Sam Houston State University

Storm Water Master Plan Update

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EXECUTIVE SUMMARY

Sam Houston State University (SHSU) is an integral higher education institution for the state of Texas and the nation. SHSU is located in Huntsville in the Southeast side of Texas about 70 miles North of Houston on Interstate 45 as shown in ***Exhibit ES-1***. It has seen academic success and growth quite notably in recent years and anticipates continuing with this trend. In order to accommodate this growth, SHSU has taken steps to create an overall master plan. Part of this campus master plan was to assess and develop a storm water system master plan for SHSU's main campus.

Exhibit ES-1: Project Vicinity Area

STORMWATER MASTER PLAN GOALS

As a member of the Smith Group JJR team, supporting SHSU, Klotz Associates was retained to produce the Storm Water Master Plan of the main campus as part of the overall campus master plan. The goals of the stormwater portion of the study as outlined in the 2008 Master Plan remain the same:

- Manage stormwater as a campus asset,
- Manage stormwater detention regionally where necessary,
- Manage water quality as close to the source as possible,
- Minimize impervious surfaces, and
- Integrate stormwater into the campus open space fabric.

In addition, stormwater conveyance facilities were analyzed with a 10-year recurrent storm flow and detention was analyzed with the 100-year recurrent storm flow.

STUDY METHODOLOGY

The first step in developing stormwater recommendations is the assessment of existing facilities. Part of this was accomplished using the University's 2004 condition assessment report. The railcars beneath the recreational fields are an example of an existing facility that is in poor condition and in need of replacement. The report helped identify all such facilities.

Addressing the need to manage the quantity of stormwater generated on campus and the understanding that increased imperviousness increases peak flows, regional detention at the recreational fields was analyzed. In addition, record drawings provided by the University were used to identify other stormwater detention facilities that have been constructed in the past and that relieve the fields of part of the burden for providing peak flow reduction.

Stormwater peak flows from the City of Huntsville's 2012 Town Creek model were used in this study to assess the capacity of existing facilities. Future condition flows were distributed to existing storm drain pipes based on contributing area. Normal flow computations were then used along with surface slopes to compare a pipe's capacity to the distributed flow. Pipes with inadequate capacity were identified for replacement, duplication with a parallel pipe, or relief if an area close by that was suitable for detention could be identified.

Information on facility condition and capacity formed the basis for recommendations on the existing system. Information developed in the other aspects of this planning effort formed the basis for recommendations for the system for future additions to the campus. Together, these were combined to form the recommendation for stormwater improvements. Phasing or ranking the need for a particular stormwater improvement was based on the urgency or need for the facility. Those qualifying in more than one of these categories were ranked higher on the list qualifying them for an earlier phase for implementation.

STORMWATER RECOMMENDATIONS

In addition to the criteria discussed above for the identification and ranking of proposed stormwater facilities, the following criteria were also considered:

- Need for Recreational Fields,
- Water Quality, and
- Overall Master Plan Goals and Recommendations.

From these considerations, Klotz Associates developed a list of recommendations including line replacements, line upgrades, new lines, and new detention facilities along with the associated costs and implementation phases as summarized in ***Table ES-1***. The recommendations are graphically shown in ***Exhibit ES-2***. Rain garden locations were also recommended and shown in the exhibit. However, due to many variables in cost that can

occur because of the adjacent hardscaping design and aesthetics, no costs or phasing was included in this report for rain gardens.

Table ES-1: Summary of Phase and Cost of Recommendations

Phase	Phase Cost	Total Number of Projects	Recommendations
1 (Years 1-6)	$ 3,500,000	16	37 Storm Drain Improvements
			3 Detention Basins
			2 Detention Chambers
			22 Manhole Rehabilitations
2 (Years 7-12)	$ 650,000	6	9 Storm Drain Improvements
3 (13+ Years)	$ 50,000	2	2 Storm Drain Improvements
Total =	***$ 4,200,000***		

*See Table 1 in main report and Appendix A for additional detailed information

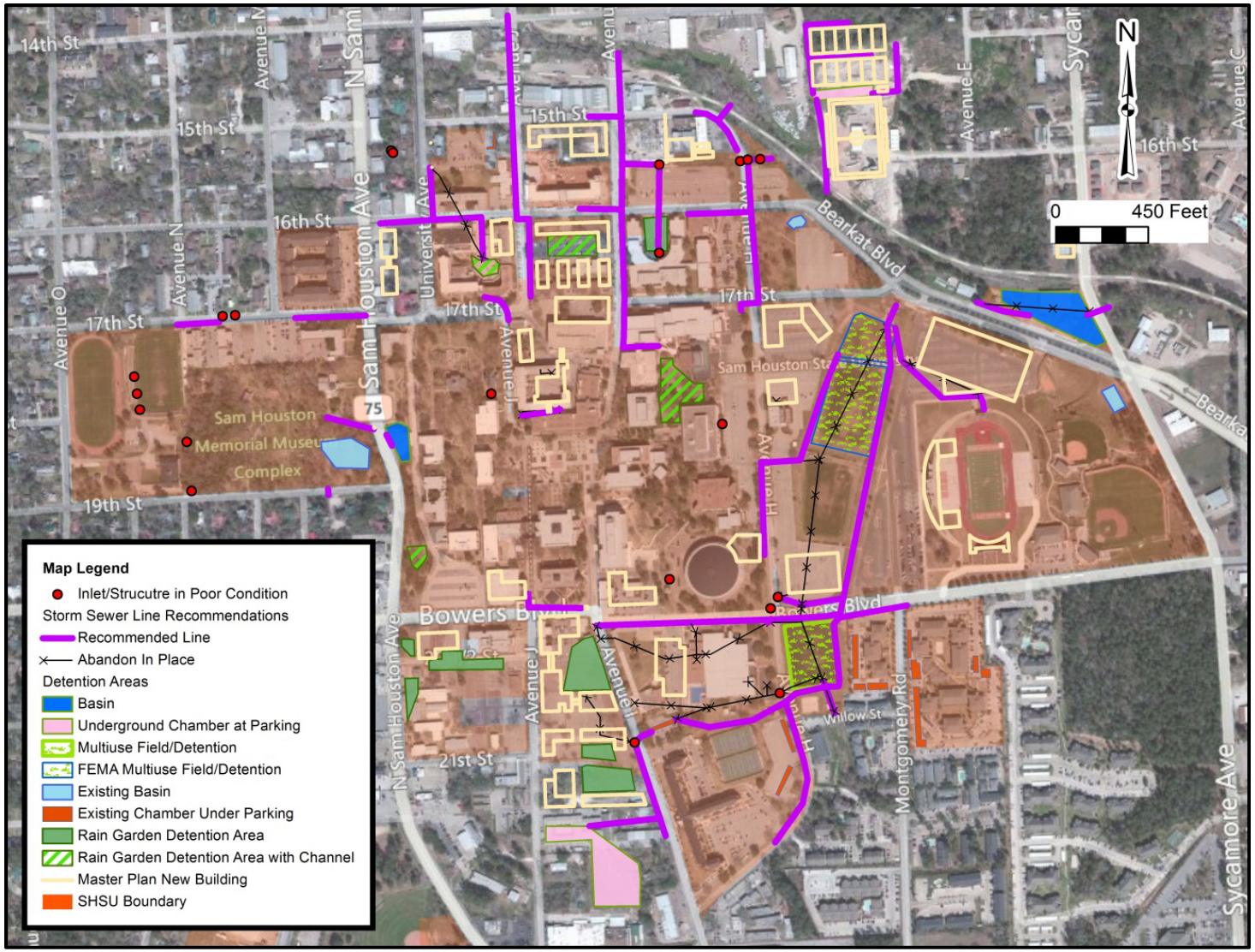


Exhibit ES-2: Overall Storm Water Recommendations

SECTION 1
INTRODUCTION

1.1 Authorization

The Sam Houston State University (SHSU) is undergoing a revision to their master plan in preparation for future growth. A team led by Smith Group JJR was selected to prepare the master plan update. Klotz Associates, Inc. as a member of the Smith Group JJR team was responsible to provide storm water recommendations encompassing the University's main campus to be incorporated into the overall SHSU Master Plan.

1.2 Project Purpose and Scope of Work

SHSU requires a conceptual plan for redevelopment of campus facilities to accommodate projected growth. The conceptual plan includes a review of the storm drain system of the main campus. Areas of the University away from the main campus, such as Gibbs Ranch and the I-45 Recreational Fields Complex, will have storm drain requirements addressed at a later stage in the development. This project will provide both conceptual improvements for existing facilities and recommendations for future drainage needs. The conceptual plan includes preliminary construction cost estimates and a phasing schedule.

1.3 Background

SHSU is a key asset in Texas and Huntsville. The university prepared a comprehensive plan for the development of campus facilities in 2008. This plan has guided development on campus for the last four years. While an update of its content was needed, some of the goals have remained the same. As per the 2008 Master Plan, several goals were developed that relate to the stormwater drainage system:

- Manage stormwater as a campus asset,
- Manage stormwater detention regionally where necessary,
- Manage water quality as close to the source as possible,
- Minimize impervious surfaces, and
- Integrate stormwater into the campus open space fabric.

These goals are carried forward in this Master Plan Update and have served as guides to the development of proposed storm drainage facilities.

SECTION 2
EXISTING DATA REVIEW

Klotz Associates obtained from SHSU available storm drain system data. Information provided included size, location, material, configuration, and condition of storm drains, inlets and detention facilities. SHSU also provided access to CAD files and as-built drawings to assist Klotz Associates in this effort.

Klotz Associates prepared maps that characterized the existing campus system and presented an overall picture of the existing storm water facilities. SHSU reviewed and provided feedback on the maps. The maps were revised based on SHSU feedback.

SHSU further provided input about one specific area on campus grounds that had flooding issues. This location is at Bowers Boulevard and Avenue H. This area was given special consideration in the analysis process to make sure that there were recommendations that remedied this area.

Klotz Associates considered a 2004 report detailing the condition of the storm sewer drainage facilities on campus. This document was used along with other information developed during the study to formulate storm drainage recommendations for existing storm drain facilities.

Klotz Associates utilized hydraulic information prepared for the City of Huntsville's 2012 Town Creek modeling effort. Ten-year event flows were developed for drainage areas that overlap the main campus. The drainage areas utilized included TC-1, TC-2, TC-4, TC-5, TC-6, TC-8, TC-10, TC-12, TC-16, TC-17, and TC-18 and are shown in ***Figure 2*** located at the end of the report. The estimated 10-year event flows were used to evaluate the capacity of existing drainage lines 24 inches and larger or those that were noted in poor condition. In addition, the Town Creek model also identified detention requirements for the main campus which were used in this report.

