Rainwater as a Resource:

A Report on Three Sites Demonstrating Sustainable Stormwater Management

TreePeople

Acknowledgments

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TreePeople's mission is to inspire the people of Los Angeles to take personal responsibility for the urban forest — educating, training and supporting them as they plant and care for trees and improve the neighborhoods in which they live, learn, work and play.

Photo on page 1 by Melinda Kelley.

Welcome.

Thank you for your interest in finding solutions to urban water quality, supply and protection issues. We've produced this report and analysis of three of the demonstration projects TreePeople has implemented as a means of advancing the state of the art of adapting cities to increase their safety, civility and sustainability.

As founder and president of the nonprofit organization TreePeople, I've spent much of the last 37 years bringing trees and people together to improve the quality of life in Los Angeles and reduce its energy, water and waste footprints. Over time I've learned that it is possible to transform cities from being amongst the most environmentally destructive forces on the planet into more benign, safe and sustainable systems.

Although cities consume huge amounts of natural resources and produce waste that is then converted into pollution, we can no longer write off cities as having nothing to offer the sustainability movement. Given the urgency of confronting climate change, rapidly increasing levels of respiratory disease in urban populations, the worldwide ubiquity of water quality and supply issues, and the compromised state of nearly every natural ecosystem on earth, it's time for cities to lead the way and share our best-tested ideas for healing the planet. It's also time to share what hasn't worked.

TreePeople has a long history of utilizing evaluation of its events and innovations – whether tree plantings, speaking engagements, community workshops or youth education programs – as the quickest path to strengthening and improving our programs and the organization itself. In each situation, we seek to learn what worked, what didn't and how to do better next time. This method has helped build TreePeople into a thriving community-based institution. I've always lived by the principle that mistakes and failures are compost for success.

The integrated urban watershed management movement is still young, but there is urgency here in the United States and abroad driving adoption of these proposals and approaches. To bring these methods to wide-scale use means building, testing, demonstrating and learning from even more projects. Helping cities fight the causes of climate change and adapt to its consequences adds even more impetus. The U.S. Environmental Protection Agency has identified over $300 billion for nonintegrated water supply and wastewater projects for U.S. cities in the next 20 years. Those single-purpose projects will, for the most part, serve as Band-Aids without improving other related problems facing the cities that build them.

On the other hand, this massive investment – informed instead by integrated approaches such as the ones studied in this report – could leverage those funds to solve multiple problems and profoundly improve the quality of life of urban residents.

If you are reading this report, you are either an innovator or problem-solver in search of solutions – and as someone aware of the tremendous challenges ahead, we hope you'll take an active part in securing a thriving future for the Los Angeles region and beyond. We hope you'll make use of the information in this report as you test and attempt further solutions. Please keep us informed of your own results and progress.

Congratulations and thank you again for being part of the solution.

Andy Lipkis, *Founder and President of TreePeople*

About Our Work

TreePeople's work is about inspiring people to transform their cities, currently significant sources of damage to human health and the environment, into sustainable urban ecosystems. We do this by creating "functioning community forests"— that is, restoring nature's cycles in urban areas – through strategically planting trees, mulching greenwaste, capturing and using stormwater right where it falls, and educating communities and engaging them in taking responsibility for the environment.

Although we have been planting and caring for trees since 1973, of all our programs our work on critical water issues has elicited the greatest range of responses: inspiration to do more; confusion about how to achieve this goal; and a mix of support and skepticism that the concepts we advocate will see large-scale adoption.

TreePeople has managed the implementation of a number of demonstration projects showcasing alternative stormwater management approaches and practices, among which are the three projects featured in this report. At the time these projects were initiated, government agencies around Los Angeles were not practicing integrated urban watershed management. At least within the governmental arena, multipurpose projects – which combine flood reduction, water conservation and stormwater protection with a host of other social, environmental and economic benefits – were considered neither necessary nor financially and technically feasible.

Rather than relying only on studies to prove otherwise, we chose to construct tangible projects that would enable public agency staff, policymakers and the public to see these projects working, and then to imagine them scaled-up to the citywide or countywide level. The demonstration sites have helped initiate an ongoing process of significant changes in local and state agency missions, funding policies, designs, projects, plans and programs.

As we continue our efforts to affect the environmental, social and economic health of the Los Angeles region and beyond, we reflect on our experiences with past projects and look ahead toward the work that must still be done.

Purpose of This Publication

The demonstration sites have spurred much interest in alternative stormwater management scenarios and technologies. We receive many inquiries about these projects from a variety of sources, and until now we have lacked a way to accurately and efficiently share the documentation and evaluation of these projects.

The purpose of this publication is thus to disseminate information about the demonstration projects, presenting a candid discussion of the processes that were involved in their implementation and sharing the lessons we learned along the way.

Our intent in producing this report is not to see the projects replicated, but rather to encourage other implementers to improve upon the concepts piloted at the three sites. Information about the retrofit processes is meant to provide as complete a picture as possible of the intricacies involved. Plans and technical information are meant as a guide, and individual conditions would preclude anyone from using them off-the-shelf.

About This Report

Definitions for terms in *italics* can be found in the glossary at the end of this publication. Appendices will be available on compact disc (for printed reports) and as separate downloadable attachments (for reports in electronic format).

Background

TreePeople launched the Transagency Resources for Environmental and Economic Sustainability (T.R.E.E.S.) Project in 1994 in response to a simple observation: conventional management of cities results in the misuse and loss of vast amounts of natural, social and economic resources. The sheer amount of natural capital that it takes to feed a city and the devastation that cities create in downstream communities serve as ever-present reminders that urban places were built with a lack of understanding and appreciation of nature's cycles. Cities have proven to be tremendously damaging to those living both within and outside their boundaries, and – when managed using the conventional methods that built them – are ultimately unsustainable. The T.R.E.E.S. Project was initiated to demonstrate that shifting the flow of – and indeed recycling – environmental, human and economic resources can result in healthier and more sustainable environments.

In the Los Angeles region, conventional development practices have meant that the city is increasingly covered with impervious surfaces, leaving fewer places where stormwater can soak into the ground and reach the aquifer. With no place else to go, water flows across the impervious surfaces, picking up oils, pesticides, animal waste, atmospheric deposits and trash. Massive flood control projects are undertaken to rush this water off the streets and into channelized rivers and the ocean, rendering natural water bodies unsafe for humans and wildlife. As the effects of global climate change begin to be felt, the precious resource of rainfall, which could be used to augment local water supplies, is mostly squandered instead. At the same time, more than half of the water needs of the county's ten million residents are met by costly imports from distant locations – a practice that has been notoriously harmful to places such as the Owens Valley, Mono Lake and the Colorado River basin.

To mitigate these problems, a variety of separate water-related agencies proposed spending in excess of $10 billion to construct numerous uncoordinated projects that would act as temporary solutions without moving the region closer to sustainability.

The T.R.E.E.S. Project sought to prove that it was technically and economically possible to retrofit and manage the region as one integrated urban watershed ecosystem by combining those funds for one coherent plan. In addition to conducting a robust, integrated cost-benefit analysis, the T.R.E.E.S. Project needed to develop sound engineering plans to guide the retrofit process. To do this, the project turned to the collective expertise that a variety of professionals would bring by participating in a *charrette*.

In May 1997, TreePeople convened the four-day Second Nature charrette – a conference of engineers, landscape architects, urban foresters, architects and planners who created retrofit designs for capturing and using stormwater on sites representing five of the major land-use types in Los Angeles. The participants' assignment: to design feasible retrofits for five existing properties. The ultimate goal: retrofitting Los Angeles to function as a community forest.

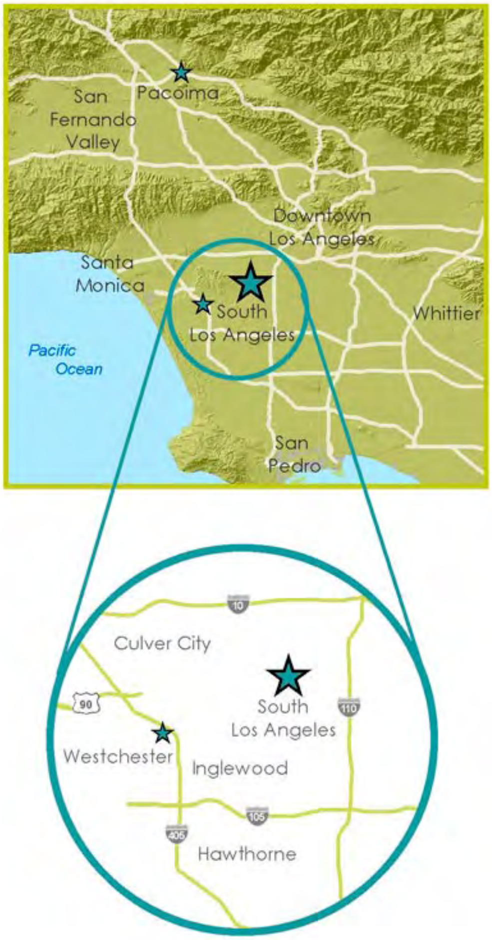
Each of the teams was charged with designing a retrofit for an existing residential, public, commercial or industrial site, using *best management practices* (BMPs) to make it function as a miniature urban forest watershed.

At the charrette the design teams concerned themselves with the environmental impacts of our water use, not only in the city, but also upstream, where the water comes from, and downstream, where it ends up. The conference resulted in the publication of a book of BMPs and design ideas titled *Second Nature: Adapting L.A.'s Landscape for Sustainable Living*. Those BMPs were used to guide and inform the three demonstration projects detailed in this report.

Since that time, TreePeople has continued to innovate upon the concepts first iterated at the charrette while also advocating their adoption at the local and regional level and beyond. The opportunity exists for us to reduce water importation significantly, prevent water pollution and flooding through increased onsite retention, reduce landfill volumes considerably and create employment opportunities – all while improving the quality of life of our communities and ecosystems.

Single-Family Home Greening and Stormwater Management

Demonstration site in
South Los Angeles, California



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Introduction

At the four-day Second Nature charrette in 1997, teams of designers created retrofit designs to facilitate the sustainable management of stormwater on five existing sites representative of Los Angeles' predominant land uses.

Due to limited financial resources, TreePeople could only implement a single charrette design and thus sought to identify the one with the most potential for replication. The prevalence of single-family residences in Los Angeles made that land-use type a logical choice. The intent of this pilot retrofit was to demonstrate the feasibility of sustainable approaches to managing urban watersheds and to inspire policy shifts that would encourage their widespread adoption. Building the demonstration site at a single-family home meant that a citywide application would be immediately evident.

Rather than fight nature's cycles of flood, drought and waste, the single-family home works with them, capturing and retaining onsite the *runoff* from a *100-year storm* event. A combination of technologies was used at the site, including retention grading, *swales* and a *cistern*. Stormwater that falls on the property is either directed to the ground, where it percolates and feeds the *aquifer*, or is stored in the cistern for later use in irrigation. Swales are designed to utilize yard waste as mulch, eliminating the need for transport to and space in a landfill.

Rather than fight nature's cycles of flood, drought and waste, the single-family home works with them, capturing and retaining onsite the runoff from a 100-year storm event.

Mark Drayse

During quarterly tours, visitors learn how the house was retrofitted to function as a miniature urban forest watershed.

TreePeople leads quarterly tours of the site, during which students, members of the public, government officials, landscape architects and city leaders learn about the opportunity to bring Los Angeles into closer harmony with its environment.

Project Objectives

- Demonstrate how a single parcel can act as a miniature watershed, and how thousands of similar parcels can be networked to meet a region's water management and flood prevention needs
- Capture onsite stormwater falling on the property from up to a 100-year storm
- Utilize a cistern to store some of the stormwater for later use in irrigation
- Infiltrate remaining water to recharge the aquifer, thereby virtually eliminating runoff
- Minimize the solid waste stream and detain irrigation water by reusing greenwaste onsite as mulch

Background

Selecting a Site

Intent on finding a site that would demonstrate the feasibility of a wide-scale retrofit, TreePeople solicited input from various agencies and organizations, including the U.S. Army Corps of Engineers, the Los Angeles Department of Water and Power (DWP), Mothers of East Los Angeles and the Concerned Citizens of South Central Los Angeles. A suitable site would be representative of the average Los Angeles home and would be located in a low- to middle-income area, demonstrating the applicability of the Transagency Resources for Environmental and Economic Sustainability (T.R.E.E.S.) model across the economic spectrum.

With these criteria in mind, the late Mrs. Rozella Hall, owner of a home on a small lot in South Los Angeles, offered her property for the retrofit. Mrs. Hall was profoundly interested in transforming her home to function sensibly while demonstrating the watershed functions that a single parcel can perform. In turn, TreePeople found Mrs. Hall's personal interest in the project ideal.

In local circles the project has become known as the "Hall House" demonstration site and that is how it will be referred to in the remainder of this document.

Site Profile

The Hall House is located in a low-income area in South Los Angeles, near the intersection of Western and Vernon Avenues. The Craftsman-style bungalow house was built in the early twentieth century on a lot measuring 50 by 150 feet, a typical lot size for homes built in Los Angeles in the first part of the twentieth century. The wood-frame house, a garage and paved areas cover approximately 60 percent of the 7,500-square-foot lot. The remainder of the property consists of turf, shrubs, planted areas and mature trees.

The house is located within the Ballona Creek watershed. The soil at the site is a well-drained loamy sand with moderately rapid subsoil permeability – ideal for infiltration BMPs.

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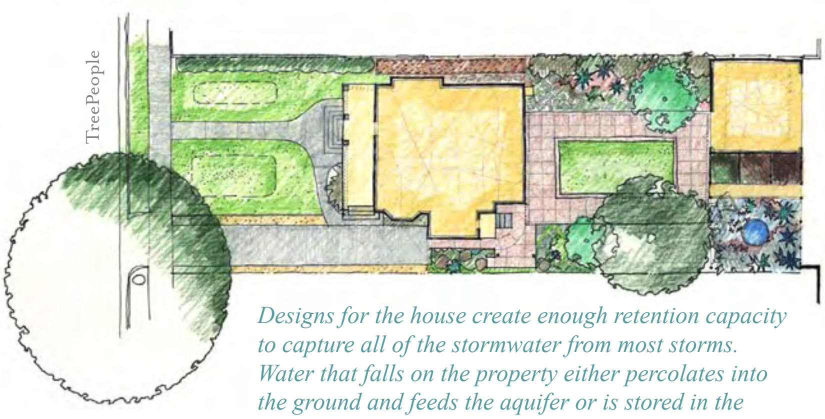
The Hall House, located on a small lot in South Los Angeles, demonstrates the feasibility of restoring some of the watershed functions of urban sites.

Designs



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Designs for the house create enough retention capacity to capture all of the stormwater from most storms. Water that falls on the property either percolates into the ground and feeds the aquifer or is stored in the cistern and later used for irrigation.

Project Features

As a demonstration project, the Hall House retrofit uses a variety of BMPs that illustrate some of the greening options available to homeowners or developers interested in managing their properties as miniature watersheds.

The BMPs used at the site include:

- A **cistern system**, comprising two connected 1,800-gallon tanks that retain stormwater for irrigation use, and a **first-flush diversion unit**. This unit collects the "first flush" of water that occurs during a storm and stores it long enough so gravity can settle out pollutants that accumulate on the roof. Remaining water is delivered to the cistern;
- A **vegetated and mulched swale** filled with yard trimmings that captures and slows rainwater runoff so it can be absorbed by the soil;
- **Retention grading** in the frontyard and backyard, which allows large quantities of stormwater to be retained onsite and percolate into the ground rather than wash down storm drains;
- A **drywell** filled with sand and crushed rock, which prevents water that falls on the driveway from reaching the street as runoff. This unit cleanses polluted water from the driveway before it percolates into the ground to recharge the aquifer.

Initial Proposals

The homeowner, Mrs. Hall, had limited ability to perform yard work or to hire others to do it for her. Consequently, the team produced a design that met all of the environmental performance requirements without requiring a burdensome amount of work for the homeowner.

The initial proposals lay out a simple design strategy. A cistern would be installed on the site to capture roughly a quarter of the stormwater that falls on the roof. Water stored in the cistern would be used to irrigate the lawn. The lawn areas would be depressed to allow the remaining stormwater to collect and be absorbed by the grass and the soil, which is relatively free of clay particles and can soak up large amounts of water quickly. A permeable pavement driveway would be installed to absorb water falling in this area and to reduce the amount of impermeable surfaces on the property.

Built Designs

The charrette plan presents the bulk of the elements that were ultimately constructed at the site, including retention grading, a vegetated swale and a cistern. A fourth element, the driveway drywell, was added later and is an alternative to the permeable driveway proposed at the charrette.

Another element that differs from the original design is an overflow pipe required by city regulation that conveys stormwater not captured by the BMPs from the property to the street. Although legally necessary, the overflow element is superfluous because of the property's ability to capture large volumes of stormwater.

The cistern was fabricated at a factory located in the San Fernando Valley and trucked to the site. Once there, a crane was necessary to lift it from the street, over the house and into its final location. With exception to manufactured elements such as the cistern, the contractor on the project performed construction of the BMPs and installation of the irrigation system and much of the landscaping.

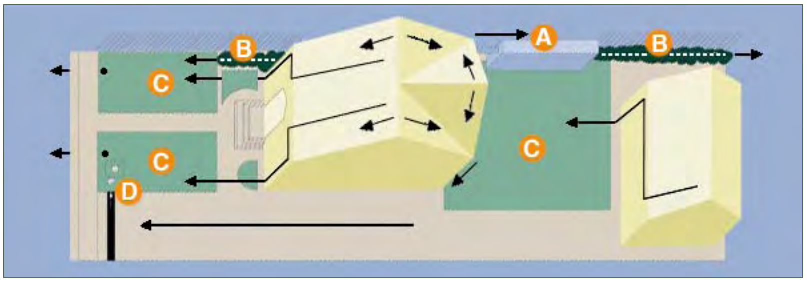
Construction was completed by July 1998, and a completion celebration was held in August.

BMPs

The operation of the demonstration site is illustrated in figure 1. Rain falling on the hard surfaces of the site (the roof and pavement) is directed to depressed lawn areas (C), or the cistern (A). Overflow amounts are carried by the vegetated swale (B), which also receives greenwaste (lawn clippings, leaves and twigs) from the site. Water flowing down the driveway toward the street is intercepted by a grated trench drain and diverted to the drywell (D).

The design strategy maximizes rainwater storage while minimizing grading and earth removal. Low maintenance is a must at this site, so all equipment and plantings function with little or no maintenance. These constraints

Fig. 1 Hall House Diagram



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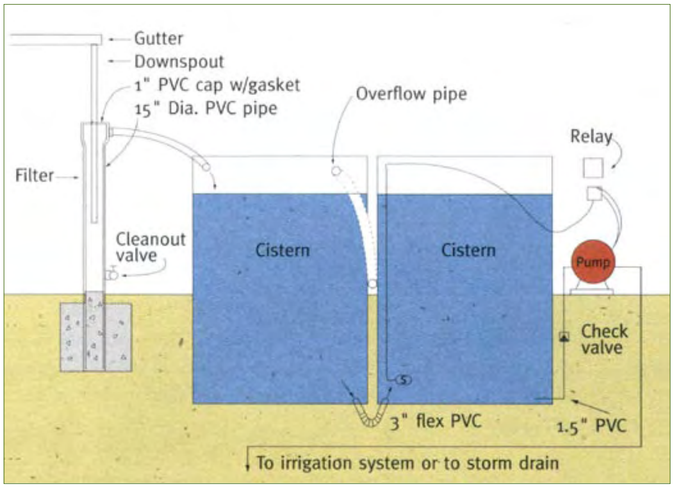
Arrows in the diagram indicate the direction of stormwater flow. Letters designate the location of the four BMPs, including the cistern (A), the vegetated swale (B), retention grading (C) and the driveway grate and drywell (D).

notwithstanding, the demonstration site successfully captures and holds all of the water falling during a two-inch storm. To accomplish this, the three lawn areas are reconfigured as shallow retention basins. Safety considerations require a maximum depth of six inches for these basins. Lowering the lawn panels two inches below existing grade while building up surrounding four-inch berms provides the maximum six-inch storage capacity in each panel. The berms are covered with shrubs, ground covers or turf in order to stabilize them and to prevent foot traffic that might compromise the effectiveness of the retention system.

Cistern System



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The cistern system captures stormwater falling on a portion of the roof. Together, the cistern's two recycled plastic tanks provide 3,600 gallons of storage space. A pump distributes water to the irrigation system.

A cistern, composed of two tank-modules, collects rainwater from the southeast quadrant of the roof. Stored water is used to irrigate the lawn and gardens. A roof-wash unit collects the first-flush water that falls during the first part of a storm and sequesters it long enough so that gravity can settle out the buildup of atmospheric deposits and bird feces. The first flush is then drained into the adjacent lawn panel while the clean water decants into the cistern. The double cistern at the demonstration site is made of polypropylene, a recycled (and recyclable) plastic that is plentiful in Los Angeles' waste stream. Each cistern tank holds 1,800 gallons of water. An electric pump distributes the water to the irrigation system. Attachment specifications include a piece of flexible three-inch PVC pipe with one end in the floor of each tank. A double backflow valve ensures that cistern water does not back up into the city water supply. Once the tanks are empty, a manually-operated set of valves shuts off the cistern supply and another set is opened to deliver municipal water for irrigation.

The total height of each of the two tanks is 11 feet, of which roughly six feet is above ground. The width above ground (from front to back) is two feet; below ground the width is four feet. The breadth (side-to-side) is eight feet. About two-thirds of the capacity is underground. The shape and the partial burial increase its stability and reduce the aboveground profile. The dimensions above ground allow the cistern to be placed discreetly next to a fence or hedge. Multiple modules could be connected in series to increase storage capacity and to form a fence or barrier.

Vegetated/Mulched Swale

Swales are used at the demonstration site to create an attractive space that also performs vital stormwater and greenwaste functions. The mulched swale is the repository of recycled greenwaste from the property. It is designed to slow the flow of stormwater and to filter pollutants so that water can be absorbed into the earth and toxic substances be removed. A swale can be used in any residential setting and may be covered with grass, vegetation or mulch.

Retention Grading

The frontyard and backyard retention grading creates "sunken gardens" that hold rainwater until it can be absorbed by the ground. This BMP works best in highly permeable soils (Los Angeles types 2 and 3). At the demonstration site, three gutter downspouts were redirected from hardscape (and the public storm drains) to the permeable graded areas. The runoff from the front half of the roof is directed into six-inch depressions in the front lawn, while the southwest roof quadrant and half of the garage roof drain to the backyard.

David O'Donnell

The sunken lawn panels, elevated at the perimeter to ensure retention capacity, provide temporary storage for up to 5,800 gallons and allow water to infiltrate into the ground and replenish the aquifer.

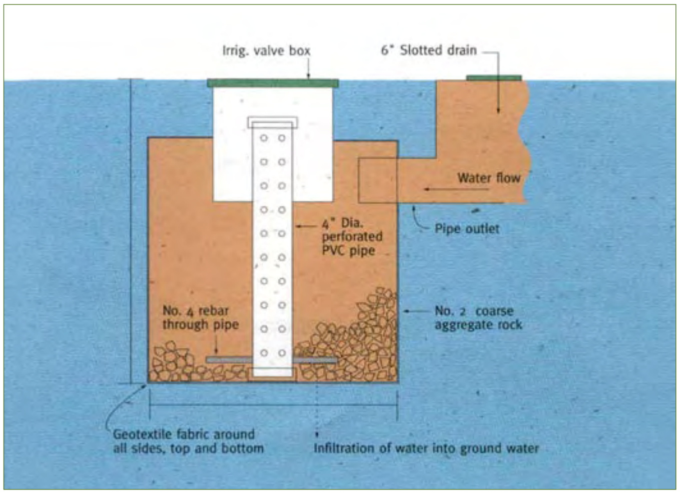
These mini retention structures are capable of handling a flash flood that could occur during a 100-year storm event. When properly maintained, the total retention capacity of the graded areas is approximately 5,800 gallons. During a more intense storm, excess rainwater would flow into the existing storm drain system. The system is designed to infiltrate all water within 72 hours.

On properties with less absorbent soils, the depressed area can be underlaid with coarse aggregate rock to increase the site's holding capacity and the amount of water that eventually infiltrates.

Driveway Grate and Drywell

David O'Donnell

The driveway grate, an unobtrusive addition to the property, directs stormwater down into the underground drywell.



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Once water passes through the driveway grate, it flows underground through sand and crushed rock. The system filters water and retains it until it can be absorbed by the ground below.

Stormwater flowing down the driveway runs into a grated trench, which carries it to a box containing sand and crushed rock that captures pollutants. The system serves the dual purpose of retaining and cleansing rainwater. It gives the water time to percolate into the ground and prevents motor oil and other pollutants from flowing into storm drains and creeks and out to local beaches and bays.

Benefits, Costs and Funding

Benefits

The house successfully captures and holds all of the water falling during a two-inch storm, thus eliminating runoff from many storms and reducing runoff volumes from large flood events.

The infiltration of stormwater yields benefits for flood management and water quality. Monitoring at the site concluded that soil appears to be a very efficient means of removing contaminants from stormwater. While bacteria were detected in stormwater samples, they were not detected, or were detected at very low concentrations, in *lysimeter* and groundwater samples.[1]

The house successfully captures and holds all of the water falling during a two-inch storm, thus eliminating runoff from many storms and reducing runoff volumes from large flood events.

Water conservation and the reduction of garden waste are two additional benefits. Significant reductions in the stream of greenwaste save the city collection, transportation and processing costs while reducing air pollution, noise and traffic congestion.

The focus on increasing the number of trees and plants onsite mitigates the urban *heat-island effect* and creates air quality benefits while diminishing the city's contributions to global climate change.

Costs

Perhaps the most pertinent aspect in determining replicability of a demonstration site such as the Hall House is cost, yet demonstration sites often suffer from higher costs because of the price associated with BMP components not readily available on the market.

Such is the case with the cistern at the Hall House, which was a custom-manufactured recycled plastic prototype and was engineered – at a higher cost – to be earthquake- and UV-proof. In order to fabricate the prototype, a unique unit had to be designed, engineered, tested and fiberglassed, pushing the total cost of manufacturing and installing the cistern to approximately $25,000.

The cistern was designed with the intention of having local manufacturers reproduce it on a large scale. Mass production would significantly reduce unit costs while also providing local employment in manufacturing and installation. Further, the intended use of locally recycled plastics would spur the development of a substantial recycled materials market and help cities sustain their recycling programs.

The Hall House cistern, however, represents only one of several options. Readymade water-storage products, including fiberglass and polyethylene tanks, are available for purchase and can be used instead of a custom-made unit. More economical homemade alternatives can also be used to construct a cistern.

Other aspects affecting cistern cost include the unit's placement above or below ground, its holding capacity, and the quality of filtering and pumping equipment. Depending on these factors, a homeowner can expect to pay anywhere from a few hundred dollars for a small, homemade cistern to several thousand dollars for a larger, professionally manufactured cistern with automated functions.

Figure 2 presents information collected by the project architect and contractor and is meant to give a general idea of what a retrofit similar to that at the Hall House might cost a homeowner. The approximate costs are for a 7,500-square-foot property, with 4,500 square feet occupied by structures and impermeable materials. The cistern's cost is intentionally omitted because of the wide range in prices between simpler, homemade systems and more complex, professionally manufactured models.

[1] The Los Angeles and San Gabriel Rivers Watershed Council, "Los Angeles Basin Water Augmentation Study Phase II Final Report," August 2005.

Fig. 2 Estimated Costs of a Retrofit Similar to the Hall House Retrofit

Project Components	Do-it-yourself Costs (materials & permits)	Optional Costs (contracted labor)	Total (incl. optional costs)
Retention Grading	**$800**	**$800**	**$1,600**
Driveway Grading and Drywell	**$1,400**	**$500**	**$1,900**
Vegetated or Mulched Swale	**$30 (for seed)**	**$250**	**$280 - $1,000**
Roof Downspout Extensions (4 total)	**$10 - 30/each**	**$45 - 65/each**	**$220 - 380**
Overflow Pipe to Street	**$550**	**$700**	**$1,250**
Estimated Total Costs	**$2,820 - $3,620**	**$2,430 - $2,510**	**$5,250 - $6,130**

Funding

Funding for the Hall House retrofit was drawn from a collection of sources that launched the T.R.E.E.S. Project. These included a challenge grant from the USDA Forest Service and grants from the City of Los Angeles Bureau of Sanitation Stormwater Program, the Los Angeles Department of Water and Power, the U.S. Environmental Protection Agency, the City of Santa Monica, the Los Angeles County Department of Public Works, the Metropolitan Water District of Southern California, the Los Angeles Urban Resources Partnership, the Southern California Association of Governments and Environment Now. Several donations from private donors were also instrumental in establishing the T.R.E.E.S. Project.

Post-Completion

Monitoring

In cooperation with TreePeople, in 2000 the USDA Forest Service, Center for Urban Forest Research installed equipment at the demonstration site and at a control site next door to record weather information and monitor the performance of the BMPs and their effect on runoff.

The monitoring study measured soil characteristics, water use for irrigation, and quantity and quality of runoff, among other indicators of BMP performance. The study made several findings, including these:

- The BMPs are effective in reducing surface runoff, conserving municipal water supplies while maintaining an irrigated landscape, and reducing stormwater runoff and its pollutant load.
- The driveway drywell appears to be a cost-effective means of reducing runoff from roof and paved surfaces.
- Water quality of runoff on the street was consistently worse than the runoff sampled at the Hall House.

Between 2002 and 2005, the Los Angeles and San Gabriel Rivers Watershed Council (LASGRWC) continued and expanded upon the monitoring activities started by the Forest Service. The council's monitoring was part of a Water Augmentation Study of the Los Angeles Basin that is exploring the potential for augmenting local groundwater supplies and reducing polluted runoff by infiltrating more stormwater, a resource that otherwise flows unused to the ocean.[2]

[2] A full copy of the monitoring report on this and other sites is available from the Los Angeles and San Gabriel Rivers Watershed Council, www.lasgrwc.org.

Monitoring tasks included taking stormwater runoff samples at both the demonstration and control sites and collecting soil samples for analysis from the front lawns of both homes. Surface stormwater samples were collected at the roof drain and the driveway. Samples were also collected from a single lysimeter (used for measuring water that percolates into soil) installed eight feet below ground surface in the front yard.

In most instances, monitoring results indicated that the soil was effective at removing pollutants from stormwater. Monitoring showed that water samples taken from the lysimeter contained lower concentrations of metals and volatile organic compounds (VOCs), including acetone, lead, zinc and total arsenic – indicating that soil at the site is able to capture pollutants in water. Concentrations of oil and grease were also significantly less in groundwater than in water collected at either the roof drain or driveway.[3]

Percolation rates were lower at the demonstration site than at the control site, particularly in the front lawn panels. Since the same soil type exists at both properties, we surmise that soil compaction must have taken place as a result of the lawn panel excavation.

Operations and Maintenance

From the start, the retrofit designs were tailored around minimal maintenance, so as to place the least physical and financial burden on the owner. Even so, the numerous BMPs that utilize natural elements require some maintenance to function properly.

Maintenance tasks fall into several categories:

- **Greenwaste:** fallen, dead or damaged leaves and branches should be processed into mulch. Mulch is then spread in the swales, under hedges on the berms, around trees and in planting beds. Soft stems, leaves and flowers can be composted, but proper attention to compost processing is required. A chipper is kept onsite to aid in processing greenwaste and eliminating greenwaste flow to the landfill.
- **Garden Upkeep:** vegetation should be maintained to prevent overgrowth that blocks natural light from reaching the inside of the home, prevents access to BMP components, and potentially damages structures.
- **Cistern:** if vector or bacteria problems are of concern, stored water may require treatment with chlorine or mosquito dunks. Occasional cleaning of the cistern is also advised, as are inspections to ensure that air and light do not enter the cistern. Although algal growth has not been a problem at the Hall House, measures to prevent development of algae are recommended if sunlight penetrates the cistern.
- **Irrigation:** the pump that moves water from the cistern to the irrigation system shuts off when the water level in the cistern reaches a pre-determined low point. The irrigation system must then be fed by city water (one manually-operated valve must be closed to shut off the cistern feed and another opened to turn on the city water supply).
- **Driveway Drywell:** the driveway grate quickly fills with leaves and sediment and must be cleared regularly. Since its function is to absorb pollutants from the driveway, the drywell's sand and crushed rock filling should be inspected before the rainy season to prevent clogging and reduced infiltration. The water level in the observation well should be measured after a storm. If the water level does not drop in the days following a storm, the drywell may be clogged and the sand and crushed rock filling may need to be replaced.
- **First-flush Unit:** the decanter component must be emptied regularly to create room for the first flush of the next storm. This is done by opening a valve at the bottom and letting the water run out onto the lawn.
- **Swales:** swales should be monitored and mulch replenished as needed. In grassy swales, turf should be mowed during the growing season.
- **Retention grading:** retention grading should be inspected for sediment accumulation or loss and appropriate maintenance done after moderate or heavy storm events. Berms should be inspected and any necessary repairs performed.

[3] The Los Angeles and San Gabriel Rivers Watershed Council, "Los Angeles Basin Water Augmentation Study Phase II Report," August 2005.

Successes

Becky Villaseñor

A mock storm "rained" 4,000 gallons onto the Hall House property during a demonstration following the project's completion.

On a sunny day in August 1998, 4,000 gallons of water "rained" from fire hoses onto Mrs. Rozella Hall's home, putting to work the newly installed BMPs. Rather than gush down the driveway and into the street and the storm drain, every drop was captured onsite, either percolating into the soil or collecting in the cistern. There to witness the demonstration were members of the public, media representatives and agency leaders, including senior representatives from the city's Watershed Protection Division, the Department of Water and Power, the USDA Forest Service and the City of Los Angeles Board of Public Works.

Among those present was Carl Blum, then deputy director of the Los Angeles County Department of Public Works (DPW) and head of its flood control division. With Los Angeles sprawling ever outward, DPW had traditionally constructed flood control projects aimed at one primary concern: protecting the city from flooding. An effective way of achieving this was to rush stormwater out of the city via storm drains and channels. The methods used at the Hall House, in stark contrast to DPW's approach, demonstrated solutions aimed at much more than flood prevention. The multipurpose and interlinked BMPs addressed issues of stormwater pollution, flooding, water supply and waste management. These connections helped break through conventional notions dictating the use of vast municipal resources to address individual problems.

The mock rainstorm laid the foundations for a partnership among DPW, TreePeople and other stakeholders to retrofit the 2,700-acre Sun Valley watershed. The area consists of neighborhoods built without storm drains, and is the location of the county's largest unresolved urban flooding problem. The county's plan treats stormwater as a resource and aims to keep it all in the watershed to control flooding, reduce water pollution, conserve potable water and recharge local aquifers. The plan is noteworthy in that it favors stormwater BMPs over the more conventional approach – a large storm drain that would tax the capacity of the Los Angeles River and route polluted runoff to the ocean.

Since its completion in 1998 the Hall House has generated tremendous interest and excitement around the potential of retrofitting the urban landscape to function with consideration to nature's cycles. When the T.R.E.E.S. Project began, stormwater capture and reuse were not under the policy purview of government agencies in and around Los Angeles. But since the retrofit was completed, TreePeople has hosted tours for hundreds of individuals, including city leaders and agency representatives, fostering support and enthusiasm that has helped shift policy around the region.

Challenges and Lessons Learned

The T.R.E.E.S. Project developed around the concept that a region-wide sustainability retrofit would find its impetus through innovative, local demonstration projects. These projects would then generate replication of sustainable practices, and change at the policy level would naturally follow. The choice to first retrofit a single-family house fit this ideal, as this path of least bureaucratic resistance offered a realistic opportunity for replication. Working on this scale, TreePeople did not come upon significant regulatory restrictions or problems obtaining permits. Nevertheless, various other challenges were encountered and lessons were learned specifically because the demonstration site was located at a private residence.

Site Ownership

When the Hall House was retrofitted in 1998, TreePeople found a dedicated partner in Rozella Hall. Mrs. Hall was eager to offer her home as a demonstration of sensible, replicable practices, and, as an established member of the community, was working toward larger neighborhood projects, including alley greening. Mrs. Hall had the opportunity to witness the completion of the project and to participate by keeping a journal of energy and water use, costs, and landscape maintenance practices. Sadly, she passed away shortly after the retrofit's completion.

Challenge: Ownership of the home was transferred to Mrs. Hall's daughter, but Rozella's emotional investment and enthusiasm were hard to match. As a result, in the following years the Hall House BMPs and the property as a whole received a different level of attention and care than previously offered by Mrs. Hall. The quality of the site as a demonstration diminished both functionally and aesthetically – yet, cognizant of the owner's right to privacy, TreePeople has had limited capability to interfere.

Lesson: Due to private ownership, public access for tours must be necessarily limited. With few exceptions, tours are conducted no more than quarterly in order to limit household disruption.

A privately owned site is also vulnerable to ownership transfer. Unless use of the house as a demonstration site is written into the deed, sale of the home would likely result in loss of the use of the site.

With sufficient financial resources, these challenges could have been averted through TreePeople's purchase of a suitable site for the project.

Choosing a Suitable Location

Challenge: The site's location has also played a key role in its success as a demonstration project. The site choice has affected both the quality of care that the property has been given and the level of participation in tours.

Lesson: The fact that the Hall House is in South Los Angeles, a part of the city noted for violence and blight, has affected the number of individuals willing to attend a tour. The distance of the site from TreePeople's headquarters (over 20 miles and up to an hour away) has also made it difficult for staff to manage its conditions closely.

Although TreePeople deliberately selected an economically depressed area to prove the viability of engaging in similar retrofits citywide regardless of the availability of financial resources, some problems have resulted specifically because of the site's location.

Contract With the Property Owner

Challenge: The Hall House project did not include a formal contract between the homeowner and TreePeople that specified the length of time that the site would be used for public demonstration purposes or that bound the homeowner to a specific maintenance schedule.

Lesson: Although the relationship-based project did not seem to call for such an agreement, a contract likely would have ensured that the condition of the site and BMPs remained consistent with TreePeople's original expectations and standards.

Choosing Sensible BMP Designs and Products

Challenge: The custom design and manufacture of the cistern was the result of an expensive and laborious process. While great effort was put into the design, there was no guarantee that the prototype would function as intended.

Lesson: If presented with a similar challenge today, TreePeople would look toward the array of products available on the market for a more economical and accessible alternative to storing captured stormwater.

Although the cistern has met its intended function, improvements to the design could be made. Access to the hatch doors is awkward despite a built-in ladder. The overflow outlet was placed at the back of the cistern but located higher than the bottom of the hatch doors, so were the cistern to overfill, the water would leak out through the hatch seams before reaching the overflow. Also valuable would be an externally viewable scale indicating the level of water in the tanks. An operations manual could have solved many of the problems encountered, but as the unit was custom-built, no such instructions were available.

Another design flaw is that the cistern allows emptying and cleaning via a pump, but that the pump is designed to flush water into the street rather than onto the swales and yard for infiltration. The purpose of pumping water into the street was to create an option for the cistern to act as part of a networked reservoir that could be emptied in advance of a storm and then capture peak storm flows to reduce the municipal flooding risk. This design, however, leads to losing collected stormwater to the storm drain – and, if the water were contaminated, would actually contribute polluted runoff. Ideally, the design would have included two options: one pump to direct water to the street and another to pump water to the lawn panels on the property.

Choice of Plant Species

Challenge: The choice of plant species has required greater garden upkeep than originally planned, and has produced more greenwaste than can be easily used as mulch on the property.

Lesson: The project partners, with input from the homeowner, chose to keep a traditional garden style. Demonstrating stormwater capture and use – not water conservation – were key objectives of the project, so using plant species requiring moderate watering did not run counter to the project's intent. Even so, the area covered in water-loving turf lawn was reduced by roughly 15 percent.

A more aggressive reduction in lawn area combined with a greater use of native and drought-tolerant species would have dramatically reduced water use, required less maintenance and added another sustainable element to the demonstration.

Project Costs

Challenge: As a prototype, the retrofit costs associated with the Hall House project – including custom design, engineering and fabrication of BMPs – together with the lack of availability of products, make some of the specific BMP components demonstrated at the house unsuitable for replication.

The primary purpose of the demonstration was to show policymakers that it was technically and socially feasible to retrofit a home to safely capture and use large volumes of rainwater without requiring unacceptable lifestyle changes from residents. The principles showcased at the site were also meant to illustrate the viability of substantially reducing stormwater flow, water pollution, water and energy use, and greenwaste. These objectives were met. Policymakers understood that economies of scale would result from a city- or watershed-wide retrofit, and that future retrofits would thus be more financially feasible, especially when combined with subsidies and incentives.

Nevertheless, without understanding the cost structure behind the Hall House project, the price tag can cause apprehension among those interested in similar retrofits.

Lesson: In all communication about the demonstration site, emphasizing its prototype purpose is essential. The project does not end with completion of construction, and the costs associated with the prototype are not representative of the costs of wide-scale adoption of similar stormwater management technologies. The real work of shifting both policies and the urban landscape begins with the end of construction.

Once the systemwide feasibility of these technologies is understood in the policymaking arena, the project partners should encourage do-it-yourself gardeners and small-scale landscaper contractors to implement similar retrofits easily and inexpensively. A new set of demonstration sites should be built and be geographically, socially and economically accessible to diverse markets of homeowners and renters. A cooperative technology development program (such as that for developing energy-conserving refrigerators) should be created, possibly with support from large government agencies. Such a program would make the various BMP technologies available to consumers. Finally, a program to facilitate and provide incentives for wide-scale retrofits should be created.

Baseline Data

Challenge: Monitoring and observations at the Hall House and at the control site next door have shed light on the effectiveness of the project's components. However, the lack of baseline data on water consumption levels for irrigation, runoff quantity and quality, and percolation rates makes accurate quantification of the project's benefits difficult.

Lesson: The purpose of the numerous BMPs utilized at the site was the exploration and illustration of available stormwater management and greening options. Although these technologies have largely succeeded in performing their intended purposes, baseline data should have been gathered prior to the retrofit so as to make possible definitive conclusions about the BMPs' performance.

Policy landscape

Challenge: Building codes for the City of Los Angeles do little to encourage onsite stormwater retention, storage and infiltration. For example, regulations on gutters and site drainage require that stormwater be directed to the street.[4]

Lesson: The project partners designed the retrofit to not stray far from existing regulations, and were able to receive the necessary permits for capturing and storing water onsite. Nevertheless, policies that actively support alternative stormwater management practices would promote the widespread adoption of the concepts showcased at the Hall House.

(There is a move currently underway by the City of Los Angeles to revise these policies through the implementation of the Integrated Resources Plan for wastewater.)

Partners

TreePeople conceived the project as part of its Transagency Resources for Environmental and Economic Sustainability (T.R.E.E.S.) Project, which promotes the integrated and sustainable management of urban watersheds. TreePeople organized the 1997 Second Nature charrette, a four-day conference that convened interdisciplinary teams to design retrofits for five existing properties in Los Angeles. The organization sought funding for the pilot retrofit at the Hall House and managed general aspects of the project.

The charrette design team produced the preliminary designs for the retrofit in 1997. The team included: Leo Marmol, architect and team facilitator; Tom Richman, landscape architect; Leslie Ryan, landscape architect; Gail Boyd, engineer; and Sharon Lockhart, environmental consultant. Graduate students on the team were Ramsey Badawi, Bonnie Dell Angelo and Ellen Hu.

CH2M HILL provided engineering services and formalized the charrette team's drawings.

PS Enterprises managed implementation of the project. Rick Ruiz was the project manager.

Robert Cornell and Associates provided contractor services, including construction of the BMP components and installation of landscaping and irrigation.

Karen Bragg aided in landscape installation and provided landscape maintenance services immediately following the project's completion.

[4] Los Angeles Municipal Code, Chapter IX, Building Regulations: **91.7013.9. Gutters. (Amended by Ord. No. 171,939, Eff. 4/15/98.)** Eave or ground gutters shall be provided to receive all roof water and deliver it through a non erosive device via gravity to a street or watercourse if the slope of the underlying natural ground exceeds three percent or if more than three feet (914 mm) of compacted fill or more than one foot (305 mm) of uncompacted fill is placed on the ground. **91.7013.10. Site Drainage. (Amended by Ord. No. 171,939, Eff. 4/15/98.)** All pads with cut or fill shall slope a minimum of two percent to an approved drainage device or to a public street. Where used, the drainage device shall be an adequately designed system of catch basins and drain lines which conducts the water to a street.

Background on School Projects

As one of the region's largest property owners, and as the second most populous public school system in the nation, the Los Angeles Unified School District (LAUSD) has a tremendous impact on quality of life in Southern California. From the everyday experiences in student life, to impacts on the urban *heat-island effect* and local *watersheds*, the district's land-use management choices for its school campuses have considerable effect on whether regional environmental and public health issues are mitigated or exacerbated.

The school district has an annual budget of $13 billion to service 850,000 students and operate more than 1,000 campuses and other facilities in its 710-square-mile service area.[1] Still, resources are not unlimited. Over the years, LAUSD has resorted to paving its campuses to reduce landscape maintenance costs. Many campuses have become expanses of heat-retaining asphalt. Together with buildings and other impervious surfaces, pavement on school grounds raises ambient temperatures, increases urban stormwater runoff, contributes to local flooding and diminishes groundwater supplies.

Ultimately, the most direct consequences of hot, unshaded campuses are borne by the students, whose health and learning conditions are compromised. During hot weather, blacktopped campuses amplify the urban heat-island effect and can raise classroom temperatures to the point where students and teachers lose the ability to focus, learn and study. Approximately 80 percent of a person's lifetime sun exposure occurs before age 18.[2] It is of little surprise, then, that childhood skin cancer is on the rise. Between 1973 and 2001, incidences of melanoma in children rose an average of three percent annually.[3] For adolescents who receive the bulk of their sun exposure at school, having no refuge from the sun and heat emanating from asphalt playgrounds can lead to a host of medical problems later in life.

