APPENDIX G

WASTEWATER BASIS OF DESIGN

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Subject: Basis of Design Report for The Mosaic Project - 17015 Cull Canyon Road Project Site (APN 85-1200-1-16)

Dear Natali,

The following is our Basis of Design Analysis for The Mosaic Project based on the project description submitted as part of the Conditional Use Permit Application (PLN2020-00093.) This basis of design follows the Alameda County *Onsite Wastewater Treatment System Manual June 2018* (Manual.)

PROJECT LOCATION

The Mosaic Project (Project) is located on an approximately 37-acre site, at 17015 Cull Canyon Road in the unincorporated portion of Alameda County, California, approximately 3 miles North of Interstate 580 (I-580). The site is bounded by Cull Canyon Road to the east, Twining Vine Winery to the north, Cull Canyon Regional Recreational Area to the west, and residential property to the south.

The site is centered at about 37°44'33.83"N latitude and 122° 3'18.85"W longitude, and is located in Section 23, Range 02W, Township 2S, Hayward USGS 7.5' Quad.

PROJECT OBJECTIVES

The Mosaic Project's mission is to work toward a peaceful future by uniting children of diverse backgrounds, providing them with essential community building skills, and empowering them to become peacemakers.

The primary program is the Outdoor Project which brings together 4th and 5th grade classes from markedly different backgrounds for a profound weeklong experience in nature.

PROJECT DESCRIPTION

The Outdoor Project facilitates three classes of 4th or 5th grade students (approximately 75-95 students) that are bussed to the project site from their schools for a 5-day, 4-night camp program in nature. Students arrive by bus +/- 11am Monday morning and depart +/- 1:30pm Friday afternoon.

The Outdoor Project currently operates seasonally during the school year with six consecutive camp sessions in the fall [September-October] and six consecutive camp sessions in the spring [April-May]. The goal is eventually to operate year-round, including summer sessions and occasional weekend programs. The programs would be spaced out so that there would never be more than two consecutive 5-day, 4-night programs. Likewise, weekend programs would never fall next to a weekday program. This will allow for the following:

- 18 Outdoor Project 5-day/4-night sessions (10 in the winter/spring and 8 in the fall)
- Four (4) 5-day/4-night summer sessions
- 12 weekend programs

WASTEWATER SOURCE AND FLOW ANALYSIS

The proposed project consists of the following structures and uses where wastewater will be generated. Wastewater predictions are based on a per person design flow assumption in terms of gallons per day. Predicted Wastewater Flows can be found in Table 1.

Central Meeting & Dining Hall: This 8,500 sf multi-purpose building would be constructed southeast of the cabins. It will be used for camp indoor activities and would contain restrooms, a medic room, kitchen, pantry, dining area, meeting space, laundry, restrooms, showers, and offices.

Restroom/Shower Building: A 1,025 sf restroom/shower building would be constructed near the camping cabins.

Family Dwelling: A 2,600 sf staff dwelling would be constructed to serve as Mosaic staff's permanent home.

Other Structures

Camping Cabins: Twelve 400 sq. non-permanent camping cabins would be placed on the project site. Cabins will be simple, light-footprint construction with no plumbing features in the buildings. Campers will be served by the Central Meeting and Dining Hall and the Restroom Shower Building.

Caretaker's Unit: The existing 1,200 sf structure will remain as a caretaker's dwelling and will be served by the existing septic system serving the structure and is not a part of this analysis.

Table 1 – Predicted Wastewater Flows

Occupant Type	Maximum Daily Occupants/Use	Flow/per Person (gpd)*	GPD
Campers	100	25	2,500
Day Staff	8	25	200
Family Dwelling Residence	8 Bedroom	N/A	825
		Total	**3,525**

* See Discussion on flow rate for details

Flow Rate Determination: The flow rate of 25gpd/person is based on multiple factors.

- Comparative Flow Analysis – a design flow per person of 25gpd/person was determined for this project based on our experience in designing similar systems and the factors below:

- Water use was measured via the water system flow meter at the current camp facility in the Spring of 2018. During a ten-day period with 124 staff and campers on site, the average water use recorded at 19 gallons per day per person. It should be noted this facility has an aging water infrastructure, which may have resulted in higher calculated water use that actual use by campers and staff.

- Review of EPA Onsite Wastewater Treatment Systems Manual (February 2002) Table 3-6. Typical wastewater flow rates from recreational facilities shows typical values for camps. Typical values for "Pioneer Camps" and "Children's Camps" are 25gpd and 45gpd respectively, with the average of these two flows at 35pgd/person. The way The Mosaic Project camp is operated is in line with a pioneer camp. Table 3-10. *Comparison of flow rates and flush volumes before and after U.S. Energy Policy Act* shows a reduction of flow for water saving fixtures at approximately 50% potential reduction in water used. This is consistent with what we see across the state in residential and school settings. Accounting for a 50% reduction in design flows for modern fixtures results in a predicted average water use per person at under 20gpd.

- A conservative design flow value 25gpd/per person was used for calculations.

- Total Design Flow Determination – The total design flow determination of 3,525gpd will be used for the sizing of the septic tanks, treatment system and dispersal field. Blackwater flow reductions as a result of any proposed or future greywater use for landscape irrigation are not subtracted from the design flow except in analyzing the impacts on secondary treatment sizing.

Conceptual Wastewater Treatment System Sizing

Wastewater treatment infrastructure is governed by the wastewater generated (both flow and waste strength), the soil resource, and the type of dispersal system selected.

In this conceptual phase of the project, primary and secondary treatment of effluent is assumed. This will require, at a minimum, grease interceptor tanks, septic tanks, and secondary treatment equipment and surge/dosing tanks with pumps and controls to move wastewater evenly and consistently to dispersal zones on the site.

Secondary wastewater treatment will be accomplished with Orenco Advantex textile filtration in with AX100 pod or AXMax configuration. The determination of secondary treatment equipment will be made as part of final design of the site and infrastructure.

Secondary treatment systems are sized for both hydraulic and organic loading. For hydraulic loading, peak flow (design flow) and average flow conditions are reviewed. Average flows are assumed as 80% of the design.

Organic loading sizing must also be reviewed again at peak and average flow conditions.

With the potential use of greywater diversion, two scenarios for treatment sizing have been analyzed;

- Scenario 1 – Full blackwater flow with no greywater diversion. This scenario models when a greywater system is not present or active, primarily when regulations limit the use of greywater in high precipitation conditions.
- Scenario 2 – Reduced blackwater flow with greywater diversion. This scenario models if a greywater system is present or active, lowering the daily flow and potentially increasing the organic loading.

A summary of the conceptual treatment sizing can be found below. Supporting calculations are attached.

Table 2 – Conceptual Treatment System Sizing		
Component	**Size**	**Notes:**
Septic Tank(s)	20,000 gallons	o May be multiple tanks serving various locations
Secondary Treatment	175s.f. of filter area	o Scenario 2 Average Flow Organic Loading Governs o May be reduced with pretreatment conditioning in final design phase.
Dosing Tank	5,000 gallons	o May be reduced with pretreatment conditioning in final design phase.

Conceptual Dispersal System Approach and Sizing

The dispersal concept includes applying secondary treated effluent to pressure dosed chambered trenches in the area identified on the attach concept site plan.

Soil profiles revealed loam/clay loam and silty clay loams soils with typical profiles to Yolo loam and Danville silty clay loam. NRCS mapping predicts Yolo loam in the vicinity of the proposed project with Danville silty clay loam appearing across Cull Canyon Road. Percolation tests results show adjusted percolation rates ranging from 8 to 48 minutes per inch (average percolation rate of 33 min.in.) These results are in the ranges outline in Table 8-4 - *Soil Types & Associated Percolation Rate Guidelines* on the Manual.

The conceptual design is based on a peak design flow of 3,525gpd and a soil application rate assumption of 1.03gpd/sf and 5.0sf of infiltrative area per lineal foot. With secondary treated effluent proposed, the final design may incorporate infiltrative area in the final design. With these conservative assumptions, the total lineal footage for the original dispersal field is approximately 480 lineal feet of pressure dosed trenches.

The replacement area would be identified in two distinct locations. The primary replacement area would be located in the spacing between the proposed pressure dosed trenches. This would use the same configuration as the original dispersal system, with 480 lineal feet of pressure dosed chambers.

A backup repair alternate would be to use a drip dispersal area on the sloped areas on the property. Using 3,525 gpd design flow and an application rate of 0.4 gpd/sf, an area of approximately 9,000 sf for drip dispersal would be required.

Soil profile and percolation test results are attached.

Table 3 – Conceptual Dispersal System Sizing			
Dispersal Method	**Application Rate:**	**Size:**	**Notes:**
Pressure Dosed Chambers	1.0gpd/sf @5sf/lf	480 lf	o Conservative application rate using enhanced application rates and infiltrative surface area
Pressure Dosed Chambers	1.0gpd/sf @8sf/lf	300 lf	o Conservative application rate and infiltrative surface area increased to 8sf/sf per Chapter 27.C.3.

Drip (only for replacement option on slope)	0.4gpd/sf	9,000 sf of surface area	o Future only for replacement field

Cumulative Impact Assessment
The project was analyzed for applicability under Chapter 10 of the Manual. The project is classified as a Nonresidential with a Design Wastewater Flow of over 2,500gpd outside the Upper Alameda Creek Watershed above Niles (Impaired Area.) Based on Table 10-1 - *Projects Requiring Cumulative Impact Assessment* in the Manual Groundwater Mounding Analysis and Nitrogen Loading Analysis are required.

- Assumptions and Data Sources:
    - Climatic Data
        - Precipitation was assumed at 22 inches per year based on Alameda County Hydrology & Hydraulics Manual from the Alameda County Flood Control District https://www.cleanwaterprogram.org/images/uploads/C3TG_v6_Oct_2017_Appendix_D_Rainfall_Map.pdf
        - Evapotranspiration was not used in any calculations keeping the calculations conservative in nature.
    - Background Groundwater Quality Data.
        - Water quality data is available from the development and permitting of the public water system wells from the project owner but not used in this report. However, because this project is not located in an area identified in Chapter 10.4.C.2 of the Manual as an Area of Concern (AOC) background data is not required for nitrogen loading calculations. A background nitrate concentration in rainfall was assumed as 2.0mg/l.
    - Soil Profile Data
        - Soil Profile Sheets and percolation test results are attached.
        - NRCS Soil Data is attached
    - Wastewater Characteristics
        - Flow – Predicted design flow is calculated at 3,525gpd and an average daily flow predicted at 80% of design flow or 2,820gpd. A summary of flows is above and detailed flow calculations are attached.
        - Biochemical Oxygen Demand (BOD) - BOD is assumed as less the 300mg/l with a peak of 400mg/l from potential greywater diversion.
        - Nitrogen - Nitrogen is assumed as similar to residential strength at 70mg/l from Table 10-2.
- Groundwater Mounding Analysis – Groundwater mounding was calculated using the Hantush Method (Case 2 in the attached methodology) and Bower Method (Case 4 in the attached methodology.) Based on these calculated methods, groundwater could mound up to 17 feet and

come within 10 feet of the bottom of the proposed dispersal trenches, which is greater than the 5 feet of separation found in Case 4 of Table 5-2 - *Nitrogen Loading Analysis Minimum Average Wastewater Flow & Nitrogen Concentration Criteria* in the Manual. Table 4 is a summary of these results. Calculations are attached.

Table 4 – Summary of Mounding Analysis Results

Scenario	Calculated Localized Mound Height	Depth to Saturated Zone Below Dispersal	Notes:
Case 2 – Design Flow	5.4 ft	21.6 ft.	o Conservative with design flow occurring 365 days per year.
Case 2 – Average Flow	4.5 ft	22.5 ft.	
Case 4 – Design Flow	17.0 ft	10.0 ft.	o Conservative with design flow occurring 365 days per year.
Case 4 – Average Flow	13.6 ft	13.4 ft.	

- Nitrogen Loading Analysis
  - Nitrogen Loading was calculated using the Hantzsche-Finnemore equation and the nitrogen limits listed in Table 10-4 - *Minimum Cumulative Nitrogen Loading Criteria from Proposed OWTS* in the manual. This calculation was used to determine nitrogen removal rate from the proposed secondary treatment system. The methodology used was to set the calculated average concentration of nitrate nitrogen entering the groundwater at 7.5mg/l and solve for the percent removal from the treatment system. Table 5 is a summary of these results. Calculations are attached.
  - For conservancy, no plant uptake or soil denitrification was assumed, leaving the nitrogen removal to the proposed secondary treatment system.

Table 5 – Summary of Nitrogen Loading Results

Scenario	Nitrogen Concentration Assumed	Calculated Percent Removal Required	Notes:
Design Flow – Predicted	70 mg/l	22.0%	
Design Flow – High	105 mg/l	48.0%	1.5 x Predicted concentration
Average Flow – Predicted	70 mg/l	5.0%	
Design Flow – High	140 mg/l	52.0%	2.0 x Predicted concentration

  - Table 5 shows that less than 25% nitrogen reduction is needed from the treatment system to satisfy the requirement of 7.5 mg/l groundwater nitrate concentration. Additionally, nitrogen concentrations ranging between 1.5 and 2.0 times higher than residential strength nitrogen would require approximately 50% reduction. This is well within a standard Orenco Advantex system without additional denitrification enhancements.

Summary

Based on the project description, the proposed use, soil testing, and conceptual sizing of treatment system components and cumulative impact assessment calculations, the project can be supported by an onsite wastewater treatment and dispersal system. The system would be sized to accommodate 3,525gpd design flow (2,820gpd average daily flow), domestic strength waste (BOD less than 300mg/l), nitrogen input ranging from 70mg/l to 140 mg/l. This system components would include:

1. Septic Tank Volume totaling 20,000 gallons.
2. An Orenco AX MAX textile filter system with 175 square feet of media and associated recirculation volume providing 30 mg/l BOD and 30 mg/l TSS and 50% nitrogen removal.
3. A 6,000-gallon dosing tank with the capacity to hold 1.5 days of design flow and delivery of secondary treated effluent to a subsurface dispersal field.
4. 480 lineal Feet of 24-inch wide x 24-inch deep pressure dosed chambered dispersal trenches.

I am happy to discuss any of the assumptions, calculations, and/or proposed treatment technologies with you at your convenience.

Best regards,
NorthStar

Dominickus J. Weigel III RCE 66282
President, Senior Managing Engineer

Enclosures:

- Design Calculations
- Mounding Calculations
- Nitrogen Loading Calculations
- Wastewater Dispersal Area Exhibit
- Mounding Analysis Exhibit
- Conceptual Dispersal Field Layout Exhibit
- Soil Profile Data Sheets
- Percolation Data Sheets
- NRCS Soil Map and Soil Unit Descriptions
- Orenco Preliminary Design Review Letter
- Alameda County Flood Control District Mean Annual Precipitation Map
- Excerpts from Methodologies for Assessment of Cumulative Impacts (Mounding Methodology Hantush and Bower)
- EPA Onsite Wastewater Treatment Systems Manual (February 2002) Table 3-6. *Typical wastewater flow rates from recreational facilities shows typical values for camps.*
- EPA Onsite Wastewater Treatment Systems Manual (February 2002) Table 3-10. *Comparison of flow rates and flush volumes before and after U.S. Energy Policy Act*

Conceptual Wastewater System Design Calculations - Treatment System

The Mosaic Project
Alameda County CA

Wastewater Design Flow

	Number	Flow Per Person	BOD	Peak Design Flow
Campers/Counselors	100	25 gpd	<300mg/l	2,500 gpd
Day Staff	8	25 gpd	<300mg/l	200 gpd
Family Dwelling Residence (3-Bedroom)	3	150 gpd	<300mg/l	450 gpd
Family Dwelling Residence (+ Bedrooms)	5	75 gpd	<300mg/l	375 gpd
			Total Flow	3,525 gpd
			Average Flow	2,820 gpd

Septic Tank Sizing

Septic Tank Size	Detention (Days) Minimum	5	17,625 gal

Use 20,000 Gallon Septic Tank

Recirculation Tank Volume

Recirc Tank	Detention (Days)	1	3,525 gal

Use 5,000 Gallon Recirc Tank

Secondary Treatment System (Advantex)

Design Flow		Hydraulic Loading	Square Footage Required
Peak	3,525 gpd	50 gpd/sf	71 sf
Average	2,820 gpd	25 gpd/sf	113 sf

Waste Strength			
Peak	400 mg/l	50 gpd/sf	
Average	300 mg/l	25 gpd/sf	
Cumulative Pounds of BOD5 at Design Flow	11.76	lb BOD_5/day	
Cumulative Pounds of BOD5 at Average Flow	7.06	lb BOD_5/day	
Design Flow Loading Rate	0.08	lb $BOD_{5/day/sf}$	147 sf
Average Flow Loading Rate	0.04	lb $BOD_{5/day/sf}$	176 sf

Dosing Tank Sizing

Dosing Tank	Detention (Days)	1.5	5,288 gal

Use 6,000 Gallon Dosing Tank

Conceptual Wastewater System Design Calculations - Original Dispersal Field

Dispersal Trenches With Chambers in Main Campus Area

The Mosaic Project
Alameda County CA

Wastewater Design Flow

	Number	Flow Per Person		Peak Design Flow
Campers/Counselors	100	25 gpd		2,500 gpd
Day Staff	8	25 gpd		200 gpd
Family Dwelling Residence (3-Bedroom)	3	150 gpd		450 gpd
Family Dwelling Residence (+ Bedrooms)	5	75 gpd		375 gpd
			Total Flow	3,525 gpd

Minimum Dispersal Field Sizing Trenches

Required Capacity			3,525 gpd
Application Rate	Average Precolation Rate 33 min/in.		1.03 gpd/sf
Dispersal Area (Using 36" wide chambers)			5.00 sf/lf
Standard Dispersal Trench Length Required			684 lf
With Chambers	Reduction	30%	479 lf

Use 480 Lineal Feet of 36-inch wide x 24-inch deep pressure dosed chambered dispersal trenches.

