APPENDIX N

Mariposa Lakes Master Drainage Plan –
Part A, Description of Stormwater Facilities

PACIFIC ADVANCED CIVIL ENGINEERING, INC.

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September 27, 2006 #8013E

City of Stockton
c/o David Wade
Wade & Associates
7777 Campus Common Dr., Suite 200
Sacramento, CA 95825

Re: Responses to the City of Stockton comments on:

Mariposa Lakes Master Drainage Plan- Part A, Description of Stormwater Facilities (8/8/06), and
Mariposa Lakes Master Drainage Plan Part B, Numerical Modeling of Stormwater Facilities (8/8/06).

Dear Mr. Wade:

Pacific Advanced Civil Engineering, Inc. (PACE) is pleased to provide the following responses to the City of Stockton and Peterson, Brustad, and Pivetti, Inc. review comments for the above-referenced Master Drainage Plan. Both the comments and responses from PACE are as follows:

2. Storm duration should equal time of concentration for flow-critical features*. A 24-hour storm is used throughout, yet the Off-Site Regional Hydrologic Investigation concluded that a 48-hour storm controls for Duck Creek. Also, the "Part B" report utilizes hydrology from the April 7 version of the Off-Site Regional Hydrologic Investigation, which has been superseded.*

PACE response:
Noted. The critical storm duration was developed for the Duck Creek and North Little Johns Creek watersheds. Time of concentration was computed for each regional watershed upstream of the Mariposa Lakes project boundary. The Tc for Duck Creek was computed to be 47.3 hours, while the Tc for North Little Johns Creek was 117.0 hours. Because most of the North Little Johns Creek watershed is located upstream of Farmington Dam, and because the larger flood hazard is presented by runoff from the Duck Creek watershed, the Duck Creek Tc of 47.3 hour is the critical duration. Therefore, a 48-hour 100-year storm was developed and modeled as part of this report. The statistical analysis used to derive the 48-hour rainfall depths and distributions is detailed in Section 5.1 of the Off-site Regional Hydrologic Investigation.

Part B of the Master Drainage Plan has been revised with inflow hydrographs and rainfall distributions from the September 27, 2006 submittal of the Off-Site Regional Hydrologic Investigation.

4. Report doesn't say where pond makeup water will come from, or how much water will be required. Use of groundwater for aesthetic lakes is undesireable due to critical groundwater overdraft in the area and associated saline intrusion. Discussions should be held with Stockton

East Water District to incorporate the ponds into its Farmington Recharge Program (using surface water). Ponds should be unlined to facilitate groundwater recharge. *Section 2 refers to make-up water being required, but does not identify the water source.*

PACE response:
We understand the necessity for a large-scale groundwater recharge program associated with Mariposa Lakes. Currently, there will be two groundwater recharge facilities, one adjacent to Duck Creek at the western boundary of the project, the second an off-site facility just east of the project adjacent to North Little Johns Creek on the Arbini Property. The Arbini Property will serve dual purposes, first to provide groundwater recharge, the second to provide floodwater detention storage. Water will be diverted from Duck Creek to the Arbini Property for groundwater recharge, while a side weir will allow floodwaters on North Little Johns Creek to spill into the Arbini Property during times of large flows. The downstream groundwater recharge basin will collect stormwater runoff and nuisance flows from a large industrial area to be used for groundwater recharge. More discussion on these facilities can be found in the Master Drainage Plan- Part B, Numerical Modeling of Stormwater Facilities (PACE, 2006).

The on-site man-made lake system will not be used for groundwater recharge. This decision was made for a variety of reasons. The primary reason is that lake levels would be more difficult to maintain in an unlined interconnected lake network. Fluctuations of water level caused by uncontrolled rates of infiltration would be difficult to plan for and balance. The second reason the lakes will be lined is because groundwater recharge basins need to be maintained as such, which requires periodic drying and scraping of the lakes. It is thought that lakefront landowners would prefer to live on a full-time lake, and that the maintenance of a recharge basin would detract from the aesthetic and recreational qualities the lakes provide.

Make-up water demand is a major focus of the Integrated Water Management Plan (Kleinfelder, 2006), which includes a project level water balance. The focus of the Master Drainage Plan is to describe the facilities and management of stormwater drainage within the Mariposa Lakes project.

5. Ponds should not ripped or plowed during maintenance. Accumulated sediment layer should be scraped. Ripping and plowing simply blends the fines deeper, and eventually causes a thicker clogging layer. *Section 4.4.4 says ponds may be tilled.*

PACE response:
Noted. References to plowing or ripping have been excluded. Regular maintenance of the groundwater recharge facilities will be described in future reports.

6. Report needs to state that operation and maintenance will be handled by a contractor, funded through assessment of Mariposa Lakes properties. *Comment has not been addressed.*

PACE response:
Noted. Section 4.4.4 of Part A of the Master Drainage Plan includes this comment.

7. Report was very broad and non-specific. Detailed on-site hydrology and hydraulics, facility layouts, and performance of the project features must be submitted. *The "Part B" document provided additional detail in response to this comment, which was good. However, it used the April 7 report hydrographs as a basis.*

PACE response:
Noted. Part B of the Master Drainage Plan has been completely rewritten and is now current with modeling results from the Off-Site Regional Hydrologic Investigation.

8. The existing and future alignment of North Littlejohns Creek indicate a segment which was historically diverted around a parcel near the east edge of the development. One theme of the development is stream restoration. It is suggested that the developer consider re-aligning and restoring this segment of stream to be more consistent with a natural plan form. Re-alignment would have hydraulic benefits, as well.

PACE response:
The developer and other consultants held discussions regarding the re-alignment of North Little Johns Creek through the project site. It was determined that there would be very little benefit, either hydraulically or in terms of re-establishing lost habitat, in re-aligning a more natural flow path along North Little Johns Creek. The habitat value of the existing channel is extremely low, and restoration of the current channel will actually create more wildlife habitat than restoring a new "cut-off" channel. Hydraulically, because channel gradients are so low, water velocities in the creek are also very low. The sharp turns in the channel present no hydraulic problems because the velocities are so low. Lastly, re-establishing a shorter, more natural flow path through the site could potentially create unnecessary jurisdictional problems by losing jurisdictional wetland area. Therefore, it was decided to focus on restoration of the current flow path of North Little Johns Creek.

Sincerely,
PACIFIC ADVANCED CIVIL ENGINEERING, INC.

Blaine K. Jones
Hydrologist

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Mariposa Lakes
Master Drainage Plan
Part A - Description of Stormwater Facilities

September 27, 2006

Prepared For:

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PACE #8013E

Table of Contents

1 Executive Summary

This report describes the stormwater facilities proposed for the Mariposa Lakes land development in Stockton, California. Proposed facilities include eleven man-made lakes, three renaturalized creeks, and twelve stormwater detention ponds. The lakes and detention ponds will serve as the stormwater treatment facilities for the project as described herein. Creeks will be renaturalized to enhance flood conveyance and wildlife habitat, and will continue to convey offsite flows across the project site.

Stormwater treatment aspects of the lakes and detention ponds will be designed to meet or exceed the requirements of the City of Stockton's Stormwater Quality Control Criteria Plan. The creeks crossing the site will be designed to safely convey the runoff from the 100-year return interval, 48-hour duration rainfall event. Onsite flood control facilities will be designed to safely detain and convey the runoff resulting from the 100-year, 48-hours design storm event. It was determined in PACE's Off-Site Regional Hydrologic Investigation (2006a) that the 48-hour, 100-year storm event is the critical design storm for the design of project stormwater facilities. The proposed level of flood protection meets or exceeds all minimum County and State requirements.

The report is one of two reports comprising the Mariposa Lakes Master Drainage Plan. This report is *Part A: Description of Stormwater Facilities*. The second part is titled *Part B: Numerical Modeling of Stormwater Facilities*. This report describes design goals and standards and the layout and function of the various stormwater facilities. Part B includes numerical modeling and analysis of all of the major stormwater facilities. The design of the streets, gutters, catch basins, and storm drain pipes within the project site will be provided by others.

2 Introduction

The Mariposa Lakes development project is proposed for a 3,800-acre site in the City of Stockton, San Joaquin County, California. The 3,800 acres of developed land will include approximately 1700 acres of residential development, approximately 180 acres of lakes, 3 restored creek channels and 12 stormwater detention basins.

Mariposa Lakes will be designed to provide high quality stormwater runoff treatment using both conventional BMPs and advanced lake stormwater treatment, and will reuse runoff and nuisance flows extensively. Man-made lakes will be centrally located within the residential portions of the project site, and runoff from land surfaces within the residential areas will drain toward the lakes. The lakes will function as wet pond stormwater treatment BMPs with stormwater treatment enhancements that will provide better stormwater treatment than a standard wet pond. This drainage arrangement will minimize stormwater runoff and non-point source pollutant loads from the site and maximize water reuse.

The lakes will require the addition of water to keep the lakes filled during dry weather. These lakes will also be used as the source of irrigation of the landscaping on public portions of the project site. As a source of irrigation water, the lakes will require additional makeup water to keep them full during much of the year. Make-up water will come from various sources, including purchased surface water conveyed down Duck Creek and/or North Little Johns Creek and pumped water. Source water for the man-made lake system is a central subject of the Integrated Water Management Plan (Kleinfelder, 2006).

In addition to the many man-made lakes, Mariposa Lakes will also utilize wet pond detention basin BMPs in the industrial and some commercial areas of the project. The wet pond BMPs will be designed to detain and treat the first flush of runoff from the site, to detain all runoff from the 100-year storm event, and possibly to possibly serve as groundwater recharge basins. Detention basins will have pump systems to discharge captured water to adjacent creeks after suitable detention times.

This report describes the underground drainage system, the man-made lakes, the BMP detention basin facilities, and the restored creek channels proposed for Mariposa Lakes.

3 Design Standards for Stormwater Facilities

3.1 Peak Flow Design Storm

Lakes, detention basins, creek channels, canals and connections between lakes will be designed for the 100-year return interval, 48-hour duration rainfall event. The rainfall total and temporal distribution of the rainfall was determined using the San Joaquin County Hydrology Manual (1997) and follows appropriate standards approved by the City of Stockton.

All onsite flood control facilities will be designed to safely contain, detain, and convey the 100-year, 48-hour storm event developed in the Off-Site Regional Hydrologic Investigation (PACE, 2006a). The Duck Creek watershed is the primary contributor to flood events off-site of the Mariposa Lakes project site. North Little Johns Creek, the other major stream channel that conveys water through the project, has the Farmington Regional Flood Control Reservoir upstream. The Farmington Reservoir blocks all flood flows, including the 100-year storm event, from continuing downstream through the project site.

Therefore, the Duck Creek watershed produces the largest flood flows that are conveyed through the Mariposa Lakes project site. It was determined that the time of concentration (Tc) for Duck Creek was 44 hours at the Mariposa Lakes upstream project boundary, which serves as a guide for the critical storm duration. Therefore, the 48-hour 100-year storm event was chosen as the critical design storm event for stormwater facilities. More specifically, each stormwater detention basin, man-made lake, and restored stream corridor will have sufficient discharge capacity and freeboard to detain/and or convey peak flow rates produced by the 48-hour, 100-year storm event.

The San Joaquin County Hydrology Manual defines the rainfall totals and rainfall distribution of design storm events, including 48-hour storm events. 48-hour rainfall distributions are in essence back-to-back 24-hour storm events, where the first day’s rainfall is decreased by a factor of 0.32 (SJ County Hydrology Manual, 1997).

All habitable structures within the project site will be designed with sufficient freeboard above the peak 100-year flood level to meet FEMA standards. FEMA flood zone designations will most likely change because of the proposed development and the restoration of the creek channels, in which case a Conditional Letter of Map Revision (CLOMR) and a Letter of Map Revision

(LOMR) will be completed. The CLOMR/LOMR process typically follows completion of the rough grading plan and will be completed in 2007.

Duck, Branch, and North Little Johns Creek will be designed to safely convey the runoff resulting from the 100-year, 48-hour flood with adequate freeboard.

3.2 100-year, 48-hour Flood Conveyance and Discharge

The project will be designed to limit post-development discharge rates in Duck Creek, Branch Creek, and North Little Johns Creek to be equal to or less than pre-development (existing conditions) peak discharge rates. Proposed modifications to the creeks will not increase peak flood water surface elevations, discharge rates, or velocities either upstream or downstream of the project site. The project will continue to accept offsite flows, including overland flows that historically have entered the project site, and will do so without increasing the depth or velocity of water on upstream properties. The project site will discharge flows only to Duck, Branch, and North Little Johns Creeks; any existing points of overland flow will no longer be used as discharge points. It should be noted that at this time no significant points of overland flow discharge are known for the project site.

3.3 Stormwater Treatment BMPs and NPDES Stormwater Permit Compliance

Mariposa Lakes is located in the City of Stockton, and therefore will comply will all applicable provisions of the City of Stockton's Stormwater Quality Control Criteria Plan. As a residential development, the project is required to include General Site Design Control Measures, Site-specific Source Control Measures, and Treatment Control Measures. The first two types of measures involve the layout of the site and the design of specific portions of the site, and will be described elsewhere. The Treatment Control Measures for the project include man-made lakes and Wet Detention Basins as described in this report.

All lakes will be designed to capture and slowly release stormwater runoff equal to the Stormwater Quality Design Volume as defined in the Stockton Stormwater Quality Control Criteria Plan. Each lake will also include a permanent pool that will meet or exceed the minimum permanent pool volume required for a wet pond BMP in the City of Stockton Stormwater Quality Control Criteria Plan. Typically, the lakes will have a volume that is many times greater than the minimum required permanent pool volume. Similarly, wet pond BMPs will meet the requirements of the Stockton Stormwater Quality Control Criteria Plan.

