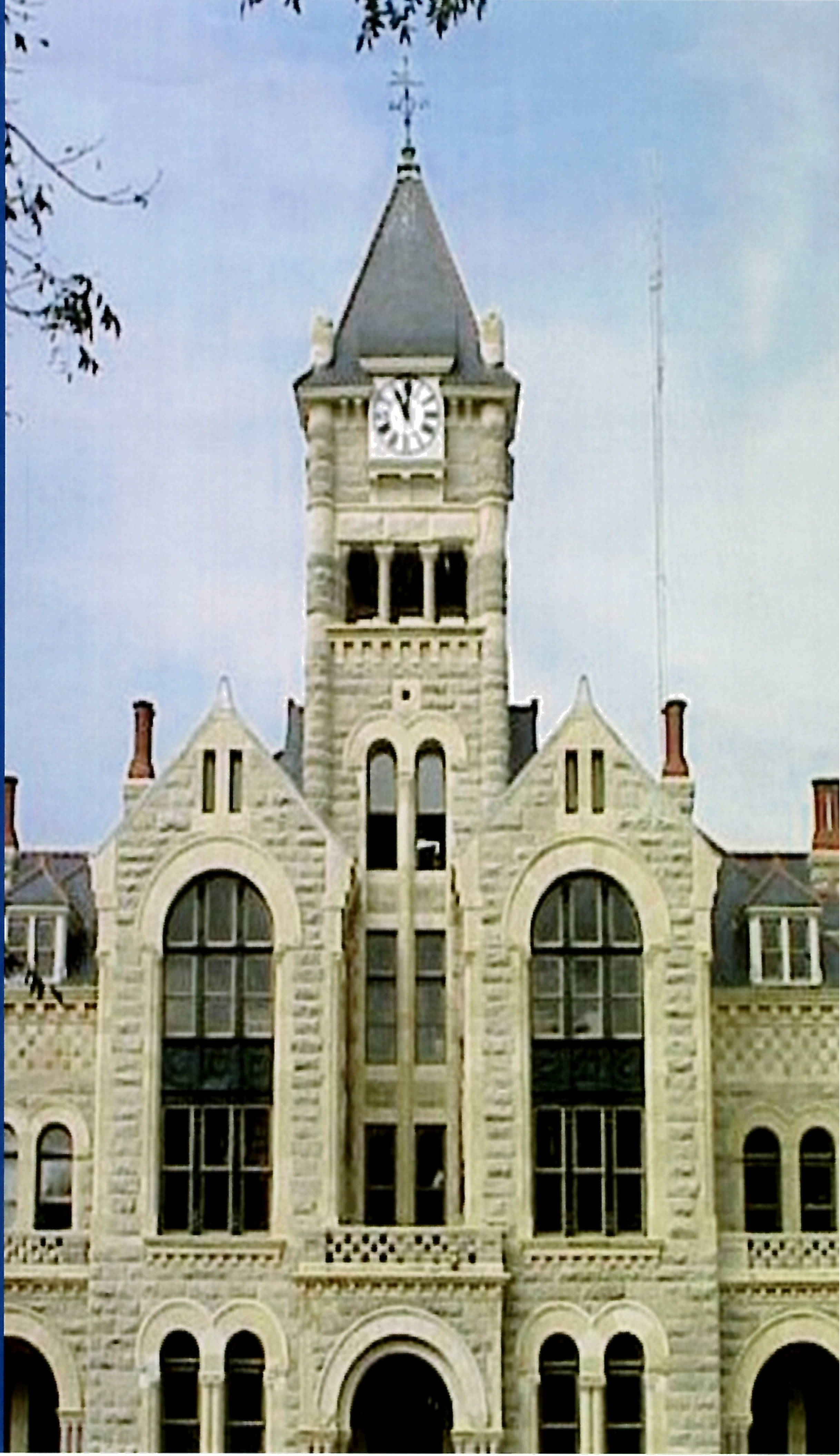
City of Victoria Storm Drainage Master Plan

Prepared for

City of Victoria

Prepared by

PBS&J



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CITY OF VICTORIA
STORM DRAINAGE MASTER PLAN

Prepared for:

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Public Works Department

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CITY OF VICTORIA
STORM DRAINAGE MASTER PLAN

EXECUTIVE SUMMARY

INTRODUCTION

This Executive Summary includes a brief discussion about the numerous work tasks that were performed in developing the City of Victoria's Storm Drainage Master Plan (SDMP or Plan) covering the Study Area as shown in Figure ES-1. The goal of the SDMP was to provide the City of Victoria with new management tools (floodplain ordinance, design criteria and GIS-based hydrologic and hydraulic models) as well as proposed structural and nonstructural control measures to address existing and future drainage problems. The SDMP report reviews the development of the overall Plan which includes establishment of regulatory authority and analysis procedures, study area reconnaissance, concept planning, solution development, prioritization, operation and maintenance planning, financing and implementation planning/scheduling. In developing the Plan a multi-objective drainage management philosophy was used that includes flood loss reduction, stormwater management, erosion/sedimentation reduction, wetland protection, wildlife and aquatic habitat enhancement, water supply and water quality enhancement, recreation and cultural resources protection. The SDMP is a dynamic and flexible tool to allow for future growth considerations and is geospatially oriented. The main report is presented under four main headings including: Project Team, City-wide Analyses, Watershed Studies, concluding with Plan Development and Reporting

1 PROJECT TEAM

Development of the Storm Drainage Master Plan (SDMP) for the City of Victoria was a broad based effort that involved input and ideas of many entities from many skilled professional personnel, highly qualified in performing a variety of traditional stormwater management projects addressing flood loss reduction, erosion/sedimentation reduction, wetland protection, wildlife and aquatic habitat enhancement, cultural resource protection, water supply enhancement, water quality, and recreation. The Project Team included:

- PBS&J, Austin and Houston
- Urban Engineering, Victoria
- Associated Engineers and Surveyors, Victoria
- Urban Surveying, Victoria
- Rimrock Consulting Company, Austin

2 CITY-WIDE ANALYSES

This effort included establishment of standardized procedures and computational methods, maintenance planning and evaluation of financial resources strategies. This analysis effort encompassed the entire SDMP study area. The Study Area consists of all areas that are within the City limits or within the City's Extraterritorial Jurisdiction (ETJ) and are in one of the following watersheds: Lone Tree Creek, Spring Creek, Jim Branch Outfall, Whispering Creek, North Outfall, West Outfall and Marcado Creek. The Guadalupe River was excluded from the study (and the Study Area). Specific work elements included:

2.A STANDARDIZED PROCEDURES AND COMPUTATIONAL METHODS

2.A.1 Ordinance, Policy and Procedures Review and Update - The City's Flood Damage Prevention Ordinance (Ordinance), which has not been updated since 1987, will require several updates to address the final decisions regarding the drainage impact policy and to tie it in with the SDMP and Drainage Criteria Manual (DCM). Final decisions regarding the drainage impact policy are being considered and the revised Ordinance will completed after the policies are finalized. The Ordinance will reference the DCM and will be the legal vehicle whereby the DCM design methods are adopted.

In coordination with City Council work sessions, several policy decisions associated with the Ordinance and DCM were adopted (number 98-47R) on April 7, 1998. The major policy resolutions will ultimately be included in either the DCM or the Ordinance. The major policy issues included the following topics:

- **POLICY ISSUE #1.“Future” Land Use Densities**
- **POLICY ISSUE #2.The Use of Regional Detention**
- **POLICY ISSUE #3.Interim Phasing Due to Phased Conveyance Improvements**
- **POLICY ISSUE #4.“Retrofit” Design Allowances to Allow Infill Development**
- **POLICY ISSUE #5.Criteria for Stormwater Ponding in the Streets**
- **POLICY ISSUE #6.Floodplain Encroachment and Finished Floor Elevations**

Following the public discussions of these major policy items and the direction of the City Council, each “issue” was incorporated into the SDMP. The adoption of a Roadside Ditch Maintenance Policy was also considered, but is not included in the final SDMP.

2.A.2 Drainage Design Manual (Drainage Criteria Manual) - The Drainage Criteria Manual (DCM) establishes the SDMP. The purpose of this DCM is to establish the storm drainage design criteria and procedures for development and capital improvements within the City of Victoria, Texas, and it’s Extraterritorial Jurisdiction (ETJ). The DCM was developed through a process that included discussion with local Developers, Builders, and Consultants, the City Staff and the City Council.

2.A.3 Hydrologic and Hydraulic Modeling Software and Hardware Systems - One of the desires for the SDMP was that it would be able to evolve and adapt to changes over time. In order to facilitate this capability, the project team analyzed and selected certain GIS-compatible hardware and software to be used in the development of the SDMP. The Hardware solution consisted of a dual processor, NT Workstation with CD read/write capability and a digitizing table. The software selected either works directly with ESRI ArcInfo and ArcView GIS formats or can readily ingest them. The ESRI GIS packages ArcInfo (PC ArcInfo 7.0) and ArcView (3.0a) were in use by the City staff and were selected as GIS engines for the SDMP.

2.A.4 Analysis Plan - The Analysis Plan developed for the project provided a complete outline of the process to be used and included the step-by-step work tasks associated with hydrologic/hydraulic modeling as well as environmental and recreational considerations.

2.B MAINTENANCE PLANNING - A major goal of the SDMP was to provide a well organized maintenance plan to support the existing and future drainage systems within the City. Key components of this plan included:

- A GIS-based database of the current drainage system.
- Estimates of potential drainage maintenance costs based on the experience of similar municipalities.
- Recommendations for purchase and use of a vacuum truck for drainage maintenance.
- Recommendations for and environmentally safe herbicide program.

2.C FINANCIAL RESOURCES STRATEGIES - The ability to finance needed drainage/flood control improvements as well as provide for operation and maintenance funds is a critical element for successful implementation of the SDMP. The viability of various funding alternatives was investigated as part of the overall effort. The key components of the evaluations are listed below:

- Information was collected from state agencies regarding existing regulatory funding authorizations and other information from other sources.
- A variety of local, state and federal funding options were identified and described.
- A matrix describing the pros and cons of various funding alternatives was developed.
- A set of evaluation criteria was developed to aid the City in the final selection of funding alternatives.
- City Council briefing on Financial Strategies Report in June 1998.

3 WATERSHED STUDIES

The watershed studies at the core of the SDMP incorporated several key elements: the identification of problem areas, the gathering of pertinent data for the areas identified, the hydrologic/hydraulic analysis of the areas, the screening and evaluation of stormwater structural and non-structural control measures and the selection of recommended control measures (or a combination therefrom) for the individual problem areas and watersheds. The study limits for the project encompasses the City's 100-square mile drainage area that includes the watershed areas contributing flow to the numerous creeks and tributaries that traverse the City. The major watersheds include Lone Tree Creek, Spring Creek, Whispering Creek, North Outfall, Jim Branch Outfall, West Outfall, Marcado Creek and their tributaries (US Highway 77 Outfall, Mockingbird Outfall, South Outfall, and Second Street). Key work tasks included:

3.A SPECIAL PROBLEM IDENTIFICATION - Specific areas throughout the Study Area that have historically experienced flooding and drainage problems were identified and classified. Knowledge of these problem areas was obtained from City Staff, Design Team members and from Public input. The effort to identify these special problem areas included reviewing City files, CIP project lists, citizen drainage complaints on file, as well as holding neighborhood meetings to obtain additional problem area locations. The results of these efforts indicated a number of existing problem areas and were used in the prioritization of the proposed SDMP improvements.

3.B DATA COLLECTION/SURVEYING - An extensive data collection effort was made by both the City Planning and Engineering Departments and by the PBS&J Team in advance of and during the SDMP project. The collected data sets, after incorporation in to the GIS, were used in all aspects of the SDMP study. The base component of the collected data was the aerial photography, mapping (topography and planimetrics) and control points developed by LanData (previously United Aerial Mapping - UAM) in ArcInfo coverage and MicroStation format. The detail of contour information within City limits was 1-foot (ft) interval and to a 2-ft interval in the ETJ. Other basic data that was gathered for use in the SDMP included storm drainage infrastructure maps, soil survey mapping, land use (including parcels) maps, FEMA study files, City's Parks Master Plan, Thoroughfare Master Plan and Demographic Study, CIP street and drainage improvements, plats, subdivision plans, right-of-ways (ROWs), easements, and homeowners agreements. In addition to this physical data, there was also an assessment of the general cultural resources and physical feature (environmental) constraints throughout the Study Area.

3.C DATA BASE/MAPS - Databases and maps for the SDMP were primarily created in ArcInfo coverage, shape or MircoSoft Access format. The primary base layer was the aerial topographic and planimetric data generated by LanData. The largest data creation efforts for the SDMP focused on the creation of spatially layers and supporting databases for the existing storm drainage system and the collected drainage complaint information.

3.D BASE HYDROLOGY/HYDRAULICS - The core of any SDMP is the evaluation and modeling of the base hydrologic and hydraulic conditions of the drainage system. In consultation with City staff, the Team selected appropriate hydrologic and hydraulic software and computational methods for this modeling. Models were created to represent three development scenarios included in the SDMP analysis. Separate sets of hydrologic and hydraulic models were generated for the following three conditions:

- Present land use and Present drainage infrastructure conditions ("present/present" condition).
- Future land use and Present drainage infrastructure conditions ("future/present" condition).
- Future land use and Future drainage infrastructure conditions ("future/future" condition).

3.D.1 "Present Condition" and "Future Condition" Hydrologic Models - The base *present condition* hydrologic modeling generally depicts 1997 physiographic watershed conditions for the approximate 100 square miles studied. The generated present condition SDMP flows are generally comparable to the existing FEMA flows.

The base *future condition* hydrologic models represent the scenario of full build-out in a watershed without any improvement to the existing drainage system. The future condition level of development was based on the policy developed by PBS&J and City staff and adopted by the City Council. Existing undeveloped and agricultural land areas within the City's ETJ (to a distance of one half mile beyond the ETJ in the Spring Creek watershed) were considered to be developed to a representative density of 4 units per acre (approximately 43% impervious). Loop 463 and other major arterials identified by the Thoroughfare Master Plan were considered to have commercial development (85% impervious) for 200 feet on either side of the roadway centerline.

3.D.2 "Present Condition" and "Future Condition" Hydraulic Models - Base "Present Condition" hydraulic models were developed for both the open channel system (43 miles) and the closed systems (57 miles) within the study areas. These models were built from a combination of the new aerial topographic data, structure information from the effective FEMA models, survey and field reconnaissance. The 5-, 10-, 25-, 50-, 100-, and 500-year flood water surface profiles were developed per the adopted policy and FEMA requirements. Another goal was to determine the 100-year floodplains (present conditions) for the major streams.

The base "Future Condition" is equivalent to the Future/Present condition described earlier. This is essentially the "do nothing" alternative for improvements to the present drainage (hydraulic) system. These models simply routed the future condition flows developed in the HEC-1 models through the present or existing drainage systems. The impacts of these increased flows were evaluated to help determine the level of improvements needed for the drainage systems.

3.D.3 Peak Discharges and Capacities of Small Drainageways - The Design Team also considered individual subbasin hydrology. A plot subbasin runoff for three storm events (5-year, 25-year, and 100-year) was prepared for the Future/Future land use conditions. Best fit curves were then fit to this discharge information in order to provide a set of simple equations that can be used as a guideline to predict flows for developed areas of less than approximately 1000 acres. This figure is included in the DCM as a design tool for the estimation of peak runoff from future subbasins.

3.E PROBLEM LOCATIONS/NEEDS - The hydrologic and hydraulic modeling results were used in conjunction with the historical drainage issue information to identify problem locations throughout the SDMP study area and to identify the principal causes and resultant needs. The Design Team examined the capacity of the existing drainage system relative to the existing peak flows and identified reaches with undersized capacity.

4. PLAN DEVELOPMENT AND REPORTING

A plan of improvements was developed to address the needs identified within each watershed. The City's multi-objective philosophy, including the expressed concern of the Federal and State permitting agencies, was thoroughly considered in development of the watershed-specific improvement plans. The Design Team worked closely with the City Staff to consider all input obtained and to select the final alternative plans for the various problem areas within each watershed. The institutional, administrative, engineering, funding requirements and other aspects of each watershed's selected plan of action are presented in this Section.

4.A STRUCTURAL AND NON-STRUCTURAL CONTROL MEASURES - Specific nonstructural (typically ordinances and criteria) and/or structural (typically detention facilities, channel modifications, bridge/culvert enlargements, etc.) control measures were developed to address the identified problem areas within each watershed. The measures that best solve the individual problems while providing a pattern of continuity and consistency from reach to reach and throughout the watershed were stressed. Multi-objective solutions received consideration when selecting plans of improvement.

4.A.1 Structural Control Measures - Four major types of structural solutions were identified in the final SDMP recommendations. The following summarizes these solutions types and the locations within the study area.

- Regional Detention Basins:
  - Lone Tree Facility - located just upstream of Business 59.
  - The Spring Creek Facility - located on the main stem of Spring Creek in the vicinity of Parson and Oliver Roads.
- Channel Improvements:
  - A "benched channel" approach was used in the sizing of conceptual channel improvements for Whispering Creek, North Outfall, US 77 Outfall, West Outfall, Ben Jordan Outfall, South Outfall, Jim Branch Outfall Lone Tree Creek and Marcado Creek, in part, to address the requests of the Federal and State review agencies. .
- Closed System Improvements – The closed systems (pipes and box culverts), which are tributaries to either the major open channels or the Guadalupe River, were typically found to be sized for a 2- to 5-year storm event with SWMP improvements sized for the 10- to 25-year storm level depending on the area served.
- Pump Station and Bypass System (Second Street Outfall) – Alternative solutions (a closed bypass system versus a small detention area with a stormwater pump) were required in order to address the identified drainage issues in the Second Street Outfall watershed (homes along Second Street near the eastern levee of the Guadalupe River and north of the high railroad embankment across from the Central Power and Light plant).

4.A.2 Structural Solutions - Cost Estimates and Hydrologic Priorities - Watershed specific conceptual level cost information was developed for each of the potential improvements identified as part of the SDMP. The overall multiyear total construction cost is estimated to be around $170 million (1999 dollars) for all the projects throughout the Study Area. Cost for the acquisition of right-of-way or project design fees would need to be added to the totals presented in the SDMP.

4.A.3 Structural Solutions - Project Priorities - One of the more critical features of the SDMP was the prioritization of individual projects. Adverse downstream impacts due to the construction of an individual project must be avoided or at least minimized to the greatest degree possible. "Drainage Improvement Priority Maps" were developed for the entire SDMP study area (see Figure ES-1.

4.A.4 Implementation Planning for Structural Solutions - Development of the implementation strategy for the SDMP involved the combination of results from the institutional, administrative, engineering, environmental and funding work efforts together. The authority (ordinances), methods/procedures (policy and drainage design manual), prioritized improvement plans and funding capabilities act together to produce an achievable program of actions and improvements.

- The prioritized set of proposed improvements provides the City with an organized but flexible guide for the order of drainage improvements within each watershed. The Citywide implementation of improvements will ultimately reflect the input received from the public, road construction improvements by the Texas Department of Transportation, short range and long range growth patterns, funding availability, coordination with Drainage District #3, and many other factors.
- It is recommended that the City create a "three year plan" which would be updated annually and specify the particular projects that are being considered for funding. This would allow for alterations and modifications as the conditions in the City continue to change. This also would allow the City to fund some "preliminary" design work for specific projects which would then in turn allow the City to begin to target the right-of-way requirement well ahead of construction.
- One major item that needs to be addressed very early in the implementation of the SDMP improvements is the issue of permitting requirements from the various State and Federal Agencies. The coordination of the Clean Water Act Section 404 permitting through the U.S. Army Corps of Engineers (COE) is critical to most of the projects.

Table ES-1
Summary of Estimated Construction Costs by Watershed

	Open Channel / Bridge		Closed System		Detention / Other	
	Length (FT)	Cost	Length (FT)	Cost	Volume (CY)	Cost
Jim Branch Outfall	19,003	$6,421,000	32,496	$18,337,000		
South Outfall	7,735	$1,514,000	18,307	$7,920,000		
Second Street Outfall			24,572	$9,985,000		
Diversion Option (655 FT)						$216,000
Pump Option						$423,000
West Outfall	11,205	$6,960,000	50,010	$25,412,000		
Spring Creek	578	$635,000	12,275	$7,229,000	3,113,000	$16,752,000
Mockingbird Outfall	7,214	$3,365,000				
Whispering Creek	13,034	$1,608,000	24,122	$8,451,000		
North Outfall	4,933	$703,000				
US 77 Outfall	7,222	$1,979,000				
Lone Tree Creek	57,117	$16,248,000	37,077	$18,730,000	1,158,000	$9,520,000
Marcado Creek			33,369	$7,696,000		
Total Estimated Costs		$39,433,000		$103,760,000		$26,911,000

Grand Total of All Improvements $170,104,000

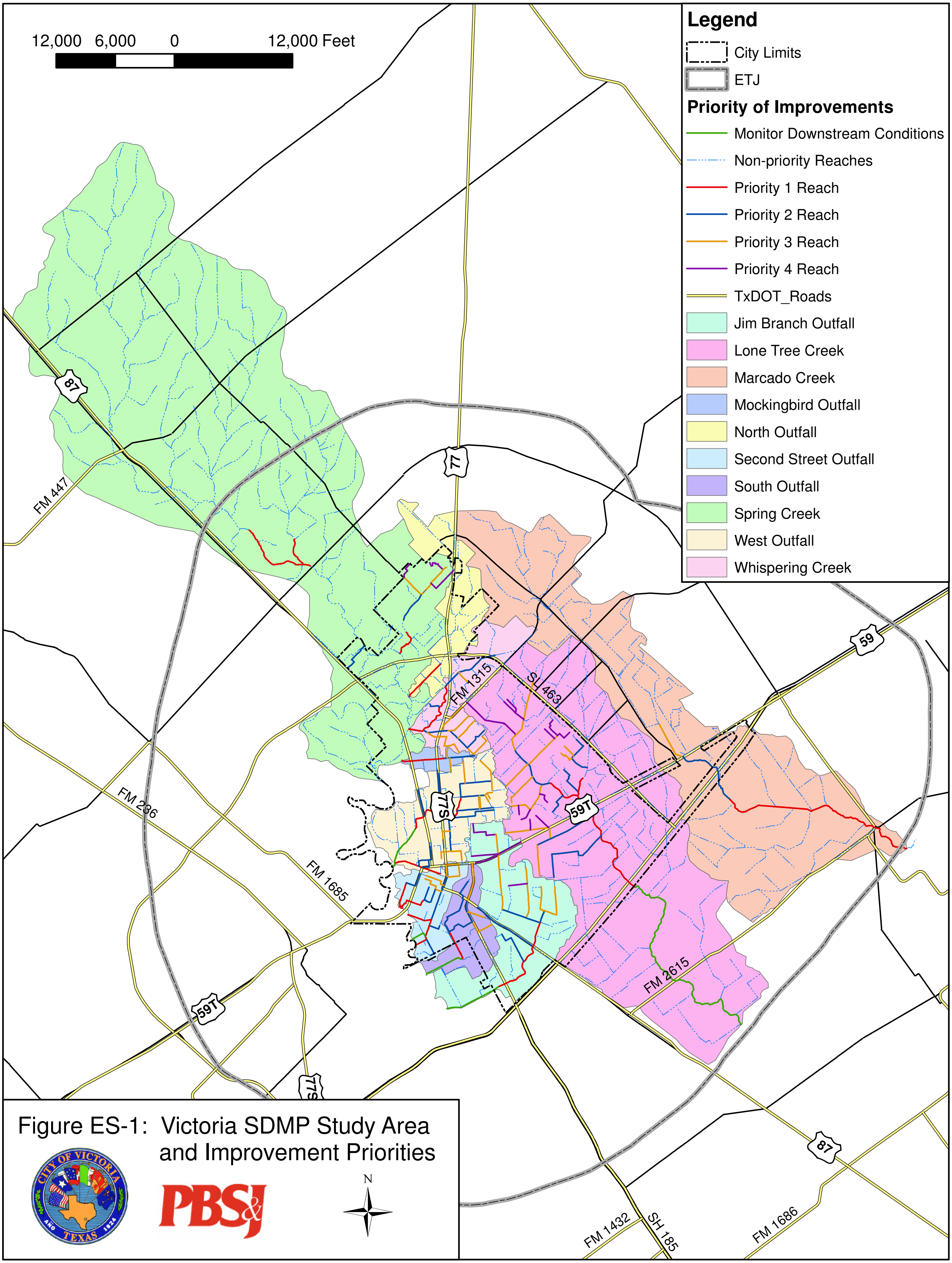

Figure ES-1: Victoria SDMP Study Area and Improvement Priorities

1.PROJECT TEAM

Development of the Storm Drainage Master Plan (SDMP) for the City of Victoria was a broad based effort that involves the input and ideas of many entities. The creation of the "Project Team" was an important element in developing the SDMP. The intent was to create a broad based Project Team which would be able to provide input to the wide range of topics under review in the SDMP. The Project Team included skilled professional personnel, highly qualified in performing a variety of traditional stormwater management projects addressing flood loss reduction, and erosion/sedimentation reduction. The Project Team also included staff personnel with expertise in wetland protection, wildlife and aquatic habitat enhancement, cultural resource protection, water supply enhancement, water quality, and recreation. The Project Team served as a "technical sounding board" for the many recommendations within the SDMP. It included several of the local engineering and surveying companies as well as specialists in other fields. Table 1 presents the subconsultant companies and their areas of participation in the SDMP.

TABLE 1

SUBCONSULTANTS INCLUDED ON THE DESIGN TEAM

Urban Engineering Mr. Tom Schmidt, P.E. Mr. Ray Bridges, P.E. 2004 N. Commerce Victoria, TX 77901 361-578-9836	Involved in Section 1 - Organize Project Team, Section 2 - Perform Citywide Analysis (Ordinances, Criteria Manual), Section 3 - Watershed Studies, and Section 4 - Plan Development
Associated Engineers and Survey Mr. C.W. "Billy" Settles, P.E. 2001 E. Sabine, Suite 106 Victoria, TX 77901 361-575-0474	Involved in Section 1 - Organize Project Team, Section 2 - Perform Citywide Analysis (Ordinances, Criteria Manual), Section 3 - Watershed Studies, and Section 4 - Plan Development
Urban Surveying Terry Ruddick, R.P.L.S. 2004 N. Commerce Victoria, TX 77901 361-578-9836	Involved in 1 - Organize Project Team, Section 3 - Watershed Studies (Data Collection and Surveying)
Rimrock Consulting Company Ms. Mickey Fishbeck, A.I.C.P., Principal 2222 Western Trails Suite 103 Austin, TX 78745	Involved in Section 2 - Perform Citywide Analysis (Financial Resource Strategies)

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Water Resources, Austin Andy Johnston, P.E. Karl McArthur, E.I.T. Nicole Beckom, E.I.T. Suzy V. McElroy, P.E. Duke G. Altman, P.E.	Involved in all Sections
Environmental, Austin Cecilia Green Patsy Turner	Involved in Section 1-Organize Project Team, Section 3 - Watershed Studies (Data Collection), and Section 4 - Plan Development (Implementation Strategy)
Cultural Resources, Austin Wayne Glander Meg Cruse	Involved in Section 1-Organize Project Team, Section 3 - Watershed Studies (Data Collection), and Section 4 - Plan Development (Implementation Strategy)
Water Resources, Houston Don VanSickle, P.E. Carl Woodward, P.E.	Involved in Section 1 - Organize Project Team, Section 2 - Perform Citywide Analysis (Ordinances, Criteria Manual), and Section 3 - Watershed Studies
GIS, Austin Brian Shirley Ty Summerville	Involved in all Sections

The City Staff and the Project Team met several times to discuss the project scope, schedule, and the specific SDMP deliverables. Communication protocols among City Staff and Team Members were established. Following the assignment of work among Team members, a meeting was held with City Staff to inform them of the assignments. Throughout the SDMP minor adjustments to the project scope, Team assignments, schedule and/or deliverables were presented to, and reviewed by, the City. A final project schedule was prepared and submitted to the City using Microsoft Project software which included "milestones and/or feedback points" as well as staff meetings, Council briefings and deliverable submittals to the City. All the tasks in the Scope of Services had timeline assignments. The use of "milestones and/or feedback points" coincided for multiple tasks in order to make Staff and Council briefings efficient. The use of this system helped the Project Team to keep the SDMP moving with key meetings occurring on time and overall the project was completed on time

A Study Area Watershed Map was created that specified the limits of study and is included as an oversized exhibit in Map Packet 1. In general, the SDMP includes almost 100 square miles of drainage area in several watersheds. The actual individual basin sizes and descriptions are more completely discussed in Section 3 - Watershed Studies.

2.CITY-WIDE ANALYSES

This section describes the work tasks associated with performing city-wide analyses. This effort included establishing standardized procedures and computational methods, maintenance planning and evaluating financial resources strategies. Each of those specific work topics will be discussed in detail in the following subsections. This analysis effort affected the entire Storm Drainage Master Plan (SDMP) over the entire Study Area and was not specific to one watershed or area.

The Study Area consists of all areas that are within the City limits or within the City's Extraterritorial Jurisdiction (ETJ) and are in one of the following watersheds: Lone Tree Creek, Spring Creek, Jim Branch Outfall, Whispering Creek, North Outfall and West Outfall and Marcado Creek. The Guadalupe River was excluded from the study (and the Study Area) except for mapping the river's 100-year floodplain. The Study Area Watershed Map is included in Map Packet 1 at the back of the report.

2.A. STANDARDIZED PROCEDURES AND COMPUTATIONAL METHODS

2.A.1. Ordinance, Policy and Procedures Review and Update

The City's Flood Damage Prevention Ordinance (Ordinance) has not been updated since 1987 and required review in order to lead the City into future stormwater management efforts and to tie to the Design Criteria Manual (DCM) policies and goals. The updated Ordinance provides the authority to manage drainage and flooding issues in a comprehensive, cooperative, consistent and effective manner. The updated Ordinance was developed to reflect the City's multi-objective drainage management philosophy as stated at the beginning of this report. Updated policies and procedures have been developed to minimize and/or eliminate the present need to routinely obtain policy variances due to outdated policy and/or procedures. The Ordinance focuses primarily upon development in the floodplain flood zone and is geared toward flood damage prevention. It also references the DCM and should be the legal vehicle whereby those design methods are adopted. The DCM is discussed in more detail in Section 2.A.2 below.

Discussions were conducted with the City Staff regarding the goals, objectives and all other requirements (i.e., needs) associated with the City's Flood Damage Prevention Ordinance, the City's Subdivision Ordinance as well as drainage-related policies and procedures. A "round table discussion" was conducted in June 1997 with the local development community and engineers. List of concerns were generated and reviewed again during subsequent staff meetings in October and November 1997. The limitations, weaknesses and past problems encountered with the Ordinance, policies and procedures were discussed with City Staff . A "needs list" was developed of items that would require resolution with the updated Ordinance, policies and procedures. Following receipt of review comments from the City, the draft updates were revised and resubmitted to the City for additional review and comments. Once the City was satisfied with the updates, they were prepared for public review and comments.

Several "policies" required public discussion before guidance could be given to the Design Team regarding the development of either the Ordinance or the DCM. The major policy issues were reviewed by the City Council during a worksession on December 2, 1998. Additional Council Worksessions were conducted on January 29, 1999, February 10 and February 26 about various Ordinance and DCM issues. After further review and discussion a Resolution was adopted (number 98-47R) on April 7, 1998. The major policy topics themselves were included into either the DCM or the Ordinance. The major policy issues included the following topics:

POLICY ISSUE #1. "Future" Land Use

Discussion: A key component in sizing and projecting costs for the SDMP improvements is the design runoff rate to be accommodated that, in turn, is a function of land use and/or degree of urbanization used in this planning process. Land use conditions to be considered in determining runoff rates for designing SDMP improvements within any particular drainage area will be a composite function of present urbanized uses as well as the degree of urbanization projected to occur in those presently undeveloped/agricultural portions of the drainage area. The SDMP drainage systems will be sized to collect and convey runoff to an outfall in accordance with "future" or planned land uses as well as appropriate policy and technical information set forth in the Drainage Criteria Manual.

Major Concerns: Setting a "target level" of anticipated development will make it more clear to the development community what the drainage requirements will ultimately be within the City's jurisdictional area enabling more effective long range planning and financing. Setting this level will also enable City staff to more effectively evaluate drainage requirements for individual tracts and should reduce plat and permit processing time. Setting a target will help assure that expenditures and improvements built to SDMP specifications will not have to be taken out and replaced at a later date with a larger system.

Recommendation to be Considered: The recommended approach for selecting the degree of urbanization for the presently undeveloped/agricultural areas would be to assume these areas develop as residential subdivisions having a density of four (4) units per acre (approximately 43% impervious cover) except in certain areas likely to develop as commercial areas. In these business areas (e.g., along Loop 463 and other selected major arterial streets) it could be assumed that for a selected distance from the arterial the land area would develop commercially (approximately 85% impervious cover). The hydrologic models discussed in Section 3.D.3 were set up with the commercial areas extending 200 feet from the centerline of the major arterial street.

POLICY ISSUE #2. Regional Detention.

Discussion: Traditionally stormwater problems have been solved by installing larger pipes, box culverts, or channels. Another structural option is the use of "regional detention facilities" in selective locations. These basins are generally dry and available for multiple uses such as park areas. However, under certain flood events, they accept inflow, restrict outflow rates and thus detain a significant portion of the inflow such that downstream flow rates are reduced. Following the storm event, these basins slowly drain.

When employed in the appropriate locations, regional detention facilities can be very cost effective SDMP flood control alternative. Since they typically and primarily involve excavation and minor concrete work, their costs can be much less than the costs to install larger drainage pipes and box culverts that would be required downstream if the peak flows were not reduced by these facilities. Additionally, the performance of a small number of regional detention facilities is more dependable (as well as the maintenance easier and less expensive) compared to a much larger number of "on-site" detention facilities that would be hydrologically equivalent.

Major Concerns: Before the SDMP process of solving the flooding problems begins, it must be clear if the use of regional detention will or will not be allowed as a possible flood control measure in the SDMP. These facilities might prove cost effective in the upper portions of the Spring Creek watershed (upstream of Loop 463) in mitigating the impacts of future development as well as in the Lone Tree watershed in mitigating or controlling the higher "future condition" discharges to "existing condition" levels before releasing the stormwater into the County.

Recommendation to be Considered: The use of Regional Stormwater Detention Facilities as a SDMP flood control alternative should be allowed in appropriate locations to achieve more effective and economically superior solutions to flooding/drainage problems.

POLICY ISSUE #3. Interim Phasing.

Discussion. As discussed earlier, the SDMP will include sizing and cost estimates for drainage improvement projects throughout the study area. Obviously all these projects cannot be built at once or even over a short time frame. Therefore, as land development continues there may be a need for "interim phasing" of these capital improvements into the overall plan. One of the main features of the SDMP is the preparation of "flexible and dynamic" computer models that will allow City staff to evaluate these interim cases as they are considered on a "watershed by watershed" or "case by case" basis. The community will need to be aware that all the drainage problems identified in the SDMP cannot be fixed overnight and that an "interim" flooding reduction level may be achieved before the full SDMP is in place.

Major Concerns: In certain watersheds it may be possible that a proposed development can be built without any significant impact to downstream property owners. However, drainage systems in other watersheds or areas cannot accommodate increased runoff rates resulting from new developments without impacts occurring. In these cases, it will likely be required that the development (residential or commercial) provide short-term mitigation until SDMP improvements can be extended to the subject area. If this mitigation is on-site detention, then the structure would be "temporary" until such a time as the full SDMP projects are completed downstream of the development. At such time (which could be a considerable time into the future), the mitigation measures could be removed and the mitigation site developed.