Klotz Associates used elevation information from 2007 Light Detection and Ranging (LiDAR) data that were made available from the City of Huntsville. LiDAR uses optical remote sensing technology to measure ground topography giving an accurate measurement of elevation for a ground surface. While not achieving the accuracy of traditional topographic surveys it does provide suitable elevation information for larger areas. This 2-foot contour data was used to estimate slopes for the sizing of conveyance facilities. A map of the topography of SHSU can be seen in ***Figure 1*** at the end of the report.

SECTION 3
SITE CONSIDERATIONS

3.1 Topography of Campus

SHSU is located atop a hill in Huntsville and has nearly 50 feet of grade change from its highest to its lowest point. Because of the relatively steep slopes, stormwater drains at a rapid pace. It is vital to direct the water to appropriate storm drain facilities to avoid flooding of campus and downstream areas and to keep roads safe for pedestrians and vehicles. Klotz Associates took this into account when evaluating the existing sizes and locations of the stormwater system to determine the need and size for existing and future facilities. ***Figure 1*** shows the topography of the main campus area.

3.2 Railcar Sewer Trunk Lines

Underneath the recreational fields north and south of Bowers Boulevard, 72-inch railcars serve as a storm sewer trunk line. This trunk line is quite vital since it serves as the outlet to the entire TC-17 drainage area as well as a large portion of TC-16. This line is also highly deteriorated and needs to be replaced as soon as possible. Klotz Associates identified the railcar line for abandonment along with the installation of a new, appropriately sized storm drain.

There is a smaller section of railcars located near the Custodial and Grounds building. It is also highly deteriorated. Klotz Associates recommends abandonment and replacement of this line as well.

3.3 Recreational Fields

SHSU currently has four main recreation fields that are utilized to a very high extent on a daily basis. The lowest field, that is also the northernmost, is the campus' primary flood control detention facility. The field is designed to fill during large rain events and release water in a controlled manner to Town Creek. Smaller, more frequent events drain straight through without ponding.

SHSU has established a high priority to maintain existing recreational facilities as well as create new facilities. Klotz Associates kept this priority in mind when determining how to satisfy stormwater drainage needs and to meet detention requirements identified by FEMA.

3.4 Detention Required by FEMA

A 2012 study performed for FEMA on the Town Creek watershed determined that 47 acre-feet of detention is required for mitigation of SHSU existing and proposed future impervious cover associated with buildings, parking lots and walkways. The existing recreation fields along Bobby K Marks Drive are currently configured into a multiuse-detention facility with the required detention capacity. Klotz Associates has been able to reduce the required detention at this location by identifying other areas on campus that can also provide detention which are all seen in their respective maps in ***Figures 3 - 7***. The fields will remain multiuse detention/recreation while maximizing space available for recreational purposes.

The proposed FEMA improvements include all detention pond work at the recreational fields on the northeast side of Bobby K Marks and Bowers as well as the abandonment and replacement of the railcar lines. These improvements funded by FEMA are expected to take place within the next three to five years.

SECTION 4
CAPITAL IMPROVEMENT PLAN DEVELOPMENT METHODOLOGY

4.1 System Capacity and Conditions

Facility condition and capacity versus flow relations were part of the capital improvement plan development for the main campus. System components that were found to be near or at the end of their useful life were identified for replacement or rehabilitation. If they were found to be under capacity for future planned development, that fact was taken into consideration when sizing their replacements. If it was economically or physically advantageous to divert flow into a new detention basin or parallel system, then that option was used instead of replacement of the pipe. Other lines considered for replacement included those that are currently located beneath existing structures.

Hydrologic modeling was not included in this study, but it is recommended that detailed modeling of the system be performed in the preliminary engineering report prior to the design of each planned improvement. Regardless, it was assumed that previous modeling efforts would provide sufficient information to serve as input for the needed drainage recommendations. Klotz Associates used hydrologic information from the work prepared for the City of Huntsville's Town Creek model to estimate flows from the drainage areas located on the main campus. These estimated 10-year event flows were used to evaluate the capacity of existing drainage lines 24-inch and larger or those that were noted to be in poor condition.

Flow information extracted from the City's model represented flow from large drainage areas encompassing the main campus. To compare capacities of existing campus facilities to projected future design flows, it was necessary to distribute the flow from the large areas upstream to facilities within each of the campus drainage areas. This was accomplished through a visual inspection of various sources

including LiDAR, topographic mapping, aerial images of the campus, existing and future proposed building layouts, and the location of existing and future proposed drainage facilities. All of these affect the directional flow of stormwater runoff.

Approximate determinations were made concerning the direction of flow of different parts of each drainage area utilizing the resources mentioned above. Drainage area flows were proportioned based on the resulting subdivision of area. Sub-drainage area flows were assumed proportional to the subdivided area. For the longer facilities, the proportional flow was distributed along the pipe/channel in an attempt to simulate how the flow will actually enter the system.

In addition to the approximation introduced by the subdivision of area, routing and attenuation of flows will also affect the peak flow used in the design of conveyance systems. Routing and attenuation are only estimated by running computer programs such as HEC-HMS, HEC-RAS or Storm Water Management Model (SWMM). It is recommended that this type of modeling be performed during final design of all pipes and channels for more accurate sizing.

In lieu of using detailed modeling techniques, Klotz Associates utilized approximate methods that incorporate Manning's equation for the conceptual sizing of recommended drainage facilities. These methods are considered suitable for planning level studies such as this master plan update.

System conditions were obtained from a condition assessment study previously undertaken by SHSU in 2004. This study called "University-Wide Storm Sewer Improvements" provided detailed condition assessments about the debris obstructions and structural integrity of existing facilities and rated facilities as in poor, fair or good condition. System components that were identified as being in poor condition were identified for immediate rehabilitation/cleaning in Phase 1 of master plan implementations. Other components that were identified as fair in condition were

identified for rehabilitation or cleaning in Phase 2. Note that no new facilities were identified to be constructed in this report.

4.2 Conveyance Improvements

Conveyance facilities include storm drain pipes, channels and swales. These typically are designed based on peak flow conditions of the 10-year design storm. Several conditions led to the recommendation of improvements to the conveyance facilities. One condition was the adequacy of capacity of the existing facility. If the facility was shown to be inadequate to convey the 10-year design flow, an appropriate size facility was recommended. If there was an existing facility that was in good, serviceable condition and there was adequate space, the recommendation was to install a smaller parallel line to carry the flow that is not able to be handled by the existing facility. If the existing facility was in poor condition or there was not adequate room, a new replacement line was recommended with adequate capacity for the entire design flow. For areas of flooding or for new proposed buildings where there were no existing facilities, new facilities were recommended. If there were lines under either existing or new proposed buildings, they were identified for relocation.

A second condition for the recommendation of conveyance facilities is existing facility condition. Based on the 2004 SHSU condition assessment study, some conveyance facilities are shown to be in poor condition. If only isolated sections are deteriorated then point repairs or rehabilitation or cleaning was recommended. If there was little to salvage of the existing facility, then the entire line was recommended for replacement (such as the railcars). These recommendations were independent of those based on capacity if the existing line was shown to have adequate capacity for the design storm peak flow.

In ***Table 2***, at the end of the report, lines identified for upgrade, new lines and lines identified for rehabilitation or cleaning are shown and numbered based on drainage area. The project group and phase that correlate to the overall Master Plan are also shown. These lines are shown in their respective ***Figures 3 – 7*** at the end of this report and are identified in more detail in ***Tables 4, 6, 8, 10, and 12***.

4.3 Detention Facilities

In order to minimize the need for detention at the recreational fields, other existing detention and potentially new detention facilities were identified in conjunction with the other planning elements of the Master Plan Update. Approximate storage volumes were determined for each location. Through this effort, 13.6 acre-feet of existing/proposed detention was identified at other locations across the main campus; 4.3 acre-feet of this being existing detention that the University has already implemented. Through the assistance of SHSU personnel, existing underground detention facilities were identified and their storage volumes quantified. New detention facilities include surface detention basins and chamber storage underneath new parking facilities.

The amount of detention left of the original 47 acre-feet that is still required at the recreational fields will continue to allow them to serve as multiuse facilities and will only impact play at them during major rain events when games would not typically be played. In order to achieve the detention capacity required at these facilities, the fields can be designed to distribute the detention in a way that best suits SHSU and the use of the recreational fields and not necessarily as noted in this report's recommendations. The main goal is to achieve the required detention, regardless of which combination of fields accomplish this.

Table 2, 5, 7, 9, 11, and 13 give a description of each facility including a name based on drainage area. Locations of the detention facilities are shown in ***Figures 3 - 7***.

In addition, any surface detention basins could be designed as a visual amenity to the campus via careful design of landscaping and/or water features.

4.4 Manhole Rehabilitation

All manholes noted as being in poor condition in the 2004 SHSU storm sewer improvements report are identified in ***Figures 3 - 7***. It is recommended that all identified manholes be rehabilitated or cleaned based on their description in the report within the first phase of improvements.

4.5 Pervious Surfaces

To further improve the quantity of pervious area on campus, all new sidewalks and parking lots should be analyzed during design to determine the benefits of pervious pavement systems. If green roof systems are applicable, they should be evaluated in order to increase the pervious area on campus.

4.6 Stream Corridors

The stream corridor on campus including Town Creek and any of its tributaries should be highly protected and enhanced so that they are campus amenities by thoughtful landscaping and design coordination with adjacent buildings. New detention will help with this effort, but new development that takes place in the future should be done so with this important goal in mind.

4.7 Water Quality Opportunities/ Rain Gardens

Water quality needs can be met as new buildings and open spaces are developed throughout campus. Rain Gardens were considered as part of the effort to maintain

water quality. Rain gardens are landscape features that offer benefits of infiltration, volume reduction, and flow rate reduction as well as scenic improvements. These coincide with the goals of managing the water quality as close to the source as possible, reducing impervious surfaces, and integrating stormwater into the campus open space fabric.

Rain gardens were proposed based on proposed building locations and space, contours and the 2008 Master Plan recommendations. Open space areas between buildings were analyzed based on space availability and topography to determine if rain gardens or rain gardens with a channel were a possible amenity. Rain garden locations are shown in ***Figures 3 - 7***. Since design of these will largely depend on the new building design and aesthetics, no detention storage calculations were considered in this report. However, if storage is acquired through one of these amenities in the future, then it becomes part of the total detention provided by the campus and can be subtracted from the storage needed at the recreation fields. Rain garden area slopes were analyzed to determine if they could support channel flow and thus increase water quality.

A cost analysis was not performed on proposed rain garden areas because their size, landscaping, and cost will depend on the design aspects of the facility they will be incorporated with in the future.

To further improve water quality, water treatment features should be analyzed as an option for any proposed detention basin or underground chambers. This option can also be looked at for existing detention facilities.