Conceptual Wastewater System Design Calculations - Replacement Dispersal Field

The Mosaic Project
Alameda County CA

Drip Dispersal Located on Slopes

Wastewater Design Flow

	Number	Flow Per Person	BOD	Peak Design Flow
Campers/Counselors	100	25 gpd	<300mg/l	2,500 gpd
Day Staff	8	25 gpd	<300mg/l	200 gpd
Care Taker/Security Residence (Bed 1-3)	3	150 gpd	<300mg/l	450 gpd
Care Taker/Security Residence (Bed 4+)	5	75 gpd	<300mg/l	375 gpd
			Total Flow	3,525 gpd

Minimum Dispersal Field Sizing Trenches

Required Capacity	3,525 gpd
Application Rate	0.20 gpd/sf
Drip Square Footage Required	17,625 sf

Conceptual Wastewater System Design Calculations - Mounding Analysis

Mounding Analysis as listed in Chapter 10 OWTS Manual - Design Flow

The Mosaic Project
Alameda County CA

Wastewater Design Flow

	Number	Flow Per Person		Peak Design Flow
Campers/Counselors	100	25 gpd		2,500 gpd
Day Staff	8	25 gpd		200 gpd
Care Taker/Security Residence (Bed 1-3)	3	150 gpd		450 gpd
Care Taker/Security Residence (Bed 4+)	5	75 gpd		375 gpd
			Total Flow	3,525 gpd
			Average Flow	2,820 gpd

Localized Mounding Using Case 2

Width of Absorption Field Area (Feet) W	100
Length of Absorption Field (Feet) L	200
Wastewater Flow (GPD) Qw	3,525 gpd
Wastewater Application Rate (Ft/Day) I	0.023562834
Soil Pore Space (Cu Ft/Cu Ft) V	0.3
Horizontal Hydraulic Conductivity of Soil (Ft/Day) K	2.77
Depth to Saturated Zone From Bottom of Disposal Trench (Feet) H	27
Assumed Initial Depth of Saturated Zone (Feet) hi	5
Duration of Wastewater Application (Days) t	365.00
Assumed Maximum Depth of Saturated Zone (Feet) hm	10.40
b (Feet)	7.70
Vo	71.10
alpha	0.31
beta	0.16
Value of Function from Table 1	0.19
Calculated Maximum Depth of Saturated Zone (Feet) hm (Note: This value should equal the	10.39
Calculated Maximum Height of Localized Mounding (Feet) hm-hi	5.40
Calculated Depth to Saturated Zone from Bottom of Disposal Trench (Feet) z	**21.61**

Ksat from NRCS Yolo Loam 0.57 to 2.2 in/hr. =1.14 to 4.4 Used Average for Calculations
H assumed as difference of lowest elevations of dispersal field (105 contour) - creek bed (75 contour) - assumed dispersal trench depth of 3 feet.

Conceptual Wastewater System Design Calculations - Mounding Analysis

Mounding Analysis as listed in Chapter 10 OWTS Manual - Average Flow

The Mosaic Project
Alameda County CA

Wastewater Design Flow

	Number	Flow Per Person		Peak Design Flow
Campers/Counselors	100	25 gpd		2,500 gpd
Day Staff	8	25 gpd		200 gpd
Care Taker/Security Residence (Bed 1-3)	3	150 gpd		450 gpd
Care Taker/Security Residence (Bed 4+)	5	75 gpd		375 gpd
			Total Flow	3,525 gpd
			Average Flow	2,820 gpd

Localilzed Mounding Using Case 2

Width of Absorption Field Area (Feet) W	100
Length of Absorption Field (Feet) L	200
Wastewater Flow (GPD) Qw	2,820 gpd
Wastewater Application Rate (Ft/Day) I	0.018850267
Soil Pore Space (Cu Ft/Cu Ft) V	0.3
Horizontal Hydraulic Conductivity of Soil (Ft/Day) K	2.77
Depth to Saturated Zone From Bottom of Disposal Trench (Feet) H	27
Assumed Initial Depth of Saturated Zone (Feet) hi	5
Duration of Wastewater Application (Days) t	365.00
Assumed Maximum Depth of Saturated Zone (Feet) hm	9.45
b (Feet)	7.23
Vo	66.73
alpha	0.32
beta	0.16
Value of Function from Table 1	0.19
Calculated Maximum Depth of Saturated Zone (Feet) hm (Note: This value should equal the	9.5
Calculated Maximum Height of Localized Mounding (Feet) hm-hi	4.5
Calculated Depth to Saturated Zone from Bottom of Disposal Trench (Feet) z	**22.5**

Ksat from NRCS Yolo Loam 0.57 to 2.2 in/hr =1.14 to 4.4 Used Average for Calculations
H assumed as difference of lowest evelations of dispersal field (105 contour) - creek bed (75 contour) - assumed dispersal trench depth of 3 feet.

Conceptual Wastewater System Design Calculations - Mounding Analysis

Mounding Analysis as listed in Chapter 10 OWTS Manual - Design Flow

The Mosaic Project
Alameda County CA

Wastewater Design Flow

	Number	Flow Per Person		Peak Design Flow
Campers/Counselors	100	25 gpd		2,500 gpd
Day Staff	8	25 gpd		200 gpd
Care Taker/Security Residence (Bed 1-3)	3	150 gpd		450 gpd
Care Taker/Security Residence (Bed 4+)	5	75 gpd		375 gpd
			Total Flow	3,525 gpd
			Average Flow	2,820 gpd

Localized Mounding Using Case 4

Width of Absorption Field Area (Feet) W	100
Length of Absorption Field (Feet) L	200
Wastewater Flow (GPD) Qw	3,525 gpd
Wastewater Application Rate (Ft/Day) I	0.023562834
Horizontal Hydraulic Conductivity of Soil (Ft/Day) K	2.77
Average Thickness of Saturated Zone Perpendicular to Flow (D)	20
Lateral Flow Distance from Disposal Field to Discharge Point (feet) d	200
Height of Dispersal Point Above Downslope Outlet (feet) H	27.00
Calculated Maximum Groundwater Depth Above Outlet (feet) h	17.0
Calculated Effective Separation Distance (feet) z	**10.0**

Ksat from NRCS Yolo Loam 0.57 to 2.2 in/hr =1.14 to 4.4 Used Average for Calculations
H assumed as difference of lowest elevations of dispersal field (105 contour) - creek bed (75 contour) - assumed dispersal trench depth of 3 feet.

Conceptual Wastewater System Design Calculations - Mounding Analysis

Mounding Analysis as listed in Chapter 10 OWTS Manual - Average Flow

The Mosaic Project
Alameda County CA

Wastewater Design Flow

	Number	Flow Per Person		Peak Design Flow
Campers/Counselors	100	25 gpd		2,500 gpd
Day Staff	8	25 gpd		200 gpd
Care Taker/Security Residence (Bed 1-3)	3	150 gpd		450 gpd
Care Taker/Security Residence (Bed 4+)	5	75 gpd		375 gpd
			Total Flow	3,525 gpd
			Average Flow	2,820 gpd

Localized Mounding Using Case 4

Width of Absorption Field Area (Feet) W	100
Length of Absorption Field (Feet) L	200
Wastewater Flow (GPD) Qw	2,820 gpd
Wastewater Application Rate (Ft/Day) I	0.018850267
Horizontal Hydraulic Conductivity of Soil (Ft/Day) K	2.77
Average Thickness of Saturated Zone Perpendicular to Flow (D)	20
Lateral Flow Distance from Disposal Field to Discharge Point (feet) d	200
Height of Dispersal Point Above Downslope Outlet (feet) H	27.00
Calculated Maximum Groundwater Depth Above Outlet (feet) h	13.6
Calculated Effective Separation Distance (feet) z	**13.4**

Ksat from NRCS Yolo Loam 0.57 to 2.2 in/hr =1.14 to 4.4 Used Average for Calculations
H assumed as difference of lowest elevations of dispersal field (105 contour) - creek bed (75 contour) - assumed dispersal trench depth of 3 feet.

Conceptual Wastewater System Design Calculations - Nitrogen Analysis

Nitrogen Loading Mass Balance as listed in Chapter 10 OWTS Manual - Design Flow

The Mosaic Project
Alameda County CA

Wastewater Design Flow

	Number	Flow Per Person	Nitrogen	Peak Design Flow
Campers/Counselors	100	25 gpd	<70mg/l	2,500 gpd
Day Staff	8	25 gpd	<70mg/l	200 gpd
Care Taker/Security Residence (Bed 1-3)	3	150 gpd	<70mg/l	450 gpd
Care Taker/Security Residence (Bed 4+)	5	75 gpd	<70mg/l	375 gpd
			Total Flow	3,525 gpd
			Average Flow	2,820 gpd

Nitrogen Loading Analysis Design Flow High

Daily Wastewater Flow (Gallons per Day) W	3,525 gpd
Total Surface Area (Acres)	37.0 acres
Duration of Wastewater Application (Days) t	365
Calculated Volume of Wastewater Entering Soil (Inches per Year) I	1.28
Total Nitrogen Concentration in Wastewater Entering System (mg/l) nw	70
Percent of Nitrate-Nitrogen loss due to Soil Denitrification d	0
Average Rainfall Recharge Rate (50% of Annual Rainfall Assumed) (Inches per Year) R	11
Background Nitrate-Nitrogen[1] Concentration in Rainfall Recharge (mg/l) nb	2
Percent Nitrogen Removal Required From Treatment System Tr	**22%**
Calculated Average Concentration of Nitrate-Nitrogen (mg/l) nr	**7.50**

Ref: HANTZSCHE-FINNEMORE EQUATION

Nitrogen Loading Analysis Design Flow High Concentration Assumption

Daily Wastewater Flow (Gallons per Day) W	3,525 gpd	
Total Surface Area (Acres)	37.0 acres	
Duration of Wastewater Application (Days) t	365	
Calculated Volume of Wastewater Entering Soil (Inches per Year) I	1.28	
Total Nitrogen Concentration in Wastewater Entering System (mg/l) nw	105	**1.5X of anticipated**
Percent of Nitrate-Nitrogen loss due to Soil Denitrification d	0	
Average Rainfall Recharge Rate[1] (50% of Annual Rainfall Assumed) (Inches per Year) R	11	
Background Nitrate-Nitrogen Concentration in Rainfall Recharge (mg/l) nb	2	
Percent Nitrogen Removal Required From Treatment System Tr	**48%**	
Calculated Average Concentration of Nitrate-Nitrogen (mg/l) nr	**7.50**	

Ref: HANTZSCHE-FINNEMORE EQUATION

1 From Attachment 6 of the Alameda County Hydrology & Hydraulics Manual and may be downloaded as a GIS file from the Alameda County Flood Control District website
https://www.cleanwaterprogram.org/images/uploads/C3TG_v6_Oct_2017_Appendix_D_Rainfall_Map.pdf

Castro Valley 22-24 inches (22 used)

Conceptual Wastewater System Design Calculations - Nitrogen Analysis

Nitrogen Loading Mass Balance as listed in Chapter 10 OWTS Manual - Average Flow

The Mosaic Project
Alameda County CA

Wastewater Design Flow

	Number	Flow Per Person	Nitrogen	Peak Design Flow
Campers/Counselors	100	25 gpd	<70mg/l	2,500 gpd
Day Staff	8	25 gpd	<70mg/l	200 gpd
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Care Taker/Security Residence (Bed 4+)	5	75 gpd	<70mg/l	375 gpd
			Total Flow	3,525 gpd
			Average Flow	2,820 gpd

Nitrogen Loading Analysis Design Flow High

Daily Wastewater Flow (Gallons per Day) W	2,820 gpd
Total Surface Area (Acres)	37.0 acres
Duration of Wastewater Application (Days) t	365
Calculated Volume of Wastewater Entering Soil (Inches per Year) I	1.02
Total Nitrogen Concentration in Wastewater Entering System (mg/l) nw	70
Percent of Nitrate-Nitrogen loss due to Soil Denitrification d	0
Average Rainfall Recharge Rate (50% of Annual Rainfall Assumed) (Inches per Year) R	11
Background Nitrate-Nitrogen Concentration in Rainfall Recharge (mg/l) nb	2
Percent Nitrogen Removal Required From Treatment System Tr	**5%**
Calculated Average Concentration of Nitrate-Nitrogen (mg/l) nr	**7.50**

Ref: HANTZSCHE-FINNEMORE EQUATION

Nitrogen Loading Analysis Design Flow High Concentration Assumption

Daily Wastewater Flow (Gallons per Day) W	2,820 gpd	
Total Surface Area (Acres)	37.0 acres	
Duration of Wastewater Application (Days) t	365	
Calculated Volume of Wastewater Entering Soil (Inches per Year) I	1.02	
Total Nitrogen Concentration in Wastewater Entering System (mg/l) nw	140	**2X of anticipated**
Percent of Nitrate-Nitrogen loss due to Soil Denitrification d	0	
Average Rainfall Recharge Rate (50% of Annual Rainfall Assumed) (Inches per Year) R	11	
Background Nitrate-Nitrogen Concentration in Rainfall Recharge (mg/l) nb	2	
Percent Nitrogen Removal Required From Treatment System Tr	**52%**	
Calculated Average Concentration of Nitrate-Nitrogen (mg/l) nr	**7.50**	

Ref: HANTZSCHE-FINNEMORE EQUATION

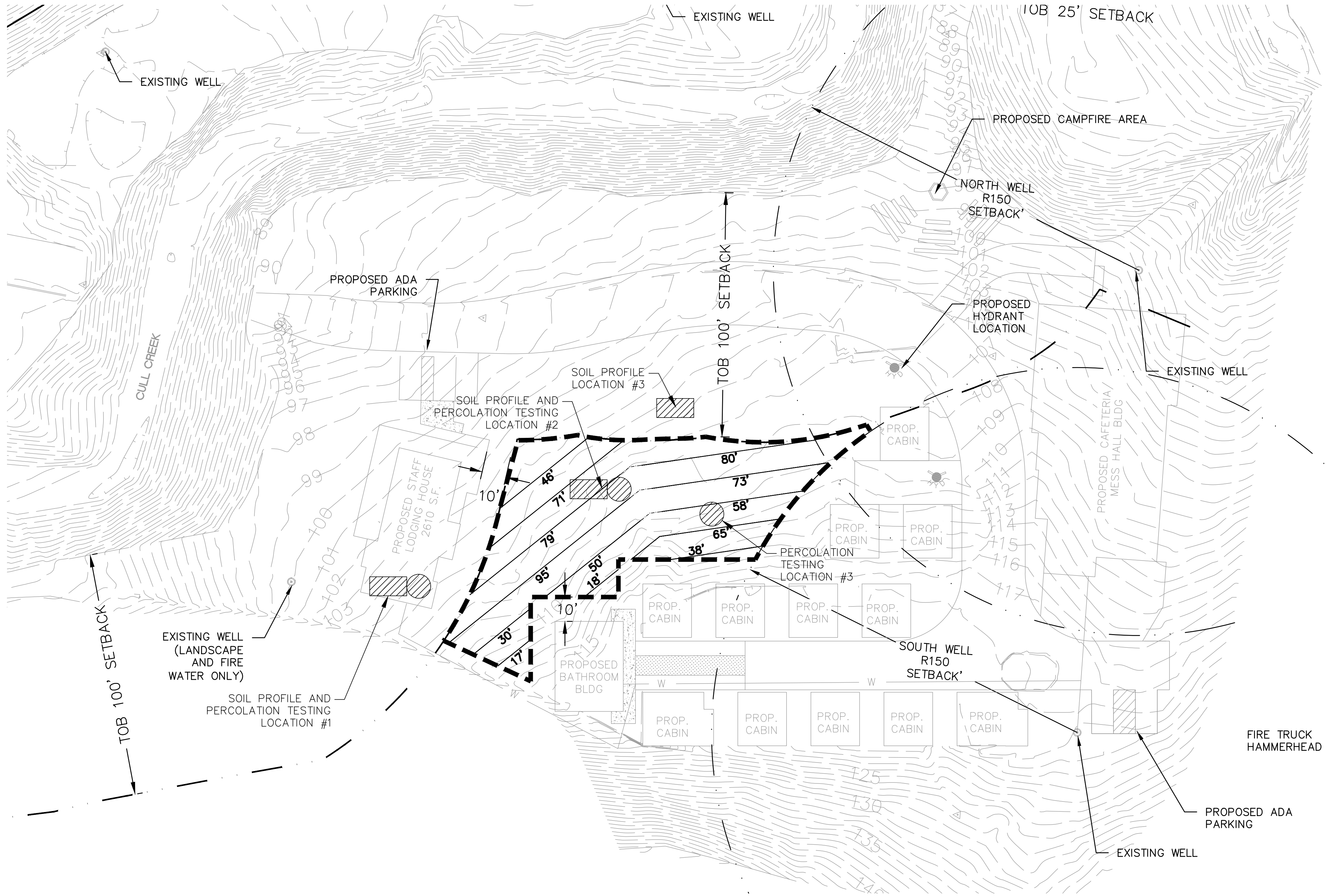
1 From Attachment 6 of the Alameda County Hydrology & Hydraulics Manual and may be downloaded as a GIS file from the Alameda County Flood Control District website

https://www.cleanwaterprogram.org/images/uploads/C3TG_v6_Oct_2017_Appendix_D_Rainfall_Map.pdf

Castro Valley 22-24 inches (22 used)

LEGEND

- PROPOSED FIRE HYDRANT
- EXISTING FIRE HYDRANT
- EXISTING WELL
- SOIL PROFILE LOCATION
- PERC. TESTING LOCATION
- PERC. TEST AND SOIL PROFILE LOCATION
- 100' TOP OF BANK SETBACK
- 150' WELL SETBACK
- SEPTIC AND LEACH AREAS WITHIN SETBACKS
- PROPOSED DISPERSAL FIELD



50 0 50 100

Designed:	DJW	
Drawn By:	SEB	
Approved:		
Date:	10-19-2020	

NORTHSTAR ... Designing Solutions

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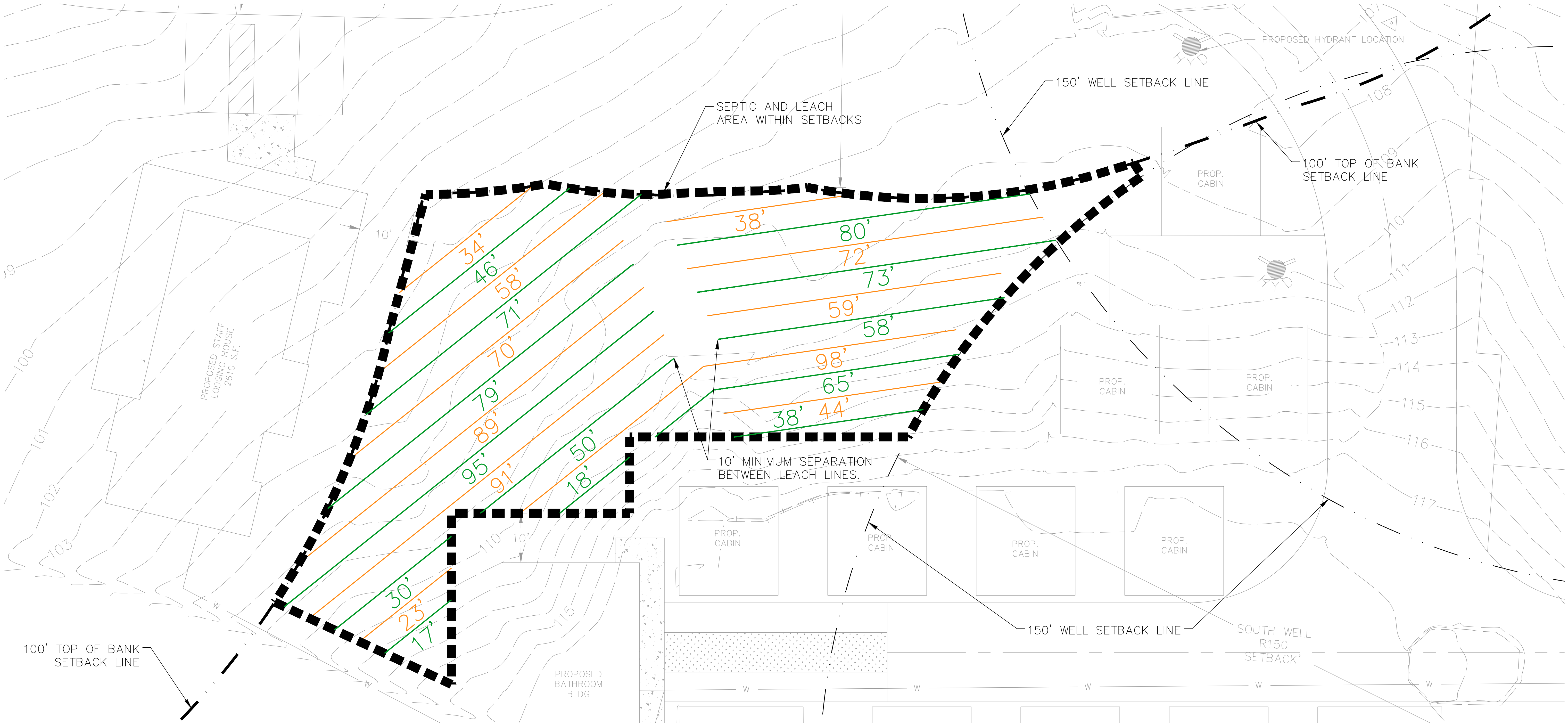
PHONE: (530) 893-1600 www.northstareng.com

