UCDavis Centralized Greenhouse Oversight and Facility Management Model

Final Report

Executive Summary

Greenhouses represent an important research resource on any research university campus. There are many types of uses and a wide range of quality of greenhouses that can be used. At UCDavis, virtually all those with research, teaching and extension responsibilities in the Plant or Pest Sciences require access to greenhouses at some time. For some faculty, greenhouses are absolutely required in the same way as labs or growth chambers. In other cases, greenhouses represent an optional approach where other resources (growth chambers, field planting, etc) could also be used. At the same time there are a large number of faculty who do not use greenhouse space at all. Theoretically, the ideal strategy for greenhouse management is to give every faculty member full access to as much greenhouse space as is feasible, whenever they want it, at little or no cost. However, this is generally not feasible and prioritization mechanisms must be implemented to maximize the greenhouse utilization, especially for times of financial difficulty or resource limitation. This report describes a prioritization scheme that can be optimized for UCDavis.

It is important to recognize that the amount of greenhouse space on campus is currently not adequate for the faculty. Even the new core greenhouse facility adds little space above the status quo. In recent years demolition of greenhouses to make room for new buildings on campus created a significant shortage of greenhouse space, which is only now being partly relieved through addition of the new space at the core greenhouse facility. It is clear from the early requests for space in the facility, that greenhouse space is still inadequate and the greenhouses which had originally been planned as part of the new facility must indeed be built. Some would argue that with declining faculty ranks and budgets, the overall campus will be smaller, but it would be foolish to think that the current shrinkage is permanent. It is narrowminded to think that the Board of Regents will allow our campus to permanently vacate buildings or reduce faculty when the population of the State is still growing and its need for research and extension results are still increasing. Our assessment is that we would do well to plan for further expansion in the campus’ research and teaching greenhouse infrastructure. This report recommends that we need to put a mechanism in place (an oversight committee) that allows for strategic planning for greenhouse resources in the future.

One of the main reasons that the campus has not focused on strategic planning for this particular resource is that there has been no centralized system for managing current greenhouse space and assuring planning for new greenhouse construction as needed or upgrading of existing greenhouses to meet the needs of the current and future faculty. Therefore we recommend that a faculty committee be assembled with responsibility for (1) oversight of all greenhouse space in the UCDavis inventory and (2) strategic planning for new greenhouses or renovation and improvement of existing greenhouses. Such a committee would use information on greenhouse use to determine whether there is an adequate supply of space, watch for trends in needs, and provide leadership to assure proper investment into the future. We propose that this committee be known as the Campus Greenhouse Oversight Committee (CGOC).
We also recommend implementation of bench fees for all greenhouse space on campus. The report provides a formula and method for setting fair and equitable recharge rates which will allow (1) some of the greenhouse costs to be recovered and (2) develop a pool of funds for investment in upgrading greenhouse facilities and erecting new facilities. We have discovered that there are some greenhouse needs on campus that do not require the expensive glass and steel greenhouses which are currently being constructed in the Core Greenhouse complex. We recommend that the greenhouse oversight committee be asked to identify the optimal level of investment on campus in low-cost greenhouses so as to provide a valuable addition to our greenhouse infrastructure inventory.

We recommend that a system be implemented that pools the current expertise in greenhouse management and some portion of the existing greenhouse space, to provide greenhouses which vary in their ability to control the interior environment. We propose to call this new facility the “Campus Greenhouse Facility” (CGF). We recommend that a large percentage of the new core greenhouse facility (perhaps all of it) be part of the CGF. The CGOC would be charged with working with each department that currently manages greenhouses on campus, to determine the fraction of space of existing facilities that would become part of this centralized pool of space.

We recognize that a significant percentage of the current greenhouse space on campus is dedicated to long-term open-ended uses, purchased with specific funds, earmarked for particular purposes. Some greenhouses exist that were purchased by particular PIs or programs. Thus there will always be some greenhouses on campus that will not be managed through the centralized management system described above. The CGOC, while not having explicit jurisdiction over such space, would be charged with tracking its use and negotiating transferral of such space to the centralized pool if that space stands vacant (or misused) for extended periods of time.

This report describes the details of how we envision the management of the CGF to work. Management of the CGF would be through a Lead Manager (LM), working at the direction of a faculty director and in conjunction with other greenhouse managers (located at the various sites), under oversight of the CGOC. Partial FTE reassignments of current greenhouse managers would be made in relation to the amount of time (on average) each works for the CGF. It should be noted that in most cases these managers have responsibilities at various sites in addition to greenhouse management, so that any other reassignment approach would require some lay-offs and some new hires. The LM would also be responsible for maintaining an on-line greenhouse space allocation system. We recommend that this system be used for the CGF as well as for short term leasing of space that is not part of the CGF. The report describes the details and especially the prioritization for space assignment.

This report also describes how recharge rates will be set, how space will be allocated, and how the greenhouse managers are expected to pool their expertise to provide the highest possible level of greenhouse management while maximizing efficiency of greenhouse space use. The key elements of this vision are the retention of the ability for short-term leasing of space in addition to semi-permanent assignments of space to particular units or faculty programs. It is envisioned that faculty, departments, or affiliated units who fund the erection of greenhouses will have exclusive rights as long as the space is used in conformance with guidelines to be determined by the CGOC.
It should be noted that this report is being prepared at a time where huge budget cuts loom. The faculty is quite emphatic that subsidies for greenhouse space continue to be at high levels to all faculty who need to use this resource. Many departments currently do not require faculty to reimburse the department (or other unit) for bench space largely because they do not require such payments for other research space (e.g. labs). This amounts to a 100% subsidy to the faculty. Other departments are not able to provide this type of subsidy. It should be noted that for some faculty, greenhouse space is the same as lab space and no faculty on campus are expected to pay for their lab space. Thus it is crucial that departments retain some ability to make greenhouse space available to their faculty outside the centralized pool. At the same time, we recognize that greenhouse space utilization is a billable item on many grant proposals, and we need a vehicle for allowing bench space charges that can be included in grant proposals. The establishment of defensible recharge rates is an important step in this direction. Another purpose served by the recharge calculation method described in this report is to provide the dean and department chairs with direct control over the subsidy provided for greenhouse space. We trust that such subsidy will be provided uniformly to all greenhouse space users.

