Project No.
13233.001.000

January 12, 2018

Mr. Reza Baradaran
San Francisco Public Works
30 Van Ness, Fifth Floor
San Francisco, CA 94102

Subject: Pier 94 Backlands Improvements
San Francisco, California

LANDFILL CAP DESIGN SUMMARY

References:

1. T&R/RYCG Joint Venture; Geotechnical Investigation, Pier 94 Backlands Improvements, San Francisco, California; July 5, 2012.

2. T&R/RYCG Joint Venture; Request to Approve Landfill Cover Design, Order No. R2-2003-0055, Pier 94 Class III Landfill, San Francisco, California; February 7, 2013.

3. San Francisco Bay Regional Water Quality Control Board; Response to Request to Approve Landfill Cover Design, Order R2-2003-0055, Pier 94 Class III Landfill, San Francisco, February 25, 2013.

4. San Francisco Port Commission, Port of San Francisco, Department of Engineering; Pier 94 Backlands Improvement Project; 95% Submittal; November 22. 2017.

Dear Mr. Baradaran:

We are pleased to submit this document summarizing our preliminary design for a landfill cover at the project (Site), located at Pier 94 in San Francisco, California. The Site, measuring approximately 34 acres in area, is located near Amador Street and Cargo Way, as shown in Figure 1. The Pier 94 Backlands area was created during the 1960s and 1970s by constructing a perimeter debris dike and placing fill on the inboard side of the dike. The fill consists primarily of dredge spoils and construction debris. The San Francisco Regional Water Quality Control Board (RWQCB) has identified a portion of the Site area as a class III landfill (regulated landfill area). A landfill cover is required for this 7.63-acre area.

We understand that the Site will be redeveloped to accommodate open-lot leasing (onsite and offsite areas). In addition to the placement of a landfill cover, grading activities, including fill placement will be performed to establish final project grades. Improvements will reportedly include stormwater and sanitary water infrastructure and construction of a roadway.

PREVIOUS DOCUMENTS

The following previous documents presented details of Site conditions, the proposed development (at the time when the reports were completed), and consideration and approval of landfill cover options.

Report 1: T&R/RYCG Joint Venture; Geotechnical Investigation, Pier 94 Backlands Improvements, San Francisco, California; July 5, 2012.

T&R/RYCG JV prepared a geotechnical investigation for the Site in 2012. Within the report, a summary overview of the Site was provided:

> The Pier 94 Backlands is an irregularly shaped, approximately 47-acre site, generally consisting of the land bound by Amador Street and Cargo Way, extending east to the Amador Street Extension. The approximate project limits of the proposed Pier 94 Backlands improvements are shown on the Site Location Map and Site Plan, Figures 1 and 2, respectively. The Pier 94 Backlands area was created during the 1960s and 1970s by constructing a perimeter debris dike and placing fill on the inboard side of the dike. The fill consists primarily of dredge spoils and construction debris. After filling ceased in 1975, a soil cap was placed over the construction debris.

As presented in the report, the proposed improvements to the Site preparation of 19 acres into leasable property, which includes a portion of the regulated landfill area. The site improvements include grading and leveling the site to accommodate leasing and installing new site infrastructure, consisting of a paved site access road and a storm water collection and treatment system, new water and sanitary sewer utilities for tenant parcels, and a new restroom facility. Site grading was reported to involve placement of up to 18 feet of fill at some locations and constructing new roadways. To treat the storm water runoff, new vegetated swales will be utilized. Site flows will reportedly be directed to a vegetated swale before being discharged to the San Francisco Bay by means of a new stormwater intake structure and outfall pipe and structure.

Subsurface conditions within the Site were described in detail. The regulated landfill area is located east of the 1961 shoreline and is reportedly capped with soil material consisting of loose to very dense sands and gravels with variable amounts of clay and silt and occasional concrete, brick, and serpentinite fragments. The thickness of the cap reportedly extends 2.5 to 8 feet below the ground surface.

The soil cap is underlain by construction debris consisting of construction and municipal waste mixed with soil, including wood, concrete, asphalt, brick, rock fragments, metal fencing, sheet metal, plastic, and foam. The bottom of the waste material was reportedly 19 to 20 feet below the ground surface. The waste material is, underlain by dredged spoils consisting of very soft to stiff clay with variable amounts of sand to an approximate depth of 38 feet below the ground surface. San Francisco Bay Mud (Bay Mud) underlies the dredged spoils to an approximate depth of 89 feet below the ground surface, which is reportedly underlain by medium dense to very dense sand.

Fill material is present to the west of the regulated landfill area to depths ranging between 25 and 40 feet below the ground surface, and reportedly consists of a mixture of clay, silt, sand, and gravel, with occasional brick, concrete, and asphalt debris. The fill is underlain by soft to stiff Bay Mud to depths between 70 and 75 feet below the ground surface. The Bay Mud is reportedly underlain by approximately 15 feet of dense to very dense sand, which is underlain by stiff to hard clay (Old Bay Clay).

The report presented an evaluation of settlement based on the placement of new fill as well as hydrologic evaluation of the existing soil cover, a "prescriptive" soil cover, and two alternative engineered covers.

The prescriptive cover consists of a 24-inch foundation soil layer, a 12-inch low-permeability soil layer, and a 12-inch erosion-resistant layer. It was concluded that the existing soil layer met the requirements of the foundation soil layer.

