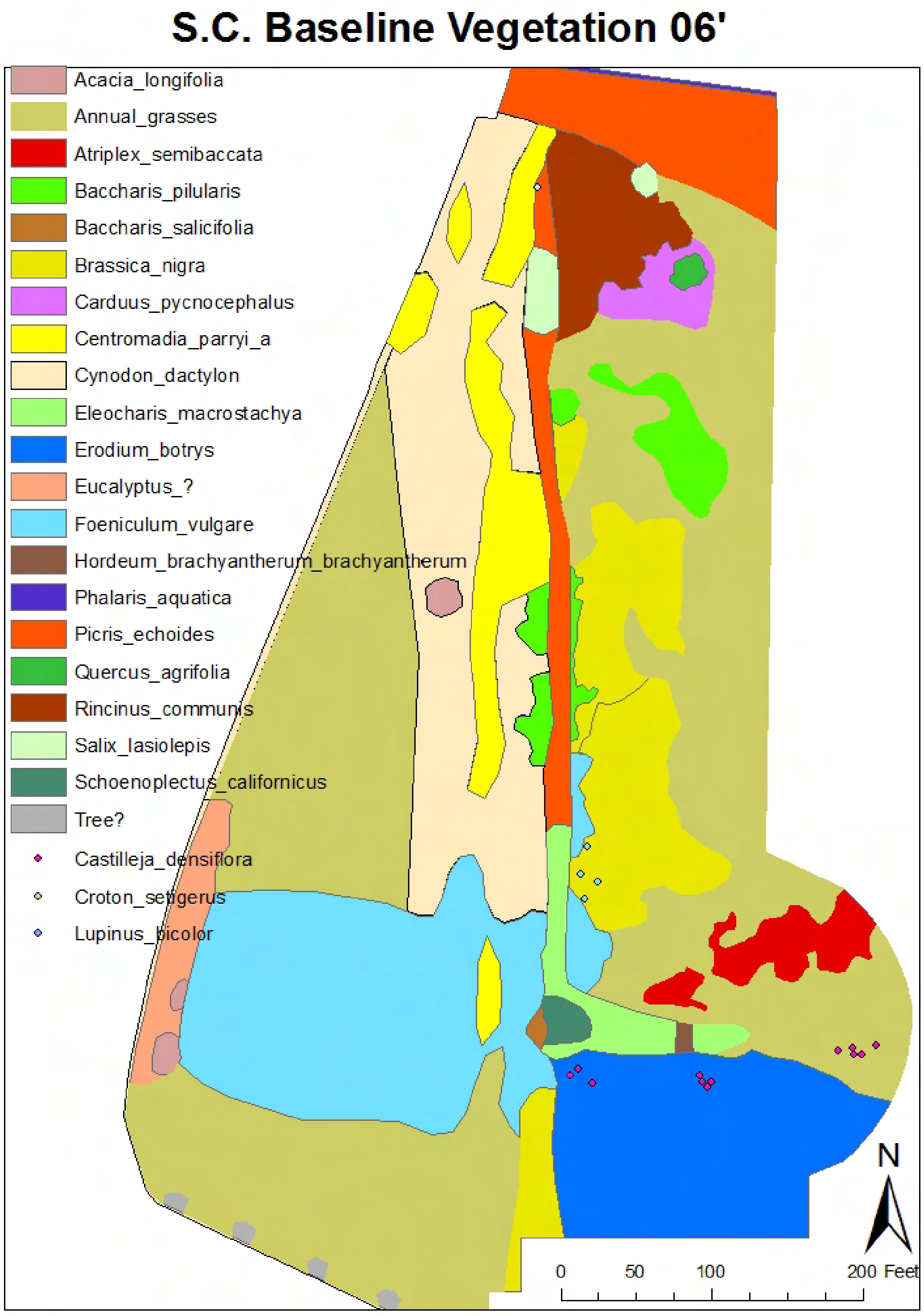


Figure 25. San Clemente baseline vegetation '07-'08

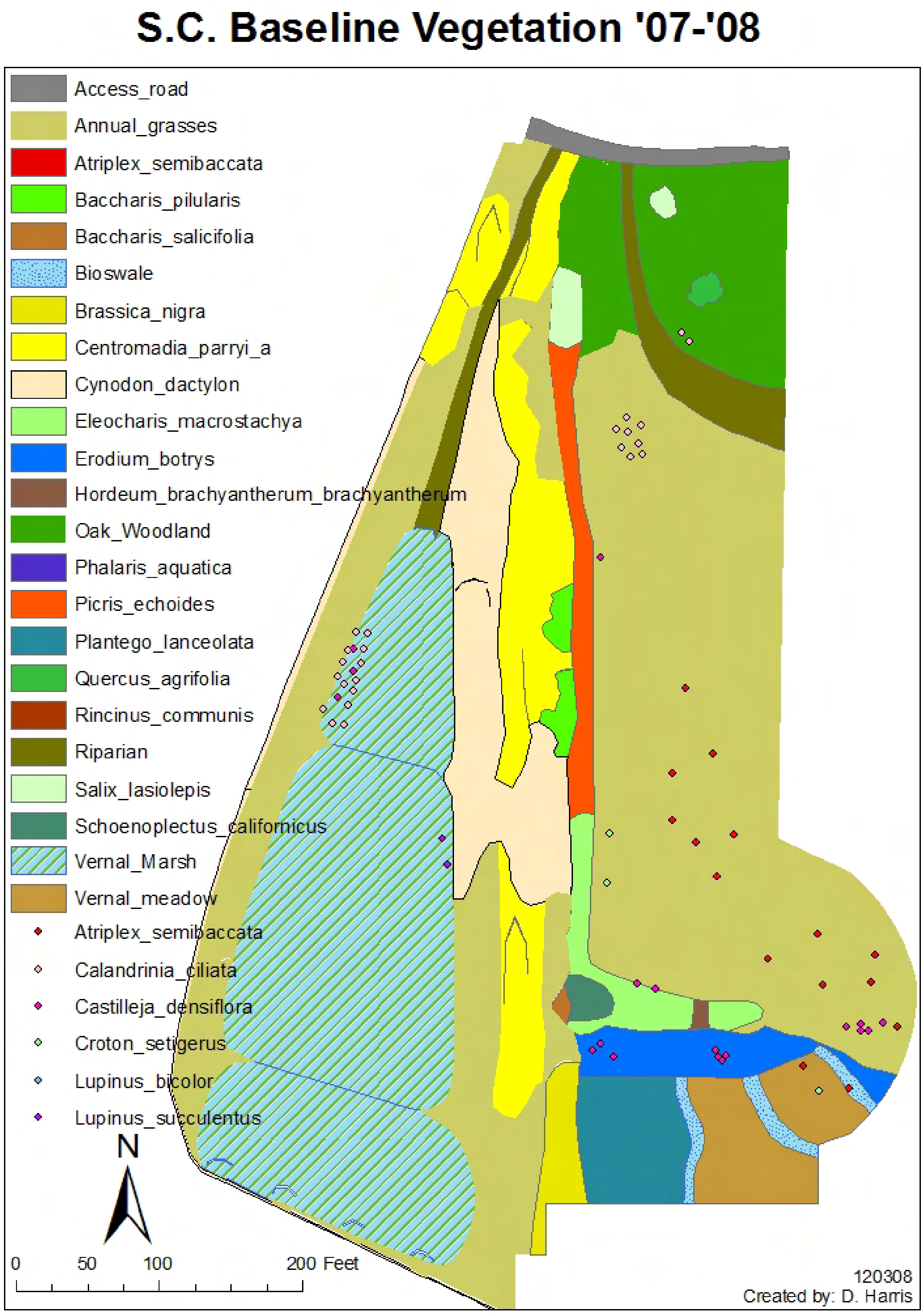


Figure 26. San Clemente baseline vegetation '09-'10

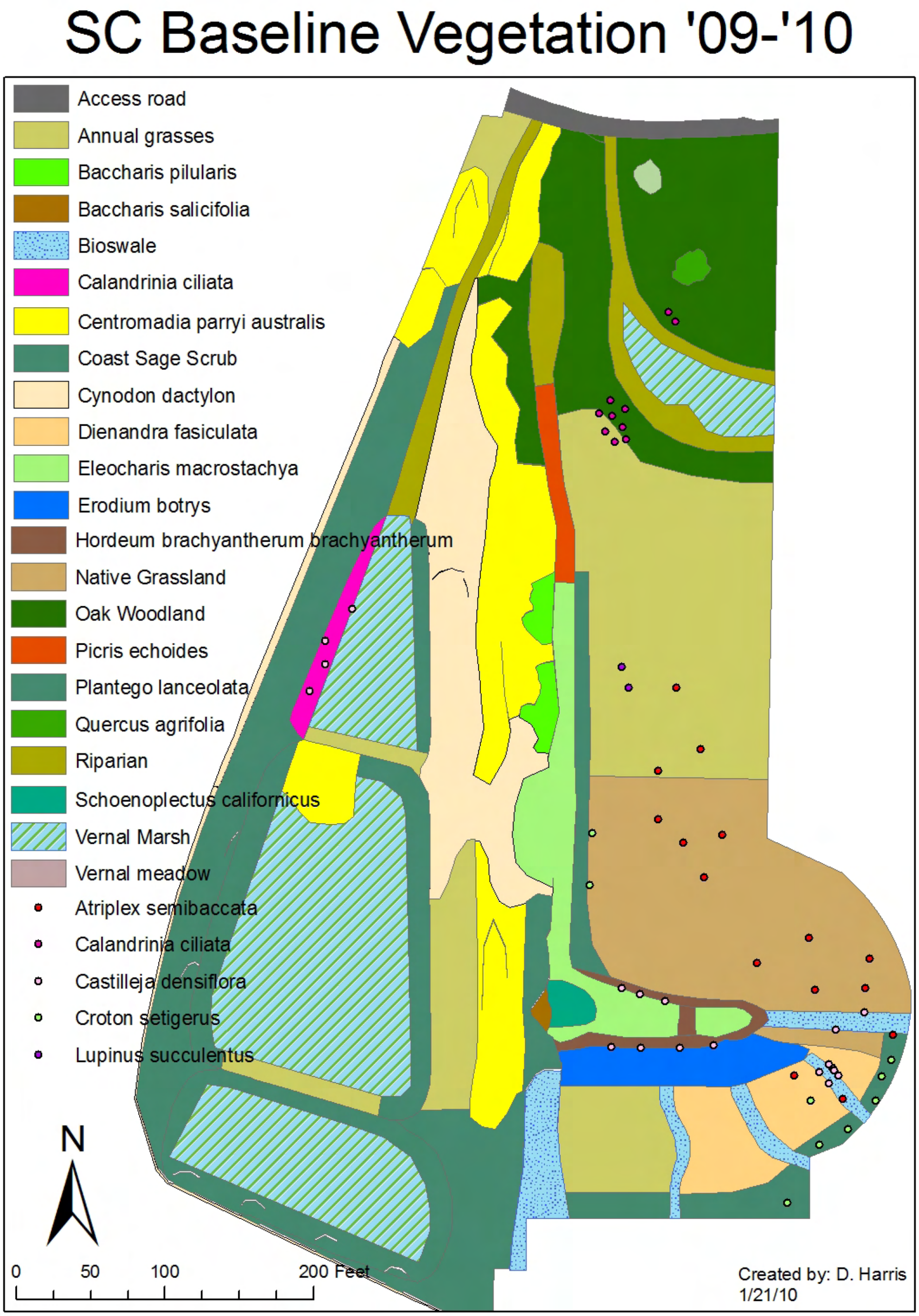


Figure 27. San Clemente baseline vegetation '10-'11

Figure 28. San Clemente restoration plan by community type

Figure 29. Tarplant preservation & creation areas with monitoring transects

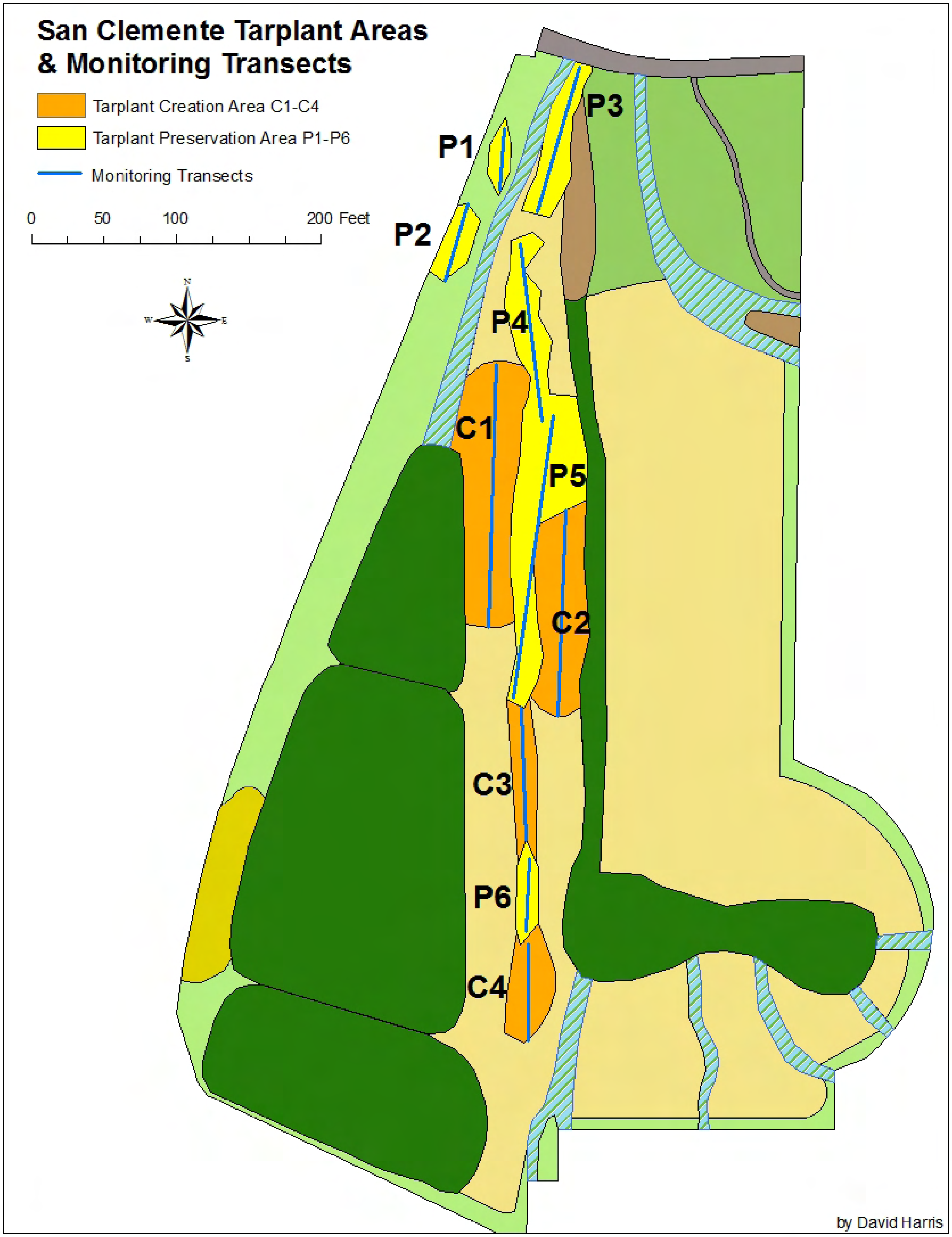


