November 3, 2011

Kenneth Landau, Assistant Executive Officer
11020 Sun Center Drive, Suite 200
Rancho Cordova, CA 95670

SUBJECT: Rebuttal of Comments on Cease and Desist Order NO. R5-2011-xxxx Requiring the City of Colfax Wastewater Treatment Plant Placer County to Cease and Desist from Discharging Contrary to Requirements.

Dear Mr. Landau,

The City of Colfax (City) has reviewed comments submitted on the draft Cease and Desist Order (CDO) and Administrative Civil Liability (ACL) posted by the Central Valley Regional Water Quality Control Board (Central Valley Water Board) regarding the City's wastewater treatment plant (WWTP). The City is supplying rebuttal to the CDO and ACL comments submitted by Edwards Family Farm, Friends of the North Fork, and Save the American River Association.

The general issues raised in the Edwards Family Farm comments include: the CDO does not order compliance with the permit nor consider compliance history, the ultimate capacity of the wastewater treatment plant is incorrect, serious problems with the dewatering and increases to overall treatment capacity, Pond 3 liner design problems, unreasonable rain delay provisions, allowance for the City to avoid necessary infiltration and inflow (I&I) work, and the CDO would allow unrestricted connections. The City disagrees with each of the issues raised by the Edwards Family Farm as discussed below.

I. The City Is Committed to Compliance, and Has Demonstrated Significant Progress Since 2009.

In early 2009, the City made a calculated decision to perform wholesale personnel changes in nearly every aspect of City management. The City Manager, City Engineer, City Attorney, and the Waste Water Treatment Plant ("WWTP") operators were replaced, in favor of personnel who would be entirely committed to ensuring compliance with the City's NPDES Permit, Cease and Desist Order, and the Settlement Agreement entered into with Allen and Nancy Edwards and the Environmental Law Foundation. In early 2010, the City replaced their contract wastewater engineers, with Larry Walker Associates now acting in this role. The City's team has demonstrated significant progress over the past three years, as described below, with the only remaining issue the dewatering and lining of Pond No. 3. The City is aggressively pursuing this project, a project repeatedly demanded by the Edwards, and adoption of the Tentative Cease and Desist Order is a crucial step towards completing this final step. The Edwards, and their colleagues at Save the American River Association ("SARA") and Friends of the North Fork, clearly want the Regional Water Board to focus on the distant past, rather than acknowledge the impressive strides by the City, in a bewildering effort to artificially continue the adversarial relationship between the parties. The City hopes the Regional Water Board will not be deceived.

Due to the perseverance and commitment of City staff, engineers, and operators, the City continues to make great strides in the operation and maintenance of its wastewater collection and treatment infrastructure, including, but not limited to:

- Successful optimization and operation of the City's WWTP by new operators, Water Pollution Control Services ("WPCS"). WPCS has been instrumental in formulating and implementing a variety of modifications to operations and maintenance that have substantially improved WWTP performance.

- Successful inspection of the City's WWTP by USEPA in November 2010. The final inspection report, along with Regional Water Board staff analysis, was issued on April 25, 2011. Importantly, the inspector found *no violations* of the City's NPDES Permit, confirming the dedication of City staff, engineers, and operators to properly operating and maintaining the WWTP infrastructure.

- Completion of a comprehensive collection system repair, replacement, and rehabilitation project in 2011 as required by Cease and Desist Order No. R5-2010-0001 ("2010 CDO"). The City completed smoke testing, Closed Circuit Television ("CCTV") inspections, repaired, replaced, or rehabilitated 7,475 linear feet of collection system, rehabilitated 11 sewer manholes, and upgraded four pump stations.

- Ongoing repair, replacement, and rehabilitation of an additional 10,182 linear feet of collection system, and rehabilitation of approximately 100 manholes. This work is expected to be complete in 2012.

- Successful completion of sampling for Water Effects Ratio ("WER") study for copper in September 2011, as required by the 2010 CDO. A completed WER study will be submitted to the Regional Water Board in March 2012.

- Successfully handled the Pond 3 emergency discharge in March –April 2011 resulting from heavy rains, implementing a temporary treatment system that minimized any water quality impacts of the discharge to receiving waters (*see* Tentative Cease and Desist Order at Findings 24-30, noting that all constituents except pH were compliant with the City's NPDES Permit limitations). While the City is diligently pursuing additional infrastructure optimization and modification to avoid this circumstance from occurring again, the City is proud of how it handled the unfortunate situation, demonstrating the City's commitment to protection of water quality.

- Launched investigation into accuracy of Western Regional Climate Center (WRCC) and National Oceanic and Atmospheric Administration ("NOAA") rain gauges used by the City in past water balance evaluations of WWTP and Pond 3. The City confirmed that the WRCC and NOAA "CFX" sites located close to Interstate 80 in Colfax were not accurately reporting the significant rainfall in and around the WWTP and Pond 3 due to significant blockage from trees/cover, which detrimentally affected previous efforts by the City to predict and control flows into Pond 3. The NOAA "CFC" began operation in November 2005 being operated November through April and located at the WWTP adjacent to the dam at Pond 3. Starting in 2010 the CFC site is now operated year round, and provides the basis for current efforts, and will result in more reliable assumptions and operations.

- Preparation and submission of a Wastewater Treatment Plant Storage Pond Water Balance (May 31, 2011) and Wastewater Treatment Plant Feasibility Analysis For Alternative Measures to Dewater Pond 3 and Meet Freeboard Requirements (June 22, 2011) to evaluate all measures needed to ensure Pond3 can be timely dewatered and lined, and that all future flows will be stored and treated in accordance with the City's NPDES Permit (using the "CFC" rain gauge site). While the initial plan for dewatering Pond 3 was negatively affected by the above-average rain during the 2010-2011 wet season, the City remains steadfast in its commitment to dewater and line Pond 3.

- Secured grant and loan funding of approximately $6.6 million dollars from USEPA, USDA, and the Clean Water Act State Revolving Fund ("SRF") in September 2011 for the ongoing repair, replacement, and rehabilitation of the City's collection system and for the Pond 3 dewatering and liner project, notwithstanding significant efforts by the Edwards, SARA, and Friends of the North Fork to derail its issuance.[1]

- Refinanced the City's existing SRF debt of $7.7 million dollars in September 2011, to reduce the interest rate and make payments less crippling on the City.

The City hardly resembles the entity portrayed by the Edwards, SARA, and Friends of the North Fork. The City hopes the Regional Water Board will see past the exaggerated rhetoric, in favor of issuing the Tentative Cease and Desist Order and Tentative ACL, which will allow the City to continue progressing forward with the Pond 3 dewatering efforts and liner project.

II. The Edwards' Objection to the Pond 3 Liner Project and Tentative CDO Is Contrary to Their Repeated Position in Federal Court

The City is involved in ongoing litigation with Allen and Nancy Edwards on issues related to the City's wastewater collection, treatment, and discharge, including the continued use and lining of Pond 3. (*See ELF and Edwards v. City of Colfax*, U.S. District Court, Eastern District, Case No.: 2:07-CV-02153-GEB-EFB) As a result of months long, intensive negotiations with federal Magistrate Brennan during the Summer and Fall of 2010, the City and the Edwards reached a negotiated settlement regarding a variety of WWTP issues, resulting in a November 2010 federal court order requiring the City to, among other things, dewater and install a liner in Pond 3 by November 30, 2012. (*See* November 2, 2010 Order Re Compliance with Settlement Agreement ("Order")) The <u>Pond 3 liner was specifically and repeatedly demanded by the Edwards in federal court,</u> and the City agreed to implement the project so as to achieve some semblance of peace with the Edwards, and to concurrently comply with the 2010 CDO requirement to address potential seepage discharges from Pond 3. Given that the Pond 3 liner project and associated activities are being completed, in part, due to the insistence by Mr. and Mrs. Edwards, the City

[1] The City is a small, disadvantaged community, with disproportionately high sewer rates of approximately $105.40 per month, due to the limited population. Funding significant infrastructure improvements can prove difficult. After several years of intensive work by the City Manager, the City secured funding for the remaining infrastructure projects.

remains puzzled and extremely frustrated by the Edwards' new assault on the project, and has to assume the Edwards simply want the City to fail. The City previously engaged in detailed discussions with the Edwards regarding the infeasibility of their now-desired Bunch Creek pipeline; however, the Edwards simply do not want to accept the factual and regulatory realities that make this project unworkable.

The parties understood at the time the Order was negotiated and adopted that the schedule for dewatering and lining Pond 3 was condensed, rainfall dependent, and required cooperation by Regional Water Board staff, the City, and the Edwards to complete all necessary tasks in a timely manner. The City was, and continues to be, committed to taking all necessary actions to complete dewatering and to line Pond 3, as continually demanded by Mr. and Mrs. Edwards in federal court. Interference and obstructionist tactics by Mr. and Mrs. Edwards, and now their colleagues at SARA and Friends of the North Fork, will unnecessarily complicate the City's efforts, divert resources and time from focusing on compliance related tasks, and may ultimately result in undue delay with respect to compliance with the Order and the 2010 CDO, *through no fault of the City.* So as to avoid this untenable outcome, the City requests the Regional Water Board adopt the Tentative Cease and Desist Order, authorizing the City to undertake actions to expedite dewatering of Pond No. 3, which will facilitate timely installation of the liner.

The City also further notes that it has, to date, met every obligation set forth in the November 2010 federal court order, and the only outstanding issue is the timely dewatering and lining of Pond No. 3. Specifically, the Order requires:

- Installation of effluent flow meter (*see* Order at ¶15).
  - *Completed November 8, 2010.*
- Complete and submit WER study to Regional Water Board by March 31, 2012 (*see* Order at ¶¶5-6).
  - *Completed technical work for WER study in August – September 2011. WER study will be timely submitted to Regional Water Board.*
- Conduct additional sampling of Persistent Chlorinated Hydrocarbon Pesticides (*see* Order at ¶¶7-9).
  - *Completed sampling in September and October 2010. Confirmed via mass spectrometry that "detected, not quantified" results were in fact non-detect. No further sampling required.*
- Provide the Edwards each month data from continuous flow, total residual chlorine, UV intensity, and turbidity meters in 15 minute intervals (*see* Order at ¶18).
  - *The City provides this data every month.*
- Complete comprehensive collection system repair, replacement, and rehabilitation project by February 14, 2011 (*see* Order at ¶10).
  - *Completed April 2011. Due to weather delays in November and December 2010, and again in February and March 2011, McGuire Hester requested extensions and the City worked to ensure the shortest timeframe possible for completion.*
- Remove all obstructions from sewer segments rated "CI" under the parties' settlement agreement sufficient to allow a CCTV camera to pass through, and complete condition assessment of those lines, by February 14, 2011 (*see* Order at ¶11).
  - *Completed April 2011. Due to weather delays in November and December 2010, and again in February and March 2011, McGuire Hester requested extensions and the City worked to ensure the shortest timeframe possible for completion.*

- Complete additional repair/replacement of sewer segments still rated CI after revised condition assessment by December 31, 2011 unless an extension is granted by the District Court to this deadline (*see* Order at ¶12).
    - *Work underway.*
- Complete Pond No. 3 liner project complete by November 30, 2012 (*see* Order at ¶¶19-23).
    - *Pending, subject to adoption of Tentative Cease and Desist Order. Financing for the project has already been secured, well before March 31, 2012 deadline set forth in the Order (see Order at ¶24).*

III. The Regional Water Board Should Reject the Edwards' Request for a Moratorium on Additional Sewage Hookups.

In federal District Court, the Edwards have repeatedly asked the Magistrate to issue a moratorium on additional sewer hookups in the same manner that the Edwards are requesting here. Magistrate Brennan has declined the Edwards' request each time. In a good faith effort to compromise, the City agreed to add the Edwards to the Interested Parties list for any CEQA process related to any project involving hookups to the City's WWTP, so the Edwards would be apprised of any changes to influent flows at the WWTP. (*See* November 2010 Order at ¶13). Notably, given the housing market and local economy, new hookups to the City's WWTP have been few and far between, so this issue has become somewhat moot. Further, the City agreed to notify the Edwards within ten (10) days of receipt of any application for building permits related to the Colfax Pines residential development project, a previously planned subdivision that has been substantially delayed due to similar effects of the housing market and local economy. (*See* November 2010 Order at ¶14)

Title 23, Cal. Code of Regulations sections 2244 through 2245 specify the appropriate parameters for issuing connection bans to community sewer systems. Importantly, Section 2244(b) states that a prohibition on additional discharges into a community sewer system can be included in a cease and desist order only if the addition in volume, type, or concentration of waste entering the sewer system would *cause an increase in violation* of waste discharge requirements or increase the likelihood of violation of requirements. In this case, neither is true. The August 2011 water balance analysis demonstrates an existing lack of capacity in Pond 3 to handle a 100-year, 365-day precipitation event when using the newly identified "CFC" rain gauge site, and an infrequent additional sewer hookup will not affect or increase the likelihood of this determination, nor will it substantially modify the cure identified in the Tentative Cease and Desist Order. Further, pursuant to Section 2244(d), connection bans cannot be used as a punitive measure for past failure to comply. Regional Water Boards have been reluctant to issue connection bans in the past, and we request the Regional Water Board reject the suggestion in this case.

IV. Additional CEQA Analysis May Not be Necessary as Analyses Already Conducted Include Consideration of Flows up to 1 MGD

The October 1, 2004 EIR evaluated the WWTP's ability to treat flows up to 1,000,000 gallons per day. *See, e.g.*, EIR at page 3-13; CEQA Addendum at pages 2, 5, and 6

V. The CDO Recognizes the Capacity of the WWTP is dependent on Controlling the Seepage into the Pond and Influent Flow Reductions from Infiltration and Inflow Work.

The City recognizes the WWTP capacity of 0.5 MGD is not adequate for the current pond storage. The City, through investigation of the available data that the historic precipitation gauges were shaded by trees and typically under record the true amount of rain. In the Wastewater Treatment Plant Storage Pond Water Balance, Revised Final (August 2011), there are in fact two predictive models presented. One model assumes all current inflows to the pond are present in the future and the other assumes the seepage is cut off. The two models effectively bookend the required WWTP treatment capacity to provide 2 foot free board under the 100-year precipitation condition with current levels of I&I.

The City is lining Pond 3 as a means to comply with Permit Discharge Prohibition III.A and prevent any leakage that is not currently captured. In the process of developing the August 2011 water balance, the calculated change in pond volume was compared to the measured change in pond volume. A plot of the difference between the measured monthly change in pond volume compared to the water balance calculated change in the monthly pond volume is presented as Figure 1 (Figure 13 in the August 2011 water balance report). As stated in the water balance report, there is an average of 0.25 MG per month (less than 0.01 MGD) loss from the reservoirs. Additionally, there is generally a ±3 MG difference between measured and calculated monthly change in storage volume, corresponding to ±4% of the available storage volume. Additionally, there are no apparent substantial systematic errors, especially in the July thorough September time period where conditions are driest. If there were significant levels of water seeping out of the ponds the pattern would be evident on Figure 1.

The Edwards Family Farm contends that the seepage into the pond is more significant than thought by the City because of the postulated high levels of seepage from the pond. However, the City intends to line the pond, blocking seepage from entering the pond; the channel parallel to Pond 3 has been relined and geologic investigations are planned to determine if there is seepage under the channel into the pond. The Edwards contend there may be an additional 3 MG per year of water to treat, but that would equate to an additional 0.008 MGD, which is within the error of the analysis. The Edwards point out that for June and July 2008 the water balance is "short" approximately 1.5 MG per month, however the June and July 2009 are calculated to have an extra 0.8 and 1.8 MG, respectively. The differences in monthly totals are within the error of the model.

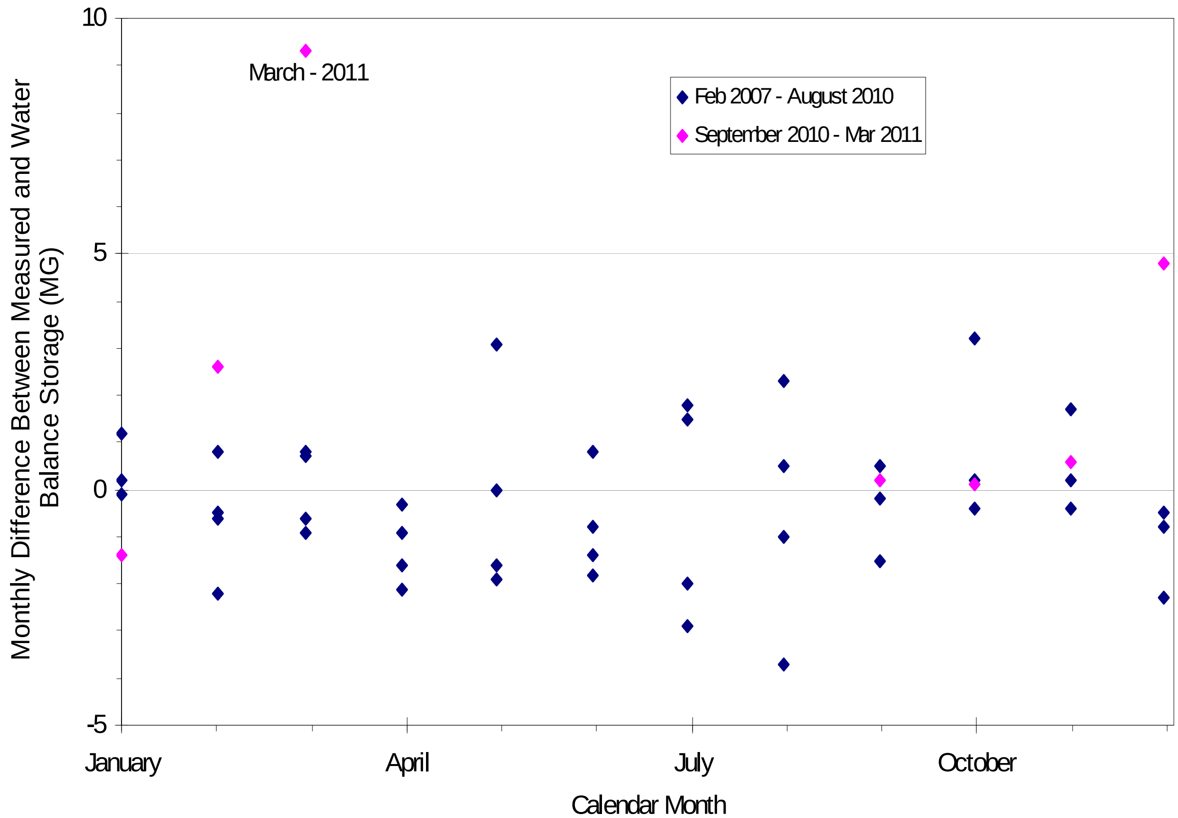

Figure 1: Difference Between Measured and Calculated Change in Storage per Calendar Month.

For the protection of the liner, pressure relief valves may be installed in the Pond 3 liner. These valves would only open when there is higher pressure under the liner than over. During the wet season, there will likely be water stored in Pond 3 which will provide downward pressure on the liner, so that the pressure relief valves would remain closed. At a water height of 10 feet, there is under 1.5 MG of water in the pond. At very small levels of storage in Pond 3, significant downward pressure is exerted on the liner.

In the Edwards Family Farm comments, the statement is made that the City has indicated that Pond 3 has a smaller volume than assumed referencing a letter from Bruce Kranz to Spencer Joplin. The letter, dated May 4, 2011, simply conveys that the level of the pond was incorrectly measured over the period March 16, 2011 through March 21, 2011. The pond level had increased beyond the usual reference point. On March 22, 2011 the correct reference point was identified and used thereafter. The letter conveyed the correction to the Central Valley Water Board.

The City has been performing aggressive I&I work within the collection system. As part of the line clearing process, the WWTP has become upset from time to time, limiting the ability to operate at full capacity. Additionally, to effectively dewater the storage ponds in the warmer weather months, algae removal is a necessary process to maintain the low effluent turbidity levels required for effective disinfection and permit compliance. Power failures have disrupted the algae removal process leading to plant upset. Modifications to the WWTP have been performed to ensure power disruptions do not lead to future disruption of the algae removal process. The WWTP flows were curtailed during the water effect ratio (WER) sampling.

As part of the SRF funded I&I work, the City will be performing extensive flow monitoring within the collection system. The monitoring is designed to not only capture flow changes in response to the I&I work performed to date, but to determine the locations that would most benefit from additional targeted rehabilitation. At the point where the August 2011 water balance was conducted, the reductions in I&I flows were not quantified sufficiently well to include in the analysis. As a conservative measure, the assumption was made in the analysis that the current levels of I&I would remain in the future. Reduction in I&I flows will reduce the ultimate WWTP capacity necessary to maintain the 2 foot freeboard requirement for the storage ponds.

VI. The CDO Provides the City with the Ability to Dewater the Pond in a Timely Manner and Allows Assessment of the Required Capacity

Discussion of Alternative 1 is best suited to the future operation of the WWTP at a consistently high flowrate. The actions outlined in Alternative 1 are directly pointed toward achieving consistent, high level treatment through the WWTP.

The WWTP discharge to the receiving water is of high quality. When the turbidity of the effluent increases toward the daily average value of 2 NTU, the effluent is diverted. Since WPCS modified to the operation of the plant by adding alkalinity to the influent, ammonia levels in the discharged effluent are typically below 0.5 mg/L as N. Operators at the plant consistently report no odors in the effluent. On October 24, 2011, the City conducted sampling for bacteria levels at several sites. Figure 2 is a schematic of the area around the City of Colfax WWTP, including the locations sampled on October 24, 2011. The samples included the WWTP effluent, dam seepage, Smuther's Ravine Creek above the WWTP confluence, and Bunch Creek upstream from the confluence with Smuther's Ravine Creek. The analytical results of the sampling are listed in Table 1. The two samples with the highest levels of bacteria are the Old R1 site on Smuther's Ravine Creek upstream of the WWTP effluent influence and Bunch Creek upstream from the Smuther's Ravine Creek confluence. The Smuther's Ravine Creek watershed contains more inputs than solely the WWTP discharge. During the October 24, 2011 sampling, there was no recent precipitation, conditions are thought to be reflective of dry conditions.

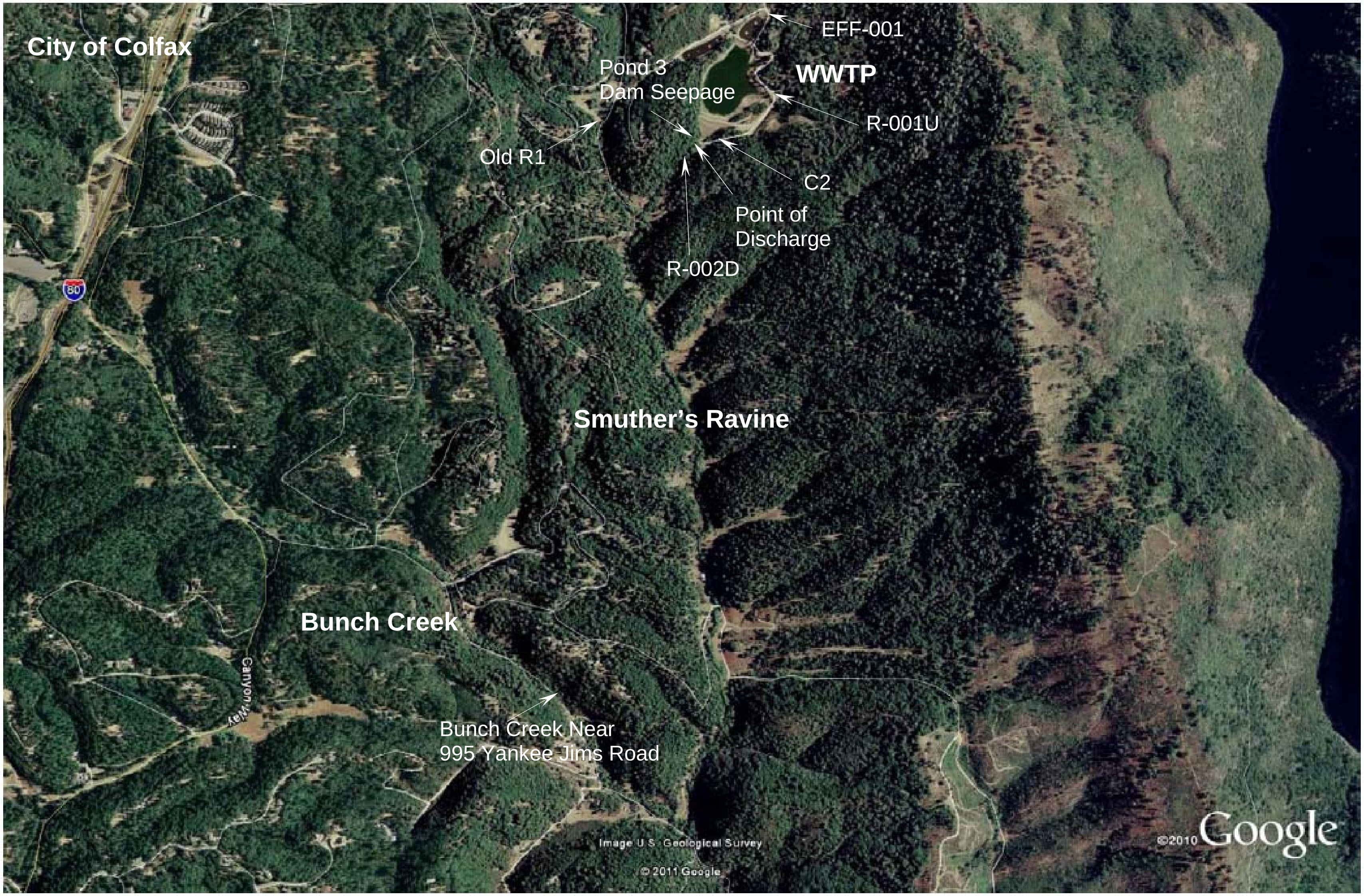

Figure 2: Bacteria Sample Location Schematic.

Table 1: Bacterial Levels Measured October 24, 2011. Sample Locations Displayed on Figure 2.

Location	Concentration (MPN/100 mL) Total Coliform	Fecal Coliform	*E. Coli*
Left Groin (Dam Seepage)	4	<2	<2
Dam Toe (Dam Seepage)	17	<2	<2
Right Groin (Dam Seepage)	2	<2	<2
C2	17	7	7
EFF-001 (WWTP Effluent)	2	<2	<2
Point of Discharge	23	<2	<2
Old R1	>1600	7	7
Bunch Creek (near 995 Yankee Jims Road)	1600	90	90

The proposed stress test has been modified to include longer stabilization periods for the WWTP based on the sludge retention time (SRT). The proposed stress test protocol is attached as attachment 1. The stress test will extend into the critical cold weather period to determine the WWTP performance in the winter. Central to the stress test is an initial period of stable operation.

The attached letters from Steve Calderwood to Wendy Wyels directly address the flow diversions in September and October 2011, attachments 2 and 3, respectively. The addition of alkalinity control for the biological process has greatly stabilized the turbidity in the treated effluent. The alkalinity adjustment allows the proper biological activity and healthy floc to form, stabilizing the settling in the secondary clarifiers. With proper settling of the mixed liquor, the filters are able to produce effluent of consistently low turbidity.

Implementation of Alternative 3, enhanced evaporation, may not cause the same odor issues as the land disposal system previously employed by the City. In the early 2000s the influent from the City of Colfax was fed through the aerated lagoons into Pond 3. The water from Pond 3 was land applied for disposal. Now that the City has installed and operates the tertiary WWTP, the situation is radically different. In dry weather conditions the influent from the City is fed to the WWTP. In cases where the effluent turbidity does not meet standards the effluent is diverted to the storage ponds, but has undergone a high level of treatment. In wet weather conditions, where I&I flows are high, the influent from the City in excess of the WWTP capacity is diverted to the storage ponds. The high I&I flows are relatively dilute (the current average dry weather flow is 0.16 MGD and the winter influent flows can exceed 2.0 MGD). Additionally, approximately one third of the water in the ponds is direct precipitation. The result is that the water in Pond 3 is typically dilute and of substantially different character than the water that was stored in the early 2000s. For enhanced evaporation, water would not be sprayed on the surrounding hillsides. Rather the spray would be confined within the bounds of Pond 3. As the enhanced evaporation is a method to assist dewatering, instead of the previous land disposal of wastewater, the amount of spray can be tailored to match the environmental conditions. With that said, the City is aware odors may be an issue with implementing enhanced evaporation and identified odor concerns in the proposal of the alternative to the Central Valley Water Board in the Wastewater Treatment

Plant Feasibility Analysis For Alternative Measures to Dewater Pond 3 and Meet Freeboard Requirements (June 22, 2011).

Implementation of Alternative 5 is a valid option. Note the City would not use the retired chlorine contact system, but instead would install a UV disinfection unit at the base of the dam to provide final treatment of the seepage before discharge to the receiving water at the same location at the discharge of the WWTP. The City agrees with the Edwards Family Farm that the retired chlorine contact basin and associated sand filters are an impracticable choice for implementing the Alternative 5. As discussed above the water in Pond 3 is generally effluent from the WWTP that did not meet the turbidity standards or excess wet weather flows dominated by I&I. A seepage sample was obtained from the wet well on October 26, 2011 and BOD5 was non-detected at a level of 3 mg/L and TSS was J-flagged at 3 mg/L. The turbidity was measured on October 21, 22, and 24, 2011 at 0.91, 0.85, and 0.62 NTU, respectively. These samples point toward the highly dilute nature of the water stored in Pond 3 that is effectively filtered as the water seeps through the dam face. During the emergency discharge in March and April of 2011, the Pond 3 water was drawn off the surface of the pond, and initially chlorinated and dechlorinated through the chlorine contact chamber and in April the disinfected water was run through the sand filters. During the emergency discharge period, the discharge was sampled on the frequency and for the constituents as specified in the permit for the WWTP effluent. With the exception of pH, the treated pond water consistently met the WWTP effluent limitations. These results indicate the seepage through the dam face is equivalent to tertiary treatment, leaving only disinfection (and possibly pH adjustment) as the final treatment process. The operation of the WWTP and the manner in which the storage ponds are used, leads to the water in Pond 3 substantially better quality than was present in the early 2000s. The City would contend the disinfected seepage would meet the WWTP effluent limitations.

The implementation of Alternative 5 would be in place as needed to dewater the pond for lining. Currently, the pond liner is designed (see attachment 4) and the City has secured funding for the project. The last remaining hurtle is to dewater the pond. The CDO provides the necessary assistance to the City to get Pond 3 dewatered for the lining to take place. Once the pond is lined, there would no further need to treat the seepage, as any natural groundwater would not require capture and treatment.

VII. The Pond 3 Liner Follows Standard Design Practices

To address the under the liner seepage, a liner subdrain system will be included in the design. Pressure relief valves will be included as an extra measure of protection against lifting of the liner. The pressure relief valves will not allow uncontrolled seepage into the pond, only prevent lifting of the liner. The weight of the water in the pond will provide downward pressure on the liner, preventing lift and the relief valves will remain closed. As described in the attached geotechnical analysis of the pond area (attachment 5), seepage was encountered 2 feet below the surface in one test pit. There were no other pits with evidence of seepage. Under dry conditions there would be likely no seepage into the pond through the pressure relief valves as the seepage would be below grade.

As is detailed in the City's August 2011 water balance, the seepage is likely due to the condition of the channel parallel to Pond 3 or the seepage under the channel. The City has relined the channel. The CDO requires the City to implement the geotechnical investigation identified in the City's June 22, 2011 dewatering feasibility analysis to determine if seepage under the channel is significant, and take action as appropriate to rectify the seepage. The City identified the additional seepage and is addressing the issue.

To minimize animal damage to the liner, HDR and City research has verified that an 8-foot high chain link fence will be adequate to prevent deer intrusion which is the highest risk for liner damage. The design currently includes a 2–foot thick ‘ballast’ layer over the liner to counteract wind life and associated stresses. The ballast layer will prevent liner uplift from wind. The manufacturer’s warranty for the specified 60-mil HDPE liner is 20 years for an exposed installation. The attached technical paper estimates the life of the liner at 36 years with direct sunlight exposure. HDR has installed this type of liner in similar applications on a number of successful projects. The liner project for Pond 3 is a typical installation similar to many such applications

VIII. The CDO Captures the Appropriate Schedule Adjustments due to Rainfall

The use of the rain gauges is not accurately portrayed in the Edwards Family Farm comments. The WRCC precipitation gauge, located near Interstate 80, was used as a basis for the water balance considered in the 2010 settlement proceedings. The precipitation levels from the WRCC gauge were compared to the measured influent flow to the WWTP to determine a relationship between rainfall and I&I flows. Additionally, the precipitation directly falling on ponds adds to the storage requirements. The wastewater base flow is determined by the dry weather measured flowrate. At the time of the 2010 settlement proceedings, the additional seepage had not been discovered by the City. Using the water balance based on the WRCC gauge levels of precipitation that would cause dewatering to be delayed were determined as listed in Table 2. It is now known that the WRCC under records the true precipitation levels. However, the relationship between WRCC gauge results and measured I&I flows in the appropriate influent flowrate for the precipitations listed in Table 2, and the water balance correctly calculates subsequent storage requirements. In other words, when the water balance used in the 2010 settlement proceedings is fed a given level of precipitation falling on the City of Colfax, the calculated required pond storage and time to dewatering are reflective of the of what will actually happen.

Table 2: Dewatering Schedule for Possible Precipitation Levels Based on WRCC Precipitation Gauge.

Precipitation (inches) 2010-11/2011-12	Return Period 2010-11/2011-12	Dewater Pond 3 with ADWF of 0.465 mgd
46.3/46.3	2 yr/2 yr	July 2011
59.3/59.3	5 yr/5 yr	August 2011
59.3/66.6	5 yr/10 yr	August 2011(1)
59.3/74.9	5 yr/25 yr	August 2011(2)
66.6/59.3	10 yr/5 yr	September 2011
74.9/59.3	25 yr/5 yr	July 2012
74.9/66.6	25 yr/10 yr	October 2012
80.5/59.3	50 yr/5 yr	August 2012
86.2/59.3	100 yr/5 yr	October 2012

(1) Pond would be dewatered in August 2012.
(2) Pond would not be fully dewatered in 2012.

With the revelation that the WRCC and NOAA CFX gauges near Interstate 80 are shaded by trees and under record the actual precipitation, the City reevaluated the water balance. In the August 2011 water balance, the NOAA CFC gauge located at the WWTP is used to determine a new relationship between the precipitation and the measured I&I. For comparable periods of time, the relationship using the CFC gauge will generally require more precipitation to generate the levels of modeled I&I than the relationship developed using the WRCC gage. The difference in relationships is simply due to the fact that the measured I&I is the same in both cases. However, the data for the CFC gauge has undergone quality checks by NOAA, has fewer missing days than the WRCC dataset, and covers a longer period of record, it is not a straightforward comparison. What remains true is that the precipitation levels in Table 2 are the minimum precipitation levels that will make it difficult to dewater Pond 3 in 2012 with sufficient time to install the liner.

The I&I flow is only a component of the water balance. The other component that is rain dependent is the direct rainfall over the WWTP. In both water balances, the direct rainfall is handled in similar fashion, direct precipitation is added to the required storage.

