SEWER STUDY FOR UNIVERSITY AND INNOVATION DISTRICT

JOB NUMBER 16693-AC

April 7, 2017

RICK ENGINEERING COMPANY
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Job Number 16693-AC

John D. Goddard, Jr. RCE 33037

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Introduction

This report provides an overview of proposed sewer services for the University and Innovation District and recommendations for upsizing portions of the proposed Otay Ranch Village 9 sewer system to serve the proposed project. In addition, it provides projected sewer flows for the project, outlines sewer facilities to be constructed and discusses current treatment capacity.

Project Overview

The University and Innovation District (UID) is located in the south east portion of the City of Chula Vista, California and totals approximately 383.8 gross acres in overall size. The proposed improvements would implement a campus development planned for the site that is a component of the Otay Ranch and Eastlake III General Development Plans (GDPs), as amended. Approximately 353.8 gross acres of the project site, the main campus, is contained within Otay Ranch GDP, while approximately 30 gross acres occur within a portion of Eastlake III GDP. The site is made up of two properties, the main campus property is located at the southeasterly corner of Hunte Parkway and Eastlake Parkway, and continues east from the intersection. The second property, located on the west side of Lower Otay Reservoir, referred to as the "Lake Property", and may be used for the Chancellor's residence and/or a conference center. See Figure 1 for the location map of the project. The proposed graded pads for the main campus grading phase's account for 288.2 ac of the 353.8 ac site boundary and the proposed graded pads for the Lake Property account for 5.2 ac of the 30 ac site boundary.

Development Plan

The proposed UID maximum development area for the UID is 10,066,200 square feet that would support a total of 34,000 people including a mix of students, faculty, staff, residents, and office/retail workers. The university land uses are assumed to include up to 20,000 full-time students and 6,000 university faculty and staff. Innovation uses would include a mix of office, laboratory, and retail uses to support up to 8,000 jobs. Residents on the site are anticipated to include up to 5,400 students and 2,000 employees. At this time, it is anticipated that main campus will be implemented in three grading sequences located directly adjacent to Hunte Pkwy. As noted above, the separate fourth portion, the Lake Property, of the site is located just west of Lower Otay Reservoir and may be designated as a residential site for the Chancellor's residence and/or conference center. To the west of the University Site is Otay Ranch Village 9 and to the south Otay Ranch Village 10. See Figure 2 for the Development Plan of the University and Innovation District.

Topography

Based on the photogrammetric survey by Robert J. Lung and Associates on August 22, 2008 the main campus property generally slopes from the northeast of the site to the Otay River Valley in the southwest. The existing topography on the property ranges from an elevation of 580 feet on the north to an elevation of 350 feet on the south. The existing terrain of the Lake Property peaks in the approximate center of the site and slopes down in all directions with the peak being a 570 elevation. The existing elevations at the corners of the Lake Property range from 540 to 470.

Existing Sewer System

There are no existing sewer facilities within the proposed UID. The High Tech High site connects into the Hunte Parkway sewer system which flows easterly in Hunte Parkway. This main ultimately connects into the Salt Creek Interceptor pipe however; this connection is east of the University Site. The Salt Creek interceptor is located south of the proposed UID project.

Currently Village 9 and Village 10 are not constructed; however they are anticipated to be completed before the UID. If the proposed UID is developed before Village 9 and 10 then Chula Vista would need to construct an additional 2200 linear feet of 12" and 15" sewer mainline to connect into the Salt Creek interceptor sewer. Figure 4 - Village 9 Sewer System provides the location of the existing and proposed sewer facilities in the vicinity of the University and Innovation District.

Existing sewer information was referenced from the report titled "Final Overview of Sewer Service for Otay Ranch Village 9", dated December 2010, prepared by Dexter Wilson Engineering.

The Salt Creek interceptor sewer starts as a 15" line in Hunte Parkway within the Rolling Hills Ranch project. From there, the line increases in size as it heads south in and along Salt Creek. The interceptor then turns westerly and follows the Otay River to a point of connection with the City of San Diego Metropolitan Sewer System.

All sewage generated within the City of Chula Vista is currently conveyed to the City of San Diego Metropolitan (Metro) Sewer System for treatment and disposal. The Metro sewer system treats wastewater from the City of San Diego and 15 other municipalities, including the City of Chula Vista. Flows are conveyed to the Point Loma Wastewater Treatment Plant which has a capacity of 240 million gallons per day (mgd) and currently treats approximately 180 mgd.

Proposed Sewer Service Alternatives

Both the main campus and the Lake Property are within the Salt Creek sewer basin. Chula Vista will be responsible for the sewer system connecting the University and Innovation District to the Salt Creek system. This report contains two alternatives for the main campus and three alternatives for the Lake Property that will be discussed below.

Main Campus

Alternative 1 is a gravity based sewer system. Grading phase's1, 2, and the northern portion of grading phase 3 would flow to the proposed Village 9 sewer system and then to the Salt Creek Interceptor sewer. A portion of the Village 9 sewer system will have to be upsized from the recommendations identified in the report titled "Final Overview of Sewer Service for Otay Ranch Village 9". This will be discussed in more depth later in this report. The south portion of grading phase 3 will require its own separate gravity sewer line that will follow an existing trail to the Salt Creek Interceptor sewer. This connection will be located upstream of Village 9. The proposed divider line for the grading phase 3 property is based on the proposed grading elevations. The proposed grading phase 3 south elevations are lower than the proposed grading phase 3 north elevations and cannot flow into the rest of the main campus sewer system without a pump system. See Figure 3 – Main Campus Alt 1 for the proposed sewer alignments.

Alternative two would involve the option of using a sewage lift station to pump the sewer flow from the south of the main campus grading phase 1 to the existing Hunte Parkway sewer system. This system would involve adding a pump station with dual systems producing the capacity for approximately 110' of static head and will include an additional 4,400 linear feet of 8" force main sewer. See Figure 4 – Main Campus Alt 2 for the proposed alignments.

Lake Property

The Lake Property also has multiple alternatives due to its location and surrounding infrastructure and terrain. Alternative 1 for the Lake Property would run a gravity sewer south of the site to the existing westward open space trail system. The existing trails may be access trails for existing utility maintenance. The sewer pipe would then follow the existing trail to the Salt Creek Sewer Interceptor. The terrain in this area provides enough elevation change for a gravity sewer connection along this alignment. Also the sewer line would have to cross a County Water Authority pipeline and property. There would be a need for 4,100 linear feet of gravity sewer pipe in with this option. See Figure 5 – Lake Property Alt 1 for the proposed alignment.

A second alternative would be for the sewer to go north, with the assistance of a sewage lift station, and connect into the existing Olympic Training center sewer system. The existing Olympic Training Center connects to the Salt Creek Sewer via a gravity sewer line. See Figure 6 Lake Property Alt 2. The sewer line would be a gravity system running north along one of the existing trails. The first segment of sewer pipe will need to use a 1% slope to keep the system to a maximum depth of 20' deep. Then at the low point of the existing open space trail (approximate elevation 520) a sewage lift station will be required to pump the sewer flows uphill to Criterium Course. From here the sewer will make a 90 degree turn and continue running uphill on Criterium Course to an approximate elevation of 545 and connect into the existing Olympic Training Center gravity sewer line which connects into the Salt Creek Sewer system. The static head for this alternative is approximately 25'. This alternative contains 1,400 linear feet of gravity sewer and 700 linear feet of 6" force main which is less sewer pipe than the first alternative. See Figure 6 – Lake Property Alt 2 for the proposed alignment.

There are multiple positives and negatives for the Lake Property alternatives. Alternatives two and three both require increased maintenance and a higher startup cost due to the pump systems. Alternative two potentially impacts some sensitive habitat areas and also impacts the Olympic training center infrastructure. The gravity alternative has the most linear feet of sewer but requires no pumping systems. Further information would have to be gathered about construction limitations due to the sensitive habitat in this region, but this sewer route is the most cost efficient with the amount of information we have obtained to date. This alternative will be discussed in greater depth later in this report.

Sewage Lift Station

The use of sewage lift stations entails additional parameters that are not associated with gravity sewer systems. Some of these parameters include additional space factor, additional operating cost, maintenance costs and environmental impacts. Some property will have to be set aside for the lift station and additional area will be required for the lift station set back from the rest of the development. There will be additional operating costs to maintain power and an operational backup generator for the pump systems. Pump station financing shall demonstrate compliance with the City of Chula Vista Sewage Pump Station Financing Policy 570-03. In addition to regular sewer maintenance requirements, lift stations will require frequent inspections and maintenance for the pumps, the ventilation systems, backup generator and the odor control systems. Pump stations shall comply with the City of Chula Vista Subdivision Manual section 3-303 and 3-304 including providing dual force mains. Environmentally there could be more restraints for the location of the lift stations due to the odors and the surrounding neighborhood. These additional parameters add an extra burden to the project because of space, cost and maintenance making it a less desirable option for this project's alternatives.

Design Criteria

This section presents the design criteria used to evaluate the sewer system for the proposed project. The design and sizing criteria for the analysis of the proposed sewer system is based on the City of Chula Vista Subdivision Manual and summarized below.