Recommendation to be Considered: In instances prior to a new development area having access to downstream SDMP improvements, the SDMP should include (perhaps in the DCM) a clear procedure to evaluate the drainage requirements for such conditions. This will greatly assist the City staff and the development community in understanding drainage requirements during this interim period that exists between the time of development for any specific tract and the time that downstream SDMP improvements are completed.

POLICY ISSUE #4. "Retrofit" Design Allowances.

Discussion: The primary purpose of the Drainage Criteria Manual (DCM) is to guide new developments in complying with established City stormwater criteria and standards. In a new development the DCM will likely require drainage improvements that extend to an outfall location that is able to adequately convey the design flow or require temporary flow control (i.e., stormwater detention) such that downstream flooding conditions are not worsened. This approach may be technically difficult and/or economically infeasible in the "retrofit" situations that exist in older developed areas. As paving/drainage improvements are constructed in older developed areas within the city, often times the existing downstream drainage system to which the new improvements must connect will be inadequate and/or not meet the desired standards.

Major Concerns: If Standard City Drainage Criteria is inflexible when considering/designing improvements in existing (older) developed areas, improvements will become impractical, prohibitively difficult and/or expensive in most instances.

Recommendation to be Considered: This City should allow a flexible "level of performance" on a case-by-case basis when considering "retrofit" improvements.

POLICY ISSUE #5. **Stormwater Ponding in the Streets.**

Discussion: The number of drainage inlets and the size of the buried storm drainage infrastructure (and hence the cost) is directly related to the amount of stormwater that can be allowed to remain upon the street surfaces for a given design storm event. Some cities focus on "permissible spread" of the stormwater based upon street classifications (i.e., residential, collector, arterial, etc.). Other cities focus on the top of curb elevation under design conditions or the maximum water depth at the crown of the street that Fire and EMS vehicles can pass through with or without regard for the street classification.

Major Concerns: Many cities use the street areas to temporarily "store" stormwater in order to reduce the size of the drainage system and the associated cost. On the other hand, there are safety and access issues due to the stormwater level in the street. The allowable amount of street ponding must balance all of the issues.

Recommendation to be Considered: The allowable stormwater ponding in streets will be governed by: 1) limiting the depth of water to the top of curb height for a 5-year storm event while also, 2) limiting the 100-year flood level to twelve (12) inches at the road crown.

POLICY ISSUE #6. **Floodplain Encroachment and Finished Floor Elevations.**

Discussion: In the absence of compensation measures such as channel improvements, land development, including the filling ans/or construction of improvements (e.g., buildings), that occur within a stream's 100-year floodplain (i.e encroachment) generally causes an increase in upstream and/or adjacent water surface elevations as well as an increase in channel velocities adjacent to the encroachment area. FEMA floodplain policy generally allows up to a one (1) foot increase in 100-year water surface elevations as a result of floodplain encroachment. However, municipalities often times have more restrictive floodplain regulations to prevent new developments from causing significant increases in floodplain levels on other properties due to development in the 100-year floodplain. Present policies in Victoria follow the general FEMA guidelines and allow encroachment to occur such that resulting 100-year flood levels can increase up to one (1) foot. Present policies in Victoria also allow minimum finished floor elevations to be placed AT the 100-year level. The combined effect of these polices can lead to structure flooding in cases where downstream encroachments raised water levels on upstream and/or adjacent properties where existing structures have been set at the 100-year flood level.. In other situations, upstream property owners would have to elevate finished floor elevations to protect buildings scheduled for future construction from water level increases due to downstream encroachments.

Major Concerns: If land development is allowed to occur within the 100-year floodplains without compensating measures to offset the negative hydrologic and/or hydraulic effects, flood levels will increase on upstream and/or adjacent properties.

Recommendation to be Considered: In order to prevent flooding on other properties, the City should consider adopting one or more policies that prevent any measurable or predictable increases n the 100-year flood levels due to the combined effect of floodplain encroachment and any compensating measures (e.g. channel improvements) used. A policy change should be made to require that finished floor elevations be set at least one (1) foot above the 100-year flood elevation. The policy would then be "no net rise" (mitigate any flood fringe encroachment increases) and "one foot above the SDMP 100-year flood elevation."

Following the public discussions of these major policy items and the direction of the City Council, each "issue" was incorporated into the SDMP. The "future land use" policy (Issue #1) was adopted into the hydrology procedures of the SDMP and will be discussed in more detail in Section 3.D.3. The "regional detention policy" (Issue #2) was included into the structural options for solving flooding problems and will be discussed in more detail in Section 4.B. The "interim phasing" policy (Issue #3) was included into the DCM. The "retrofit design allowances" policy (Issue #4) was included into the DCM. The "stormwater ponding in the streets" policy (Issue #5) was included into the DCM. The "floodplain encroachment and finished floor elevations" policy (Issue # 6) is discussed in the DCM but must be included in the revised Ordinance to be legally binding.

The actual wording and legal protocol of the Ordinance change is outside the scope of the SDMP and will be handled by the City of Victoria's legal staff. Besides the floodplain encroachment and finished floor elevation policy issue there are other items that could be included in any Ordinance revision the City may wish to make. The standard FEMA "model" ordinance was reviewed in order to insure that updates to ordinances, policies and procedures will generally comply with FEMA requirements (again the full compliance is outside this scope and rests with the legal authorities of the City). Compared to the "model" ordinance, Section 9.5-3 of the existing City Ordinance could be modified to include a definition for "appeal," "city council," "director of engineering," "elevated building," "existing manufactured home subdivision," "historic structure," "manufactured home subdivision," "new manufactured home subdivision," and possibly "recreational vehicle." The Ordinance should prohibit dumping any material into a drainage facility (garbage, trash, engine oil and so forth). The Ordinance should provide for adequate erosion and sediment controls which will be discussed in detail in the DCM which will be a critical feature of the upcoming federal and state Phase 2 stormwater permit regulations. The Ordinance should discuss the responsibilities for maintenance of stormwater management facilities. Provisions for any development that will change the water flow from overland sheet flow to a concentrated flow must be included in the Ordinance or the DCM. The City's Subdivision Ordinance policies and procedures should be developed to be consistent with the updated Drainage Design Manual and the multi-objective management philosophy.

Consideration could also be given to adopting some type of Roadside Ditch Maintenance Policy by the City since roadside channels are a major drainage infrastructure component throughout the City. Many times the evolution of roadside channels in a subdivision is erratic leading to 1) pipes that are not progressively sized to increase in diameter further downstream and 2) flowlines of the roadside ditches not following a uniform grade in the downstream direction. Some type of "policy" could be prepared that expresses the rights of the private owner and the public entity toward the establishment and maintenance of this critical drainage facility.

2.A.2. Drainage Design Manual (Drainage Criteria Manual)

The development of a Drainage Design Manual (Drainage Criteria Manual - DCM) constituted an important element in establishing the SDMP. The DCM is a separate document from this part of the SDMP report. Uniformity in design calculations in an updated Manual reduces City Staff review time and provide for a standardization of procedures that will greatly assist in insuring the proper design capacity of facilities. Effective design criteria is also the first step in a low maintenance flood control program. The Manual addresses the procedures to follow in designing improvements along existing drainage ways as well as the design of drainage systems in newly-developing areas.

Utilizing City Staff desires, the Manual format was developed with a balance between printed tables and design charts versus computer software design tools. As in the process to update the ordinance policy and procedures, the update of the manual was also performed using public input obtained from interested parties such as citizens, property owners, businesses, developers, builders, engineers, planners and others. Discussions were conducted with the City Staff regarding the goals, objectives and all other requirements associated with the City's Design Criteria Manual (DCM) as well as drainage-related policies and procedures. A "round table discussion" was conducted in June 1997, with the local development community and engineers. List of concerns were generated and reviewed again during subsequent staff meetings in October and November 1997. The limitations, weaknesses and past problems encountered with the DCM, policies and procedures were discussed with City Staff . A list of technical areas (i.e., sections or chapters) was developed for inclusion in the Manual along with a list of analysis tools and procedures. A "needs list" was developed of items that would require resolution with the updated DCM, policies and procedures. Following receipt of review comments from the City, the draft updates were revised and resubmitted to the City for additional review and comments. Once the City was satisfied with the updates, they were prepared for public review and comments.

Several "policies" required public discussion before guidance could be given to the Design Team regarding the development of either the DCM or the Ordinance. The major policy issues were reviewed by the City Council during a worksession on December 2, 1998. Additional Council Worksessions were conducted on January 29, 1999, February 10 and February 26 about various DCM and Ordinance issues. After further review and discussion a Resolution was adopted (number 98-47R) on April 7, 1998, and listed in Section 2.A.1 above. The major policy topics themselves will be included into either the DCM or the Ordinance as listed above.

Discussion with the Developers, Builders, and Consultants within the development community, the City Staff and the City Council was aimed at identifying the level of detail desired and the type of examples to include. The purpose of this Storm Drainage Design Criteria Manual (DCM) is to establish the storm drainage design criteria and storm drainage design procedures for development and capital improvements within the City of Victoria, Texas, and its Extraterritorial Jurisdiction (ETJ). These criteria and procedures were used in the preparation of the Storm Drainage Master Plan (SDMP).

The overall "style" of this DCM is in the form of a "users guide" with nomographs and tables. It is *not* intended to be an educational textbook with pages and pages of theory and equations. It is assumed that the user of this DCM will already have a working knowledge of the basic mathematical theories involved in hydrology and hydraulics and is simply looking for the "standard practices" of the City. A Bibliography is presented at the end of the DCM should the user wish to make further study of the theories within a particular area.

In some of the sections, we have included the use of "rules-of-thumb" tables and charts to simplify the design. That is to say that if the developer/designer wishes to not spend a great deal of time with that section of the DCM, then simply using a value from the "rules-of-thumb" tables will suffice. These tables will be based upon other modeling calculations and are simply summaries. However, if the developer/designer wishes to spend the time and make the unique calculations for a particular site, then the other nomographs provided in the DCM will be of use.

The DCM includes a list of "deliverables" that should be submitted to the City as "backup information" for an individual design review submittal package. This will focus upon "what" is to be submitted, and the "how" is left up to the developer/designer within the boundaries presented in the DCM. The format will be in three-ring notebook format. Some of the critical tables and frequently used figures will be printed on heavy paper (like in the current DCM) or perhaps onto pages with reinforcement on the page near the binder rings. One goal of the DCM is to develop a balance desired between printed tables and design charts versus software design tools. The DCM has a section for Sediment and Erosion Control.

Sections of the DCM cover (but not limited to): Drainage Policy, Storm Runoff, Street Flow, Inlets, Storm Drains, Open Channels, Culverts, Detention, and Appendices.

2.A.3. Hydrologic and Hydraulic Modeling Software and Hardware Systems

The goal of this section was to provide the City with hardware and software systems capable of manipulating all the data acquired during the creation of the SDMP. This hardware would reside in PBS&J offices in Austin until the project was complete at which time the loaded system (with project software) was delivered and setup at the City.

Hardware and Operating System

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The intent was to have an open and flexible hardware platform that would be able to expand as the need arose. Toward that goal there was a review of the hardware requirements and options with City Staff at the very early stages of the SDMP. The hardware basically consists of a NT Workstation with CD read/write usage and a digitizing table. The digitizer was purchased through the City and delivered to PBS&J, whereas all the other components were purchased by and shipped directly to PBS&J.

The hardware platform selected for the GIS/Modeling system was the COMPAQ Professional Workstation 8000. The final configuration for the system included the following components:

1. COMPAQ Proliant 8000 with dual 200 MHZ Pentium Pro Processors, 128 MB of RAM, 16X CD-Rom, 8 MB Matrox Millenium Video Card, and 4 GB internal hardrive;
2. 7-Bay COMPAQ Proliant storage tower with 2, 9.1 GB Ultra Wide SCSI drives;
3. COMPAQ 4/8 GB internal tape drive;
4. COMPAQ P110 21 inch monitor;
5. 100 Base Ethernet Card;
6. COMPAQ Proliant Redundant Power Supply;
7. Iomega 1 GB SCSI Jaz external drive;
8. CD-Rom reader/writer; and
9. 36 inch by 48 inch digitizer.

The external drive array has the capacity for five additional hard drives. With similar hard drives, the total storage capacity could be increased to greater than 63 GB. Windows NT Version 4.0 was selected as the operating system for the work station.

A list was made of the final model names and serial numbers of all the items purchased. Each individual piece of hardware (five units have their own footprint) was assigned a City Property ID Tag number (COV 12103 through and including COV 12107) which was placed on the unit in conformance to standard City purchasing methods. A great deal of time was used in coordinating with the City Staff about the various hardware platforms. The project had good fortune in that the hardware prices were stable through the review/evaluation period and a more powerful machine was able to be acquired than originally anticipated (but is probably slow compared to current standards and could be reevaluated for low cost speed and data handling improvements).

GIS and Modeling Software

The software was to be state-of-the art and able to work in the GIS environment (not just the CAD environment). The software selected can use in ESRI ArcInfo and ArcView GIS formats which the City uses and maintains. There was a review of the software requirements and options with the City Staff. The selected software packages were installed on the City hardware system. The license for all the software is with the City of Victoria (not PBS&J). The software purchased includes hydrologic and hydraulic programs. Additionally, an upgrade license and software for PC ARC/INFO was obtained in November, 1997, on behalf of the City. Training on how to use the hardware and software was provided to City Staff.

The ability to process and manipulate Geographic Information System based files was essential to the SDMP. The ESRI GIS packages ArcInfo and ArcView are currently in use by the City staff and were selected for GIS processing on the workstation. An upgrade to an old version of PC ArcInfo owned by the City to PC ArcInfo 7.0 was purchased and installed on the workstation. ArcView 3.0a also was purchased and installed on the system. Both of these packages represented the state of the art in GIS capabilities at the time of the SDMP.

The Design Team performed a thorough evaluation of available hydrologic and hydraulic software to insure that the software selected would be able to perform the type of comprehensive analyses required given Victoria's topographic setting. The procedures and software selected are capable of assessing any potential positive and negative impacts that might occur as solutions are evaluated. The hydrologic/hydraulic software and procedures selected enable the City Staff to develop design storm rainfall patterns, apply rainfall loss rates, create composite curve numbers for different land uses and soil types, develop individual subbasin times of concentration, generate flood/flow hydrographs, route hydrographs to downstream locations, determine if flow splitting occurs, combine subarea hydrographs, consider detention storage, compute velocities, flow distributions and flood elevations, design improvements, evaluate designs for negative impacts in other locations as well as other hydrologic/hydraulic considerations. A more complete discussion about the watershed modeling techniques and methods is included in Section 3D - Base Hydrology and Hydraulics.

The hydrologic model selected for the SDMP was the Watershed Modeling System (WMS) Version 5.0. WMS was developed through the collaborative efforts of the U.S. Army Corps of Engineers (COE) Waterways Experiment Station (Vicksburg) and the Engineering Computer Graphics Laboratory at Brigham Young University. The software provides a flexible, GIS data based, interface to several popular rainfall-runoff modeling techniques. WMS includes an interface and the actual programs for the COE's HEC-1 model, the National Resource Conservation Service (NRCS) TR-20 model, the Rational Method, and the U.S. Geological Survey's (USGS) National Flood Frequency software. The HEC-1 model and interface was used for this study. The packages extensive capabilities for manipulation of GIS data were the primary reasons for selection. The WMS interface includes four separate methods for generation of watershed models. The software is capable of delineating basins from a Digital Terrain Model (DTM) in the form of a Triangular, Irregular, Network (TIN) and a file representing streams. The TIN can be generated directly in WMS from a set of elevation points (usually in the form of a DEM) or imported from an external package such as ArcInfo. The second method for generation of a watershed model is based on the determination of flow paths from a set of gridded elevation data. WMS includes software that will determine the flow direction for each grid cell and accumulate these flow directions to create streams. The third method, which was used in creation of models for the SDMP, creates models through direct importation of digitized watersheds and streams in ArcView shape file format. Finally, models without GIS data can be created directly with the schematic model tools available in WMS.

In addition to extensive model creation tools, WMS also provides extensive model parameter editing capabilities and output display options. Each model supported by WMS has a tailored interface that allows for input and modification of the required parameters. The HEC-1 interface includes a model checking routine that will evaluate the HEC-1 model for potential problems. The output interface includes an output file text viewer and the capability to graph simulated or observed hydrographs. Hydrographs from any location in the model or from different models can be overlaid on the same graph. This provides a simple, graphical, method for comparison of various watershed conditions such as the three states of development evaluated in the SDMP.

Two separate hydraulic models were required to model open channel and closed conduit systems evaluated in the SDMP. The open channel flow model that was selected is called RiverCAD through BOSS International Version 3.5 which is currently in use by FEMA. RiverCAD provides the modeler with a wide range of graphical tools to created models and view the resultant floodplains. The software provides an interface to both the COE's HEC-2 and HEC-RAS models. RiverCAD is also able to switch back and forth between models. RiverCAD includes its own CAD engine which is similar to

AutoCAD. The CAD functionality allows the software to generate cross sections and lengths directly from three-dimensional contour data. RiverCAD also includes methods to work with two-dimensional contour files and other forms of elevation data. The primary strength of the RiverCAD package is its ability to generate floodplains based on model results and a DTM created from the available elevation data.

The closed system model selected for the SDMP was AVsand system (Version 4.1) developed by the CEDRA Corporation. AVsand is unique in that it was the only model available that provided access to the infrastructure database directly in the GIS environment. There are several other models that will perform closed system hydraulic calculations within the CAD environment, however, AVsand was the only model found by the Design Team which could perform the work directly in the GIS environment. AVsand provides an interface to two separate computational engines, the Sand modeler developed by CEDRA and the EPA SWMM model. The SWMM engine, which provides greater flexibility in the types of pipe shapes, boundary conditions, and flow input options available, was selected for use in the SDMP. AVsand has the capability to evaluate entire inflow hydrographs (in lieu of just the peak flow as several other models use) which helps to eliminate “coincident peak” situations in elaborate pipe networks. The model can make use of several different shapes of culvert including boxes and pipes and is able to simulate parallel pipe systems. Again, a more complete discussion about the watershed modeling techniques and methods is included in Section 3D - Base Hydrology and Hydraulics.

2.A.4. Analysis Plan

The development of an Analysis Plan provided a complete outline of the process to be used in establishing the SDMP. The Analysis Plan included the step-by-step work tasks that were performed with certain general concepts that would be followed. For example, in the establishment of hydrologic and hydraulic procedures it was important to provide consistency with software and Drainage Design Manual. The conditions for existing, future and future with pan improvements were considered as were discussed in Section 2A “Standard Procedures” above. The plan provided details on design storms, loss rates, hydrograph routing and combining, split flows, temporary floodplain storage, flood profile computations (open and closed systems) and other hydrologic/hydraulic procedures.

Many the basic processes are evident from the Section 3 "Watershed Studies" portion of this report. For example, the use of the Rational methodology was compared to the SCS unit hydrograph methods for watersheds in the 200 acres range (the limit for when one model must be used over the other). It was very important that there is general agreement between these two methods before the modeling (SCS) began and before any charts in the Drainage Criteria Manual were finalized. The use of Technical Memorandums (TM) was used from time to time to keep City Staff informed of the specific technical issues being encountered and resolved.

Besides the pure hydrology and hydraulics, environmental, recreation and other considerations were also reviewed to include other multi-objective considerations. Along the lines of coordinating the SDMP development with other master plan efforts occurring concurrently, PBS&J attended several "Growth Management" meetings to coordinate efforts with other ongoing City projects. Many of the Multi-objective targets established by the Parks Department for linear parks and more open space recreation areas were incorporated into the overall plan to solve the various drainage problems throughout the City as discussed in more detail in Section 4B "recommended Structural and Nonstructural Measures."

2.B. MAINTENANCE PLANNING

A major issue for the SDMP involved the need to provide a solid maintenance plan to support the existing and future drainage systems within the City. If City drainage systems do not receive proper maintenance, improvements to existing drainage systems as well as well-designed drainage systems will likely not perform to design levels. This could seriously reduce the effectiveness of the City's existing and future drainage systems. A goal of the proposed Stormwater Drainage Master Plan is to develop a well organized maintenance plan that will include many items such as 1) a GIS based labeling system to identify individual drainage system elements, 2) a GIS based system to define the type/material of the infrastructure, and 3) the GIS based ability to log past maintenance activities and schedule for future maintenance activities (e.g., clearing) as well as the need for repairs (e.g., broken pipe or channel erosion). This information will become part of the Land Information System (LIS) being developed by the City in ArcInfo. This information must be able to be seamlessly used in the GIS environment by the hydraulic models.

Several meetings were conducted with City Staff to review and discuss the various drainage maintenance procedures currently occurring in the City. The City currently has an "Observation Memo" that is used for several City divisions including the Street and Drainage Division. The form includes drainage items such as curb and gutter repair, right-of-way mowing, drainage ditch mowing, standing water, drainage blockage, and other observations. Many articles were reviewed from Public Works magazines that referred to other City's drainage maintenance efforts which included a myriad of other more specific maintenance items related to channels, pipes, manholes/junction boxes, and inlets.

The main concern of this work item is to create a framework in the SDMP for more detail to be added to the drainage maintenance program at a later date, but to not collect any data except the basic data needed for the hydraulic models. The flexibility of the GIS database to add additional columns of information (condition, last date of maintenance, next scheduled maintenance, type of work required, and so forth) can be added at a later date by the City Staff. The development of a budgeting and expenditure tracking system can also be addressed using the results of the SDMP at a later date. One major goal of the SDMP was to develop a ditch vegetation control/herbicide program.

Several meetings were held with City Staff to discuss various coding system options with the City staff. Many times there is a tendency to make things more complicated that are necessary simply because "the computer" can handle the complications. However, the goal of the SDMP was to create a numbering system with the Maintenance Staff in mind that was simple to use in the field and over the radio system. The last thing the City needs is a method that is such a difficult thing to use that the need for it gets lost in the daily problems created by trying to use the system. Several options were proposed to the City for review. There were several meetings to work with City Staff to fine tune the level of detail desired in the coding system. One key factor was the examination of the long term time and cost requirements of maintaining the data (more detail will cost more to keep updated).

Section 3C "Database Maps" includes a more detailed discussion of the GIS mapping that the City provided to all the consultants performing master plan efforts so a great deal of information will not be included in this Section. Suffice it to say that the City provided topographic and planimetric information for the entire City and the Extraterritorial Jurisdiction (ETJ). Although the two data sets were at different map scales (detail) the information that was included referenced a specific horizontal coordinate system that had been created. Within general accuracies, the horizontal location of an inlet or a headwall for a stormwater pipe could be identified which would be unique across the City. The goal of the GIS maintenance numbering system was to create a numeric system that would also provide an "unique number" for that specific inlet or headwall. This way a maintenance crew could be dispatched to one specific site and both the office and the field staff would know they were referring to the exact same location.

One basic piece of information that make each location unique is the general "basin" that it existing within such as West Outfall (WO) or Lone Tree (LT) for example. Another piece of information that was created to help convey a general location to the user was the distance above the mouth of the main creek outfall that the structure was located. For example, if an inlet was located within a smaller drainage area sewer system (within the WO watershed) which drained into the main WO channel about two thousand (2,000) feet above the mouth of the WO watershed at the Guadalupe River, then that location was twenty (20) "stations" along the main stem of the WO channel. Each "station" is equivalent to one hundred (100) feet. Therefore, if there was a way to identify a way to identify the "location" of pipes, inlets or headwalls that were 20 stations from the mouth as compared to infrastructure that was further upstream at 60 stations then the user would be able to generally know where to look for that structure.

For example, an inlet in West Outfall in the lower watershed could have the ID of *WO-20-2105* whereas another inlet further upstream could have the ID of *WO-60-1709.* The "nodes" (junction boxes, headwalls, inlets, etc) have *odd* numbers, and the individual "pipes" or box culverts have *even* numbers to help the user *(WO-60-1708* is the pipe that connects to the *1709* inlet). The electronic files presented in Appendix 1 as CDS contain the ID numbers for all the pipes and nodes identified in the SDMP as well as the database of pertinent characteristics (diameter, flowline, slope, and so forth). Also of interest if that enough unused numbers were left between the individual assigned numbers that are being used to allow the City to come back at a later date and add new subdivision drainage infrastructure or new City CIP pipes and the overall numbering system within the same general area will still be reasonably logical.

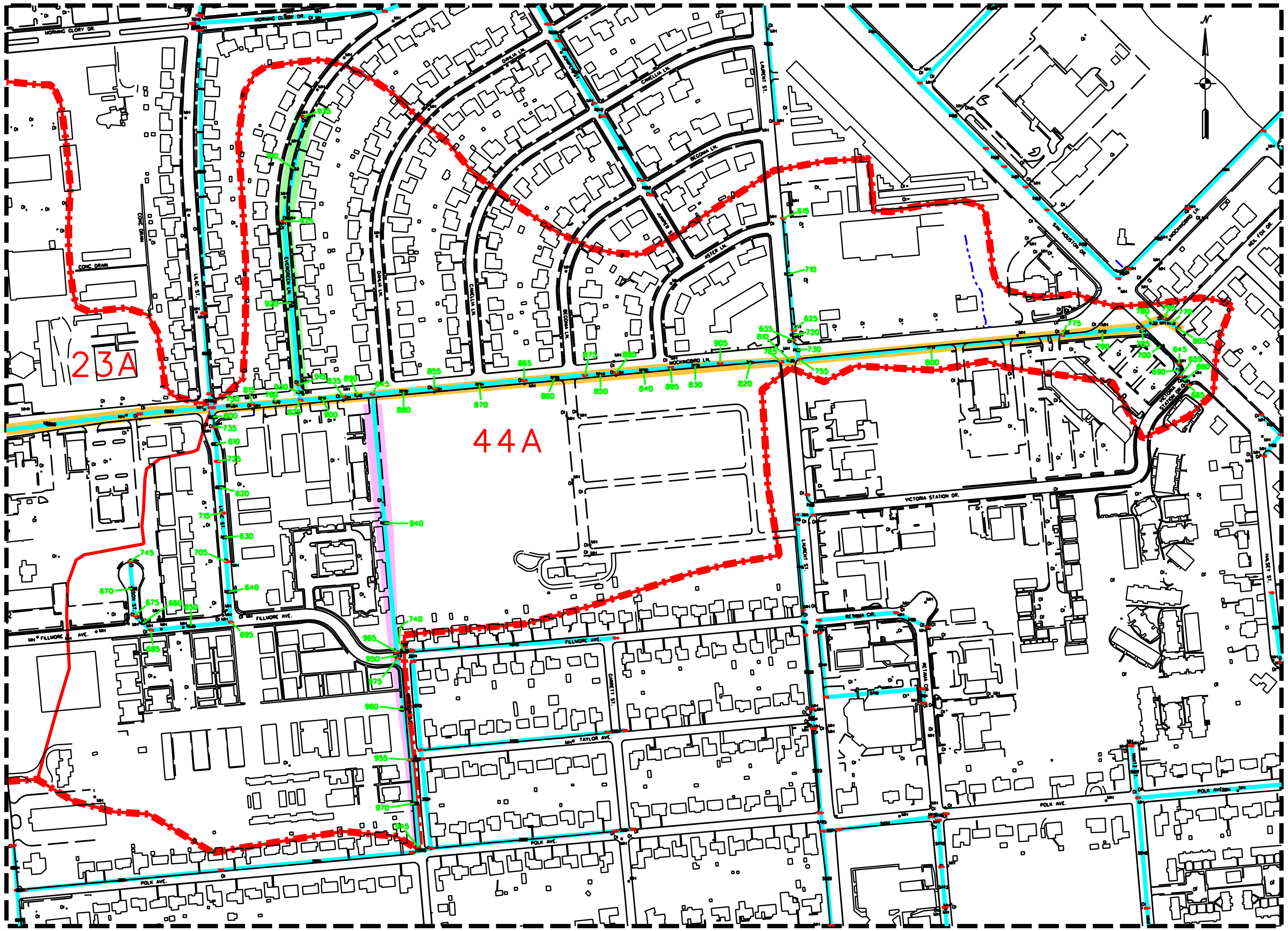
Of interest is that the numbering system which includes "stations" has been used in the hydrologic model numbering as well as the hydraulic modeling. This way all the modeling and the maintenance numbering would be interrelated and the user could move among all three models or databases and generally be referring to the same horizontal location within the City watersheds. More detail is included about the hydrologic and hydraulic numbering systems in Section 3C "Base Hydrology and Hydraulics".

Again there was a great deal of communication and coordination with the City Staff on these issues. Due to the flexibility of the GIS software, the final numbering system was made up six basic "building blocks" of information that all three uses could access. The six components are graphically presented in Figure 2.1 and includes the Basin, the Service Area, the Sewer System (drainage area), the Subbasin, the Strip number, and the ID number. The "hydrologic model" makes use of four of the numbers including the Basin, the Sewer System, the Subbasin, and the ID number. The "closed system hydraulics model" makes use of three of the numbers including the Service Area, the Strip number, and the ID number. And in keeping with the initial goal of the Maintenance Numbering System, just three of the six numbers are used including the Basin, the Sewer System, and the ID number to create the "maintenance number" for use by the City crews.

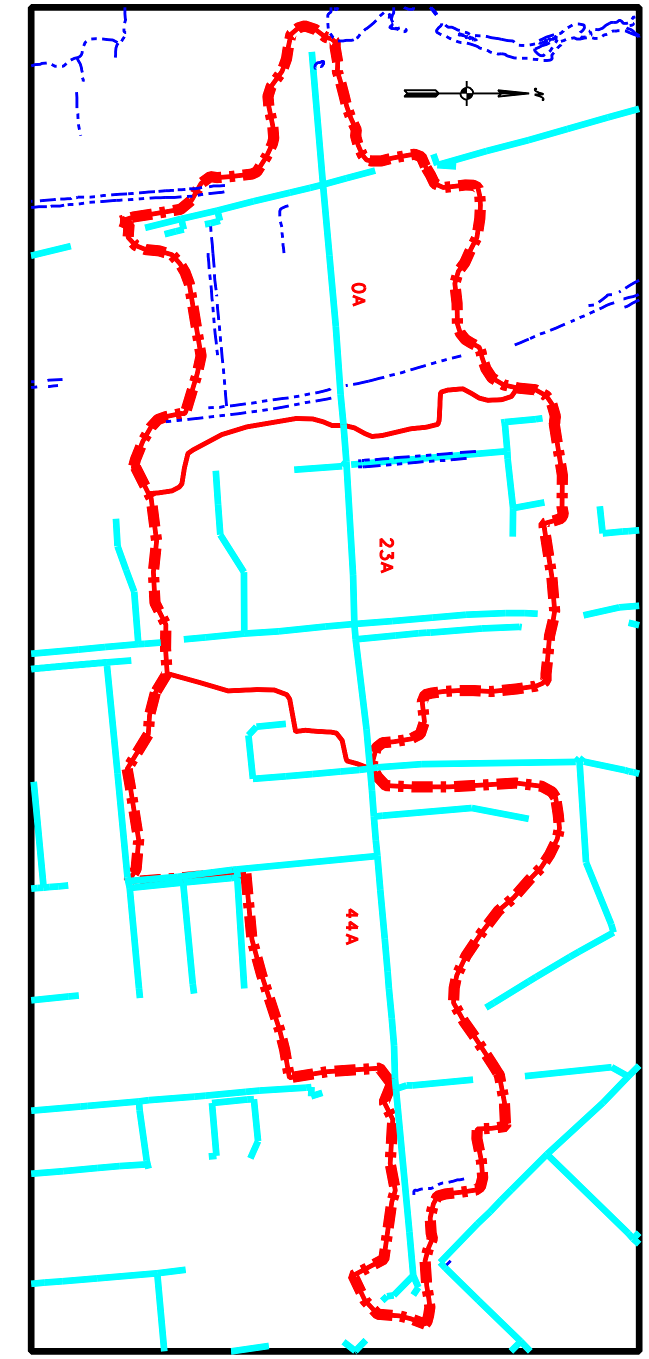
For example, an individual inlet in the City is given six "building blocks" to identify it, and then depending upon the user's need, some (not all) of the six numbers are used. The beauty of the GIS system is that all six numbers are still attached to a specific inlet and are not erased or written over when accessed by the individual models. As mentioned above, additional columns of information can be added at a later date that are more specific to the maintenance needs of a particular stormwater infrastructure feature. As mentioned before, there is a link between the database of maintenance needs and the GIS/LIS system. Methods have been developed for updating the system database with options for graphical display.

As an example of the numbering system, please refer to Figure 2.1. The User can pan all over the City and zoom in and out as needed, or the User can query the database and ask the map to display the requested item. All of this information is included in the electronic files (Appendix 1) and just generic portions of the information are presented in this Figure. The example being shown is the Mockingbird Outfall (MO) watershed. On the right hand side of the exhibit is a "Locator Map" view of the entire MO watershed (rotated so that the Guadalupe River is to the top of the page). Note that the MO watershed was

Inset Map



Locator Map



Mockingbird Watershed/Service Area Boundary (Only 1 Service Area for MO)

Sewer System/Subbasin Boundary

Inset Map Coverage Boundary

Strip 1

Strip 2

Strip 3

44A Sewer System/Subbasin Number

965 ID Number

Node Number

Pipe Number

Maintenance Numbering Example:

Watershed Id → MO 1 44 A 2 910 ← ID Number

Service Area Number; Sewer System Number; Subbasin ID; Strip Number

Inset Map Scale: 0 100 200 300 400 ft; 0 25 50 75 100 m

Locator Map Scale: 0 200 600 1000 ft; 0 50 150 250 m

PBS&J
206 Wild Basin Rd., Ste. 300
Austin, Texas 78746-3343
Phone: (512) 329-8342 FAX: (512) 327-2453

FIGURE 2.1
MAINTENANCE NUMBERING SCHEMATIC

PREPARED FOR: CITY OF VICTORIA, TEXAS	
JOB NO.: 18153	SCALE: 1"=400'
DRAWN BY: T. SUMMERVILLE	DATE: 8-5-98
FILE: O:/DGN/FIGURES/MAINTNUM.DGN	

subdivided into three subareas. The mouth of the first subarea is also the mouth of the entire MO watershed (the location of this point is at Station 0) so all the infrastructure maintenance item will have a "sewer system number" of zero (0). The subbasin ID for this first subbasin is "A" since there is only one subbasin joining the main stem at this point. Some other watersheds have several subbasins coming in a the same location and then the "B" and "C" distinctions will be used. The combination of the station and the subbasin ID makes this subarea "0A" in the HEC-1 hydrologic model.

Further upstream is the second subbasin with its mouth approximately 2,300 feet above the mouth of the MO watershed (Station 23) so all the infrastructure maintenance item will have a "sewer system number" of twenty three (23). The subbasin ID is "A" since there is only one subbasin joining the main stem at this point. This numbering combination makes this subarea "23A" in the HEC-1 hydrologic model. The mouth of the third subbasin is about 4,400 ft above the mouth of the MO watershed (Station 44) so all the infrastructure maintenance item will have a "sewer system number" of forty four (44). The subbasin ID is "A" since there is only one subbasin joining the main stem at this point. The combination makes this subarea "44A" in the HEC-1 hydrologic model.

Again, please remember that the inclusion of this figure is simply to demonstrate the maintenance numbering system. The extreme detail for the entire drainage system ID can be found in all the CDS files and the GIS data presented in Appendix 1. Referring back to Figure 2.1, the largest part of the graphic labeled "Inset Map" (on the left side) presents more detail. Please note that in this portion of the Figure, the Guadalupe River is to the left side of the page. In Appendix 1 all of the information is oriented properly and the rotation of the "Locator Map" was done simply for inclusion into this graphic.