The only real effect of using a new gauge is in the calculation of annual precipitation corresponding to return periods.

The precipitation data for the CFC site for water year 2011 are presented in Table 3. The water balances indicate the dewatering of Pond 3 in 2012 will be difficult when Water Year 2011 had over 74 inches of rain.

Table 3: Water Year Precipitation Measured at Station CFC.

Month	Precipitation (inches)
October 2010	7.90
November 2010	8.86
December 2010	18.14
January 2011	3.19
February 2011	7.53
March 2011	20.27
April 2011	1.77
May 2011	3.92
June 2011	2.66
July 2011	0
August 2011	0
September 2011	0
Water Year Total	74.24

IX. The City is Committed to Substantial Infiltration and Inflow Work

Approximately half of the funds recently secured by the City are devoted to I&I work. As described above and in Finding 11 of the CDO, the City has plans to rehabilitate over 10,000 feet of sewer line and 100 man holes as well as flow monitoring and smoke testing. As these efforts are completed, if the I&I is still excessive, the City may evaluate the benefit of additional I&I work in the collection system compared to the additional levels of WWTP capacity.

X. The CDO Does Not Allow Unrestricted New Connections

The City is keenly aware that the effluent flowrates are determined to maintain the 2 feet of freeboard in Pond 3. The number of connections cannot be quadrupled, increasing the base flow of wastewater to the WWTP 4-fold, and still maintain the 2 feet of freeboard.

XI. The CDO Does Not Need to Require a Pretreatment Program

The City is not required to have a pretreatment program. The City Ordinance Section 13 clearly outlines the process for determining the equivalent dwelling units (EDUs) for new connections, including an evaluation of the type of connection.

XII. The Phase 2 Stormwater Program Does not Include the City of Colfax

The NPDES permit for the WWTP does not have any bearing on the inclusion of the City in the Phase 2 Stormwater program.

XIII. The Dam Creating Pond 3 is Safe

The Pond 3, 75-foot dam was constructed in 1978[2] with the construction of the original wastewater treatment plant. The Department of Water Resources, Division of Safety of Dams (DSOD), inspected and permitted the dam through permit #2202-0. Over the past forty years, the dam has been subject to annual inspections by the DSOD. Dam safety instrumentation includes two peizometers, four survey monuments, one seepage weir and a seepage collection pipe. The last five inspections conducted by DSOD have concluded that, "From the known information and visual inspection, the dam, reservoir, and all appurtenances are judged safe for continued use." [3] (2010 report as attachment 7) With the above information refuting Friends of the North Fork's(FONF) observation, the City could not find documentation supporting the statement of an "unsafe" dam.

FONF provided no supporting documentation that "the dam and other reservoir slopes are inadequate for the purpose of placing a liner." The WWTP Pond 3 Liner Project was designed by a Professional Engineer. In regard to any safety concerns of the liner installation within the reservoir, the DSOD in a letter dated, February 26, 2008, to the City of Colfax notified the City that an "alteration application" was not required for the project. DSOD only requires notification of construction so they may observe the work. (Attachment 8)

XIV. The Edwards list of alleged violations in their ACL comments have been largely reviewed in federal District Court

Most of the listed alleged violations were already raised at the District Court level, and that per the Nov. 2010 Order, the judge stayed any and all stipulated penalties pertaining to these. No further action is warranted or necessary.

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[2] Dams Within the Jurisdiction of the State of California, DSOD, Retrieved October 26, 2011, http://www.water.ca.gov/damsafety/damlisting/index.cfm

[3] Inspection of Dam and Reservoir in Certified Status, State of California-California Natural Resource Agency-Department of Water Resources-Division of Safety of Dams, Report dates 2004, 2006, 2007, 2009 & 2010.

Unless Plaintiffs can demonstrate that the increased TDS/EC levels measured in groundwater down-gradient from the plant are exceeding the increase typically caused by the percolation discharge of domestic wastewater, violate a water quality objective, adversely impact beneficial uses, or cause pollution or nuisance, the data cited cannot be considered in violation of the TDS/EC groundwater limitation in the City's NPDES permit specified for these constituents and, therefore, no violation needed to be reported as alleged. Alleged violations of the groundwater receiving water limitations for Dissolved Oxygen (DO), Total Kjeldahl Nitrogen (TKN), coliform and ammonia. The Fact Sheet for the City's NPDES permit states in section IV.D.4.b that "percolation from the ponds may result in an increase in the concentration of [wastewater constituents] in groundwater. The increase in the concentration of these constituents in groundwater must be consistent with Resolution 68-16."

The Edwards have alleged that the City is violating the receiving water limitations contained in the City's NPDES permit. Each of the alleged receiving water limitations relates to fecal coliform, which is ubiquitous in the environment. Many other sources of fecal coliform exist in the area where the City's R-002 sampling location lies, including wildlife and other warm blooded animals (*e.g.*, pets, livestock, rodents). The City's NPDES permit requires that "<u>the discharge not cause the following</u> in the receiving water: "**Fecal Coliform**. The fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, to exceed a geometric mean of 200 MPN/100 mL, nor more than 10 percent of the total number of fecal coliform samples taken during any 30-day period to exceed 400 MPN/mL." For a violation to occur, the discharge must be demonstrated to be the ***cause*** of the downstream exceedance.

Except for the instances in October of 2009, when the WWTP was experiencing high levels of fecal coliform in its discharge, the WWTP cannot be shown to be the cause of the fecal coliform exceedances in the receiving waters alleged by the Plaintiffs because the effluent from the WWTP was 2 MPN/100 ML or less (<2). Even in October 2009, there does not seem to be a direct correlation between discharge levels and receiving water samples. For example, on 10/6/2009, the fecal coliform in the discharge was <2 MPN/100 ML and the receiving water samples on the same date registered at 500 MPN/100 ML. Similarly, on October 16, 2009, the fecal coliform in the discharge was 2 MPN/100 ML and the receiving water samples on the same date registered at >1600 MPN/100 ML.

The City contends that if the groundwater well specified in the permit monitoring and reporting program is dry, the City should report "Well Dry" and not submit data for any other well.

The City of Colfax would like to again thank the Central Valley Regional Water Quality Control Board in addressing the issues facing the City in terms of compliance with the Permit. The City goal is to implement prioritized actions that produce the best results. In working together to create solutions, the City is confident the proper actions will be performed to protect the environment and meet the Permit requirements. If you have any questions or concerns regarding these comments, please contact me at (530) 753-6400.

Sincerely,

Mitchell Mysliwiec

City of Colfax City Engineer
Larry Walker Associates

Cc:
David Coupe, Senior Staff Council
Wendy Wyles, Environmental Program Manager
Allen and Nancy Edwards
Michael Garabedian, Friends of the North Fork
Save the American River Association, info@SARAriverwatch.org

ONE COMPANY
Many Solutions℠

Memo

To:	Mitch Mysliwiec (LWA)		
From:	Craig Olson, PE (HDR)	Project:	City of Colfax WWTP Improvement
CC:	City of Colfax WWTP Capacity Assessment		
Date:	October 28, 2011	Job No:	030333

RE: FULL-SCALE STRESS TEST OF WASTEWATER TREATMENT PROCESSES

The "Treatment Capacity Assessment Memo" illustrates that the existing treatment processes would be able to handle up to 0.8 mgd flow. In order to know if the entire treatment process could actually handle 0.8 mgd, a "stress test" is recommended.

Two key treatment process units in the "stress test" are the activated sludge system for nitrification and denitrification and the secondary clarifier(s). If the biological treatment and settling systems do not work, the downstream filters and UV will not work properly. The "stress test" will be used to answer two key questions associated with the two key process units:

1. Water quality – ammonia and total nitrogen: is nitrification/denitrification going to work under 0.8 mgd of diluted sewage (i.e. sewage 20% + pond water 80%)?
2. Hydraulics – will the secondary clarifiers provide target solids settling under 0.8 mgd with potential algae load from the ponds?

In order to answer these questions, a combination of field testing and computer process simulation is recommended. A series bench-scale tests may also be necessary 1) to provide computer simulation model input of kinetic parameters for nitrification and denitrification; 2) to determine sludge settleability of secondary effluent.

If the treatment plant is not able to achieve 0.8 mgd, the stress test will identify the level at which the treatment plant can sustain, and also provide unit capacity information for future plant expansion.

STRESS TEST OF ACTIVATED SLUDGE SYSTEM

The treatment flows (up to 0.8 mgd) and diurnal performance of the activated sludge system will be determined using a combination of computer process simulation modeling and full-scale field stress testing. The computer process simulation model will be calibrated according to the actual plant operating results, and the simulation under the "stress" conditions will provide process control parameters for the full-scale test.

A testing and sampling work plan will be developed for the full-scale "stress test. The work plan shall use the computer simulation results as the operating start points for the full-scale stress test. The work plan is designed to increase wastewater flow and loads to the activated sludge system without causing significant operation problems or deterioration of the effluent quality.

For that purpose, the full-scale "stress test" will consist of a series of segments with an incremental flow increase for each segment, i.e. 0.1 mgd increase per segment.

The computer simulation model will be calibrated with the operating results under the current sustained peak flow of 0.5mgd. At the end of the first stress testing segment, for example, first segment under 0.6 mgd, the operating results including diurnal profiles will be used to recalibrate the computer simulation model.

General steps of the "stress test" are proposed as follows:

1. Increase the wastewater pumping capacity (i.e. minimum up to 0.8 mgd) to facilitate the "stress test"
2. Establish an activated sludge process simulation model of the AeroMod plant
3. Perform the first "stress test" segment (i.e. 0.6 mgd total inflow to AeroMod plant)
4. Calibrate the activated sludge process simulation model with the first segment "stress" operating conditions and results
5. Simulate the subsequent "stress" conditions with incremental increase of flows (i.e. 0.1 mgd addition after 0.6 mgd)
6. Develop a work plan for subsequent full-scale testing segments based on the process simulation results
7. Perform the subsequent segments of full-scale testing under the "stress" conditions

Process Simulation

Computer process simulations serve estimating and predicting purpose:

1. First, the calibrated model can be used to simulate any "stress test" condition, determining the field operating parameters and predicting effluent quality under the "stress" conditions
2. Second, the calibrated models of the AeroMod process allow simulating the stress test conditions up to and beyond the target point (i.e. 0.8 mgd with 20% sewage and 80% stored wet weather flow) and provide an estimate of the treatment capacity.

The goal of the simulation is to answer the following questions:

- What is the optimal mixed liquor recycle rate (RAS control) under various "stress" conditions?
- What is the sludge age sufficient for nitrification to occur (WAS control) under various "stress" conditions?
- What is the air requirement under the "stress" condition? What improvements would be required to better match airflow with oxygen demand?
- What is the alkalinity demand change under the "stress" conditions? What adjustments would be required for alkalinity addition?

The computer process simulation can be performed with AeroMod or HDR steady state modeling tools, or a dynamic activated sludge process modeling program (i.e. BioWin™) in combination of the steady state process modeling tools. The dynamic simulation provides diurnal performance curves which can be used to examine diurnal water quality variation under various "stress" conditions.

Sampling and Bench Testing

During the "stress test" segment, diurnal profiles throughout the nitrification/denitrification processes will be measured for ammonia, nitrate, total nitrogen and other key regulatory compliance water quality parameters. Nitrification/denitrification kinetic parameters for the dynamic model can be determined by conducting bench-scale nitrogen uptake and release tests.

Full-Scale Field Testing

The "stress test" work plan will be designed to investigate the entire plant treatment performance by increasing the wastewater flow up to 0.8 mgd or to the maximum flow that can be achieved where the effluent quality starts to deteriorate. The results from the "stress test" can be used to evaluate the actual treatment capacity of the existing processes and identify future expansion needs.

The simulation will provide an estimate of a flow increase increment without a significant impact on effluent quality. We are proposing total four (4) segments with 0.1 mgd flow increase per segment for the full-scale testing. In the first segment, flow is first increased to a target of 0.6 mgd, and the flow increased by 0.1 mgd in each subsequent segment.

- Segment 1 - Baseline Test at 0.5 mgd
- Segment 2 - Diurnal Test at 0.6 mgd
- Segment 3 - Diurnal Test at 0.7 mgd
- Segment 4 - Diurnal Test at 0.8 mgd

During the Segment 1 - Baseline Test, the key parameters (Table 1) will be measured daily to establish a set of baseline operating parameters. This is necessary to establish the computer simulation model with current flows and loads before simulating the "stress" conditions.

Segment 1 testing should continue for as long as the activated sludge system operation is stabilized (i.e. minimum 1 SRT).

Table 1. Baseline Test Sampling and Testing Parameters

SAMPLE	INFLUENT BOX	ANAEROBIC SELECTOR	1ST STAGE AERATION BASIN	2ND STAGE AERATION BASIN	SECONDARY EFFLUENT
DO			1	1	
VFA	O				
NH_4-N	O	O	O	O	O
Nitrate-N	O	O	O	O	O
Mg	O	O	O	O	O
Ca	O	O	O	O	O
K	O	O	O	O	O
TSS					P

SAMPLE	INFLUENT BOX	ANAEROBIC SELECTOR	1ST STAGE AERATION BASIN	2ND STAGE AERATION BASIN	SECONDARY EFFLUENT
Temp	O				
Flow	1				

1 = hourly grab sample or PLC download
P = Peak hour sample
O = daily measurement

For Segment 2 testing, the WWTP flow rate will be increased to 0.6 mgd. After the process stabilization under the "stress" conditions (minimum 1 SRT), diurnal profiling will be conducted. To develop the diurnal profile throughout the activated sludge system, samples will be taken periodically during the day and night from the AeroMod processes to capture the process performance under "stress" condition.

Table 2 provides the potential sampling and testing plan for the diurnal profiling and the sample locations. Ideally the diurnal tests should be conducted 4 to 6 weeks after the each flow adjustment. A short time frame between flow increase and testing may be desired due to the time constrains for Pond 3 dewatering. A minimum of two (2) SRTs acclimation period is recommended for each flow adjustment before testing commences.

Table 2. Diurnal (6 am to 6 pm) Test Sampling and Testing Parameters

SAMPLE	INFLUENT BOX	ANAEROBIC SELECTOR	1ST STAGE AERATION BASIN	2ND STAGE AERATION BASIN	SECONDARY EFFLUENT
DO			1	1	
VFA	2				
NH_4-N	2	2	2	2	2
Nitrate-N	2	2	2	2	2
Mg	2	2	2	2	2
Ca	2	2	2	2	2
K	2	2	2	2	2
TSS					P
Turbidity					2
Temp	O				
Flow	1				

1 = hourly grab sample or PLC download
2 = bi-hourly grab sample
P = Peak hour sample
O = daily measurement

STRESS TEST OF SECONDARY CLARIFIERS

The stress test of the secondary clarifiers is planed to be conducted one day in each flow Segment of the "stress test" on the activated sludge system. Clarifiers will be on-line along with the activated sludge units in operation under the various "stress" conditions up to 0.8 mgd flow through. The clarifiers will experience the higher flows and loads during the "stress test" allowing the performance of the clarifiers to be evaluated. During stress testing, a set of field tests will be conducted.

Suspended Solids Test

Abbreviation used in this section:

- FSS = flocculated suspended solids
- DSS = dispersed suspended solids
- ESS = effluent suspended solids

A biological flocculation problem is indicated if FSS is "high." For an activated sludge process like the AeroMod plant, "high" is an FSS concentration greater than approximately 10 mg/L.

Potential sampling locations for the suspended solids testing are listed in Table 3.

Table 3. Sampling Locations for Suspended Solids Test

TEST	SAMPLING LOCATION	SAMPLING DEPTH	PROCEDURE	PARAMETER ANALYZED
DSS	2nd Stage Aeration Basin when aeration is on	12-18 inches	Release top portion of sample, settle 30 minutes, collect 1-L supernatant	TSS (Influent DSS)
DSS	By the center walkway above the air lift hood	Above sludge blanket; in supernatant	Collect and analyze top portion of sample, settle remaining sample for 30 minutes, collect 1-L supernatant	TSS (Effluent DSS)
FSS	By the center walkway above the air lift hood	Above sludge blanket; in supernatant	Stir/flocculate 30 minutes, settle 30 minutes, collect a minimum of 250 mL supernatant by siphon	TSS (Effluent FSS)
ESS	Filter influent box	any	TSS test (typical)	TSS (Effluent TSS)

- If the influent DSS > effluent DSS, this indicates that good flocculation is occurring in the clarifier and there are no hydraulic problems.
- If the influent DSS = effluent DSS, this indicates that the mixed liquor was well flocculated before entering the clarifier and there are no hydraulic problems.
- Regardless of the influent DSS concentration, if effluent FSS = effluent DSS < effluent ESS, this indicates good flocculation with hydraulic problems.

- Regardless of the influent DSS concentration, if effluent FSS < effluent DSS < effluent ESS, this indicates both flocculation and hydraulic problems.
- Regardless of the influent DSS concentration, if effluent FSS < effluent DSS = effluent ESS, this indicates flocculation problems but no hydraulic problems.

Stress Test Procedure

1. Both clarifiers will be stress tested.
2. Become familiar with the influent flow control structure and the settled sludge collection, transport, and pumping systems associated with both clarifiers.
3. Configure PLC to collect RAS flow from "bucket test" for either clarifier. Each clarifier has a single RAS flow meter. Collect RAS TSS data for each clarifier.
4. Obtain hourly composite effluent TSS samples. Manually grab samples every 20 minutes for the hourly composite samples.
5. Stress testing will last for duration of approximately twice the hydraulic retention time of each clarifier. Sampling is expected to occur over four (4) days. A potential sampling schedule is proposed below:
   - Day 1 - Samples from each clarifier will be collected and DSS and FSS tests performed for each clarifier. Sludge blanket heights in clarifier should be measured throughout the day to determine any flow imbalance between the two clarifiers. To accommodate the variation of sludge blanket, average height will be calculated. It is also recommended to measure water level in the stage 2 tanks using a measuring tape with water sensing paste. Estimated test duration: 8 hours
   - Day 2 - Monitoring the sludge blanket height to avoid building blankets thicker (i.e. thicker than 1.5 feet). Monitor the turbidity and color of the clarifier effluent. After the stabilization period, samples from each clarifier will be collected and DSS and FSS tests performed. DSS and FSS testing procedure will be provided at the "stress test". Estimated test duration: 8 hours
   - Day 3 - During the stabilization period, read off effluent turbidity every 15 minutes, and visually observe the water color in the clarifier. After the stabilization period, samples from Clarifier 1 will be collected and DSS and FSS tests performed. Estimated test duration: 8 hours.
   - Day 4 - Simulate a peak flow event, in this case, 0.8 mgd. Wait till the activated sludge system stabilizes. During the stabilization period, measure effluent turbidity every 15 minutes, and visually observe the water color in the clarifier. After the stabilization period, samples from each clarifier will be collected and DSS and FSS tests performed. Estimated test duration: 8 hours.

Sampling and Bench Testing

During each stress test, collect samples/data for each of the sampling locations (influent TSS and flow, RAS TSS and flow, effluent TSS and turbidity). Sampling parameters are provided in Table 4.

Table 4. Sampling Test Parameters per Sample

CHARACTERISTIC	SAMPLING METHOD	SAMPLING FREQUENCY	PARAMETER ANALYZED
Influent	Grab Kemmerer Sampler/Jar Tester Flow Meter	Every 30-60 minutes Twice per test run Three per test run Calculated from influent flow meter	TSS/MLSS SVI DSS/FSS Flow rate
Clarifiers	Calculate		SOR gpd/sf SLR lb/day/sf HRT w/o recycle HRT w/ recycle
Effluent (for each clarifier)	Manual composite Portable Turbidity Meter (stabilization period)	20 minutes (grab) for hourly composite sample	TSS Turbidity
RAS	Composite	One per day per clarifier for first two days; two per day per clarifier for last two days	TSS RAS Flow rate
Sludge blanket (for each clarifier)	observation (stabilization period)	30 minutes 30-60 minutes	Depth

Note for sampling and testing:

- During each stress test, the sludge blanket should be observed and recorded every 15 or 30 minutes.
- After a period of time equal to at least two times the theoretical hydraulic retention time (HRT), perform DSS and FSS testing.
- Read off effluent turbidity every 30 to 60 minutes and monitor visual quality of the effluent. Stop stress test if turbidity reaches 5 NTU
- During each stress test, measure the sludge volume index (SVI) at the beginning, middle and end of each stress test run. The SVI test should be performed according to Standard Methods by using 2-liter settleometer or 1 liter settleometer available at the plant lab.

- The SVI is defined as the volume, in milliliters, occupied by one gram of mixed liquor solids after 30 minutes of settling. The SVI test should be performed in a stirred (1 rpm) 1-L graduated cylinder.
- SVI is determined by dividing the settled volume by the MLSS.

$$SVI = \frac{SettledVolume * 1000}{MLSS}$$

- Obtain the MLSS of the sample that fills the 1-L graduated cylinder. Allow the sample to settle for 30 minutes. After 30 minutes read the volume of the settled sludge and express in terms of mL/L.

Wendy Wyles 10/21/2011
Central Valley Regional Water Quality Control Board

Steve Calderwood
Water Pollution Control Services Inc.
City of Colfax WWTP Contract Operator

Re: WWTP Effluent Diversion to Oxidation/Storage Pond #2 on 9/14/2011

This letter is being prepared at your request to help document, explain and demonstrate corrective and preventative actions for an Effluent diversion to Oxidation/Storage Pond #2 at the City of Colfax WWTP on 9/14/2011 at approximately 1655 hrs.

On 9/14/2011 an Effluent diversion was automatically trigger at the Colfax WWTP by the on line turbidity meter due to a “high turbidity” alarm. In the days, and hours, preceding this event there were numerous power interruptions (one power failure creates several interruptions due to power switching and generator loading/unloading). When these events occur the pumps and equipment at the Contact Basin used for algae removal shut off and need to be restarted manually. This equipment helps remove the algae from pond waters being returned to the Influent of the WWTP. Once this equipment shuts down, the pond return pump keeps running sending algae laden water into the WWTP. If this happens once, or occasionally, it does not have a huge effect on the WWTP. When it occurs repeatedly, too many algae cells get returned to the WWTP, and as we know from experience, the biological / sedimentation treatment system does not perform well with a lot of algae cells. This condition normally creates a high turbidity situation because the algae tend to stay suspended in the water column and the chlorophyll creates a color problem sometimes detected as turbidity.

Once these algae were mixed into the mixed liquor there was little to do than to waste sludge from the system, maintain an acceptable mixed liquor concentration and examine and monitor the process for recovery. It was actually through microscopic examination that the operators discovered an abundance of algae cells in the sludge and a slight green hew in the water color. On September 29, 2011 the Effluent turbidity started to drop with in acceptable limits and on 9/30/2011 at approximately 0655 the Effluent diversion valve was closed and the Effluent sent to Smuthers Ravine.

It was a logical assumption that these algae cells entered the plant from the power loss events preceding the diversion because there is no other source of algae than to pump it in from the pond waters. An evaluation of the plant electrical system by a WPCS Operator, whose previous profession was Industrial Electrician, revealed that some float and wiring changes could be made so the algae removal equipment would restart automatically after power interruptions. The required electrical changes are currently scheduled to be complete the end of the week of 10/16/2011.

If you have any questions or concerns regarding this report I can be reached at (530) 613-6588.

Respectfully,

Steve Calderwood
WPCS Inc.

Wendy Wyles 10/24/2011
Central Valley Regional Water Quality Control Board

Steve Calderwood
Water Pollution Control Services Inc.
City of Colfax WWTP Contract Operator

Re: WWTP Effluent Diversions to Oxidation/Storage Pond #2 in October 2011

On October 1, 2011 the City of Colfax WWTP Effluent was automatically diverted to Oxidation/Storage Pond #2 at approximately 1201 hours due to an approaching "high turbidity 24 hour average". Effluent flow was restored to the receiving waters at 0608 hours on October 4th after allowing the plant to stabilize and operate a full 24 hours at an acceptable turbidity level.

The specific cause for the rising Effluent turbidity is largely unknown but the Contract Lab notified WPCS on October 12th that the Influent BOD on October 1st was 727 mg/l and on October 5th was 554 mg/l. These Influent BOD values indicate a waste almost four (4) and three (3) times that of normal Influent BOD loadings. It is assumed at this point that the City's WWTP is receiving some sort of shock loadings from its Collection System. The City's Director of Public Works visited one known Industrial Discharger on 10/12/11 that may have the potential to discharge a load of this magnitude and the visit ended with minimal assistance in the matter. WPCS has also entered into discussions with the Public Works Director, the Contract Lab and LWA regarding potential sampling of the discharge from this industry. No site-specific sampling has occurred at this time due to several factors that need to be resolved. Discussions concerning sampling location for a good representative sample, timing of such sampling to be non-suspicious and non-suspected in order that a good representative and meaning full sample is collected and obtaining the proper sampler, equipment and sample type to get an indicative and representative sample. WPCS has also forwarded the Influent sample BOD data results to the Public Works Director to see if any sewer line cleaning events were taking place during these sample times. There has been no correlation indicated at this time concerning sewer line cleaning and Influent sample BOD's.

On October 6, 2011 at 0800 hours Steve Calderwood received a call from the Operator on duty that the turbidity was increasing steadily, and rapidly, and was concerned of a potential violation. The Operator was instructed to manually open the diversion valve (0810) to Oxidation/Storage Pond #2 until an evaluation of the plant could be made to ensure that all systems were working correctly. Also, the Edwards were given a courtesy call for the plant diversion at this time. A plant evaluation revealed that the only condition that existed was work being performed on the Magnesium Hydroxide (MgOH) feed system which over feed some MgOH causing a slightly elevated pH and alkalinity readings but unlikely caused the increasing turbidity. By 1445 hours on October 6th the

Effluent turbidity levels were on a decreasing trend and the WWTP Effluent discharge was resumed to the receiving waters.

Test results received on 10/12/2011 showed a high Influent BOD for October 5th. Please refer to comments above regarding high Influent BOD's.

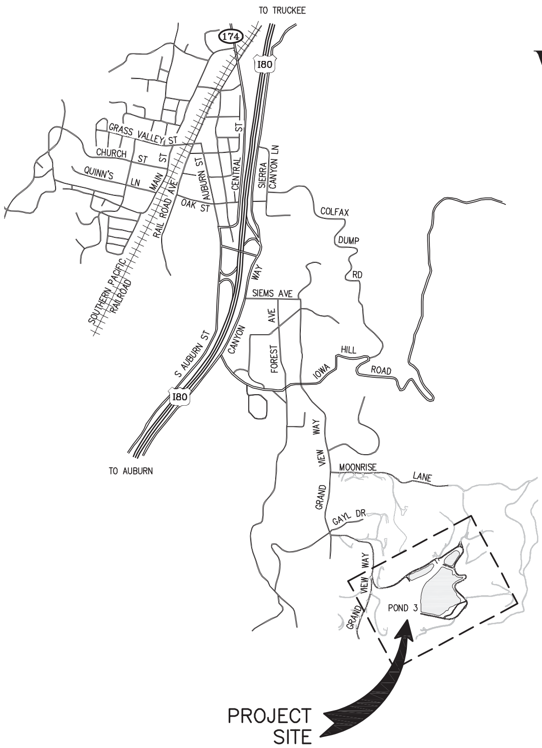
On October 11, 2011 the WWTP Effluent was diverted to Oxidation/Storage Pond #2 from approximately 1300-1330 hours for maintenance on the Effluent discharge pipe.

If you have any concerns or question regarding this report please do not hesitate to contact me at (530) 613-6588.

Respectfully,

Steve Calderwood
WPCS Inc. President

DESIGN DRAWINGS FOR
CITY OF COLFAX
WWTP POND 3 LINING PROJECT



VICINITY MAP
NTS

CITY OF COLFAX

Submitted By:

Craig Olson, Project Manager
HDR Engineering Inc.
Date

REGISTERED PROFESSIONAL ENGINEER
CRAIG A. OLSON
NO. 39819
EXP. 12-31-11
CIVIL
STATE OF CALIFORNIA

Reviewed By:

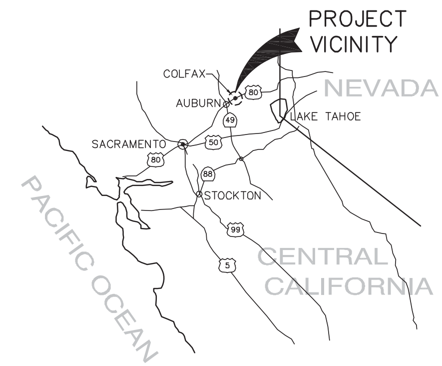
Gabe Armstrong, CS Director
City of Colfax
Date

Approved for Construction:

Nicolas J. Ponticello, City Engineer
City of Colfax
Date

MAY 5, 2011

REVIEW SET FOR CITY ENGINEER



LOCATION MAP
NTS

SHEET LIST

GENERAL

G-01	COVER SHEET, MAPS AND SHEET LIST
G-02	LEGEND, SYMBOLS AND ABBREVIATIONS

CIVIL

C-01	EXISTING SITE PLAN
C-02	DEMOLITION PLAN
C-03	TREE DEMOLITION OVERALL PLAN AND DATA
C-04	TREE DEMOLITION ENLARGED PLANS
C-05	GRADING PLAN
C-06	GRADING SECTIONS AND DETAILS I
C-07	GRADING SECTIONS AND DETAILS II
C-08	LINER AND IMPROVEMENTS PLAN
C-09	LINER DETAILS
C-10	OUTLET GATE DETAILS
C-11	CIVIL DETAILS

HDR
HDR Engineering Inc.
Folsom, CA

C:/pwworking/soc/dms86956/74238-00-01.dwg
05-05-11 BOWN 11:32:35

SITE PLAN SYMBOLOGY

- EMBANKMENT SLOPE
- 50.5 CONTOUR
- VEGETATION (SIZE)
- WM WASHDOWN MONITOR
- CO CLEANOUT
- MH MANHOLE
- MW MONITORING WELL
- PZ PIEZOMETER
- CB STORM DRAIN CATCH BASIN
- UV UTILITY VAULT
- PP POWER POLE
- TP TELEPHONE POLE
- FH FIRE HYDRANT
- YH–X YARD HYDRANT
- X 75.5 EXISTING SPOT ELEVATION
- 75.8 FINISHED SPOT ELEVATION
- CP–X HORIZONTAL CONTROL POINT
- BENCHMARK
- TH–"X" IDENTIFICATION AND APPROXIMATE LOCATION OF SOIL TEST HOLE
- DOWNGUY
- EXTERIOR PAD MOUNTED TRANSFORMER
- POLE – MOUNTED TRANSFORMER
- Y ELECTRICAL HANDHOLE OR MANHOLE Y – MHX OR HHX, WHERE X INDICATES SEQUENCE NUMBER

NOTES:

1. UTILITIES THAT ARE SUSPENDED ABOVE GRADE ARE DESIGNATED BY THE PREFIX "OH" (OVERHEAD).

- T TELEPHONE LINE
- E ELECTRIC LINE
- F FIBER OPTIC
- C COMMUNICATION
- HANDRAIL AND GUARDRAIL
- PIPELINE
- LARGE PIPELINE
- UTILITY BENEATH STRUCTURE
- RAILROAD
- DRAINAGE FLOW
- NATURAL WATERWAY
- X X CHAIN LINK FENCE
- X X FIELD FENCE
- PROPERTY LINE
- CENTERLINE
- RB ROCK BERM
- SF SILT FENCE
- EASEMENT
- LIMITS OF CONSTRUCTION
- ROW

MATERIALS IN PLAN/SECTION

- ACOUSTICAL CEILING TILE (SECTION)
- ASPHALT (PLAN OR SMALL–SCALE SECTION)
- ASPHALT (LARGE–SCALE SECTION)
- BATT INSULATION (SECTION)
- BRICK MASONRY (PLAN AND/OR SECTION)
- CHECKERED PLATE (PLAN)
- CONCRETE (PLAN AND/OR SECTION)
- CONCRETE MASONRY (PLAN AND/OR SECTION)
- DEMOLITION (PLAN AND/OR SECTION)
- EARTH (SECTION)
- FILTER POINT MAT (PLAN)
- FINISHED WOOD (SECTION)
- GLULAM LUMBER (SECTION)
- GRANULAR FILL (SECTION)
- GRATING (SECTION)
- GRATING (PLAN)
- GROUT (SECTION)
- GYPSUM BOARD (SECTION)
- METAL (SECTION)
- ORIENTED STRAND BOARD (SECTION)
- PARTICLE BOARD (SECTION)
- PLYWOOD (LARGE–SCALE SECTION)
- PLYWOOD (SMALL–SCALE SECTION)
- PRECAST CONCRETE (PLAN AND/OR SECTION)
- RIGID INSULATION (SECTION)
- RIPRAP (PLAN AND/OR SECTION)
- SAND (SECTION)
- SOD (SECTION)
- WEEP JOINT MORTAR PROTECTION SYSTEM (SECTION)
- WOOD – CONTINUOUS (SECTION)
- WOOD BLOCKING (SECTION)

GENERAL SYMBOLOGY

ARROW INDICATES DIRECTION OF PLAN NORTH

N

PLAN
1/4" = 1'-0"

1/4" = 1'-0"
PLAN TITLE

SECTION LETTER
FLAG INDICATES DIRECTION OF SECTION CUT
X
XXX
SHEET WHERE SECTION IS LOCATED *
SECTION CUT MARKER

SECTION
3/8" = 1'-0"
SECTION LETTER
X
XXX
SHEET WHERE SECTION VIEW IS FIRST CUT *
SECTION TITLE

#
XXX
DETAIL NUMBER
SHEET WHERE DETAIL IS LOCATED *
DETAIL MARKER
FOR REFERENCING DETAILS INCLUDED IN DRAWING SET.

XXXXXXXXX
DETAIL MARKER
FOR REFERENCING DETAILS BOUND IN SPECIFICATIONS OR SEPARATE VOLUME.

DETAIL
1/4" = 1'-0"
DETAIL NUMBER
X
XXX
SHEET WHERE DETAIL WAS CALLED OUT
DETAIL TITLE

* FOR COMMON DETAILS AND SECTIONS OR DETAILS THAT ARE CUT OR CALLED OUT ON MULTIPLE SHEETS, THE SHEET NUMBER IS REPLACED BY A DASH (–).

X
XXX
ELEVATION NUMBER
ARROW INDICATES POINT OF VIEW
SHEET WHERE ELEVATION IS LOCATED *
SINGLE ELEVATION OR PHOTO MARKER

A B C D
X
XXX
ELEVATION NUMBER
ARROW INDICATES POINT OF VIEW ELEVATION
INDICATES SHEET WHERE ELEVATION IS LOCATED
MULTIPLE ELEVATION OR PHOTO MARKER

ELEVATION
3" = 1'-0"
ELEVATION IDENTIFICATION NUMBER
X
XXX
SHEET WHERE POINT OF VIEW MARKER CAN BE FOUND *
ELEVATION TITLE

TARGET ELEVATION

NOTES:
SYMBOLOGY SHOWN IS FOR SINGLE LINE PIPING. DOUBLE LINE PIPING SYMBOLS ARE SIMILAR.