Sewage Generation Factors

As a result of discussions with City of Chula Vista staff, and as based on the University Innovation District Projected Water Demands and Sewer Flows table from Dexter Wilson Engineering Inc.'s report, direction by City staff was given to utilize a commercial land use generation rate of 1,401 gallons per day (gpd) per acre to be applied to the main campus to account for the range of uses proposed for the campus. A student housing generation rate of 45 gpd per population and faculty housing generation rate of 90 gpd per population was applied. The Lake Property has determined to have 5.2 ac of developable area for the chancellor's property and an event center. The Lake Property was analyzed using the same generation rate of 1,401 gallons per day and the assumption of a maximum population of 1,000 persons for peak usage.

Peaking Factor

To convert daily flow to peak wet weather flows, the population-based peaking factor curve provided in the City of Chula Vista Subdivision Manual, CVDS-18 was utilized. This peaking factor curve has been included in Appendix A.

Sewer Pipe

The proposed gravity flow sewer pipe on the site is intended to convey the peak wet weather flow. Maximum design flow depths are as follows:

½-full design flow for pipes 12 inches or smaller.

¾-full design flow for pipes larger than 12 inches.

Velocities: Minimum = 2 feet/second

Maximum = 12 feet/second

Pump systems

Pump station capacity will be based on peak flow plus a 30% safety factor.

Each pump station will have 1 backup pump in addition to the primary system

Recommended Sewer Facilities

For the Main Campus Alternative 1, the gravity sewer, is the recommended alternative. This alternative requires fewer linear feet of sewer pipe and does not necessitate a sewage lift station capable of 110' of static head. Below are the calculations and supporting information for Main Campus Alternative 1 recommendation.

The Main Campus is comprised of 3 separate grading phases that are bisected by proposed roadways. At this point in the planning process the corresponding student density allotted for each grading phase is unknown. Grading phases 1, 2 and the north portion of grading phase 3 of the main campus will use gravity sewer systems (Lines A & B) that will connect to the proposed Village 9 gravity sewer at node 12 (see Figure 8 for node numbers). This combined system will connect to the Salt Creek Interceptor via the proposed system through Village 9, as shown on Figure 8. With the addition of the UID, nodes 4 through 12 of the Village 9 gravity sewer will need to be upsized. Table 1, an excerpt of Dexter Wilson Engineering's Otay Ranch Village 9 Sewer Study, Summary, dated September 23, 2010, shows flows from just Village 9. Table 2 is a summary of combined flows of Village 9 and the UID with upsized pipe locations noted. Village 9 sewer mains between nodes 12 and 4 from Figure 8 will need to be upsized from 8" main line to a 12" main line. The sewer pipe between nodes 4 and 2 will not need to be upsized and will remain 15". Village 9 is anticipated to begin construction before the UID phases. In this event, it will be necessary for the UID to construct the portion of sewer between nodes 12 and 2 of the upsized Village 9 sewer system to connect to the Salt Creek Sewer system.

Due to the elevation being 12' lower than the "divider line" the grading phase 3 south portion cannot gravity flow to Lines A and B. The south portion of grading phase 3 would require a lift station with a static head of 14' for an 6" force main or deepening Lines A and B 28', which would produce manholes that exceed standard design and access. To alleviate this situation, it is recommended that the south portion of grading phase 3 flow through a separate gravity sewer line (Line C) that will flow south and also connect into the Salt Creek Interceptor, but at a more easterly connection point, see Figure 3. This line will traverse an existing utility maintenance trail.

With the environmental information, easement information and existing utility information available at this time, the recommended alternative for the Lake Property is Alternative 1, the gravity sewer option. The pad net square footage for this property is 5.2 ac and we assumed a max population of 1,000 persons which equates to a ratio of peak to average flow of 2.5. The 2.5 ratio is the maximum number for populations on the chart. Per Table 2 this produces 0.018 mgd of peak sewerage production for the Lake Property. If the Lake Property anticipates a larger population on this site the ratio will become lower and this will decrease the sewage production.

All three of the UID main grading sequences have the potential to include commercial use. At this point in time it is not clear what the distribution for the commercial use will be. The proposed pad grading for the main campus's grading sequences accounts for a net area of 288.2 ac, of the 353.8 ac main campus boundary, and the Lake Property account for a net area of 5.2 ac of the 30 ac site boundary. These areas combined (293.4 ac) are greater than the proposed maximum development area of 231 ac (10,066,200 square feet), but are used to calculate the gross acreage for the sewer capacity to maximize the ability to develop on each grading pad. Not all of this capacity will be used, but calculating the sewer capacity this way will ensure that each grading pad can be maximized, giving the UID flexibility for its development allotment per grading pad. To account for the mixed use of campus and commercial use, the capacity of each grading phase's sewer line will be calculated to meet 1,401 gpd per gross acre. Pursuant to discussions with the planning department of the City of Chula Vista, the UID is intended to facilitate 20,000 full-time students, 6,000 faculty and up to 8,000 jobs on campus. The site's peak factor of 1.60 is based upon a population of 34,000 people (from the New University Campus at Otay, Chula Vista, CA Draft Program dated 1/17/2015) and/or faculty being located on all 3 parcels until further planning refines the student/faculty distribution among the properties. Student and faculty housing distribution among the site is not know at this point, but it is assumed that the 5,400 students for student housing and 2,000 faculty for faculty housing will be distributed evenly about the site. No information is available at this time for the student and faculty housing acreage. The following assumptions were made to discern an assumed area for the housing. For student housing it was assumed to have 2 persons per dwelling unit (DU) and a density of 56 DU per acre. This amounts to 48.2 acres of student housing. For faculty housing it was assumed to have 1 person per DU and a density of 28 DU per acre for a total of 71.4 acres of faculty housing. The combined faculty and student housing area amounts to 120 acres of housing. This housing area was then evenly deducted from the net area of 288.2 ac for these calculations.

Table 2 shows the different sewer systems and their total peak design flow. In total the UID would add a peak of 0.857 mgd from lines A and B, 0.199 mgd from line C and 0.0180 mgd from the Lake Property for a peak total of 1.074 mgd to the Salt Creek Interceptor Sewer. These peak flows are for the UID only and do not include Villages 9 and 10 flow rates.

Sewer Line A, as shown on Figure 8, is designed to handle the full capacity sewer demands of grading phases 1 and 2 (1.075 million gallons per day (mgd) with peak factor). The 8" minimum sewer main size of Line B is designed to handle the full capacity sewer demands of the north portion of Property 3. In addition, Line B also has the capacity to handle the complete sewage flows from grading phase 2 if grading phase 2's building sewer laterals are routed east towards line B instead of west towards Line A.

The Lake Property sewer line will need to maintain a minimum slope of 2.07% in order to maintain the minimum velocity of 2 feet per second.

The Salt Creek Interceptor Technical Sewer Study for the South Otay Ranch (Village 8 West and Village 9), prepared by PBS&J, in October of 2010, projects UID to include 3,961.5 Equivalent Dwelling Units (EDUs) of institutional and residential per the report category TAZ Zone 4353 and 283 EDUs of institutional per the report category TAZ Zone 4350, for a total of 4,244.5 EDUs. The sewerage generation in the PBS&J report was projected at 265 gpd per EDUs, thus totaling the University Site at 1.125 mgd. The proposed projections from this UID study are less than the PBS&J study by 0.051 mgd. The PBS&J report also anticipated the University and Innovation District connecting into the Village 10 sewer system. The UID and Village 10 sewer systems connect into the Salt Creek Interceptor Sewer system further upstream of the Village 9 system. The PBS&J report states that "Under the cumulative conditions, increased flow projections from Village 10 / University, are assumed to drain into the identified deficiency located within Salt Creek south of the Otay Lake. The City should closely monitor the development planning of Village 10 / University to properly condition those projects at the tentative map stage related to any required improvements to the Salt Creek Interceptor." By splitting the UID sewer flows, 0.857 mgd entering the system south of the identified deficiency area and 0.199 mgd entering the system north of this area, Alternative 1 alleviates some of that problem. As development in this region proceeds forward, it is recommended that the Salt Creek Sewer system being further investigated.

The Lake Property enters the Salt Creek Sewer System at node 347. Per the PBS&J Sewer Study the nodes just downstream of node 347 (nodes 282-270) are deemed deficient. Adding the 0.018 mgd from the Lake Property will only exacerbate this problem. Nodes 282 to 270 of the Salt Creek Sewer system will have to be updated to handle the planned development in this region. See Exhibit 1 – Salt Creek Interceptor Capacity Analysis of the PBS&J report for node locations.

As the development of the UID is refined and the surrounding development's sewer flows are updated, flows in the Salt Creek interceptor sewer should be further evaluated to determine if any upgraded sections are required.