Looking at the "Inset Map" view of Figure 2.1 the detail for primarily "sewer system" number 44 is visible. Note that each node (junction box, blind tee for inlet stub, headwall, or union with another system) has been labeled with an "*odd number.*" The pipe segment between the nodes has been labeled with an "*even number*" These numbers are the "ID" number. Please note in the Legend that there are three "strips" within this particular sewer area that are shaded for reference. This is a part of the closed system modeling nomenclature and will be discussed in more detail in Section 3D.

In the center portion of the figure (at the bottom) is a "Maintenance Numbering Example." This example presents the six components of identification for all the infrastructure items in the SDMP. The first value (of six) is for the "watershed ID" which in this case is MO for Mockingbird Outfall. The two letter abbreviations for all the watersheds can be viewed on the upper right hand side of Map Packet 1 which presents the entire SDMP study area, and also on Figure 3.1 to a reduced scale. The second value (of six) is for the "service area" number (again this is a closed system modeling term that will be discussed in Section 3D). As discussed above, there was only one service area in the MO watershed (so the value is 1 in the example) but are many service areas in the West Outfall (WO) watershed. The third value is the "sewer system" number, which in this case is 44 for the reasons mentioned above. The fourth value is the "subbasin ID" which is "A" in this case for the reasons mentioned above. The fifth value (of six) is the "strip" number which could vary from one to three in this particular watershed, but has a value of two (2) in this example. The final (sixth) value is the unique "ID" number assigned to the node *(odd)* or segment *(even)*. As mentioned above, different parts of these six pieces of identification information can then be grouped into subsets for use in either the watershed modeling, the closed system hydraulic modeling, or the maintenance numbering. The SDMP goal of being "flexible" and "dynamic" were definitely achieved.

In an effort to obtain price estimates for different types of drainage maintenance costs a "form letter" was created. The questions focused upon just the basic services including grading and maintenance of shallow roadside ditches, cleaning inlet boxes (junction boxes), and the cost to conduct a herbicide program. The form letter was sent to the Texas Municipal League (TML) general office and 13 specific Texas cities having either the same general geographic location or population as Victoria. Information was received from just Longview (LV) and McAllen (MA). The cost for perform grading and maintenance on shallow roadside ditches was $5.50 per linear foot (LV) or $76.00 per hour (MA). The cost for perform cleaning inlet boxes (junction boxes) was $18.00 per cubic yard (LV) using a vacuum truck or $39.00 per hour (MA). The cost to conduct a herbicide program is $84.00 per acre (LV) or $52.00 per hour (MA).

The Urban Drainage and Flood Control District in Denver, Colorado, keeps a historical database of maintenance costs similar to the data the City wants to collect. They are a great resource of information on all aspects of the drainage maintenance issues. Table 2.1 presents a summary of some of their information based upon different creek widths and components within the channel itself. The maintenance cost per foot is then projected into cost per foot per year by dividing by the period of time between their reported maintenance efforts.

TABLE 2.1

Type of Channel	Type of Maintenance	Length (feet)	Cost per foot	Cost/foot/ year
Natural earthen channel (45 ft) Average ROW width of 65 ft Access trail on one side	No Mowing Debris pickup (3 /yr)	22,750	$4.61	$0.35

PBSJ

Type of Channel	Type of Maintenance	Length (feet)	Cost per foot	Cost/foot/ year
Natural earthen channel (40 ft) Average ROW width of 60 ft Access trail on one side	No Mowing Debris pickup (3 /yr)	14,000	$1.01	$0.25
Natural earthen channel (20 ft) Average ROW width of 40 ft Access trail on one side	Minor Mowing Debris pickup (4-5 /yr)	4,600	$1.60	$0.23
Natural earthen channel (20 ft) Average ROW width of 40 ft Access trail on one side	No Mowing Debris pickup (3 /yr)	10,300	$0.97	$0.16
Sand bottom channel (35 ft) Boulder edges (low flow channel) Concrete walls on either side create flood channel (80 ft) Access trail on one side	Mowing (6 /yr) Debris pickup (30 to 40 /yr)	17,315	$51.83	$3.46
Concrete and boulder trickle channel (6 ft) Grassed lined channel (4:1 sides) Average ROW width of 100 ft No access trail on either side	Mowing (3/ yr) Debris pickup (5 /yr)	4,150	$12.73	$1.41
Concrete and boulder trickle channel (8 ft) Grassed lined channel (4:1 sides) Average ROW width of 125 ft Access trail on one side	Mowing (3/ yr) Debris pickup (3 /yr)	4,700	$3.35	$0.67
Concrete trickle channel (12 ft) Average ROW width of 150 ft Access trail on one side	Mowing (3/ yr) Debris pickup (3 /yr)	1,100	$10.35	$1.15
Rip rap banks, earthen bottom (25 ft) Average ROW width of 150 ft Access trail on one side	Mowing (5 /yr) Debris pickup (5 /yr)	7,750	$16.42	$1.64
Natural earth bottom Natural trickle channel Rip-rap lined banks at ROW (80 ft)	Mowing (3 /yr) Debris pickup (3 /yr)	4,450	$24.44	$1.63
Natural earth bottom Natural trickle channel	Mowing (5 /yr) Debris pickup (5 /yr)	7,550	$25.37	$1.69

Type of Channel	Type of Maintenance	Length (feet)	Cost per foot	Cost/foot/ year
Concrete trickle channel (6 ft) Average ROW width of 50 ft Access trail on one side	Mowing (3/ yr) Debris pickup (3 /yr)	4,550	$7.71	$0.86

The estimated costs associated with operating the maintenance program at the desired level of service for the City of Victoria will most likely exist within the range of numbers presented in text and tabular formats above. Certainly the current level of service can be adjusted by "backing in" to the annual drainage maintenance cost and then compared to a higher lever of service if desired. Of key importance is an evaluation by the City of 1) purchasing a vacuum truck (several models on the market) for the use in drainage maintenance and 2) using herbicide in lieu of mechanical mowing.

The vacuum truck has long been used in the wastewater utility departments for removal of sludge from lift stations and for the unplugging of collector lines. From personal experience the same benefits from the use of this type of equipment can reap great dividends in the stormwater maintenance efforts as well. Many times drainage problems can be traced to a blocked inlet or a silted storm drain line. The use of this piece of equipment revolutionizes the work required to clean these structures quickly and safely. Many times caked or packed in silt that has not been maintained for a long period of time can only be removed with the high pressure jet action of the nozzle attachments on these trucks. Two people can work their way around the City on a routine basis and complete work that would otherwise take many more staff a great deal longer time to accomplish. The benefits of this type of maintenance are immediate and very noticeable to the general public. Storm events of one to two inches rainfall that used to create problems at certain intersections, are now carried off without any problems.

The use of herbicide in lieu of mowing has become very environmentally safe, manpower efficient, and attractive on a cost basis. Some programs have been able to reduce the number of mowers in half by using herbicide in just one fourth of the area under its jurisdiction. Walton County, Georgia, reports that they are spending about sixty (60) percent less to maintain the sprayed areas. They report spending about $60 per mile using herbicides whereas they previously spent $130 per mile over the same area using the mechanical mowers. There are many types of Federally approved herbicides on the market which are safe to the receiving waters (surface water and ground water). Some of the types of herbicide are classified as a "Bermuda release" category where the invasive weeds are killed but the Bermuda grasses (a great ground cover in drainage situations due to the long roots and fairly short growth height) are stimulated. Many of the government entities make the transition gradually in an effort to not "shock" the system by killing all the weeds at one time and running the risk of exposing too much of the drainage system (which may not have any grasses along the banks) to erosion. There needs to be a combined effort of stimulating and promoting grass development and growth in concert with the herbicide efforts of economically controlling the invasive weeds. At some point in time, the grasses have covered, they resist and block out the weeds, and the channel is protected from erosion.

2.C. FINANCIAL RESOURCES STRATEGIES

The ability to finance needed drainage/flood control improvements as well as provide for operation and maintenance funds is a critical element to the Storm Drainage Master Plan. If funds are made available, proposed Plan improvements can be built and properly maintained along with existing drainage systems. The viability of funding alternatives was investigated as part of the overall effort.

Meetings were conducted early in the Project with the City Staff including the Finance Director. Information was identified that would be needed to evaluate possible funding source strategies available to the City. Information was collected for alternative analysis such as the number of water/ wastewater bills that are issued monthly current property tax rate and sales tax rate and other useful information. Table 2.2 presents the number of water billing accounts in mid 1997.

Type of Account	Number of Accounts
Apartment / Trailer Park	978
Commercial / Business	3,126
Church	193
Duplex	154
Mobile Home	707
Other	142
School	54
Single Family Residential	27,179
Yard Meter	1,215

This information was included in the evaluation of existing and future funding potential for several of the options described in more detail in later subsections of this section.

Information was collected from many state agencies regarding existing regulatory funding authorizations and other information from other sources including:

Existing County taxes including County Utility District #2, and #3,
Drainage Impact Fees authorization through Texas Local Government Code Chapter 395,
Watershed Drainage District authorization through Chapter 56 of the Texas Water Code,
Municipal Drainage Utility System authorization through Texas Local Government Code Chapter 402, Subchapter C,
Stormwater Control District authorization through Texas Water Code Chapter 66.

Additional information was gathered and used for the purposes of this analysis such as the existing drainage fees are $0.0504 per $100 valuation (Drainage District No. 3), the State tax was 6.25%, the County sales tax was 0.50% and the City sales tax was 1.50%. The current ad valorem tax rate was $0.71 per $100 valuation. The City does not currently have any "impact fees", but does have an "oversizing" agreement and procedures. The current assessed valuation for the City is $1,876,808,950 (1997). The number of residential and commercial building permits for the last three fiscal years was collected and reviewed. The current population was estimated to be 62,000. Copies of the current City budget was reviewed to include the debt service payment schedule. There are no current ordinances or other documents with any drainage inspection or related fees. It is estimated that the amount of tax exempt property within the City is about eight (8) percent.

The objective of this evaluation was to use input from the City, estimate the overall financial needs/goals, problems, constraints and institutional adjustments needed to operate and maintain the storm drainage master plan program. The "pros and cons" associated with the use of a variety of Alternatives were evaluated and developed to include but not limited to the following techniques:

General Fund,
Drainage Utility Service Charges,
City-County Drainage Utility District,
Stormwater District,
Public Improvement District,
Drainage Impact Fees,
Plan Review and Inspection Fees,
"Stand-by" fees, and
Federal and State Funding/Grants

A copy of the Draft Financial Resources Strategies Report was presented to and discussed with the City in March 1998. PBS&J used the technical consultant Ms. Mickey Fishbeck, A.I.C.P. of Rimrock Consulting Company, Austin, to provide the analysis of all the collected information. The Draft Report provided an overview of the funding alternative evaluation process including a presentation of the "pros and cons" of using the various alternatives. The Draft Report served as the beginning in the overall selection and implementation of eventual funding sources ultimately selected by the City. The Draft Report served as a platform for continued discussion and review by the City. The City Council received a briefing of this Financial Strategies Report in June 1998.

The actual implementation of whichever method is selected is up to City staff and is beyond the scope of the current SDMP contract, however, PBS&J would be available to conduct a more detailed "implementation plan" on any of the evaluated techniques. The options are discussed separately, but a single method of generating funds will most likely not be capable of meeting the needs of an expanded and comprehensive stormwater management program. A combination of methods is generally necessary to generate sufficient funds for a comprehensive program, including major capital improvements to drainage systems and an adequate maintenance program. Historically, the availability of funds from the budget of a city's general fund has been limited to the highest priority and the most critical needs. Equity and consistency are other reasons for developing a combination of funding options.

The following information presents an "overview" of the full Financial Resources Strategies report. The entire report is presented in Appendix 2 . This section will present the "decision matrix" that relates the various "funding options" (see the nine options listed above) with the various "evaluation criteria" used in the study. The evaluation criteria include the following items:

Types of Facilities that can be Funded,
Types of Costs that can be Funded,
Capital Funding Mechanisms,
Allocation of Costs to Residents,
Legal Basis for each of the Funding Options,
Administrative Control of each Funding Option,
Generational Equity,
Geographic Equity,
Other Equity Issues and Exemptions,
Tax Effects,
Start-up Requirements,
Administrative Ease,
Revenue Predictability,

Revenue Timing,
Social Effects, and
Public Understanding and Acceptance Issues.

The definition and description of both the Funding Options as well as the Evaluation Criteria is thoroughly discussed in Appendix 2. Following the "decision matrix" are a series of summary sheets that present the same basic information in a summary manner by the type of funding. For example, the first sheet will present "bullet information" about how the General Funds was rated on all the aforementioned evaluation criteria. This allows the reader to focus on one or two specific funding options and read specifically about that option.

STORM DRAINAGE MASTER PLAN FUNDING DECISION MATRIX

EVALUATION CRITERIA	GENERAL FUND	DRAINAGE UTILITY	DRAINAGE DISTRICT	STORMWATER DISTRICT	PUBLIC IMPROVEMENT DISTRICT	IMPACT FEES	INSPECTION FEES	STAND-BY FEES	GRANTS
A. FACILITIES FUNDED									
Drainage	X	X	X		X	X		X	
Stormwater	X	X		X	X	X			
Parks in Detention/Retention Areas	X			X					
Growth-Related Facilities	X	X	X	X	X	X		X	
Facilities for Existing Development	X	X	X	X	X				
B. TYPES OF COSTS FUNDED									
Capital	X	X	X	X	X	X		X	
Renovation/Replacement/Repair	X	X	X						
Operations and Maintenance	X	X	X		X				
Administration	X	X	X		X		X	X	
Organizational/Study Costs	X	X	X		X	X		X	
C. CAPITAL FUNDING MECHANISMS									

STORM DRAINAGE MASTER PLAN FUNDING DECISION MATRIX

EVALUATION CRITERIA	GENERAL FUND	DRAINAGE UTILITY	DRAINAGE DISTRICT	STORMWATER DISTRICT	PUBLIC IMPROVEMENT DISTRICT	IMPACT FEES	INSPECTION FEES	STAND-BY FEES	GRANTS
General Obligation Bonds	X		X	X	X				
Revenue Bonds		X			X				
Current Tax/Rate Revenues (Cash-Funding)	X	X	X	X	X				
Fees						X		X	
Grant									X

STORM DRAINAGE MASTER PLAN FUNDING DECISION MATRIX

EVALUATION CRITERIA	GENERAL FUND	DRAINAGE UTILITY	DRAINAGE DISTRICT	STORMWATER DISTRICT	PUBLIC IMPROVEMENT DISTRICT	IMPACT FEES	INSPECTION FEES	STAND-BY FEES	GRANTS
D. ALLOCATION OF COSTS TO RESIDENTS									
None									X
Cost-Based		X				X	X	X	
Benefit-Based			X		X				
Property Value-Based	X		X	X					
Sales Tax	X								
E. LEGAL BASIS									
Home-Rule Authority (Article X1, Section 5, Texas Constitution; Chapter 51, Tex. Local Govt. Code)	X	X			X	X	X	X	
Article VIII, Section 9, Texas Constitution	X								
Title 1, Subtitle D, Section 26, Texas Tax Code	X								
Article III, Section 52, Texas Constitution			X						
Article XVI, Section 59, Texas Constitution			X	X					
Chapter 49, Texas Water Code			X	X					
Chapter 56, Texas Water Code			X						
Chapter 66, Texas Water Code				X					
Chap 402, Subchapter C, Texas Local Govt Code		X							
Chapter 395, Texas Local Government Code						X			
Chapter 372, Texas Local Government Code					X				
F. ADMINISTRATIVE/LEGAL CONTROL									
City	X	X			X	X	X	X	
County			X	X					
TNRCC			X	X					
District			X	X					

STORM DRAINAGE MASTER PLAN FUNDING DECISION MATRIX

EVALUATION CRITERIA	General Fund	Drainage Utility	Drainage District	Stormwater District	Public Improvement District	Impact Fees	Inspection Fees	Stand-by Fees	Grants
G. GENERATIONAL EQUITY									
Subsidy to Following Generations	X	X	X	X	X				
Reduces Generational Cross-Subsidies						X	X	X	
H. GEOGRAPHIC EQUITY									
Allows Differential Costs by Area		X	X	X	X	X	X	X	
ETJ Areas Included				X	X	X	X		
Outside-City Areas Through Interlocal Agreement			X						
I. OTHER EQUITY (EXEMPTIONS)									
Other Governments Exempted	X	X	X	X					
Undeveloped Areas Exempted		X							
Religious Properties Exempted	X	X	X	X					
J. RATE/TAX EFFECTS									
Mitigates City-Wide Rates/Taxes			X	X	X	X	X	X	X
Payments Deductible on Income Taxes	X		X	X	X	X			
K. START-UP REQUIREMENTS									
Petition			X	X	X				
Notice/Hearing		X	X	X	X	X			
Creation/Bond Election	X		X	X					
Organization of Special District			X	X	X				
Board/Committee Appointment/Election			X	X	X	X			
Special Surveys		X	X						
Technical Studies (Feasibility, Planning, Engr.)		X	X	X	X	X	X	X	X
Establishment of Accounts		X	X		X	X			
Establishment of Enterprise Fund		X							
New Collection Procedures					X	X		X	

STORM DRAINAGE MASTER PLAN FUNDING DECISION MATRIX

EVALUATION CRITERIA	GENERAL FUND	DRAINAGE UTILITY	DRAINAGE DISTRICT	STORMWATER DISTRICT	PUBLIC IMPROVEMENT DISTRICT	IMPACT FEES	INSPECTION FEES	STAND-BY FEES	GRANTS
L. ADMINISTRATIVE EASE									
Separate Accounts Required		X	X	X	X	X			
Collection with Other Taxes	X		X	X	X				
Collection with Other Utility Rates		X							
Collection with Other Fees						X	X		
Special Reporting Required			X			X			
Special Record-keeping Required						X			
M. REVENUE PREDICTABILITY									
Lump-Sum									X
Regular Periodic Collection	X	X	X	X	X			X	
Collection Erratic	X					X	X		
N. REVENUE TIMING									
Up-Front									X
Annually	X		X	X	X				
Monthly		X			X			X	
Erratic	X					X	X		
O. SOCIAL EFFECTS									
Increase in Home/Business Property Costs						X	X		
Increase in Home/Business Operational Costs	X	X	X	X	X			X	
P. PUBLIC UNDERSTANDING/ACCEPTANCE ISSUES									
Technical Difficulty		X			X	X		X	
Segregation of Benefitted Properties		X	X	X	X	X	X	X	
Reduction of Cross-Subsidies		X	X	X	X	X	X	X	

GENERAL FUND

FACILITIES FUNDED
- All

TYPES OF COSTS FUNDED
- Capital
- Renovation/Repair/Replacement
- Operations & Maintenance
- Administration
- Study Costs

CAPITAL FUNDING MECHANISMS
- General Obligation Bonds
- Cash-Funding from Current Tax Revenues

ALLOCATION OF COSTS
- Property-Value Based
- Sales Taxes

LEGAL BASIS
- Home-Rule Authority
- Art VII, Sec 9, Texas Constitution
- Title 1, Subtitle D, Sec 26, Texas Tax Code

CONTROL
- City

GENERATIONAL EQUITY
- Subsidy to Following Generations

GEOGRAPHIC EQUITY
- Some Sales Tax From Outside City

EXEMPTIONS
- Government
- Religious

RATE/TAX EFFECTS
- Payments Income-Tax Deductible

START-UP REQUIREMENTS
- None

ADMINISTRATIVE EASE
- Standard Tax Collection

REVENUE PREDICTABILITY
- Periodic Collection (Property Taxes)
- Erratic Collection (Sales Taxes)

REVENUE TIMING
- Annual (Property Taxes)
- Erratic (Sales Taxes)

SOCIAL EFFECTS
- Increase in Home Operating Costs
- Sales Tax Regressive

UNDERSTANDING/ACCEPTANCE
- Property/Sales Tax Increases

DRAINAGE UTILITY

FACILITIES FUNDED
- Drainage
- Stormwater
- Growth-Related
- Existing Development

TYPES OF COSTS FUNDED
- Capital
- Renovation/Repair/Replacement
- Operations & Maintenance
- Administration
- Study Costs

CAPITAL FUNDING MECHANISMS
- Revenue Bonds
- Cash-Funding from Current Rate Revenues

ALLOCATION OF COSTS
- Cost Based

LEGAL BASIS
- Home-Rule Authority
- Chapter 402, Subchapter C, Texas Local Government Code

CONTROL
- City

GENERATIONAL EQUITY
- Subsidy to Following Generations

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area

EXEMPTIONS
- Government
- Religious
- Undeveloped Areas

RATE/TAX EFFECTS
- Payments Not Income-Tax Deductible

START-UP REQUIREMENTS
- Notice/Hearing
- Special Surveys
- Technical Studies
- Establishment of Accounts
- Establishment of Enterprise Fund

ADMINISTRATIVE EASE
- Collection with Other Utility Rates
- Separate Accounts Required

REVENUE PREDICTABILITY
- Periodic Collection

REVENUE TIMING
- Monthly Collection

SOCIAL EFFECTS
- Increase in Home Operating Costs

UNDERSTANDING/ACCEPTANCE
- Technical Difficulty
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

DRAINAGE DISTRICT

FACILITIES FUNDED
- Drainage
- Growth-Related
- Existing Development

TYPES OF COSTS FUNDED
- Capital
- Renovation/Repair/Replacement
- Operations & Maintenance
- Administration
- Study Costs

CAPITAL FUNDING MECHANISMS
- General Obligation Bonds
- Cash-Funding from Current Tax Revenues

ALLOCATION OF COSTS
- Property-Value Based
- Benefit-Based

LEGAL BASIS
- Texas Constitution: Article III, Section 52; Article XVI, Section 59
- Texas Water Code: Chapters 49, 56

CONTROL
- County
- TNRCC
- District

GENERATIONAL EQUITY
- Subsidy to Following Generations

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area
- Interlocal Agreements Allowed

EXEMPTIONS
- Government
- Religious

RATE/TAX EFFECTS
- Payments Income-Tax Deductible
- Mitigates City-Wide Rates/Taxes

START-UP REQUIREMENTS
- Petition
- Notice/Hearing
- Creation/Bond Election
- Organization of Special District
- Board Appointment/Election
- Special Surveys
- Technical Studies
- Establishment of Accounts

ADMINISTRATIVE EASE
- Collection with Other Taxes
- Separate Accounts Required
- Special Reporting Required

REVENUE PREDICTABILITY
- Periodic Collection

REVENUE TIMING
- Periodic Collection

SOCIAL EFFECTS
- Increase in Home/Business Operating Costs

UNDERSTANDING/ACCEPTANCE
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

STORMWATER DISTRICT

FACILITIES FUNDED
- Stormwater
- Parks in Detention/Retention Areas
- Growth-Related
- Existing Development

TYPES OF COSTS FUNDED
- Capital

CAPITAL FUNDING MECHANISMS
- General Obligation Bonds
- Cash-Funding from Current Tax Revenues

ALLOCATION OF COSTS
- Property-Value Based

LEGAL BASIS
- Texas Constitution Article XVI, Section 59
- Texas Water Code: Chapters 49, 66

CONTROL
- County
- TNRCC
- District

GENERATIONAL EQUITY
- Subsidy to Following Generations

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area
- ETJ Areas Included

EXEMPTIONS
- Government
- Religious

RATE/TAX EFFECTS
- Payments Income-Tax Deductible
- Mitigates City-Wide Rates/Taxes

START-UP REQUIREMENTS
- Petition
- Notice/Hearing
- Creation/Bond Election
- Organization of Special District
- Board Appointment/Election
- Technical Studies

ADMINISTRATIVE EASE
- Collection with Other Taxes
- Separate Accounts Required

REVENUE PREDICTABILITY
- Periodic Collection

REVENUE TIMING
- Periodic Collection

SOCIAL EFFECTS
- Increase in Home Operating Costs

UNDERSTANDING/ACCEPTANCE
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

PUBLIC IMPROVEMENT DISTRICT

FACILITIES FUNDED
- Drainage
- Stormwater
- Growth-Related
- Existing Development

TYPES OF COSTS FUNDED
- Capital
- Operations & Maintenance
- Administration
- Study Costs

CAPITAL FUNDING MECHANISMS
- General Obligation Bonds
- Revenue Bonds
- Cash-Funding from Current Tax Revenues

ALLOCATION OF COSTS
- Benefit-Based

LEGAL BASIS
- Home Rule Authority
- Chapter 372, Texas Local Govt Code

CONTROL
- City

GENERATIONAL EQUITY
- Subsidy to Following Generations

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area
- ETJ Areas Included

EXEMPTIONS
- None

RATE/TAX EFFECTS
- Payments Income-Tax Deductible
- Mitigates City-Wide Rates/Taxes

START-UP REQUIREMENTS
- Petition
- Notice/Hearing
- Organization of Special District
- Committee Appointment
- Technical Studies
- Establishment of Accounts
- New Collection Procedures

ADMINISTRATIVE EASE
- Collection with Other Taxes
- Separate Accounts Required

REVENUE PREDICTABILITY
- Periodic Collection

REVENUE TIMING
- Periodic Collection

SOCIAL EFFECTS
- Increase in Operating Costs

UNDERSTANDING/ACCEPTANCE
- Technical Difficulty
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

IMPACT FEES

FACILITIES FUNDED
- Drainage
- Stormwater
- Growth-Related

TYPES OF COSTS FUNDED
- Capital
- Study Costs

CAPITAL FUNDING MECHANISMS
- Fees and In-Kind Contributions

ALLOCATION OF COSTS
- Cost-Based

LEGAL BASIS
- Home Rule Authority
- Chapter 395, Texas Local Govt Code

CONTROL
- City

GENERATIONAL EQUITY
- Reduces Generational Cross-Subsidies

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area
- ETJ Areas Included

EXEMPTIONS
- None

RATE/TAX EFFECTS
- Mortgage Interest Income-Tax Deductible
- Mitigates City-Wide Rates/Taxes

START-UP REQUIREMENTS
- Notice/Hearing
- Committee Appointment
- Technical Studies
- Establishment of Accounts
- May Require New Collection Procedures

ADMINISTRATIVE EASE
- Possible Collection with Other Fees
- Separate Accounts Required
- Semi-Annual Reports
- Special Record-Keeping
- Update Every Three Years

REVENUE PREDICTABILITY
- Dependent on Development Activity

REVENUE TIMING
- After City Funding Through Other Means

SOCIAL EFFECTS
- Increase in Home/Business Purchase Cost

UNDERSTANDING/ACCEPTANCE
- Technical Difficulty
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

ENGINEERING REVIEW AND INSPECTION FEES

FACILITIES FUNDED
- None

TYPES OF COSTS FUNDED
- Administration

CAPITAL FUNDING MECHANISMS
- None

ALLOCATION OF COSTS
- Cost-Based

LEGAL BASIS
- Home Rule Authority

CONTROL
- City

GENERATIONAL EQUITY
- Reduces Generational Cross-Subsidies

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area
- ETJ Areas Included

EXEMPTIONS
- None

RATE/TAX EFFECTS
- Mortgage Interest Income-Tax Deductible
- Mitigates City-Wide Rates/Taxes

START-UP REQUIREMENTS
- Technical Studies

ADMINISTRATIVE EASE
- Collection with Other Fees

REVENUE PREDICTABILITY
- Dependent on Development Activity

REVENUE TIMING
- At Time Service is Provided

SOCIAL EFFECTS
- Increase in Home/Business Purchase Cost

UNDERSTANDING/ACCEPTANCE
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

STAND-BY FEES

FACILITIES FUNDED
- Drainage
- Growth-Related

TYPES OF COSTS FUNDED
- Capital
- Maintenance
- Administration
- Study Costs

CAPITAL FUNDING MECHANISMS
- Monthly Fees

ALLOCATION OF COSTS
- Cost-Based

LEGAL BASIS
- Home Rule Authority
- Legal Basis Uncertain

CONTROL
- City

GENERATIONAL EQUITY
- Reduces Generational Cross-Subsidies

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area

EXEMPTIONS
- None

RATE/TAX EFFECTS
- Mitigates City-Wide Rates/Taxes

START-UP REQUIREMENTS
- Technical Studies
- May Require New Collection Procedures

ADMINISTRATIVE EASE
- May Be Difficult to Collect

REVENUE PREDICTABILITY
- Monthly

REVENUE TIMING
- Monthly

SOCIAL EFFECTS
- Increase in Property Operational Cost

UNDERSTANDING/ACCEPTANCE
- Legal Basis Uncertain
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

3. WATERSHED STUDIES

An integral part of the storm drainage master plan development involves the identification and location of problem areas, the gathering of pertinent data for the areas identified, the hydrologic/ hydraulic analysis of the areas, the screening and evaluation of stormwater structural and non-structural control measures and the selection of recommended control measures (or a combination therefrom) for the individual problem areas and watersheds. This effort was organized and carried out on a watershed and subwatershed basis for various reasons including the interactions of the hydrologic and hydraulic systems within a watershed. Care was taken to avoid creating a new problem while solving the original problem. In that regard, drainage solutions were generally be developed working from downstream to upstream.

The study limits for the proposed project encompasses the City's 100-square mile drainage area and surrounding area that includes the watershed areas contributing flow to the numerous creeks and tributaries that traverse the City. The major watersheds include Lone Tree Creek, Spring Creek, Whispering Creek, North Outfall, Jim Branch Creek, West Outfall, Mercado creek and their tributaries (U.S. Highway 77 Outfall, Mockingbird Outfall, South Outfall, and Second Street). Figure 3.1 presents a reduced copy of a map showing all the watersheds included in the SDMP. A full size plot of this same map is included in Map Packet 1. The various work elements involved in these watershed studies are discussed further below.

3.A. SPECIAL PROBLEM IDENTIFICATION

Specific areas throughout the Study Area that have historically had flooding and drainage problems were identified and classified. These problem areas are "special" in that they are known about prior to performing hydrologic and/or hydraulic analysis/modeling due to past flooding occurrences. Knowledge of such problem areas was obtained from City Staff, Design Team members and from Public input. These problem areas reside along small, intermediate or large drainage ways. This data was very useful in the "prioritization" task of the Master Plan. The effort needed to identify these special (known) problem areas involved an intense review of City files (complaint files, notes and sketches of problem areas, etc.), discussions with City staff, surveying and related items. The work included an examination of all drainage projects that are presently identified as Capital Improvement Projects (CIP).

The Design Team assisted the City in drafting a mailout "questionnaire" form and in obtaining general public input from three neighborhood meetings. A copy of the form is included in Appendix 3. The form includes specific questions regarding the number of times houses, streets, or garages have been flooded, and whether the person registering the complaint owns flood insurance. An additional space was provided for relevant comments.

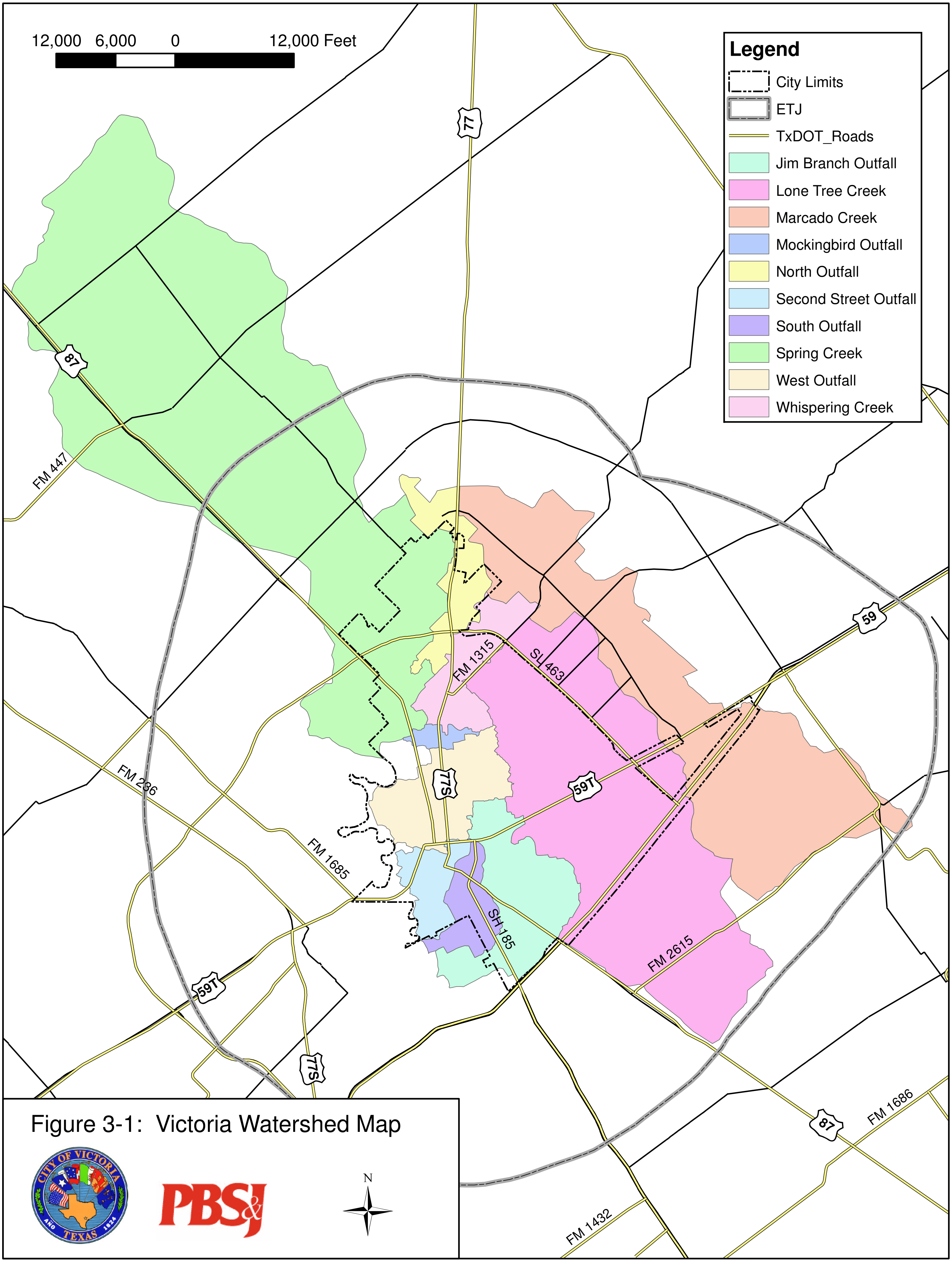


Figure 3-1: Victoria Watershed Map

The forms were included in the water bill mailing of June 20, June 27, July 3 and July 11, 1997. The citizens then could either mail the form back to the City or bring it in person to one of the three Neighborhood Meetings. The first neighborhood meeting was conducted on July 17, 1997, at Vickers Elementary, the second meeting on July 22 at Crane Elementary, and the final meeting on July 24 at the Community Center. The locations were selected to allow citizens from all areas of town to attend a session near to their homes. The goal was to allow the citizens access to the SDMP process and to include everyone that had an interest in the drainage problems of the City.

Each meeting was conducted in a similar manner. The City Staff and Officials made introductory remarks setting the goals for the meeting. Then members of the Design Team and the City Staff split into three groups and went to three locations within the meeting room with a City map mounted on foam board. As each citizen would discuss their drainage problem, their questionnaire form was assigned a number, and then a "map dot" was attached to the city map in the general location of the complaint. A total of 3187 complaint forms were collected for the study.