VALVES

- GATE VALVE
- GLOBE VALVE
- BALL VALVE
- CHECK VALVE
- BUTTERFLY VALVE
- DIAPHRAGM VALVE
- OR PRESSURE RELIEF VALVE
- PLUG VALVE
- NEEDLE VALVE
- PRESSURE REDUCING VALVE
- X AIR RELIEF / VACUUM VALVE A = AIR RELIEF V = VACUUM
- PRESSURE REGULATING VALVE

MISCELLANEOUS

- VARIABLE AREA METER
- ROTAMETER
- UNION
- WYE–STRAINER
- LINE SIZE CHANGE (CONCENTRIC REDUCER)
- FLEXIBLE HOSE OR TUBING
- FLEXIBLE PIPING CONNECTION
- LINE SIZE CHANGE (CONCENTRIC REDUCER)
- LINE SIZE CHANGE (ECCENTRIC REDUCER)
- LINE TURNING DOWN
- LINE TURNING UP
- BLIND FLANGE
- PIPE JOINT (SEE SPECS FOR REQUIREMENTS)
- SLEEVE TYPE COUPLING
- FLANGED COUPLING ADAPTER (FCA)

- FLEXIBLE CONNECTION
- HARNESSED MECHANICAL COUPLING
- PRESSURE GAGE (W/COCK)
- TRAP
- QUICK DISCONNECT CAM & GROOVE COUPLING
- CAP or PLUG
- CO INTERIOR CLEANOUT
- HB–X HOSE VALVE, HOSE BIBB OR FLUSHING CONNECTION
- HR–X HOSE RACK X = TYPE DESIGNATED IN SPECIFICATIONS
- FD–X FLOOR DRAIN
- PIPE IN SECTION
- BU BELL UP (PLAN)
- BU BELL UP (SECTION OR SCHEMATIC)

IDENTIFICATION SYMBOLOGY

PIPING

FIGURE — EXAMPLE

36" SS
LINE SIZE — 36"
SERVICE — SANITARY SEWER

PIPE SERVICES

BWW	BACKWASH WASTE
CA	COMPRESSED AIR
CHM	CHEMICAL
CVT	CULVERT
EBR	EQUALIZATION BASIN RETURN
FE	FINAL EFFLUENT
FIL	FILTRATE
IA	INSTRUMENT AIR
INF	INFLUENT
INFP	INFLUENT (PRESSURE)
LPA	LOW PRESSURE AIR
NPW	NON–POTABLE WATER
PD	PLANT DRAIN
PW	POTABLE WATER
RL	RAIN LEADER
SDR	STORM DRAIN
SE	SECONDARY EFFLUENT
SMP	SAMPLE
V	VENT
WAS	WASTE ACTIVATED SLUDGE
WST	WASTE

IDENTIFICATION SYMBOLOGY

EQUIPMENT IDENTIFICATION

FIGURE — EXAMPLE

NPWP–701
SERVICE ABBREVIATION — INDICATES NON–POTABLE WATER
EQUIPMENT ABBREVIATION — INDICATES PUMP
AREA DESIGNATOR — INDICATES UV BASIN
EQUIPMENT NUMBER — PUMP 01

EQUIPMENT ABBREVIATIONS

AC	AIR COMPRESSOR
BFP	BELT FILTER PRESS
BLWR	BLOWER
EBRP	EQUALIZATION BASIN RETURN PUMP
FCV	FLOW CONTROL VALVE (MODULATING)
FV	FLOW VALVE (OPEN/CLOSE)
INFP	INFLUENT PUMP
NPWP	NON–POTABLE WATER PUMP
PBTF	PACKAGE BIOLOGICAL TREATMENT FACILITY
PBU	POLYMER BLENDING UNIT
SCCV	SCREW CONVEYOR
SCR	SPIRAL SCREEN
SFP	SLUDGE FEED PUMP
SG	SLIDE GATE
STPG	STOP GATE

SHEET NAMING CONVENTION

AREA DESIGNATION

0	GENERAL/STANDARD DETAILS
1	GENERAL SITE
2	SCREENINGS/DIVERSION STRUCTURE
3	INFLUENT PUMPING STATION
4	PACKAGE BIOLOGICAL TREATMENT FACILITY
5	DEWATERING BUILDING
6	FILTERS
7	UV DISINFECTION

DISCIPLINE DESIGNATOR & DISCIPLINE ORDER

G	GENERAL
C	CIVIL
SP	STRUCTURAL/PROCESS
A	ARCHITECTURAL
M	MECHANICAL (HVAC AND PLUMBING)
E	ELECTRICAL
Y	INSTRUMENTATION

EXAMPLE:
DEWATERING BUILDING ARCHITECTURAL SECTION, SHEET 01

3 0 3 3 3
PROJECT NUMBER
–
SPACER
5
AREA DESIGNATION
A
DISCIPLINE DESIGNATOR
–
SPACER
0 1
SHEET NUMBER

GENERAL NOTES:

1. THIS IS A STANDARD SHEET SHOWING COMMON SYMBOLOGY. ALL SYMBOLS ARE NOT NECESSARILY USED ON THIS PROJECT.
2. SCREENING OR SHADING OF WORK IS USED TO INDICATE EXISTING COMPONENTS OR TO DE–EMPHASIZE PROPOSED IMPROVEMENTS TO HIGHLIGHT SELECTED TRADE WORK. REFER TO CONTEXT OF EACH SHEET FOR USAGE.

HDR
HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
C	4–15–11	ISSUED FOR BID
B	2–18–09	ISSUED FOR 100% REVIEW
A	6/12/08	ISSUED FOR 50% REVIEW

PROJECT MANAGER	CRAIG A. OLSON
DESIGNED	C. OLSON
CHECKED	C. OLSON
DRAWN	P. VAN MEURS
DATE	FEBRUARY 2009
PROJECT NUMBER	202087–74238

REGISTERED PROFESSIONAL ENGINEER
CRAIG A. OLSON
No. 39819
EXP. 12–31–11
CIVIL
STATE OF CALIFORNIA

CITY OF COLFAX
POND No. 3 LINING PROJECT

LEGEND, SYMBOLS AND ABBREVIATIONS

0 1" 2"

FILENAME	74238_0G–02.dwg
SCALE	NONE

SHEET
G-02

FILE: C:\pwworking\sac\dms86956\74238_0G–02.dwg
DATE: 05/05/11 11:33:32am, bdown

GENERAL NOTES:

1. CONTOURS BELOW ELEVATION 2080 ARE APPROXIMATE BASED ON ORIGINAL POND GRADING PLAN.
2. CITY WILL DEWATER POND TO ELEVATION 2080. CONTRACTOR IS REQUIRED TO PROCESS ALL LIQUID BELOW ELEVATION 2080 THROUGH CONTRACTOR–SUPPLIED TEMPORARY PUMP AND SOLIDS DEWATERING EQUIPMENT. FILTRATE WATER FROM DEWATERING EQUIPMENT MAY BE DISCHARGED TO POND NO. 1 OR POND NO. 2, LIMITATIONS FOR FILTRATE DISPOSAL ARE AS FOLLOWS:
   - TOTAL SUSPENDED SOLIDS (TSS) < 100 mg/l.
   - AMMONIA (NH3) < ___ mg/l.
   - TOTAL DISSOLVED SOLIDS (TDS) < ___ mg/l.
   - CONTRACTOR IS REQUIRED TO TEST FILTRATE ON DAILY BASIS AND PROVIDE LAB RESULTS TO OWNER.
3. CONTRACTOR TO PROPERLY DISPOSE OF EXISTING SOLIDS OFF–SITE PRIOR TO INSTALLING LINER.
4. CONTRACTOR IS REQUIRED TO VISIT SITE PRIOR TO SUBMITTAL OF BID.
5. NO DISTURBANCE CAN OCCUR ON EXISTING DAM EMBANKMENT FILL OTHER THAN LINER TRENCH, OUTLET GATE REPLACEMENT, AND FENCING.
6. TWO BENCHMARKS ARE INDICATED ON THIS SHEET AS △. CONTRACTOR TO VERIFY CONTROL PRIOR TO BEGINNING WORK.
7. EXISTING SPOT ELEVATION INFORMATION SHOWN ON THESE PLANS WAS DETERMINED USING PHOTOGRAMMETRIC METHODS. IT IS ACCURATE TO WITHIN ±0.3 FEET OF ELEVATIONS SHOWN.

CONSTRUCTION SEQUENCING AND CONSTRAINTS

A. OWNER WILL DEWATER POND NO. 3 TO ELEVATION 2080.0. VOLUME OF REMAINING WATER IS UNKNOWN.

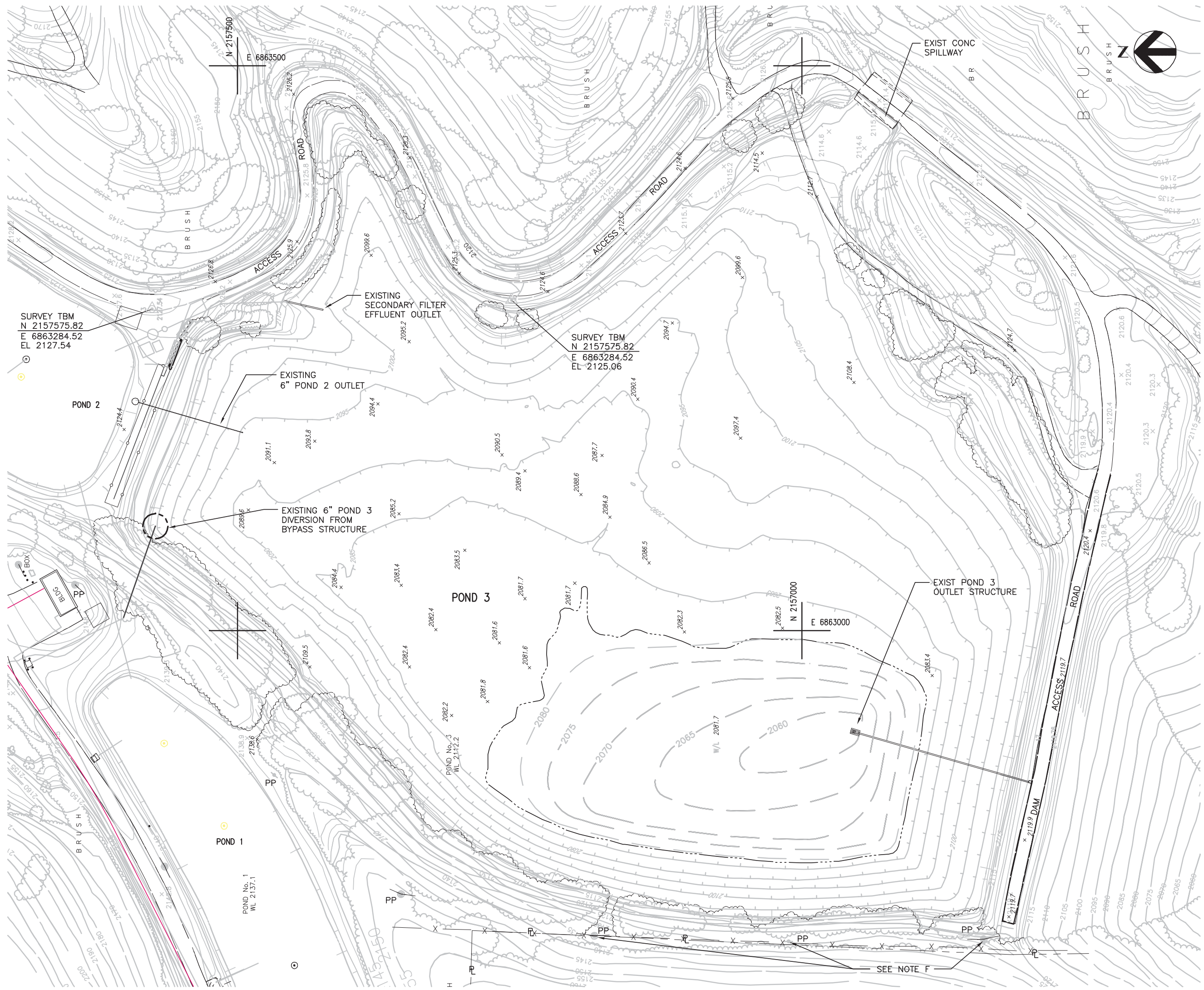
B. OWNER TO GIVE WRITTEN NOTICE TO CONTRACTOR THAT CONTRACTOR HAS ACCESS TO CONSTRUCT POND NO. 3 IMPROVEMENTS.

C. CONTRACTOR TO COMMENCE CLEARING AND GRUBBING OPERATION.

D. CONTRACTOR TO COMMENCE DEWATERING OPERATION ON REMAINING LIQUID IN POND NO. 3. CONTRACTOR TO PROVIDE ALL NECESSARY DEWATERING EQUIPMENT. CONTRACTOR TO PROVIDE PUMPING AND PIPELINE FACILITIES TO CONVEY FILTRATE DISCHARGE TO POND NO. 2. DISCHARGE TO POND NO. 2 IS LIMITED TO 100,000 GALLONS PER DAY. OWNER CAN PROVIDE UV DISINFECTED EFFLUENT FOR DEWATERING OPERATIONS AT NEW WWTP NON–POTABLE WATER PUMPING STATION. PRESSURE IS 40 PSI AND AVAILABLE FLOWRATE IS 20 GPM.

E. DEMOLISH EXISTING OUTLET GATE OPERATING STEM SUPPORTS.

F. CONTRACTOR TO PROTECT IN–PLACE EXISTING POWER POLES AND 480 VOLT, 3–PHASE ELECTRICAL CABLING DURING CONSTRUCTION.



C	4–15–11	ISSUED FOR BID	
B	2–18–09	ISSUED FOR 100% REVIEW	
A	6/12/08	ISSUED FOR 50% REVIEW	
ISSUE	DATE	DESCRIPTION	

PROJECT MANAGER	CRAIG A. OLSON
DESIGNED	C. OLSON
CHECKED	C. OLSON
DRAWN	P. VAN MEURS
DATE	FEBRUARY 2009
PROJECT NUMBER	202087–74238

HDR
HDR Engineering, Inc.

REGISTERED PROFESSIONAL ENGINEER CRAIG A. OLSON No. 39819 EXP. 12–31–11 CIVIL STATE OF CALIFORNIA

CITY OF COLFAX
POND No. 3 LINING PROJECT

EXISTING SITE PLAN

0 1" 2"

FILENAME	74238_C–01.dwg
SCALE	1" = 50'

SHEET C-01

FILE: C:\pwworking\sac\dms86956\74238_C-01.dwg
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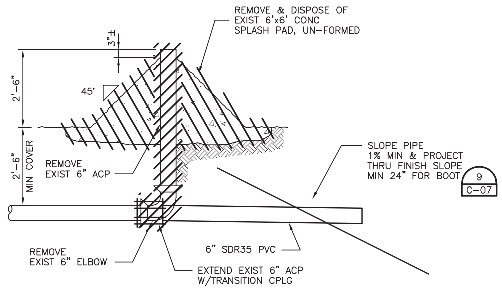
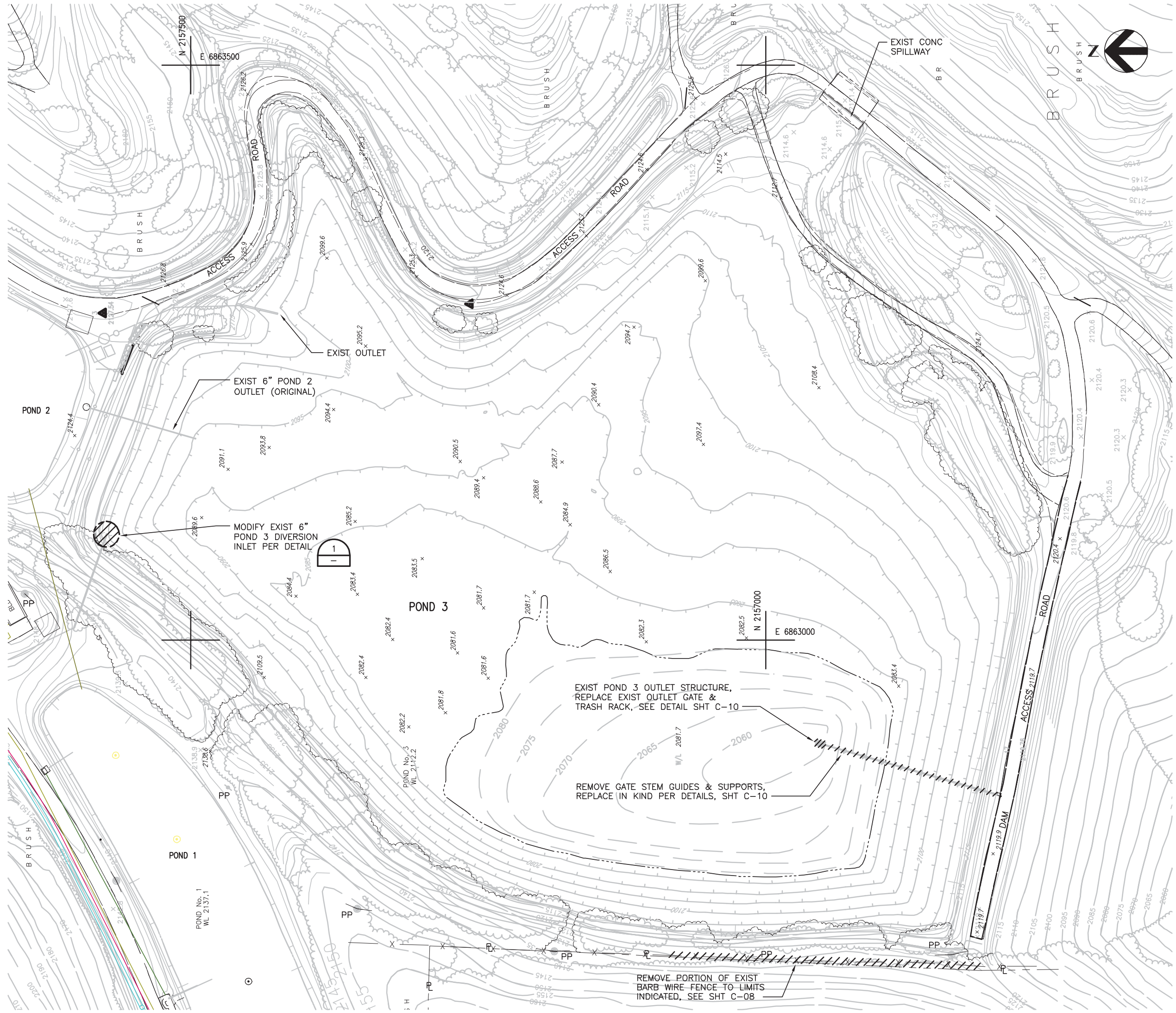


SECTIONAL VIEW
EXISTING DIVERSION INLET
1/2" = 1'-0"



HDR
HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
C	4-15-11	ISSUED FOR BID
B	2-18-09	ISSUED FOR 100% REVIEW
A	6/12/08	ISSUED FOR 50% REVIEW

PROJECT MANAGER	CRAIG A. OLSON
DESIGNED	C. OLSON
CHECKED	C. OLSON
DRAWN	P. VAN MEURS
DATE	FEBRUARY 2009
PROJECT NUMBER	202087-74238

REGISTERED PROFESSIONAL ENGINEER
CRAIG A. OLSON
No. 39819
EXP. 12-31-11
CIVIL
STATE OF CALIFORNIA

CITY OF COLFAX
POND No. 3 LINING PROJECT

DEMOLITION PLAN

0 1" 2"

FILENAME	74238_C-02.dwg
SCALE	1" = 50'

SHEET
C-02

FILE: C:\pwworking\sac\dms86956\74238_C-02.dwg
DATE: 05/05/11 11:35:52am, bdown

TREE TAG TABLE

No.	TAG	DESCRIPTION	PT #	EASTING	NORTHING	ELEV
1	701	FIR/ 14"	8005	2156852.6	6862735.5	2121.7
2	702	FIR/ 12"	8006	2156874.8	6862733.3	2123.5
3	703	OAK/ 6"	8007	2156949.4	6862731.1	2125.4
4	704	OAK/ 6"	8008	2156966.7	6862731.4	2123.1
5	705	FIR/ 14"	8009	2156970.5	6862736.6	2120.5
6	706	FIR/ 6"	8010	2157001.1	6862738.2	2117.3
7	707	OAK/ 6"	8012	2157018.8	6862730.3	2122.5
8	708	OAK/ 8"	8013	2157090.6	6862736.8	2118.9
9	709	FIR/ 12"	8014	2157094.5	6862737.2	2119.7
10	710	FIR/ 2-12"	8015	2157125.1	6862734.1	2123.2
11	711	FIR/ 6"	8016	2157129.1	6862739.7	2121.5
12	712	OAK/ 6"	8017	2157133.9	6862741.4	2119.7
13	713	FIR/ 6"	8018	2157140.5	6862743.7	2121.1
14	714	FIR/ 6"	8019	2157139.0	6862740.0	2121.6
15	715	FIR/ 8"	8020	2157145.1	6862745.6	2119.5
16	716	FIR/ 6"	8021	2157149.0	6862744.3	2119.7
17	717	FIR/ 8"	8022	2157149.8	6862746.1	2119.7
18	718	FIR/ 2-12"	8023	2157152.7	6862746.9	2120.3
19	719	FIR/ 10"	8024	2157151.9	6862737.3	2127.0
20	720	OAK/ 8"	8025	2157154.5	6862733.4	2131.3
21	721	FIR/ 8"	8026	2157133.7	6862735.8	2125.1
22	722	FIR/ 6"	8027	2157134.9	6862735.2	2126.0
23	723	FIR/ 2-6"	8029	2157185.8	6862756.5	2121.4
24	724	PIN/ 10"	8030	2157193.7	6862762.8	2117.2
25	725	PIN/ 8"	8031	2157213.2	6862768.7	2117.6
26	726	FIR/ 12"	8032	2157205.1	6862756.7	2121.9
27	727	FIR/ 8"	8033	2157205.9	6862750.6	2126.5
28	728	FIR/ 8"	8034	2157204.5	6862747.5	2127.9
29	729	FIR/ 10"	8035	2157213.6	6862747.0	2131.1
30	730	FIR/ 2-12"	8036	2157223.4	6862750.2	2132.3
31	731	OAK/ 2-8"	8037	2157241.5	6862757.7	2131.0
32	732	PIN/ 18"	8038	2157246.0	6862758.9	2132.4
33	733	FIR/ 12"	8039	2157251.5	6862756.0	2133.4
34	734	FIR/ 6"	8040	2157253.3	6862756.5	2133.5
35	735	PIN/ 12"	8041	2157233.9	6862770.6	2119.7
36	736	FIR/ 10"	8043	2157242.5	6862767.7	2123.4
37	737	FIR/ 8"	8044	2157246.2	6862769.7	2124.1
38	738	PIN/ 10"	8045	2157258.6	6862778.5	2121.8
39	739	FIR/ 6"	8046	2157299.5	6862792.5	2126.5
40	740	FIR/ 6"	8047	2157298.9	6862804.7	2119.0
41	741	PIN/ 8"	8048	2157295.4	6862811.6	2114.6
42	742	OAK/ 3-6"	8049	2157345.8	6862836.8	2121.8
43	743	FIR/ 8"	8050	2157353.8	6862824.7	2130.1
44	744	PIN/ 16"	8051	2157400.6	6862868.4	2133.3
45	745	PIN/ 6"	8052	2157397.2	6862883.2	2125.6
46	746	OAK/ 6+12"	8053	2157388.8	6862885.7	2121.8
47	747	PIN/ 8"	8054	2157378.8	6862879.4	2120.2
48	748	PIN/ 12"	8055	2157372.3	6862878.2	2117.9
49	749	OAK/ 8"	8056	2157387.9	6862900.1	2117.3
50	750	OAK/ 6"	8057	2157400.0	6862910.7	2117.9
51	751	PIN/ 14"	8058	2157422.9	6862925.3	2122.9
52	752	PIN/ 18"	8059	2157430.8	6862928.2	2124.9
53	753	OAK/ 3-6"	8060	2157477.5	6862969.1	2127.4
54	754	OAK/ 6"	8061	2157472.5	6862986.1	2120.4
55	755	OAK/ 6"	8062	2157536.3	6863033.6	2122.9
56	756	FIR/ 12"	8063	2157536.3	6863032.6	2122.9
57	757	OAK/ 6"	8064	2157535.0	6863034.5	2121.7
58	758	FIR/ 6"	8065	2157534.0	6863034.3	2121.7
59	759	FIR/ 8"	8066	2157538.6	6863035.8	2123.9
60	760	PIN/ 18"	8067	2157559.1	6863059.1	2118.8
61	761	FIR/ 12"	8068	2157564.5	6863049.6	2123.7
62	762	FIR/ 10"	8069	2157588.9	6863070.9	2123.9
63	763	PIN/ 8+12"	8070	2156776.0	6863087.4	2118.6
64	764	PIN/ 2-8"	8071	2156781.8	6863081.2	2115.4
65	765	PIN/ 10"	8072	2156787.2	6863085.6	2115.5
66	766	PIN/ 6"	8073	2156783.4	6863096.4	2117.8
67	767	PIN/ 12"	8074	2156779.8	6863097.0	2118.1
68	768	PIN/ 10"	8075	2156780.0	6863114.0	2119.2
69	769	PIN/ 6"	8076	2156776.9	6863114.4	2119.7
70	770	PIN/ 6"	8077	2156780.8	6863120.7	2120.0
71	771	PIN/ 6"	8078	2156791.6	6863096.7	2116.0
72	772	PIN/ 6"	8079	2156795.6	6863106.9	2116.0
73	773	PIN/ 6"	8080	2156795.5	6863110.2	2116.2
74	774	PIN/ 6"	8081	2156803.9	6863118.6	2116.3
75	775	PIN/ 10"	8082	2156804.5	6863124.0	2117.0
76	776	PIN/ 6"	8083	2156792.0	6863121.8	2118.1
77	777	PIN/ 10"	8084	2156794.6	6863126.2	2118.2
78	778	PIN/ 12"	8085	2156802.2	6863135.4	2118.5
79	779	PIN/ 12"	8086	2156797.6	6863142.1	2119.9
80	780	PIN/ 12"	8087	2156808.2	6863142.3	2118.5
81	781	PIN/ 6"	8088	2156804.0	6863150.9	2119.5
82	782	PIN/ 6"	8089	2156805.6	6863152.7	2119.6
83	783	PIN/ 6"	8090	2156802.4	6863154.9	2120.1
84	784	PIN/ 12"	8091	2156811.4	6863154.0	2119.1
85	785	PIN/ 10"	8092	2156798.7	6863152.4	2120.4
86	786	PIN/ 12"	8093	2156819.4	6863164.3	2118.9
87	787	PIN/ 10"	8094	2156812.5	6863165.2	2118.9
88	788	PIN/ 12"	8095	2156818.7	6863154.1	2117.7
89	789	PIN/ 10"	8096	2156825.0	6863172.2	2118.2
90	790	PIN/ 12"	8097	2156820.5	6863176.1	2118.4
91	791	PIN/ 12"	8098	2156835.0	6863152.9	2115.2
92	792	PIN/ 10"	8099	2156832.3	6863149.6	2115.3
93	793	PIN/ 10"	8100	2156841.6	6863174.1	2115.5
94	794	PIN/ 6"	8101	2156848.7	6863173.5	2114.5
95	795	PIN/ 6"	8102	2156854.5	6863176.0	2113.6
96	796	PIN/ 6"	8103	2156849.7	6863181.8	2114.6
97	797	PIN/ 6"	8104	2156848.5	6863187.3	2115.1
98	798	PIN/ 10"	8105	2156844.7	6863191.0	2116.1
99	799	PIN/ 12"	8106	2156838.4	6863193.6	2117.4

No.	TAG	DESCRIPTION	PT #	EASTING	NORTHING	ELEV
100	800	PIN/ 6"	8107	2156881.6	6863217.0	2115.2
101	801	PIN/ 8"	8108	2156867.2	6863217.9	2116.6
102	802	PIN/ 12"	8109	2156911.4	6863250.7	2115.1
103	803	PIN/ 6"	8110	2156918.9	6863256.2	2114.3
104	804	PIN/ 8"	8111	2156917.5	6863261.5	2114.7
105	805	PIN/ 10"	8112	2156912.3	6863260.2	2115.5
106	806	PIN/ 8"	8113	2156913.7	6863257.1	2115.4
107	807	PIN/ 6"	8114	2156910.1	6863258.4	2115.9
108	808	PIN/ 10"	8115	2156903.5	6863250.5	2116.6
109	809	PIN/ 10"	8116	2156890.2	6863254.1	2118.5
110	810	PIN/ 10"	8117	2156892.3	6863256.1	2118.5
111	811	PIN/ 8"	8118	2156893.9	6863256.9	2118.1
112	812	PIN/ 6"	8119	2156887.0	6863264.5	2118.9
113	813	PIN/ 6"	8120	2156901.4	6863264.3	2117.6
114	814	PIN/ 6"	8121	2156895.4	6863266.2	2118.1
115	815	PIN/ 6"	8122	2156896.5	6863273.3	2117.9
116	816	PIN/ 6"	8123	2156898.4	6863272.7	2117.9
117	817	PIN/ 6"	8124	2156906.0	6863276.0	2117.3
118	818	PIN/ 8"	8125	2156907.7	6863272.7	2116.4
119	819	PIN/ 8"	8126	2156912.0	6863274.5	2116.3
120	820	PIN/ 8"	8127	2156911.8	6863275.8	2116.6
121	821	PIN/ 10"	8128	2156925.2	6863282.2	2114.4
122	822	PIN/ 6"	8129	2156913.5	6863272.6	2115.7
123	823	PIN/ 6"	8130	2156929.7	6863288.9	2114.6
124	824	PIN/ 8"	8131	2156940.0	6863313.6	2114.8
125	825	PIN/ 10"	8132	2156936.6	6863310.1	2114.5
126	826	PIN/ 10"	8133	2156965.4	6863331.1	2113.1
127	827	PIN/ 12"	8134	2156957.6	6863329.9	2114.3
128	828	PIN/ 8"	8135	2156924.6	6863296.6	2115.5
129	829	PIN/ 10"	8136	2156913.5	6863291.1	2117.5
130	830	PIN/ 8"	8137	2156913.3	6863296.1	2117.0
131	831	PIN/ 6"	8138	2156893.7	6863286.9	2118.2
132	832	PIN/ 6"	8139	2156870.7	6863267.3	2120.7
133	833	PIN/ 22"	8140	2157022.7	6863462.2	2125.1
134	834	PIN/ 18"	8141	2157060.0	6863432.9	2121.8
135	835	PIN/ 14"	8145	2156784.5	6863132.8	2120.8
136	836	PIN/ 10"	8146	2156788.7	6863146.7	2121.5
137	837	PIN/ 10"	8147	2156785.8	6863145.2	2121.4
138	838	PIN/ 12"	8148	2156796.4	6863167.2	2121.8
139	839	PIN/ 10"	8149	2156800.7	6863166.2	2121.1
140	840	PIN/ 10"	8150	2156805.1	6863164.7	2120.5
141	841	PIN/ 10"	8151	2156798.4	6863176.6	2121.9
142	842	PIN/ 6"	8152	2156803.6	6863177.3	2121.6
143	843	PIN/ 10"	8153	2156801.3	6863184.2	2121.6
144	844	PIN/ 8"	8154	2156806.6	6863186.4	2121.3
145	845	PIN/ 8"	8155	2156810.6	6863185.1	2120.8
146	846	PIN/ 6"	8156	2156817.0	6863191.9	2120.2
147	847	PIN/ 10"	8157	2156809.6	6863195.5	2121.6
148	848	PIN/ 6"	8158	2156824.1	6863219.5	2121.4
149	849	PIN/ 8"	8159	2156833.5	6863215.7	2120.0
150	850	PIN/ 8"	8160	2156838.1	6863213.3	2118.0
151	851	PIN/ 18"	8196	2157344.0	6863371.5	2124.5
152	852	FIR/ 8"	8197	2157346.0	6863369.3	2122.6
153	853	PIN/ 18"	8198	2157374.2	6863415.3	2119.0
154	854	PIN/ 16"	8200	2157532.6	6863264.2	2122.3
155	855	PIN/ 14"	8201	2157247.1	6863273.4	2115.7
156	856	PIN/ 12"	8208	2156922.3	6863431.0	2122.1
157	857	PIN/ 6"	8209	2156931.6	6863416.4	2121.2
158	858	PIN/ 8"	8210	2156943.6	6863416.8	2115.2
159	859	PIN/ 12"	8211	2156952.6	6863401.9	2115.8
160	860	PIN/ 12"	8212	2156956.2	6863394.0	2115.1
161	861	PIN/ 10"	8213	2156957.4	6863392.0	2115.1
162	862	PIN/ 8"	8214	2156940.0	6863405.2	2121.0
163	863	PIN/ 6"	8215	2156937.8	6863398.6	2121.2
164	864	PIN/ 8"	8216	2156932.9	6863386.6	2122.1
165	865	PIN/ 8"	8217	2156926.1	6863386.8	2123.3
166	866	PIN/ 6"	8218	2156927.8	6863382.0	2122.5
167	867	PIN/ 6"	8219	2156925.9	6863377.8	2122.5
168	868	PIN/ 8"	8220	2156928.6	6863366.7	2121.2
169	869	PIN/ 8"	8221	2156923.6	6863367.6	2122.2
170	870	PIN/ 12"	8222	2156950.2	6863362.9	2117.3
171	871	PIN/ 8"	8223	2156946.7	6863362.1	2117.8
172	872	PIN/ 8"	8224	2156943.1	6863354.3	2117.9
173	873	PIN/ 8"	8225	2156926.7	6863343.4	2118.8
174	874	PIN/ 8"	8226	2156914.1	6863342.6	2120.2
175	875	PIN/ 6"	8227	2156902.1	6863339.1	2122.0
176	876	PIN/ 8"	8228	2156907.2	6863337.4	2120.8
177	877	PIN/ 6"	8229	2156898.4	6863336.1	2122.1
178	878	PIN/ 10"	8230	2156884.4	6863333.1	2124.2
179	879	PIN/ 6"	8231	2156925.4	6863330.8	2117.7
180	880	PIN/ 8"	8232	2156911.3	6863328.7	2118.7
181	881	PIN/ 10"	8233	2156913.4	6863332.6	2118.8
182	882	PIN/ 6"	8234	2156908.3	6863332.0	2119.7
183	883	PIN/ 6"	8235	2156894.9	6863318.3	2120.5
184	884	PIN/ 8"	8236	2156893.0	6863321.1	2121.2
185	885	PIN/ 6"	8237	2156881.2	6863317.4	2122.7
186	886	PIN/ 10"	8238	2156877.6	6863302.8	2122.5
187	887	PIN/ 8"	8239	2156870.4	6863305.1	2123.7
188	888	PIN/ 6"	8240	2156896.5	6863308.0	2120.1
189	889	PIN/ 10"	8241	2156899.6	6863311.4	2119.8
190	890	PIN/ 14"	8243	2157389.2	6863431.2	2115.6
191	891	DEC/ 10+14"	8244	2157406.1	6863441.0	2110.5
192	892	PIN/ 16"	8245	2157399.8	6863450.4	2118.3
193	893	PIN/ 12"	8246	2157403.1	6863453.1	2119.5
194	894	PIN/ 8"	8247	2157418.1	6863450.2	2115.4
195	895	PIN/ 8"	8248	2157420.4	6863452.6	2117.3
196	896	PIN/ 12"	8249	2157413.8	6863460.0	2120.4
197	897	PIN/ 12"	8250	2157406.4	6863459.7	2122.9
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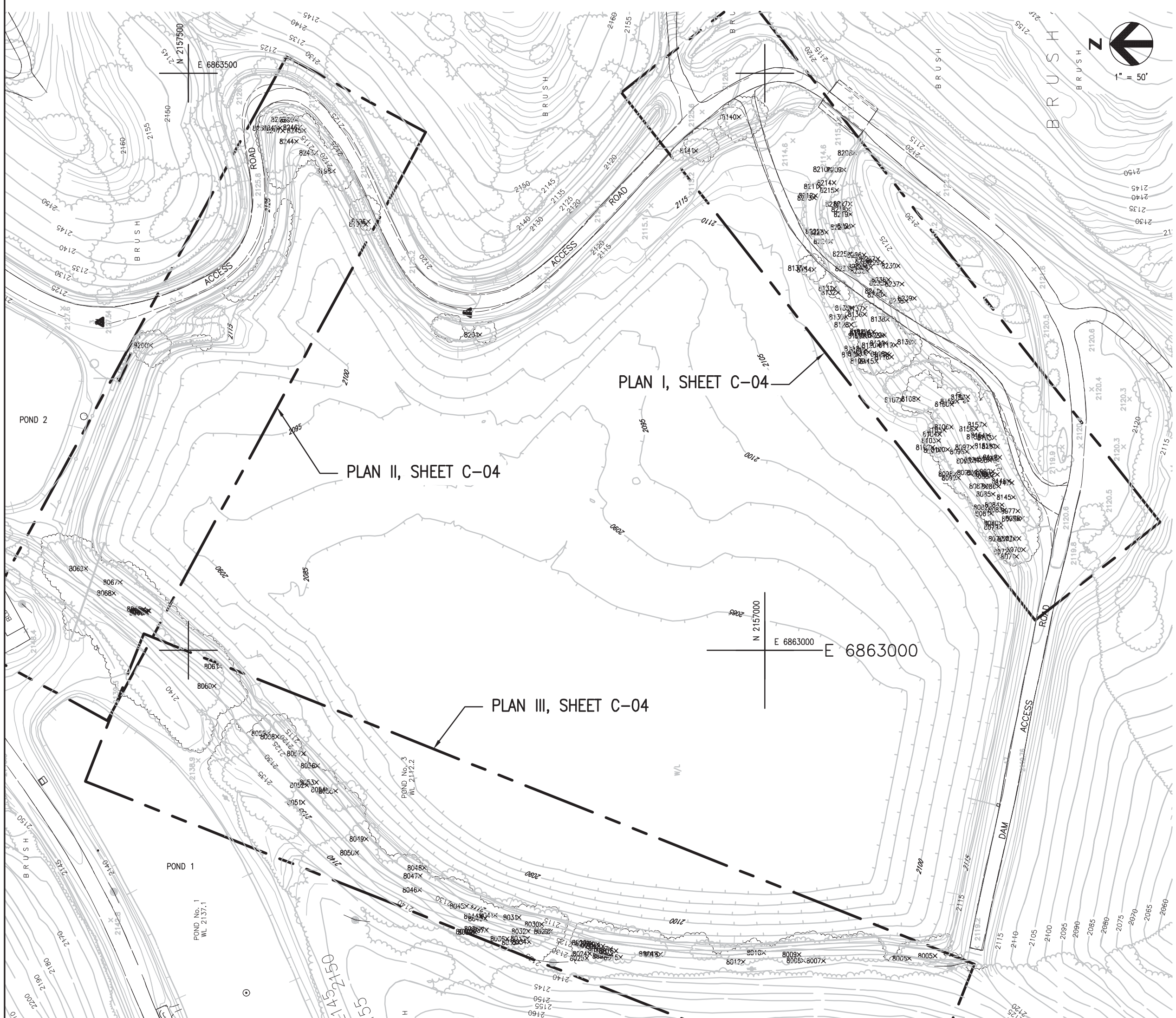