The engineered alternatives included (1) a vegetated swale consisting of 12 inches of vegetation soil layer underlain by a low hydraulic conductivity geomembrane liner that is placed directly over the existing cover, and (2) asphalt concrete pavement section consisting of asphalt concrete over aggregate base underlain by a low hydraulic conductivity geomembrane liner. Details of the alternative covers are presented below.

The hydrologic analysis of these alternatives was performed using USEPA's HELP-3 software. It was concluded that the average annual percolation through the engineered alternative covers is less that the average annual percolation through the existing and prescriptive covers.

A landfill soil gas study was also performed. Concentrations of detected VOCs were reportedly below their respective commercial/industrial screening levels in all samples. It was concluded that the waste disposal site did not appear to be a potential source for VOCs or methane capable of adversely affecting ambient air quality.

Report 2: T&R/RYCG Joint Venture; Request to Approve Landfill Cover Design, Order No. R2-2003-0055, Pier 94 Class III Landfill, San Francisco, California; February 7, 2013.

T&R/RYCG JV prepared a summary document requesting approval of three landfill cover design alternatives. The three cover alternatives included the following:

- Soil Cover: The upper 18 inches of soil consisting of sandy or clayey sand with at least 30 percent fines, no more than 5 percent gravel, a liquid limit of less than 40 and a plasticity index of 12 or less, be compacted to at least 90 percent relative compaction, and have a hydraulic conductivity of less than 1×10^{-6} centimeters per second (cm/s) at 90 percent relative compaction. The soil subgrade underlying the 18-inch soil cover should be stripped of vegetation and compacted to at least 90 percent relative compaction.

- Vegetated Swale: The upper 6 inches of soil subgrade should be scarified, moisture conditioned to near optimum moisture content, and compacted to at least 90 percent relative compaction. The soil subgrade of the vegetated swale should be graded with a minimum 1 percent slope and covered with a low-permeability geomembrane liner. The geomembrane liner should have a maximum hydraulic conductivity of 1×10^{-9} cm/s, maximum transmissivity of 0.3 square meters per second (cm^2/s), and a total defect of 11 holes per acre. The geomembrane liner should be established on this layer, and the surface of the soil layer should be graded to a minimum 1 percent slope and to direct runoff to emerging wetlands or new stormwater structures. Irrigation on the vegetation swale should not be permitted.

- Asphalt Concrete Pavement: The upper 6 inches of soil subgrade should be scarified, moisture conditioned to near optimum moisture content, and compacted to at least 95 percent relative compaction. Aggregate base should conform to Section 26-1.02A of the

current Caltrans Standard Specifications and should be compacted to at least 95 percent relative compaction. The asphalt pavement should have a minimum slope of 1 percent slope and underlain by a geomembrane liner. The geomembrane liner should have a maximum hydraulic conductivity of 1 x 10^{-9} cm/s, maximum transmissivity of 0.3 square meter per second (cm^2/s), and a total defect of 11 holes per acre. An R-Value of 10 was assumed, and pavement sections were presented based on representative Traffic Indices (TIs).

Report 3: San Francisco Bay Regional Water Quality Control Board; Response to Request to Approve Landfill Cover Design, Order R2-2003-0055, Pier 94 Class III Landfill, San Francisco, February 25, 2013.

The San Francisco Bay Regional Water Quality Control Board (SFRWQCB) reviewed Reference 2 and the three landfill cover alternatives presented. SFRWQCB agreed that the three alternative cover types were appropriate for use as cover materials for the Site. SFRWQCB also indicated that a detailed plan for site closure, specifying the locations and acreage where each of the three alternative cover types will be used, must be submitted for SFRWQCB approval a minimum of 60 days prior to initiation of any cover construction activities.

LANDFILL CAP ALTERNATIVE ANALYSIS

Identification and Analysis of Capping Alternatives

The alternatives to cap the regulated landfill area include Alternative 1: Soil Cover, Alternative 2: Vegetated Swale, and Alternative 3: Asphalt Concrete Pavement. These response actions are considered the appropriate landfill capping alternatives for the Site and have been approved by the Regional Water Quality Control Board (RWQCB). A roadway and vegetated swales are planned within the project footprint. The respective alternatives listed for this land use will be implemented accordingly. The majority of the regulated landfill area; however, has been proposed for a soil cover cap. We consider use of all three alternatives in these areas as described below.

Alternative 1 – Soil Cover

As approved by the RWQCB, the soil cover alternative has been proposed as a means of encapsulating the landfill. As presented in the referenced T&R/RYCG Geotechnical Investigation, soil materials at the Site do not meet the prescribed requirements, specifically the hydraulic conductivity, as a potential capping material. Therefore, the use of a soil cover alternative would consist of select imported material, per the approved soil specifications, over the area requiring capping (Figure 2). As presented above, the upper 18 inches of soil is to consist of sandy or clayey sand with at least 30 percent fines, no more than 5 percent gravel, a liquid limit of less than 40 and a plasticity index of 12 or less, and have a hydraulic conductivity of less than 1 x 10^{-6} centimeters per second (cm/s) when compacted at 90 percent relative compaction. The soil subgrade underlying the 18-inch soil cover should be stripped of vegetation and compacted to at least 90 percent relative compaction. Imported soil would require environmental testing as part of quality assurance to the development.

Alternative 2 – Geomembrane and Soil Cover

This approved alternative combines the effort of capping the landfill with two geotextiles encasing a geomembrane overlain by a 12-inch-thick layer of vegetated soil.

Prior to installation of the geotextiles, the upper 6 inches of soil subgrade that is currently placed above the fill material would be scarified, moisture conditioned to near-optimum moisture content, and compacted to at least 90 percent relative compaction. The soil subgrade of the vegetated swale would be graded with a minimum 1 percent slope and covered with a low-permeability geomembrane liner.