4 Drainage Facilities

The stormwater management design for Mariposa Lakes includes five separate major components:

1. An internal underground drainage system within the Mariposa Lakes community that conveys the 100-year storm runoff event to the outfalls into the proposed man-made lake network.
2. A man-made lake system to provide sufficient storage and/or conveyance for the stormwater volume for the entire 48-hour 100-year storm event.
3. Three restored creek channels, Duck , Branch, and North Little Johns Creek, naturalized to provide safe conveyance of the 100-year 48-hour, off-site storm event

and provide the community with aesthetic value, wildlife habitat, and creekside trails and parks

4. Stormwater detention basin BMPs designed to treat stormwater runoff and detain runoff from large storms. These wet ponds may also serve as groundwater recharge basins.

4.1 Underground Drainage Network

Within residential and industrial areas of the project, stormwater runoff will be collected in a standard underground drainage system. This system will include streetside gutters, catch basins, buried storm drains, and associated facilities. These facilities will be designed to applicable standards. They will collect and convey stormwater toward BMPs and lakes, and will not have significant impacts on the quantity or quality of runoff from the project site.

4.2 Man-made Lake Network

Runoff from the residential areas comprising approximately 65% of the project area will drain to one of three separate networks of interconnected lakes. A total of eleven proposed lakes will safely collect all urban stormwater runoff up to the 100-year storm event and provide a collection and transport system for dry weather nuisance flows as well.

4.2.1 Description of Facilities

There are three separate man-made lake systems in the Mariposa Lakes project area. The first, the Duck Creek lake network, is an interconnected network of four lakes that will collect surface runoff for much of the residential areas south of Duck Creek and north of the power line easement that bisects the project area and discharge into Duck Creek. Each lake will collect stormwater from the nearby drainage areas, as seen in Figure 1. The lakes will be arranged in a cascading arrangement, so that water from uppermost lake will flow into the second lake in the series. Water from the second lake (which includes the water from the first lake) will flow into the third lake, and so on. The fourth lake will discharge into Duck Creek via a pumping station.

The second lake network, The Branch Creek Lake Network, is the largest lake network in terms of number of lakes, acreage of lakes, and drainage area. The Branch Creek Lake Network will consist of five lakes and five canals that will collect runoff from the residential areas in the middle of the project, between the power line easement to the north and North Little Johns Creek to the south. Canals will operate with the same water quality and stormwater conveyance standards as the man-made lakes. The only difference is the terminology ascribed to each. As with all of the residential lakes, each lake and canal will collect water from a drainage basin surrounding the lake, as seen in Exhibit 1. This network will be arranged as a branching network with one outlet and two branches. Within each branch, the uppermost lake will discharge to the second lake and so on. The two branches will meet when they both discharge into the same large community lake. Water flow will continue downstream from this large lake and discharge into Branch Creek through a pumping station. The final lake network, the North Little Johns Lake Network consists of two small lakes that will collect surface runoff on either side of North Little Johns Creek and will be pumped into North Little Johns Creek during times of high runoff. The three lake networks will be referred to as the Duck Creek, Branch Creek, and North Little Johns Creek Lake Networks in this report.

All surface runoff will be collected in standard urban drainage facilities and delivered to the lakes. Once in the lakes, water will be continually treated by a system of underwater bio-filters, constructed wetlands, in-lake circulation, aeration, and carefully managed lake vegetation. This system is designed to maintain the highest possible level of water quality in the lake for the sake of both environmental health and the aesthetics of the lake. The system that will be designed for the Mariposa Lakes project is based on systems that have successfully operated in similar man-made residential communities for many years, maintaining excellent water quality despite inflows of nuisance flow, urban runoff, and other nutrient-laden waters.

The network of lakes will be built with enough reserve storage capacity to eliminate all dry-weather discharges. Therefore, dry weather flows will never leave the site, but will instead be captured and retained within the lakes, treated, and reused for landscaping and irrigation. During rain events, on-site runoff will enter the lakes and a portion of the rainfall representing the “first flush” volume will be retained then slowly discharged over the course of approximately 48 hours. During larger rainfall events, excess water will be discharged downstream through the lake outlet facility. This water will receive a high level of water quality treatment and will carry significantly reduced loads of Total P and Total N as compared to typical urban runoff. Therefore, the Mariposa Lakes will be designed to both greatly reduce the volume and significantly improve the quality of runoff from the site.

4.2.2 Lake Water Quality Treatment

All runoff will pass through a series of treatment control BMPs as it enters and resides in the lakes, and dry weather runoff will be retained in the lakes, minimizing the release of pollutants. Each lake will include stormwater pretreatment wetlands, in-lake circulation, biofilters, aeration, wetland planters, and the lake itself, which serves as a large wet detention pond, one of the most effective and reliable stormwater BMPs. The system of BMPs within each man-made lake is illustrated below (See Figure 2). Nuisance flows will follow that same route and be treated in the same BMPs as stormwater runoff, and the discussion below applies to both stormwater and nuisance (dry-weather) flows.

4.2.2.1 Pretreatment Wetlands

Pretreatment Wetlands (See Figure 3) will be the first BMP that runoff will encounter. The wetland areas will remove sediments, pathogens, and nutrients through a variety of natural physical, chemical and biological processes. All runoff, both stormwater runoff and dry-weather runoff, that is conveyed to the lakes will comes enter a Pretreatment Wetland, via gravity flow or through a storm drain outfall similar to the one illustrated in Figure 3. As water enters the wetlands, it will pass into the gravel beneath the planting media and flow upwards through the root zone. Larger flows will partially bypass the media by flowing upwards from the storm drain outlet box and into the wetland along the surface. Within the media, microbes will absorb nutrients and break down many types of pollutants. Sediments will be removed by settling and filtration. Coarse sediments and trash will be retained within the storm drain outlet box, which will be fitted with an access port and periodically cleaned. Sediment will also accumulate within the standpipe in the wetland and will be periodically removed. Emergent native wetland vegetation growing in the media will aid in nutrient absorption, provide a substrate for microbes, and transport oxygen to the root zone, enhancing many biological processes that break down pollutants. Pretreatment Wetlands will be sized to provide a minimum of 24 hours of detention for nuisance flows and adequate pretreatment of the entire Stormwater Quality Design Volume as defined in the Stockton Stormwater Quality Control Criteria Plan.

4.2.2.2 In-Lake Circulation

Water within each lake will be continuously circulated to enhance aeration and move water through a system of biofilters. The circulation helps to mix the lake water and move nutrients and pollutants around the lake, allowing the entire lake to serve as a treatment facility. The circulation system within each lake will be designed to draw water from one location and distribute the water throughout the lake. This system creates circulation within the lake, eliminates stagnant areas, and enhances many of the natural treatment processes that maintain water quality in the lake. The in-lake circulation systems will distribute water through biofilters distributed throughout the lakes.

4.2.2.3 Aeration

The lakes will include a lake aeration system in each lake. Aeration devices serve two primary functions in a man-made lake, circulation and oxygenation. This system will introduce many small air bubbles at the lake bottom. The bubbles rise, creating a column of rising water and vertical circulation. This helps to prevent vertical stratification of the lake water, which generally has a deleterious effect on lake water quality in small lakes. In addition to creating circulation, the air bubbles will transfer oxygen to the lake water, and by moving oxygen-poor water from the bottom of the lake to the top, will enhance oxygen transfer through the water/air interface. Typical aeration equipment is depicted in Figure 4.

Lake aeration equipment a will include air compressors, air distribution tubing, and fine bubble diffusers. At each lake, one or more air compressors will be located in an enclosure, typically at the wet well where water pumps are located. The compressors will distribute compressed air through tubing laid on the bottom of the lake, leading to numerous diffusers located throughout the lake. Typically, weighted tubing will be used to prevent air lines from floating. The diffusers will be fine bubble diffusers with weighted bases that will rest on the lake bottom. Systems such as these have performed well in numerous lakes throughout the country.

4.2.2.4 Biofilters

Biofilters will be built in the lake bottom to continually treat lake water and maintain water quality. A biofilter (See Figure 5) is a gravel bed equipped with a system of perforated water distribution pipes through which lake water is constantly pumped into the gravel media. The biofilter removes nutrients, pathogens, and sediment through biological and physical processes such as absorption and biological conversion of nutrients, and filtration and settling of sediments. The lake circulation system moves water through the biofilters, enabling the biofilters to treat all of the lake water approximately once every 3 to 7 days. Biofilters will be regularly cleaned to maintain a high rate of biological growth and pollutant uptake.

4.2.2.5 Wetland Planters

Wetland planters will be located along much of the lake shoreline. These planters support emergent, native, wetland vegetation, which provides many benefits to the lake. Emergent vegetation absorbs nutrients, helping to improve water quality, and the vegetation provides a substrate for diverse community of beneficial microbes. Among these are attached algae and bacteria, which compete for nutrients with the less desirable planktonic algae that live in the water column. Other microbes break down pollutants, improving water quality. In addition to wetland planters supporting rooted emergent vegetation such as rushes or sedges, some wetland planters may be placed in deeper water and will support rooted floating vegetation such as water lilies. Like emergent vegetation, rooted floating vegetation supports microbes, shades the water, helping to control temperature and algal growth, enhances the lakes' appearance, and supports wildlife. See Figure 6 for an illustration of a typical wetland planter.

In addition to wetland planters, which are covered by shallow water, deep water planters will be located in various locations throughout each lake. These planters will support rooted submergent or floating vegetation that provides many of the same benefits as emergent vegetation.

In addition to the vegetation in the planters, aquatic vegetation will become established in various parts of the lake bottom. This vegetation forms the basis of the aquatic ecosystem and is important for the maintenance of clean, clear water. Aquatic vegetation will be maintained in the lakes to control its density, maintain active growth, and promote water quality.

4.2.2.6 Treatment within the Lakes

Even without the water quality treatment system described above, the lakes would serve as wet detention ponds, one of the most effective standard water quality BMPs available. Lakes provide treatment by diluting runoff, detaining runoff, and treating runoff. The water within the lakes will be maintained at a very high quality by the treatment systems within the lakes. As runoff enters the lake it will be diluted by much cleaner lake water, which will immediately reduce the concentrations of pollutants even during large runoff events that cause discharge from the lakes.

The lakes will provide effective stormwater treatment. The treatment capabilities of simple wet detention ponds are well studied, and wet ponds are recognized as one of the most effective stormwater BMPs. Because they receive all of the runoff from the project and have a large volume compared to the volume of runoff that the site will generate, the lakes will serve as wet detention ponds, treating stormwater through a variety of natural processes. The lakes will remove a large percentage of suspended sediments from stormwater through setting and filtration within the treatment wetlands and biofilters. The large volume of the lakes will mean that water passing through the lakes, even during very large storm events, will move at a very slow velocity preventing the resuspension of sediments from the lake bottom as happens in smaller BMPs. Algae and other plankton living in the lake water will absorb nutrients from runoff that enters the lake, improving the quality of water in the lake. In addition, these microbes are predators of many pathogens and bacteria in runoff and help reduce the bacterial levels in runoff. Finally, vegetation and the lake bottom sediments support many biological and chemical processes that sequester contaminants from the lake water. All of these processes will be enhanced by the water quality improvements described above in this section.

4.2.3 Lake Geometry and Operating Design Requirements

The lake will be lined with 30-mil PVC and will have a constructed lake edge designed to prevent shoreline erosion, enhance safety for visitors, and provide an attractive appearance. Various shorelines designs will be used (see Figures 11 and 12) but all will be similar in many regards.

The other important characteristic of the geometry influencing lake quality is the average operating water depth, since this determines the effects of temperature and biological reaction time increases with temperature. An average operating depth of eight feet will eliminate light penetration, maintain lower average temperature, allow temperature stratification, and minimize evaporation.

The lake edge will be designed to provide safe conditions for persons visiting the lake and to eliminate any need for fencing around the lake. Many of the lakes will be designed with a concrete bulkhead that will provide secure footing for anyone who happens to step or fall into the lakes. The lakes edges will drop from the waters edge to a depth of 18 inches (see Figure 11). This ensures that anyone who accidentally falls into the lakes will be able to easily stand up and exit the lakes. Beyond edge the bottom will fall into the lake at a gentle slope of not more than 4:1 (horizontal:vertical). This gentle slope allows anyone who chooses to wade into the lake to easily return to the shore, while the steady slope makes it clear that the lake grows deeper toward the middle. The 4:1 slope extends to a depth of at least 4 feet. This depth is intended to be deep enough that anyone who cannot swim well should have second thoughts about wading to this depth. Beyond the 4 foot depth, the lake bottom will consist of PVC liner typically buried beneath a layer of soil (typically 12 inches in depth). The slope of the bottom is typically 3:1 or flatter.

4.2.4 Vector Control

Mosquitoes and other vectors will be controlled through physical and chemical means. The lake water system will be designed with physical characteristics to minimize the habitat for propagation of mosquito larvae (by eliminating stagnant water surfaces and allowing the sun and wind to contact the open water surface, it is impossible for mosquito larvae to survive). In addition, habitat will be provided for predator species to control vectors. Lake operations and management personnel are trained to contact County Vector Control and apply the appropriate chemicals, if necessary.

4.2.5 Storm Drain Lake Outfall Structures

Specialized outfall structures will be developed for the storm drain connections to the lake in order to prevent the normal lake water surface from entering the storm drain pipes. This is necessary because many storm drain pipes are located at elevations below the normal lake water surface. Figure 3 includes a typical plan of a storm outfall to a lake. The outfall consists of a covered concrete weir box located at the edge of the lake into which the storm drain pipe will outlet. The weir elevation is located at a height near the top of the box and is the only outlet. All nuisance flows will be pumped to a specially designed vegetated water quality filter at the edge of the lake. The weir is situated to discharge all the overflows into the water quality filter before entering the lake. The system is designed to prevent vector problems or additional water quality issues associated with storm drain pipes that are partially filled with water during dry weather.

4.2.6 Lakes as Flood Control Facilities

All of the proposed lakes will serve as the primary flood control and flow conveyance facilities for their on-site watersheds. In addition, the Branch Creek lake network will convey runoff from a small offsite watershed. The lakes will be designed to safely convey the runoff from the 100-year, 48-hour storm event with adequate freeboard. Stormwater conveyance between lakes will operate via gravity flow, while pumping stations will pump water from each downstream lake into the downstream receiving stream.