The faculty consider it absolutely vital that recharge rates and reductions in subsidy be implemented gradually to avoid causing irreparable harm to ongoing research programs. At the same time, we feel that subsidies be provided only to those units who allow themselves to be regulated by the CGOC.

The proposed recharge formula includes an element for renewal and reinvestment in greenhouses as an explicit line item. As such it is a justified item that can be included in the costs of the space. It is unclear whether the rate of funds accumulation will be adequate as no specific data are available at this time as to amounts of funds that are needed or exact future space needs. We recommend that the CGOC be charged with identifying the level of investment that is needed at any point in the future and to adjust the recharge rate to collect that needed amount of money.

The committee balanced the important criteria of equal access, financial stability, reinvestment, and utilization efficiency to create a system that is optimized and customized for UCDavis. It provides budgetary flexibility that currently does not exist. It retains all our current excellent greenhouse staff and improves our ability to do world class research now and in the future. We considered the full range of management possibilities ranging from our current distributed system to a 100% centralized system and reached the conclusion that the approach described in this report is the one that will work best for UCDavis.
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Introduction

On March 18, 2003, a campus committee was formed by CAES Dean Neal Van Alfen to consider the issues of “Greenhouse space allocation and greenhouse maintenance” at the UCDavis Campus. Although the committee was formed as the “College Greenhouse Committee” we recognized our campus-wide responsibility and thus functioned as the “Campus Greenhouse Committee” (CGC). The committee was specifically charged with development of a set of recommendations.

Charge to the committee.

The issues that had emerged included some that had developed over time, representing general problems with allocation of greenhouse space, and others that had come to a point where urgent action was needed. The primary general issue was that of “equal access” to greenhouse facilities by all those on campus who need this resource. The more urgent motivation included the impending opening of the Core Greenhouse facility that was funded from a variety of sources on
campus. Furthermore, the impending budget problem required the various deans to look at everything with regard to the budget problems at hand.

To avoid confusion, it is important to understand that this committee was one of two separate greenhouse committees that were active at the same time. While the CGC consisted of faculty and staff representatives from each department/section that uses greenhouses, the other committee was composed primarily of greenhouse managers of both CAES and DBS who were meeting regularly to develop standard operating procedures for the new greenhouse facilities on campus. We worked closely with this committee to develop recommendations.

Our charge was to develop department-based recommendations for (1) a process for allocating greenhouse space on campus and (2) for mechanisms and suggestions for greenhouse maintenance and improvement. We were asked to adhere to the following guiding principles: “faculty should have equal access to space that suits their needs, greenhouse space needs to be more efficiently used than at present, and there needs to be a mechanism for continual repair and upgrading of greenhouse space to meet our changing needs”.

Our committee was also asked to address issues related to financial management of the campus greenhouses. It was also pointed out to us that “declining budgets will reduce the funds available for greenhouse management at a time where new investments are needed”. Thus we were asked to recommend “a standardized recharge rate to be adopted that is consistent with greenhouse quality and services provided”.

Background

Over the past 40 years, UCDavis has grown from a field station to a preeminent research University. The inventory of greenhouse space has also grown, but (up until recently) only in as far as individual departments and PIs could muster on their own. Departments with faculty that are very dependant on availability of greenhouse space invested significant resources to buy, maintain, and upgrade greenhouses, while those less dependent, used an approach of minimal (or no) investment. Furthermore, some departments are devoting a significant amount of staff FTE to greenhouse management, while other departments do not.

The result of these policies is that campus greenhouse space in recent years has been inadequate for many uses, and falls below the quality that would be commensurate with our reputation as one of the premiere research institutions for plant biology, agriculture, and environmental sciences. A significant step toward rectifying this situation was the successful proposal to NSF that resulted in replacement of some aging greenhouses on campus with the state-of-the-art new Core Greenhouses located near the Bowley Plant Science Teaching facility. The success of this faculty initiative also resulted in significant campus investment in this project, although much of the envisioned ultimate scope of the project remains unbuilt. The CGC sees the build-out of this site, which includes further replacement of our current facilities, as a major goal for the campus in the upcoming years. At the same time, budgetary constraints require that we progress slowly as there are currently no funds available for constructing new greenhouse space.

The objective of this report is to provide a strategic plan for optimal management of campus greenhouse space and identify mechanisms for reinvestment to develop a state-of-the-art research greenhouse facility.
We took an analytical approach to the issues and considered an inventory of available greenhouse space and the general uses that exist on campus. This analytical framework allowed us to identify an effective management strategy for our complex set of uses and relatively large and complex campus greenhouse infrastructure. It involves faculty representation and broad-based use of current greenhouse manager expertise with elements that we hope will result in greater efficiency than we have currently.

**Analysis of greenhouse usage at UCDavis.**

In the UCDavis community, greenhouses are used for teaching, research, conservation (or collection) and extension. Below is a description of each of these types, along with notes as to how such space might be managed. The broadest use of greenhouse space is for “Research” - for this category there are three sub-categories, each of which require a different approach to space management and allocation.