In 1997, residents of Los Angeles County passed Proposition BB, a $2.6-billion bond to fund upgrades to aging campuses and construction of new ones. A significant portion of these funds – $187 million – was earmarked for repaving schoolyards, and another $250 million for installing air conditioning equipment in classrooms. TreePeople's Andy Lipkis and Steve Soboroff, then advisor to Los Angeles Mayor Richard Riordan, became aware of the situation and advocated for some of the repaving money to be used for campus greening instead.

Lipkis and Soboroff argued that Proposition BB funds could be used for multi-benefit projects that would make campuses more energy efficient and save the district money, both by reducing the size of air conditioning equipment needed and by lowering the amount of electricity required to power the equipment. In addition to cooling the schools, these projects would beautify campuses, reduce stormwater pollution, decrease flood risk, reduce sun exposure, improve air quality and mitigate the urban heat-island effect. With new water quality regulations (in the form of Total Maximum Daily Loads, or TMDLs) scheduled to come online for the Los Angeles area, Lipkis argued that the repaving budget should be used to ensure that campuses would meet the emerging standards and avoid the cost of reengineering for compliance at a later date.

The Proposition BB oversight committee and the school board ultimately agreed to reallocate 30 percent of the paving budget – about $62 million – to campus greening projects.

In 1998, the Los Angeles Department of Water and Power (DWP) partnered with LAUSD and several nonprofit groups – including the Hollywood Beautification Team, Los Angeles Conservation Corps, North East Trees and TreePeople – to initiate its Cool Schools program. The program, aimed at the citywide greening of blacktopped campuses in order to reduce energy use, funded the planting of more than 4,200 trees at 40 campuses during its first phase.[4] Both Broadous and Open Charter received Cool Schools funding. Two schools selected for additional work were designated Sustainable Schools. One of these was Broadous Elementary, which received funding from DWP to install a stormwater management system. The other Sustainable School was Multnomah Street Elementary in El Sereno, a neighborhood in the east part of Los Angeles. North East Trees oversaw the installation of a cistern on that campus.

Few policymakers or operations managers in the school district understood the health, energy conservation and stormwater pollution issues in existence at many of campuses. Also misunderstood was the ability of proper campus management to mitigate and even reverse these problems in order to protect student and community health. Despite the directive to green the schools, school construction managers greeted proposals to implement integrated water quality, energy-saving and health-protecting designs with skepticism and resistance, and ultimately an unwillingness to implement the needed best management practices (BMPs). To break through this resistance, TreePeople determined to implement demonstration projects that would illustrate the multipurpose viability of utilizing these technologies.

[1] LAUSD figures are for 2005-2006.

[2] Boe, Kathy and Tillotson, Elizabeth A. "Encouraging Sun Safety for Children and Adolescents." *The Journal of School Nursing:* June 2006; Vol. 22, No. 3, pp. 136-141.

[3] John J. Strouse, Thomas R. Fears, et. al. "Pediatric Melanoma: Risk Factor and Survival Analysis of the Surveillance, Epidemiology and End Results Database." *Journal of Clinical Oncology:* July 20, 2005; Vol. 23, No. 21, pp. 4735-4741.

[4] USC Sustainable Cities Program, "Assessment of Los Angeles Department of Water and Power Cool Schools Tree Planting Program," January 2001.

Campus Greening and Stormwater Management

Demonstration site at
Hillery T. Broadous Elementary School
Pacoima, California

TreePeople

Introduction

The stormwater management demonstration project at Hillery T. Broadous Elementary School illustrates the viability of using an integrated, cooperative approach between government and nonprofit entities to create an environmentally sustainable school campus.

The project was designed to provide a working demonstration of a multi-benefit, multi-agency approach to managing the urban environment while addressing site-specific problems. By capturing, treating and infiltrating stormwater that used to flood and run off the campus, the project turns stormwater into a resource. The retrofit of the campus was designed to produce an array of benefits, including:

- Alleviation of flooding on campus (allowing students to access classrooms that were isolated on rainy days)
- Alleviation of flooding in areas surrounding the campus
- Replenishment of groundwater
- Reduced energy use by shading air conditioning units
- Reduced polluted stormwater runoff to local water bodies
- Shading of play areas to improve student health and safety
- Opportunities to use greenwaste onsite to reduce the solid waste stream to landfills
- Creation of green recreation space and outdoor education areas

The project received major funding from the Los Angeles Department of Water and Power (DWP) Cool Schools program. Broadous was designated a Sustainable School and received funding from DWP to install a stormwater management system. (See "Background on School Projects" on page 17 for more information on the Cool Schools program.)

The greening of Broadous Elementary occurred in two phases. The first was in 1999, when the school community came together to plant dozens of trees during two TreePeople-sponsored tree planting events. The second phase began shortly thereafter and was marked by the construction of the infiltration field. Another series of tree planting events followed the completion of the stormwater facility in 2001.

Broadous Elementary School's transformation from an urban, hardscaped campus into a sustainable place for learning and playing was made possible through the collaboration of government and nonprofit representitives, and thus serves as an early example of an integrated, interagency approach to solving regional infrastructure and natural resource issues.

The primary collaborators on this project were the Los Angeles Unified School District (LAUSD), DWP and TreePeople.

The interests, expertise and resources of each stakeholder were instrumental in leveraging this effort from concept to completion. While much of the process required partnerships that were nontraditional at the time, the campus greening and stormwater management demonstration project at Broadous Elementary ultimately shows not only the viability of the retrofit itself, but also the feasibility of using an interagency approach to address problems of environmental quality, public health and distribution of environmental and fiscal resources.

Project Objectives

- Reduce flooding on and near the campus
- Create natural outdoor learning and playing areas
- Increase green space by replacing approximately one-third of the playground asphalt with a grassy ball field, trees and other landscaped areas
- Collect, treat and store stormwater until it can be absorbed by the soil
- Replenish the aquifer with a supply of treated water

Prior to the project, the Broadous campus was almost entirely covered with impermeable surfaces.

Site Selection and Profile

Shortly after beginning its Cool Schools program, DWP sought to showcase the potential benefits of the citywide greening initiative by funding the sustainable transformation of a school campus. In response to DWP's search, a nonprofit community improvement group, Pacoima Beautiful, directed TreePeople's attention toward Broadous Elementary.

During the rainy season, Broadous students and their families often found themselves asking whether neighborhood flooding was severe enough to prevent them from getting to school. Many times, it was easier to stay home than to contend with the challenges of getting to and from school on a rainy day. Beyond the loss of instruction time for students, absenteeism has financial ramifications because school funding is partially based on attendance. With widespread absences during the rainy season, much-needed funding at Broadous was lost.[1]

The flooding problem in Pacoima is aggravated by the same development practices that have covered much of the region with impervious structures, roads and parking lots. Stormwater that falls on these surfaces cannot be absorbed onsite and thus adds to the volume of urban runoff.

The project partners saw the Broadous project as an opportunity to restore some of the site's natural functions by removing impermeable surfaces and creating a campus "forest" capable of intercepting and absorbing rainfall.

The campus was almost entirely covered by buildings or pavement, offering students little shade in a part of the city prone to soaring summer temperatures. The site also generated stormwater runoff in a neighborhood already susceptible to winter flooding. These characteristics made the campus ideal as the subject of a Sustainable School retrofit that would include campus greening and the installation of stormwater *best management practices* (BMPs).

Broadous Elementary School's 7.4-acre campus is located in Pacoima, California, in the northeast San Fernando Valley portion of the City of Los Angeles. It lies within the Tujunga sub-watershed of the Los Angeles River watershed. Soils at the site are sandy and highly permeable, suggesting that incorporating infiltration technologies to reduce runoff from the site would be feasible.

The project partners saw the Broadous project as an opportunity to restore some of the site's natural functions by removing impermeable surfaces and creating a campus "forest" capable of intercepting and absorbing rainfall.

[1] During the 2006-2007 school year, Broadous Elementary served 894 students in grades K through 5. Students were 95 percent Latino, four percent African-American and less than one percent white. Due to high enrollment numbers, Broadous is on a year-round four-track system. The school receives Title I federal funding.

Designs

Landscaping

The landscaping at Broadous provides the first contact for rainwater and is also a living textbook for students. Students, teachers and neighbors made suggestions for the greening of the campus and their input was incorporated into the designs created by landscape architecture firm Mia Lehrer + Associates.

A vegetated *swale* originates on the slopes of a grassy mound dubbed Mount Broadous. The swale simulates the form and function of a river and meanders through the campus, conveying water away from school buildings, walkways and impervious surfaces and toward the infiltration system. Trees and permeable groundcover act like a sponge, absorbing rainwater where it falls. Among the tree species planted were crepe myrtle (*Lagerstroemia indica*), coast live oak (*Quercus agrifolia*), camphor (*Cinnamomum camphora*), tipu (*Tipuana tipu*) and London plane (*Platanus acerifolia*).

As a result of the retrofit and the designation of the campus as a Sustainable School by DWP, canopy cover nearly doubled from nine to 16 percent.[2] Roughly one-third of the pavement was replaced with trees, vegetation and grass.

Mia Lehrer + Associates

Originally, the Broadous campus had very few trees and other vegetation to provide refuge to students on hot days.

Mia Lehrer + Associates

About a third of the impervious surfacing was replaced with trees, grasses and shrubs.

Project Features

With the support of the school district, in 2001 the site was retrofitted using BMPs that capture, treat and hold virtually all of the rain that falls on campus, reducing flood risk on the campus and surrounding areas while recharging groundwater. The project consists of the following components:

- A **unit that treats stormwater** collected from the campus;
- An underground **infiltration system** that stores water until it can be absorbed by the soil;
- A **vegetated swale** that meanders through the campus and functions as a "river," conveying water toward the infiltration system;
- A system of **permeable groundcover** and **strategically planted trees** that slows, filters and safely channels rainwater through the campus;
- Two **outdoor classrooms** located atop vegetated mounds; and
- A **drainage system** that conveys stormwater to the treatment and infiltration area.

David O'Donnell

A grassy swale winds through the campus and channels stormwater toward an infiltration system.

[2] Travis Longcore, Ph.D., Kyle Fitzpatrick and Maureen Phelan, "Assessment of Los Angeles Department of Water and Power Cool Schools Tree Planting Program," University of Southern California, Sustainable Cities Program, January 2001.

Built Designs

Although the original project objectives were met, some of the elements in the initial design proposal were not realized. Fruiting trees were not planted because of school district concerns over high-maintenance tree species. A demonstration and community garden was not established because a bungalow structure was placed on the intended garden site – although the school did eventually build raised garden beds through a state-funded nutrition program.

Approximately one-third of the playground asphalt (over 100,000 square feet) was replaced with a grassy ball field, trees and landscaped areas, allowing much of the campus to function as a miniature watershed.

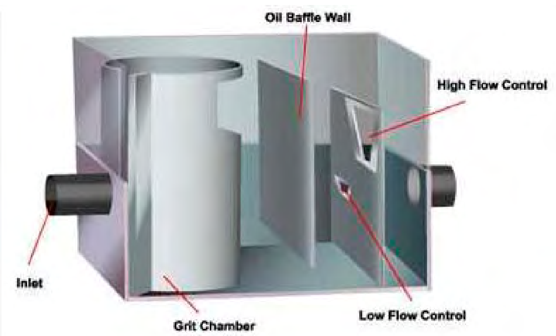
Still, the existing elements succeed in directing all stormwater falling on the site to either percolate in the tree wells, swales and other vegetated areas, or be collected, treated and held in the underground basin until the ground can absorb it. Approximately one-third of the playground asphalt (over 100,000 square feet) was replaced with a grassy ball field, trees and landscaped areas, allowing much of the campus to function as a miniature watershed.

For construction plans, see "Broadous As-Built Drawings" (Appendix A-1).

Stormwater BMPs

Design criteria for Broadous Elementary included the mitigation or elimination of the flooding problem on the campus, the reduction of pollutant loads in runoff to the storm drain system and the recharge of groundwater. To meet these criteria, the following BMPs were installed: vegetated swales, a stormwater treatment unit and an infiltration field.

Stormwater that is not captured by trees and vegetation flows to catch basins and into the treatment unit, where trash, oil and pollutants are removed. Once treated, the water is directed to the infiltration gallery under the playing field, where it is absorbed by the soil.



Contech Construction Products, Inc.

The Vortechs 9000 treatment system uses swirl technology and gravity to separate and retain pollutants, oils and trash.

Treatment

Runoff from the campus flows first through catch basins and into the separator – a Vortechs 9000 unit manufactured by Contech Construction Products, Inc. (formerly Vortechnics). Essentially a large concrete box enclosing a set of steel baffles, the separator works hydraulically to settle sediment (which could otherwise clog and eventually fill the infiltration units), skim off oil and other pollutants, and segregate trash. Maintenance hatches provide access for periodic inspections and cleaning.

Infiltration

After it passes through the separator, pipes distribute the stormwater to the infiltration field, an underground storage area that retains water until soil can absorb it. The plastic Cultec Model 400 infiltrator units are roughly U-shaped, with the opening at the bottom. Their function is to create storage space for water while bearing sufficient weight to allow the unimpaired use of the surface above the system. They rest on a base of drain rock and are covered with another layer of crushed rock. A sheet of filter fabric excludes fine silt, which has the potential to cause clogging. The 7,600-square-foot field has 220 such units. Together they can hold up to 95,200 gallons, or 0.3 acre-feet of water, at one time.

Montgomery Watson Constructors

Two hundred and twenty infiltrator units below the ball field hold up to 95,200 gallons of water.

The system is designed to collect 100 percent of the runoff from a 10-year storm. In a year of average rainfall, all the runoff from the site is retained and infiltrated by the system.

Both the separator and the infiltration units are buried under a grassy playing field that replaced a barren expanse of asphalt. The only sign of the system's presence is the separator's maintenance hatch.

Mulch

A third, nonstructural BMP was designed to assist in attaining the project's goals. Plans called for the greenwaste produced on the campus to be kept onsite and used as mulch. Mulch retains moisture for more efficient irrigation, slows runoff for greater infiltration, and begins the process of capturing pollutants. Since greenwaste constitutes a significant portion of the municipal waste stream, keeping it onsite would reduce the need for offsite processing and hauling to landfills, which in turn would save the school district and city money.

Although integral to the design, the school district has not implemented the use of greenwaste as mulch on the campus.

Benefits, Costs and Funding

Benefits

The retrofit of the Broadous campus produced numerous environmental and social benefits.

Environmental Benefits – Water

By capturing onsite virtually all of the rain that falls on campus, the project:

- Alleviates campus flooding;
- Eliminates runoff;
- Mitigates flooding and erosion downstream;
- Reduces water imports;
- Improves water quality; and
- Recharges the aquifer.

Monitoring conducted at Broadous by the Los Angeles and San Gabriel Rivers Watershed Council suggests that the BMPs improve water quality and that soil removes contaminants from percolating stormwater. While bacteria were detected in stormwater samples, they were undetected, or detected at very low concentrations, in lysimeter and groundwater samples.[3]

A runoff modeling study by the University of California at Riverside (UCR) confirms the runoff and infiltration benefits of the project. Under a pre-retrofit modeling scenario, the average yearly runoff volume from the Broadous campus was approximately 126,000 cubic feet. Under a second, post-retrofit model, runoff was reduced by 99.9 percent. Average infiltration (conservatively calculated from 46 years of rainfall data for downtown Los Angeles, where rainfall is generally less than in Pacoima) increased by nearly three acre-feet per year.[4]

Environmental Benefits – Trees and Landscaping

Landscaping at the campus yields a host of benefits as well, including:

- Reducing energy use by shading school buildings, windows and air conditioners;
- Improving student health and safety by shading play areas;
- Providing much-needed recreation space where heat-retaining asphalt once existed;
- Providing opportunities to reduce the greenwaste stream to landfills by using greenwaste as mulch onsite; and
- Reducing contributions to the heat-island effect.

[3] The Los Angeles and San Gabriel Rivers Watershed Council, "Los Angeles Basin Water Augmentation Study Phase II Final Report," August 2005.

[4] Autumn Dewoody, W. Bowman Cutter and David Crohn, "Costs and Infiltration Benefits of the Water Augmentation Study Sites," University of California, Riverside, Department of Environmental Sciences, April, 2006.

The table *(fig. 3)* was adapted from the University of Southern California study "Assessment of Los Angeles Department of Water and Power Cool Schools Tree Planting Program." The study was conducted prior to the project's completion and thus evaluates projected rather than observed benefits of the tree-planting project. The assessment, conducted with CITYGreen software, developed by American Forests, evaluated the benefits brought to the campus by landscaping and does not include an evaluation of the benefits of the structural BMPs that were part of the more comprehensive retrofit.

Fig. 3 Environmental Benefits of the First Campus-Greening Phase

(does not include benefits from structural BMPs such as infiltration system)

Buildings and Permeable Surfaces	BEFORE	AFTER
Permeability (acres and %)	0.50 (5%)	1.98 (21%)
Tree Benefits		
Tree Canopy	9%	16%
Carbon Storage (tons per acre)	5.03	5.29
Carbon Sequestration (tons per year per acre)	0.01	0.12
Energy Savings (% per year)	19.9%	20.1%
Stormwater Benefits		
Runoff Reduction	6.5%	11.2%
Avoided Storage (cubic feet per acre)	386	574
Air Pollution Benefits		
Ozone Removal (lb/acre)	3.2	5.6
SO_2 Removal (lb/acre)	1.0	1.7
NO_2 Removal (lb/acre)	1.8	3.2
PM10 Removal (lb/acre)	2.8	4.8
CO Removal (lb/acre)	0.4	0.6

Adapted from USC Sustainable Cities Program, "Assessment of Los Angeles Department of Water and Power Cool Schools Tree Planting Program," January 2001.

Social Benefits

The retrofit at Broadous Elementary produced social benefits as well. Where rain once caused flooding, preventing children from reaching classrooms, students now have the opportunity to grasp how natural water cycles work by seeing water flow down from Mount Broadous in the upper part of campus and "downriver" along the swale. In an urban watershed that has sealed the earth with impermeable surfaces and disrupted natural cycles, the school provides the opportunity for this part of Pacoima to contribute to a healthier environment.

In a neighborhood where many children are considered at-risk due to high levels of youth gang involvement, Broadous students enjoy an environment that welcomes and supports healthy physical

David O'Donnell

The most direct benefits of the transformation of the campus include fun and physical play and are enjoyed by Broadous students.

play. Green spaces such as those found at Broadous generate significantly higher levels of play among children than do barren spaces.[5] Students further benefit from participating in planning, planting and maintaining the campus forest, which offer them a sense of validation, empowerment, belonging and ownership and help to advance environmental justice in this neglected part of Los Angeles.

Costs

The cost of installing the treatment and infiltration systems and planting trees was approximately $306,738, with the majority of funding coming from DWP's Cool Schools program.

Fig. 4 Project Costs

BMP CONSTRUCTION COSTS		
Contractor		$167,249
Stormwater Treatment Unit		$21,000
Infiltrator Units		$29,747
Total Construction Costs	**=**	**$217,996**
ADMINISTRATION		
Project Administration		$48,935
Total Administration Costs	**=**	**$48,935**

TREE PLANTING AND TRAINING COSTS		
Tree Planting - Trees		$14,500
Tree Planting - Materials		$3,500
Tree Planting - Labor		$5,000
Campus Greening Workshop		$3,000
In-Class Curriculum		$5,625
Curriculum Development		$3,000
Administration		$5,182
Total Tree Planting Costs	**=**	**$39,807**

TOTAL COSTS* = $306,738

**LADWP's Cool Schools program paid for installation of the stormwater treatment and infiltrator systems, as well as tree planting costs. LAUSD paid for installation of the ball field, grassy swale, outdoor classrooms and irrigation system. The latter cost figures were not provided to TreePeople.*

Funding

Los Angeles Department of Water and Power - Cool Schools Program

DWP's Cool Schools program provided $286,000 for the project. In addition to funding tree plantings at Broadous, DWP designated the campus a Sustainable School and funded significant portions of the more extensive retrofit that included stormwater treatment and infiltration systems.

TreePeople

Working with Montgomery Watson Harza, TreePeople removed the asphalt over the infiltration area and installed the infiltration system. The system was then turned over to the school district's Proposition BB bond project manager.

Proposition BB and LAUSD

With Proposition BB County funds, LAUSD funded the installation of the ball field, grassy swale, outdoor classrooms and irrigation system. LAUSD also paid for asphalt resurfacing where needed.

Montgomery Watson Harza

Due to the innovative, high-profile nature of the project and the opportunity to partner with a nonprofit organization, MWH (formerly Montgomery Watson Americas) offered pro bono design and engineering services for the treatment and infiltration system.

[5] Andrea Faber Taylor, Angela Wiley, et. al., "Growing Up in the Inner City: Green Spaces As Places to Grow." *Environment and Behavior:* 1998; Vol. 30, No. 1, pp. 3-27. Researchers found that in barren spaces, levels of play were approximately half as much as those found in spaces with more trees and grass. The incidence of creative play was significantly lower in barren spaces than in relatively green spaces.

Anne and Kirk Douglas Playground Award

A $25,000 Anne and Kirk Douglas Playground Award supported the planting of 250 new trees on the campus and surrounding streets.

USDA Forest Service – Greenlink Program

The Greenlink Program was created in the mid-1990s to promote the connection between urban neighborhoods and their surrounding wildlands. The Forest Service provided $10,000 toward the Broadous project through this program.

Post-Completion

Monitoring

Between 2001 and 2005, the Los Angeles and San Gabriel Rivers Watershed Council (LASGRWC) conducted water quality monitoring at Broadous. Monitoring was done as part of the "Water Augmentation Study" of the Los Angeles Basin, which is exploring the potential for increasing local water supplies and reducing water pollution by capturing and infiltrating stormwater that would otherwise run off to the ocean.[6]

Surface stormwater samples were collected at one location in the playground. During the first two monitoring seasons, single grab samples were collected at approximately 30-minute intervals for the first two hours of storm runoff.

A lysimeter, originally at a depth of 60 feet but later moved to 24 feet, collected soil pore fluid samples. The shallower placement made sampling easier and allowed a more accurate characterization of the quality of water exiting the infiltration BMP. Samples were typically taken daily for two to three days, beginning one day after the collection of a surface sample.

Groundwater samples were collected from two monitoring wells. These samples were collected periodically.

With regard to nitrate, TDS, chemical oxygen demand, total and dissolved copper, total and dissolved lead, and total and dissolved zinc, stormwater infiltration does not seem to have had an adverse effect on water quality. Concentrations of some constituents, including E. coli and total and fecal coliforms, were in some cases significantly lower in lysimeter and groundwater samples than in surface stormwater.[7]

Loss in Soil Percolation Rates

No monitoring for changes in soil permeability was performed, but a reduction in the percolation rates of the soil above the infiltration field has been noted, with occasional standing water following storms. One possible explanation is that soils were over-compacted during construction. Further investigation is required to determine if this occurred and whether it has compromised the system's ability to absorb the stormwater that falls directly atop the infiltration gallery.

Operations and Maintenance

In order to ensure proper system function, maintenance is required on the collection system and the stormwater treatment unit.

Stormwater Treatment System

- Inspection of the system, which includes logging sediment levels and checking for vector problems, takes about 12 hours per year.

[6] A full copy of the monitoring report on this and other sites is available from the Los Angeles and San Gabriel Rivers Watershed Council, www.lasgrwc.org.

[7] The Los Angeles and San Gabriel Rivers Watershed Council, "Los Angeles Basin Water Augmentation Study Phase II Report," August 2005.

- Maintenance includes removing and disposing of the contents of the treatment unit and treating for vector problems. It requires approximately 24 licensed waste disposal operator hours and a nominal number of vector specialist hours per year.
- Before being removed from the unit, contents must be classified by a licensed disposal company.
- The sedimentation chamber requires cleaning by a vacuum truck about once a year. Access is through a manhole. Sediment is generally classified as non-hazardous and does not typically exceed 750 gallons of liquid and solid waste.
- The oil and grit chamber must be cleaned approximately every two years. This waste is generally classified as hazardous; its quantity does not typically exceed 60 gallons.

Infiltration System

Cultec, Inc., the manufacturer of the infiltrations units, states that maintenance on their product is not necessary since preventative treatment is required prior to the water entering the chambers.[8]

See "Broadous Operation, Maintenance and Inspection Costs" (Appendix A-2).

Successes

Melinda Kelley

Approximately 100,000 square feet of asphalt were removed and replaced with trees, grass and other vegetation.

In all, more than 250 new trees were planted in and around the campus, and roughly one-third of formerly paved playground space was unpaved and covered with grass and vegetation. Broadous students, teachers and parents, together with TreePeople staff and volunteers, planted a campus forest. Its care and maintenance continues. Perhaps more remarkably, this integrated effort relied on the collaboration of agencies across the government spectrum, as well as private and nonprofit organizations. This partnership model and the stormwater management project that it produced have spurred much interest in and hope for the way we manage our cities.

Energy Savings and Water Quality Improvement

Before the Cool Schools greening, tree canopy cover at Broadous was nine percent. Canopy cover nearly doubled to 16 percent following implementation of the landscape plans.[9] The DWP-sponsored greening yielded immediate benefits, which, with proper care, can grow to bring about even greater benefits in the form of increased runoff reduction, water quality improvement and energy savings.

David O'Donnell

A grassy swale leads water to the ball field, below which an infiltration system holds up to 0.3 acre-feet of stormwater at one time. Captured water is slowly released into the ground underneath, where it replenishes the aquifer.

Flood Mitigation

Historically, the campus and some of the surrounding streets have been susceptible to flooding. Even during moderate rains, heavy volumes of water flow on street surfaces, often pooling

[8] On their Web site (www.cultec.com) Cultec, Inc. states: "Preventative maintenance is required prior to the water entering the chambers. Therefore, maintenance on the chamber bed is eliminated."

[9] Travis Longcore, Ph.D., Kyle Fitzpatrick and Maureen Phelan, "Assessment of Los Angeles Department of Water and Power Cool Schools Tree Planting Program." University of Southern California, Sustainable Cities Program, January 2001.

and creating difficult conditions for pedestrians. The BMPs reduce 99.9 percent of the runoff from Broadous – equivalent to nearly 126,000 cubic feet of water annually – from reaching surrounding streets and exacerbating existing flooding conditions.[10]

Stormwater Quality and Groundwater Quantity

The stormwater BMPs succeed in improving the quality of runoff and in effect eliminating water that used to run off the campus. Stormwater that falls on the campus now serves to replenish the aquifer.

Teaching Opportunities

At Broadous, landscaping has taken a departure from LAUSD's traditional playground design criteria. Here, landscaping is treated as a living textbook. Designs use the entire campus to demonstrate on a micro scale what exists just beyond: mountains to the north and a network of streams that comes alive during a storm. Science curricula were developed in conjunction with campus greening, giving children the opportunity for hands-on experience in an outdoor classroom.

Community Engagement

Pacoima Beautiful and TreePeople's involvement in the Broadous project provided meaningful community engagement. The community provided input on what was wanted and needed in this underserved neighborhood. Participation in this planning process helped shape the final design elements of the project.

Challenges and Lessons Learned

Retrofitting a school campus involves many parties and numerous levels of bureaucracy. Both factors tend to extend a project's timeline and add to its final cost. The challenges encountered and lessons learned during the Broadous project underscore the importance of effective project management.

Extended Timeline

Challenge: From project kickoff to completion, the retrofit of Broadous Elementary took over three years. The length of the timeline and the likelihood of staff turnover both increase with the number of agencies involved.

Lesson: In multi-agency projects, allow at least twice the timeline you think is necessary. Complications arising from liability issues and delegation of responsibilities can create hurdles and stretch the project beyond the expected timeline, and make good project coordination essential.

Partnership and Communication Protocols

Challenge: The agreement process for establishing partnership protocols takes time and often takes second priority to project planning – but establishing these protocols is of particular importance in nontraditional, multi-partner projects requiring a great deal of commitment and patience.

Lesson: Redundancy is important, as people move on and positions remain. Regular meetings during design and construction, with representatives from all involved parties in attendance, are a must. Partners should be fully invested in the project to ensure its successful completion and continued care.

Protocol for sharing credit should be established together with general partnership protocols. This will prevent the project partners from being wrongly credited or omitted in publications and media pieces. Discussing the sharing of ownership at the beginning of the project should also set the tone for all project partners to share responsibility when things go well and if they do not.

[10] Autumn Dewoody, W. Bowman Cutter and David Crohn, "Costs and Infiltration Benefits of the Water Augmentation Study Sites." University of California, Riverside, Department of Environmental Sciences, April 2006.

Wide-ranging Support

Challenge: It is easy to lose sight of the benefits brought to the table by the collective knowledge and expertise of staff at all levels of the partnership. Deadlines and budgetary constraints create pressure that can lead to some partners being excluded from decision-making.

Lesson: Seek support from all staff levels in the partnership in order to get input from all those who will be involved – beginning with design, moving through construction, and ending with operations and maintenance. It is important that personnel who will be responsible for operating and maintaining the system be involved early in the design process to provide input and foster a sense of ownership. Local educators should be involved in the development of any project-related curricula and in ensuring that the curricula are applied.

If the project is multi-purpose, with funding from multiple partners, attempt to have relevant partners sponsor portions of the project consistent with their mission, mandate, core competencies and skills. If, for example, the project includes water quality or water supply components, it is ideal to have an agency with a water quality or water supply mission commit to provide the maintenance of the water quality infrastructure.

Maintenance and Other Ongoing Responsibilities

Challenge: In the absence of a written maintenance agreement for the Broadous project, partners whose contractual obligations ended when construction did nevertheless found themselves working without compensation in an effort to maintain the viability of the project. The lack of a comprehensive and easy-to-use operations manual, inadequate communication among the partners and turnover among the district's operations and maintenance staff exacerbated the problem.

Lesson: It is difficult to get anyone to accept liability as complicated issues arise. Construction and other liabilities (such as issues of contaminated soils disposal, underground utilities, and construction fencing to ensure student safety) nevertheless have to be adopted. It is advisable to budget extra time, care and resources toward these challenges, and to plan quarterly meetings between representatives from all involved parties for the first year after construction. Written maintenance contracts and clear instructions should be developed and agreed upon before the project is completed.

Despite the intensive resource demands of the planning and implementation phase, the project does not end once construction is complete. The project will only fulfill its purpose if there is sustained interest and a plan for continuity.

Making Obvious the Project's Meaning

Challenge: Staff, faculty and students move on and even those who stay cannot always be relied upon to interpret or defend the project. The Broadous project budget did not include funds for signage or other permanent interpretive elements. As a result, knowledge of the project's meaning – and even its existence – has been lost.

The significance of the project was not sufficiently evident to district personnel, and several disheartening events consequently occurred without notification to the other partners, including improper pruning and care of trees on the campus. In the summer of 2005, the district removed trees and grass from the swale and paved its entire length with concrete in order to accommodate the passage of delivery trucks.

Safety concerns about children playing in the area of the manhole covers made district engineers elect to bury all but the primary maintenance port on the treatment unit. If maintenance of the primary port is not performed regularly, other unit areas serviced by the secondary ports need to be cleaned out.

Due to the irregular maintenance schedule that followed the project's completion (two years before the first pumping and another two-and-a-half years until the next service) the other ports were located with difficulty and unearthed for service. Burying the ports makes evaluating the need for service difficult and tends to encourage a passive approach to maintenance.

Also challenging has been that the project offers students the opportunity for hands-on science education – but that the campus has not used education curricula that were developed for this purpose.

Lesson: The project should be visually memorialized, especially if design elements are underground and out of sight. Options for memorialization include interpretive signage, permanent student art projects, student participation, and before-and-after shots displayed where the students, staff and faculty can view them.

David O'Donnell

The grassy swale at Broadous was planted with trees and conveyed stormwater to the infiltrator below the ball field.

Sensible Design and Accurate Design Interpretation

Challenge: Some of the design elements chosen for Broadous required a great deal of care and attention but did not yield significant benefits. For example, redwoods (*Sequoia sempervirens*) were planted to represent one of California's many ecosystems even though Pacoima experiences hot, dry summers that are not appropriate for this species. As a result, the trees needed extra care and still failed to survive.

In initial designs, the Mount Broadous mound and the grassy swale were meant to illustrate the watershed functions that mountains and rivers serve. Ultimately, due to district decisions that were perhaps driven by safety concerns, the top of Mount Broadous was flattened and the mound built as a small lump rather than a shape more representative of a mountain. The grassy swale, which was designed to act as a shallow canal, lost much of its anticipated channeling ability in the built version. The intended functions of these chief design elements were lost – and the elimination of these components should have perhaps been considered.

Rebecca Drayse

In order to facilitate truck access across the swale, the school district removed the vegetation and paved the swale with concrete. The rest of the project partners were not notified in advance.

Lesson: Designs should not compromise common sense for optimism and wishful thinking. Practical design should complement the way that the space will be used, and close attention should be paid to accurate interpretation of design elements.

The swale could have been designed to include a permeable pavement crossing to accommodate truck traffic, which would likely have prevented the district from removing trees and grass and paving it.

Evaluation Criteria and Baseline Data

Challenge: It is difficult to make convincing claims about the project if you cannot talk confidently about pre-project conditions.

Lesson: Prior to starting construction, collect baseline data at the site. The effort should also include extensive "before" photography and the recording of anecdotal accounts.

Vector Issues

Challenge: Standing water occurs in many stormwater BMPs, making them potential breeding grounds for vectors.

Lesson: The Vortechs treatment unit at Broadous developed a mosquito problem, but the issue was not anticipated in the design phase, when a solution could have been included. Periodic treatment by a vector control specialist is therefore necessary.

Partners

TreePeople acted as the project manager and oversaw the design process. The nonprofit managed the design and installation of the stormwater capture, treatment and infiltration system and coordinated community plantings and environmental education around the project. Rebecca Drayse was the project manager.

Los Angeles Department of Water and Power (DWP) funded tree plantings and the installation of the infiltration system through its Cool Schools program. The program was the largest school-based tree planting effort in the city's history, and existed through collaboration among DWP, the Los Angeles Unified School District and community groups including the Hollywood Beautification Team, Los Angeles Conservation Corps, North East Trees and TreePeople.

Los Angeles Unified School District (LAUSD) is the property owner of the Broadous campus and installed the grassy swale, a new soccer field, two outdoor classrooms and an irrigation system.

Broadous Elementary students, teachers and neighbors shared ideas for greening the campus with TreePeople and Pacoima Beautiful. The Broadous community was instrumental in planning and planting the campus forest.

Pacoima Beautiful first brought TreePeople's attention to the Broadous campus. The nonprofit community improvement group surveyed the observations and desires of kids, parents, teachers, gang members and residents in relation to the campus and the neighborhood. The community's ideas were incorporated into a conceptual design that was delivered to Mia Lehrer + Associates. Pacoima Beautiful also participated in several community planting days.

Montgomery Watson Harza (MWH, formerly Montgomery Watson Americas) provided design and engineering services.

Montgomery Watson Constructors, the construction arm of MWH, was the contractor.

Mia Lehrer + Associates provided landscape architecture services. Final designs incorporated the conceptual designs that Pacoima Beautiful created with community input.

Los Angeles Conservation Corps (LACC) provides service project opportunities for at-risk youth. The group was initially involved in implementation of the retrofit, but ultimately decided that the project was not a match for the organization and pulled out before construction began.

Campus Greening and Stormwater Management

Demonstration site at
Open Charter Magnet Elementary School
Westchester, California

TreePeople

Introduction

The Open Charter Magnet Elementary School demonstration project is an example of a cooperative effort between government and nonprofit agencies in the making of an environmentally sustainable school.

The project was conceived to provide a working demonstration of new approaches to managing the urban environment while addressing site-specific problems. By capturing stormwater that used to run off the campus, the project reduces pollutant loads to nearby water bodies and provides a new source of water for irrigating the campus. The project is designed to provide a host of benefits, including:

- Reduction of polluted *runoff* from the campus to Ballona Creek and Santa Monica Bay
- Reduced energy use
- Shading of play areas to improve student health and safety
- Opportunities to use greenwaste onsite to reduce the solid waste stream to landfills
- Creation of much-needed green recreation space at this urban campus
- Creation of a water supply for irrigating the campus
- Creation of outdoor ecosystem learning spaces to support the school's environmental curriculum

The project was implemented in two general phases. First, strategic planting of 88 new trees and placement of vegetation and *swales* were conducted as part of a campus greening initiative funded by the Los Angeles Department of Water and Power's Cool Schools program.

The second phase, funded largely by a Santa Monica Bay Restoration Project grant, consisted of the design and installation of additional, more structural stormwater *best management practices* (BMPs) on the campus, including a treatment device and an underground *cistern*. This phase provided an opportunity to demonstrate the feasibility of greening a typically *hardscaped* elementary campus and using BMPs to emulate some of its original *watershed* functions.

The primary collaborators on this project were the City and County of Los Angeles, the Los Angeles Unified School District (LAUSD), the Los Angeles Department of Water and Power (DWP) and TreePeople.

The project is innovative in several ways. First, it uses new and alternative technologies to solve old urban problems. Second, it is the product of a collaboration among groups unaccustomed to working together – government agencies, the school community, the neighborhood and a nonprofit organization. The design and community building process held many challenges, but resulted in a transformed campus that provides a model for increasing urban green space, improving learning environments and mitigating urban environmental problems.

By capturing stormwater that used to run off the campus, the project reduces pollutant loads to nearby water bodies and provides a new source of water for irrigating the campus.

Project Objectives

- Protect Santa Monica Bay from the increased load of pollutants that would result from addition of a new bus and car parking lot on this campus
- Create natural outdoor learning and playing areas
- Increase green space by replacing a significant portion of the asphalt playground with a grassy ball field, trees and other landscaped areas
- Collect, treat and store the stormwater that falls on the campus
- Make stored stormwater available for use in irrigation

Background

Site Selection and Profile

Recognizing the potential impact of a single policy decision by an institution the size of LAUSD, TreePeople sought an opportunity to demonstrate the benefits of a more sustainable approach to campus design. The former Osage Elementary School campus, then being refurbished to house Open Charter Magnet School, seemed an appropriate site for a project intended to pilot a district-wide greening campaign.

Rebecca Drayse

Before the project, most of the campus was paved with asphalt. Few trees and grassy areas existed.

The Open Charter campus is in Westchester, on L.A.'s Westside, about two miles from Los Angeles International Airport (LAX).[1] It falls within the Ballona Creek watershed, in a middle- to upper-middle-class neighborhood of mostly owner-occupied single-family homes.

Prior to the project, the 6.75-acre campus was largely hardscaped and contributed to the *heat-island effect*. Stormwater runoff volumes at the school were so high that a single large catch basin, located in the southwest corner of the campus, was fenced to prevent accidents. These large quantities of water contributed to peak flows already exceeding the capacity of the city's existing stormwater infrastructure.

The renovation of the Osage Elementary campus into Open Charter Elementary included the creation of a bus and teacher parking lot in the area directly adjacent to the campus' single storm drain. The location of this parking lot meant that runoff from the campus would be inoculated with the pollutants from school busses that would sit idling in large numbers while waiting for students. That polluted stormwater would then be carried into adjacent storm drains, creeks and the ocean. The same effect occurs throughout the 128-square-mile Ballona Creek watershed, resulting in high bacteria counts that force frequent post-storm closures of Santa Monica Bay's popular beaches.

The recently formed Santa Monica Bay Restoration Project sought to support projects that could demonstrate technologies and management practices that – if adopted on a wide scale – would prevent pollution of the bay. The retrofit of Open Charter with stormwater BMPs set out not only to meet this goal, but also provide a host of other benefits to students, faculty and residents in the area.

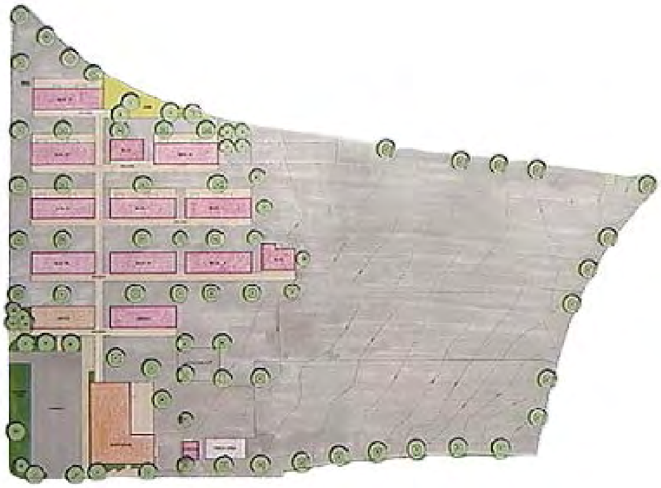
[1] During the 2006-2007 school year, Open Charter served 360 students in grades K through 5. Students were 38 percent white, 24 percent African-American, 21 percent Asian and 15 percent Latino.

Designs

Landscaping

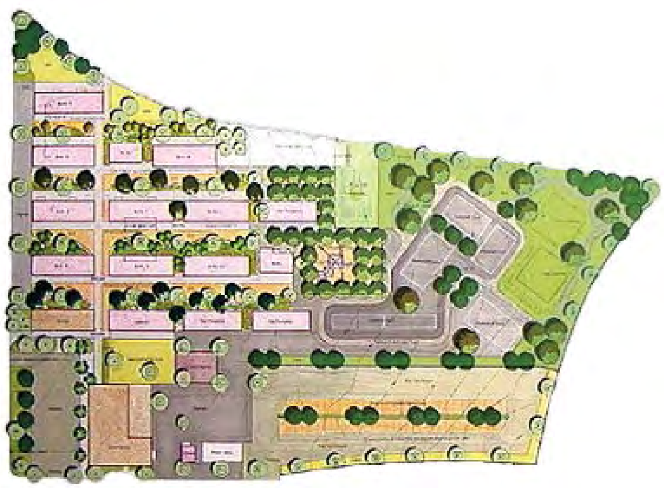
Landscaping is the first stop on the route stormwater takes across the Open Charter campus. A system of permeable groundcover, swales, trees and shrubs intercepts and soaks up rain, reducing runoff. The swales convey stormwater away from school buildings and walkways, while trees, shrubs and permeable groundcover absorb rainwater where it falls. The campus forest includes 150 trees, as well as shrubs, swales, gardens and grassy play areas. Among the tree species are coast live oak (*Quercus agrifolia*), sweet gum (*Liquidambar styraciflua*), London plane (*Platanus acerifolia*) and coast redwood (*Sequoia sempervirens*).

The campus forest, designed and implemented with the help of students, parents and teachers, uses various parts of the campus to represent the diverse landscapes of California – from redwood forests to desert gardens. Most of the plants were chosen to thrive in the local climate, but the learning opportunities that a variety of species could offer were also considered. Some species selected from other climate zones do require extra care.



Mia Lehrer + Associates

Prior to the project, the Open Charter campus was mostly covered by impervious surfaces. The planned addition of a bus and car parking lot would have further contributed to polluted runoff from the campus.



Mia Lehrer + Associates

The addition of trees, swales, vegetation and a cistern succeeds in effectively eliminating runoff.

Project Features

The demonstration project consists of three components that utilize "forest-mimicking" technologies:

- A system of **trees**, **vegetation** and **mulched swales** slows, filters and safely channels rainwater through the campus.
- A **treatment device** removes pollutants from water collected on campus.
- A 110,000-gallon underground **cistern** stores the treated rainwater and feeds the irrigation system.

Seeking to minimize the discharge of stormwater pollutants to Santa Monica Bay, the project's designers used these components to retrofit the site for the collection, treatment, storage and use of stormwater. BMPs were selected to work specifically with the site's unique features.

Soil tests revealed clayey-sand and silty-clay sediments with low percolation rates. The project engineers decided that storing stormwater would be more practical than attempting to infiltrate it.

Melinda Kelley

Trees and grassy areas on the campus intercept and capture rainfall. Stormwater not captured by the campus forest is channeled to a treatment and storage system below the ball field.

Ambitious designs proposed in the project partners' Santa Monica Bay Competitive Grant Program application incorporated BMPs that met the stormwater management criteria used by the L.A. County Flood Control District for a 100-year, 24-hour precipitation event. The designs called for the capture and treatment of all stormwater falling on the campus during such a storm, with special attention paid to the impermeable surfaces of roofs, driveways, parking lots and asphalt playing fields – all sources of polluted runoff.

The proposal met the Santa Monica Bay Competitive Grant Program's four criteria:

- Protect public health in Ballona Creek and Santa Monica Bay by eliminating the stormwater pollutants;
- Preserve and enhance the ecological integrity of the Ballona Wetlands Significant Ecological area;
- Incorporate BMPs as defined in the NPDES (National Pollutant Discharge Elimination System) permit; and
- Reduce runoff volume into Santa Monica Bay where the runoff travels across lands that contribute significant amounts of toxic pollutants to the storm drain system.


Melinda Kelley

Water drains into a storm drain after a mock flash flood at Open Charter. Rather than running off the campus and eventually into Santa Monica Bay, stormwater is collected and detained onsite by a system of BMPs including trees, vegetation, swales and a cistern.

Initial Proposals

In their Santa Monica Bay Competitive Grant Program application, the project partners included the following technologies for Open Charter Elementary's retrofit:

- Porous pavement in parking areas and asphalt play areas;
- Stormwater collection, infiltration and storage BMPs;
- Trees and vegetation; and
- Grass areas.

Design Process – BMP Selection

A significant portion of landscaping was completed in the first phase of the Open Charter retrofit. BMPs for the collection, treatment and storage of stormwater were the next features to be designed and installed.

Using County Flood Control District criteria, preliminary designs for water retention included installation of an underground cistern large enough to capture the estimated 825,000 gallons of rain that would fall on the campus during a 100-year, 24-hour storm. This capacity was chosen to provide watershed protection for a full range of storms, including low-probability events.

An early, rough cost estimate for the system came in at budget, but a second, more rigorous calculation by Montgomery Watson Harza (MWH), the project engineer, determined that the project would cost $750,000 – 50 percent more than the grant award.

Design Process – Evaluation for Cost Savings

In order to capture the high volumes of runoff, the design for the 825,000-gallon cistern extended to the site's limits of available space, making for an irregularly shaped cistern. This asymmetric design resulted in higher costs, due to the intricacies of excavating for, installing and lining the manufactured system. Maneuvering maintenance equipment through the space (which is required to guarantee proper function of the cistern) in that configuration further added to the system's long-term cost.