THE MOSAIC PROJECT
17015 CULL CANYON
CASTRO VALLEY, CALIFORNIA

WASTEWATER DISPERSAL AREA EXHIBIT

THE MOSAIC PROJECT

APN Number	Job Number	Scale	Sheet
085-1200-001-16	17-231	1"= 50 Horz. N/A Vert.	Sheet 1 Of 1



ORIGINAL FIELD – 720 LINEAL FEET
REPLACEMENT FIELD – 680 LINEAL FEET
REQUIRED LINEAL FOOTAGE – 480 LINEAL FEET

20 0 20 40

Designed:	DJW
Drawn By:	SEB
Approved:	
Date:	10-19-2020

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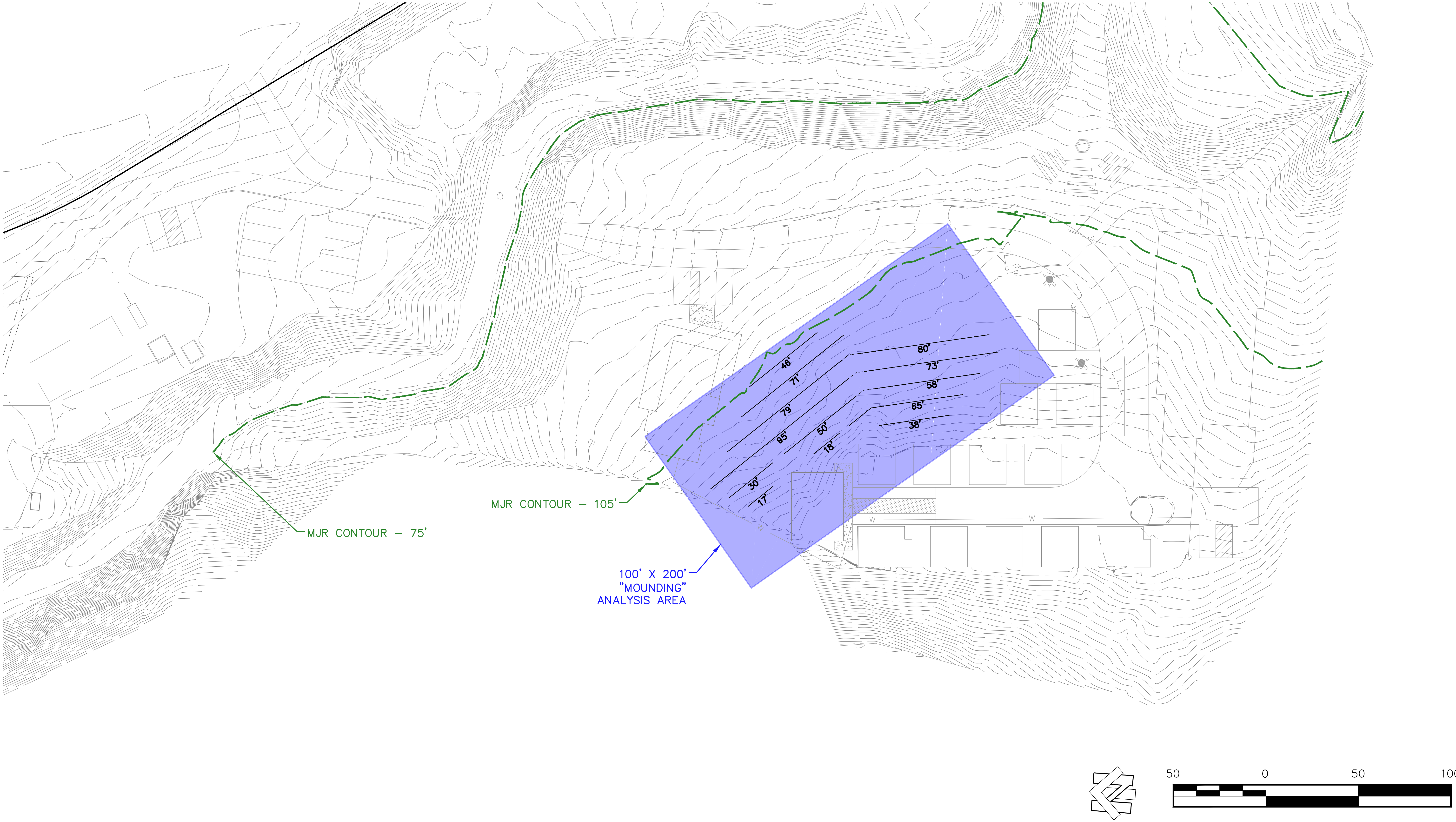
THE MOSAIC PROJECT
17015 CULL CANYON
CASTRO VALLEY, CALIFORNIA

PROPOSED DISPERSAL FIELD EXHIBIT

THE MOSAIC PROJECT

APN Number	Job Number	Scale	Sheet
085-1200-001-16	17-231	1"= 50' Horz. N/A Vert.	Sheet 1 Of 1



Designed:	DJW
Drawn By:	SEB
Approved:	
Date:	10-19-2020

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THE MOSAIC PROJECT
17015 CULL CANYON
CASTRO VALLEY, CALIFORNIA

MOUNDING ANALYSIS EXHIBIT

THE MOSAIC PROJECT

APN Number	Job Number	Scale	Sheet
085-1200-001-16	17-231	1"= 50' Horz. N/A Vert.	Sheet 1 Of 1

Property Owner: THE MOSAIC PROJECT Location: 17015 Cull Canyon Rd Job #: 17-231
AP#: 85-1200-1-16 Date: 10/9/2020 Weather/Lighting/Temp: OVERCAST 65

Test Pit #: #1

Horizon Depth: 0 - 24"
Color Chip: 7.5 YR 3/2
Rock: 0-15% 15-35% 35-50% 50% -75% %
Texture: LOAM
Structure:
Grade: structureless weak moderate strong
Shape: platy prismatic columnar
blocky (angular/subanglar) granular single grain
sandy texture massive
Sand Size: very fine fine medium coarse very coarse
Consistence:
Dry: loose soft slight-hard hard very-hard Ex-hard
Moist: loose V-friable friable firm V-firm Ex-firm
Sticky: not s slight s s very s
Plasticity: not p slight p p very p
Roots: very fine 1mm | fine 1-2mm | medium 2-5mm | coarse 5-10mm
Few: <10 <10 <1 <1
Common: 10-100 10-100 1-10 1-5
Many: >100 >100 >10 >5
Pores: very fine .1-.5mm | fine .5-2mm | medium 2-5mm | coarse 5-10mm
Few: <25 <10 <1 <1
Common: 25-200 10-50 1-5 1-5
Many: >200 >50 >5 >25
Boundary: abrupt <1 in | clear 1-2.5 in | gradual 2.5-5 in | diffuse >5 in
Mottles: yes no
Size: fine <5mm medium 5-15mm large >15mm
Quantity: few 2% common 2-20% many <20%
Contrast: faint distinct prominent
Shape: streaks bands spots
Redoximorphic Characteristics yes no
Redox concen: ___nodules___concretions___masses___Pore linings
Redox depletions: iron/clay Depth to: obs/ind water
Soil Water: Dry Moist Sat. Groundwater/Seepage: Yes No
Comments: WELL PUMP TEST WATER DISCHARGE IN AREA

Test Pit #: #1

Horizon Depth: 72" - 84"
Color Chip: 2.5 YR 3/2
Rock: 0-15% 15-35% 35-50% 50% -75% %
Texture: Silty clay loam
Structure:
Grade: structureless weak moderate strong
Shape: platy prismatic columnar
blocky (angular/subanglar) granular single grain
sandy texture massive
Sand Size: very fine fine medium coarse very coarse
Consistence:
Dry: loose soft slight-hard hard very-hard Ex-hard
Moist: loose V-friable friable firm V-firm Ex-firm
Sticky: not s slight s s very s
Plasticity: not p slight p p very p
Roots: very fine 1mm | fine 1-2mm | medium 2-5mm | coarse 5-10mm
Few: <10 <10 <1 <1
Common: 10-100 10-100 1-10 1-5
Many: >100 >100 >10 >5
Pores: very fine .1-.5mm | fine .5-2mm | medium 2-5mm | coarse 5-10mm
Few: <25 <10 <1 <1
Common: 25-200 10-50 1-5 1-5
Many: >200 >50 >5 >25
Boundary: abrupt <1 in | clear 1-2.5 in | gradual 2.5-5 in | diffuse >5 in
Mottles: yes no
Size: fine <5mm medium 5-15mm large >15mm
Quantity: few 2% common 2-20% many <20%
Contrast: faint distinct prominent
Shape: streaks bands spots
Redoximorphic Characteristics yes no Possible
Redox concen: X nodules___concretions___masses___Pore linings
Redox depletions: iron/clay Depth to: obs/ind water
Soil Water: Dry Moist Sat. Groundwater/Seepage: Yes No
Comments:

Test Pit #:

Horizon Depth: 24" - 72"
Color Chip: 2.5 YR 3/2
Rock: 0-15% 15-35% 35-50% 50% -75% %
Texture: Silty clay loam
Structure:
Grade: structureless weak moderate strong
Shape: platy prismatic columnar
blocky (angular/subanglar) granular single grain
sandy texture massive
Sand Size: very fine fine medium coarse very coarse
Consistence:
Dry: loose soft slight-hard hard very-hard Ex-hard
Moist: loose V-friable friable firm V-firm Ex-firm
Sticky: not s slight s s very s
Plasticity: not p slight p p very p
Roots: very fine 1mm | fine 1-2mm | medium 2-5mm | coarse 5-10mm
Few: <10 <10 <1 <1
Common: 10-100 10-100 1-10 1-5
Many: >100 >100 >10 >5
Pores: very fine .1-.5mm | fine .5-2mm | medium 2-5mm | coarse 5-10mm
Few: <25 <10 <1 <1
Common: 25-200 10-50 1-5 1-5
Many: >200 >50 >5 >25
Boundary: abrupt <1 in | clear 1-2.5 in | gradual 2.5-5 in | diffuse >5 in
Mottles: yes no
Size: fine <5mm medium 5-15mm large >15mm
Quantity: few 2% common 2-20% many <20%
Contrast: faint distinct prominent
Shape: streaks bands spots
Redoximorphic Characteristics yes no
Redox concen: ___nodules___concretions___masses___Pore linings
Redox depletions: iron/clay Depth to: obs/ind water
Soil Water: Dry Moist Sat. Groundwater/Seepage: Yes No
Comments:

Test Pit #:

Horizon Depth: #4 84" - 121"
Color Chip:
Rock: 0-15% 15-35% 35-50% 50% -75% %
Texture: Silty clay loam
Structure:
Grade: structureless weak moderate strong
Shape: platy prismatic columnar
blocky (angular/subanglar) granular single grain
sandy texture massive
Sand Size: very fine fine medium coarse very coarse
Consistence:
Dry: loose soft slight-hard hard very-hard Ex-hard
Moist: loose V-friable friable firm V-firm Ex-firm
Sticky: not s slight s s very s
Plasticity: not p slight p p very p
Roots: very fine 1mm | fine 1-2mm | medium 2-5mm | coarse 5-10mm
Few: <10 <10 <1 <1
Common: 10-100 10-100 1-10 1-5
Many: >100 >100 >10 >5
Pores: very fine .1-.5mm | fine .5-2mm | medium 2-5mm | coarse 5-10mm
Few: <25 <10 <1 <1
Common: 25-200 10-50 1-5 1-5
Many: >200 >50 >5 >25
Boundary: abrupt <1 in | clear 1-2.5 in | gradual 2.5-5 in | diffuse >5 in
Mottles: yes no
Size: fine <5mm medium 5-15mm large >15mm
Quantity: few 2% common 2-20% many <20%
Contrast: faint distinct prominent
Shape: streaks bands spots
Redoximorphic Characteristics yes no Possible
Redox concen: X nodules___concretions___masses___Pore linings
Redox depletions: iron/clay Depth to: obs/ind water
Soil Water: Dry Moist Sat. Groundwater/Seepage: Yes No
Comments:

Property Owner: THE MOSAIC PROJECT Location: 17015 Cull Canyon Rd Job #: 17-231

AP#: 85-1200-1-16 Date: 10/9/2020 Weather/Lighting/Temp: OVERCAST / 65

Test Pit #: #1

Horizon Depth: 0-48"

Color Chip: 7.5YR 3/3

Rock: **0-15%** 15-35% 35-50% 50% -75% %

Texture: CLAY LOAM

Structure:

Grade: structureless weak **moderate** strong

Shape: platy prismatic columnar **blocky (angular/subanglar)** granular single grain sandy texture massive

Sand Size: very fine **fine** medium coarse very coarse

Consistence:

Dry: loose soft **slight-hard hard** very-hard Ex-hard

Moist: loose V-friable friable firm V-firm Ex-firm

Sticky: not s **slight s** s very s

Plasticity: not p **slight p** p very p

Roots:	very fine 1mm	fine 1-2mm	medium 2-5mm	coarse 5-10mm
Few:	<10	<10	<1	<1
Common:	10-100	10-100	1-10	1-5
Many:	**>100**	**>100**	**>10**	**>5**

Pores:	very fine .1-.5mm	fine .5-2mm	medium 2-5mm	coarse 5-10mm
Few:	**<25**	**<10**	**<1**	**<1**
Common:	**25-200**	**10-50**	**1-5**	**1-5**
Many:	>200	>50	>5	>25

Boundary: abrupt <1 in clear 1-2.5 in gradual 2.5-5 in **diffuse >5 in**

Mottles: yes **no**

Size: fine <5mm medium 5-15mm large >15mm

Quantity: few 2% common 2-20% many <20%

Contrast: faint distinct prominent

Shape: streaks bands spots

Redoximorphic Characteristics yes no Possible localized @48"+

Redox concen: x nodules ___ concretions ___ masses ___ Pore linings

Redox depletions: **iron/clay** Depth to: obs/ind ___ water

Soil Water: **Dry** Moist Sat. Groundwater/Seepage: Yes No

Comments:

Test Pit #: #2

Horizon Depth: 48"-111"

Color Chip: 7.5YR 3/2

Rock: **0-15%** 15-35% 35-50% 50% -75% %

Texture: Silty clay loam

Structure:

Grade: structureless weak **moderate** strong

Shape: platy prismatic columnar **blocky (angular/subanglar)** granular single grain sandy texture massive

Sand Size: very fine **fine** medium coarse very coarse

Consistence:

Dry: loose soft slight-hard **hard very-hard** Ex-hard

Moist: loose V-friable friable **firm V-firm** Ex-firm

Sticky: not s slight s **s** very s

Plasticity: not p slight p **p** very p

Roots:	very fine 1mm	fine 1-2mm	medium 2-5mm	coarse 5-10mm
Few:	**<10**	**<10**	**<1**	**<1**
Common:	**10-100**	**10-100**	1-10	1-5
Many:	>100	>100	>10	>5

Pores:	very fine .1-.5mm	fine .5-2mm	medium 2-5mm	coarse 5-10mm
Few:	**<25**	**<10**	**<1**	**<1**
Common:	**25-200**	10-50	1-5	1-5
Many:	>200	>50	>5	>25

Boundary: abrupt <1 in clear 1-2.5 in gradual 2.5-5 in **diffuse >5 in**

Mottles: yes **no**

Size: fine <5mm medium 5-15mm large >15mm

Quantity: few 2% common 2-20% many <20%

Contrast: faint distinct prominent

Shape: streaks bands spots

Redoximorphic Characteristics yes no Possible localized

Redox concen: X nodules ___ concretions ___ masses ___ Pore linings

Redox depletions: iron/clay Depth to: obs/ind ___ water

Soil Water: Dry **Moist** Sat. Groundwater/Seepage: Yes No

Comments:

Test Pit #: 2

Horizon Depth:

Color Chip:

Rock: 0-15% 15-35% 35-50% 50% -75% %

Texture:

Structure:

Grade: structureless weak moderate strong

Shape: platy prismatic columnar blocky (angular/subanglar) granular single grain sandy texture massive

Sand Size: very fine fine medium coarse very coarse

Consistence:

Dry: loose soft slight-hard hard very-hard Ex-hard

Moist: loose V-friable friable firm V-firm Ex-firm

Sticky: not s slight s s very s

Plasticity: not p slight p p very p

Roots:	very fine 1mm	fine 1-2mm	medium 2-5mm	coarse 5-10mm
Few:	<10	<10	<1	<1
Common:	10-100	10-100	1-10	1-5
Many:	>100	>100	>10	>5

Pores:	very fine .1-.5mm	fine .5-2mm	medium 2-5mm	coarse 5-10mm
Few:	<25	<10	<1	<1
Common:	25-200	10-50	1-5	1-5
Many:	>200	>50	>5	>25

Boundary: abrupt <1 in clear 1-2.5 in gradual 2.5-5 in diffuse >5 in

Mottles: yes no

Size: fine <5mm medium 5-15mm large >15mm

Quantity: few 2% common 2-20% many <20%

Contrast: faint distinct prominent

Shape: streaks bands spots

Redoximorphic Characteristics yes no

Redox concen: ___ nodules ___ concretions ___ masses ___ Pore linings

Redox depletions: iron/clay Depth to: obs/ind ___ water

Soil Water: Dry Moist Sat. Groundwater/Seepage: Yes No

Comments:

Test Pit #: 2

Horizon Depth:

Color Chip:

Rock: 0-15% 15-35% 35-50% 50% -75% %

Texture:

Structure:

Grade: structureless weak moderate strong

Shape: platy prismatic columnar blocky (angular/subanglar) granular single grain sandy texture massive

Sand Size: very fine fine medium coarse very coarse

Consistence:

Dry: loose soft slight-hard hard very-hard Ex-hard

Moist: loose V-friable friable firm V-firm Ex-firm

Sticky: not s slight s s very s

Plasticity: not p slight p p very p

Roots:	very fine 1mm	fine 1-2mm	medium 2-5mm	coarse 5-10mm
Few:	<10	<10	<1	<1
Common:	10-100	10-100	1-10	1-5
Many:	>100	>100	>10	>5

Pores:	very fine .1-.5mm	fine .5-2mm	medium 2-5mm	coarse 5-10mm
Few:	<25	<10	<1	<1
Common:	25-200	10-50	1-5	1-5
Many:	>200	>50	>5	>25

Boundary: abrupt <1 in clear 1-2.5 in gradual 2.5-5 in diffuse >5 in

Mottles: yes no

Size: fine <5mm medium 5-15mm large >15mm

Quantity: few 2% common 2-20% many <20%

Contrast: faint distinct prominent

Shape: streaks bands spots

Redoximorphic Characteristics yes no

Redox concen: ___ nodules ___ concretions ___ masses ___ Pore linings

Redox depletions: iron/clay Depth to: obs/ind ___ water

Soil Water: Dry Moist Sat. Groundwater/Seepage: Yes No

Comments:

Property Owner: THE MOSAIC PROJECT Location: 17015 Cull Canyon Rd Job #: 17-231

AP#: 85-1290-1-16 Date: 10/9/2020 Weather/Lighting/Temp: Overcast 65

Test Pit #: 3

Horizon Depth: 0-18"

Color Chip: 7.5YR 3/2

Rock: **0-15%** 15-35% 35-50% 50% -75% %

Texture: Loam

Structure:

Grade: structureless weak **moderate** strong

Shape: platy prismatic columnar **blocky (angular/subanglar)** granular single grain sandy texture massive

Sand Size: very fine **fine** medium coarse very coarse

Consistence:

Dry: loose soft slight-hard hard very-hard Ex-hard

Moist: loose V-friable friable firm V-firm Ex-firm

Sticky: not s **slight s** s very s

Plasticity: not p **slight p** p very p

Roots:	very fine 1mm	fine 1-2mm	medium 2-5mm	coarse 5-10mm
Few:	<10	<10	<1	<1
Common:	10-100	10-100	1-10	1-5
Many:	**>100**	**>100**	**>10**	**>5**

Pores:	very fine .1-.5mm	fine .5-2mm	medium 2-5mm	coarse 5-10mm
Few:	<25	<10	<1	<1
Common:	25-200	10-50	1-5	1-5
Many:	**>200**	**>50**	**>5**	**>25**

Boundary: abrupt <1 in **clear 1-2.5 in** gradual 2.5-5 in diffuse >5 in

Mottles: yes **no**

Size: fine <5mm medium 5-15mm large >15mm

Quantity: few 2% common 2-20% many <20%

Contrast: faint distinct prominent

Shape: streaks bands spots

Redoximorphic Characteristics yes **no**

Redox concen: ____nodules____concretions____masses____Pore linings

Redox depletions: iron/clay Depth to: obs/ind ____ water ____

Soil Water: **Dry** Moist Sat. Groundwater/Seepage: Yes No

Comments:

Test Pit #: 3

Horizon Depth: #3 24"-86"

Color Chip: 2.5YR 3/2

Rock: 0-15% **15-35%** 35-50% 50% -75% %

Texture: Silty clay loam

Structure:

Grade: structureless weak moderate strong

Shape: platy prismatic columnar **blocky (angular/subanglar)** granular single grain **sandy** texture massive

Sand Size: **very fine** fine medium coarse very coarse

Consistence:

Dry: loose soft slight-hard **hard very-hard** Ex-hard

Moist: loose V-friable friable firm V-firm Ex-firm

Sticky: not s slight s **s** very s

Plasticity: not p slight p **p** very p

Roots:	very fine 1mm	fine 1-2mm	medium 2-5mm	coarse 5-10mm
Few:	**<10**	**<10**	**<1**	**<1**
Common:	10-100	10-100	1-10	1-5
Many:	>100	>100	>10	>5

Pores:	very fine .1-.5mm	fine .5-2mm	medium 2-5mm	coarse 5-10mm
Few:	**<25**	**<10**	**<1**	**<1**
Common:	25-200	10-50	1-5	1-5
Many:	>200	>50	>5	>25

Boundary: abrupt <1 in clear 1-2.5 in gradual 2.5-5 in diffuse >5 in

Mottles: yes **no**

Size: fine <5mm medium 5-15mm large >15mm

Quantity: few 2% common 2-20% many <20%

Contrast: faint distinct prominent

Shape: streaks bands spots

Redoximorphic Characteristics yes no Possible

Redox concen: ✓ nodules____concretions____masses____Pore linings

Redox depletions: iron/clay Depth to: obs/ind 76" water —

Soil Water: Dry **Moist** Sat. Groundwater/Seepage: Yes No

Comments:

Test Pit #: 3

Horizon Depth: 18"-24"

Color Chip: 7.5YR 3/2

Rock: **0-15%** 15-35% 35-50% 50% -75% %

Texture: Silty clay loam

Structure:

Grade: structureless weak moderate strong

Shape: platy prismatic columnar **blocky (angular/subanglar)** granular single grain sandy texture massive

Sand Size: very fine **fine** medium coarse very coarse

Consistence:

Dry: loose soft slight-hard **hard very-hard** Ex-hard

Moist: loose V-friable friable firm V-firm Ex-firm

Sticky: not s **slight s** s very s

Plasticity: not p slight p **p** very p

Roots:	very fine 1mm	fine 1-2mm	medium 2-5mm	coarse 5-10mm
Few:	<10	<10	<1	<1
Common:	**10-100**	**10-100**	**1-10**	**1-5**
Many:	>100	>100	>10	>5

Pores:	very fine .1-.5mm	fine .5-2mm	medium 2-5mm	coarse 5-10mm
Few:	<25	<10	<1	<1
Common:	**25-200**	**10-50**	**1-5**	**1-5**
Many:	>200	>50	>5	>25

Boundary: abrupt <1 in clear 1-2.5 in **gradual 2.5-5 in** diffuse >5 in

Mottles: yes **no**

Size: fine <5mm medium 5-15mm large >15mm

Quantity: few 2% common 2-20% many <20%

Contrast: faint distinct prominent

Shape: streaks bands spots

Redoximorphic Characteristics ? yes **no**

Redox concen: ____nodules____concretions____masses____Pore linings

Redox depletions: iron/clay Depth to: obs/ind ____ water ____

Soil Water: **Dry** Moist Sat. Groundwater/Seepage: Yes No

Comments:

Test Pit #:

Horizon Depth:

Color Chip:

Rock: 0-15% 15-35% 35-50% 50% -75% %

Texture:

Structure:

Grade: structureless weak moderate strong

Shape: platy prismatic columnar blocky (angular/subanglar) granular single grain sandy texture massive

Sand Size: very fine fine medium coarse very coarse

Consistence:

Dry: loose soft slight-hard hard very-hard Ex-hard

Moist: loose V-friable friable firm V-firm Ex-firm

Sticky: not s slight s s very s

Plasticity: not p slight p p very p

Roots:	very fine 1mm	fine 1-2mm	medium 2-5mm	coarse 5-10mm
Few:	<10	<10	<1	<1
Common:	10-100	10-100	1-10	1-5
Many:	>100	>100	>10	>5

Pores:	very fine .1-.5mm	fine .5-2mm	medium 2-5mm	coarse 5-10mm
Few:	<25	<10	<1	<1
Common:	25-200	10-50	1-5	1-5
Many:	>200	>50	>5	>25

Boundary: abrupt <1 in clear 1-2.5 in gradual 2.5-5 in diffuse >5 in

Mottles: yes no

Size: fine <5mm medium 5-15mm large >15mm

Quantity: few 2% common 2-20% many <20%

Contrast: faint distinct prominent

Shape: streaks bands spots

Redoximorphic Characteristics yes no

Redox concen: ____nodules____concretions____masses____Pore linings

Redox depletions: iron/clay Depth to: obs/ind ____ water ____

Soil Water: Dry Moist Sat. Groundwater/Seepage: Yes No

Comments:

Project Name: The Mosaic Project

PERCOLATION TEST NO. 1

SITE DATA

Hole Diameter: 6 " Hole Depth Below Ground Surface: ____ " Pipe Diameter: 4 "

Soil Description: Color: ________ Texture:

Cover: dry grass

Test Method: Standard: ____ Standpipe: X

Location: APN: 85-1200-1-16 Address: 17015 Cull Canyon Road

PRESOAKING DATA

Date: 10/7/2020 Test Performed By: DJW3

Start Time	Record Time	Depth of Water Level Remaining	Depth of Water Level After Filling	Remarks
11:30	11:45	0 "	12 "	
11:45	12:13	0 "	12 "	
12:13	12:38	0 "	12 "	
12:38	1:03	0 "	12 "	
1:03	1:25	5 "	12 "	
1:25	2:11	5 "	12 "	
2:11	2:34	1 "	7 "	
2:34	2:49	5 "	5 "	
2:49	2:59	3.5 "	- "	
		"	"	

PERCOLATION DATA

Date: 10/8/2020 Depth of Presoak Remaining: 0 "

Start Time	Record Time	Depth of Water Level Remaining	Depth of Water Level After Filling	Time Measured	Inches of Drop	Minutes Per Inch	Remarks
		----------	"	------	------	------	
11:38	12:08	0 "	6 "	30	6	5.00	
12:08	12:38	0 "	6 "	30	6	5.00	
12:38	13:08	0 "	6 "	30	6	5.00	
13:08	13:38	0 "	6 "	30	6	5.00	
		"	"				
		"					
				Average:	5.00	Min/Inch	

Interval: 30.0 minutes Drop: 6.0 inch Rate: 5.0 min/inch

Standpipe Method Multiplier: 1.6 **Adjusted Percolation Rate: 8 min/inch**

Signed: ____________________ R.C.E. No. C66282

Client: Town of Paradise Job No. 9228

Project Name: The Mosaic Project

PERCOLATION TEST NO. 2

SITE DATA

Hole Diameter: 6 " Hole Depth Below Ground Surface: ____ " Pipe Diameter: 4 "

Soil Description: Color: ____________ Texture:

Cover: dry grass

Test Method: Standard: ____ Standpipe: X

Location: APN: 85-1200-1-16 Address: 17015 Cull Canyon Road

PRESOAKING DATA

Date: 10/7/2020 Test Performed By: DJW3

Start Time	Record Time	Depth of Water Level Remaining	Depth of Water Level After Filling	Remarks
11:32	11:45	0 "	12 "	
11:45	12:04	8 "	12 "	
12:04	12:34	11 "	12 "	
12:34	1:04	10.5 "	12 "	
1:04	1:36	11 "	11 "	
1:36	2:19	11 "	10 "	
2:19	2:49	11 "	9 "	
		"	"	

PERCOLATION DATA

Date: 10/8/2020 Depth of Presoak Remaining: 0 "

Start Time	Record Time	Depth of Water Level Remaining	Depth of Water Level After Filling	Time Measured	Inches of Drop	Minutes Per Inch	Remarks
		----------	"	------	------	------	
11:26	12:06	4.625 "	6 "	30	1.375	21.82	
12:06	12:36	4.75 "	6 "	30	1.250	24.00	
12:36	1:06	4.875 "	6 "	30	1.125	26.67	
1:06	1:36	4.875 "	6 "	30	1.125	26.67	
		"	"				
		"					
				Average:	24.79	Min/Inch	

Interval: 30.0 minutes Drop: 1.125 inch Rate: 26.67 min/inch

Standpipe Method Multiplier: 1.6 **Adjusted Percolation Rate: 43 min/inch**

Signed: ____________________ R.C.E. No. C66282

Client: Town of Paradise Job No. 9228

Project Name: The Mosaic Project

PERCOLATION TEST NO. 3

SITE DATA

Hole Diameter: 6 " Hole Depth Below Ground Surface: ____ " Pipe Diameter: 4 "

Soil Description: Color: ________ Texture:

Cover: dry grass

Test Method: Standard: ____ Standpipe: X

Location: APN: 85-1200-1-16 Address: 17015 Cull Canyon Road

PRESOAKING DATA

Date: 10/7/2020 Test Performed By: DJW3

Start Time	Record Time	Depth of Water Level Remaining	Depth of Water Level After Filling	Remarks
11:33	12:10	7 "	12 "	
12:10	12:35	10.5 "	12 "	
12:35	12:35	11 "	12 "	
12:35	1:07	11 "	12 "	
1:07	1:40	10.5 "	12 "	
1:40	2:20	10.5 "	12 "	
2:20	2:53	10.35 "	12 "	
		"	"	

PERCOLATION DATA

Date: 10/8/2020 Depth of Presoak Remaining: 0 "

Start Time	Record Time	Depth of Water Level Remaining	Depth of Water Level After Filling	Time Measured	Inches of Drop	Minutes Per Inch	Remarks
		----------	"	------	------	------	
11:31	12:01	4.313 "	6 "	30	1.687	17.78	
12:01	12:31	4.8125 "	6 "	30	1.188	25.26	
12:31	13:01	5 "	6 "	30	1.000	30.00	
13:01	13:31	5 "	6 "	30	1.000	30.00	
		"	"				
		"					
				Average:	25.76	Min/Inch	

Interval: 30.0 minutes Drop: 1.000 inch Rate: 30.00 min/inch

Standpipe Method Multiplier: 1.6 **Adjusted Percolation Rate: 48 min/inch**

Signed: __________________ R.C.E. No. C66282

Client: Town of Paradise Job No. 9228

Soil Map—Alameda Area, California
(The Mosaic Project)

Map Scale: 1:3,010 if printed on B landscape (17" x 11") sheet.

Meters: 0 40 80 160 240

Feet: 0 100 200 400 600

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Alameda Area, California
Survey Area Data: Version 14, May 29, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 31, 2019—Jun 6, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
DaB	Danville silty clay loam, 3 to 10 percent slopes	8.8	13.0%
HnF2	Henneke rocky loam, eroded	5.2	7.7%
LpF2	Los Gatos-Los Osos complex, 30 to 75 percent slopes, eroded, MLRA 15	31.5	46.6%
LtD	Los Osos silty clay loam, 7 to 30 percent slopes	0.4	0.7%
LtE2	Los Osos silty clay loam, 30 to 45 percent slopes, eroded	2.4	3.5%
LtF2	Los Osos silty clay loam, 45 to 75 percent slopes, eroded	14.6	21.5%
YmB	Yolo loam, 0 to 8 percent slopes, MLRA 15	4.8	7.0%
Totals for Area of Interest		**67.6**	**100.0%**

Alameda Area, California

YmB—Yolo loam, 0 to 8 percent slopes, MLRA 15

Map Unit Setting

National map unit symbol: 2w89h
Elevation: 70 to 2,530 feet
Mean annual precipitation: 16 to 29 inches
Mean annual air temperature: 57 to 61 degrees F
Frost-free period: 260 to 360 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Yolo and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Yolo

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium derived from metamorphic and sedimentary rock

Typical profile

Ap - 0 to 8 inches: loam
A - 8 to 16 inches: loam
C1 - 16 to 24 inches: very fine sandy loam
C2 - 24 to 46 inches: fine sandy loam
C3 - 46 to 60 inches: loam

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline (0.3 to 0.5 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: High (about 10.6 inches)

Interpretive groups

Land capability classification (irrigated): 2e

Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Unnamed
Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Livermore
Percent of map unit: 5 percent
Hydric soil rating: No

Sycamore
Percent of map unit: 5 percent
Hydric soil rating: No

Data Source Information

Soil Survey Area: Alameda Area, California
Survey Area Data: Version 11, Sep 13, 2017

Alameda Area, California

DaB—Danville silty clay loam, 3 to 10 percent slopes

Map Unit Setting

National map unit symbol: hb35
Elevation: 100 to 2,500 feet
Mean annual precipitation: 14 to 20 inches
Mean annual air temperature: 57 degrees F
Frost-free period: 240 to 360 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Danville and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Danville

Setting

Landform: Fan terraces, fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sandstone and shale

Typical profile

H1 - 0 to 21 inches: silty clay loam
H2 - 21 to 53 inches: silty clay
H3 - 53 to 80 inches: clay loam

Properties and qualities

Slope: 3 to 10 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water capacity: High (about 9.4 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Los osos

Percent of map unit: 10 percent
Hydric soil rating: No

Los gatos

Percent of map unit: 5 percent
Hydric soil rating: No

Data Source Information

Soil Survey Area: Alameda Area, California
Survey Area Data: Version 14, May 29, 2020

Orenco® Changing the Way the World Does Wastewater®

10/05/2020

Nick Weigel
Northstar Engineering
111 Mission Ranch Blvd
Suite 100
Chico, CA 95926

Subject: Preliminary Design Review of the Mosaic Project

Mr. Weigel,

Orenco Systems, Inc. ("Orenco") has received the Plans and other documents that comprise the Preliminary Design for the Mosaic Project. Orenco staff reviews the Final Design of all wastewater collection and treatment systems for commercial applications to ensure that the design is compliant with the most current version of the system's applicable design criteria published by Orenco for the specified parameters provided by the system's designer in the Plans. The findings and conclusions of my review of this Preliminary Design are as follows:

Design Basis

The system has been designed for a Campground application. Influent flow and constituent concentrations and effluent constituent concentration requirements have been provided by the system's designer on the Plans and were used in my review of the Preliminary Design.

The influent flow on the Plans were not extrapolated from the metered flows from the subject site, but in our experience, they are consistent with influent flows from other, similar Campground systems that Orenco has previously observed. As such, I have no reason to doubt the accuracy of the designer's findings and assumptions as to the influent flow, and find that it was reasonable for the designer to use them as the design basis for the system.

System Design

The proposed Preliminary Design of the system consists of sewage from a central meeting & dining hall, a restroom shower building, and family dwelling going to 20,000 gallons of septic tankage for primary treatment. Effluent flows to a one AdvanTex AX-Max175-28 for secondary treatment. Treated effluent flows to 5,000-gallon dosing tank where it is pumped to a pressurized drainfield for final disposal.

Design Criteria

The applicable design criteria for this system, which I used to conduct the review of its Preliminary Design, is revision 7.0 of document NDA-ATX-1, titled *Orenco® AdvanTex® Design Criteria, Commercial Treatment Systems*, which was published by Orenco in May, 2019. A copy of the design criteria can be downloaded from Orenco's online document library at www.orenco.com/corporate/doclibrary.cfm.

Findings

The findings of my review as to whether the Preliminary Design complies with Orenco's design criteria for treating wastewater to the effluent constituent concentration requirements are as follows:

Primary Treatment

Orenco always recommends the use of a pre-anoxic return tank and requires them on all projects that require significant nitrogen reduction. This pre-anoxic tank should be sized equal to one day at maximum day design flow and is considered part of the overall primary tank volume.