The large set of complaint forms was entered in to a Microsoft Access database. A customized interface was created for the extensive amount of data entry required. An example of the input screen is shown in Appendix 4. A set of reports was also generated in order to track the status of the database populations. Space was also provided in the database to store the source of the complaint form (i.e., either a public meeting number or utility mail-out that was returned).

A drainage complaint graphical database was then generated for use in identification of problem areas and tracking of drainage issues which linked the database information to a specific location on the GIS/LIS map (that was provided by the City). In order for the drainage complaint forms to provide a graphical visualization of problem areas, each complaint had to be located on a map of Victoria. Each complaint form with sufficient address information was located on a set of street maps for the city. These locations were then digitized and tagged with the unique number on the complaint form. The file was then brought into ArcView and the database was connected to the graphical representation through the unique identification number. A total of 2002 complaint forms contained sufficient information to locate the complaint on a map. ArcView could then be used to query for any item in the database such as queries for flood insurance, garage flooding, house flooding and street flooding

Table 3.1 presents a tabular summary of all the drainage complaint information that is in the database. It includes 1) the total number of complaints, 2) the number reporting ownership of flood insurance, 3) the number without a street address, 4) the number with garage, house, street flooding occurring less than five times, between five and ten times, and over ten times. Besides being able to extract this information through the database, the information can also be reviewed using a graphical GIS picture.

Table 3.1: Drainage Complaint Form Summary

	Number of Complaint Forms Reporting Issues				
	Number of Occurrences in Past 10 Years				
Type of Issue	5-Jan	10-Jun	>10	Total	
Streets Impassable	1035	101	33	1169	
House Flooded	372	28	19	419	
Garage Flooded	337	78	54	469	
Number Reporting Ownership of Flood Insurance					438
Total Number of Drainage Complaints Received					3187
Number with Adequate Address Information for Location on Map					2002

For example, the question could be raised, "how many houses have experienced street flooding in the last ten years" and a graphic could be displayed on the computer screen or the same information could be plotted out as a hard copy similar to the one included in Map Packet 2. Each dot represents a response in the database and the color codes represent the different frequencies.

One of the major goals of the SDMP was to create work products that were "flexible and dynamic" allowing the City to add more information as the future dictates. This objective was achieved in the creation of this graphical complaint database. For example, as more drainage information is collected by the City (on a regular basis or after specific storm events) more information could be added to the existing data form, or new columns of information can be added at any time to capture more information than was requested in the initial "questionnaire" form discussed above. Other Additional/Future Steps could include a direct interface to ArcView that would allow for entry of drainage complaint information and automated location of the complaint address. If the city prefers to keep the data entry and mapping aspects of the drainage complaint form process separate, the Access interface could continue to be used for data entry, while an ArcView interface could be created to automatically locate the complaint addresses on a map.

The Design Team has the technical capabilities to assist the City in the development of any of these enhancement options or other improvements the City Staff would like to create. Like the maintenance database discussed in Section 2B, the system is intentionally created with an "open architecture" to allow for growth and refinement. This database could evolve into more than a drainage complaint database to include tracking and graphically documenting all the Public Works complaints throughout the City. Should the City wish to conduct the "questionnaire" format again, the Design Team would like to make some recommendations for future drainage complaint forms which include the following:

1. Specific address and zip code information. This will allow the use of geocoding abilities native to ArcView to automatically locate the complaint sites.
2. Section of questions specific to the address listed on the form. This would include the information collected on the original form.
3. Space for non-address specific issues. This could include information about street or property flooding areas other than the specific address, drainage system repair or maintenance concerns, and general comments.

The additional breakdown of drainage complaints categories should help to isolate specific problems and clarify general drainage issues.

3.B. DATA COLLECTION/SURVEYING

An extensive effort in data collection, including surveying, was made by the City Planning Department to obtain good, usable topographic, drainage structure and other physical feature data. Aerial and field data collected was used in describing drainage patterns, locating overflow diversions, identifying the sources of problems and allowing for the proper designs for difficult solutions. The Land Information System (LIS) developed by LanData (previously United Aerial Mapping - UAM) in the PC ARCInfo format and MicroStation format was eventually made available for this study. The detail of contour information within City limits was 1-foot (ft) interval and to a 2-ft interval in the ETJ. This electronic contour interval mapping was used with USGS topographic information (upper Spring Creek) as well as site specific field surveying.

Other basic data that was gathered for use in the SDMP included reports from the Soil Conservation Service (SCS) that discuss the apparent soil conditions in the area. This information was digitized onto the LIS base map and eventually used in the determination of the hydrologic runoff coefficient. Also obtained were the existing land use maps from the City Planning Department. This information was also used in the determination of the hydrologic runoff coefficient. It already came in an electronic format and did not need to be digitized. As the SDMP progressed, a list of additional data that was added to the LIS through this Project was created. Besides hydrologic information, there was also a review of the Randy Thompson Report on Lone Tree Creek, and the retrieval of past FEMA study files, work maps, products, and data. This information proved particularly helpful in the creation of the hydraulic models. Also obtained was a copy of the City's Parks Master Plan which provided guidance regarding opportunities for "multiuse" facilities ties to the drainageways. In addition to the LIS electronic files, the Design Team also obtained the LanData (UAM) horizontal and vertical control points. Throughout the SDMP the City provided information of recently constructed CIP street and drainage improvements.

General information was collected in certain specific areas regarding existing Plats, Subdivision Plans, Rights-of-Way (ROWs), Easements, and Homeowners Agreements. There were several "unique" agreements made in the past regarding drainage and land use that were shared with the Design Team and included into the SDMP analysis. The data collection effort was of the detail of the Appraisal District and did not duplicate their readily available information. The focus of the data collection was on the FEMA creek corridors and special problem (drainage complaint) areas mentioned above. Of major importance and use was access to the stormwater information currently presented on the City's Storm Drainage infrastructure maps. That data was assumed to be correct without extensive research of the County records.

In order to get a better handle on some of the problem areas, there was an assessment made of the "additional data gathering needs" on Special Problem Areas and Along Primary Study Creeks. The Design Team prepared a list of areas where additional field data must be collected such as pipe diameter, the flowline of certain structures, and the interrelation of several "interconnected" drainage systems within the City. After a determination of the required data collection/surveying was complete, then this field information was gathered by the local company, Urban Surveying. All the LIS topography and surveying was to be utilized to the maximum extent practical and simply supplemented with field surveying for special problems areas and for any measurements required to perform the base hydrology/hydraulics modeling efforts.

The LIS was used to identify the need and relative success in collecting additional information using a data "reliability index." If the information was surveyed to two decimal points (such as during "as built" surveying at the end of a CIP project) then the database information was tagged with an "A" as being the best information. If the information was taped in the field to the nearest tenth of a foot, then a "B" label was attached. If the information was estimated between two A or B level pieces of information, then a "C" was used. And finally, if the database information was estimated by any number of methods, then a "D" was included. The intent of this "reliability index" system is to relay to the user the relative accuracy of the data that was included in the model. Simply because a number can be displayed electronically to several decimal places does not mean that is actually known to that high level of detail. The difference between "precision" and "accuracy." The Design Team wanted to leave information for the City that would allow City Staff to "upgrade" the overall level of detail in the SDMP through time by retrieving field data that would raise the C and D levels up to at least B level. Certainly after the proposed CIP drainage projects are completed, then the information on the new infrastructure would be upgraded to the A category.

In addition to this physical data, there was also an assessment of the general cultural resources and physical feature (environmental) constraints throughout the Study Area. The next two sections describe that data collection effort in more detail.

Cultural Resources

This section presents a brief overview of the cultural history and cultural resources of Victoria County, particularly those within the Extra Territorial Jurisdiction (ETJ) of the project. Map Packet 3 includes a large color map that goes along with this section of the report and the locations referenced herein. The cultural developments of the Southern Coastal Corridor Archaeological Region (Mercado-Allinger et al., 1996) are usually classified by archaeologists according to four primary chronological an developmental periods: Paleoindian, Archaic, Late Prehistoric, and Historic. These classifications have been defined primarily by changes in material culture over time, as evidenced through information and artifacts recovered from archaeological sites. One general theoretical tenet that underlies this classification scheme is that change in material culture reflects behavioral and cultural adaptation to change in the natural and manmade environment.

Cultural Setting

Paleoindian Period

The earliest cultural manifestation in this region of Texas is the Paleoindian period. It dates from 9,200 to 6,000 B.C. and according to Black (1989:48) this period was marked by "very low population density, small band size, and extremely large territorial ranges." The *Clovis* projectile point is the hallmark of Paleoindian occupation in this area. Site 41VT15, the Johnston-Heller site, in Victoria County yielded a *Clovis* point from a deep erosional gully at the site (Mercado-Allinger et al., 1996). In addition to the *Clovis* point, later Paleoindian points such as *Plainview* and *Golondrina* were also recovered from site 41VT15. This site is outside of the ETJ for this project.

Materials from the latter part of the Paleoindian period are more common in the ETJ than are *Clovis* points. Recent test excavations conducted at the River Spur site (41VT112) in the ETJ have identified late Paleoindian deposits (Cloud et al., 1994). Diagnostic artifacts recovered include *Angostura*, *Golondrina*, *Plainview*, and *Scottsbluff* projectile points and *Clear Fork* tools. Materials like those recovered at the River Spur site have also been identified in sites from outside the ETJ such as 41VT5 (the Miller site), 41VT16 (the Willeke site), and 41VT43 (Hester, 1980). The materials from the three latter sites are all from surface contexts.

Archaic Period

Following the Paleoindian period, the Archaic period in the ETJ dates from 6,000 B.C. to A.D. 700. Shifts in subsistence strategies are suggested by the first evidence of reliance upon estuarine resources such as oysters (Ricklis, 1993). In Victoria County, but outside of the current ETJ, Site 41VT17 (the Shumla site), contains deposits from the early Archaic. Data derived from archaeological work in the region support the contention that some Paleoindian patterns such as low population density and large territorial ranges continued into the early Archaic. The middle Archaic period is poorly represented in the ETJ. A lack of sites dating to this period and a lack of generally recognized Middle Archaic projectile point types may represent a variation in long-term adaptive patterns in the region (Mercado-Allinger et al., 1996). The late Archaic period is represented in the ETJ by large, thick shell midden deposits and triangular shaped dart points. Subsistence data from the late Archaic period are indicative of a reliance upon a broad range of marine and terrestrial resources. Cemetery sites are common in this region and include sites 41VT1, 41VT9, 41VT12, and 41VT94, all in Victoria County. Of these, Site 41VT12 is within the ETJ for this project.

Late Prehistoric

The Late Prehistoric period follows the Archaic period. Characteristics of the Late Prehistoric period include the appearance of the bow and arrow, smaller projectile point types, and the emergence of ceramics. The lifestyle of the preceding Archaic period did not appear to change much during the Late Prehistoric (Huebner and Comuzzie, 1992). Hunting and gathering continued as the subsistence base, but changes did occur in tool technology and hunting techniques.

The Late Prehistoric is identified based on the Rockport complex (Story, 1968). Sandy paste ceramics are often decorated or mended with asphaltum, and various arrow points including Scallorn, Fresno, and Perdiz are typical at Rockport sites. Sites from this period are known to occur on the barrier islands, along bay margins, on brackish water streams, rivers, and on interior uplands. The diversity in site locations implies that Late Prehistoric groups were exploiting numerous habitats and taking advantage of seasonally abundant and diverse food resources (Black, 1989).

Historic

Among the early explorers, Cabeza de Vaca, Sieur de la Salle, Pedro de Rivera, Mardin de Alarcon, and Alonzo de Leon are prominent, the latter being the discoverer of the Guadalupe River in 1689. The first European settlement in what is now Victoria County was established in 1685. In that year Rene Robert Cavelier, Sieur de La Salle, established Fort St. Louis on the southwest bank of Garcitas Creek (Tunnell, 1997). Plagued by disease, starvation and Indian attacks Fort St. Louis ceased to exist. In 1722, the Spanish established the mission of Nuestra Senora del Espiritu Santo del Zuniga (also called La Bahia del Espiritu Santo) near the ruins of La Salles' Fort St. Louis in an attempt to Christianize the indigenous people. The mission was later moved to a site near the Guadalupe River and in 1754 it was again moved, this time to Goliad. It was during this time that the Franciscans missionaries laid the foundation for the livestock industry of Texas. The missionaries stock formed the nucleus from which vast herds of wild cattle and mustangs later developed in Texas (Webb, 1952).

During the Mexican revolt against Spain in the earliest years of the nineteenth century, some skirmishes were fought in the area of these early Spanish missions. After Mexico gained independence in 1821, Mexican colonization began in earnest. The first permanent settlement in the area was a colony established by the rancher Martin de Leon who had secured a land grant from the Mexican government. The city of Victoria, the county seat, is on the site along the Guadalupe River selected by de Leon in 1824.

The early settlers in Victoria were primarily Mexican, but there were also some Irish and German and a few Anglo-Americans from Louisiana and other southern states.

Present day Victoria County was established in 1836 and organized in 1837. It was one of the original twenty-three counties established by the First Congress of the Republic of Texas on March 17, 1836 (Tyler, 1996). Its modern boundaries were not determined until March 1846, however. The county was crossed by popular roads and as such was heavily traveled by traders and immigrants. During the period of the Republic of Texas and the early years of statehood, many settlers from the Old South established plantations and ranches in Victoria. Large number of German immigrants increased the county's population between 1840 and 1848.

The economy of Victoria County was based primarily on cattle, horses, cotton, and corn. Another important industry was the manufacture of molasses from sugar cane. With the influx of southerners into the area the slave population increased from 28.3% in 1850 to 33.9% in 1860 (Webb, 1952). With the increase in slaves there was also an increase in the number of acres under cultivation. The acreage under cultivation increased during the 1850s from 4,072 to 31,495 (Webb, 1952).

In 1861 Victoria County overwhelmingly voted for Texas' secession from the Union. Military units were organized in the county and many men served in the Confederate Army. The Guadalupe River, an important waterway due to its navigability, was rendered unnavigable by General John B. Magruder. He sank boats and filled the river channel with trees when Union invasion seemed imminent. The San Antonio and Mexican Gulf Railroad from Victoria to Port Lavaca, which was established in 1861, was also destroyed by General Magruder.

PREVIOUS INVESTIGATIONS

Victoria County

The first archaeological site recorded in Victoria County was the Morhiss Site (41VT1). This site that was identified and investigated by A.T. Jackson and A.M. Woolsey in 1932 is approximately 300 m south of the ETJ. Archaeological investigations were also conducted by Woolsey at the Peach Tree Knoll, Spring Creek (41VT7), Doc Hiller (41VT10), and Vic Urban (41VT12) sites (Woolsey 1932), all of which are within the current ETJ boundaries. Works Progress Administration crews returned to the Morhiss Site in 1938 and continued investigations until 1940 (Campbell, 1976).

Avocational archaeologists have contributed much to the archaeological record of Victoria County. During the 1960s W.W. Birmingham conducted extensive excavations at 41VT15, the Johnston-Heller Site on Rocky Creek (Birmingham and Hester, 1976) and Ed Vogt conducted investigations at

41VT12, the Vic Urban Site (Huebner and Commuzzie, 1992). Site 41VT15 is outside of the ETJ and Site 41VT12 is within the ETJ boundaries. Virgil Branch and Cecil Calhoun conducted salvage excavations at 41VT9, the Texas West Indies Ranch Site. Salvage excavations were necessary when road construction exposed several burials. The Texas West Indies Site dates to the Archaic and Late Prehistoric periods and yielded the remains of about 22 individuals and more than 400 artifacts (Birmingham and Huebner, 1991). Excavations at 41VT6, the J-2 Ranch Site were initiated in 1961 by W.W. Birmingham and Smitty Schmiedlin and continued through 1963. The Southern Texas Archaeological Association spent a second field season at 41VT6 in 1976 and 1977. During these investigations Paleoindian through Late Prehistoric components were identified at the site (Fox et al., 1978). These materials have yielded the most complete chronological sequence yet excavated in Victoria County (Huebner and Commuzzie, 1992). Sites 41VT6 and 41VT9 are both outside of the ETJ boundaries.

In 1975, the Center for Archaeological Research (CAR), The University of Texas at San Antonio initiated the first large scale survey in Victoria County. This survey, which recorded 49 sites, was conducted for the Coleto Creek Reservoir Project along the Coleto, Turkey, Perdido, and Sulphur Creek drainages (Fox and Hester, 1976). The temporal range of the sites recorded during this survey ranged from Paleoindian to Late Prehistoric with Archaic sites being the most abundant. In 1979, Fox and Livingston recorded and investigated a German farmstead in Victoria County.

Construction for a transmission power line exposed site 41VT66 (the Burris Site) in May 1978. Avocational archaeologists (Schmiedlin, 1979) and CAR staff (Brown, 1983) visited and surface collected the site. More recently Huebner (1987) has conducted excavations at the site and has exposed a Toyah Horizon bison processing feature. His work has also determined that cultural material at this site possibly continues for approximately four meters. However, this site was extensively impacted by the construction of a flume for the Coleto dam before any archaeological work was initiated

In 1980, during the construction of the Regional Wastewater Treatment Plant in Victoria, a representative of the Guadalupe-Blanco River Authority informed CAR that human bones had been uncovered at the construction site. Archaeologists from CAR carried out investigations and recorded the human remains of one adolescent male. The burial had been extensively impacted by the construction and no grave goods were recovered (Potter and Spencer, 1980). This burial was associated with Site 41VT78. In 1989, CAR conducted an archaeological survey of the Children's Park in Victoria. No cultural resources were identified during this survey (Potter, 1989).

In 1982 and 1983, archaeological investigations were conducted at the Blue Bayou site, one of the largest mortuary sites in the Coastal Plain (Huebner and Comuzzie, 1992). Archaeological investigations were also completed at the presumed second location of the Espiritu Santo Mission (41VT11) during the summer and fall of 1995 (Walter, 1997).

More recent archaeological work in Victoria County includes the excavation of eight cannons at Site 41VT4, Fort St. Louis (Tunnel, 1997), excavations at 41VT10, the Tonkawa Bank Site (Hindes, Fox and Schmiedlin, 1997), and investigations at 41VT112, the River Spur Site, (Cloud et al., 1994).

Extra Territorial Jurisdiction (ETJ)

A literature review was conducted for the proposed ETJ area. Known cultural resources sites within or adjacent to the ETJ were plotted on 7.5' quadrangle maps. The cultural resources files at the Texas Archeological Research Laboratory (TARL) and at the Texas Historical Commission (THC) were reviewed for sites located within or adjacent to the project area. A search was conducted of both published and unpublished National Register of Historic Places (NRHP) data for sites on or determined eligible for inclusion on the NRHP. The list of State Archeological Landmarks (SAL) prepared by the Department of Antiquities Protection of the THC was reviewed. The Historical Marker Program of the THC was also consulted.

The available records at TARL revealed that 16 archaeological site are recorded within the study area. Of the 16 sites recorded, 12 (41VT7, 41VT12, 41VT25, 41VT69, 41VT72, 41VT73, 41VT74, 41VT75, 41VT76, 41VT78, 41VT104, and 41VT112) are prehistoric, one is prehistoric/historic (41VT10), and one (41VT122), is historic. Site 41VT114 was reserved in 1994 by Barto Arnold, however, no site data has been submitted to TARL.

The files at the THC revealed ten sites listed on the NRHP and three sites determined eligible for listing on the NRHP. All of these sites are located within the ETJ of the project. Three of the NRHP listed properties are also registered as SALs. These are sites 41VT10, 41VT112, and the Old Victoria County Courthouse.

The files at the THC revealed 64 State Historic Markers in Victoria County and all but four are listed within the City of Victoria.

The THC records listed 15 projects in the vicinity of Victoria that had been issued Department of Antiquities Protection (DAP) permits for cultural resources surveys. Of these 15, information was available for 6.

Environmental

A brief discussion of wetland concerns or other environmental issues associated with construction (including fill or discharge of dredged material) into drainages and floodplains is presented below. Construction within waters of the U.S., including wetlands, is within the regulatory authority of the U.S. Army Corps of Engineers (COE) as regulated by Section 404 of the Clean Water Act. Waters of the U.S. protected by the Clean Water Act (under the COE jurisdiction) include streams, rivers, estuaries, and most ponds, lakes and wetlands.

The initial review of the wetland areas in the study area vicinity included a review of the U.S. Fish and Wildlife Service (FWS) National Wetland Inventory (NWI) maps. These USGS topographic base maps identify wetland features and water bodies. Color infrared (CIR) aerial photography (flown in early 1995) covering the study area vicinity was purchased to use in photo-interpretation of wetland areas. With the combination of the NWI maps and the CIR photography wetland features within the study area are identifiable. A brief field reconnaissance within public access allowed for verification of certain wetland features.

In general, the wetlands occurring within the study area are concentrated within the Guadalupe River floodplain. These wetland areas include: forested wetlands (primarily depressional features which maintain sufficient saturation); oxbow lakes and sloughs which are typically covered in water with a fringe of hydrophytic (water adapted) plant species; scrub shrub wetlands which are associated with sloughs and oxbows, however the woody species are the predominate cover; and wet meadows that typically are round, depressional features located within pastures or cleared areas. A brief description of wetland and water features found within the watersheds of concern are presented.

Spring Creek Watershed

Within this watershed water bodies and wetland features are predominately located south of Loop 463 to the confluence with the Guadalupe River within the floodplain of Spring Creek. Several ponds with adjacent fringe wetlands and gravel pits with associated wetland vegetation are found in this stretch of Spring Creek (approximately 3 miles). Also found scattered throughout this watershed are stock ponds and depressional wet features (meadows) within non-forested communities. Along Spring Creek, a narrow fringe of streamside vegetation would likely be included as jurisdictional wetlands in addition to the stream channel.

Other Watersheds

As far as the wetland features found within two of the larger watersheds (Lone Tree Creek and Mercado Creek), wetland areas are associated with streamside vegetation and scattered depressional features. The depressional features are typically non-forested areas, found within pasture or crop land uses.

The small West Outfall watershed supports a remnant floodplain forest (wet and non-wet communities), east of Victoria Memorial Municipal Park. The remaining watersheds typically are characterized by urban, channelized drainage features, represented by concrete-lined or natural vegetation-lined channels.

Agency Meeting

On February 12,1998, a multi-agency meeting to introduce a project overview of the Storm Drainage Master Plan occurred. Representatives from the U.S. Army Corps of Engineers (COE), FWS, Texas Parks and Wildlife Department (TPWD), General Land Office (GLO) of Texas, the City of Victoria, and PBS&J were in attendance at TPWD offices on the Texas A&M University-Corpus Christi campus.

The primary wetland issue discussed in the meeting included the recommendation that a blanket permit or general permit, that addresses potential impacts to the waters of the U.S. and wetlands, would be the best approach for permitting impacts within the study area. The type of wetlands or waters and the extent of those affected would be a requirement for the permit. In addition, compliance with regulations required by the EPA, TNRCC, FWS and NRHP criteria, will be a condition of any general permit issued by the COE.

An additional concern was about what maintenance activities will be permitted within the stormwater features. These methods would need to be addressed within the COE permit. Certain maintenance procedures are not regulated by the COE. Also, it was voiced that the location of the maintenance fill (disposal site) should be within a non-jurisdictional (non-wetland) area, perhaps a disturbed or degraded upland site.

General concern was voiced about the typical design of drainage channels, such that the design should represent a more natural drainageway. A low-flow channel design using a vegetation cover along the channel banks as opposed to concrete trapezoidal channels was suggested. The more natural design could provide conditions for wildlife use.

Another concern mentioned in the meeting included habitat not associated with wetlands. Large stands of remnant natural vegetation, large specimen trees, or known avian nesting or roosting areas are sites that may be considered for avoidance during the planning stages. However, these areas may not fall within the jurisdiction of the COE and may not be regulated by that or other local, state or federal agencies.

Clean Water Act - Section 404 Permitting

Based on the multi-agency meeting and a follow-up phone conversation with Galveston District COE representative Janet Thomas, the main objective for the City will be to obtain a General Permit (GP). The initial effort involved in the development of the GP and its implementation will result in the ultimate reduction of expenditures by the City and the amount of time required by the City and COE to permit the individual drainage projects. This permit will outline the City's plans for all minor and major construction and maintenance that will be implemented through the various drainage projects set forth within the Storm Drainage Master Plan. The GP will include general guidelines and conditions which the City will follow during their construction and maintenance activities within the drainage projects. The GP would come up for review every five years, therefore, there may be additional regulations or conditions that will be need to be addressed within the GP.

The GP will identify: all of the areas involved in the plan; all activities that will occur in these areas; how the activities will be accomplished; and how much and what type of wetland habitat will be impacted. A determination of wetlands potentially affected by the projects will be a requirement prior to approval of the GP. In addition, a conceptual wetland mitigation plan (to replace waters/wetlands affected) will need to be included within the GP.

The City will need to have several meetings with the COE and other participating agencies to draft the GP conditions. Once the GP has been drafted, the COE will publish the GP for public review. Once agency and public comments or issues have been addressed, the COE will review the individual projects presented by the City. This review period by the COE will be expedited as long as the conditions set forth in the GP are met by the City. There may be a possibility for the need of an Individual Permit (IP) if a project has a large impact on water/wetland features or if there is great concern about the activity by the public. Individual permits require an additional public review period and require a longer period for COE review.

It is recommended that this "permitting" effort be made a high priority as one of the initial "projects" to be funded from the SDMP. More discussion of the overall "implementation" of the SDMP and the permitting requirements is included in Section 4D.

3.C. DATA BASE/MAPS

This section discusses the creation methodology of the base maps containing all the drainage infrastructure (both closed pipe and open channel system). The GIS/LIS is an effective "host" for numerous physical feature data through linked spatial (mapped) means or through PC ARCInfo's ability to link data through relational "attribute" matrices. It was a very good plan on the part of the City for obtain this citywide information and make it available to all the concurrent master plan efforts that were underway. This way, all the spatial and vertical information was interrelated and the projects impacts in one master plan upon other plans can be readily evaluated.

The LIS was used to manipulate physiographic feature data for the studied watersheds and their subwatersheds. In this manner runoff parameters were easily developed which were used extensively in the hydrologic and hydraulic modeling effort. Additionally, the LIS was used to display final products in the form of color coded charts and/or maps which greatly enhances the project's deliverables. As previously discussed, the topography for areas within the City Limits was prepared using 1-ft contours and in the ETJ at a 2-ft contour interval. The Design Team acquired the data from the City in large data volumes (tape drives, and CDS). The coordinate system that comes with the LIS was used throughout the SDMP.

CAD Delineation

The storm sewer network was developed in Microstation. Microstation versions of the city topographic and planimetric mapping was obtained through time and as created by LanData (in individual "tiles") for use by all the master plan efforts. For the purposes of the SDMP it was assumed that the Mapping Consultant had performed cross checking of the various Lot and Block designations against the Plats as well as the data purity (minimal errors or electronic glitches). It was assumed that the Digital Terrain Model (DTM) was available from LanData as well as topography, vegetation, paved areas (cultural features), and orthophoto. The Design Team did have some problems with some of the data and had to spend time trying to "clean" some of the data, and communicate with them in an effort to obtain useful data. In Spring Creek, the upper most portions of the watershed extended north of the furthest ETJ data from LanData, therefore, subbasins digitized from USGS topographic maps were added in those regions and "blended" into the ETJ information to complete the watershed.

The storm sewer elements were digitized in heads-up fashion over the topographic and planimetric base maps using the City's Storm Sewer Atlas paper maps. The Design Team tried to use the City provided reduced copies in the Atlas, however, due to the detail on the Atlas maps, the physically smaller maps were not productive. The Design Team requested and received larger blueline copies (smaller scale, more detail) maps from the City and they worked out much better. There is an incredible amount of detail on the Atlas sheets, more than on the average City's drainage infrastructure maps, and more than initially estimated. Two Microstation macro tools were created to aid in the proper entry of the pipe and node elements. The tools insured that all pipe elements connected at nodes and that each pipe and node was identified by a unique number. If necessary, parallel pipes were added between the same nodes and appear as a single element in the plan view (but are really two pipes). Each pipe element received a tag containing the unique identifier assigned on the paper storm sewer atlas map so the parallel pipes will be able to be distinguished. Each node was represented by the text of the unique identifier centered on the node location. A total of 5209 pipes and 5164 nodes were digitized from the storm sewer atlas. As mentioned earlier, an electronic version of the SCS soils maps was digitized from the 1:24000 scale soil survey maps for Victoria County.

Database Attribution

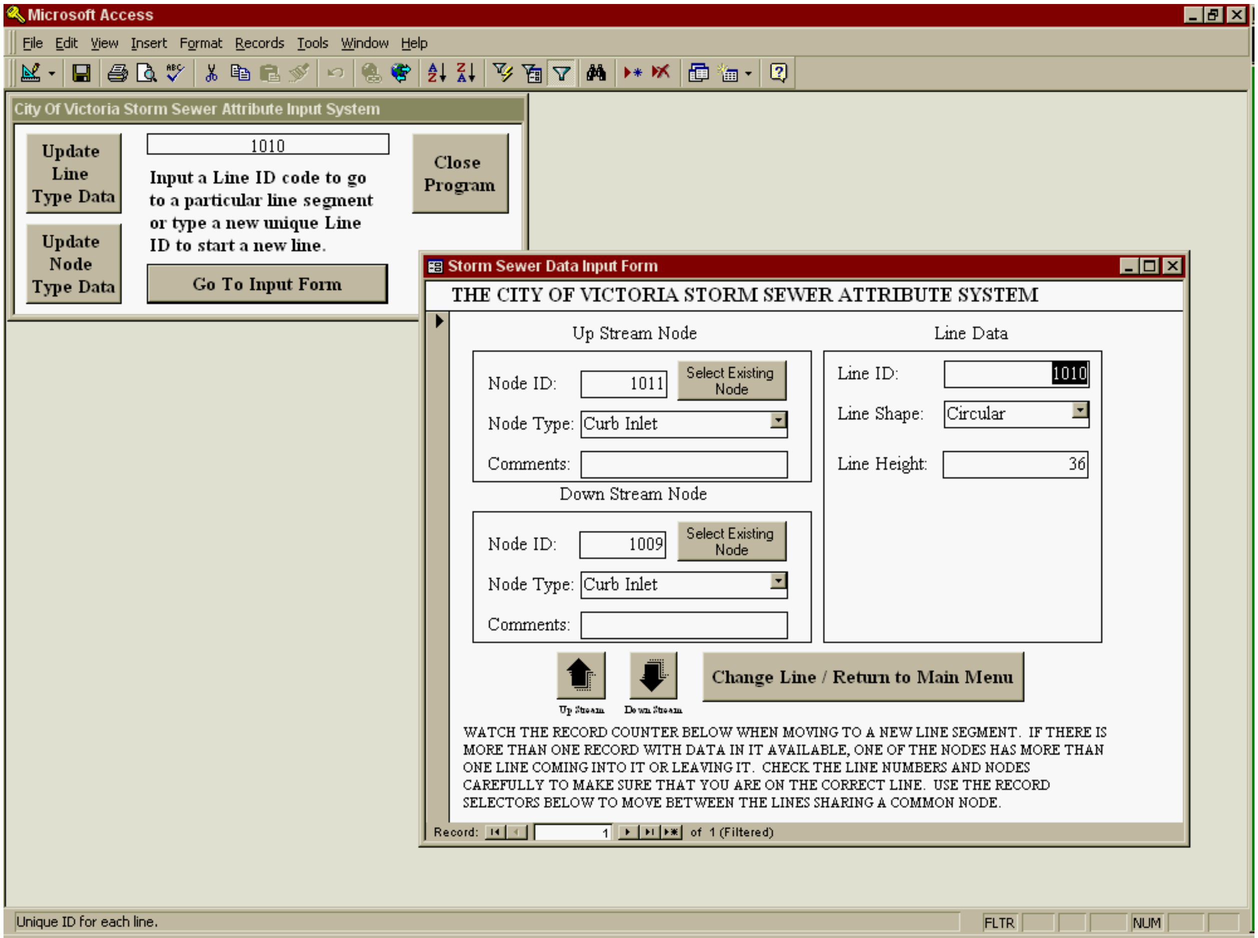
The most time consuming phase of the storm sewer database creation was the entry of "attribute" data for the conduits and junctions in the system. The database includes specific attributes of the system such as the size, and type of material (i.e., reinforced concrete pipe, corrugated metal pipe, concrete box culverts, open channel, paved concrete channel, and so forth). And although the focus of this section of the SDMP was on the "existing drainage infrastructure system" the same LIS system was also used to present the "proposed" stormwater drainage system as presented in Section 4 of the report.

The initial phase of the database creation effort involved the markup of the existing storm sewer maps with unique identifiers for each element and the delineation of flow directions. A Microsoft Access interface was developed by the Design Team to facilitate the data entry process. Several "checks and balances" were built into the interface to insure that actual pipe to pipe connectivity was maintained in the database. The usefulness of the new electronic map is only as good as the data that is fed into the system. The interface provided fields for entry of the conduit shape, size, upstream junction, downstream junction, and junction attributes. Each pipe and node was identified by a unique integer. A total of 3186 pipes and 3089 nodes received attribute data. The database interface is shown in Figure 3.2.

Conversion to ArcView

The Design Team was able to bring the pipes directly into ArcView through the CAD Reader extension. The tags that identified the pipe segments in Microstation were converted to attribute in ArcView. The nodes were represented by text centered on the physical location of the node. In order

Figure 3.2: Storm Sewer Database Creation Interface



to use the nodes in ArcView, they had to be represented as points. The conversion from text to points was not possible in ArcView. It was necessary to bring the nodes first into ArcInfo and then into ArcView. The IDGSARC command was used to convert the nodes from Microstation format. The resulting Arc coverage contained a point at the center of each text elements. The identifying number attribute was contained in a separate Info file. The ID attribute data were joined to the points in the coverage. The node coverage was then converted to a shape file and added to the ArcView storm sewer project.

The final step in the conversion process involved the addition of the attribute data for the pipes and nodes that was developed with the Access interface. The attribution effort was limited to the systems that the Design Team anticipated modeling. The Design Team tried to capture all this information for use in the maintenance task as well as in the modeling task, however, some summarization and simplification was required. Although the scope points out that the "inlets will not be included" the Design Team, nevertheless, included node points for the blind tee intersection of the inlet stubout pipes into the main collector pipe. The individual inlets could be connected (added to the database) at a later date by the City Staff or by the Design Team under another contract agreement. The unique number assigned to each element was present in both the ArcView node and pipe shape files and the Access database tables. The access tables for nodes and pipes were joined to the respective shape files and the attributes in the tables were copied into the attribute tables for the shape files.

Data Editing and Correction

Some additional data editing and correction was required to finalize the database in ArcView. The Access interface was not used for the entire system, therefore, some pipe data was entered without the correct upstream and downstream nodes. Pipe sizes and shapes also were checked and corrected in Microsoft Excel and ArcView. The database created in Access was easily portable to both Excel and ArcView through the DBF file format. Both Excel and ArcView provided useful tools to check and correct attribute and graphical errors. This is another example of the QCAP techniques employed by the Design Team throughout the creation of the SDMP. Typical industry standards for GIS database information suggests that 96% of the data has to be 100% correct. Due to all the QCAP efforts, the SDMP has far exceeded those requirements.

Maintenance Numbering System

The maintenance numbering system provides a comprehensive method to uniquely identify any element in any of the HEC-2, HEC-1, or AVsand models. It is also discussed in Section 2B of this report (Figure 2.1). The full version of the maintenance number applies to pipe/channel and node elements in the storm drainage. The HEC-2 and HEC-1 models employ a limited version of the maintenance number to aid in the identification of cross section locations, combination points, subbasins, and routing reaches.