In early 2001, the cistern size was reduced to 430,000 gallons, the approximate capacity required to store the runoff from a 10-year, 24-hour storm. The new plan was approved by LAUSD, but MWH later produced a cost estimate of $895,000 – more than the larger cistern and even farther over budget. The increase was partly due to a significant increase in material and shipping costs for Invisible Structures' Rainstore3 product, which had been chosen for the cistern.[2]

Design Process – Further Design Evaluation

In mid-2001, the project partners held a value-engineering meeting to discuss cost-saving measures. The chief variables discussed were the capacity of the system and the materials to be used. One option the partners considered – replacing Rainstore3 with a more economical corrugated metal pipe system – would still cost over $650,000, excluding design amendments. Use of these conventional materials seemed less appropriate to the project's status as a demonstration of new technologies. More commonly seen in infiltration projects, the Rainstore3 product had only once before been used as a cistern – the 27,000-gallon unit installed by North East Trees at Multnomah Elementary School in L.A.'s El Sereno neighborhood.

The partners decided to continue with Rainstore3. They issued a request for proposals asking contractors to revise existing plans and provide the largest cistern possible within the $500,000 grant budget. Ultimately, a system that included a 110,000-gallon cistern was approved by the city and the school district. While its storage capacity was significantly reduced, the system's other elements remained unchanged. All campus runoff, whether destined for the cistern or the storm drain, would still pass through a treatment unit that would skim off oil and other pollutants, segregate trash and settle out sediment. The new design thus fulfilled the general grant objectives and complied as well with a more specific rule established by the L.A. Regional Water Quality Control Board after the grant had been awarded. That rule requires the onsite capture and treatment of the first three quarters of an inch of rain falling on the property.

Infiltration

The project's original design included porous pavement in the school's parking lot to allow stormwater to reach and infiltrate the underlying soils. Subsequent investigation revealed fairly tight soils at the site, which reduce the effectiveness of porous pavement as a stormwater BMP.

Designs were modified to divert parking lot runoff to the cistern via to the treatment unit. The shift from infiltration to storage did not affect the volume of water treated onsite.

Built Designs

All stormwater on the site is either percolated in the tree wells and swales; collected, treated in a sedimentation basin and stored in an underground cistern for later use; or treated and released to the storm drain system if the cistern is full. Water that enters the sedimentation basin is treated with chlorine tablets to prevent bacterial growth and discourage mosquito breeding after being stored.

[2] TreePeople obtained an estimate of $649,230 from an independent construction consultant, lower than the MWH estimate but still considerably over budget.

Stormwater BMPs

Except for the cistern's holding capacity and plans for pervious pavement in the parking lot, the system was built much as originally proposed. Stormwater that falls on the upper half of the campus flows into and through the vegetated swales where much of it is infiltrated into the soil. Overflow from the swales and runoff from the remaining half of the campus flow to catch basins in and around the ball field. From there, stormwater passes through the treatment unit, where sediment, grease, trash and pollutants are retained. The treated stormwater is then stored in the 110,000-gallon cistern and used to irrigate the ball field and other landscaped areas.

TREATMENT

Rebecca Drayse

The Vortechs 7000 treatment system uses swirl technology and gravity to separate and retain pollutants, oils and trash from stormwater.

Contech Construction Products, Inc. (formerly Vortechnics) manufactured the stormwater treatment unit. The Vortechs Model 7000 hydrodynamic system uses a combination of swirl-concentrator and flow-control technologies to remove sediment, particles, trash, oil and grease from stormwater.

The major sources of the pollutants targeted by the Vortechs unit are impermeable surfaces on the site, such as roofs, driveways, parking lots and playing fields. As stormwater enters the system it first flows through a swirl chamber, where it spirals gently. Here, gravitational separation of pollutants works to clean the water of heavy sediment. Over time, sinking pollutants accumulate on the swirl chamber floor and have to be removed by a vactor truck or other means. From the swirl chamber, water flows into a chamber with a baffle wall designed to capture floating pollutants and trash that were not captured in the swirl chamber. Water then enters a third chamber that regulates flow according to the volume of water. At this point, the treated stormwater is directed into a final chamber and to an outlet pipe that conveys it to the cistern, where it is stored, circulated and mildly chlorinated.

The Vortechs system has a peak treatment capacity of 11 cubic feet per second (cfs) and offers 4 cubic yards of sediment storage space. The unit's external dimensions are 15 feet by nine feet by eight feet.

The project partners considered other treatment systems, including the BaySaver Separation System and AquaShield's Aqua-Swirl Concentrator. Both are hydrodynamic systems that use swirl technology to separate pollutants from the stormwater. Although these alternatives may have provided the necessary function to the project, the Vortechs product had been selected in the original design. Any change would have required further redesign and resulted in increased costs.

[3] International Stormwater BMP Database. Statistical Analysis Report for Marine Village Watershed BMP site. Available from www.bmpdatabase.org.

STORAGE

Rebecca Drayse



The cistern's excavated hole was lined with impermeable liner, upon which Rainstore3 modules were stacked to a height of approximately eight feet. The sides and top of the assembly were then wrapped with the impermeable liner and the hole backfilled.

Rainstore3 Cistern

Invisible Structures, Inc. manufactured the Rainstore3 module used to construct the cistern. Each module is an open plastic grid that measures one meter squared by one-tenth of a meter (approximately 40 inches by 40 inches by 4 inches) and provides storage space for about 25 gallons of water. The modules can be stacked to create columns, which are arrayed in sufficient numbers to create the desired storage capacity. The entire assembly is wrapped with an impermeable liner of 40 mil PVC that retains water. A layer of geotextile on either side protects the liner. The manufacturer states that the system provides a higher percentage of void space than conventional methods and thus requires less excavation.

Accu-Tab Tablet Chlorination System

The stormwater treatment system removes sediment, garbage, oil and grease, but organic matter and bacteria may still enter the cistern. Chlorinating stored water reduces health risks and odors. The Accu-Tab chlorination system offers a reasonably safe and accurate method of administering chemical treatment of stored water. Slow-release chlorine tablets are automatically dispensed in a pump vault adjacent to the cistern. A secondary pipe carries some chlorine from the vault to the Vortechs unit as a precaution against mosquito breeding in the standing water that is likely with this design.

For construction plans, see "Open Charter As-Built Drawings" (Appendix B-1).

Benefits, Costs and Funding

Benefits

The benefits of the Open Charter retrofit run the gamut from the tangible to those more difficult to quantify. The primary goal of the project was to provide a working demonstration of new approaches to managing the urban environment while also mitigating physical conditions on the campus that had a negative impact on the quality of life of those near it. With these conditions alleviated, the campus would serve as an example of healthier land-use management practices. As such, the general goal of the project touches on different kinds of benefits – from issues of water quality and import, to those of green space and responsibility to downstream communities.

Environmental Benefits – Water

The water-related benefits derived from capturing, treating and storing stormwater include:

- Improving water quality in Ballona Creek and Santa Monica Bay;
- Significantly reducing stormwater runoff from the campus;

- Mitigating flooding and erosion downstream; and
- Reducing water imports.

In monitoring conducted on a project located in Lake George, New York, the Vortechs unit proved to be effective in removing suspended solids.[3] Suspended solids carry pathogens and pollutants, and their removal from stormwater thus improves water quality by decreasing pollutant loads. In the Lake George scenario, inflow levels of suspended solids were consistently much higher than post-treatment outflow levels.

Environmental Benefits – Trees and Landscaping

Landscaping the campus with trees, plants and grass yields a host of benefits as well, including:

- Reducing energy use by shading air conditioning units;
- Improving student health and safety by shading play areas;
- Providing much-needed recreation space where only heat-retaining asphalt once existed;
- Decreasing the solid waste stream to landfills by using greenwaste onsite as mulch; and
- Reducing contributions to the heat-island effect.

The table *(fig. 5)* shows the expected benefits of the greening portion of the Open Charter project. The assessment was conducted by the University of Southern California, using American Forests' CITYGreen software.[4] It did not include the stormwater BMPs, so the analysis reflects only a portion the project's true benefits.

Fig. 5 Environmental Benefits of the First Campus-Greening Phase

(does not include benefits from structural BMPs such as the cistern)

Buildings and Permeable Surfaces	BEFORE	AFTER		
Permeability (acres and %)	0.53 (7%)	1.53 (20%)		
Tree Benefits	**BEFORE**	**AFTER**	**10 YEAR**	**20 YEAR**
Tree Canopy	12%	14%	23%	29%
Carbon Storage (tons per acre)	5.95	4.80	8.26	10.03
Carbon Sequestration (tons per year per acre)	0.03	0.05	0.16	0.16
Energy Savings (% per year)	22.2%	23.4%	32.1%	32.7%
Stormwater Benefits				
Runoff Reduction	8.5%	9.4%	15.7%	15.8%
Avoided Storage (cubic feet per acre)	491	495	849	852
Air Pollution Benefits				
Ozone Removal (lb/acre)	4.2	4.7	8.0	9.7
SO_2 Removal (lb/acre)	1.3	1.4	2.5	3.0
NO_2 Removal (lb/acre)	2.4	2.7	4.6	5.6
PM10 Removal (lb/acre)	3.6	4.0	6.9	8.4
CO Removal (lb/acre)	0.5	0.5	0.9	1.1

Adapted from USC Sustainable Cities Program, "Assessment of Los Angeles Department of Water and Power Cool Schools Tree Planting Program," January 2001.

[3] International Stormwater BMP Database. Statistical Analysis Report for Marine Village Watershed BMP site. Available from www.bmpdatabase.org.

[4] Travis Longcore, Ph.D., Kyle Fitzpatrick and Maureen Phelan, "Assessment of Los Angeles Department of Water and Power Cool Schools Tree Planting Program." University of Southern California, Sustainable Cities Program. January 2001.

Social Benefits

The benefits that Open Charter's retrofit offers for people are profound. Each school year, hundreds of Open Charter students enjoy a school environment that welcomes and supports healthy physical play and hands-on science education.

The majority of children in Los Angeles lack adequate access to parks.[5] Within this urban landscape, Open Charter provides a unique learning environment and the opportunity for children to see, smell, touch and learn about California's diverse ecosystems. The implementation of similar projects throughout the district could have a considerable and positive impact on its 700,000 K through 12 students.

Melinda Kelley

Open Charter students learn about the cistern. The stormwater management demonstration project offers an opportunity for hands-on science education.

Costs

Phase 1

The first phase of the project, which included strategic planting of 88 trees on the campus, cost approximately $44,000 and occurred through DWP's Cools Schools program.

Phase 2

The $500,000 Proposition A grant set the budget for the second phase, which included installation of the stormwater capture, treatment and storage systems. The project partners worked hard to stay within that budget. A financial cushion was set aside in the event of unexpected problems, such as construction complications. Ultimately, approximately $25,000 of this buffer amount was not spent, bringing the total expended portion of the grant to $476,925.

In addition to the Proposition A grant, the project benefited from several in-kind donations and funding sources that covered costs not traditionally associated with similar projects, such as funds required to execute a cooperative agreement between the City of Los Angeles, LAUSD and TreePeople.

The total cost of the project, including these less conventional costs, was $673,925.

Fig. 6 Project Costs

BMP AND LANDSCAPING COSTS	
Contractor	$343,381
Water Treatment Unit	$18,000
Cistern	$60,015
Landscaping (Phase 1)*	$44,000
LAUSD Site Work	$88,000
Total Construction Costs =	**$553,396**

ENGINEERING AND ADMINISTRATION	
Construction Consultation	$16,000
Project Administration	$30,529
Engineering (incl. modifications)	$54,000
Cooperative Agreement	$20,000
Total Additional Costs =	**$120,529**

TOTAL PROJECT COSTS = $673,925

** Landscaping that occurred during Phase 2 was paid for by LAUSD. These cost figures were not provided to TreePeople.*

[5] In the report *No Place to Play*, the Trust for Public Land states that two-thirds of children 18 and under in Los Angeles do not live within walking distance of a park. The Trust for Public Land, *No Place to Play*, www.tpl.org.

Funding

Proposition A (The Safe Neighborhood Parks Act of 1996) and the Santa Monica Bay Restoration Commission

In 1999, the Los Angeles County Regional Park and Open Space District awarded a $500,000 grant to the City of Los Angeles. These funds were transferred to the Santa Monica Bay Restoration Commission – an independent state organization whose mission is to ensure the long-term health of the bay and its watershed – which in turn funded the project at Open Charter Elementary.

Proposition A, passed by Los Angeles County voters in 1996, established a $319-million park and open space property assessment to fund acquisition and preservation of endangered wilderness lands and to rehabilitate and improve dozens of parks and recreational facilities. The grant awarded to the Open Charter project was drawn from a fund for restoration and improvement projects to Santa Monica Bay that reduce the toxicity of or pollutant load in urban runoff to the bay.

The grant was awarded in support of the following project components:

- Demolition, excavation and grading of areas proposed for construction;
- Purchase of supplies and equipment, including: backfill, piping, underground tankage, irrigation pumps, irrigation piping, related drainage supplies and appropriate pavement materials; and
- Design and installation of the above.

Proposition BB and LAUSD

The project's timing coincided with a wide-scale LAUSD infrastructure improvement campaign funded by Proposition BB, passed in 1997 (see "Background on School Projects" on page 17 for more information on Proposition BB).

With these funds, the district renovated the campus in preparation for its reopening to students. In addition, the district provided in-kind matching services in the amount of $88,000 (15 percent of estimated total costs) to cover various site work, including the irrigation system, landscaping over the cistern and construction inspection.

Los Angeles Department of Water and Power - Cool Schools Program

The program provided $44,000 in funding for ground preparation and planting of 88 new trees in the first phase of the project.

Montgomery Watson Harza

The engineering firm provided $20,000 in in-kind services to supplement design and engineering costs.

City of Los Angeles

The city provided $20,000 to TreePeople for the development of a cooperative agreement among TreePeople, the school district and the City of Los Angeles. The City Attorney required the completion of the agreement before the city was permitted to accept and administer Proposition A funds.

The City of Los Angeles Watershed Protection Division provided $30,000 for engineering of the stormwater capture, treatment and storage system.

Post-Completion

Monitoring Plan

Monitoring the project's performance is an integral part of determining its effectiveness and the feasibility of replicating its innovations across the district's facilities.

The Watershed Protection Division (City of Los Angeles Bureau of Sanitation) created a short-term monitoring plan for Open Charter. The plan calls for sampling at two points (at influent areas before water is treated, and at the irrigation pump station after water is treated) during storms where precipitation is greater than one-tenth of an inch. Samples monitor bacterial indicators, including total coliforms, E. coli and enterococcus, as well as evaluate the effectiveness of the chlorination system.

Monitoring Activities

Although the Watershed Protection Division agreed to monitor the site in the original grant request, no monitoring protocols were specified and no budget was allocated. Due to staff changes at the city and the lack of instructions, the monitoring plan was not finalized until the demonstration project had been complete for two years. As of the writing of this publication, site monitoring has not begun.

Questions regarding the maintenance and operation of the system by the school district caused a delay of sampling at the beginning of the 2006-2007 storm season and monitoring will now most likely begin in the 2007-2008 storm season.

Operation and Maintenance Plan

Like monitoring, maintenance of the project is an essential component of its success. Without adhering to a maintenance schedule to ensure proper operation, benefits such as water quality improvement and reduction of runoff are compromised. A document prepared by MWH in advance of construction identifies maintenance tasks, schedules and approximate costs.

Operation and Maintenance Activities

Effective delegation of operation and maintenance responsibilities has proven difficult. The development of a formal commitment, whereby LAUSD would assume responsibility for a regular maintenance and inspection schedule, has moved at a slow and unsatisfactory pace. Due to factors beyond the control of TreePeople and MWH, Open Charter's landscaping and water capture and treatment system received inadequate care following the project's completion and leading to the publication of this report. Dismaying occurrences, including neglected system maintenance and improper pruning of trees, have been reported on multiple occasions and appear to be the result of miscommunication within the school district.

Recently, positive actions have been taken toward preventing such events from reoccurring. TreePeople had a productive meeting with maintenance staff, a local school board member, parents and teachers which resulted in an action plan to create a maintenance manual for the cistern system and a written protocol for notification to the principal before any new tree pruning is performed. Trees that died from a broken sprinkler system were replaced and the sprinklers repaired. We hope this commitment to the maintenance of this valuable asset will be sustained.

See "Open Charter Operation, Maintenance and Inspection Costs" (Appendix C-2).

Successes

TreePeople led the school community in the removal of more than 30 percent of the asphalt on the campus, the creation of swales and miniature forest ecosystems between buildings, and the planting of 150 trees. TreePeople and the school community – including committed teachers, parents, students, volunteers and a supportive school principal and faculty – participated in each of three planting days and continue to take part in caring for the campus forest.

Melinda Kelley

Four thousand gallons of water "rained" from a fire hose during a mock flash flood that demonstrated the project's ability to capture and retain large volumes of stormwater falling onsite.

Stormwater Runoff Quantity

The campus greening campaign yielded immediate stormwater quality and quantity benefits. With proper tree care, these benefits can easily increase. Without considering the cistern, which stores stormwater not otherwise captured, trees and vegetation reduce runoff by nine percent.[6] As trees mature, that number can be expected to rise to 16 percent after ten years.

Melinda Kelley

Signs created by students hang at the ball field.

Raised Awareness of Stormwater as a Resource

Collaboration across diverse disciplines and agencies has helped foster awareness of stormwater as a valuable resource rather than a nuisance.

This model continues to attract attention – including interest from media and government representatives, and public requests for assistance in similar efforts. The high volume of interest expressed in the demonstration sites spurred the research and writing of this publication.

Teaching Opportunities

At Open Charter, trees define the play space. This is radically different from many of LAUSD's campuses, where playground design follows safety protocols with limited consideration given to how the space will be used. Beyond the pleasant interaction that students have with the campus during breaks and on their way to classes, the landscape design at Open Charter offers numerous teaching opportunities. Science and gardening curricula have been developed to give children hands-on experience in an outdoor classroom.

[6] USC Sustainable Cities Program, "Assessment of Los Angeles Department of Water and Power Cool Schools Tree Planting Program," January 2001.

Challenges and Lessons Learned

Given the complexity of the retrofit, the project at Open Charter held many challenges and offered numerous opportunities to learn from and improve upon the process.

Extended Timeline and Project Coordination

Challenge: From concept to completion, the retrofit of Open Charter into a stormwater management demonstration site took six years – a great deal longer than anticipated. The extended timeline was largely due to liability issues that arose among partners. Specifically, the cooperative agreement – required by the city attorney before the city could accept and administer $500,000 in Proposition A funds – took two years to complete and cost the city an additional $20,000.

During this period, representatives from over a dozen entities – including TreePeople, the City of Los Angeles, the County of Los Angeles, the Los Angeles Unified School District and the Los Angeles Department of Water and Power – integrated their efforts to complete this unconventional project.

The long timeline also exposed the partners to staff turnover, the related loss of project knowledge and material and service cost increases. This was the case with the cistern, which was originally designed to hold 825,000 gallons but was ultimately downsized to 110,000 gallons. Reasons for this rescoping included: the difficulty in constructing an awkward design that stretched to the limits of the property's space; an inaccurate cost estimate that was later corrected; and an extraordinary and unprecedented increase in construction and material costs associated with billions of dollars in concurrent public works and school construction projects throughout the Los Angeles area.

Lesson: In multi-agency projects, allow at least twice the timeline you hope for. Complications arising from liability issues and delegation of responsibilities can extend the project far beyond a projected timeline and require effective project management.

Factor in budget increases associated with an extended timeline. Assess the local construction cost inflation rate if the region is undergoing extensive construction, or if international demand for materials such as plastic, steel or concrete is causing increases.

Partnership and Communication Protocols

Challenge: Developing partnership protocols takes time and patience, especially in projects involving many partners.

The more partners involved, the higher the likelihood that key personnel will move on to new positions during the project's lengthy timeline – and that important information will be lost. A new person filling a position seldom has all facts at hand, and a lack of accurate records reflecting the progress to date leads to assumptions.

Lesson: Start your agreement process when you start your design process. Engage enthusiastic partners to ensure the successful completion of the project. Set protocol for crediting all partners under all circumstances to make sure credit is shared equally both during positive media attention and if things go wrong. Document the process, as detailed records of the facts, timeline and major decision points can serve to give the project context.

Maintenance and Other Ongoing Responsibilities

Challenge: In the months and years following completion of the retrofit, effective delegation of maintenance responsibilities has been problematic. The school district has been unsuccessful in providing the necessary care to various project components, including the treatment system and landscaping. Neglect and mistreatment of these compromise the system's effectiveness and decrease the benefits yielded. For example, severe mispruning left trees with a fraction of their original canopy, compromising their ability to intercept and retain stormwater and to provide shade. The first contact for stormwater is thus diminished, decreasing energy, water and air quality benefits.

Lesson: Spend extra time and care ironing out the details of who will be responsible for what, from budget issues and agreements, to construction liability and maintenance. In multi-agency projects, it is often difficult to get any party to accept liability.

Consider the importance of operations and maintenance – as the project is not over when construction ends. Develop written maintenance contracts and clear instructions and get general agreement from all partners before the project is completed.

At Open Charter, the cistern is not a typical structure for district maintenance staff to oversee. As it was custom designed, no system manual exists – only individual component manuals. In such a case, develop a custom maintenance manual with the site's operations and maintenance staff at the table.

Wide-ranging Support

Challenge: Ensuring the involvement of staff at all levels is difficult in multi-partner projects, yet it is the diverse knowledge that rests collectively with all partners that enriches the project. Failure to solicit input from all staff levels early on also makes the project vulnerable to problems that could be averted if the appropriate partner is given a chance to provide input.

Lesson: Establish wide-ranging support. Seek support from all staff levels in the partnership in order to get input from all those who will be involved – from design to maintenance.

If the project is multi-purpose, with funding from multiple partners, attempt to have relevant partners sponsor portions of the project consistent with their mission, mandate, core competencies and skills. If, for example, the project includes water quality or water supply components, it is far better to have an agency with a water quality or water supply mission commit to provide the maintenance of the water quality infrastructure.

Making Obvious the Project's Meaning

Challenge: The idea of stormwater BMPs can be difficult to grasp for someone new to these concepts. BMPs that are underground and out of sight can seem even more abstract. In the absence of interpretive elements, the meaning of a project can be lost soon after completion – making it susceptible to improper care and treatment.

Lesson: Memorialize the project at the site. Staff, faculty and students eventually move on, leaving no one behind who remembers the project's significance, or even its existence. The project should be visually memorialized with interpretive signage, displays or permanent photo and student art projects.

Evaluation Criteria and Baseline Data

Challenge: Drawing conclusions about the benefits the project brings and the effectiveness of the system's BMPs is difficult in light of the limited monitoring that has occurred at the Open Charter site. For TreePeople, which advocates for widespread application of the technologies utilized at this campus and other demonstration sites, the challenge is deriving reliable, replicable results that can be implemented at other projects.

Lesson: Collect quantifiable baseline data prior to the beginning of construction. Gather anecdotal reports of the site and complete photographic documentation of the site's conditions before beginning the project.

Sensible Design

Challenge: From selecting the right tree species to verifying that the design is realistic, continuously confirming the feasibility of the project's details is challenging but important.

Detailed and reliable cost estimates are imperative early on in a project – as the scope of the project obviously needs to fit the budget.

Lesson: Choose an appropriate and practical design. Ask a contractor to review custom design features early in the process for constructability feedback. In retrospect, the project partners would likely have used a treatment unit that provides more filtration than the one chosen.

Determine costs early on. The sooner a realistic scope is determined, the more likely the project will avoid insurmountable barriers.

Partners

The stormwater BMPs project at Open Charter Magnet School was a collaborative effort among TreePeople, the L.A. City Bureau of Sanitation, LAUSD, LADWP and Santa Monica Bay Restoration Commission/L.A. County Regional Park and Open Space District. Open Charter students, parents, administration, faculty and school board were also instrumental in the design and implementation of the project.

TreePeople conceived and managed the project as part of its T.R.E.E.S. (Transagency Resources for Environmental and Economic Sustainability) Project, which promotes the integrated and sustainable management of urban watersheds. TreePeople drafted agreements, performed contractor bidding, administered funds and managed design and construction. The nonprofit organization also coordinated community plantings and environmental education around the project. Rebecca Drayse was the project manager.

The City of Los Angeles acted as fiscal agent for funding supplied by the County of Los Angeles. The city provided funding for the cooperative agreement and is responsible for monitoring pollutant loads captured by the BMPs.

Santa Monica Bay Restoration Commission provided Proposition A funding for the treatment and storage system via its fiscal agent, the County of Los Angeles Park and Open Space District.

The Los Angeles Unified School District (LAUSD) provided $88,000 in matching funds for the project. As property owner, LAUSD also agreed to operate and maintain the stormwater demonstration site for the project's design life (estimated at 20 to 30 years). The district also provided concrete removal, installed the irrigation equipment and prepared the site for the school community-led first phase of greening, which included installation of the vegetated swales and tree wells.

Montgomery Watson Harza (MWH) provided design and engineering services, as well as $20,000 in in-kind services.

Mia Lehrer + Associates provided landscape architecture services.

Open Charter Elementary School students learned about the water cycle and resource management, and then made suggestions that were incorporated in the landscape design of Mia Lehrer + Associates. Parents, teachers and the school principal continue to provide leadership, tree care and oversight of site conditions.

Los Angeles Department of Water and Power (LADWP) provided trees through its Cool Schools program.

Doty Brothers Equipment Co., a construction services business located in Norwalk, California, was the contractor.

Conclusion

The projects at Hall House, Broadous Elementary and Open Charter Elementary give us glimpses into how action at the micro scale can begin to undo damage created at the macro scale. They also call attention to the recurring challenges inherent in undertaking endeavors of this sort – from the extraordinarily effective project facilitation and management that is required to execute them, to the irony of the relative availability of funding for building but not for maintaining them.

Most importantly, they point to the need for a much more serious public commitment to and investment in integrated, multipurpose, multi-partner management as a means of achieving local, regional, national and international goals of sustainability.

Although often challenging, multipartner, multipurpose projects are ultimately very valuable. The partnerships that form as a result and the awareness such projects raise about sustainable solutions to conventional problems are successes that are rarely achieved in traditional efforts.

The vision behind this integrated, multipurpose ecosystem approach is that it will ultimately become standard practice for planning, funding and managing urban land and infrastructure. Although this approach has shown great value in Los Angeles – and has led to significant changes in agencies, policies and approaches – it is not yet familiar to many politicians or the general public, and is not recognized by most governments as essential for all future resource management endeavors. Clearly, this practice is still in its infancy.

Since the completion of the three demonstration projects, TreePeople has been working with regional stakeholders to achieve wide-scale adoption of the underlying concepts showcased at the sites. Through site tours, additional charrettes, participation in projects that integrate the work of agencies across the spectrum, and efforts to influence regional water management policy, TreePeople has continued the work that was first iterated at the Second Nature charrette in 1997.

As a result, the tide has begun to turn. Since the completion of the Hall House retrofit, Los Angeles has witnessed a shift in the way that local agencies interact with one another and with the communities they serve.

Following the opening celebration and demonstration at the Hall House in 1998, former deputy director of the Los Angeles County Department of Public Works (DPW) Carl Blum gave his support to a partnership among DPW, the City of Los Angeles and TreePeople to develop and implement a multi-year, wide-scale watershed retrofit of Sun Valley. Sun Valley is a polluted, underserved community in the northeast San Fernando Valley. Having no storm drains or significant stormwater infrastructure, the community has long been plagued by chronic flooding. The ongoing project is seeing the transformation of one of the city's most disadvantaged and industrialized neighborhoods into a model of integrated watershed management.

The Hall House, Broadous and Open Charter pilots are widely seen as exemplars of the multipurpose approach and the interagency cooperation increasingly demanded by local, state and federal funders of watershed projects. City officials mention them in public presentations; they inform the larger-scale designs of public works departments; and they are discussed by regional watershed groups and depicted in their final plans.

The three sites have garnered attention from various media outlets, including the *Los Angeles Times*, the *Sacramento Bee*, *Daily News*, *LA Weekly*, ABC Weekend News with Peter Jennings, KTLA-TV, KCOP-TV, KPCC 89.3 FM, KCRW 89.9 FM, and KNX 1070 News Radio. The projects have also been featured in various professional journals, including *Government Engineering*, *Civil Engineering* (American Society of Civil Engineers), *Urban Land* (The Urban Land Institute), and *Western Water*.

And there is more reason to be hopeful. In recent years, both the state legislature and voters have passed numerous laws and initiatives aimed at improving water resources and requiring some form of integrated planning and multi-benefit outcomes. In 2004, Los Angeles County voters overwhelmingly approved Proposition O, a $500-million bond that is bringing the county closer to meeting federal Clean Water Act standards. Funds from this measure are already supporting projects that protect water bodies and water sources, reduce flooding and runoff, and capture, treat and use stormwater. In 2006, California voters passed Proposition 84, a $5.4-billion bond measure in support of projects related to water quality, safe drinking water, water supply, flood control, natural resource protection and park improvements.

The technologies outlined in this report have implications at multiple scales – from the single parcel to the region and beyond. If, for example, cistern systems like that at the Hall House were installed citywide, they could be designed to act as a flood-control device. When a major storm threatens, cisterns can be drained to the street prior to the storm hitting. This creates detention capacity, as stormwater can then be captured in the cisterns and the flow of water into the flood control system regulated. If implemented on a larger scale, cisterns around the Los Angeles basin could be equipped with remote-control switches that would enable flood control authorities to use them as a sort of "networked reservoir." An integrated effort of this sort would create an effective water conservation, pollution prevention and flood control system able to store or release water as needed.

To be truly effective, however, integrated management must shift from its growing use primarily in project design and planning and instead become institutionalized as a core government management practice. Achieving that vision requires a new investment in training engineers and practitioners in multi-stakeholder process facilitation and development of new policies, ordinances, software, protocols, management and accounting systems that ease and enable this large-scale conversion.

As TreePeople continues to advocate a holistic view of the urban landscape, we invite individuals, organizations and government agencies to do their part to advance the concepts presented in these pages. Whether restoring the watershed functions of a single home or adopting region-wide policy in support of integrated watershed and resource management, each step in the right direction can help turn the tide of damage done – and do much to promote healthier communities and cities.

For more information, please visit:

www.treepeople.org
www.treepeople.org/trees
www.sunvalleywatershed.org

Thanks to everyone who contributed to this report, including:

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Glossary

Acre-foot: the volume of water – 325,851 gallons – that would cover an acre of ground to a depth of one foot; roughly a year's supply for two families.

Aquifer: the underground bed or layer of earth, porous stone or gravel that contains or supplies groundwater. See groundwater.

Best Management Practice (BMP): in a given field, a tool or technique generally recognized as one of the best available. Stormwater BMPs include cisterns, infiltration basins, swales, strategic tree plantings and other technologies.

Canopy Cover: the portion of land area covered by the spread of a tree, including its leaves and branches.

Charrette: a planning or creative problem-solving activity in which an interdisciplinary group of participants is assigned a complicated design project and asked to complete it within a very short period of time.

Cistern: a tank or recess used to capture and store rainwater for later use.

Groundwater: water that saturates the soil at some distance below the surface, held in rocks and soil. See aquifer.

Hardscape: portions of a property covered by buildings, pavement and other hard and impervious materials.

Heat-island Effect: the increase in ambient temperature caused by a prevalence of heat-retaining buildings and paved surfaces. According to the U.S. Environmental Protection Agency, on hot summer days urban air temperatures can be up to 10°F hotter than the surrounding countryside.

Infiltration: the absorption of surface water by the soil. Also called percolation.

Lysimeter: an instrument used to measure water that percolates through soil.

Mulch: a ground covering, especially of organic materials, that holds water, slows evaporation and enriches the soil.

One Hundred-year Storm: a probability-based measure of storm magnitude. On average, a 100-year storm can be expected to occur every 100 years. Similarly, a 50-year storm is expected to occur every 50 years, on average.

Percolation: see infiltration.

Runoff: stormwater flowing across the surface of the earth. In urban environments, runoff becomes contaminated with pollutants as it flows across impermeable surfaces such as streets, roofs and parking lots.

Stormwater: rainwater that hits the surface of the earth. Stormwater can evaporate, percolate into the ground or flow across the surface to the nearest storm drain inlet, stream, or wetland area. If stormwater does not evaporate or percolate into the ground, it becomes runoff.

Swale: a natural or sculpted channel that slows runoff. Usually vegetated or covered with mulch, it can filter pollutants and increase aquifer recharge.

T.R.E.E.S. Project: Transagency Resources for Environmental and Economic Sustainability Project.

Vector: an organism, such as a mosquito or tick, that acts as a carrier of disease-causing microorganisms.

Watershed: the area of land drained by a particular body of water. Also called a drainage basin.

“In a city that imports more than half of its water, technology like that implemented at Open Charter could significantly impact Los Angeles. This technology reduces use of potable water for irrigation, decreases our demand for imported water and conserves unused water in a time of increased competition for limited supplies.”

- **Shahram Kharaghani, Manager, Watershed Protection Division City of Los Angeles Bureau of Sanitation**

“As project manager for the Broadous and Open Charter retrofits, I can say that forging the necessary partnerships was incredibly challenging at times, but ultimately rewarding. New relationships were formed among entities that don’t typically work together and a model for collaboration between local agencies and nonprofits was created. By continuing to listen to one another and work together, we can build on the lessons learned in these projects. They can help us create even better multipurpose projects to sustain our natural resources and make the best use of our scarce and precious public spaces.”

- **Rebecca Drayse, Natural Urban Systems Group Director, TreePeople, and project manager for the school demonstrations**

“This project transformed our school into a beautiful oasis with grass ballfields, trees and gardens that actually help protect the surrounding neighborhood and the beach. The kids love tending to the trees and plants and watching things grow – it’s a great way to teach about caring for the natural world.”

- **Robert Burke, Open Charter Elementary School Principal**

The Sacramento Bee

May 26, 2002

HOW L.A. RAINFALL COULD MEET HALF ITS WATER NEEDS

But a slow change is creeping over the Southland. Ever on the lookout for the next new thing, and facing a price tag of billions of dollars to clean up the polluted mess its waterways have become, L.A. is embracing a radical idea: save and use its own rainwater instead of everyone else's. It's about to embark on what officials hope will be a model of water-wise urban planning for the entire country. Their goal – to make the concrete jungle behave more like a natural place.

FAO FIAT PANIS

"The information and demonstrations of the T.R.E.E.S. Project resulted in substantial changes in Los Angeles public works agencies and local policies."

State of the World's Forests 2003, United Nations Food and Agriculture Organization

Los Angeles Times

August 16, 1998

TREEPEOPLE'S L.A. PILOT PROJECT IS TESTING THE WATERS

In a city where so much of the land is paved or roofed over and where gutters run freely, TreePeople's ideas make good sense.

Los Angeles Times

March 4, 2005

LEARNING TO SAVE SOMETHING FOR A DRIER DAY

At Thursday's demonstration [at Open Charter Elementary School], a one-pint jar of murky water polluted with oil, trash and dust displayed what goes into the ocean after it rains.

The city of Los Angeles Bureau of Sanitation reported that in a 0.45-inch rain, approximately 3.8 billion gallons of runoff flow to the Pacific Ocean from the Los Angeles River, Ballona Creek, Santa Monica Bay and Dominguez Channel watersheds.

California Coast & Ocean

Autumn 2001

TREEPEOPLE'S SUMMER STORM

On a clear day in August 1998, a "hundred-year storm" – a storm so severe that it occurs, on average, only once a century – hit Mrs. Hall's home. With the cooperation of the DPW and other agencies, "we dumped 4,000 gallons of water on the house in 10 minutes," [Andy Lipkis said]. The water retention features worked as expected, and the water that fell on the property was absorbed into the ground. What fell on adjacent pavement ran into gutters, en route to the Los Angeles River.

Government Engineering

March/April 2005

COLLECTION AND REUSE OF STORMWATER: THE PHRASE "URBAN ENVIRONMENT" DOES NOT HAVE TO BE AN OXYMORON.

"As we look at how the system evolved over time we realize the way we designed the (stormwater) system was reactionary and single purpose in its approach," said Michael Drennan, [P.E. who worked with the engineering firm MWH on the Open Charter Magnet School job and was his firm's project manager]. "If you think about multiple objectives like flooding, pollution reduction, and water supply, then you might design a system like we did at Open Charter, which manages stormwater as a resource rather than a waste."

Daily Breeze

www.dailybreeze.com The South Bay's choice for 111 years

March 4, 2005

THINGS START TO FLOW FOR RECYCLING SYSTEM

It's a concept as old as time: In a parched desert, it helps to have a good bucket on hand when the precious rains finally come.

Make that bucket a 110,000-gallon underground tank and you've got enough water to transform one of the Los Angeles Unified School District's trademark blacktop campuses into a grassy, tree-dotted play space.

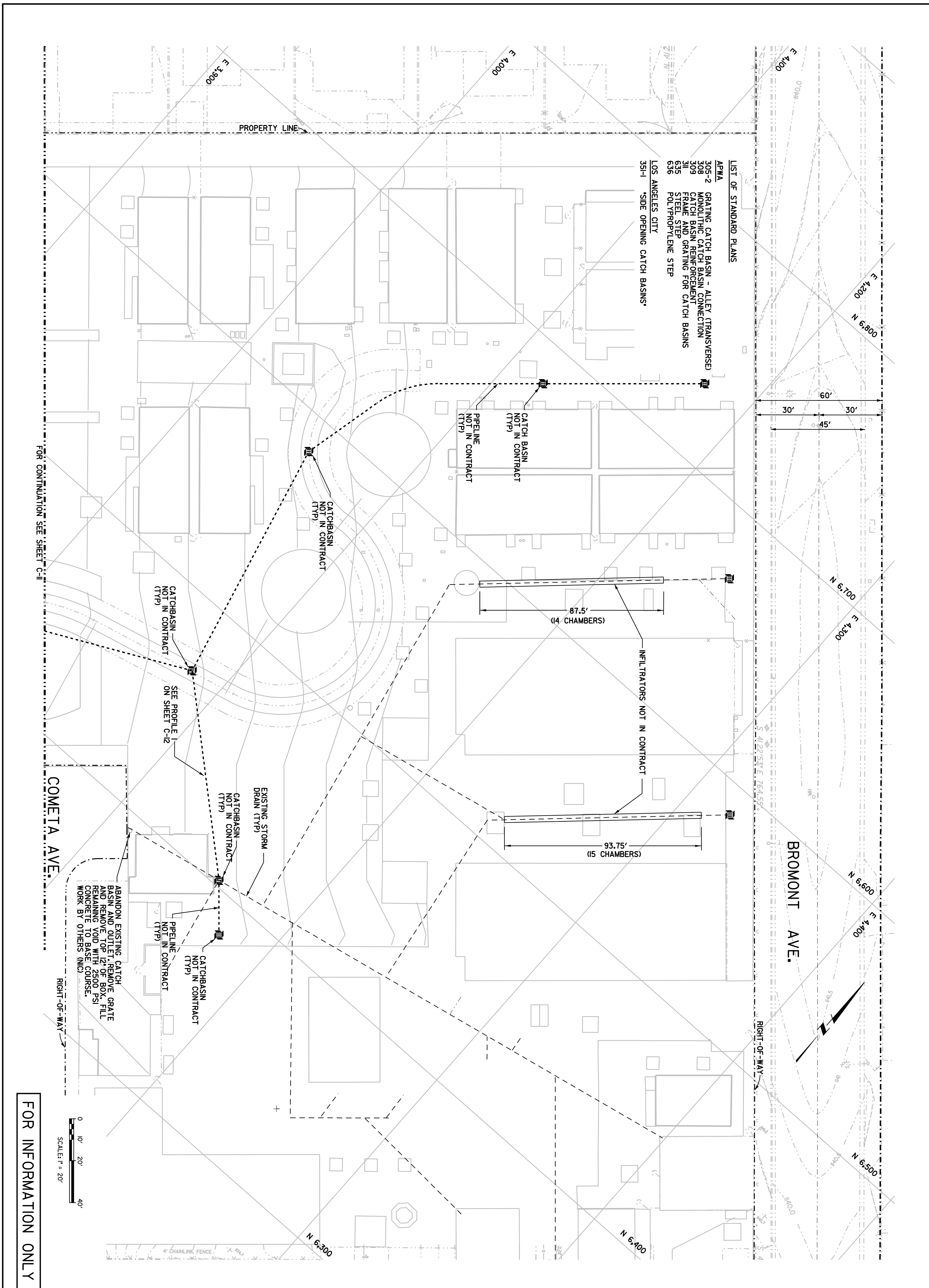
Rainwater as a Resource:

A Report on Three Sites Demonstrating Sustainable Stormwater Management

TreePeople

12601 Mulholland Drive, Beverly Hills, CA 90210
(818) 753-4600 www.treepeople.org

Job No: 1026497 File: P:\Projects\LA_UNI~1\broadus\civ\broud_c10.dlv Plot Date: 13-SEP-2000 14:31



DRAWN BY S. STONE CHECKED BY C.J. GANTNEY DATE 13-SEP-2000	DRAWING NO. C-10 INDEX NO. 11	JOB NUMBER REVISIONS

STORMWATER DRAINAGE PLAN - I

MONTGOMERY WATSON
Pasadena, California

PROJECT
STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT PHASE I

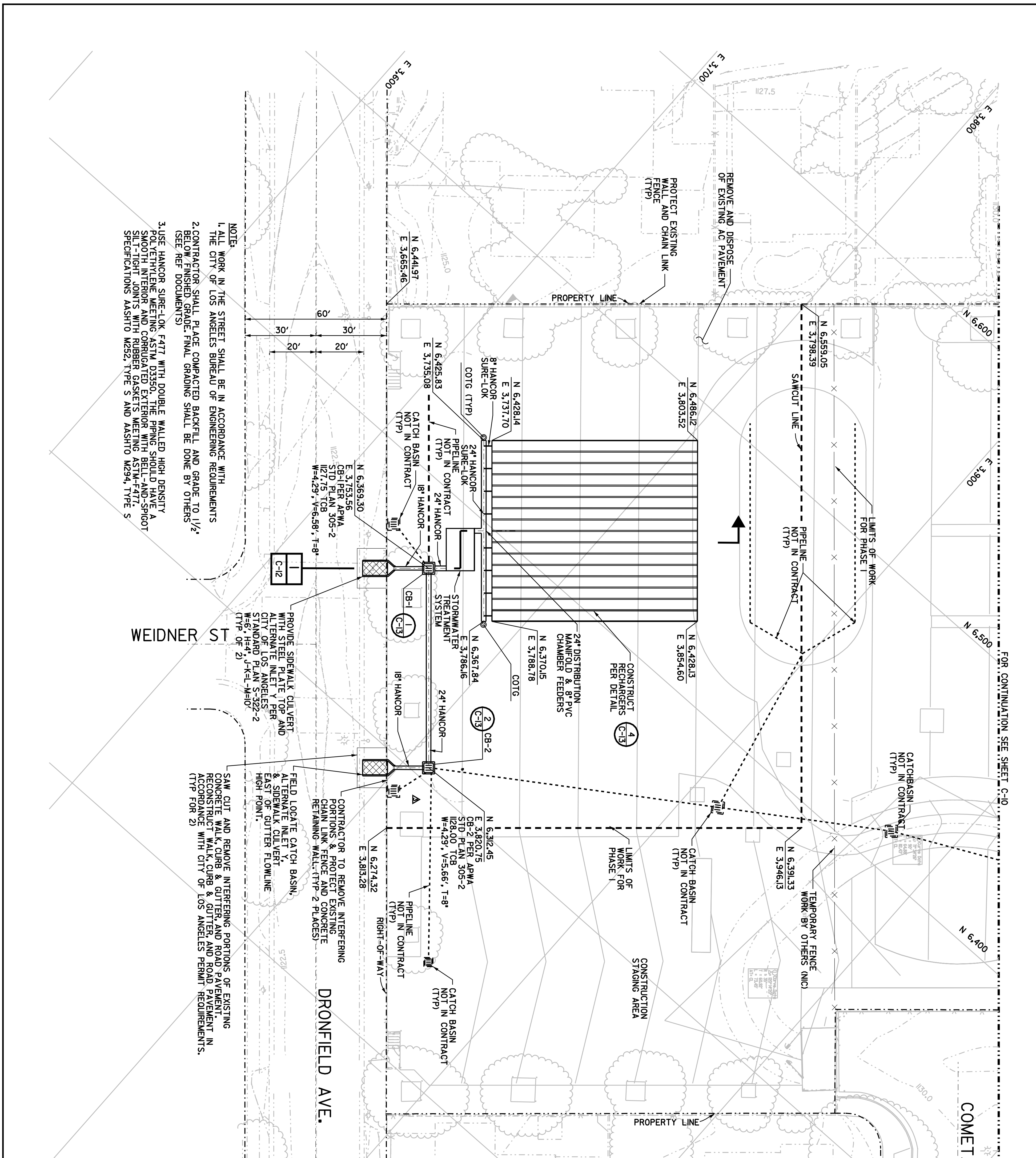
SCHOOL
BROADOUS E.S.
12561 FILMORE STREET
PACOIMA, CA 91331

D.S.A. STAMP
NOT APPROVED FOR CONSTRUCTION

LOS ANGELES UNIFIED SCHOOL DISTRICT · BOARD OF EDUCATION

DESIGN & INSPECTION BRANCH
FACILITIES SERVICES DIVISION
355 NORTH GRAND AVENUE
LOS ANGELES CALIFORNIA

Job No: 1026497 File: P:\Projects\la_unified\broadus\civ\broud_c11.dlv Plot Date: 05-JAN-2001 14:48



STORMWATER DRAINAGE PLAN - II

PROJECT	STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT PHASE I
SCHOOL	BROADOUS E.S. 12561 FILMORE STREET PACOIMA, CA 91331