Treatment Capacity

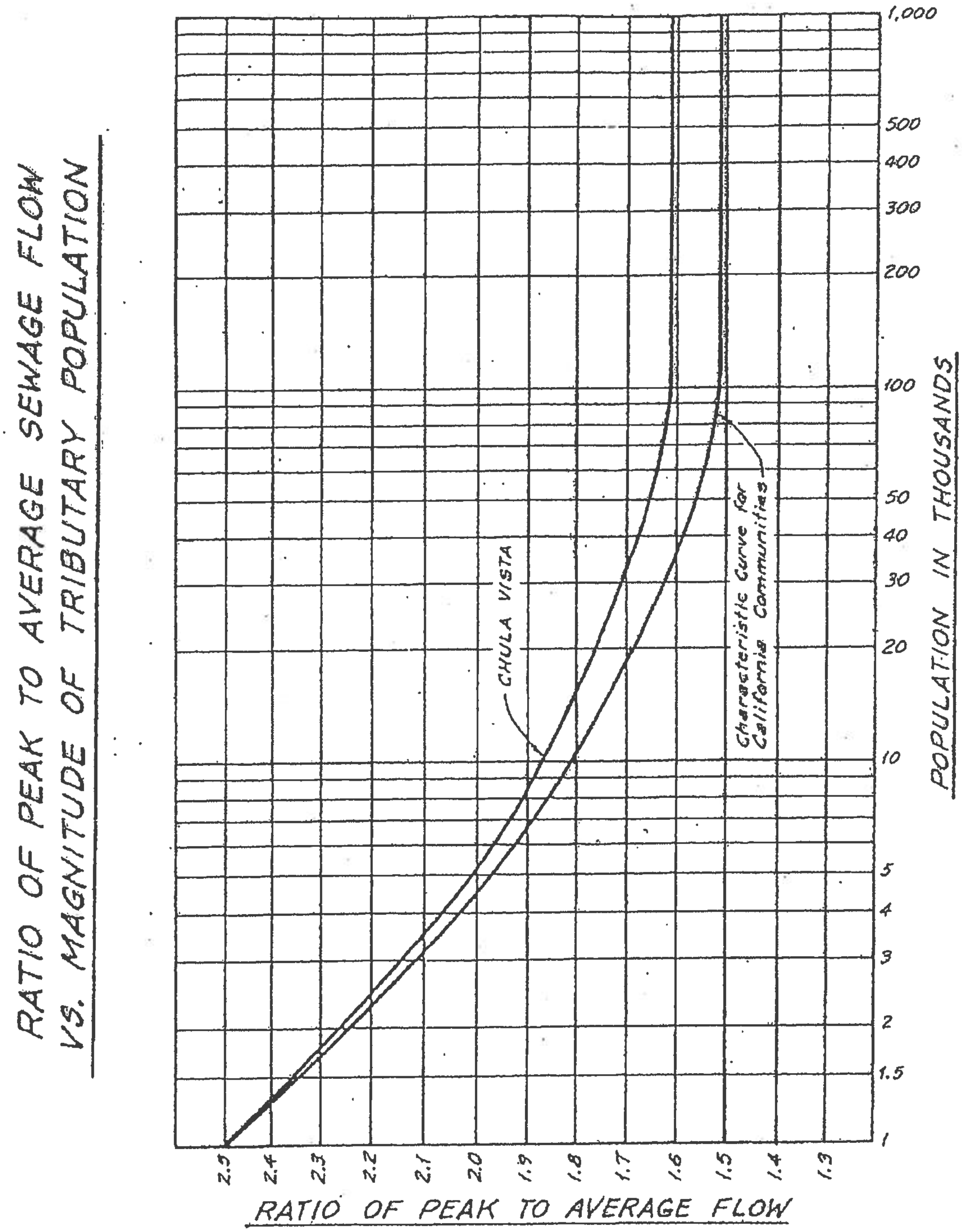
The University and Innovation District's sewage production will also have an impact on Chula Vista's capacity rights for the Metro sewer system. Per the Final Overview of Sewer Service for Otay Ranch Village 9, dated December 2010, prepared by Dexter Wilson Engineering, the City of Chula Vista has capacity rights of 20.864 mgd in the Metro sewer system. Current flows in the City average approximately 16.2 mgd. Based on capacity calculations developed in this report, the University and Innovation District's total sewage is 1.074 mgd. The Dexter Wilson Engineering Otay Ranch Village 9 report projects that in the year 2030 the sewage production to reach a level of 32.548 mgd which will exceed the 20.864 mgd limit. The 1.074 mgd sewage generation from the UID will add to the overall capacity for Chula Vista and the timeframe of this project will be a factor to when Chula Vista meets its METRO capacity. The Salt Creek Interceptor Technical Sewer Study for the South Otay Ranch (Village 8 West and Village 9), prepared by PBS&J in October of 2010 has a more thorough analysis about the METRO treatment capacity, please refer to this report for more details.

Salt Creek Sewer Basin Development Impact

Per the Salt Creek DIF Report on the City of Chula Vista website "The City first developed a sewer analysis and basin plan for the Salt Creek Sewer Basin in 1994. The purpose of the basin plan was to project development in the basin, determine sewer facilities needed to serve development, and to calculate an impact fee to recover the cost of those facilities. The 1994 Study included the Salt Creek Interceptor Reaches 1 through 8 at a total cost of $8.2 million. At that time, Reach 9 was assumed to be a regional facility that would serve customers outside of the Salt Creek Basin. The cost of Reaches 1 through 8 was spread among nearly 29,000 equivalent dwelling units (EDUs) in the basin to calculate a Salt Creek Sewer Basin development impact fee (DIF) of $284 per EDU. The City adopted the DIF with Ordinance No. 2617 on December 6, 1994. The concept of the DIF is that customers benefiting from capital facilities should pay their proportionate share for the construction of those facilities." Per the City of Chula Vista the density conversion is 230 GPM per EDU. The UID total sewer generation is 1.074 MGD which equates to 4,670 EDU. At $284 per EDU, this equates to a Salt Creek Sewer Basin Development Impact fee of $1,326,280.

APPENDIX A:

CITY OF CHULA VISTA PEAK TO AVERAGE FLOW



Revised	Drawn J.W.H. Date 10-10-72	CITY OF CHULA VISTA PUBLIC WORKS DEPARTMENT	
	Approved Date 8-18-78		
	[signature]	PEAK TO AVERAGE SEWER FLOW	CVD-SW01
	CITY ENGINEER Date: 11-7-02		

APPENDIX B:

KINGS HANDBOOK TABLE 7-14

TABULAR VALUES OF HYDRAULIC ELEMENTS OF PIPES (n CONSTANT)

(Table from Kings Handbook do not edit-you may edit Mannings "n" value only)

(table named "PIPE")

n=0.012

K	d/D	A/D^2	W.P./D	Rh/D
0.00007	0.01	0.001	0.20	0.01
0.00031	0.02	0.004	0.28	0.01
0.00074	0.03	0.007	0.35	0.02
0.00138	0.04	0.011	0.40	0.03
0.00222	0.05	0.015	0.45	0.03
0.00328	0.06	0.019	0.49	0.04
0.00455	0.07	0.024	0.54	0.05
0.00604	0.08	0.029	0.57	0.05
0.00775	0.09	0.035	0.61	0.06
0.00967	0.10	0.041	0.64	0.06
0.01181	0.11	0.047	0.68	0.07
0.01417	0.12	0.053	0.71	0.08
0.01674	0.13	0.060	0.74	0.08
0.01952	0.14	0.067	0.77	0.09
0.02250	0.15	0.074	0.80	0.09
0.02570	0.16	0.081	0.82	0.10
0.02910	0.17	0.089	0.85	0.10
0.03270	0.18	0.096	0.88	0.11
0.03650	0.19	0.104	0.90	0.12
0.04060	0.20	0.112	0.93	0.12
0.04480	0.21	0.120	0.95	0.13
0.04920	0.22	0.128	0.98	0.13
0.05370	0.23	0.136	1.00	0.14
0.05850	0.24	0.145	1.02	0.14
0.06340	0.25	0.154	1.05	0.15
0.06860	0.26	0.162	1.07	0.15
0.07390	0.27	0.171	1.09	0.16
0.07930	0.28	0.180	1.12	0.16
0.08490	0.29	0.189	1.14	0.17
0.09070	0.30	0.198	1.16	0.17
0.09660	0.31	0.207	1.18	0.18
0.10270	0.32	0.217	1.20	0.18
0.10890	0.33	0.226	1.22	0.18
0.11530	0.34	0.235	1.25	0.19
0.12180	0.35	0.245	1.27	0.19
0.12840	0.36	0.255	1.29	0.20
0.13510	0.37	0.264	1.31	0.20
0.14200	0.38	0.274	1.33	0.21
0.14900	0.39	0.284	1.35	0.21
0.15610	0.40	0.293	1.37	0.21
0.16330	0.41	0.303	1.39	0.22
0.17050	0.42	0.313	1.41	0.22
0.17790	0.43	0.323	1.43	0.23
0.18540	0.44	0.333	1.45	0.23
0.19290	0.45	0.343	1.47	0.23
0.20100	0.46	0.353	1.49	0.24
0.20800	0.47	0.363	1.51	0.24
0.21600	0.48	0.373	1.53	0.24
0.22400	0.49	0.383	1.55	0.25
0.23200	0.50	0.393	1.57	0.25
0.40270	0.51	0.403	1.59	0.25
0.41270	0.52	0.413	1.61	0.26
0.42270	0.53	0.423	1.63	0.26
0.43270	0.54	0.433	1.65	0.26
0.44260	0.55	0.443	1.67	0.26
0.45260	0.56	0.453	1.69	0.27
0.46250	0.57	0.462	1.71	0.27
0.47240	0.58	0.472	1.73	0.27
0.48220	0.59	0.482	1.75	0.28
0.49200	0.60	0.492	1.77	0.28
0.50180	0.61	0.502	1.79	0.28
0.51150	0.62	0.512	1.81	0.28
0.52120	0.63	0.521	1.83	0.28
0.53080	0.64	0.531	1.85	0.29
0.54040	0.65	0.540	1.88	0.29
0.54990	0.66	0.550	1.90	0.29
0.55940	0.67	0.559	1.92	0.29
0.56870	0.68	0.569	1.94	0.29
0.57800	0.69	0.578	1.96	0.29
0.58720	0.70	0.587	1.98	0.30
0.59640	0.71	0.596	2.00	0.30
0.60540	0.72	0.605	2.03	0.30
0.61430	0.73	0.614	2.05	0.30
0.62310	0.74	0.623	2.07	0.30
0.63190	0.75	0.632	2.09	0.30
0.64050	0.76	0.640	2.12	0.30
0.64890	0.77	0.649	2.14	0.30
0.65730	0.78	0.657	2.17	0.30
0.66550	0.79	0.666	2.19	0.30
0.67360	0.80	0.674	2.21	0.30
0.68150	0.81	0.681	2.24	0.30
0.68930	0.82	0.689	2.27	0.30
0.69690	0.83	0.697	2.29	0.30
0.70430	0.84	0.704	2.32	0.30
0.71150	0.85	0.712	2.35	0.30
0.71860	0.86	0.719	2.37	0.30
0.72540	0.87	0.725	2.40	0.30
0.73200	0.88	0.732	2.43	0.30
0.73840	0.89	0.738	2.47	0.30
0.74450	0.90	0.745	2.50	0.30
0.75040	0.91	0.750	2.53	0.30
0.75600	0.92	0.756	2.57	0.29
0.76120	0.93	0.761	2.61	0.29
0.76620	0.94	0.766	2.65	0.29
0.77070	0.95	0.771	2.69	0.29
0.77490	0.96	0.775	2.74	0.28
0.77850	0.97	0.779	2.79	0.28
0.78170	0.98	0.782	2.86	0.27
0.78410	0.99	0.784	2.94	0.27
0.78540	1.00	0.785	3.14	0.25