As mentioned in the 2008 SHSU Master Plan, it is important to note that the federally mandated National Pollution Discharge Elimination System (NPDES) guidelines should be followed and the "university should attempt to treat 90 percent of the average annual rainfall, which is approximately a 2-inch rain event for this climate".

4.8 Phasing

In order to determine phasing of storm drain facilities, several factors were considered. For example, condition of facility, capacity of facility, dependency on FEMA funded improvements, and need of other building/street construction planned in Master Plan Update. Recommendations were first assigned a phase based on priority and location of other improvements, but were then assigned a project group based on adjacent storm water and building improvements. These project groups are not based on priority; this is only established by phase. Project groups and phases are identified in ***Table 2***.

The two components generated from the analysis of the storm drainage facilities, capacity and condition, were combined into a matrix type methodology for determining priorities. Facilities that are considered the highest priority are those with both the greatest capacity deficiencies and the highest degree of deterioration. Of course, there were other considerations in assigning priority. For instance, if several segments of a longer line were considered in critical need of repair or replacement, then the entire line was also included out of practical construction necessities.

In addition, this analysis was not isolated from other aspects of the Master Plan Update. The need to provide services for a new building facility or the desire to fix a storm drain with a low priority at the same time a road with a higher priority is being repaired were considered in the phasing of storm drainage facilities. The leveraging of funds was also considered and will continue affecting decisions in the future. Where SHSU money can be combined with other funds such as FEMA funding or joint projects with the City, priorities can easily change. The Master Plan Update should be considered a flexible document from that standpoint.

4.9 Costs

Costs for storm drain facilities include components for construction based on materials and dimensions, excavation, repair of paved surfaces incidental to the construction, the likelihood of other utility relocations required, a construction contingency of 25 percent, as well as 15 percent for engineering and administration. Estimation of rehabilitation costs included a total of 15 percent contingency costs.

Unit costs used in the estimate were derived from construction costs from recent projects constructed in the City of Huntsville. Unit costs of items not found in Huntsville's bid tabs were supplemented with values from TXDOT, the City of Houston or other cities in southern Texas. ***Table 3*** at the end of the report lists the conceptual costs of the recommended improvements. Detailed costs estimates and unit costs are included in ***Appendix A***.

4.10 Other Considerations

Klotz Associates worked with the other members of the Smith Group JJR team to identify additional criteria in making the determination about storm drainage facilities that are needed for each particular new facility. Aesthetics, convenience and the value of the adjacent non-drainage facilities were among the types of criteria that were considered in making recommendations. All recommendations included in the report are made consistent with University guidelines, input and direction.

SECTION 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 Recommendations

It is recommended that SHSU implement the phased storm water improvements outlined in the previous section. ***Table 1*** below summarizes the recommended facilities costs by phase.

Table 1 – Estimated Cost Per Phase

Phase	Phase Cost
1 (Years 1-6)	$ 3,500,000
2 (Years 7-12)	$ 650,000
3 (13+ Years)	$ 50,000
Total	***$ 4,200,000***

5.2 Future Considerations & Recommendations

When implementing new aspects of the campus, five stormwater considerations must be addressed:

- Determine if the project increases the imperviousness of the development area. If it does, then stormwater detention will need to be implemented concurrently.
- Define an approach for maintaining or improving water quality and determine how the strategy can be integrated into an adjacent open space network or with another stormwater management facility.
- Perform soil and slope analysis to determine suitability of pervious pavement and infiltration based techniques.
- Each improvement must be properly evaluated and sized through needed detailed H & H modeling.
- Overall, new construction should be designed to have no impact to any receiving watershed.

The above considerations are significant, but also important is the development of a detailed model of the SHSU storm drain system in the EPA's SWMM. A detailed model will be needed during the design phase of each facility to better estimate sizes (and cost) of recommended improvements. This tool would not only help the university manage the stormwater assets that it has, but also address concerns and requirements from FEMA. Depending on results, one direct improvement would likely be the reduction of needed storage based on an improved analysis of flows generated on campus.

Table 2 - Recommendations and Phasing

Project Group	Line Name	Det. Name	Desctiption
Phase 1 (Years 1-6)			
1A	**TC01-1**		NL to Replace Railcar to Det.
	TC01-2		NL to Replace Railcar from Det.
		TC01-D	Detention Basin/Water Amenity
1B	**TC02-4**		Stadium - Upgrade
	TC04-1		Inlet + Stadium Flow - Upgrade
1C	**TC05-1**		Multi-use Rec Complex - Parking
	TC05-4		Multi-use Rec Complex - Parking
		TC05-C	Detention Chamber Under Parking
1D	**TC06-1**		17th & Ave H -Upgrade
	TC06-3		NL1 - Ave H (til 16th)
	TC08-1		Along 16th - Upgrade
	TC08-3		NL2 - Ave H (16th to 24")
	TC08-6		15" in Poor Condition-Rehab/Cleaning
1E	**TC08-4**		NL3 - Ave H (curve)
	TC08-5		NL4 - Ave H (outlet)
1F	**TC10-1**		Performing Arts Center -Upgrade
	TC10-2		Crosses 16th - Upgrade
	TC10-3		New Line1 - Ave I
	TC10-4		New Line2 -Ave I
	TC10-5		8" in Poor Condition-Rehab/Cleaning
1G	**TC12-3**		17th & Ave. J - Upgrade
	TC12-9		NL - Replace 54" Across 16th
1H	**TC12-6**		8" in Poor Condition-Rehab/Cleaning
		TC12-D	Detention Basin at West Plant Demo Site
	TC18-9		Pipe by Museum Lake-Rehab
1I	**TC12-8**		New Line - LSC Expansion
1J	**TC17-4**		Railcar1 + TC16 - Upgrade
	TC17-6		Railcar2+Railcar1+TC16 - Upgrade
	TC17-7		New Line1 - Bowers & Ave H
	TC17-12		New Line -Replace 48"
	TC17-13		New Line - Bowers Blvd
	TC17-15		New Line - From Health & Kines.
	TC17-16		New Line -From TC17 Detention
		TC17-D	Multiuse Field/Detention at Intramural Site
1K	**TC17-5**		Ave H & Library - Upgrade
	TC17-14		New Line - N. Ave H
1L	**TC17-8**		New Line - Montgomery Rd
1M	**TC17-1**		Ave I & TC17-C4 - Rehab/Cleaning
	TC17-9		New Line - S. Ave H
	TC17-11		New Line -Off Ave H
		TC17-C	Detention Chamber Under Parking
1N	**TC17-10**		New Line -From TC16
1O	**Manholes**		Manhole Rehabilitation/Cleaning
Phase 2 (Years 7-12)			
2A	**TC05-2**		NL In Between Multi-Use Rec Complex
	TC05-3		NL from North Parking
2B	**TC08-2**		Outlet to Creek (S) - Rehab/Cleaning
2C	**TC10-6**		New Line - 16th
	TC10-7		New Line - 15th
2D	**TC12-7**		New Line - Ave J
2E	**TC18-5**		Stream Area (by #1) - Rehab/Cleaning
2F	**TC18-7**		Assumed 24" on 17th - Upgrade
	TC18-8		From TC12 on 17th - Upgrade
Phase 3 (13+ Years)			
3A	**TC12-10**		NL - From Future #2
3B	**TC17-17**		NL - From Future #1

*NL=New Line, D=Detention Basin, and C =Detention Chamber
*See Tables 3 and 4 – 13 for line recommendation details.
*See Figures 3 -7 for location of recommendations.

Table 3 - Conceptual Costs

Project Group	Line Name	Det. Name	Total Cost w/ Contingency	Sum of Costs Per Project
Phase 1 (Years 1-6) - $3,500,000				
1A	TC01-1		$ 106,018	$ 335,822
	TC01-2		$ 107,136	
		TC01-D	$ 122,668	
1B	TC02-4		$ 119,615	$ 144,585
	TC04-1		$ 24,970	
1C	TC05-1		$ 39,457	$ 483,569
	TC05-4		$ 62,488	
		TC05-C	$ 381,624	
1D	TC06-1		$ 2,976	$ 118,067
	TC06-3		$ 52,470	
	TC08-1		$ 22,516	
	TC08-3		$ 28,553	
	TC08-6		$ 11,552	
1E	TC08-4		$ 28,963	$ 38,485
	TC08-5		$ 9,522	
1F	TC10-1		$ 22,813	$ 250,266
	TC10-2		$ 56,934	
	TC10-3		$ 83,119	
	TC10-4		$ 84,648	
	TC10-5		$ 2,752	
1G	TC12-3		$ 18,251	$ 206,187
	TC12-9		$ 187,936	
1H	TC12-6		$ 4,389	$ 80,712
		TC12-D	$ 25,924	
	TC18-9		$ 50,399	
1I	TC12-8		$ 19,441	$ 19,441
1J	TC17-4		$ 47,908	$ 795,815
	TC17-6		$ 173,082	
	TC17-7		$ 20,309	
	TC17-12		$ 107,618	
	TC17-13		$ 133,434	
	TC17-15		$ 2,182	
	TC17-16		$ 187,299	
		TC17-D	$ 123,983	
1K	TC17-5		$ 82,848	$ 127,780
	TC17-14		$ 44,932	
1L	TC17-8		$ 24,921	$ 24,921
1M	TC17-1		$ 28,719	$ 741,369
	TC17-9		$ 53,846	
	TC17-11		$ 22,764	
		TC17-C	$ 636,040	
1N	TC17-10		$ 73,696	$ 73,696
1O	Manholes		$ 55,000	$ 55,000
Phase 2 (Years 7-12) - $650,000				
2A	TC05-2		$ 29,855	$ 86,293
	TC05-3		$ 56,438	
2B	TC08-2		$ 28,719	$ 28,719
2C	TC10-6		$ 15,250	$ 33,124
	TC10-7		$ 17,874	
2D	TC12-7		$ 390,328	$ 390,328
2E	TC18-5		$ 30,086	$ 30,086
2F	TC18-7		$ 29,022	$ 63,143
	TC18-8		$ 34,121	
Phase 3 (13+ Years) - $50,000				
3A	TC12-10		$ 25,789	$ 25,789
3B	TC17-17		$ 24,028	$ 24,028

*NL=New Line, D=Detention Basin, and C =Detention Chamber
*See Tables 4 – 13 for line recommendation details.
*See Figures 3 -7 for location of recommendations.