HDR

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
C	4-15-11	ISSUED FOR BID
B	2-18-09	ISSUED FOR 100% REVIEW
A	6/12/08	ISSUED FOR 50% REVIEW

PROJECT MANAGER	CRAIG A. OLSON
DESIGNED	C. OLSON
CHECKED	C. OLSON
DRAWN	P. VAN MEURS
DATE	FEBRUARY 2009
PROJECT NUMBER	202087-74238

REGISTERED PROFESSIONAL ENGINEER
CRAIG A. OLSON
No. 38819
EXP. 12-31-11
CIVIL
STATE OF CALIFORNIA

CITY OF COLFAX

POND No. 3 LINING PROJECT

TREE DEMOLITION
OVERALL PLAN AND DATA

FILENAME	74238_C-03.dwg	SHEET
SCALE	AS NOTED	C-03

0 1" 2"

FILE: C:\pwworking\sac\dms86956\74238_C-03.dwg
DATE: 05/05/11 11:36:09am, bdown

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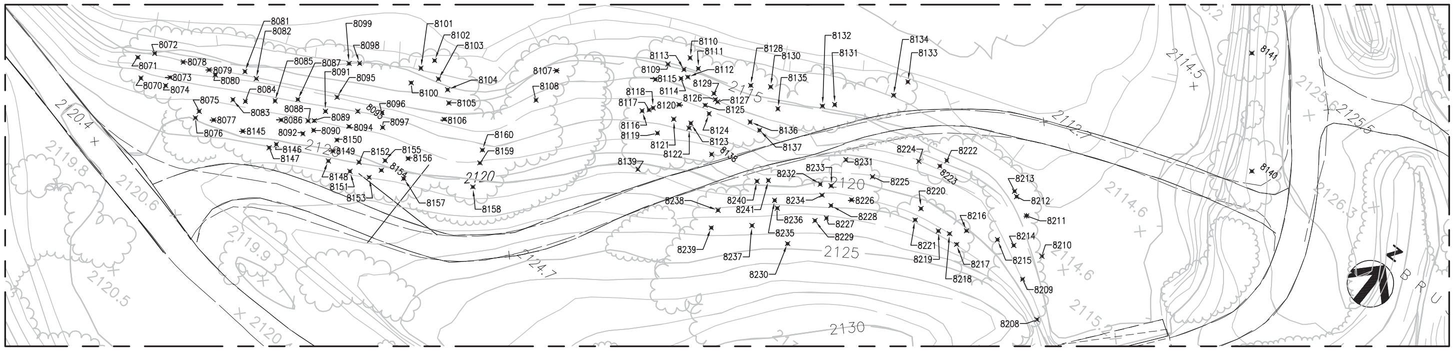
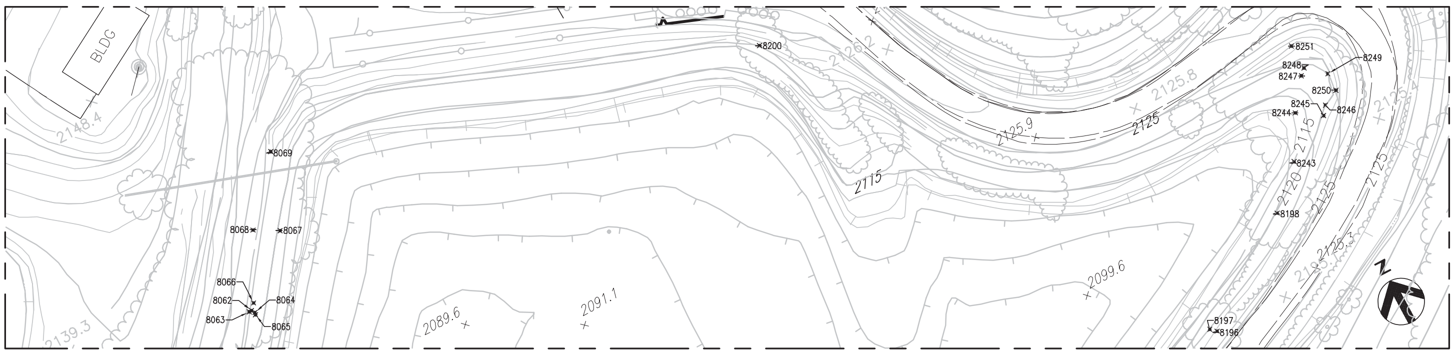
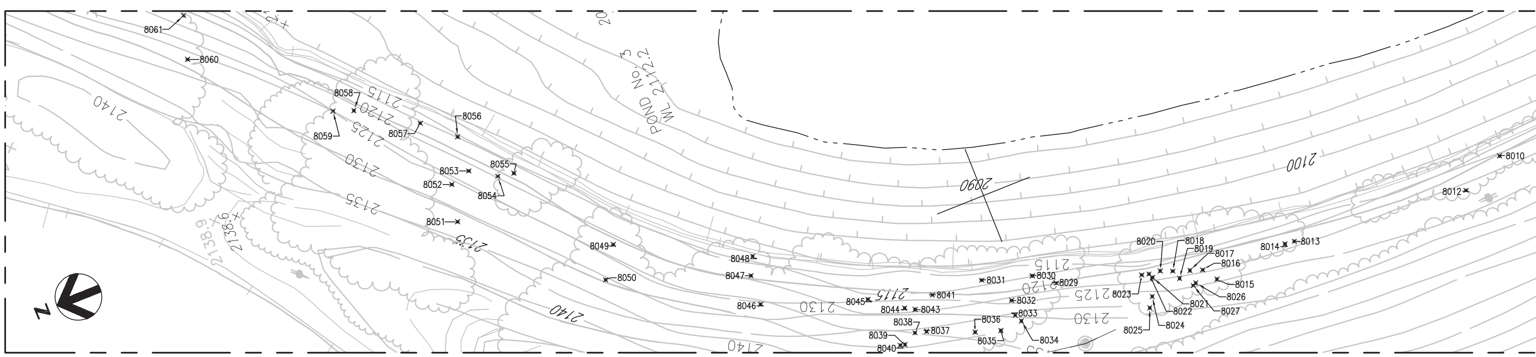


PLAN I
1" = 25'



PLAN II
1" = 25'



PLAN III
1" = 25'

NOTES:

1. CONTRACTOR TO REMOVE AND PROPERLY DISPOSE OF ALL TREES AND VEGETATION BELOW ELEVATION 2122.0. REMOVE TREES ALONG ACCESS ROAD AS REQUIRED TO INSTALL LINER. REMOVE ALL STUMPS TO 6-INCHES BELOW FINISH GRADE.
2. TREES INDICATED ARE 6-INCHES DIAMETER AND LARGER. SMALLER TREES AND VEGETATION EXIST WITHIN THE PROJECT AREA AND WILL REQUIRE REMOVAL AND DISPOSAL.
3. SEE SPECIFICATION SECTION 02110 FOR SITE CLEARING REQUIREMENTS.
4. SEE TREE TAG TABLE ON SHEET C-03. NOT ALL TREES REQUIRING REMOVAL ARE INDICATED.
5. CONTRACTOR TO OBTAIN APPROVED TIMBER HARVESTING PLAN FROM CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION PRIOR TO TREE REMOVAL. PLAN TO BE PREPARED BY REGISTERED PROFESSIONAL FORESTER. COMPLY WITH PUBLIC RESOURCE CODE (PRC) 4581 AND PRC 4527.

HDR
HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
C	4-15-11	ISSUED FOR BID
B	2-18-09	ISSUED FOR 100% REVIEW
A	6/12/08	ISSUED FOR 50% REVIEW

PROJECT MANAGER	CRAIG A. OLSON
DESIGNED	C. OLSON
CHECKED	C. OLSON
DRAWN	P. VAN MEURS
DATE	FEBRUARY 2009
PROJECT NUMBER	202087-74238

REGISTERED PROFESSIONAL ENGINEER
CRAIG A. OLSON
No. 39819
EXP. 12-31-11
CIVIL
STATE OF CALIFORNIA

CITY OF COLFAX
POND No. 3 LINING PROJECT

TREE DEMOLITION ENLARGED PLANS

0 1" 2"

FILENAME	74238_C-04.dwg
SCALE	AS NOTED

SHEET C-04

FILE: C:\pwworking\sac\dms86956\74238_C-04.dwg
DATE: 05/05/11 11:36:32am, bdown

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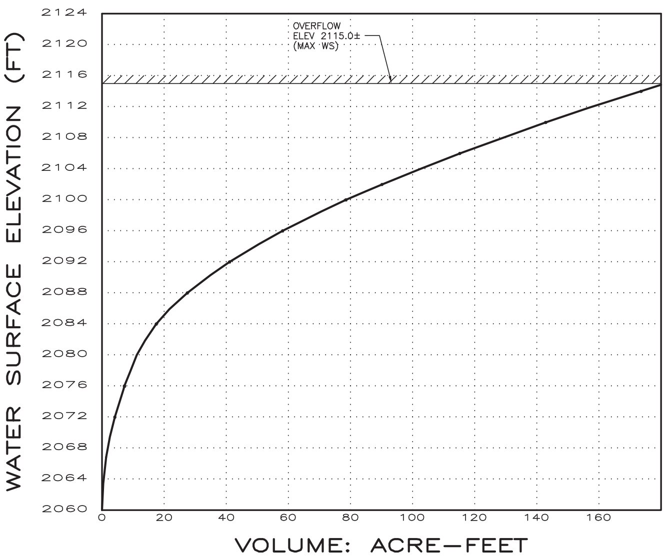
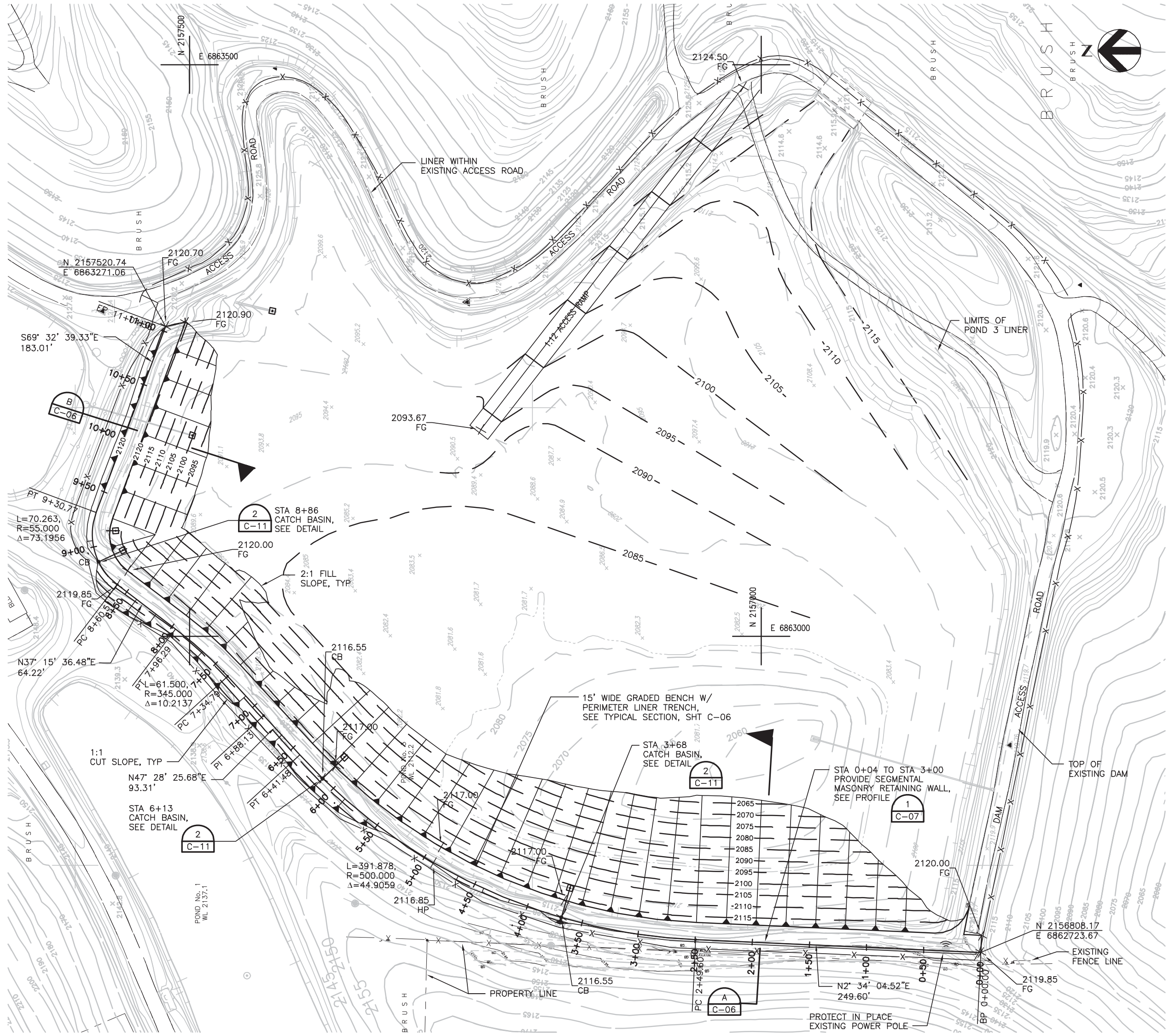


POND 3 CAPACITY CHART

AS NOTED



GRADING NOTES:

1. SEE SPECIFICATION SECTION 02200 FOR EARTHWORK REQUIREMENTS.
2. NO EMBANKMENT FILL MATERIAL IS AVAILABLE ON SITE.
3. RESIDUAL SOLIDS REMAINING AFTER POND DEWATERING OPERATION MAY BE SPREAD ON RESERVOIR BOTTOM FOR FURTHER DRYING AND BLENDING PRIOR TO LINER INSTALLATION. RESIDUAL SOLIDS MOISTURE CONTENT TO BE A MAXIMUM OF 50% PRIOR TO BLENDING.
4. DO NOT DISTURB EXISTING DAM EMBANKMENT EXCEPT AS REQUIRED TO CONSTRUCT NEW IMPPROVEMENTS.
5. SLOPES RECEIVING LINER TO BE NO STEEPER THAN 2:1 (HORIZONTAL:VERTICAL).

HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
C	4-15-11	ISSUED FOR BID
B	2-18-09	ISSUED FOR 100% REVIEW
A	6/12/08	ISSUED FOR 50% REVIEW

PROJECT MANAGER	CRAIG A. OLSON
DESIGNED	C. OLSON
CHECKED	C. OLSON
DRAWN	P. VAN MEURS
DATE	FEBRUARY 2009
PROJECT NUMBER	202087-74238

REGISTERED PROFESSIONAL ENGINEER CRAIG A. OLSON No. 39819 EXP. 12-31-11 CIVIL STATE OF CALIFORNIA

CITY OF COLFAX

POND No. 3 LINING PROJECT

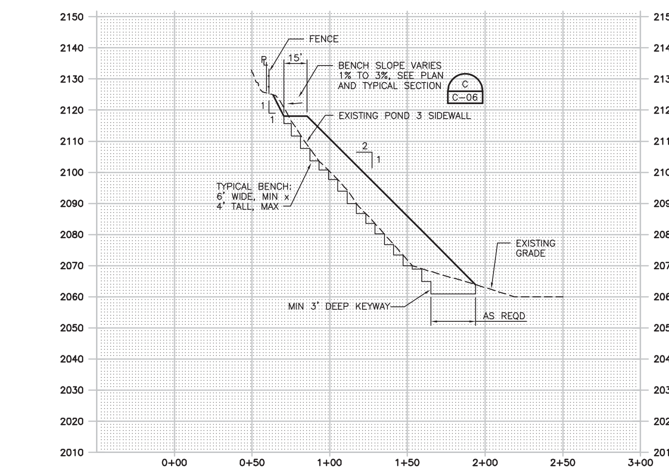
GRADING PLAN

0 1" 2"

FILENAME	74238_C-05.dwg
SCALE	1"=50'

SHEET C-05

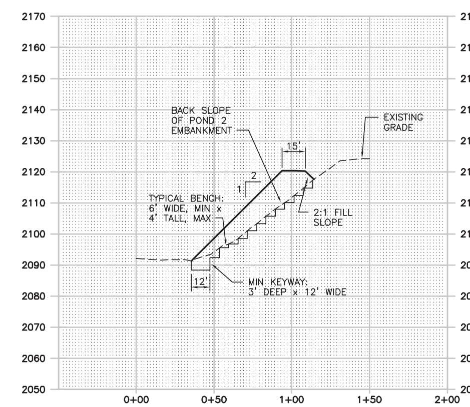
FILE: C:\pwworking\sac\dms86956\74238_C-05.dwg
DATE: 05/05/11 11:38:01am, bdown



SECTION

HORIZONTAL: 1" = 40'
VERTICAL: 1" = 20'

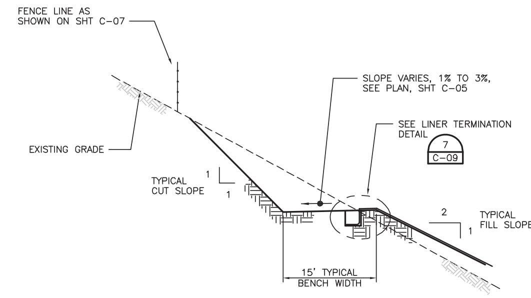
A
C-05



SECTION

HORIZONTAL: 1" = 40'
VERTICAL: 1" = 20'

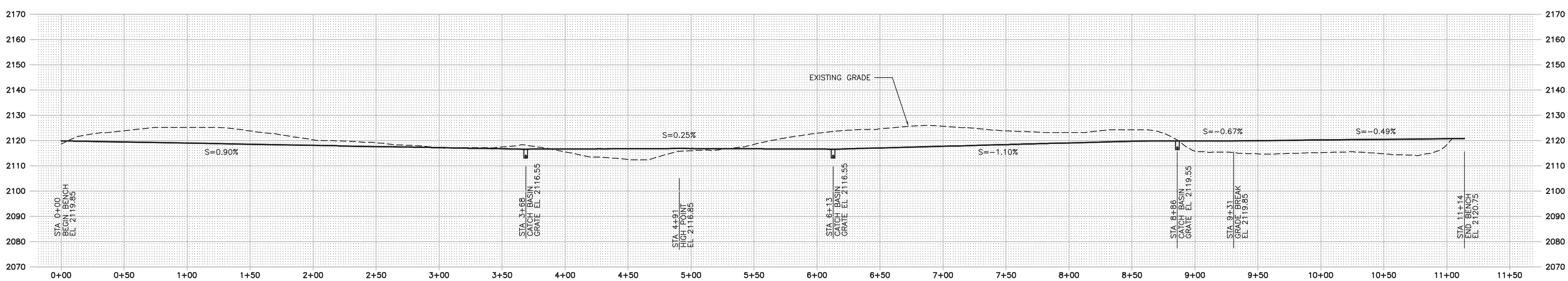
B
C-05



TYPICAL SECTION THRU BENCH

1" = 10'

C
C-05



PROFILE – BACK OF BENCH

HORIZONTAL: 1" = 40'
VERTICAL: 1" = 20'

1
C-05

HDR
HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
C	4-15-11	ISSUED FOR BID
B	2-18-09	ISSUED FOR 100% REVIEW
A	6/12/08	ISSUED FOR 50% REVIEW

PROJECT MANAGER	CRAIG A. OLSON
DESIGNED	C. OLSON
CHECKED	C. OLSON
DRAWN	P. VAN MEURS
DATE	FEBRUARY 2009
PROJECT NUMBER	202087-74238

REGISTERED PROFESSIONAL ENGINEER CRAIG A. OLSON No. 39819 EXP. 12-31-11 CIVIL STATE OF CALIFORNIA

CITY OF COLFAX
POND No. 3 LINING PROJECT

GRADING SECTIONS AND DETAILS I

0 1" 2"

FILENAME	74238_C-06.dwg
SCALE	AS NOTED

SHEET C-06

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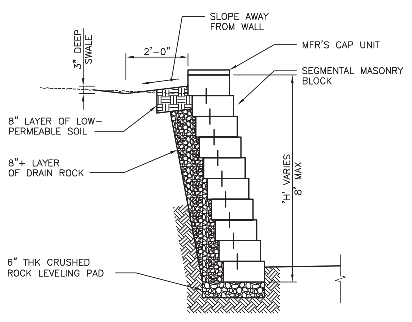
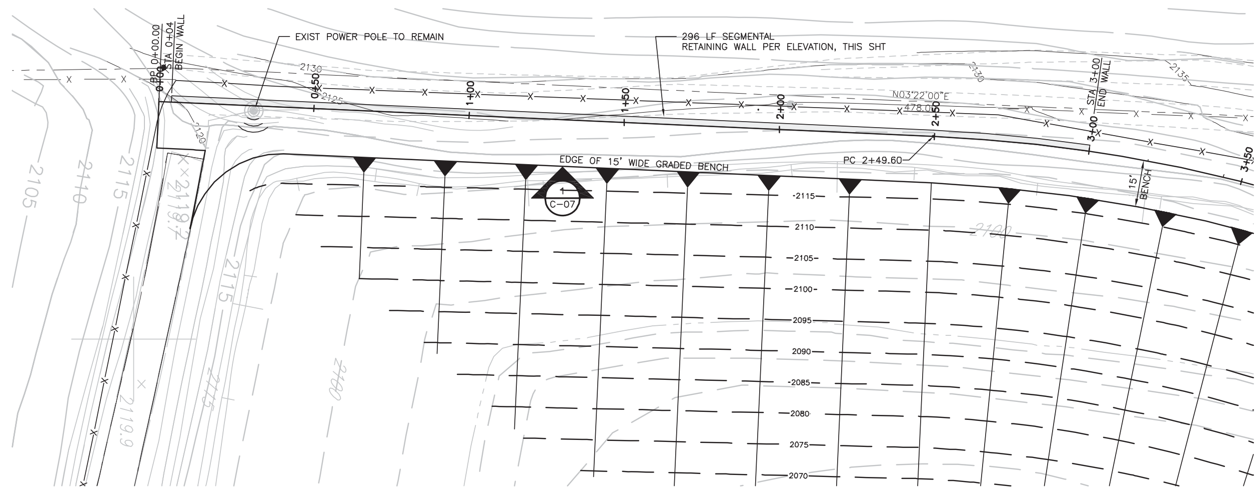


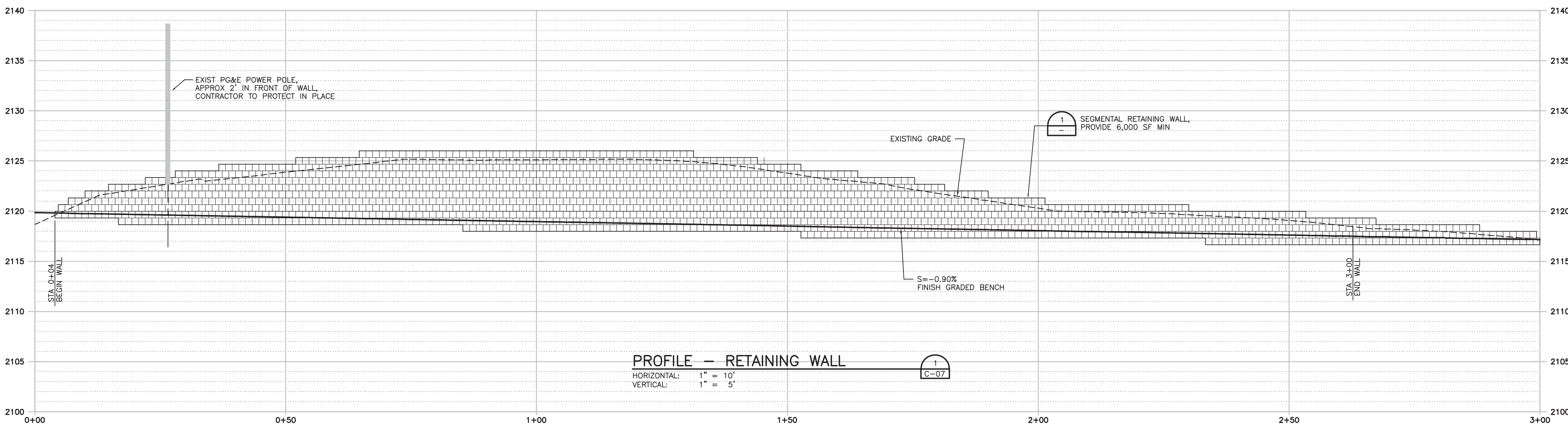
SEGMENTAL RETAINING WALL DETAIL
NONE



PLAN – RETAINING WALL
1" = 20'

NOTES:

1. PROTECT EXISTING POWER POLES IN PLACE.
2. EXACT CONFIGURATION OF SEGMENTAL RETAINING WALL TO BE DETERMINED IN THE FIELD DURING CONSTRUCTION.



PROFILE – RETAINING WALL
HORIZONTAL: 1" = 10'
VERTICAL: 1" = 5'

HDR
HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
C	4-15-11	ISSUED FOR BID
B	2-18-09	ISSUED FOR 100% REVIEW
A	6/12/08	ISSUED FOR 50% REVIEW

PROJECT MANAGER	CRAIG A. OLSON
DESIGNED	C. OLSON
CHECKED	C. OLSON
DRAWN	P. VAN MEURS
DATE	FEBRUARY 2009
PROJECT NUMBER	202087-74238

REGISTERED PROFESSIONAL ENGINEER
CRAIG A. OLSON
No. 39819
EXP. 12-31-11
CIVIL
STATE OF CALIFORNIA

CITY OF COLFAX
POND No. 3 LINING PROJECT

GRADING SECTIONS AND DETAILS II

0 1" 2"

FILENAME	74238_C-07.dwg
SCALE	AS NOTED

SHEET
C-07

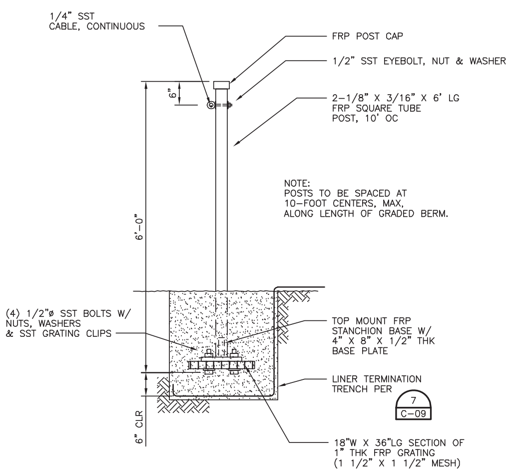
FILE: C:\pwworking\sac\dms86956\74238_C-07.dwg
DATE: 05/05/11 11:40:32am, bdown

LEGEND

(shaded area)	APPROXIMATE LIMITS OF BALLAST LAYER. SEE SHEET C-09
— — — —	APPROXIMATE BOUNDARY OF GEOMEMBRANE LINER

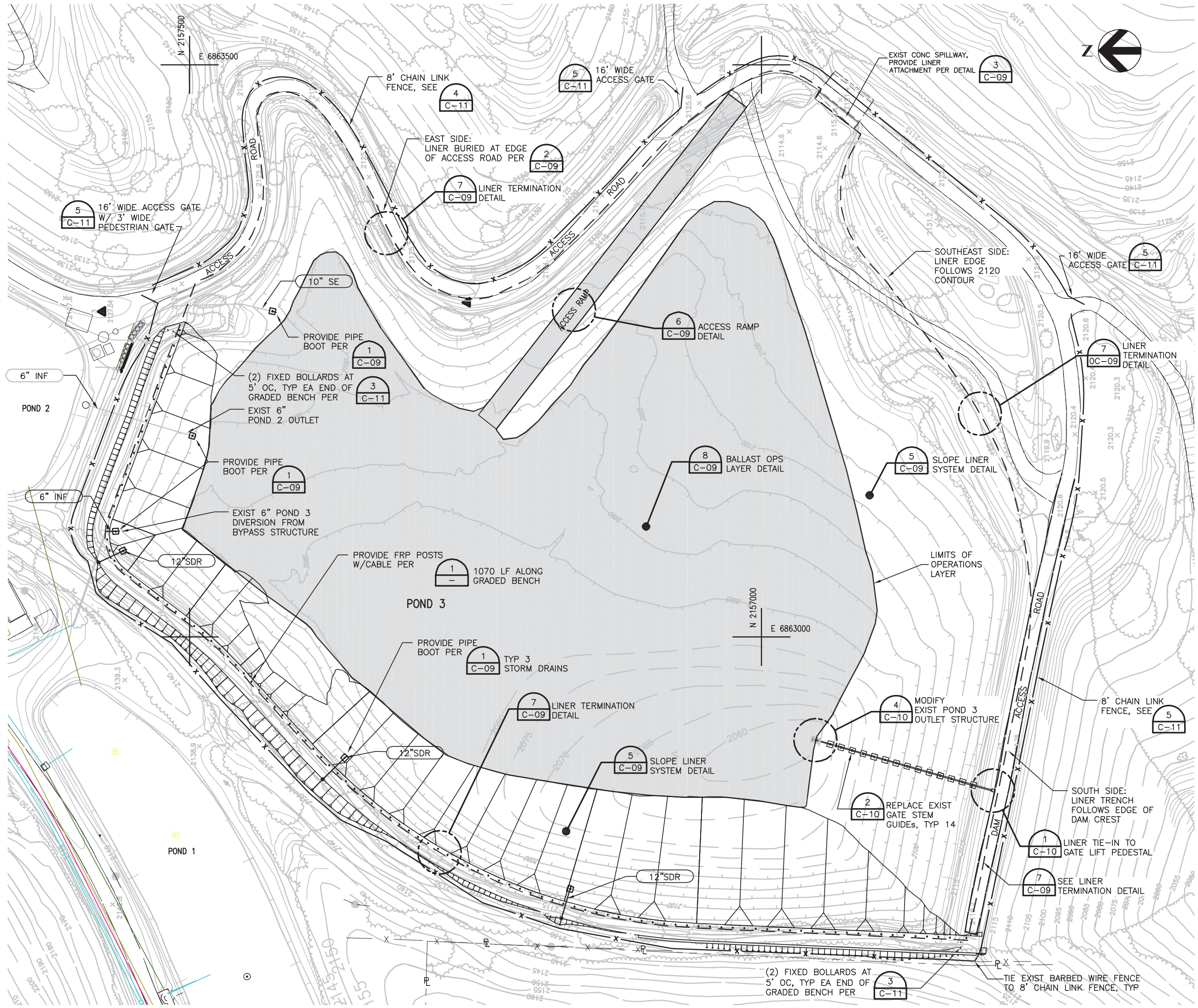
GENERAL NOTES:

1. BALLAST LAYER TO BE TERMINATED 10 FEET AWAY FROM OUTLET STRUCTURE
2. LOCATIONS FOR NEW FENCE ARE APPROXIMATE AND WILL BE DETERMINED IN THE FIELD AFTER GRADING IS COMPLETED.
3. CONNECT EXISTING BARB-WIRE FENCE TO NEW FENCE AT TWO LOCATIONS ALONG WEST PROPERTY LINE.