The Preliminary Design specifies the use of 20,000 gallons of septic tankage for primary treatment. Using the flow data specified on the Plans the hydraulic retention times for primary treatment calculate as follows:

Primary Tank(s) Hydraulic Retention Time (HRT)[1]				
Design Average Flow (gpd)	Design Maximum Day Flow (gpd)	Effective Combined Primary Tankage (gpd)	Avg HRT (days)	Max Day HRT (days)
2820	3525	20000	7.1	5.7

[1] Design Max Day Flow is the maximum daily flow a facility is expected to receive no more than one day within any week's time.

According to the Primary Tank Sizing Recommendations in the applicable design criteria, Campground treatment systems are recommended to have a minimum of 3 days of hydraulic retention time at the Design Max Day Flow. Therefore, the specification of the septic tanks in the Preliminary Design satisfies Orenco's design criteria.

Recirculation Tank — Standard Stage

The Preliminary Design further specifies the use of an AX-Max Treatment System for recirculation and blending of the AdvanTex-treated effluent with primary tank effluent. The recirculation volume in the AX-Max System satisfies the requirement for recirculation tank volume.

Hydraulic Load — Standard Stage

The Preliminary Design specifies the use of one AX-Max175-28, which contains a nominal surface area of 175 square feet of treatment media. Using the flow data specified on the Plans the hydraulic loading rate for the system calculates as follows:

Hydraulic Loading Rate (HLR) — Standard Stage				
Design Average Flow (gpd)	Design Maximum Day Flow (gpd)	Nominal Textile Area (sq. ft.)	Average HLR (gal. per day/sq. ft.)	Peak HLR (gal. per day/sq. ft.)
2820	3525	175	16	20

According to the AdvanTex System Loading Chart in the applicable design criteria, the standard AdvanTex treatment system (Stage 1) should not be hydraulically loaded more than 25 gpd/square foot at Design Average Flow or 50 gpd/square foot at Design Max Day Flow. Therefore, the specified type and number of AdvanTex units in the Preliminary Design satisfy Orenco's design criteria to achieve the effluent quality listed in the design criteria at a 95% confidence level for this Campground application.

Organic Load — Standard Stage

The following influent characteristics were estimated and not derived from direct sampling. Even though the influent characteristics were not derived from direct sampling, the values assumed are consistent with values we have seen in other, similar Campground applications.

Influent (Primary Tank Effluent) Characteristics — Loading to Textile		
Average BOD_5 (mg/L)	Average TSS (mg/L)	Max FOG (mg/L)
300	150	25

Based on the average influent biochemical oxygen demand (BOD_5) concentration and flow data specified on the Plans, the system will receive approximately 7.1 pounds of BOD_5 per day at Design Average Flow, and 8.8 pounds of BOD_5 per day at Maximum Day Design Flow. Using this information, the organic loading rate of the system calculates as:

Organic Loading Rate (OLR) — Standard Stage				
Average Organic Load (lbs/day)	Maximum Organic Load (lbs/day)	Nominal Treatment Area (sq. ft.)	Average OLR (lbs BOD/sq. ft./day)	Maximum OLR (lbs BOD/sq. ft./day)
7.1	8.8	175	0.04	0.05

According to the Organic Load Requirements in the applicable design criteria, an AdvanTex Treatment System should not be organically loaded more than 0.04 pounds BOD_5/square foot at Design Average Flow or 0.08 pounds BOD_5/square foot at Design Peak Flow. Therefore, the specified type and number of AdvanTex units in the preliminary design satisfy Orenco's design criteria to achieve the effluent quality listed in the design criteria at a 95% confidence level for this Campground application.

Nitrogen Reduction — Standard Stage

According to the Nitrogen Reduction Standards in the applicable design criteria, the standard configuration of a single-stage AdvanTex Treatment System will typically achieve 60% reduction of Total Nitrogen, depending on wastewater strength and other characteristics such as BOD_5, grease and oils, pH, and alkalinity concentrations, primary treatment hydraulic retention time, or temperature.

Based on the average influent Total Kjeldahl Nitrogen (mg/L) concentrations and other influent constituent concentrations and flow data specified on the Plans the nitrogen loading for the standard stage calculates as follows:

Total Nitrogen Loading Rate — Standard Stage		
Total Kjeldahl Nitrogen (mg/L)	Average Nitrogen Load (lbs/day)	Total Nitrogen Loading Rate (lbs/day/square foot)
70	1.6	0.009

The standard stage loading is 0.014 pounds per day/square foot based on Design Average Flow. Therefore, the specified type and number of AdvanTex units in the final design satisfy Orenco's design criteria to achieve the effluent quality listed in the design criteria at a 95% confidence level for this shopping center application.

Conclusions

I have reviewed the Preliminary Design of the Mosaic Project wastewater treatment system, and have found that the design is compliant with the most current version of the system's applicable design criteria published by Orenco for the specified parameters provided by the system's designer in the Plans. In addition, I noted no anomalies in the site layout or configuration of the system during my review.

Compliance Table — Meets Minimum Design Standards	
	Standard Stage
Recirc Tank Size	Yes
Hydraulic Load	Yes
Organic Load	Yes
Nitrogen Load	Yes

As such, the system as designed satisfactorily complies with Orenco's design criteria to meet the following effluent limits at a 95% confidence level, provided that all influent flows and constituent concentrations specified in the Plans are not exceeded:

Expected Effluent Quality	
Constituent	**Average (mg/L)**
BOD_5	<30
TSS	<30
TN	>50% reduction

It is important to note that even though the AdvanTex Treatment System has the capability to meet or exceed the required treatment parameters, there is no way that Orenco can guarantee that a particular system will be operated or maintained in a manner consistent with the Preliminary Design reviewed. Once the facility is placed into operation, the influent flows and constituent concentrations to the facility should be monitored, and if flow or any of the influent constituent concentrations exceed those listed in the Plans, measures should be taken to reduce the flow or constituent concentration to those listed. However, if additional treatment capacity becomes necessary, the system is designed to have the capability to expand to account for the new flow or constituent concentration.

Proper air ventilation is a critical feature of all commercial AdvanTex Treatment Systems, and as such, adequate active ventilation is required for all systems. In addition, please note that disposing of toxics or chemicals into the system is strictly prohibited. Examples of toxics include restaurant degreasers, cleansers, wax strippers for linoleum, carpet shampoo, waste products, or any other toxins. Furthermore, water softener brine discharge is prohibited from being discharged into the AdvanTex Treatment System. Failure to adhere to these policies will void Orenco's limited product warranties.

If you have any questions about my review process, findings, or conclusions, please feel free to call or e-mail me.

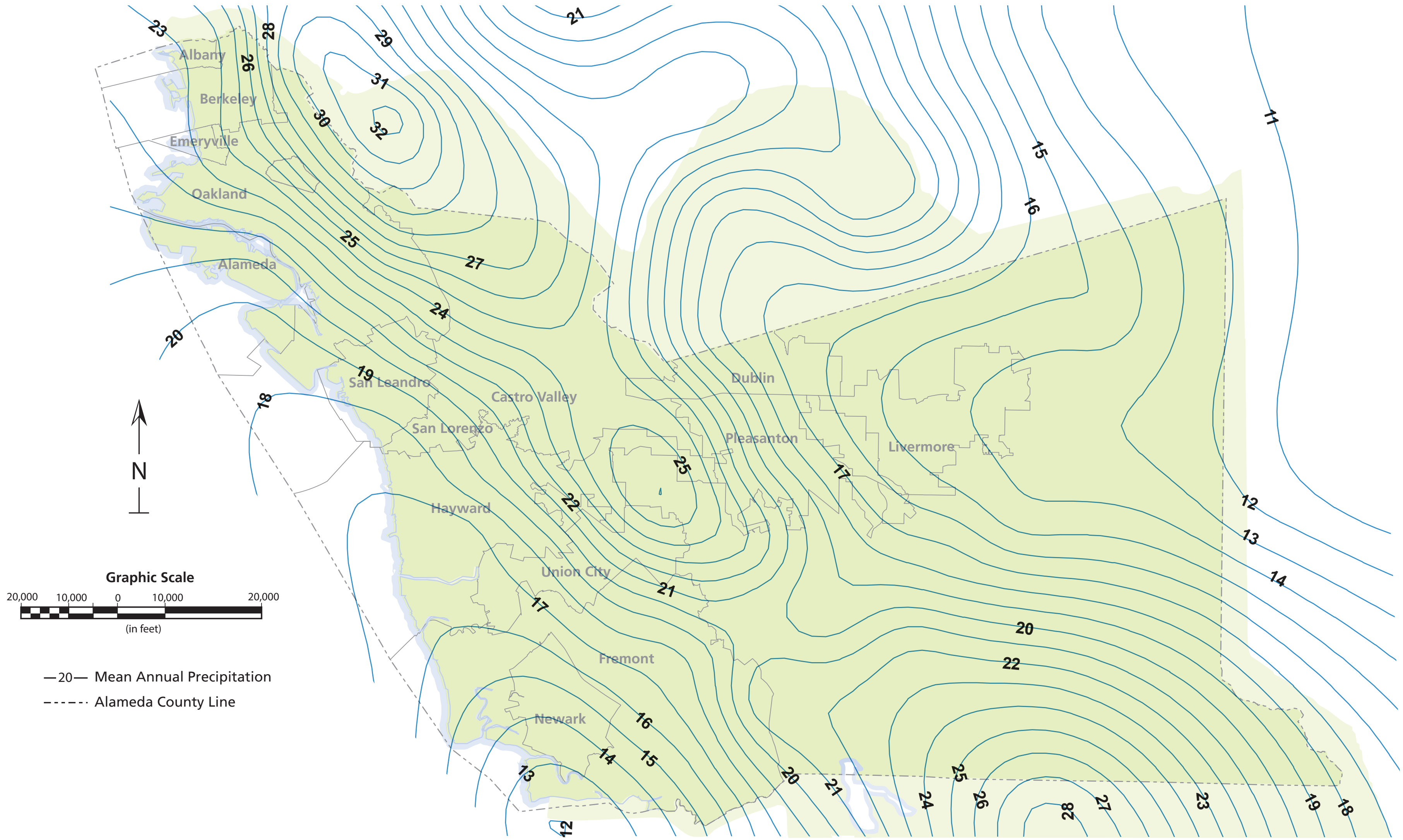
Sincerely,

Keith Fortenbach
Systems Engineering
Orenco Systems Inc.
(800) 348-9843 ext. 412
kfortenbach@orenco.com

Appendix

D

Mean Annual Precipitation Map: Alameda County



This map is Attachment 6 of the Alameda County Hydrology & Hydraulics Manual and may be downloaded as a GIS file from the Alameda County Flood Control District website.

(District 2011)

Alameda County Flood Control & Water Conservation District

Mean Annual Precipitation

North Coast RWQCB

SECTION III

METHODOLOGIES FOR ASSESSMENT OF CUMULATIVE IMPACTS

Standard siting and design criteria for on-site sewage disposal systems are mainly for the purpose of protecting water supplies and public health from the standpoint of bacterial contamination and disease transmission. The primary objective is to assure that inadequately treated sewage effluent does not discharge to the surface of the ground or enter useable groundwaters. Individual septic tank/soil absorption systems are generally evaluated independently of one another. The effects of many systems in a concentrated area are not directly taken into account. The purpose of this section is to propose various procedures and criteria that can be utilized to examine the potential cumulative impacts of on-site sewage disposal practices.

The methodologies presented in this section are aimed at providing simplified, yet technically sound, assessment tools for use by the Regional Board and local health and planning officials in their review of land use plans and specific development proposals. While the results of these analyses may influence the siting or design of systems for individual residences, it is not anticipated that they would be exercised by local health departments in the routine review and permitting of sewage disposal systems for single family dwellings. The main usefulness is likely to be in reviewing and setting standards for major subdivisions, large common on-site systems, and zoning and land use plans.

The presentation is divided into several sections addressing the following cumulative impact issues:

- *Groundwater Hydraulics;*
- *Salt Accumulation in Groundwater;*
- *Nitrate Accumulation in Groundwater;*
- *Nutrient Additions to Surface Waters;*
- *Bacteriological-Public Health Impacts.*

The main focus of the assessment methodologies is on the projection of areawide water quality and public health effects, which is the overall objective of this study. Where appropriate, additional techniques for examining localized impacts are presented as an indication of more site-specific analyses that may be required in certain instances.

It should be recognized further that the procedures and criteria presented here are of a general nature. They do not attempt to cover the many special considerations relative to hydrology, geology, water quality, etc., that may need to be addressed in follow-up detailed studies of individual impact areas. The methodologies are offered as initial guidelines, with the expectation that alternative analytical approaches and refinements may evolve as additional experience is gained. At this time, they may be most useful in establishing an orderly review process and reducing the need for individual and repititious research with each new development proposal or land use decision.

GROUNDWATER HYDRAULICS

Problem Overview

The introduction of wastewater into the soil by means of on-site systems has a surcharging effect on the groundwater system which is not necessarily addressed by standard siting and design criteria. The occurrence of long-term groundwater hydraulic problems in any particular instance depends upon the ability of the soil and groundwater system to accept and disperse the added wastewater loading. The specific areawide and localized concerns are briefly as follows:

(1) The potential areawide problem is that of an overall rise in groundwater levels in a particular area due to the hydraulic loading from large numbers of systems. A general rise of the water table occurring over all or portions of a development area would effectively reduce the amount of unsaturated soil available for wastewater renovation.

(2) The potential localized problem is that of hydraulic mounding immediately beneath the disposal field. The rise of the groundwater table in response to wastewater loading will reduce the effective "depth to groundwater" and likewise the filtering potential of the soil. In the extreme case, mounding of groundwater may reach as high as the leaching trenches, (a) resulting in direct introduction of sewage effluent into groundwater, and (b) promoting anaerobic soil conditions, clogging of infiltrative surfaces and premature system failure.

An additional consideration in regard to groundwater hydraulics is the relative proportion of wastewater loading in comparison with normal background amounts of rainfall percolation (recharge) in the project area. As will be discussed later, this determines the effective initial dilution ratio, and, in the case of conservative substances, controls the quality of combined wastewater-rainfall percolate eventually reaching groundwaters.

In developing workable assessment approaches to these problems it must be recognized that the soil and groundwater conditions at any particular site will be extremely complex and differ markedly from one site to the next. A highly accurate scientific analysis cannot be made for each site without investing significant time and money, and even then all uncertainties will not necessarily be eliminated. The approaches outlined here are aimed at defining general types of conditions likely to be encountered, and providing simplifying assumptions and analytical tools to make reliable assessments needed for regulatory, planning and design decisions.

Areawide Groundwater Effects

Evaluation of potential areawide influences on groundwater from on-site systems should focus on the water balance and comparison of wastewater additions with natural inputs to the groundwater system. Figure 1 provides a schematic summary of the steps and typical computations involved. Discussion of the various elements and the key assumptions and data needs is provided below.

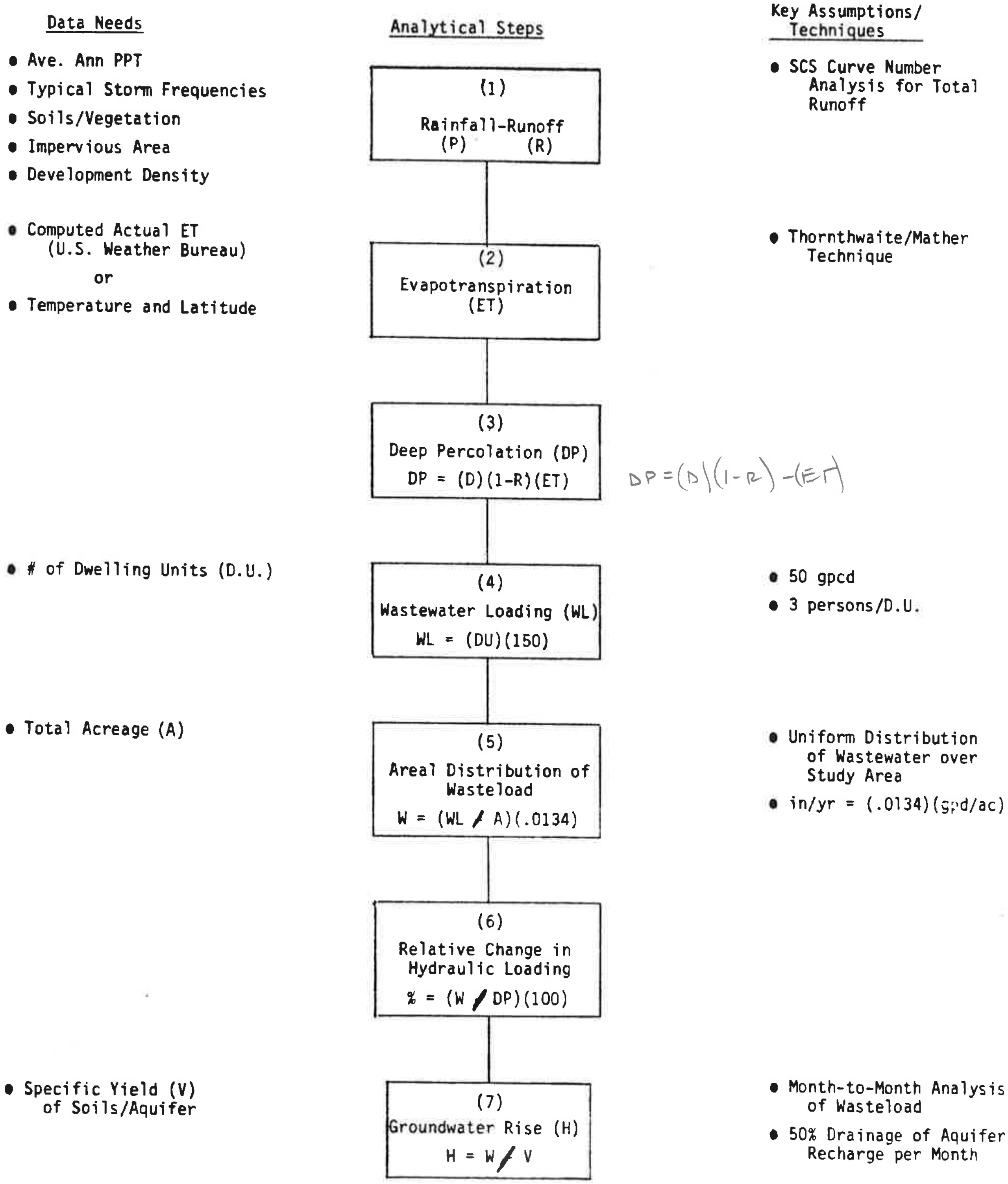
Step 1: Rainfall-Runoff

The first step in evaluating the water balance is determining rainfall and runoff amounts for the project area. Average yearly rainfall should be estimated from long-term weather data. Various methods are available to estimate runoff amounts. A convenient and reliable method is that developed and used widely by the USDA Soil Conservation Service (U.S. SCS, 1964). The method involves (1) assigning "curve numbers" for the wateshed area according to type of hydrologic soil-cover complex, and then (2) computing total runoff amounts for individual storms using established rainfall-runoff plots.