Figure 30. Tarplant distribution September of 2007

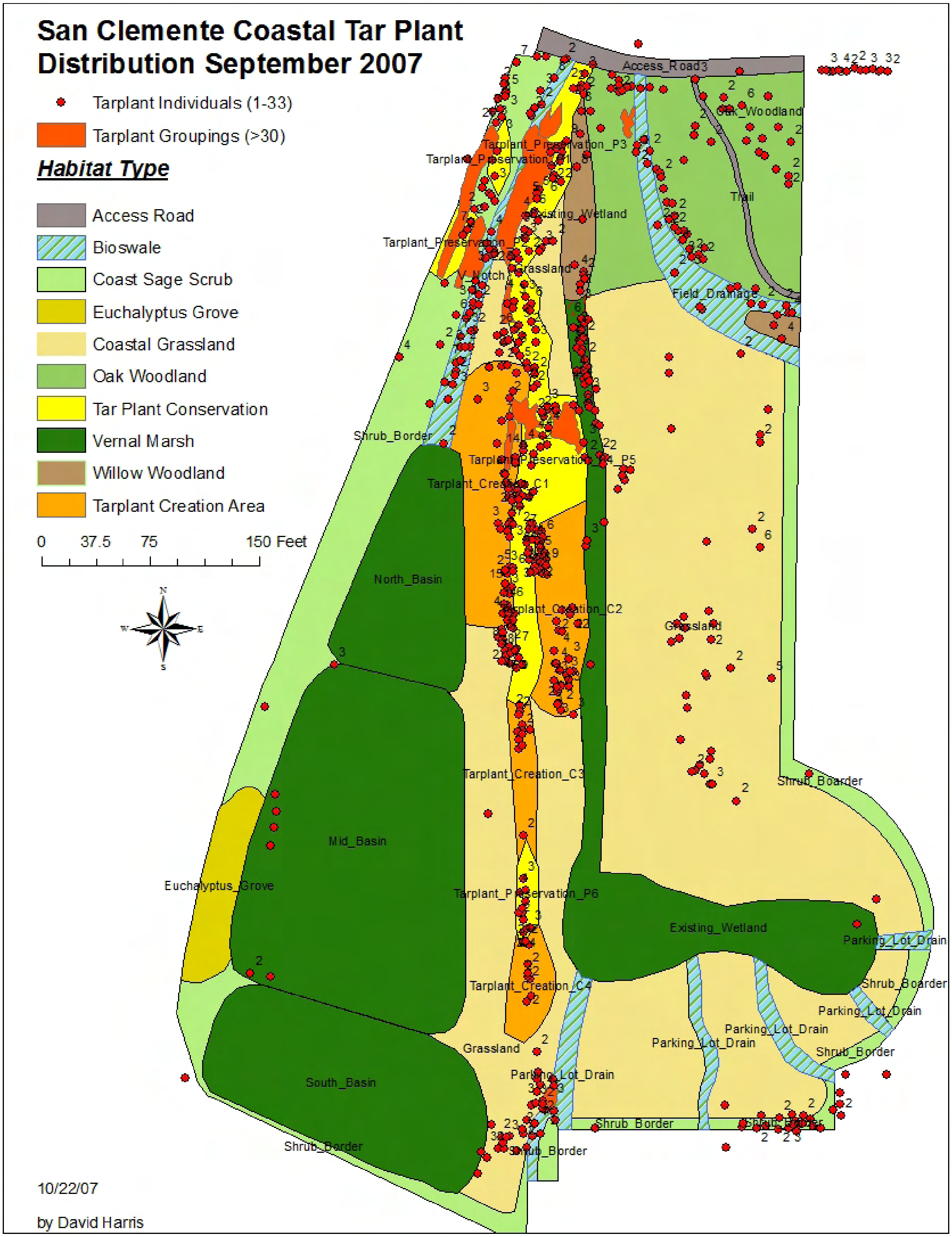


Figure 31. Tarplant distribution September of 2009

Figure 32. Tarplant distribution September of 2010

Figure 33. Tarplant distribution September of 2011

Figure 34. San Clemente Planted Areas as of 2011

Figure 35. Weed techniques applied on the San Clemente project site in 2007

Figure 36. Weed techniques applied on the San Clemente project site in 2009

Figure 37. Weed techniques applied on the San Clemente project site in '10-'11

