PRELIMINARY TECHNICAL DRAINAGE STUDY

Open Door Community Health Center
Tydd Street, Eureka, California

Assessor's Parcel Numbers 002-191-027, -028, and -031

Prepared for:
Open Door Community Health Center
670 Ninth Street, Suite 203
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Prepared by:
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December 2010
LACO Project No. 7119.05

PRELIMINARY TECHNICAL DRAINAGE STUDY

Open Door Community Health Center
Vacant Property at Tydd Street, Eureka, California
Assessor's Parcel Numbers 002-191-027, -028, and -037
LACO Project No. 7119.05

Executive Summary

This Preliminary Technical Drainage Study (Study) describes the alternatives evaluated for the proposed construction of the Open Door Community Health Center (ODCHC) on Tydd Street in Eureka, California. As specified in Section 4.D.7 of the City of Eureka (City) General Plan Policy Document and as confirmed with City staff, "The City shall require new development that would increase storm drainage run-off in a ten-year storm event to more than 1 cubic foot per second (cfs) to provide retention/siltation basins to limit new run-off to prior-to-development flows". The three drainage design alternatives presented in this Study were designed to comply with the City's development criteria: stormwater flows are not increased more than 1 cfs for the ten-year event. Existing flow patterns at the site will be perpetuated to the greatest extent practicable.

This Study documents post-construction flows at the site will be less than or equal to pre-development flows. Additionally, this Study describes how run-off from events up to the 100-year storm event will be safely conveyed from the developed parcels to the existing outlet, an unnamed slough tributary, flowing to the Eureka Slough and discharging to Humboldt Bay. Due to the conceptual nature of the site plan and preliminary nature of this Study, several conceptual drainage design alternatives have been analyzed and are presented herein. The conceptual alternatives are designed to be easily modified to accommodate the final building and site design. The final drainage design will be based on the building and site layout accepted by and satisfying the City's design criteria and standards.

Introduction

Presented herein are the drainage calculations for development of the proposed ODCHC, located in Eureka, Humboldt County, California; Assessor's Parcel Numbers (APNs) 002-191-027, 002-191-028, 002-191-031 (Figure 1 Location Map). Onsite detention or other methods must be designed to store the incremental increase in stormwater generated by the proposed development using the ten-year, 24-hour storm event.

This Study acknowledges street improvement and drainage concerns raised by the City's Director of Community Development, Ms. Sidnie Olson, in her November 9, 2010 letter to LACO Associates' (LACO) Planning Division Director, Michael Nelson. LACO anticipates offsite Tydd Street improvements and related drainage improvements may be required as part of this proposed development. Minor increases in flow from widening Tydd Street can be conveyed in the existing road side ditch at the approximate midpoint of Tydd Street. A new drop inlet (DI) will accompany the new curb and gutter on the east side of Tydd Street. Surface flows will be

directed to their historical outlet, the roadside ditch. LACO will work with the City to provide an acceptable drainage design for Tydd Street to compliment any required street improvements.

The existing vacant site encompasses approximately 6.6 acres. Wetlands at the site were delineated by Winzler & Kelly Consulting Engineers in their February 2005 *Wetlands Delineation Assessors Parcel Numbers 002-191-013 & 020 (*Wetlands Delineation). The Wetlands Delineation includes plant species found onsite. Wetland and buffer zones have been identified on approximately the southern two-thirds of the property, limiting development of the parcels. While the northwest quadrant of the site is relatively flat, the property generally slopes to the southeast, towards the existing wetland area/slough tributary. Stormwater run-off generally flows from the higher-elevation northwest property corner across the site towards the southeast corner. Based on a site investigation following a storm event and the existing topography at the site, the site is impacted by a small area that contributes offsite run-off (onsite run-on); Project Area Hydrologic Subbasin included as Figure 2. Offsite run-off originates from a portion of the proposed roundabout and the access road from Tydd Street.

In order to reduce stormwater run-off increases associated with the site development, Low Impact Development (LID) drainage features are proposed to be incorporated into the site design. LID is an innovative stormwater management approach using basic principles modeled after nature: manage rainfall at the source by uniformly distributing. LID's goal is to mimic a site's predevelopment hydrology using design techniques that infiltrate, filter, store, evaporate, and detain run-off close to its source. Techniques are based on managing stormwater rather than disposal. Rather than managing, conveying, and treating stormwater in large, costly detention basins, LID addresses stormwater through small, cost-effective landscape features located closer to the development.

LID features may include, but are not limited to; rain gardens, permeable paving within the non-traffic areas of the parking lots, bioswales, and underground storage devices. LID design approaches are “green design approaches” supported by most regulatory agencies such as the Department of Fish and Game (DFG) and the Regional Water Quality Control Boards (RWQCB). There is an increasing trend in using LID designs as the advantages of reducing development impacts using these approaches becomes more accepted. Since the site layout is still in the conceptual phases, several general drainage design alternatives are presented within this report. The final site design will govern the drainage alternative(s) utilized for the site.

Method and Calculations for Run-off Volume Storage Determination

The design storm event is the ten-year event according to the City of Eureka’s General Plan Policy Document. City standards state that the incremental increase in stormwater run-off generated during the design storm must be detained onsite in order to limit post-development flow to pre-development conditions if the proposed development produces more than 1 cfs of additional run-off during the ten-year storm. In order to reduce the potential for property damage

or erosion from the 100-year storm event, the run-off generated from this storm event was also evaluated.