<table>
<thead>
<tr>
<th>Category of use</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>1. Teaching</td>
<td>• Laboratory exercises by students enrolled in courses with laboratory sections(^<em>),(^@)&lt;br&gt;• Greenhouse use as part of internships and similar educational use(^</em>),(^@)&lt;br&gt;• Cultivation of material for use in classes(^*),(^@)</td>
</tr>
<tr>
<td>2a. Research (not involving organisms that must be contained)</td>
<td>• Experimentation during times of the year where plants would not grow outside(^#),(^$,)&lt;br&gt;• Plant production for later out-planting in field plots(^#),(^$,)&lt;br&gt;• Imposition of particular constant environmental conditions as treatments in experiments(^#),(^$,)&lt;br&gt;• Experimentation that takes advantage of optimizing the plant environment for variables that are not part of the study(^#) (e.g. controlled temperature in a fertilizer study)&lt;br&gt;• Experiments with fixed start and end date for short duration(^#),(^$,) (less than one year)&lt;br&gt;• Experiments with indefinite end dates such as for slow-growing plants(^&amp;,),(^$,)</td>
</tr>
<tr>
<td>2b. Research involving the need for containment of organisms</td>
<td>• Research involving pest and disease organisms that must remain contained so as not to affect other experiments or the outside world(^&amp;,),(^$.)&lt;br&gt;• Research involving evaluation of plants for resistance to pests and pathogens or evaluating the efficacy of new pesticides(^&amp;,),(^$.)&lt;br&gt;• Experimentation where it is necessary to prevent contaminating the outside world with organisms that require containment(^&amp;,),(^$.) (GMOs,...)&lt;br&gt;• Research involving stable- or radioactive isotope use on plants or plant organs(^&amp;,),(^$.)</td>
</tr>
</tbody>
</table>
| 2c. Research specific to greenhouse production and engineering | • Greenhouse environment control research and technology development (engineering)$\&$.  
• Greenhouse crop production (hydroponic crops, potted flowering plants, etc)$^5$  
• Experimentation that specifically focuses on protected cultivation as the target of study$^2$.  |
| 3. Conservatory | • Collections of plants that are needed so as to preserve specimens for campus-based teaching$^*$.  
• Collections of plants that are needed as archival material for research purposes$^\&$.  
• Collections of plants for conservation of valuable resources for the public$^\&$.  
• Collection of organisms (insects, viruses, etc) e.g. insectary use$^\&$.  |
| 4. Outreach and Cooperative Extension | • Testing products for the public$^*$.  
• Demonstration facility$^*$.  
• Training facility for persons interested in greenhouse control$^5$.  
• Applied research to develop data for labeling agricultural materials$^\&$.  
(pesticides, etc)  |

Management notes:  
$^*May need to be close to central campus for student or public access  
$^\&May benefit from centralized management  
$^\&May be better suited for non-centralized management  
$^XThis use is frequently not compatible with other research use  

Funding notes:  
$^\&Funding for this use is frequently difficult to come by  
$^5Funding mechanisms may exist through grants, contracts, or user fees (e.g. lab fees)

Of the uses described above, some lend themselves to a management mechanism where space is secured as short-term leases. Other uses lend themselves better to open-ended space assignment. Also, some of the uses require significant modification and specialization of space by the user (e.g. containment, black-cloth curtains, mist-benches etc).

It should also be noted that the notion of “equal access” for all faculty must be tempered by the understanding that for some faculty and students access to greenhouse is indispensable rather than merely important or optional. Many such examples exist at UCDavis. For example, researchers of tropical plants cannot do research at all without greenhouse facilities. Screening for many pest and pathogen resistances cannot be done without dedicated greenhouse facilities. Another example is of research on horticultural methods in greenhouse production. There are also examples of teaching and outreach that are absolutely dependent on access to greenhouses. Thus it is important to understand that such users need to have greater access than others.
Centralization

The committee extensively discussed the “centralization” of greenhouse space. There are several possible interpretations of this term and this needs to be clarified here. The three major possibilities for interpretation is
(1) for oversight purposes
(2) for ownership and rental purposes
(3) for management (labor and supplies) and space assignment
(4) for financial purposes.

Our recommendation is for complete centralization with regard to oversight of campus greenhouse space. This oversight will extend over space that is leased out in short term leases from a newly-created centralized greenhouse space facility, as well as greenhouse space that is not part of this. We recommend that these two categories of greenhouse space be managed by the same set of managers as a team.

In our deliberations we considered various other campus resources and how these are managed. In particular, we considered the Controlled Environment Facility (CEF). It consists of an array of modern fully-functional growth chambers. It exists in parallel with a number of other growth chambers on campus that are maintained by departments. The committee felt that the CEF is an fantastic resource on campus which, none-the-less cannot and does not accommodate all the needs of all the faculty. If this were the only way to get access to growth chamber space, then there would be a serious problem for many faculty. While the CEF management model was considered by us as a model for centralization of the greenhouses, we felt that (1) it is not truly centralized and (2) our model could go one step further to add truly centralized oversight to provide a mechanism for directing underutilized greenhouse space to the benefit of the entire campus.

Recommendation: Thus we recommend the creation of a Campus Greenhouse Facility (CGF) that parallels the CEF as a campus resource. Unlike the CEF, it would not be located solely in one building but would have some space in a number of the greenhouse complexes on campus. This would result in availability of a range of different types of greenhouses, each suitable for specific needs.