Figure 38. San Clemente grading activities ’10-‘11

Figure 39. San Clemente photo monitoring points with directional vectors

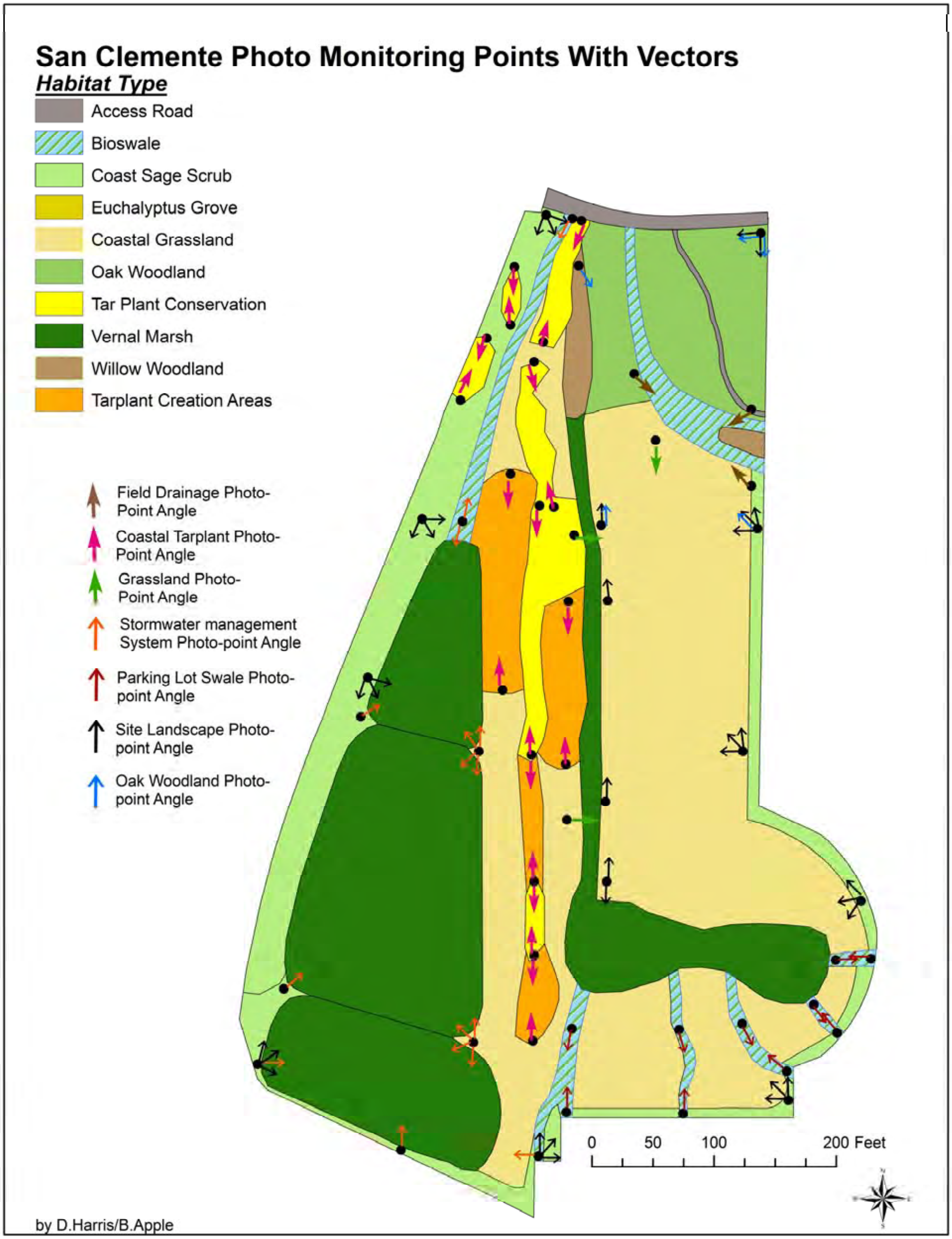


Figure 40. Stormwater management system re-grade map

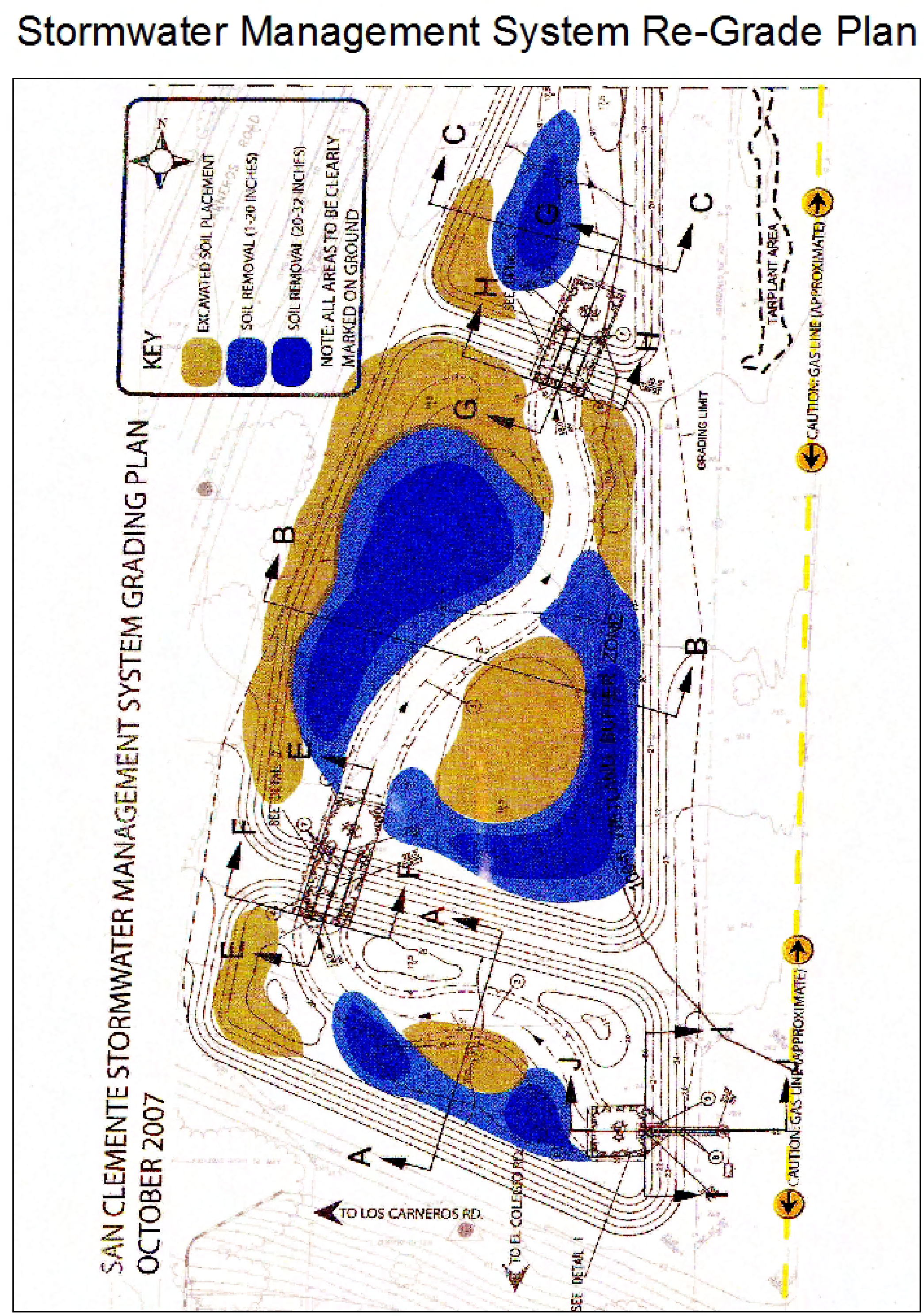


Figure 41. Stormwater management System Monitoring

Figure 42. San Clemente transition area plan

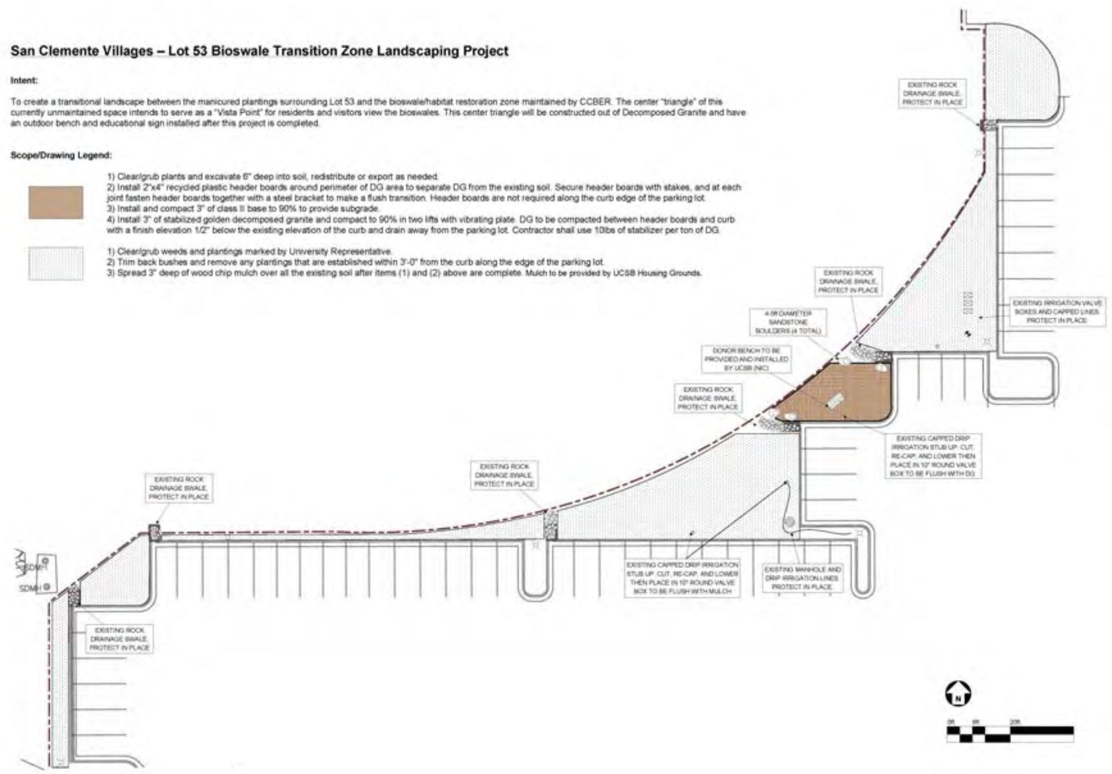
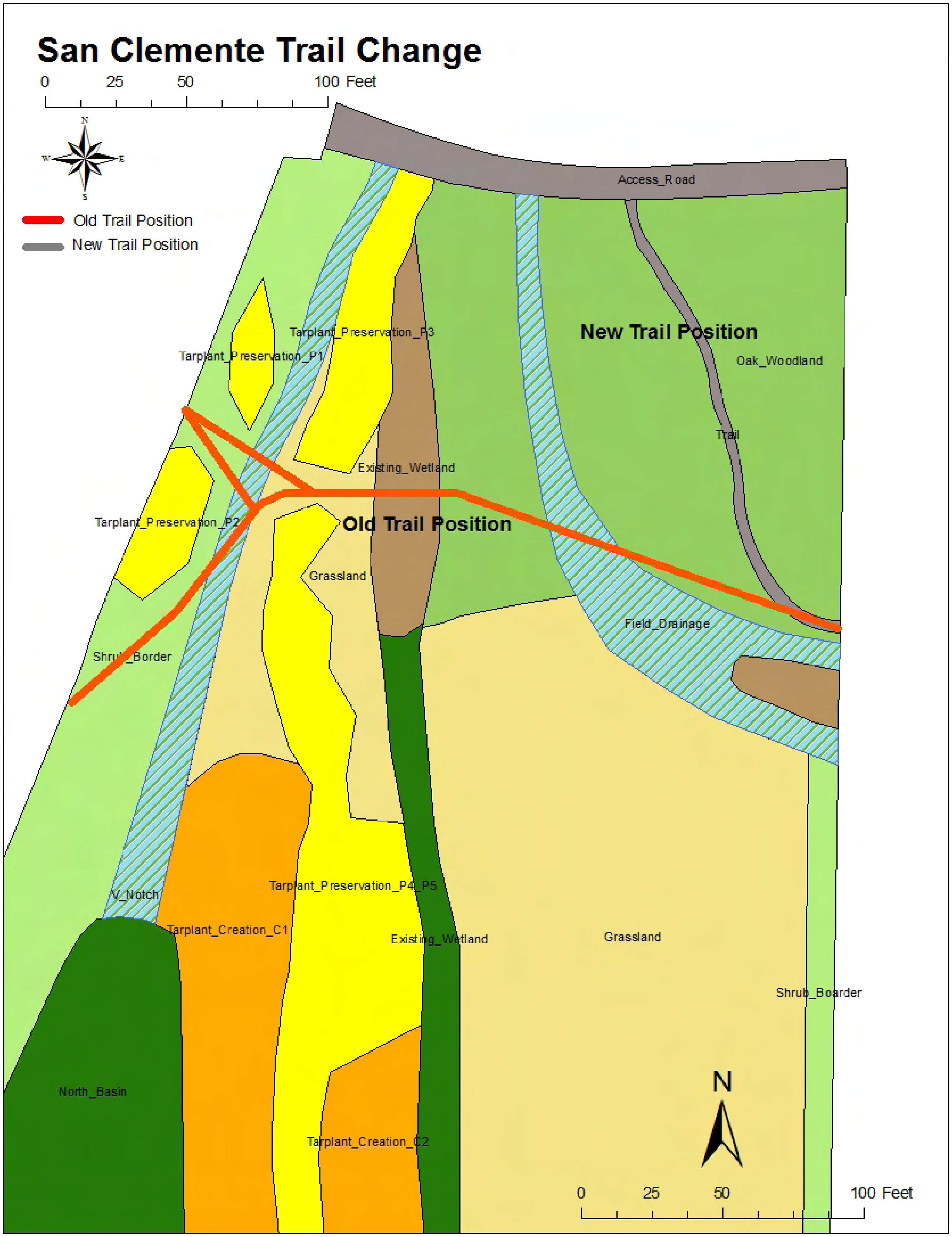


Figure 43. Locations of Storke Wetland & Tarplant Area P3 in Relation to Access Road

Figure 44. Depicting repositioning of Pedestrian Trail



8 PHOTOS

Photo 1. SMS site prior to construction looking North

Photo 2. SMS site in 2009 looking Northwest

Photo 3. SMS site in current condition looking Northwest

Photo 4. SMS initial grading 7/28/06

Photo 5. SMS during construction

Photo 6. SMS re-grade

Photo 7. Same location after the SMS regrade

Photo 8. Same location today

Photo 9. SMS coconut netting for erosion control

Photo 10. SMS: same location today

Photo 11. Field crew installing coconut netting

Photo 12. SMS drip irrigation setup

Photo 13. SMS planting South basin

Photo 14. Same location in South basin as it looks today

Photo 15. SMS planting South basin

Photo 16. South basin in the same location as it looks today

Photo 17. SMS storm event taken at inflow

Photo 18. SMS storm event

Photo 19. CCBER grading parking lot bioswale #5 that feed the existing wetland on site