SYMBOLS LIST

K=Kings Handbook Tbl 7-14

d= DEPTH OF FLOW

D=PIPE DIAMETER

A=WETTED AREA

W.P.=WETTED PERIMETER

Rh=HYDRAULIC RADIUS

K=Qn / d^(8/3) s^(1/2)

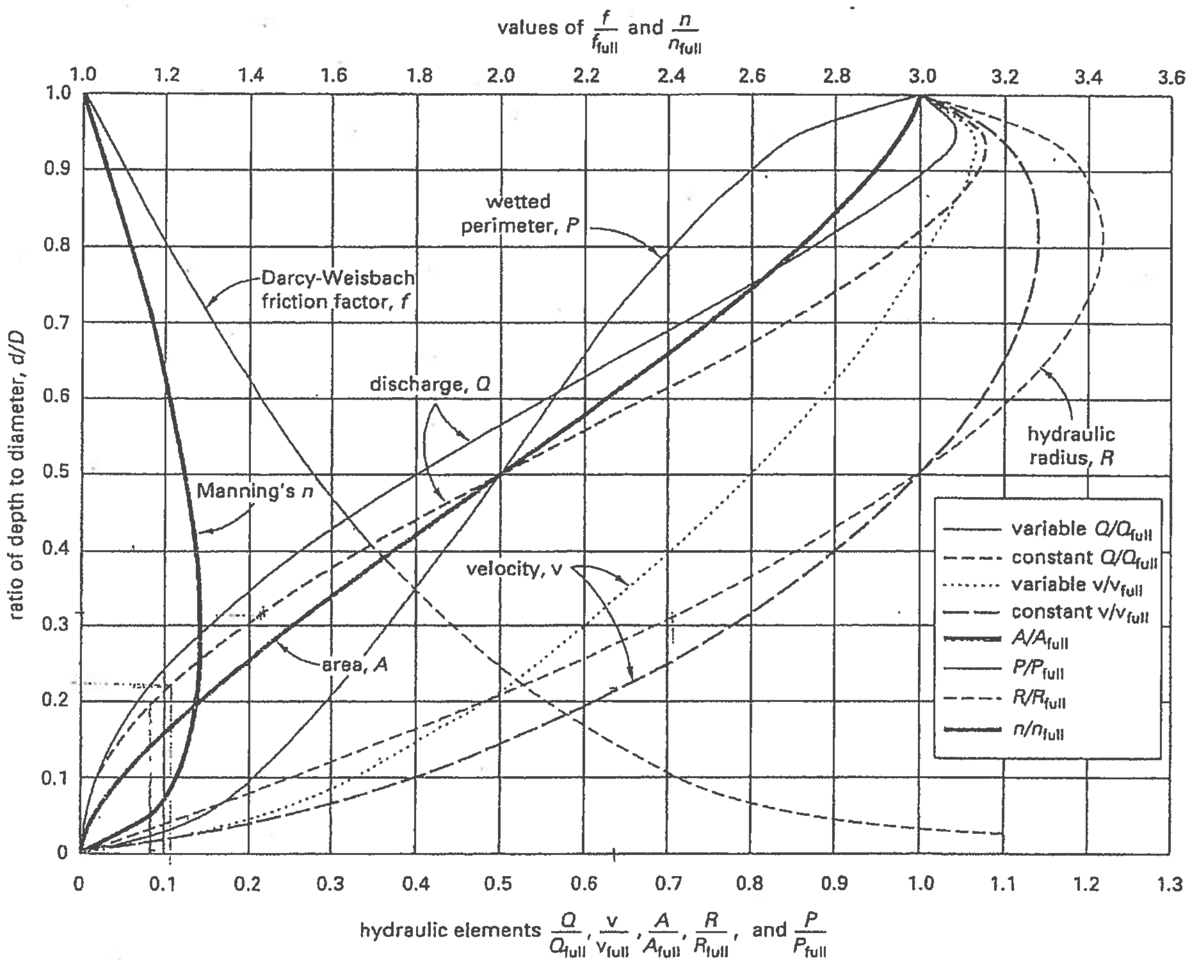
(Mannings n is variable)

APPENDIX C:
CIRCULAR CHANNEL RATIOS TABLE

APPENDIX 19.C

Circular Channel Ratios[a,b,c]

Experiments have shown that n varies slightly with depth. This figure gives velocity and flow rate ratios for varying n (solid line) and constant n (broken line) assumptions.



Governing equations

$$\theta_{deg} = 2 \arccos\left(\frac{\frac{D}{2} - h}{\frac{D}{2}}\right)$$

$$A = \left(\frac{D}{2}\right)^2 \frac{\theta_{rad} - \sin\theta_{deg}}{2}$$

$$P = \frac{D\theta_{rad}}{2}$$

$$R = \frac{A}{P}$$

$$v = \left(\frac{1.486}{n}\right) R^{\frac{2}{3}} \sqrt{S}$$

$$Q = \frac{A}{v}$$

Slope is constant.

$n = 0.013$

$$\frac{n}{n_{full}} = 1 + \left(\frac{d}{D}\right)^{0.540} - \left(\frac{d}{D}\right)^{1.200}$$

[a]Adapted from *Design and Construction of Sanitary and Storm Sewers*, p. 87, ASCE, 1969, as originally presented in "Design of Sewers to Facilitate Flow," Camp, T. R., *Sewage Works Journal*, 18, 3 (1946).
[b]For n = 0.013

Support Material

APPENDIX D:
SAMPLE CALCULATIONS

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6/25/13
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Future University Site Sample Sewer Calculations (Nodes 1 to 3)

Gross Area = 141 ac
Sewer Production = 2,500 gpd/ac

Anticipated Flow Rate

$141\,ac \times \frac{2{,}500\,gpd}{ac} \times \frac{1\,mgd}{1{,}000{,}000\,gpd} = 0.3525\ MGD$

Peaking Factor (per CVD-SW01) ≅ 1.77

Peak Q = 352,500 (1.77) = 623,925 GPD

$Q = \frac{623{,}925\ Gal}{day} \times \frac{1\ day}{24\ hrs} \times \frac{1\ hr}{60\ min} \times \frac{1\ min}{60\ sec} \times \frac{0.13368\ ft^3}{gal}$

$Q = \frac{0.965\ ft^3}{sec} \cong 0.97\ ft^3/sec$

Mannings Equation

$Q_{max} = \left(\frac{1.49}{n}\right) A R^{2/3} \sqrt{S}$

A = Area of flow (SF) → $\pi r^2 = \pi(0.333)^2 = 0.349\ ft^2$

R = Hydraulic Radius (FT) = $\frac{A}{P}$ → Flow Area / → Wetted Perimeter $= \frac{D}{4} =$

$\frac{0.67}{4} = 0.167'$

S = Pipe Slope

n = Manning Roughness Coefficient
= 0.012 for PVC (Per Chula Vista Design Manual)

$Q_{max} = \left(\frac{1.49}{0.012}\right)(.349\ ft^2)(0.167)^{2/3}(0.042)^{1/2} = 2.69\ cfs$