In assessing impacts from on-site systems, the main interest is in determining yearly or seasonal rainfall-runoff amounts. This may be done by computing and summing runoff from actual or statistical series of storm events over the period of a year. The resulting runoff computation

Figure 1

Areawide Groundwater Hydraulics Analysis



can be compared to total rainfall to estimate the runoff percentage.

Step 2: Evapotranspiration

Losses due to plant uptake and evaporation can be estimated on the basis of "actual evapotranspiration" (ET). This is defined as the "computed amount of water loss under existing conditions of temperature and precipitation" (Elford and McDonough, 1963). Computations may be made following the water balance techniques developed by Thornthwaite & Mather (1957). Actual ET values have been computed by the U.S. Weather Bureau for a number of locations in the North Coast Region (Elford and McDonough, 1963-1966). For typical computations it is assumed that the soil in the root zone is capable of storing 4 inches of plant-available moisture. Available moisture (i.e., rainfall) in excess of this is assumed to runoff or percolate to underlying soils and groundwater, beyond the reach of plant roots. It is also assumed that plants use stored moisture at the full, or "potential" rate until all stored moisture has been used.

For purposes of cumulative impact assessment, actual ET values may be estimated from existing U.S. Weather Bureau computations or developed individually for specific sites using the basic methodology outlined by Thornthwaite and Mather.

Step 3: Deep Percolation of Rainfall

Computation of the amount of deep percolation (recharge) of rainfall may be made from the preceding estimates of rainfall, runoff and actual ET. The average yearly deep percolation is computed as follows:

$$(DP) = (P)(1-R) - (ET)$$

where:

DP = Average deep percolation of rainfall (in/yr);
P = Average precipitation (in/yr);
R = Runoff percentage;
ET = Actual evapotranspiration (in/yr).

Step 4: Wastewater Loading

Wastewater discharges through subsurface disposal systems will generally be beneath the root zone, resulting in complete percolation to groundwater. The long-term hydraulic loading can be computed on the basis of average wastewater flow over the area under study. For typical residential on-site systems the following assumptions are appropriate:

(1) 50 gpcd
(2) 3 persons/dwelling unit.

These are consistent with reported literature values and planning studies (NEHA, 1979; EPA, 1980). Maximum wastewater flow estimates (e.g., 150 gpd per bedroom) are suitable for designing individual systems, but do not adequately represent average long-term loading characteristics which are of chief concern in assessing cumulative effects.

Step 5: *Areal Distribution of Wasteload*

The next step is the determination of the areal distribution of wastewater loading. This is expressed as waste flow per unit area (e.g., gpd/acre). It may be approximated by dividing the total wastewater flow by the total acreage under study. Conversion can then be made to in/yr as follows:

$$(\text{in/yr}) = (\text{gpd/acre})(0.0134)$$

Step 6: *Relative Change in Hydraulic Loading*

Hydraulic impacts due to wastewater additions can be assessed by determining the relative change in hydraulic loading. This is done simply by computing wastewater loading as a percentage of average background deep percolation. The results are a useful indicator of the amount of natural dilution normally available on-site. Additionally, projected changes in salt and nitrate loadings may conveniently be expressed as a function of the amount of wastewater loading relative to deep percolation (see following sections dealing with salts and nitrates).

Step 7: *Groundwater Rise*

Potential areawide increases in groundwater levels can be approximated by dividing the wastewater hydraulic loading by the specific yield of the underlying soils or aquifer. Specific yield varies among soils and water bearing formations, and normally falls between about 5 and 30%. The potential for change in natural water table levels should be examined on a month-to-month and seasonal basis. In the water balance method of Thornthwaite and Mather (1957), 50 percent of the surplus waters percolating to groundwater are assumed to discharge to surface streams each month. This is based on studies of watersheds in the Eastern United States. Month-to-month accumulation of wastewater should be reduced by a similar amount.

Whether or not long-term (yearly) accumulation occurs depends upon the natural fluctuations and drainage characteristics of the groundwater system. To assess the potential impacts specifically requires more detailed characterization of aquifer properties and groundwater movement. In many instances it is likely that natural fluctuations from year-to-year will far outweigh the effects from wastewater additions. Also, a detailed analysis should account for related land use and development activities which may contribute to changes in groundwater levels, e.g., groundwater withdrawals, irrigation, and alteration of natural recharge areas. These effects may further negate impacts from on-site sewage disposal systems.

Localized Hydraulic Mounding

The growth and decay of groundwater mounds in response to percolation and recharge of surface water has been studied by a number of investigators (Glover, 1966; Hantush, 1967; Bianchi, 1970; Bouwer, 1976; DeCoster, 1976). Various predictive equations have been developed and tested. While derived specifically for the purpose of assessing groundwater recharge operations, many of the techniques are equally applicable to the case of subsurface effluent disposal systems.

These analytical methods can be applied by defining four typical situations which characterize the conditions under which on-site systems are generally employed. These are:

- *Case 1* - Relatively level topography with underlying unconfined shallow aquifer of greater than 50' thickness and of effectively "infinite" lateral extent;
- *Case 2* - Relatively level topography with underlying unconfined shallow aquifer of less than 50' thickness (includes perched water) and of effectively "infinite" lateral extent;
- *Case 3* - Level to moderately sloping topography, with shallow groundwater having a defined lateral seepage or discharge point near the disposal field;
- *Case 4* - Sloping terrain with perched groundwater and/or a clearly defined impermeable substrata.

Assessment techniques applicable to each of these situations are described below.

Case 1. The case of percolation to an aquifer of relatively large thickness is illustrated in Figure 2. Analysis can follow a method developed by Glover (1966). It allows prediction of the shape and maximum rise of the water table beneath square and rectangular recharge plots under different loading rates and soil-groundwater conditions. The maximum rise is of most concern with on-site sewage disposal systems.

1. Data Needs

Computation of the height at the center of the groundwater mound requires the following input data:

- W = Width of the disposal field (ft);
- L = Length of the disposal field (ft);
- I = Wastewater application rate (ft/day);
- V = Specific yield or fillable pore space of the soil (ft^3/ft^3);
- K = Horizontal hydraulic conductivity of the aquifer (ft/day);
- D = Saturated thickness of the aquifer (ft);
- H = Depth to groundwater from bottom of the disposal trenches (ft);
- t = Duration of wastewater application (days).

The parameters W, L and I are readily obtainable from the design and layout of the disposal system. Soil and aquifer characteristics, V,K,D and H, may be obtained from prior groundwater studies or site-specific field investigations. A useful reference on this topic is the EPA Land Treatment Design Manual (1977). The duration of wastewater application, t, corresponds to the period for mound height analysis during which a given background water table level is sustained. For seasonally fluctuating water tables (common to most of the North Coast) the most critical time for analysis would likely be for periods of 30 to 180 days during the wet weather season. The selected value should be based upon observed or estimated characteristics of the aquifer.

2. Analysis

The maximum groundwater rise may be estimated with the following 3-step procedure:

Step 1: Compute the following quantities:

(1) $\alpha = \frac{KD}{V}$

(2) $R = \frac{I}{V}$

(3) $\frac{W}{\sqrt{4\ t}}$

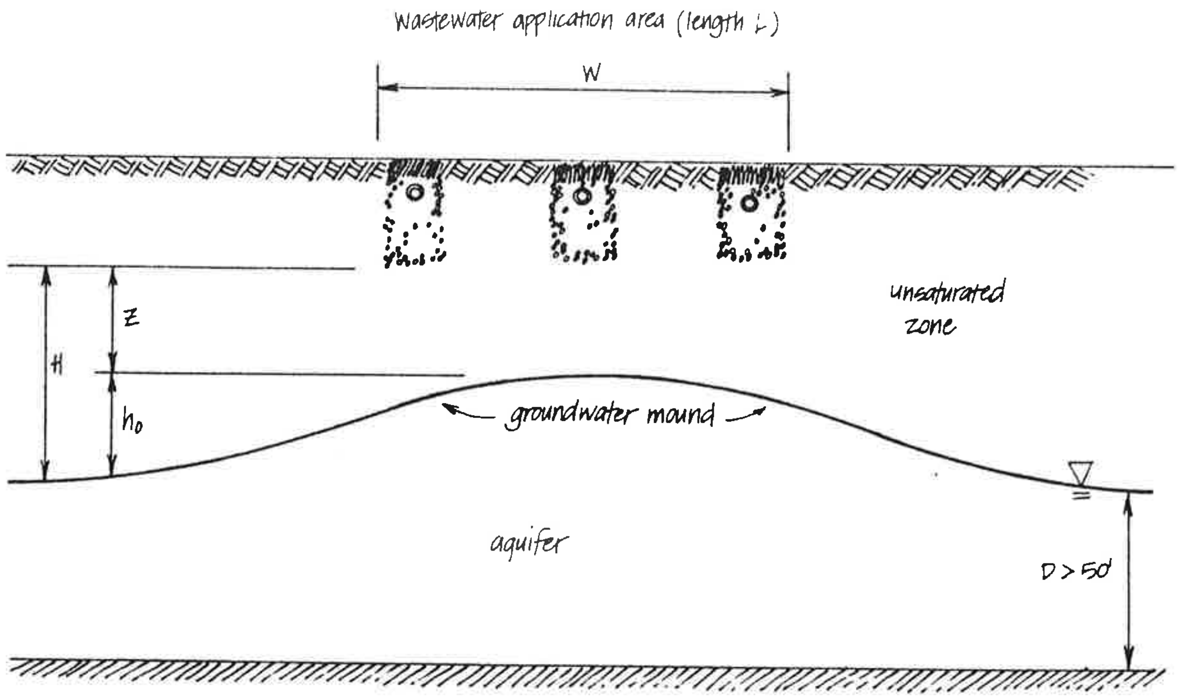


Fig. 2. Groundwater Mounding for Case 1 - Aquifer of Relatively Large Thickness

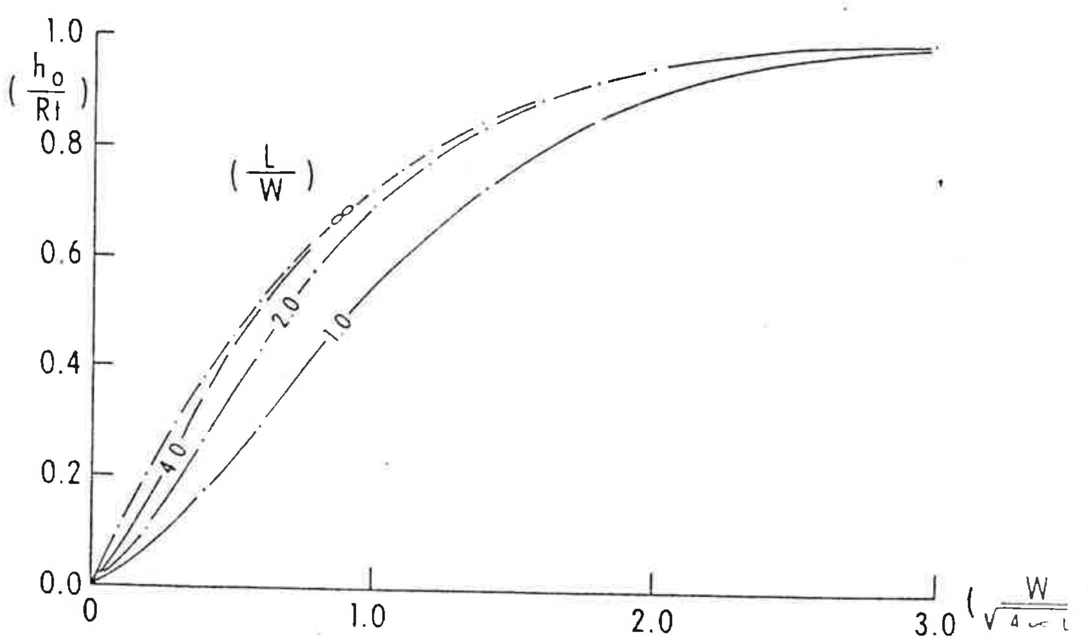


Fig. 3. Dimensionless Plot of the Rise at the Center (h_o) of the Mound Beneath a Rectangular Recharge Area for Different Ratios of Length to Width (Glover,1966)

Step 2: Obtain values of $\frac{h_o}{Rt}$ from Figure 3; from these compute the maximum mound height h_o.

Step 3: Compute the effective separation distance (z) between the disposal point and the maximum groundwater height:

$$z = H - h_o$$

Case 2. The case of a relatively thin aquifer is illustrated in Figure 4. A method developed by Hantush (1967) provides a suitable means for estimating groundwater mounding. The approach is similar to that previously described for the case of a thick aquifer. The estimation method has been shown to provide fairly accurate estimates when the rise of the water table relative to the initial depth of saturation does not exceed about 50%.

1. Data Needs

Computation of maximum mound height requires the following input data:

- W = Width of disposal field (ft);
- L = Length of disposal field (ft);
- I = Wastewater application rate (ft/day);
- V = Specific yield or fillable pore space of the soil (ft^3/ft^3);
- K = Horizontal hydraulic conductivity of the aquifer (ft/day);
- H = Depth to groundwater from point of disposal (ft);
- h_i = Initial water table height (ft);
- t = Duration of wastewater application (days).

As discussed for Case 1, these data are readily obtainable or can be reasonably estimated in most instances.

2. Analysis

The maximum mound height (h_m) is determined by the following 4-step procedure:

Step 1: Compute the following:

(1) $\bar{b} = 0.5\ (h_i + h_m)$*

(2) $V_o = \frac{K\bar{b}}{V}$

(3) $\alpha = \frac{L}{4\sqrt{V_o t}}$

*Estimated value of h_m is assumed initially and final solution derived by method of successive approximation.

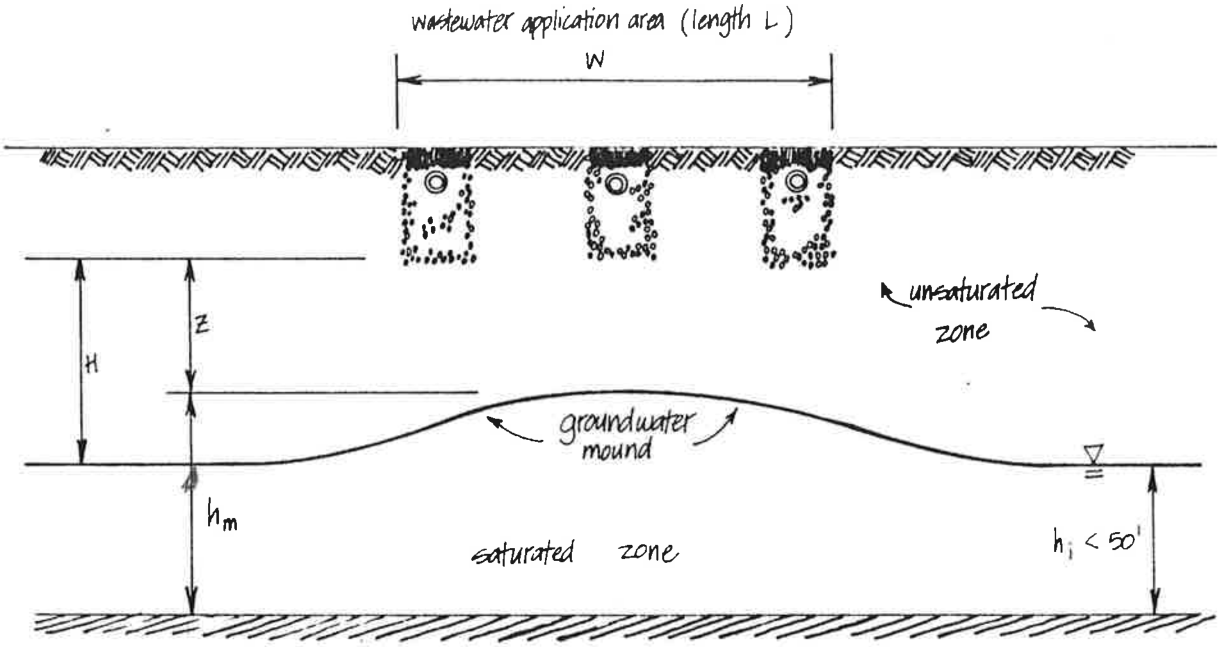


Fig. 4. Groundwater Mounding for Case 2 -
Relatively Thin Groundwater Zone

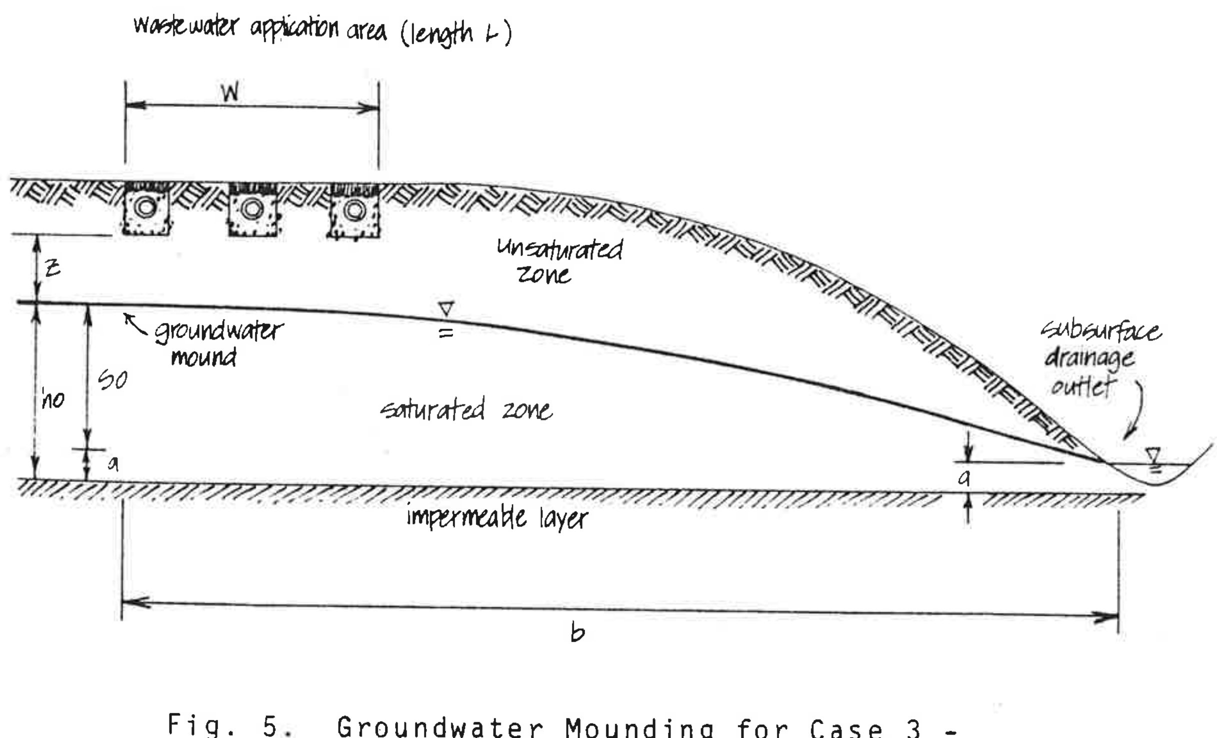


Fig. 5. Groundwater Mounding for Case 3 -
Flow to Lateral Seepage Outlet

TABLE 1. Numerical Solutions for Groundwater Mounding Analysis

Values of the function $S^{*}(\alpha,\beta) = \int_0^1 \operatorname{erf}\left(\frac{\alpha}{\sqrt{\tau}}\right) \operatorname{erf}\left(\frac{\beta}{\sqrt{\tau}}\right) d\tau$