The Design Team determined that it was critical to interrelate all the numbering systems to allow movement by the User from one area to the other without extensive "criss-cross" indexes.

As many as six separate fields can be combined to identify an element in the drainage system. Only two fields (watershed and ID number) are required to uniquely identify a particular element. The additional fields provide information about the location of an element within a watershed. The additional fields include service area number, sewer system number, subbasin ID and strip number. The combination of the sewer system and subbasin ID corresponds to the basins delineated for the HEC-1 models.

The ID number for each pipe and node is unique within each watershed. As a result, the most simple combination of data fields that will uniquely identify a given element is the watershed with the ID number. The ID number also identifies an element as either a pipe or a node. All pipe ID numbers are *even* while node numbers are *odd*. In order to leave unused ID numbers for future additions of pipe the existing pipe and node numbers were entered as multiples of 5 and 10. Except for a small number of pipes and nodes added for modeling purposes, each pipe ID number will end in a zero (0) while each node ID number will end in a five (5). The unique number used in the initial creation of the database has also been retained as a criss cross and for use by the City as they see fit.

Although the Maintenance Numbering focused upon assigning a unique number to all the pipes and boxes in the system, there were some segments (as indicated in the Storm Sewer Atlas) that were very short in length (less than 40 feet). Although this would not be a problem to just the maintenance numbering system, as mentioned above, this database was also to be accessed and used by the closed system hydraulics model as well. In the model, short segments can cause problems. They require a very short time step which leads to long run time and many times model instability. SWMM will convert short pipes to equivalent longer pipes with higher roughness values. However, the conversion results in increased volume for the system. Therefore, the Design Team had to aggregate several of the short pipe segments into longer ones. Fields were added to the storm sewer database subsets that included the pipe numbers of any pipes that were aggregated to form a single element. The pipe number for the downstream most pipe was retained for the pipe number of the aggregated element.

Determination of Control Elevations and Calculation of Pipe Inverts

The final step in the preparation of the storm sewer database for AVsand modeling was the determination of invert elevations. As mentioned earlier, Urban Surveying was hired to obtain data for a number of key points identified in the sewer system. Field surveys were conducted to obtain data for manhole depths and outfall elevations. The depth to the pipe invert in a manhole was measured by a tape-down from the manhole rim. The elevation of the manhole rim was determined from the digital topographic data provided by the City. Surveyed outfall elevations were referenced to a nearby point that could be readily identified on the digital topographic and planimetric data. The reference point was usually the centerline of a road near the outfall.

Elevations for each node in the storm sewer database were determined with the aid of digital terrain models. A set of DTMs which covered the entire area serviced by storm sewers was created from the LanData topographic files. These DTMs were then overlayed on the set of nodes and the elevation at each node was extracted and stored as a database attribute.

An record of the relative accuracy of the technique used to establish elevation for each element in the system was maintained in a data quality descriptor in the database. This descriptor used the letters A, B, C, and D to describe the relative accuracy of measurements at each node. The Design Team recommends that the City continue to upgrade the accuracy of the elevation data as time and resources allow.

After all the Storm Sewer Atlas information was placed into the electronic format, the limits of the individual watershed boundaries were then evaluated. The digital terrain model was able to provide "watershed divide" information in the areas without much storm sewer infrastructure. However, in the central portions of the City, the Storm Sewer Atlas information was critical to truly determining the watershed divide. There are several areas where the natural watershed divide has increased or decreased due to the manual collection and conveyance of stormwater form one small subwatershed into another adjoining subwatershed by simply extending the drainage pipe. The final watershed and subwatershed boundaries were finalized and also transferred onto a "layer" in the LIS system. These boundaries were used throughout the maintenance numbering creation and the actual modeling. As discussed in the scope of services, the watershed size was targeted to be between 0.1 and 0.25 square miles in area with some slightly larger subbasins being created in the ETJ in the agricultural portions of Spring Creek, Lone Tree Creek, Marcado Creek. The basin name was included (or coded) into the database for each watershed as well as the individual watershed hydrologic characteristics (discussed in more detail in Section 3D). "User Training" with City Staff was conducted in Austin during several of the progress meeting sessions. A "Users Manual" of sorts is included in this report as to the location of the various project files (CDs are included as Appendix 1) and the general type of data that is included in each of the files.

3.D. BASE HYDROLOGY/HYDRAULICS

The major issue concerning the modeling of base hydrologic and hydraulic conditions throughout the City is the need to develop technically sound, reliable and defensible design discharges as well as related flood elevations. In consultation with City staff, the Team selected the appropriate hydrologic and hydraulic software (as discussed previously in Section 2A2). The same basic procedure was followed in selecting the detailed hydrologic and hydraulic "computational methods" to be used within the selected software in developing the existing and future condition models (as discussed previously in Section 2A4).

This Section focuses upon the creation of the existing condition hydrology, the future condition hydrology, the existing system hydraulics, and a first estimate of the future system hydraulics. As these individual aspects of the City drainage are combined with each other, the following three scenarios were generated and will be included in this SDMP analysis:

1. Present land use and Present drainage infrastructure conditions (the "present/present" condition),
2. Future land use and Present drainage infrastructure conditions (the "future/present" condition), and
3. Future land use and Future drainage infrastructure conditions (the "future/future" condition).

A separate set of hydrologic and hydraulic models was generated for each of the three conditions.

3.D.1 FEMA Report and Back-up Data (Calculations, Surveying)

In an effort to determine the current hydrologic and hydraulic regimes within the City, the first step included a review of data and information from the original FEMA Flood Insurance Study (FIS) to determine its usability in the SDMP. The Design Team did receive back up information from the City for the initial FIS created by Albert Halff and Associates. A catalogue list was prepared of all the information that was received and a copy of that list was sent to the City. This information was temporarily stored in two file cabinets in the Design Team offices for safety and for future use in later modeling tasks in this Project. All the FEMA back-up data has been returned to the City at the completion of this Project. Data included the input data for the models used in that analysis, work maps (drainage area demarcations) and surveying information (bridges) that was originally used in the preparation of the FIS.

The first step was to review the hydraulic model (HEC-2) data for the number of bridges and culverts that used in the FIS study. This planimetric and geometric data was reused as much as possible and simply converted to the datum of the LIS information. In order to enhance this new model's ability to receive favorable review by FEMA, the decision was made to continue to use the Special Bridge (SB) routine in HEC-2 as was used in the original study. Data on the new bridges (built since the original FIS) was collected from ground investigations by Urban Surveying as previously discussed.

The next step was to examine the FIS report water surface profiles and the Flood Insurance Rate Map (FIRM) to determine what the 10-year water surface elevation (WSEL) is along the Guadalupe River. The 10-year WSEL was determined in the "analysis plan" to be considered as the starting condition for the backwater models of the 25-, 50- and 100-year events inside the City. It was agreed that assuming that the City drainage would be discharging into the coincident frequency event on the Guadalupe River (e.g., the 100-year in the City draining into the 100-year on the Guadalupe River) would be too conservative an assumption.

Additional information that was gathered from the original FIS included the 100-year WSEL along all of the designated watersheds. As discussed in the analysis plan, this original WSEL was used as the "target" elevation for the Future/Future floodplain model. That is to say that as the structural and nonstructural measures are being sized for the "future land use" drainage discharges, the resulting water surface elevation will be at or below the existing FEMA floodplain elevation. This created a "vertical target" as opposed to a "horizontal" target (reduce the floodplain width by a certain percentage or by a certain number of feet in certain areas.

3.D.2 "Existing Condition" Hydrologic Models

The hydrologic modeling effort encompassed approximately 100 square miles in and around Victoria. In a brief general summary this task involved the following efforts:

1. Use the model/software selected in previous task,
2. Delineate watershed subareas,
3. Develop six design storms (5-, 10-, 25-, 50-, 100-, and 500-year) subject to the adopted Council policy mentioned in Section 2.A.1 and to FEMA study requirements,
4. Develop subarea loss rates (soil, land use, impervious cover, and Curve Numbers).
5. Develop subarea hydrograph response characteristics (Lag Time and Peaking Coefficient).
6. Develop reach routing parameters,
7. Finalize watershed stream system set-up,
8. Develop the final set of hydrologic models for the six (5-, 10-, 25-, 50-, 100-, and 500-year) specified storm events, and
9. Develop tables of discharges at selected locations.

In more detail, the creation of the existing condition hydrologic models began with basin delineations. As mentioned earlier, the study area is comprised of seven main watersheds: Lone Tree, Spring Creek, Jim Branch, South Outfall, West Outfall, Marcado and Second Street. A reduced size map is included as Figure 3.1 and a larger size map is in Map Packet 1. The Lone Tree watershed includes both the East Branch and Southern Pacific tributaries. Whispering Creek, North Outfall, US 77 and Mockingbird are all tributaries of Spring Creek and are included in the Spring Creek Watershed. These seven watersheds were divided into a total of 304 subbasins using Microstation as discussed in Section 3C. Table 3.2 presents the total area of each major watershed, the tributary watersheds, the number of modeled subbasins, and the average size of each basin. All of the watersheds studied are withing the Victoria City limit or ETJ except for the northern portion of Spring Creek. Approximately 26 square miles of the Spring Creek Watershed lies to the northwest of the City's ETJ.

As previously discussed, the main channels of all the watersheds were measured in feet. A location along a creek that was 2,000 ft from the mouth was at Station 20 (in hundreds of feet). For example, a tributary basin that drained into the main channel at Station 20 was labeled as subbasin *WO-20* (for West Outfall, 20 stations above the mouth). On occasion, there would be two tributaries joining the main stem at the same location (one from the east and one from the west for example). In this situation one watershed was labeled *WO-20A* and the other as *WO-20B*. Map Packet 4 provides detailed information about the SDMP hydrology which includes the basin ID. Please note that the CDS provided in Appendix 1 contains the electronic files with extremely detailed information about all the watersheds should there be a need to "zoom in" on any particular one.

The next step included the creation of individual basin hydrologic parameters for the COE HEC-1 model. The modeling software is actually called WMS (as previously discussed in Section 2.A.3.) but the core model that is being used is the HEC-1 model. The following parameters were defined for each subbasin using ArcInfo and ArcView:

1. subbasin area,
2. length of main channel/flow path if miles (L),
3. slope of the main channel/flow path in feet per mile (S),
4. length to centroid along the main flow path in miles (L_{ca}),
5. weighted SCS Curve Number (CN), and
6. approximate percent of development.

These parameters were used to define the subbasins in the HEC-1 model. The drainage basin delineations for the HEC-1 models resulted in a total of 304 subbasins within the seven major watersheds. Basin boundaries were defined from three sources. The primary guide for delineation was the set of one (city) and 2-ft (ETJ) contour interval topographic data produced by Landata. The second source was the set of storm sewer maps for the city. In a number of cases, storm sewers were found to carry water across topographic basin divides. Some uncertain areas were confirmed by site visits. The portion of Spring

Table 3.2: Drainage Basin Information Summary (HEC-1)

Watersheds	HEC-1 Drainage Area (sq. miles)	HEC-1 Number of Subbasins	HEC-1 Average Area (sq. miles)
Jim Branch	4.64	18	0.26
Ben Jordan[1]	(1.78)[2]	(8)	0.22
South Outfall	1.59	8	0.20
Second Street	1.48	11	0.13
West Outfall	3.60	31	0.12
Spring Creek	46.55	109	0.43
Mockingbird	(.40)	(3)	0.13
Whispering Creek	(2.50)	(16)	0.16
North Outfall	(0.20)	(2)	0.10
US 77	(2.29)	(10)	0.23
Lone Tree	25.73	83	0.31
Southern Pacific	(0.86)	(3)	0.29
East Branch	(2.80)	(14)	0.20
Marcado	17.46	44	0.40
Total	101.05	304	0.33

Notes:
[1] Indentions indicate tributary watersheds.
[2] Parentheses indicate sub-watershed data that were aggregated into single models.

Creek beyond the extent of the ETJ topographic data was delineated from USGS quad sheets. Most of the delineation was performed graphically in Microstation. A full set of topographic and planimetric maps in Microstation format were obtained from Landata for this purpose. These maps served as the base for both delineation of watersheds and heads-up digitization of storm sewers.

Consistent subbasin sizes tend to produce more accurate hydrologic models. The target subbasin size for the master plan models was 0.1 to 0.25 square miles. As shown on Table 3.2, this subbasin size was maintained in most cases. Subbasins for watershed areas outside of the city limits tended to be larger than those defined within the city..

The delineated watersheds comprised the first set of data for generation of watershed parameters in the GIS system. Microstation Geographics was used to build polygons from the subbasins. These polygons were then attributed with the subbasin identifier. The subbasin files were then converted to ArcView shape files for inclusion in the GIS database.

A set of flow paths was delineated for each watershed. These flow paths were comprised of the routing reaches for the model and the main flow path within each subbasin. The reaches and flow paths follow stream lines shown in the Landata maps, storm sewers, or topographically defined drainage swales. A schematic diagram of the full system of routing reaches and flow paths is shown in Map Packet 4. The routing reaches were each tagged with corresponding HEC-1 reach identifiers. The stream files were then converted from Microstation to ArcView.

In general the watershed delineations for the SDMP agree well with those from the existing FIS study. The LanData topographic information allowed the Design Team to provide much more detailed subdivisions within the major watersheds. The largest difference between watershed delineations between the FIS study and this SDMP occur at the in the upper reaches of the Whispering Creek, Marcado Creek, and Lone Tree Creek watersheds. An area of approximately 3.7 square miles comprising the 7 subbasins upstream of Salem Road in Marcado Creek were considered part of the Whispering Creek watershed. A portion of this flow was also diverted into Lone Tree Creek in the FIS study. The Design Team determined after a careful evaluation of the new topographic data, that all or a majority of this area contributed to Marcado Creek. The area in question is extremely flat as are the few drainage channels present. Some runoff from the area may still overflow into Whispering Creek or Lone Tree Creek.

Electronic files from the Planning Department of the “existing” GIS/LIS land use information were used in combination with the soils map to determine the runoff coefficients. Discrepancies between the paper plot of the land use and the electronic file information existed (there are some gaps in the land use file and other places have land use numbers that are not one of the listed choices in the legend). These differences were resolved through coordination between the Design Team and the City Staff. There were some land use categories that were not on the standard City master list, and other areas that were simply blank. Again these discrepancies were resolved. For the areas outside the City limits (and not available from the City) the Design Team accessed some USGS Internet files for land use information (in the ETJ). These files have been blended into one coverage. Also, please recall that the "hydrology" section of the Design Criteria Manual (DCM) presents a table of SCS Curve Numbers (CN) that *includes* the roadways (it is a total land use factor and not just for the development density on the private property itself).

Generation of Watershed Parameters in GIS

The GIS system was used to automate the generation of watershed parameters for the HEC-1 models. Both ArcInfo and ArcView were used in this process. The final basin and reach parameters were stored as attributes in ArcView shape files. These shape files were then processed with the WMS Hydro extension for ArcView, and then imported into WMS to create the final watershed models.

The primary components for the generation of the necessary watershed parameters were subbasin and watershed boundaries, stream lines for the longest path in a basin and routing reaches, topographic data, land use information, and soils information. The original basin and stream delineation was performed in Microstation as discussed earlier. The watershed outer boundary, subbasins, longest flow paths, and routing reaches were converted into ArcInfo format to be used in the calculation of parameters. In the conversion process ArcInfo placed a label point at the centroid of each subbasin polygon.

The surface modeling capabilities of ArcInfo were used to develop elevation information for slope calculations for both the routing reach and longest flow path stream files. A digital terrain model in the form of a Triangular Irregular Network (TIN) was created for each watershed form the topographic files provided by LanData. The stream files were identified as break lines for the DTM. These stream lines were then extracted back from the TIN as lines broken into short segments. Each segment created in this fashion included the elevation at both ends of the segment. The route generation capabilities of ArcInfo were then used to orient the segments from downstream to upstream. As a result, each end of a segment was attributed with the distance from the downstream end of the routing reach or flow path.

ArcView was used to organize the information generated in ArcInfo and to calculate parameters required for generation of the HEC-1 models. The watershed subbasins, basin centroids, and stream lines were converted into shape file format for use in calculations. The length of routing reaches and streams was calculated from the sum of the individual segment lengths. Slopes were calculated by selection of steam segments at 10% and 80% of the length of the stream. The average elevations of the two segments were then subtracted and divided by 70% of the stream length. A minimum allowable slope of 0.0005 was used when measured slopes were small or negative. The spatial query abilities of ArcView were used to select the nearest stream segment to each subbasin centroid. The distance to the centroid along the main flow path was then calculated as the average distance of either end from the downstream end of the stream.

SCS Curve Numbers and the percentage of development for each subbasin were also required of generation of HEC-1 parameters. Curve numbers were generated based on a relationship defined between curve number and land use type. The primary source of land use data for the study was the digital parcel map provided by the City. Additional land use data for portions of the study in the ETJ were obtained from USGS Land Use and Land Cover (LULC) digital files. Elements of the City's Thoroughfare Master Plan were used to modify future land use conditions. The Grid processing module of ArcInfo was used in conjunction with basic ArcInfo commands to generate the desired curve numbers. The grid based approach provided a simple method to account for unattributed roadway areas in the Parcel data. Roadways areas were simply incorporated into the predominant land use type adjacent to the road. This is essentially the same as the consideration of roads as part of a particular type of land use in the original derivation of the SCS curve numbers. A composite grid of both Parcel and LULC data was generated and then intersected with a grid representation of the drainage basins. Curve Numbers were calculated as a weighted average of the curve number for each grid element comprising a subbasin. The calculation of the percentage of development followed the same procedure with the simple substitution of a table relating percent development to land use instead of the curve number table.

Future condition CN and percent development calculations included considerations for the expected level of development in and around the City of Victoria. The conditions for future land use were discussed extensively in Section 2.A.1. Existing undeveloped and agricultural land areas within the City's ETJ were considered to be developed to a representative density of 4 units per acre (approximately 43% impervious). These areas were also considered developed to a distance of one half mile beyond the ETJ in the Spring Creek watershed. Loop 463 and other major arterials identified by the Thoroughfare master plan were considered to have commercial development for 200 ft on either side of the roadway. The lookup tables used for the present condition calculations were modified to account for the development of agricultural and undeveloped areas. The new set of land use data combined with the corridors of commercial development were then combined. The same procedure used for present conditions was then applied to the new data to generate curve numbers and percent development values.

The final parameter generation step was performed in Excel. Subbasin data from the ArcView DBF attribute files were imported into Excel for the final calculation. Within Excel the main flow path length and slope, the length to the centroid along the main flow path, and the percent of development were used to calculate the subbasin lag time and peaking coefficient. Routing parameters were also calculated based on the length and slope of the identified routing reaches.

Rainfall

Critical to the development of the SDMP was the determination of the proper rainfall amounts and the distribution of the rainfall. The FIS was the first source of limited information. The FIS backup material provided a table of 24-hour duration storm totals for the 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval events. These rainfall totals were verified by comparison with values taken from the National Weather Service TP-40 and Hydro35 publications. These comparisons verified that the total rainfall amounts used in the FIS study were correct for the Victoria area.

Although the Design Team was able to locate data on the total rainfall amounts, the information about the distribution was more sketchy. Figure 3.5 displays the Rainfall Distribution Hyetographs from various sources. Note that the HCFCD distribution is very similar in shape to the Type III distribution except that it is shifted in time to provide the peak intensities later in the storm event. The HCFCD method uses the USACE's critical pattern distribution. The creation of the distribution used in the original FIS was not discussed in the FIS report or in any of the backup materials to which the Design Team had access (Section 3D). It was obvious that the distribution was not a Type III pattern which is the recommended method for the Gulf Coastal areas. The Type III distribution that was used for the SDMP is clearly indicated on the Figure 3.3. Table 3.3 presents the storm total rainfall information that was used in the SDMP.

Unit Hydrograph Method

The SCS curve number and Snyder's Unit Hydrograph were the methods used to define the loss rate and runoff, respectively. The two components of the Snyder's unit Hydrograph are the lag time and the peaking coefficient. There are several different equations available to calculate the lag time. Based on the location of the study area, the Tulsa District Lag Time Equation and a modified version of the peaking coefficient were used. Two complete sets of basin parameters were generated, one for the present flow conditions and one for the future flow conditions. In the future flow scenario, the curve number and the percent development were modified (in keeping with the Council policy directives), therefore changing the lag time and peaking coefficient in many subbasins.

The Design Team paid particular attention to correlating the hydrologic methods proposed in the DCM for the subdivision work (Rational) to be sure it was compatible with the larger watershed HEC-1 modeling (SCS). As you recall, the DCM sets 200 acres as the upper limit for use of the Rational method. A few individual subwatersheds in this size range examined using both methods in order to achieve reasonable correlation (they will not be exact) relative to time to peak, peak flow, and runoff volume.

Figure 3.3: Rainfall Distribution Cumulative Hyetograph Comparison

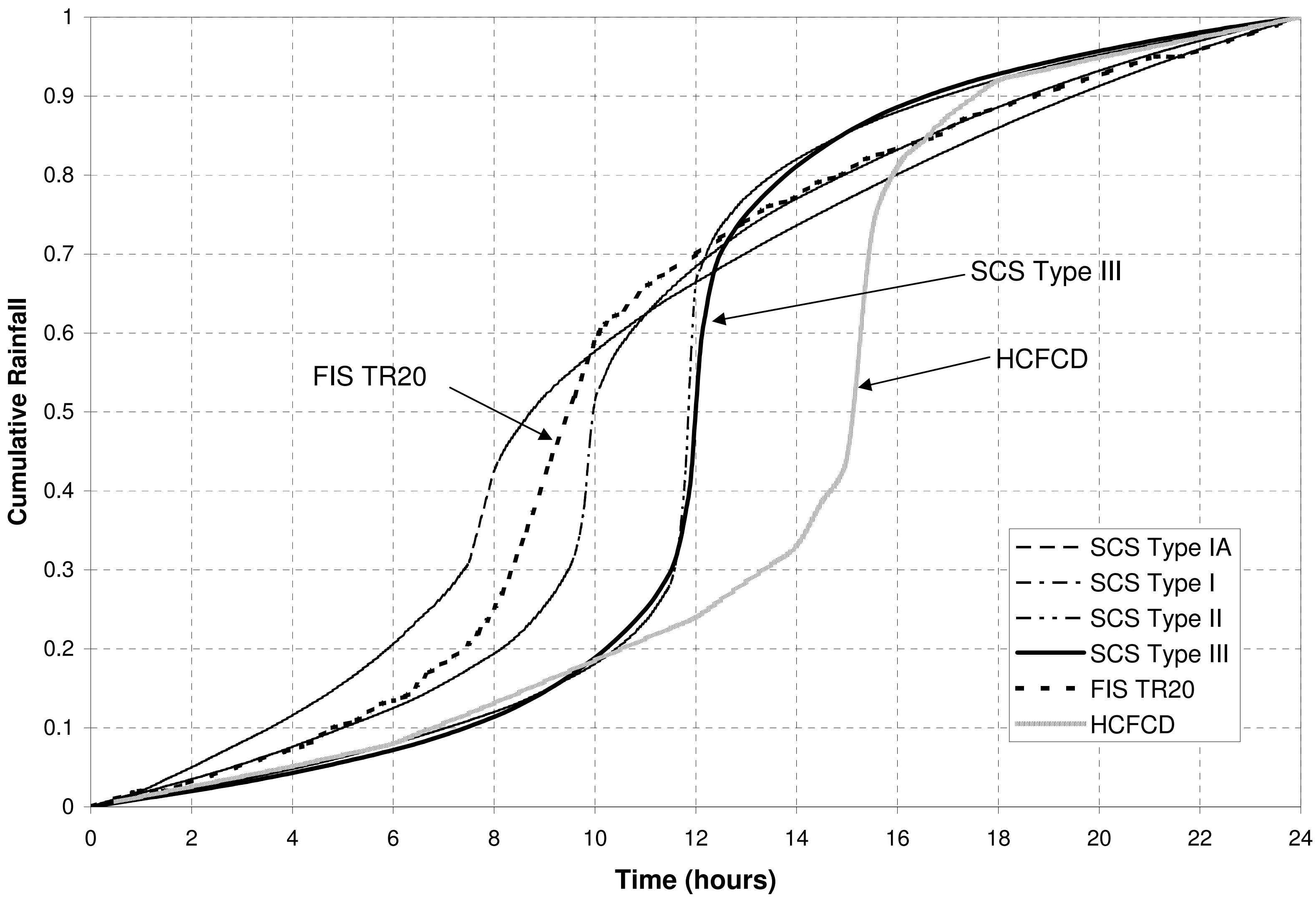


Table 3.3: Rainfall Totals for the City of Victoria

Recurrance Interval (years)	Rainfall Duration									
	5-min	10-min	15-min	30-min	60-min	2-hr	3-hr	6-hr	12-hr	24-hr
1						2.11	2.28	2.68	3.04	3.45
2	0.54	0.91	1.17	1.68	2.21	2.62	2.86	3.39	3.86	4.50
5	0.61	1.04	1.34	2.02	2.72	3.40	3.75	4.51	5.35	6.25
10	0.67	1.14	1.47	2.27	3.09	3.94	4.39	5.32	6.38	7.50
25	0.75	1.30	1.67	2.63	3.62	4.64	5.14	6.30	7.58	8.90
50	0.82	1.42	1.83	2.91	4.03	5.20	5.83	7.11	8.66	10.10
100	0.89	1.54	1.99	3.19	4.44	5.81	6.35	7.92	9.75	11.50
500	1.06	1.85	2.39	3.91	5.49	7.26	8.03	10.00	12.37	14.55

Note:
1. Durations from 5-minutes to 60-minutes were develped from Hydro35
2. Durations greater than one hour were developed from TP-40
3. Highlighted cells indicate recurrance intervel storms not used in study

The Tulsa method lag equation is a straightforward method base on the geometry of the watershed and the state of development. The lag time equation is given as

$$T_{Lag}=C_t(\frac{LL_{ca}}{\sqrt{S}})^{0.39}$$

where: C_t is a coefficient based on the percentage of development in a watershed, L is the length of the main flow path for the subbasin in miles, L_{ca} is the length to the centroid of the subbasin along the main flow path in miles, and S is the slope of the main flow path in feet per mile. The C_t coefficient was assigned a value o 1.42 for natural, undeveloped watersheds (0-33% urbanized), 0.92 for moderate urbanization (33-66% urbanized), and 0.59 for full urbanization (66-100% urbanized). The slope of the main flow path was calculated between points 10% and 80% up the stream.

An additional peaking coefficient is required to define the shape of the Snyder Unit Hydrograph. In the original form of the Tulsa method equations, the peaking coefficient was determined by the following equations

$$q_p=380T_{Lag}^{-0.92}$$

$$C_p=q_p\frac{T_{Lag}}{640}$$

where q_p is the peak flow rate, T_{Lag} is the watershed lag time, and C_p is the peaking coefficient. These equations simplify to a power curve in the form of

$$C_p=0.59T_{Lag}^{0.08}$$

that can be used for direct calculation of the peaking coefficient. The Tulsa method as stated was developed for watersheds with vertical relief. In order to modify the method to more closely match conditions in a Gulf Coastal area such as Victoria, the equations were adjusted based on techniques used by the Harris County Flood Control District (HCFCD).

The HCFCD method uses the Clark unit hydrograph with parameters based on an extensive set of physical characteristics that define the hydrologic properties of a watershed. The methodology uses these watershed parameters to compute Clark's unit graph time of concentration (Tc) and storage coefficient (R) values. The parameters considered are: 1) drainage area, 2) watershed length, 3) watershed length to centroid, 4) channel slope, 5) watershed slope, 6) percent land urbanization, 7) percent channel improvement, 8) percent channel conveyance, and 9) percent ponding. The parameters developed from these equations have been verified on a number of gaged watersheds in Harris County.

The Snyder Unit Hydrograph method was ultimately selected for use in the Victoria SDMP. The Snyder Unit Hydrograph proved to be the most simple approach that produced results comparable to the methods used by the HCFCD. A modified version of the Tulsa Lag and C_p equations was selected for use with the Snyder Unit Hydrograph. The Tulsa lag time equation gave times that were comparable to those calculated with the HCFCD method. The HCFCD comparisons were based on HEC-1 models for the Brays Bayou, White Oak Bayou, Willow Creek, and Green Bayou watersheds. These models used the Clark Unit Hydrograph method with coefficients calculated from detailed equations developed for the Harris County area. This method requires information for a wide range of variable. The goal for Victoria was to simplify the data requirements as much as possible while still producing valid results.

Sufficient parameter information was available for 46 of the HCFCD watersheds to allow a direct comparison of lag time between the HCFCD method and the Tulsa method. Figure 3.4 presents a the results of lag time this comparison. The parameters for the HCFCD were used to calculate a lag time based on the Tulsa method. These lag times were then compared to those generated by HEC-1 from the Clark Unit Hydrograph input parameters. The best fit line through the data is relatively close to a 45 degree line that would represent a one to one correlation between the two methods. This comparison convinced the design team that the timing was good, and that just the peaking factor needed slight modification.

The Tulsa equations for C_p were modified to reflect the flatter nature of flood peaks in coastal areas such as Victoria and Houston. The coefficient in the equation for the peak flow was changed from 380 to 128. The change was based on plots of C_p vs. T_{Lag} for a number of calibrated HCFCD watersheds. The relationship between C_p and lag time for the HCFCD watersheds are shown in Figure 3.5. As shown in the figure, the original Tulsa method equations produce peaking coefficients much higher than those for the calibrated HCFCD watersheds. The curves fit to the data show that the best fit C_p for a lag time of 1 hour is approximately 0.20. The C_p value of 0.20 yields the adjusted coefficient for the peak flow equation.

The Snyder UH with the modified Tulsa lag time equations produces results that roughly match those generated by the Rational Method. The two methods were compared for several subbasins within the West Outfall watershed. The basins varied in size and degree of development. The revised

Figure 3.4: Comparison of Lag Times from HCFCD HEC-1 Models and Tulsa Equation Calculations

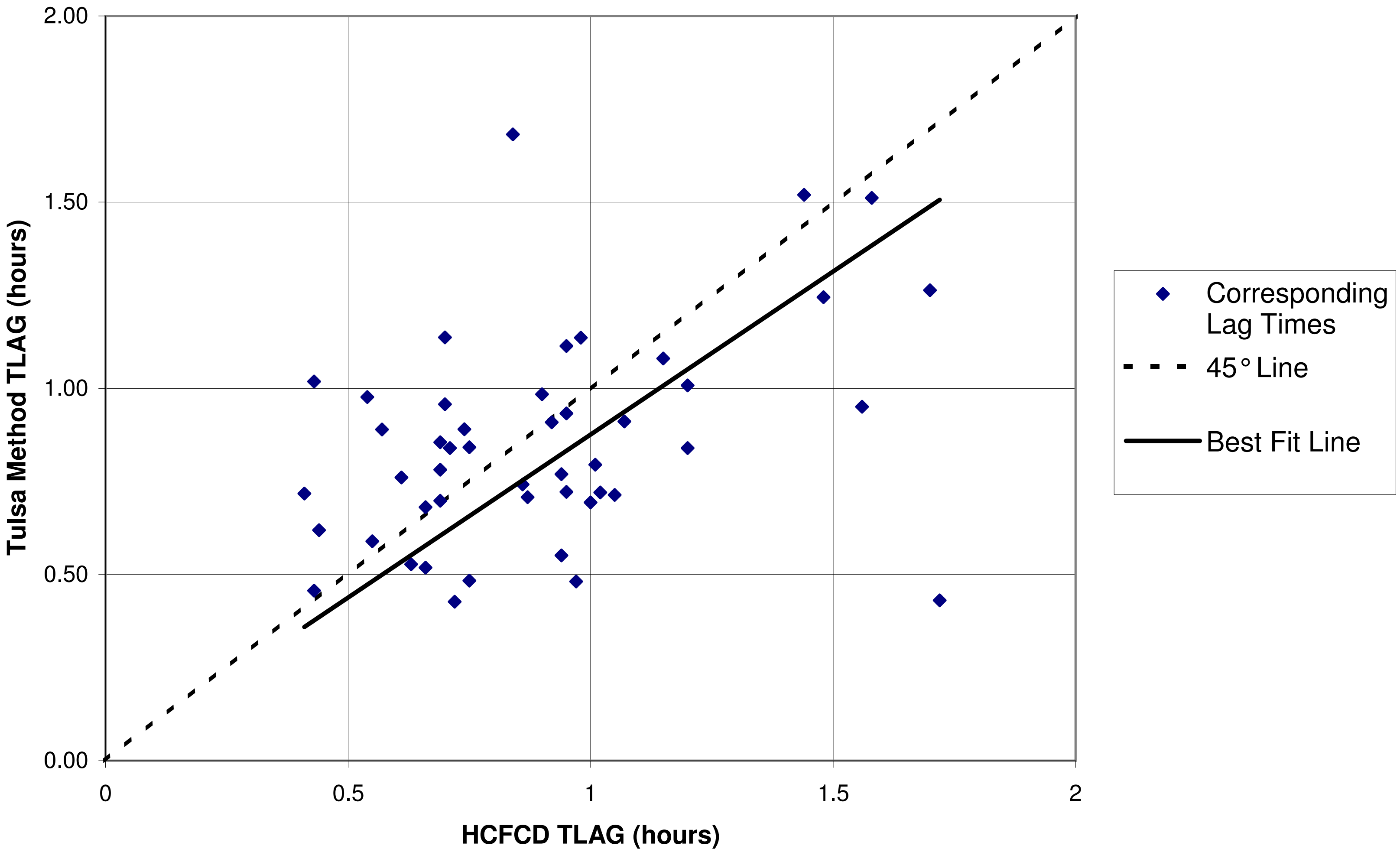
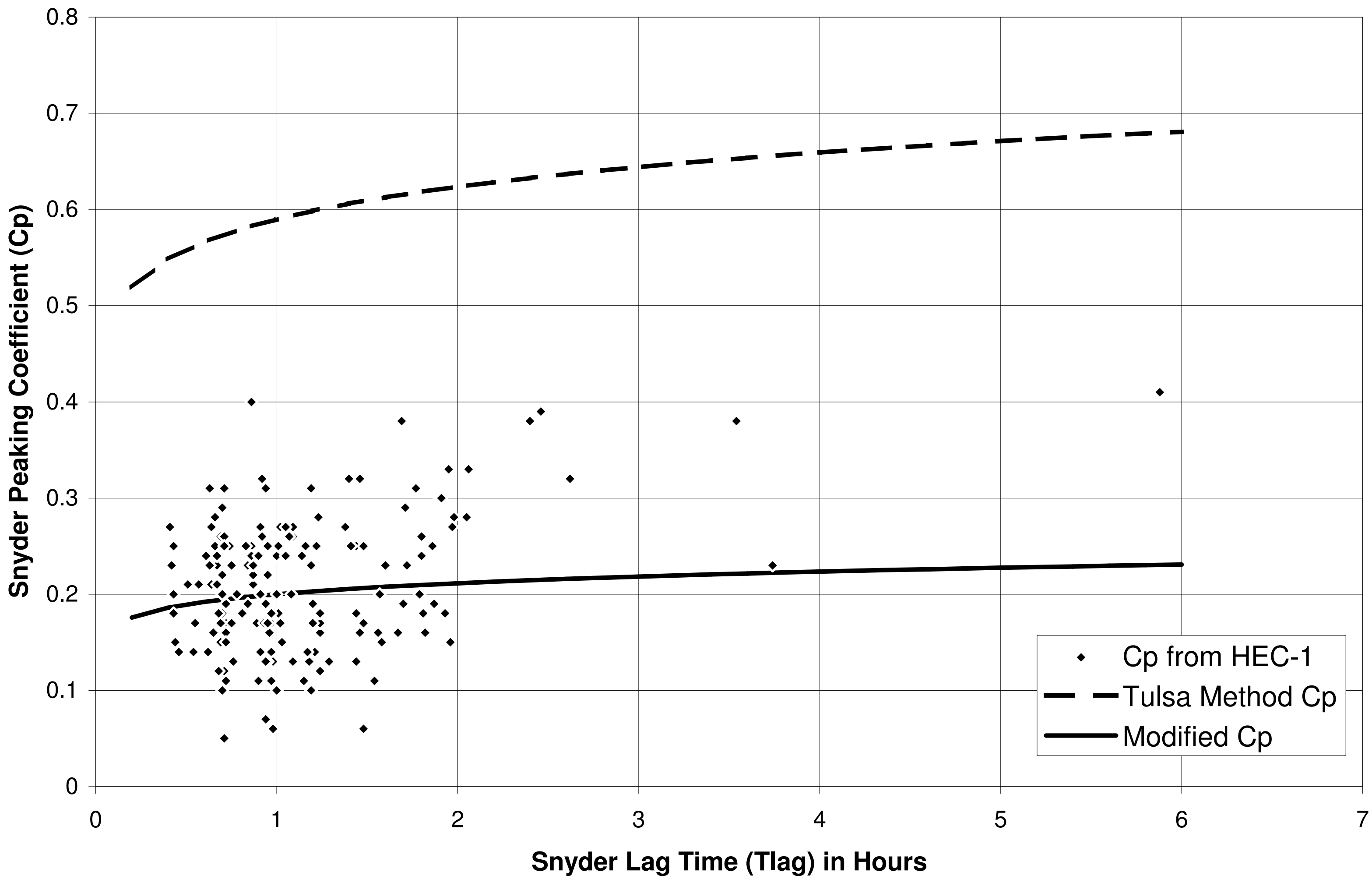


Figure 3.5: Relationship Between Snyder Lag Time and Peaking Coefficient for Four Watersheds in Harris County, Texas



HEC-1 methodology generated results in line with the Rational Method without modification of the runoff coefficient for soil type. The final version of the Rational Method procedure; therefore, should not include the adjustment for soil type.