While the runoff from the 100-year, 48-hour storm event is passing through the lakes the water level in each lake will rise. Within 24 hours of the peak of the 48-hour storm (when lakes reach their highest water levels) water level in all lakes will have receded to a water level within 0.2 feet of the normal operating water surface. Each lake will again have sufficient freeboard to again convey and discharge another large storm event. This does not mean that within 24 hours after the end of the design storm event the water level in each lake will have receded to pre-storm, normal operating level. Due to the size of the project site and the extensive, interconnected network of lakes, it is not possible to convey all runoff from the design storm through the lake networks within 24 hours of a large storm.

Figure 1, which shows the layout of man-made lakes within the project, also includes five canals. Canals operate as connectors between large lakes, and will be designed with the same water quality and flood control standards as other lakes in the project.

All residential areas served by the lake systems (which include almost all of the residential areas proposed for the project site) will be graded to provide building pads that are higher than peak water level in the lake with adequate freeboard (usually one foot). Part B of the Master Drainage Report (PACE, 2006) discusses in detail the surcharge and freeboard associated with each lake.

4.2.7 Connections between Lakes

Within each lake network, water will pass from one lake to the next via facilities that will include a system of weirs and open channels. Gravity-operated flow control devices will control the water level and discharge rate within and between each lake. As water level rises in each lake, water will overflow at a controlled rate and flow towards the next lake or receiving water. The connections between lakes will be different and unique. One example of a typical weir box used to control flow between lakes is shown in Figure 7. Part B of the Master Drainage Plan (PACE, 2006) will discuss the hydraulic details of these structures.

4.3 Restored Creek Channels

Three existing channelized creeks flow through the Mariposa Lakes project site, Duck Creek, North Little Johns Creek, and the much smaller Branch Creek. As part of the Mariposa Lakes project, Duck Creek, North Little Johns Creek, and Branch Creek will be restored such that they will have the capacity to transport the 100-year, 24-hour storm event through the project site.

Currently, all three creeks have been channelized to maximize agricultural use in the area. All three are trapezoidal in shape with steep side slopes, have no clear floodplain areas, limited vegetation in and around the channel, and low wildlife habitat value. Restoration will drastically improve the wildlife habitat of all three creeks by widening the channels, introducing floodplain terraces, and by planting native vegetation (mule fat, cottonwoods, willow, oak, etc). A typical cross-sections of a restored creek channel is shown in Figure 10.

The renaturalization of the creeks will prevent the creeks from flooding the project site during the 100-year, 48-hour flood and all smaller flood events. Channel alterations will not increase the volume or peaks of flood flows passing through the project site.

The Branch Creek watershed area, both upstream of the Mariposa Lakes project area and within the Mariposa Lakes project area, will drain into a network of lakes within the Mariposa Lakes project area. The downstream-most lake in the Branch Creek network, L-3, will spill into the beginning of the Branch Creek channel near Lake L-3 near the western edge of the project site. The area of Branch Creek that hosts a number of larger old-growth trees will be restored.

4.4 Wet Detention Pond BMPs

4.4.1 Description of Facilities

Portions of the project site that will be developed as industrial land uses, and some portions of the site that will be used for commercial purposes will drain towards wet detention pond BMPs. The wet ponds will provide stormwater treatment, floodwater detention, and will serve as groundwater recharge basins. In addition, the basins and the sites they occupy will be designed to provide recreational opportunities that are compatible with the primary functions of the basins. Potential recreational uses of the sites include walking or jogging on trails, birdwatching, dog walking, and similar activities.

4.4.2 Stormwater Treatment in Wet Ponds

Stormwater treatment within the wet pond basin BMPs will be accomplished by maintaining a permanent pool of water into which all runoff will be collected. This permanent pool distinguishes a wet pond from a dry detention pond. Generally, wet ponds are known to provide far better water quality treatment than dry ponds. In addition to the permanent pool, an additional volume of water will be detained after each rain event and slowly released. Both the volume of water to be detained and the release rate will meet or exceed the minimum standards of the Stockton Stormwater Quality Control Criteria Plan. Other design features of the wet detention pond BMPs will meet or exceed the City of Stockton standards.

In order to maintain a permanent pool of water, wet detention pond BMPs may be constructed with a liner under portions of the basin bottom. Permanent ponds will require a source of water during dry weather to supplement the nuisance flows that will be generated by surrounding development. Permanent pond design will include shallow, gently sloping edges similar to the edges proposed for lakes for public safety. However, in many cases wet ponds may not include a hardened (concrete) edge because the pond sites will be designed to discourage foot traffic, eliminating the need for a hardened edge. Wet detention ponds may incorporate many of the same water quality features proposed for man-made lakes, and may include sediment forebays, wetland benches, and other design features typical of wet pond BMPs.

4.4.3 Flood Control in Wet Ponds

The basins will capture and detain all runoff from events up to the 100-year, 48-hour rainfall event with adequate freeboard. Within many of the industrial areas, ground surface elevations will require that stormwater collected in wet detention basin BMPs be pumped to creeks for discharge. The basins will be designed with sufficient freeboard and pump station capacity so that within 24 hours from the peak of the 100-year, 48-hour design storm event, the basins will again have sufficient capacity for a second large storm event.

4.4.4 Groundwater Recharge

Some or all of the wet-pond detention basin BMPs may be designed to serve also as groundwater recharge facilities. To allow groundwater recharge the bottoms of the basins would be unlined. Basins would be graded to create shallow lakes, incorporating a similar shallow, gently sloped edge as the proposed lakes. However, the basins would be unlined to allow water to percolate into the ground. If recharge is an important function of the basins, basins would be periodically drained and basin bottoms would be scraped to remove fine sediments and improve water percolation rate into the ground. Basins designed for groundwater recharge might contain some water quality enhancements that are compatible with periodic drainage and maintenance. These enhancements might include sediment forebays, aeration, wetland benches, and others.

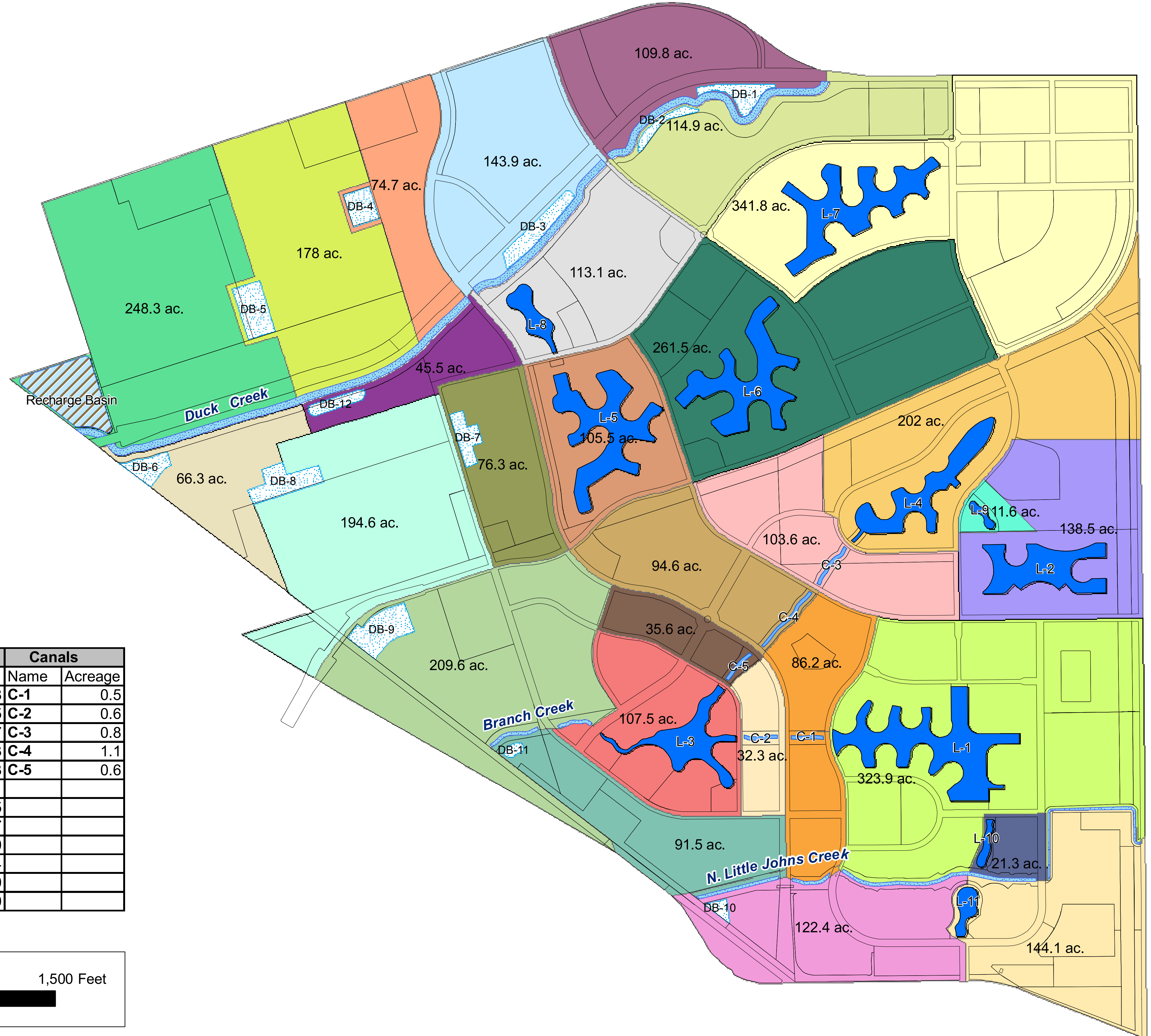
A groundwater recharge basin will be constructed adjacent to Duck Creek at the downstream boundary of the Mariposa Lakes project site. This recharge basin will be constructed and maintained to accept runoff from the adjacent 248-acre industrial area and to occasionally accept overflow from Duck Creek in times of heavy runoff. Over time, runoff will carry small sediments and particulates into the basin that will settle and act to block infiltration. Occasionally the recharge basin will be dried, cracked, and tilled or scraped to maintain adequate pore spaces and percolation rates. More information on the groundwater recharge basin can be found in the Integrated Water Management Plan (Kleinfelder, 2006).

A second groundwater recharge basin will be constructed upstream of the Mariposa Lakes project site on the Arbini property. This groundwater recharge facility will operate initially as a Tier III (vacant lot) and later as a Tier 1 (engineered groundwater recharge facility) site. The Integrated Water Management Plan (Kleinfelder, 2006) provides more detailed information regarding this recharge facility. The site will receive water from various potential sources, including overflow from North Little Johns Creek and piped water from Duck Creek. This offsite basin will have the dual purpose of accepting stormwater runoff conveyed by North Little Johns Creek while also providing a large groundwater recharge basin. Part B of the Master Drainage Plan provides preliminary design recommendations for the side weir that would deliver flood flows from North Little Johns Creek to the recharge basin. Operation and maintenance of all groundwater recharge facilities will be handled by a contractor, funded through assessment of Mariposa Lakes properties.

DRAINAGE AREAS

Legend

- Lakes
- Restored Stream Channels
- Canals
- Recharge Basin
- Wet Pond Detention Basins
- Drainage Areas (color varies)



Lakes		Detention Basins		Canals	
Name	Acreage	Name	Acreage	Name	Acreage
L-1	33.6	DB_1	4.8	C-1	0.5
L-2	18.0	DB-2	2.5	C-2	0.6
L-3	14.5	DB-3	6.7	C-3	0.8
L-4	17.9	DB-4	4.3	C-4	1.1
L-5	25.8	DB-5	7.3	C-5	0.6
L-6	25.8	DB-6	4.1		
L-7	26.9	DB-7	4.5		
L-8	5.9	DB-8	7.7		
L-9	1.2	DB-9	9.0		
L-10	1.6	DB-10	1.4		
L-11	3.4	DB-11	1.0		
		DB-12	3.0		