α \ β	0.02	0.04	0.06	0.08	0.10	0.14	0.18	0.22	0.26	0.30	0.34	0.38	0.42	0.46	0.50	0.54	0.58	0.62
0.02	0.0041	0.0073	0.0101	0.0125	0.0146	0.0184	0.0215	0.0243	0.0267	0.0288	0.0306	0.0322	0.0337	0.0349	0.0361	0.0371	0.0380	0.0387
0.04	0.0073	0.0135	0.0193	0.0236	0.0273	0.0353	0.0415	0.0470	0.0513	0.0551	0.0596	0.0628	0.0657	0.0683	0.0705	0.0725	0.0743	0.0759
0.06	0.0101	0.0193	0.0265	0.0335	0.0393	0.0509	0.0602	0.0684	0.0751	0.0817	0.0871	0.0920	0.0963	0.1001	0.1035	0.1065	0.1091	0.1115
0.08	0.0125	0.0236	0.0335	0.0425	0.0503	0.0652	0.0776	0.0884	0.0973	0.1060	0.1133	0.1197	0.1254	0.1305	0.1350	0.1389	0.1425	0.1456
0.10	0.0146	0.0278	0.0393	0.0508	0.0605	0.0786	0.0939	0.1072	0.1183	0.1290	0.1381	0.1461	0.1532	0.1595	0.1650	0.1700	0.1744	0.1783
0.14	0.0184	0.0353	0.0509	0.0652	0.0786	0.1025	0.1232	0.1414	0.1573	0.1714	0.1839	0.1941	0.2045	0.2135	0.2212	0.2281	0.2343	0.2397
0.18	0.0216	0.0416	0.0602	0.0776	0.0939	0.1232	0.1499	0.1716	0.1916	0.2094	0.2251	0.2391	0.2515	0.2626	0.2724	0.2812	0.2890	0.2959
0.22	0.0243	0.0470	0.0684	0.0884	0.1072	0.1414	0.1716	0.1954	0.2222	0.2433	0.2621	0.2789	0.2938	0.3071	0.3189	0.3295	0.3393	0.3472
0.26	0.0267	0.0518	0.0754	0.0978	0.1159	0.1573	0.1916	0.2222	0.2494	0.2737	0.2954	0.3147	0.3320	0.3474	0.3612	0.3735	0.3844	0.3941
0.30	0.0288	0.0559	0.0817	0.1060	0.1290	0.1714	0.2094	0.2433	0.2737	0.3009	0.3252	0.3470	0.3665	0.3839	0.3995	0.4134	0.4257	0.4368
0.34	0.0306	0.0596	0.0871	0.1133	0.1381	0.1839	0.2251	0.2621	0.2954	0.3252	0.3520	0.3761	0.3976	0.4169	0.4341	0.4495	0.4633	0.4756
0.38	0.0322	0.0628	0.0920	0.1197	0.1461	0.1949	0.2391	0.2789	0.3147	0.3470	0.3761	0.4022	0.4256	0.4466	0.4654	0.4823	0.4973	0.5108
0.42	0.0337	0.0657	0.0963	0.1254	0.1532	0.2045	0.2515	0.2938	0.3320	0.3665	0.3976	0.4256	0.4508	0.4734	0.4937	0.5119	0.5281	0.5427
0.46	0.0349	0.0683	0.1001	0.1305	0.1595	0.2135	0.2626	0.3071	0.3474	0.3839	0.4167	0.4466	0.4734	0.4975	0.5191	0.5385	0.5559	0.5715
0.50	0.0361	0.0705	0.1035	0.1350	0.1650	0.2212	0.2724	0.3189	0.3612	0.3995	0.4341	0.4654	0.4937	0.5191	0.5420	0.5626	0.5810	0.5975
0.54	0.0371	0.0725	0.1065	0.1389	0.1700	0.2281	0.2812	0.3295	0.3735	0.4134	0.4495	0.4823	0.5119	0.5385	0.5626	0.5842	0.6036	0.6209
0.58	0.0380	0.0743	0.1091	0.1425	0.1744	0.2343	0.2890	0.3393	0.3844	0.4257	0.4633	0.4973	0.5281	0.5559	0.5810	0.6036	0.6239	0.6420
0.62	0.0387	0.0759	0.1115	0.1456	0.1783	0.2397	0.2959	0.3472	0.3941	0.4368	0.4756	0.5108	0.5427	0.5715	0.5975	0.6209	0.6420	0.6609
0.66	0.0394	0.0773	0.1136	0.1484	0.1815	0.2445	0.3022	0.3547	0.4027	0.4466	0.4865	0.5227	0.5556	0.5854	0.6122	0.6364	0.6582	0.6778
0.70	0.0401	0.0785	0.1154	0.1509	0.1849	0.2488	0.3075	0.3612	0.4104	0.4553	0.4962	0.5334	0.5672	0.5977	0.6254	0.6503	0.6728	0.6929
0.74	0.0406	0.0796	0.1171	0.1531	0.1876	0.2526	0.3123	0.3671	0.4172	0.4630	0.5048	0.5429	0.5774	0.6087	0.6371	0.6627	0.6857	0.7064
0.78	0.0411	0.0806	0.1185	0.1550	0.1900	0.2559	0.3165	0.3722	0.4232	0.4699	0.5125	0.5513	0.5865	0.6185	0.6475	0.6736	0.6972	0.7184
0.82	0.0415	0.0814	0.1198	0.1567	0.1921	0.2589	0.3203	0.3766	0.4286	0.4760	0.5192	0.5587	0.5946	0.6272	0.6567	0.6834	0.7074	0.7291
0.86	0.0419	0.0822	0.1209	0.1582	0.1940	0.2615	0.3237	0.3808	0.4333	0.4813	0.5252	0.5653	0.6017	0.6348	0.6648	0.6920	0.7165	0.7386
0.90	0.0422	0.0828	0.1219	0.1595	0.1957	0.2638	0.3266	0.3844	0.4374	0.4860	0.5305	0.5711	0.6080	0.6416	0.6721	0.6996	0.7245	0.7469
0.94	0.0425	0.0834	0.1228	0.1607	0.1971	0.2658	0.3292	0.3875	0.4411	0.4902	0.5351	0.5762	0.6135	0.6476	0.6784	0.7063	0.7316	0.7543
0.98	0.0428	0.0839	0.1236	0.1617	0.1984	0.2676	0.3314	0.3902	0.4442	0.4938	0.5392	0.5807	0.6184	0.6528	0.6840	0.7123	0.7378	0.7608
1.00	0.0429	0.0842	0.1239	0.1622	0.1990	0.2684	0.3324	0.3914	0.4457	0.4955	0.5410	0.5827	0.6206	0.6552	0.6865	0.7150	0.7406	0.7638
1.20	0.0437	0.0858	0.1263	0.1654	0.2030	0.2740	0.3395	0.4001	0.4558	0.5070	0.5540	0.5969	0.6362	0.6719	0.7044	0.7339	0.7605	0.7846
1.40	0.0441	0.0866	0.1275	0.1669	0.2049	0.2767	0.3431	0.4043	0.4608	0.5127	0.5603	0.6039	0.6438	0.6801	0.7132	0.7432	0.7704	0.7949
1.80	0.0444	0.0871	0.1283	0.1680	0.2062	0.2785	0.3454	0.4071	0.4641	0.5165	0.5645	0.6086	0.6489	0.6856	0.7190	0.7494	0.7769	0.8018
2.00	0.0444	0.0871	0.1284	0.1681	0.2064	0.2787	0.3457	0.4075	0.4645	0.5169	0.5651	0.6092	0.6495	0.6863	0.7198	0.7502	0.7778	0.8027
2.20	0.0444	0.0872	0.1284	0.1682	0.2065	0.2788	0.3458	0.4076	0.4646	0.5171	0.5653	0.6094	0.6497	0.6865	0.7200	0.7505	0.7781	0.8030
2.50	0.0444	0.0872	0.1284	0.1682	0.2065	0.2789	0.3458	0.4077	0.4647	0.5172	0.5653	0.6095	0.6498	0.6867	0.7202	0.7506	0.7782	0.8032
3.00	0.0444	0.0872	0.1284	0.1682	0.2065	0.2789	0.3458	0.4077	0.4647	0.5172	0.5654	0.6095	0.6499	0.6867	0.7202	0.7506	0.7782	0.8032

Source: (Hantush, 1967)

TABLE 2. (cont.)

α \ β	0.62	0.66	0.70	0.74	0.78	0.82	0.86	0.90	0.94	0.98	1.00	1.20	1.40	1.80	2.00	2.20	2.50	3.00
0.02	0.0387	0.0394	0.0401	0.0406	0.0411	0.0415	0.0419	0.0422	0.0425	0.0428	0.0429	0.0437	0.0441	0.0444	0.0444	0.0444	0.0444	0.0444
0.04	0.0759	0.0773	0.0785	0.0796	0.0806	0.0814	0.0822	0.0828	0.0834	0.0839	0.0842	0.0855	0.0866	0.0871	0.0871	0.0872	0.0872	0.0872
0.06	0.1115	0.1136	0.1154	0.1171	0.1185	0.1198	0.1209	0.1219	0.1228	0.1236	0.1239	0.1263	0.1275	0.1283	0.1284	0.1284	0.1284	0.1284
0.08	0.1456	0.1484	0.1509	0.1531	0.1550	0.1567	0.1582	0.1595	0.1607	0.1617	0.1622	0.1654	0.1669	0.1680	0.1681	0.1682	0.1682	0.1682
0.10	0.1783	0.1818	0.1849	0.1876	0.1900	0.1921	0.1940	0.1957	0.1971	0.1984	0.1990	0.2030	0.2049	0.2062	0.2064	0.2065	0.2065	0.2065
0.14	0.2397	0.2445	0.2488	0.2526	0.2559	0.2589	0.2615	0.2638	0.2658	0.2676	0.2684	0.2740	0.2767	0.2785	0.2787	0.2788	0.2788	0.2789
0.18	0.2959	0.3020	0.3075	0.3123	0.3166	0.3203	0.3237	0.3266	0.3292	0.3314	0.3324	0.3396	0.3431	0.3454	0.3457	0.3458	0.3458	0.3458
0.22	0.3472	0.3547	0.3612	0.3671	0.3722	0.3768	0.3808	0.3844	0.3875	0.3902	0.3914	0.4001	0.4043	0.4071	0.4075	0.4076	0.4077	0.4077
0.26	0.3941	0.4027	0.4104	0.4172	0.4232	0.4286	0.4333	0.4374	0.4411	0.4442	0.4457	0.4558	0.4603	0.4641	0.4645	0.4646	0.4647	0.4647
0.30	0.4368	0.4465	0.4553	0.4630	0.4699	0.4760	0.4813	0.4860	0.4902	0.4938	0.4955	0.5070	0.5127	0.5165	0.5169	0.5171	0.5172	0.5172
0.34	0.4756	0.4865	0.4962	0.5048	0.5125	0.5192	0.5252	0.5305	0.5351	0.5392	0.5410	0.5540	0.5603	0.5645	0.5651	0.5653	0.5653	0.5654
0.38	0.5108	0.5227	0.5334	0.5429	0.5513	0.5587	0.5653	0.5711	0.5762	0.5807	0.5827	0.5969	0.6039	0.6086	0.6092	0.6094	0.6095	0.6095
0.42	0.5427	0.5556	0.5672	0.5774	0.5865	0.5946	0.6017	0.6080	0.6136	0.6184	0.6206	0.6362	0.6438	0.6489	0.6495	0.6497	0.6498	0.6499
0.46	0.5715	0.5854	0.5977	0.6087	0.6185	0.6272	0.6348	0.6416	0.6476	0.6528	0.6552	0.6719	0.6801	0.6856	0.6863	0.6865	0.6867	0.6867
0.50	0.5975	0.6122	0.6254	0.6371	0.6475	0.6567	0.6648	0.6721	0.6784	0.6842	0.6865	0.7044	0.7132	0.7190	0.7198	0.7200	0.7202	0.7202
0.54	0.6209	0.6364	0.6503	0.6627	0.6736	0.6834	0.6920	0.6996	0.7063	0.7125	0.7150	0.7339	0.7432	0.7494	0.7502	0.7505	0.7506	0.7506
0.58	0.6420	0.6582	0.6728	0.6857	0.6972	0.7074	0.7165	0.7245	0.7316	0.7378	0.7406	0.7605	0.7704	0.7769	0.7778	0.7781	0.7782	0.7782
0.62	0.6609	0.6778	[illegible]	0.7064	0.7184	0.7291	0.7386	0.7469	0.7543	0.7608	0.7638	0.7846	0.7949	0.8018	0.8027	0.8030	0.8032	0.8032
0.66	0.6778	0.6953	0.7110	0.7250	0.7375	0.7486	0.7584	0.7671	0.7748	0.7816	0.7846	0.8064	0.8171	0.8243	0.8252	0.8255	0.8257	0.8257
0.70	0.6929	0.7110	0.7272	0.7417	0.7546	0.7660	0.7762	0.7852	0.7932	0.8002	0.8034	0.8259	0.8370	0.8445	0.8454	0.8458	0.8460	[illegible]
0.74	0.7064	0.7250	0.7417	0.7560	0.7688	0.7816	0.7921	0.8014	0.8096	0.8165	0.8201	0.8434	0.8549	0.8627	0.8636	0.8640	0.8642	0.8642
0.78	0.7184	0.7375	0.7546	0.7699	0.7834	0.7956	0.8063	0.8159	0.8243	0.8317	0.8351	0.8591	0.8710	0.8789	0.8799	0.8803	0.8805	0.8805
0.82	0.7291	0.7486	0.7660	0.7816	0.7956	0.8080	0.8190	0.8288	0.8374	0.8450	0.8485	0.8731	0.8853	0.8935	0.8945	0.8949	0.8951	0.8951
0.86	0.7386	0.7584	0.7762	0.7921	0.8063	0.8190	0.8302	0.8402	0.8491	0.8569	0.8604	0.8855	0.8980	0.9065	0.9075	0.9079	0.9081	0.9081
0.90	0.7469	0.7671	0.7852	0.8014	0.8159	0.8288	0.8402	0.8504	0.8594	0.8674	0.8710	0.8966	0.9094	0.9180	0.9191	0.9195	0.9197	0.9197
0.94	0.7543	0.7745	0.7932	0.8096	0.8243	0.8374	0.8491	0.8594	0.8686	0.8767	0.8803	0.9064	0.9195	0.9282	0.9294	0.9298	[illegible]	0.9300
0.98	0.7603	0.7816	0.8002	0.8168	0.8317	0.8450	0.8569	0.8674	0.8767	0.8849	0.8886	0.9151	0.9281	0.9373	0.9384	0.9389	0.9391	0.9391
1.02	0.7638	0.7845	0.8034	0.8201	0.8351	0.8485	0.8604	0.8710	0.8803	0.8886	0.8924	0.9191	0.9324	0.9414	0.9426	0.9430	0.9432	0.9433
1.20	0.7846	0.8064	0.8259	0.8434	0.8591	0.8731	0.8855	0.8966	0.9064	0.9151	0.9191	0.9472	0.9614	0.9709	0.9722	0.9726	0.9728	0.9729
1.40	0.7949	0.8171	0.8370	0.8549	0.8710	0.8853	0.8980	0.9094	0.9195	0.9284	0.9324	0.9614	0.9759	0.9858	0.9871	0.9875	0.9878	0.9878
1.80	0.8018	0.8243	0.8445	0.8627	0.8789	0.8935	0.9065	0.9180	0.9282	0.9373	0.9414	0.9709	0.9858	0.9959	0.9972	0.9977	0.9979	0.9980
2.00	0.8027	0.8252	0.8454	0.8636	0.8799	0.8945	0.9075	0.9191	0.9294	0.9384	0.9426	0.9722	0.9871	0.9972	0.9985	0.9990	0.9992	0.9993
2.20	0.8030	0.8255	0.8458	0.8640	0.8803	0.8949	0.9079	0.9195	0.9298	0.9389	0.9430	0.9726	0.9875	0.9977	0.9990	0.9995	0.9997	0.9998
2.50	0.8032	0.8257	0.8460	0.8642	0.8805	0.8951	0.9081	0.9197	0.9300	0.9391	0.9432	0.9728	0.9878	0.9979	0.9992	0.9997	1.0000	1.0000
3.00	0.8032	0.8257	0.8460	0.8642	0.8805	0.8951	0.9081	0.9197	0.9300	0.9391	0.9433	0.9729	0.9878	0.9980	0.9993	0.9998	1.0000	1.0000

Source: Hantush (1967)

(4) $\beta = \frac{W}{4\sqrt{V_o t}}$

Step 2: Using Table 1, obtain values for the function $S^*(\alpha, \beta)$.

Step 3: Compute the maximum mound height (h_m) from the following formula:

$$h_m = \sqrt{(2I/K)V_o t S^*(\alpha, \beta) + h_i^2}$$

Case 3. The situation where lateral drainage of groundwater is influenced by an adjacent road cut, underdrain, rock outcropping, etc., is illustrated in Figure 5. Groundwater mounding can be estimated using a method developed by Decoster (1976). Based upon the Dupuit-Forcheimer approximation and Darcy's law, Decoster developed an equation describing the shape of the phreatic surface extending from the disposal field to the drainage outlet. The equation which gives the maximum height of groundwater beneath the disposal field is:

$$\frac{h_o}{W} = \left[\frac{P_o}{K}\left(\frac{2b}{W} - 1\right) + \left(\frac{a}{W}\right)^2\right]^{\frac{1}{2}}$$

where parameters are as shown in Figure 5 and are described in data needs below.

1. Data Needs

The following input data are required for this analysis:

W = Width of disposal field (ft);
P_o = Wastewater application rate (ft/day);
K = Horizontal hydraulic conductivity of the soil (ft/day);
d = Depth to impervious layer below point of disposal (ft);
a = Height of water at the drainage outlet (ft);
b = Lateral distance from far edge of disposal field to drainage outlet (ft).