MONTGOMERY WATSON
Pasadena, California

REVISIONS
1 REVISED SCOPE OF WORK
2 REVISED CB IN. 2

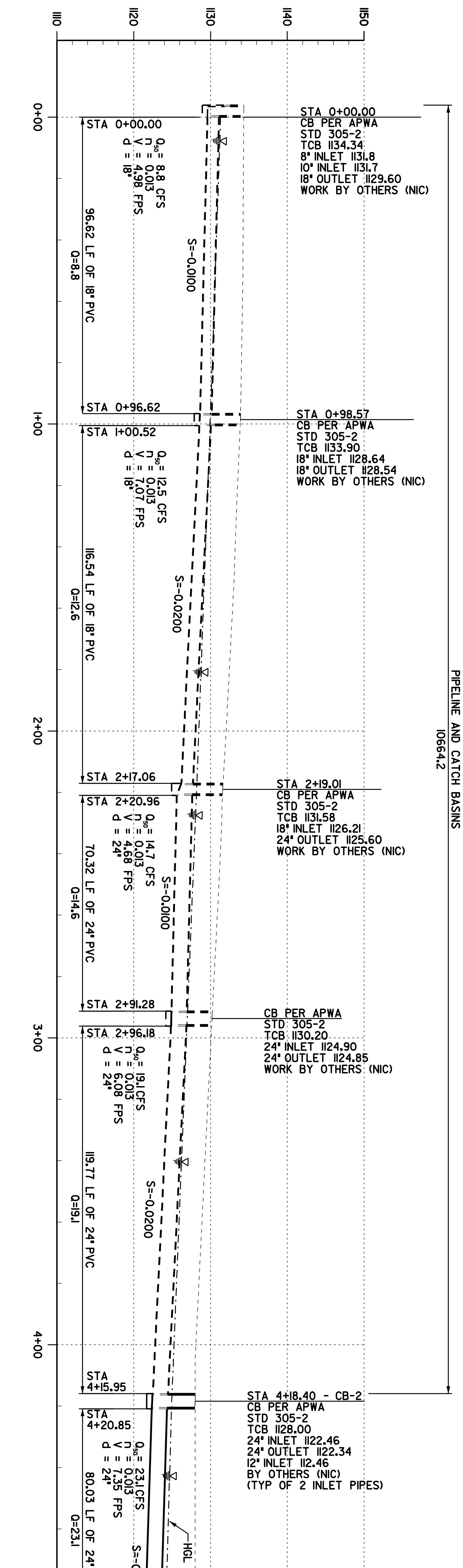
JOB NUMBER	
DRAWN BY	J. JESSEY
CHECKED BY	C.J. GANTNEY
DATE	05-JAN-2001
DRAWING NO.	C-11
INDEX NO.	12

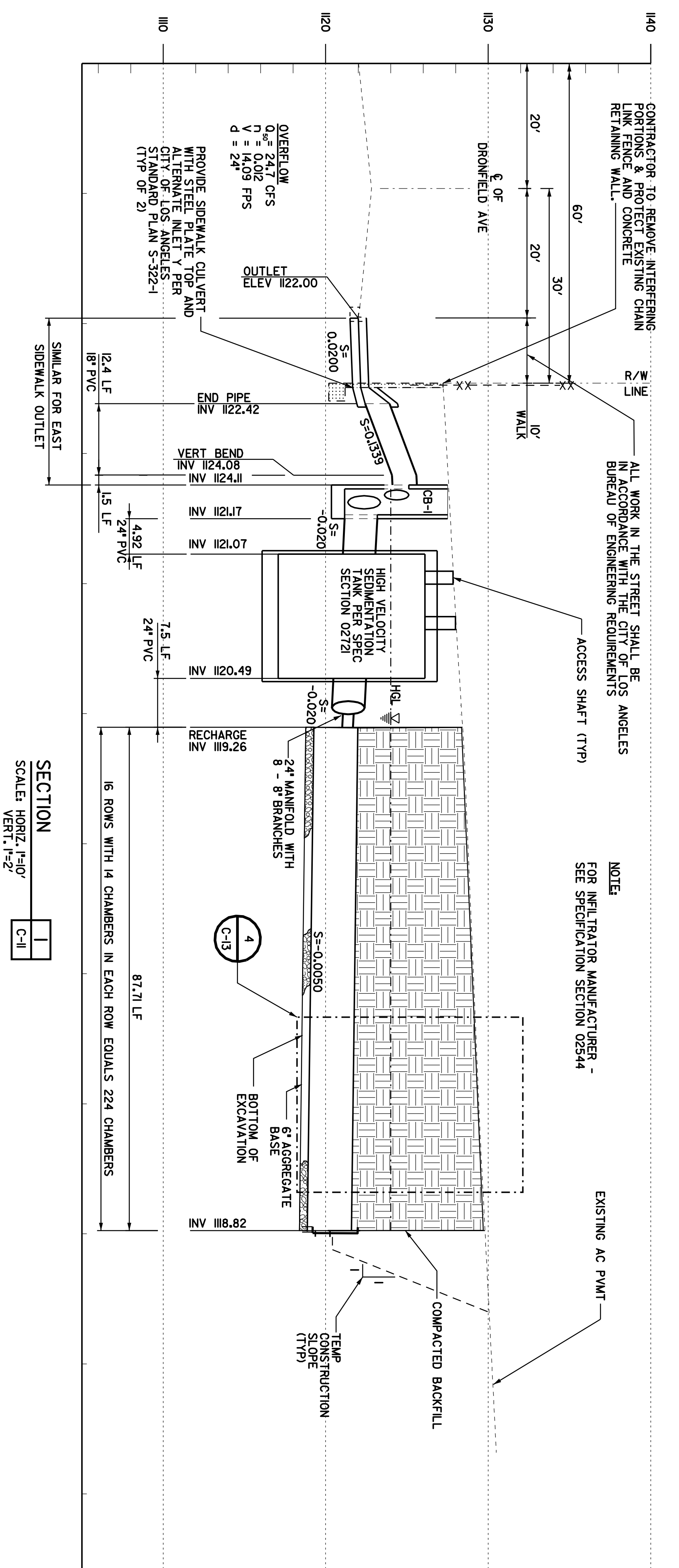
D.S.A. STAMP

LOS ANGELES UNIFIED SCHOOL DISTRICT · BOARD OF EDUCATION

DESIGN & INSPECTION BRANCH
FACILITIES SERVICES DIVISION
355 NORTH GRAND AVENUE
LOS ANGELES CALIFORNIA

Job No: 1026497 File: P:\Projects\LA_UNI~1\broadus\civ\broud_c12.dlv Plot Date: 13-SEP-2000 15:48





REGISTERED PROFESSIONAL ENGINEER
CORNELIUS J. GANTNEY
No. 34674
CIVIL
STATE OF CALIFORNIA

DATE	13-SEP-2000
CHECKED BY	C.J. GANTNEY
DRAWN BY	S. STONE
JOB NUMBER	
DRAWING NO.	C-12
INDEX NO.	13

REVISIONS
2 REVISED SCOPE OF WORK
1 REVISED DIMENSIONS

STORMWATER DRAINAGE PLAN - SECTIONS

MONTGOMERY WATSON
Pasadena, California

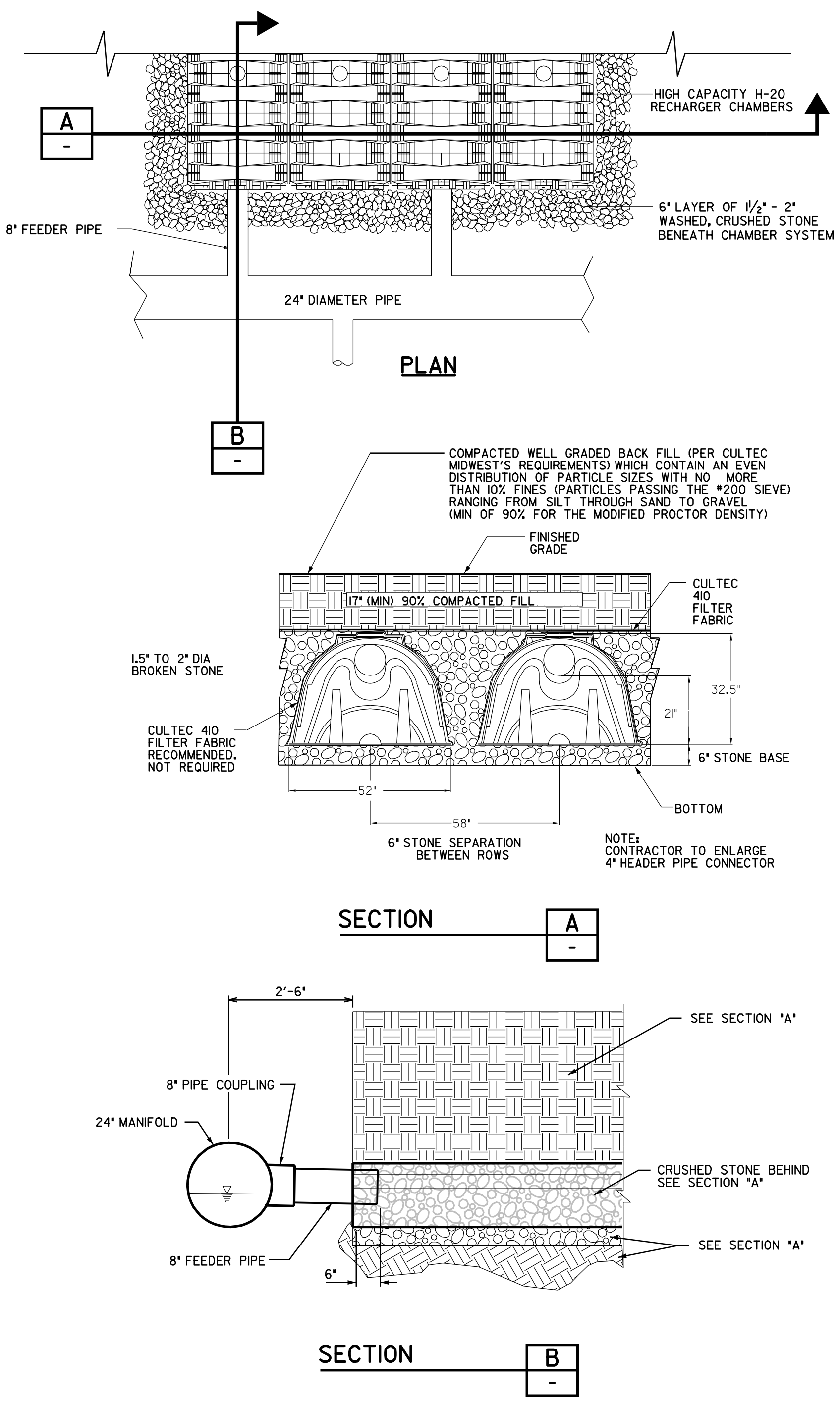
PROJECT
STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT PHASE 1

SCHOOL
BROADOUS E.S.
12561 FILMORE STREET
PACOIMA, CA 91331

D.S.A. STAMP
NOT APPROVED FOR CONSTRUCTION

LOS ANGELES UNIFIED SCHOOL DISTRICT
BOARD OF EDUCATION

DESIGN & INSPECTION BRANCH
FACILITIES SERVICES DIVISION
355 NORTH GRAND AVENUE
LOS ANGELES CALIFORNIA

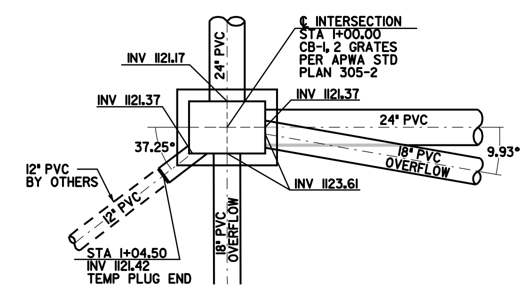


NOTES:

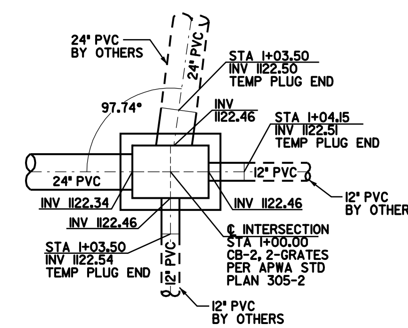
1. ALL WORK ON THE RECHARGERS SHALL BE IN ACCORDANCE WITH THE MANUFACTURER'S REQUIREMENTS.
2. THE INFORMATION SHOWN HERON SHALL BE CONFIRMED BY THE MANUFACTURER PRIOR TO INSTALLATION.
3. THE MANUFACTURER'S REPRESENTATIVE SHALL BE PRESENT FULL TIME DURING THE INFILTRATOR WORK.
4. PROVIDE SHOP DRAWINGS FOR LAYOUT, SEQUENCE OF WORK, MATERIALS, AND METHOD OF INSTALLATION

CULTEC DETAILS
NTS — 4 / C-11

NOTE: EXTEND STUB END 1FOOT (MIN) BEYOND CB.



CB-1 DETAIL
NTS — 1 / C-11



CB-2 DETAIL
NTS — 2 / C-11

A. FLEXIBLE PIPE REFERS TO ALL STEEL, DUCTILE-IRON AND PLASTIC PIPES.

B. TYPICAL TRENCH SECTIONS (I, II AND III) ARE TO BE USED ONLY WHERE STABLE, COMPACT SOIL CONDITIONS EXIST. IF BOULDER OR LARGE OBSTRUCTIONS WOULD BE ENCOUNTERED, TRENCH SECTIONS MAY BE DEEPER OR WIDER THAN SHOWN. THE ENGINEER SHOULD BE ADVISED SHOULD THIS OCCUR.

C. THE NEED FOR PROTECTIVE SYSTEMS, AND EXCAVATION SLOPES SHALL BE DETERMINED CONSIDERING APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS AND GEOTECHNICAL CONSULTANTS' RECOMMENDATIONS.

D. PROTECTIVE SYSTEMS SHALL BE DESIGNED AND BUILT IN ACCORDANCE WITH THE APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS.

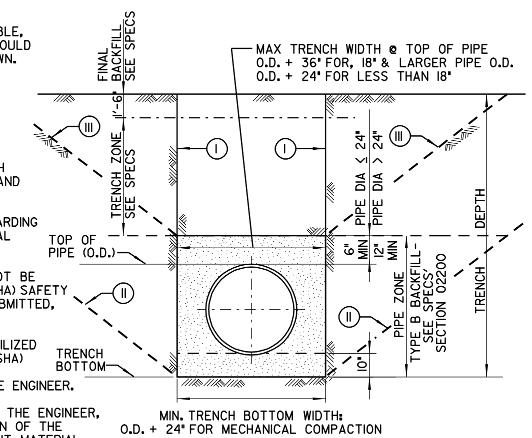
E. SUPPORTING DOCUMENTATION SHALL BE SUBMITTED TO THE ENGINEER REGARDING PIPE DESIGN AND COMPLIANCE WITH APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS.

F. UNSUPPORTED VERTICAL AND/OR SLOPING TRENCH WALL SLOPES SHALL NOT BE STEEPER THAN ALLOWED BY APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS, UNLESS SUPPORTING DOCUMENTATION IS SUBMITTED, ACCORDING TO AFOREMENTIONED SAFETY STANDARDS.

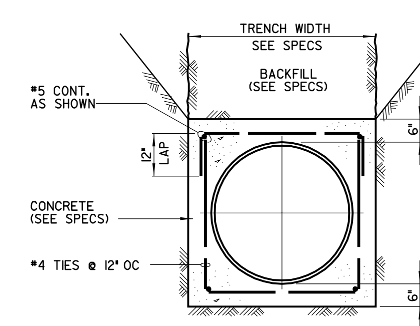
G. TRENCH SECTIONS OTHER THAN THE TYPICAL SECTIONS SHOWN MAY BE UTILIZED PROVIDED THEY COMPLY WITH APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS. DOCUMENTATION SUPPORTING THIS COMPLIANCE AND PIPE DESIGN CALCULATIONS SHALL BE SUBMITTED TO THE ENGINEER.

H. IF OVER-EXCAVATION DUE TO POOR FOUNDATION MATERIAL IS ORDERED BY THE ENGINEER, THE BACKFILL MATERIAL SHALL BE ACCORDING TO THE EARTHWORK SECTION OF THE SPECIFICATIONS ARTICLE ENTITLED, "USE OF FILL, BACKFILL AND EMBANKMENT MATERIAL TYPES."

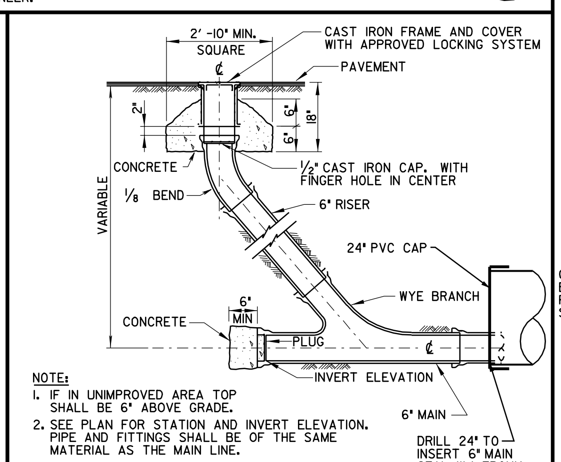
I. IF DURING CONSTRUCTION, THE WATER TABLE WILL BE DISCOVERED TO BE ABOVE THE TRENCH BOTTOM, THE ENGINEER SHALL BE NOTIFIED, AND APPROPRIATE DEWATERING SHALL BE IMPLEMENTED TO LOWER THE WATER LEVEL BELOW THE TRENCH BOTTOM. THE BACKFILL MATERIAL SHALL BE ACCORDING TO THE EARTHWORK SECTIONS OF THE SPECIFICATIONS, OR AS ORDERED BY THE ENGINEER.



TRENCH SECTION - FLEXIBLE PIPE
NTS — 3 / -

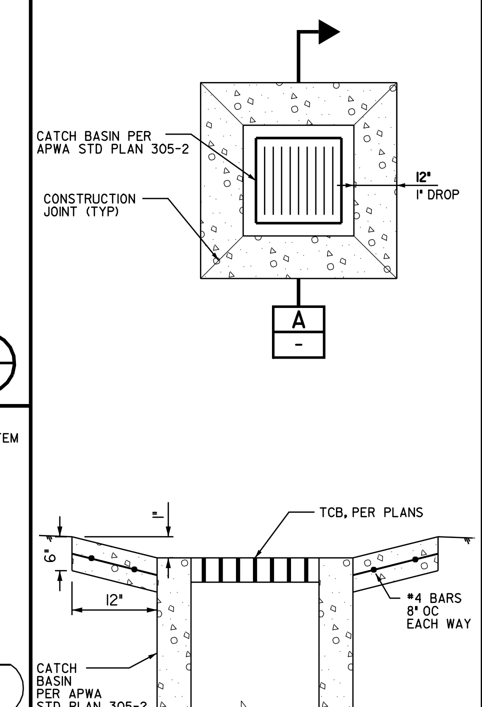


CONCRETE ENCASEMENT
NTS — 5 / C-11



NOTE:
1. IF IN UNIMPROVED AREA TOP SHALL BE 6" ABOVE GRADE.
2. SEE PLAN FOR STATION AND INVERT ELEVATION. PIPE AND FITTINGS SHALL BE OF THE SAME MATERIAL AS THE MAIN LINE.

CLEANOUT (COTG)
7 / C-11



SECTION A
NTS

LOCAL DEPRESSION
NTS — 6 / C-10

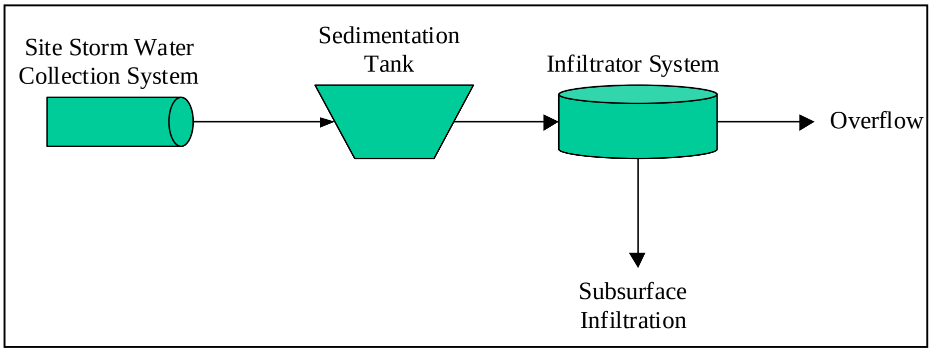
REGISTERED PROFESSIONAL ENGINEER — CORNELIUS J. GANTNEY — No. 34674 — CIVIL — STATE OF CALIFORNIA

DESIGN & INSPECTION BRANCH	FACILITIES SERVICES DIVISION, 355 NORTH GRAND AVENUE, LOS ANGELES CALIFORNIA
D.S.A. STAMP	NOT APPROVED FOR CONSTRUCTION
PROJECT	STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT PHASE I
SCHOOL	BROADOUS E.S. 12561 FILMORE STREET PACOIMA, CA 91331
	MONTGOMERY WATSON, Pasadena, California
REVISIONS	2: CATCH BASIN DETAIL DELETED; 1: REVISED DIMENSIONS
DRAWN BY	S. STONE
CHECKED BY	C.J. GANTNEY
DATE	13-SEP-2000
DRAWING NO.	C-13
INDEX NO.	14

STORMWATER DRAINAGE PLAN - DETAILS

Description of Maintenance & Inspection Tasks

There are several maintenance and inspection tasks which have been identified for this project. The following assumptions and recommendation were made in an effort to calculate the costs associated with the construction of this project. Below is a schematic of the project process and a description of the maintenance and inspection tasks.



MAINTENANCE COST ESTIMATE

Sedimentation Tank

There are two chambers in the sedimentation tank that need periodic cleaning. One of the chambers is the sedimentation chamber, the other is an oil and grit chamber located next to each other inside the sedimentation tank. The sedimentation chamber must be cleaned when the buildup of sediment reaches within six inches of the water service level in the sedimentation chamber. This is expected to occur once every year and will require a Vacutruck to vacuum out and remove the collected sediment. It is assumed that this maintenance will be contracted out and will include the removal and disposal of the sediment. It is assumed that the contents for the sediment from the sediment chamber will be classified as non-hazardous material and that the total quantity of waste should not exceed 750 gallon of liquid/solid waste.

The oil and grit chamber must also be cleaned periodically. When the thickness of the oil layer in this chamber reaches a thickness of three inches that it will require removal from the chamber. It is estimated that this will occur every two years. It is assumed that the contents from the oil/grit chamber of the sedimentation tank be removed every two years. It is assumed that this waste will be classified as hazardous waste and its quantity will not exceed 60 gallons.

Before removal of the sediment and/or oils from the sedimentation tank, its contents must be classified. A licensed disposal company must be contracted to test and classify the contents of the sedimentation tank. After this procedure is completed, the sediment from the sediment chamber of the must be removed. Access to the sediment chamber requires that only the manhole cover over the chamber be removed. Collection and disposal of this material must be conducted by a licensed waste disposal company.

The costs have been determined from quotes from waste disposal companies. Access to the grit/oil chamber is through a separate manway lid. Entry into the sedimentation tank either to the sedimentation chamber or to the oil/grit chamber is not required.

Labor Requirements: *Contracted out*

Collection System

To ensure that the collection system is working properly it is recommended that the stormwater collection system be cleaned three times every year. The cleaning of the collection system requires the removal of all obstructions from all catch basins on site that collect and directs runoff to the Infiltrators system, the sedimentation tank and the curb inlet/outlet. The cleaning of the catch basins will require the removal of the grating above the catch basins and the extraction of all solid waste in the catch basin. The curb inlet/outlet must also be cleaned of all obstacles so flow through the catch basin is not blocked. This tasks is estimated to take 2 workman ½ day to complete.

Labor Requirements: *24 hours/year*

INSPECTION COST ESTIMATE

Inspection of the Sedimentation Tank

The procedures recommended by the manufacture must be followed. For both systems, it is recommended that a log be maintained to determine the buildup of sediments throughout the life of the system. A log from the sedimentation tank manufacturer is available. It is estimated that this task will require four hours of one maintenance worker to complete. This inspection task should take place three times every year.

Labor Requirements: *12 hours/year*

Cost Estimate Summary

The annual maintenance & inspection cost was calculated using the Equivalent Uniform Annual Cost (EUAC). These costs are listed in Table 2. The annual interest rate used to calculate the EUAC is 7%. The life span of the system is estimated as 20 years.

Table 2
Cost Estimates

Activity	**Costs ($) EUAC**
Annual Maintenance	3,420
Annual Inspection	360
Subtotal	3,780
Contingency 20%	756
TOTAL COSTS	4,536

Table 3
Yearly Maintenance & Inspection Activity Schedule*

	January	February	March	April	May	June	July	August	September	October	November	December
MAINTENANCE										Sediment Removal from Sed. Tank		
	Clean Collection System			Clean Collection System						Clean Collection System		
INSPECTION	Inspect Sediment Buildup in Infiltrators & Sed. Tank			Inspect Sediment Buildup in Infiltrators & Sed. Tank						Inspect Sediment Buildup in Infiltrators & Sed. Tank		

*Does not include removal of oil/grit from the sedimentation tank which is assumed to occur every 2 years

OPEN CHARTER MAGNET SCHOOL

STORMWATER

BEST MANAGEMENT PRACTICES

DEMONSTRATION PROJECT

OCTOBER 2002

AS-BUILTS
Doty Bros. Equipment Co.

Date 7-21-04
Revised: 10/06/04

REGISTERED PROFESSIONAL ENGINEER
KEVIN H. MONROE
No. C 046756
Exp. 6-30-03
CIVIL
STATE OF CALIFORNIA

LOS ANGELES UNIFIED SCHOOL DISTRICT · BOARD OF EDUCATION

DESIGN & INSPECTION BRANCH
FACILITIES SERVICES DIVISION
355 NORTH GRAND AVENUE
LOS ANGELES CALIFORNIA

D.S.A. STAMP

TITLE SHEET

PROJECT
STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL
OPEN CHARTER MAGNET SCHOOL
5540 W. 77TH STREET
LOS ANGELES, CA 90045

MWH
MONTGOMERY WATSON HARZA
Pasadena California

REVISIONS

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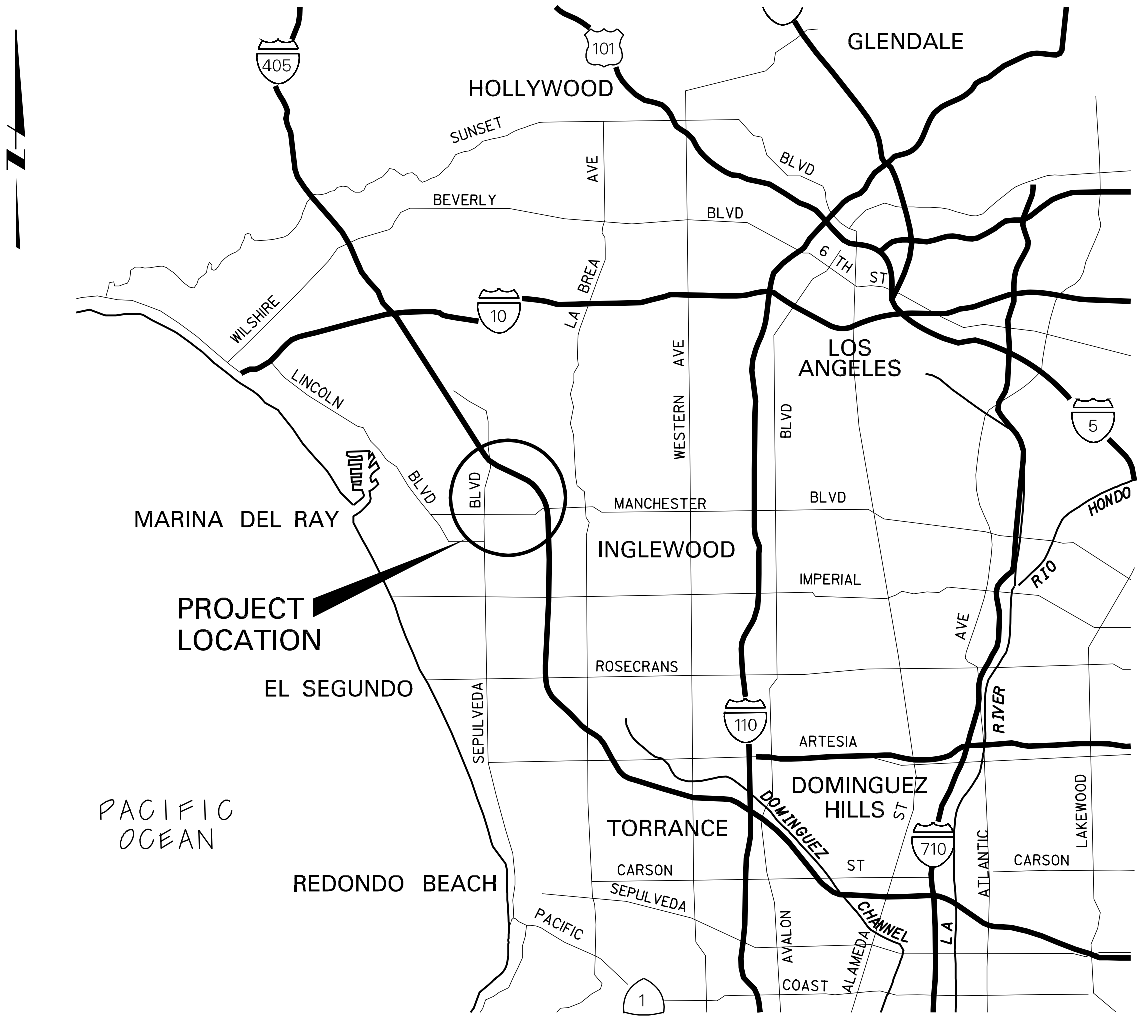
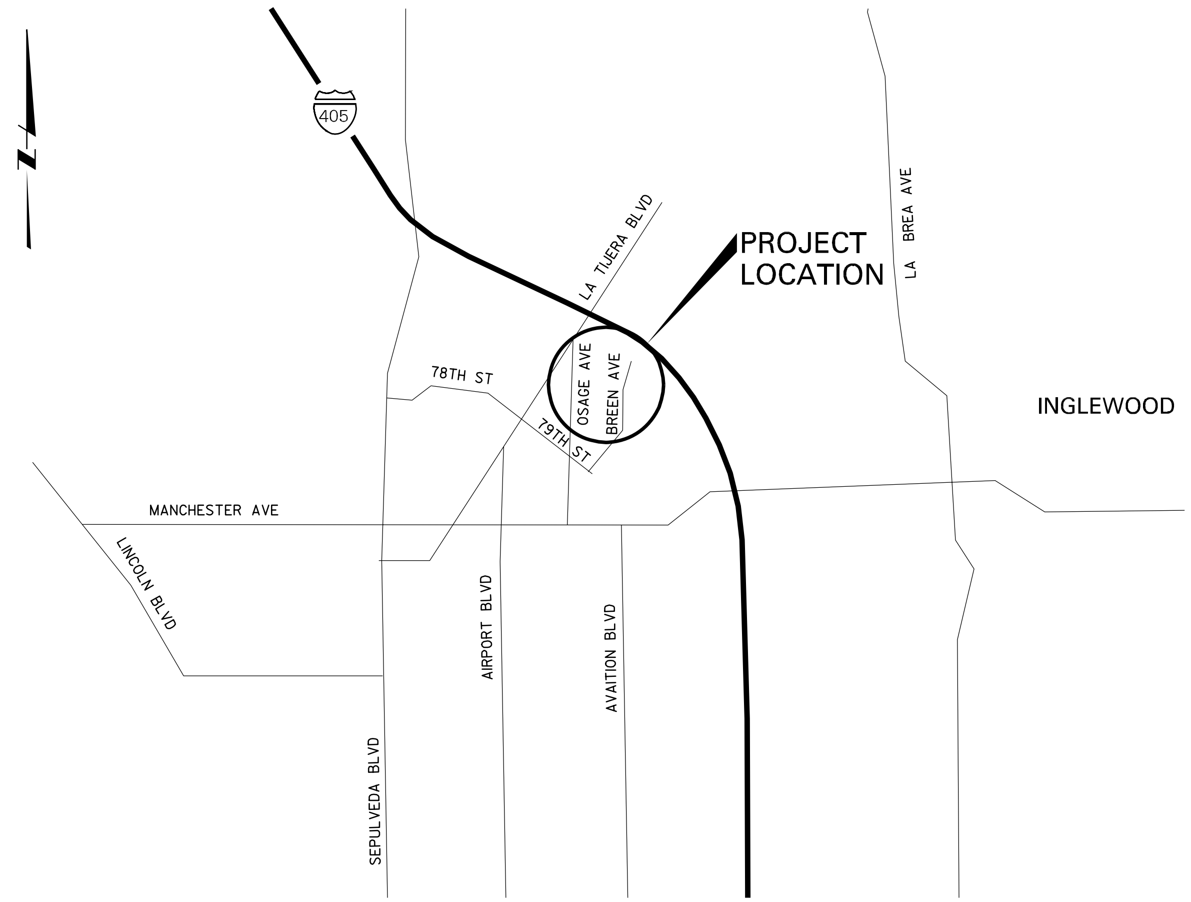
△	
△	
△1	REISSUED SET

JOB NUMBER	
DRAWN BY G. BEHNKE	DRAWING NO. T-1
CHECKED BY G. BEHNKE	
DATE 17-OCT-2002	INDEX NO.

File: P:\Projects\la_unified\open charter\civ\ocg00.dgn
Job No: 102650



LOCATION MAP
NOT TO SCALE



VICINITY MAP
NOT TO SCALE

LIST OF DRAWINGS

GENERAL

- T-1 TITLE SHEET
- G-1 LOCATION MAP, VICINITY MAP & LIST OF DRAWINGS

CIVIL

- GC-1 CIVIL GENERAL NOTES, SYMBOLS & ABBREVIATIONS
- GC-2 CIVIL DETAILS - 1
- GC-3 CIVIL DETAILS - 2
- C-1 KEY MAP
- C-2 SITE PLAN
- C-3 GRADING PLAN
- C-4 YARD PIPING PLAN
- C-5 GRADING SECTIONS

MECHANICAL

- GM-1 PIPING MATERIALS SCHEDULE
- GM-2 MECHANICAL STANDARD DETAILS - II
- GM-3 MISCELLANEOUS EQUIPMENT SCHEDULE
- M-1 IRRIGATION PUMP STATION

INSTRUMENTATION

- GI-1 INSTRUMENTATION SYMBOLS AND ABBR. - I
- GI-2 INSTRUMENTATION SYMBOLS AND ABBR. - II
- I-1 IRRIGATION WATER P.S.

ELECTRICAL

- GE-1 ELECTRICAL SYMBOLS AND ABBREVIATIONS
- E-1 ELECTRICAL SITE PLAN
- E-2 ELECTRICAL SITE PLAN - PARTIAL
- E-3 SINGLE LINE DIAGRAM & PUMP STATION PLAN

REGISTERED PROFESSIONAL ENGINEER · CORNELIUS J. GANTNEY · No. 34674 · Exp. 9/30/03 · CIVIL · STATE OF CALIFORNIA

LOS ANGELES UNIFIED SCHOOL DISTRICT · BOARD OF EDUCATION

DESIGN & INSPECTION BRANCH
FACILITIES SERVICES DIVISION
355 NORTH GRAND AVENUE LOS ANGELES CALIFORNIA

D.S.A. STAMP

LOCATION MAP, VICINITY MAP & LIST OF DRAWINGS

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL: OPEN CHARTER MAGNET SCHOOL
5540 W. 77TH STREET
LOS ANGELES, CA 90045

Pasadena
California

MWH
MONTGOMERY WATSON HARZA

REVISIONS
REISSUED SET

JOB NUMBER	
DRAWN BY: S. STONE	DRAWING NO. G-1
CHECKED BY: J. GANTNEY	
DATE: 17-OCT-2002	INDEX NO.

Job No: 1026510 File: P:\Projects\la_unified\open charter\civ\ocg01.dwg

CIVIL GENERAL NOTES

1. PRIOR TO THE START OF CONSTRUCTION, THE CONTRACTOR SHALL LOCATE ALL EXISTING UTILITIES IN AND AROUND THE AREAS OF NEW CONSTRUCTION. THE CONTRACTOR SHALL POTHOLE FOR EXISTING UTILITIES PRIOR TO SUBMITTAL OF SHOP DRAWINGS, FOR POINTS OF CONNECTIONS.
2. THE CONTRACTOR SHALL PROTECT ALL EXISTING UTILITIES TO REMAIN.
3. LOCATIONS OF UNDERGROUND UTILITIES SHOWN ON THE DRAWINGS WERE OBTAINED FROM AVAILABLE RECORDS. NEITHER THE OWNER NOR ENGINEER ASSUMES ANY RESPONSIBILITY FOR UTILITIES NOT SHOWN OR NOT IN THE LOCATION SHOWN. THE CONTRACTOR SHALL VERIFY ALL LOCATIONS AND ELEVATIONS AND SHALL TAKE ALL PRECAUTIONARY MEASURES NECESSARY TO PROTECT UTILITY LINES WHETHER SHOWN OR NOT SHOWN.
4. THE CONTRACTOR SHALL CONTACT THE UTILITY AGENCIES, SCHOOL DISTRICT, AND/OR OWNER FOR FIELD LOCATION OF UTILITIES, AT LEAST 72 HOURS PRIOR TO START OF CONSTRUCTION.
5. THE CONTRACTOR SHALL TAKE ALL PRECAUTIONARY MEASURES NECESSARY TO PROTECT EXISTING IMPROVEMENTS WHICH ARE TO REMAIN IN PLACE FROM DAMAGE. ALL IMPROVEMENTS DAMAGED BY THE CONTRACTOR'S OPERATIONS SHALL BE EXPEDITIOUSLY REPAIRED OR RECONSTRUCTED AT THE CONTRACTOR'S EXPENSE WITHOUT ADDITIONAL COMPENSATION.
6. THE CONTRACTOR SHALL COMPLY WITH THE STATE DEPARTMENT OF HEALTH SERVICES CRITERIA FOR THE SEPARATION OF WATER MAINS AND SANITARY SEWERS AS SET FORTH IN SECTION 64630, TITLE 22 OF THE CALIFORNIA ADMINISTRATIVE CODE.
7. THE CONTRACTOR SHALL PROVIDE A MINIMUM OF 36 INCHES COVER ON ALL PIPELINES UNLESS OTHERWISE SHOWN OR DIRECTED.
8. ELEVATIONS SHOWN ARE TO INVERT (FLOWLINE) OF CONDUIT.
9. STRAIGHT SLOPES SHALL BE MAINTAINED BETWEEN INVERTS SHOWN OR SPECIFIED.
10. THE CONTRACTOR SHALL PROPERLY DISPOSE OF ALL DEBRIS FROM DEMOLITION AT CONTRACTORS EXPENSE.
11. ALL PIPE TRENCHING AND BACKFILL SHALL BE IN ACCORDANCE WITH DETAIL 1/GC-2
12. PRIOR TO ANY CONNECTION TO AN EXISTING UTILITY, THE CONTRACTOR SHALL COORDINATE WITH THE UTILITY AGENCIES, SCHOOL DISTRICT, AND/OR OWNER.
13. FOR PIPING INSIDE STRUCTURES SEE MECHANICAL DRAWINGS.
14. THE CONTRACTOR SHALL DISPOSE OF ALL NON-ORGANIC WASTES SUCH AS OLD GUNITE, PIPING, ROCK RUBBLE ETC. AT AN APPROVED LANDFILL OR, OTHER SUITABLE DISPOSAL SITES AT THE CONTRACTOR'S EXPENSE.
15. THE CONTRACTOR SHALL SUBMIT AN EROSION CONTROL PLAN FOR WORK DURING THE CONSTRUCTION, PRIOR TO THE START OF CONSTRUCTION.
    - A. ALL SLOPES SHALL BE PROTECTED FROM EROSION DURING ROUGH GRADING OPERATIONS AND THEREAFTER, UNTIL INSTALLATION OF FINAL GROUNDCOVER (SEE LANDSCAPE PLANS FOR FINAL GROUNDCOVER).
    - B. ALL SLOPE PROTECTION SWALES SHALL BE CONSTRUCTED AT THE SAME TIME AS BANKS ARE GRADED.
16. A DIG ALERT IDENTIFICATION NUMBER MUST BE ISSUED BEFORE A PERMIT TO EXCAVATE WILL BE VALID. FOR THE DIG ALERT ID NUMBER, CONTRACTOR SHALL CALL UNDERGROUND SERVICE ALERT AT 1-800-422-4133 AT LEAST 48 HOURS BEFORE ANY EXCAVATION IN THE VICINITY OF ANY EXISTING UNDERGROUND FACILITIES PER SPECIFICATION SECTION 01530.
17. CONTRACTOR SHALL RESTORE ALL SURVEY MONUMENTS THAT ARE DAMAGED OR DESTROYED DURING CONSTRUCTION.
18. THE CONTRACTOR SHALL CONTACT THE CITY OF LOS ANGELES BUREAU OF ENGINEERING WEST LA DISTRICT FOR ALL WORK WITHIN THE PUBLIC RIGHT-OF-WAY.
19. ALL WORK WITHIN THE CITY OF LOS ANGELES RIGHT-OF-WAY SHALL REQUIRE "A-PERMIT". IT IS THE CONTRACTORS RESPONSIBILITY TO OBTAIN SUCH PERMITS AS NECESSARY AND PAY FOR ALL ASSOCIATED FEES, INSURANCES AND BONDS.
20. THIS PROJECT DOES NOT GRADE TO THE FINISHED GRADE BUT TO TURF SUBGRADE 4 INCHES BELOW FINISHED GRADE. THE FINISHED GRADE WORK WILL BE DONE BY OTHERS INCLUDING THE LANDSCAPING, IRRIGATING AND CONCRETE WALKWAYS.
21. SWING TIE MONUMENTS SHALL BE NO LONGER THEN 2½" DIAMETER BY 4 INCHES DEEP WITH A CENTER POINT VISIBLE AND SET FLUSH WITH THE TURF GRADE (BELOW THE CUT GRASS). SAID SWING TIE MONUMENT CAN BE A CONCRETE FILLED SODA CAN WITH A GALVANIZED NAIL OR OTHER NON-CORROSIVE NAIL.
23. PVC PIPE CONNECTIONS TO CATCH BASINS, MANHOLES AND WET WELLS SHALL BE THE "MANHOLE BOOT" TYPE CONNECTION WITH A PVC OUTERSLEEVE EMBEDDED INTO THE CONCRETE. THE PVC PIPELINE IS THEN INSECTED INTO THE GASKETED "BOOT" FOR A COMPLETED CONNECTION.

CIVIL SYMBOLS

- PROPOSED IMPROVEMENT
- EXISTING IMPROVEMENT
- EXISTING IMPROVEMENT TO BE REMOVED OR DEMOLISHED
- SOIL BORING
- BENCH MARK
- HORIZONTAL AND VERTICAL CONTROL POINT
- STRUCTURE, TANK OR BUILDING
- ASPHALT CEMENT PAVING
- CONCRETE PAVING
- GRAVEL PAVING
- EARTH (IN SECTION)
- COMPACTED EARTH (IN SECTION)
- CONCRETE CURB
- CONCRETE CURB AND GUTTER
- DROP INLET CATCH BASIN
- CURBSIDE DROP INLET CATCH BASIN WITH LOCAL DEPRESSION
- SIDE INLET CATCH BASIN WITH LOCAL DEPRESSION
- CONCRETE WALK
- DRIVEWAY / ACCESS RAMP
- MASONRY WALL, RETAINING WALL, HEADWALL
- 123.25 — FINISHED ELEVATION
- (123.25) — EXISTING ELEVATION
- TOP / TOE — CUT OR FILL SLOPE
- — — GB — — — GRADE BREAK
- — — R — — — RIDGE LINE
- — — C/F — — — CUT/FILL OR DAYLIGHT LINE
- FLOW LINE
- S=0.0123 — SLOPE ON PAVED SURFACE
- 3:1 — BERM SLOPE (HORIZ. TO VERT)
- BURIED ACCESS MH (IN PLAN) LOCATE ON SIDE SHOWN.
- BURIED ACCESS MH (IN PROFILE).
- AV/AR VALVE (IN PROFILE)
- AV/AR VALVE (IN PLAN)
- A/R VALVE (IN PROFILE)
- A/R VALVE LOCATE ON SIDE SHOWN (IN PLAN)
- BLOWOFF (IN PROFILE)
- BLOWOFF (IN PLAN) LOCATE ON SIDE SHOWN
- DELTA
- BUMPED HEAD

CIVIL ABBREVIATIONS

AB, ABAN.	ABANDON, ABANDONED
AC	ASPHALTIC CONCRETE
AV/AR	AIR VACUUM/AIR RELEASE VALVE
AWWA	AMERICAN WATER WORKS ASSOCIATION
BC	BEGIN CURB
BF	BLIND FLANGE
BM	BENCH MARK
BO	BLOW-OFF
BV	BUTTERFLY VALVE
C	COPPER
CB	CATCH BASIN
CJ	CONTROL JOINT
CL	CHAIN LINK, CLEARANCE OR CENTERLINE
CLS	CLASS
CLSM	CONTROLLED LOW STRENGTH MATERIAL
CML&C	CEMENT MORTAR LINED AND COATED
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
CP	CONTROL POINT
D, DR	DRAIN
DI	DUCTILE IRON
DIP	DUCTILE IRON PIPE
DWG	DRAWING
EC	END CURVE
EL	ELEVATION
EXIST	EXISTING
FG	FINISHED GRADE
FL	FLOWLINE OR FLOOR
FS	FINISHED SURFACE
G	GAS
GR BRK	GRADE BREAK OR GRADE CHANGE
GV	GATE VALVE
GW	GROUNDWATER
HORIZ	HORIZONTAL
HP	HIGH POINT
INV	INVERT
IRR	IRRIGATION
LAUSD	LOS ANGELES UNIFIED SCHOOL DISTRICT
LEV	LEVEL
LP	LOW POINT
MH	MANHOLE
MON	MONUMENT
NIC	NOT IN CONTRACT
NTS	NOT TO SCALE
O.C.	ON CENTER
OH	OVER HEAD
PB	PULLBOX
PCC	PORTLAND CEMENT CONCRETE
PI	POINT OF INTERSECTION
PL	PROPERTY LINE
POC	POINT OF CONNECTION
PP	POWER POLE
PS	PUMP STATION
PSI	POUND PER SQUARE INCH
PV	PLUG VALVE
PVC	POLYVINYL CHLORIDE
PVMT	PAVEMENT
R	RADIUS, RISER, RETURN OR RIDGE
R/W	RIGHT OF WAY
RCP	REINFORCED CONCRETE PIPE
RD	ROUND OR ROAD
RDWD	REDWOOD
REV	REVISION
RP	RADIAL POINT
S	SOUTH, SEWER, SECOND OR SLOPE
SCE	SOUTHERN CALIFORNIA EDISON
SCH	SCHEDULE
SDR, SD	STORM DRAINS
SE	SECONDARY EFFLUENT
SPECS	SPECIFICATIONS
SQ	SQUARE
SS	SANITARY SEWER, STAINLESS STEEL
STA	STATION
STD	STANDARD
STL	STEEL
T	TELEPHONE
TBM	TEMPORARY BENCH MARK
TC	TOP OF CURB OR TOP OF CONCRETE
TCB	TOP OF CATCH BASIN
TEL	TELEPHONE
TEMP	TEMPORARY
TP	TELEPHONE POLE OR TELEGRAPH POLE
TW	TOP OF WALL
TYP	TYPICAL
UNKN	UNKNOWN
UW	UTILITY WATER
VCP	VITRIFIED CLAY PIPE
VERT	VERTICAL
W	WEST OR WATER

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LOS ANGELES CALIFORNIA

D.S.A. STAMP

CIVIL GENERAL NOTES, SYMBOLS & ABBREVIATIONS

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL: OPEN CHARTER MAGNET SCHOOL
5540 W. 77TH STREET
LOS ANGELES, CA 90045

MWH MONTGOMERY WATSON HARZA
Pasadena California

REVISIONS

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△	
△	
△1	REISSUED SET

JOB NUMBER	
DRAWN BY: S.STONE	DRAWING NO.: GC-1
CHECKED BY: J.GANTNEY	
DATE: 17-OCT-2002	INDEX NO.