Using the California Department of Water Resources Intensity-Duration-Frequency curves for Eureka, and calculating the site-specific time of concentration for both the pre- and post-development conditions, the resulting storm intensities were determined. In its unimproved state, run-off from the site travels in a southeasterly direction from the property's high point, adjacent to the proposed Tydd Street roundabout, to the wetland area and the unnamed slough tributary located along the southern extents of the site. Once the Health Center and its associated improvements are constructed, run-off from the developed site will be detained and the detained stormwater metered out and allowed to sheet flow directly into the slough tributary. Since the proposed drainage features must be able to detain the incremental increase in stormwater run-off produced during the ten-year storm event while also providing conveyance for flows exceeding this event up to the 100-year event, overflow drains or other outlet mechanisms will be included in the final design, once a drainage design alternative is selected and the site geometry is finalized. Overflows will be sized to safely convey excess flows away from the building and towards the slough tributary/wetland area. The drainage design alternatives considered for this project are discussed in detail in the *Design Alternatives* section of this Study.

Due to the different overland flow paths of the run-off before and after construction of the Health Center, two separate times of concentration were calculated for the site. The time of concentration is generally defined as the time required for a particle of water to travel from the most hydrologically remote point in the subbasin to the point of collection. The longest, post-construction time of concentration calculated, 5.1 minutes, was used to determine the rainfall intensity for the design and 100-year storm events. The Intensity-Duration-Frequency Curves for the site are included as Attachment A. The time of concentration was calculated using the Kirpich Method, which takes both flow length and ground slope into consideration.

In order to determine both the pre- and post-development run-off flows at the site, the Rational Method for overland flow was employed. This method takes into account the rainfall intensity for a given storm event, the type of surfaces present at the site, and the area associated with each surface type.

The subject site was analyzed considering both the pre- and post-development conditions in order to calculate the weighted rational run-off coefficients. Table 1 contains a tabular listing of the run-off coefficients used to calculate the coefficients. Table 2 lists the surface types, areas for each surface, and the run-off coefficients used for determining the weighted run-off coefficients for the site.

Table 1: Typical Run-off Coefficients

Description of Area	Run-off Coefficients (C)
Business: Downtown areas	0.70 - 0.95
Neighborhood areas	0.50 - 0.70
Residential: Single family areas	0.30 - 0.50
Multi-units detached	0.40 - 0.60
Multi-units attached	0.60 - 0.75
Suburban	0.25 - 0.40
Residential 1.2 ac lots or more	0.30 - 0.45
Apartments dwelling areas	0.50 - 0.70
Industrial: Light areas	0.50 - 0.80
Industrial: Heavy areas	0.60 - 0.90
Park, Cemeteries	0.10 - 0.25
Playgrounds	0.20 - 0.40
Railroad yard areas	0.20 - 0.40
Unimproved areas	0.10 - 0.30
Street: Asphalt	0.75 - 0.95
Concrete	0.80 - 0.95
Drives and walks	0.75 - 0.85
Roofs	0.75 - 0.95

Source: Table 819.2B of the Caltrans Highway Design Manual

Table 2: Surfaces and Run-off Coefficients

Surface	Area (Acre)	Run-off Coefficient (C)
Pre-Development Conditions		
Asphalt Concrete	0.64	0.90
Permeable Paving	0.00	0.35
Roof	0.00	0.90
Landscape/Open	1.58	0.30
Post-Development Conditions		
Asphalt Concrete	1.48	0.90
Permeable Paving	0.07	0.35
Roof	0.43	0.90
Landscape/Open	0.24	0.30

Weighted run-off coefficients were determined for pre- and post-development condition and are listed below. Only the portion of the site proposed for development, north of the 100-foot wetland setback, has been considered in the hydrologic calculations. The remaining portion of the site is not proposed for development, the flow quantities from these areas are expected to remain unchanged and therefore do not require analysis. The run-off coefficient used for permeable paving was obtained from the Massachusetts Nonpoint Source Pollution Management Manual; the run-off coefficient for the actual pavers installed at the site will be verified prior to finalization of the drainage design based on the actual paver selected for installation.

- Weighted Pre-Development Run-off Coefficient (C): 0.47
- Weighted Post-Development Run-off Coefficient (C): 0.83

Using the weighted run-off coefficients calculated, pre- and post-construction stormwater run-off flows from the site were calculated for the ten-year and 100-year storm events The Rational Method parameters and run-off flow quantities calculated are presented in Tables 3 and 4:

Table 3: Pre- and Post-Development Flows for the Design Storm Event (ten-year)

Pre-Development Conditions	
Total Area (Ac)	2.22 Acres
C_{avg}	0.47
i_{10}	2.90 in/hr
Q_{pre}	**3.03 cu.ft./sec**
Post-Development Conditions	
Total Area (Ac)	2.22 Acres
C_{avg}	0.83
i_{10}	2.90 in/hr
Q_{post}	5.36 cu.ft./sec
Incremental Increase	**2.33 cu.ft./sec**

Table 4: Pre- and Post-Development Flows for the 100-Year Storm

Pre-Development Conditions	
Total Area (Ac)	2.22 Acres
C_{avg}	0.47
i_{100}	4.25 in/hr
Q_{pre}	**4.43 cu.ft./sec**
Post-Development Conditions	
Total Area (Ac)	2.22 Acres
C_{avg}	0.83
i_{100}	4.25 in/hr
Q_{post}	7.86 cu.ft./sec
Incremental Increase	**3.43 cu.ft./sec**

The Modified Rational Method was used to determine the volume of stormwater requiring onsite detention in order to satisfy the City‘s design criteria during a ten-year storm event. The Modified Rational Method is commonly used for detention basin sizing. The Modified Rational Method uses the peak flow calculating capability of the Rational Method, paired with assumptions about the inflow and outflow hydrographs to compute an approximation of storage volumes for simple detention calculations.