N

1,500 0 1,500 Feet

FILE: \\pacefs01\projects\8013E\GIS\mxds\8013E_LakeDrainAreasFig1PC8_072406.mxd

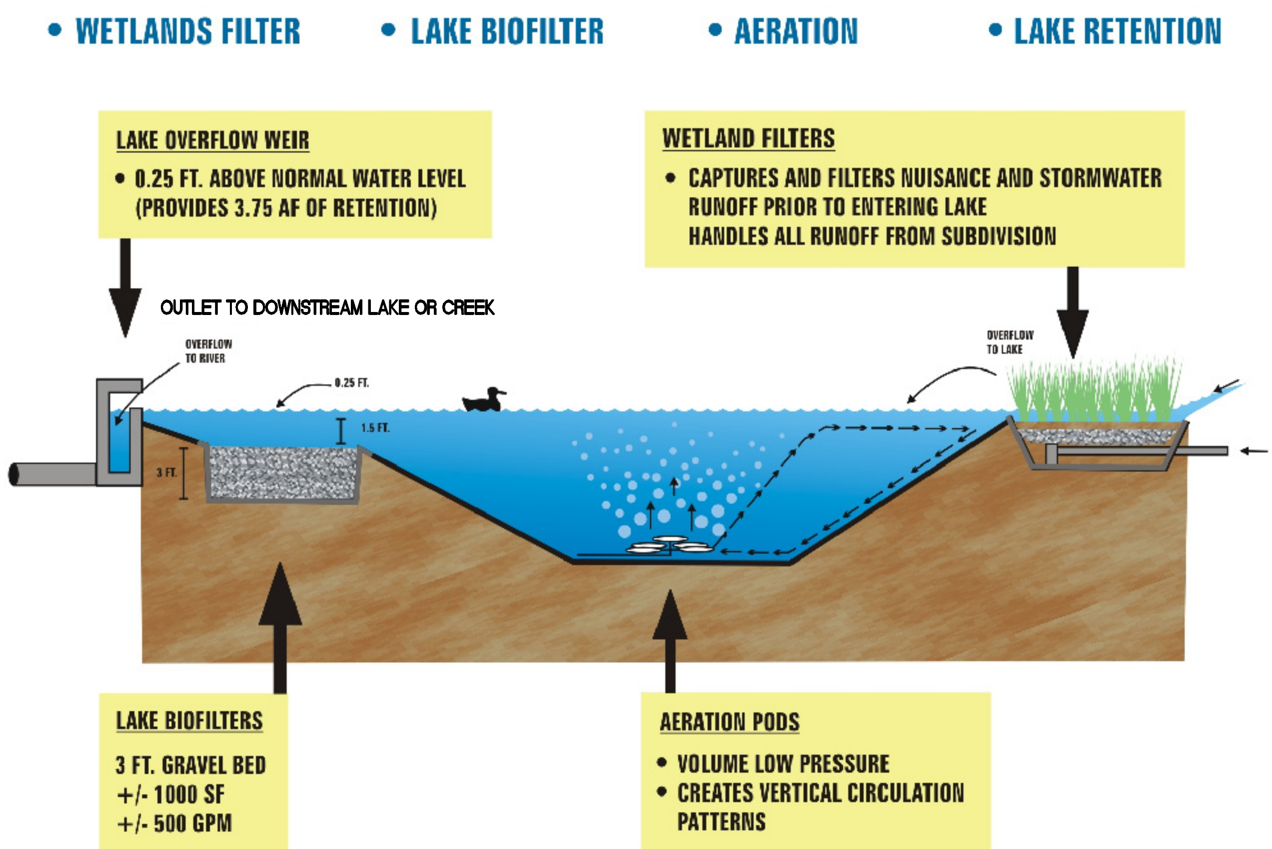
TITLE: DRAINAGE AREAS

JOB: MARIPOSA LAKES
SAN JOAQUIN CNTY CA

SCALE 1"=1500'
DESIGNED BJ
DRAWING RS
CHECKED BJ
DATE 07/17/06
JOB NO. 8013-E

PACE
PACIFIC ADVANCED CIVIL ENGINEERING
17520 NEWHOPE STREET, SUITE 200
FOUNTAIN VALLEY, CA 92708
PH (714) 481-7300 FAX (714) 481-7299

FIGURE 1



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FOUNTAIN VALLEY, CA 92708
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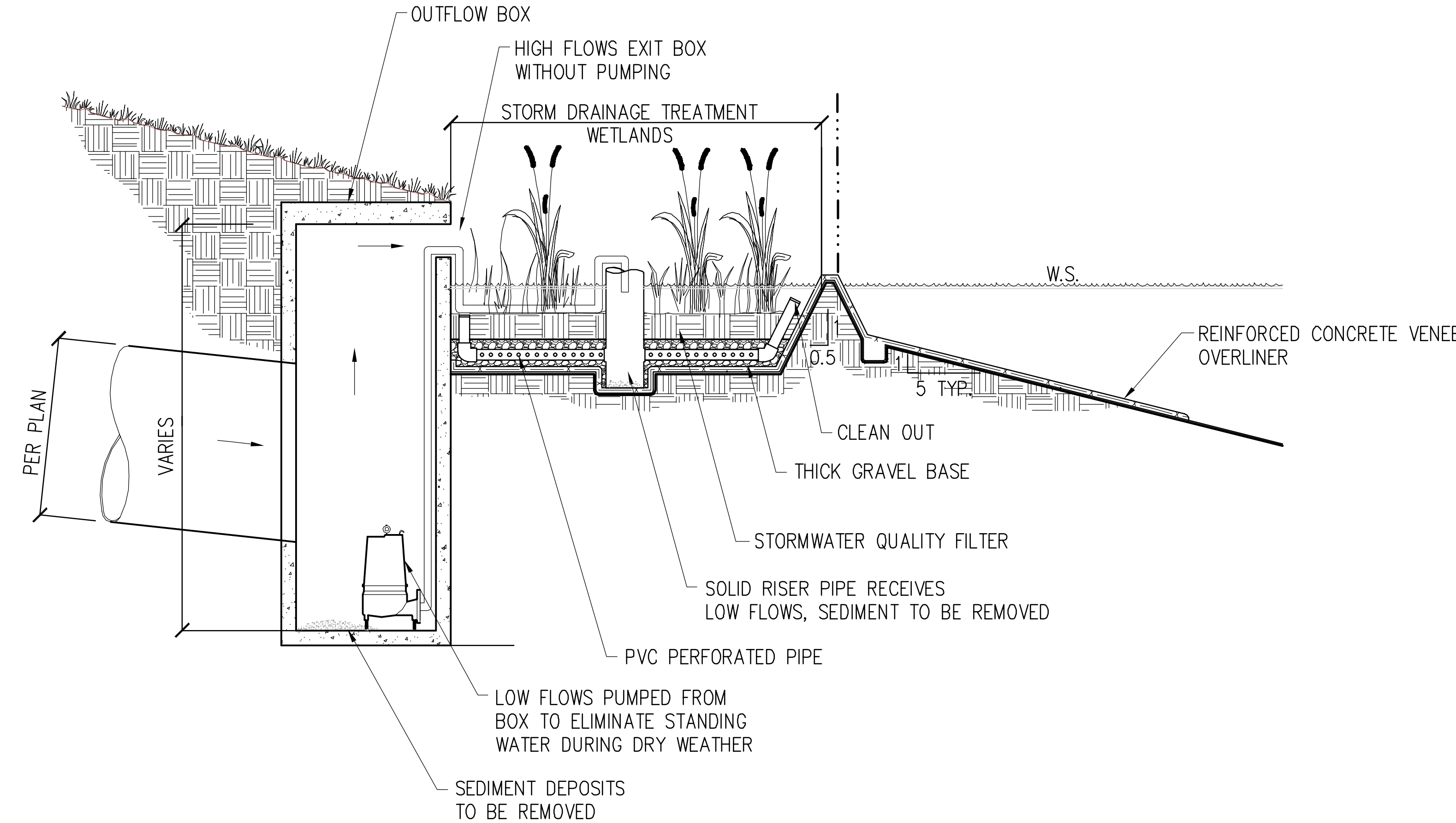
SCALE	N.T.S.
DESIGNED	B.J.
DRAWN	T.B.
CHECKED	B.M.P.
DATE	02-17-06
JOB NO.	8013-E

MARIPOSA LAKES

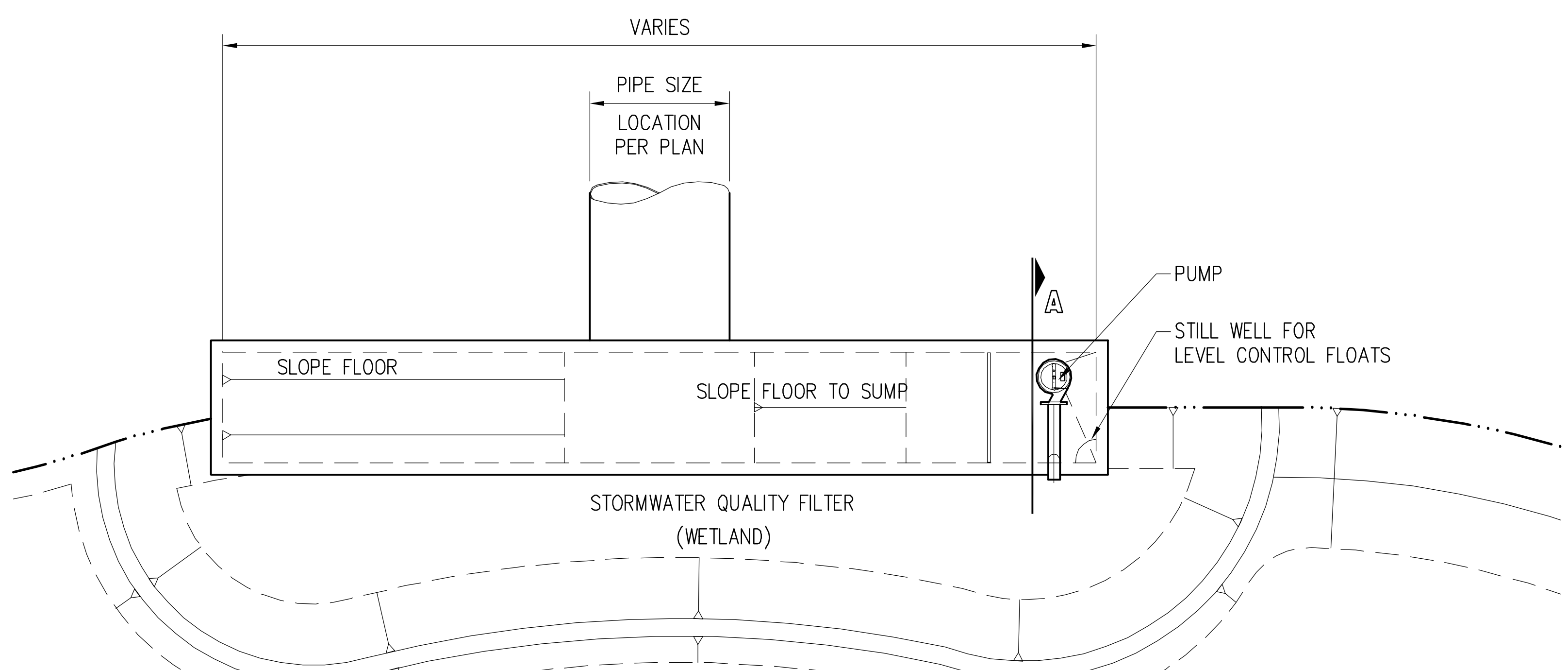
TYPICAL LAKE CROSS SECTION

FIGURE 2



TYPICAL PRETREATMENT WETLAND/LAKE SECTION WITH PROFILE FOR STORM DRAIN

NTS



PLAN

NTS

NO	BY	DATE	REVISIONS	DATE	APP.

SCALE	AS SHOWN
DESIGNED	B.J.
DRAWN	T.B.
CHECKED	B.M.P.
DATE	03-02-06
JOB NO.	8013-E

TITLE

STORM DRAIN OUTFALL TO LAKE AND WETLAND

JOB

MARIPOSA LAKES

STOCKTON CA

PACE
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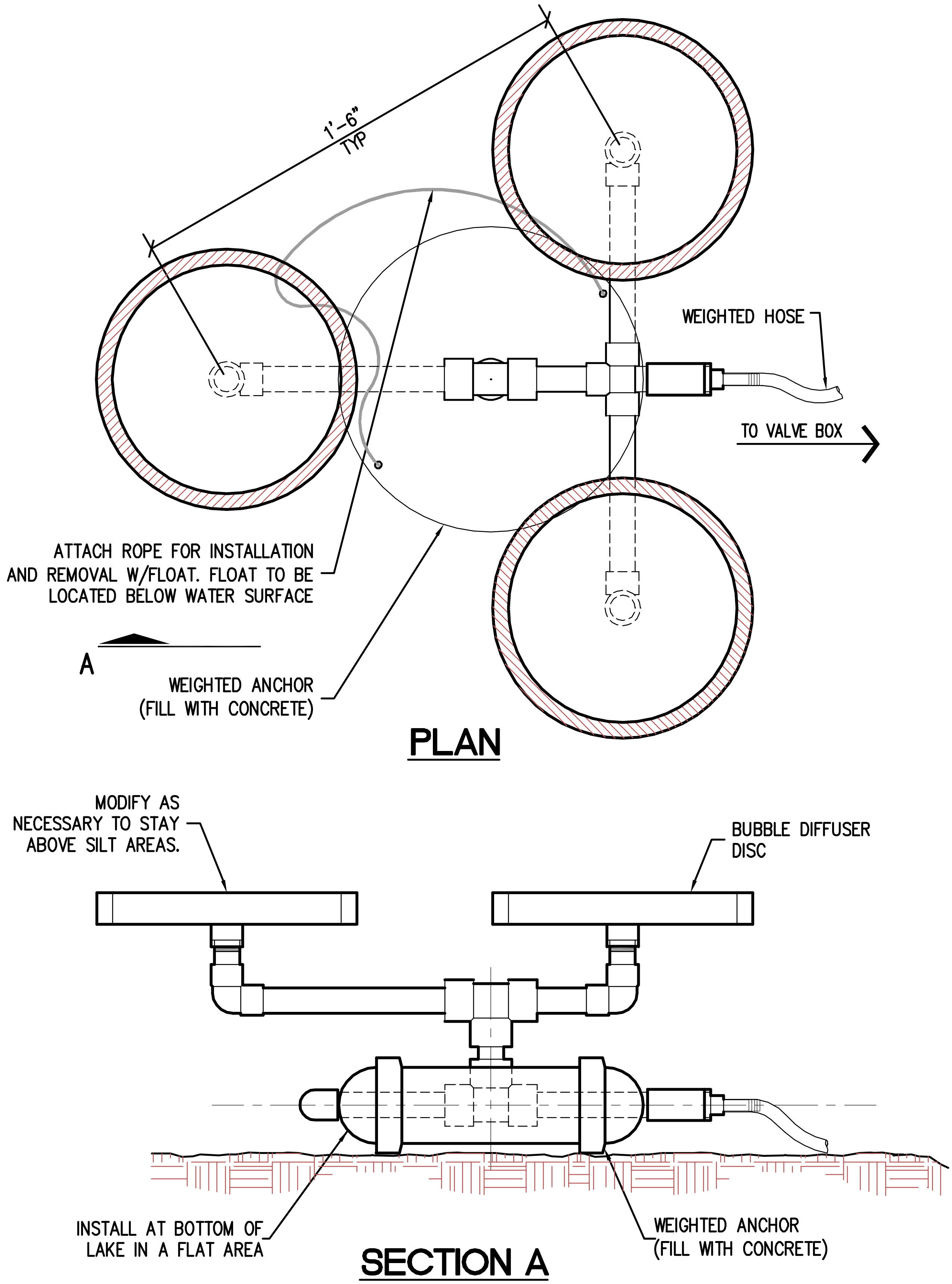
FOUNTAIN VALLEY, CA 92708
PH (714) 481-7300 FAX (714) 481-7299