The CGF would include greenhouses, shade houses, and cold frames that are administered through a management system that prioritizes use so as to provide equal access to all faculty on the UCDavis campus making greenhouse bench space available on a leased basis (i.e. through payment of bench fees).

Level of Control or Protection

The Level of Control or Protection (LCP) of any greenhouse space on campus is related to the level of customization and degree of investment in environmental control technology. Below we define the LCP index specifically for UCDavis. Out-door nursery space and cold-frames are also included in this characterization as it is also in need of management and typically goes hand-in-hand with greenhouse space utilization.
<table>
<thead>
<tr>
<th>LCP</th>
<th>Definition</th>
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<tbody>
<tr>
<td>1</td>
<td>Minimal control over the plants’ environment; primarily protection from extremes and reduction of evapotranspiration so as to manage plant stress for plant survival. Accomplished by lath house, screen house, cold-frame, etc. No environmental controls. This category also includes outdoor nursery space with or with out shading. Water and other utilities are available (although electricity might not be available). Automatic watering and fertilizing may be available for adding by the PI as an option. No treatment of incoming water can be expected at this level.</td>
</tr>
<tr>
<td>2</td>
<td>Moderate control of environment resulting in temperatures that are better than the outside environment. No explicit guarantee for specific levels of the particular variables. Accomplished with relatively-simple greenhouses with electro-mechanical controls for temperature, possibly some minimal level of supplemental lighting if the greenhouse has structure to support lamps. No control over many variables such as CO₂, relative humidity, etc. Water supply is at most filtered; no reverse-osmosis (RO) or de-ionization (DI).</td>
</tr>
<tr>
<td>3</td>
<td>Greenhouse with electro-mechanical controls for temperature with the ability to keep temperatures within 10F of a set-point when outside temperatures are below 80F and above 40F. Greenhouse has structure to support some conventional supplemental lighting, which is available in the winter. Simple controls for automatic watering (timers) and fertilizer injection to provide one standard injected formula. Treatment of incoming water with RO or DI. Chart recorders are available as an option for temperature. During extreme winter conditions, air temperatures can generally be maintained above 50F.</td>
</tr>
<tr>
<td>4</td>
<td>Solid structure greenhouse (typically glass) that meet the criteria of level 3 except that some of the controls are electronic and logging/recording of some of the environmental variables is part of the management protocol. Electronic controllers may be available for irrigation. Shading may be provided by one or more levels of shade curtain. Supplemental lighting is available from October through April and its control is automated. Temperature is generally controlled to be within ±6 F of a set-point and expected to be at least 20F below the outside temperature on hot summer days. During extreme winter conditions, air temperatures can generally be maintained above 55F.</td>
</tr>
<tr>
<td>5</td>
<td>As level 4 except for the following: Temperature control consists of multi-stage computer control with 4 or more steps for heating and 4 or more steps for cooling. Complete electronic logging by environmental control computer. Independent logging is available as an option. Temperature is generally controlled to be within ±3 F of a set-point and expected to be at least 20F below the outside temperature on hot summer days. During extreme winter conditions, air temperatures can generally be maintained above 60F.</td>
</tr>
</tbody>
</table>

It should be noted that the above definitions are general minimal levels that are used solely for categorization. Greenhouse users should not assume that a guarantee is made just because a greenhouse has been classified at a particular level. Greenhouse systems tend to be complex and prone to failure. Dedicated staff are always needed to attend to problems. It should also be noted that there is inherent lack of uniformity in every greenhouse. For example, in a fan-and-pad
cooled greenhouse there is a large gradient of temperature over the length or width of the greenhouse. Also, in the winter time, air and plant temperatures are much higher near the heat source than near the walls of the greenhouse. Lack of uniformity can have a confounding effect on experiments and PIs should always expect deviations from set-points and build the proper statistical control into their experiments.

It should be noted that lower levels of LCP are much less expensive to build and maintain. Thus the cost of use of such space is much lower. Currently the campus is investing only in LCP 5 space, while there are many uses where that high LCP is not needed. It is important that future investment in greenhouses focus on shortages in specific LCP categories so as to prevent PIs having to lease LCP 5 space when much lower LCP space will do.

**Recommendation:** All greenhouse space at UC Davis should be categorized by LCP so as to assure efficient use of space utilization. All greenhouse management functions and future investment should account for LCP to assure that the LCP needed by the faculty are available.

Importance and value of each type of greenhouse space.

The committee reached the conclusion that all the uses and LCPs described above are of strategic importance to the campus.

It is the vision of the committee that the campus needs to establish a balance of short-term lease space (the CGF) as well as permanently assigned space as recommended above. Each department that currently “owns” a greenhouse facility will be asked to evaluate their use and determine the fraction of their facility (if any) that would become part of the CGF. Coordination of conversion of space to centralized management will require a fair and equitable process managed by a campus faculty committee.

It is also clear that the inventory of space in each of the LCP categories has not been subject to any sort of strategic campus management in the past. It is likely that many researchers seeking a particular LCP may not be able to find what they need. Indeed many departments currently hold space that is inadequate for their specific needs causing them to either pay more than their needs mandate or jeopardize their experiments with less than ideal greenhouse facilities. For instance, many researchers might find their needs met by a relatively simply double-polyethylene plastic film covered structure; yet the campus has none of this type of relatively inexpensive greenhouse space. Also, slow reinvestment prior to the recent faculty-initiated push for new greenhouse facilities has left the campus inventory languishing so that we still have a significant shortage of LCP 5 space even after the Core Greenhouses come on line. The solution to this is to continue build-out of the Core Greenhouse facility until the CGOC determines (through usage data) that the greenhouse infrastructure has reached an optimal size.