<u>Modified Rational Method for Storage Volume Determination</u>

$$V_{st} = \frac{1}{2}(Q_{post} - Q_{pre}) * 3 * t_c * K$$

As Table 5 indicates, the volume of the increase in stormwater run-off produced by the site post-construction without stormwater detention would be 1,277 cubic feet for the ten-year design storm event. The K Factor utilized in the Modified Rational Method equation accounts for the nonlinearity of the actual hydrograph, which conservatively models the volume of run-off from the storm event through time. The K Factor typically ranges from 1.2 to 1.5. The property has many favorable drainage attributes, including the wetland/slough tributary onsite, and the downward-sloping topography to this area. Since the site characteristics provide a natural means of safely conveying stormwater run-off away from the proposed development without causing building flooding and damage, the lower K Factor was employed to determine the required storage volume.

Table 5: Required Storage Volume for the ten-year Storm using the Modified Rational Method

Time of Concentration (Tc)	Pre-Development Flow (Qpre)	Post-Development Flow (Qpost)	K Factor	Needed Storage Volume (Vst)
5.1 min	3.03 cfs	5.36 cfs	1.2	1,277 cu. ft.

Design Alternatives

Three drainage design alternatives are presented in this section of the Study in order to illustrate many options exist for handling and detaining the stormwater run-off generated by the proposed ODCHC. The design alternatives considered in this Study include the development of a bioswale, rain gardens throughout the parking lot, and the utilization of a pre-fabricated underground storage system, all of which can be considered LID features. The design alternatives discussed in this Study have been sized to detain the incremental increase in stormwater run-off generated by the developed site for the design event, while providing adequate additional capacity and/or overflow protection is required for events exceeding the design. The preliminary drainage design includes the use of permeable pavers in the non-traffic areas of the parking lots as one LID feature planned for the site. LID features improve water quality in the stormwater discharged from the site, delay the time to peak and assist with reducing flow increases due to the proposed development. Final sizing of the detention facility may be completed once a drainage design alternative has been selected.

Rain Gardens

Rain gardens located within the landscaped area of the parking lot can be designed to provide the required stormwater infiltration and detention. In order to accommodate the detention volume required for the design storm event, the rain gardens should be comprised of 12-inches of poorly-graded gravel (drain rock) below approximately 6 inches of topsoil. The topsoil would be planted with grasses and other shallow rooting vegetation. In order to prevent the gravel layer from becoming plugged with soil, the drain rock should be wrapped in a geotextile filter fabric. The drain rock selected will have approximately 40 percent void space, providing the required detention volume for the stormwater to be held during the design event, while allowing time for the stormwater to infiltrate into the groundwater during and following an event.

The vegetation planted in the rain gardens will filter the stormwater as it passes through to the drain rock. Other rain garden biological processes such as phytoremediation will further improve the quality of the stormwater discharged from the site. Overflows need to be included in the rain garden design for times when the stormwater flow coming into the rain garden exceeds the design event. Although groundwater is not expected within several feet of the ground surface within the developable portion of the property, rain gardens and other infiltrating features should be sited at least 10-feet from building foundations to avoid saturating the soils around the foundation. At 1-foot deep and with 40 percent void space for the drain rock, the total area of

rain garden would be approximately 3,200 square feet; providing 1,280 cubic feet of detention volume storage.

When full, the rain gardens would be connected below ground to perforated pipes within "trench overflows" located near the 100-foot wetland setback. The trench overflows would operate like a French drain in reverse. Comprised of perforated pipes outletting from the rain gardens surrounded by open-graded drain rock with a high void space percentage, the trench overflows would allow stormwater to slowly percolate up through the drain rock to the ground surface and sheet flow down the property toward the wetland/slough tributary area. The trench overflows could be constructed on contour to mimic pre-development sheet flow. Rain gardens outletting to trench overflows is the recommended drainage design alternative of this Study and appears to be the most cost-effective. (Figure 3 Design Alternative 1 Rain Gardens)

Bioswale

A bioswale, constructed on contour, would be a cost-effective and easily constructible design alternative for detaining the required volume of stormwater run-off. The proposed bioswale option would act as a detention basin, storing the stormwater until it naturally percolates into the groundwater. Run-off flow would be directed towards the bioswale using appropriate grading of the parking lots in conjunction with directing the building's downspouts to the swale through gravel energy dissipation galleries or similar devices. A rock-armored overflow notch at the eastern end of the bioswale would allow for the gradual, controlled overflow of water from larger events. Water flowing over this armored notch would be directed down the slope of the property towards the slough tributary area by flowing through an energy dissipating corridor lined with rock slope protection (RSP). The RSP lining will be sized based on the flow velocities calculated. Due to the constrained nature of the site and the relatively small area available for building construction, this bioswale would likely need to be placed within the 100-foot wetland setback (between the 50 and 100-foot setback delineation). This option may require additional design review by the regulatory agencies involved if the proposed bioswale is installed within the wetland setback.

Using an iterative process while also considering site conditions and standard bioswale construction, the bottom and top widths of the bioswale were manipulated in order to produce a channel cross-section that would be capable of handling and detaining the required 1,277 cubic feet of water. Preliminary design indicates the bioswale may be approximately 115-feet long, and have a bottom width of 4-feet, a top width of 14-feet, and a depth of 1.25-feet, thus providing approximately 1,300 cubic feet of detention volume.