Table 4 – TC-1, TC-2, and TC-4 Recommendations and Line Analysis

ID	Exist/ Proposed	Facility Description	Facility Length (ft)	Design Flow (cfs)	Depth/Height/ Diameter (ft)	Cover Depth (ft)	Invert Slope (ft/ft)	Manning's "n" Roughness Coefficient	Total Capacity (cfs)
TC01-1	P	**NL to Replace Railcar to Det.**	111	114	**5.0**	4	0.0075	0.013	**225**
TC01-2	P	**NL to Replace Railcar from Det.**	236	114	**4.0**	4	0.0250	0.013	**227**
TC02-1	E	Residential	1,320	25	2.0		0.0150	0.013	**28**
TC02-2	E	Baseball & Woods	81	45	2.5		0.0350	0.013	**77**
TC02-3	E	Softball & #2	132	57	3.0		0.0300	0.013	**115**
TC02-4	E	Stadium	523	51	1.5		0.0182	0.013	**14**
	P	**Stadium - Upgrade**	523	51	**2.5**	4	0.0182	0.013	**55**
TC04-1	E	Inlet + Stadium Flow	159	69	2.0		0.0050	0.013	**16**
	P	**Inlet + Stadium Flow - Upgrade**	159	69	**3.5**	4	0.0050	0.013	**71**

Table 5 – TC-1, TC-2, and TC-4 Detention Recommendations and Analysis

ID	Exist/ Proposed	Facility Description	Depth/Height/ Diameter (ft)	Detention Basin Volume (ac ft)
TC01-D	P	**Bearkat Detention Basin**	4	6.53
Exist TC02-D	E	Baseball/Softball Complex Detention	4	0.71

Table 6 – TC-5, TC-6, TC-8 and TC-10 Recommendations and Line Analysis

ID	Exist/ Proposed	Facility Description	Facility Length (ft)	Design Flow (cfs)	Depth/Height/ Diameter (ft)	Cover Depth (ft)	Invert Slope (ft/ft)	Manning's "n" Roughness Coefficient	Total Capacity (cfs)
TC05-1	P	**NL from East Parking**	351	19	**2.5**	4	0.0040	0.013	**26**
TC05-2	P	**NL In Between Multi-Use Rec Complex**	301	14	**2.0**	4	0.0040	0.013	**14**
TC05-3	P	**NL from North Parking**	569	19	**2.0**	4	0.0200	0.013	**32**
TC05-4	P	**NL from Underground Detention**	450	51	**3.0**	4	0.0075	0.013	**58**
TC06-1	E	17th & Ave H	30	25	1.3		0.0500	0.013	14
	P	**17th & Ave H -Upgrade**	30	25	**2.0**	4	0.0500	0.013	**51**
TC06-2	E	Parking (4 pipes)	93	22	2.0		0.0015	0.013	**35**
TC06-3	P	**NL1 - Ave H (til 16th)**	529	29	**2.0**	4	0.0340	0.013	**42**
TC08-1	E	Along 16th	227	23	1.5		0.0160	0.013	13
	P	**Along 16th - Upgrade**	227	23	**2.0**	4	0.0160	0.013	**29**
TC08-2	E	Outlet to Creek (S) - Rehab/Cleaning	117	27	2.0		0.0168	0.013	**29**
TC08-3	P	**NL2 - Ave H (16th to 24")**	254	47	**2.5**	4	0.0220	0.013	**61**
TC08-4	P	**NL3 - Ave H (curve)**	292	9	**2.0**	4	0.0040	0.013	**14**
TC08-5	P	**NL4 - Ave H (outlet)**	96	9	**2.0**	4	0.0300	0.013	**39**
TC08-6	E	15" in Poor Condition - Rehab/Cleaning	37	9	1.3		0.0200	0.013	**9**
TC10-1	E	Performing Arts Center	230	17	1.3		0.0200	0.013	**9**
	P	**Performing Arts Center-Upgrade**	230	17	**2.0**	4	0.0200	0.013	**32**
TC10-2	E	Crosses 16th	574	17	1.5		0.0120	0.013	**12**
	P	**Crosses 16th - Upgrade**	574	17	**2.0**	4	0.0120	0.013	**25**
TC10-3	P	**New Line1 - Ave I**	838	34	**2.0**	4	0.0250	0.013	**36**
TC10-4	P	**New Line2 -Ave I**	539	68	**3.5**	4	0.0050	0.013	**71**
TC10-5	E	8" in Poor Condition-Replace	37	9	0.7		0.0260	0.013	**2**
	P	**8" in Poor Condition-Replace**	37	9	**1.5**	4	0.0260	0.013	**17**
TC10-6	P	**New Line - 16th**	205	13	**1.5**	4	0.0220	0.013	**16**
TC10-7	P	**New Line - 15th**	159	17	**2.5**	4	0.0038	0.013	**25**

Table 7 – TC-5, TC-5, TC-8 and TC-10 Detention Recommendations and Analysis

ID	Exist/ Proposed	Facility Description	Depth/Height/ Diameter (ft)	Detention Basin Volume (ac ft)
TC05-C	P	**1-Underground Detention @ Soccer/Tennis Parking**	6.0	0.53
	P	**2-Underground Detention @ Soccer/Tennis Parking**	6.0	
	P	**3-Underground Detention @ Soccer/Tennis Parking**	6.0	
Exist TC06-D	E	Bearkat & Ave H Detention	4	0.36

Table 8 – TC-12 Recommendations and Line Analysis

ID	Exist/ Proposed	Facility Description	Facility Length (ft)	Design Flow (cfs)	Depth/Height/ Diameter (ft)	Cover Depth (ft)	Invert Slope (ft/ft)	Manning's "n" Roughness Coefficient	Total Capacity (cfs)
TC12-3	E	17th & Ave. J	184	62	2.0		0.0303	0.013	39
	P	**17th & Ave. J - Upgrade**	184	62	**2.5**	4	0.0303	0.013	**71**
	P	**17th & Ave. J - Parallel**	184	62	**2.0**	4	0.0303	0.013	**39**
TC12-4	E	Between 16th & 17th	400	111	3.0		0.0400	0.013	**133**
TC12-5	E	Univeristy Ave & 15th	182	148	3.0		0.0500	0.013	**149**
TC12-6	E	8" in Poor Condition-Replace	59	12	0.7		0.0550	0.013	3
	P	**8" in Poor Condition-Replace**	59	12	**1.5**	4	0.0550	0.013	**25**
TC12-7	P	**New Line - Ave J**	1,431	198	**4.5**	4	0.0120	0.013	**215**
TC12-8	P	**New Line - LSC Expansion**	196	25	**2.0**	4	0.0240	0.013	**35**
TC12-9	P	**NL - Replace 54" Across 16th**	689	148	**4.5**	4	0.0090	0.013	**186**
TC12-10	P	**New Line - From Future #2**	260	12	**2.0**	4	0.0050	0.013	**16**

Table 9 – TC-12 Detention Recommendations and Analysis

ID	Exist/ Proposed	Facility Description	Depth/Height/ Diameter (ft)	Detention Basin Volume (ac ft)
Exist TC12-C	E	15th and Ave J Underground Detention	4	0.03
TC12-D	P	West Plant Detention Basin	4	1.38

Table 10 – TC-17 Recommendations and Line Analysis

ID	Exist/ Proposed	Facility Description	Facility Length (ft)	Design Flow (cfs)	Depth/Height/ Diameter (ft)	Cover Depth (ft)	Invert Slope (ft/ft)	Manning's "n" Roughness Coefficient	Total Capacity (cfs)
FEMA TC17-1	P	**FEMA funded Railcar Replacement**	1,206	358	**7.0**	5	0.0040	0.013	**404**
TC17-1	E	Ave I & TC17-C4 - Rehab/Clean	98	31	2.0		0.0300	0.013	**39**
TC17-2	E	Ave I (N) & TC17-C4	532	10	3.0		0.0050	0.013	**47**
TC17-3	E	Parking Lot	126	10	2.0		0.0137	0.013	**26**
TC17-4	E	Railcar1 + TC16	161	256	6.0		0.0123	0.013	470
	P	**Railcar1 + TC16 - Upgrade**	161	256	**5.0**	5	0.0123	0.013	**289**
TC17-5	E	Ave H & Library	284	51	2.0		0.0175	0.013	30
	P	**Ave H & Library - Upgrade**	737	51	**2.5**	4	0.0175	0.013	**54**
TC17-6	E	Railcar2 + Railcar1 + TC16	349	358	6.0		0.0040	0.013	268
	P	**Railcar2+Railcar1+TC16 - Upgrade**	349	358	**7.0**	5	0.0040	0.013	**404**
TC17-7	P	**New Line1 - Bowers & Ave H**	273	10	**1.5**	4	0.0235	0.013	**16**
TC17-8	P	**New Line - Montgomery Rd**	335	5	**1.5**	4	0.0050	0.013	**7**
TC17-9	P	**New Line - S. Ave H**	479	20	**2.5**	4	0.0050	0.013	**29**
TC17-10	P	**New Line -From TC16**	743	17	**2.0**	4	0.0190	0.013	**31**
TC17-11	P	**New Line -Off Ave H**	306	10	**1.5**	4	0.0400	0.013	**21**
TC17-12	P	**New Line -Replace 48"**	775	31	**3.0**	4	0.0050	0.013	**47**
TC17-13	P	**New Line - Bowers Blvd**	1,187	51	**2.5**	4	0.0230	0.013	**62**
TC17-14	P	**New Line - N. Ave H**	453	10	**2.0**	4	0.0050	0.013	**16**
TC17-15	P	**New Line - From Health & Kines.**	22	10	**2.0**	4	0.0096	0.013	**22**
TC17-16	P	**New Line -From TC17 Detention**	412	287	**6.5**	5	0.0040	0.013	**331**
TC17-17	P	**New Line - From Future #1**	323	10	**1.5**	4	0.0136	0.013	**12**