$Q < Q_{max}$

$0.97 < 2.69$

8" line has Capacity for Demands

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Depth of Flow in 8" Sewer, Post Project

$$\frac{Q}{Q_{max}} = \frac{0.97}{2.69} = 0.361$$

Circular Channel Ratios Chart (Cerm, Appen 19.C page A-37)

$\frac{d}{D} = 0.41$ $D = 8'' = 0.67'$ $d = 0.41(0.67) = 0.273 = 3.28''$

$Q_{full} = (VA)_{Full}$ $V_{full} = \frac{Q_{full}}{A_{full}} = \frac{2.69}{0.349} = 7.71$ cfs

$\frac{V}{V_{full}} = 0.91$ $V = 0.91(7.71) = 7.02 > 2$ FPS ✓

APPENDIX E:

TABLE 1 - VILLAGE 9 SEWER STUDY SUMMARY

TABLE 1 SEWER STUDY SUMMARY FOR THE UNIVERSITY SITE PROJECT 5/23/2013

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LINE NO.	FROM NODE	TO NODE	IN-LINE FLOW (gpd)	AVG DRY WEATHER FLOW (gpd)	EQUIV POP.	PEAK DESIGN FLOW			LINE SIZE (INCHES)	DESIGN SLOPE (%)	dn(FT) n= 0.012	dn/D	Rh (ft)	VELOCITY (fps)	d (in)	% FULL
						PEAK/AVG RATIO (area)	TOTAL M.G.D.	CFS								
	22	20	31660	31660	396	2.50	0.079	0.123	8	3.00	0.10	0.15	0.06	3.36	1.20	15.00%
	20	18	12000	43660	546	2.50	0.109	0.169	8	3.00	0.12	0.18	0.07	3.75	1.44	18.00%
	18	16	30250	73910	924	2.50	0.185	0.286	8	2.00	0.17	0.26	0.10	3.80	2.08	26.00%
	16	14	18170	92080	1151	2.47	0.227	0.352	8	2.00	0.19	0.29	0.11	4.04	2.32	29.00%
	14	12	18170	110250	1378	2.44	0.269	0.416	8	2.00	0.21	0.32	0.12	4.26	2.56	32.00%
	12	10	13930	124180	1552	2.35	0.292	0.452	8	3.00	0.20	0.30	0.11	5.04	2.40	30.00%
	10	8	22885	147065	1838	2.30	0.338	0.524	8	3.00	0.21	0.32	0.12	5.22	2.56	32.00%
	8	6	53570	200635	2508	2.20	0.441	0.683	8	3.00	0.25	0.37	0.13	5.64	2.96	37.00%
	6	4	6890	207525	2594	2.19	0.454	0.704	8	3.00	0.25	0.38	0.14	5.71	3.04	38.00%
	4	2	699580	907105	11339	1.86	1.687	2.612	15	3.00	0.39	0.31	0.22	7.80	4.65	31.00%

APPENDIX F:

TABLE 2 - FUTURE UNIVERSITY SITE SEWER STUDY SUMMARY

TABLE 2

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FUTURE UNIVERSITY SITE SEWER STUDY SUMMARY

12/29/2016

LINE NO.	FROM NODE	TO NODE	IN-LINE FLOW (gpd)	AVG DRY WEATHER FLOW (gpd)	EQUIV POP.	AREA ACERAGE	SEWAGE PRODUCTION (GPD/ACRE)	IN LINE D.U.'S	CUMM D.U.'S	SEWAGE PRODUCTION (GPD PER EDU)	STUDENT HOUSING POP	FACULTY HOUSING POP	STUDENT HOUSING SWR (GPD PER POP)	FACULTY HOUSING SWR (GPD PER POP)	TOTAL M.G.D. (from area)	TOTAL M.G.D. (from DU)	TOTAL M.G.D. (STUDENT)	TOTAL M.G.D. (FACULTY)	PEAK DESIGN FLOW PEAK/AVG RATIO (area)	PEAK/AVG RATIO (DU)	PEAK/AVG RATIO (HOUSE)	TOTAL M.G.D.	CFS	LINE SIZE (INCHES)	DESIGN SLOPE (%)	dn(FT) n= 0.012	dn/D	Rh (ft)	VELOCITY (fps)	d (in)	% FULL
B	32	30				67	1401	0	0	0.0	2,135.0	791.0	45.0	90.0	0.094	0.000	0.096	0.071	1.60	0.00	1.60	0.418	0.647	8	4.20	0.22	0.33	0.12	6.28	2.64	33.00%
B	30	26				10	1401	0	0	0.0	322.0	119.0	45.0	90.0	0.014	0.000	0.014	0.011	1.60	0.00	1.60	0.481	0.744	8	2.00	0.29	0.44	0.15	5.01	3.52	44.00%
A	28	26				50	1401	0	0	0.0	1,606.0	595.0	45.0	90.0	0.070	0.000	0.072	0.054	1.60	0.00	1.60	0.794	1.229	8	5.25	0.29	0.44	0.15	8.12	3.52	44.00%
A	26	24				10	1401	0	0	0.0	322.0	119.0	45.0	90.0	0.014	0.000	0.014	0.011	1.60	0.00	1.60	0.857	1.326	12	1.00	0.40	0.40	0.21	4.43	4.80	40.00%
A	24	12				0	1401	0	0	0.0	0.0	0.0	45.0	90.0	0.000	0.000	0.000	0.000	1.60	0.00	1.60	0.857	1.326	12	0.75	0.43	0.43	0.23	3.98	5.16	43.00%
C	40	38				32	1401	0	0	0.0	1,015.0	376.0	45.0	90.0	0.045	0.000	0.046	0.034	1.60	0.00	1.60	0.199	0.308	8	10.00	0.12	0.18	0.07	6.85	1.44	18.00%
C	38	36				0	1401	0	0	0.0			45.0	90.0	0.000	0.000	0.000	0.000	1.60	0.00	1.60	0.199	0.308	8	25.00	0.09	0.14	0.06	9.29	1.12	14.00%
C	36	34				0	1401	0	0	0.0			45.0	90.0	0.000	0.000	0.000	0.000	1.60	0.00	1.60	0.199	0.308	8	13.00	0.11	0.17	0.07	7.54	1.36	17.00%
V9	22	20	31660	31660	396			120	120	265.0					0.000	0.032			2.50	2.50		0.080	0.123	8	3.00	0.10	0.15	0.06	3.36	1.20	15.00%
V9	20	18	12000	43660	546			165	165	265.0					0.000	0.044			2.50	2.50		0.110	0.170	8	3.00	0.12	0.18	0.07	3.75	1.44	18.00%
V9	18	16	30250	73910	924			280	280	265.0					0.000	0.074			2.50	2.50		0.186	0.287	8	2.00	0.17	0.26	0.10	3.80	2.08	26.00%
V9	16	14	18170	92080	1151			349	349	265.0					0.000	0.092			2.47	2.47		0.228	0.353	8	2.00	0.19	0.29	0.11	4.04	2.32	29.00%
V9	14	12	18170	110250	1378			418	418	265.0					0.000	0.111			2.44	2.44		0.270	0.418	8	2.00	0.21	0.32	0.12	4.26	2.56	32.00%
V9*	12	10	13930	124180	1552			470	470	265.0					0.000	0.125			1.77	1.77		1.077	1.668	12	3.00	0.34	0.34	0.19	7.07	4.08	34.00%
V9*	10	8	22885	147065	1838			557	557	265.0					0.000	0.148			1.77	1.77		1.118	1.731	12	3.00	0.34	0.34	0.19	7.07	4.08	34.00%
V9*	8	6	53570	200635	2508			760	760	265.0					0.000	0.201			1.74	1.74		1.207	1.869	12	3.00	0.36	0.36	0.20	7.28	4.32	36.00%
V9*	6	4	6890	207525	2594			786	786	265.0					0.000	0.208			1.74	1.74		1.219	1.887	12	3.00	0.36	0.36	0.20	7.28	4.32	36.00%
V9*	4	2	699580	907105	11339			3,436	3,436	265.0					0.000	0.911			1.71	1.71		2.414	3.736	15	3.00	0.48	0.38	0.26	8.69	5.70	38.00%
V9*	PLUS Future University Site																														
D**						5.2	1401	0	0	0.0					0.007	0.000			2.50	0.00		0.018	0.028	6	2.07	0.06	0.12	0.04	2.00	0.72	12.00%
TOTALS											**5,400.0**	**2,000.0**										**1.074**									

** based on maximum peaking factor per CVD-SW01 which equates to a population of 1000

LINE NO.	FROM NODE	TO NODE	TOTAL AREA	% OF TOTAL AREA	HOSING AREA *** (ACRE)	TOTAL AREA MINUS HOUSING AREA
B	32	30	114	39.69%	48	67
B	30	26	17	5.91%	7	10
A	28	26	86	29.71%	36	50
A	26	24	17	5.96%	7	10
A	24	12	0	0.00%	0	0
C	40	38	54	18.74%	22	32
C	38	36	0	0.00%	0	0
C	36	34	0	0.00%	0	0
Total Area			**288.2**	**100.00%**	**120**	**168**

*** HOUSING AREA EQUALS % OF TOTAL AREA TIMES 120 ACRES (ACRE)

STUDENT HOUSING AREA		FACULTY HOUSING AREA	
5,400 PEOPLE	(5400/2)*(1/56)=48.2 ACRE	2,000 PEOPLE	2000/28=71.4 ACRE
2 PERSONS PER DU		1 PERSON PER DU	
DENSITY OF 56 DU PER ACRE		DENSITY OF 28 DU PER ACRE	
Total Housing Area = 48.2 + 71.4 = 119.6 = 120 ACRE			