Photo 20. Bioswale # 5 after major grading completed

Photo 21. Bioswale #5 after planting and erosion control

Photo 22. Bioswale #3 flooded during a storm event

Photo 23. Field Drainage Before Final Grading

Photo 24. Field Drainage After Grading and Initial Planting

Photo 25. Field Drainage As It Looks Today

Photo 26. Existing wetland south before enhancement

Photo 27. Existing wetland south immediately after enhancement

Photo 28. Existing wetland south as it looks today

Photo 29. Existing wetland middle before enhancement

Photo 30. Existing wetland middle immediately after enhancement

Photo 31. Existing wetland middle as it looks today

Photo 32. Existing wetland north before enhancement

Photo 33. Removal of debris found in area of existing wetland north

Photo 34. Existing wetland north during enhancement

Photo 35. Existing wetland north immediately after enhancement

Photo 36. Existing wetland north as it looks today

Photo 37. Tarplant Area P3 before enhancement

Photo 38. Debris removed from tarplant area P3

Photo 39. Tarplant area P3 as it looks today

Photo 40. Former tool shed location cleaned up and planted

Photo 41. Weed management – Hand weeding, see the tiny tarplant left behind

Photo 42. Mowing, a good method to keep seeds down until final eradication is completed

Photo 43. Same location today

Photo 44. Weed whacking - similar to mowing yet more mobile

Photo 45. Same location today

Photo 46. Solarization using black plastic probably the most effective large scale eradication method. See the already solarized area at the left of the frame

Photo 47. Same location today

Photo 48. Tilling the upland using a small loader

Photo 49. Same location today

Photo 50. Southern Tarplant, *Centromadia Parryi subsp. Australis*

Photo 51. One of the Tarplant preservation areas early on. Notice the thick fennel.

Photo 52. Same tarplant area in current condition. Tarplant(brown)!! Fennel??

Photo 53. One of a few delightful natives already present on site. – Purple Owl's Clover *Castilleja exserta subsp. Exerta*

Photo 54. CCBER staff salvaging plants that would otherwise be destroyed by grading

Photo 55. Planting the bioswale draining the SMS

Photo 56. Bioswale above as it currently looks

Photo 57. Planting the vernal meadow

Photo 58. Vernal meadow today

Photo 59. Coastal Fund volunteers planting the oak woodland w/ housing in background

Photo 60. Same area today

Photo 61. Killdeer chicks hatching out in the vernal meadow

Photo 62. Mother duck and her brood in the SMS w/ a black phoebe in back

Photo 63. One of our usual visitors, a friendly juvenile Red Tailed Hawk

Photo 64. Great Blue Heron in SMS Basin

Photo 65. Dragon Flies mating in SMS Basin

Photo 66. Unidentified caterpillar species on willow

Photo 67. Transition Area, 2012

Photo 68. Shrub Border, 2010

Photo 69. Shrub Border, 2011

9 WATER QUALITY LAB ANALYSIS PROTOCOLS

UCSB
CCBER San Clemente Water Quality Monitoring

UCSB CCBER

Cheadle Center for Biodiversity and Ecological Restoration

http://ccber.lifesci.ucsb.edu/

San Clemente Bioswales and Wetland Monitoring

Updated January 29, 2010

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UCSB
CCBER San Clemente Water Quality Monitoring

Nutrient Analysis in the Keller Lab
2326 Bren Hall, University of California, Santa Barbara, CA 93106
Phone (805) 893-5352

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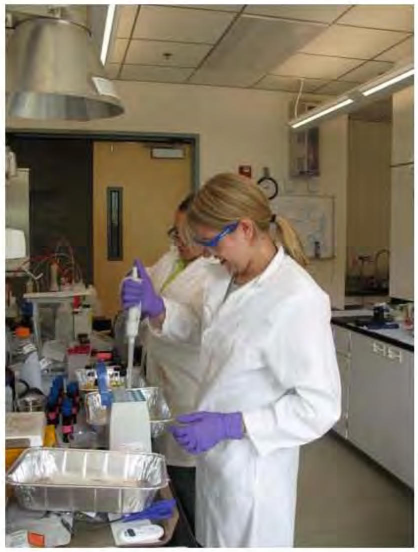
UCSB
CCBER San Clemente Water Quality Monitoring



I. Lab Safety

A. Rules
   1. Goggles must be worn when working with acids and bases
   2. Closed toed shoes must be worn at all times in the lab
   3. No eating or drinking in the lab
      i. Food and water bottles must be left outside of the lab
      ii. Wash your hands after leaving the lab and always before eating

B. Reasons: When working in a laboratory it is mandatory that you wear goggles, and closed toed shoes. Accidents can happen in the lab; some common accidents are when shaking vials a small leak of chemicals onto your hands or clothes may occur, and glassware can easily be broken when processing and cleaning sample vials. In the event that this happens it is best to be wearing some protective coverage on your eyes (goggles), on your arms and body such as a lab coat, and shoes sufficient to prevent exposure.

It is recommended that you tie back long hair when working in the lab.

Music is highly encouraged! We have a radio in the lab feel free to use it.

3

II. Notebook Keeping

A. General documentation for everyday
   1. Always number the pages of the notebook in the upper right hand corner
   2. Record the date the samples were processed in the upper right hand corner
   3. Record your names in case there is any confusion in interpreting numbers and handwriting

B. Headers to use when recording the nutrient analysis
   1. Sample ID
      a. Record the Number that corresponds to the sample site
      b. Record the Date it was sampled
      c. Record the Time the sample was taken
   2. Reading (what units did you measure it in mgP/L or $mgPO_4/L$)
   3. Comments
      i. Did you have to dilute a sample and run it again
      ii. Did anything strange happen like bubbles being formed or the sample had a chunky precipitate in it?

VIII. Log Sheets

A. Two types of sheets will be used: one for phosphate analysis (Table 1) and one for total nitrogen analysis (Table 2)

B. Phosphate samples should be analyzed with-in 48 hours of sampling

C. Total Nitrogen samples should be analyzed within 10 days

Table 1. Example of Phosphate Log Sheet

Date Sampled	Date Analyzed	Sample ID	Phosphate Test	Dilution Factor
2/02/10	2/03/10	1	0.90 limit	1
2/02/10	2/03/10	1	0.75	2
		2		
		3		
		4		
		5		

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Table 2. Example of Total Nitrogen Log Sheet

Date Sampled	Date Analyzed	Sample ID	Test Total N	Time of Final Timer Relative to Reading
		Standard 10	8.9	11 min 30 sec
		Standard 10	9	12 min 30 sec
		Standard 10	9.5	14 min 30 sec
		Standard 10	10	15 min 30 sec
		1		11 min 30 sec
		2		15 min 30 sec
		3		
		4		
		5		
		6		
		7		
		8		
		9		
		10		
		11		
		12		
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		16		
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		18		
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		20		
		21		
		22		

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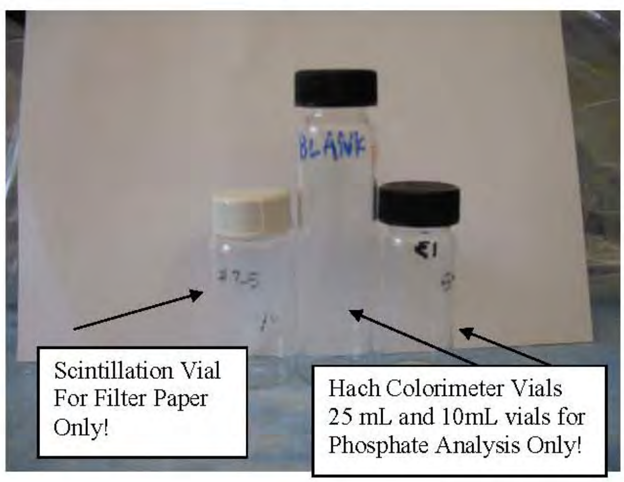
The phosphate log sheet has a column for dilutions.
If the sample turns blue right away dilute the sample with deionized water (DI water).
First run a dilution of 1:2 use 5mL of DI water to 5mL of sample.
If the reading is 0.90 Limit run a dilution of 1:10 use 9 mL of DI water and 1mL of sample.