Table 11 – TC-17 Detention Recommendations and Analysis

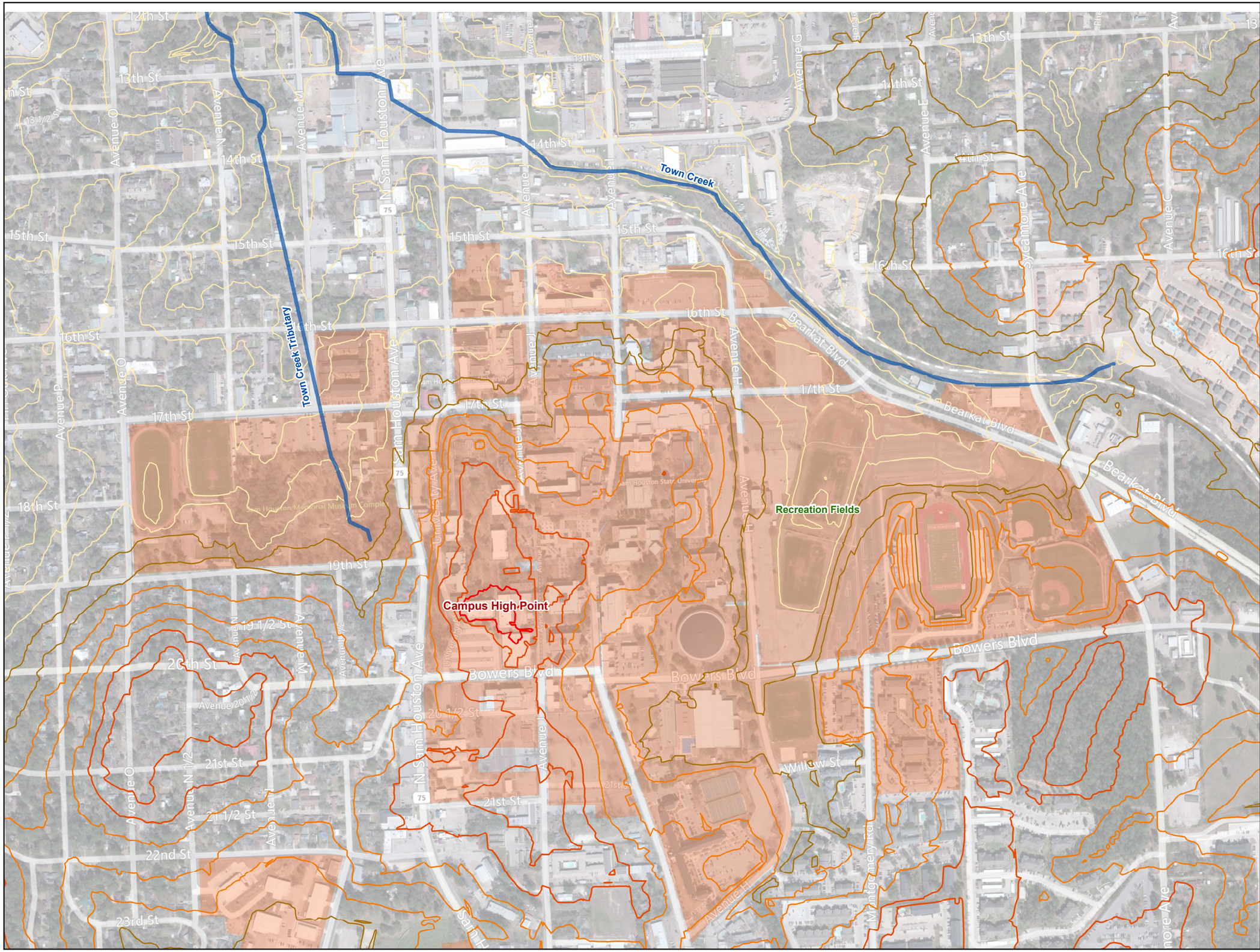
ID	Exist/ Proposed	Facility Description	Depth/Height/ Diameter (ft)	Detention Basin Volume (ac ft)
Exist TC17-C1	E	Bearkat Village Underground Detention	-	1.66
Exist TC17-C2	E	Willow St Underground Detention	4	0.14
Exist TC17-C3	E	15th and Ave J Underground Detention	4	0.11
TC17-C	P	**1-Underground Detention @ Ave I**	6.0	0.88
	P	**2-Underground Detention @ Ave I**	6.0	
	P	**3-Underground Detention @ Ave I**	6.0	
	P	**4-Underground Detention @ Ave I**	6.0	
	P	**5-Underground Detention @ Ave I**	6.0	
TC17-D	P	**Multiuse Field/Detention**	4	6.6
FEMA TC17-D1	P	**Multiuse Field/Detention-Lower Field**	4	18
FEMA TC17-D2	P	**Multiuse Field/Detention-Mid Field**	4	8.8

Table 12 – TC-18 Recommendations and Line Analysis

ID	Exist/ Proposed	Facility Description	Facility Length (ft)	Design Flow (cfs)	Depth/Height/ Diameter (ft)	Cover Depth (ft)	Invert Slope (ft/ft)	Manning's "n" Roughness Coefficient	Total Capacity (cfs)
TC18-1	E	Bowers & Sam Houston	90	24	2.0		0.0300	0.013	**39**
TC18-2	E	From TC-12-1	23	71	3.0		0.0100	0.013	**134**
TC18-3	E	From TC-18-8	56	108	4.5		0.0075	0.013	**170**
TC18-4	E	From 17th (N & M)	168	82	3.0		0.0200	0.013	**94**
TC18-5	E	**Stream Area (by #1) - Rehab/Cleaning**	159	47	7.5		0.0250	0.013	**1,214**
TC18-6	E	Sam Houston Village	44	24	2.0		0.0330	0.013	**41**
TC18-7	E	Assumed 24" on 17th	209	82	2.0		0.0289	0.013	38
	P	**Assumed 24" on 17th - Upgrade**	209	82	**3.0**	4	0.0289	0.013	**113**
TC18-8	E	From TC12 on 17th	344	25	1.5		0.0320	0.013	19
	P	**From TC12 on 17th - Upgrade**	344	25	**2.0**	4	0.0320	0.013	**40**
TC18-9	E	**Pipe by Museum Lake-Rehab/Cleaning**	234	12	2.0		0.0340	0.013	**42**

Table 13 – TC-18 Detention Recommendations and Analysis

ID	Exist/ Proposed	Facility Description	Depth/Height/ Diameter (ft)	Detention Basin Volume (ac ft)
Exist TC18-D	E	Museum Lake	2	1.26



N

0 500 Feet

Legend

Contour Elevation

- < 400'
- 401 - 425'
- 426 - 450'
- 451 - 475'
- > 475'
- SHSU Boundary

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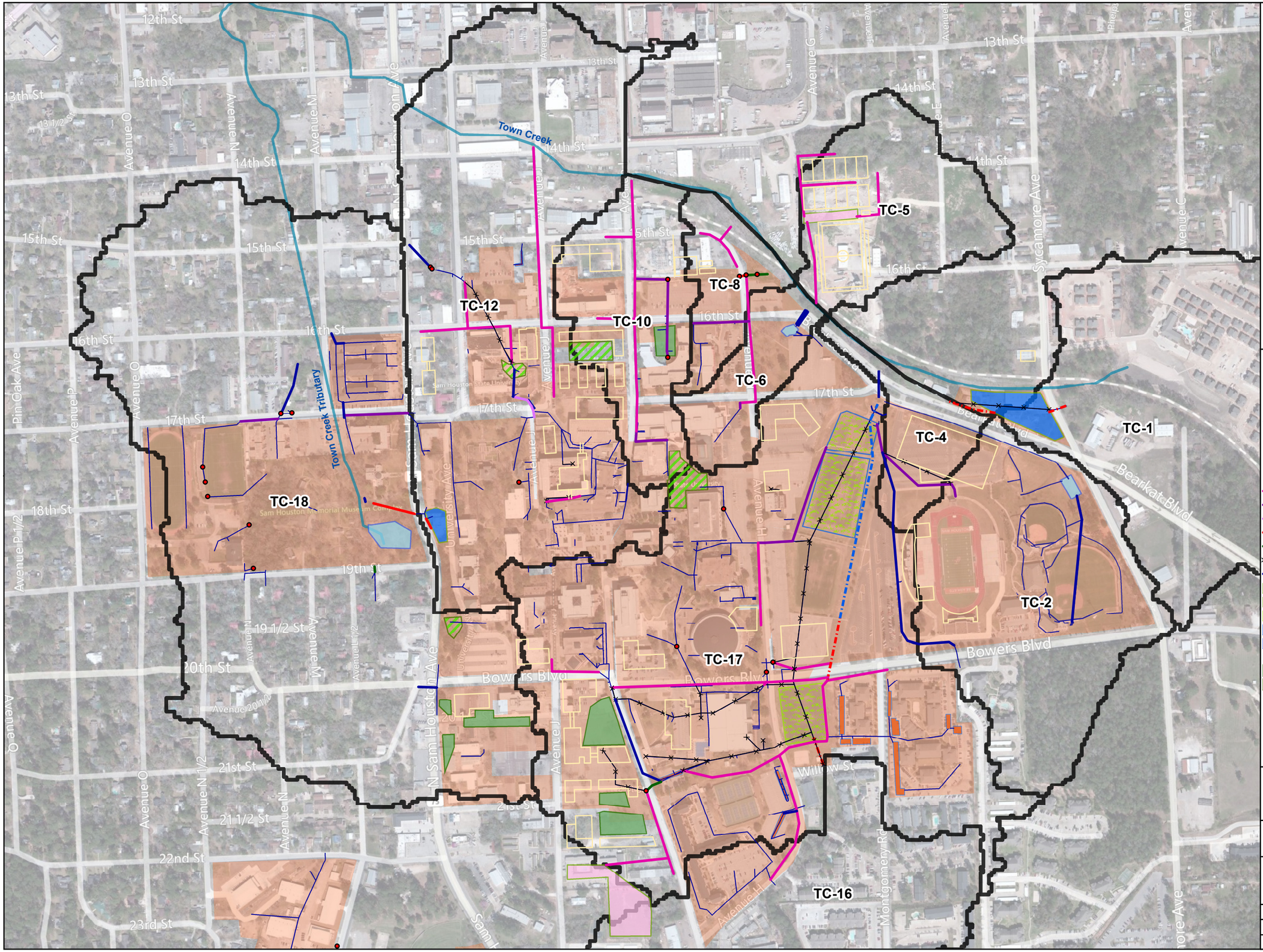
Campus Topography Map

Sam Houston State University
Drainage Master Plan

KLOTZ PROJ. NO.: 1062.001.000	EXHIBIT 1
SCALE: 1 " = 500 '	
DATE: January 2013	



N

0 500 Feet

Legend

- Existing Storm Sewer
- Inlet/Strucutre in Poor Condition

Storm Sewer Line Recommendations

- Railcar Replacement
- FEMA Railcar Replacement
- New Line
- Upgrade
- Parallel Upgrade
- 1st Tier Rehab/Cleaning
- 2nd Tier Rehab/Cleaning
- Abandon/Remove
- Adequate Existing Pipe
- Basin
- Underground Chamber at Parking
- Multiuse Field/Detention
- FEMA Multiuse Field/Detention
- Existing Basin
- Existing Chamber Under Parking
- Rain Garden Detention Area
- Rain Garden Detention Area w/ Channel
- Master Plan New Building
- SHSU Boundary