Loss Rate

The SCS curve number method was selected to calculate rainfall losses due to infiltration and depression storage. Curve numbers were calculated for each subbasin based on a relationship between land use, soil type, and curve number. The land use, curve number relationships used for the study were based on curve number tables from National Resource Conservation Service (formerly SCS) publication TR-55. Refer to the Drainage Criteria Manual for tables of SCS Curve Numbers and Rational Runoff Coefficients for City land use categories.

Routing

The two methods of routing used in the HEC-1 modeling were: 1) Muskingum routing for closed conduits and tributaries to larger streams and 2) Modified Puls routing along main channels which were modeled in HEC-2. Each "reach" of the major channel was assigned specific routing parameters. Each "reach" was given an ID number which followed the same general nomenclature as other ID labeling in the SDMP. A location along a creek that was 2,000 feet from the mouth was at Station 20 (in hundreds of feet). Therefore, the "reach" that had its downstream end at this point was labeled as *Reach 20*.

Muskingum routing parameters were developed for any routing reaches not modeled in HEC-2. The travel time parameter (K) for each reach was developed from a velocity nomograph based on the slope and nature of the channel. The weighting factor (X) was determined based on the type of channel (grass line, concrete lined, etc.) Refer to the DCM for a complete discussion of the routing technique.

Modified Puls routing was developed for routing reaches modeled in HEC-1. This method is based on the relationship between storage and outflow in a particular channel reach. Storage volumes for each reach were determined from HEC-1 output as the volume in the reach over a range of flows. The set of modeled flows was selected to provide definition of the storage-discharge relationship over the range of flow expected in the channel. Refer to the DCM for a more complete discussion of this routing technique.

As mentioned earlier, Map Packet 4 shows a detailed view of the individual watersheds and subbasins that are a part of the hydrologic model. Please note that the electronic files for all the models are available to the City in the enclosed CDS and any location can be "zoomed in" on for more detailed viewing. The enclosed map shows all the Basin ID numbers as well as the Routing Reach ID numbers. This map is a great criss-cross reference guide to many of the other tables presented in the SDMP.

HEC-1 Model Creation

The next step in creating the HEC-1 models focused upon the use of the Visual HEC-1 software. Skeletons of the various watersheds and their interrelationships (create, route, or combine) were created for the seven main watersheds, and their respective tributaries. Three separate models were set up in HEC-1 as discussed earlier:

Present Flows with Present Channel Conditions (P/P),
Future Flows with Present Channel Conditions (F/P), and
Future Flows with Future Channel Conditions (F/F).

The only parameters modified from the P/P condition to the F/P condition were the curve number, lag time and peaking coefficient parameters. No routing parameters were modified in this scenario. Due to the channel improvements in the F/F condition, the Modified Puls routing parameters were modified from the F/P condition to the F/F condition (the improved channels provided less storage and therefore less attenuation of the hydrograph peak). However, all of the individual basin parameters were the same for the F/P and the F/F conditions. The flows for the F/P and the F/F condition in HEC-1 are slightly different due to the difference in Modified Puls routing parameters in the F/F condition.

The Spring Creek Watershed presented the greatest challenge in the HEC-1 modeling effort. The final Spring Creek model included the main stream as well as three major tributary watersheds. The Mockingbird Outfall, Whispering Creek, and North/US77 Outfall watersheds were incorporated in the complete Spring Creek Model. The inclusion of the tributaries allowed the Design Team to simulate flows for the entire Spring Creek basin without the need for combination of hydrographs from separate models. This approach also allowed for direct modeling of the North Outfall diversion from Whispering Creek. A rating curve for this diversion was developed based on output from the HEC-2 models for Whispering Creek and North Outfall. The Lone Tree Creek HEC-1 model also included the aggregation of the East Branch and Southern Pacific Railroad Ditch tributary watersheds.

Final HEC-1 Models in WMS

The final HEC-1 models were created in the WMS software package. The WMS version of the models include a graphical view of the watershed subbasins and stream networks, a tree diagram representing the HEC-1 model structure, and a hydrograph output window. The ability to view hydrographs graphically in WMS was used to check the results of the HEC-1 models. WMS also allowed for direct comparison of hydrographs between development conditions.

The WMS versions of the models were created through the importation of ArcView shape files of the subbasins, streams, and outlet points. WMS automatically creates the structure for the HEC-1 model from the data in the shape files. These files were formatted for WMS with the WMS HYDRO extension for ArcView which is available with the WMS package. The final work copies of the HEC-1 models were then brought into WMS to complete the attribution of the HEC-1 models structure created from the shape files.

HEC-1 Modeling Results

Table 3.4 presents a summary of the results of this "existing condition hydrology" task at selected locations. Peak flow data is presented for each of the major watersheds for all of the six design storms, and then compared back to the flow information that was presented in the original FIS. The tables provide a description of the "location" or flow combination point that was referenced in the original FIS. Please recall that the individual models (on the CDS in Appendix 1) contain a great deal more information at many more combination points than is presented in the table. Next to the "location" the table presents the drainage area in square miles that was reported in the FIS as well as the drainage area based upon the more detailed topographic information of the SDMP (the column is labeled HEC-1). The specific ID number for the "combination point" that matches the original FIS location is included. Again, the nomenclature of the ID numbering is such that C38 is at a point 3,800 feet along the main channel upstream from the mouth of the watershed.

It is interesting to note that where the vast majority of the "new" drainage area sizes matched the FIS data very closely, there were a couple of differences discovered. Each of the individual watershed sheets in the table has a "notes" section at the bottom describing any strange things that were noticed. For example, a difference was noted in the Whispering Creek tributary to the Spring Creek watershed (so the drainage area numbers in Spring Creek are also different). In Whispering Creek it was noted that the difference in drainage areas between the new HEC-1 and the FIS at the North Outfall "location" were due to the inclusion of the upper portion of Whispering Creek (approximately 4.7 square miles) in the total area for *BOTH* the North Outfall and Whispering Creek watersheds in the FIS study. This drainage area was only included once in this study. Also noted was the fact that there is an area (approximately 3 square miles in size) in the upper reached of Whispering Creek that the new more detailed topographic information indicates really drains to the Marcado Creek watershed. This area was added to the Marcado Creek total. There was no FIS information to compare to, however, since Marcado Creek was not included in the original FIS.

Table 3.4A: Comparison of All FIS Flows and HEC-1 Flows for Jim Branch

Flooding Location	Area (sq. miles) FIS	Area (sq. miles) HEC-1	HEC-1 ID	500-Year Peak Flow (cfs) FIS	500-Year Peak Flow (cfs) HEC-1 P/P	500-Year Peak Flow (cfs) HEC-1 F/P	500-Year Peak Flow (cfs) HEC-1 F/F	500-Year Peak Flow per Acre FIS	500-Year Peak Flow per Acre HEC-1 P/P	500-Year Peak Flow per Acre HEC-1 F/P	500-Year Peak Flow per Acre HEC-1 F/F	100-Year Peak Flow (cfs) FIS	100-Year Peak Flow (cfs) HEC-1 P/P	100-Year Peak Flow (cfs) HEC-1 F/P	100-Year Peak Flow (cfs) HEC-1 F/F	100-Year Peak Flow per Acre FIS	100-Year Peak Flow per Acre HEC-1 P/P	100-Year Peak Flow per Acre HEC-1 F/P	100-Year Peak Flow per Acre HEC-1 F/F
At confluence with the Guadalupe River	4.7	4.64	C0	4350	3676	3679	4864	1.45	1.24	1.24	1.64	3400	2977	2982	4197	1.13	1.00	1.00	1.41
At Hand Road	4.1	4.14	C38	4100	3671	3724	4956	1.56	1.39	1.41	1.87	3200	3228	3281	4160	1.22	1.22	1.24	1.57
At Callis Street	3.5	3.33	C102	3400	3973	4211	4607	1.52	1.86	1.98	2.16	2650	3350	3549	3693	1.18	1.57	1.67	1.73

Flooding Location	Area (sq. miles) FIS	Area (sq. miles) HEC-1	HEC-1 ID	50-Year Peak Flow (cfs) FIS	50-Year Peak Flow (cfs) HEC-1 P/P	50-Year Peak Flow (cfs) HEC-1 F/P	50-Year Peak Flow (cfs) HEC-1 F/F	50-Year Peak Flow per Acre FIS	50-Year Peak Flow per Acre HEC-1 P/P	50-Year Peak Flow per Acre HEC-1 F/P	50-Year Peak Flow per Acre HEC-1 F/F	10-Year Peak Flow (cfs) FIS	10-Year Peak Flow (cfs) HEC-1 P/P	10-Year Peak Flow (cfs) HEC-1 F/P	10-Year Peak Flow (cfs) HEC-1 F/F	10-Year Peak Flow per Acre FIS	10-Year Peak Flow per Acre HEC-1 P/P	10-Year Peak Flow per Acre HEC-1 F/P	10-Year Peak Flow per Acre HEC-1 F/F
At confluence with the Guadalupe River	4.7	4.64	C0	2900	2659	2730	3523	0.96	0.90	0.92	1.19	2050	2039	2109	2590	0.68	0.69	0.71	0.87
At Hand Road	4.1	4.14	C38	2750	2796	3048	3576	1.05	1.06	1.15	1.35	1950	2077	2198	2645	0.74	0.78	0.83	1.00
At Callis Street	3.5	3.33	C102	2300	2659	3244	3212	1.03	1.25	1.52	1.51	1600	2290	2516	2462	0.71	1.07	1.18	1.16

Table 3.4B: Comparison of All FIS Flows and HEC-1 Flows for South Outfall

Flooding Location	Area (sq. miles) FIS	Area (sq. miles) HEC-1	HEC-1 ID	500-Year Peak Flow (cfs) FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	500-Year Peak Flow per Acre FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	100-Year Peak Flow (cfs) FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	100-Year Peak Flow per Acre FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F
At confluence with the Guadalupe River	na	1.59	C0	na	1347	1348	1475	na	1.32	1.32	1.45	na	1077	1084	1175	na	1.06	1.07	1.15
At Missouri Pacific/Hand Rd. Bridge	na	1.34	C40	na	1706	1855	2324	na	1.32	2.16	2.71	na	1358	1433	1556	na	1.58	1.67	1.81
South Street intersection	na	0.71	C70	na	1343	1361	1361	na	2.96	3.00	3.00	na	1045	1065	1065	na	2.30	2.34	2.34

Flooding Location	Area (sq. miles) FIS	Area (sq. miles) HEC-1	HEC-1 ID	50-Year Peak Flow (cfs) FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	50-Year Peak Flow per Acre FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	10-Year Peak Flow (cfs) FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	10-Year Peak Flow per Acre FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F
At confluence with the Guadalupe River	na	1.59	C0	na	977	991	994	na	0.96	0.97	0.98	na	760	783	767	na	0.75	0.77	0.75
At Missouri Pacific/Hand Rd. Bridge	na	1.34	C40	na	1174	1238	1375	na	1.37	1.44	1.60	na	833	879	715	na	0.97	1.02	0.83
South Street intersection	na	0.71	C70	na	907	929	929	na	2.00	2.04	2.04	na	650	674	674	na	1.43	1.48	1.48

Note: Flows from the HEC-1 model in some cases are higher in upper portions of the watershed than at the mouth. The reduced flow at the mouth is due to attenuation in the main chanel routing reaches. Toward the downstream end of the watershed the flow tends to spread out extensively into the floodplan.

Table 3.4C: Comparison of All FIS Flows and HEC-1 Flows for West Outfall

Flooding Location	Area (sq. miles)		HEC-1 ID	500-Year Peak Flow (cfs)				500-Year Peak Flow per Acre				100-Year Peak Flow (cfs)				100-Year Peak Flow per Acre			
	FIS	HEC-1		FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F
At confluence with the Guadalupe River	3.2	3.6	C0	3730	3988	3963	2544	1.82	1.73	1.72	1.10	2900	3209	3196	2119	1.42	1.39	1.39	0.92
At Red River Street	2.7	3.17	C20	3290	3631	3599	2146	1.90	1.79	1.77	1.06	2580	2915	2905	1689	1.49	1.44	1.43	0.83
At Main Street	2.3	2.35	C67	2830	3139	3163	1996	1.92	2.09	2.10	1.33	2230	2548	2576	1591	1.51	1.69	1.71	1.06
At Navarro Street	1.7	2.13	C85	2180	3316	3335	2236	2.00	2.43	2.45	1.64	1720	2742	2766	1747	1.58	2.01	2.03	1.28

Flooding Location	Area (sq. miles)		HEC-1 ID	50-Year Peak Flow (cfs)				50-Year Peak Flow per Acre				10-Year Peak Flow (cfs)				10-Year Peak Flow per Acre			
	FIS	HEC-1		FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F
At confluence with the Guadalupe River	3.2	3.6	C0	2500	2802	2894	1830	1.22	1.22	1.26	0.79	1760	2578	2625	1240	0.86	1.12	1.14	0.54
At Red River Street	2.7	3.17	C20	2230	2553	2553	1481	1.29	1.26	1.26	0.73	1590	1978	1979	1123	0.92	1.14	0.98	0.55
At Main Street	2.3	2.35	C67	1940	2254	2283	1414	1.32	1.50	1.52	0.94	1390	1731	1757	1077	0.94	1.14	1.17	0.72
At Navarro Street	1.7	2.13	C85	1490	2428	2459	1546	1.37	1.78	1.80	1.13	1070	1788	1799	1158	0.98	1.14	1.32	0.85

Note: Flows from the HEC-1 model in some cases are higher in upper portions of the watershed than at the mouth. The reduced flow at the mouth is due to attenuation in the main chanel routing reaches. Toward the downstream end of the watershed the flow tends to spread out extensively into the floodplan.

Table 3.4D: Comparison of All FIS Flows and HEC-1 Flows for Spring Creek

	Area (sq. miles)			500-Year Peak Flow (cfs)					500-Year Peak Flow per Acre					100-Year Peak Flow (cfs)					100-Year Peak Flow per Acre				
Flooding Location	FIS	HEC-1	HEC-1 ID	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET
At confluence with the Guadalupe River	53.3	46.93	C0A	22250	18167	17046	21833	18625	0.65	0.60	0.57	0.7	0.6	17100	13656	16671	16774	14289	0.50	0.45	0.56	0.6	0.5
At confluence of Whispering Creek	52.7	43.64	C87	21400	17037	19402	21051	17770	0.63	0.61	0.69	0.8	0.6	16600	13095	16285	16221	13891	0.49	0.47	0.58	0.6	0.5
At confluence of North Outfall	46.4	42.08	C124	19900	15308	16296	18808	14957	0.67	0.57	0.61	0.7	0.6	15300	12021	14246	14396	11653	0.52	0.45	0.53	0.5	0.4
At Clark School Rd.	35.8	35.32	C203	18800	14565	14205	14228	13247	0.82	0.64	0.63	0.6	0.6	14400	10896	10633	10694	6887	0.63	0.48	0.47	0.5	0.3
At Parsons Rd.	31.6	30.97	C360	17700	13961	13473	13485	13498	0.88	0.70	0.68	0.7	0.7	13600	10450	10129	10131	10141	0.67	0.53	0.51	0.5	0.5
At Oliver Rd.	25.5	26.07	C421	15000	12882	12822	12827	12827	0.92	0.77	0.77	0.8	0.8	11500	9642	9633	9634	9634	0.70	0.58	0.58	0.6	0.6
At Raab Rd.	18.7	24.25	C489	11350	12622	12679	12679	12679	0.95	0.81	0.82	0.8	0.8	8700	9442	9519	9519	9519	0.73	0.61	0.61	0.6	0.6
At U.S. Route 87	11.3	17.97	C543	7600	10581	10706	10706	10706	1.05	0.92	0.93	0.9	0.9	5800	7910	8033	8033	8033	0.80	0.69	0.70	0.7	0.7

	Area (sq. miles)			50-Year Peak Flow (cfs)					50-Year Peak Flow per Acre					10-Year Peak Flow (cfs)					10-Year Peak Flow per Acre				
Flooding Location	FIS	HEC-1	HEC-1 ID	FIS	HEC-1 Model	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET
At confluence with the Guadalupe River	53.3	46.93	C0A	14650	11546	14298	14401	12246	0.43	0.38	0.48	0.5	0.4	10100	7097	9021	9922	8266	0.34	0.24	0.30	0.3	0.3
At confluence of Whispering Creek	52.7	43.64	C87	14250	11969	14388	13984	12081	0.42	0.43	0.52	0.5	0.4	9950	6806	11403	9810	8407	0.36	0.24	0.41	0.4	0.3
At confluence of North Outfall	46.4	42.08	C124	13050	10239	12913	12390	10138	0.44	0.38	0.48	0.5	0.4	8950	6606	7857	8678	7152	0.33	0.25	0.29	0.3	0.3
At Clark School Rd.	35.8	35.32	C203	12300	9228	9079	9182	6202	0.54	0.41	0.40	0.4	0.3	8450	6164	6258	6352	5212	0.37	0.27	0.28	0.3	0.2
At Parsons Rd.	31.6	30.97	C360	11600	8856	8607	8610	8618	0.57	0.45	0.43	0.4	0.4	7900	5930	5810	5803	5809	0.40	0.30	0.29	0.3	0.3
At Oliver Rd.	25.5	26.07	C421	9800	8167	8178	8179	8179	0.60	0.49	0.49	0.5	0.5	6700	5469	5512	5503	5503	0.40	0.33	0.33	0.3	0.3
At Raab Rd.	18.7	24.25	C489	7400	7995	8078	8078	8078	0.62	0.52	0.52	0.5	0.5	5100	5349	5440	5440	5440	0.33	0.34	0.35	0.4	0.4
At U.S. Route 87	11.3	17.97	C543	4950	6694	6814	6814	6814	0.68	0.58	0.59	0.6	0.6	3400	4472	4583	4583	4583	0.30	0.39	0.40	0.4	0.4

Table 3.4E: Comparison of All FIS Flows and HEC-1 Flows for Whispering Creek

Flooding Location	Area (sq. miles)		HEC-1 ID	500-Year Peak Flow (cfs)				500-Year Peak Flow per Acre				100-Year Peak Flow (cfs)				100-Year Peak Flow per Acre			
	FIS	HEC-1		FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F
At confluence with the Spring Creek	5.9	2.79	WC0A	2700	3740	3956	3953	0.72	2.09	2.22	2.21	2050	2927	3068	3017	0.54	1.64	1.72	1.69
At private drive 0.33 mi US of confl.	5.3	2.62	WC15A	2200	3463	3662	3650	0.65	2.07	2.18	2.18	1650	2696	2832	2789	0.49	1.61	1.69	1.66
At Country Club Drive	5.1	2.03	WC33	2050	2091	2268	2255	0.63	1.61	1.75	1.74	1550	1626	1743	1704	0.47	1.25	1.34	1.31
At confluence of North Outfall	4.7	1.3	WC77	2183	2245	2445	2445	0.73	2.70	2.94	2.94	1574	1756	1921	1946	0.52	2.11	2.31	2.34
At John Stockbauer Dr.	4.1	0.99	WC108	1833	1622	1741	1734	0.70	2.56	2.75	2.74	1274	1271	1378	1374	0.49	2.01	2.17	2.17
At 0.93 mi US of John Stockbauer Dr.	4.1	0.67	WC132	3450	1191	1199	1199	1.31	2.78	2.80	2.80	2650	921	930	930	1.01	2.15	2.17	2.17

Flooding Location	Area (sq. miles)		HEC-1 ID	50-Year Peak Flow (cfs)				50-Year Peak Flow per Acre				10-Year Peak Flow (cfs)				10-Year Peak Flow per Acre			
	FIS	HEC-1		FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F
At confluence with the Spring Creek	5.9	2.79	WC0A	1750	2562	2687	2622	0.46	1.43	1.50	1.47	1150	1876	1993	1926	0.30	1.05	1.12	1.08
At private drive 0.33 mi US of confl.	5.3	2.62	WC15A	1400	2360	2480	2425	0.41	1.41	1.48	1.45	900	1733	1843	1787	0.54	1.03	1.10	1.07
At Country Club Drive	5.1	2.03	WC33	1300	1428	1531	1481	0.40	1.10	1.18	1.14	850	1070	1161	1107	0.54	0.82	0.89	0.85
At confluence of North Outfall	4.7	1.3	WC77	1259	1533	1686	1696	0.42	1.84	2.03	2.04	778	1089	1219	1200	0.54	1.31	1.47	1.44
At John Stockbauer Dr.	4.1	0.99	WC108	1009	1102	1211	1210	0.38	1.74	1.91	1.91	578	779	872	864	0.54	1.23	1.38	1.36
At 0.93 mi US of John Stockbauer Dr.	4.1	0.67	WC132	2250	797	806	806	0.86	1.86	1.88	1.88	1550	564	574	574	0.54	1.32	1.34	1.34

Notes:
1. The difference in area between PBS&J HEC-1 and FIS HEC-1 is due to a larger drainage area (approximately 3 sq. miles) for the May, 1990 City of Victoria FIS study.

2. Flows from the HEC-1 model in some cases are higher in upper portions of the watershed than at the mouth. The reduced flow at the mouth is due to attenuation in the main chanel routing reaches. Toward the downstream end of the watershed the flow tends to spread out extensively into the floodplan.

Table 3.4F: Comparison of All FIS Flows and HEC-1 Flows for North Outfall

	Area (sq. miles)			500-Year Peak Flow (cfs)				500-Year Peak Flow per Acre				100-Year Peak Flow (cfs)				100-Year Peak Flow per Acre			
Flooding Location	FIS	HEC-1	HEC-1 ID	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F
At confluence with the Spring Creek	7.3	2.49	NC0A	3350	3110	3543	3261	0.72	1.95	2.22	2.05	2600	2551	2949	2627	0.56	1.60	1.85	1.65
At Confluence of US Route 77 Outfall	5	2.4	NC28	1750	2943	3385	3135	0.52	1.32	2.20	2.04	1350	2426	2818	2528	0.42	1.58	1.83	1.65
US 77- At Confluence with North Outfall	2.3	2.29	NC47	1550	2057	2470	2444	1.05	1.40	1.69	1.67	1200	1652	2017	1868	0.82	1.13	1.38	1.27
US 77- At US Route 77	1.9	2.03	NC61	1310	1971	2308	2339	1.08	1.52	1.78	1.80	1020	1564	1854	1782	0.84	1.20	1.43	1.37

	Area (sq. miles)			50-Year Peak Flow (cfs)				50-Year Peak Flow per Acre				10-Year Peak Flow (cfs)				10-Year Peak Flow per Acre			
Flooding Location	FIS	HEC-1	HEC-1 ID	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F
At confluence with the Spring Creek	7.3	2.49	NC0A	2300	2230	2644	2320	0.49	1.40	1.66	1.46	1650	1544	1980	1659	0.35	0.97	1.24	1.04
At Confluence of US Route 77 Outfall	5	2.4	NC28	1200	2127	2530	2230	0.38	1.38	1.65	1.45	900	1473	1906	1595	0.28	0.96	1.24	1.04
US 77- At Confluence with North Outfall	2.3	2.29	NC47	1030	1465	1821	1649	0.70	1.00	1.24	1.13	715	1039	1416	1202	0.49	0.71	0.97	0.82
US 77- At US Route 77	1.9	2.03	NC61	880	1360	1667	1572	0.72	1.05	1.28	1.21	610	975	1289	1142	0.50	0.75	0.99	0.88

Notes:

1. The difference in area between PBS&J HEC-1 and FIS HEC-1 is due to the inclusion of the upper portion of Whispering Creek (approximately 4.7 sq. miles) in the total area for North Outfall and Whispering Creek in the May, 1990 City of Victoria FIS study.

2. Flows from the HEC-1 model in some cases are higher in upper portions of the watershed than at the mouth. The reduced flow at the mouth is due to attenuation in the main chanel routing reaches. Toward the downstream end of the watershed the flow tends to spread out extensively into the floodplan.

Table 3.4G: Comparison of All FIS Flows and HEC-1 Flows for Lone Tree Creek

Flooding Location	Area (sq. miles)		HEC-1 ID	500-Year Peak Flow (cfs)					500-Year Peak Flow per Acre					100-Year Peak Flow (cfs)					100-Year Peak Flow per Acre				
	FIS	HEC-1		FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET
At Wood Hi Road	21.4	22.07	C1211A	13330	12037	12499	13846	12810	0.97	0.85	0.88	0.98	0.91	10310	8700	9323	11541	11266	0.75	0.62	0.66	0.82	0.80
At FM 2615	17.2	17.74	C1316A	11430	11567	12329	15361	11820	1.04	1.02	1.09	1.35	1.04	8840	9040	9874	11493	9722	0.80	0.80	0.87	1.01	0.86
At Interstate Route 175	13.1	11.19	C1453A	9280	8919	9942	12989	9063	1.11	1.25	1.39	1.81	1.27	7180	7005	7922	10546	7438	0.86	0.98	1.11	1.47	1.04
At Southern Pacific Railroad	8.7	8.8	C1550A	6260	7892	9424	11295	7304	1.12	1.40	1.67	2.01	1.30	4840	5830	7055	9096	5669	0.87	1.04	1.25	1.62	1.01
At Confluence of East Branch	8.1	7.34	C1580A	5830	7385	8889	10539	10539	1.12	1.57	1.89	2.24	2.24	4510	5680	7096	8386	8386	0.87	1.21	1.51	1.79	1.79
At Airline Road	4.5	4.33	C1615A	4110	5187	5521	5917	5917	1.43	1.87	1.99	2.14	2.14	3190	3880	4616	4785	4785	1.11	1.40	1.67	1.73	1.73
Approximately 1200 ft upstream of Ben Jordan Street	2.6	2.81	C1670A	2370	2967	3428	3608	3608	1.42	1.65	1.91	2.01	2.01	1840	2284	2663	2922	2922	1.11	1.27	1.48	1.62	1.62
East Branch-Downstream of John Stockbauer Drive	3.6	2.8	C1580I	2190	2869	3842	4413	4413	0.95	1.25	1.67	1.92	1.92	1690	2262	3073	3439	3439	0.73	0.98	1.33	1.49	1.49

Flooding Location	Area (sq. miles)		HEC-1 ID	50-Year Peak Flow (cfs)					50-Year Peak Flow per Acre					10-Year Peak Flow (cfs)					10-Year Peak Flow per Acre				
	FIS	HEC-1		FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	HEC-1 F/F w/ DET
At Wood Hi Road	21.4	22.07	C1211A	8850	7303	7722	10777	10767	0.65	0.52	0.55	0.76	0.76	6160	5009	5363	9016	8699	0.45	0.35	0.38	0.64	0.62
At FM 2615	17.2	17.74	C1316A	7590	7660	8546	10070	8888	0.69	0.67	0.75	0.89	0.78	5270	5006	5788	7992	7280	0.48	0.44	0.51	0.70	0.64
At Interstate Route 175	13.1	11.19	C1453A	6160	6069	6873	9487	6741	0.73	0.85	0.96	1.32	0.94	4280	4252	5066	7079	5146	0.51	0.59	0.71	0.99	0.72
At Southern Pacific Railroad	8.7	8.8	C1550A	4150	5050	5999	8097	5269	0.75	0.90	1.07	1.44	0.94	2880	3542	4397	6165	4297	0.52	0.63	0.78	1.09	0.76
At Confluence of East Branch	8.1	7.34	C1580A	3870	4873	6121	7355	7355	0.75	1.04	1.30	1.57	1.57	2680	3385	4254	5242	5242	0.52	0.72	0.91	1.12	1.12
At Airline Road	4.5	4.33	C1615A	2740	3607	3855	4240	4240	0.95	1.30	1.39	1.53	1.53	1910	1984	2418	3053	3053	0.66	0.72	0.87	1.10	1.10
Approximately 1200 ft upstream of Ben Jordan Street	2.6	2.81	C1670A	1580	1966	2312	2595	2595	0.95	1.09	1.29	1.44	1.44	1100	1363	1641	1998	1998	0.66	0.76	0.91	1.11	1.11
East Branch-Downstream of John Stockbauer Drive	3.6	2.8	C1580I	1440	1996	2708	3000	3000	0.63	0.87	1.18	1.30	1.67	1000	1427	2040	2124	2124	0.43	0.62	0.89	0.92	0.92

Notes:

1. The proposed upstream detention pond is located downstream of the Airline Road bridge at the confluence with the East branch.

2. The proposed downstream detention pond is located between the FM 2615 bridge and the Wood Hi Road bridge.

3. Flows from the HEC-1 model in some cases are higher in upper portions of the watershed than at the mouth. The reduced flow at the mouth is due to attenuation in the main

Table 3.4H: Comparison of All FIS Flows and HEC-1 Flows for Marcado

Flooding Location	Area (sq. miles)		HEC-1	500-Year Peak Flow (cfs)				500-Year Peak Flow per Acre				100-Year Peak Flow (cfs)				100-Year Peak Flow per Acre			
	FIS	HEC-1	ID	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F
At the mouth	NA	17.46	C418A	NA	9030	10528	12339	NA	0.81	0.94	1.10	NA	6840	7971	9697	NA	0.61	0.71	0.87
DS of Hambleton Rd. Bridge	NA	14.54	C538A	NA	7826	9114	11084	NA	0.84	0.98	1.19	NA	6000	7031	8614	NA	0.64	0.76	0.93
DS of Hwy. 59 Bridge (Loop 175)	NA	9.32	C662	NA	4883	5916	5581	NA	0.82	0.99	0.94	NA	3596	4492	4405	NA	0.60	0.75	0.74
DS of Hwy. 59 Business	NA	8.21	C707A	NA	4693	5770	5310	NA	0.89	1.10	1.01	NA	3485	4395	4283	NA	0.66	0.84	0.82

Flooding Location	Area (sq. miles)		HEC-1	50-Year Peak Flow (cfs)				50-Year Peak Flow per Acre				10-Year Peak Flow (cfs)				10-Year Peak Flow per Acre			
	FIS	HEC-1	ID	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F	FIS	HEC-1 P/P	HEC-1 F/P	HEC-1 F/F
At the mouth	NA	17.46	C418A	NA	5869	6888	8445	NA	0.53	0.62	0.76	NA	4102	4905	6046	NA	0.37	0.44	0.54
DS of Hambleton Rd. Bridge	NA	14.54	C538A	NA	5162	6098	7472	NA	0.55	0.66	0.80	NA	3609	4362	5312	NA	0.39	0.47	0.57
DS of Hwy. 59 Bridge (Loop 175)	NA	9.32	C662	NA	2993	3798	3846	NA	0.50	0.64	0.64	NA	1872	2420	2755	NA	0.31	0.41	0.46
DS of Hwy. 59 Business	NA	8.21	C707A	NA	2910	3747	3734	NA	0.55	0.71	0.71	NA	1805	2403	2672	NA	0.34	0.46	0.51

Note: Flows from the HEC-1 model in some cases are higher in upper portions of the watershed than at the mouth. The reduced flow at the mouth is due to attenuation in the main chanel routing reaches. Toward the downstream end of the watershed the flow tends to spread out extensively into the floodplan.

Table 3.4 presents both the flow in cubic feet per second (cfs) at the FIS "location" specified as well as the cfs per acre of drainage watershed. Again this information was computed for the Present/Present condition, the Future/Present condition, and the Future/Future condition and are labeled as such on the column heading. Appendix 5 presents similar type of flow information but in a slightly different format. In this case the various flow condition (P/P, F/P, and F/F) information is listed for ALL the hydrologic "combination points" throughout all the watersheds for all the six storm events. Although this information is available in the CD files, it was thought to be valuable to the general user to have this discharge information available. Again, the map provided in Map Packet 4 presents the location of all the combination points for reference.

3.D.3 Base "Future Conditions" Hydrologic Models

As mentioned above one of the hydrologic flow conditions that was evaluated was the "future" land use scenario. The Design Team assisted the City in selecting the level of development that will constitute the "Future Land Development Conditions" for the SDMP analysis. The City Council adopted a "policy" on what would constitute this level of development that would then ultimately lead to the sizing of the future channel sizes and funding by the Public Sector. This is a major action and demonstrated vision and determination on the part of the Council.

As discussed in Section 2A, the Council's Resolution 98-47R (April 7, 1998) adopted a "policy" on all the issues for use in this (SDMP) drainage planning effort. Included in that action was the decision to assume forty three percent (43%) impervious cover for the residential infill of all existing land use areas less dense than that, except in the Spring Creek watershed which had the 43% impervious development extended to just ½ mi *beyond* the current ETJ and the remaining watershed will remain as *existing conditions* (agricultural). Also included in the future land use are strips of commercial development considered as 85% impervious along the Loop and the major streets as designated in the Master Thoroughfare Plan (MTP). In the model, the commercial strips were assumed to be 200 ft either side of the street center line.

The procedures discussed in Section 3.D.2 were then repeated for the new land use scenario. All of the runoff parameters were changed. As mentioned before, the resulting discharge values are presented in Table 3.4 in comparison to the FIS values, and in Appendix 5 for all the combination points in the entire model. Please recall that the Future land use generates a certain volume of stormwater runoff that is greater than the Present condition. The condition of the conveyance channels throughout the City does have an impact on the routing of the runoff to the downstream combination points. Therefore, the SDMP evaluated this Future land use runoff in both the Present channels (the Future/Present condition) and in the Future channels (the Future/Future condition).