Job No: 1026510 File: P:\Projects\la_unified\open charter\civ\ocgc01.dlv

A. FLEXIBLE PIPE REFERS TO ALL STEEL, DUCTILE-IRON AND PLASTIC PIPES.

B. TYPICAL TRENCH SECTIONS (I, II AND III) ARE TO BE USED ONLY WHERE STABLE, COMPACT SOIL CONDITIONS EXIST. IF BOULDER OR LARGE OBSTRUCTIONS WOULD BE ENCOUNTERED, TRENCH SECTIONS MAY BE DEEPER OR WIDER THAN SHOWN. THE ENGINEER SHOULD BE ADVISED SHOULD THIS OCCUR.

C. THE NEED FOR PROTECTIVE SYSTEMS, AND EXCAVATION SLOPES SHALL BE DETERMINED CONSIDERING APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS AND GEOTECHNICAL CONSULTANTS' RECOMMENDATIONS.

D. PROTECTIVE SYSTEMS SHALL BE DESIGNED AND BUILT IN ACCORDANCE WITH THE APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS.

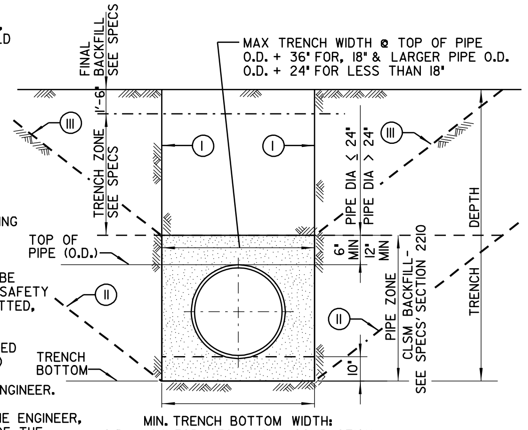
E. SUPPORTING DOCUMENTATION SHALL BE SUBMITTED TO THE ENGINEER REGARDING PIPE DESIGN AND COMPLIANCE WITH APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS.

F. UNSUPPORTED VERTICAL AND/OR SLOPING TRENCH WALL SLOPES SHALL NOT BE STEEPER THAN ALLOWED BY APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS, UNLESS SUPPORTING DOCUMENTATION IS SUBMITTED, ACCORDING TO AFOREMENTIONED SAFETY STANDARDS.

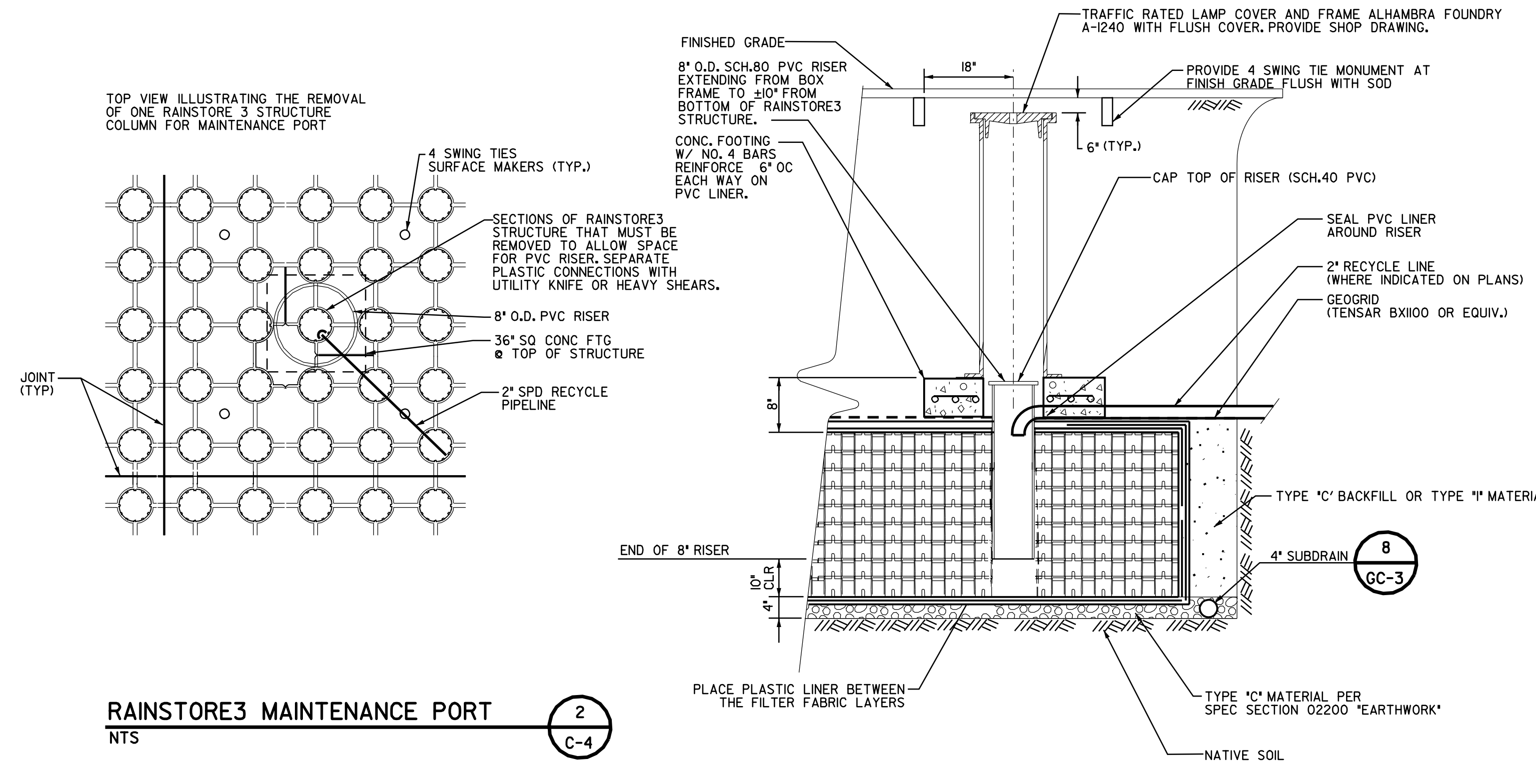
G. TRENCH SECTIONS OTHER THAN THE TYPICAL SECTIONS SHOWN MAY BE UTILIZED PROVIDED THEY COMPLY WITH APPLICABLE LOCAL, STATE AND FEDERAL (OSHA) SAFETY STANDARDS AND REGULATIONS. DOCUMENTATION SUPPORTING THIS COMPLIANCE AND PIPE DESIGN CALCULATIONS SHALL BE SUBMITTED TO THE ENGINEER.

H. IF OVER-EXCAVATION DUE TO POOR FOUNDATION MATERIAL IS ORDERED BY THE ENGINEER, THE BACKFILL MATERIAL SHALL BE ACCORDING TO THE EARTHWORK SECTION OF THE SPECIFICATIONS ARTICLE ENTITLED, "USE OF FILL, BACKFILL AND EMBANKMENT MATERIAL TYPES."

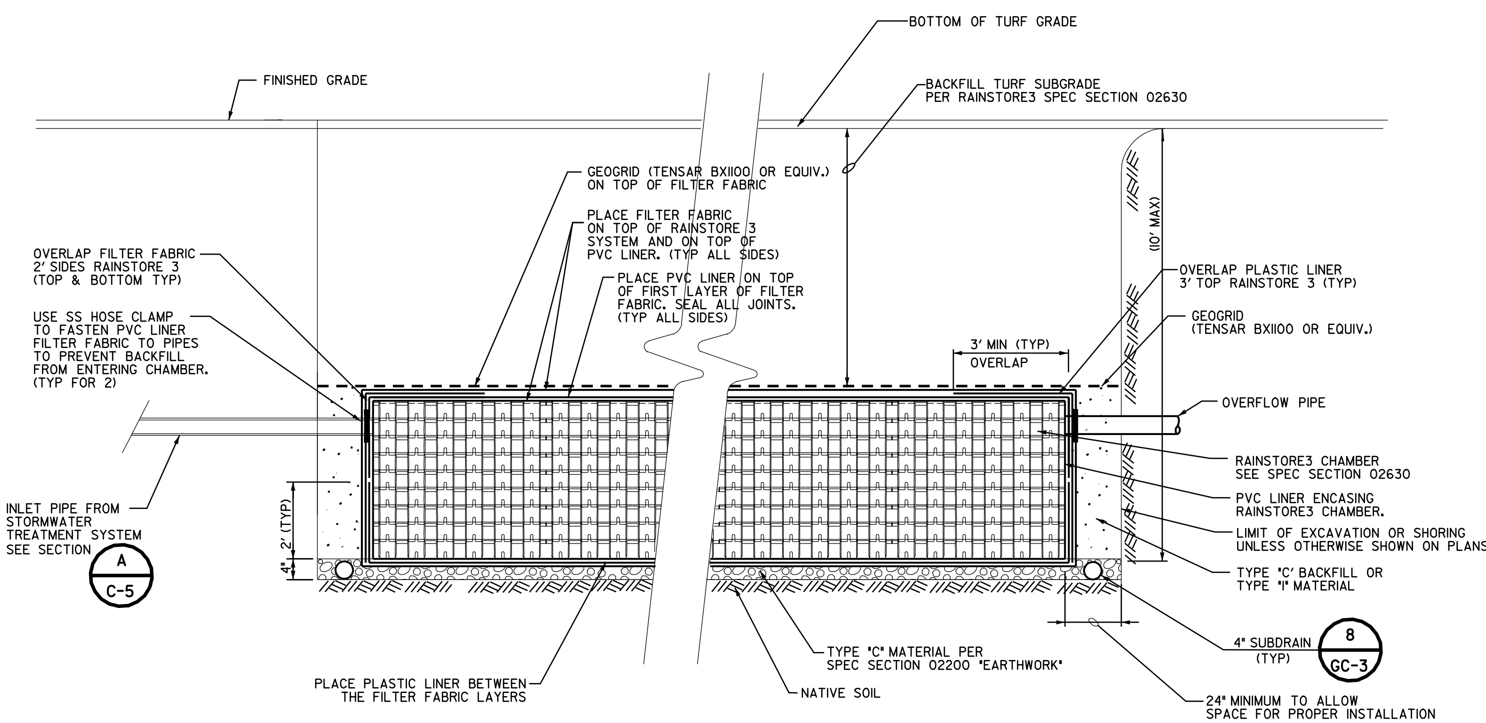
I. IF DURING CONSTRUCTION, THE WATER TABLE WILL BE DISCOVERED TO BE ABOVE THE TRENCH BOTTOM, THE ENGINEER SHALL BE NOTIFIED, AND APPROPRIATE DEWATERING SHALL BE IMPLEMENTED TO LOWER THE WATER LEVEL BELOW THE TRENCH BOTTOM. THE BACKFILL MATERIAL SHALL BE ACCORDING TO THE EARTHWORK SECTIONS OF THE SPECIFICATIONS, OR AS ORDERED BY THE ENGINEER.



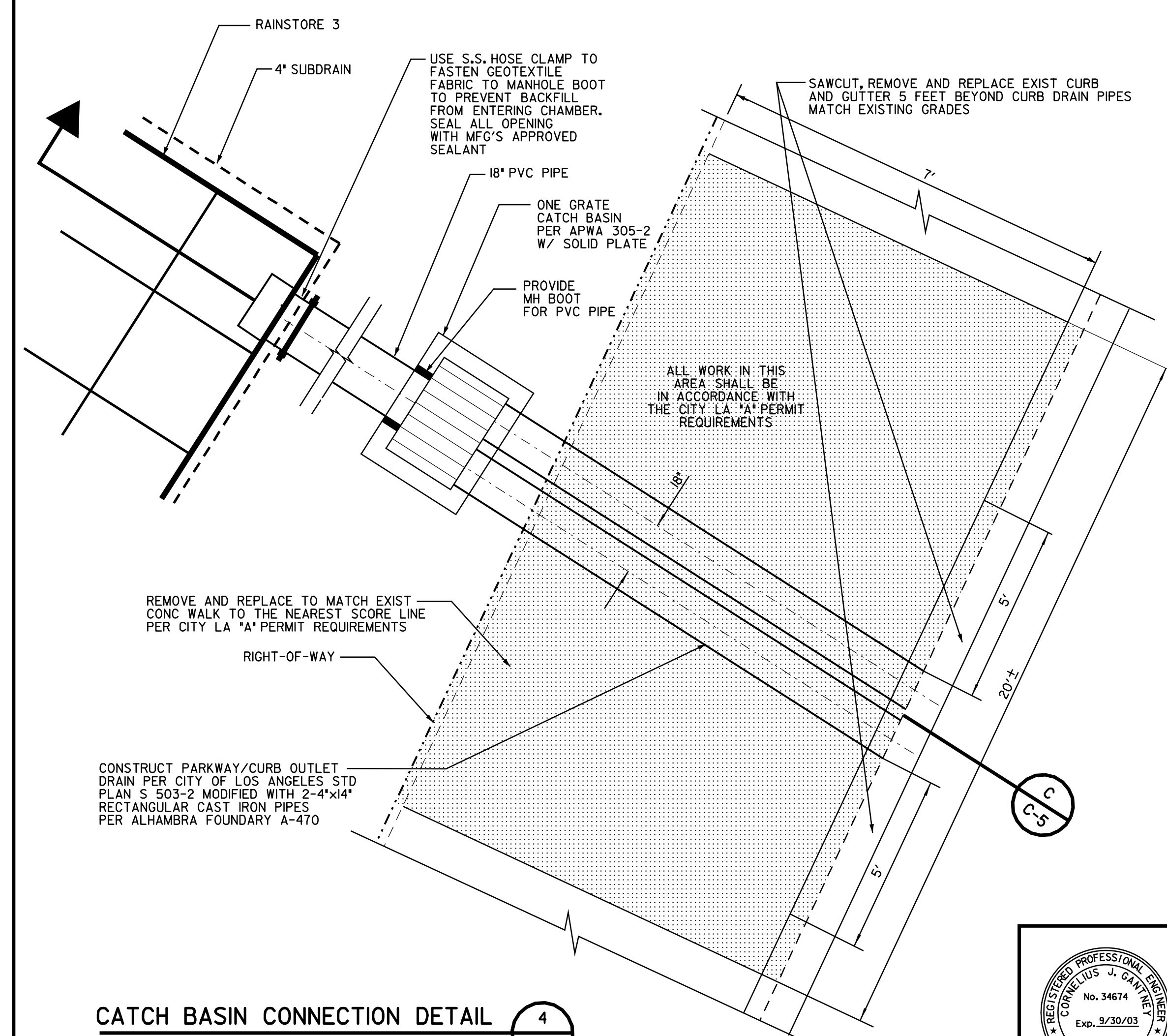
TRENCH SECTION - FLEXIBLE PIPE (1 / VAR)
NTS



RAINSTORE3 MAINTENANCE PORT (2 / C-4)
NTS



RAINSTORE3 DETAILS (3 / C-4)
NTS



CATCH BASIN CONNECTION DETAIL (4 / C-4)
NTS

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CIVIL DETAILS - I

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL: OPEN CHARTER MAGNET SCHOOL, 5540 W. 77TH STREET, LOS ANGELES, CA 90045

MWH MONTGOMERY WATSON HARZA — Pasadena California

REVISIONS

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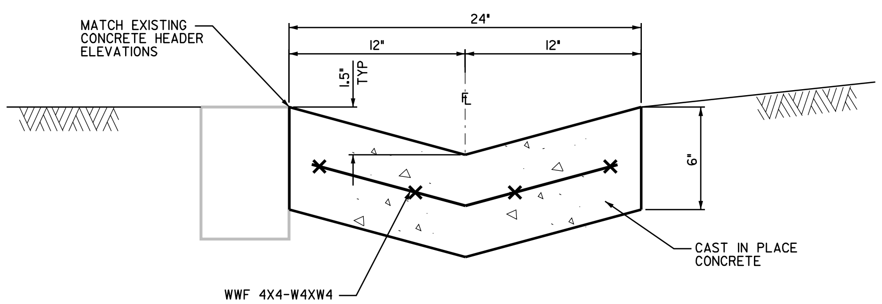
JOB NUMBER	
DRAWN BY: S. STONE	DRAWING NO. GC-2
CHECKED BY: J. GANTNEY	
DATE: 17-OCT-2002	INDEX NO.

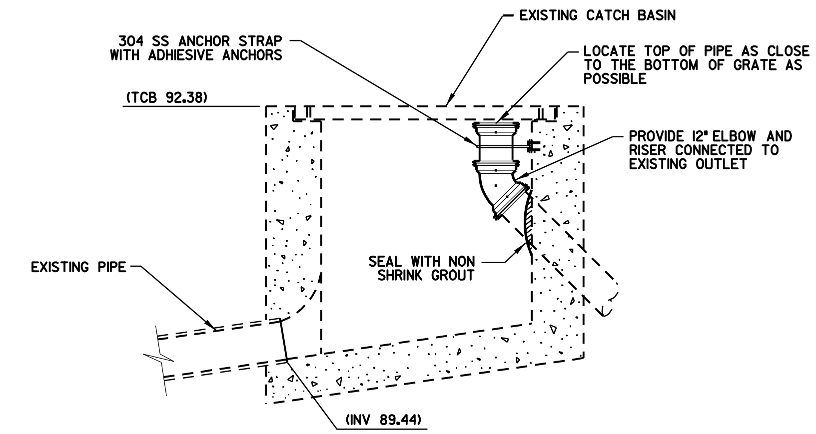
Job No: 102650 File: P:\Projects\la_unified\open charter\civ\ocgc02.dwg



TYPICAL DRAINAGE SWALE SECTION

NTS

5 / C-2



CATCH BASIN MODIFICATION DETAIL

NTS

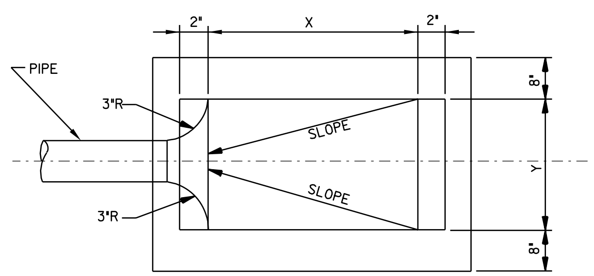
7 / C-2

TRAFFIC LOADING	STEEL BARS	MAXIMUM CLEAR SPAN, X	CLEAR BAR SPACING
NON-VEHICULAR	3/8" X 1-1/2"	24"	1/2"
VEHICULAR	1/2" x 2-1/4"	24"	1/2"
	1/2" x 3-1/2"	35-3/8"	1/2"

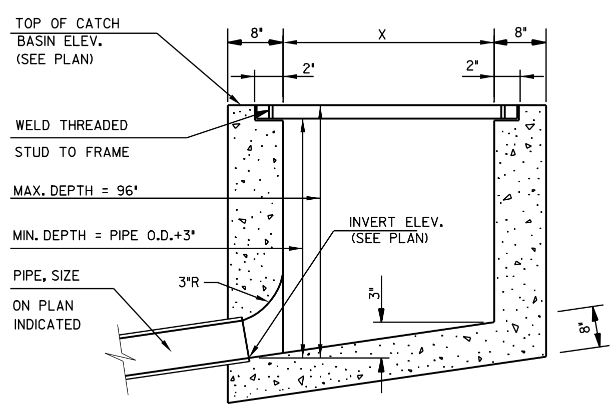
SCHEDULE	
CATCH BASIN	GRATE & FRAME MODEL NO.
CB-A	
CB-B	
CB-C	

NOTES:

1. USE 3/4" DIA. PIPE BAR SPACERS ASSEMBLED ON (2) 1/2" DIA RODS WITH THREADS AND NUTS AT BOTH ENDS.
2. ALL STEEL PARTS SHALL BE HOT-DIP GALVANIZED AFTER FABRICATION AND WELDING, AND BEFORE ASSEMBLY.
3. FRAME AND GRATE SHALL BE SIMILAR TO ALHAMBRA FOUNDRY CO., LTD. SERIES OR BROOKS PRODUCTS, INC. OR APPROVED EQUAL.
4. GRATES SHALL BE OF VANDAL-RESISTANT CONSTRUCTION.
5. FORM "X" AND "Y" TO FIT FRAME.



PLAN

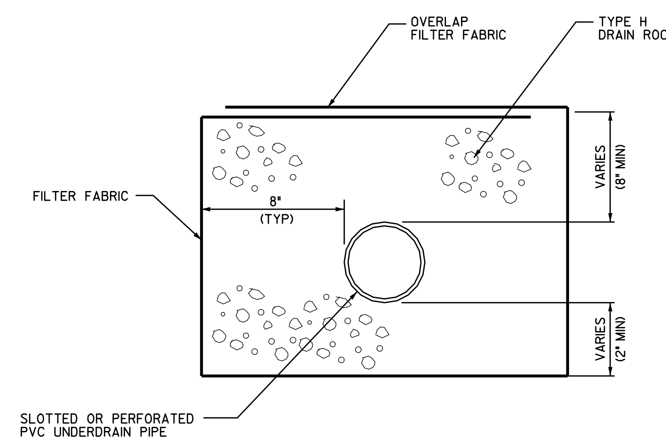


SECTION

CATCH BASIN DETAIL

NTS

6 / C-2



1. UNDERDRAIN PVC PIPE MATERIAL AND INSTALLATION SHALL BE ACCORDANCE WITH CALTRANS STANDARD SPECIFICATION 68-2 "HORIZONTAL DRAINS".
2. FITTINGS FOR PVC PLASTIC PIPE SHALL BE SCHEDULE 80 TYPE II SOLVENT WELD TYPE CONFORTING TO THE REQUIREMENTS IN ASTM D2467.

UNDERDRAIN DETAIL

NTS

8 / GC-2 C-4, C-5, M-1

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D.S.A. STAMP

CIVIL DETAILS - 2

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL: OPEN CHARTER MAGNET SCHOOL 5540 W. 77TH STREET LOS ANGELES, CA 90045

Pasadena California

MWH MONTGOMERY WATSON HARZA

REVISIONS

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JOB NUMBER

DRAWN BY: P BOGDANOFF

CHECKED BY: J. GANTNEY

DATE: 17-OCT-2002

DRAWING NO. GC-3

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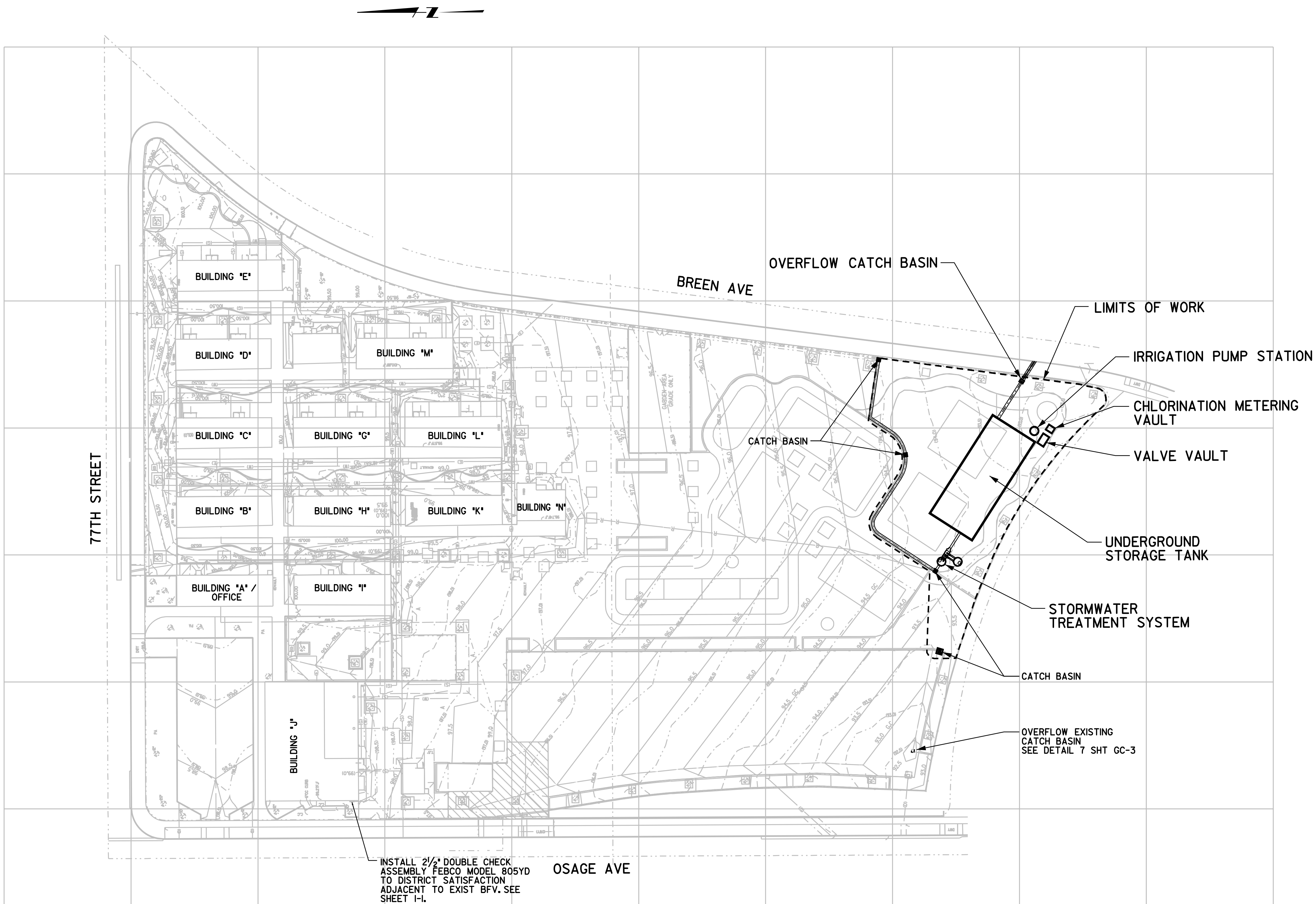
Job No: 1026510



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FACILITIES SERVICES DIVISION
355 NORTH GRAND AVENUE
LOS ANGELES CALIFORNIA

D.S.A. STAMP

KEY MAP

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL: OPEN CHARTER MAGNET SCHOOL
5540 W. 77TH STREET
LOS ANGELES, CA 90045

Pasadena California

MWH
MONTGOMERY WATSON HARZA

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DATE: 17-OCT-2002
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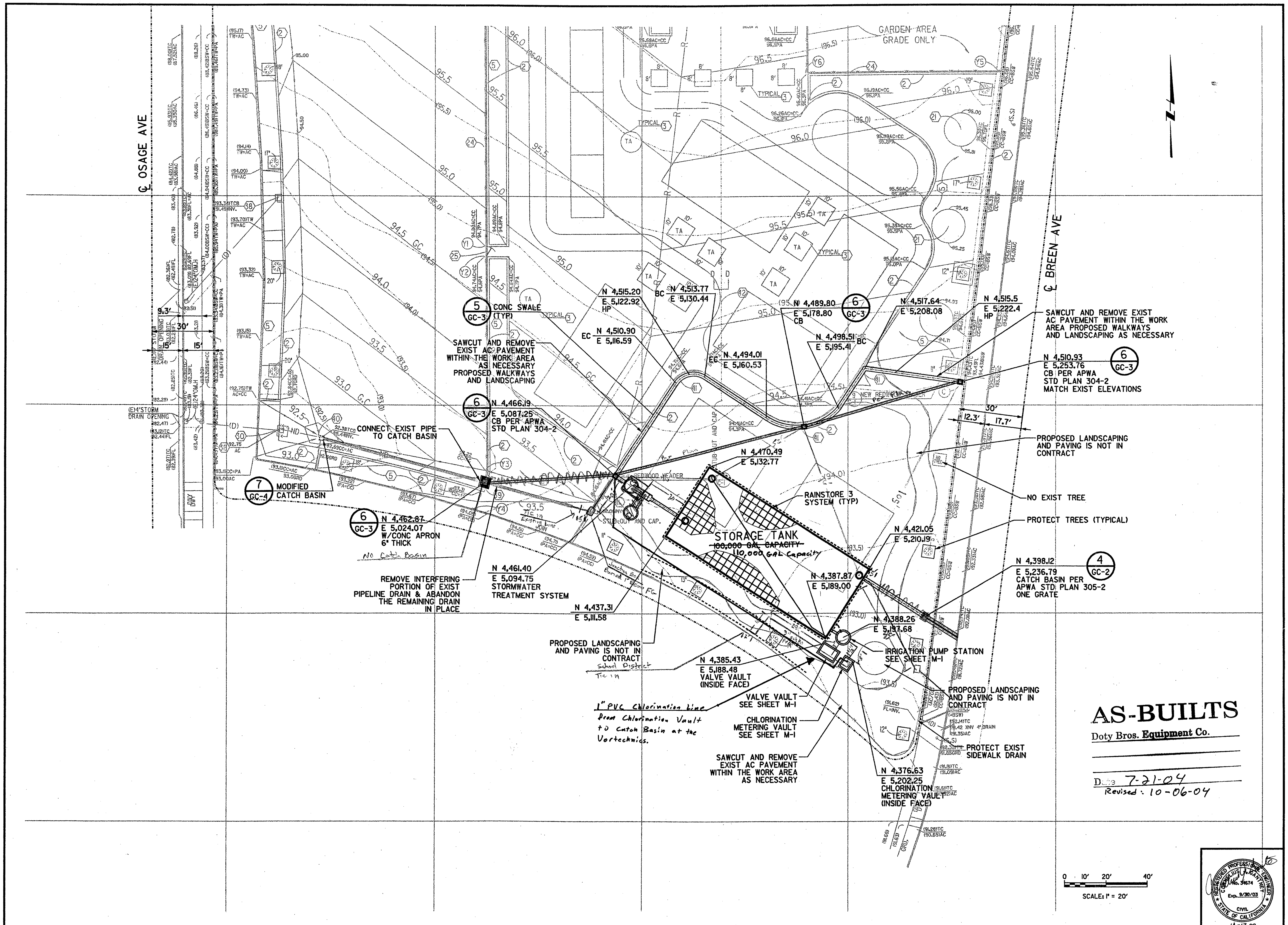
Job No: 1026510 File: P:\Projects\la_unified\open charter\civ\occ01.dw



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333 NORTH GRAND AVENUE LOS ANGELES CALIFORNIA

D.S.A. STAMP

SITE PLAN

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL: OPEN CHARTER MAGNET SCHOOL, 5540 W. 77TH STREET, LOS ANGELES, CA 90045

MWH MONTGOMERY WATSON HARZA, Pasadena California

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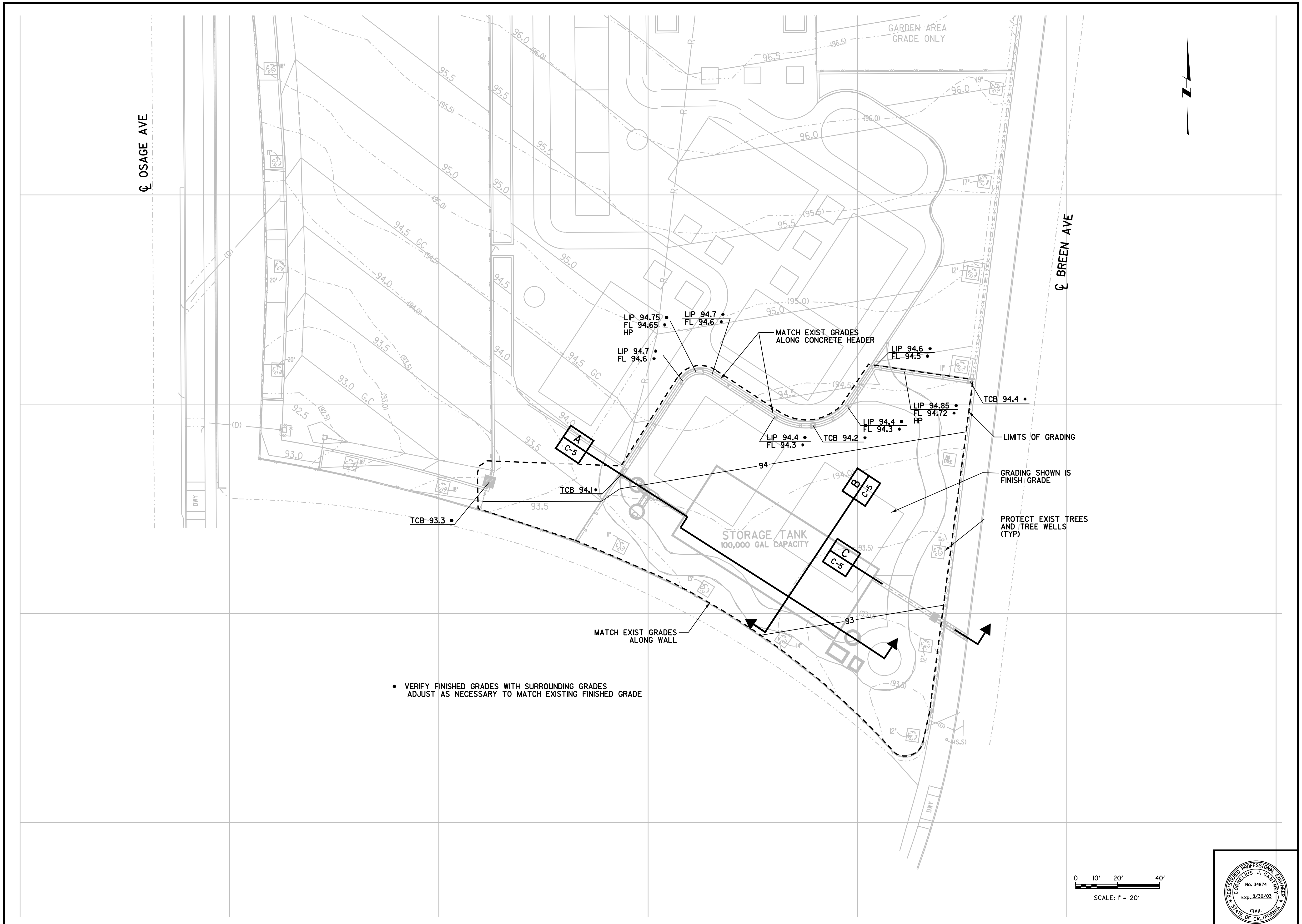

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FACILITIES SERVICES DIVISION

355 NORTH GRAND AVENUE LOS ANGELES CALIFORNIA

D.S.A. STAMP

GRADING PLAN

PROJECT
STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL
OPEN CHARTER MAGNET SCHOOL
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LOS ANGELES, CA 90045

Pasadena California

MWH
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DATE 17-OCT-2002	INDEX NO.

Job No: 1026510

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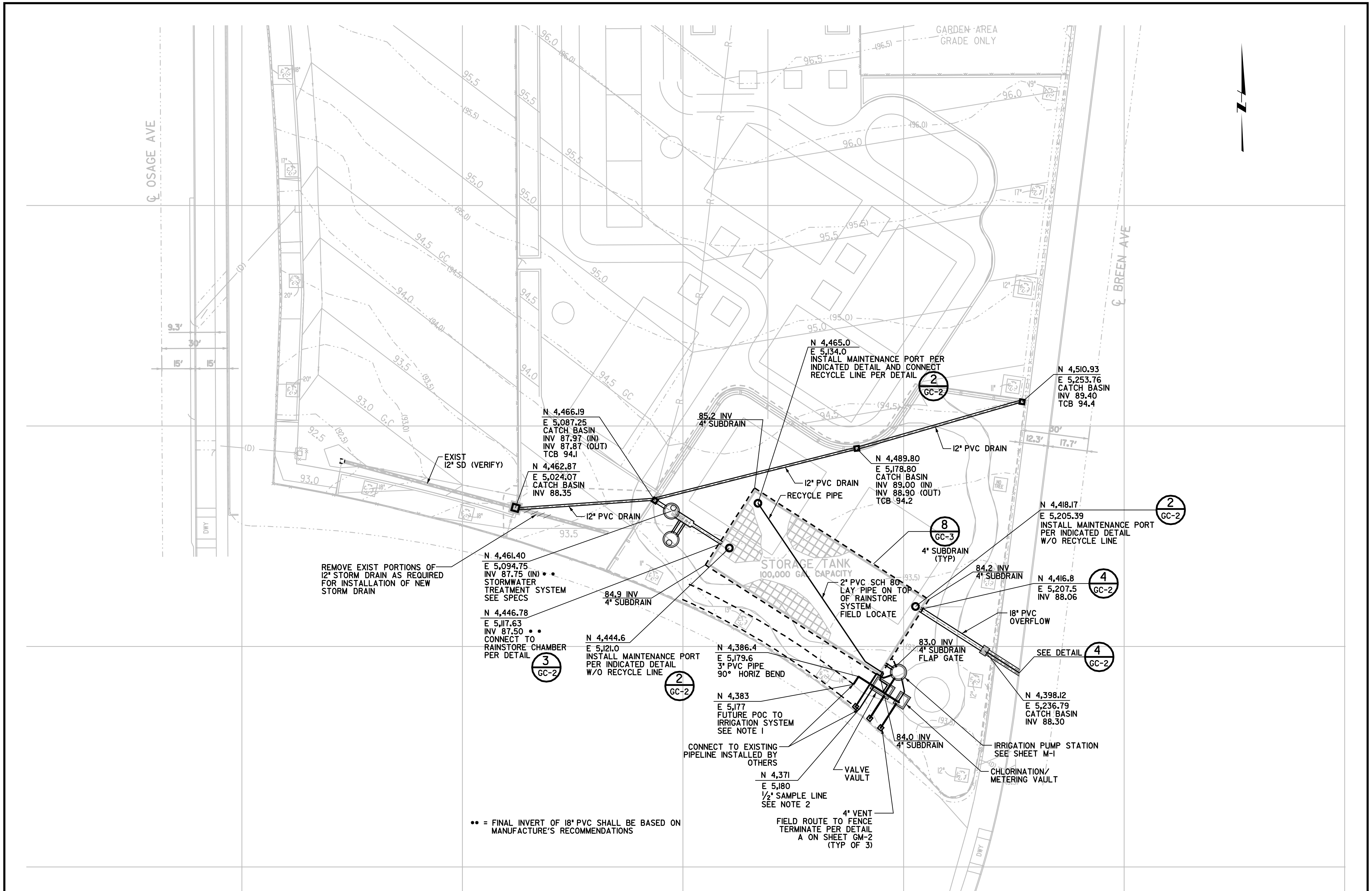

NOTEES:

1. CONNECT IRRIGATION PIPING TO NEW IRRIGATION PIPELINE PROVIDED BY OTHERS.
2. CONNECT SAMPLE LINE TO NEW SAMPLE LINE PROVIDED BY OTHERS.

0 10' 20' 40'
SCALE: 1" = 20'

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YARD PIPING PLAN

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL: OPEN CHARTER MAGNET SCHOOL
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LOS ANGELES, CA 90045

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Pasadena California

REVISIONS
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JOB NUMBER	
DRAWN BY: P. BOGDANOFF	DRAWING NO. C-4
CHECKED BY: J. GANTNEY	
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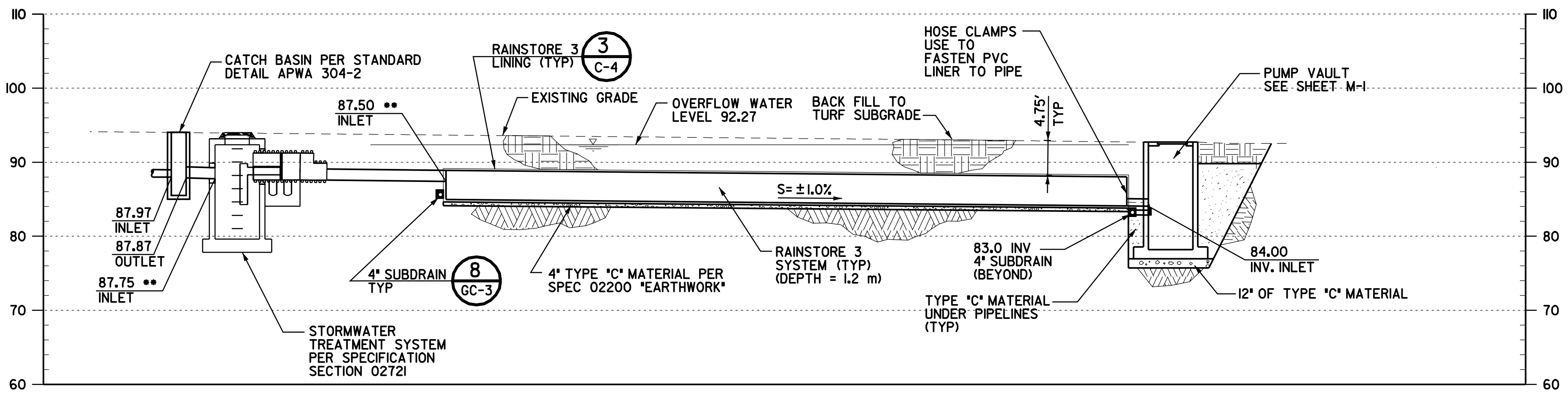
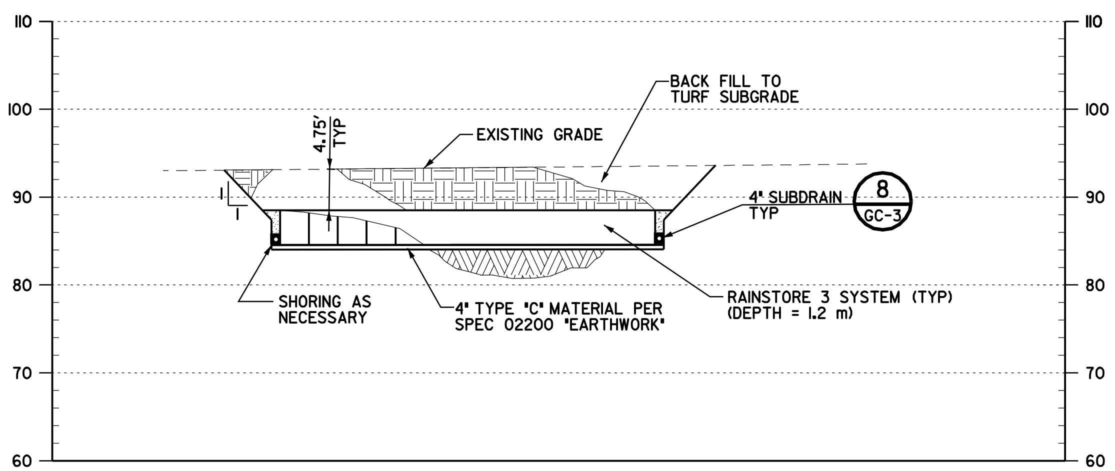
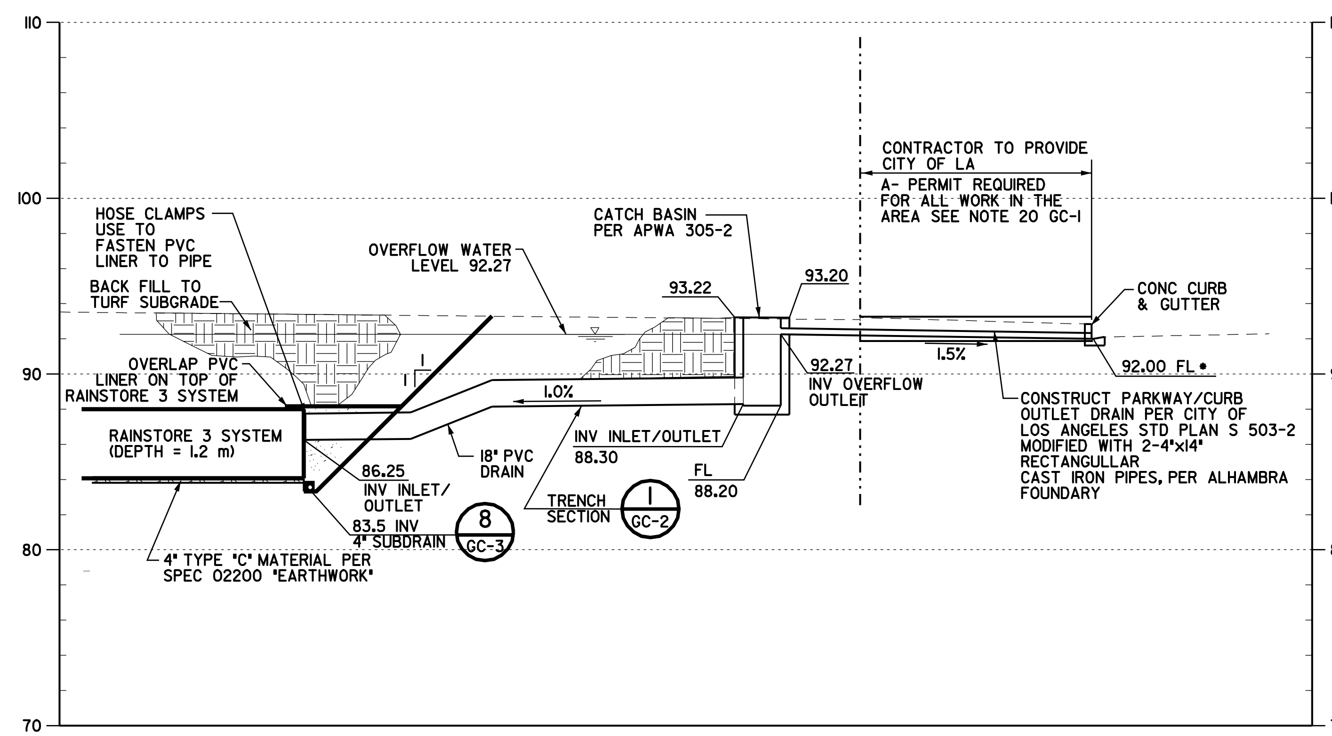


SECTION A / C-3
SCALE: 1"=10'



SECTION B / C-3
SCALE: 1"=10'



SECTION C / C-3
SCALE: H= 1"=10'
V= 1"=5'

TYPE G MATERIAL PER SPEC 02200 "EARTHWORK"

TYPE "C" BACKFILL OR TYPE "I" MATERIAL

NATIVE SOIL

OVEREXCAVATED/COMPACTED SOIL WITH SELECT TYPE "I" MATERIAL PER SPEC 02200 "EARTHWORK"

* CONTRACTOR TO VERIFY

** FINAL INVERT SHALL BE BASED ON MANUFACTURER'S RECOMMENDATIONS.

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D.S.A. STAMP

GRADING SECTIONS

PROJECT
STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL
OPEN CHARTER MAGNET SCHOOL
5540 W. 77TH STREET
LOS ANGELES, CA 90045

Pasadena California

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REVISIONS

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JOB NUMBER

DRAWN BY P. BOGDANOFF

CHECKED BY J. GANTNEY

DATE 17-OCT-2002

DRAWING NO. C-5

INDEX NO.