FIGURE 3

JOB NO. 8013-E



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17520 NEWHOPE STREET, SUITE 200
FOUNTAIN VALLEY, CA 92708
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SCALE	N.T.S.
DESIGNED	B.J.
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CHECKED	B.M.P.
DATE	02-17-06
JOB NO.	8013-E

MARIPOSA LAKES

TYPICAL AERATION BUBBLE DIFFUSER

FIGURE 4

Xrefs: 8013-REPORT-8½x11.dwg
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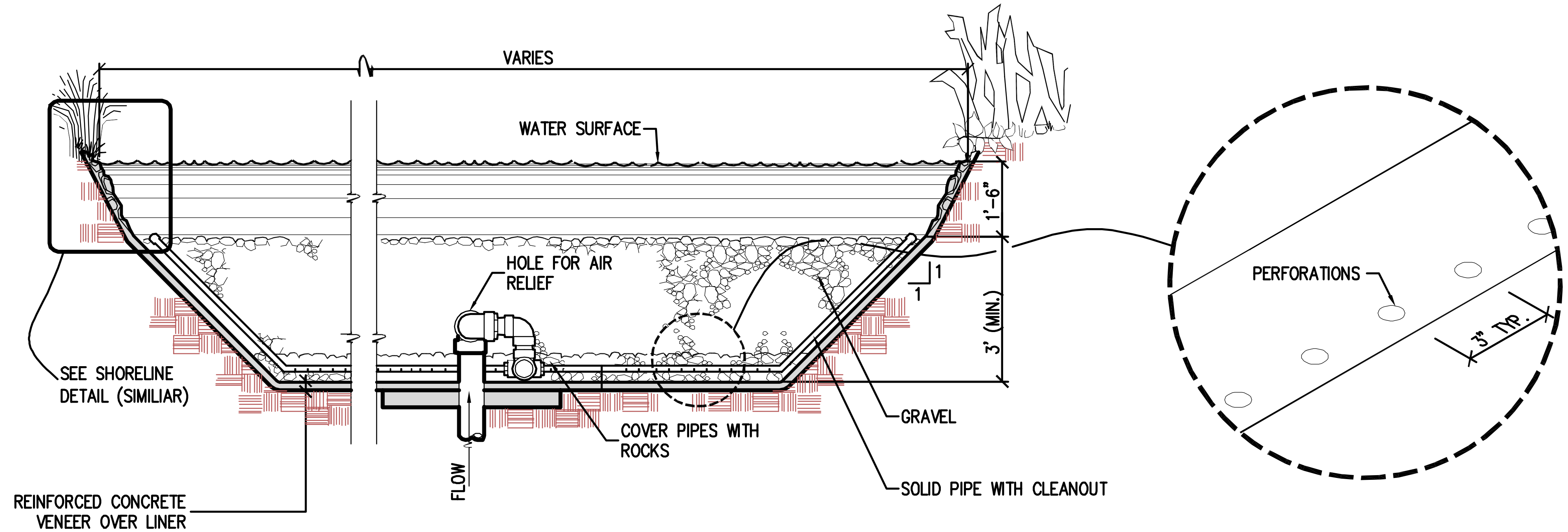
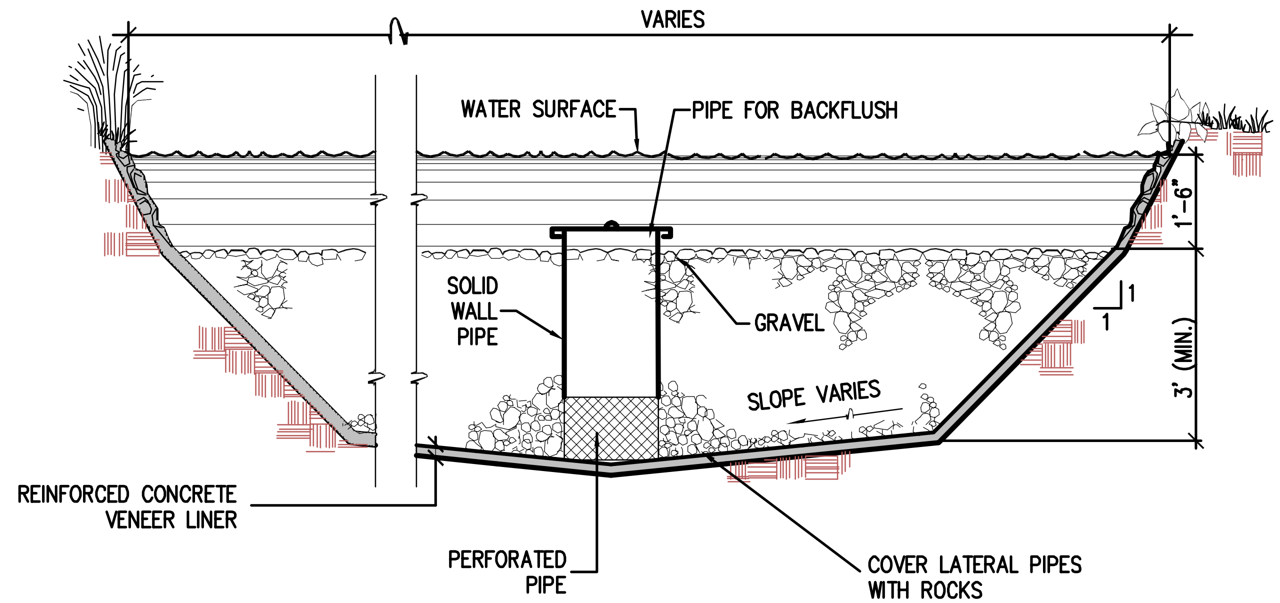


TYPICAL SECTION AT DISCHARGE



TYPICAL SECTION AT BIOFILTER BACKFLUSH

NO	BY	DATE	REVISIONS	DATE	APP.

SCALE N.T.S.
DESIGNED B.J.
DRAWN T.B.
CHECKED B.M.P.
DATE 03-02-06
JOB NO. 8013-E

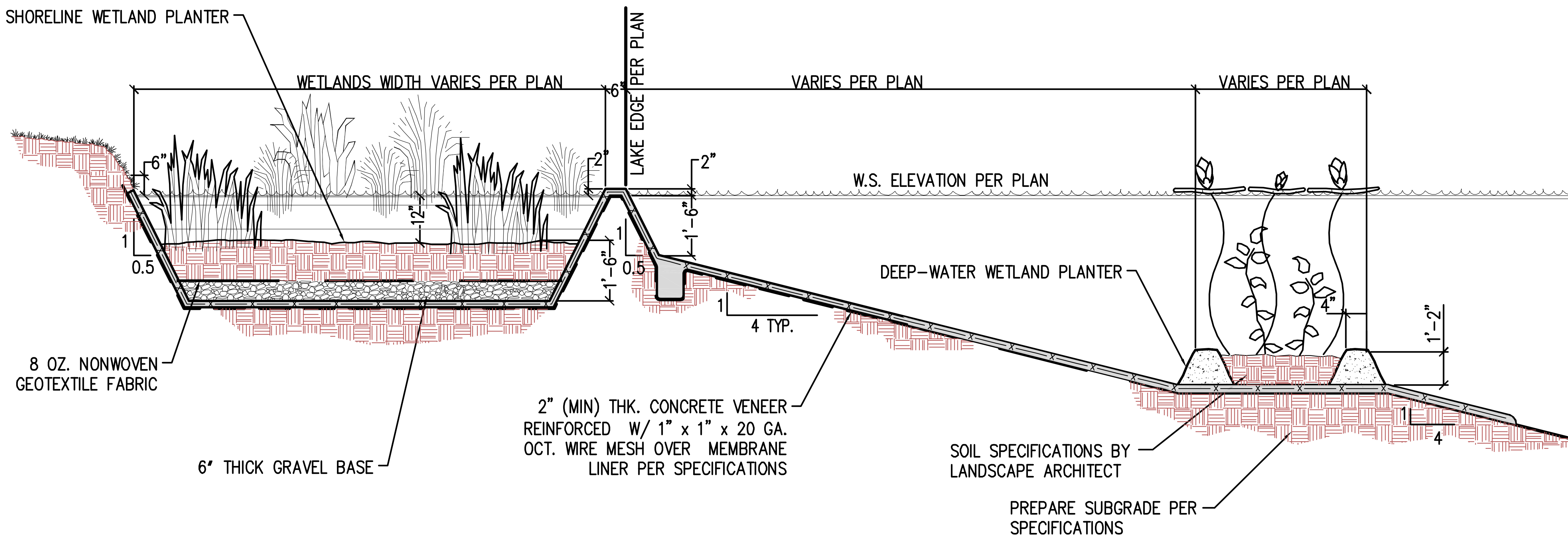
TITLE
TYPICAL BIOFILTER AREA

JOB
MARIPOSA LAKES
STOCKTON CA

PACE
PACIFIC ADVANCED CIVIL ENGINEERING
17520 NEWHOPE STREET, SUITE 200
FOUNTAIN VALLEY, CA 92708
PH (714) 481-7300 FAX (714) 481-7299

FIGURE
5

JOB NO. 8013-E



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SCALE N.T.S.
DESIGNED B.J.
DRAWN T.B.
CHECKED B.M.P.
DATE 03-02-06
JOB NO. 8013-E

TITLE
TYPICAL WETLAND PLANTERS

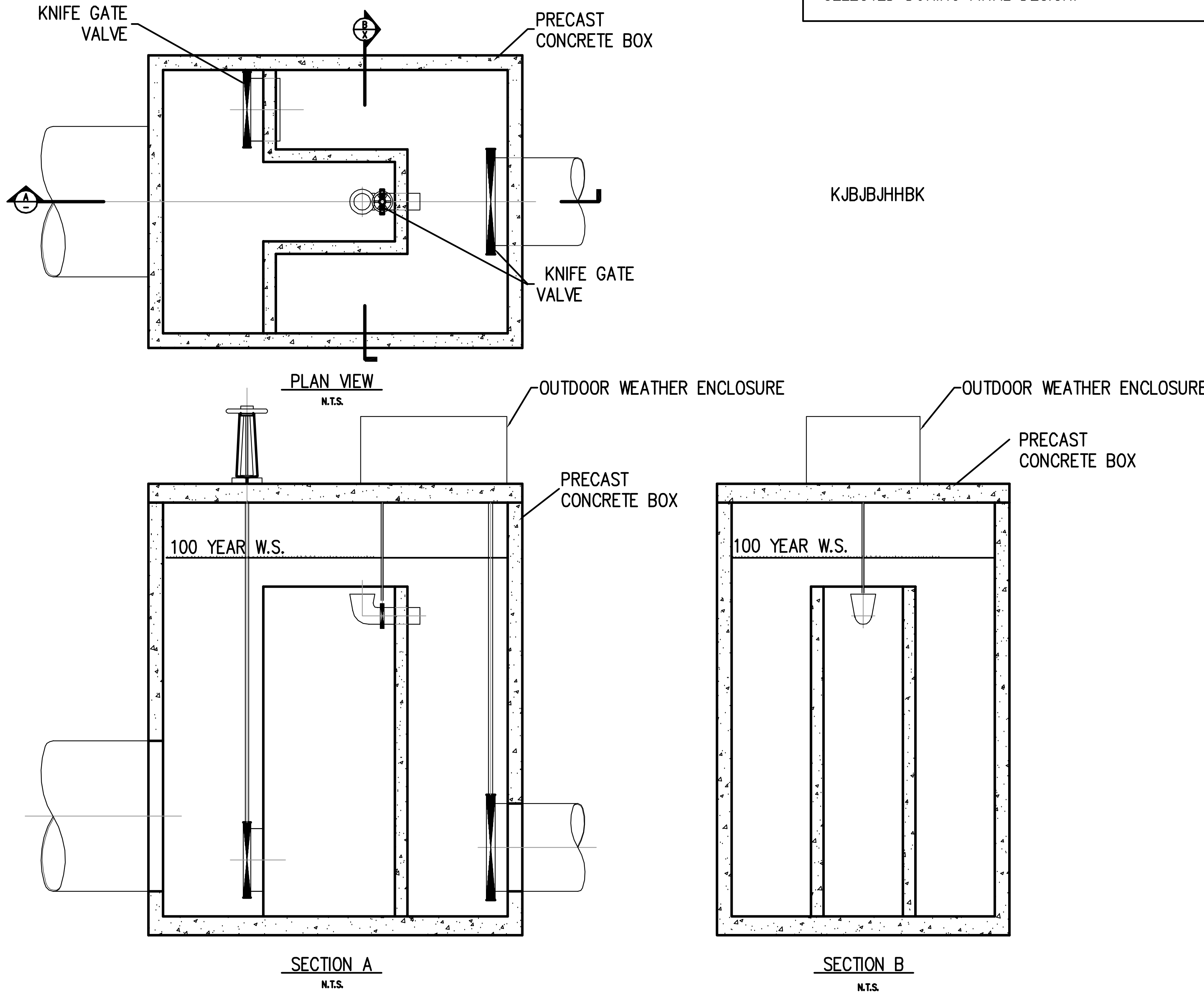
JOB
MARIPOSA LAKES
STOCKTON CA

PACE
PACIFIC ADVANCED CIVIL ENGINEERING
17520 NEWHOPE STREET, SUITE 200
FOUNTAIN VALLEY, CA 92708
PH (714) 481-7300 FAX (714) 481-7299

FIGURE 6

JOB NO. 8013-E

NOTE: DIMENSIONS OF WEIR, ENCLOSURE AND VALVES VARIES ACCORDING TO FLOW RATES. OTHER WEIR BOX DESIGNS MAY BE SELECTED DURING FINAL DESIGN.



KJBJBJHHBK

NO	BY	DATE	REVISIONS	DATE	APP.