It is also important to note that the general value of greenhouse space, as perceived by the users and managers, is proportional to the LCP of the facility. Cost of management generally differs for the different LCP, but not in direct relation to this perception of value. Faculty members are generally reluctant to pay the same rate for space that has little control capability as for space that is very tightly controlled, even if actual costs are the same. Also, the University’s costs for tight control is greater than for space that has no control equipment, so that incentives should be used to have users in the least-costly space that suits the use.
Recommendations for creation of new committees

**Recommendation:** One of the main conclusions of our deliberations is that UCDavis should have a Campus Greenhouse Oversight Committee (CGOC) comprised of faculty from departments that contain greenhouse users and/or greenhouse facilities. It would provide strategic oversight over all greenhouse resources on campus and provide guidance for reinvestment. It is envisioned that this committee would also serve an advisory function for all units that manage greenhouse facilities. The charge to this committee should be to continue the optimization of greenhouses and to develop the UCDavis greenhouse infrastructure into one that is state-of-the-art, providing adequate inventory of all types of LCP to meet the needs of the campus community. We also recommend that within 3 years this committee explicitly review the overall greenhouse system on campus, the functionality of both centralized and non-centralized space, whether the balance is ideal and what new greenhouse space is needed at each of the LCP levels. We expect that the CGOC would be the faculty group that would initiate the development of new initiatives that would lead to continued improvement, some of which would come through build-out of the Core Greenhouse complex.

**Recommendation:** We also recommend that a second committee be maintained, consisting of all campus greenhouse managers. More specific detail on this Campus Greenhouse Managers committee (GMC) is provided below as it is envisioned to have specific responsibilities for the CGF (described below).

**Centralized Oversight of all Greenhouse Space**

All campus greenhouse space would be subject to oversight by a faculty committee (described above). This committee would set standards for prudent greenhouse use. For the CGF this is described in detail below. For greenhouses that are not part of the CGF, the oversight committee would expect the users to make good use of the space for scientific, pedagogical, or extension purposes. At times when the space is not needed for short durations (weeks or months) such space would be made available to other users on a recharge basis. If space ceases to be needed on a long-term basis, then the space should become part of the CGF. Departments should recognize that it is very expensive to maintain exclusive greenhouse space and there will clearly be a motivation for departments to convert as much greenhouse and nursery space to be part of the CGF.

This report assumes that all greenhouse space has a greenhouse manager who is responsible for assuring the continued operations and availability of the space. Any space that is left without such oversight will be prime candidate for inclusion in the CGF.

**Recommendation:** We recommend the creation and management of a database that reflects greenhouse space utilization of all greenhouse space on campus. Any space that becomes available (regardless of whether it is part of the CGF or not) would be available through this online mechanism. This mechanism would also list the prevailing recharge rates for each resource. This will provide every faculty member with equal access to space.

The actual assignment of space is then handled through the Greenhouse Manager Committee (by assigning this duty to one of the committee) with input from the responsible manager.
Funds collected through bench fees would go to the unit that manages the space (CGF or Department).

**Management of the Campus Greenhouse Facility (CGF):**

**Oversight**

**Recommendation:** Administrative management of the CGF should be provided by one organized campus unit. The CGOC will provide oversight and report to the Deans of CAES and DBS as well as the VC-Research.

We could not reach a consensus as to which higher-level administrator(s) should have responsibility of oversight beyond the CGOC. We agreed that this responsibility should be given to the office that is best able to achieve the goals of optimal management and continual reinvestment so as to meet the objectives set by the CGOC. We recommend that the VC-Research, CAES Dean, and DBS Dean meet with the CGOC to develop a optimal and workable oversight strategy.

The committee considered whether the CGF should be a separate unit on campus reporting to the office of the VC-Research (like the CEF). It was clear to us that upper administration or the various deans were not interested in this. This is an issue that should be reconsidered explicitly by the CGOC together with the deans and VC-Research once it is in place.

**Day-to-day management**

All the hands-on work in the CGF will be carried out by the members of the CGMC. One of the members of this group will be assigned to be Lead Manager (LM) to handle day-to-day activities. The LM would work under supervision of a faculty director. (It is envisioned that CGMC would not be involved in making every decision as it currently does during the interim period.)

All the centralized space in the various greenhouse complexes on campus would be subdivided into logical units (bays, ranges, etc) and each of these would be grouped into zones in such a way as to allow one person to easily manage it as one unit. All projects in that zone would be under one manager’s jurisdiction with oversight from the LM.

The CGF Director position would be filled by a faculty member familiar with greenhouse function and with all types of greenhouse activities at UCDavis. This faculty member would also serve ex-officio on the CGOC and accept guidance from this committee.

Each member of the CGMC that is involved in any way with centralized greenhouse space would report in part to the LM. The CGF Director and LM would be involved in performance evaluations of each greenhouse manager (to the level that it is relevant). The director should establish an agreement with each department chair (or whoever supervises the manager) as to what percent of each greenhouse manager is dedicated to the CGF. This will result in an official designation on the employee’s job description.

Each of the zones of CGF would be assigned to one of the members of this group. The idea is that it is necessary for one person to be very familiar with the space and the intricacies of the
systems therein. It will be up to the LM to make assignments, perhaps with advice from the
director. Some greenhouse manager FTE may need to be assigned to other functions. For
example, one manager may be given the responsibility over all irrigation and fertilizer injection
systems in the CGF. This job might consume all the CGF-assigned FTE.