The design of the proposed bioswale should include adequate freeboard (distance between design water surface elevation and lowest elevation at the top of bioswale), with 1-foot as a recommended minimum to reduce the potential for the sides to erode. Run-off flows exceeding the storage capacity of the bioswale may be discharged over a rock-armored notch at the low end

of the bioswale and along a rock-lined energy dissipating corridor or channel, which would safely convey the run-off towards existing outlet, the unnamed slough tributary to Eureka Slough. Rock would be sized to resist the shearing forces of the flow velocities calculated for the final channel design geometry and slope, minimizing scour and erosion. (Figure 4 Design Alternative 2 Bioswale)

StormTech Subsurface Stormwater Management System

For the underground storage option, the *StormTech* subsurface stormwater management system was considered. Comprised of interconnected parabolic polypropylene chambers, the *StormTech* system creates an underground piping system into which surface run-off is detained until the soil naturally percolates the run-off into the groundwater table. The parking areas would be graded so stormwater run-off from the lot would be directed to the landscaped areas within the parking lot. Inlet pipe stub outs, covered with an appropriate grate to prevent deleterious and other materials from entering the storage chambers, may be placed throughout the landscaping to allow surface water to flow into the chamber system. The chambers create a large void space underneath the parking lot, providing the necessary detention volume. A minimum of 6-inches of clean, angular stone should be placed below the chambers, providing a suitable foundation below the chambers and allowing stored water within time to infiltrate into the ground. 6-inches of a granular aggregate mixture must be compacted over the chambers in order to provide structural capacity to the system. The chamber system would be designed with overflow pipes to discharge excess run-off to the surface when the underground system becomes full.

This outlet pipe, which may be sized to limit the discharge rate from the *StormTech* system to pre-existing conditions, would be directed towards the wetland portion of the site where it would daylight at some point down slope of the Health Center. Any excess water being discharged from the underground system would flow into a graveled energy dissipating corridor directed towards the slough tributary. Preliminary calculations indicate that a minimum of 41 chambers, totaling 293 feet in length, would be needed to detain the volume of increased run-off generated by the new development during the ten-year design storm. This option would be the most expensive drainage design alternative to implement. This alternative appears to be the least cost effective alternative presented in this Study. (Figure 5 Design Alternative 3 Underground Storage Chambers)

Conclusions

As demonstrated through the three drainage design alternatives described within this Study, several different drainage features can be implemented at the site in order to detain the incremental increase in stormwater run-off that would be generated within the hydrologic subbasin of the project area during the ten-year design storm event. The drainage design alternatives described in this Study allow the site designer some latitude in completing the final design. Incorporation of LID features into the design will improve water quality, delay the time to peak and assist with reducing flow increases due to the proposed development. This Study

demonstrates that post-development flows have been designed to match pre-development conditions for the ten-year design storm event while discussing design options for handling flows up to the 100-year storm event.

LACO anticipates street improvements and related drainage improvements may be required on Tydd Street in conjunction with this proposed development after a more in-depth review of the project has been completed. These additional features may include street widening, curb, gutter, and sidewalk, re-paving and related drainage improvements. As detailed in Sidnie Olson's November 9, 2010 letter to LACO, a new drop inlet may be required on the east side of Tydd Street. LACO has determined these improvements are feasible and stormwater flows from Tydd Street can be conveyed to the historical outlet, the roadside ditch. Additionally, Ms. Olson discusses development of secondary ingress/egress road to the northeastern portion of the site. This secondary access would likely be from the existing Bank Plaza parking lot north of the site. At this preliminary stage, the Plaza property owner's input and permission to record an ingress/egress easement across the parking lot have not been solicited. If this option were pursued, collection and conveyance of the stormwater from this new road will be discussed in the final Technical Drainage Study.

Recommendation

A Technical Drainage Study should be finalized once the drainage design alternative(s) have been selected and the building layout and final site design have been determined. Completion of the final Technical Drainage Study will demonstrate the selected drainage design satisfies the City's criteria for new development.

Attachments

Figure 1:	Location Map
Figure 2:	Project Area Hydrologic Subbasin
Figure 3:	Design Alternative 1 Rain Gardens
Figure 4:	Design Alternative 2 Bioswale
Figure 5:	Design Alternative 3 Underground Storage Chambers
Attachment A:	Intensity-Duration-Frequency Curves

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LACO ASSOCIATES CONSULTING ENGINEERS 21 W 4TH ST. EUREKA, CA 95501 (707)443-5054	PROJECT	OPEN DOOR COMMUNITY HEALTH CENTER	BY	JDB	FIGURE
	CLIENT	OPEN DOOR COMMUNITY HEALTH CENTER	DATE	12/21/10	1
	LOCATION	TYDD STREET, EUREKA, CA	CHECK	RLD	JOB NO.
		VICINITY MAP	SCALE	AS SHOWN	7119.05