According to the approved alternatives proposed based on the soil conditions, we understand the geomembrane liner is required to have a maximum hydraulic conductivity of 1×10^{-9} cm/s, maximum transmissivity of 0.3 square meter per second (cm^2/s), and a total defect of 11 holes per acre. Based upon these specifications, the following liner system or equivalent would be applicable and recommended for the Site:

- A 40-mil linear low-density polyethylene (LDPE) liner encased between 12-ounce geotextiles. A 12-ounce geotextile would be placed above the conditioned subgrade soil to provide protection to the geomembrane. A 12-ounce geotextile would be placed above the geomembrane to provide protection during fill placement. An additional alternative to the LDPE geomembrane may be a high-density polyethylene (HDPE) liner, although we recommended against this due to the lower durability as compared to the LDPE liner.

The surface of the soil layer would then be graded to a minimum 1 percent slope to direct runoff to emerging wetlands or new stormwater structures. Irrigation on the vegetation swale would not be permitted.

Alternative 3 – Asphalt Concrete Pavement

According to the approved Alternative 3, the upper 6 inches of soil subgrade would be scarified, moisture conditioned to near optimum moisture content, and compacted to at least 95 percent relative compaction. Aggregate base (AB) should conform to Section 26-1.02A of the current Caltrans Standard Specifications and should be compacted to at least 95 percent relative compaction. The asphalt pavement would have a minimum slope of 1 percent slope and be underlain by a geomembrane liner with identical specification to that of Alternative 2. A similar recommendation as to that proposed in Alternative 2 would apply to the recommended geomembrane in Alternative 3. An R-Value of 10 was assumed, and pavement sections were presented based on representative Traffic Indices (TIs). For the purpose of our analysis, we have assumed a conservative TI of 6 given its proposed use, and a corresponding 3.5-inch-thick layer of asphalt concrete and 11.5-inch-thick laver Class 2 aggregate base.

EVALUATION CRITERIA

Each capping alternative was independently analyzed without consideration to the other alternatives. Each of the capping alternatives is screened based on effectiveness and implementability.

Effectiveness

In the effectiveness evaluation, the following factors are considered:

- Approved capping alternatives based on previous investigations and the proposed development of the Site.
- Overall Protection of Human Health and the Environment - This criterion evaluates whether the capping alternatives provides adequate protection to human health and the environment, specifically in consideration to stormwater and infiltration mitigation.
- Short-Term Effectiveness - This criterion evaluates the effects of the capping alternative during the construction and implementation phase until the capping objectives are met. It accounts for the protection of workers and the community during capping activities and environmental impacts from implementing the capping action.
- Long-Term Effectiveness and Permanence - This criterion addresses issues related to the management of material onsite after capping has been performed. The primary focus is on how the proposed options would withhold given the variance in future applications for the Site.
- Geotechnical Considerations for Construction Feasibility – This criterion evaluates the potential for each alternative based on previous geotechnical investigations of the Site, knowledge of underlying soil materials, settlement, and suitability for the proposed development.

Implementability

This criterion evaluates the technical and administrative feasibility of implementing the alternative, as well as the availability of the necessary equipment and services. This includes the ability to design and install a capping alternative, ability to obtain services and equipment, and ability to monitor the performance and effectiveness of technologies.

COMPARATIVE ANALYSIS OF CAPPING ALTERNATIVES

A comparative analysis was conducted to identify the advantages and disadvantages of each capping alternative. The comparative analysis of the capping alternatives was conducted to address the criteria listed above.

Effectiveness

The landfill is currently capped with soil material consisting of loose to very dense sands and gravels with variable amounts of clay and silt and occasional concrete, brick, and serpentinite fragments. The thickness of the cap reportedly extends 2.5 to 8 feet below the ground surface. Prior environmental investigations for the Site have not identified chemicals of potential concern within the capped soil material. For each alternative, Site safety hazards, such as methane of VOC vapors, are not a concern pertaining to the landfill material that is to be capped. The Class III material will not be exposed during installment for any of the alternatives.

The HELP-3 analyses, presented in the referenced Geotechnical Investigation, indicated the average annual percolation through an 18-inch-thick existing cover with a hydraulic conductivity less than $1x10^{-6}$ is less than the average annual percolation through the prescriptive covers.

This, therefore, results in minimal infiltration to underlying waste material. All alternatives have been proposed based on the impermeable characteristics of each option. Surface runoff would be properly managed through the proposed stormwater control systems.

Settlement evaluation in the referenced Geotechnical Investigation for areas to be capped with up to 10 feet of fill, and with Bay Mud thickness of between 35 and 50 feet, could potentially cause settle up to 3.0 feet within the next 50 years. Further, significant differential loads may be applied across the capped area during future activities at the Site, which may induce additional settlement. When considering long-term effectiveness, excessive strain, caused by settlement, may occur in the geomembrane, leading to increased permeability or the generation of ruptures or defects. Quality assurance of this technology during long-term use is therefore limited in our opinion.

The 18-inch-thick soil cover (Alternative 1) is better suited when taking into consideration the potential for differential settlement across the capped area. If such earthwork activity is to become necessary for this area, reworking the engineered soil will be far more feasible than performing potential maintenance or re-installment of a geomembrane when considering either Alternative 2 or 3.