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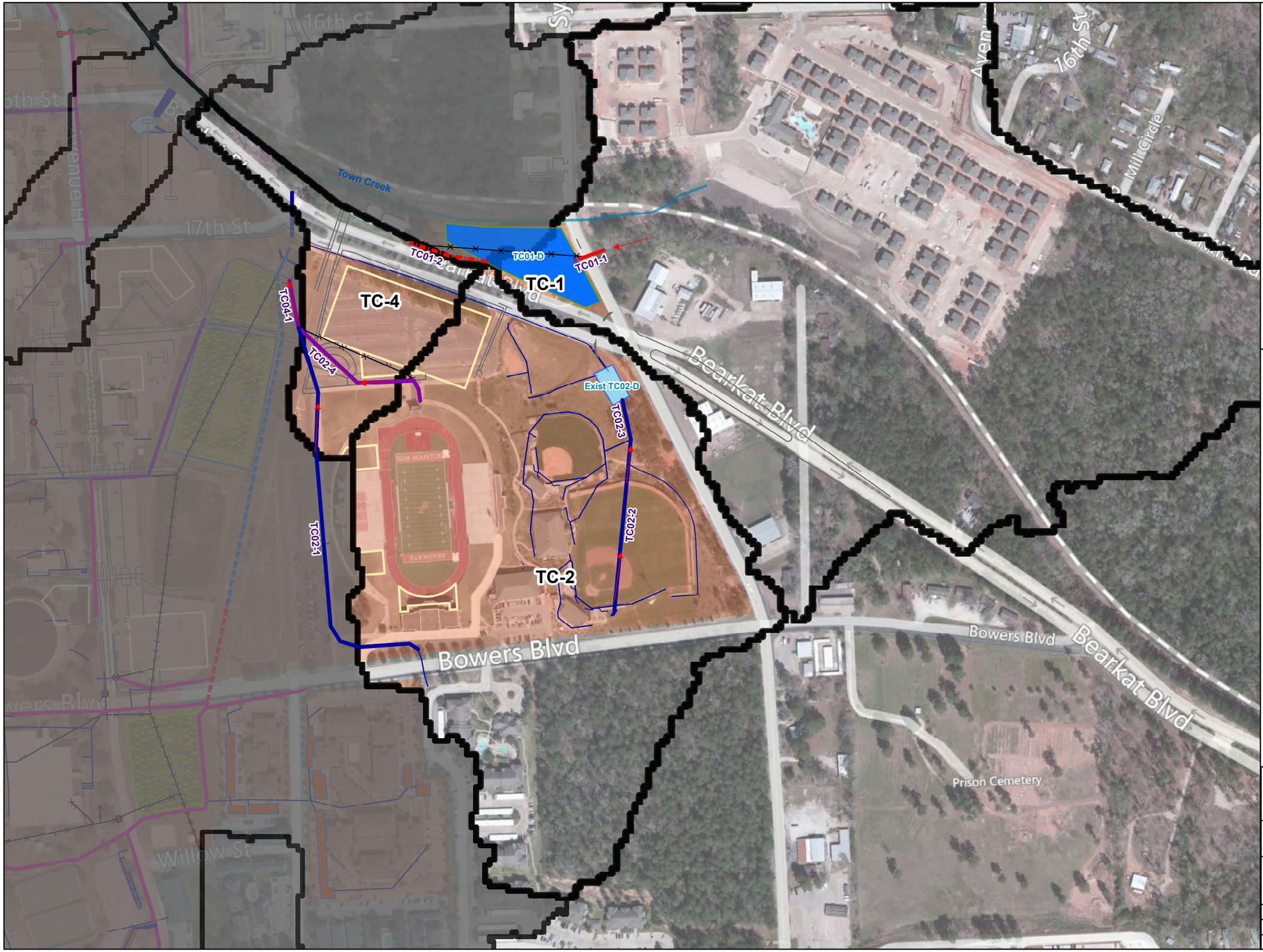
Overall Recommendation Map

Sam Houston State University
Drainage Master Plan

KLOTZ PROJ. NO.: 1062.001.000	EXHIBIT 2
SCALE: 1 " = 500 '	
DATE: January 2013	



N

0 300 Feet

Legend

- Existing Storm Sewer
- Inlet/Strucutre in Poor Condition

Storm Sewer Line Recommendations

- Railcar Replacement
- FEMA Railcar Replacement
- New Line
- Upgrade
- Parallel Upgrade
- 1st Tier Rehab/Cleaning
- 2nd Tier Rehab/Cleaning
- Abandon/Remove
- Adequate Existing Pipe

Detention Areas (acre-ft)

- Basin
- Underground Chamber at Parking
- Multiuse Field/Detention
- FEMA Multiuse Field/Detention
- Existing Basin
- Existing Chamber Under Parking
- Rain Garden Detention Area
- Rain Garden Detention Area with Channel
- Master Plan New Building
- Master Plan New Hardscape
- SHSU Boundary

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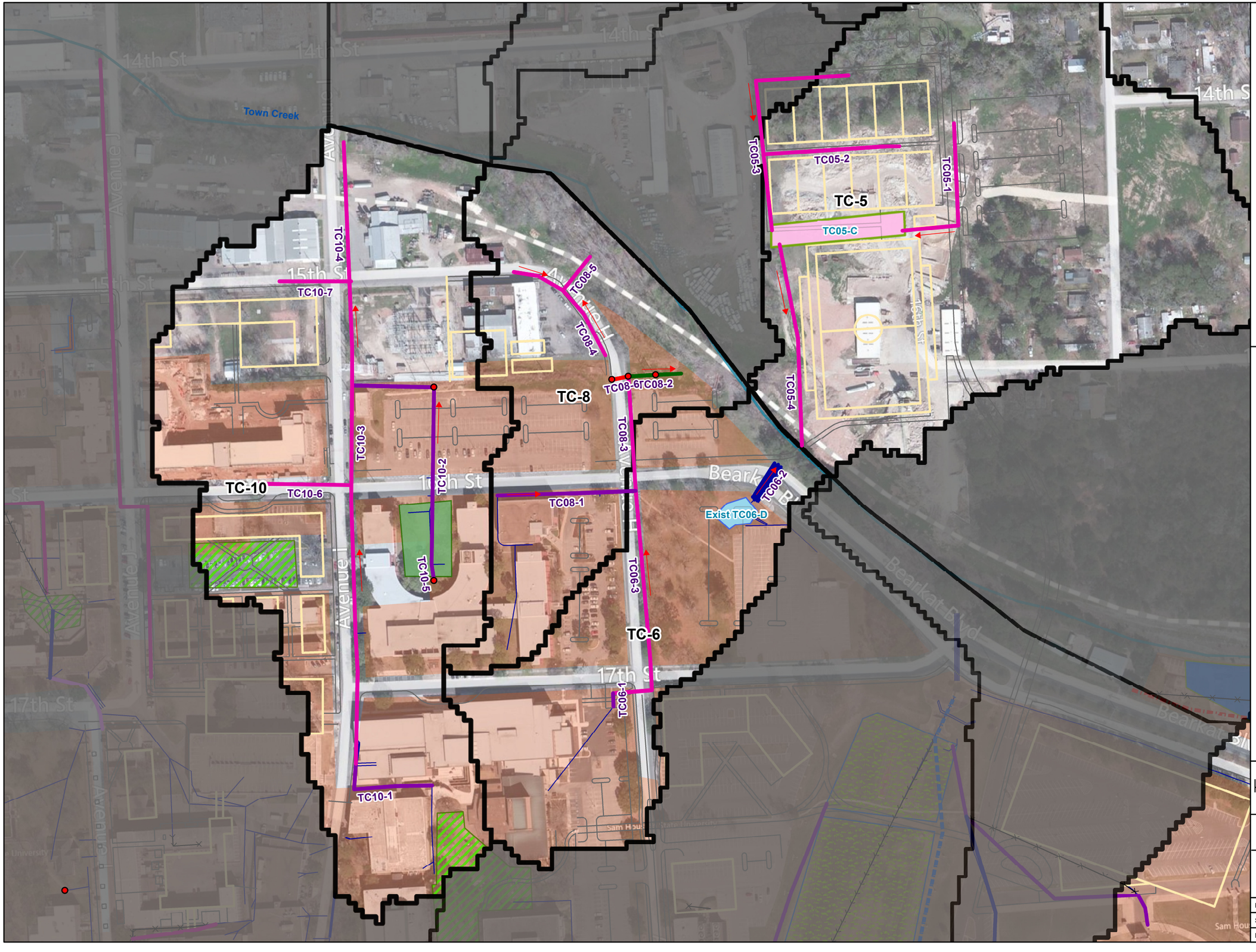
TC-1, TC-2, and TC-4 Drainage Recommendations

Sam Houston State University
Drainage Master Plan

KLOTZ PROJ. NO.: 1062.001.000	EXHIBIT 3
SCALE: 1 " = 300 '	
DATE: January 2013	



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TC-5, TC-6, TC-8 and TC-10 Drainage Recommendations

Sam Houston State University
Drainage Master Plan

KLOTZ PROJ. NO.: 1062.001.000	EXHIBIT 4
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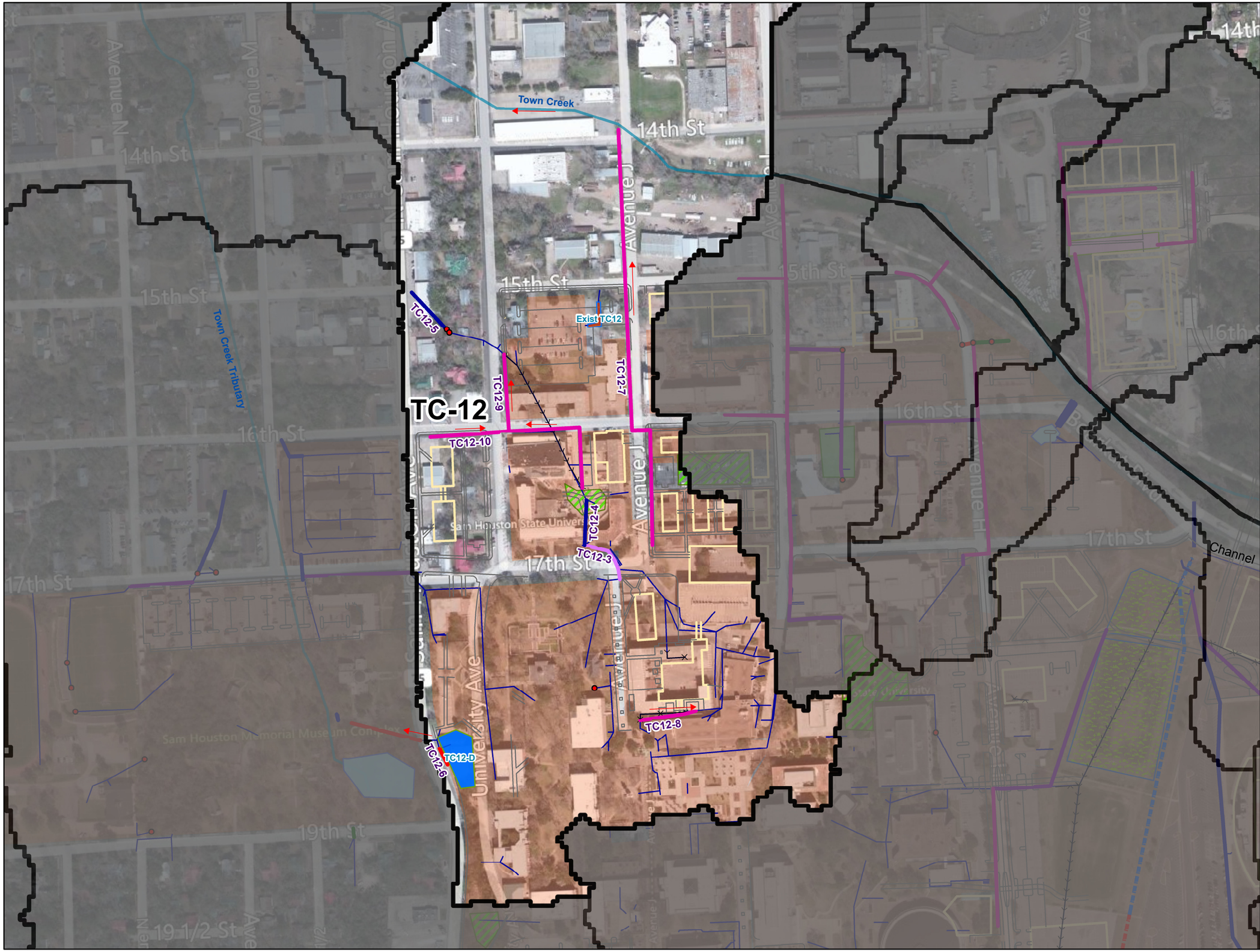
DATE: January 2013	