SCALE
DESIGNED B.J.
DRAWN T.B.
CHECKED B.M.P.
DATE 03-02-06
JOB NO. 8013-E

TITLE
LAKE OVERFLOW WEIR BOX

JOB
MARIPOSA LAKES
STOCKTON CA

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PACIFIC ADVANCED CIVIL ENGINEERING
17520 NEWHOPE STREET, SUITE 200
FOUNTAIN VALLEY, CA 92708
PH (714) 481-7300 FAX (714) 481-7299

FIGURE 7

JOB NO. 8013-E

P:\8013E\Engineering\GlobalBase\EIR Conceptual Design Plans\8013E-Fig-7.dwg - Tab: Layout2 By: bjones on Mar. 06, 2006 at 09:57 am
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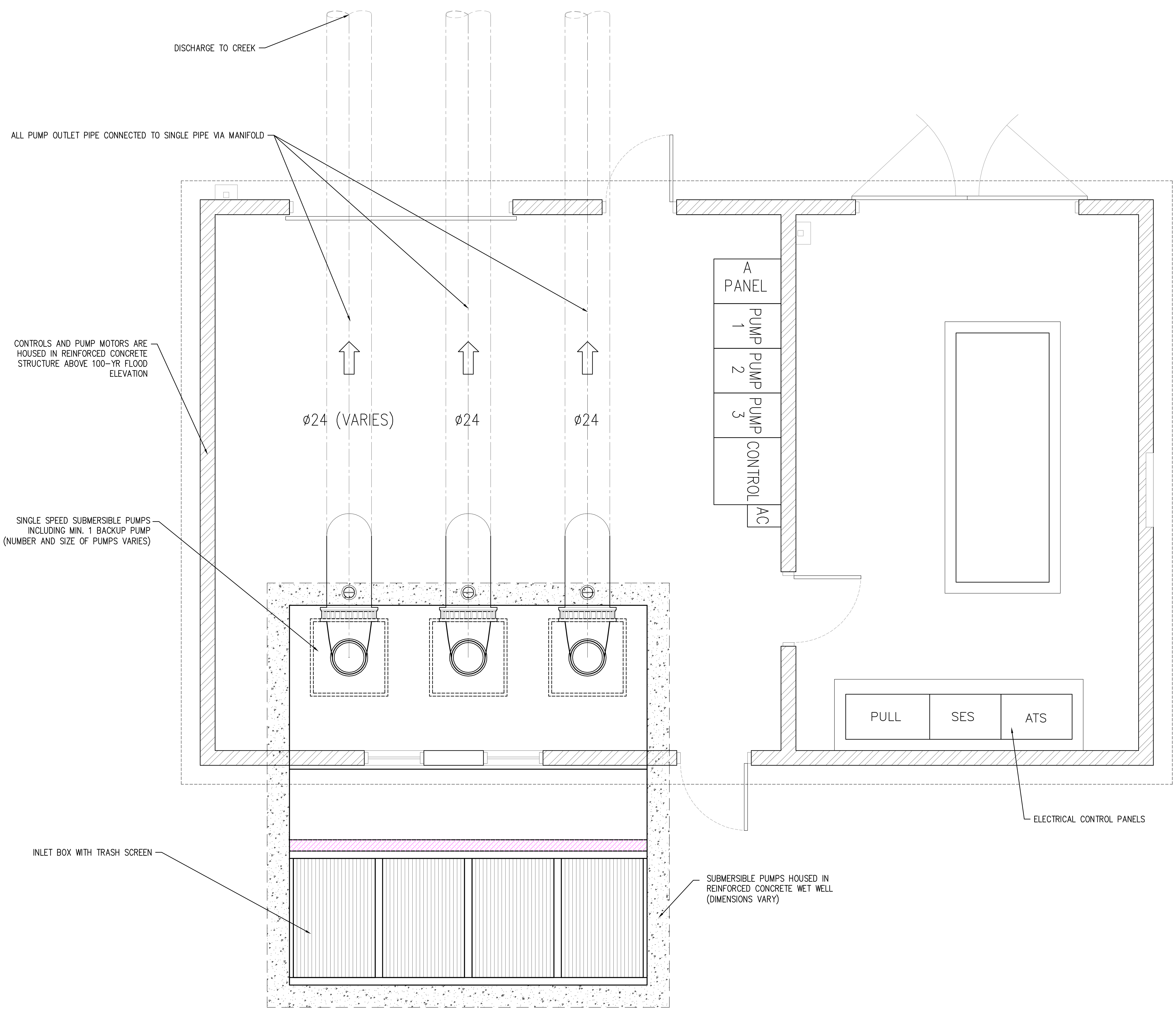


NO	BY	DATE	REVISIONS	DATE	APP.

SCALE N.T.S.
DESIGNED B.J.
DRAWN T.B.
CHECKED B.J./R.R.
DATE 03/02/06
JOB NO. 8013E

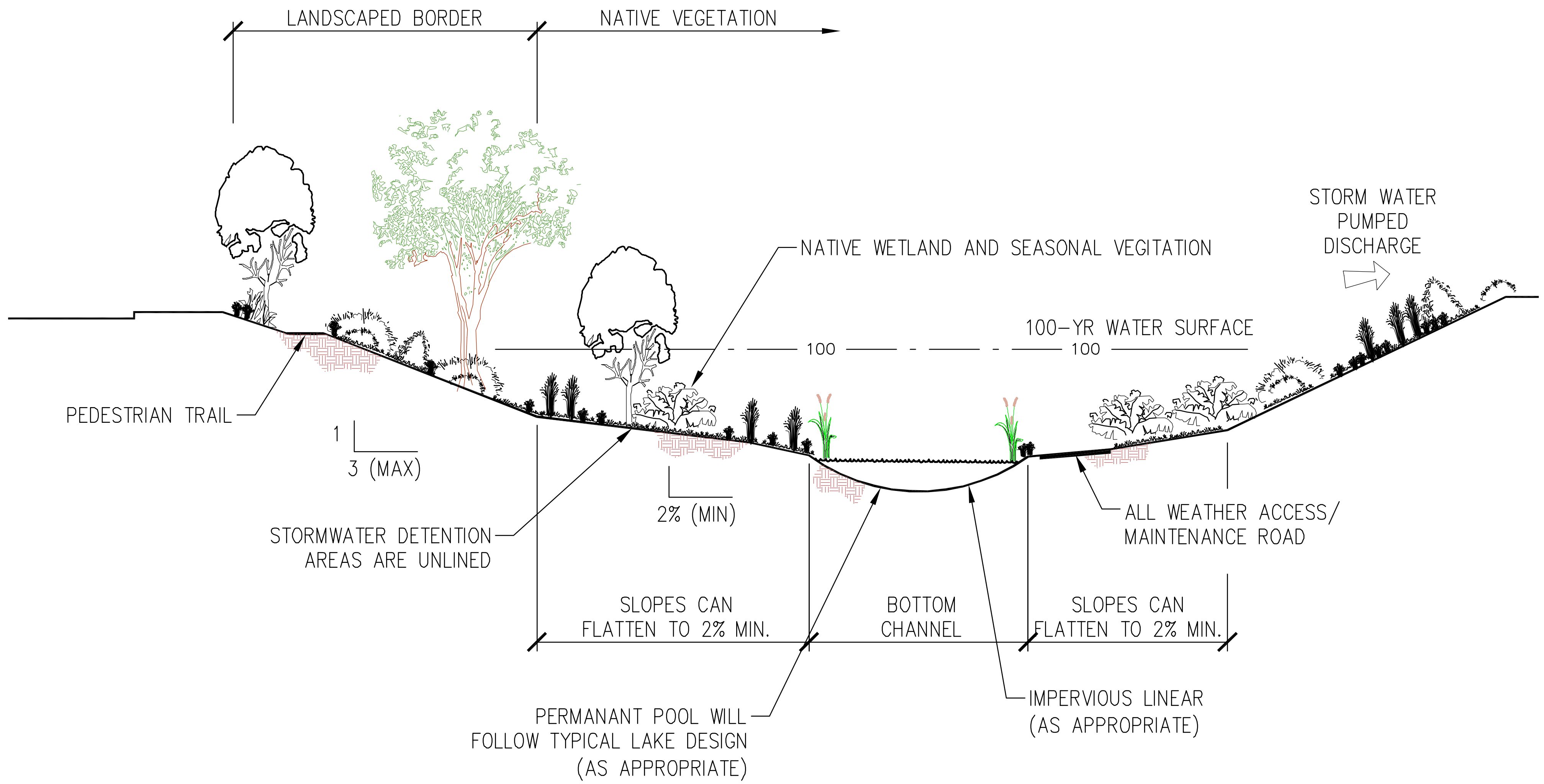
TITLE
TYPICAL DETENTION BASIN PUMP STATION (PLAN VIEW)

JOB
MARIPOSA LAKES
STOCKTON CA

PACE
PACIFIC ADVANCED CIVIL ENGINEERING
17520 NEWHOPE STREET, SUITE 200
FOUNTAIN VALLEY, CA 92708
PH (714) 481-7300 FAX (714) 481-7299

FIGURE
8

JOB NO. 8013-E



NO	BY	DATE	REVISIONS	DATE	APP.

SCALE N.T.S.
DESIGNED B.J.
DRAWN T.B.
CHECKED B.M.P.
DATE 03-02-06
JOB NO. 8013-E

TITLE
WET EXTENDED DETENTION BASIN BMP

JOB
MARIPOSA LAKES
STOCKTON CA

PACE
PACIFIC ADVANCED CIVIL ENGINEERING
17520 NEWHOPE STREET, SUITE 200
FOUNTAIN VALLEY, CA 92708
PH (714) 481-7300 FAX (714) 481-7299

FIGURE 9

JOB NO. 8013-E

Xrefs: 8013-REPORT-11x17.dwg
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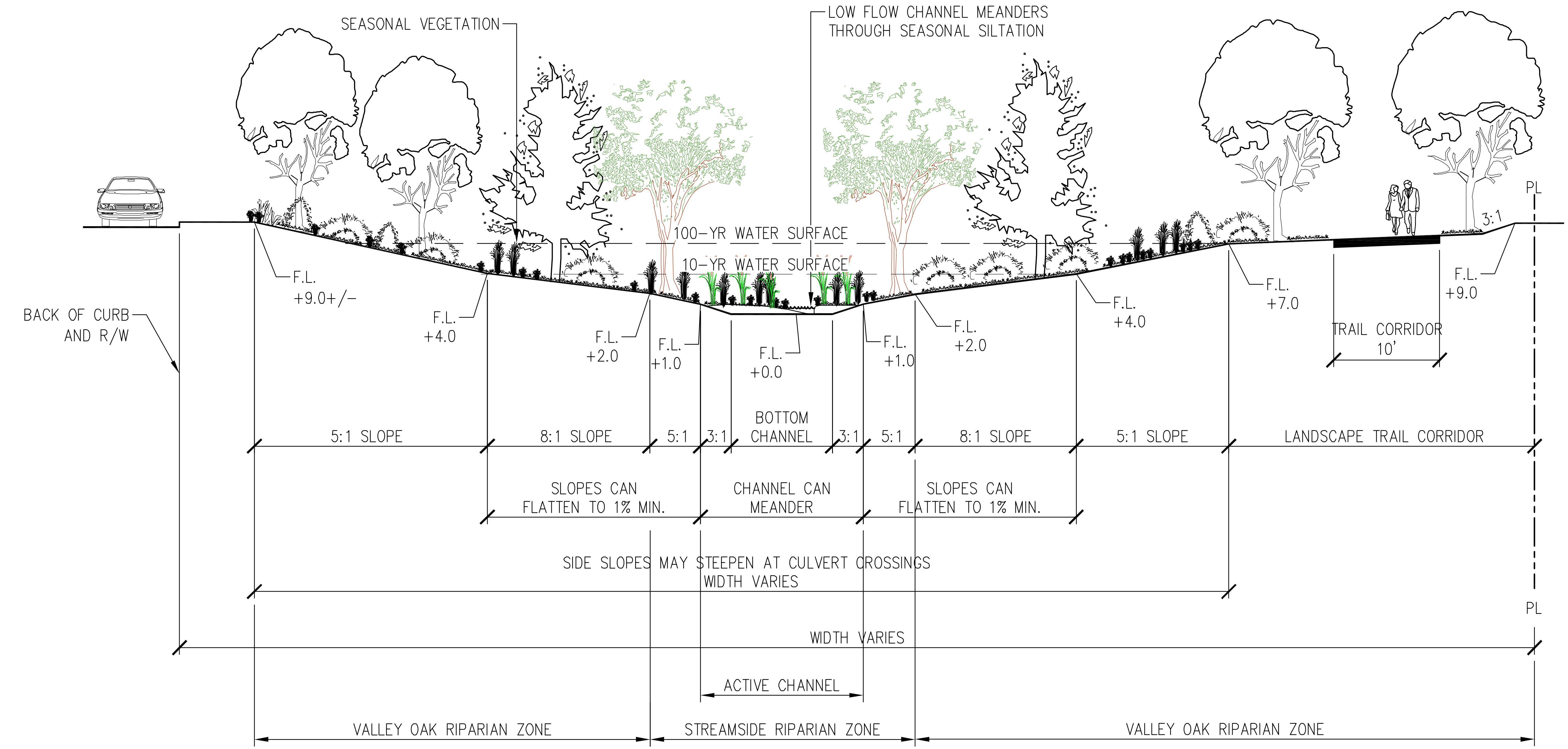

NO	BY	DATE	REVISIONS	DATE	APP.