FRP GUARDRAIL POST DETAIL 1 –

NTS



HDR Engineering, Inc.				PROJECT MANAGER	CRAIG A. OLSON	LINER AND IMPROVEMENTS PLAN
				DESIGNED	C. OLSON	
	C	4-15-11	ISSUED FOR BID	CHECKED	C. OLSON	
	B	2-18-09	ISSUED FOR 100% REVIEW	DRAWN	P. VAN MEURS	
	A	6/12/08	ISSUED FOR 50% REVIEW	DATE	FEBRUARY 2009	
	ISSUE	DATE	DESCRIPTION	PROJECT NUMBER	202087-74238	

REGISTERED PROFESSIONAL ENGINEER CRAIG A. OLSON No. 39819 EXP. 12-31-11 CIVIL STATE OF CALIFORNIA

CITY OF COLFAX

POND No. 3 LINING PROJECT

0 1" 2"

FILENAME	74238_C-08.dwg	SHEET
SCALE	1" = 50'	C-08

FILE: C:\pwworking\sac\dms86956\74238_C-08.dwg
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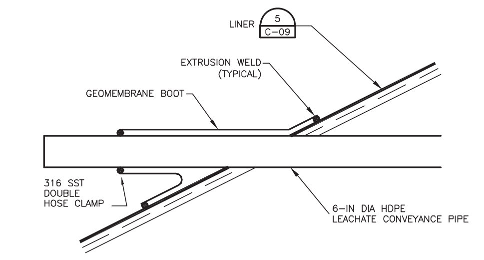
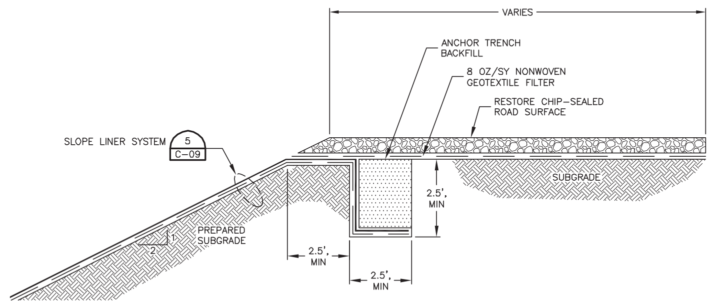
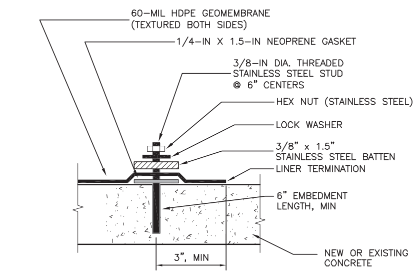


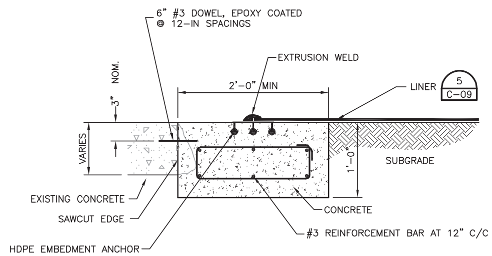
MISCELLANEOUS PIPE OUTLET DETAIL
NO SCALE
1 C-09



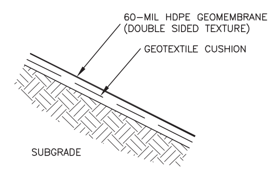
LINER TERMINATION AT ROAD DETAIL
NO SCALE
2 C-09



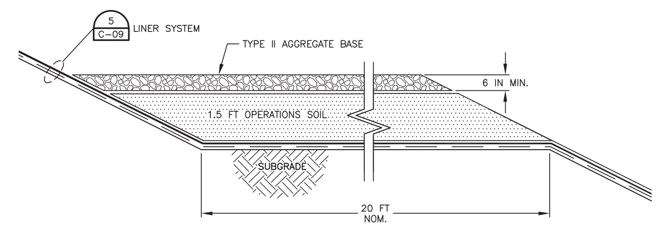
TYPICAL ALTERNATIVE BATTEN STRIP ANCHOR DETAIL
NO SCALE
3 C-09



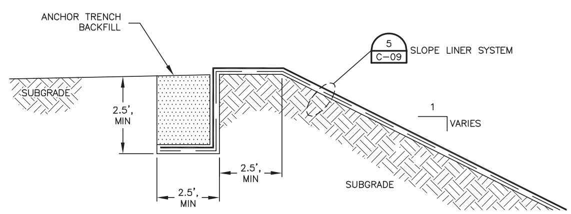
TYPICAL HDPE EMBEDMENT ANCHOR STRIP DETAIL
NO SCALE
4 C-09



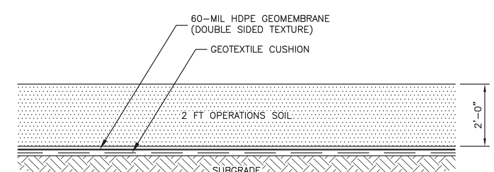
SLOPE LINER SYSTEM DETAIL
NO SCALE
5 C-09



ACCESS RAMP DETAIL
NO SCALE
6 C-09



LINER TERMINATION DETAIL
NO SCALE
7 C-09



BALLAST OPERATIONS LAYER DETAIL
NO SCALE
8 C-09

HDR
HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
C	4-15-11	ISSUED FOR BID
B	2-18-09	ISSUED FOR 100% REVIEW
A	6/12/08	ISSUED FOR 50% REVIEW

PROJECT MANAGER	CRAIG A. OLSON
DESIGNED	C. OLSON
CHECKED	C. OLSON
DRAWN	P. VAN MEURS
DATE	FEBRUARY 2009
PROJECT NUMBER	202087-74238

REGISTERED PROFESSIONAL ENGINEER
CRAIG A. OLSON
No. 39819
EXP. 12-31-11
CIVIL
STATE OF CALIFORNIA

CITY OF COLFAX
POND No. 3 LINING PROJECT

LINER DETAILS

0 1" 2"

FILENAME	74238_C-09.dwg
SCALE	AS NOTED

SHEET
C-09

FILE: C:\pwworking\sac\dms86956\74238_C-09.dwg
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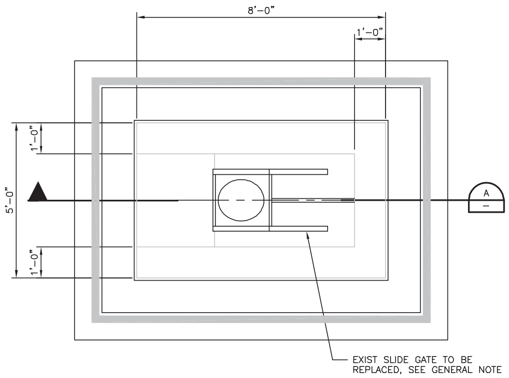
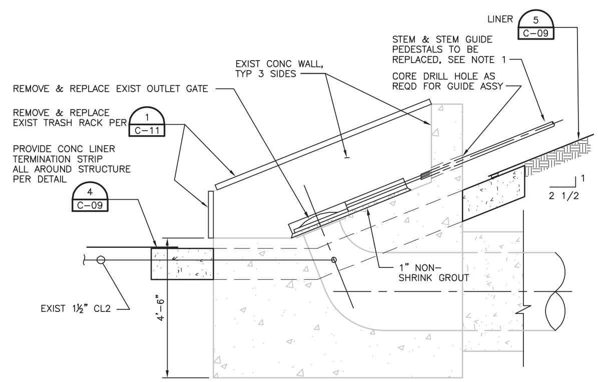
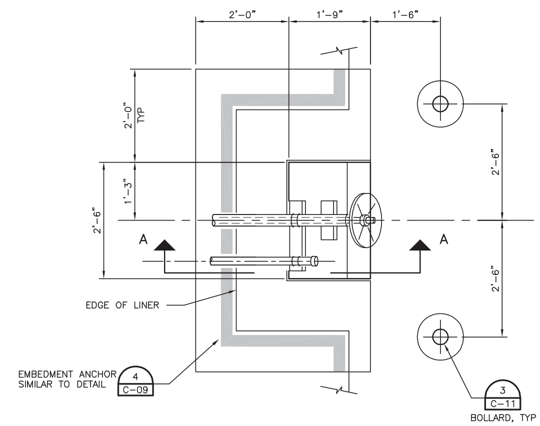


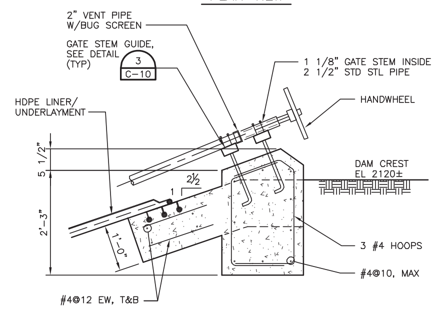
PLAN VIEW
EXISTING INTAKE STRUCTURE
1/2" = 1'-0"
4 C-10



SECTION
1/2" = 1'-0"
A –

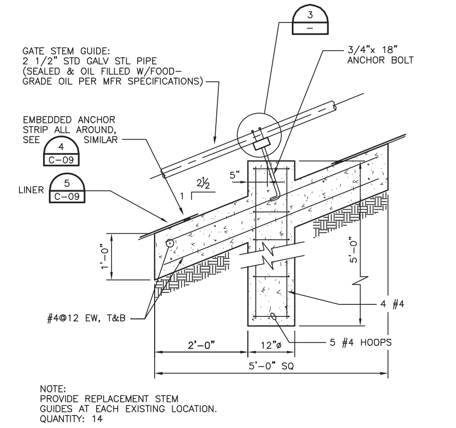


PLAN VIEW



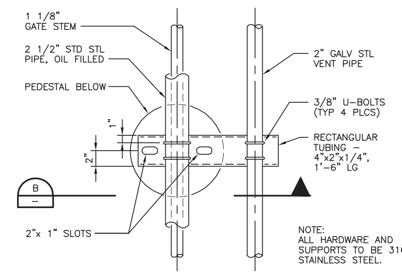
SECTION A–A

GATE LIFT PEDESTAL DETAIL
3/4" = 1'-0"
1 C-10



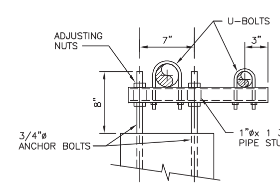
NOTE:
PROVIDE REPLACEMENT STEM GUIDES AT EACH EXISTING LOCATION.
QUANTITY: 14

GATE STEM GUIDE DETAIL
3/4" = 1'-0"
2 C-10



NOTE:
ALL HARDWARE AND SUPPORTS TO BE 316 STAINLESS STEEL.

STEM GUIDE DETAIL
1 1/2" = 1'-0"
3 –



SECTION
1 1/2" = 1'-0"
B –

GENERAL NOTES

1. CONTRACTOR TO REPLACE EXISTING POND 3 OUTLET GATE. SEE SPECIFICATION SECTION 15115.
2. CONTRACTOR TO REPLACE ENTIRE GATE STEM AND HANDWHEEL ASSEMBLY. ITEMS TO BE REMOVED AND REPLACED INCLUDE:
   (14) GATE STEM GUIDE ASSEMBLIES, INCLUDING CONCRETE PEDESTALS
   (1) GATE LIFT PEDESTAL ASSEMBLY INCLUDING HANDWHEEL AND CONCRETE PEDESTAL
   (1) 2" VENT PIPE ASSEMBLY FROM CONNECTION POINT AT INTAKE STRUCTRE TO GATE LIFT PEDESTAL
3. ALL CONCRETE PEDESTALS AND STRUCTURES, INCLUDING EXISTING STRUCTURES TO REMAIN, SHALL BE MODIFIED TO ACCEPT LINER CONNECTION PER DETAILS SHOWN ON SHEET C-09.
4. EXISTING TRASH RACK TO BE REPLACED IN KIND. ASSEMBLY TO BE HOT-DIPPED GALVANIZED AFTER FABRICATION.

HDR
HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
C	4-15-11	ISSUED FOR BID
B	2-18-09	ISSUED FOR 100% REVIEW
A	6/12/08	ISSUED FOR 50% REVIEW

PROJECT MANAGER	CRAIG A. OLSON
DESIGNED	C. OLSON
CHECKED	C. OLSON
DRAWN	P. VAN MEURS
DATE	FEBRUARY 2009
PROJECT NUMBER	202087-74238

REGISTERED PROFESSIONAL ENGINEER
CRAIG A. OLSON
No. 39819
EXP. 12-31-11
CIVIL
STATE OF CALIFORNIA

CITY OF COLFAX
POND No. 3 LINING PROJECT

OUTLET GATE DETAILS

0 1" 2"

FILENAME	74238_C-10.dwg
SCALE	AS NOTED

SHEET
C-10

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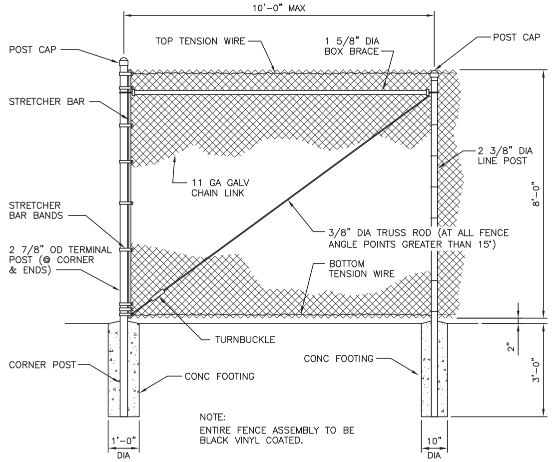
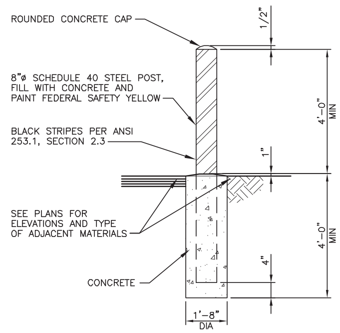
DATE: 05/05/11 11:43:11am, bdown



CHAIN LINK FENCE DETAIL

1/2" = 1'-0"

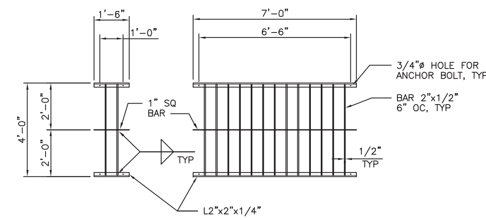
4 / C-11



FIXED BOLLARD DETAIL

NO SCALE

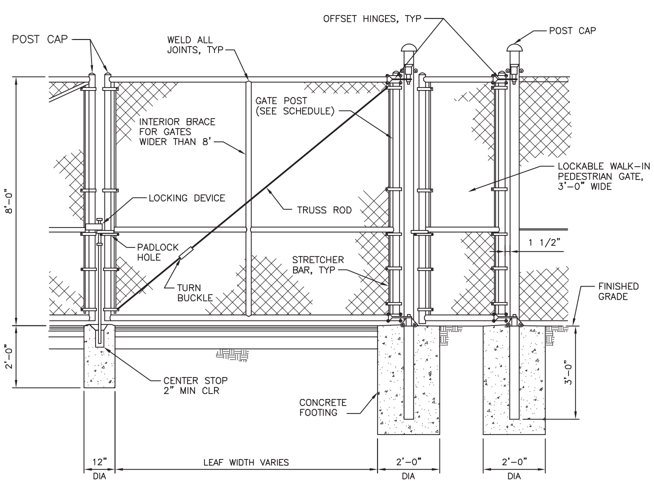
3 / C-11



TRASH RACK DETAIL

3/8" = 1'-0"

1 / C-11



CHAIN LINK GATE DETAIL

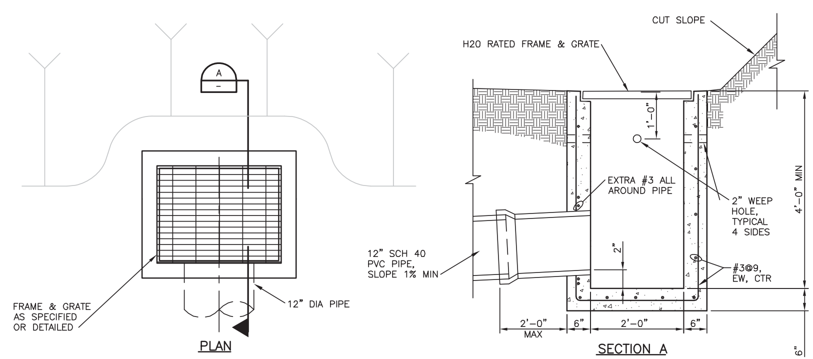
1/2" = 1'-0"

5 / C-11

GATE POST SCHEDULE	
LEAF SPAN	NOMINAL DIAMETER
≤ 6'	3"
6'-12'	5"
12'-18'	6"
18'-24'	8"

NOTES:

1. POSTS, BRACES, AND RAILS TO BE SCHEDULE 40.
2. SINGLE LEAF GATES TO BE REINFORCED SIMILAR TO DOUBLE SWING GATE DETAIL.
3. FINISHED GRADE PER SITE GRADING.
4. GATE FABRIC TO MATCH THAT USED IN FENCE.
5. BLACK VINYL COATED 11 GAGE STEEL 2" MESH.



NOTE:
CONTRACTOR MAY SUBMIT PRECAST CONCRETE CATCH BASIN PROVIDING IT MEETS MINIMUM REQUIREMENTS SHOWN IN THIS DETAIL.

CATCH BASIN DETAIL

NO SCALE

2 / C-11

HDR
HDR Engineering, Inc.

ISSUE	DATE	DESCRIPTION
C	4-15-11	ISSUED FOR BID
B	2-18-09	ISSUED FOR 100% REVIEW
A	6/12/08	ISSUED FOR 50% REVIEW

PROJECT MANAGER	CRAIG A. OLSON
DESIGNED	C. OLSON
CHECKED	C. OLSON
DRAWN	P. VAN MEURS
DATE	FEBRUARY 2009
PROJECT NUMBER	202087-74238

REGISTERED PROFESSIONAL ENGINEER
CRAIG A. OLSON
No. 39819
EXP. 12-31-11
CIVIL
STATE OF CALIFORNIA

CITY OF COLFAX
POND No. 3 LINING PROJECT

CIVIL DETAILS

0 1" 2"

FILENAME	74238_C-11.dwg
SCALE	AS NOTED

SHEET
C-11

FILE: C:\pwworking\sac\dms86956\74238_C-11.dwg
DATE: 05/05/11 11:43:36am, bdown

MEMORANDUM
FUGRO WEST, INC.
502 Giuseppe Court, Suite 11
Roseville, CA 95678
Tel: 916-773-2600
Fax: 916-782-4846

To:	HDR Engineering, Mr. Craig Olsen	Date:	01/09/08
From:	Fugro West, Mike Hughes	Project No:	3161.008
Subject:	City of Colfax WWTP, Pond No. 3	Copy to:	

Supplemental Geotechnical Services for Colfax Wastewater Treatment Plant

Wastewater Storage Pond

INTRODUCTION

Fugro West, Inc., is pleased to present the findings of our field investigation and laboratory testing program for the large wastewater storage pond at Pond No. 3 located at Colfax Wastewater Treatment Plant (WWTP). A Vicinity Map is included as Plate 1. The work was performed in general accordance with our proposal of November 22, 2005.

The existing storage pond is to be lined and our geotechnical study was conducted to evaluate the depth and nature of subsurface materials at the site and provide appropriate design recommendations

SCOPE OF WORK

The scope of work outlined in our proposal of November 22, 2005 is generally as follows:

1. Review existing available geotechnical data for the pond and other pertinent information generated for the existing adjacent facilities.
2. Excavate six (6) exploratory test pits in the drained storage pond to investigate the subsurface materials and their properties and identify the likely depth of excavation and recompaction of materials that may be required.
3. Perform laboratory testing on selected disturbed samples obtained from the trial pits.
4. Prepare a technical memorandum, including the results of our field exploration and laboratory testing, a description of the soil and groundwater conditions encountered across the site and conclusions and recommendations for design and construction of the proposed pond liner.

DESK STUDY REVIEW

A geotechnical report was prepared by España Geotechnical Consulting in June 2002 (España, 2002) as part of the investigation for an Interim Disinfection Facility at the WWTP. The disinfection facility was to be constructed along the crest of the embankment between storage Pond No. 2 and No. 3. As part of the investigation four (4) borings were undertaken along the crest of the embankment to depths of between 16 and 40 feet.

The report identified that existing embankment between the two ponds was constructed in the late 1970's and consists of fill generated from past excavation and mining activities at the site. The embankment is sloped at 2.5:1 (horizontal to vertical), with a height of 12 feet on the upstream, northern face and 43 feet on the downstream, southern face. The report noted that after construction of the embankment and Pond No. 2 was filled with wastewater, leakage was detected. A subsequent investigation by Laver Roper and Associates (LPA) in 1979, indicated that seepage was occurring in the natural soils beneath and around the compacted embankment. However, the España report noted that no basis for such an opinion was obvious from the work presented in the LPA report.

SITE CONDITIONS

General

The existing WWTP is situated within a valley, which drains to the southwest towards Smuthers Ravine and ultimately to the North Fork of the American River. The surrounding hillsides are moderately steep to very steep and are typically tree-covered with thick undergrowth. Some of the steeper slopes are un-vegetated and contain exposed rock outcrops, which are steeply dipping. The cut slope along the access road parallel to Pond No. 1 of the WWTP exposes very thinly-bedded, fissile shales and claystones categorized as ultramafic materials. These materials are highly fractured and appear susceptible to air slaking, with small angular gravel sized fragments accumulating at the toe of the cut slopes.

The storage pond under investigation is existing Pond No. 3, which is located along the approximate centerline of the valley about 300 to 400 feet to the southeast of the access road into the WWTP (Plate 2). At the time of the investigation the pond had been drained substantially allowing access to the bottom of the pond along the central and western portions. The side slopes of the pond were largely clear of vegetation to within about 10 feet of the top of the dam, where grasses shrubs and some small trees were observed. Field observations on 10/11/07 identified several old tree stumps at isolated locations within the pond area both above and below the existing past high water level elevation.

A dirt road, formed on a fill embankment, provides access to the base of the pond from the northeastern (upstream end) corner of the pond (Plate 2). A subsurface drainage pipe and an area of rip-rap are located to the east of the embankment. At the time of our investigation, water was discharging from the pipe into the pond area at this location.

Along the eastern valley side, two gullies trend in a roughly east-west direction towards Pond No. 3. One of the gullies leads into the northeastern corner of the pond, while the other leads into the central portion. During rainfall, these gullies likely discharge surface water runoff towards the pond. A drainage ditch has been installed along the toe of the slopes to collect such water and direct it towards the existing dam toe drains. At the time of the investigation, water collected from the dam toe drains was being pumped back into Pond No. 3 via the drainage pipe located at near the east spillway.

Based on discussions with staff from the WWTP, seepage has historically been observed at the northeastern corner of the pond. This seepage is likely related to runoff and infiltration along the natural gully leading into the pond at this location during seasonal periods of precipitation and/or seepage arising from the unlined drainage ditch. In December 2006, the drainage ditch was lined with gunite and this may resolve the seepage issue at this location.

Regional Geology

The project is located with in the Sierra Nevada Geomorphic Province of California. The project is situated within the Sierra Nevada metamorphic belt, which lies on the western flank of the Sierra Nevada Batholith. Bedrock consists of sedimentary, metasedimentary, and metavolcanics of the Jurassic-age Mariposa Formation (Jm). The Mariposa formation is comprised of marine deposited sands and silts that have been altered to sandstones and slates. Geologic structure in the area consists of both anticlinal and synclinal folding and normal faulting associated with the Foothills Fault System.

The Foothills fault system is a major zone of basement faults. It is a complex zone of deformation that formed primarily during the Mesozoic period. It is characterized by shear zones commonly associated with elongate bodies of variably serpentinized ultramafic rocks. Lorin Clark (1960) originally defined the Foothills fault system as bounded by the Melones fault zone on the east and the Bear Mountains fault zone on the west. Later usage commonly considers the Foothills to include all zones of deformation between Melones fault and western most exposures of metamorphic rocks.

Faulting

There are two major fault systems in the project vicinity, namely the Foothills fault system and the Sierra Nevada Frontal fault system. The WWTP is located within the Foothills fault system, but significant faults associated with the Sierra Nevada Frontal fault system are far away from the project site and are not considered relevant.

The Foothills fault system contains the primary seismic sources for earthquakes at the project site. It consists of numerous fault strands along a similar trend. The fault system is bounded on the west by the Bear Mountain fault zone and on the east by the Melones fault zone. Within the Foothills fault system, many areas of late Cenozoic and some areas of late Quaternary faulting have been identified along the Mesozoic bedrock fault zones as a result of studies conducted after the 1975 Oroville earthquake.

Based upon a review of available published reports and data in PG&E's files, the significant faults of the Foothills fault system potentially affecting the project site include the Dewitt, Drum, Giant Gap- Junction House, Highway 49, Maidu, Rescue, Spencerville, and Succor Flat faults. These faults have shown evidence of late Cenozoic or late Quaternary movement and represent reactivated segments of the bedrock faults of the Foothills fault system. These sources are considered to be "conditionally active" based on the Department of Safety of Dams (DSOD) guidelines.

The WWTP is located between traces of the Weimar and Gillis Hill faults of the Foothills fault system. The Weimar fault is located approximately 2 miles (3.2 km) west of the dam site and the Gillis Hill fault is located approximately 1,700 feet east (0.5 km) measured to the closest point on each trace.

The Weimar fault is a northerly striking bedrock fault zone that is associated with moderate and locally strong lineaments. The fault separates metasedimentary and metavolcanics on the west from slate and greywacke on the east (PG&E, 1994c). Correlation of Mehrten remnants on either side of the fault zone appear to show no evidence of offset at the base of the Mehrten based or review of PG&E cross section (PG&E, 1994). PG&E study of this fault zone does indicate evidence of a displaced Tertiary erosion surface (PG&E, 1994a). From this evidence, the fault activity is estimated as late Cenozoic (approx. < 6million years)(PG&E, 1994). Based the data reviewed, it is our opinion that the Weimar fault zone is not considered to be a significant seismic source or qualify as "conditionally active" per DSOD guidelines.

The Gillis Hill fault is also a bedrock fault zone. Study in the project area did identify a geomorphic anomaly near Burnt Flat (PG&E, 1994 files), approximately 1¼ miles northeast of the project site and near Interstate 80. The anomaly is close to the Gillis Hill bedrock fault. The projections of the surface of the Mehrten Formation are separated about 50 meters, down-east, and the gradient of the Mehrten surface differs by 6 meters/kilometer across the anomaly along Highway 80 (PG&E, 1994 files). The lateral separation of Mehrten remnants, combined with the poor, eroded quality of the Mehrten remnants was insufficient to evaluate the origin of the anomaly (PG&E, 1994 files). Based on the insufficient evidence sited, review of reports prepared by PG&E and other consultants in the project vicinity with evaluations of potential seismic sources, and the California Fault Activity Map of California (Jennings, 1994), it is our opinion that the Burnt Flat anomaly would not be considered as a potential seismic source or qualify as "conditionally active" per DSOD guidelines.

Seismicity

A computerized search was performed as part of the geotechnical report prepared by España Geotechnical Consulting in June 2002. The program EQSEARCH was used to search for historical earthquakes within a 62.5 mile (100 km) radius of the project site. The search was limited to magnitude 4 or greater earthquakes. The search found a total of 110 earthquakes within the search area specified. The majority of these earthquakes are to the east and northeast, along the northwest trending Walker Lane Shear Zone that includes faults of the Sierra Nevada frontal fault zone, such as the Mohawk Valley fault zone. The closest historical earthquake to the site occurred in 1875 at a distance of 9.1 miles and a magnitude of 4.3. The largest earthquake magnitude found in the search area was a 6.3 at a distance of 61.6 miles (98.6 km) in 1887.

Site Geology

The subject site appears to be underlain by Jurassic age phylitic shales and slates of the Mariposa Formation (Wagner et al, 1987). Locally, the slates and shales are light brown to orange-tan in color. Variations in composition of the original marine deposit (more silt and fine sand, less clay) allow for the observation of bedding planes in the rock stratigraphy.

Where the original claystone and mudstones are sufficiently unaltered by metamorphism, the bedding planes are observed to be strike North 40-50° West and dip at 70° to 80° to the northeast. The predominant joint set observed is perpendicular to the direction of bedding and strikes North 40-50° East and dips at 70° to 80° to the southeast. The metashales and metasedimentary are deeply weathered, thinly bedded (blocky to fissile) and closely to very closely fractured. Depending on the location, bedrock has weathered to a sandy silt and clayey silt. Where the altered rock (sandy silt material) is exposed in road cuts, the original rock fabric is very visible. Accessory mineralization as a result of regional metamorphism, aside from iron oxide staining within the sheared and fractured rock, is not readily discernable.

Subsurface Exploration

Fieldwork was conducted on October 11, 2007. Six (6) shallow test pits (TP-10 through TP-15) were excavated to depths of between 2 and 6 feet using a Cat 416B backhoe. Three (3) test pits, TP-10, TP-13 and TP-14, were excavated along the approximate centerline axis of the pond and three (3) test pits, TP-11, TP-12 and TP-15, were excavated along the eastern side of the pond. The locations of the test pits are shown on Plate 2.

Fieldwork was performed in general accordance with selected ASTM field exploration and sampling standards. The test pit logs and a discussion of the equipment and procedures used during field investigation are presented in Appendix A.

The test pits typically encountered a thin soil profile between 0 and 2 feet thick, overlying about 2 feet of severely to moderately severely weathered metashales and metasedimanetary over moderately weathered deposits. The soil profile typically comprised clayey/silty gravels with sand.

Test pits were terminated due to hard digging within hard, moderately weathered metashales and metasedimentary deposits at depths of between 2 and 6 feet. The exception was test pit TP-14, which was terminated within a soft silt layer at a depth of 3 feet due to the presence of seepage and the development of standing water at the base of the pit, leading to sloughing and collapse of the sides of the test pit.

No test pits were performed on the west side of the pond due to the steepness of the slopes and limited access. Inspection of surface materials exposed above the water line on the western slopes identified outcrops of metashales and shallow weathered rock conditions, similar to those identified in the test pits.

The soil conditions described above are generalized; therefore, the reader is advised to consult the logs of the exploratory test pits, Plates A-1 through A-6 in Appendix A, if the logged soil conditions at a specific location are desired. On the test pit logs, the soil type, color, moisture, consistency, and Unified Soil Classification symbol are indicated.

Four (4) borings were previous undertaken along the dam separating Pond No. 2 from Pond No. 3. These borings were completed in May 2002. The locations of the borings are shown on Plate 2 and boring logs are presented in Appendix A.

Groundwater

Water was only encountered in one test pit, TP-14, where seepage was encountered at a depth of about 2 feet. The seepage appears to be related to water perching above the shallow bedrock. The source of seepage is not certain. Test pit TP-14 was located slightly upslope from the area of standing water within Pond No. 3 (Plate 2), but seepage was entering the test pit from the upper northern portion, i.e. the end furthest away from the body of standing water. Therefore, seepage does not appear to be related to the standing water. Seepage could be related to the water inflow into the pond at the northeastern corner, where a pipe was observed to be discharging water into the pond at this location. Alternatively, the perched water could be related to seepage from Pond No. 2, upslope of TP-14. Indeed, the borings undertaken in 2002 along the dam crest between Pond No.2 and No. 3 did encounter groundwater within the dam fill at an elevation of between 2,109 feet and 2,114 feet. However, Pond No. 2 has a gunite lining that should prevent excessive leakage, but the lining was applied in 1978/79 and defects could be present leading to leakage from Pond No. 2 towards test pit TP-14.

Test pit TP-15 was excavated in the northeasten corner of the pond where historically seepages had been observed. However, no seepage was encountered during excavation of the test pit, even though there had been heavy rainfall the day before.

It should be noted that groundwater observations were made at the time and under the conditions stated. Perched and hydrostatic groundwater levels can fluctuate by season and with variations in precipitation, irrigation, groundwater withdrawal or injection, and other factors.

Laboratory Testing

Gradation and Atterberg limits tests were performed on selected samples obtained during field exploration. The tests confirmed that the soils on site are generally granular in nature comprising clayey and silty gravel with sand. The test types, procedures used, and test results are presented in Appendix B.

CONCLUSIONS AND RECOMMENDATIONS

Based on our initial desk study review and observations at the site, no significant geologic hazards were identified in the area of Pond No. 3. Seepage was only encountered at test pit TP-14. No other evidence of seepage and/or natural springs were observed within the pond areas inspected at the time of our investigation. The proposal to line the existing pond bottom is feasible from a geotechnical standpoint provided that the recommendations presented in this report are incorporated into the project design and specifications.

Site Preparation and Grading

Site Preparation

Grading preparation should include removal of all vegetation, surface cobbles/boulders, debris, near surface organics and old tree stumps. Any holes resulting from the removal of trees, organic surface soils, and/or obstructions extending above the current base profile of the pond should be cleared and backfilled with approved on-site and/or imported material compacted to the requirements of the section on "Fill Placement and Compaction". Holes resulting from the removal of tree root systems may penetrate to depths of 4 feet and extend laterally to the drip line of each tree.

We recommend that all backfilling operations for any excavation to remove deleterious material be carried out under the observation of the geotechnical engineer.

Subgrade Preparation and Potential pond Liners

Following grading work to prepare the pond bottom for liner materials, soil subgrades in areas to receive engineered fill should be firm and unyielding such that construction equipment is able to traffic the area without undue pumping and yielding of the subgrade soils. Locally weak soils, if encountered, should be excavated and replaced or otherwise stabilized as recommended by the geotechnical engineer at the time of construction.

Shallow bedrock exists at the site and grading work will likely expose rock in certain areas of the pond. Such areas may require additional preparation to remove prominent high spots.

Engineered Fill Materials

If a synthetic geotextile material is to be used to line the pond, a soil bedding layer should be placed across the surface of the pond area to smooth out irregularities and eliminate point pressures from underlying angular materials. Bedding soil should essentially comprise a fine gravel/coarse sand. As such, import material should be graded such that 100 percent passes the 1/2-inch sieve, more than 50 percent passes the No. 4 sieve, and less than 25 percent passes the No. 200 sieve. Imported soil should have a Plasticity Index (P.I.) of less than 12, and an Expansion Index (E.I.) of less than 20.

Existing surface soils at the site typically consist of gravelly lean clay/clayey gravel with varying quantities of sand. The gravel fragments are typically angular to sub-angular and comprise locally derived metashales and metasedimentary deposits. These materials are in various states of weathering and will be prone to mechincal breakdown during construction. That is, rock fragments will get broken down to smaller particle size as the material is worked and tracked over by construction equipment. The engineer on site should be aware of this material characteristic, as it may prove relevant if grading and compaction specifications are to be met for on site materials.