APPENDIX G:
FIGURES 1-8

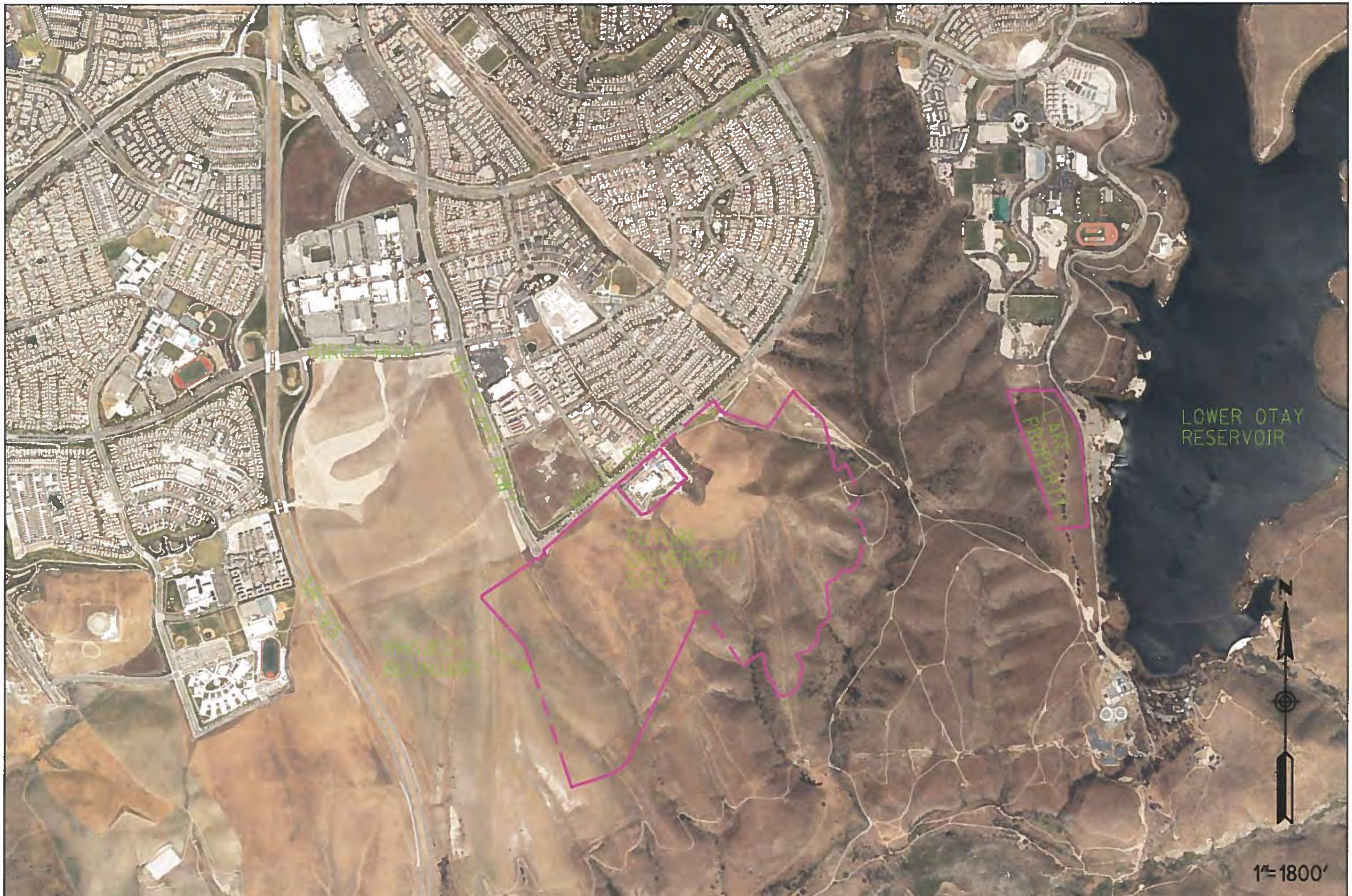

FIGURE 1

LOCATION MAP

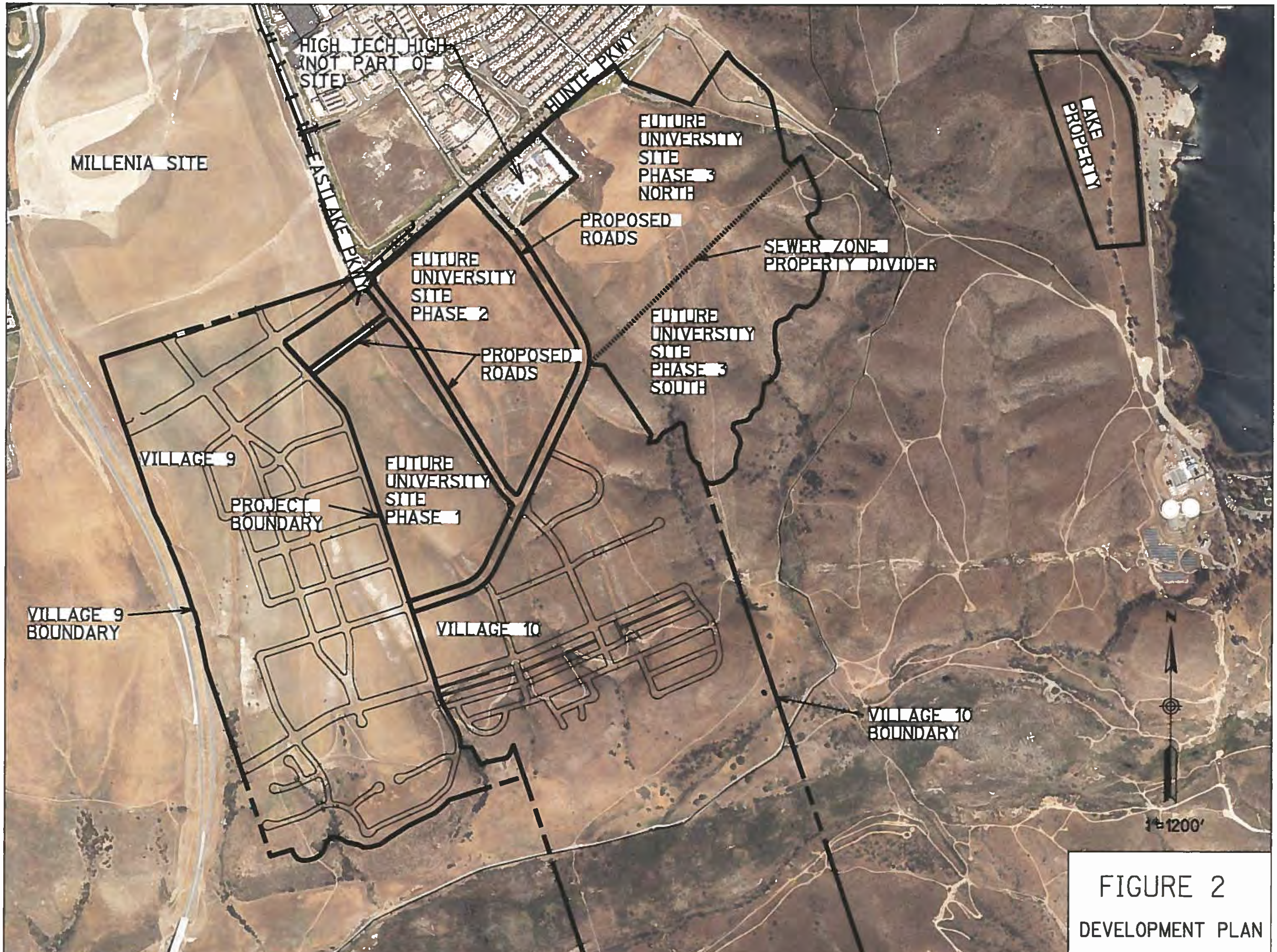

FIGURE 2

DEVELOPMENT PLAN

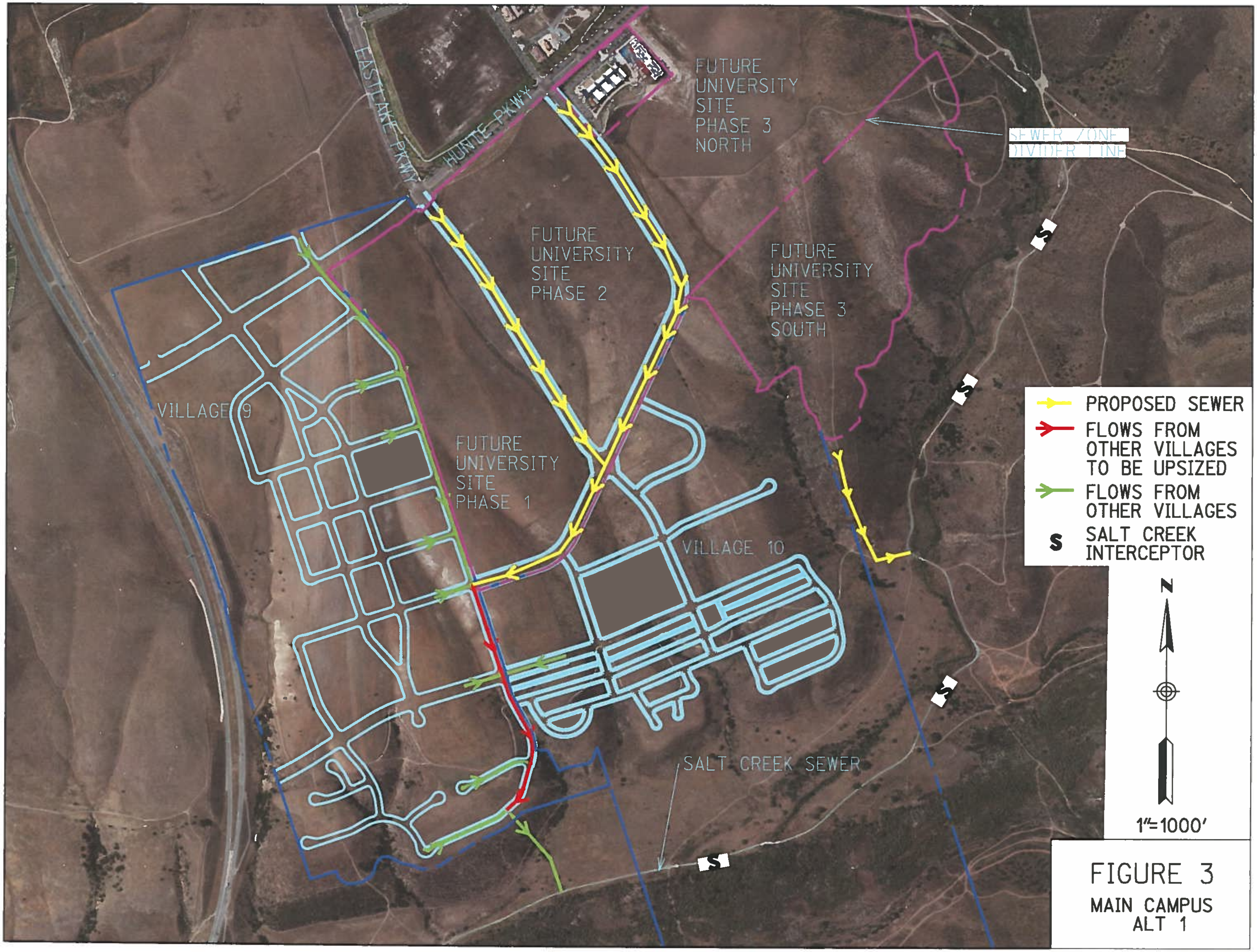