Implementability

Equipment and labor required to implement Alternative 1 is rather uncomplicated and readily available. Alternative 1 will, however, result in greater transport truck traffic to and from the Site and related emissions associated with the import of soil. The use of Alternative 2 would eliminate 6 inches of soil cap; one-third of the required soil volume. If on-Site soil were to be used for Alternative 2, import traffic could be greatly reduced. Traffic control will be necessary at the entrance/exit points for imported soil. Approximately 1,420 truckloads would be required to import the estimated 17,300 cubic yards for Alternative 1. Alternative 2 would require 12,000 cubic yards of imported soil, if taken from an off-Site source, for an approximate 1,000 truckloads. Alternative 3 will require a similar volume of import of asphaltic concrete and aggregate base.

The geomembrane would be installed by an approved contractor. This liner will be secured in a perimeter anchor trench. Further backfilling will be performed by the contractor. Vegetated soil could be imported to the Site or obtained from other locations within the Site.

Alternatives 1 and 2 would additionally require additional import testing with respect to quality assurance. Alternative 2 would not require additional testing if this vegetated soil were to be obtained from locations within the Site.

Alternative 1 is a proven, readily implementable technology. However, Alternative 1 requires additional handling of soil, resulting in a potential increase in dust and noise generation, and would also require environmental import testing. Imported material for Alternative 2 would also require environmental testing. Alternative 1 would result in greater impacts to transportation/traffic; however, the impacts are of short duration and can be effectively managed to minimize disturbances.

Given the greater volume of imported soil, implementation of Alternative 1 has the potential to be of a longer duration, dependent on the availability of soil as compared to general vegetated soil for Alternative 2.

RECOMMENDED CAPPING ALTERNATIVE

Based on the comparative analysis described in this document, Alternative 1, Soil Capping with imported soil per the approved specifications is the preferred and recommended capping alternative for addressing the soil cover area of the Site. We believe this alternative provides better quality assurance with respect to differential settlement that will likely occur as well as any proposed developmental loads that may add to the primarily settlement to occur based on Bay Mud thickness underlying the Site.

RECOMMENDED MATERIAL SPECIFICATIONS

Import Soil Capping Area:

Imported soil for capping purposes, as discussed in the above alternative analysis, must conform to the following parameters:

- Consist of at least 30 percent fines and no more than 5 percent gravel
- A hydraulic conductivity of or less than $1x10^{-6}$ cm/sec
- Liquid limit less than 40
- Plasticity index of 12 or less
- Compacted to at least 90 percent relative compaction for a total compacted depth of at least 18-inches

The soil subgrade under the 18-inch soil cover should be stripped of vegetation and compacted to at least 90 percent relative compaction prior to placing the cover.

We recommend placing a Mirafi 170N or equivalent filter fabric between the soil subgrade and overlying import soil for separation purposes and to conserve the specified 18-inch depth of the overlying capping material. This filter fabric will serve to conserve the grade of the Site by prevention of displacement of fine material within this layer of discontinuity.

Further, if additional fill is to be placed above the soil cap material, Mirafi 170N filter fabric or equivalent should be placed on between the capped material and the overlying fill for similar separation purposes. We do recommend placing a 6-inch layer of fill material above the cap material as a protective layer for the cap.

Vegetated Soil Area

The Property is to include vegetated swales along the northern portion of the regulated landfill area as well as adjacent to the roadway that traverses through the capped area. These vegetated swales will be lined with a geomembrane topped by a 12-inch layer of soil.

- Maximum hydraulic conductivity of $1x10^{-9}$ cm/sec
- Maximum transmissivity of 0.3 cm^2/sec
- Maximum total defects of 11 holes per acre

Based on these specified properties, we recommend a 40-mil, low-density polyethylene (LDPE) liner encased between 12-ounce geotextiles. A 12-ounce geotextile would be placed above the conditioned subgrade soil to provide protection to the geomembrane. A 12-ounce geotextile would be placed above the geomembrane to provide protection during fill placement.

The upper 6 inches of soil subgrade should be scarified, moisture conditioned to near optimum moisture content and compacted to at least 90 percent relative compaction. The soil subgrade of the vegetated swale should be graded with a minimum 1 percent slope.

A 12-inch vegetated soil layer will be required above this geomembrane/geotextile complex. There are no specifications to this soil layer, with the exception that is environmentally suitable material for commercial standards. On-Site material may be reused for the purpose of the vegetated soil cap. Vegetation should be established on this soil layer and should be graded to a minimum of 1 percent slope and to direct runoff to emerging wetlands or new stormwater structures. We understand this is the purpose of the swales and has been incorporated within the stormwater control plans.

Asphalt Concrete Pavement

The current development plans for the area of the Property that includes the regulated landfill includes a roadway. This roadway will require encapsulation by means of a similar or equivalent geomembrane/geotextile complex as to that stated above within the vegetated swale portions of the Site.

Soil subgrade will be pretreated as the same as stated above within the vegetated swale areas.

Aggregate base should conform to Section 26-1.02A of the current Caltrans Standard Specifications and should be compacted to at least 95 percent relative compaction. The asphalt pavement should have a minimum slope of 1 percent. The geomembrane/geotextile complex will underlie the aggregate base and further the asphalt concrete.

The pavement section recommendation for the asphalt concrete is based on an assumed R-value for the soil subgrade in addition to a traffic index (TI) of 6. Based on these recommendations, an 11.5-inch-thick layer of Class 2 AB material will be placed above the upper geotextile layer and will be overlain by a 3.5-inch-thick asphalt concrete layer above the Class 2 AB material.