Cheat sheet for recording in the dilution factor column based on 10mL being the total volume of sample and water

Water : Sample Ratio	How much water used (mL)	How much Sample Used (mL)	Number to multiply Reading by and Record in Dilution Factor Column
1:1	0.0	10.0	1
1:2	5.0	5.0	2
1:4	7.5	2.5	4
1:5	8.0	2.0	5
1:10	9.0	1.0	10

Please make sure you use the correct vial for filtration and the correct vial for phosphate analysis as shown in the figure below.



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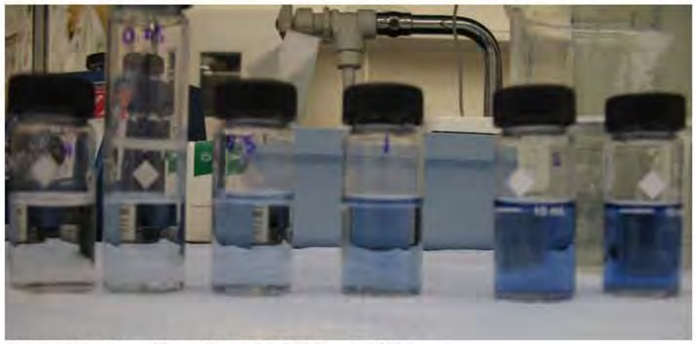
IV. Nutrient Protocols



A. **Phosphorus (Reactive) (0-0.90 mg P/L)**

1. Turn the Hach 890 colorimeter on
2. Hit the program button
3. Enter program 79
4. Use the "CONC" button to select mg P/L
    i. This will be displayed in the lower right portion of the screen
5. Select the number of sample vials you will need
6. Use rubbing alcohol and a paper towel to wipe off any sharpie labels on the vial
7. Using a blue, purple or green sharpie label the vial with the sample id
    i. For example "1 at T1" this would mean sample location 1 sampled at time 1
8. Label a vial with "Blank"
    i. Run a blank with every batch of samples
    ii. The PhosVer3 pillow has some color to it
    iii. By running the powder pillow with DI water you can subtract out any residual color from the powder pillow
    iv. Pipette 10mL of DI water into the "blank" sample cell
9. For multiple samples, measure only one at a time
    i. If working in pairs you can run two samples on one timer
10. For each sample pipette 10ml of water into the sample cell
11. Add one "PhosVer 3 Phosphate Powder Pillow" and shake vigorously for 10-15 seconds
12. Wait 2 minutes (can press TIMER, ENTER on colorimeter)
13. Wipe vial and insert into colorimeter, cap and press ZERO
14. Insert wiped vial and press READ
15. Record the value displayed and any observations such as bubble formation

Note: If you did not run the blank first and you started with a sample first that is okay. Quickly blank the program with a vial with just DI water. Run a blank after reading the sample. Then record how much the blank read (0.00 up to 0.10mg/L is normal). Write a note to subtract that reading from the sample that was read prior to setting the correct blank of DI water + PhosVer 3 reagent. Make sure to set the blank with reagent as the zero value so all of the other samples are then correctly adjusted to zero out readings due to the PhosVer3 reagent.

B. **Total Nitrogen Low level (0-25.0 mg/L)**

Part One

1. When testing multiple samples, you need only one blank (prepare it as a regular sample, using DI water instead of sample water)
2. Turn on DR Reactor so it starts warming up (the rocker switch is on the back left side of the block)
   i. Hit start to warm the block to 105°C for 30 minutes
3. For each sample, add one "Total Nitrogen Persulfate Powder Pillow Cat No. **26719-46**" to one "Total Nitrogen Hydroxide Reagent Vial" (These vials contain a hydroxide reagent and say: Cat 26717-45, Total N 0-25 mg/L)
4. Also add 2 ml of sample water (using the Finnpippette with green topper), cap and shake vigorously for 30 seconds to mix (it's okay if it doesn't all dissolve)
5. Incubate at 105°C for 30 minutes in DR Reactor You can run 15 samples on the left block and 6 samples on the right block.
6. Remove immediately when 30 minute timed reaction is done
7. Allow samples to cool to room temperature (place them in 4 deg C room to accelerate this process)

Part Two

8. Set each timer for 3 min 15 seconds, 2 minutes 15 seconds and 12 min 30 seconds
9. Cut all packets needed for step A and step B
10. Label Vial #2 with the corresponding sample ID to match Vial 1
11. When vials are 25 deg C or less (check using the laser thermometer)
12. Add one "TN Reagent A Powder Pillow" and shake 15 seconds to mix
13. Allow to sit for 3 minutes (To use colorimeter timer, enter PRGM, 58, ENTER, TIMER, ENTER)
14. Add one " TN Reagent B Powder Pillow" and shake 15 seconds to mix
15. Allow to sit for 2 minutes
16. Use a 1000 µL pipette (purple Finnpippette) to transfer 1 mL at a time of the prepared sample into a "TN Reagent C Vial" Transfer 2 mL in total (These vials contain an acid reagent and say: Cat 26721-45, Total N 0-25 mg/L (LR) or 10-150 mg/L (HR)) and cap, Warning! **It will get hot!** Be cautious!

Slowly invert 10 times (take about 30 seconds) Turn upside down wait for all of the liquid to go to the cap. Flip right side up and wait for all of the liquid to return to the bottom of the test tube. If not done properly the readings will be lower due to incomplete mixing!

17. Allow sample to sit for 11 minutes or until cool (11 to 15 min) Use the 10 mg /L Hach standard as a guide for time to run sample readings at
18. Enter program 58 if you haven't yet