N

0 300 Feet

Legend

- Existing Storm Sewer (in)
- Inlet/Strucutre in Poor Condition

Storm Sewer Line Recommendations

- Railcar Replacement
- FEMA Railcar Replacement
- New Line
- Upgrade
- Parallel Upgrade
- 1st Tier Rehab/Cleaning
- 2nd Tier Rehab/Cleaning
- Abandon/Remove
- Adequate Existing Pipe

Detention Areas (acre-ft)

- Basin
- Underground Chamber at Parking
- Multiuse Field/Detention
- FEMA Multiuse Field/Detention
- Existing Basin
- Existing Chamber Under Parking
- Rain Garden Detention Area
- Rain Garden Detention Area with Channel
- Master Plan New Building
- Master Plan New Hardscape
- SHSU Boundary

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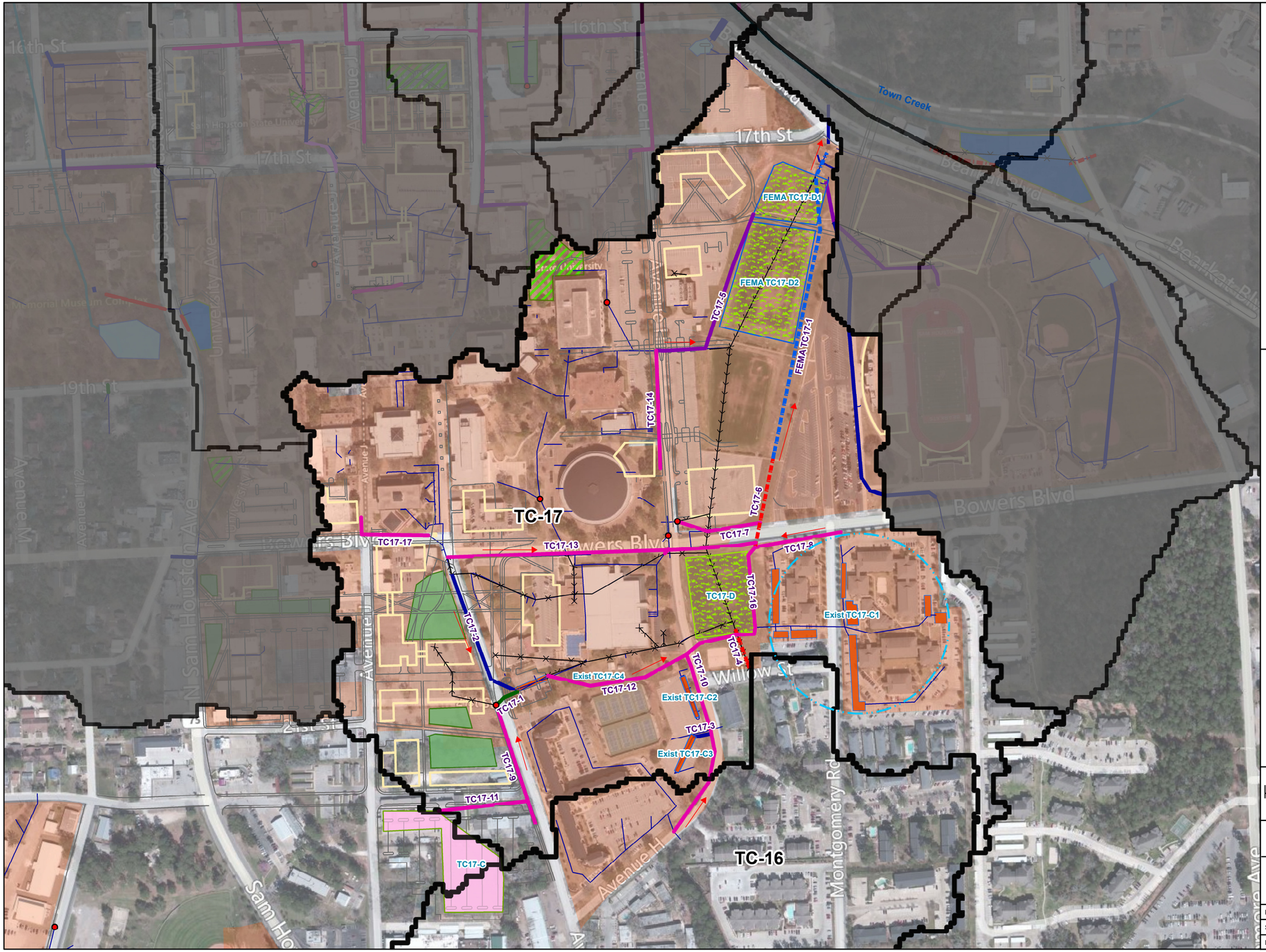
TC-12
Drainage Recommendations

Sam Houston State University
Drainage Master Plan

KLOTZ PROJ. NO.: 1062.001.000	EXHIBIT
SCALE: 1 " = 300 '	5
DATE: January 2013	



N

0 350 Feet

Legend

- Existing Storm Sewer
- Inlet/Strucutre in Poor Condition
- Railcar Replacement
- FEMA Railcar Replacement
- New Line
- Upgrade
- Parallel Upgrade
- 1st Tier Rehab/Cleaning
- 2nd Tier Rehab/Cleaning
- Abandon/Remove
- Adequate Existing Pipe

Detention Areas (acre-ft)

- Basin
- Underground Detention at Parking
- Multiuse Field/Detention
- FEMA Multiuse Field/Detention
- Existing Basin
- Existing Chamber Under Parking
- Rain Garden Detention Area
- Rain Garden Detention Area w/ Channel
- Master Plan New Building
- Master Plan New Hardscape
- SHSU Boundary

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TC-17
Drainage Recommendations

Sam Houston State University
Drainage Master Plan

KLOTZ PROJ. NO.: 1062.001.000	EXHIBIT 6
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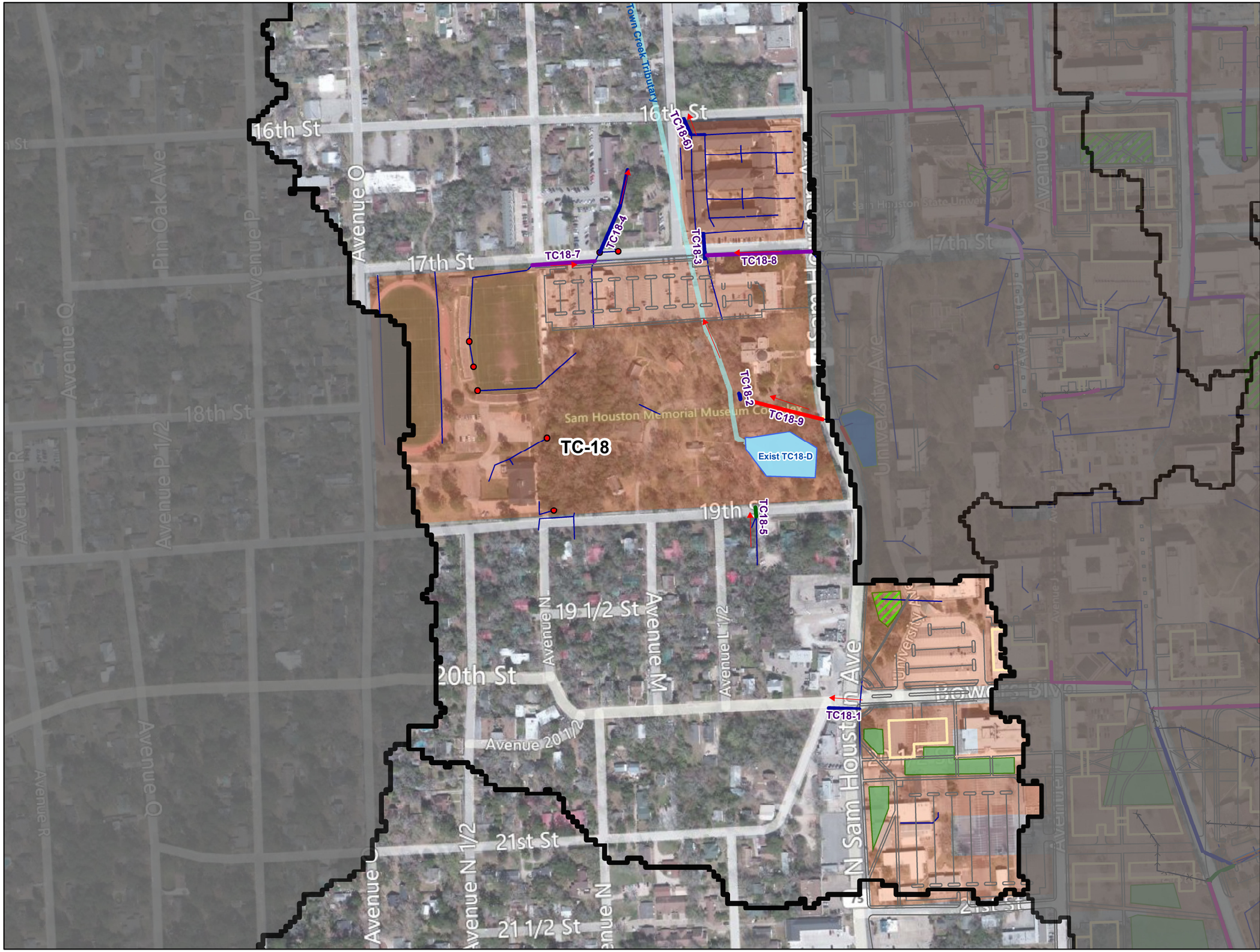
DATE: January 2013	