The unit which administers the CGF (henceforth abbreviated AU) would need to (at a minimum)
provide the following: (1) accounting skills and facilities to handle acceptance of funds that
users of CGF pay per recharge rates (i.e. DaFIS transfers/recharges), (2) supervisory oversight
over key greenhouse staff persons (as is normally done by department chair over departmental
greenhouse manager(s) and (3) ability to quickly authorize purchases of supplies. If the AU also
manages non-CGF greenhouse space, then separate accounts would be maintained for that and
the CGF space.

The LM would manage the assignment of centralized space to projects and would assure that
each zone manager is aware of, and has the skills to deal with, each project in her/his zone. Any
shifting of projects from one site to another would be managed by the LM and reported to the
director. The LM would also manage unoccupied space in the CGF and assure that it does not
fall into disrepair.

The LM would also be responsible for providing all information needed by the AU office staff to
do the accounting work associated with recharges. The LM would make a monthly report to the
director on all recharge activity and balances. This should alert the director as to impending
deficits or surpluses. The LM would work directly for the director, freeing up the director to
focus primarily on policy, oversight, and dispute issues.

The incumbent of the LM position should have the skills and experience to manage all the types
of greenhouses (all LCPs) on campus (not just the types represented in the CGF).

The LM’s primary administrative home must be the AU so as to achieve maximum operating
efficiency. If the position is filled by one of the existing greenhouse managers (as envisioned by
us), this could be accomplished through lateral transfer if the selected LM’s home is not already
the selected AU. We recognize that under some circumstances this may cause problems; this
should be resolved in consultation with the CGOC.

Prioritization and space assignment

The lead manager would accept requests and reservations for use of CGF from PIs in the campus
community, assign/schedule projects to particular zones, and work with the zone managers to
assure high-quality service for all greenhouse activities. In a resource-limited environment the
LM will work with the director to make decisions as to which project is accommodated in which
way. The director is responsible for assuring equity in allocation, subject to the prioritization
described below. The director is also responsible for oversight of the financial integrity of the
system.

Allocation of space in the CGF will be governed by the following priorities. These will be
employed by the LM to determine which use has priority in a resource-limited environment, and
by the director to resolve any disputes or appeals.
### CGF Space Assignment Prioritization

<table>
<thead>
<tr>
<th>Priority</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (highest)</td>
<td>The highest level of prioritization focuses on whether the proposed project fulfills part of the University mission. Thus uses that are specific to AES, I&amp;R, and CE will receive priority over ones that are not (e.g. outside groups wishing to rent space). Rental of space to off-campus users will only occur after all other campus needs are met, even if the financial incentive to rent out to off-campus PIs is very great.</td>
</tr>
<tr>
<td>2</td>
<td>The second level of prioritization involves meeting the needs of the faculty. Projects submitted by faculty with AES, I&amp;R, or CE appointments will have priority over projects that are submitted by others (e.g. post docs on their own, graduate students on their own). Thus students, post docs, visiting scientists with UCD appointments would have priority over off-campus units, but not over Academic Senate or Academic Federation faculty. Thus it may behoove graduate students to request space through their major professors, assuming that that professor does not already have a lot of other projects in the CGF.</td>
</tr>
<tr>
<td>3</td>
<td>Within the above prioritization, projects will be prioritized depending on how much space a particular researcher already has allocated to her/him in any campus greenhouse space. In a resource-limited environment the principles of equal access require that those who have no space be given priority over ones that do.</td>
</tr>
<tr>
<td>4</td>
<td>If several projects are competing for space where all the above are equal, the project that has provided the greatest amount of advanced notice as represented by a written, dated application for space will get into space first.</td>
</tr>
<tr>
<td>5</td>
<td>Unfunded projects that cannot pay the costs associated with a project would generally given the lowest priority and be expected to provide most or all labor and supplies.</td>
</tr>
</tbody>
</table>

It should be noted that the above prioritization guidelines are general guidelines and there may well be instances where a greater priority needs to be assigned depending on particular circumstances. Such issues must be resolved by the CGF Director (with possible appeal to the CGOC) who can take the following special circumstances into account:

<table>
<thead>
<tr>
<th>Factor in special prioritization</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>faculty rank</td>
<td>assistant professors may need special priority so as to have the opportunity to initiate a research program and get tenured</td>
</tr>
<tr>
<td>critical need of research</td>
<td>sometimes research needs suddenly arise where research must be initiated quickly</td>
</tr>
</tbody>
</table>

The committee feels that projects should only be allocated space in the CGF on a fixed length of time basis. A project in the CGF must pay recharge rates throughout the period requested even if the project terminates early, unless the next user is willing to assume this responsibility.
Eviction

No user will be evicted from space due to a greater priority use by another user, i.e. once space use has begun, the user can count on having the space for the approved time frame.

There are a few conditions which can lead to eviction:
1. failure to pay the specified recharge rate
2. misuse of university property,
3. poor stewardship of the space (bad weed control or pest control where the user did not contract for this service, etc)
and 4. keeping space empty for long periods of time when others are waiting to be assigned space.

In the event that the problem can be solved by adding services, the LM with support from the CGF Director can impose additional services at cost to the PI.

Flagrant violations can result in immediate removal of a project from the CGF; generally the LM will give the culprit 2 weeks notice to give time for the user to appeal to the Director.

Common administrative elements for all campus greenhouses

Allocation of greenhouse space

Allocation of space will be through an on-line database tool that represents the complete inventory of all greenhouse space (at identified LCPs) over time. This on-line system will be set up and governed by the LM. Once space has been identified collaboratively between the LM and the PI, the LM will have authority to allocate available space. While the primary purpose of this system will be to provide faculty with a mechanism for equal access to CGF, it should also be used to allocate unused greenhouse space that is not part of the CGF.