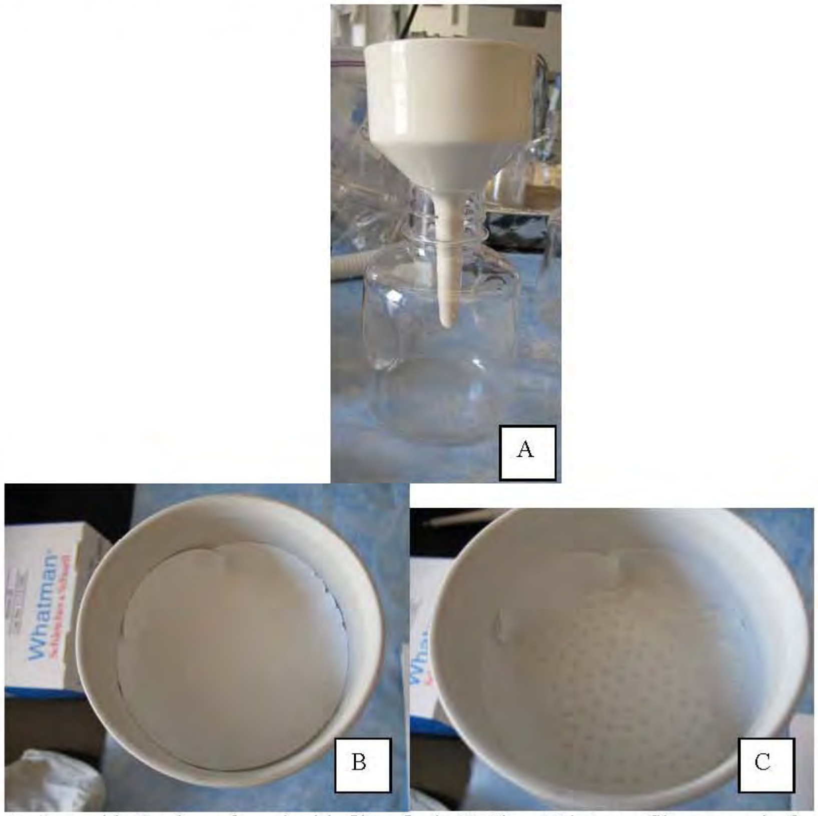
19. Insert adapter into colorimeter (rotate until the prongs line up and it drops in securely) (do not remove the plastic band)
20. Wipe the prepared blank vial and insert into the adapter, cover colorimeter with cap and press ZERO
21. Remove blank, wipe and insert sample and press READ, record

Disposal

1. Keep all of the vials from step 1 267**17**-45 and place in a Styrofoam container together
2. Place all of the step 2 vials 267**21**-45 in a separate container
3. Keep waste vials separate from new vials; write WASTE on the container
4. Add a waste label to the box (these are preprinted just cut them out and tape them on)
5. Write the start date on the waste label

V. Filtration

1. Check the log sheet to see if all phosphate and total N tests have been completed
2. If so setup gravimetric filtration station (See figures on next page)
3. Arrange a Buchner funnel on top of a filter flask
4. Place a Whatman filter paper inside the B. funnel
5. Wet the filter paper with DI water and make sure all holes are covered
6. Pour sample through 30 mL at a time
7. Return filtrate to bottle if a repeat analysis needs to be performed
8. If you are positive the sample has been successfully analyzed pour it down the drain near the bench or in the sink
9. Use tweezers to remove the filter paper
10. With clean gloves on roll the filter paper up like a taco and place in a scintillation vial
11. Immediately label the scintillation vial with Sample Name, Date and Time
12. Collect all sample vials in a Ziploc Bag labeled with Sample Date and Time
13. Please keep sampling events in separate bags



A. Assemble Buchner funnel with filter flask. **B.** Place Whatman filter paper in funnel make sure to cover all of the holes. **C**. Wet filter paper with DI water to prime filter before pouring sample in.

VI. Clean Up
A. Nalgene Bottles
1. When all analysis has been completed empty remaining solution from Nalgene bottles
2. Take all labels and tape off of the bottles
3. Open up the Dishwasher
4. Empty if necessary (clean glassware can be placed in the glassware cabinet directly to the left of the dishwasher or on the peg board above the sink)
5. Rinse all the dirt and sediment out of and off of the bottles at the sink
6. Place the bottles on the lower rack with the openings face down
7. Load the detergent kept under the sink
8. Add a cup of vinegar (splash it in) to fight the hard water of Santa Barbara
9. Turn the Dial to **#2** this runs the dishwasher through the complete cycle

Glassware Cabinet (on the left) and Dishwasher (on the right)

B. Hach Colorimeter Vials
1. Empty reacted solution into waster beaker
2. Place glass vial in acid bath (use thick green Nitrile gloves)
3. Place caps in a plastic beaker (usually kept by the sink)
4. Fill plastic beaker + caps with DI water 3 times and dump
5. Fill a 4th time and leave to soak. Place beaker behind acid bath

C. Used Scintillation Vials
1. If needed clean vials by dumping old filter paper
2. Submerge s. vials in purple dish tub in sink filled with soap and water
3. Concentrated soap kept under the sink
4. Rinse 3 x with tap water
5. Place in acid bath

All vials are moved from the acid bath after 4+ hours and into a DI water bath
The vials are then placed on a peg board to air dry or on the heated peg board to quickly dry vials.

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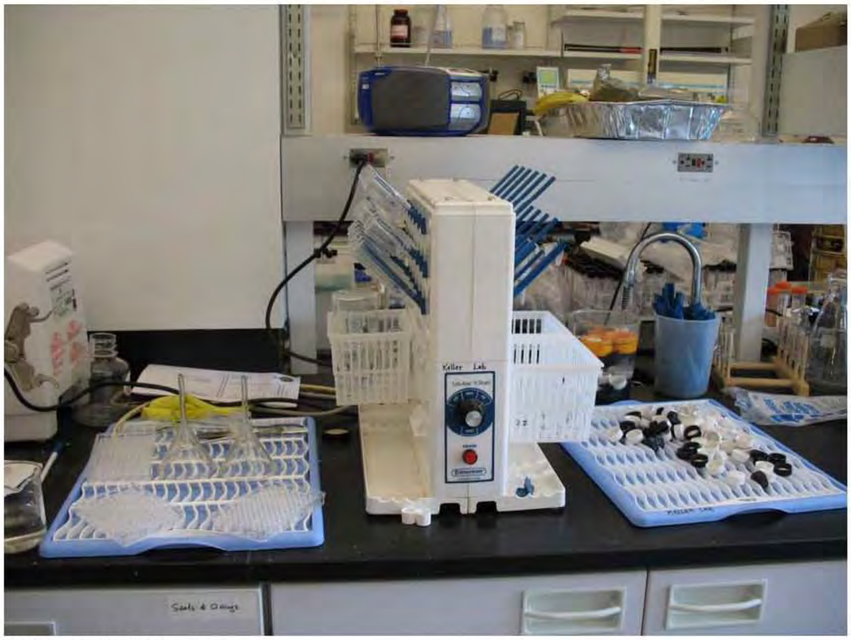

Peg board with heater.
Vials found on this unit are clean!
Caps are air dried on the two drain boards on either side of the heater.
Feel free to take caps and vials from here if not enough are on the bench in the labeled clean vial bag.

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VII. Waste Disposal Extra Info

A. Phosphate waste

1. Label a large ~500mL beaker "Phosphate Waste"
2. Dump all samples into the beaker
3. Place the beaker in the sink
4. Open the cabinet under the sink
5. Add one scoop of baking soda to the beaker in the sink
   watch the fun foaming reaction take place as the waste is neutralized and carbon dioxide is generated
6. Pour the neutralized waste down the drain
7. Rinse the waster beaker three times and set on the side of the sink

B. Total Nitrogen waste

1. Keep all of the vials from STEP 1: **27140**-45 and place in a Styrofoam container together labeled Step 1 Waste
2. Place all of the STEP 2 vials: 267**21**-45 in a separate container labeled Step 2 Waste
3. Add a preprinted waste label
4. Write the start date on the label

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