CITY OF EUREKA

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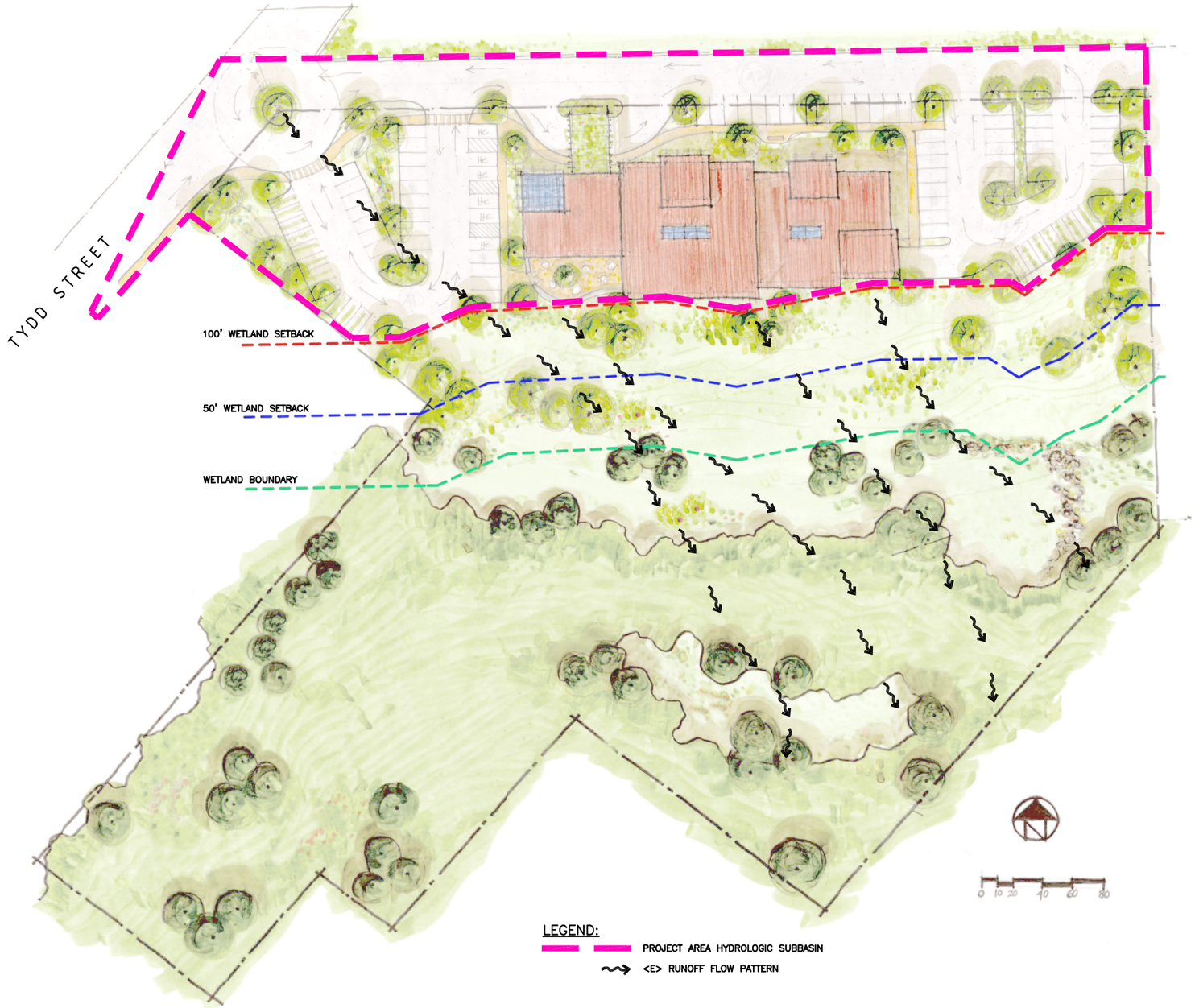

LEGEND:

PROJECT AREA HYDROLOGIC SUBBASIN

<E> RUNOFF FLOW PATTERN

1"

GRAPHIC SCALE MEASURES 1 INCH ON FULL-SIZE PLANS.

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NO.	REVISION	BY	CHK	DATE

OPEN DOOR COMMUNITY HEALTH CENTER
PROJECT AREA HYDROLOGIC SUBBASIN

OPEN DOOR COMMUNITY HEALTH CENTER
TYDD STREET, EUREKA, CA

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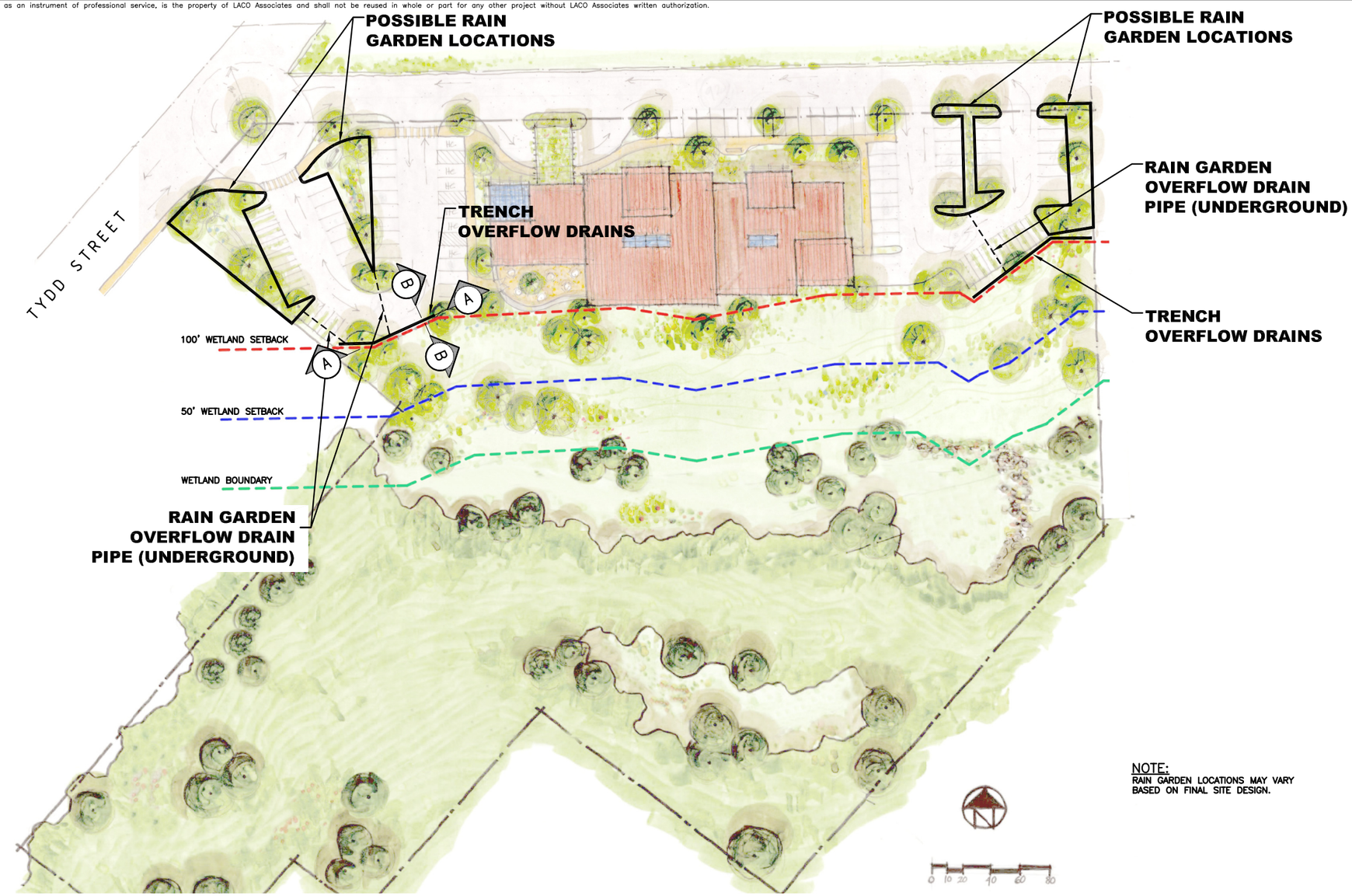
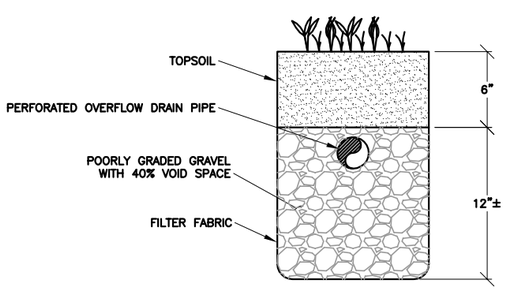