N

0 300 Feet

Legend

- Existing Storm Sewer (in)
- Inlet/Strucutre in Poor Condition

Storm Sewer Line Recommendations

- Railcar Replacement
- FEMA Railcar Replacement
- New Line
- Upgrade
- Parallel Upgrade
- 1st Tier Rehab/Replacement
- 2nd Tier Rehab/Replacement
- Abandon/Remove
- Adequate Existing Pipe

Detention Areas (acre-ft)

- Basin
- Underground Chamber at Parking
- Multiuse Field/Detention
- FEMA Multiuse Field/Detention
- Existing Basin
- Existing Chamber Under Parking
- Rain Garden Detention Area
- Rain Garden Detention Area with Channel
- Master Plan New Building
- Mater Plan New Hardscape
- SHSU Boundary

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TC-18
Drainage Recommendations

Sam Houston State University
Drainage Master Plan

KLOTZ PROJ. NO.: 1062.001.000	EXHIBIT 7
SCALE: 1 " = 300 '	
DATE: January 2013	

Appendix A – Detailed Cost Estimate

Table A-1 – New Line, Upgrade, and Detention Cost Estimates

ID	Exist/ Proposed	Facility Description	Facility Length (ft)	Depth/ Height/ Diameter (ft)	Volume Excav./Stor. (cu yd)	Excavation Cost ($ x 1,000)	Unit Cost ($/unit)	Unit	Facility Cost ($ x 1,000)	Total Cost w/ Contig. ($)
TC01-1	P	**NL to Replace Railcar to Det.**	111	5.0	555	$0.0	$180	/ lin ft	$20.0	**$106,018**
TC01-2	P	**NL to Replace Railcar from Det.**	236	4.0	979	$0.0	$100	/ lin ft	$23.6	**$107,136**
TC01-D	P	**Bearkat Detention Basin**		4	10,535	$68.3				**$122,668**
TC02-4	P	**Stadium - Upgrade**	523	2.5	1,574	$0.0	$68	/ lin ft	$35.6	**$119,615**
TC04-1	P	**Inlet + Stadium Flow - Upgrade**	159	3.5	596	$0.0	$95	/ lin ft	$15.1	**$24,970**
TC05-1	P	**NL from East Parking**	351	2.5	1,056	$0.0	$68	/ lin ft	$23.9	**$39,457**
TC05-2	P	**NL In Between Multi-Use Rec Complex**	301	2.0	803	$0.0	$60	/ lin ft	$18.1	**$29,855**
TC05-3	P	**NL from North Parking**	569	2.0	1,517	$0.0	$60	/ lin ft	$34.1	**$56,438**
TC05-4	P	**NL from Underground Detention**	450	3.0	1,517	$0.0	$84	/ lin ft	$37.8	**$62,488**
TC05-C	P	**1-Underground Detention @ Soccer/Tennis Parking**	270	6.0	1,760	$0.0	$285	/ lin ft	$77.0	**$127,208**
	P	**2-Underground Detention @ Soccer/Tennis Parking**	270	6.0	1,760	$0.0	$285	/ lin ft	$77.0	**$127,208**
	P	**3-Underground Detention @ Soccer/Tennis Parking**	270	6.0	1,760	$0.0	$285	/ lin ft	$77.0	**$127,208**
TC06-1	P	**17th & Ave H -Upgrade**	30	2.0	80	$0.0	$60	/ lin ft	$1.8	**$2,976**
TC06-3	P	**NL1 - Ave H (til 16th)**	529	2.0	1,411	$0.0	$60	/ lin ft	$31.7	**$52,470**
TC08-1	P	**Along 16th - Upgrade**	227	2.0	605	$0.0	$60	/ lin ft	$13.6	**$22,516**
TC08-3	P	**NL2 - Ave H (16th to 24")**	254	2.5	764	$0.0	$68	/ lin ft	$17.3	**$28,553**
TC08-4	P	**NL3 - Ave H (curve)**	292	2.0	779	$0.0	$60	/ lin ft	$17.5	**$28,963**
TC08-5	P	**NL4 - Ave H (outlet)**	96	2.0	256	$0.0	$60	/ lin ft	$5.8	**$9,522**
TC10-1	P	**Performing Arts Center-Upgrade**	230	2.0	613	$0.0	$60	/ lin ft	$13.8	**$22,813**
TC10-2	P	**Crosses 16th - Upgrade**	574	2.0	1,531	$0.0	$60	/ lin ft	$34.4	**$56,934**
TC10-3	P	**New Line1 - Ave I**	838	2.0	2,235	$0.0	$60	/ lin ft	$50.3	**$83,119**
TC10-4	P	**New Line2 -Ave I**	539	3.5	2,021	$0.0	$95	/ lin ft	$51.2	**$84,648**
TC10-5	P	**8" in Poor Condition-Replace**	37	1.5	87	$0.0	$45	/ lin ft	$1.7	**$2,752**
TC10-6	P	**New Line - 16th**	205	1.5	480	$0.0	$45	/ lin ft	$9.2	**$15,250**
TC10-7	P	**New Line - 15th**	159	2.5	478	$0.0	$68	/ lin ft	$10.8	**$17,874**
TC12-3	P	**17th & Ave. J - Parallel**	184	2.0	491	$0.0	$60	/ lin ft	$11.0	**$18,251**
TC12-6	P	**8" in Poor Condition-Replace**	59	1.5	138	$0.0	$45	/ lin ft	$2.7	**$4,389**
TC12-7	P	**New Line - Ave J**	1,431	4.5	6,532	$0.0	$165	/ lin ft	$236.1	**$390,328**
TC12-8	P	**New Line - LSC Expansion**	196	2.0	523	$0.0	$60	/ lin ft	$11.8	**$19,441**
TC12-9	P	**NL - Replace 54" Across 16th**	689	4.5	3,145	$0.0	$165	/ lin ft	$113.7	**$187,936**
TC12-10	P	**New Line - From Future #2**	260	2.0	693	$0.0	$60	/ lin ft	$15.6	**$25,789**
TC12-D	P	**West Plant Detention Basin**		4	2,226	$14.4				**$25,924**
TC17-4	P	**Railcar1 + TC16 - Upgrade**	161	5.0	894	$0.0	$180	/ lin ft	$29.0	**$47,908**
TC17-5	P	**Ave H & Library - Upgrade**	737	2.5	2,218	$0.0	$68	/ lin ft	$50.1	**$82,848**
TC17-6	P	**Railcar2+Railcar1+TC16 - Upgrade**	349	7.0	2,637	$0.0	$300	/ lin ft	$104.7	**$173,082**
TC17-7	P	**New Line1 - Bowers & Ave H**	273	1.5	640	$0.0	$45	/ lin ft	$12.3	**$20,309**
TC17-8	P	**New Line - Montgomery Rd**	335	1.5	785	$0.0	$45	/ lin ft	$15.1	**$24,921**
TC17-9	P	**New Line - S. Ave H**	479	2.5	1,441	$0.0	$68	/ lin ft	$32.6	**$53,846**
TC17-10	P	**New Line -From TC16**	743	2.0	1,981	$0.0	$60	/ lin ft	$44.6	**$73,696**
TC17-11	P	**New Line -Off Ave H**	306	1.5	717	$0.0	$45	/ lin ft	$13.8	**$22,764**
TC17-12	P	**New Line -Replace 48"**	775	3.0	2,612	$0.0	$84	/ lin ft	$65.1	**$107,618**
TC17-13	P	**New Line - Bowers Blvd**	1,187	2.5	3,572	$0.0	$68	/ lin ft	$80.7	**$133,434**
TC17-14	P	**New Line - N. Ave H**	453	2.0	1,208	$0.0	$60	/ lin ft	$27.2	**$44,932**
TC17-15	P	**New Line - From Health & Kines.**	22	2.0	59	$0.0	$60	/ lin ft	$1.3	**$2,182**
TC17-16	P	**New Line -From TC17 Detention**	412	6.5	2,895	$0.0	$275	/ lin ft	$113.3	**$187,299**
TC17-17	P	**New Line - From Future #1**	323	1.5	757	$0.0	$45	/ lin ft	$14.5	**$24,028**
TC17-C	P	**1-Underground Detention @ Ave I**	210	6.0	1,369	$0.0	$285	/ lin ft	$59.9	**$98,940**
	P	**2-Underground Detention @ Ave I**	285	6.0	1,858	$0.0	$285	/ lin ft	$81.2	**$134,275**
	P	**3-Underground Detention @ Ave I**	285	6.0	1,858	$0.0	$285	/ lin ft	$81.2	**$134,275**
	P	**4-Underground Detention @ Ave I**	285	6.0	1,858	$0.0	$285	/ lin ft	$81.2	**$134,275**
	P	**5-Underground Detention @ Ave I**	285	6.0	1,858	$0.0	$285	/ lin ft	$81.2	**$134,275**
TC17-D	P	**Multiuse Field/Detention**		4	10,648	$69.0				**$123,983**
TC18-7	P	**Assumed 24" on 17th - Upgrade**	209	3.0	704	$0.0	$84	/ lin ft	$17.6	**$29,022**
TC18-8	P	**From TC12 on 17th - Upgrade**	344	2.0	917	$0.0	$60	/ lin ft	$20.6	**$34,121**

Table A-2 – Rehabilitation Cost Estimates

ID	Description	Diameter	Length	Depth	Number of Manholes	Unit Price Cost Schedule			Manhole Unit Cost	Facility Cost	Construction Cost	Capital Cost
		(in)	(ft)	(ft)		R/R	C.I.P.	SLIP	($)	($)	($)	($)
TC08-2	Outlet to Creek (S) - Rehab/Clean	24	117	4	2	0	130	125	2,500	12,168	17,168	**24,173**
TC08-6	15" in Poor Condition-Rehab/Clean	15	37	4	2	97	97	70	2,500	3,589	8,589	**12,093**
TC17-1	Ave I & TC17-C4 - Rehab/Clean	24	98	4	3	0	130	132	2,500	10,192	17,692	**24,910**
TC18-5	Stream Area (by #1) - Rehab/Clean	91.4	30	6	2	0	460	192	4,000	11,040	19,040	**26,808**
TC18-9	Pipe by Museum Lake-Rehab/Clean	24	234	4	2	0	130	125	2,500	24,336	29,336	**41,305**
Manholes	Manhole Rehabilitation				22	-			2,500	-	-	**55,000**