SCALE	N.T.S.
DESIGNED	B.J.
DRAWN	T.B.
CHECKED	B.M.P.
DATE	03-02-06
JOB NO.	8013-E

TITLE
TYPICAL STREAM CROSS - SECTION

JOB
MARIPOSA LAKES
STOCKTON CA

PACE
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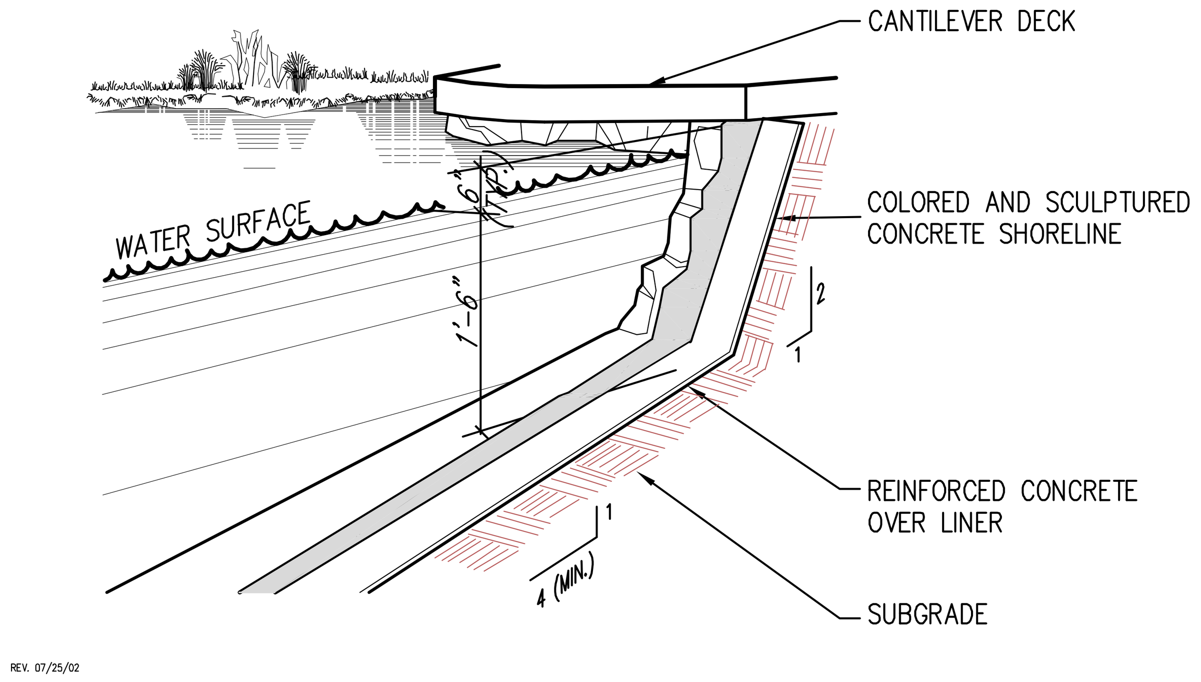
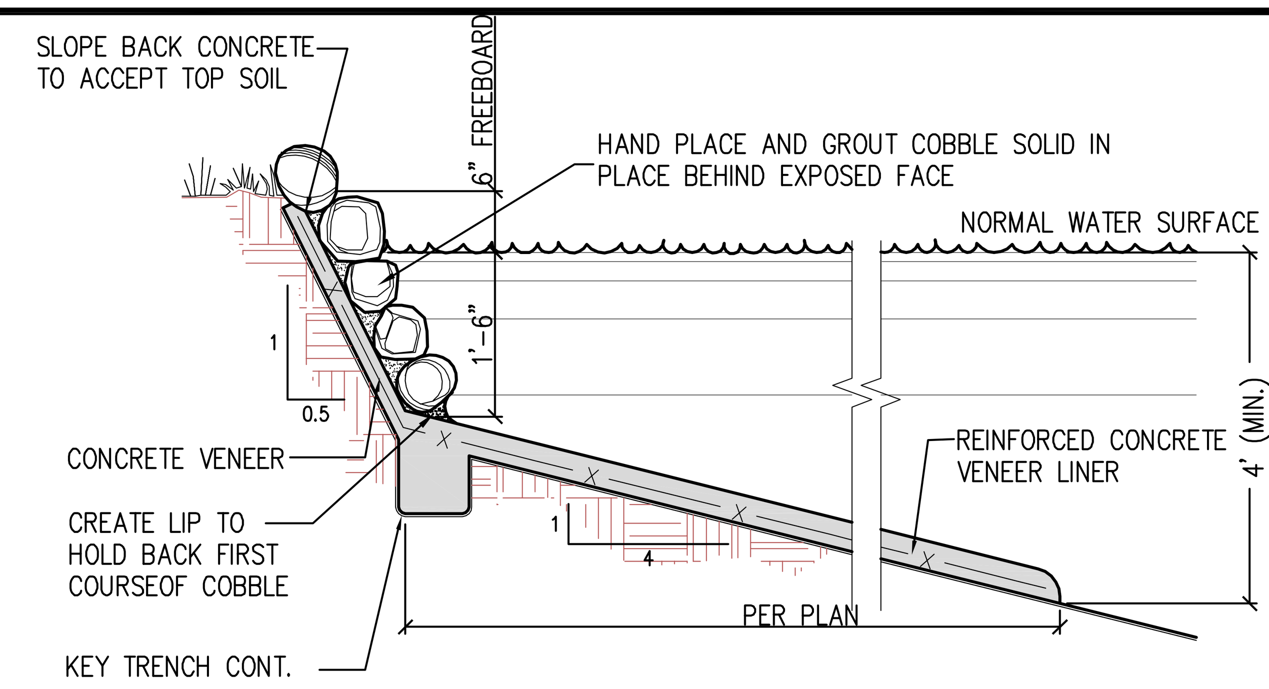
17520 NEWHOPE STREET, SUITE 200
FOUNTAIN VALLEY, CA 92708
PH (714) 481-7300 FAX (714) 481-7299

FIGURE **10**

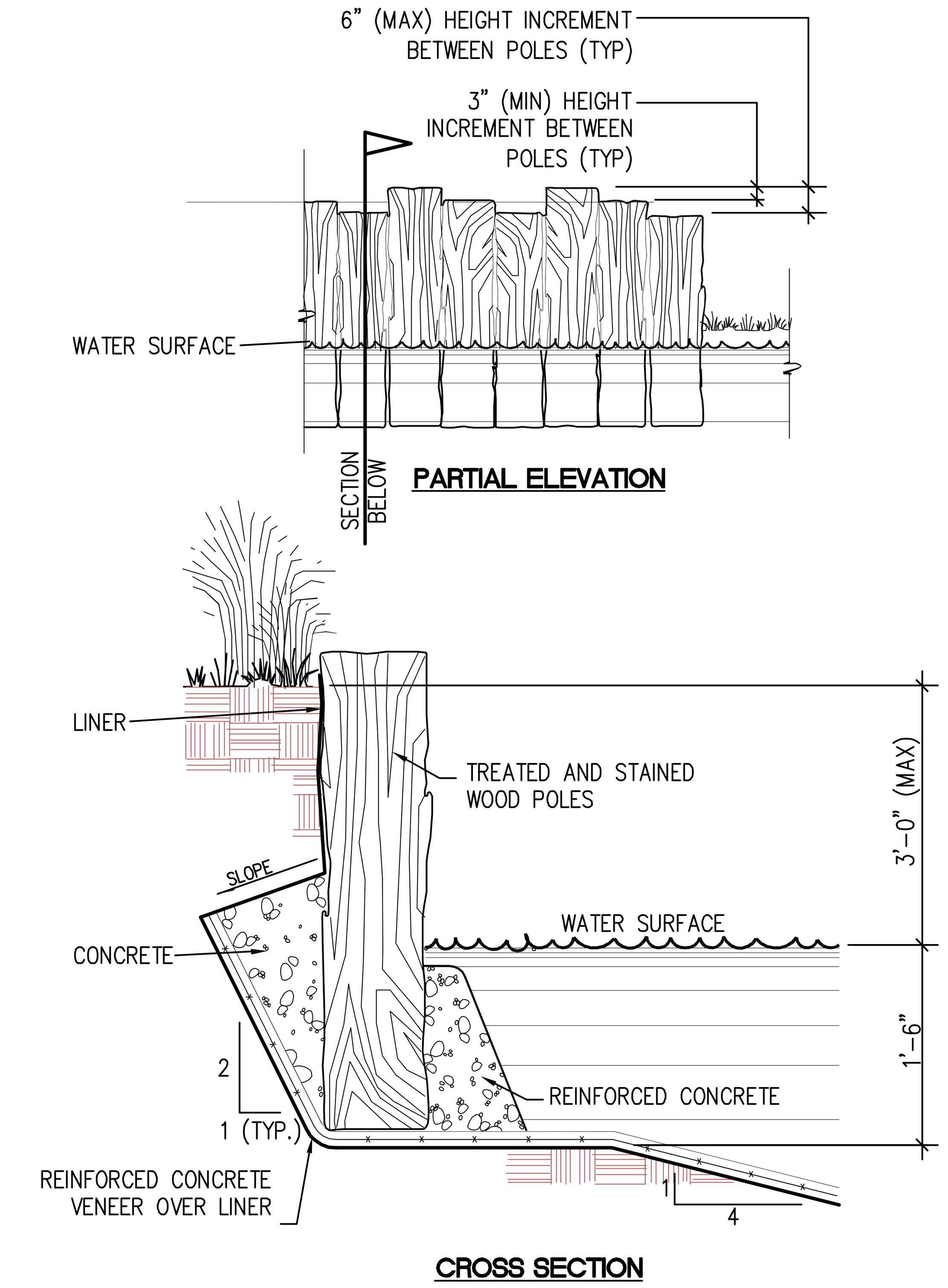
JOB NO. 8013-E



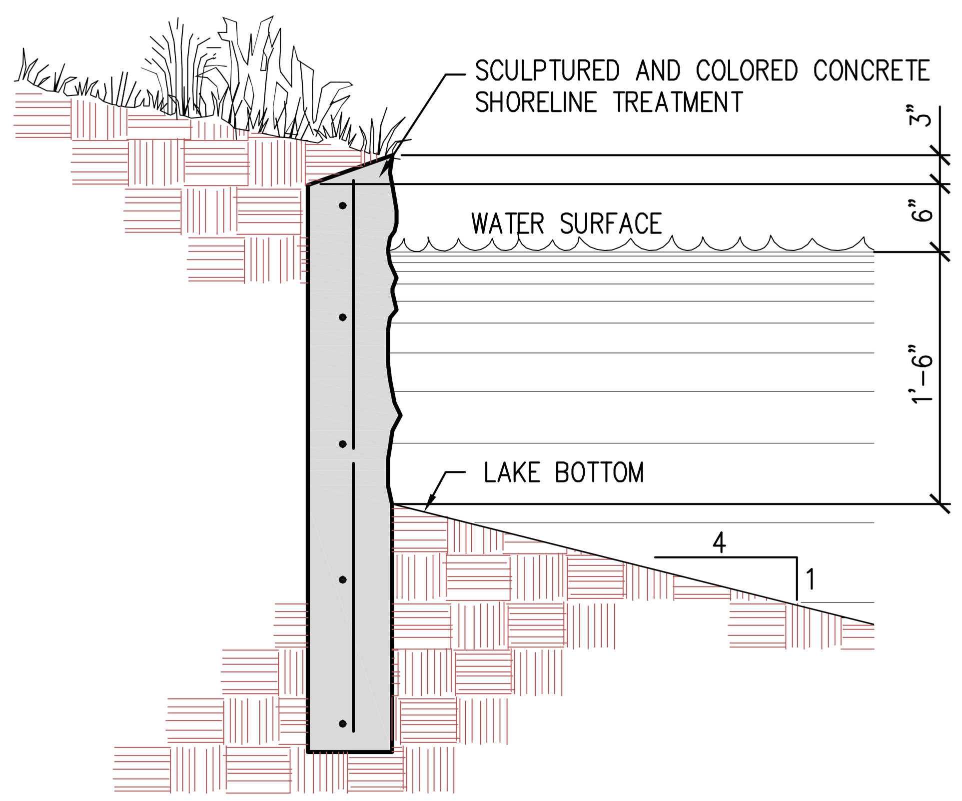
CANTILEVER DECK EDGE N.T.S.



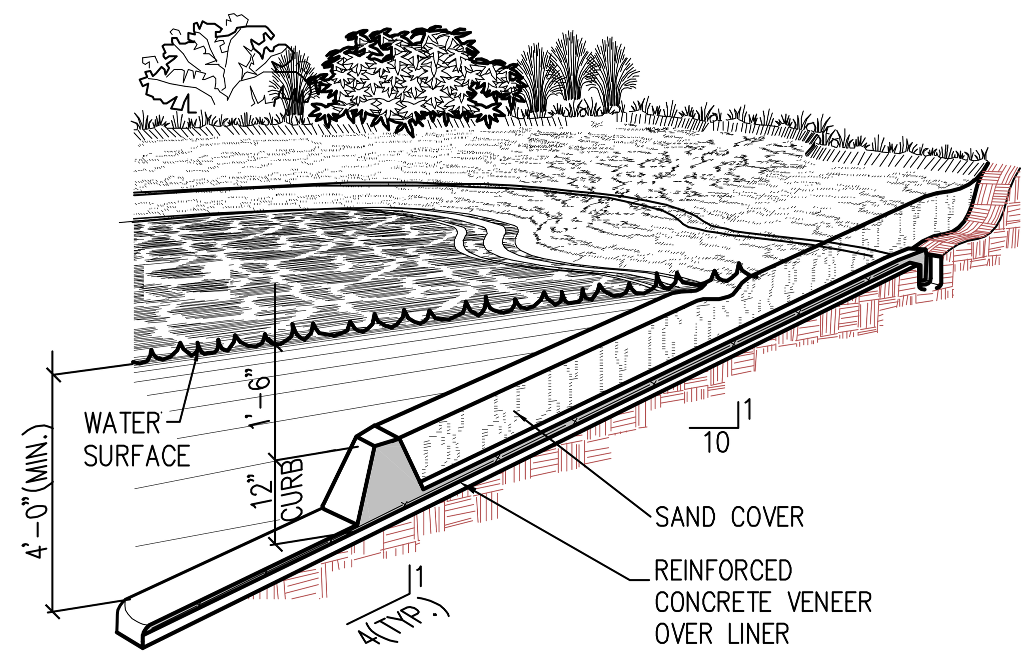
COBBLE SHORLINE N.T.S.