Based on the ability of the native materials to be readily broken down to smaller particles sizes under mechanical action, it is likely that materials could be processed on site, by crushing and screening, to provide suitable material for the soil bedding layer. This could provide a cost saving to the project and would reduce the amount of construction traffic required to complete the project and therefore provides environmental and operational benefits to the WWTP.

Fill Placement and Compaction

Fill to areas of excavation to remove organics, obstructions and the like should be placed in horizontal lifts not exceeding 8 inches in compacted thickness. Each lift should be compacted to a minimum of 90 percent relative compaction as determined by ASTM Designation D1557.

The moisture content of the onsite soils should be moisture conditioned slightly above the optimum moisture content at the time of compaction. In order to achieve satisfactory compaction of the fill materials, it may be necessary to adjust the water content at the time of construction. This may require that water be added to soils that are too dry, or that aeration be performed in any soils that are too wet. Given the setting of the site, it is likely that the moisture content of the soils will be above optimum and will need drying.

Fills greater than 5 feet in height, constructed on slopes with a gradient steeper than 6:1 (horizontal to vertical), must be provided with a base key cut into firm soil. The base key should be constructed at the toe of the fill, extend below the existing surface a minimum of 2 feet into firm soil or rock and should be a minimum of 8 feet wide. As fill is placed on the slope, benching should be provided at intervals frequent enough to remove any loose surface soil (approximately 2 to 4 feet horizontally into the slope for every 1 foot vertical).

The project geotechnical engineer should be present during all site clearing and grading operations to test and observe earthwork construction. The foregoing recommendations within this report are predicated upon our continued involvement in this project.

Construction Quality Assurance

Based on our experience of similar projects, testing and observation of soils during the preparation of the liner subgrade is key to the successful installation of a liner. This would include, but not be limited to, visual classification and observation of processed onsite soils (such as potential bedding soil) and/or import materials, laboratory testing, determination of unsuitable materials requiring over-excavation and compaction testing on fill to areas of over excavation. As the project geotechnical engineer, Fugro should be retained for such services during construction.

LIMITATIONS

The data, conclusions, and recommendations contained herein are based on site conditions as they existed at the time of our study, and further assume that probes such as exploratory test pits are representative of the subsurface conditions throughout the site; i.e., the subsurface conditions everywhere are not significantly different from those disclosed by the probes.

If, during construction, different subsurface conditions from those encountered during our exploration or assumed in design are observed or appear to be present, or where variations from our design recommendations are made, we must be advised promptly so that we can review these conditions and modify the applicable recommendations, if necessary. We cannot be held responsible for differing site conditions or variations in design or field recommendations not brought to our attention.

Soil conditions cannot be fully determined by test pits and, therefore, unanticipated soil conditions are commonly encountered. Such unexpected soil conditions often require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

A determination of flooding potential or the existence of wetlands was beyond the scope of this report.

This geotechnical study did not include an investigation regarding the existence, location, or type of possible hazardous materials. If an investigation is necessary, we should be advised. In addition, if any hazardous materials are encountered during construction of the project, the proper regulatory officials should be notified immediately.

Other standards or documents referenced in any given standard cited in this report, or otherwise relied upon by authors of this report, are only mentioned in the given standard; they are not incorporated into it or "included by reference", as that latter term is used relative to contracts or other matters of law.

Our professional services were performed, our findings obtained, and our comments presented in accordance with generally accepted geotechnical engineering principles and practices in the greater Sacramento area. This warranty is in lieu of all other warranties, either expressed or implied.

REFERENCES

Clark, L.D., 1960, Foothills Fault System, Western Sierra Nevada, California: Geological Society of America Bulletin, V.71, p. 483-496.

España Geotechnical Consulting, 2002, Geotechnical Report for the Interim Disinfection Facility, Colfax Wastewater Treatment Plant, Colfax, California.

Jennings, C.W., 1994, Preliminary Fault Activity Map of California, California Division of Mines and Geology, Scale 1:750,000.

PG&E, 1994a, Characterization of Potential Earthquake Sources for the Ralston Afterbay Dam.

PG&E, 1994b, Characterization of Potential Earthquake Sources for the Rock Creek (Drum) Dam.

PG&E, 1998, Late Cenozoic Faulting within the Northern and Central Sierra Nevada: Unpublished Report to be Submitted to the California Division of Safety of Dams, Sacramento, California.

PG&E, 2003, Regional Geology, Seismicity, and General Ground Motion Considerations for the Drum/Spaulding Hydroelectric System.

PG&E and Geomatrix Consultants, 2003, Geology, Seismicity, and Potential Ground Motions for Halsey Forebay Dam.

PLATES

SOURCE: This Vicinity Map was based on Google Earth Aerial Maps.

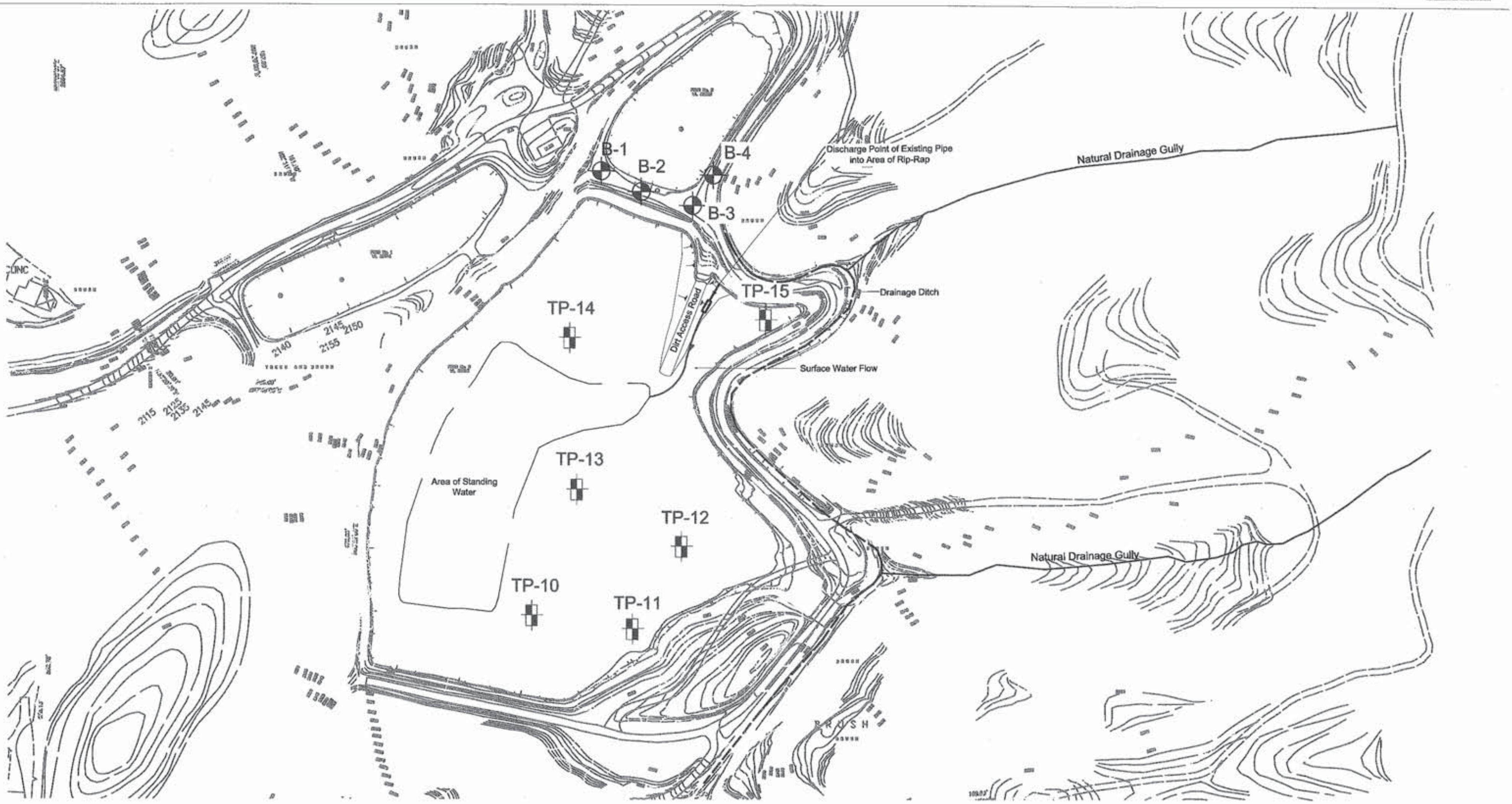
NORTH

0 1000 2000
FEET

G:\Jobdocs\3161\3161.008\Drawings\Vicinity_Map.dwg 1-08-08 03:35:08 PM gvishnan

VICINITY MAP
Colfax WWTP Upgrade Project
Colfax, California

January 2008
Project No. 3161.008



LEGEND

B-1 Approximate Boring Locations completed in June 2002

TP-2 Approximate Test Pit Locations completed in October 2007

SITE MAP AND TEST PIT LOCATION PLAN
Colfax WWTP Upgrade Project
Colfax, California

NORTH
0 150 300
FEET

PLATE 2

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APPENDIX A
FIELD EXPLORATION

APPENDIX A
FIELD EXPLORATION

The field exploration consisted of a surface reconnaissance and a subsurface investigation program. The investigation was conducted on October 11, 2007 with a Cat 416B rubber tyred backhoe using a 30-inch bucket. Six (6) exploratory test pits, designated TP-10 through TP-15, were excavated to depths of 3 to 6 feet below the existing grade. The approximate locations of the exploratory test pits are shown on the Site Map - Plate 2. The soils are described in accordance with the Unified Soil Classification System (ASTM D-2487.) Upon completion of our field explorations, the test pits were backfilled with soil cuttings. The logs of the test pits (Plate A-1 through A-6), as well as a Test Pit Legend of the soil (Plate A-7) and a Rock Classification System (Plate A-8), are included as part of this Appendix.

In the field, our representative visually examined the samples and continuously logged the soils and rock encountered in the test pits.

TEST PIT LOGS FROM CURRENT INVESTIGATION

Surface Elevation: ---	**Date Excavated:** 10/11/07
Excavation Method: Backhoe - Cat 416B	**Logged By:** Duston Marlow
Excavation Contractor: City of Colfax	**Checked By:** Gopalan Vishnan
Bucket Size: 2.5 Feet	**Depth to Groundwater:** Not Encountered

Material Description and Classification	Depth (feet) Elevation	Soil Type	Sample Type	Dry Density (pcf)	Moisture Content (%)	Unc. Comp. (Strength ksf)	Pocket Pen. (ksf)	Torvane (ksf)	Remarks and Other Lab Tests
CLAYEY GRAVEL with Sand (GC), orange - brown, moist, fine to coarse, very severely to severely weathered rock fragments, metasedimentary shale/siltstone.	0.0								LL=39, PI=16 Sieve analysis -#200=24%
SILTY GRAVEL with Sand (GM), reddish gray to gray, very moist, very severely to severely weathered rock fragments, metasedimentary shale/siltstone.	2.5								LL=29, PI=4 Sieve analysis -#200=23%
META-SHALE, gray, moderately severely to moderately weathered, weak, very closely bedded, soft to low hardness.	5.0								Hard digging at 4.0 feet No seepage observed
	7.5								

Excavation Terminated At 6.0 ft BGS

LOG OF TEST PIT TP-10

Colfax WWTP Expansion Project

Colfax, California

FUGRO

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Project No. 3161.008

Plate A-1

Surface Elevation: ---	**Date Excavated:** 10/11/07
Excavation Method: Backhoe - Cat 416B	**Logged By:** Duston Marlow
Excavation Contractor: City of Colfax	**Checked By:** Gopalan Vishnan
Bucket Size: 2.5 Feet	**Depth to Groundwater:** Not Encountered

Material Description and Classification	Depth (feet) Elevation	Soil Type	Sample Type	Dry Density (pcf)	Moisture Content (%)	Unc. Comp. (Strength ksf)	Pocket Pen. (ksf)	Torvane (ksf)	Remarks and Other Lab Tests
GRAVEL with Silt and Sand (GP-GM), gray, moist, fine to coarse, severely to moderately severely weathered rock fragments, metasedimentary shale/siltstone.	0.0								Sieve analysis -#200=7%
META-SHALE, orange and gray, moderately severely to moderately weathered, weak to moderately strong, very closely bedded, low to moderate hardness.	2.5								Hard digging at 1.5 feet No seepage observed
	5.0								
	7.5								

Excavation Terminated At 4.0 ft BGS

LOG OF TEST PIT TP-11

Colfax WWTP Expansion Project

Colfax, California

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Project No. 3161.008

Plate A-2

Surface Elevation: ---	**Date Excavated:** 10/11/07
Excavation Method: Backhoe - Cat 416B	**Logged By:** Duston Marlow
Excavation Contractor: City of Colfax	**Checked By:** Gopalan Vishnan
Bucket Size: 2.5 Feet	**Depth to Groundwater:** Not Encountered

Material Description and Classification	Depth (feet) Elevation	Soil Type	Sample Type	Dry Density (pcf)	Moisture Content (%)	Unc. Comp. (Strength ksf)	Pocket Pen. (ksf)	Torvane (ksf)	Remarks and Other Lab Tests
GRAVELLY LEAN CLAY (CL), orange, moist, fine to coarse, very severely to severely weathered rock fragments, metasedimentary shale/siltstone.	0.0								
LEAN CLAY with Gravel (CL), reddish brown, moist, fine to coarse, very severely to severely weathered rock fragments, metasedimentary shale/siltstone.									LL=28, PI=8
CLAYEY GRAVEL (GC), META-SHALE, orange and gray, moderately severely to moderately weathered, weak to moderately strong, very closely bedded, low to moderate hardness.	2.5								Hard digging at 2.0 feet No seepage observed
	5.0								
	7.5								

Excavation Terminated At 4.0 ft BGS

LOG OF TEST PIT TP-12

Colfax WWTP Expansion Project

Colfax, California

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Project No. 3161.008

Plate A-3

Surface Elevation: ---	**Date Excavated:** 10/11/07
Excavation Method: Backhoe - Cat 416B	**Logged By:** Duston Marlow
Excavation Contractor: City of Colfax	**Checked By:** Gopalan Vishnan
Bucket Size: 2.5 Feet	**Depth to Groundwater:** Not Encountered

Material Description and Classification	Depth (feet) Elevation	Soil Type	Sample Type	Dry Density (pcf)	Moisture Content (%)	Unc. Comp. (Strength ksf)	Pocket Pen. (ksf)	Torvane (ksf)	Remarks and Other Lab Tests
META-SHALE, orange and gray, moderately weathered, weak to moderately strong, very closely bedded, low to moderate hardness.	0.0								moderately hard digging, becoming hard digging with depth No seepage observed
	2.5								
	5.0								
	7.5								

Excavation Terminated At 3.0 ft BGS

LOG OF TEST PIT TP-13

Colfax WWTP Expansion Project

Colfax, California

FUGRO

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Telephone: (916) 773-2600 Fax: (916) 782-4846

Project No. 3161.008

Plate A-4

Surface Elevation: ---	**Date Excavated:** 10/11/07
Excavation Method: Backhoe - Cat 416B	**Logged By:** Duston Marlow
Excavation Contractor: City of Colfax	**Checked By:** Gopalan Vishnan
Bucket Size: 2.5 Feet	**Depth to Groundwater:** Not Encountered

Material Description and Classification	Depth (feet)	Elevation	Soil Type	Sample Type	Dry Density (pcf)	Moisture Content (%)	Unc. Comp. (Strength ksf)	Pocket Pen. (ksf)	Torvane (ksf)	Remarks and Other Lab Tests
CLAYEY GRAVEL with Sand (GC), brown and gray, moist, fine to coarse, very severely to severely weathered rock fragments, metasedimentary shale/siltstone. Gravel seem, 3 to 4 inches thick, at a depth of about 1 feet (Fill).	0.0									LL=31, PI=9 Sieve analysis -#200=16%
SILT (ML), soft, dark brown, wet, seepage running in pit on top of silt.	2.5									LL=30, PI=5
Seepage at upslope face of test pit at a depth of about 2 feet. Seepage causing collapse of test pit side walls and therefore excavation terminated at a depth of 3 feet.	5.0 7.5									

Excavation Terminated At 3.0 ft BGS

LOG OF TEST PIT TP-14

Colfax WWTP Expansion Project

Colfax, California

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Project No. 3161.008

Plate A-5

Surface Elevation: ---	**Date Excavated:** 10/11/07
Excavation Method: Backhoe - Cat 416B	**Logged By:** Duston Marlow
Excavation Contractor: City of Colfax	**Checked By:** Gopalan Vishnan
Bucket Size: 2.5 Feet	**Depth to Groundwater:** Not Encountered

Material Description and Classification	Depth (feet)	Elevation	Soil Type	Sample Type	Dry Density (pcf)	Moisture Content (%)	Unc. Comp. (Strength ksf)	Pocket Pen. (ksf)	Torvane (ksf)	Remarks and Other Lab Tests
LEAN CLAY (CL), topsoil, reddish brown, moist, with roots.	0.0									
CLAYEY GRAVEL with Sand (GP), reddish brown, moist, fine to coarse, severely to moderately severely weathered rock fragments, metasedimentary shale/siltstone.										
META-SHALE, orange and gray, moderately severely to moderately weathered, weak to moderately strong, very closely bedded, low to moderate hardness.	2.5									Hard digging at 2.0 feet No seepage observed
	5.0									
	7.5									

Excavation Terminated At 4.0 ft BGS

LOG OF TEST PIT TP-15

Colfax WWTP Expansion Project

Colfax, California

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Project No. 3161.008

Plate A-6

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions		grf	ltr	Description	Major Divisions		grf	ltr	Description
Coarse Grained Soils	Gravel And Gravelly Soils		GW	Well-graded gravels or gravel sand mixtures, little or no fines	Fine Grained Soils	Silts And Clays LL < 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
			GP	Poorly-graded gravels or gravel sand mixture, little or no fines				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			GM	Silty gravels, gravel-sand-silt mixtures				OL	Organic silts or clays of low plasticity
			GC	Clayey gravels, gravel-sand-clay mixtures		Silts And Clays LL > 50		MH	Inorganic silts, micaceous or diatomaceous fine or silty soils, elastic silts
	Sand And Sandy Soils		SW	Well-graded sands or gravelly sands, little or no fines				CH	Inorganic clays of high plasticity, fat clays
			SP	Poorly-graded sands or gravelly sands, little or no fines				OH	Organic silts or clays of medium to high plasticity
			SM	Silty sands, sand-silt mixtures	Highly Organic Soils			PT	Peat and other highly organic soils
			SC	Clayey sands, and-clay mixtures					

GRAIN SIZES

U.S. STANDARD SERIES SIEVE — 200, 40, 10, 4
CLEAR SQUARE SIEVE OPENINGS — 3/4", 3", 12"

Silts and Clays	Sand			Gravel		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

Notes

bgs Below Ground Surface
bbd Below Barge Deck
MDD Maximum Dry Density
OMC Optimum Moisture Content
c cohesion
psf pounds per square foot
pcf pounds per cubic foot
LL Liquid Limit
PI Plasticity Index
-200 Passing the #200 Sieve
CGI Combustible Gas Indicator
VOC Volatile Organic Compound
CO Carbon Monoxide
LEL Lower Explosive Limit
H_2S Hydrogen Sulfide
ppm parts per million

Increasing Visual Moisture Designation
Dry
Moist
Wet

SYMBOL

Grab Sample

TEST PIT LEGEND

Colfax WWTP Expansion Project

Colfax, California

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Project No. 3161.008

Plate A-7

WEATHERING*

FRESH - Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer blows if crystalline.
VERY SLIGHT - Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rings under hammer blows if crystalline.
SLIGHT - Rock generally fresh, joints stained, and discoloration extends into rock up to 1 inch. Joints may contain clay. In granitiod rocks, occasional feldspar crystals are dull & discolored. Crystalline rock rings under hammer blows.
MODERATE - Significant portions of rock show discoloration and weathering effects. In granitiod rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
MODERATELY SEVERE - All rock except quartz discolored or stained. In granitiod rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick. Rock goes "clunk" when struck.
SEVERE - All rock except quartz discolored/stained. Rock "fabric" clear & evident, but reduced in strength to strong soil. In some granitiod rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually remain.
VERY SEVERE - All rock except quartz discolored or stained. Rock "fabric" discernible, but rock mass effectively reduced to "soil" with only fragments of strong rock remaining.
COMPLETE - Rock reduced to "soil." Rock "fabric" not discernible or discernible only in small scattered locations. Quartz may be present as dikes or stringers.

STRENGTH

VERY STRONG - Resists breakage from hammer blows; but will yield dust and small chips.
STRONG - Withstands a few hammer blows; but will yield large fragments.
MODERATELY STRONG - Withstands a few firm hammer blows.
WEAK - Crumbles with light hammer blows.
FRIABLE - Can be broken down with hand and finger pressure.

DISCONTINUITY SPACING

JOINTS	BEDDING, CLEAVAGE, FOLIATION	ENGLISH	METRIC
VERY CLOSE	Very Thin	Less than 2 inches	Less than 5 cm
CLOSE	Thin	2 inches to 1 foot	5 cm to 30 cm
MODERATELY CLOSE	Medium	1 foot to 3 feet	30 cm to 1 m
WIDE	Thick	3 feet to 10 feet	1 m to 3 m
VERY WIDE	Very Thick	Greater than 10 feet	Greater than 3 m

HARDNESS

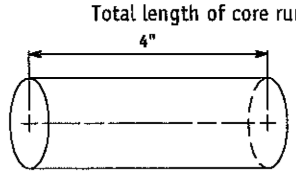
VERY HARD - Cannot be scratched with a knife; metal powder left on sample.
HARD - Scratched with knife with difficulty; trace of metal powder left on samples; scratch faintly visible.
MODERATELY HARD - Readily scratched with knife, scratch leaves heavy trace of dust and is readily visible.
LOW HARDNESS - Gouged or grooved to 1/16 inch by firm pressure on knife; scratches with penny.
SOFT - Gouged or grooved readily with a knife; small thin pieces can be grooved by finger pressure.
VERY SOFT - Carves with knife; scratched by fingernail.

ROUGHNESS OF JOINT OR DISCONTINUITY SURFACES

SMOOTH - Appears smooth and is essentially smooth to the touch. May be slickensided.
SLIGHTLY ROUGH - Asperities on the fracture are clearly visible.
MEDIUM ROUGH - Asperities are clearly visible and fracture surface feels abrasive.
ROUGH - Large angular asperities can be seen. Some ridge and high side angle steps are evident.
VERY ROUGH - Near vertical steps and ridges occur on the fracture surface.

ROCK QUALITY DESIGNATION (RQD)

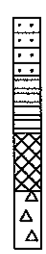
$$RQD\ (\%) = \frac{\text{Sum of length of solid core pieces 4" or greater}}{\text{Total length of core run}} \times 100$$



SYMBOLS

ROCK

Dolomoite
Igneous
Lignite
Limestone



Sandstone
Shale
Metasediments, Metamorphics, Metavolcanics
Volcanics

SAMPLER

Rock Core Bit

* After GSA Engineering Geology Division Data Sheet 1, 1980.

ROCK CLASSIFICATION SYSTEM

Colfax WWTP Expansion Project

Colfax, California

FUGRO

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Project No. 3161.008

Plate A-8

BOREHOLES LOGS FROM PREVIOUS INVESTIGATION

LOG OF BORING

Boring No. B-1

ESPAÑA Geotechnical Consulting

Project: COLFAX WASTEWATER TREATMENT PLANT **Project No.:** N161

Elevation: 2126 **Date Drilled:** 05/09/02

Drilling Method: CME-750, 8" DIA. HOLLOW STEM AUGERS **Logged By:** APW

Elevation/ Depth	Soil Symbols Sampler Symbols and Field Test Data	USCS	MATERIAL DESCRIPTION	REMARKS	Sample Number	Density p.c.f.	Moisture %
0		ML	Orange-brown, moist, stiff to very stiff, Clayey SILT; with abundant deeply weathered rock fragments from 1/4" to 1" in diameter (FILL)				
2124	5 8 12				BULK 1		
4					B-1-1	107.1	17.1
	5 10 14						
2120					B-1-2	101.2	20.3
8	4 8 9	GM	Orange-brown, wet, loose/medium dense, Silty GRAVEL (rock fragments)with clay (FILL)		B-1-3		
2116	7 7 10				B-1-4		
12							
2112	7 19 35	ROCK	Gray, red, black and orange-tan, laminated metasedimentary SILTSTONE; with vertical fractures, deeply weathered.		B-1-6		
16					B-1-5		
			Bottom of boring at 16.5 feet.				
2108							
20							
2104							
24							
2100							
28							

Notes: *Borings tremmie grouted with cement grout upon completion of the holes. Groundwater encountered 12 feet below top of boring.*

Figure I-1

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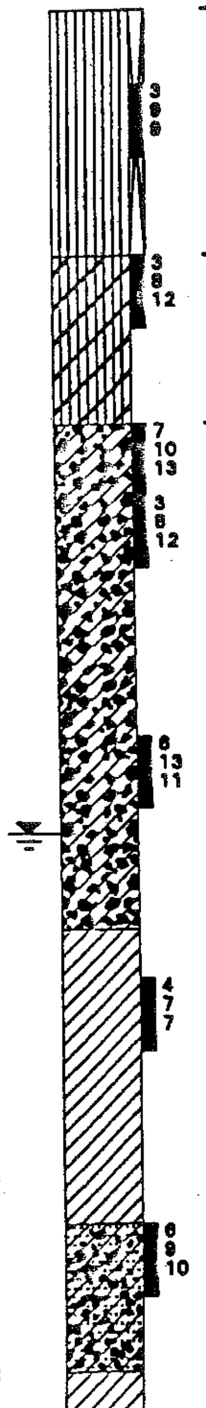
LOG OF BORING

Boring No. B-2

ESPAÑA Geotechnical Consulting

Project: COLFAX WASTEWATER TREATMENT PLANT
Project No.: N161
Elevation: 2126
Date Drilled: 05/09/02 to 05/10/02
Drilling Method: CME-750, 8" HSA/4" ROTARY WASH
Logged By: APW



Elevation/ Depth	Soil Symbols Sampler Symbols and Field Test Data	USCS	MATERIAL DESCRIPTION	REMARKS	Sample Number	Density p.c.f.	Moisture %
0 – 5 (2124)	3 9 9	ML	Brown-orange-tan, moist, stiff Clayey SILT; with abundant weathered Siltstone rock fragments, 1/4" to 1/2" diameter.		B-2-1 BULK 2	102.2	21.3
5 – 8.5 (2120)	3 8 12	CL-ML	Brown-orange, moist, stiff, rocky SILT and CLAY (rock fragments 1/2" to 1" diameter)		B-2-2	104.2	21.8
8.5 – 19 (2116, 12, 2112, 16, 2108)	7 10 13; 3 8 12; 6 13 11	GW-GC	Tan-gray, orange and rust, medium dense, Clayey GRAVEL, (deeply weathered metasedimentary Slate) (FILL)		B-2-3	104.7	20.6
					B-2-4		
					B-2-6	113.2	14.0
					B-2-5		
19 – 25 (20, 2104, 24)	4 7 7	CL	Red-brown, moist, stiff, Silty CLAY; with weathered, fractured rock fragments.		B-2-7	95.0	22.9
25 – 28 (2100)	6 9 10	GP-GC	Orange-tan, and dark gray and rust, very moist, dense, Clayey GRAVEL (rock fragments)		B-2-8		
28			Orange-brown, moist, stiff, Gravelly				

Notes: *Boring was tremmie grouted with cement grout upon completion of the hole. Groundwater was encountered 17 feet from the top of the boring.*

Figure I-2

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LOG OF BORING

Boring No. B-2

ESPAÑA Geotechnical Consulting

Elevation/ Depth	Soil Symbols Sampler Symbols and Field Test Data	USCS	MATERIAL DESCRIPTION	REMARKS	Sample Number	Density p.c.f.	Moisture %
			CLAY, with Silt				
2096	6 10 11	CL			B-2-9	101.2	23.3
32							
2092			Dark brown, moist, very stiff, Clayey SILT; with fine rock fragments				
	8 12 16	ML			B-2-10	105.2	20.4
36							
2088							
40	50/ 3"	ROCK	Bedrock: fractured black-blue/gray, SLATE; with clay in seams.		B-2-11		
			Bottom of boring at 40.25 feet.				
2084							
44							
2080							
48							
2076							
52							
2072							
56							
2068							
60							
2064							

Figure I-2

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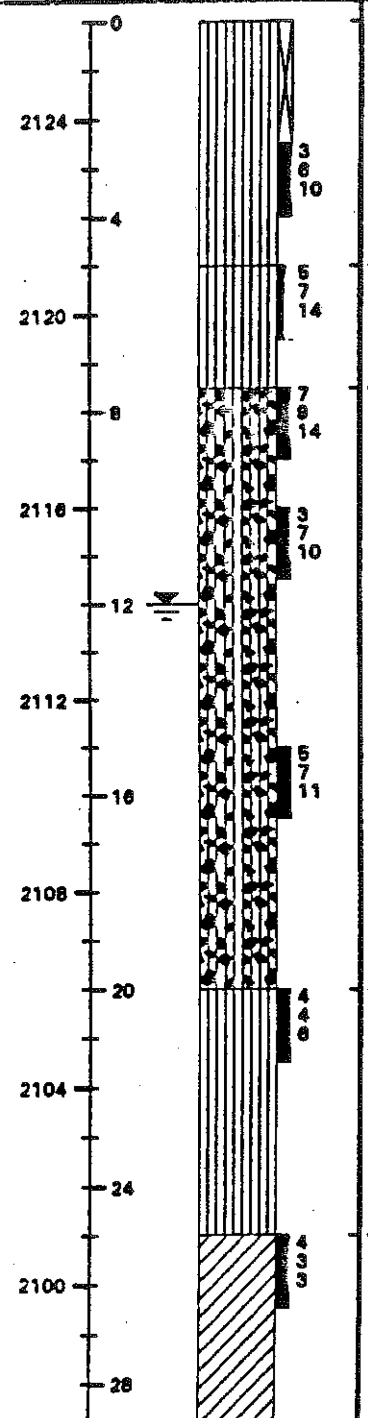
LOG OF BORING

Boring No. B-3

ESPAÑA Geotechnical Consulting

Project: COLFAX WASTEWATER TREATMENT PLANT
Project No.: N161
Elevation: 2126
Date Drilled: 05/09/02
Drilling Method: CME-750, 8" HSA/4" ROTARY WASH
Logged By: APW

Elevation/ Depth	Soil Symbols Sampler Symbols and Field Test Data	USCS	MATERIAL DESCRIPTION	REMARKS	Sample Number	Density p.c.f.	Moisture %
		ML	Orange-brown, moist, stiff Clayey SILT; with some small rock fragments.		BULK 3		
	3 6 10				B-3-1	99.5	22.1
	5 7 14	ML	Orange-brown with gray-red, moist, stiff SILT with Clay		B-3-2	107.2	18.2
	7 9 14	GM	Orange-brown, wet, dense, Silty GRAVEL (rock fragments)		B-3-3	103.7	22.9
	3 7 10				B-3-4	111.4	14.8
	5 7 11				B-3-5		
	4 4 6	ML	Dark reddish brown, medium stiff SILT; with rock fragments throughtout matrix.		B-3-6		
	4 3 3	CL	Dark brown, wet, soft/medium stiff, Silty CLAY; with organics (roots)		B-3-8	107.8	22.9
					B-3-7	85.9	24.6



Notes: *The boring was tremmie grouted with cement grout upon completion of the hole. Groundwater was encountered 12 feet below the top of the boring.*

Figure I-3

502 Giuseppe Court, Suite 11, Roseville, CA 95678

LOG OF BORING

Boring No. B-4

ESPAÑA Geotechnical Consulting

Project: COLFAX WASTEWATER TREATMENT PLANT
Elevation: 2124
Drilling Method: CME-750, 8" HSA/4" ROTARY WASH

Project No.: N161
Date Drilled: 05/09/02
Logged By: APW

Elevation/ Depth	Soil Symbols Sampler Symbols and Field Test Data	USCS	MATERIAL DESCRIPTION	REMARKS	Sample Number	Density p.c.f.	Moisture %
2124 — 0		ML	Orange-tan, moist, very stiff, Sandy SILT; with rock fragments				
	11 14 9		Orange-brown, moist, medium stiff, Clayey SILT; with rock fragments		B-4-1	107.2	19.1
2120 — 4							
	4 6 7				B-4-2	99.6	18.2
2116 — 8	3 4 5	ML	Medium orange/tan with red-brown staining, moist, stiff, rocky SILT with rock fragements.		B-4-3	96.2	23.9
	6 8 11				B-4-4	99.6	20.0
2112 — 12		CL	Orange-tan, moist, soft, Clayey SILT				
	14 22 50/5"	ROCK	Dark tan-brown and gray, wet, angular, deeply weathered SLATE/ SILTSTONE		B-4-5		
2108 — 16			Bottom of boring at 16.4 feet.				
2104 — 20							
2100 — 24							
2096 — 28							

Notes: *Boring backfilled with cuttings upon completion of the hole. Groundwater was not encountered in the boring.*

Figure I-4

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APPENDIX B
LABORATORY TESTING PROGRAM

APPENDIX B
LABORATORY TESTING PROGRAM

Atterberg limit tests and gradations were performed on selected disturbed samples taken from the test pits completed in October 2007. Atterberg limit tests were performed on five (5) samples in accordance with ASTM Test Designations D-428 and D-424. The values were used to classify soil type in accordance with the Unified Soil Classification System and to indicate the soil's compressibility and expansion potentials. The result of the tests are presented summarized on Plate B-1 and shown graphically on Plate B-2. Values are also indicated on the test pit logs at the appropriate sample depth.

Gradation tests were performed on four (4) samples of subsurface soil in accordance with Caltrans Test Method No. 202. These tests were performed to assist in the classification of the soils and to determine grain size distribution. The results of these tests are presented on Plate B-3.