REGISTERED PROFESSIONAL ENGINEER CORNELIUS J. GANTNEY No. 34674 Exp. 9/30/03 CIVIL STATE OF CALIFORNIA

FLUID ABBREVIATION	FUNCTION THIS LIST INCLUDES SOME LINES NOT USED IN THIS PROJECT	PIPING MATERIALS (SEE SCH AT RIGHT) EXPOSED PIPING (SEE NOTE 14) 2" DIA AND SMALLER	EXPOSED PIPING 2½" DIA AND LARGER	BURIED PIPING (SEE NOTE 13) 2" DIA AND SMALLER	BURIED PIPING 2½" DIA AND LARGER	FIELD TEST REQUIREMENTS (SEE NOTE 3 AND NOTE 4) MINIMUM TEST PRESSURE PSI	TEST MEDIUM	LEAKAGE ALLOWANCE (SEE NOTE 2)
D	DRAIN	16	16	16	16	50	WATER	(A)
SPD	SUMP PUMP DISCHARGE	16	16	16	16	125	WATER	(A)
V	VENT	16	16	16	16	NOTE 8	--	--

PIPING MATERIAL SCH (SEE NOTE 4)

GROUP NO	PIPE (SEE NOTE 13)	FITTINGS	VALVES, 6" AND SMALLER (SEE NOTE 1, 11 & 16)
1	STEEL, ASTM A53, SCH 40, BLACK WELDED.	2½" AND SMALLER, MALLEABLE IRON, ANSI B16.3, THREADED, BANDED, BLACK, 150 PSI OR STEEL, ANSI B16.9, BUTT-WELDED. 3" AND LARGER, CAST IRON, ANSI B16.1, 125 PSI FLGD OR MECH CPLG.	BRONZE, THREADED, GATE, CRANE NO. 428 UB OR STOCKHAM B-105.GLOBE, CRANE NO. 14-1/2P OR STOCKHAM B-29, CHECK, CRANE NO.37 OR STOCKHAM B-319. STEEL, LUBRICATED PLUG, ROCKWELL FIG. 142 OR 143 OR POWELL FIG 2200 OR 2201, ECCENTRIC PLUG, DEZURIK SERIES 118 KEYSTONE 1512. BALL, JENKINS NO.900T OR JAMESBURY FIG.351
2	STEEL, ASTM A53, SCH 40, BLACK WELDED, GALVANIZED	2½" AND SMALLER, MALLEABLE IRON, ANSI B16.3, THREADED, BANDED, GALVANIZED 150 PSI. 3" AND LARGER, CAST IRON, ANSI B16.1, 125 PSI FLGD OR MECH CPLG.	2½" AND SMALLER, ECCENTRIC PLUG, SYNTHETIC RUBBER FACED, DEZURIK 118S OR HOMESTEAD 1512. BALL, JENKINS NO. 900T OR JAMESBURY FIG. 351 3" AND LARGER, ECCENTRIC PLUG, SYNTHETIC RUBBER FACED, DEZURIK 118F OR KEYSTONE 1522 OR 1532 EWG. GATE, AWWA 500. BUTTERFLY, AWWA, FLGD.
3	STEEL, ASTM A106 OR A53, SCH 80, SEAMLESS, BLACK.	FORGED STEEL, ANSI B16.11, SOCKET WELDED OR THREADED, BLACK, 2000 PSI, OR STEEL, ANSI B16.9, BUTT-WELDED, SCH 80.	CAST IRON, LUBRICATED PLUG, ROCKWELL FIG. 214 OR 305 OR POWELL FIG. 2210 OR 2211.
4	SAME AS GROUP NO. I	CAST IRON, ANSI B16.12, THREADED, DRAINAGE PATTERN.	--------
5	WELDED STEEL, AWWA C200, UNLINED.	WELDED STEEL, FABRICATED, AWWA C200, UNLINED.	AS INDICATED ON DRAWINGS
6	STEEL, ASTM A106, OR A53, SCH 40, SEAMLESS, BLACK.	STEEL, ANSI B16.9, BUTT-WELDED. CAST IRON, ANSI B16.1, 125 PSI, FLGD. FORGED STEEL, SOCKET WELDED, ANSI B16.11, 2000 PSI OR STEEL, ANSI B16.5, 150 PSI FLGD.	CAST IRON, FLGD, LUBRICATED PLUG, ROCKWELL FIG 143 OR POWELL FIG 2201.
7	SAME AS GROUP NO. 2.	MALLEABLE IRON, ANSI B16.3, THREADED, BANDED, GALVANIZED, 300 PSI.	BRONZE THREADED, GLOBE, CRANE NO. 212P OR 229C OR STOCKHAM B-62 OR B-32. BALL, JENKINS NO. 900T OR JAMESBURY FIG. 351CHECK, CRANE NO. 27 OR STOCKHAM B-322.
8	WELDED STEEL, AWWA C200.	WELDED STEEL, AWWA C200, FABRICATED.	AS INDICATED ON DRAWINGS.
9	SAME AS GROUP NO. 1.	2½" AND SMALLER, MALLEABLE IRON, ANSI B16.3, THREADED, BANDED, BLACK, 150 PSI. 3" AND LARGER, STEEL, ANSI B16.9, BUTT-WELDED	ECCENTRIC PLUG, DEZURIK SERIES 118 OR KEYSTONE 1512, CHECK, CRANE NO. 336E OR WALWORTH NO. 904 OR POWELL FIG 668Y. BALL, JENKINS NO. 900T OR JAMESBURY FIG. 351.
10	SAME AS GROUP NO. 3.	1-1/4" AND SMALLER, FORGED STEEL, ANSI B16.11, THREADED OR SOCKET WELDED, BLACK, 3000 PSI, WITH FLGD AMMONIA UNIONS. 1-1/2" AND LARGER, STEEL, ANSI B16.9, BUTT-WELDED OR FLGD, SCH 80	SEMI-PLUG AND YOKE TYPE OR BALL FOR CHLORINE SERVICE, FORGED CARBON STEEL
11	DUCTILE IRON, ANSI A21.51, (AWWA C151) OR CAST IRON ANSI A21.6, 150 PSI, BELL AND SPIGOT, MECH JTS, MECH CPLG, OR 125 PSI FLGD (TYPICAL SERVICE - WATER LINES)	DUCTILE IRON OR CAST IRON, ANSI A21.10, OR AWWA C110, BELL AND SPIGOT, MECH CPLG, FLGD OR MECH JTS, 250 PSI, (PRESSURE RATING) 12" AND SMALLER, 150 PSI, (PRESSURE RATING) 14" AND LARGER, WITH 125 PSI ANSI B16.1 FLANGES.	GATE, AWWA C500, 'O' RING SEALS, MECH JTS ENDS, MUELLER A-2380-20, OR EDDY-IOWA (CLOW) F-5155. BUTTERFLY, AWWA. ECCENTRIC PLUG, DEZURIK SERIES 118 OR KEYSTONE 1512, OR BALL, PRATT OR W-K-M.
12	CAST IRON SOIL, ANSI/ASTM A-74, SERVICE WEIGHT, BELL AND SPIGOT OR HUBLESS. AT THE OPTION OF THE CONTRACTOR, DUCTILE IRON (GROUP NO. 11) MAY BE SUBSTITUTED	CAST IRON SOIL, ANSI/ASTM A-74, SERVICE WEIGHT, BELL AND SPIGOT OR HUBLESS. AT THE OPTION OF THE CONTRACTOR, DUCTILE IRON (GROUP NO 11) MAY BE SUBSTITUTED.	AS INDICATED ON DRAWINGS.
13	CORROSION RESISTANT (HIGH SILICON CONTENT) CAST IRON, SERVICE WEIGHT, BELL AND SPIGOT OR HUBLESS.	CORROSION RESISTANT (HIGH SILICON CONTENT) CAST IRON, SERVICE WEIGHT, BELL AND SPIGOT OR HUBLESS.	--------
14	STAINLESS STEEL, TYPE 316, ASTM A312, SCH 40S.	STAINLESS STEEL, TYPE 316 ANSI B16.3, SCREWED, 150 PSI, ANSI B16.9, BUTT-WELDED, SCH 40S, OR 150 PSI FLGD.	STAINLESS STEEL, BALL, FLGD, LADISH NO. 4202, OR JAMESBURY TYPE A/D150F. CHECK, LADISH, NO.5272 OR STOCKHAM FIG. 15 SF 316 OR AS SHOWN ON DRAWINGS.
15	STAINLESS STEEL, TYPE 316, ASTM A312, SCH 10S.	STAINLESS STEEL, TYPE 316 ANSI B16.9 BUTT-WELDED SCH 150 PSI FLGD.	STAINLESS STEEL, AS INDICATED ON DRAWINGS.
16	POLYVINYL CHLORIDE, SCH 80, NORMAL IMPACT. ASTM D1785	POLYVINYL CHLORIDE, SCH 80, NORMAL IMPACT, SOCKET SOLVENT WELD JTS, ASTM D2467.	POLYVINYL CHLORIDE, BALL, DIAPHRAGM, BUTTERFLY, BALL OR LIFT CHECK. CHEMTROL, HILLS-MCCANNA OR GSR-R.G. SLOAN CO.
17	POLYPROPYLENE, ASTM D2146, SCH 40, WITH HEAT FUSED JTS.	POLYPROPYLENE, SCH 40, DRAINAGE TYPE WITH HEAT FUSED SOCKET JTS.	--------
18	FIBERGLASS REINFORCED PLASTIC, ASTM D2996, FILAMENT-WOUND, SOCKET AND SPIGOT ENDS, ADHESIVE BONDED.	FIBERGLASS REINFORCED PLASTIC, FILAMENT-WOUND, SOCKET ENDS, ADHESIVE BONDED, OR FIBERGLASS FLGD.	PLASTIC LINED, FLGD. FLANGES TO MATCH 150 PSI ANSI B16.5 DIMENSIONS, OR AS INDICATED ON DRAWINGS.
19	POLYVINYL CHLORIDE PRESSURE PIPE ASTM D2241 WITH BELL AND SPIGOT JTS.	CAST IRON, 150 PSI, FOR POLYVINYL CHLORIDE PIPE, AWWA C110 CEMENT MORTAR LINED, AWWA C104.	SAME AS GROUP NO. 11.
20	VITRIFIED CLAY, PERFORATED, ASTM C 700, EXTRA STRENGTH, FLEXIBLE COMPRESSION JTS FOR BELL AND SPIGOT PIPE OR PLAIN END WITH MECH COMPRESSION JTS	VITRIFIED CLAY, ASTM C700, FLEXIBLE JTS FOR BELL AND SPIGOT PIPE OR PLAIN END WITH MECH COMPRESSION JTS.	--------
21	VITRIFIED CLAY, ASTM C700, EXTRA STRENGTH, FLEXIBLE COMPRESSION JTS FOR BELL AND SPIGOT PIPE OR PLAIN END WITH MECH COMPRESSION JTS	VITRIFIED CLAY, ASTM C700, FLEXIBLE JTS FOR BELL AND SPIGOT PIPE OR PLAIN END WITH MECH COMPRESSION JTS.	--------
22	REINFORCED CONCRETE, ASTM C76, T&G JTS. (TYPICAL SERVICE-CULVERTS)	SAME AS GROUP NO. 8	--------
23	TEMPERED GLASS. (ARMORED, WHERE BURIED). ANSI/ASTM C599	TEMPERED GLASS DRAINAGE TYPE WITH COMPRESSION CPLG AND TEFLON JTS. ANSI/ASTM C599 (ARMORED WHERE BURIED)	--------
24	COPPER, ASTM B88, TYPE K, SOFT TEMPERED WHERE BURIED, HARD TEMPERED WHERE EXPOSED.	WROUGHT COPPER OR CAST BRONZE, ANSI B16.22, SOLDER JOINT, 150 PSI, OR COMPRESSION FITTINGS. (FOR OXYGEN PIPING USE SILVER SOLDER, FOR COMPRESSED AIR PIPING USE 95-5 TIN-ANTIMONY SOLDER)	BRONZE, SOLDER JOINT, GLOBE, CRANE NO. 1310 OR STOCKHAM B-14. CHECK, CRANE NO. 1342 OR 36, OR STOCKHAM B-309 OR B-345. GATE, CRANE NO. 1320 OR 426, OR STOCKHAM B-104 OR B-105.
25	STEEL, ASTM A106 OR A53, SCH 40, SEAMLESS, BLACK, SARAN OR POLYPROPYLENE-LINED	STEEL, ANSI B16.5, 150 PSI FLGD, SARAN OR POLYPROPYLENE-LINED.	CAST STEEL PLUG, DIAPHRAGM OR CHECK, 150 PSI FLGD, SARAN OR POLYPROPYLENE-LINED.
26	SAME AS GROUP NO. 11 (TYPICAL SERVICE - SLUDGE AND SEWAGE LINES)	SAME AS GROUP NO. 11.	ECCENTRIC PLUG, SYNTHETIC RUBBER FACED, DEZURIK 118F OR KEYSTONE 1522. SWING TYPE CHECK, CRANE NO. 383 OR POWELL FIG. 559. BALL, PRATT OR W-K-M.
27	POLYVINYL CHLORIDE GRAVITY SEWER PIPE, ASTM D3034, BELL AND SPIGOT.	POLYVINYL CHLORIDE, ANSI/ASTM D3034, BELL AND/OR SPIGOT.	--------
28	REINFORCED CONCRETE, AWWA C302, CLASS-SEE DRAWINGS. (TYPICAL SERVICE - PRESSURE PIPELINES)	SAME AS GROUP NO. 8.	AS INDICATED ON DRAWINGS.
29	SAME AS GROUP NO. 1.	2" AND SMALLER, MALLEABLE IRON, ANSI B16.3, THREADED, BANDED, BLACK, 150 PSI. 2-½" AND LARGER, STEEL ANSI B16.9, BUTT-WELDED.	SAME AS GROUP NO 1, EXCEPT LUBRICATED PLUG SHALL BE ROCKWELL FIG. 114 OR 115, OR POWELL FIG 2202 OR 2203.
30	SAME AS GROUP NO. 11, GLASS-LINED OR STEEL ASTM A53, SCH 40, GLASS LINED	SAME AS GROUP NO. 11, GLASS-LINED OR STEEL, ANSI B16.9, SCH 40, GROOVED WITH MECH CPLG, GLASS-LINED.	SAME AS GROUP NO 26.
31	2-1/2 " AND SMALLER, STEEL, ASTM A106 OR A53, SCH 80, SEAMLESS, BLACK. 3" AND LARGER DUCTILE IRON, ANSI A21.51 (AWWA C151) OR CAST IRON ANSI A21.6 OR A21.8 MECH CPLG OR 125 PSI FLGD.	2-½" AND SMALLER, FORGED STEEL, ANSI B16.11, SOCKET WELDED OR THREADED, BLACK, 2000 PSI, OR STEEL, ANSI B16.9, BUTT-WELDED SCH 80. 3" AND LARGER, DUCTILE IRON OR CAST IRON, ANSI A21.10 OR AWWA C110, MECH COUPLING OR 125 PSI FLGD.	CAST IRON, LUBRICATED PLUG, ROCKWELL FIG 142 OR 143, OR POWEL FIG 2200 OR 2201.

LIST OF SAMPLE LINES

PIPE DESIGNATION	SAMPLE POINT

TYPICAL PIPE DESIGNATION:

2" UW (24)

PIPE DIAMETER — FLUID ABBREVIATION — MATERIAL GROUP NUMBER (SEE NOTE 12)

NOTES:

GENERAL NOTE
ALTHOUGH SEVERAL PIPING MATERIALS ARE SHOWN THAT MAY BE USED FOR A GIVEN FUNCTION, ONLY THE CALLED PIPING MATERIAL SHOWN ON THE CONSTRUCTION DRAWINGS AND SPECIFICATIONS SHALL BE USED. THE CONTRACTOR DOES NOT HAVE THE OPTION TO USE A DIFFERENT MATERIAL.

NOTE 1
PROPRIETARY NAMES HAVE BEEN QUOTED FOR IDENTIFICATION PURPOSES ONLY. SUBSTITUTIONS WILL BE PERMITTED SUBJECT TO PROVISIONS OF THE SPECIFICATIONS.

NOTE 2
LEAKAGE ALLOWANCE IS AS FOLLOWS:

(A) PIPES SO DESIGNATED SHALL SHOW ZERO LEAKAGE.
(B) PIPES SO DESIGNATED SHALL SHOW ZERO LEAKAGE FOR UNBURIED PIPE AND NOT MORE THAN 0.02 GALLON PER HOUR PER INCH DIAMETER PER 100 FEET OF BURIED PIPE.
(C) PIPES SO DESIGNATED SHALL NOT SHOW A LEAKAGE OF MORE THAN 0.15 GALLON PER HOUR PER INCH OF DIAMETER PER 100 FEET OF PIPE
(D) PIPES SO DESIGNATED SHALL NOT SHOW A LOSS OF PRESSURE OF MORE THAN 5 PERCENT
(E) PIPE SO DESIGNATED SHALL NOT SHOW A LOSS OF VACUUM OF MORE THAN 4 INCHES MERCURY COLUMN

NOTE 3
FOR FIELD TEST PROCEDURES AND ADDITIONAL TEST REQUIREMENTS, SEE PIPING SECTION OF SPECIFICATIONS.

NOTE 4
ANY DEVIATION FROM THE PIPING MATERIALS OR FIELD TEST REQUIREMENTS SHOWN WILL BE NOTED IN THE SPECIFICATION OR ON THE DRAWINGS.

NOTE 5
PIPING GROUP NUMBER SHOWN THUS * SHALL BE INSULATED. SEE PIPING SECTION OF SPECIFICATIONS FOR INSULATING MATERIALS.

NOTE 6
STATIC WATER TEST WITH SURFACE 5 FEET ABOVE HIGH POINT OF PIPE.

NOTE 7
INSPECTION AND TESTING SHALL BE IN ACCORDANCE WITH APPLICABLE PLUMBING CODE.

NOTE 8
NO APPARENT LEAKS UNDER NORMAL OPERATING CONDITIONS.

NOTE 9
INSPECTION AND TESTING SHALL BE IN ACCORDANCE WITH APPLICABLE NATIONAL FIRE PROTECTION ASSOCIATION STANDARDS.

NOTE 10
PIPING MATERIALS SHALL BE IN ACCORDANCE WITH NATIONAL FIRE PROTECTION ASSOCIATION STANDARDS.

NOTE 11
FOR VALVES 8" AND LARGER SEE VALVE SCH FOR SPECIAL VALVES SEE SPECIFICATIONS.

NOTE 12
CHANGE IN PIPING MATERIAL GROUP NUMBER IS INDICATED THUS:

NOTE 13
FOR PIPE LINING AND COATING, SEE SPECIFICATIONS.

NOTE 14
EXPOSED PIPING SHALL BE PAINTED IN ACCORDANCE WITH SPECIFICATIONS. COLORS TO BE SELECTED BY ENGINEER.

NOTE 15
PIPING MATERIAL SHALL BE NON-ABRASIVE FLEXIBLE RUBBER HOSE AND QUICK CONNECTION CPLG WITH GROUP NO 1 AT EQUIPMENT.

NOTE 16
VALVES 2½" AND SMALLER MAY HAVE SCREWED ENDS. VALVES 3" AND LARGER SHALL HAVE FLGD ENDS UNLESS OTHERWISE INDICATED.

REV 042898

REGISTERED PROFESSIONAL ENGINEER CHIN CHUAN TEY No. M029976 Exp. 6/30/04 MECHANICAL STATE OF CALIFORNIA

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FACILITIES SERVICES DIVISION
355 NORTH GRAND AVENUE LOS ANGELES CALIFORNIA

LOS ANGELES UNIFIED SCHOOL DISTRICT · BOARD OF EDUCATION

D.S.A. STAMP

MECHANICAL STANDARD DETAILS - I

PROJECT
STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL
OPEN CHARTER MAGNET SCHOOL
5540 W. 77TH STREET
LOS ANGELES, CA 90045

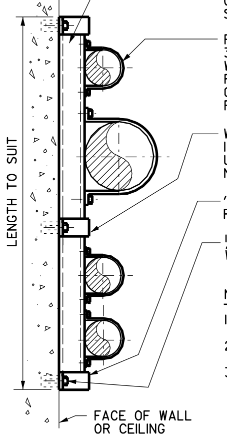
MWH MONTGOMERY WATSON HARZA
Pasadena California

REVISIONS

REISSUED SET

JOB NUMBER	
DRAWN BY T. WU	DRAWING NO. GM-1
CHECKED BY G. TEY	
DATE 17-OCT-2002	INDEX NO.

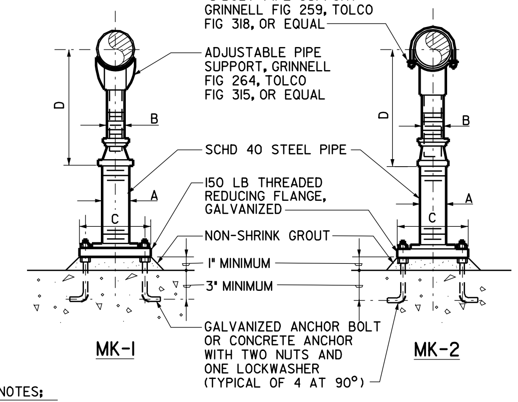
Job No: 102651O File: P:\Projects\la_unified\open charter\mec\ocgm01.dwg



NOTES:

1. FOR FLANGED PIPES, USE EXTENDED PIPE SUPPORT AS SHOWN ON DETAIL M-103.
2. THIS PIPE SUPPORT IS LIMITED FOR PIPES UP TO 6" DIAMETER, INCLUSIVE.
3. FOR ADDITIONAL REQUIREMENTS SEE SPECIFICATION SECTION 'PIPE SUPPORTS'.

FLUSH MOUNTED PIPE SUPPORT M-102
REV 010199



NOTES:

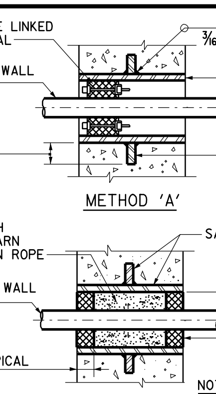
1. FOR ADDITIONAL REQUIREMENTS SEE SPECIFICATION SECTION 'PIPE SUPPORTS'.
2. GALVANIZE ALL PARTS AFTER FABRICATION.
3. WHERE PIPE SUPPORT OCCURS ON GRADE REFER TO STRUCTURAL DRAWINGS FOR DETAILS.

ADJUSTABLE PIPE SUPPORT
APPROXIMATE DIMENSIONS IN INCHES

PIPE SIZE	A	B	C	D MINIMUM	D MAXIMUM
3	2-1/2	1-1/2	9	8-1/4	11-3/4
3-1/2	2-1/2	1-1/2	9	8-1/2	12
4	3	* 2-1/2	9	10-1/4	14
6	3	* 2-1/2	9	11-5/8	15-1/4
8	3	* 2-1/2	9	13-5/8	16-1/2
10	3	* 2-1/2	9	14-5/8	18-1/4
12	3	* 2-1/2	9	15-5/8	19-3/4
14	4	3	11	18-7/8	20-3/4
16	4	3	11	19-7/8	22-1/4
18	6	3-1/2	13-1/2	21-1/4	24
20	6	3-1/2	13-1/2	23-1/4	25-1/2
24	6	4	13-1/2	26-1/2	28-1/4
30	6	4	13-1/2	29-5/8	31-1/2
32	6	4	13-1/2	30-5/8	32-3/4
36	6	4	13-1/2	32-5/8	34-3/4

* SEE MFR

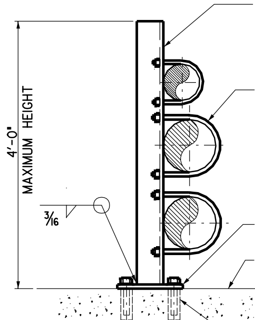
ADJUSTABLE PIPE SUPPORT WITH OR WITHOUT 'U' BOLT M-108
REV 041499



NOTES:

1. THESE SLEEVED PIPE OPENING DETAILS ARE TO BE USED IN DRY WALLS ONLY AND SHALL NOT BE USED FOR WALLS WITH WATER ON ONE OR BOTH SIDES.
2. SLEEVES ARE NOT REQUIRED IN CORE DRILLED WALLS OR FLOORS.

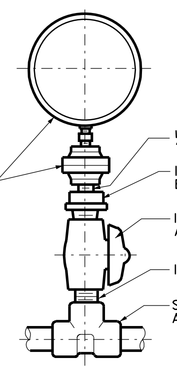
SLEEVED PIPE OPENING M-111
REV 010199



NOTES:

1. FOR ADDITIONAL REQUIREMENTS SEE SPECIFICATION SECTION 'PIPE SUPPORTS'.
2. THIS PIPE SUPPORT IS LIMITED TO PIPES 1/2" THRU 12" DIAMETER.

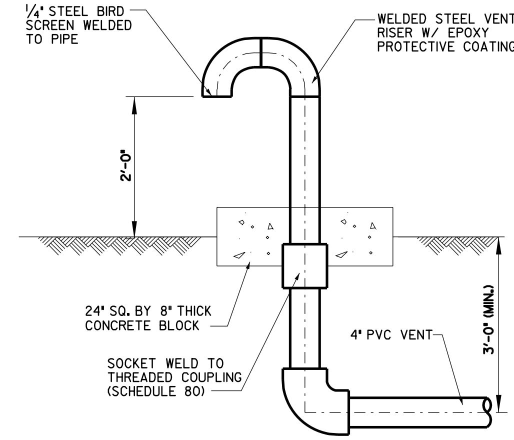
UPRIGHT PIPE SUPPORT M-150
REV 052099



NOTE:

DO NOT USE FOR CHLORINE OR SULFUR DIOXIDE LINES UNDER PRESSURE.

PRESSURE GAUGE OR PRESSURE SWITCH WITH PVC DIAPHRAGM SEAL M-612
REV 010199



VENT RISER DETAIL A
NOT TO SCALE

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LOS ANGELES UNIFIED SCHOOL DISTRICT · BOARD OF EDUCATION

D.S.A. STAMP

MECHANICAL STANDARD DETAILS - I

PROJECT
STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL
OPEN CHARTER MAGNET SCHOOL
5540 W. 77TH STREET
LOS ANGELES, CA 90045

MWH
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REVISIONS

1 REISSUED SET

REGISTERED PROFESSIONAL ENGINEER
CHIN CHUAN TEY
No. M029976
Exp. 6/30/04
MECHANICAL
STATE OF CALIFORNIA

JOB NUMBER	
DRAWN BY T. WU	DRAWING NO. GM-2
CHECKED BY G. TEY	
DATE 17-OCT-2002	INDEX NO.

Job No.: 102651O File: P:\Projects\la_unified\open charter\mec\ocgm02.dlv

MISCELLANEOUS EQUIPMENT SCHEDULE

TAG NUMBER	TYPE	SIZE	OPERATOR
V-1	BALL	1"	HANDWHEEL
V-2	GATE	3"	HANDWHEEL
V-3	PRESSURE REDUCING	3"	---
V-4	BACK PRESSURE	2"	---
V-5	GATE	3"	HANDWHEEL
V-6	BALL CHECK	3"	---
V-7	AIR RELEASE	1/2"	---
V-8	GATE	1"	HANDWHEEL
V-9	BALL	1"	HANDWHEEL
P-1	SUBMERSIBLE	100 GPM @ 210 TDH (13 BHP)	N/A
P-2	SUBMERSIBLE	100 GPM @ 210 TDH (13 BHP)	N/A
M-1	PADDLE WHEEL	3"	N/A
M-2	ROTAMETER	1"	N/A
ME-1	DUPLEX STRAINER	3"	N/A
ME-2	Y-STRAINER	1"	N/A
ME-3	TABLET CHLORINATOR	1"	N/A

Job No: 1026510
File: P:\Projects\la_unified\open charter\mec\ocgm03.dwg

REGISTERED PROFESSIONAL ENGINEER
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No. M029976
Exp. 6/30/04
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355 NORTH GRAND AVENUE
LOS ANGELES CALIFORNIA

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MISCELLANEOUS EQUIPMENT SCHEDULE

PROJECT
STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL
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5540 W. 77TH STREET
LOS ANGELES, CA 90045

MWH
MONTGOMERY WATSON HARZA
Pasadena California

REVISIONS

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JOB NUMBER

DRAWN BY	DRAWING NO.
T. WU	GM-3
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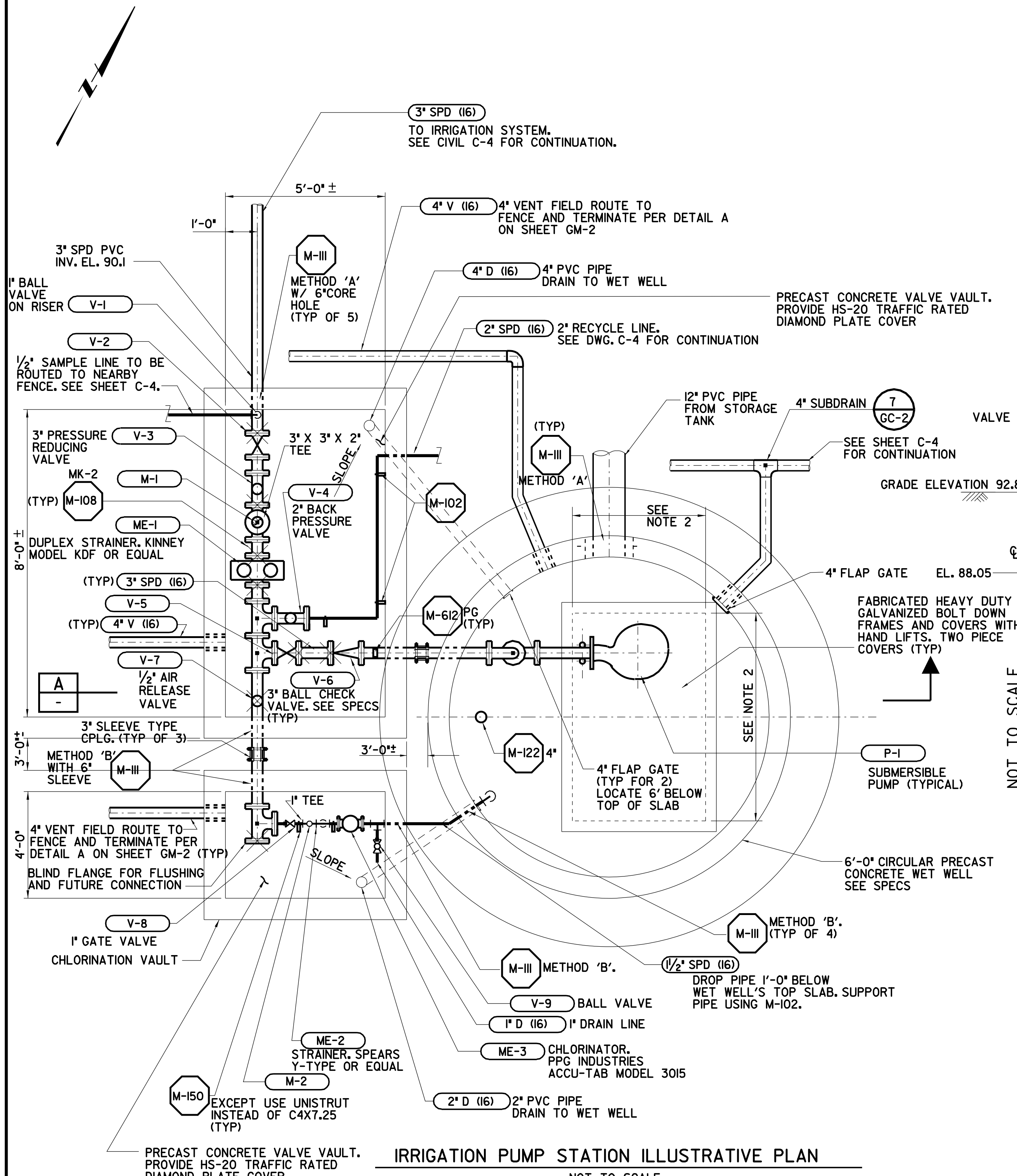
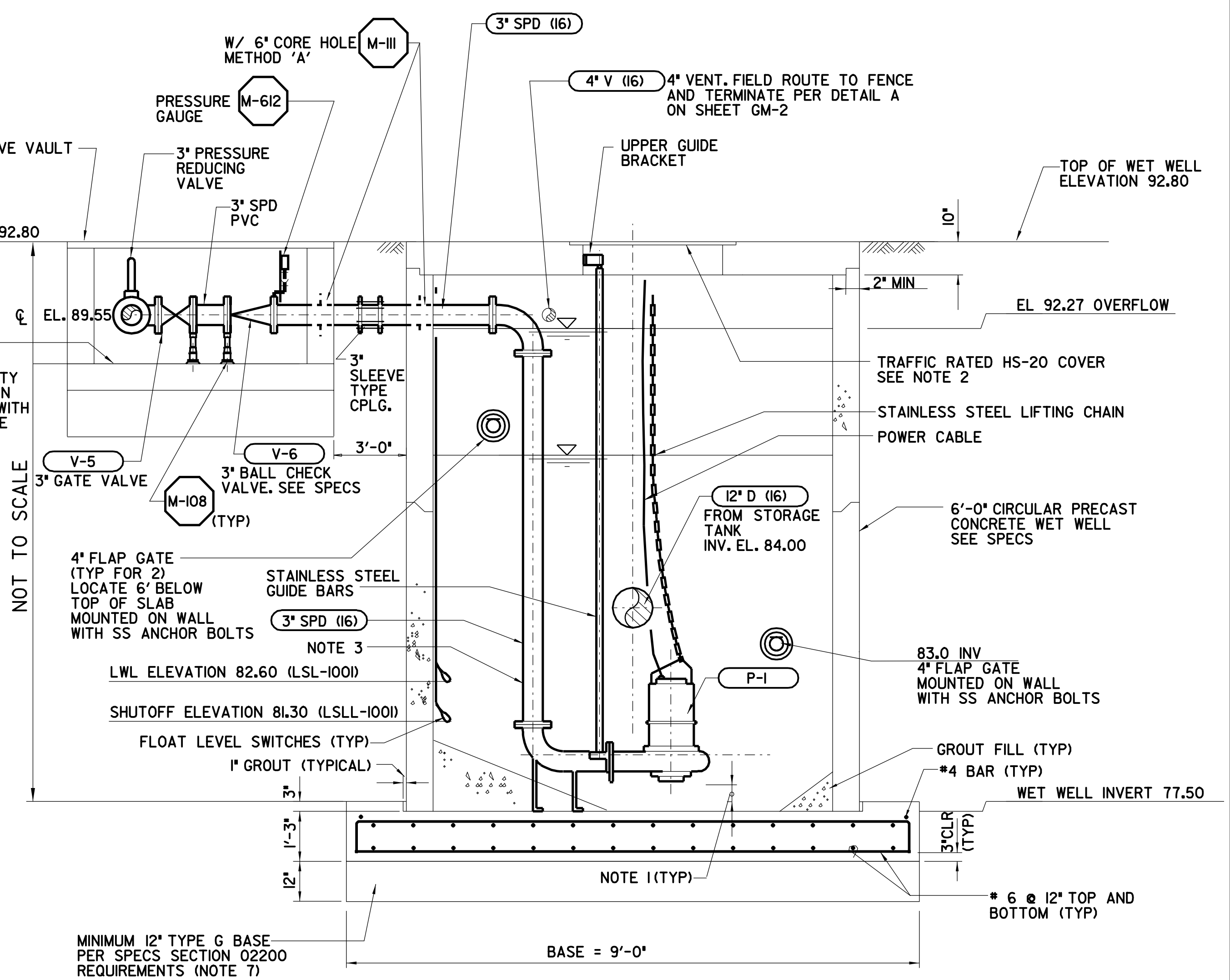
DATE 17-OCT-2002	INDEX NO.



IRRIGATION PUMP STATION ILLUSTRATIVE PLAN

NOT TO SCALE



SECTION A -
SCALE: NTS

NOTES:

1. CLEARANCE TO PUMP SUCTION IN ACCORDANCE WITH PUMP MFR'S SHOP DRAWING.
2. ACCESS COVER DIMENSIONS ARE APPROXIMATELY 36" X 48" OR DIMENSIONS PER PUMP MFR'S SHOP DRAWING.
3. PROVIDE 316 SS M-101 PIPE SUPPORTS EVERY 5 FT ON VERTICAL SEGMENT OF DISCHARGE
4. FOR LOCATION SEE SHEET C-2.
5. PROVIDE HINGED STEEL CHECKERED PLATE COVER FOR CHLORINATION VAULT WITH FLUSH PADLOCK HASP.
6. PROVIDE BOLT DOWN COVER PLATES ON VALVE VAULT, AND 3'-0" WIDE HINGED CHECKERED PLATE ACCESS PANEL OVER DUPLEX STRAINER WITH FLUSH PADLOCK HASP.
7. PROVIDE COMPACTED TYPE G BASE UNDER WET WELL AND VAULTS PER SPECS. SECTION 02200 REQUIREMENTS.

PUMP SCHEDULE

EQUIPMENT	SERVICE	TYPE	DESIGN CAPACITY GPM	DESIGN CAPACITY TDH (FT)	BHP	REMARKS
IRRIGATION PUMP NO. 1	STORMWATER	NONCLOG SUBMERSIBLE	100	210	13	

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IRRIGATION PUMP STATION

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

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5540 W. 77TH STREET
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REGISTERED PROFESSIONAL ENGINEER CHIN CHUAN TEY No. M029976 Exp. 6/30/04 MECHANICAL STATE OF CALIFORNIA

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DATE 17-OCT-2002	INDEX NO.

Job No: 1026510 File: P:\Projects\la_unified\open charter\mec\ocm01.dgn

GENERAL INSTRUMENT OR FUNCTION SYMBOLS

INSTRUMENT TAG IDENTIFICATION

	PRIMARY LOCATION (b)NORMALLY ACCESSIBLE TO OPERATOR	FIELD MOUNT	AUXILIARY LOCATION (b)NORMALLY ACCESSIBLE TO OPERATOR
DISCRETE INSTRUMENTS	XXX(a)		
SHARED DISPLAY, SHARED CONTROL			
COMPUTER FUNCTION			
PROGRAMMABLE LOGIC CONTROL			

(a) DESIGNATIONS SUCH AS 100 (LOCAL CONTROL BOARD NO. 100), 200 (LOCAL CONTROL BOARD NO.200), ETC., ARE USED WHEN NECESSARY TO SPECIFY INSTRUMENT OR FUNCTION LOCATION.

(b) NORMALLY INACCESSIBLE OR BEHIND-THE-PANEL DEVICES OR FUNCTIONS ARE DEPICTED BY USING THE SAME SYMBOLS BUT WITH DASHED HORIZONTAL BARS, I.E.

SINGLE INSTRUMENT OR OTHER COMPONENT HAVING MULTIPLE FUNCTIONS

(XXX) SOFTWARE OR LOGIC RESIDENT IN DISTRIBUTED CONTROL SYSTEM (DCS) AT PROGRAMMABLE LOGIC CONTROLLER (PLC) XXX. SEE ASSOCIATED LOGIC DIAGRAMS.

(XXX) PANEL MOUNTED PILOT LIGHT WITH PANEL NUMBER DESIGNATION(I.e. XXX = 100, 200, ETC.).

FY INSTRUMENT PANEL MOUNTED WITH COMPUTING OR CONVERTING FUNCTION

CONVERT

E - VOLTAGE
I - CURRENT
P - PNEUMATIC
A - ANALOG
B - BINARY

H - HYDRAULIC
O - ELECTROMAGNETIC, SONIC
R - RESISTANCE (ELECT.)
D - DIGITAL
PF - PULSE FREQUENCY

COMPUTE

SUMMING	Σ	AVERAGING	Σ/n
SUBTRACTOR	−	RATIO	1:1
MUTIPLYING	X	DIFFERENCE	Δ
DIVIDING	÷	HIGH SELECTING	>
ROOT EXTRACTION	√	LOW SELECTING	<
PROPORTIONAL	P	INTEGRAL	∫
DERIVITIVE	R	OR	OR
		AND	AND
		EXCLUSIVE OR	OR

WTP - WATER TREATMENT PLANT
WWTP - WASTE WATER TREATMENT PLANT
MCB - MAIN CONTROL BOARD
RTU - REMOTE TELEMETRY UNIT
LCB - LOCAL CONTROL BOARD
LCP - LOCAL CONTROL PANEL (BY VENDOR/EQUIPMENT SUPPLIER)

ISA FUNCTION IDENTIFICATION TABLE

	FIRST-LETTER		SUCCEEDING-LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION				
C	CONDUCTIVITY			CONTROL	CLOSED
D	DENSITY	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOW RATE	RATIO (FRACTION)			
G	GAGE		GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	MOTOR	MOMENTARY			MIDDLE, INTERMEDIATE
N	TORQUE		ISOLATE	ISOLATOR	
O			ORIFICE, RESTRICTION		OPEN
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT, FORCE		WELL		
X	INTRUSION	X AXIS			
Y	EVENT, STATE OR PRESENCE	Y AXIS		COMPUTE, CONVERT	
Z	POSITION, DIMENSION	Z AXIS		DRIVER, ACTUATOR, FINAL CONTROL ELEMENT	

TYPICAL:
FORMAT TIC-1 - INSTRUMENT IDENTIFICATION OR TAG NUMBER
TIC - FUNCTIONAL IDENTIFICATION
T - FIRST-LETTER
IC - SUCCEEDING-LETTER(S)
1 - LOOP NUMBER

EXPANDED:
FORMAT 10-PAH-1A - TAG NUMBER
10 - OPTIONAL PREFIX
A - OPTIONAL SUFFIX

FIRST LETTER
SUCCEEDING LETTER
SUCCEEDING LETTER
INSTRUMENT LOOP NUMBER
(INSTRUMENT SYMBOLS)

(XXX) DESIGNATIONS OF CONTROL FUNCTIONS ASSOCIATED INSTRUMENT OR OTHER COMPONENTS.

AHC - AUTO/HOLD/CLOSE
AM - AUTO/MANUAL
DEV - DEVIATION
HOA - HAND/OFF/AUTO
HOR - HAND/OFF/REMOTE
LOS - LOCKOUT STOP
LR - LOCAL/REMOTE
MOA - MANUAL/OFF/AUTO
OO - ON/OFF

OCA - OPEN/CLOSE/AUTO
OSC - OPEN/STOP/CLOSED
POT - POTENTIOMETER
RL - RAISE/LOWER
RSL - RAISE/STOP/LOWER
SD - SHUTDOWN
SEL - SELECT
SP - SET POINT
SR - START/RESET
SS - STOP/START

INSTRUMENT LINE SYMBOLS

PRIMARY PROCESS LINE
SECONDARY PROCESS LINE
INSTRUMENT OR CONNECTION TO PROCESS (1)
ELECTRIC DISCRETE SIGNAL (ON/OFF)
A — ELECTRIC ANALOG SIGNAL (4-20 ma, 1-5 Vdc, etc.)
PF — ELECTRIC PULSE FREQUENCY SIGNAL (0-100 CYCLE/SEC., 0-150 PULSE/MIN., etc.)
PD — ELECTRIC PULSE DURATION SIGNAL (15 SEC., 3/12 SEC = 0 % etc.)
PNEUMATIC SYMBOL (2)
HYDRAULIC SYMBOL
CAPILLARY TUBE
ELECTROMAGNETIC OR SONIC SIGNAL (3)
INTERNAL SYSTEM LINK (SOFTWARE OR DATA LINK)
MECHANICAL LINK
CONNECTING LINES
NON-CONNECTING LINES

(1) THE FOLLOWING ABBREVIATIONS ARE USED TO DENOTE THE TYPES OF POWER SUPPLIES. THEY MAY ALSO BE USED TO DENOTE PURGE FLUID SUPPLIES.