NOTE:
RAIN GARDEN LOCATIONS MAY VARY BASED ON FINAL SITE DESIGN.



RAIN GARDEN DETAIL

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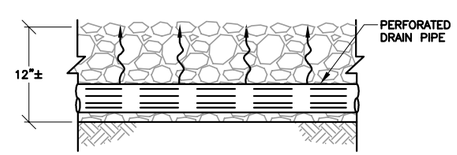

A TRENCH OVERFLOW DRAIN DETAIL

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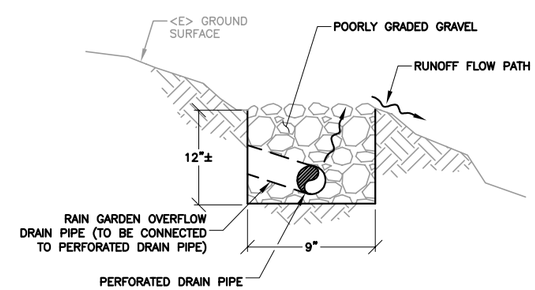

B TRENCH OVERFLOW DRAIN SECTION

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1"
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OPEN DOOR COMMUNITY HEALTH CENTER
DESIGN ALTERNATIVE 1
RAIN GARDENS

OPEN DOOR COMMUNITY HEALTH CENTER
TYDD STREET, EUREKA, CA

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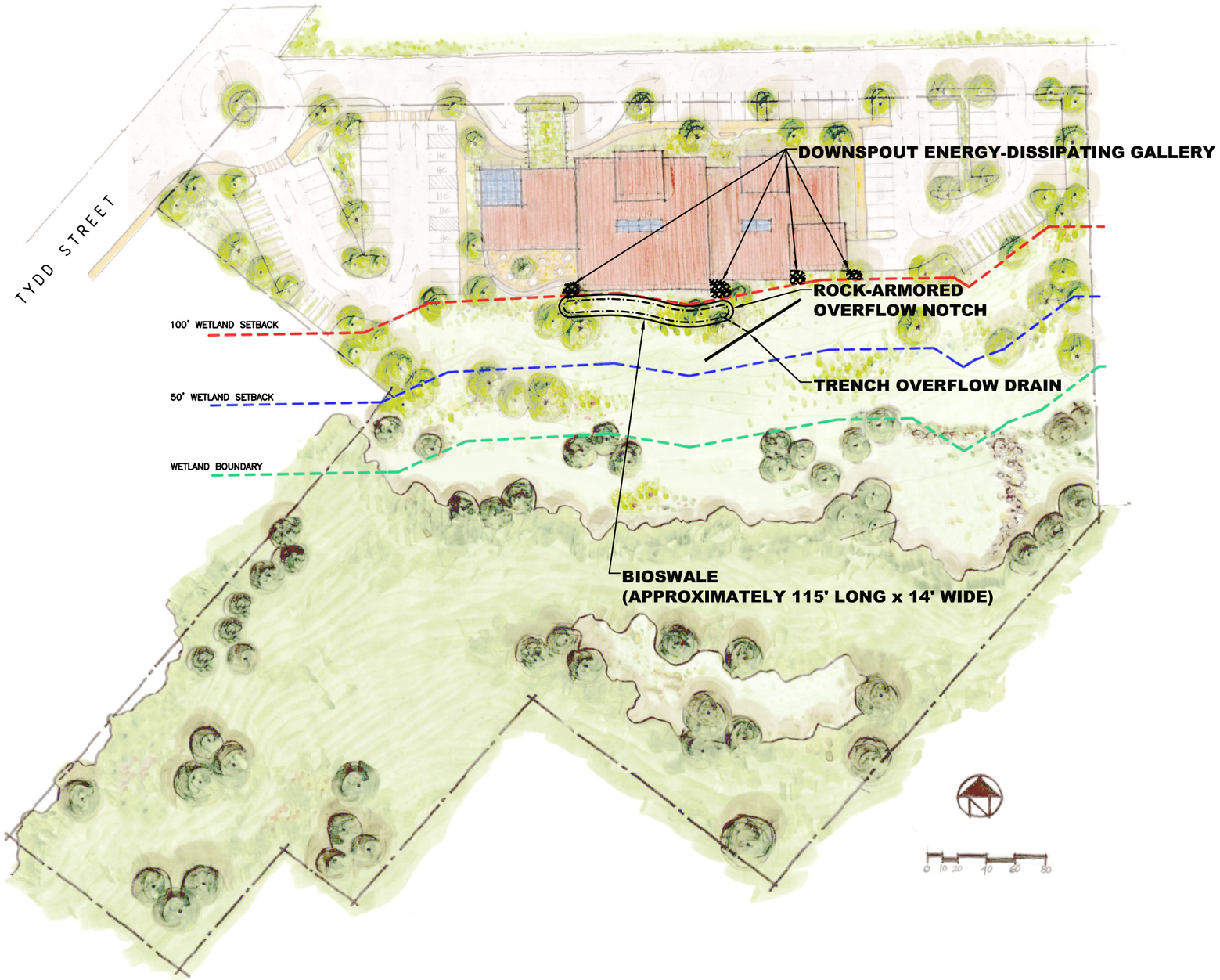