Boring	Depth (feet)	Liquid Limit	Plasticity Index	Maximum Size	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Phi, degrees	Apparent Cohesion (psf)	Unconfined Compressive Strength (psf)
TP-10	1.0	39	16	1.5 in	24	GC					
TP-10	3.0	29	4	3/4 in	23	GM					
TP-11	1.0			3 in	7						
TP-12	1.0	28	8								
TP-14	1.0	31	9	3 in	16	GC					
TP-14	3.0	30	5								

FUGRO LAB SUMMARY 3161.008.GPJ ESPANA GEOTECH.GDT 1/8/08

SUMMARY OF LABORATORY RESULTS

Colfax WWTP Expansion Project

Colfax, California

FUGRO

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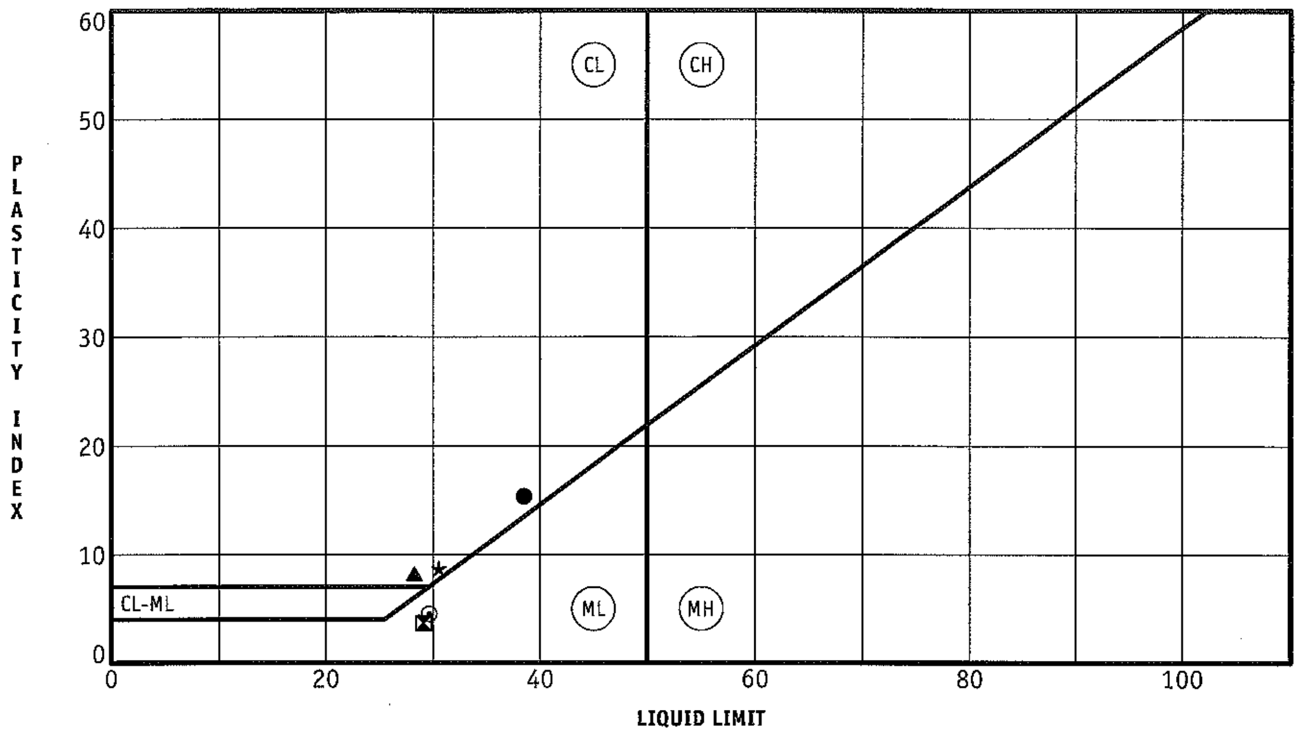
Project No. 3161.008



Sym	Specimen Identification Sample	Depth (ft)	LL	PL	PI	Fines	Classification
●	TP-10	1.0	39	23	16	24	CLAYEY GRAVEL with SAND(GC)
⊠	TP-10	3.0	29	25	4	23	SILTY GRAVEL with SAND(GM)
▲	TP-12	1.0	28	20	8		LEAN CLAY with Gravel (CL)
★	TP-14	1.0	31	22	9	16	CLAYEY GRAVEL with SAND(GC)
⊙	TP-14	3.0	30	25	5		SILT (ML)

ATTERBERG LIMITS 3161.008.GPJ ESPANA GEOTECH.GDT 1/8/08

ATTERBERG LIMITS RESULTS

Colfax WWTP Expansion Project

Colfax, California

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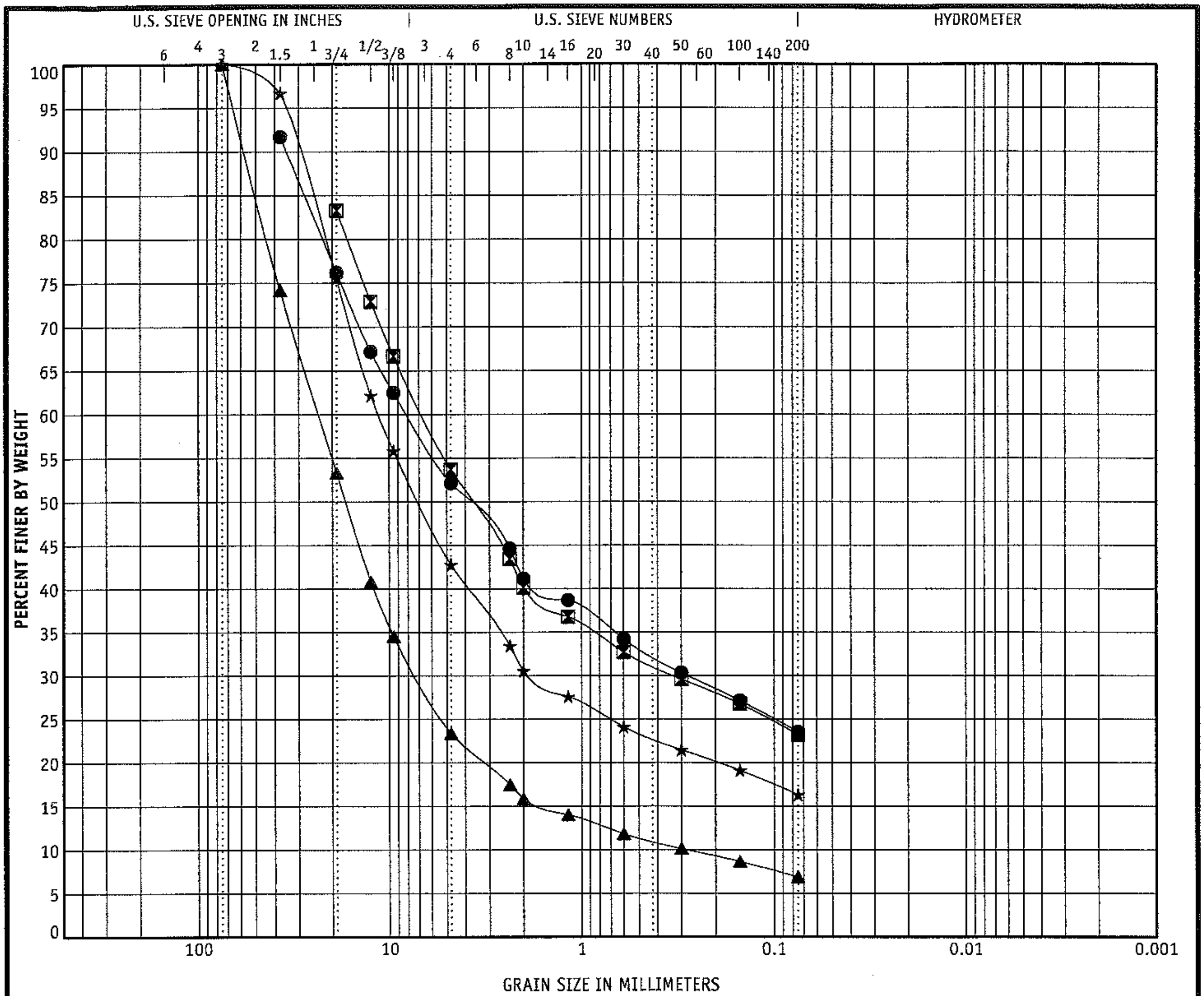
Plate B-2



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sym	Specimen Identification Boring	Depth (ft)	Classification	LL	PL	PI	C_c	C_u
●	TP-10	1.0	CLAYEY GRAVEL with SAND(GC)	39	23	16		
⊠	TP-10	3.0	SILTY GRAVEL with SAND(GM)	29	25	4		
▲	TP-11	1.0	POORLY GRADED GRAVEL with Silt and Sand (GP-GM)				7.63	82.81
★	TP-14	1.0	CLAYEY GRAVEL with SAND(GC)	31	22	9		

Sym	Specimen Identification		D_{100},mm	D_{60},mm	D_{30},mm	D_{10},mm	%Gravel	%Sand	%Silt / %Clay
●	TP-10	1.0	37.5	8.045	0.281		39.6	28.6	23.5
⊠	TP-10	3.0	19	6.653	0.331		29.6	30.5	23.2
▲	TP-11	1.0	75	23.643	7.176	0.286	76.6	16.5	6.9
★	TP-14	1.0	75	11.379	1.818		57.2	26.5	16.3

GRAIN SIZE 3161.008.GPJ ESPANA GEOTECH.GDT 1/8/08

GRAIN SIZE DISTRIBUTION

Colfax WWTP Expansion Project

Colfax, California

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Plate B-3

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GRI White Paper #6

- on -

Geomembrane Lifetime Prediction:
Unexposed and Exposed Conditions

by

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Geomembrane Lifetime Prediction: Unexposed and Exposed Conditions

1.0 Introduction

Without any hesitation the most frequently asked question we have had over the past thirty years' is "how long will a particular geomembrane last".* The two-part answer to the question, largely depends on whether the geomembrane is covered in a timely manner or left exposed to the site-specific environment. Before starting, however, recognize that the answer to either covered or exposed geomembrane lifetime prediction is neither easy, nor quick, to obtain. Further complicating the answer is the fact that all geomembranes are formulated materials consisting of (at the minimum), (i) the resin from which the name derives, (ii) carbon black or colorants, (iii) short-term processing stabilizers, and (iv) long-term antioxidants. If the formulation changes (particularly the additives), the predicted lifetime will also change. See Table 1 for the most common types of geomembranes and their approximate formulations.

Table 1 - Types of commonly used geomembranes and their approximate formulations (based on weight percentage)

Type	Resin	Plasticizer	Fillers	Carbon Black	Additives
HDPE	95-98	0	0	2-3	0.25-1
LLDPE	94-96	0	0	2-3	0.25-3
fPP	85-98	0	0-13	2-4	0.25-2
PVC	50-70	25-35	0-10	2-5	2-5
CSPE	40-60	0	40-50	5-10	5-15
EPDM	25-30	0	20-40	20-40	1-5

HDPE = high density polyethylene
LLDPE = linear low density polyethylene
fPP = flexible polypropylene
PVC = polyvinyl chloride (plasticized)
CSPE = chlorsulfonated polyethylene
EPDM = ethylene propylene diene terpolymer

* More recently, the same question has arisen but focused on geotextiles, geogrids, geopipe, turf reinforcement mats, fibers of GCLs, etc. This White Paper, however, is focused completely on geomembranes due to the tremendous time and expense of providing such information for all types of geosynthetics.

The possible variations being obvious, one must also address the degradation mechanisms which might occur. They are as follows accompanied by some generalized commentary.

- Ultraviolet Light - This occurs only when the geosynthetic is exposed; it will be the focus of the second part of this communication.
- Oxidation - This occurs in all polymers and is the major mechanism in polyolefins (polyethylene and polypropylene) under all conditions.
- Ozone - This occurs in all polymers that are exposed to the environment. The site-specific environment is critical in this regard.
- Hydrolysis - This is the primary mechanism in polyesters and polyamides.
- Chemical - Can occur in all polymers and can vary from water (least aggressive) to organic solvents (most aggressive).
- Radioactivity - This is not a factor unless the geomembrane is exposed to radioactive materials of sufficiently high intensity to cause chain scission, e.g., high level radioactive waste materials.
- Biological - This is generally not a factor unless biologically sensitive additives (such as low molecular weight plasticizers) are included in the formulation.
- Stress State – This is a complicating factor which is site-specific and should be appropriately modeled in the incubation process but, for long-term testing, is very difficult and expensive to acheive.
- Temperature - Clearly, the higher the temperature the more rapid the degradation of all of the above mechanisms; temperature is critical to lifetime and furthermore is the key to

time-temperature-superposition which is the basis of the laboratory incubation methods which will be followed.

2.0 Lifetime Prediction: Unexposed Conditions

Lifetime prediction studies at GRI began at Drexel University under U. S. EPA contract from 1991 to 1997 and was continued under GSI consortium funding until ca. 2002. Focus to date has been on HDPE geomembranes placed beneath solid waste landfills due to its common use in this particular challenging application. Incubation of the coupons has been in landfill simulation cells (see Figure 1) maintained at 85, 75, 65 and 55°C. The specific conditions within these cells are oxidation beneath, chemical (water) from above, and the equivalent of 50 m of solid waste mobilizing compressive stress. Results have been forthcoming over the years insofar as three distinct lifetime stages; see Figure 2.

Stage A - Antioxidant Depletion Time

Stage B - Induction Time to the Onset of Degradation

Stage C - Time to Reach 50% Degradation (i.e., the Halflife)

2.1 Stage A - Antioxidant Depletion Time

The dual purposes of antioxidants are to (i) prevent polymer degradation during processing, and (ii) prevent oxidation reactions from taking place during Stage A of service life, respectively. Obviously, there can only be a given amount of antioxidants in any formulation. Once the antioxidants are depleted, additional oxygen diffusing into the geomembrane will begin to attack the polymer chains, leading to subsequent stages as shown in Figure 2. The duration of the antioxidant depletion stage depends on both the type and amount of the various antioxidants, i.e., the precise formulation.

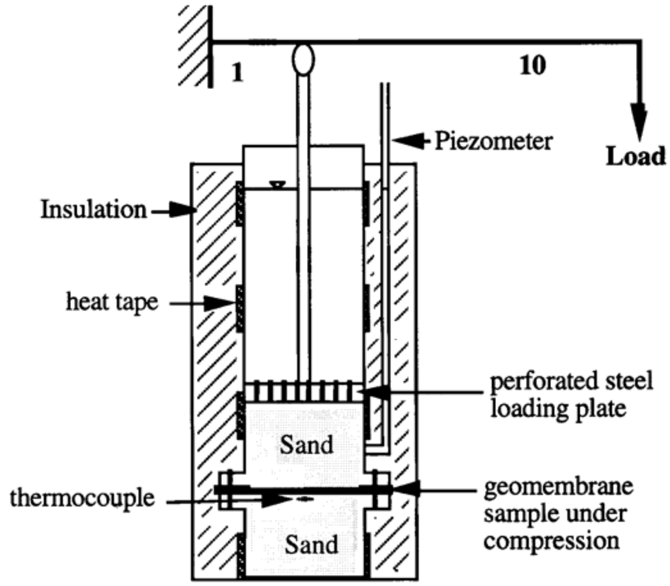


Figure 1. Incubation schematic and photograph of multiple cells maintained at various constant temperatures.

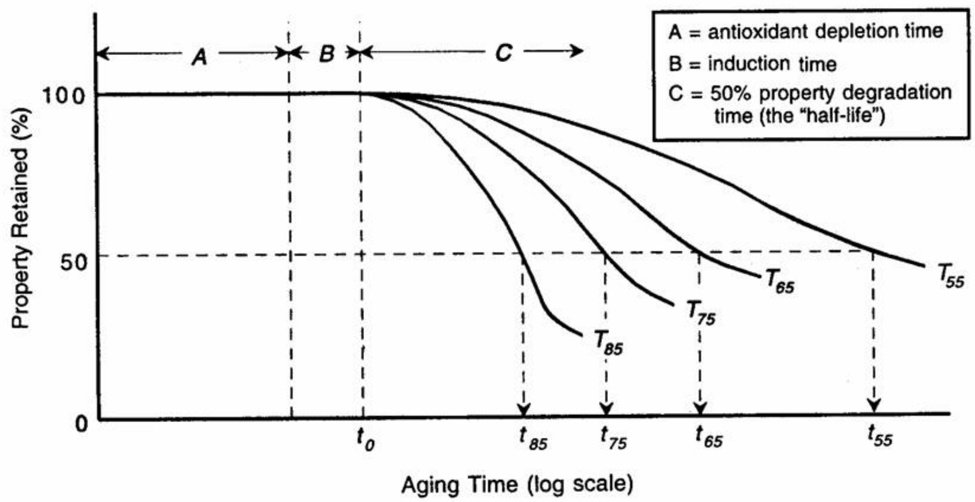


Figure 2. Three individual stages in the aging of most geomembranes.

The depletion of antioxidants is the consequence of two processes: (i) chemical reactions with the oxygen diffusing into the geomembrane, and (ii) physical loss of antioxidants from the geomembrane. The chemical process involves two main functions; the scavenging of free radicals converting them into stable molecules, and the reaction with unstable hydroperoxide (ROOH) forming a more stable substance. Regarding physical loss, the process involves the distribution of antioxidants in the geomembrane and their volatility and extractability to the site-specific environment.

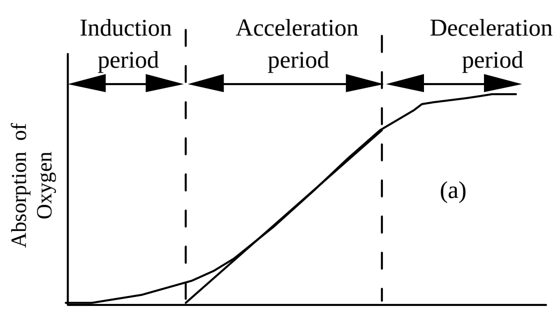
Hence, the rate of depletion of antioxidants is related to the type and amount of antioxidants, the service temperature, and the nature of the site-specific environment. See Hsuan and Koerner (1998) for additional details.

2.2 Stage B - Induction Time to Onset of Degradation

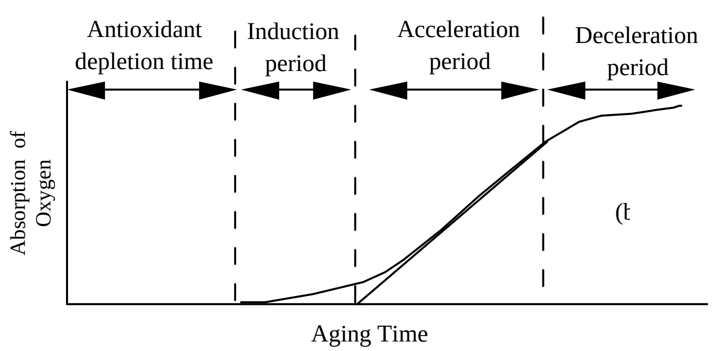
In a pure polyolefin resin, i.e., one without carbon black and antioxidants, oxidation occurs extremely slowly at the beginning, often at an immeasurable rate. Eventually, oxidation occurs more rapidly. The reaction eventually decelerates and once again becomes very slow.

This progression is illustrated by the S-shaped curve of Figure 3(a). The initial portion of the curve (before measurable degradation takes place) is called the induction period (or induction time) of the polymer. In the induction period, the polymer reacts with oxygen forming hydroperoxide (ROOH), as indicated in Equations (1)-(3). However, the amount of ROOH in this stage is very small and the hydroperoxide does not further decompose into other free radicals which inhibits the onset of the acceleration stage.

In a stabilized polymer such as one with antioxidants, the accelerated oxidation stage takes an even longer time to be reached. The antioxidants create an additional depletion time stage prior to the onset of the induction time, as shown in Figure 3(b).



(a) Pure unstabilized polyethylene



(b) Stabilized polyethylene

Figure 3. Curves illustrating various stages of oxidation.

$$RH \rightarrow R\bullet + H\bullet \tag{1}$$

(aided by energy or catalyst residues in the polymer)

$$R\bullet + O2 \rightarrow ROO\bullet \tag{2}$$

$$ROO\bullet + RH \rightarrow ROOH + R\bullet \tag{3}$$

In the above, RH represents the polyethylene polymer chains; and the symbol "•" represents free radicals, which are highly reactive molecules.

2.3 Stage C - Time to Reach 50% Degradation (Halflife)

As oxidation continues, additional ROOH molecules are being formed. Once the concentration of ROOH reaches a critical level, decomposition of ROOH begins, leading to a substantial increase in the amount of free radicals, as indicated in Equations (4) to (6). The additional free radicals rapidly attack other polymer chains, resulting in an accelerated chain reaction, signifying the end of the induction period, Rapopport and Zaikov (1986). This indicates that the concentration of ROOH has a critical control on the duration of the induction period.

$$ROOH \rightarrow RO\bullet\ OH\bullet \text{ (aided by energy)} \tag{4}$$

$$RO\bullet + RH \rightarrow ROH + R\bullet \tag{5}$$

$$OH\bullet + RH \rightarrow H2O + R\bullet \tag{6}$$

A series of oxidation reactions produces a substantial amount of free radical polymer chains (R•), called alkyl radicals, which can proceed to further reactions leading to either cross-linking or chain scission in the polymer. As the degradation of polymer continues, the physical and mechanical properties of the polymer start to change. The most noticeable change in physical properties is the melt index, since it relates to the molecular weight of the polymer. As for mechanical properties, both tensile break stress (strength) and break strain (elongation) decrease.

Ultimately, the degradation becomes so severe that all tensile properties start to change (tear, puncture, burst, etc.) and the engineering performance is jeopardized. This signifies the end of the so-called "service life" of the geomembrane.

Although quite arbitrary, the limit of service life of polymeric materials is often selected as a 50% reduction in a specific design property. This is commonly referred to as the halflife time, or simply the "halflife". It should be noted that even at halflife, the material still exists and can function, albeit at a decreased performance level with a factor-of-safety lower than the initial design value.

2.4 Summary of Lifetime Research-to-Date

Stage A, that of antioxidant depletion for HDPE geomembranes as required in the GRI-GM13 Specification, has been well established by our own research and corroborated by others, e.g., Sangram and Rowe (2004). The GRI data for standard and high pressure Oxidative Induction Time (OIT) is given in Table 2. The values are quite close to one another. Also, as expected, the lifetime is strongly dependent on the service temperature; with the higher the temperature the shorter the lifetime.

Table 2 - Lifetime prediction of HDPE (nonexposed) at various field temperatures

In Service Temperature (°C)	Stage "A" (years)			Stage "B" (years)	Stage "C" (years)	Total Prediction* (years)
	Standard OIT	High Press. OIT	Average OIT			
20	200	215	208	30	208	446
25	135	144	140	25	100	265
30	95	98	97	20	49	166
35	65	67	66	15	25	106
40	45	47	46	10	13	69

*Total = Stage A (average) + Stage B + Stage C

Stage "B", that of induction time, has been obtained by comparing 30-year old polyethylene water and milk containers (containing no long-term antioxidants) with currently produced containers. The data shows that degradation is just beginning to occur as evidenced by slight changes in break strength and elongation, but not in yield strength and elongation. The lifetime for this stage is also given in Table 2.

Stage “C”, the time for 50% change of mechanical properties is given in Table 2 as well. The data depends on the activation energy, or slope of the Arrhenius curve, which is very sensitive to material and experimental techniques. The data is from Gedde, et al. (1994) which is typical of the HDPE resin used for gas pipelines and is similar to Martin and Gardner (1983).

Summarizing Stages A, B, and C, it is seen in Table 2 that the halflife of covered HDPE geomembranes (formulated according to the current GRI-GM13 Specification) is estimated to be 449-years at 20°C. This, of course, brings into question the actual temperature for a covered geomembrane such as beneath a solid waste landfill. Figure 4 presents multiple thermocouple monitoring data of a municipal waste landfill liner in Pennsylvania for over 10-years, Koerner and Koerner (2005). Note that for 6-years the temperature was approximately 20°C. At that time and for the subsequent 4-years the temperature increased to approximately 30°C. Thus, the halflife of this geomembrane is predicted to be from 166 to 446 years within this temperature range. The site is still being monitored, see Koerner and Koerner (2005).

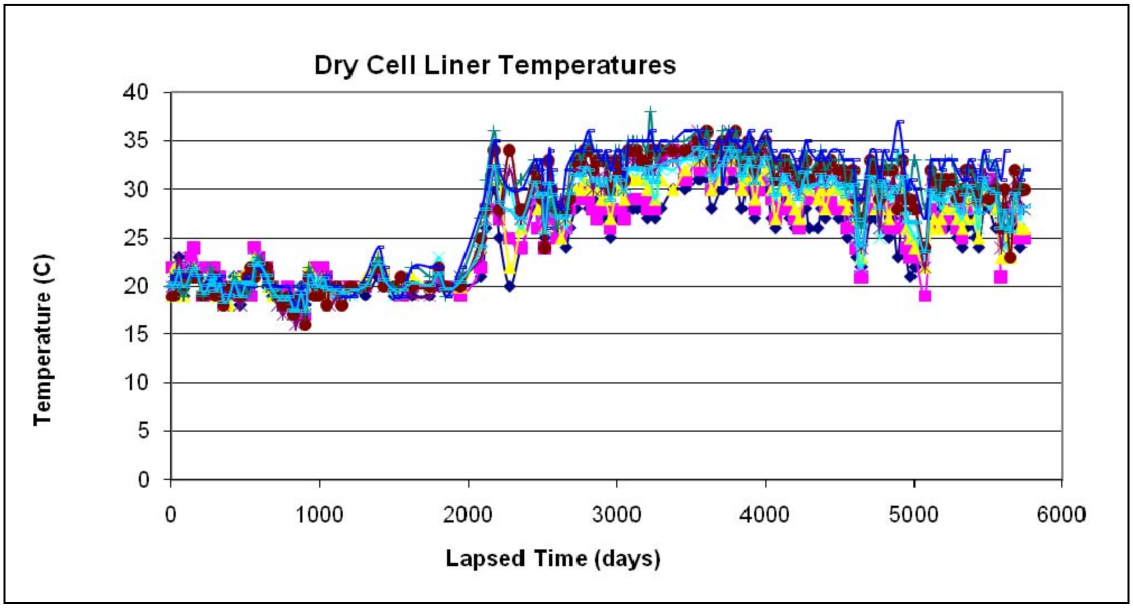


Figure 4. Long-term monitoring of an HDPE liner beneath a municipal solid waste landfill in Pennsylvania.

2.5 Lifetime of Other Covered Geomembranes

By virtue of its widespread use as liners for solid waste landfills, HDPE is by far the widest studied type of geomembrane. Note that in most countries (other than the U.S.), HDPE is the required geomembrane type for solid waste containment. Some commentary on other-than HDPE geomembranes (recall Table 1) follows:

2.5.1 Linear Low Density Polyethylene (LLDPE) geomembranes

The nature of the LLDPE resin and its formulation is very similar to HDPE. The fundamental difference is that LLDPE is a lower density, hence lower crystallinity, than HDPE; e.g., 10% versus 50%. This has the effect of allowing oxygen to diffuse into the polymer structure quicker, and likely decreases Stages A and C. How much is uncertain since no data is available, but it is felt that the lifetime of LLDPE will be somewhat reduced with respect to HDPE.

2.5.2 Plasticizer migration in PVC geomembranes

Since PVC geomembranes necessarily have plasticizers in their formulations so as to provide flexibility, the migration behavior must be addressed for this material. In PVC the plasticizer bonds to the resin and the strength of this bonding versus liquid-to-resin bonding is significant. One of the key parameters of a stable long-lasting plasticizer is its molecular weight. The higher the molecular weight of the plasticizer in a PVC formulation, the more durable will be the material. Conversely, low molecular weight plasticizers have resulted in field failures even under covered conditions. See Miller, et al. (1991), Hammon, et al. (1993), and Giroud and Tisinger (1994) for more detail in this regard. At present there is a considerable difference (and cost) between PVC geomembranes made in North America versus Europe. This will be apparent in the exposed study of durability in the second part of this White Paper.

2.5.3 Crosslinking in EPDM and CSPE geomembrnaes

The EPDM geomembranes mentioned in Table 1 are crosslinked thermoset materials. The oxidation degradation of EPDM takes place in either ethylene or propylene fraction of the co-polymer via free radical reactions, as expressed in Figure 5, which are described similarly by Equations (4) to (6).

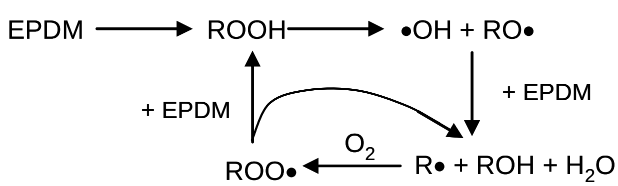


Figure 5. Oxidative degradation of crosslinked EPDM geomembranes, (Wang and Qu, 2003).

For CSPE geomembranes, the degradation mechanism is dehydrochlorination by losing chlorine and generating carbon-carbon double bonds in the main polymer chain, as shown in Figure 6.

The carbon-carbon double bonds become the preferred sites for further thermodegradation or cross-linking in the polymer, leading to eventual brittleness of the geomembrane.

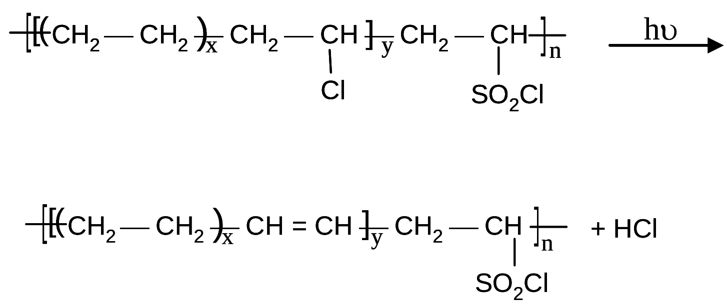


Figure 6. Dechlorination degradation of crosslinked CSPE geomembranes (Chailan, et al., 1995).

Neither EPDM nor CSPE has had a focused laboratory study of the type described for HDPE reported in the open literature. Most of lifetime data for these geomembranes is antidotal by virtue of actual field performance. Under covered conditions, as being considered in this section, there have been no reported failures by either of these thermoset polymers to our knowledge.

3.0 Lifetime Prediction: Exposed Conditions

Lifetime prediction of exposed geomembranes have taken two very different pathways; (i) prediction from anecdotal feedback and field performance, and (ii) from laboratory weathering device predictions.

3.1 Field Performance

There is a large body of anecdotal information available on field feedback of exposed geomembranes. It comes form two quite different sources, i.e., dams in Europe and flat roofs in the USA.

Regarding exposed geomembranes in dams in Europe, the original trials were using 2.0 mm thick polyisobutylene bonded directly to the face of the dam. There were numerous problems encountered as described by Scuero (1990). Similar experiences followed using PVC geomembranes. In 1980, a geocomposite was first used at Lago Nero which had a 200 g/m^2 nonwoven geotextile bonded to the PVC geomembrane. This proved quite successful and led to the now-accepted strategy of requiring drainage behind the geomembrane. In addition to thick nonwoven geotextiles, geonets, and geonet composites have been successful. Currently over 50 concrete and masonry dams have been rehabilitated in this manner and are proving successful for over 30-years of service life. The particular type of PVC plasticized geomembranes used for these dams is proving to be quite durable. Tests by the dam owners on residual properties show only nominal changes in properties, Cazzuffi (1998). As indicated in Miller, et al. (1991) and Hammond, et al. (1993), however, different PVC materials and formulations result in very different behavior; the choice of plasticizer and the material's thickness both being of paramount importance. An excellent overview of field performance is recently available in which 250 dams which have been waterproofed by geomembranes is available from ICOLD (2010).

Regarding exposed geomembranes in flat roofs, past practice in the USA is almost all with EPDM and CSPE and, more recently, with fPP. Manufacturers of these geomembranes regularly warranty their products for 20-years and such warrants appear to be justified. EPDM and CSPE, being thermoset or elastomeric polymers, can be used in dams without the necessity of having seams by using vertical attachments spaced at 2 to 4 m centers, see Scuero and Vaschetti (1996). Conversely, fPP can be seamed by a number of thermal fusion methods. All of these geomembrane types have good conformability to rough substrates as is typical of concrete and masonry dam rehabilitation. It appears as though experiences (both positive and negative) with geomembranes in flat roofs should be transferred to all types of waterproofing in civil engineering applications.

3.2 Laboratory Weatherometer Predictions

For an accelerated simulation of direct ultraviolet light, high temperature, and moisture using a laboratory weatherometer one usually considers a worst-case situation which is the solar maximum condition. This condition consists of global, noon sunlight, on the summer solstice, at normal incidence. It should be recognized that the UV-A range is the target spectrum for a laboratory device to simulate the naturally occurring phenomenon, see Hsuan and Koerner (1993), and Suits and Hsuan (2001).

The Xenon Arc weathering device (ASTM D4355) was introduced in Germany in 1954. There are two important features; the type of filters and the irradiance settings. Using a quartz inner and borosilicate outer filter (quartz/boro) results in excessive low frequency wavelength degradation. The more common borosilicate inner and outer filters (boro/boro) shows a good correlation with solar maximum conditions, although there is an excess of energy below 300 nm wavelength. Irradiance settings are important adjustments in shifting the response although they do not eliminate the portion of the spectrum below 300 nm frequency. Nevertheless, the Xenon Arc device is commonly used method for exposed lifetime prediction of all types of geosynthetics.

UV Fluorescent devices (ASTM D7238) are an alternative type of accelerated laboratory test device which became available in the early 1970's. They reproduce the ultraviolet portion of the sunlight spectrum but not the full spectrum as in Xenon Arc weatherometers. Earlier FS-40 and UVB-313 lamps give reasonable short wavelength output in comparison to solar maximum. The UVA-340 lamp was introduced in 1987 and its response is seen to reproduce ultraviolet light quite well. This device (as well as other types of weatherometers) can handle elevated temperature and programmed moisture on the test specimens.

Research at the Geosynthetic Institute (GSI) has actively pursued both Xenon and UV Fluorescent devices on a wide range of geomembranes. Table 3 gives the geomembranes that were incubated and the number of hours of exposure as of 12 July 2005.

Table 5 - Details of the GSI laboratory exposed weatherometer study on various types of geomembranes

Geomembrane Type	Thickness (mm)	UV Fluorescent Exposure*	Xenon Exposure*	Comment
1. HDPE (GM13)	1.50	8000 hrs.	6600 hrs.	Basis of GRI-GM13 Spec
2. LLDPE (GM17)	1.00	8000	6600	Basis of GRI-GM-17 Spec
3. PVC (No. Amer.)	0.75	8000	6600	Low Mol. Wt. Plasticizer
4. PVC (Europe)	2.50	7500	6600	High Mol. Wt. Plasticizer
5. fPP (BuRec)	1.00	2745**	4416**	Field Failure at 26 mos.
6. fPP-R (Texas)	0.91	100	100	Field Failure at 8 years
7. fPP (No. Amer.)	1.00	7500	6600	Expected Good Performance

*As of 12 July 2005 exposure is ongoing
**Light time to reach halflife of break and elongation

3.3 Laboratory Weatherometer Acceleration Factors

The key to validation of any laboratory study is to correlate results to actual field performance. For the nonexposed geomembranes of Section 2 such correlations will take hundreds of years for properly formulated products. For the exposed geomembranes of Section 3, however, the lifetimes are significantly shorter and such correlations are possible. In particular, Geomembrane #5 (flexible polypropylene) of Table 3 was an admittedly poor geomembrane formulation which failed in 26 months of exposure at El Paso, Texas, USA. The reporting of this failure is available in the literature, Comer, et al. (1998). Note that for both UV Fluorescent and Xenon Arc laboratory incubation of this material, failure (halflife to 50% reduction in strength and elongation) occurred at 2745 and 4416 hours, respectively. The comparative analysis of laboratory and field for this case history allows for the obtaining of acceleration factors for the two incubation devices.

3.3.1 Comparison between field and UV Fluorescent weathering

The light source used in the UV fluorescent weathering device is UVA with wavelengths from 295-400 nm. In addition, the intensity of the radiation is controlled by the Solar Eye irradiance control system. The UV energy output throughout the test is 68.25 W/m^2.