ESTIMATED QUANTITIES OF CONSTRUCTION MATERIALS

Based on a review of the referenced 95 percent submittal plans reviewed, the following quantities have been estimated within the regulated landfill portion of the Property:

TABLE 1: Development Areas within Regulated Landfill Cap

PORTION OF REGULATED LANDFILL AREA	SQUARE FEET	ACRES
Imported Capped Area	306,191	7.03
Vegetative Swale	5020	0.12
Roadway	13,814	0.32
Total	**329, 442**	**7.56**

TABLE 2: Unit Quantities and Total Cost

MATERIAL	SQUARE FEET	DEPTH (INCHES)	CUBIC YARDS	ESTIMATED UNIT COST	TOTAL
Import Soil per Specifications	306,191	18	19,562	$50 per CY	$978,000
Quality Assurance Testing	306,191	18	17,011	$825 per Sample	$65,000
MIRAFI 170N Filter Fabric (2 Layers)	612,382	--	--	$0.07 per SF	$43,000
12-ounce Geotextile (2 Layers)	37,668	--	--	$0.35 per SF	$13,000
40-Mil LDPE Geomembrane	18,834	--	--	$0.9 per SF	$17,000
Vegetated Soil	5020	12	186	$0 (to $20 per CY)	$0
Class 2 AB	13,814	11.5	490	$3.90 per SF	$54,000
Asphalt Concrete	13,814	3.5	149		
TOTAL					**$1.12 million**

Table 1 provides the areas that comprise of the regulated landfill area. Table 2 breaks down the associated costs, assuming the specific recommended design we provided above. The geomembrane/geotextile unit quantities provided within Table 2 reflect the sum of the vegetated swale and roadway sections within the capped area. A conservative value of $50 per cubic yard was chosen for the import soil, per the approved specifications, that is intended to be representative of the cost of material in addition to transport and placement. The volumetric total for the imported soil assumes a conservative shrinkage of 15 percent when placed and compacted.

The 12 inches of vegetated soil necessary for the vegetated swale may vary in cost due to availability of material. We understand that onsite material likely may be used, which would not incur additional costs for the material or quality assurance testing. We assumed on Site material will be used within our cost estimate.

Standard quality assurance for environmental and geotechnical purposes will be required for any imported material. Environmental testing should be performed in general conformance with the Department of Toxic Substance Control (DTSC) import fill guidelines[1]. Plasticity indices, gradation curves, and other appropriate geotechnical tests may be required to assure the material will conform to the approved specifications. This line item accounts only for the 18-inch capped fine material. If additional soil is imported for fill placement above the capped material or as part of the vegetated 12-inch soil layer, these quality assurance costs would need to be adjusted.

SUMMARY OF NOTES (Acknowledge Design Plans)

A set of earthwork and grading landfill cap area notes have been provided within our design plans. All grading work within the landfill cap area shall be performed in accordance with these notes and the requirements and recommendations contained within this report as well as the San Francisco Bay Regional Water Quality Control Board's Response to Request to Approve Landfill Cover Design (SFRWQCB, February 2013).

[1] Department of Toxic Substances Control (DTSC); Information Advisory Clean Imported Fill Material; October 2001.

The landfill cap geotechnical engineer shall be present at the Site during grading operations and shall perform all testing deemed necessary. This on-site personnel will observe and identify conditions with recommended corrective measures and discuss with the contractor and construction manager. Earthwork shall be performed in accordance with the recommendations of the geotechnical engineer and the geotechnical engineer should be provided at least 48 hours' notice prior to any earthwork operations.

Excavations should be adequately shored, braced, and sheeted to prevent slide or settling of earth to prevent damage of existing improvements. Further, all cut-fill slopes at the boundary lines shall be constructed in a manner to avoid damage to adjacent fences.

The contractor is responsible for any potential damages and is required to effect necessary repairs at their own expense. The contractor shall comply with OSHA requirements and should conform to the specified lines, grades, sections, and dimensions within our plans. Corrective grading should be required, at no cost to the owner, if vertical elevations are not within tolerance of one-tenth of a foot. All grade lines shown in the plans are finished grades unless otherwise noted. Grades encountered on-Site may vary from what is shown on the plans and the contractor shall review the plans and conduct investigations as required to verify existing conditions. The contractor is responsible for matching existing streets, surrounding landscaping, and other improvements with a smooth transition in paving, curbs, gutters, sidewalks, grading etc. and to avoid the creation of any low spots or hazardous conditions as well as any abrupt or apparent changes in appearances, grades, or cross slopes.

The project shall conform with the San Francisco Department of Public Works Order No. 178940 regarding excavating and restoring streets in San Francisco.

If you have any questions regarding the contents of this report, we will gladly discuss with you.

Sincerely,

ENGEO Incorporated

Jeffrey A. Adams, PhD, PE

Shawn Munger, CHG

Brooke Spruit, EIT

Stefanos Papadopulos, GE

jaa/sm/bs/sp/cjn

Attachments: Figures 1 and 2

LANDFILL CAP PLAN NOTES
PIER 94 BACKLAND IMPROVEMENTS
SAN FRANCISCO, CALIFORNIA

EARTHWORK/GRADING LANDFILL CAP AREA NOTES

1. ALL GRADING WORK WITHIN THE LANDFILL CAP AREA SHALL BE PERFORMED IN ACCORDANCE WITH THESE NOTES AND THE REQUIREMENTS AND RECOMMENDATIONS CONTAINED THE FOLLOWING REPORTS:

   A. SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD; RESPONSE TO REQUEST TO APPROVE LANDFILL COVER DESIGN, ORDER R2-2003-0055, PIER 94 CLASS III LANDFILL, SAN FRANCISCO, FEBRUARY 25, 2013.