AS - AIR SUPPLY
IA - INSTRUMENT AIR
PA - PLANT AIR
ES - ELECTRIC SUPPLY
GS - GAS SUPPLY

HS - HYDRAULIC SUPPLY
NS - NITROGEN SUPPLY
SS - STEAM SUPPLY
WS - WATER SUPPLY

(2) THE PNEUMATIC SIGNAL SYMBOLS APPLIES TO A SIGNAL, NOT A SUPPLY SOURCE, USING ANY GAS AS A MEDIUM. IF A GAS OTHER THAN AIR IS USED, THE GAS IS IDENTIFIED BY A NOTE ON THE SIGNAL.

(3) ELECTROMAGNETIC PHENOMENA INCLUDE HEAT, RADIO WAVES, NUCLEAR RADIATION, AND LIGHT.

MISCELLANEOUS SYMBOLS

RADIO ANTENNA
THERMOSTAT
UNIT HEATER

INTERFACING SYMBOLS

91-2 — PROCESS/SIGNAL INTERFACE WITHIN THIS PROJECT
DRAWING NO.

OR — PROCESS INTERFACE WITHIN THE SAME SHEET

X — SIGNAL INTERFACE WITHIN THE SAME SHEET

PROCESS INTERFACE WITH EQUIPMENT NOT SHOWN

MECHANICAL EQUIPMENT CALLOUT

AREA (LOCATION) DESIGNATION
EQUIPMENT NUMBER
EQUIPMENT ABBREVIATION (BUTTERFLY VALVE)

GENERAL NOTES

1. ADDITIONAL INSTRUMENTATION AND CONTROL SYMBOLS MAY BE USED AS REQUIRED. SYMBOLS AND NOMENCLATURE ARE BASED ON ISA STANDARDS S5.1, S5.2, S5.4.
2. SEE ASSOCIATED ELECTRICAL AND MECHANICAL SYMBOL SHEETS FOR ADDITIONAL SYMBOLS AND ABBREVIATIONS.
3. FOR PIPE SIZES, MATERIAL, AS WELL AS DETAILS OF METER COUPLING AND OTHER MECHANICAL EQUIPMENT (E.G. VALVE, PUMP, ETC.) SEE PROCESS AND INSTRUMENTATION DIAGRAMS, MECHANICAL DRAWINGS AND SPECIFICATIONS.
4. POWER SUPPLIES FOR LOOPS OR SYSTEMS SHALL BE FURNISHED BY THE INSTRUMENTATION MANUFACTURER TO MEET THE PARTICULAR CHARACTERISTICS (E.G. VOLTAGE AND CURRENT REQUIREMENTS) OF COMPONENTS IN EACH LOOP OR SYSTEM.

REGISTERED PROFESSIONAL ENGINEER LOUIS A. YAUSSI No. 4842 Exp. 12/31/04 CONTROL SYSTEM STATE OF CALIFORNIA

DESIGN & INSPECTION BRANCH
FACILITIES SERVICES DIVISION
355 NORTH GRAND AVENUE LOS ANGELES CALIFORNIA

LOS ANGELES UNIFIED SCHOOL DISTRICT · BOARD OF EDUCATION

D.S.A. STAMP

INSTRUMENTATION SYMBOLS & ABBR.-1

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL: OPEN CHARTER MAGNET SCHOOL 5540 W. 77TH STREET LOS ANGELES, CA 90045

Pasadena California

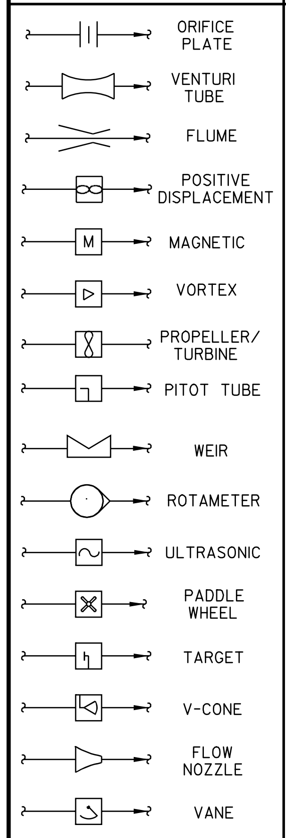
MWH MONTGOMERY WATSON HARZA

REVISIONS
1 REISSUED SET

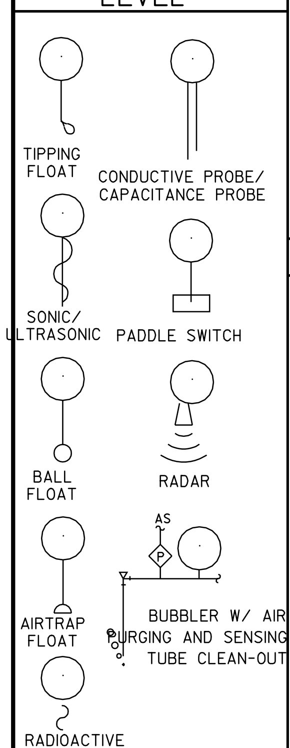
JOB NUMBER
DRAWN BY J. JACKSON
CHECKED BY L. YAUSSI
DATE 17-OCT-2002
DRAWING NO. GI-1
INDEX NO.

Job No: 1026510 File: P:\Projects\la_unified\open charter\ins\ocgi01.dgn

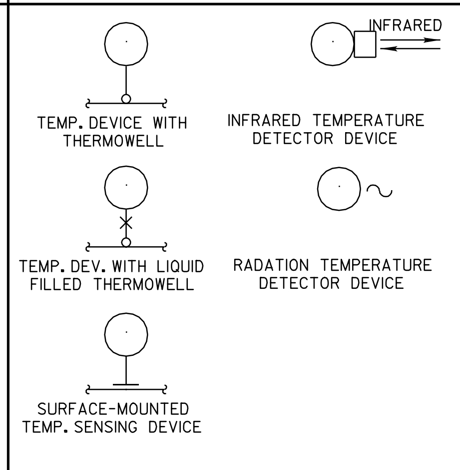
FLOW ELEMENT



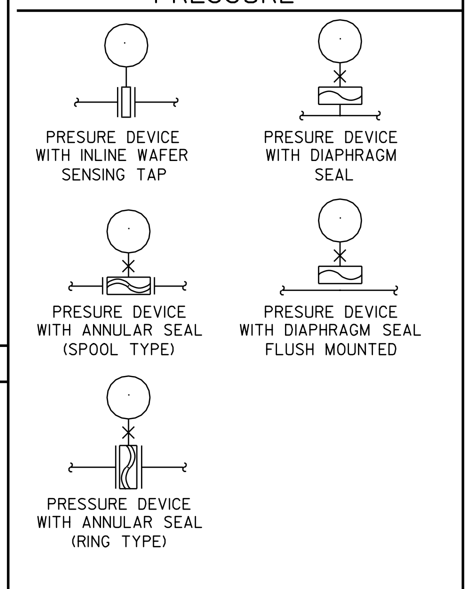
LEVEL



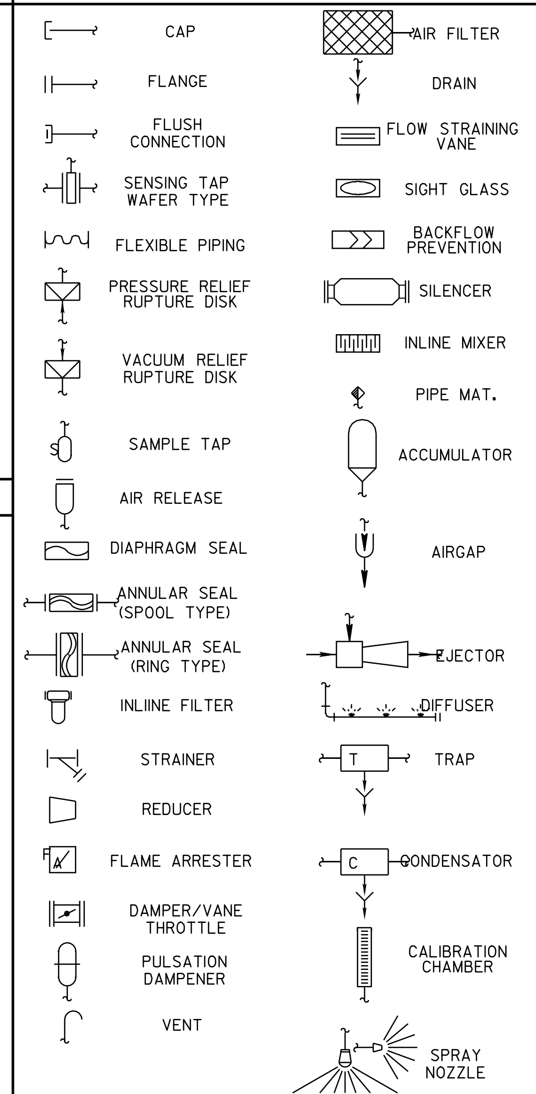
TEMPERATURE



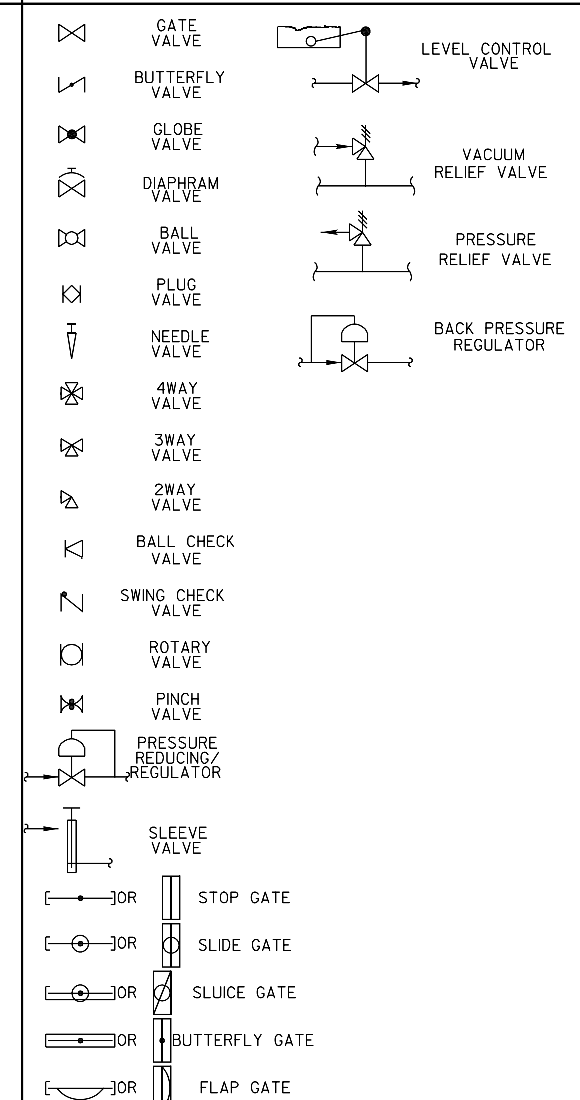
PRESSURE



PIPING EQUIPMENT SYMBOLS



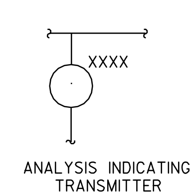
VALVE AND GATE SYMBOLS



FLOW STREAM IDENTIFICATION

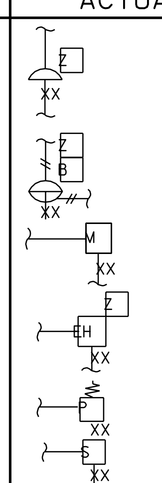
LEGEND	SERVICE	LEGEND	SERVICE
A	AERATION	NG	NATURAL GAS
AA	AQUEOUS AMMONIA	OF	OVERFLOW
AC	ACTIVATED CARBON	OG	OFF-GAS
AW	FILTER AIR WASH	OTE	OXIDATION TOWER EFFLUENT
BD	BOTTOM DRAIN	OW	OZONATED WATER
BP	BYPASS	OX	OXYGEN
BW	FILTER BACKWASH	OZ	OZONE
C	CONDENSATE	PA	PLANT AIR
CAW	CHANNEL AGITATION WATER	PD	PLANT DRAIN
CD	CHEMICAL DRAIN AND VENT	PEA	POLYMER - ANIONIC
CHE	CHLORINATED EFFLUENT	PEC	POLYMER - CATIONIC
CL	CHLORINE (GAS OR LIQUID STATE)	PEF	PRIMARY EFFLUENT
CLS	CHLORINE SOLUTION	PEN	POLYMER - NONIONIC
CLV	CHLORINE GAS UNDER VACUUM	PI	PLANT INFLUENT
CN	CENTRATE	PO	PLANT OVERFLOW
CS	CAUSTIC SODA	PW	POTABLE WATER
CSL	CONDITIONED SLUDGE	RAS	RETURN ACTIVATED SLUDGE
CV	CHLORINATOR VENT & DETECTION LINE	RC	RECYCLE COOLANT
DCS	DEFOAMING CHEMICAL SOLUTION	REW	RECLAIMED WATER
DN	DECANT	RSL	RAW SLUDGE
DSL	DIGESTED SLUDGE	RW	RAW WATER
ET	ELECTROLYTE	RWL	RAINWATER LEADER
EW	ELUTRIATION WATER	S	SCUM
EWR	ENGINE COOLING WATER RETURN	SA	SAMPLE LINE
EWS	ENGINE COOLING WATER SUPPLY	SC	SPARE CHEMICAL
F	FROTH	SCS	SCRUBBER CHEMICAL SUPPLY
FA	FOUL AIR	SD	SANITARY DRAIN & VENT
FE	FINAL EFFLUENT	SDR	STORM DRAIN
FLW	FLOCCULATED WATER	SE	SECONDARY EFFLUENT
FM	FORCE MAIN	SF	SLUDGE FILTRATE
FOR	FUEL OIL RETURN	SI	SODIUM SILICATE
FOS	FUEL OIL SUPPLY	SN	SUPERNATANT
FS	FROTH SPRAY	SO	SULFUR DIOXIDE (GAS OR LIQUID STATE)
FSP	FIRE PROTECTION SPRINKLER SYSTEM	SOA	SULFURIC ACID
FSW	FILTER SURFACE WASHWATER	SOS	SULFUR DIOXIDE SOLUTION
FTW	FILTER TO WASTE	SOV	SULFUR DIOXIDE GAS UNDER VACUUM
FW	FILTERED WATER	SPD	SUMP PUMP DISCHARGE
G	GRIT	SS	SANITARY SEWER
H	HYPOCHLORITE	ST	STEAM (LOW PRESSURE TO 10 PSI)
HF	HYDROFLUOSILICIC ACID	SU	STRUCTURE UNDERDRAIN
HP	HYDROGEN PEROXIDE	SUC	STRUCTURE UNDERDRAIN COLLECTOR
HR	HEATING WATER RETURN	SW	SETTLED WATER
HS	HEATING WATER SUPPLY	SWR	SCRUBBER WATER RETURN
HWR	DOMESTIC HOT WATER RETURN	TPR	THICKENER PRESSURIZED RECYCLE
HWS	DOMESTIC HOT WATER SUPPLY	TS	THICKENER SUPERNATANT
IA	INSTRUMENT AIR	TSL	THICKENED SLUDGE
IE	INTERMEDIATE EFFLUENT	TSO	THICKENER SUBNATANT OVERFLOW
ISL	INTERMEDIATE SLUDGE	UW	UTILITY WATER (NON-POTABLE WATER)
LO	LUBE OIL	V	VACUUM
LPG	LIQUEFIED PETROLEUM GAS	WAS	WASTE ACTIVATED SLUDGE
LS	LIME SLURRY	WLO	WASTE LUBE OIL
LSP	LANDSCAPING SPRINKLER SYSTEM	WW	WASTE WATER
MA	MURIATIC ACID	WWR	WASTE WATER RECLAIMED
ML	MIXED LIQUOR	WWW	WASTE WASHWATER

ANALYTICAL INSTRUMENT



XXXX =
- ALK - ALKALINITY
- CL_2 - CHLORINE CONCENTRATION
- COMB - COMBUSTABLE GAS
- CON - CONDUCTIVITY
- DO - DISSOLVED OXYGEN
- H_2S - HYDROGEN SULFIDE
- LEL - LOWER EXPLOSIVE LIMIT
- O_2 - OXYGEN CONCENTRATION
- O_3 - OZONE
- ORP - OXIDATION/REDUCTION POTENTIAL
- PH - HYDROGEN ION CONCENTRATION
- SO_2 - SULFUR DIOXIDE
- TH - TOTAL HARDNESS
- TURB - TURBIDITY
- UV - ULTRA VIOLET

ACTUATOR SYMBOLS



DIAPHRAGM ASSEMBLY WITH PILOT AND POSITIONER. ONE INPUT SHOWN (TYP. WITH ELECTRIC INPUT)

PRESSURE-BALANCED PNUMATIC DIAPHRAGM WITH POSITIONER AND VOLUME BOOSTER

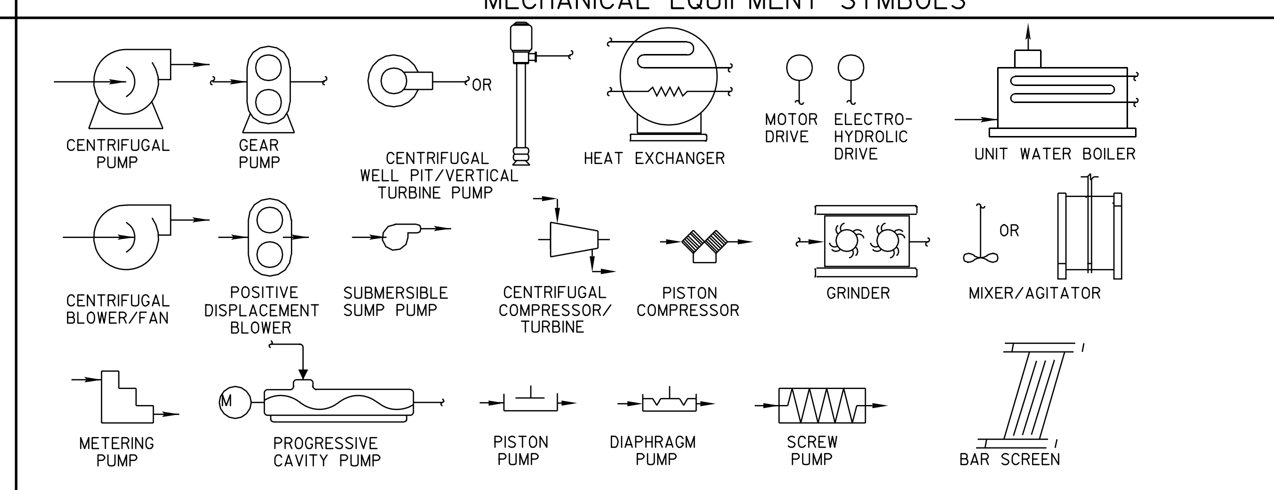
ROTARY MOTOR (SHOWN TYPICALLY WITH ELECTRIC SIGNAL. MAY BE HYDRAULIC OR PNEUMATIC)

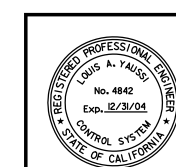
ELECTROHYDRAULIC WITH POSITIONER

PNUMATIC PISTON ACTUATOR WITH SPRING RETURN

SOLENOID

MECHANICAL EQUIPMENT SYMBOLS





DESIGN & INSPECTION BRANCH
FACILITIES SERVICES DIVISION
355 NORTH GRAND AVENUE LOS ANGELES CALIFORNIA

D.S.A. STAMP

INSTRUMENTATION SYMBOLS & ABBR. - 2

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL: OPEN CHARTER MAGNET SCHOOL
5540 W. 77TH STREET
LOS ANGELES, CA 90045

Pasadena California

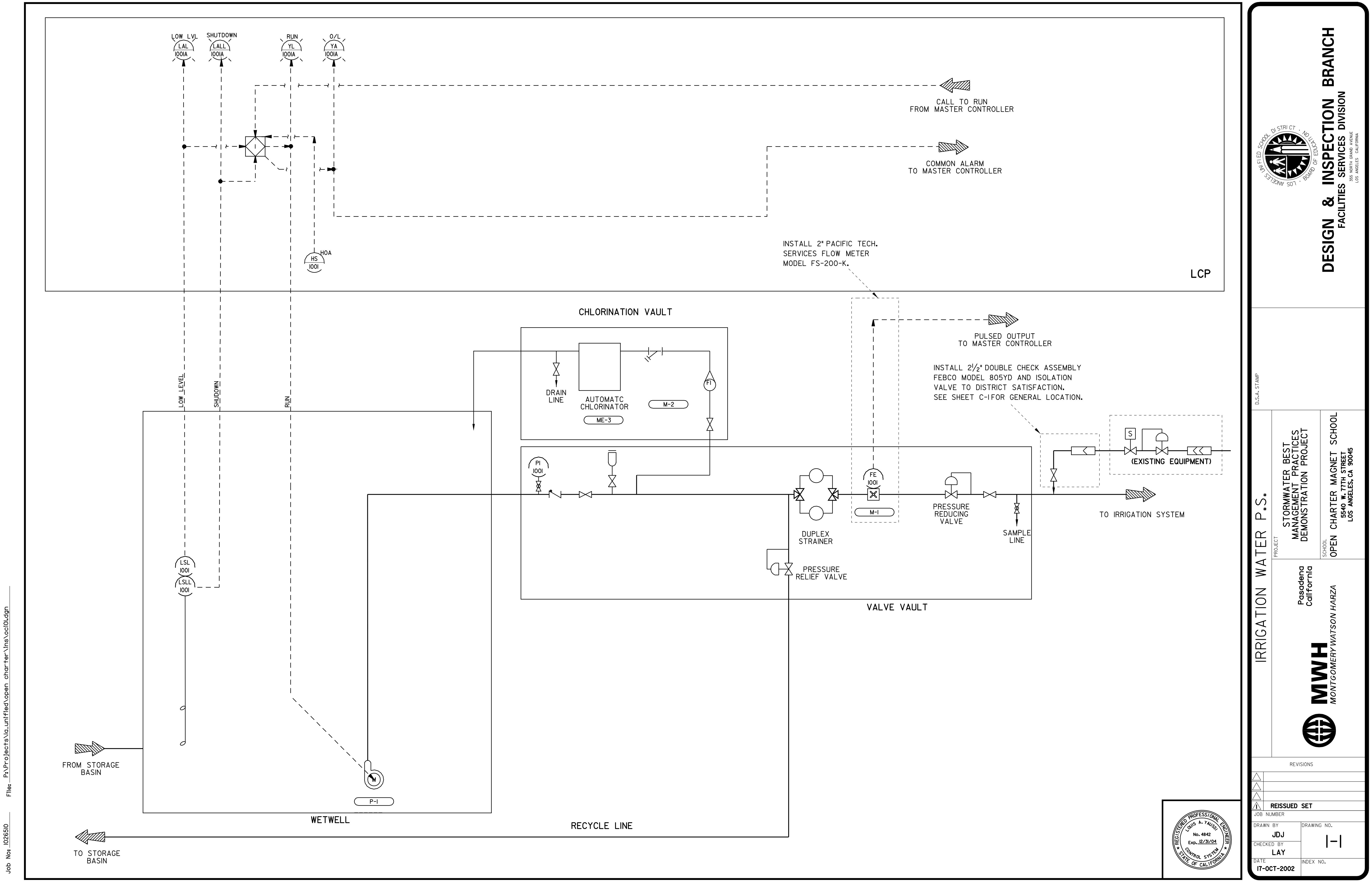
MWH MONTGOMERY WATSON HARZA

REVISIONS

REISSUED SET

JOB NUMBER	
DRAWN BY J. JACKSON	DRAWING NO. GI-2
CHECKED BY L. YAUSSI	
DATE 17-OCT-2002	INDEX NO.

Job No: 1026510   File: P:\Projects\la_unified\open charter\Ins\ocgi02.dgn


LOW LVL
LAL 1001A
SHUTDOWN
LALL 1001A
RUN
YL 1001A
O/L
YA 1001A
CALL TO RUN
FROM MASTER CONTROLLER
COMMON ALARM
TO MASTER CONTROLLER
HS 1001
HOA
LCP
INSTALL 2" PACIFIC TECH.
SERVICES FLOW METER
MODEL FS-200-K.
CHLORINATION VAULT
PULSED OUTPUT
TO MASTER CONTROLLER
INSTALL 2 1/2" DOUBLE CHECK ASSEMBLY
FEBCO MODEL 805YD AND ISOLATION
VALVE TO DISTRICT SATISFACTION.
SEE SHEET C-1 FOR GENERAL LOCATION.
DRAIN LINE
AUTOMATC CHLORINATOR
ME-3
M-2
FI
LOW LEVEL
SHUDOWN
RUN
PI 1001
FE 1001
M-1
S
(EXISTING EQUIPMENT)
DUPLEX STRAINER
PRESSURE REDUCING VALVE
SAMPLE LINE
TO IRRIGATION SYSTEM
PRESSURE RELIEF VALVE
VALVE VAULT
LSL 1001
LSLL 1001
FROM STORAGE BASIN
P-1
WETWELL
RECYCLE LINE
TO STORAGE BASIN
Job No: 1026510
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DESIGN & INSPECTION BRANCH
FACILITIES SERVICES DIVISION
355 NORTH GRAND AVENUE
LOS ANGELES CALIFORNIA
LOS ANGELES UNIFIED SCHOOL DISTRICT · BOARD OF EDUCATION
D.S.A. STAMP
IRRIGATION WATER P.S.
PROJECT
STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT
SCHOOL
OPEN CHARTER MAGNET SCHOOL
5540 W. 77TH STREET
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Pasadena California
MWH
MONTGOMERY WATSON HARZA
REVISIONS
1 REISSUED SET
JOB NUMBER
DRAWN BY JDJ
DRAWING NO. I-I
CHECKED BY LAY
DATE 17-OCT-2002
INDEX NO.
REGISTERED PROFESSIONAL ENGINEER
LOUIS A. YAUSSI
No. 4842
Exp. 12/31/04
CONTROL SYSTEM
STATE OF CALIFORNIA

SYMBOLS

PLAN

- BARE COPPER GROUND TO GROUND WIRE OR UNDERGROUND GROUND GRID
- EXPOSED CONDUIT
- CONDUIT RUN CONCEALED
- EXPOSED CONDUIT RUN BEHIND OBSTRUCTION
- TELEPHONE CONDUIT RUN
- LPI-I, 3, 7 — HOME RUN TO PANEL "LA", CIRCUITS I, 3 AND 7. CROSS MARKS ON CONDUIT INDICATE NO. OF CONDUCTORS. 3/4" CONDUIT WITH 5 NO. I2 WIRES SHOWN. CIRCUITS I AND 3 WITH COMMON NEUTRAL; CIRCUIT 7 WITH SEPARATE NEUTRAL. CONDUIT NOT MARKED IS 3/4". CONDUCTORS ARE NO. I2 IF NOT NOTED.
- CONDUIT BENDS TOWARD OBSERVER
- CONDUIT BENDS AWAY FROM OBSERVER
- GROUND ROD AND GROUND ROD BOX
- FLEXIBLE LIQUID - TIGHT CONDUIT CONNECTION
- M — MOTOR
- DISCONNECT SWITCH
- SS — PUSHBUTTON STATION REFER TO SCHEMATIC DIAGRAMS FOR DEVICESREQ'D
- J — EQUIPMENT JUNCTION BOX
- J — JUNCTION BOX OR FITTING
- M — MOTOR OPERATED VALVE
- SV — SOLENOID VALVE
- LS — LIMIT SWITCH
- PS — PRESSURE SWITCH
- LIGHTING PANEL
- POWER PANEL
- MOTOR CONTROL CENTER
- I — INDEX TO NOTE I. "SEE NOTE I"
- EF — ELECTRODE FITTING
- LS — LEVEL SWITCH OR LIMIT SWITCH
- S_{PL} — SWITCH AND PILOT LIGHT
- A 2/40 3 — FIXTURE TYPE A. 2-40 WATT LAMPS 3 - NUMBER OF TYPE "A" FIXTURES
- FLUORESCENT FIXTURE OUTLET
- CEILING MOUNTED LTG. OUTLET
- WALL MOUNTED LTG. OUTLET
- Sa — SWITCH OUTLET. CONTROLS FIXTURES WITH SUBSCRIPT "a"
- S^M — SWITCH OUTLET. MOMENTARY CONTACT SWITCH
- CONVENIENCE RECEPTACLE HT 24" IF NOT NOTED OTHERWISE
- POLE MLD FIXTURE WITH RECEPTACLE
- INTERCOMMUNICATION OUTLET , "WP" INDICATES WEAHERPROOF OUTLET, SEE SPECIFICATION
- TELEPHONE OUTLET

DIAGRAM

- II — ACROSS-THE-LINE, NON-REVERSING NEMA SIZE 2 (REV-REVERSING)
- IV RVAT — NEMA SIZE 4 REDUCED VOLTAGE MAGNETIC STR: AT+AUTOXFMR
- SOLID STATE REDUCED VOLTAGE STARTER W/ BYPASS CONTACTOR
- UNIT MOUNTED COMBINATION STARTER
- I5A MCP — MOTOR CIRCUIT PROTECTOR, RAITING I5AMP
- 50A — MOLDED CASE CIRCUIT BREAKER, 3 POLE UNLESS OTHERWISE NOTED: 50A.-TRIP RATING IN AMPERES NA-NON-AUTOMATIC
- TRANSFORMER, PARAMETERS AS NOTED. GROUNDED SECONDARY
- CONTROL RELAY OR COIL
  - IT2 PUMP NO. I, TIME DELAY RELAY NO. 2
  - 2RI PUMP NO. 2, GENERAL PURPOSE RELAY NO. I
  - CRI CONTROL RELAY IN STARTER NO. I
  - MI STARTER NO. MAIN COIL
- NORMALLY OPEN CONTACT
- NORMALLY CLOSED CONTACT
- NORMALLY OPEN LIMIT SWITCH
- NORMALLY CLOSED LIMIT SWITCH
- FLOAT TYPE LIQUID LEVEL SWITCH, CLOSING ON RISING LEVEL
- FLOAT TYPE LIQUID LEVEL SWITCH, OPENING ON RISING LEVEL
- VACUUM OR PRESSURE SWITCH, CLOSING ON RISING PRESSURE
- VACUUM OR PRESSURE SWITCH, OPENING ON RISING PRESSURE
- TEMPERATURE ACTUATED SWITCH; CLOSING ON RISING TEMPERATURE
- TEMPERATURE ACTUATED SWITCH; OPENING ON RISING TEMPERATURE
- NORMALLY OPEN PUSHBUTTON, MOMENTARY CLOSE
- NORMALLY CLOSED PUSHBUTTON, MOMENTARY OPEN
- FUSE
- R — PUSH-TO-TEST INDICATING LIGHT, R-RED, A-AMBER
- LOCATED NEAR MOTOR
- ET — ELAPSED TIMER
- CONTACT-TIME DELAY
  - T. C.: NORMALLY OPEN WITH TIME DELAY CLOSING
  - I. C. -T. O.: NORMALLY OPEN WITH INSTANT CLOSING AND TIME DELAY OPENING
  - T. C. -T. O.: NORMALLY OPEN WITH TIME DELAY CLOSING AND TIME DELAY OPENING AFTER DEENERGIZATION
- CONTACT-TIME DELAY
  - T. O.: NORMALLY CLOSED WITH TIME DELAY OPENNING
  - T. O. -T. C.: NORMALLY CLOSED WITH TIME DELAY OPENING AND TIME DELAY CLOSING AFTER DEENERGIZATION
  - I. O. -T. C.: NORMALLY CLOSED WITH INSTANT OPENING AND TIME DELAY CLOSING
- HEATER
- CROSSING OF CONDUCTORS-NOT CONNECTED
- CONNECTION OF CONDUCTORS, FITTING AS REQUIRED
- ELECTRODE PROBES
- PANEL MOUNTED DEVICE (SCHEMATIC)
- FIELD OR REMOTE MOUNTED DEVICE (SCHEMATIC)

ABBREVIATIONS

AA	ALARM ANNUNCIATOR
AF	AMPERE FRAME SIZE OF CKT. BRKRS.
AMP	AMPERES, AMPERAGE
AT	AMPERE TRIP
ATS	AUTOMIC TRANSFER SWITCH
AUT	AUTO-TRANSFORMER
AUTO	AUTOMATIC
AWG	AMERICAN WIRE GAUGE
BCSD	BARE COPPER SOFT DRAWN
BKR	BREAKER
BP	BY-PASS
C	CONDUIT
CAB	CABINET
CHLOR	CHLORINE, CHLORINATION
CKT	CIRCUIT
CMD	COMMAND
CO	CONDUIT ONLY
CP	CONTROL PANEL
CPT	CONTROL POWER TRANSFORMER (IN INDIVIDUAL STARTER CUBICLE)
CR	CONTROL RELAY (MAGNETICALLY HELD)
CT	CURRENT TRANSFORMER
DISC	DISCONNECT
DWG	DRAWING
ENCL	ENCLOSURE
EXH	EXHAUST
EXIST	EXISTING
FS	FLOW SWITCH
FUT	FUTURE
FLUOR	FLUORESCENT
GFI	GROUND FAULT INTERRUPTER
GRD	GROUND
HOA	HAND - OFF - AUTOMATIC
HP	HORSEPOWER
HPS	HIGH PRESSURE SODIUM
HTR	HEATER
HZ	HERTZ
IJB	INSTR. J BOX
JB	JUNCTION BOX
KVA	KILOVOLTAMPERE
LCB	LOCAL CONTROL BOARD (SOD)
LOC	LOCAL
LOS	PUSHBUTTON W/"LOCK-OUT-STOP"
LS	LIMIT SWITCH
LT, LTS	LIGHT, LIGHTS
LTG	LIGHTING
LTNG	LIGHTNING
MAN	MANUAL
MAG	MAGNETIC
MAX	MAXIMUM
MCC	MOTOR CONTROL CENTER
MCP	MAIN CONTROL PANEL
MOV	MOTOR OPERATED VALVE
MT, MTD	MOUNT, MOUNTED
N	NEUTRAL
NO, NOS	NUMBER, NUMBERS
NTS	NOT TO SCALE
OL	OVERLOAD RELAY
PB	PUSHBUTTON
PLCS	PLACES
PNL	PANEL
PNLBD	PANELBOARD
PS	PRESSURE SWITCH
PVC	POLYVINYL CHLORIDE
PW	PART WINDING
REQ'D	REQUIRED
RTU	REMOTE TERMINAL UNIT
SCH	SCHEDULE
SEC	SECONDS, SECONDARY
SEL SW	SELECTOR SWITCH
SHLD	SHIELDED
SHT	SHEET
SP HTR	SPACE HEATER
STA	STATION
STD	STANDARD
SV	SOLENOID VAVLE
SW	SWITCH
TC	TIMED CLOSED
TEL	TELEPHONE
TO	TIMED OPEN
TS	TIME SWITCH
TYP	TYPICAL
UG	UNDERGROUND
UH	UNIT HEATER
VFD	VARIABLE FREQUENCY DRIVE
WP	WEATHERPROOF
XFMR	TRANSFORMER
XMTR	TRANSMITTER

GENERAL NOTES:

I. RACEWAY IS 3/4" IF NOT NOTED, RACEWAY CONTAINS TWO CONDUCTOR IF NOT NOTED. CONDUCTORS ARE NO. I2 IF NOT NOTED.

2. THE WORK ON THE ELECTRICAL DWGS. IS TO SOME EXTENT, DIAGRAMATIC. EXACT RACEWAY ROUTING AND TERMINATION MUST BE DETERMINED AT THE JOB SITE TO SUIT FIELD CONDITIONS. THE WORK OF OTHER TRADES, AND THE REQUIREMENTS OF APPROVED SHOP DRAWINGS.

3. LIQUID - TIGHT FLEXIBLE CONDUIT SHALL BE INSTALLED WITH GROUNDING FITTINGS TO DEVICES WHICH REQUIRE FLEXIBLE CONNECTION. FLEXIBLE CONDUIT LARGER THAN 2" SHALL BE INSTALLED IN LENGTHS THAT DO NOT EXCEED 30"; SMALLER CONDUITS SHALL NOT BE INSTALLED IN LEHGTHS THAT EXCEED I8".

4. ALL RACEWAY PENETRATIONS TO STRUCTURES THAT ARE BELOW GROUND LEVEL SHALL BE WATERTIGHT. ASIDES FROM BEING WATERTIGHT THE RACEWAYS SHALL BE ARRANGED SO THAT WATER THAT MAY FIND ITS WAY THROUGH THE RACEWAY SHALL DRAIN AWAY FROM THE INSTRUMENTS, PANELS OR ANY ELECTRICAL COMPONENTS, THAT THE RACEWAY IS INTENDED TO CONNECT. SEE SPEC. SECTION I6050 FOR ADDITIONAL INFORMATION ON PENETRATIONS.

5. THE CONTRACTOR SHALL VERIFY EXACT LOCATION OF TERMINAL BOXES AND CONDUIT ENTRANCES OF ALL EQUIPMENT AGAINST SHOP DRAWINGS BEFORE STUBBING UP CONDUITS.

6. CONDUITS TERMINATING AT SWITCHBOARD, MOTOR CONTROL CENTER, POWER AND LIGHTING PANEL, CONTROL CABINET, ETC SHALL BE EQUIPPED WITH SEALING HUB AND GROUNDING BUSHING, AND SHALL BE GROUNDED WITH NO. 6 GROUND WIRE.

7. INSTALL EXPANSION FITTINGS EVERY 200 FEET OF STRAIGHT RUN OF CONDUITS.

8. CONDUIT CROSSING BUILDING OR STRUCTURAL EXPANSION JOINTS SHALL BE PROVIDED WITH SUITABLE EXPANSION FITTINGS. THESE FITTINGS MUST BE CONSTRUCTED IN SUCH A MANNER THAT WILL INSURE THE CONTINUITY OF THE GROUND PATH IN EACH CONDUIT OR RACEWAY.

9. ALL UNDERGROUND CONDUIT RUNS SHALL BE WITH LONG RADIUS SWEEP BENDS. THE MINIMUM BENDING RADIUS SHALL BE I2 TIMES NOMINAL DIAMETER OF THE CONDUIT.

I0. ALL UNDERGROUND CONDUITS NOT ENCASED IN CONCRETE SHALL BE RIGID STEEL, GALVANIZED, PVC COATED.

II. THE MINIMUM SIZE OF CONDUITS INSTALLED BELOW GRADE SHALL BE I" UNLESS OTHERWISE NOTED.

I2. ALL METALLIC STRUCTURES , METALLIC ENCLOSURES, AND ELECTRICAL EQUIPMENT, SUCH AS STRUCTURAL STEEL, METALLIC RACEWAY, FENCE, STAIR HANDRAILS, LIGHTING POLE, TANK, VESSELS, SWITCHING EQUIPMENT, PANEL, EQUIPMENT ENCLOSURE AND CABINETS GENERATOR, MOTOR, TRANSFORMERS, SWITCHGEAR, ETC. SHALL BE PERMANENTLY AND EFFECTIVELY GROUNDED AND GROUND CONNECTION SHALL BE MADE TO THE PLANT GROUND GRID. THE GROUND CONDUCTOR SHALL BE SIZED PER N. E. C. UNLESS OTHERWIZE SHOWN EXCEPT THE MINIMUM SIZE.

I3. ALL EQUIPMENT DIMENSIONS SHOWN ON PLANS AND ELEVATIONS ARE APPROXIMATE ONLYTHE CONTRACTOR SHALL USE THE SHOP DRAWINGS FOR PROPER LAYOUT, FOUNDATION AND PAD, ETC. FOR FINAL INSTALLATION. WITHOUT ANY ADDITIONAL COST TO THE OWNER.

I4. SWITCHBOARD, MOTOR CONTROL CENTER AND ALL FREE STANDING PANEL SHALL BE SET ON CONCRETE PAD AND LEVELING CHANNELS EMBEDDED IN THE PAD UNLESS OTHERWISE NOTED.

I5. ALL DEVICES SHOWN ON MOTOR STARTER SCHEMATIC DIAGRAMS SHALL BE MOUNTED IN THE MOTOR STARTER CUBICLES UNLESS OTHERWISE NOTED.

I6. IN CASE OF INTERFERENCE BETWEEN ELECTRICAL EQUIPMENT SHOWN ON THE DRAWINGS AND OTHER EQUIPMENT, THE CONTRACTOR SHALL NOTIFY THE ENGINEER IN WRITING AND ENGINEER SHALL REVIEW THE PROPOSED CHANGES BEFORE THEY ARE MADE.

I7. ALL RECEPTACLES SHALL BE MOUNTED 24" ABOVE FLOOR SURFACE UNLESS OTHERWISE NOTED.

I8. ALL RECEPTACLES IN OUTDOOR AND ANTICIPATED WET AREA SHALL BE GROUND FAULT INTERRUPTER RECEPTACLES.

I9. ALL OUTDOOR DEVICES SHALL BE WEATHERPROOF TYPE.

20. LOCATION OF MANHOLES AND PULLBOXES ARE APPROXIMATE. CONTRACTOR SHALL COORDINATE EXACT LOCATION OF MANHOLES AND PULLBOXES WITH MECHANICAL AND CIVIL WORK.

2I. CONTRACTOR SHALL PROVIDE ADDITIONAL MANHOLES OR PULLBOXES TO THOSE SHOWN WHERE THEY ARE REQUIRED TO MAKE A WORKABLE INSTALLATION.

REGISTERED PROFESSIONAL ENGINEER PHOENIX N. PHAM No. E016254 Exp. ELECTRICAL STATE OF CALIFORNIA

DESIGN & INSPECTION BRANCH
FACILITIES SERVICES DIVISION
355 NORTH GRAND AVENUE LOS ANGELES CALIFORNIA

D.S.A. STAMP

ELECTRICAL SYMBOLS AND ABBREVIATIONS

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL: OPEN CHARTER MAGNET SCHOOL, 5540 W. 77TH STREET, LOS ANGELES, CA 90045

MWH MONTGOMERY WATSON HARZA, Pasadena California

REVISIONS: REISSUED SET

JOB NUMBER

DRAWN BY: N. CHRAKIAN

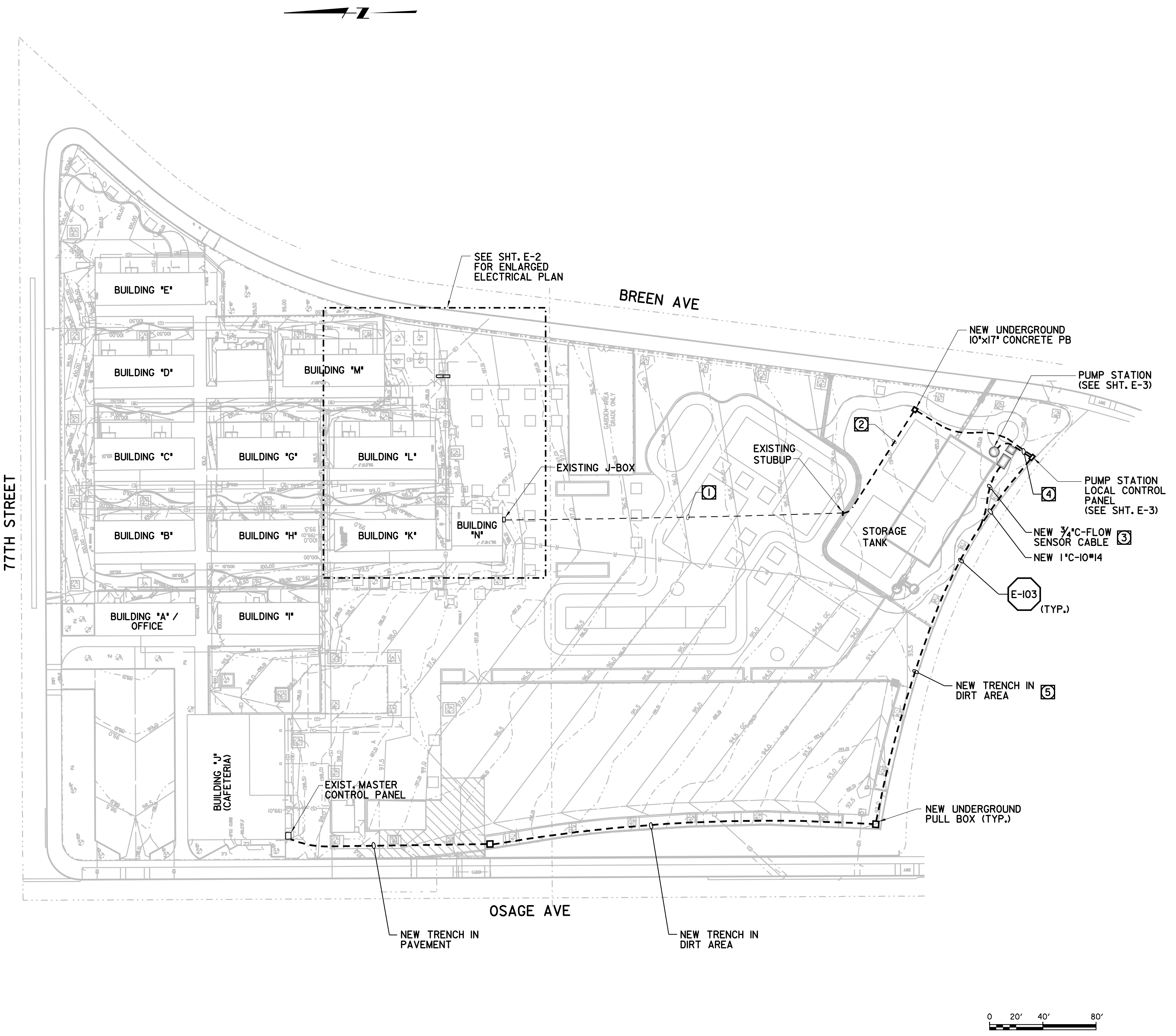
DRAWING NO.: GE-I

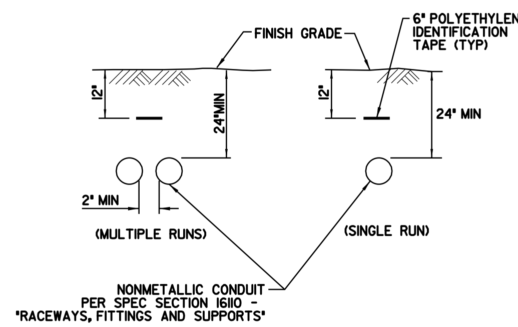
CHECKED BY: P. PHAM

DATE: I7-OCT-2002

INDEX NO.