2. Analysis

Estimation of the maximum rise of the water table (h_o) is determined by the following 4-step procedure:

Step 1: Compute the following two non-dimensional quantities:

(1) $A = \frac{a}{W}\sqrt{\frac{K}{P_o}}$

(2) $B = \frac{W}{b}$

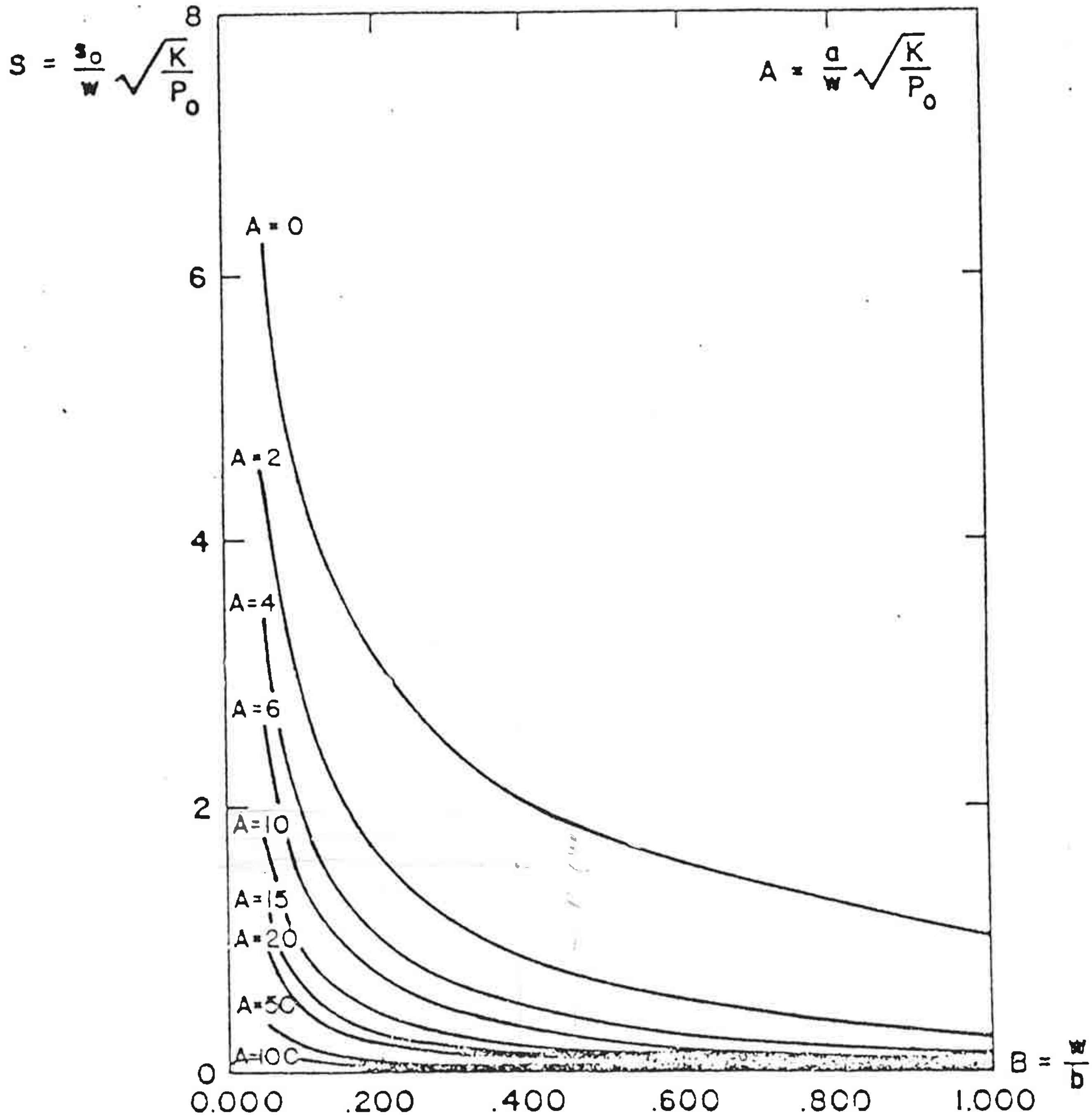


Figure 6. Subsurface drainage design graph.

Source: Small Scale Waste Management Project, 1978

Step 2: With values for A and B, graphically determine the non-dimensional quantity S using Figure 6.

Step 3: Calculate the rise of the groundwater mound (s_0) above the control level (a) as follows:

$$s_o = SW\sqrt{\frac{P_o}{K}}$$

Step 4: Compute the effective separation distance (z) between the disposal point and the maximum groundwater height:

$$z = d - a - s_o$$

This analysis has certain limitations which should be recognized:

(1) Accuracy is expected to be within about 15% (subject to data reliability);

(2) Groundwater movement is projected only in two dimensions. Therefore, the analysis becomes increasingly conservative as the length:width ratio of the disposal field decreases;

(3) Estimates are likely to be conservative where subsurface drainage is to a single lateral boundary outlet. This difficulty can be overcome by solving for lateral flow opposite to the drain using the method described for Case 2. An imaginary line can be constructed through the disposal field as shown in Figure 7. By successively adjusting and computing mound heights at the division line, the combined analyses will converge to an estimate of the position and height of maximum groundwater rise.

Case 4. The case of perched, laterally moving groundwater in sloping terrain is illustrated in Figure 8. A method developed by Bouwer (1976) can be used to roughly approximate groundwater mounding under such conditions.

1. Data Needs

The following input data are required:

W = Width of disposal field in direction of groundwater flow (ft);
I = Wastewater application rate (ft/day);
D = Average thickness of groundwater perpendicular to direction of flow (ft);

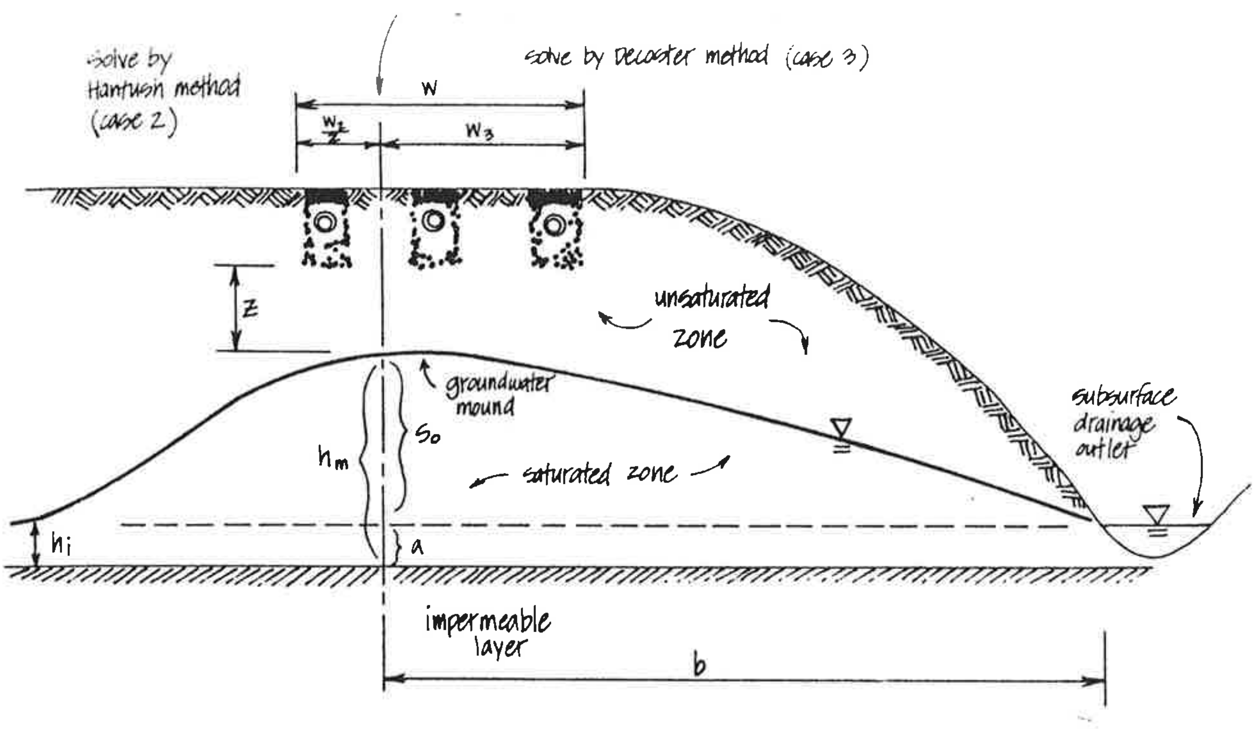


Fig. 7. Combined Application of Case 2 and Case 3 Methodologies

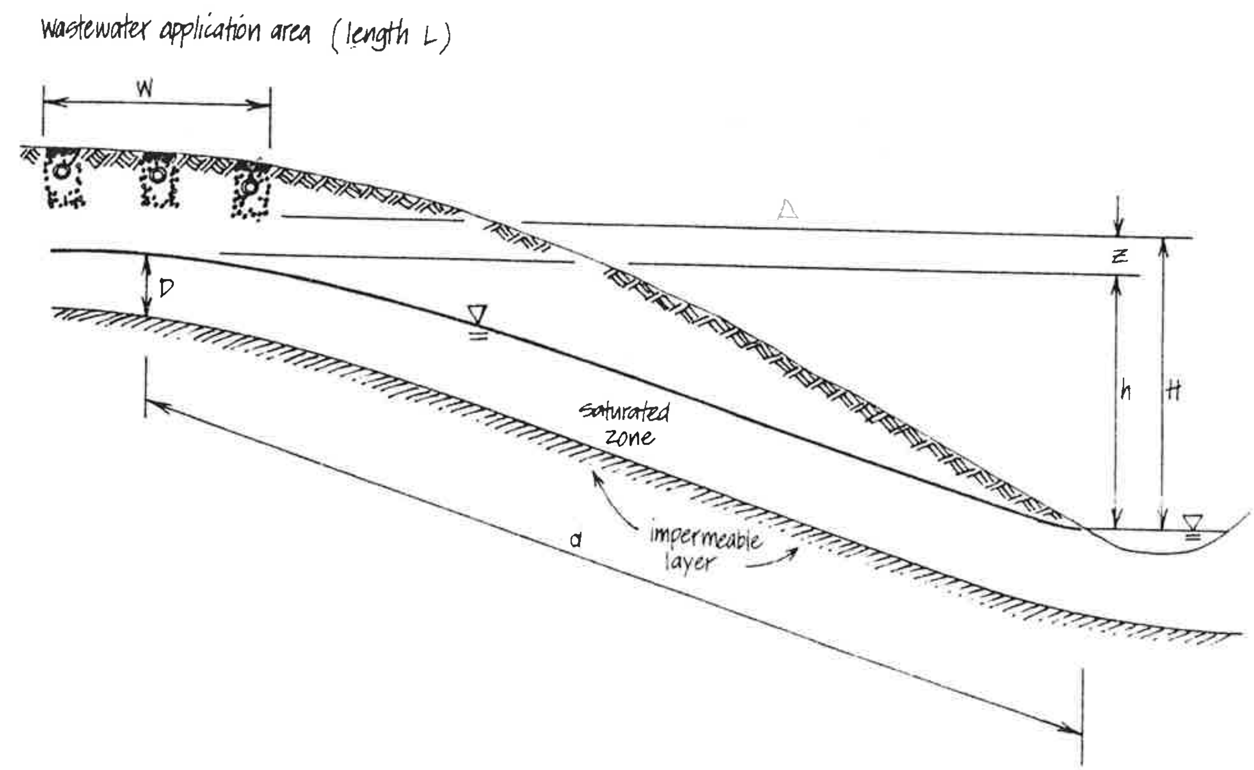


Fig. 8. Groundwater Mounding for Case 4 - Perched Water in Sloping Terrain

d = Lateral flow distance from disposal field to seepage or discharge point (ft);
K = Horizontal hydraulic conductivity (ft/day);
H = Height of the disposal point above the downslope outlet (ft).

2. Analysis

Groundwater mounding is determined by the following 2-step procedure:

Step 1: Compute the maximum groundwater depth (H) above the outlet from the formula:

$$h = \frac{WdI}{KD}$$

Step 2: Compute the effective separation distance (z) between the disposal point and the maximum groundwater height:

$$z = H - h$$

SALT ACCUMULATION

Problem Overview

The accumulation of salts (dissolved solids) in ground and surface waters is a result of (a) leaching of minerals from soils and geologic formations (b) evaporative processes and (c) inputs from waste disposal and other cultural practices. While high salt concentrations are not generally recognized as a widespread water quality problem in the North Coast Region, there are areas where background total dissolved solids (TDS) concentrations in groundwaters are in the range of 400-600 mg/L. In these situations, the added long-term effect from on-site sewage disposal practices may be of concern. In addition, water supplies in many parts of the Region are obtained from relatively small groundwater basins, particularly in the coastal areas. These groundwaters, which rely extensively on local recharge, are affected by changes in watershed conditions, and may be particularly sensitive to waste inputs from on-site sewage disposal practices.

The potential problems from on-site systems are directly related to:

(1) the concentration of salts in domestic wastewaters, and

(2) the fact that dissolved solids are essentially conservative substances, the concentration of which may be reduced only by means of dilution.

Table 3-6. Typical wastewater flow rates from recreational facilities[a]

Facility	Unit	Flow, gallons/unit/day Range	Flow, gallons/unit/day Typical	Flow, liters/unit/day Range	Flow, liters/unit/day Typical
Apartment, resort	Person	50–70	60	190–260	230
Bowling alley	Alley	150–250	200	570–950	760
Cabin, resort	Person	8–50	40	30–190	150
Cafeteria	Customer	1–3	2	4–11	8
	Employee	8–12	10	30–45	38
Camps:					
Pioneer type	Person	15–30	25	57–110	95
Children's, with central toilet/bath	Person	35–50	45	130–190	170
Day, with meals	Person	10–20	15	38–76	57
Day, without meals	Person	10–15	13	38–57	49
Luxury, private bath	Person	75–100	90	280–380	340
Trailer camp	Trailer	75–150	125	280–570	470
Campground-developed	Person	20–40	30	76–150	110
Cocktail lounge	Seat	12–25	20	45–95	76
Coffee Shop	Customer	4–8	6	15–30	23
	Employee	8–12	10	30–45	38
Country club	Guests onsite	60–130	100	230–490	380
	Employee	10–15	13	38–57	49
Dining hall	Meal served	4–10	7	15–38	26
Dormitory/bunkhouse	Person	20–50	40	76–190	150
Fairground	Visitor	1–2	2	4–8	8
Hotel, resort	Person	40–60	50	150–230	190
Picnic park, flush toilets	Visitor	5–10	8	19–38	30
Store, resort	Customer	1–4	3	4–15	11
	Employee	8–12	10	30–45	38
Swimming pool	Customer	5–12	10	19–45	38
	Employee	8–12	10	30–45	38
Theater	Seat	2–4	3	8–15	11
Visitor center	Visitor	4–8	5	15–30	19

[a] Some systems serving more than 20 people might be regulated under USEPA's Class V UIC Program.

Source: Crites and Tchobanoglous, 1998.

pollutants, the strength of residential wastewater fluctuates throughout the day (University of Wisconsin, 1978). For nonresidential establishments, wastewater quality can vary significantly among different types of establishments because of differences in waste-generating sources present, water usage rates, and other factors. There is currently a dearth of useful data on nonresidential wastewater organic strength, which can create a large degree of uncertainty in design if facility-specific data are not available. Some older data (Goldstein and Moberg, 1973; Vogulis, 1978) and some new information exists, but modern organic strengths need to be verified before design given the importance of this aspect of capacity determination.

Wastewater flow and the type of waste generated affect wastewater quality. For typical residential sources peak flows and peak pollutant loading rates do not occur at the same time (Tchobanoglous and Burton, 1991). Though the fluctuation in wastewater quality (see figure 3-5) is similar to the water use patterns illustrated in figure 3-3, the fluctuations in wastewater quality for an individual home are likely to be considerably greater than the multiple-home averages shown in figure 3-5.

Table 3-10. Comparison of flow rates and flush volumes before and after U.S. Energy Policy Act

Fixture	Fixtures installed prior to 1994 in gallons/minute (liters/second)	EPACT requirements (effective January, 1994)	Potential reduction in water used (%)
Kitchen faucet	3.0 gpm (0.19 L/s)	2.5 gpm (0.16 L/s)	16
Lavatory faucets	3.0 gpm (0.19 L/s)	2.5 gpm (0.16 L/s)	16
Showerheads	3.5 gpm (0.22 L/s)	2.5 gpm (0.16 L/s)	28
Toilet (tank type)	3.5 gal (13.2 L)	1.6 gal (6.1 L)	54
Toilet (valve type)	3.5 gal (13.2 L)	1.6 gal[a] (6.1 L)	54
Urinal	3.0 gal (11.4 L)	1.0 gal (3.8 L)	50

Source: Konen, 1995.

Table 3-11. Wastewater flow reduction: water-carriage toilets and systems [a]

Generic type	Description	Application considerations	Operation & maintenance	Water use per event gal (L)	Total flow reduction in gpcd (Lpcd); % of use [b]
Toilets with tank inserts	Displacement devices placed into storage tank of conventional toilet to reduce volume but not height of stored water. Varieties: Plastic bottles, flexible panels, drums, or plastic bags	Device must be compatible with existing toilet and not interfere with flush mechanism Installation by owner Reliability low; failure can result in large flow increase	Frequent post-installation inspections to ensure proper positioning	3.3–3.8 (12.5–14.4)	1.8–3.5 (6.8–13.2) 4%–8%
Water-saving toilets	Variation of conventional flush toilet fixture; similar in appearance and operation. Redesigned flushing rim and priming jet to initiate siphon flush in smaller trapway with less water.	Interchangeable with conventional fixture	Essentially the same as for a conventional unit	1.0–1.6 (3.8–13.2)	5.3–13 (12.1–49.2) 6%–20%
Washdown flush toilets	Flushing uses only water, but substantially less due to washdown flush Varieties: Few Note: Water usage may increase due to multiple flushings	Rough-in for unit may be nonstandard Drain-line slope and lateral-run restrictions Plumber installation advisable	Similar to conventional toilet Cleaning possible	0.8–1.6 (3.0–6.1) (but more frequent flushings possible)	9.4–12.2 (35.6–46.2) 21%–27%
Pressurized-tank toilets	Specially designed toilet tank to pressurize air contained in toilet tank. Upon flushing, compressed air propels water into bowl at increased velocity Varieties: Few	Compatible with most conventional toilet units Increased noise level Water supply pressure of 35–120 psi (180–620 cm Hg) required	Periodic maintenance of compressed air source	2.0–2.5 (7.6–9.5)	6.3–8.0 (23.8–30.3) 14%–18%

[a] Adapted from USEPA, 1992. Compared to conventional toilet usage (4.3 gallons/flush [16.3 liters/flush], 3.5 uses per person per day, and a total daily flow of 45 gallons/person/day [170 liters/person/day]).

[b] gpcd = gallons per capita (person) per day; Lpcd = liters per capita (person) per day.