   B. ENGEO INC., LANDFILL CAP DESIGN SUMMARY, DECEMBER 15, 2017, JOB NO. 13233.001.000.

2. THE LANDFILL CAP GEOTECHNICAL ENGINEER SHALL BE PRESENT AT THE SITE DURING GRADING OPERATIONS AND SHALL PERFORM ALL TESTING DEEMED NECESSARY. THE LANDFILL CAP GEOTECHNICAL ENGINEER SHALL OBSERVE GRADING OPERATIONS FOR THE LANDFILL CAP AND IDENTIFY THOSE CONDITIONS WITH RECOMMENDED CORRECTIVE MEASURES TO THE CONTRACTOR AND THE CONSTRUCTION MANAGER.
3. EARTHWORK SHALL BE PERFORMED IN ACCORDANCE WITH THE RECOMMENDATIONS OF THE GEOTECHNCIAL ENGINEER. THE GEOTECHNICAL ENGINEER SHOULD BE PROVIDED AT LEAST 48 HOURS ADVANCE NOTIFICATION OF ANY EARTHWORK OPERATIONS
4. EXCAVATIONS SHALL BE ADEQUATELY SHORED, BRACED, AND SHEETED SO THAT THE EARTH WILL NOT SLIDE OR SETTLE AND SO THAT EXISTING IMPROVEMENTS OF ANY KIND WILL BE FULLY PROTECTED FROM DAMAGE. ANY DAMAGE RESULTING FROM A LACK OF ADEQUATE SHORING, BRACING AND SHEETING SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR AND THE CONTRACTOR AFFECT NECESSARY REPAIRS OR RECONSTRUCTION AT HIS OWN EXPENSE. THE CONTRACTOR SHALL COMPLY WITH OSHA REQUIREMENTS AT ALL TIMES.
5. CONTRACTOR SHALL CONFORM TO THE LINES, GRADES, SECTIONS, AND DIMENSIONS AS SET FORTH ON THESE PLANS. GRADED AREAS SHALL CONFORM TO THE VERTICAL ELEVATIONS SHOWN WITHIN TOLERANCE OF ONE-TENTH OF A FOOT. WHERE GRADED AREAS DO NOT CONFORM TO THESE TOLERANCES, THE CONTRACTOR SHALL BE REQUIRED TO DO CORRECTIVE GRADING, AT NO EXTRA COST TO THE OWNER.
6. ALL CUT FILL SLOPES AT THE BOUNDARY LINES SHALL BE CONSTRUCTED IN SUCH A MANNER THAT ADJACENT FENCES WILL NOT BE DAMAGED.
7. ALL GRADE SHOWN ARE FINISHED GRADES UNLESS OTHERWISE NOTED.
8. GRADES ENCOUNTERED ON-SITE MAY VARY FROM THOSE SHOWN. CONTRACTOR SHALL REVIEW THE PLANS AND CONDUCT INVESTIGATIONS AS REQUIRED TO VERIFY EXISTING CONDITIONS AT THE PROJECT SITE.
9. THE CONTRACTOR IS RESPONSIBLE FOR MATCHING EXISTING STREETS, SURROUNDING LANDSCAPING AND OTHER IMPROVEMENTS WITH A SMOOTH TRANSITION IN PAVING, CURBS, GUTTERS, SIDEWALKS, GRADING, ETC., AND AVOID THE CREATION OF ANY LOW SPOTS OR HAZARDOUS CONDITIONS OR ANY ABRUPT OR APPARENT CHANGES IN APPEARANCE, GRADES, OR CROSS SLOPES.
10. IMPORT FILL MATERIAL SHALL CONFORM TO THE SPECIFICATIONS AND REQUIREMENTS OF THE THE REPORTS REFERENCED IN NOTE 1.
11. PROJECT SHALL CONFORM WITH THE SAN FRANCISCO DEPARTMENT OF PUBLIC WORKS ORDER NO. 178940 REGARDING EXCAVATING AND RESTORING STREETS IN SAN FRANCISCO.
12. LANDFILL COVER MATERIALS IN THE AREAS IDENTIFIED IN THE PLAN SHEET 2 SHALL CONFORM TO THE FOLLOWING REQUIREMENTS:

A. SOIL COVER:

I. THE SOIL COVER SHALL CONSIST OF SANDY OR CLAYEY SAND WITH AT LEAST 30 PERCENT FINES, NO MORE THAN 5 PERCENT GRAVEL, A LIQUID LIMIT OF LESS THAN 40 AND A PLASTICITY INDEX OF 12 OR LESS.

II. THE SOIL COVER SHALL BE PLACED IN 1-FOOT LIFTS, SHALL BE COMPACTED TO AT LEAST 90 PERCENT RELATIVE COMPACTION.

III. THE SOIL COVER SHALL HAVE A HYDRAULIC CONDUCTIVITY OF LESS THAN 1 X 10-6 CENTIMETERS PER SECOND (CM/S) AT 90 PERCENT RELATIVE COMPACTION.