3.D.4. "Existing Condition" Hydraulic Models

The creation of the existing condition hydraulic models consisted of developing models for the open channel system as well as for the closed system (pipe and box culvert). As discussed in Section 3.D.1, information in the original FEMA/FIS hydraulic model was used as a guide. To this older data was incorporated new cross sections and structure information from the LIS and USGS topographic and other data as well as from field surveying. The closed system elevations, slopes, and other information was estimated from best readily available information as discussed in Section 3B and Section 3C. Several field reconnaissance trips were made throughout the SDMP as needed. Updates were made with any known changes or refinements from recent CIP construction. The goal of this task was to develop 5-, 10-, 25-, 50-, 100-, and 500-year flood water surface profiles subject to adopted policy and FEMA requirements. Another goal was to plot the 100-year floodplain (existing conditions) as well as the 100-year FEMA WSEL for the Guadalupe River floodplain.

Open Channel Models

As discussed in Section 2.A.3 "Modeling Software", the Boss RiverCAD River Modeling Software was used to cut cross sections for a total of fourteen basins and to generate the initial HEC-2 models. Unlike the HEC-1 models, HEC-2 models were created for every main channel or tributary in the study area. Several criteria were followed when cutting the cross sections:

1. Cross sections were cut wider than the apparent FEMA 500 year floodplain, except in areas near the Guadalupe River where the floodplain may extend for miles. In these areas the sections were simply cut reasonably wide.
2. A cross section was cut at the beginning of each reach with subsequent upstream cross sections cut at 500 ft. intervals in the city and 1000 ft. intervals in the ETJ.
3. A total of four cross sections were cut at the bridges, two upstream of the bridge and two downstream of the bridge. Cross sections were cut directly upstream and downstream of the bridge perpendicular to the channel. Cross Sections were also cut one constriction width upstream and four constriction widths downstream of the bridge. A fifth cross section was also cut along the top of the road to define the high cord elevations for the BT cards in HEC-2. The elevations in RiverCAD were compared to the FIS HEC-2 model road elevations for accuracy at existing bridges. The bridge geometry information in the old FIS was reused by simply adjusting the elevations based upon the comparison of the elevation of some common point between the old and new datums at the bridge (usually the top of road).
4. Cross Sections were cut just downstream of any tributary.

5. Left and Right overbanks were selected and left, right and main channel lengths were defined using Boss RiverCAD. The sections were coded from left to right looking *downstream*.

After all the cross sections were cut, HEC-2 files were created and exported out of RiverCAD for each of the 14 models. This made the process of entering new and old bridges, expansion/contraction coefficients, and Manning's 'n' coefficients in the models much more efficient than entering the data in River CAD. This was a "production" issue during the creation of all the large magnitude of information for the models. Now that all the information has been created, the "use" of this information should remain within the River CAD environment. Modification of the initial HEC-2 topographic data was performed using the Dodson Pro HEC-2 software. Manning's 'n' values were chosen and entered in the models based on pictures from the many field reconnaissance trips and knowledge of the area. Expansion and contraction coefficients were added to the models at bridges and other points as needed. A summary of general information for all the open channel hydraulics models created for the SDMP is presented in Table 3.5.

As mentioned in Section 3.D.1, a great amount of data collected from the original FEMA/FIS study was reused in the SDMP study. In almost every case the "Bridge Data" was input as a Special Bridge (SB) condition. The first step in bridge input was entering in existing bridge information from tho FIS HEC-2 model. Bridge information from the FIS HEC-2 study was used for those bridges which have not been updated since the study. The "top of road" cross sections from RiverCAD were compared with existing top of road data found on the bridge deck (BT) cards in the FIS HEC-2 model for accuracy. The most accurate top of road data was then entered on BT cards on the upstream cross section.

All of the existing bridge information which was modeled as normal bridge in the FIS HEC-2 was converted to SB in the new models. Inverts on the SB card for the existing bridges was modified based on recent upstream and downstream inverts (sections cut in RiverCAD) type of bridge and open area. Then the X2 card was added to the existing upstream section identifying the high cord and low cord elevations. The encroachment information was modified on the X3 cards on all upstream and downstream cross sections based on the bottom width of the bridge. The Manning's 'n' values and expansion/contraction coefficients were checked for accuracy. Several bridges have been improved since the FIS HEC-2 study. Therefore, the Design Team had to update SB, X2 and X3 cards and top of road for those bridges which have been updated since the FIS HEC-2 model. Similarly, modifications of bottom width, obstruction, open area, side slopes and inverts for the improved bridges on the SB card were also made. Adjust the distance between the upstream and the downstream cross sections based on the width of the improved bridge. Enter in BT cards on the upstream cross section based on RiverCAD cross section cut on the top of road. Add X2 card on the upstream cross section to define the high cord and low cord. Add encroachments on the X3 card on upstream and downstream cross sections based on bottom width.

Table 3.5: Summary of Open Channel Hydraulics Models (HEC-2)

Watersheds[1]	HEC-2 Channel Length (ft)	HEC-2 Number of Stations
Jim Branch	16,100	68
Ben Jordan[2]	3,603	13
South Outfall	8,224	26
Second Street	NA[3]	NA
West Outfall	12,750	51
Spring Creek	47,114	90
Mockingbird	NA	NA
Whispering Creek	14,180	77
North Outfall	4,993	32
US 77	7,720	43
Lone Tree	60,137	155
Southern Pacific	9,168	29
East Branch	8,805	34
Marcado	33,369	61
Total	226,163	679

Notes:

[1] Each subwatershed was modeled independantly in HEC-2.

[2] Indentions indicate tributary watersheds.

[3] NA indicates watersheds with closed system drainage only.

Modify Manning's 'n' value and expansion/contraction coefficients where necessary. Enter in New Bridge information for those bridges which did not exist during the FIS HEC-2 study based on survey information and RiverCAD topography. Following the same procedures outlined above for the updated bridges.

As mentioned in the hydrology sections, there were three different models set up in hydraulic model to evaluate the Present land use in the Present channels (P/P), the Future land use in the Present channels (F/P), and the Future land use in the Future channels (F/F). To accomplish that goal several steps needed to be taken. The flows from the P/P HEC-1 model were entered on discharge (QT) cards at the appropriate section in the file. The internal "quality check" at this point relies on the numbering system that has been described in several previous sections of the report. That system focusing upon the distance a certain point is from the mouth of a certain watershed. If a point was 2,000 ft from the mouth, then in the hydrologic model the point would be referenced as Station 20 (hundreds of feet) in an effort to minimize the size of the numbers in the "maintenance coding system," and in the hydraulic model that same point would be called out as Station 2,000. Therefore, the discharge numbers that were generated for "combination point" 20 would be inserted at section 2000. If they were inserted in any other location, the ID numbers would not match and the Design Team would be able to move them to the proper location. This is just one example of the Quality Control and Assurance for Projects (QCAP) efforts that went on "behind the scenes" during the creation of the SDMP.

Similarly, flows from the F/P HEC-1 model were entered on the QT cards at the appropriate section in the file. However, to ultimately arrive at a good F/F hydraulics model there was one additional step that needed to be included. First the F/P flows were entered on QT cards and this model was run. Then there was a comparison between P/P computed water surface elevations and F/F water surface elevations to determine the approximate size of channel improvements and improved bridge openings. Low flow conditions were preserved and channel improvements began 1 to 3 ft off the channel invert. Channel improvements kept approximately the same slopes as the overbanks. Drop Structures were added where channel improvements met the invert. Side slopes were set at 3:1 (H:V) where possible and set at 2:1 or 1:1 in tight residential locations. The Bottom width was changed until the computed water surface elevation of the F/F condition was below or close to the P/P computed water surface elevation.

Bridge modified based on improvements. Bridge was modified in channel improvements to have approximately one-half of the open area of the upstream section. Side slopes were changed to 2:1. Bottom width was modified to match half the open area of the upstream cross section with 2:1 side slopes. New Modified Puls routing was generated using the F/F models with the approximate channel improvements and the new Modified Puls routing reach information was entered in the F/F HEC-1 model to produce more accurate F/F flows. The new F/F HEC-1 flows were entered in the F/F HEC-2 model and channel improvements were improved upon to assure that the F/F computed water surface elevations were below the P/P computed water surface elevations and the FIS computed water surface elevations. This iteration was necessary to provide the future hydrology model with the information about the loss of channel storage (overbank flooding) which ultimately reduced the attenuation (reduction) of routed storm peaks. The result of channel improvements is that the stormwater is able to be conveyed downstream much more efficiently and therefore, the peak flow is not reduced as much as under unimproved channel conditions. This "iteration" between the hydrologic and hydraulic models was a critical step to take.

Besides the creation of the open channel hydraulics model there was also the creation of the closed system (pipes and box culverts) model. The AVsand modeling system developed by the Cedra Corporation was used to model the closed drainage systems in the city. The AVsand system contains two computational engines, the Sand engine developed by Cedra, and the U.S. EPA's SWMM model. The SWMM engine was used because it provides extra flexibility in the definition of the storm sewer system and, most importantly, it allows for user input of hydrograph inflows. This feature allows the model to use hydrographs developed with the HEC-1 models for the watersheds. The Sand engine is excellent for use in the design of storm, sanitary, and combined systems using the rational method. The model includes the capability to calculate simple hydrograph inflows with the rational method.

Closed System Models

The AVsand software system was used in the closed system modeling effort. AVsand allows for creation and editing of the storm sewer (or sanitary sewer) directly in ArcView. AVsand also provides two computational engines for the simulation of flows. The SWMM engine, which allows more flexibility for flow input and sewer system elements, was selected for this effort. The alternate SAND engine can be used for design of new systems or redesign of existing system using rational method flows generated by AVsand.

Closed system of the storm sewers were created for eight major watersheds. A complete list of systems modeled in AVsand is shown in Table 3.6. The actual systems modeled are indicated on the maps comprising Map Packet 4. The most extensive modeling was performed for West Outfall and Lone Tree watersheds.

The systems modeled were selected based on the size of the system (area drained and actual pipe sizes) and the number of reports of drainage problems in areas drained by the system. The graphical version of the Drainage Complaint database was used to evaluate the severity of drainage problems reported for a particular system. Additional systems were modeled at the request of the City.

Table 3.6: List of Watersheds Modeled in AVsand

Watersheds	Numer of Service Areas	Number of Modeled Strips	Length of Pipe Modeled (miles)
Jim Branch	2	10	8.56
Ben Jordan[1]	(1)[2]	(6)	(4.90)
South Outfall	1	4	3.91
Second Street	2	11	7.29
West Outfall	3	24	11.50
Spring Creek	4	6	5.04
Mockingbird	1	3	1.82
Whispering Creek	1	8	5.15
North Outfall	NA	NA	NA
US 77	NA	NA	NA
Lone Tree	11	22	13.69
Southern Pacific	(1)	(4)	(2.2)
East Branch	(2)	(4)	(2.05)
Marcado	NA	NA	NA
Total	25	88	56.96

Notes:

[1] Indentions indicate tributary watersheds

[2] Parentheses indicate sub-watershed data that were aggregated into single models.

[3] NA indicates watersheds not modeled in AVsand

The storm sewer systems identified in Table 3.6 were modeled for future/present and future/future conditions. Since the master plan focusses on the steps necessary to prevent future flooding problems in the city, the present/present condition was not modeled. Present/present conditions could be modeled simply by replacing the future condition flows in the future/present model with the present/present condition flows. The future/present condition models represent the drainage situation that will exist at full development conditions if no improvements are made to the existing system.

Future/future condition models present the storm sewer system that would be required to drain either the 10- or 25-year event based on fully developed conditions. In keeping with the Traffic Thoroughfare Plan, and the Design Criteria Manual, the major arterial streets are to be designed for the 25-year event and then the smaller streets are to be designed for the 10-year event. The Design Team used the electronic storm sewer maps and identified the major street corridors (requiring the 25-year design). After identifying these special street corridors, the entire closed system drainage system from that point out to the main open channel creek was thereby targeted to be designed to the 25-year event (regardless of the type of street that passed over the closed system). Table 3.7 presents a summary of the closed system models (watershed, service area, and strip) and whether they were designed to the 10-year or to the 25-year event. The 10-year systems were always located in the upper reaches (upstream) of the 25-year systems. When the 10-year design system was created, the 10-year event was modeled through the larger 25-year downstream infrastructure in order to get the proper starting water surface (hydraulic gradeline) condition for the upper 10-year design. Table 3.7 also includes general information about the length and flowline elevations for the modeled system.

Import Data into AVsand

Each major watershed was modeled independently with the AVsand model. The Mockingbird Outfall and Whispering Creek watersheds which are part of the Spring Creek watershed also were modeled independently. A separate ArcView/AVsand project was created for each of the major watersheds. Each watershed project file consisted of the pipe, node, and service area shape files for the watershed and an inflow data file in DBF format. Additional database tables with model control and open channel parameters were added within the model interface.

Once the project file was created, the pipe and node geometry was integrated into the model through the Build Model Geometry command in AVsand. This command searches for pair of pipe and node files with all of the fields required by the AVsand model. If there are no such files, the model prompts the user for the name of the node and pipe shape files. The model interface will use any AVsand fields that are already defined in the files and add any additional fields need by the model interface.

Table 3.7: Design Storm and Summary Data for AVsand Strips

	Basin	Service Area	Strip	Design Storm	Length (ft)	Minimum Invert Elev. (ft)	Maximum Invert Elev. (ft)	Maximum Ground Elev. (ft)
1	JB	2	1	25	10,991	74.04	94.50	100.00
2	JB	1	2	25	4,153	64.58	73.86	81.78
3	JB	1	3	25	6,780	68.12	81.54	94.12
4	JB	2	4	25	4,088	68.90	77.79	91.00
5	JB	2	5	25	4,297	70.70	85.32	93.64
6	JB	2	6	25	5,185	71.98	86.39	96.82
7	JB	2	7	25	1,919	82.36	86.87	95.06
8	JB	2	8	25	2,428	84.66	95.60	98.71
9	JB	2	9	25	2,625	84.66	89.90	100.00
10	JB	2	10	25	2,745	84.66	90.14	99.49
11	SO	1	1	25	9,108	55.00	83.55	99.78
12	SO	1	2	25	6,858	55.50	82.10	94.00
13	SO	1	3	25	2,748	61.41	69.85	80.99
14	SO	1	4	25	1,952	65.38	73.99	83.36
15	SS	1	1	25	3,778	31.02	55.18	60.48
16	SS	1	2	10	2,564	37.21	44.52	50.09
17	SS	1	3	10	1,846	31.23	38.05	57.93
18	SS	2	1	25	9,625	40.23	89.92	97.19
19	SS	2	2	10	1,494	41.39	44.84	56.91
20	SS	2	3	10	2,682	75.96	83.87	91.91
21	SS	2	4	10	1,937	76.48	82.93	91.64
22	SS	2	5	10	2,321	80.03	87.02	95.54
23	SS	2	6	10	5,558	33.50	77.78	83.90
24	SS	2	7	10	1,386	66.51	84.84	91.33
25	SS	2	8	10	5,289	34.00	85.39	71.94
26	WO	1	1	25	5,457	52.00	89.47	94.97
27	WO	1	2	25	1,549	83.93	87.22	94.71
28	WO	1	3	25	3,106	84.43	92.31	97.97
29	WO	2	2	25	2,696	65.10	89.24	94.88
30	WO	2	3	25	5,036	71.15	90.67	94.37
31	WO	2	4	25	3,801	81.88	92.07	94.45
32	WO	2	5	25	5,271	79.08	89.09	100.93
33	WO	2	6	25	1,432	84.42	93.01	97.70
34	WO	2	7	10	1,977	84.91	91.14	99.00
35	WO	3	1	25	7,299	82.76	94.31	101.08
36	WO	3	8	25	5,104	80.60	89.20	101.12
37	WO	3	9	25	3,772	82.74	89.60	100.15
38	WO	3	10	10	1,168	87.66	88.95	97.07
39	WO	3	11	25	3,367	86.06	94.51	98.00
40	WO	3	12	10	1,353	87.66	91.43	96.91
41	WO	3	13	10	558	93.49	93.50	96.00
42	WO	3	14	10	659	94.30	95.35	97.26
43	WO	3	15	25	3,004	83.25	84.73	93.00
44	WO	3	16	25	2,195	84.73	89.45	94.85
45	WO	3	17	25	952	88.63	90.53	98.88
46	WO	3	18	N/A	247	89.20	89.60	
47	WO	3	19	N/A	244	87.66	89.60	

Table 3.7: Design Storm and Summary Data for AVsand Strips

	Basin	Service Area	Strip	Design Storm	Length (ft)	Minimum Invert Elev. (ft)	Maximum Invert Elev. (ft)	Maximum Ground Elev. (ft)
48	WO	3	20	N/A	245	87.66	88.10	
49	WO	3	21	N/A	244	87.66	88.10	
50	SC	2	1	10	10,203	89.00	118.67	126.79
51	SC	2	2	10	3,512	97.00	105.54	113.68
52	SC	2	3	10	4,349	103.54	115.41	129.00
53	SC	2	4	10	3,328	110.13	119.62	125.00
54	SC	2	5	10	2,197	116.14	119.75	129.20
55	SC	4	1	10	3,012	76.00	81.56	97.00
56	MO	1	1	25	7,215	57.00	95.45	101.65
57	MO	1	2	10	930	83.79	85.68	94.00
58	MO	1	3	10	1,479	84.33	88.56	92.96
59	WC	1	8	10	983	79.82	86.70	93.00
60	WC	1	9	10	1,398	94.00	100.70	109.66
61	WC	2	2	25	8,682	65.50	97.20	103.31
62	WC	2	3	25	5,414	70.50	94.08	96.54
63	WC	2	4	25	3,202	84.33	99.92	105.00
64	WC	2	5	10	2,474	85.39	101.50	105.04
65	WC	2	6	10	2,471	89.24	99.70	105.07
66	WC	2	7	10	2,548	91.28	97.98	104.93
67	LT	1	1	25	7,885	77.58	89.37	95.20
68	LT	2	2	25	5,604	82.85	89.57	97.35
69	LT	2	3	25	1,830	84.84	89.38	95.00
70	LT	2	4	10	1,054	87.43	88.49	94.84
71	LT	2	5	10	3,147	85.59	91.35	96.02
72	LT	3	1	10	2,263	80.65	85.45	95.00
73	LT	4	1	25	6,170	81.40	91.62	102.39
74	LT	4	2	10	1,260	85.85	88.28	93.93
75	LT	4	3	10	3,656	88.39	89.52	94.86
76	LT	4	4	10	879	90.56	91.88	98.63
77	LT	5	1	25	3,618	84.97	91.93	99.00
78	LT	6	1	25	6,125	90.00	98.43	111.50
79	LT	6	2	10	1,441	96.70	100.99	106.34
80	LT	6	3	10	2,206	96.75	99.60	107.28
81	LT	7	1	10	3,129	87.29	92.09	99.00
82	LT	8	1	25	6,492	93.70	102.23	114.00
83	LT	9	1	25	2,832	95.14	100.25	107.09
84	LT	9	2	10	1,871	96.29	98.19	107.07
85	LT	10	1	10	3,165	84.00	89.18	99.72
86	LT	11	1	25	4,714	87.00	92.53	103.80
87	LT	11	2	25	1,551	89.57	94.82	101.00
88	LT	11	3	10	1,417	90.00	92.28	101.00
				Total	300,796	ft =	57	miles

Two additional database files must be created after import of the model geometry. The outfall nodes must be identified and boundary conditions supplied. User defined shapes for open channel segments also must be defined. For use in the SWMM model, the user defined shapes must be converted to a HEC-2 style format with a unique set of data for each individual segment. The interface includes a command to convert the user defined shapes into the format required by AVsand. The open channel shapes were converted and then modified in Excel to provide a unique definition for each segment.

Database Structure in AVsand

The original structure for the Storm Sewer database was supplemented by additional fields within AVsand. AVsand added a number of records for storage of model results and initial conditions, maintenance records, and more extensive descriptions of pipe and node characteristics. These fields were automatically added to the model subset of the database upon import into AVsand. Complete lists of the fields present in the pipe and node databases are shown in tables 3.8 and 3.9, respectively.

The tables also indicate the fields created in the original database and those added by the software. While the extended set of fields is incorporated in a subset of the original storm sewer database, this data can easily be linked back to the original database through the ArcView join or link command.

Design Flow Data

As discussed earlier, the design flow for a particular storm sewer system was either the 10- or 25-year event depending on type of street system drained. Design flow inputs for the models were developed from the HEC-1 output data. The HEC-1 files were set up to generate "Tape22" hydrograph output files with flow ordinates every fifteen minutes. A Fortran program was written to read these Tape22 file and distribute the flows based on data from a key file. The key file for a watershed contains the nodes at which flows are to be entered, the service area and strip for the node, up to two drainage basins contributing to the node, and the percentage of the drainage basin actually contributing to the node. The program reads the relevant basin names, searches the Tape22 file for the appropriate basin(s), applies the given percentage to each ordinate of the hydrograph, and combines hydrographs if two basins are indicated. An ASCII text output file is generated with the resulting hydrograph inflow data for each specified node. The program also determines the peak inflow at each node. This information was helpful for the resizing of pipes to handle the expected peak flows. The source code for the conversion program and samples of the key file, Tape22 file, and AVsand format data file are included in Appendix 6. This Fortran software package was created by the Design Team specifically for the City of Victoria to be used

Table 3.8: AVsand Pipe Attributes

Location		Orientation and Identification		Geometry		Physical Characteristics	
SRVAREA[1]	Service Area Number	*DNNOD*	Downstream Node Number	*PSHAP*	Conduit Shape	WASTETYP	Type of Waste Load
SEWSYST	Sewer System (Network) Number	*DNINDX*	Downstream Node Index	*PHIGH*	Conduit Height in inches (mm)	FLOWTYP	Flow Type and Parallel Pipe Code
STRIP	Sewer Model Strip Number	*UPNOD*	Upstream Node Number	*PWIDE*	Conduit Width in inches (mm)	*PMATR*	Conduit Material
DNMAP	Donwstream Node Map Number	*UPINDX*	Upstream Node Index	PSLOPL	Slope of Left Trapezoidal Side	WALLTHK	Conduit Material Thickness in inches (mm)
UPMAP	Upstream Node Map Number	*PIPID*	Incidence (Pipe) Number	PSLOPR	Slope of Right Trapezoidal Side	JOINTYP	Conduit Joint Type
		DNINV	Downstream Invert in feet (m)	PXAREA	Conduit Cross Sectional Area in square feet (m)	PLINER	Conduit Lining Type
		UPINV	Upstream Invert in feet (m)	EXPONENT	Curve Exponent of Parabolic Shape Conduit	PLNTHK	Conduit Lining Thickness in inches (mm)
		PLONG	Conduit Length in feet (m)	PDROPINV	Invert Elevation of the Conduit Drop	*PMANN*	Conduit Manning's Roughness
		PSLOP	Conduit Slope in feet per foot (m)	PDROPDIA	Diameter of the Conduit Drop in inches (mm)	PHAZN	Conduit Hazen-Williams Roughness
				HEC2SECT	HEC-2 Section Identification Number	INITFLOW	Initial Flow in ft3/s [m3/s]
				FLAPGATE	Existance of Flap Gate at Downstream End		

PBS&J Fields		Maintenance		Analysis Results	
	Original Unique Identifier	*STATUS*	Activity Status and/or Action Code	*8 Fields*	Pipe Hydraulic Capacity Data
	Aggregated Pipes	*METHOD*	Method of Pipe Construction	*7 Fields*	Pipe Capacity Analysis Wastewater Contributions
	Parallel Pipes	*INSTALL*	Date Installed or Reconstructed	*4 Fields*	Pipe Capacity Analysis Stormwater Contributions
	Sorting Field	*INSPECT*	Date of Last Inspection	8 Fields	Pipe Capacity Analysis Flow Computational Results
	Order Field	*MAINTNC*	Date of Last Maintenance	8 Fields	New Pipe Replacement Recommendations
	Conectivity Fields				
	Data Quality Field (Nodes?)				

[1] Fields in italics were populated in the database creation and AVsand modeling

Table 3.9: AVsand Node Attributes

Location		Orientation and Identification		Geometry and Model Input		Physical Characteristics	
SRVAREA [1]	Service Area Number	*NODID*	Node Number	*NTYPE*	Node Type	CRELV	Critical Elevation for Backwater Computations in feet (m)
SEWSYST	Sewer System (Network) Number	NODEX	East (X) Coordinate in feet (m)	*NSHAP*	Node Shape Code	NLOSS	Head Loss to Override Program Defaults in feet (m)
NOMAP	Map Number	NODEY	North (Y) Coordinate in feet (m)	*NLONG*	Node Length or Radius in feet (m)	DETAL	Structure Type Code - Reference to Construction Detail
		NODEZ	Top or Grate (rim) Elevation (Z) in feet (m)	*NWIDE*	Node Width or Radius in feet (m)	CASTDIA	Casting and Cover Diameter in inches (mm)
		NROTN	Cartesian Rotation of Node's Length from x-axis in degrees	NDROP	Design Drop from Up to Down Inverts Along a Strip in feet (m)	CASTTYP	Casting and Cover Type Code
				NSUMP	Lowest Elevation at the Node in feet (m)	BARLWAL	Structure Wall (barrel) Type Code
				CONSTQ	Net Constant Flow at the Node	CORBEL	Structure Corbel Type Code
				INITLDPTH	Initial Flow Depth Above Invert	BENCH	Structure Bench Type Code
						TRAP	Structure Trap Type Code
						INPIPE	Pipe Connection Indicator

PBS&J Fields		Maintenance		Analysis Results	
	Original Unique Identifier	STATUS	Activity Status and/or Action Code		
	Aggregated Pipes	ALIGNUM	Corresponding Horizontal Alignment Number		
	Parallel Pipes	STATION	Alignment Station of Node		
	Sorting Field	ALIGOFF	Node Offset from the Alignment		
	Order Field	INSTALL	Date Installed or Reconstructed		
	Conectivity Fields	INSPECT	Date of Last Inspection		
	Data Quality Field (Nodes?)	MAINTNC	Date of Last Maintenance		

[1] Fields in italics were populated in the database creation and AVsand modeling

as a tool in the conversion of the hydrologic "output" from HEC-1 easily into an "input" file for the use by the AV Sand model.

3.D.5 Base "Future Condition" Hydraulic Models

The base "Future Condition" is equivalent to the Future/Present condition described earlier. This is essentially the "do nothing" alternative for improvements to the existing drainage system. These models simply route the future condition flows developed in the HEC-1 models through the existing drainage systems. The impacts of these increased flows were evaluated to help determine the level of improvements needed for the drainage systems. These evaluations were based on increases in water surface elevations and floodplain sizes for open channel and overflows and surcharges for the closed systems.

Open Channel Models

The Future/Present conditions open channel models were used to evaluate the relative increase in water levels due to increased flows from future development without any improvements to the existing channels. These models incorporate flows developed in the Future/Present condition HEC-1 models into the existing channel systems modeled in the Present/Present HEC-2 models. The Future/Present HEC-2 models and related output can be found on the CD-ROM included with this report.

Closed System Models

As mentioned earlier, the Future/Present condition was the only "base" condition modeled for the closed systems. The storm sewer systems listed in Table 3.6 were simulated based on the inverts estimated as described in Section 2 and the pipe sizes transferred from the storm sewer atlas into the storm sewer database. Design flows for the models were generated from the HEC-1 Future/Present condition output as described above. The adequacy of each system was evaluated based on the amount of surcharging and overflow for the appropriate design event. These models represent the "do nothing" option for each system. These models and related output can be found on the CD-ROM included with this report.

File Management

The previous sections have discussed the various modeling efforts that were a part of the SDMP. This section briefly discusses the file management component of this effort. It is important that the end user of these products know where to look to find the particular model or spreadsheet. Certainly with time this nomenclature will become second nature or could even be altered by the City to another format.

On the hard drive of the PC is a folder labeled “Models”. This is the folder that actually contains all of the HEC-1, RiverCAD and HEC-2 models, as well as any spreadsheets which may have been used to generate these models. The subfolders which are located in the models folder are labeled with the two letter designation for that particular watershed (i.e., JB, LT, MC, MO, NO, SC, SO, SS, US, WC, and WO).

Under each of these folders there are four subfolders entitled “Work, PP, FP, and FF.” The Work folder contains spreadsheets on flows, routing, basin parameters and water surface elevation comparisons to name a few. There are also many intermediate data files and runs which are kept here because they were used to develop the final models. Under each of the PP, FP, and FF folders there are model subfolders titled WMS, RiverCAD, HEC-1 and AVSAND. The HEC-1 and HEC-2 files are located under the HEC-1 and RiverCAD folders respectively. The RiverCAD files and flood mapping information will also be in the RiverCAD model subfolder.

Some of the watershed folders, for instance Second Street (SS), may not have actual data files in all of the model folders, this is because not all of the models have a HEC-2 model or their own HEC-1 model. For example under the WC, NO and US folders there are no HEC-1 datafiles or output because these models are included in the Spring Creek HEC-1 model and output on these watersheds will be found in the SC folder under the HEC-1 folder for each of the three conditions.

Below is an example schematic on how one would find the Future/Future conditions HEC-2 model for Whispering Creek:

Models
- WC
  - FF
    - RiverCAD

Wcff.dat- input

Wcff.out- output

There are several different spreadsheets located in the Models folder which have information on all of the watersheds. These include the following:

Costest99.xls- Includes complete cost estimates for all of the watersheds waterinfo.xls- Includes information on the total drainage area, river miles, and number of subbasins modeled in HEC-1 and HEC-2.

damcost.xls- Includes information on the parameters for determining cost of the detention ponds.

brcost.xls- Includes information on the parameters for determining cost of the detention ponds.

basinQ.xls- Includes data for the flows for every subbasin and every storm in the entire study area, as well as graphs for flow based on the size of drainage area for all of the subbasins in the entire study area

There are also several spreadsheets located in the individual watershed "work" folders which include information on that particular watershed alone. The following provides the framework nomenclature of particular types of computations with the blank lines being filled in with the two letter abbreviation for the particular watershed in question:

pp-ff__.xls- Includes the comparison of P/P and F/F conditions computed water surface elevations with FIS computed water surface elevations for this particular watershed.

__hc1sum.xls- Includes data for the HEC-1 flows and flow per acre for the P/P, F/P and F/F conditions compared to the FIS study flows and flow per acre.

coflow__.xls- Includes flow data and flow per acre data for each combo point found in the HEC-1 for this particular watershed.

Qtloc__.xls- Includes the location of the QT (flow input) by HEC-2 station for this particular watershed.

__params.xls- Includes the present and future parameters that were used in the HEC-1 models for this particular watershed.

rtreach__.xls- Includes the routing reaches for HEC-1 based on upstream and downstream station for this particular watershed.

Rtecal__.xls Includes the Muskingum routing reach parameters for HEC-1 for this particular watershed.

__hc1rt.xls- Includes the Modified Puls routing reach information derived from the HEC-2 model for this particular watershed.

3.D.6. Peak Discharges and Capacities of Small Drainageways

The Design Team also considered individual subbasin hydrology. A plot of three storm events (5-year, 25-year, and 100-year) was prepared for the Future/Future land use conditions. Figure 3.6 shows all the individual subbasin data and then the "best fit" lines through this data. Discharge information for all the subbasins for all the storm frequencies can be located in each of the individual watershed HEC-1 models. Figure 3.7 presents just the three curve fit lines without the data. This figure will also be presented in the DCM as a design tool for the estimation of peak runoff from future subbasins. The equations for the three storm events are as follows:

(5yr) $y = 5.8662\, x^{0.6913}$

(25 yr) $y = 7.8599\, x^{0.7169}$

(100 yr) $y = 9.8272\, x^{0.7301}$

where y is the peak flow in cubic feet per second, and x is the subbasin drainage area in acres (from 10 to 1000 acres). Please note that these equations summarize "subbasin" information from the HEC-1 model. If the user is interested in the "combination point" flows (not the individual subbasin watersheds) at certain locations which does include the effects of channel routing, then that information should be found in Appendix 5.