FIGURE 3

MAIN CAMPUS
ALT 1

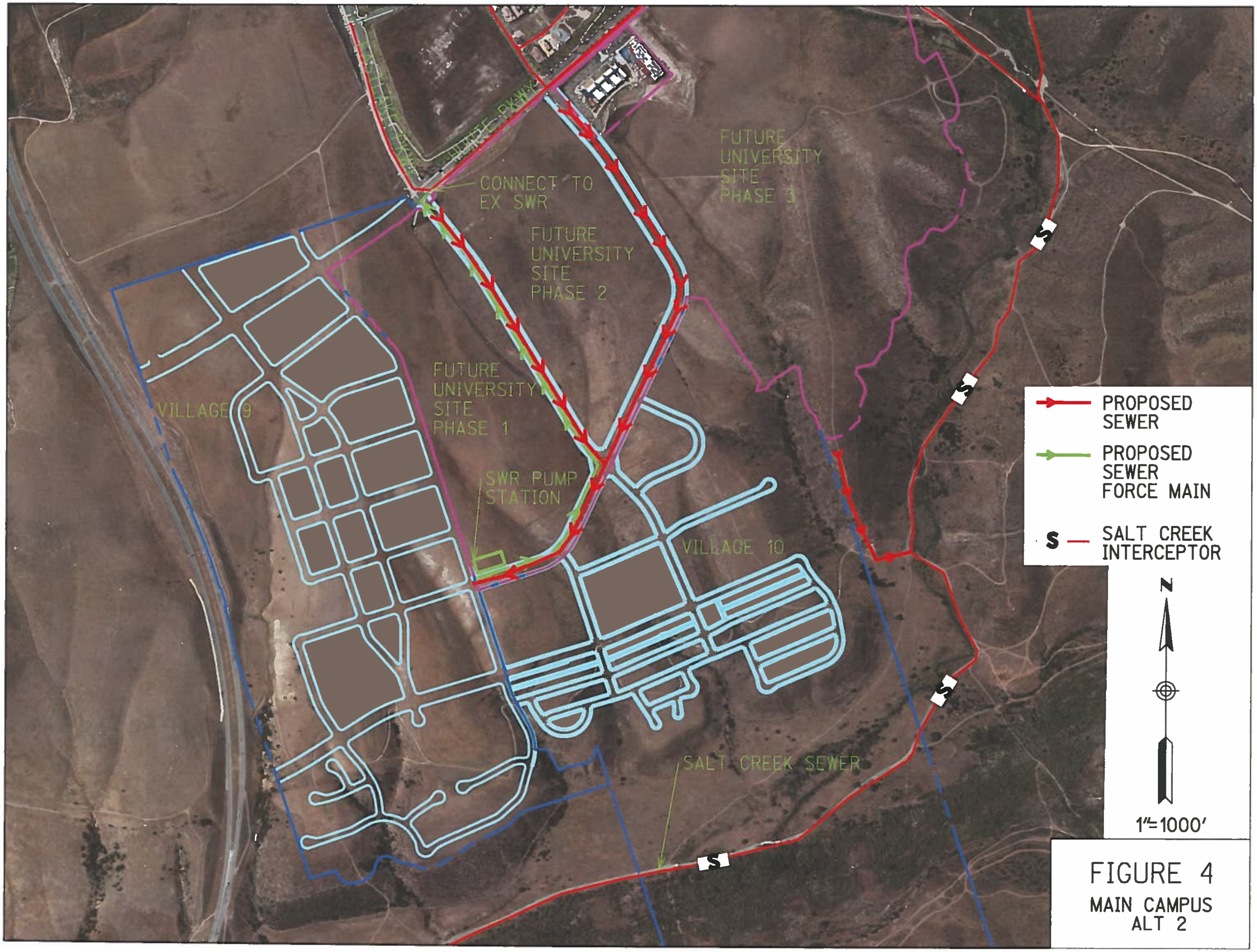

FIGURE 4
MAIN CAMPUS
ALT 2

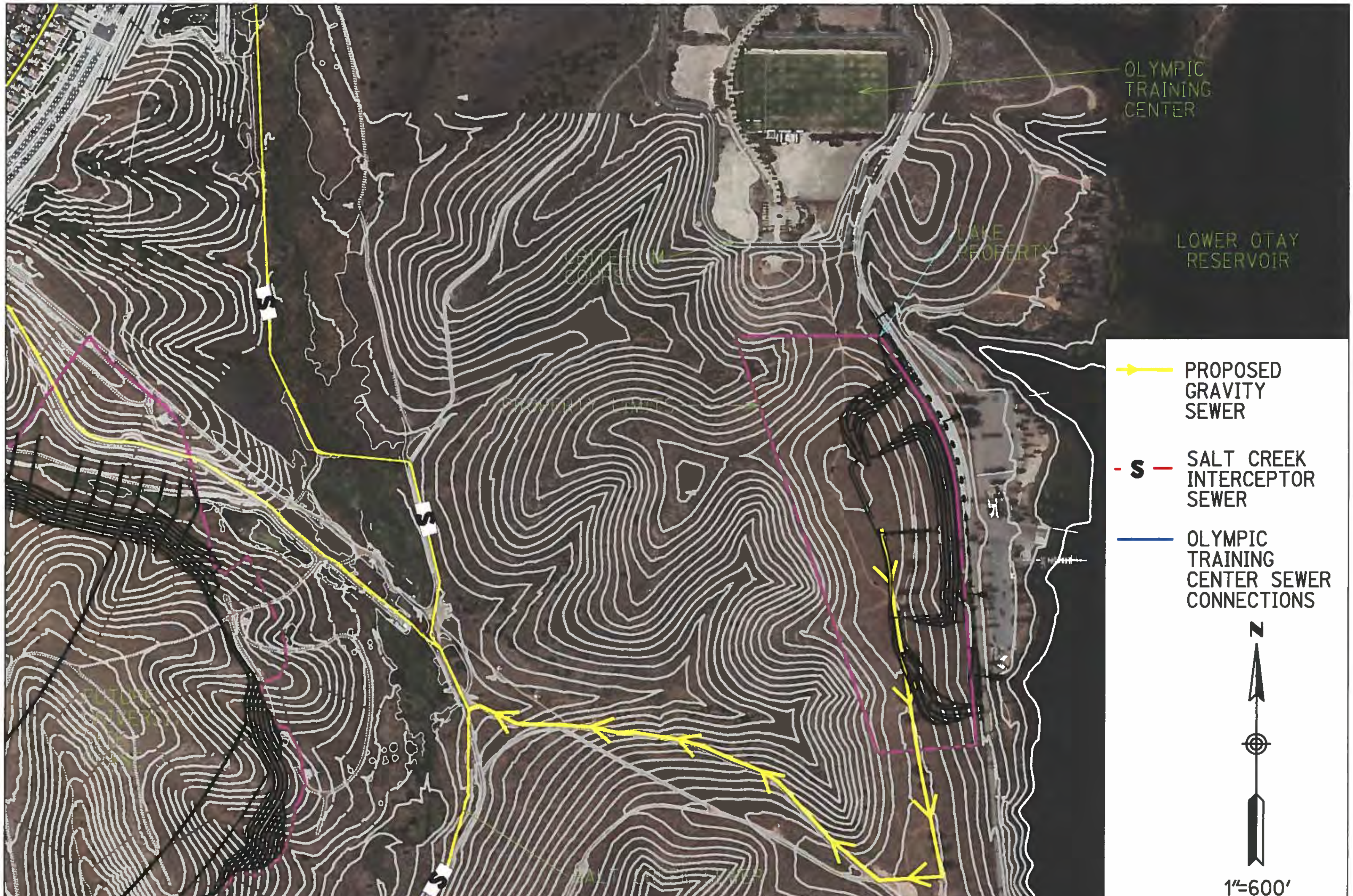

FIGURE 5
LAKE PROPERTY ALT 1