It should be noted that space utilization statistics and observations can be misleading. Many times sequential uses of greenhouse bench space does not dove-tail smoothly, so that frequently bench space cannot be programmed to be in explicit use all the time regardless of management proficiency. Furthermore, a particular project may have some down-time at various times during the project, especially at the end, so that many times casual observation of space utilization will not reveal the level of space utilization for recharge purposes. Thus there will be a level of overall utilization (% occupancy) substantially below 100%. The exact value of this variable will need to be determined annually so as to track the need for modification of the base recharge rate and to determine whether new greenhouse space needs to be developed.

Recharge systems

The recharge rates for greenhouse space will be driven by the actual cost incurred. This will depend on the level of service in addition to the greenhouse LCP. Below we describe a campus base-line greenhouse recharge rate for the CGF. Greenhouse space that is not part of the CGF will set recharge rates higher or lower based on the level of deviation of cost of operation from the CGF.
We recommend that the CGOC have the duty of setting the baseline recharge rate for the CGF with input from the LM, CGF Director, and the CGMC. Since each unit that manages greenhouse space must identify higher or lower costs in relation to this, departments generally will charge rates that differ from the recharge rates for the CGF. Such increases or decreases would need to be applied uniformly to all and would only apply to the rates collected by and for non-centralized space.

The prevailing recharge rates for all greenhouse space should be listed at a web site maintained by the CGF. This tabulated information should provide a listing of anticipated future rates to allow PIs to include credible information in the direct-cost estimates in budgets of grant proposals.

It should be noted that differences in what faculty pay can still vary as each department chair and dean can provide subsidies as he/she wishes. While the dean decides on the subsidy for all greenhouse users in the her/his college, the individual departments would decide on the subsidy level for the greenhouse space that they manage as non-centralized space.

The CGOC will have the duty of annually adjusting the greenhouse recharge rate that conforms to the standards for such rates on campus. The campus has a mechanism that mandates that recharge rates must be set to recover only the actual costs. Thus the CGOC should use the following greenhouse recharge rate system which considers these variables:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Symbol</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost of operating the space including labor</td>
<td>C</td>
<td>$ per year</td>
</tr>
<tr>
<td>Percent utilization</td>
<td>Q</td>
<td>a fraction between 0 and 1</td>
</tr>
<tr>
<td>LCP</td>
<td>L</td>
<td>an integer between 1 and 5</td>
</tr>
<tr>
<td>Total amount of greenhouse space</td>
<td>T</td>
<td>sq ft floor space</td>
</tr>
<tr>
<td>Projected funds that need to be collected for upgrades and expansion</td>
<td>P</td>
<td>$ per year</td>
</tr>
<tr>
<td>Campus-wide subsidy</td>
<td>V</td>
<td>$ per year</td>
</tr>
</tbody>
</table>

Typically a question arises as to whether greenhouse recharge should be on a bench-space basis or floor-space basis. The latter is used here because access to the plants on the benches via the aisles is part of the “service”. Also, this way the rate is the same regardless of modification to benches (or their removal). It also motivates use of rolling benches (which is more efficient).

The baseline recharge rate will be calculated from these numbers as follows. First, one calculates the average recharge rate ($R_{avg}$) over all greenhouse space

$$R_{avg} = \frac{(C+P-V)}{(Q*T)}$$

To account for LCP it is necessary to know how much of T is in each of the five LCP categories; these amounts (in sq ft) are $T_1$, $T_2$, $T_3$, $T_4$, and $T_5$. If these were all the same value then the
baseline recharge rate for each LCP level ($R_L$) would be $R_{avg}(m*L + b)$ where $m$ and $b$ are set so that the costs are distributed over the different types of space to provide incentives for users to use lowest LCP that is feasible. The committee recommends that initially the values be set to be $m=0.25$ and $b=0.25$, which results in LCP level 3 space with a recharge rate of $R_{avg}$, the rate of LCP=1 space would be 50% lower; the rate of level 5 space would be 50% higher. (Note for future reference: values of $b=5/8$ and $m=1/8$ would result in LCP=1 space costing 25% less than LCP=3 space and the rate of LCP=5 space would be 25% higher than LCP=3 space).

However, since the amounts of space available at each of the five LCP categories is not the same, this is likely to result in over-collection or under-collection of funds needed to sustain the operation. This will be handled by a correction factor $k$

$$R_L = R_{avg}(m*L + b)*k$$

where $k$ is equal to 1.0 if no correction is needed; $k$ is less than one if the total amount collected is too much and greater than one if more funds need to be collected. The CGOC would annually determine what this $k$ value needs to be so that this would have resulted in no deficit or surplus given the actual value of $Q$ for that year. The CGOC would also have the authority to set $m$ and $b$ values that result in more appropriate incentives if this is deemed necessary by that committee.

Since it is impossible to accurately forecast the exact amount of space utilization ($Q$) and cost recovery, it is possible that a deficit or surplus may occur, although this amount can be minimized though careful analysis of data. The LM will be responsible for collection and maintaining these data. In the event that a surplus does occur, this will be subtracted from the anticipated value of $C$ for the coming year (i.e. carried forward with a commensurate recharge rate adjustment).

The calculation above can be carried out using all campus greenhouse space if such numbers are available. It is, however, likely that more accurate numbers will be available by any one management unit. Thus the committee recommends that the LM for the CGF maintain data from the CGF for calculating these rates and provide the input data along with the resulting rate calculation to the non-centralized units so that these can set their own rates. The latter may be different if the unit has higher or lower costs or different levels of service than the standard provided by the CGF.