Job No: I02650 File: P:\Projects\la_unified\open charter\ele\ocge01.dgn

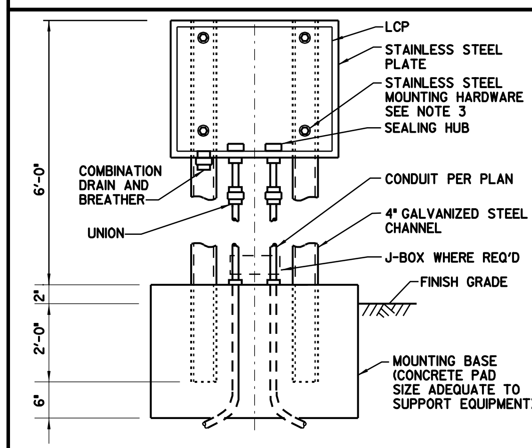




NOTES:

1. NUMBER AND SIZE OF CONDUITS PER PLAN AND CONDUIT SCHEDULES.

TYPICAL DUCT BANK — E-103



1. LOCAL CONTROL PANEL SHALL MEET ENVIROMENTAL CONDITIONS.
2. NO. AND SIZE OF CONDUITS PER PLAN DWGS.
3. SIZE AND LOCATION PER MANUFACTURER RECOMMENDATIONS.

LOCAL CONTROL PANEL INSTALLATION — E-504

NOTES:

1. EXISTING 1½" CONDUIT. INSTALL 3#2 & 1#6GRD.
2. TAP EXISTING 1½" CONDUIT AND EXTEND TO NEW PUMP CONTROL PANEL AND INSTALL 3#2 & 1#6GRD.
3. FLOW SENSOR VENDOR CABLE SHALL BE ARIZONA ELECTRIC FABRICATION INC. PRODUCT #9516-2SP.
4. FOR DETAILS, SEE SHT E-3
5. INSTALL NEW 1"C-10#14 AND ¾"C-FLOW SENSOR CABLE IN SAME TRENCH.

REGISTERED PROFESSIONAL ENGINEER — PHOENIX H. PHAM — No. E016254 — Exp. ____ — ELECTRICAL — STATE OF CALIFORNIA

DESIGN & INSPECTION BRANCH
FACILITIES SERVICES DIVISION
355 NORTH GRAND AVENUE LOS ANGELES CALIFORNIA
LOS ANGELES UNIFIED SCHOOL DISTRICT · BOARD OF EDUCATION

D.S.A. STAMP

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL: OPEN CHARTER MAGNET SCHOOL, 5540 W. 77TH STREET, LOS ANGELES, CA 90045

ELECTRICAL SITE PLAN

MWH — MONTGOMERY WATSON HARZA — Pasadena, California

REVISIONS
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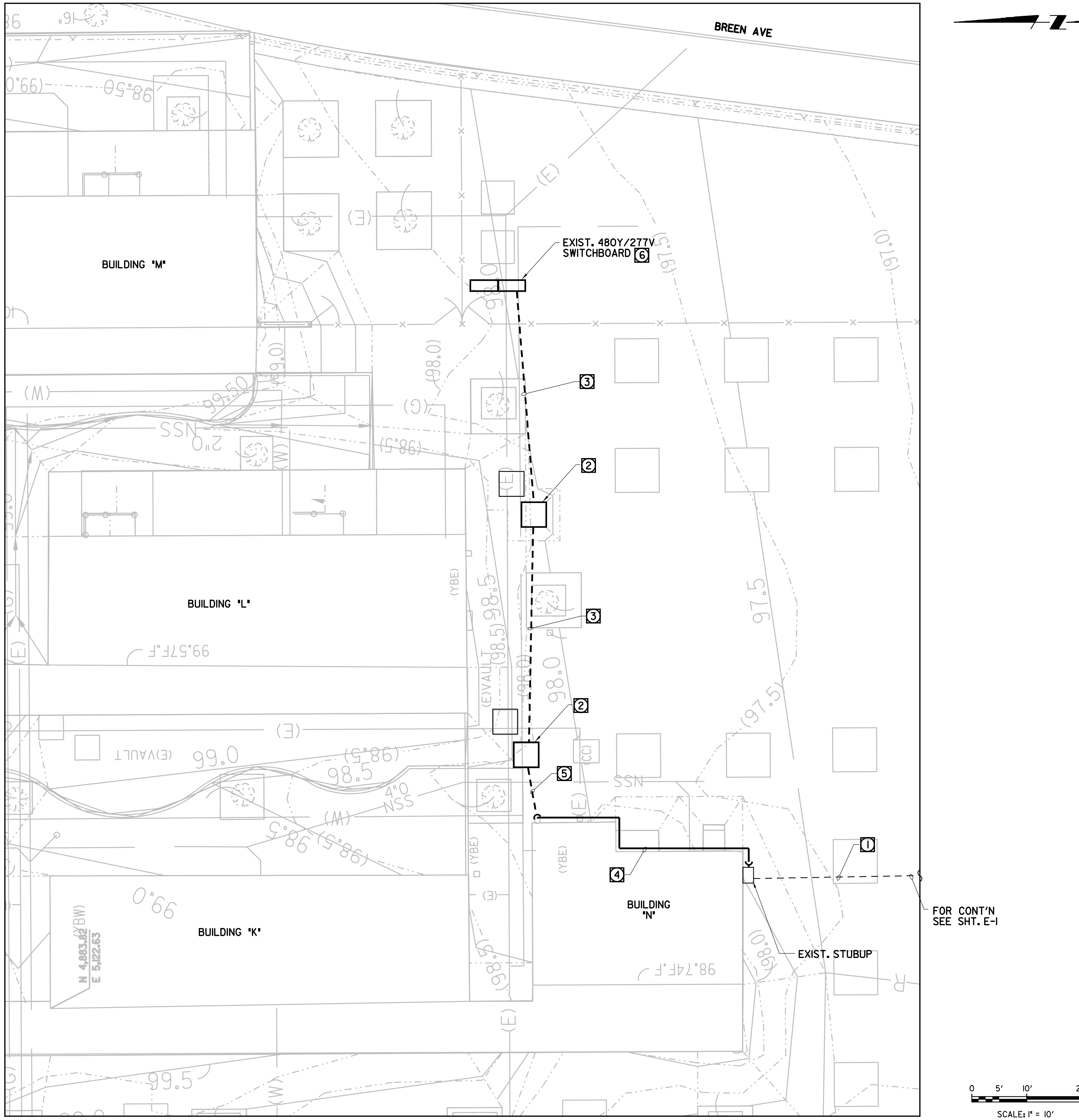
DATE: 17-OCT-2002	INDEX NO.

Job No: 1026510 File: P:\Projects\la_unified\open charter\ele\oce01.dwg



NOTES:

1. EXISTING 1½" CONDUIT. INSTALL 3-#2 & 1-#6 GRD
2. EXISTING POWER PULL BOX.
3. EXISTING SPARE CONDUIT. INSTALL 3#2 & 1#6 GRD.
4. NEW 1½"C-3#2 & 1#6 GRD. INSTALL CONDUIT EXPOSED ON THE WALL ALONG SIDE EXISTING CONDUITS AND PAINT TO MATCH EXISTING.
5. SAW CUT EXISTING CONCRETE AND INSTALL 1½"C-3#2 & 1#6 GRD AND REPAIR ASPHALT TO DISTRICT SATISFACTION.
6. INSTALL A 60A, 3 POLE CIRCUIT BREAKER AT AVAILABLE SPACE AT EXISTING SWITCHBOARD TO FEED NEW PUMP STATION.

DESIGN & INSPECTION BRANCH
FACILITIES SERVICES DIVISION
355 NORTH GRAND AVENUE LOS ANGELES CALIFORNIA

D.S.A. STAMP

ELECTRICAL SITE PLAN-PARTIAL

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL: OPEN CHARTER MAGNET SCHOOL
5540 W. 77TH STREET
LOS ANGELES, CA 90045

MWH MONTGOMERY WATSON HARZA
Pasadena California

REVISIONS
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JOB NUMBER	
DRAWN BY: N. CHRAKIAN	DRAWING NO. E-2
CHECKED BY: P. PHAM	
DATE: 17-OCT-2002	INDEX NO.

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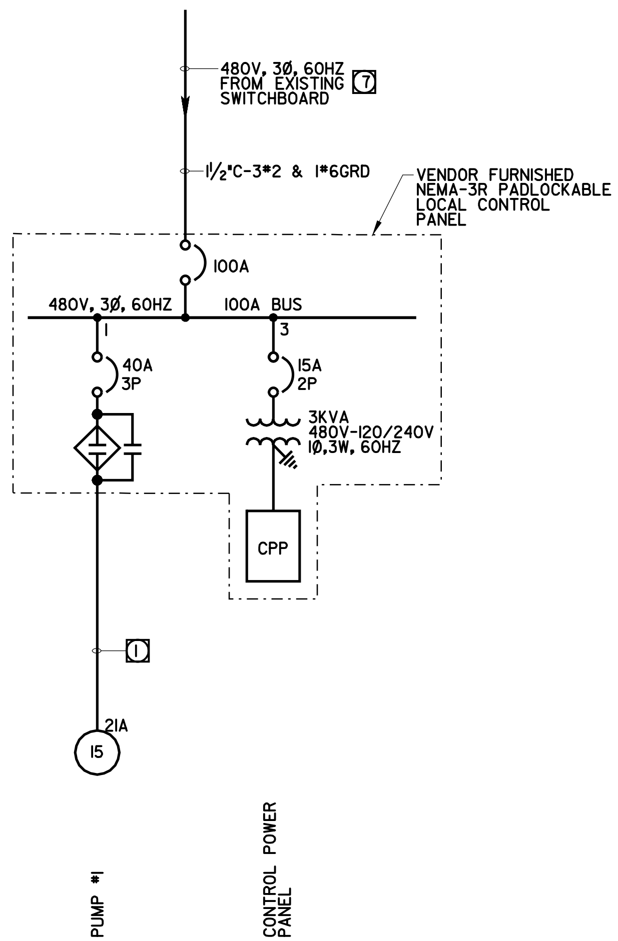
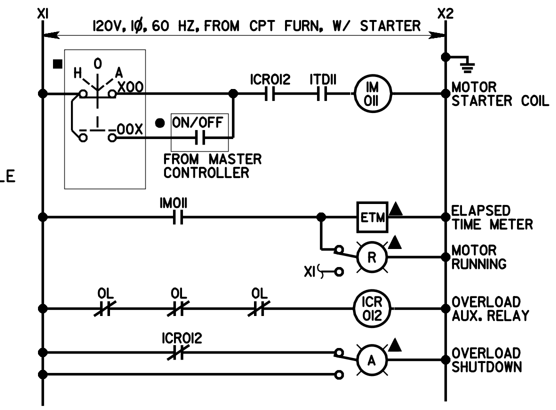
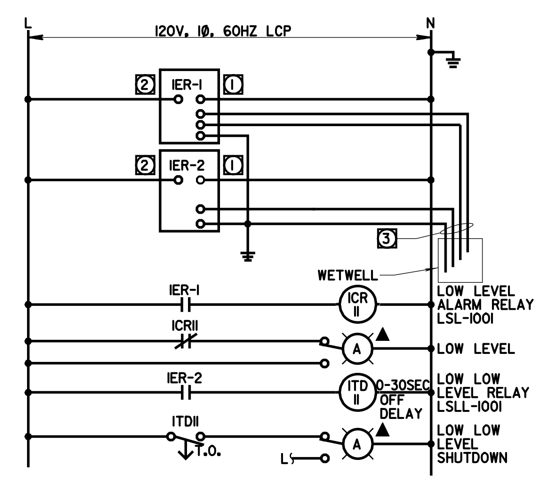


SINGLE LINE DIAGRAM



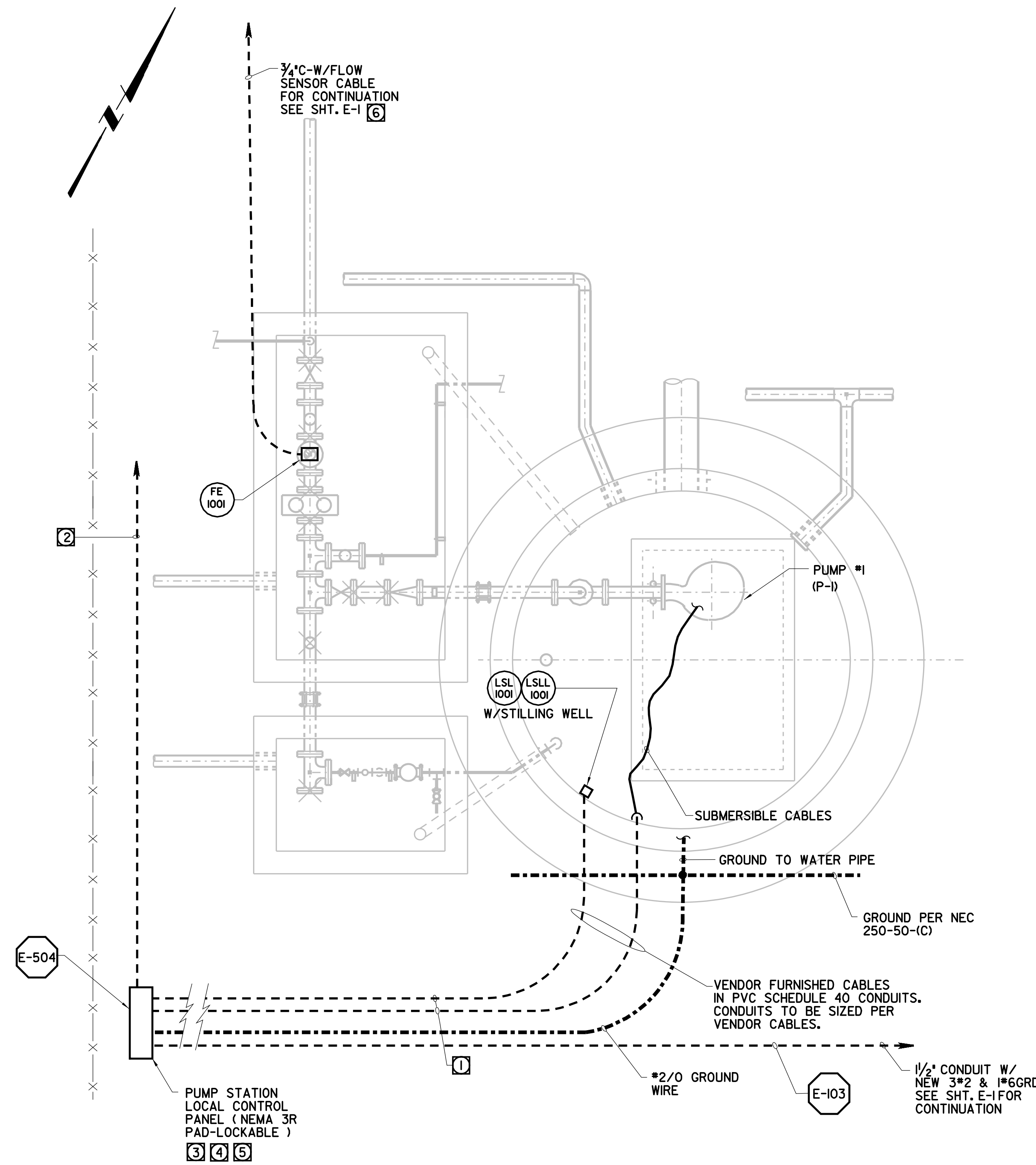
PUMP P-1 STARTER



ICR11 (N. O.) ------- LOW LEVEL
ITD11 (T. O.) ------- LOW LOW LEVEL } TO LCP

1 LEVEL RELAY B/W CONTROLS SERIES 53 OR EQUAL.
2 ONE LEVEL OPERATION.
3 ELECTRODE OR FLOAT SWITCH, LEVEL TO BE DETERMINED BY PROCESS REQUIREMENTS.

WET WELL LEVEL CKT.
(ALL ITEMS LOCATED AT LCP UNLESS OTHERWISE NOTED)



NOTES:

1. VENDOR FURNISHED SUBMERSIBLE CABLES IN PVC CONDUITS. CONDUITS TO BE SIZED PER VENDOR FURNISHED SUBMERSIBLE CABLES.
2. 1"C-10#14.(FOR CONTINUATION, SEE SHT E-1)
3. FOR EXACT LOCATION OF THE LOCAL CONTROL PANEL, SEE SHT. E-1. MOUNT LCP ON FIELD FABRICATED RACK.
4. EXPOSED CONDUIT RISERS TO THE PANEL SHALL BE RIGID STEEL GALVANIZED.
5. INSTALL ONE GFCI TYPE RECEPTACLE INSIDE THE LCP.
6. FLOW SENSOR VENDOR CABLE SHALL BE ARIZONA ELECTRIC FABRICATION INC PRODUCT # 9516 - 2 SP
7. APPROXIMATE DISTANCE BETWEEN EXISTING SWITCHBOARD AND NEW LOCAL CONTROL PANEL IS 580'. THE VOLTAGE DROP IS 3.2% FOR 80A MAXIMUM LOAD.

Job No: 102651O File: P:\Projects\la_unified\open charter\ele\oce03.dwg

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D.S.A. STAMP

SINGLE LINE DIAGRAM & PUMP STATION PLAN

PROJECT: STORMWATER BEST MANAGEMENT PRACTICES DEMONSTRATION PROJECT

SCHOOL: OPEN CHARTER MAGNET SCHOOL 5540 W. 77TH STREET LOS ANGELES, CA 90045

MWH MONTGOMERY WATSON HARZA
Pasadena California

REVISIONS

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CHECKED BY P. PHAM	
DATE 17-OCT-2002	INDEX NO.

Operation, Maintenance, And Inspection Costing

There are several operation, maintenance and inspection tasks which have been identified for this project and serve to assist in the estimate of the annual costs. The following is a discussion on the specific tasks as well as the assumptions made to complete these tasks. An activity schedule has been developed as well which helps in determining when specific tasks are expected to be done throughout the year. Travel time to and from the site are included in the hours associated with all tasks. Based on the tasks and assumptions at Open Charter, costs were estimated and presented as an Equivalent Uniform Annual Cost. Below is a schematic of the project process.

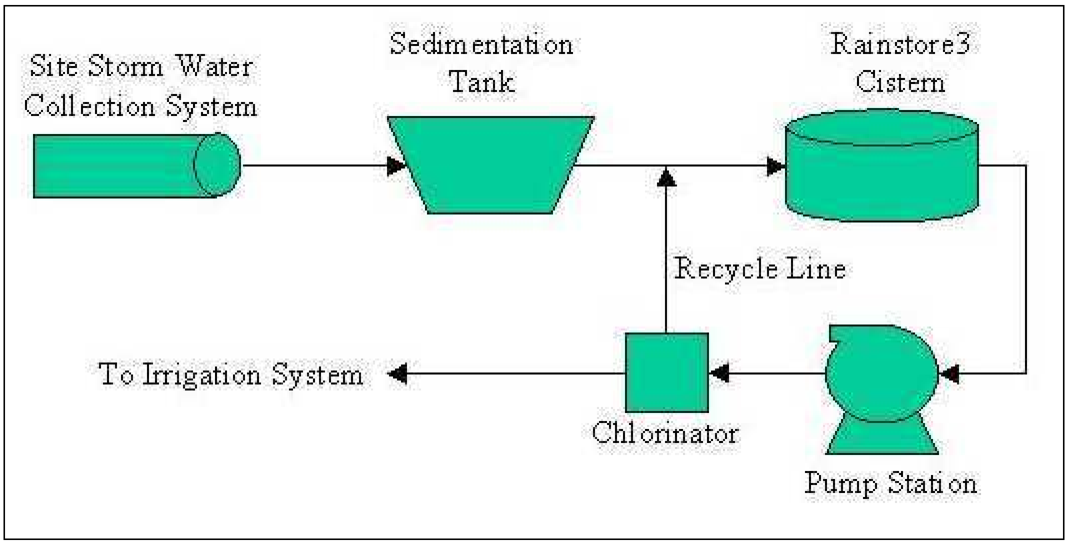

Figure 1
Open Charter School Stormwater Treatment and Retention Process

OPERATION COST ESTIMATE

Pumps
The pumps electrical power consumption is based on turning the pump on once every day (assuming there is enough water in the system) for 20 minutes to sufficiently irrigate at the school. The pumping is required as part of the recycle system, pumping water back to the beginning of the Rainstore3 cistern.

The total volume of the Rainstore3 cistern is 776,000 gallons. Assuming the cistern fills up once a year and that it will be emptied completely by the end of the year, approximately one hour of pumping is required once a day during a six month period. Therefore, for this cost estimate, it is assumed that for 180 days during the year, the pumps will be in operation for one hour and 20 minutes and for 185 days the pumps will be in operation for 20 minutes.

Chlorinator

Each month, as part of the operation of this system, an operator must replace the chlorine tablets in the chlorinator. The type of chlorine tablets recommended by the manufacturer of the chlorinator is the Accu-tab tablets, which have a silica inhibitor added. For the safety of the operator and proper operation of the system, the replacement tablets must be Accu-Tab Tablet from PPG Industries, or approved equal. This maintenance task begins with the unlocking and lifting the hatch door opening on the chlorinator vault. The inlet valve must then be closed. The lid of the chlorinator is then unscrewed and the canister is then removed from the chlorinator. The tablets in the canister are removed and replaced with three new Accu-Tab tablets. The canister is then placed back into the chlorinator, and the lid is tightly secured to the top of the chlorinator. The operator must ensure that the gasket is clean and properly seated in place. A silicon oil or lubricant may be used on the gasket o-ring. The inlet valve is then returned to its normal "open" position and the vault hatch door closed and locked. Those steps must be repeated every month. The operator must properly dispose of the tablets that were removed from the chlorinator. This procedure is estimated to take one operator two hours to complete.

Labor Requirements: *24 hours/year*

Replacement Parts

The scheduled maintenance of the Local Control Panel (LCP) is expecteed to require replacement parts. It is estimated that the total cost of these replacement parts for the LCP will be $250 every five years. These replacement parts will ensure the proper operation of the LCP during the life span of the system.

The duplex filter located on the discharge line of the distribution system has an expected life span of 5 years. The cost of the replacement filter is expected to be $50. The replacement of the duplex filter is similar to the steps taken during the regular cleaning of the duplex filter. A description of this procedure is located in the Duplex Filter Maintenance Section below.

The replacement of the pumps is expected to occur at the end of their life span. It is estimated that these pumps will require replacement at the end of 10 years.

Replacement Cost: LCP *$250/five years*
Replacement Cost: Duplex Filter: *$50/five years*
Replacement Cost: Pumps *$11,000 at the end of ten years*

MAINTENANCE COST ESIMATE

Pumps

The maintenance of the pumps is vital to the system's life span. It is assumed that both pumps should be removed and inspected every year. Each pump must be taken offline, removed from the wet well and inspected. Removal of pumps will require the unlocking of the hatch doors over the wet well and removal of the pumps using a hoist. It is assumed that it will take a crew of two persons one day to remove and inspect both pumps.

Labor Requirements: *16 hours/ year*

Collection System

To ensure that the collection system is working properly it is recommended that the stormwater catch basins and overflow drain be cleaned three times every year. The cleaning of the collection system requires the removal of all obstructions from the three catch basins and the parkway drain. The cleaning of the catch basin will require the removal of the grating above the catch basins and the extraction of all solid waste in the catch basins. The parkway drain must also be cleaned of all obstacles so flow through the conduits is not blocked. These tasks are estimated to take two maintenance workers four hours to complete.

Labor Requirements: *24 hours/year*

Duplex Filter

It is expected that the duplex filter will require cleaning every month. This maintenance is required to ensure that the system is working properly. Both the upstream and downstream gate valves must be closed before removing the duplex filter. The duplex filter should then be rinsed with potable water to remove sediment trapped in it. Once the filter has been re-installed, the maintenance worker must return the upstream and downstream gate valves to the normal "open" status. It is estimated that it will take one worker one hour to complete these tasks and that they will be done at the same time as other site tasks. The duplex filter if worn or damaged, must be replaced. It is assumed that this filter will require replacing every five years.

Labor Requirements: *12 hours/year*

Local Control Panel (LCP)

Maintenance for the LCP has been estimated as requiring service twice a year. This maintenance involves the tightening of all bolts, checking for corrosion, and the removal/replacement of all parts that are not functioning properly. It is assumed that it will require one skilled maintenance worker four hours to complete this task.

Labor Requirements: *8 hours/year*

Rainstore3 System

It is expected the sediments from the Rainstore3 system will need to be pumped out once every year. It is assumed that this task will require two maintenance workers a total of eight hours to complete. Maintenance will require a sump pump to remove sediments that have accumulated at the bottom of the Rainstore3 system. This sump pump must be able to fit into the Rainstore3 system through the access ports. The sump pump is not included in this estimate.

Labor Requirements: *16 hours/year*

Chlorinator

The chlorination system is expected to require maintenance twice every year. This maintenance will require the closing of the isolation valves on either side of the chlorinator. After the chlorinator is isolated, the lid and the canister must be removed. The chlorinator is then filled with a diluted solution of muriatic acid. After 20 minutes, the solution is completely drained through the drain valve near the chlorinator into a removable bin and disposed of properly. It would also be beneficial to replace the chlorination tablets at this time. After the chlorinator is drained of the acid, the drain valve must be shut. The canister, with the chorine tablets, is then placed back into the chlorinator and the lid placed tightly. The isolation vales are then returned to their normally open positions and the vault door shut and locked. This maintenance task is expected to take one maintenance personnel two hours to complete.

Labor Requirements: *4 hours/year*

Sedimentation Tank

There are two chambers in the sedimentation tank that need periodic cleaning. One of the chambers is the sedimentation chamber, the other is an oil and grit chamber located next to each other inside the sedimentation tank. The sedimentation chamber must be cleaned when the buildup of sediment reaches within six inches of the water service level in the sedimentation chamber. This is expected to occur once every year and will require a Vacutruck to vacuum out and remove the collected sediment. It is assumed that this maintenance will be contracted out and will include the removal and disposal of the sediment. It is assumed that the contents for the sediment from the sediment chamber will be classified as non-hazardous material and that the total quantity of waste should not exceed 750 gallon of liquid/solid waste.

The oil and grit chamber must also be cleaned periodically. When the thickness of the oil layer in this chamber reaches a thickness of three inches that it will require removal from the chamber. It is estimated that this will occur every two years. It is assumed that the contents from the oil/grit chamber of the sedimentation tank be removed every two years. It is assumed that this waste will be classified as hazardous waste and its quantity will not exceed 60 gallons.

Before removal of the sediment and/or oils from the sedimentation tank, its contents must be classified. A licensed disposal company must be contracted to test and classify the contents of the sedimentation tank. After this procedure is completed, the sediment from the sediment chamber of the must be removed. Access to the sediment chamber requires that only the manhole cover over the chamber be removed. Collection and disposal of this material must be conducted by a licensed waste disposal company.

The costs have been determined from quotes from waste disposal companies. Access to the grit/oil chamber is through a separate manway lid. Entry into the sedimentation tank either to the sedimentation chamber or to the oil/grit chamber is not required.

Labor Requirements: *Contracted out*

INSPECTION COST ESTIMATE

Rainstore3 System and Sedimentation Tank

Both the Rainstore3 system and the sedimentation tank are expected to buildup sediments over the year. Inspection of the two systems should take place three times every year. The inspection of the Rainstore3 system requires the removal of the lid of each maintenance port. There are a total of four provided. Also, as part of the inspection of the Rainstore3 system, the distance from the top of the maintenance port to the bottom of the system must be measured. This distance will vary from port to port based on the sediment buildup and the finished grade elevation of the port.

The time required to inspect the Rainstore3 system is included in the time required to inspect the sedimentation tank.

The inspection of the sedimentation tank should take place at the same time as the inspection of the Rainstore3 system. The procedures recommended by the manufacture must be followed. For both systems, it is recommended that a log be maintained to determine the buildup of sediments throughout the life of the system. A log from the sedimentation tank manufacturer is available. It is estimated that this task will require four hours of one maintenance worker to complete. This inspection task should take place three times every year.

Labor Requirements: *12 hours/year*

Entire System

The inspection of the entire system is recommended to occur three times each year. This general inspection should include the testing of the double check valve at the connection point of the system, all of the isolation valves, the check valves and both the Pressure Release Valves (PRVs). Valves should be check to ensure that they are working properly. The sensors and electrical connection of the system should also be checked. Repairs should be made as necessary. This task is estimated to take one maintenance personnel four hours to inspect the system.

Labor Requirements: *9 hours/year*

Cost Estimate Summary

The annual O&M cost was calculated using the Equivalent Uniform Annual Cost (EUAC). These costs are listed in **Table 2**. The annual interest rate used to calculate the EUAC is 8%. The lifespan of the system is estimated as 20 years.

Table 2
Open Charter School
Operation, Maintenance, and Inspection Cost Estimate

ITEM	$ / Year
Operation	
Pumps	$251.52
Chlorinator	$1,440.00
Replacement Parts	$2,177.95
Operation Subtotal	*$3,869.47*
Maintenance	
Pumps	$960.00
Chlorinator	$240.00
Collection System	$1,440.00
Duplex Filters	$720.00
Local Control Panel	$480.00
Rainstore3	$530.97
Sedimentation Tank	$1,979.64
Maintenance Subtotal	*$6,350.61*
Inspection	
Rainstore3 & Sedimentation Tank	$720.00
Entire System	$540.00
Chlorine Tablets	$110.00
Inspection Subtotal	*$1,370.00*
Subtotal	*$11,600*
Contingency 20 %	$2,320
TOTAL ANNUAL COST	**$13,920**

Table 3
Yearly Operation, Maintenance & Inspection Activity Schedule*

	January	February	March	April	May	June	July	August	September	October	November	December
OPERATION	Remove & Refill Chlorine Tablets (3)	Remove & Refill Chlorine Tablets (3)	Remove & Refill Chlorine Tablets (3)	Remove & Refill Chlorine Tablets (3)	Remove & Refill Chlorine Tablets (3)	Remove & Refill Chlorine Tablets (3)	Remove & Refill Chlorine Tablets (3)	Remove & Refill Chlorine Tablets (3)	Remove & Refill Chlorine Tablets (3)	Remove & Refill Chlorine Tablets (3)	Remove & Refill Chlorine Tablets (3)	Remove & Refill Chlorine Tablets (3)
MAINTENANCE										Sediment Removal from Sed. Tank		
										Remove & Inspect Pumps		
	Clean Collection System			Clean Collection System						Clean Collection System		
	Cleaning of Duplex Filter	Cleaning of Duplex Filter	Cleaning of Duplex Filter	Cleaning of Duplex Filter	Cleaning of Duplex Filter	Cleaning of Duplex Filter	Cleaning of Duplex Filter	Cleaning of Duplex Filter	Cleaning of Duplex Filter	Cleaning of Duplex Filter	Cleaning of Duplex Filter	Cleaning of Duplex Filter
				Service Chlorinator						Service Chlorinator		
				Service LCP						Service LCP		
INSPECTION	Inspect Sediment Buildup in Rainstore3 & Sed. Tank			Inspect Sediment Buildup in Rainstore3 & Sed. Tank						Inspect Sediment Buildup in Rainstore3 & Sed. Tank		
	Inspect System			Inspect System						Inspect System		

*Does not include removal of oil/grit from the sedimentation tank which is assumed to occur every two years

Open Charter Magnet School
Water Retention System
OPERATION, MAINTENANCE & INSPECTION SUPPLEMENT
October 20, 2007
Richard Haimann, P.E.

This supplemental guide has been prepared to provide specific operations, maintenance and inspection guidance to operators of the water retention system at the Open Charter Magnet School.

Operation, Maintenance, And Inspection

There are several operation, maintenance and inspection tasks that have been identified for this project. The following is a discussion on the specific tasks as well as the assumptions made to complete these tasks. An activity schedule (Table 1) has been developed as well which helps in determining when specific tasks are expected to be done throughout the year.

Figure 1 shows a schematic of the water retention system as it is currently believed to be configured.

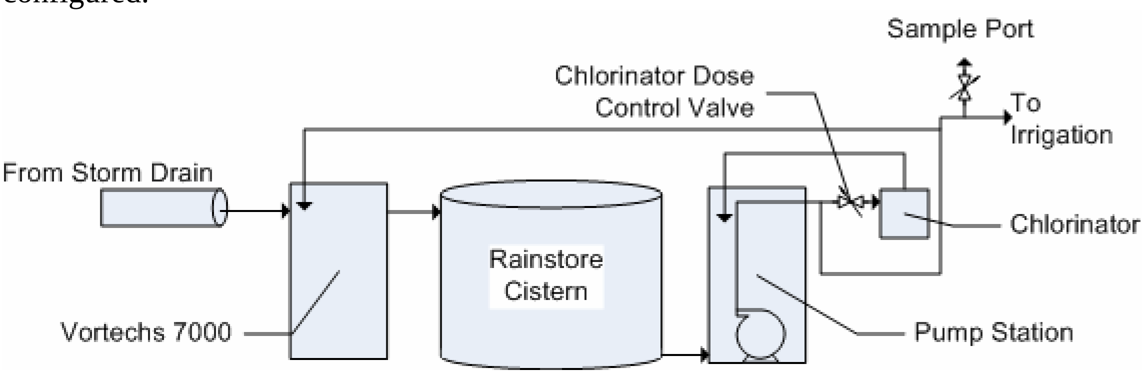

Figure 1: Open Charter School Stormwater Treatment and Retention Process

System Operation

Overall system operation is expected to require minimal operator attention. As it rains, the Cistern will fill with water. The Cistern can hold approximately 110,000 gallons. There is an overflow pipe that leads to a stormdrain. If the Cistern overfills, the additional water will drain to the storm drain.

The water level in the pump station should match the water level in the cistern. When the water level in the pump station is **above the low level set**, the valves should be set so that irrigation occurs from cistern water rather than from public water. When the water level in the pump station is **below the low level set**, the valves should be set so that irrigation occurs from public water rather than cistern water. The water level in the pump station **should not be allowed to drop to the low low level set**, which requires resetting the pump. During Irrigation, the operator should watch the level lights on the control panel and adjust the valves when the water level drops to the **low level set**.

The chlorinator is designed to work fairly automatically. The valves on the chlorinator allow a portion of the water to flow through the chlorinator and back to the pump station. The remaining pump station water flows to the irrigation system with a portion recycled to the cistern.

The **optimal residual chlorine** in the irrigation water is **0.2 ppm of free chlorine**. The **maximum residual chlorine** that can be in the irrigation water is **2 ppm free chlorine**. Higher spikes of free chlorine are not likely to damage vegetation. However, typical free chlorine concentrations should be managed to be **as close to 0.2 ppm of free chlorine as possible**. Do **not allow the free chlorine levels to drop below 0.2 ppm**. Free chlorine should be measured at the sample port prior to the irrigation system as shown in Figure 1. Free chlorine can be measured with a variety of available test kits or instruments that are typically used for swimming pool system inspections. Note, the instrument should be measuring **free chlorine** and **not total chlorine**.

To manage the chlorine dose, adjust the recycle valve during system operation (i.e. during irrigation) until the free chlorine at the sample port is **near, but above 0.2 ppm**. Note, the amount of chlorine required may vary based on temperature, time of year, and quality of influent water which may vary randomly. It is important to routinely measure free chlorine in the irrigation water to ensure adequate operation.

Occasionally, chlorine tablets will need to be added as they are consumed. Frequency of addition will depend on chlorine demand of the water and amount of rain and use of the system. It is recommended that chlorine **tablets be inspected monthly**. Each month, as part of the operation of this system, an operator must inspect the chlorine tablets in the chlorinator. The type of chlorine tablets recommended by the manufacturer of the chlorinator is the **Accu-tab tablets**, which have a silica inhibitor added. For the safety of the operator and proper operation of the system, the replacement tablets must be **Accu-Tab Tablet from PPG Industries**, or approved equal. This task begins with the unlocking and lifting the hatch door opening on the chlorinator vault. The inlet valve must then be closed. The lid of the chlorinator is then unscrewed and the canister is then removed from the chlorinator. The tablets in the canister are inspected and, if they are degraded, removed and replaced with three new Accu-Tab tablets. The canister is then placed back into the chlorinator, and the lid is tightly secured to the top of the chlorinator. The operator must ensure that the gasket is clean and properly seated in place. A silicon oil or lubricant may be used on the gasket o-ring. The inlet valve is then returned to its normal "open" position and the vault hatch door closed and locked. Those steps must be repeated every month. The operator must properly dispose of the tablets that were removed from the chlorinator. This procedure is estimated to take one operator two hours to complete.

MAINTENANCE

When possible, schedule all maintenance activities during dry weather, typically at least 3 days following a rainfall event.

Collection System

To ensure that the collection system is working properly it is recommended that the stormwater catch basins and overflow drain be cleaned **three times every year** – once **before the rainy season starts** (October 1), once **mid-way through the rainy season**, and once toward the **end of the rainy season** (April). Should inspections show that more frequency maintenance is needed due to accumulation of sediment or debris, increase inspection and maintenance frequencies. The cleaning of the collection system requires the removal of all obstructions from the catch basins and the parkway drains. The cleaning of the catch basin will require the removal of the grating above the catch basins and the extraction of all solid waste in the catch basins. The parkway drain must also be cleaned of all obstacles so flow through the conduits is not blocked. If sediments are accumulated in the catch basins, they are to be removed. A vacuum truck or manual methods may be used.

Vortechs 7000

There are three chambers in the separator that need periodic cleaning. The upstream chamber is the sedimentation chamber, the second is an oil trash chamber, and the downstream is a flow control chamber that may accumulate some sediments or trash. . The sedimentation chamber must be cleaned when the buildup of sediment reaches within six inches of the water service level in the sedimentation chamber. This is expected to occur once every year and will require a Vac-truck to vacuum out and remove the collected sediment and associated water. Inspect **3 times per rainy season** – once just **before the rainy season** (October 1), once **mid-way through the rainy season**, and once at the **end of the rainy season** (April). If inspections suggest more frequent maintenance is required, increase maintenance frequencies.

The oil and trash and flow control chambers must also be cleaned periodically. When the thickness of the **oil** layer in either of these chambers reaches a thickness of **three inches** then it will **require removal** from the chamber. It is estimated that this will occur every two years, if at all. When **trash** has accumulated in either of these chambers any measurable thickness, it **will require removal**.

The operator may install **oil Sorbent pillows** or pads in accordance with manufacturer's instructions should oil accumulation occur. If oil Sorbent pads or pillows are used, they are to be replaced annually or when a sheen of oil is observed, whichever occurs first.

Before removal of the sediment, trash, and/or oils from Vortechs 7000, its contents must be classified. A licensed disposal company must be contracted to test and classify the contents of the Vortechs unit. After this procedure is completed, the sediment, trash, and/or oil must be removed. Access requires that only the manhole cover over the chamber be removed. Collection and disposal of this material must be conducted by a licensed waste disposal company.

Materials removed are not likely to be hazardous waste. If a spill of hazardous wastes or materials has occurred upstream of the system, then the accumulated materials may be hazardous waste. If the operator is uncertain, then the materials should be profiled in accordance with applicable hazardous waste regulations.

Rainstore3 System

It is expected that sediments will not accumulate significantly in the Rainstore3. However, given the possibility of sediment accumulation, **3 access ports** have been installed beneath the sod in the field over the Rainstore3. **Once per year**, typically just **prior to the rainy season** (October 1), the Rainstore3 should be inspected by **locating the access ports**, **removing overlying sod**, opening the ports, and **sounding the depth to the bottom** of the Rainstore3 systems. The **bottoms** of the Rainstore3 systems installed should be approximately **8.5 to 8.75 feet below the finished grade**.

If the depths sounded are significantly less than 8.5 feet below the finished grade (e.g. 7.5 feet below the finished grade), the sediments will need to be removed. This can be accomplished by lowering the stinger of a vacuum truck into the access port to the bottom and removing the sediments as necessary. Water may need to be injected should the sediments be dry. This would need to be done at each of the three access ports.

Pumps

The maintenance of the pumps is vital to the system's life span. Pumps should be **removed and inspected every year**. Each pump must be taken offline, removed from the wet well and inspected. Removal of pumps will require the unlocking of the hatch doors over the wet well and removal of the pumps using a hoist. Inspect impellers, seals, bearings, electrical connections. Replace any damaged parts or replace pumps, if necessary. Repack bearings in fresh grease as necessary. Replace seals as necessary. Reassemble in accordance with manufacturer's instructions.

Chlorinator

The chlorination system is expected to require **maintenance twice every year**. Note, this is in addition to the monthly inspection and potential addition of chlorine tablets. This maintenance will require the closing of the isolation valves on either side of the chlorinator. After the chlorinator is isolated, the lid and the canister must be removed. The chlorinator is then filled with a **diluted solution of muriatic acid**. After 20 minutes, the solution is completely drained through the drain valve near the chlorinator into a removable bin and disposed of properly. It would also be beneficial to replace the chlorination tablets at this time. After the chlorinator is drained of the acid, the drain valve must be shut. The canister, with the chorine tablets, is then placed back into the chlorinator and the lid placed tightly. The isolation vales are then returned to their normally open positions and the vault door shut and locked. This maintenance task is expected to take one maintenance personnel two hours to complete.

Strainers

Inspect the strainers **3 times during the rainy season** and, if filled with debris, remove the debris.

Local Control Panel (LCP)
Maintenance for the LCP has been estimated as requiring **service once a year**. This maintenance involves the tightening of all bolts, checking for corrosion, and the removal/replacement of all parts that are not functioning properly.

INSPECTION

Vortechs 7000
The inspection of the Vortechs unit should take place **three times per rain season –** once just **prior to the rainy season** (October 1), once **midway through the rainy season**, and once at the **end of the rainy season** (April). Should inspections reveal that the Vortechs unit is filling and requiring maintenance more frequently, more frequent inspections should be scheduled. The procedures recommended by the manufacture must be followed. It is recommended that **a log be maintained** to determine the buildup of sediments **throughout the life** of the system. A log from the Vortechs unit manufacturer is available. The purpose of the inspection is to measure the accumulation of sediments, trash/debris, and oil and grease in the system and schedule its removal as necessary. Typical inspection procedures would include removing manhole covers and measuring the **depth to sediments, the thickness of accumulated debris, and the thickness of accumulated oils**. If the depth to sediments shows that sediment accumulation is **within 6 inches of the fill line, then removal** is required. If there is measurable thickness of accumulated debris then removal is required, If the oil thickness is 3 inches or more, or oil shows, then removal is required. At a minimum, irrespective of the thickness of oil or debris, **annual removal** is recommended.

Rainstore3 System
The Rainstore3 system should take place **once every year prior to the rainy season** (October 1). The inspection of the Rainstore3 system requires the removal of the lid of each maintenance port. Also, as part of the inspection of the Rainstore3 system, the distance from the top of the maintenance port to the bottom of the system must be measured. This distance will vary for each port based on the sediment buildup and the finished grade elevation of the port. Based on the as-built drawings, the **depths to the bottom** of the Rainstore3 system from the finished grade are expected to be from **8.5 to 8.75 feet**. Should the depths be significantly less than this (e.g. 7.5 feet), then removal of accumulated sediments is required.

Entire System
The inspection of the entire system is recommended to occur **three times each year**. This general inspection should include the testing of all check valves, all of the isolation valves, the Pressure Release Valves (PRVs), and all other valves. Valves should be checked to ensure that they are working properly. The sensors and electrical connection of the system should also be checked. Repairs should be made as necessary. Structural elements should be inspected.

Table 1
Yearly Operation, Maintenance & Inspection Activity Schedule

	January	February	March	April	May	June	July	August	September	October	November	December
OPERATION	Inspect & Refill Chlorine Tablets (3)	Inspect & Refill Chlorine Tablets (3)	Inspect & Refill Chlorine Tablets (3)	Inspect & Refill Chlorine Tablets (3)	Inspect & Refill Chlorine Tablets (3)	Inspect & Refill Chlorine Tablets (3)	Inspect & Refill Chlorine Tablets (3)	Inspect & Refill Chlorine Tablets (3)	Inspect & Refill Chlorine Tablets (3)	Inspect & Refill Chlorine Tablets (3)	Inspect & Refill Chlorine Tablets (3)	Inspect & Refill Chlorine Tablets (3)
MAINTENANCE									Sediment, oil, trash removal from Vortechs			
									Sediment removal from Rainstore3			
									Remove & Inspect Pumps			
	Clean Collection System			Clean Collection System					Clean Collection System			
				Service Chlorinator					Service Chlorinator			
									Service LCP			
INSPECTION	Inspect Vortechs			Inspect Vortechs					Inspect Vortechs			
									Inspect Rainstore3			
	Inspect Strainers			Inspect Strainers					Inspect Strainers			
	Inspect System			Inspect System					Inspect System			

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