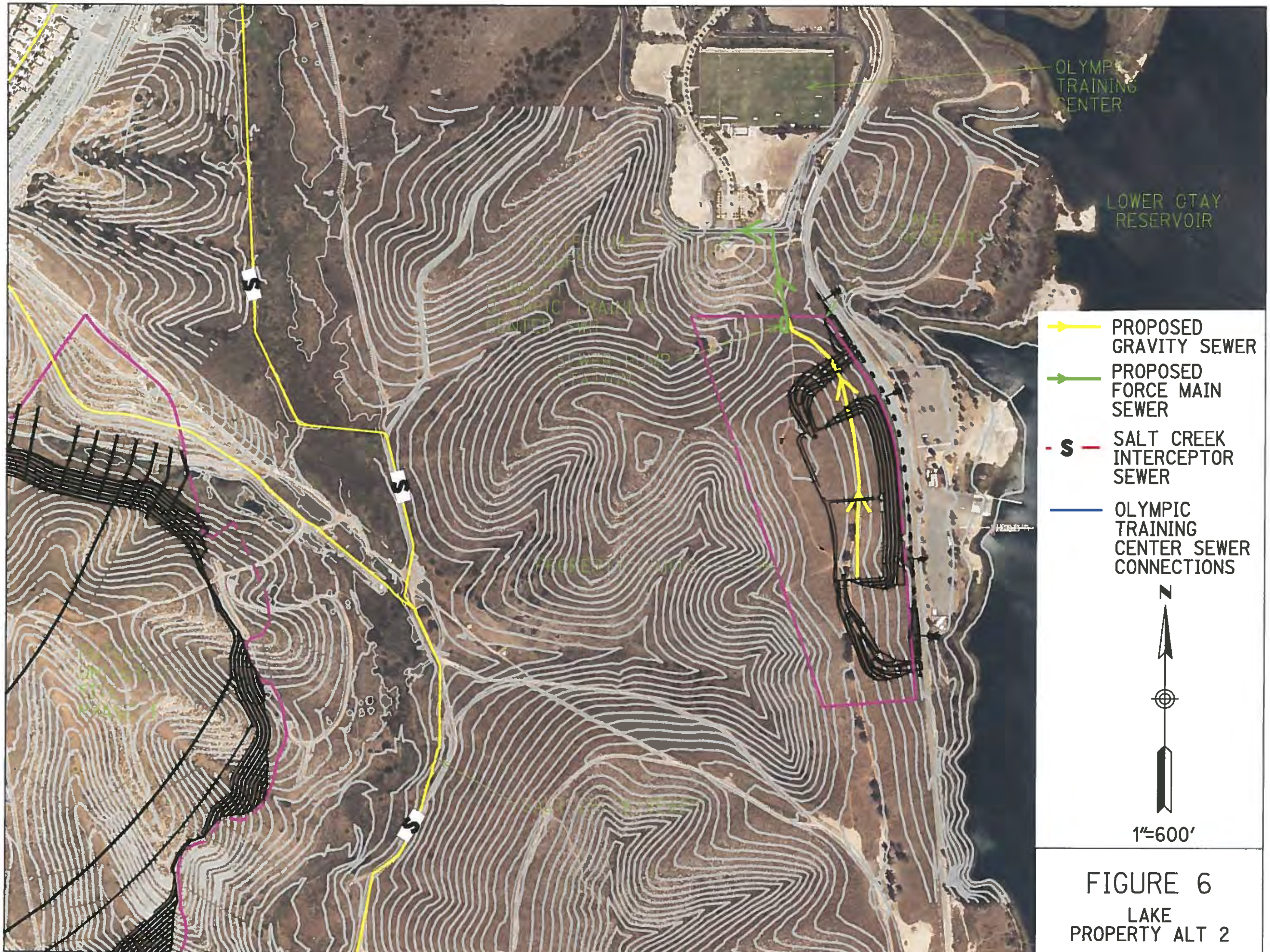

FIGURE 6
LAKE PROPERTY ALT 2

FIGURE 7
LAKE PROPERTY ALT 3

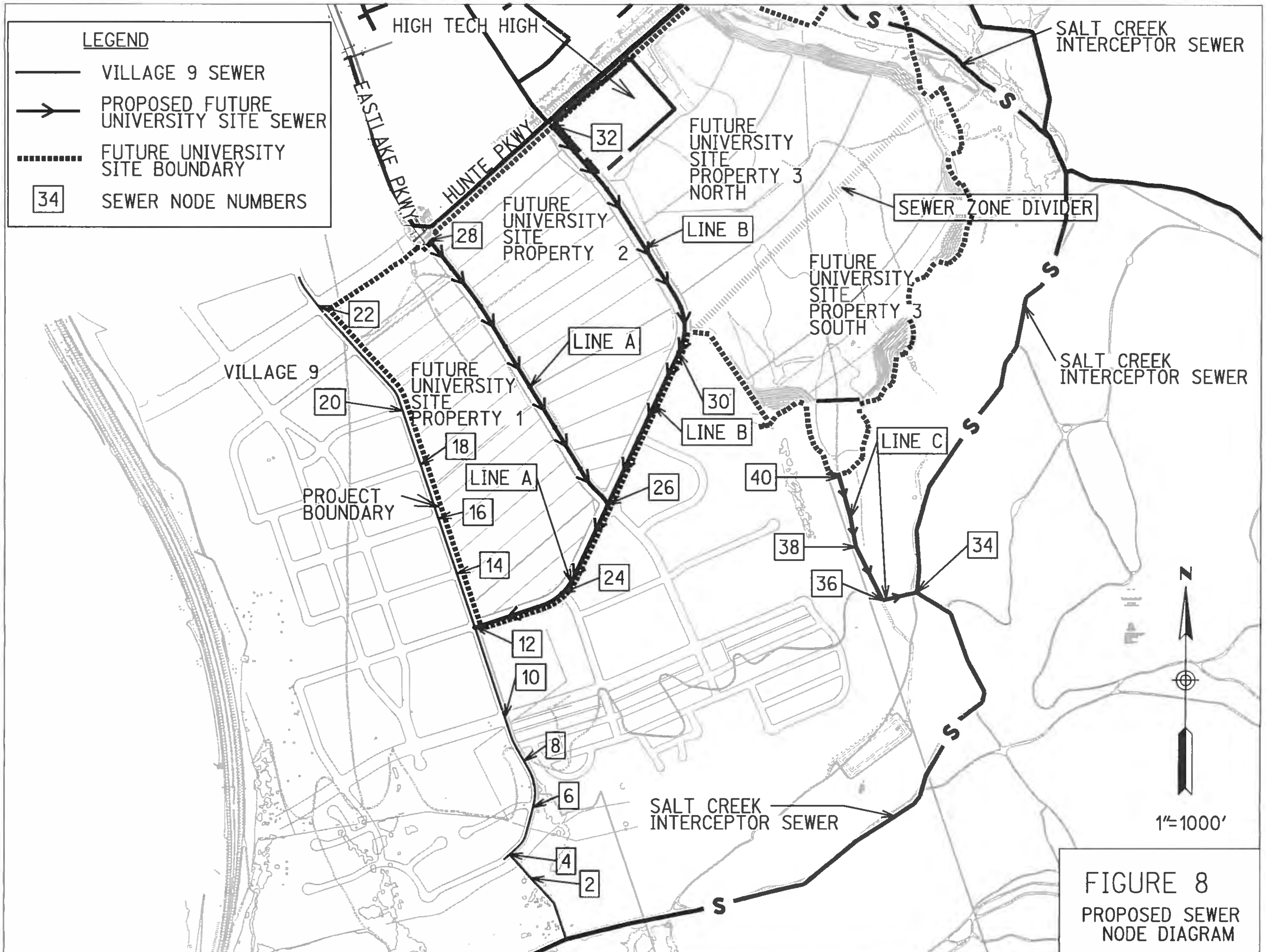

FIGURE 8
PROPOSED SEWER NODE DIAGRAM