1"

GRAPHIC SCALE MEASURES 1 INCH ON FULL-SIZE PLANS.

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OPEN DOOR COMMUNITY HEALTH CENTER
DESIGN ALTERNATIVE 2
BIOSWALE

OPEN DOOR COMMUNITY HEALTH CENTER
TYDD STREET, EUREKA, CA

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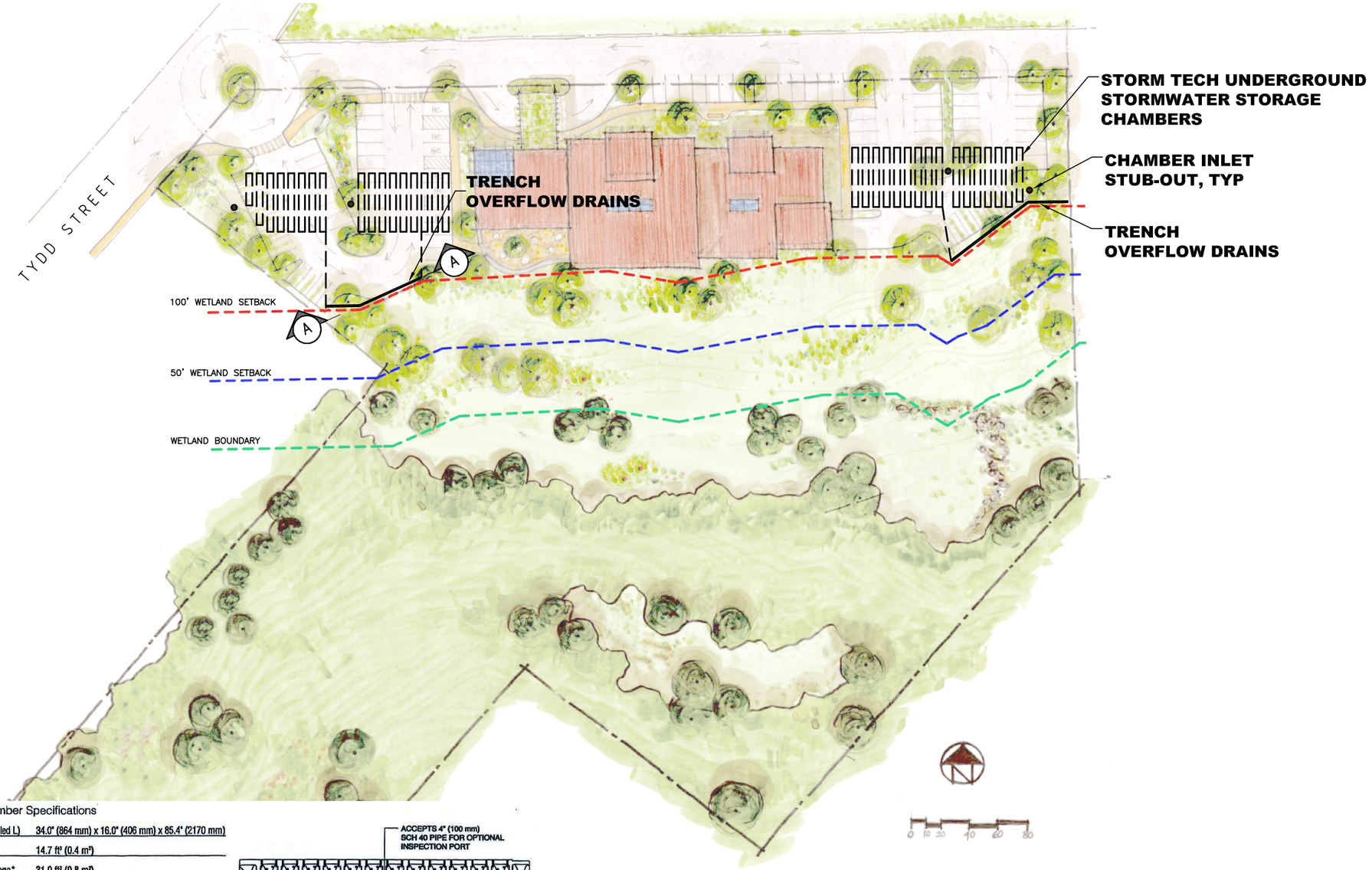
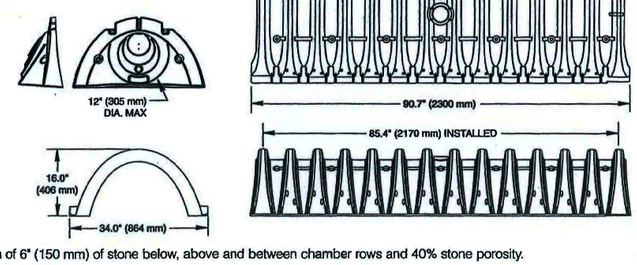


Nominal Chamber Specifications

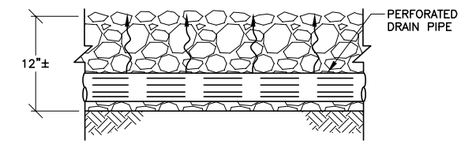
Size (W x H x Installed L)	34.0" (864 mm) x 16.0" (406 mm) x 85.4" (2170 mm)
Chamber Storage	14.7 ft³ (0.4 m³)
Min. Installed Storage*	31.0 ft³ (0.8 m³)
Weight	37 lbs (16.8 kg)



*This assumes a minimum of 6" (150 mm) of stone below, above and between chamber rows and 40% stone porosity.