IV. THE THICKNESS OF THE SOIL COVER SHOULD BE A MINIMUM OF 18 INCHES WHEN COMPACTED AT 90 PERCENT RELATIVE COMPACTION.

V. THE SOIL SUBGRADE UNDERLYING THE 18-INCH SOIL COVER SHOULD BE STRIPPED OF VEGETATION AND COMPACTED TO AT LEAST 90 PERCENT RELATIVE COMPACTION. SEPARATION FABRIC MIRAFI 170N OR EQUIVALENT, SHALL BE PLACED ON THE SUBGRADE PRIOR TO PLACING THE SOIL COVER MATERIAL. IF THE SOIL COVER IS COVERED WITH ADDITIONAL FILL, SEPARATION FABRIC MIRAFI 170 N OR EQUIVALENT SHALL BE PLACE ON THE TOP OF THE SOIL COVER PRIOR TO PLACING ADDITIONAL FILL

B. VEGETATED SWALE:

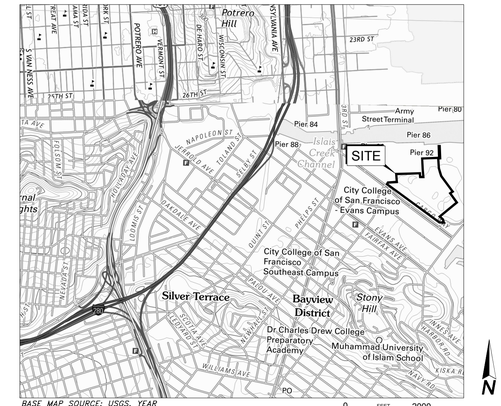
I. THE UPPER 6 INCHES OF SOIL SUBGRADE SHOULD BE SCARIFIED, MOISTURE CONDITIONED TO NEAR OPTIMUM MOISTURE CONTENT, AND COMPACTED TO AT LEAST 90 PERCENT RELATIVE COMPACTION.

II. THE SOIL SUBGRADE OF THE VEGETATED SWALE SHOULD BE GRADED WITH A MINIMUM 1 PERCENT SLOPE AND COVERED WITH A LOW-PERMEABILITY GEOMEMBRANE LINER. THE GEOMEMBRANE LINER SHOULD HAVE A MAXIMUM HYDRAULIC CONDUCTIVITY OF 1 X 10-9 CM/S, MAXIMUM TRANSMISSIVITY OF 0.3 SQUARE CENTIMETERS PER SECOND (CM2/S), AND A MAXIMUM TOTAL DEFECT OF 11 HOLES PER ACRE. THE GEOMEMBRANE LINER SHOULD BE ESTABLISHED ON THIS LAYER, AND THE SURFACE OF THE SOIL LAYER SHOULD BE GRADED TO A MINIMUM 1 PERCENT SLOPE AND TO DIRECT RUNOFF TO EMERGING WETLANDS OR NEW STORMWATER STRUCTURES. IRRIGATION ON THE VEGETATION SWALE SHOULD NOT BE PERMITTED.

C. ASPHALT CONCRETE PAVEMENT :

I. THE UPPER 6 INCHES OF SOIL SUBGRADE SHOULD BE SCARIFIED, MOISTURE CONDITIONED TO NEAR OPTIMUM MOISTURE CONTENT, AND COMPACTED TO AT LEAST 95 PERCENT RELATIVE COMPACTION.

SHEET INDEX



BASE MAP SOURCE: USGS, YEAR

VICINITY MAP

ENGEO Expect Excellence
2010 CROW CANYON PLACE
SUITE 250
SAN RAMON, CALIFORNIA 94583
(925) 866-9000
FAX (888) 279-2698
SAN RAMON - SAN JOSE - SAN FRANCISCO - ROCKLIN - RIPON

PUBLIC WORKS JOB ORDER NUMBER: 1616J FILE NO. 106,

NO.	DATE	DESCRIPTION	BY	APP.

TABLE OF REVISIONS

REFERENCE INFORMATION & FILE NO. OF SURVEYS

SAN FRANCISCO PORT COMMISSION
PORT OF SAN FRANCISCO
DEPARTMENT OF ENGINEERING

DESIGNED: DATE: BES 12/15/17
DRAWN: DATE: SRP 12/15/17
CHECKED: DATE: SAP 12/15/17

SFPW APPROVALS
SECTION MANAGER DATE:
DEPUTY DIVISION MANAGER DATE:
DIVISION MANAGER DATE:

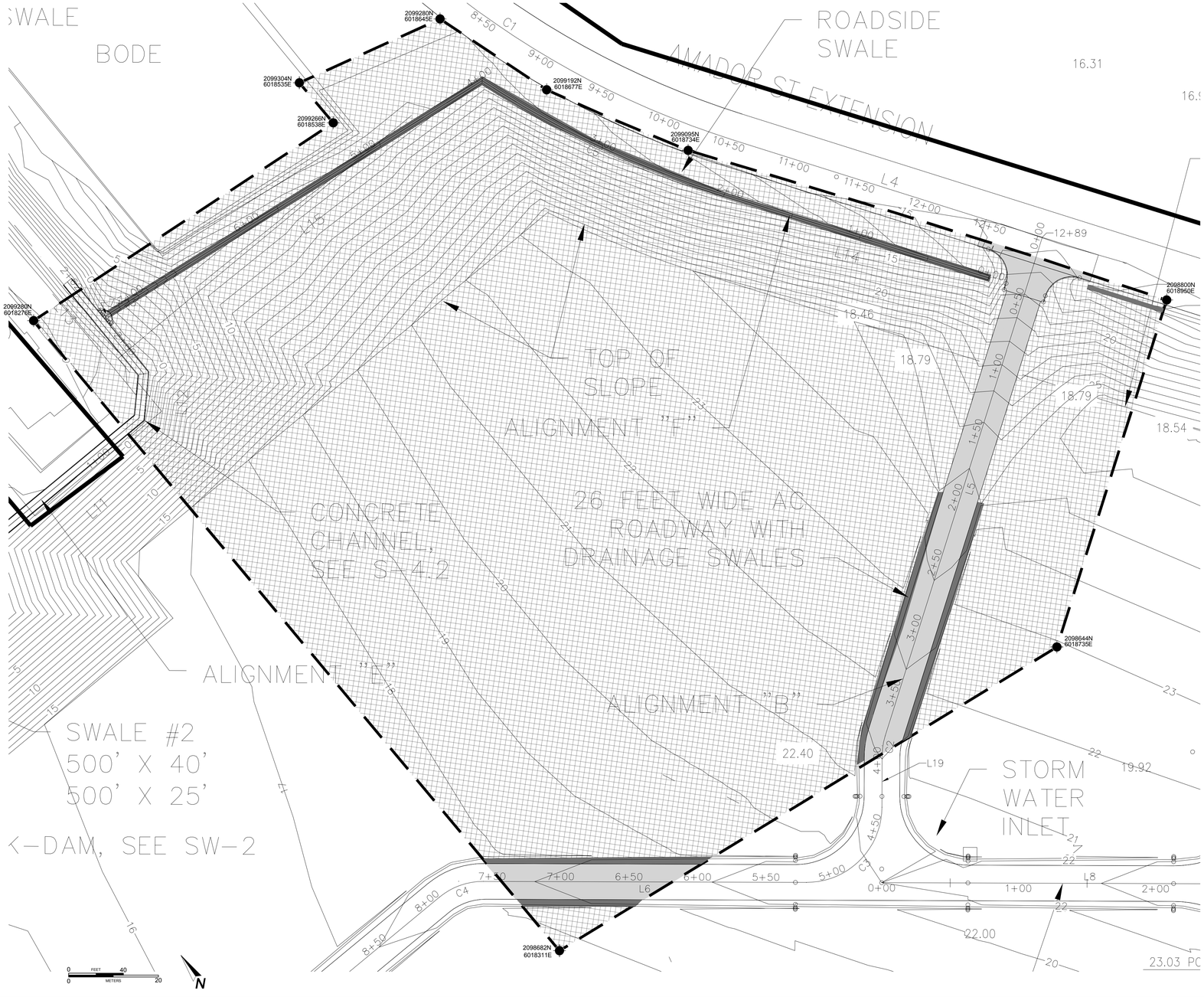
APPROVED BY SAN FRANCISCO PORT COMMISSION
DATE: _____
CHIEF HARBOR ENGINEER

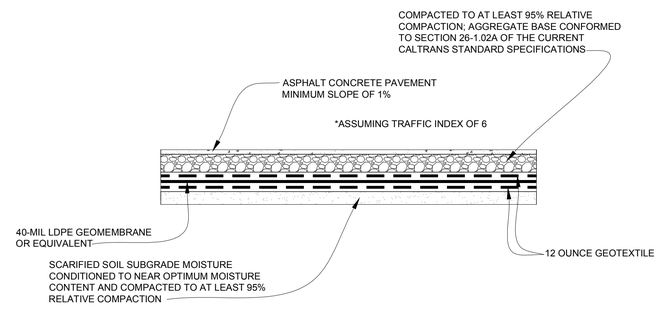
SCALE: AS SHOWN
REV. NO. 0

PIER 94 BACKLANDS IMPROVEMENTS PROJECT

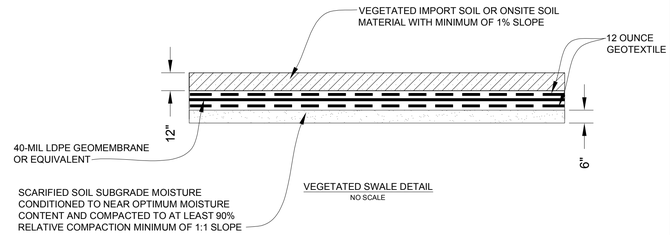
LANDFILL CAP NOTES, VICNITY MAP, AND SHEET INDEX

CONTRACT NO. 2786
DRAWING NO. 19036-344-LC
SHEET OF SHEETS LC-1

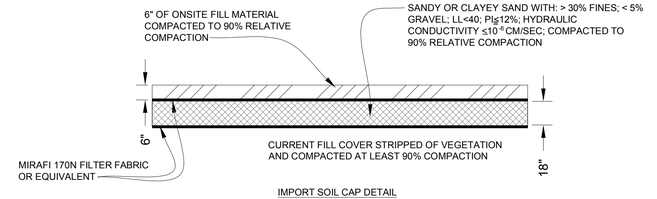




ROADWAY ASPHALT CONCRETE PAVEMENT DETAIL
NO SCALE



VEGETATED SWALE DETAIL
NO SCALE



IMPORT SOIL CAP DETAIL
NO SCALE

MATERIALS	SQUARE FEET
IMPORT SOIL CAP	306,191
VEGETATED SWALE	5020
ROADWAY	13,814
TOTAL	329,442

EXPLANATION
ALL LOCATIONS ARE APPROXIMATE

- IMPORT SOIL CAP
- VEGETATED SWALE
- ROADWAY
- 2098800N 6018950E / 2098644N 6018735E — LANDFILL CAP LIMITS

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SCALE: AS SHOWN
REV. NO. 0

PIER 94 BACKLANDS IMPROVEMENTS PROJECT

LANDFILL CAP PLAN, DETAILS

CONTRACT NO. 2786
DRAWING NO. 19036-344-LC
SHEET OF SHEETS LC-2