The CGOC should be aware that if values are developed based on prior years and includes all services rendered and costs incurred, then this coincides with a level of service that includes all possible services and purchase of all materials. The CGOC advises the initial recharge rates be set in this manner and that the standard level of service be high. Once actual data are available, it may then be possible to lower the recharge rate and shift more costs to actual costs incurred by specific projects. This will increase the cost to very labor- and supply-intensive projects while reducing the costs for low-maintenance projects.

The committee recognizes that each dean and department needs to be able to provide some level of subsidy for greenhouse space to its faculty. Numerous examples exist from all across the globe where greenhouse recharge rates at research institutions were so high that virtually no one could afford to pay them, resulting in closure of the facilities and failure of research programs. It is essential that college deans specifically provide for subsidy (as they have been doing) so as to
keep this facility accessible. The deans should seek advice from the CGOC on the balance for this. We recommend that for the coming fiscal year (2003/04), the subsidy be set at 90% for CGF and 85% for space that is not part of the CGF. The former would be a campus-wide subsidy, the latter would be college-specific. It is clear to the committee that these levels represent very significant budget cuts for some faculty. Future adjustment can be made once usage and recharge data are available.

Transition to this universal, fair recharge system needs to be handled carefully, and will probably take two or three years. Currently many PIs have not budgeted for explicit greenhouse recharges as part of their projects. Thus a certain amount of “grandfathering” of such greenhouse use without recharge will be needed for non-centralized space. Another reason for careful and gradual implementation is that it is virtually impossible to set realistic numbers that protect both the users (faculty and departments) as well as the campus.

Recharge rates for activities that typically cannot pay: There are clearly some activities that cannot pay for greenhouse use. Such activities need to be evaluated as to their overall importance to the PI, department, or campus. Some activities such as conservatory functions are of vital importance to all our programs and thus need to be paid for by the PI, department or college.

There is a general perception that teaching uses cannot pay recharge rates. This however is not correct. Funds are available for many costs incurred for teaching, these simply need to be identified. Once recharge rates are set, some of these costs can be recovered in the same way that other teaching costs are handled. If the result is to make a course too expensive for a department to teach, then the cost of greenhouse usage should be offset by use of the lab fee mechanism.

**Epilogue**

The time has come at UCDavis for some changes in how greenhouses are managed and overseen. We considered a wide range of uses and found that some of our current uses are best managed through a centralized short-term leasing system, while others are best managed under direct control of departments or sections.

Some would argue that all greenhouse space on campus should be managed through one mechanism (either centralized or non-centralized) for the sake of efficiency. We do not envision that this is the case but recognize that at some time in the future this might be the case. At that time the CGOC can be afforded the latitude to make such a change. We do not see the faculty relinquishing departmental space until the CGF is fully functional and proven to work well for everyone.

One of the challenges to the committee was to develop a management approach that would improve space utilization efficiency while giving more faculty access to greenhouse space when they need it. Additionally we were asked to devise a structure that would not be more costly than what we have now. We were impressed by the broad expertise in our pool of greenhouse managers and sought to find a way to apply this in a broad-based manner without imposing excessive levels of inefficiency. The use of a lead manager in conjunction with a faculty director and a number of greenhouse managers accomplishes this.

The committee deliberated on various financial elements of the overall picture and was
particularly sensitive that mechanisms had to be provided that would allow cost cutting without harming the system or the staff. We developed a recharge system that can be applied directly to projects in the CGF with a mechanism for developing recharge rates for all other greenhouse facilities on campus through comparison with the CGF. In the proposed recharge system we also included an element that will collect funds for moderate upgrade and maintenance.

We deliberated extensively on the need for future greenhouse development on campus and concluded that it is imperative that an Greenhouse Oversight Committee focus on this need and initiate planning (possibly including proposal writing) to continue the build-out of the Core Greenhouse Facility with the LCP level that is suitable to meet the needs of the campus community. Such new space should become part of the CGF.

Respectfully submitted,

Heiner Lieth, Professor and Department Chair, Environmental Horticulture, Committee Chair, Bryce Falk, Professor, Plant Pathology
Howard Ferris, Professor, Nematology
Larry Godfrey, Extension Specialist, Entomology
Tom Gradziel, Professor, Pomology
Tim Hartz, Extension Specialist, Vegetable Crops
Tim Metcalf, Staff Research Associate, Plant Biology - DBS
Garry Pearson, Superintendent of Facilities, Vegetable Crops
Eliska Rejmankova, Professor, Environmental Science and Policy
Jim Richards, Professor, Land Air Water Resources
Larry Teuber, Professor, Agronomy and Range Science
Steve Theg, Professor, Plant Biology - DBS
M. Andrew Walker, Professor, Viticulture and Enology
Thomas M. Kaiser, Assistant Dean - Administration, CAES Deans’s Office

Appendix: List of abbreviations and acronyms

<table>
<thead>
<tr>
<th>Acronym or abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>AU</td>
<td>Administering unit (a department or section)</td>
</tr>
<tr>
<td>CEF</td>
<td>Controlled Environment Facility on the UCDavis Campus</td>
</tr>
<tr>
<td>CGF</td>
<td>Campus Greenhouse Facility</td>
</tr>
<tr>
<td>CGMC</td>
<td>Campus Greenhouse Managers Committee</td>
</tr>
<tr>
<td>CGOC</td>
<td>Campus Greenhouse Oversight Committee</td>
</tr>
<tr>
<td>LCP</td>
<td>acronym: Level of Control or Protection index: same meaning with values ranging from 1 to 5 as defined on page 9</td>
</tr>
<tr>
<td>LM</td>
<td>Lead Manager of the CGF</td>
</tr>
</tbody>
</table>