STORMTECH SC-310 CHAMBER DETAIL

N.T.S.



(A) **TRENCH OVERFLOW DRAIN SECTION**

N.T.S.

1"

GRAPHIC SCALE MEASURES 1 INCH ON FULL-SIZE PLANS.

LACO ASSOCIATES
CONSULTING ENGINEERS
21 W 4TH ST. EUREKA, CA 95501 (707)443-5054

NO.	REVISION	BY	CHK	DATE

OPEN DOOR COMMUNITY HEALTH CENTER
DESIGN ALTERNATIVE 3
UNDERGROUND STORAGE CHAMBERS

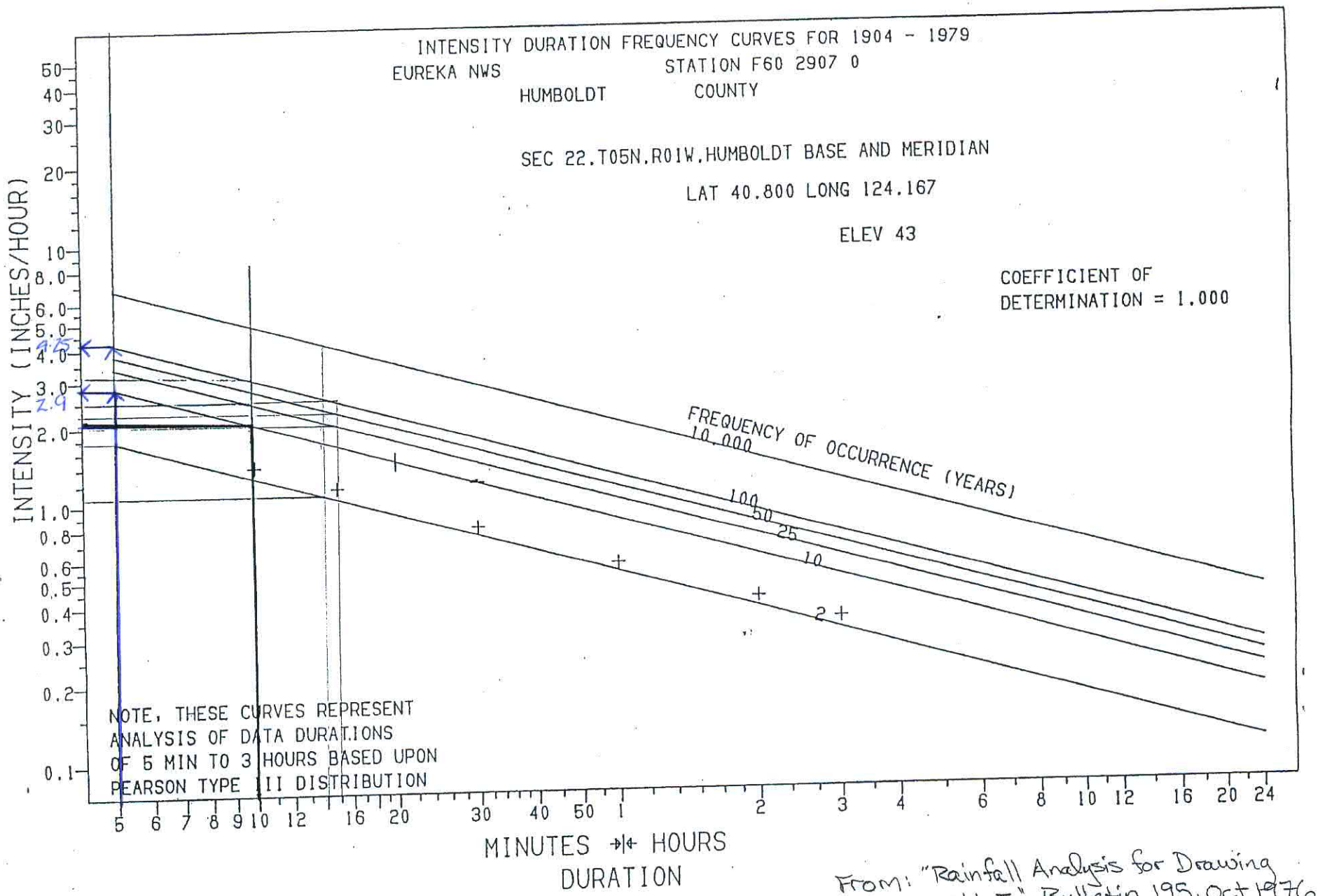
OPEN DOOR COMMUNITY HEALTH CENTER
TYDD STREET, EUREKA, CA

SCALE	1"=40'
DRAWN	JDB
CHECK	RLD
APPVD	AWP
DATE	12/21/10
JOB NO.	7119.05
FIGURE	5

Dec 21,2010-2:35pm
T:\Casfiles\7100\7119\DWG\ 7119-05 DESIGN ALT FIGURE 5.dwg

ATTACHMENT A

Intensity Duration Frequency Curves



From: "Rainfall Analysis for Drawing Design Vol. I" Bulletin 195, Oct 1976 CA Dept of Water Resources