The time of exposure to reach 50% elongation at break was as follows:

	= 2745 hr. of light
	= 9,882,000 seconds
Total energy in MJ/m^2	= 68.25 W/m^2 $\times$ 9,882,000
	= 674.4 MJ/m^2

The field site was located at El Paso, Texas. The UVA radiation energy (295-400 nm) at this site is estimated based on data collected by the South Florida Testing Lab in Arizona (which is a similar atmospheric location). For 26 months of exposure, the accumulated UV radiation energy is 724 MJ/m^2 which is very close to that generated from the UV fluorescent weatherometer. Therefore, direct comparison of the exposure time between field and UV fluorescent is acceptable.

Field time	vs.	Fluorescent UV light time:	**Thus, the acceleration factor is 6.8.**
= 26 Months		= 3.8 Months	

3.3.2 Comparison between field and Xenon Arc weathering

The light source of the Xenon Arc weathering device simulates almost the entire sunlight spectrum from 250 to 800 nm. Depending of the age of the light source and filter, the solar energy ranges from 340.2 to 695.4 W/m^2, with the average value being 517.8 W/m^2.

The time of exposure to reach 50% elongation at break

	= 4416 hr. of light
	= 15,897,600 seconds
Total energy in MJ/m^2	= 517.8 W/m^2 $\times$ 15,897,600
	= 8232 MJ/m^2

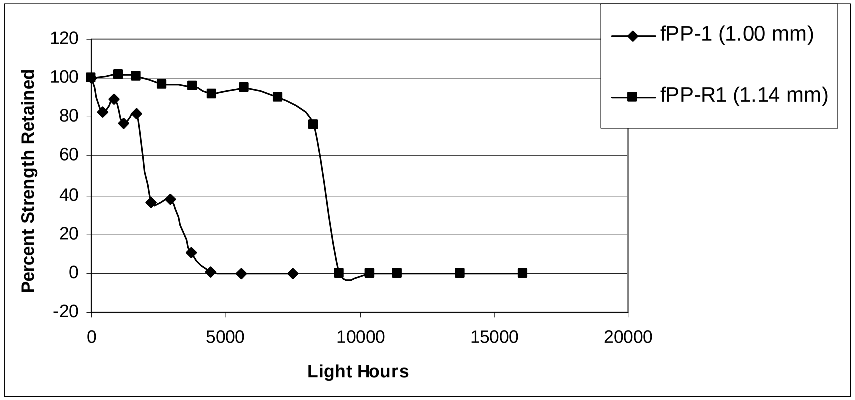
The solar energy in the field is again estimated based on data collected by the South Florida Testing Lab in Arizona. For 26 months of exposure, the accumulated solar energy (295-800 nm) is 15,800 MJ/m^2, which is much higher than that from the UV Fluorescent device. Therefore, direct comparison of halflives obtained from the field and Xenon Arc device is not anticipated to be very accurate. However, for illustration purposes the acceleration factor based on Xenon Arc device would be as follows:

Field	vs.	Xenon Arc	:	**Thus, the acceleration factor is 4.3.**
= 26 Months		= 6.1 Months		

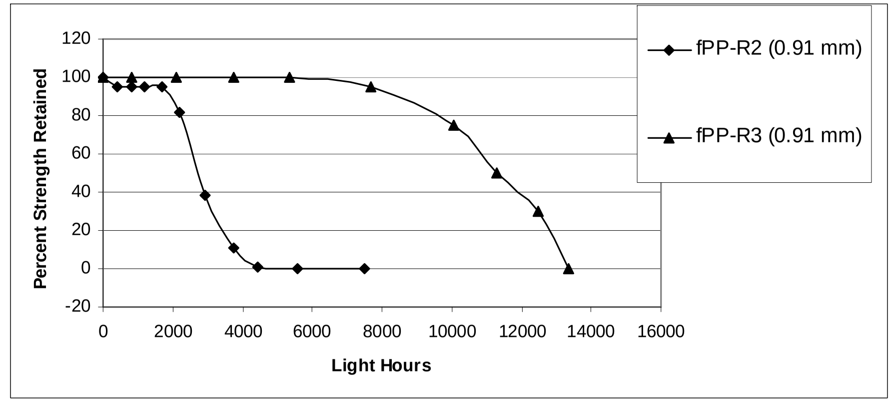
The resulting conclusion of this comparison of weathering devices is that the UV Fluorescent device is certainly reasonable to use for long-term incubations. When considering the low cost of the device, its low maintenance, its inexpensive bulbs, and ease of repair it (the UV Fluorescent device) will be used exclusively by GSI for long-term incubation studies.

3.3.3 Update of exposed lifetime predictions

There are presently (2011) four field failures of flexible polypropylene geomembranes and using unexposed archived samples from these sites their responses in laboratory UV Fluorescent devices per ASTM D7328 at 70°C are shown in Figure 5. From this information we deduce that the average correlation factor is approximately *1200 light hours $\underset{\sim}{\ }$ one-year in a hot climate.* This value will be used accordingly for other geomembranes.



(a) Two Sites in West Texas



(b) Two Sites in So. Calif.

Lab-to-Field Correlation Factors
(ASTM D7238 @ 70°C)

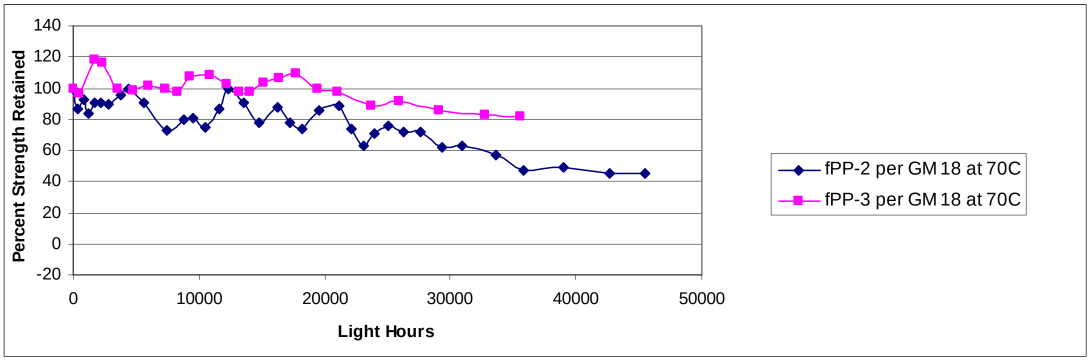
Method	Thickness (mm)	Field (yrs.)	Location	Lab (lt. hr.)	Factor (lt. hrs./1.0 yr.)
fPP-1	1.00	$\simeq$ 2	W. Texas	1800	900
fPP-R1	1.14	$\simeq$ 8	W. Texas	8200	1025
fPP-R2	0.91	$\simeq$ 2	So. Calif.	2500	1250
fPP-R3	0.91	$\simeq$ 8	So. Calif.	11200	1400
					1140*

*Use 1200 lt. hr. = 1.0 year in hot climates

Figure 5. Four field failures of fPP and fPP-R exposed geomembranes.

Exposure of a number of different types of geomembranes in laboratory UV Fluorescent devices per ASTM D7238 at 70°C has been ongoing for the six years (between 2005 and 2011) since this White Paper was first released. Included are the following geomembranes:

- Two black 1.0 mm (4.0 mil) unreinforced flexible polypropylene geomembranes formulated per GRI-GM18 Specification; see Figure 6a.
- Two black unreinforced polyethylene geomembranes, one 1.5 mm (60 mil) high density per GRI-GM13 Specification and the other 1.0 mm (40 mil) linear low density per GRI-GM17 Specification; see Figure 6b.
- One 1.0 (40 mil) black ethylene polypropylene diene terpolymer geomembrane per GRI-GM21 Specification; see Figure 6c.
- Two polyvinyl chloride geomembranes, one black 1.0 mm (40 mil) formulated in North America and the other grey 1.5 mm (60 mil) formulated in Europe; see Figure 6d.



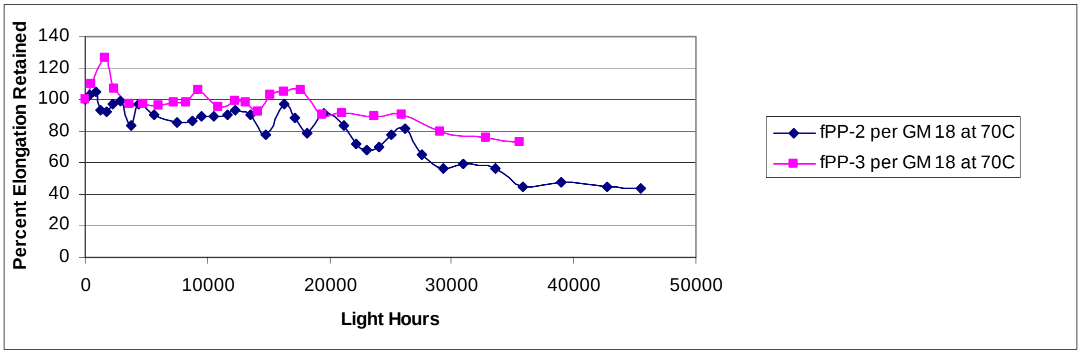
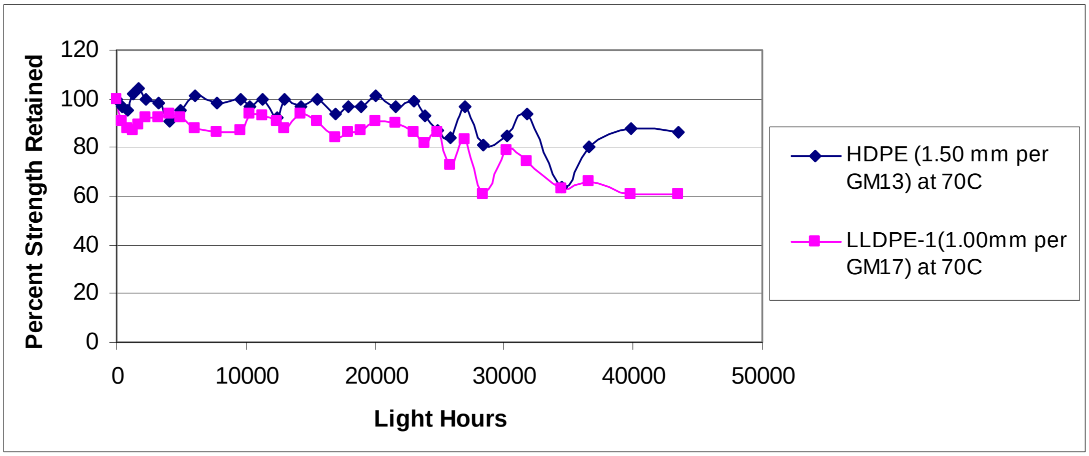


Figure 6a. Flexible polyethylene (fPP) geomembrane behavior.



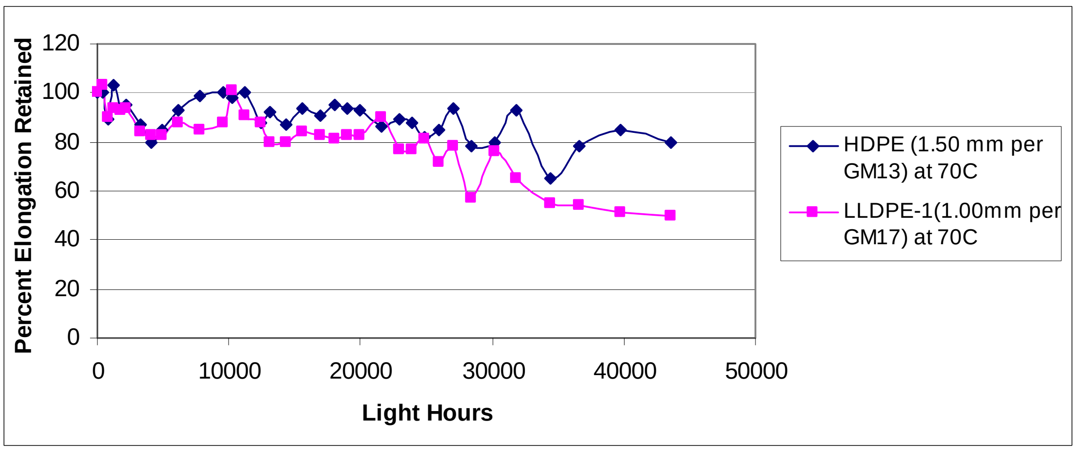
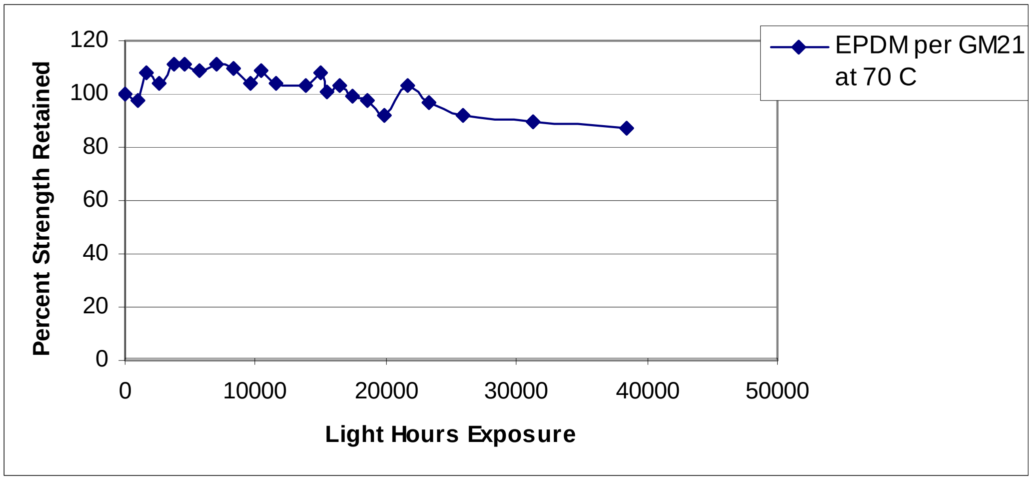


Figure 6b. Polyethylene (HDPE and LLDPE) geomembrane behavior.



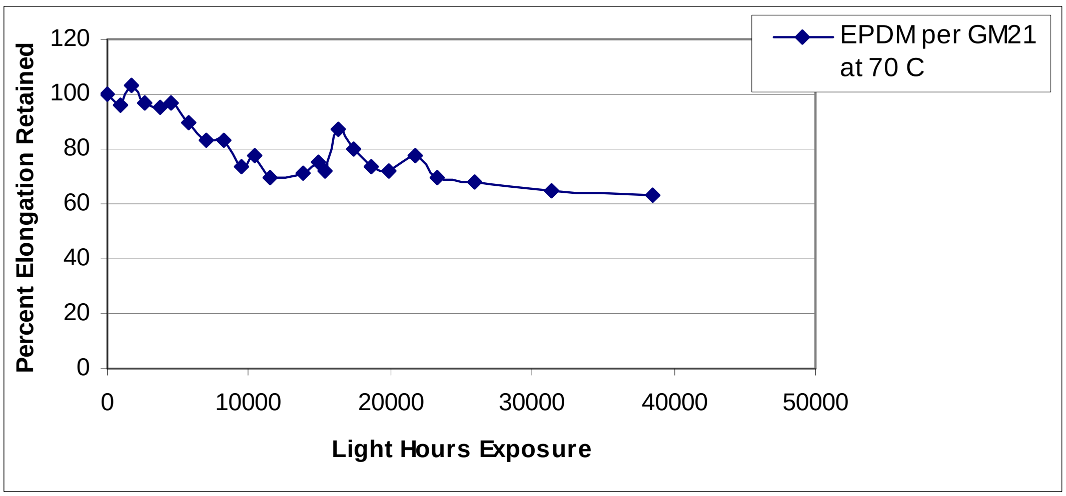


Figure 6c. Ethylene polypropylene diene terpolymer (EPDM) geomembrane.

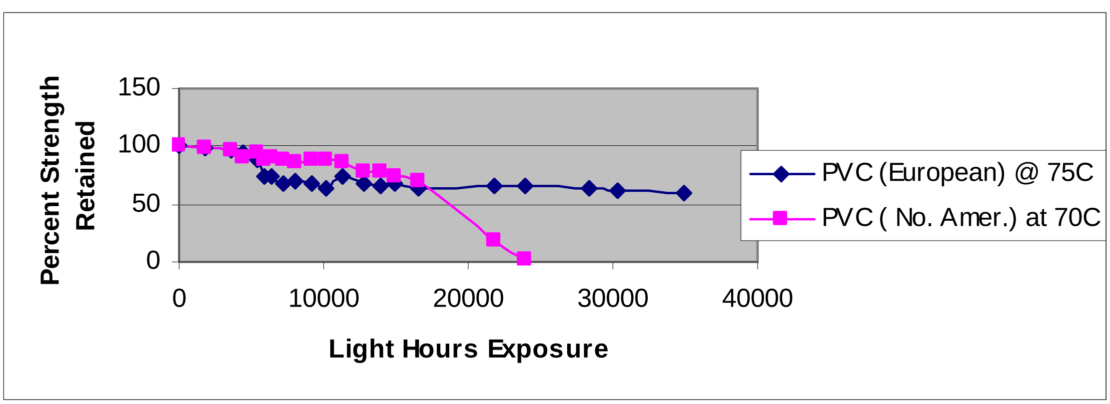


Figure 6d. Polyvinyl chloride (PVC) geomembranes.

From the response curves of the various geomembranes shown in Figure 6a-d, the 50% reduction value in strength or elongation (usually elongation) was taken as being the “halflife”. This value is customarily used by the polymer industry as being the materials lifetime prediction value. We have done likewise to develop Table 6 which is our predicted values for the designated exposed geomembrane lifetimes to date.

Table 6 – Exposed lifetime prediction results of selected geomembranes to date

Type	Specification	Prediction Lifetime in a Dry and Arid Climate
HDPE	GRI-GM13	> 36 years (ongoing)
LLDPE	GRI-GM17	≃ 36 years (halflife)
EPDM	GRI-GM21	> 27 years (ongoing)
fPP-2	GRI-GM18	≃ 30 years (halflife)
fPP-3	GRI-GM18	> 27 years (ongoing)
PVC-N.A.	(see FGI)	≃ 18 years (halflife)
PVC-Eur.	proprietary	> 32 years (ongoing)

4.0 Conclusions and Recommendations

This White Paper is bifurcated into two very different parts; covered (or buried) lifetime prediction of HDPE geomembranes and exposed (to the atmosphere) lifetime prediction of a number of geomembrane types. In the covered geomembrane study we chose the geomembrane type which has had the majority of usage, that being HDPE as typically used in waste containment applications. Invariably whether used in landfill liner or cover applications *the geomembrane is covered.* After ten-years of research Table 2 (repeated here) was developed which is the conclusion of the covered geomembrane research program. Here it is seen that HDPE decreases its predicted lifetime (as measured by its halflife) from 446-years at 20°C, to 69-years at 40°C. Other geomembrane types (LLDPE, fPP, EPDM and PVC) have had essentially no focused effort on their covered lifetime prediction of the type described herein. That said, all are candidates for additional research in this regard.

Table 2 - Lifetime prediction of HDPE (nonexposed) at various field temperatures

In Service Temperature (°C)	Stage "A" (years)			Stage "B" (years)	Stage "C" (years)	Total Prediction* (years)
	Standard OIT	High Press. OIT	Average OIT			
20	200	215	208	30	208	446
25	135	144	140	25	100	265
30	95	98	97	20	49	166
35	65	67	66	15	25	106
40	45	47	46	10	13	69

*Total = Stage A (average) + Stage B + Stage C

Exposed geomembrane lifetime was addressed from the perspective of field performance which is very unequivocal. Experience in Europe, mainly with relatively thick PVC containing high molecular weight plasticizers, has given 25-years of service and the geomembranes are still in use. Experience in the USA with exposed geomembranes on flat roofs, mainly with EPDM and CSPE, has given 20^{+}-years of service. The newest geomembrane type in such applications is fPP which currently carries similar warranties.

Rather than using the intricate laboratory setups of Figure 1 which are necessary for covered geomembranes, exposed geomembrane lifetime can be addressed by using accelerating laboratory weathering devices. Here it was shown that the UV fluorescent device (per ASTM D7238 settings) versus the Xenon Arc device (per ASTM D 4355) is equally if not slightly more intense in its degradation capabilities. As a result, all further incubation has been using the UV fluorescent devices per D7238 at 70°C.

Archived flexible polypropylene geomembranes at four field failure sites resulted in a correlation factor of 1200 light hours equaling one-year performance in a hot climate. Using this value on the incubation behavior of seven commonly used geomembranes has resulted in the following conclusions (recall Figure 6 and Table 6);

- HDPE geomembranes (per GRI-GM13) are predicted to have lifetimes greater than 36-years; testing is ongoing.
- LLDPE geomembranes (per GRI-GM17) are predicted to have lifetimes of approximately 36-years.
- EPDM geomembranes (per GRI-GM21) are predicted to have lifetimes of greater than 27-years; testing is ongoing.
- fPP geomembranes (per GRI-GM18) are predicted to have lifetimes of approximately 30-years.
- PVC geomembranes are very dependent on their plascitizer types and amounts, and probably thicknesses as well. The North American formulation has a lifetime of approximately 18-years, while the European formulation is still ongoing after 32-years.

Regarding continued and future recommendations with respect to lifetime prediction, GSI is currently providing the following:

(i) Continuing the exposed lifetime incubations of HDPE, EPDM and PVC (European) geomembranes at 70°C.

(ii) Beginning the exposed lifetime incubations of HDPE, LLDPE, fPP, EPDM and both PVC's at 60°C and 80°C incubations.

(iii) With data from these three incubation temperatures (60, 70 and 80°C), time-temperature-superposition plots followed by Arrhenius modeling will eventually provide information such as Table 2 for covered geomembranes. This is our ultimate goal.

(iv) Parallel lifetime studies are ongoing at GSI for four types of geogrids and three types of turf reinforcement mats at 60, 70 and 80°C.

(v) GSI does not plan to duplicate the covered geomembrane study to other than the HDPE provided herein. In this regard, the time and expense that would be necessary is prohibitive.

(vi) The above said, GSI is always interested in field lifetime behavior of geomembranes (and other geosynthetics as well) whether covered or exposed.

Acknowledgements

The financial assistance of the U. S. Environmental Protection Agency for the covered HDPE lifetime study and the member organizations of the Geosynthetic Institute and its related institutes for research, information, education, accreditation and certification is sincerely appreciated. Their identification and contact member information is available on the Institute's web site at <<geosynthetic-institute.org>>.

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Owner's Copy

STATE OF CALIFORNIA
CALIFORNIA NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
DIVISION OF SAFETY OF DAMS

INSPECTION OF DAM AND RESERVOIR IN CERTIFIED STATUS

Name of Dam Wastewater Storage Dam No. 2022-0 County Placer

Type of Dam Earth Type of Spillway Unlined Channel

Water is 5.0 feet below spillway crest and 9.0 feet below dam crest.

Weather Conditions Clear and cool, 65 degrees F.

Contacts Made Mark Fischer w/ City of Colfax.

Reason for Inspection Annual Maintenance Inspection.

Important Observations, Recommendations or Actions Taken

The next annual instrumentation submittal from the owner is due in spring of 2010.

All settlement monuments on the dam should be located and identified clearly in plan view with the next instrumentation submittal.

To avoid continued data scatter, a more accurate method of surveying needs to be employed for future settlement surveys.

Conclusions

From the known information and visual inspection, the dam, reservoir, and all appurtenances are judged safe for continued use.

Observations and Comments

Dam	I walked the crest, groins and downstream toe of the dam, and observed the downstream face and visible portions of the upstream face. The crest road appeared to be straight, level and in excellent condition. Both abutments had solid contact and appeared to be in good condition. The upstream and downstream faces were both covered in low-growing well-maintained native vegetation, and appeared to be stable and in good condition. Vegetation control on the dam was excellent. There were no signs of rodent activity anywhere on the dam.
Spillway	The spillway approach, control section and downstream channel were clear and unobstructed. There were no signs of cracking or spalling on any of the concrete surfaces.
Outlet	The outlet is equipped with a 15" upstream slide gate and a 16" downstream gate valve. The valve wheels, stems and all visible appurtenances appeared to be well-maintained and in good operating condition. The owner reported that the valve is operated frequently, and was last cycled in summer of 2009. The entire system was last cycled in DSOD's presence during the maintenance inspection on 1/11/2008. No problems were reported.
Seepage	The downstream face and groins of the dam were dry. There are two seepage measurement devices at the toe of the dam. The first device, an electronic flow meter, collects accumulated water from the left groin area, and reads it through an underground pipe with an inline flow meter. The seepage flow on this date was ~63 gpm. The second device, a 90 degree v-notch weir in the right groin, was dry. These conditions are consistent with those observed in prior years.
Instr.	Instrumentation for this dam consists of two piezometers, four survey monuments, one seepage

Photos taken? Yes x No

cc for Owner/Book

Inspected by A. C. Roundtree ACR 1/11/10

Date of Inspection 11/3/2009 AO 1/12/10

Date of Report 1/7/2010

DWR 1261 (Rev. 10/09)

Name of Dam Wastewater Storage Dam No. 2022-0

Date of Inspection 11/3/2009

Observations and Comments

weir and a seepage collection pipe. The most recent instrumentation data was transmitted to DSOD on January 31, 2009, and includes data through November 15, 2008. Following is my review and analysis of that data.

Per our records, the tip of piezometer P-1 is located in the core of the dam. Readings taken from this piezometer show that it mimics the changes in reservoir level, as expected. Per our records, the tip of piezometer P-2 is located in the outer shell. Readings taken from this piezometer show that it remains nearly constant and near dry, indicating a free-draining shell zone.

It has been noted by the client's consultant that the survey data reported for 2007 was obtained using different instruments than those historically used for obtaining survey data, and should not therefore be considered representative with the data from other years. Removing data reported for 2007, the maximum settlement between 2003 and 2008 was 0.098' at monument #4. There is a lot of data scatter between 2003 and 2008 which appears to be the result of inaccurate surveying. A more accurate method of surveying needs to be employed in the future. All settlement monuments on the dam should be located and identified clearly in plan view with the next instrumentation submittal.

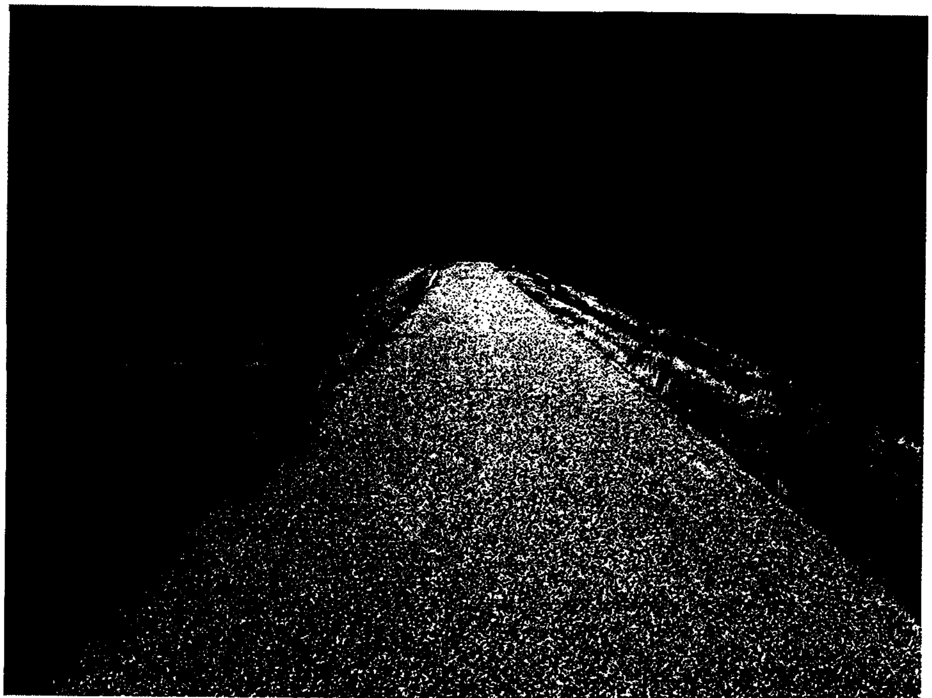
According to the owner, the seepage weir in the right groin only runs when it is raining, and otherwise remains dry. Since June 2006, all seepage is collected via underground pipe and measured by the in-line flow meter. In 2008, seepage ranged from 31 to 88 gpm, and mirrored the reservoir elevation almost exactly, as expected. There are no indications of any seepage related dam safety issues.

I noted no irregularities or anomalies in the data indicating any specific dam safety issues or concerns. The current instrumentation network is deemed adequate.

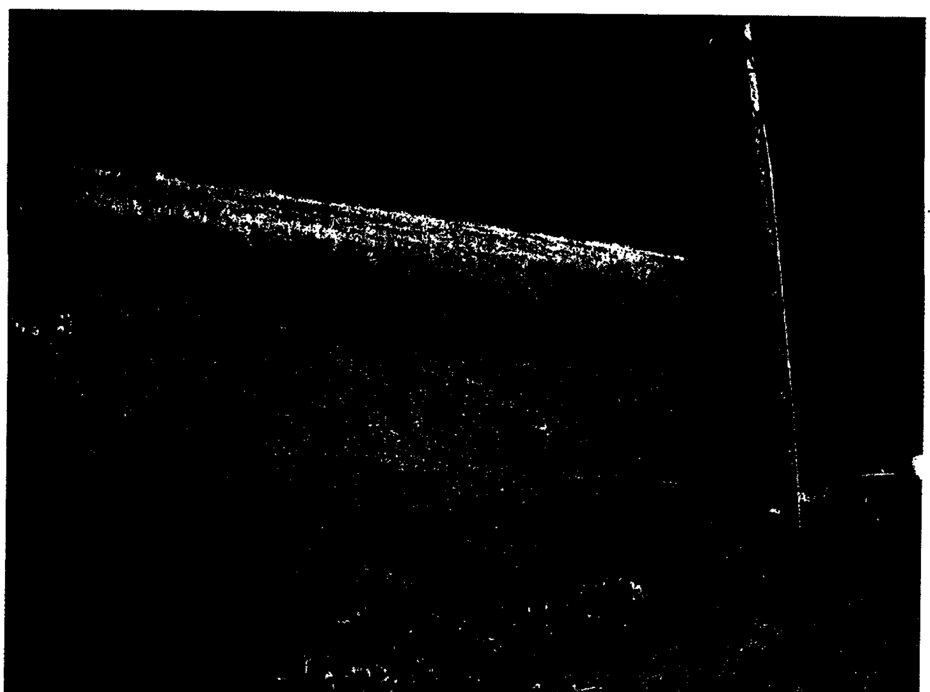
INSPECTION OF DAM AND RESERVOIR IN CERTIFIED STATUS

Name of Dam Wastewater Storage Dam No. 2022-0

Date of Inspection 11/3/2009



Crest of Dam viewed from Left Abutment



Downstream Face of Dam viewed from Toe

INSPECTION OF DAM AND RESERVOIR IN CERTIFIED STATUS

Name of Dam Wastewater Storage Dam No. 2022-0

Date of Inspection 11/3/2009

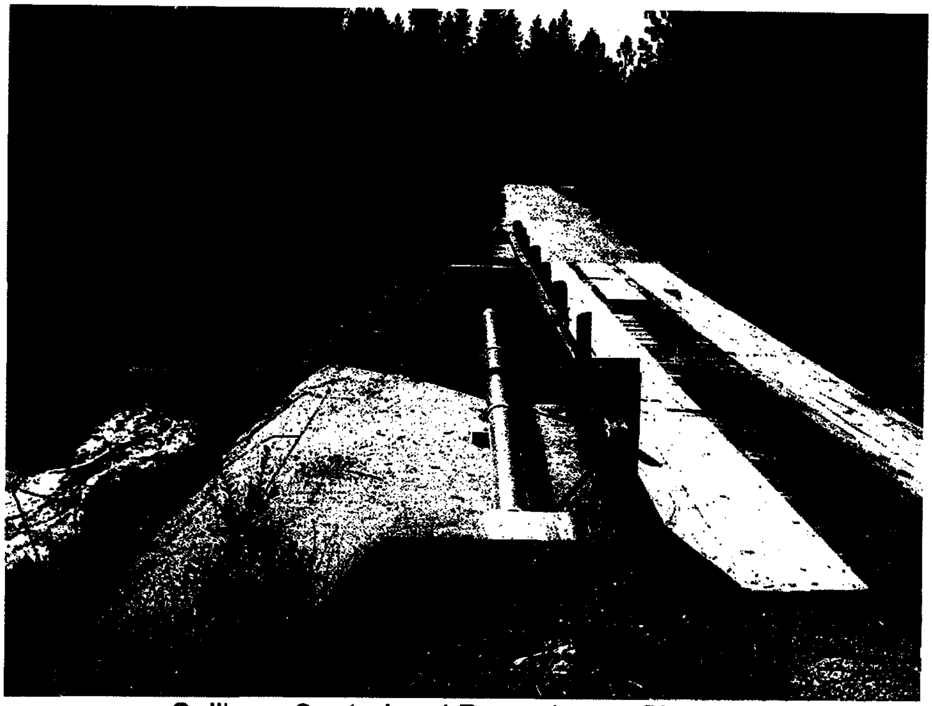
Typical Dampness and Iron Oxide Deposits in Left Groin

90° V-notch Weir in Right Groin

INSPECTION OF DAM AND RESERVOIR IN CERTIFIED STATUS

Name of Dam Wastewater Storage Dam No. 2022-0

Date of Inspection 11/3/2009



Spillway Control and Downstream Channel

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

FEB 26 2008

Ms. Joan Phillipe, City Manager
City of Colfax
Post Office Box 702
Colfax, California 95713

Wastewater Storage Dam, No. 2022
Placer County

Dear Ms. Phillipe:

This is in reply to a letter from HDR Incorporated, dated February 11, 2008, enclosing an alteration application and supporting technical reports for the planned installation of a reservoir liner and replacement of the low level outlet gate at Wastewater Storage Dam.

We have reviewed the proposed work and have determined that an application is not necessary, provided excavation into the dam for the liner anchor system does not exceed 3 feet in depth and the outlet gate is replaced in-kind. All excavations into the dam must be backfilled with suitable material compacted to the same standard as the existing fill. Trench backfill should be placed in 4-inch loose lifts, moisture-conditioned, and compacted to at least 97 percent relative compaction, as determined by ASTM D698. Soils testing needs to be conducted during the work to verify these requirements are met.

Both copies of your alteration application are being returned with this letter. Please notify us prior to starting construction and keep us apprised of your schedule so that we may observe some of this work. Also, submit one full size and one reduced (11 inch x 17 inch) set of "As-Built" drawings for dam related work upon completion of the project.

If you have any questions or need additional information, you may contact Field Engineer Mike Sutliff at (916) 227-2148 or Acting Regional Engineer Aspet Ordoubigian at (916) 227-4625.

Sincerely,

ORIGINAL SIGNED BY

Mike Zumot, Acting Chief
Division of Safety of Dams

Enclosures

cc: (See attached list.)