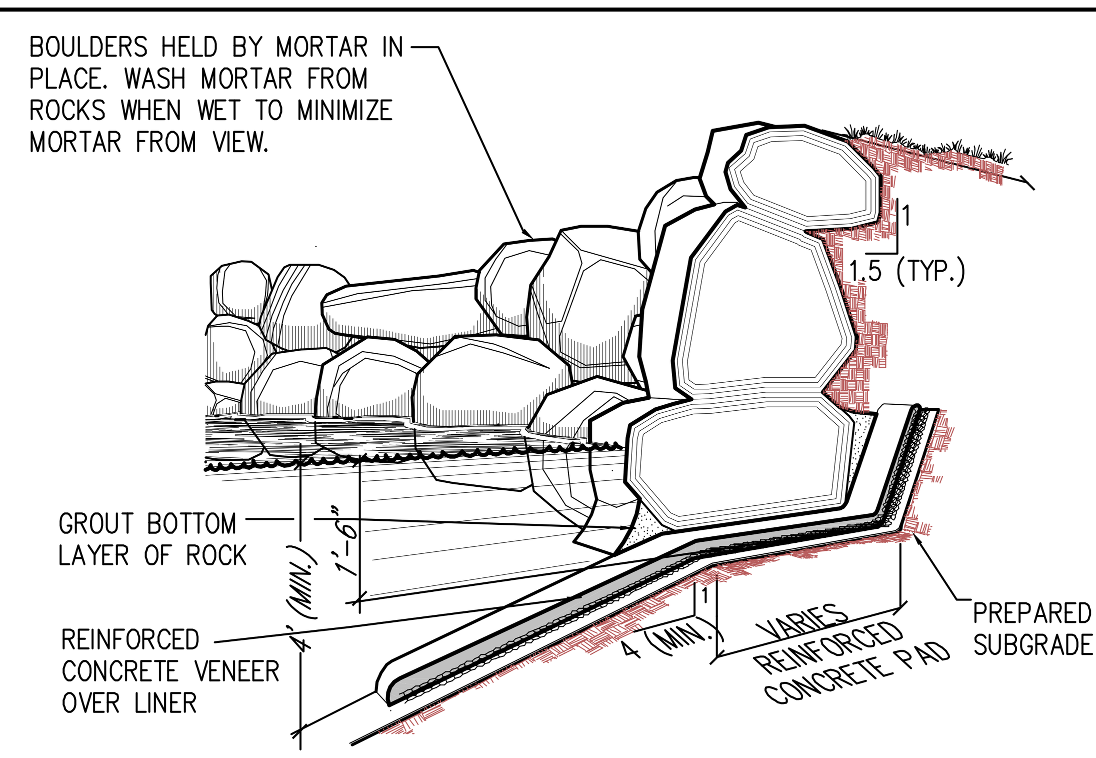
BOLLARD SHORELINE N.T.S.



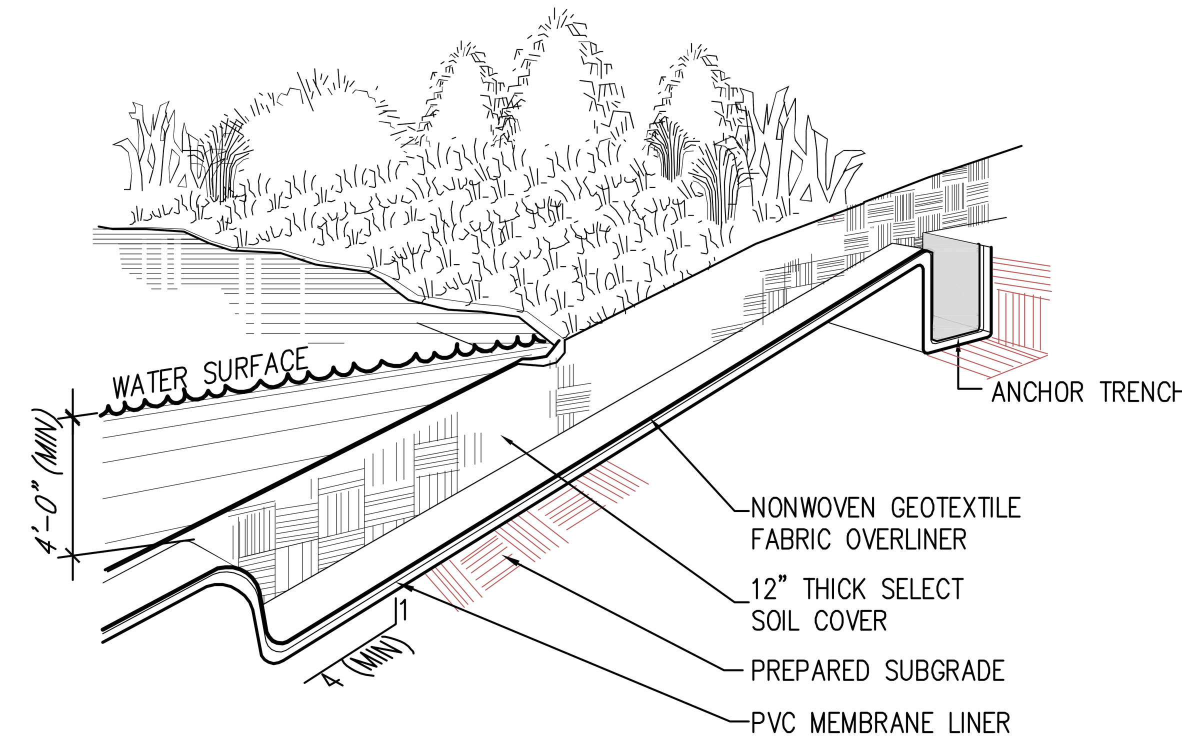
BULKHEAD SHORE TREATMENT N.T.S.



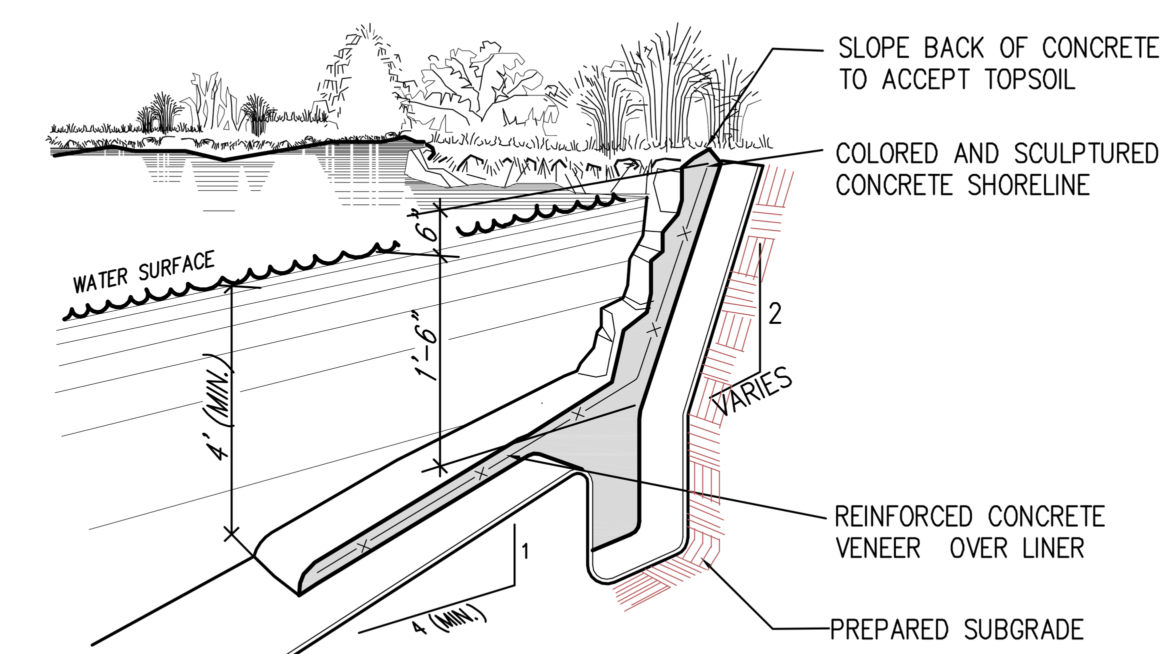
BEACH SHORELINE N.T.S.



BOULDER WALL N.T.S.

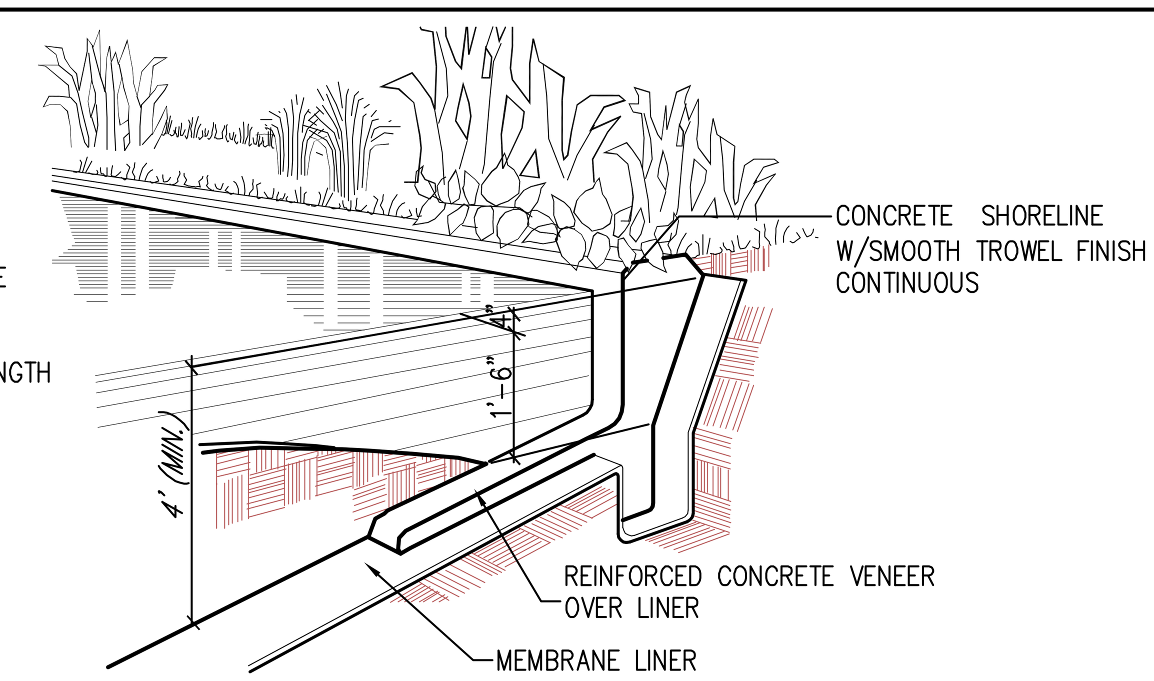


GRASS SHORELINE W/ EARTH COVER N.T.S.



ERODED CONCRETE SHORELINE N.T.S.

NOTE: FORMAL SHORE TREATMENT SHALL BE DONE WITH HAND TOOLS ONLY RESULTING IN SLIGHT LINE VARIATIONS ALONG THE LENGTH OF THE SHORELINE



FORMAL CONCRETE SHORELINE N.T.S.

NO	BY	DATE	REVISIONS	DATE	APP.

SCALE
DESIGNED B.J.
DRAWN T.B.
CHECKED B.J./R.R.
DATE 03/02/06
JOB NO. 8013E

TITLE
LAKE SHORELINE DETAILS

JOB
MARIPOSA LAKES
STOCKTON CA

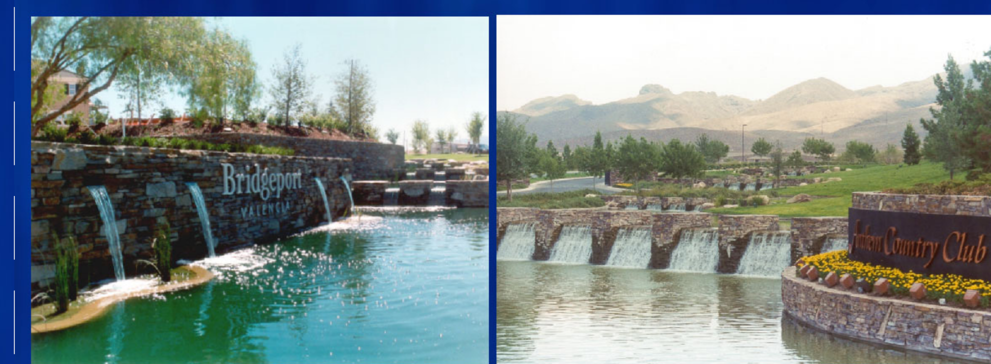
PACE
PACIFIC ADVANCED CIVIL ENGINEERING
17520 NEWHOPE STREET, SUITE 200
FOUNTAIN VALLEY, CA 92708
PH (714) 481-7300 FAX (714) 481-7299

FIGURE 11

JOB NO. 8013-E

LAKE ACCESS


WETLAND PLANTER


RETAINING WALL EDGE


CONCRETE


LAKE ACCESS


PLANTERS


STACKED ROCK


CONCRETE WITH COBBLE


LAKE ACCESS


TIMBER BULKHEAD WALL


ERODED CONCRETE


NATURAL


LAKE ACCESS


CONCRETE BULKHEAD WALL


ERODED CONCRETE


GRASS


PROPOSED LAKE CONSTRUCTION
SHORELINE DETAILS AND EXAMPLES

MARIPOSA LAKES
PROPOSED LAKES PLAN
CITY OF STOCKTON

PACE
PACIFIC ADVANCED CIVIL ENGINEERING

EXHIBIT
12

JOB NO. 8022-E