3.E. PROBLEM LOCATIONS/NEEDS

The major issue for the City related to establishing problem locations and needs was to insure that all of the principal problem areas were identified and correctly located with the basic problem and solution/needs well-defined. This basic work effort was a culmination and combining of the "problem

Figure 3.6: Drainage Area versus Discharge - Data and Curve Fits

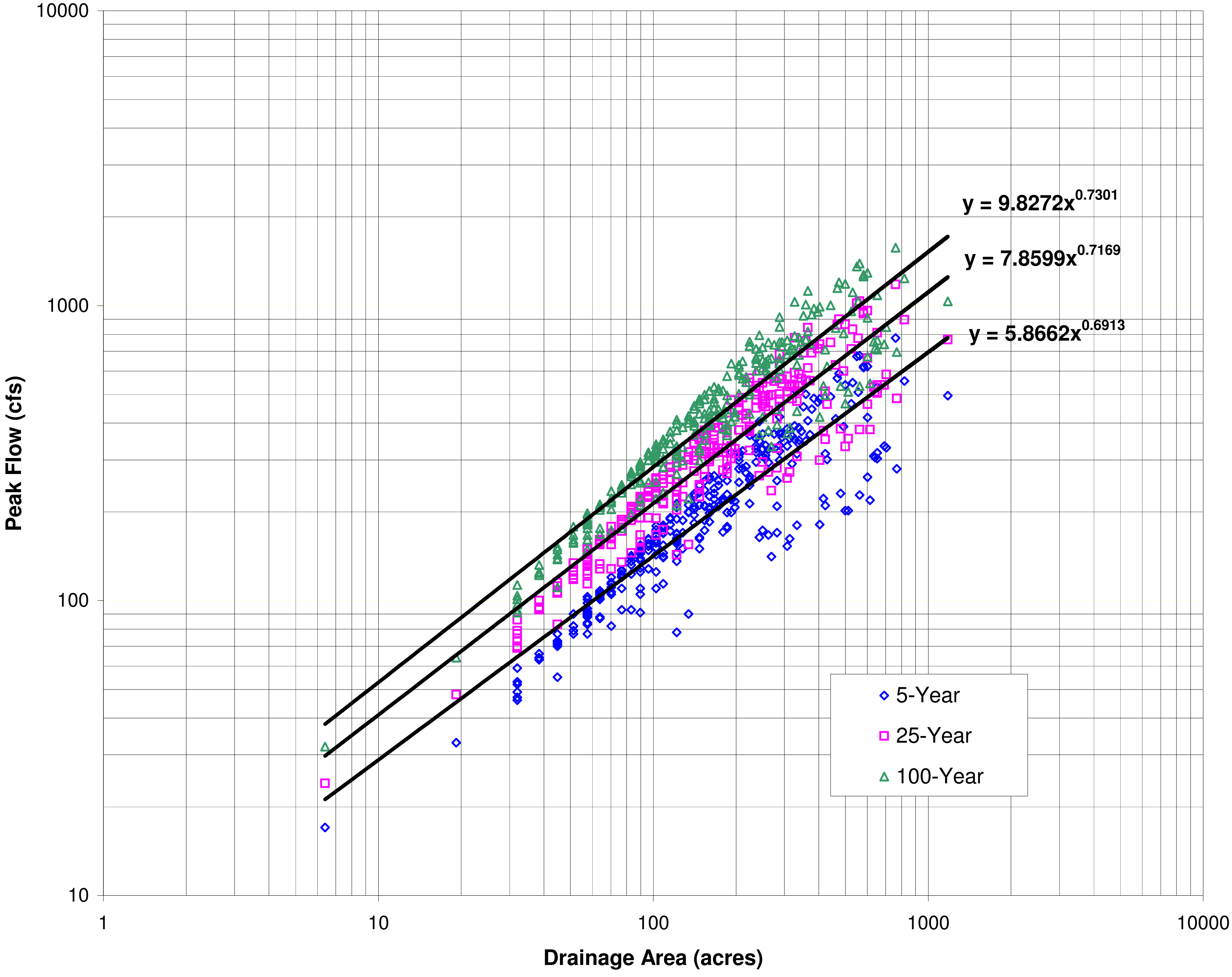
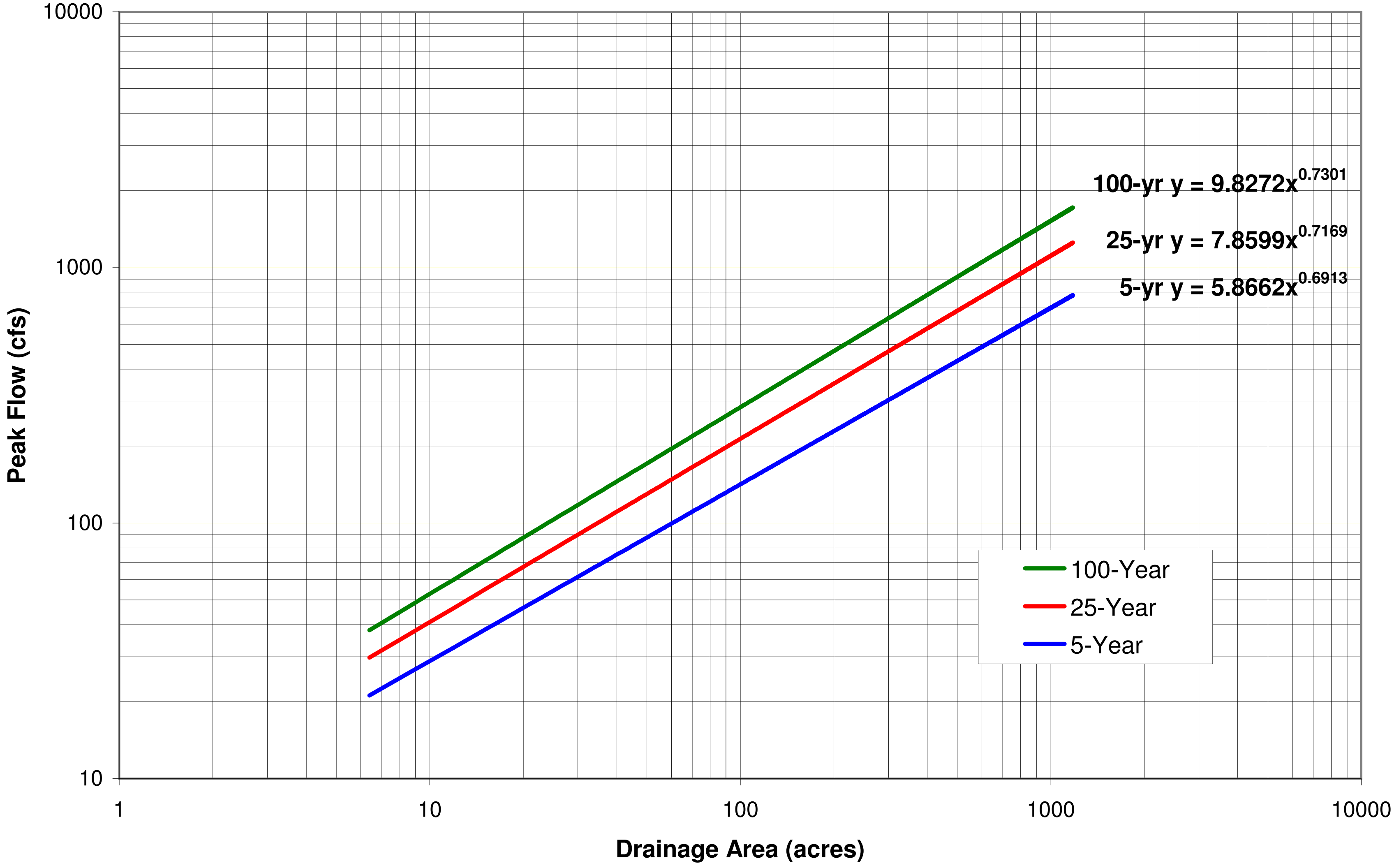


Figure 3.7: Drainage Area versus Discharge - Curve Fits for 5-, 25-, and 100-year Events



identification efforts" undertaken by reviewing records and accounts of past flooding experiences in addition to the problem identification process resulting from the hydrologic and hydraulic modeling.

It was very interesting to note that the general information gathered during the Public Meeting (Section 3A) was very similar to the mathematical model results of the "existing conditions" modeling (Section 3D). The "severity" of the pubic information was more clearly identified (quantified) through the use of the models, but the "location" of the problem locations was in the same general area of the watershed. The Design Team examined the capacity of the existing drainage system relative to the existing peak flows and identified reaches where undersized existing capacities are identified. Of special interest was the ability to identify the approximate location of the true "bottleneck" to the system. That is to say that although the citizens may have observed flood streets (for example) in one particular location, the models were able to identify that the cause of the problems may be at a location many blocks downstream from that location. This information was then used in Section 4 to remediate the problems.

4. PLAN DEVELOPMENT AND REPORTING

After the problems and needs in each watershed were identified and quantified (Section 2) and the hydrologic and hydraulic models were created (Section 3), a plan of improvements was then developed addressing those needs for each watershed. This section discusses the general approach to the Plan Development as well as the specific improvements that were ultimately recommended. The City's multi-objective philosophy, including the expressed concern of the Federal and State permitting agencies, was thoroughly considered in development of the watershed-specific improvement plans. The Design Team worked closely with the City Staff to consider all input obtained in order to assist in the selection of final alternative plans in the various problem areas within each watershed. The institutional, administrative, engineering, funding requirements and other aspects of each watershed's selected plan of action are presented in this section.

4.A. EVALUATE STRUCTURAL AND NON-STRUCTURAL CONTROL MEASURES

Specific watershed nonstructural and/or structural control measures were developed to provide solutions to the identified problem areas therein. This section presents a general discussion of the process used to develop solutions and the results of the specific recommendations. A continual screening process was employed until the most promising control measures were conceptualized. The measures that best solve the individual area problems while providing a pattern of continuity and consistency from reach to reach and throughout the watershed were stressed. Multi-objective solutions received consideration when selecting plans of improvement.

Interaction with the City Staff was most critical at this stage of control measure consideration. Control measures are usually grouped into “structural” items (typically construction projects) and “nonstructural” items (typically ordinances and criteria). Table 4.1 presents some alternative solutions to drainage problems that were considered. The table breaks the “alternative solutions” into the two main categories, and also includes a general grouping of what “means of protection” the particular solution provides.

TABLE 4.1

ALTERNATIVE SOLUTIONS TO DRAINAGE PROBLEMS

Alternative Solutions	Means of Protection
<u>STRUCTURAL</u>	
Onsite Detention/Retention	Decrease Peak Flows
Offsite or Regional Detention/Retention	
Floodplain Storage Preservation	
Flow Diversion	
Channel Improvements (excavation)	Decrease Peak Stage for Given Flow
Removal/Modification of Flow Constrictions (bridges)	
Closed System Improvements (pipes, box culverts, inlets)	
Levees/Dikes/Pump Stations	
<u>NONSTRUCTURAL</u>	
Mechanical Floodproofing of Existing Structures	Keep Water Out of Structures
Mechanical Floodproofing of New Structures	
Elevate Foundations of Existing Structures	
Elevate Foundations of New Structures	
Relocation/Acquisition of Structures	Keep Structures Away from Water
Subdivision and/or Zoning Regulations	
Public Acquisition of Open Space	
Flood Early Warning System/Evacuation Plan	Decrease Damages Under Existing Conditions
Flood Insurance	
Street Sweeping	Water Quality
Less Fertilizer on Yards	
Public Information Programs	
Erosion and Sediment Controls	
No Action	

FIGURE 4.3

PROFILES OF OPEN CHANNEL IMPROVEMENTS

The structural aspects or improvements were analyzed hydrologically and hydraulically to determine the benefits provided while also determining the costs of the improvements. The nonstructural aspects of each proposed alternative plan were analyzed in terms of their acceptability, effectiveness, and implementation costs within the City of Victoria. It is important to the long term success of the storm drainage master plan that this list of "options" was uniquely tailored to the City.

General cost estimates and construction quantities for the controls were developed. The possibility of using improvements as multi-use facilities also was explored during their development. Regional detention sites received particular attention as they offer a wide variety of uses for the public such as playgrounds, picnic areas, and aesthetically pleasing park areas in addition to their drainage benefits. Regional detention basins were authorized for use by the Council as "structural" alternatives in one of the major policy decisions discussed in Section 2.A.1. Please note that "detention basins" and not "retention basins" were included for consideration. Detention basins drain out after a storm event and are dry again form multi-use, while retention basins retain water after an event and, therefore, maintain a permanent pool. Again assistance from local consultants on the Project Team and the City staff was very important in establishing appropriate unit prices for all the construction elements.

A presentation of selected control measures was provided to the City Staff. The process the Design Team used to arrive at the best measures were presented along with the advantages and disadvantages of the various options under consideration. Discussions included the terms of each measure's ability to correct existing flood problems, prevent new flood problems, provide considerable benefits for the costs involved, utilize stream corridors as open space and parks, as well as be funded and implemented. City Staff input and recommendations were received throughout the process and were acted upon by the Design Team.

Each problem area or reach was examined for non-structural and structural control measures. The Design Team formulated lists of structural and non-structural improvements that were compatible with the environmental setting of the given area. The broad list presented in Table 4.1 was reduced to include only the measures that would be used in the SDMP. Those measures included the following:

Regional detention,
Onsite detention,
Channel improvements,
Removal/modification of flow constrictions (undersized bridges),
Closed system improvements (pipes, box culverts, inlets)
Pump stations (in leveed areas)
Elevate foundations of structures (FEMA ordinance),
Subdivision regulations (drainage design criteria), and
Flood insurance.

All of the alternatives are still available to the City for use in the future, but for the purposes of SDMP design, only the items on the list presented above were considered. A continual "screening" process (or process of elimination) was employed that allowed for the selection of the most feasible structural and non-structural flood control measures for each particular problem area.

The majority of the work presented in this section of the report will focus upon sizing the "structural" components for each problem area. The "open channel" solutions were arranged by "reach" in keeping with the hydrologic nomenclature presented on the maps in Map Packet 4. These maps should be used as a criss cross of basic information and linkage between all the models and the various other spreadsheet calculations included in the SDMP. The "closed system" solutions were developed based upon the numbering system discussed in Section 2B and Section 3D, and also presented in Map Packet 4. Most of the reaches had one to three structural control measures identified as possible solutions. The control measures were submitted to the City and other members of the Design Team for further review and comment. Interaction with City Staff was critical to the evaluation of the control measures. The Design Team assisted the City Staff in selecting one control measures per reach for further evaluation. Included for each alternative was an evaluation of the ROW and/or drainage easement needs.

Develop Hydrologic and Hydraulic Models for Selected Control Measures

Section 3 discusses in detail the types of hydrologic and hydraulic models used in the SDMP. In summary, the hydrologic analysis was performed with the HEC-1 model. The WMS package, which incorporates the HEC-1 model with many pre- and post-processing tools, was used to aid the analysis. The size and complexity of the hydrologic models was presented in Table 3.2. The focus of the hydrology in Section 4 was on the "Future" condition models (whereas the "Present" condition was the focus in Section 3).

The hydraulic analysis was divided into two main sets each with its own model. The "open channel" model was HEC-2 using the RiverCAD interface. The size and detail of the open channel hydraulics models was presented in Table 3.5. The second hydraulic model was for the "closed system" which includes all the pipes and box culverts. The AVS and model (SWMM) was used for this analysis. A summary of storm sewer systems modeled in each watershed was presented in Table 3.6

The procedure for the hydrologic analysis included use of the modeling software to assess the impact of the selected control measures. Assessments also included considerations of hydraulic changes on watershed hydrology. As mentioned in Section 3, there was one "iteration" in the modeling effort (between the hydrologic and hydraulic models) to reflect the changes in the routing of the storm hydrographs along the various creek reaches. The construction of channel improvements in most cases provided less overbank storage, therefore, less peak attenuation was seen in the channel routing (the hydrologic peak flows increased due to the channel improvements). Following the iteration, the revised Future/Future condition flows were then used for the duration of the analysis.

Structural Solutions - Detention Basins

The overall "performance" goal of the structural solutions was developed through interaction with the City. The final measure approved by the City was a specific vertical elevation. The goal was to put the Future land use condition discharges into a Future drainage system (F/F) with the resulting water surface elevation no greater than either the current FEMA floodplain elevation (if available) or the Present land use condition discharges in the Present drainage system (P/P). The Design team was able to hydraulically model solutions that met and is some places significantly exceeded the target elevations. It is important to remember that the target was a reduction based upon the vertical elevation of the floodplain and not based upon any horizontal goal of reducing the floodplain width by a certain amount or percentage.

As mentioned above, regional detention was included on the refined list of acceptable structural solutions. Since these large areas alter the hydrology of the downstream portions of a watershed, the regional detention basins were the first structural solutions evaluated. Please recall from previous sections, that the "detention" basins considered in the SDMP will drain after the storm event whereas, "retention" basins retain a permanent pool of stormwater after the storm event and are not under consideration in the SDMP. The Spring Creek (SC) and Lone Tree (LT) watersheds would derive the largest potential benefit from regional detention.

The first step in the analysis of these alternatives was to identify "conceptual" sites for detention basins. Map Packet 5 shows the locations of the conceptual basins considered in the SDMP. The SC and the LT watersheds are shown as shaded areas. The three sites were evaluated as to their "conceptual" ability to provide relief to the future stormwater conditions in their respective basins. Two "conceptual" sites proved to be strong candidates (shown on Map Packet 5 with a solid circle) while the third site did not prove to be beneficial (shown with a dotted circle). It must be pointed out that since the SDMP is simply a "plan," the exact location of the detention areas could be adjusted and/or modified during the actual "design" of the basins. The conceptual basins were analyzed to determine if the particular structural solution would have any impact and or benefit to the overall solution.

For example, Figure 4.1 presents the elevation and volume relationship for the regional detention basin evaluated in the Spring Creek watershed. The location for the final design may differ slightly from the "conceptual" location shown on the figure. However, as long as the elevation/storage relationship is generally duplicated, the beneficial performance should be similar. Figure 4.2 presents the elevation and volume relationship for the regional detention basin evaluated in the Lone Tree watershed.

Figure 4.1
Spring Creek Regional Detention Basin - Generic Elevation/Volume Relationship

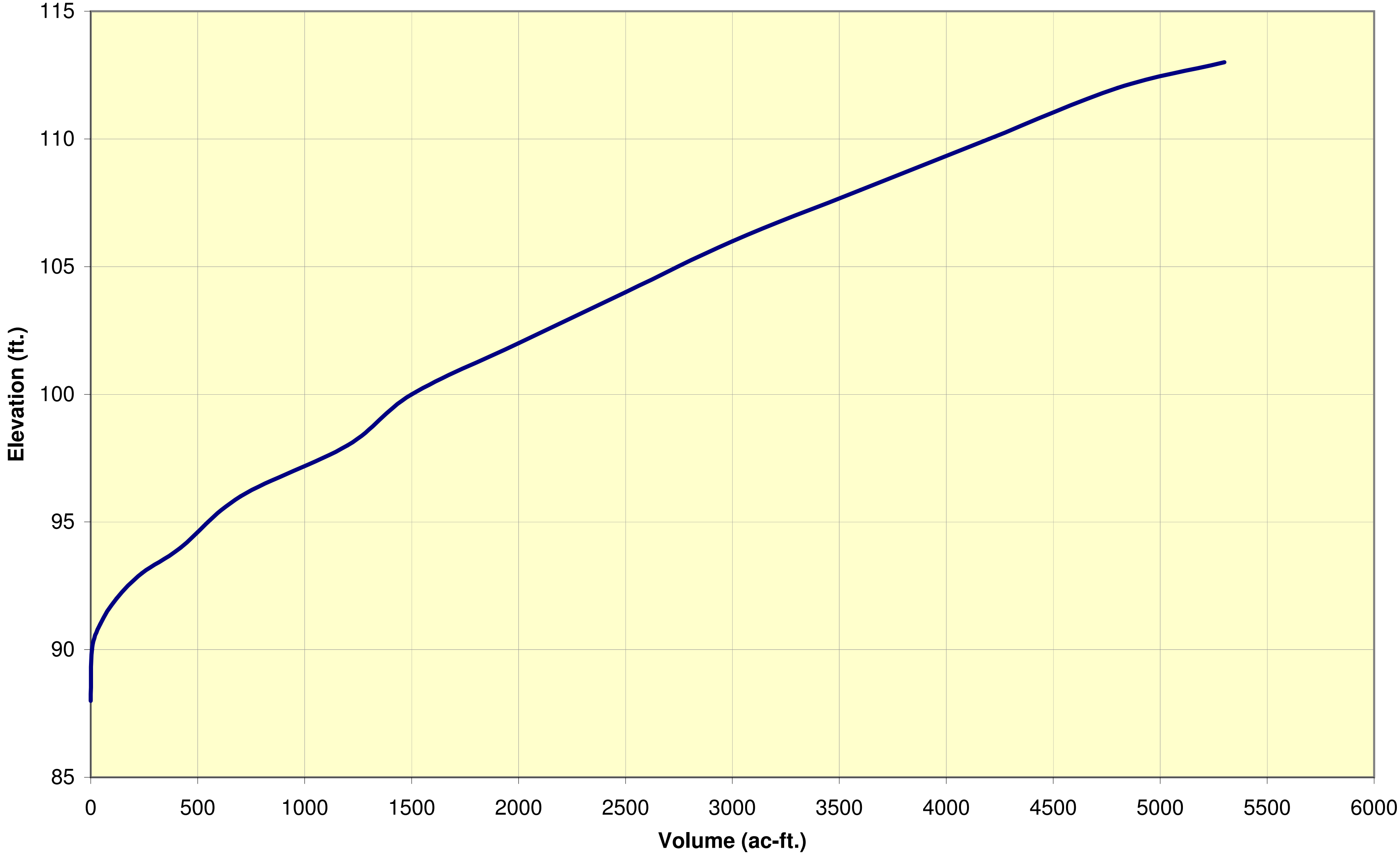
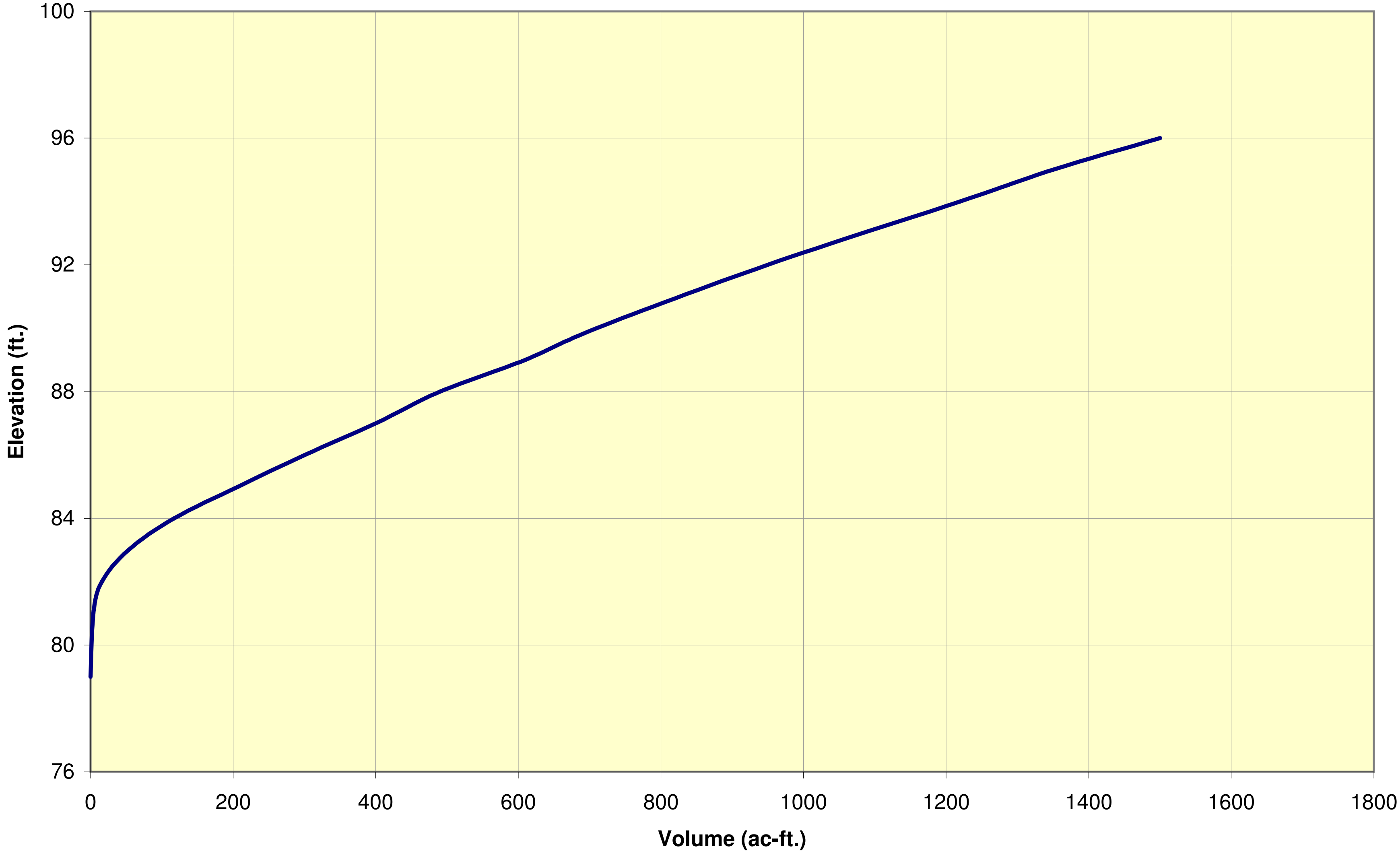


Figure 4.2
Lone Tree Regional Detention Basin - Generic Elevation/Volume Relationship



The detailed results of the regional detention basins upon the reduction of peak flow rates (reductions) at various "combination points" in the downstream reaches can be seen in Appendix 5. For a general summary of the flow rates with detention compared to the original FIS values please refer to Table 3.4. Also of interest in the Table is a column that presents the Future/Future flowrates if NO DETENTION were used. It would be very costly to address the large increase stormwater flow with only channel improvements, whereas reduction of these future peak flowrates using detention would be much more cost effective

For use with the Appendix or the Table, please note that in the "conceptual" model the Spring Creek detention basin was located at "Reach 360A" and "Reach 360B" near combination point C360. Likewise, in the "conceptual" model the Lone Tree basin was located along "Reach 1580A," "Reach 1580B," and "Reach 1596A" near combination point C1580A.

For the Lone Tree basin, please note that immediately downstream of the proposed site the peak discharges were greatly reduced. For example at combination point C1550A the F/F flow without detention for the 500-year event is estimated to be around 11,295 cubic feet per second (cfs) whereas with detention the flow reduces to 7,304 cfs which is less than the P/P estimate of 7,892 cfs. The focus of this conceptual basin in the Lone Tree watershed was to lower the peak flow the thereby reduce the sizing of the channel modifications that would be required downstream.

The focus for the Spring Creek basin was somewhat different. The Design Team determined that the overall watershed was composed of an agricultural watershed (the upper portions) and an urban watershed (the lower portions). The upper watershed (where the conceptual detention basin is located) responds much slower to the peak rainfall intensities. The peak flow from the upper basin occurs several hours later than the peak from the more urbanized lower basin. The lower watershed responds quickly and the peak flow occurs soon after the peak rainfall. Therefore, the increased peak flowrates shown in Table 3.4 for combination point COA at the Guadalupe River (21,833 cfs under F/F conditions without detention compared to 18,167 cfs under P/P conditions) came primarily from the increased peaks urbanized Whispering Creek (urban) tributary watershed.

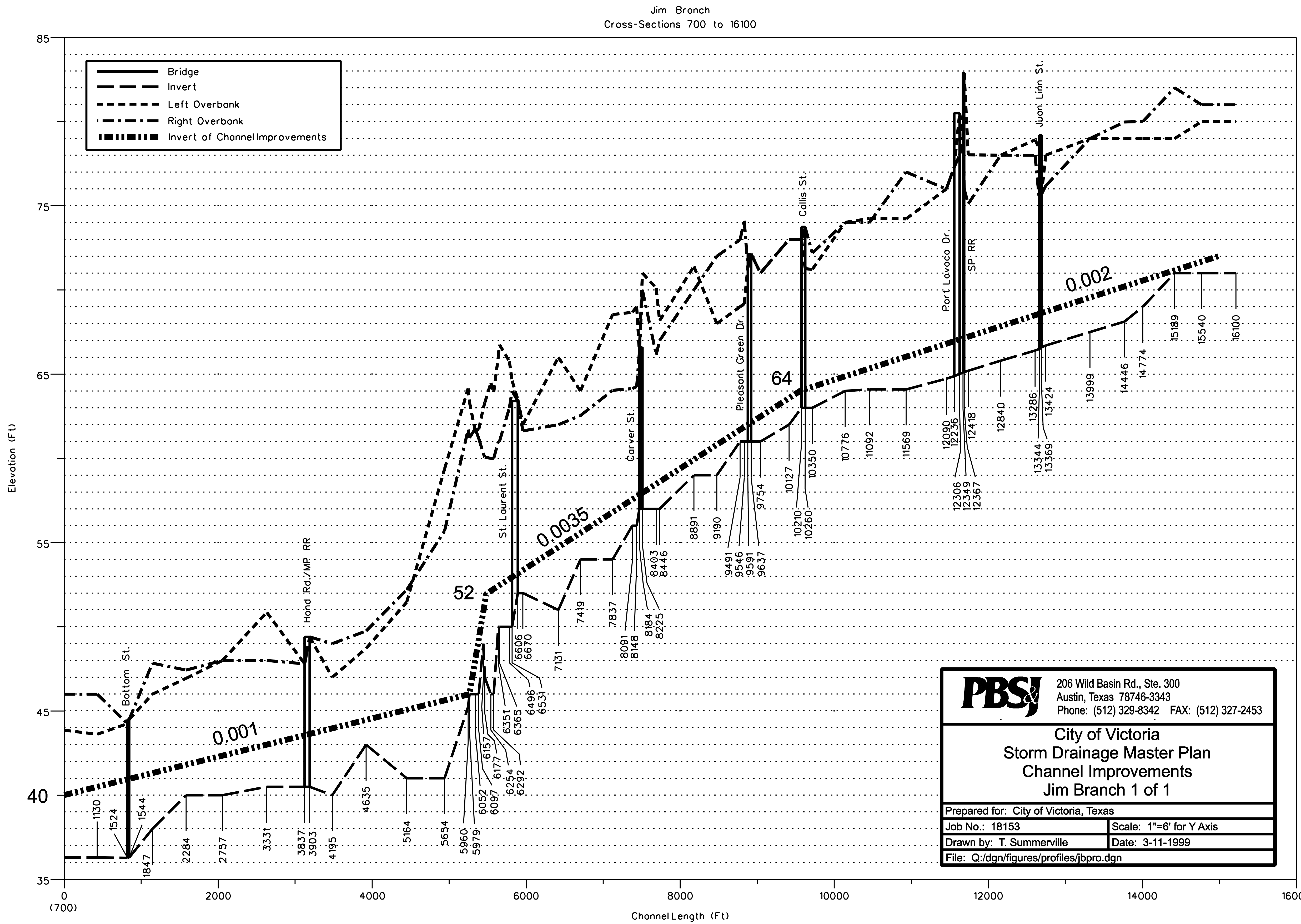
The Design Team initially tried to reduce the peak flowrates in the lower reaches by reducing the flowrates at the conceptual detention basin site (as in the Lone Tree watershed). However, this did not achieve the desired results. The Design Team then considered using the detention basin to modify the leading edge of the upper hydrograph (the first part of the storm). This was successful as reported in the Appendix and the table. The Design Team realized that by reducing the leading portion of the storm event (holding it upstream and releasing it later in the storm event) that the increased flows from the lower basin could then pass to the Guadalupe River without a significant increase if flows from the upper watershed. With detention, the peak flow for the same storm referenced above at the confluence with the Guadalupe River was reduced from 21,833 cfs to 18,625 cfs which is very close to the P/P conditions of 18,167 cfs.

The single Spring Creek detention basin reduced the peak flows from the future land use to roughly match those from the present land use. Please note that the "structural alternative" of the detention basin was able to reduce flows in two different ways (detain the peak flow or detain the leading flow). This illustrates the flexibility of this single option to perform in different ways to achieve the common goal of reducing downstream impacts. Also, please note that the regional detention "conceptual" sites were examined for development of potential multi-purposes uses such as parks. The Design Team examined the reaches where additional uses could be included into each selected control measure. The Design Team also examined the Parks Board multi-year improvement plan on the LIS and determined that these two sites would blend in with their general objectives. The specifics of the detention basin location and design should include the Parks Department for refined comments and identification of areas of special interest for multi-use facilities. The detention basins will also provide benefits related to future NPDES permitting requirements. The potential contributions that the detention basins could make to future NPDES efforts include sedimentation and filtration benefits as well as reduction of flow velocities in localized areas (scour and erosion).

Structural Solutions - Channel Improvements

As mentioned above, the overall "performance" goal of the structural solutions was a specific target vertical elevation. The goal was to put the Future land use discharges into a Future drainage system (F/F) with the resulting water surface elevation no greater than either the current FEMA floodplain elevation (if available) or the Present land use discharges in the Present drainage system (P/P). Also as mentioned earlier, regional detention, which significantly alters the hydrology of downstream portion of a watershed, was the first structural measure evaluated. Having successfully performed this evaluation which resulted in the identification of two potential regional basins (one in Spring Creek and another in Lone Tree Creek) the next task was to take the resulting reduced "future condition" peak flow rates and place them in an appropriately sized open channel. The sizing of the open channel structural improvements will be presented in this section. The third step was to evaluate the closed system improvements (pipes and box culverts) which are tributary to the open channels. These evaluations will be discussed in following sections.

In order to properly size the open channel improvements for over 40 stream miles, several steps were required. The first task was to examine the existing channel profiles. Elevation data was extracted from the existing system hydraulic model and individual creek "profiles" were created. The set of profiles included as Figure 4.3 presents profile elevation information for each watershed included in the SDMP. The channel length is presented on the bottom of the figure and the elevation value is on the left side. A Legend is presented showing the different symbols for the channel "invert," the left and right overbank elevation of the channel, and the location and name of bridge structures (or channel crossings that influence the hydraulics). Please note that for each cross section in the hydraulic model, there is a



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Austin, Texas 78746-3343
Phone: (512) 329-8342 FAX: (512) 327-2453

City of Victoria
Storm Drainage Master Plan
Channel Improvements
Jim Branch 1 of 1

Prepared for: City of Victoria, Texas	
Job No.: 18153	Scale: 1"=6' for Y Axis
Drawn by: T. Summerville	Date: 3-11-1999
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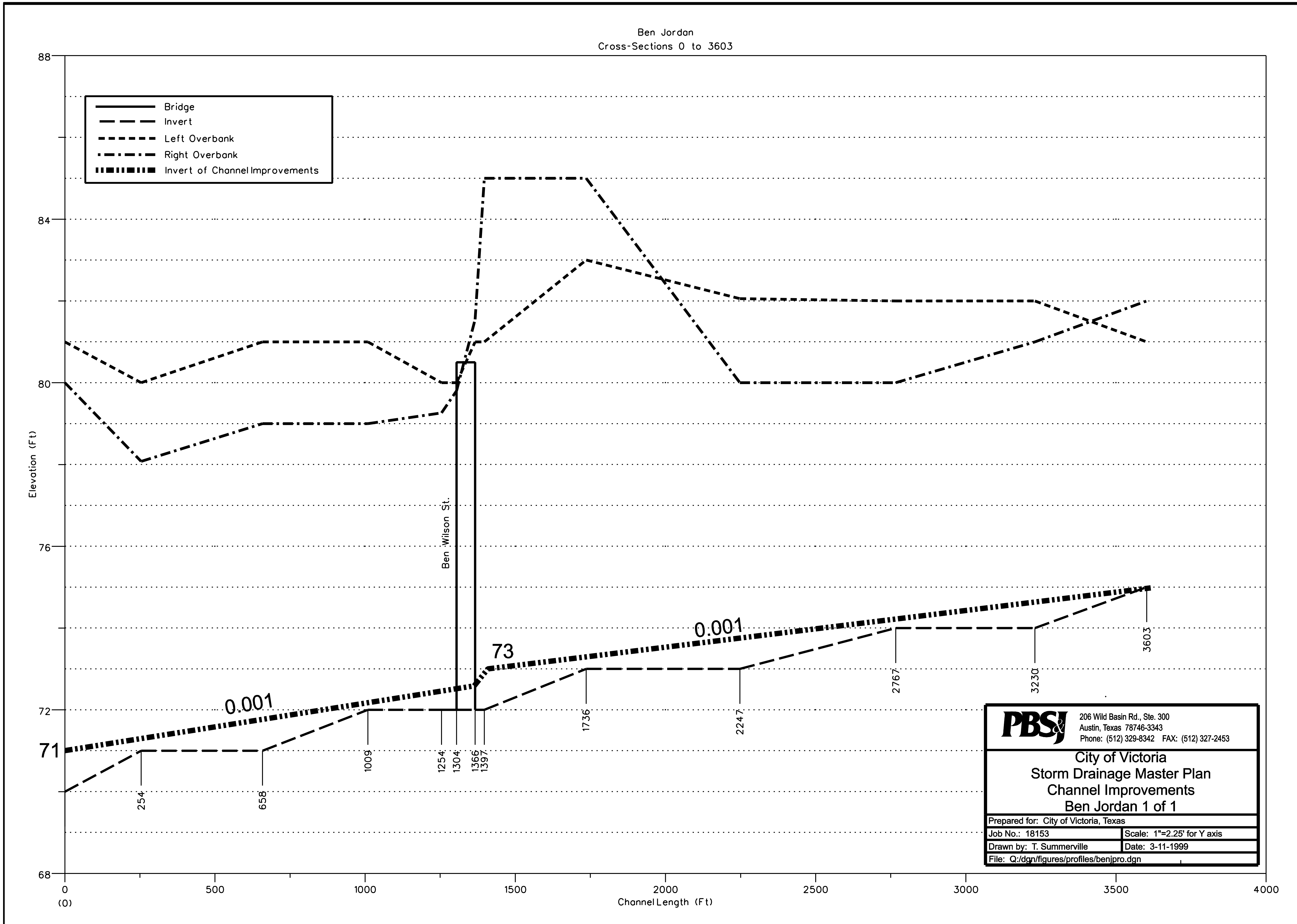

Ben Jordan
Cross-Sections 0 to 3603
Bridge
Invert
Left Overbank
Right Overbank
Invert of Channel Improvements
Elevation (Ft)
Channel Length (Ft)
88
84
80
76
72
68
0
(0)
500
1000
1500
2000
2500
3000
3500
4000
Ben Wilson St.
0.001
0.001
71
73
254
658
1009
1254
1304
1366
1397
1736
2247
2767
3230
3603
PBSJ
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Austin, Texas 78746-3343
Phone: (512) 329-8342 FAX: (512) 327-2453
City of Victoria
Storm Drainage Master Plan
Channel Improvements
Ben Jordan 1 of 1
Prepared for: City of Victoria, Texas
Job No.: 18153
Scale: 1"=2.25' for Y axis
Drawn by: T. Summerville
Date: 3-11-1999
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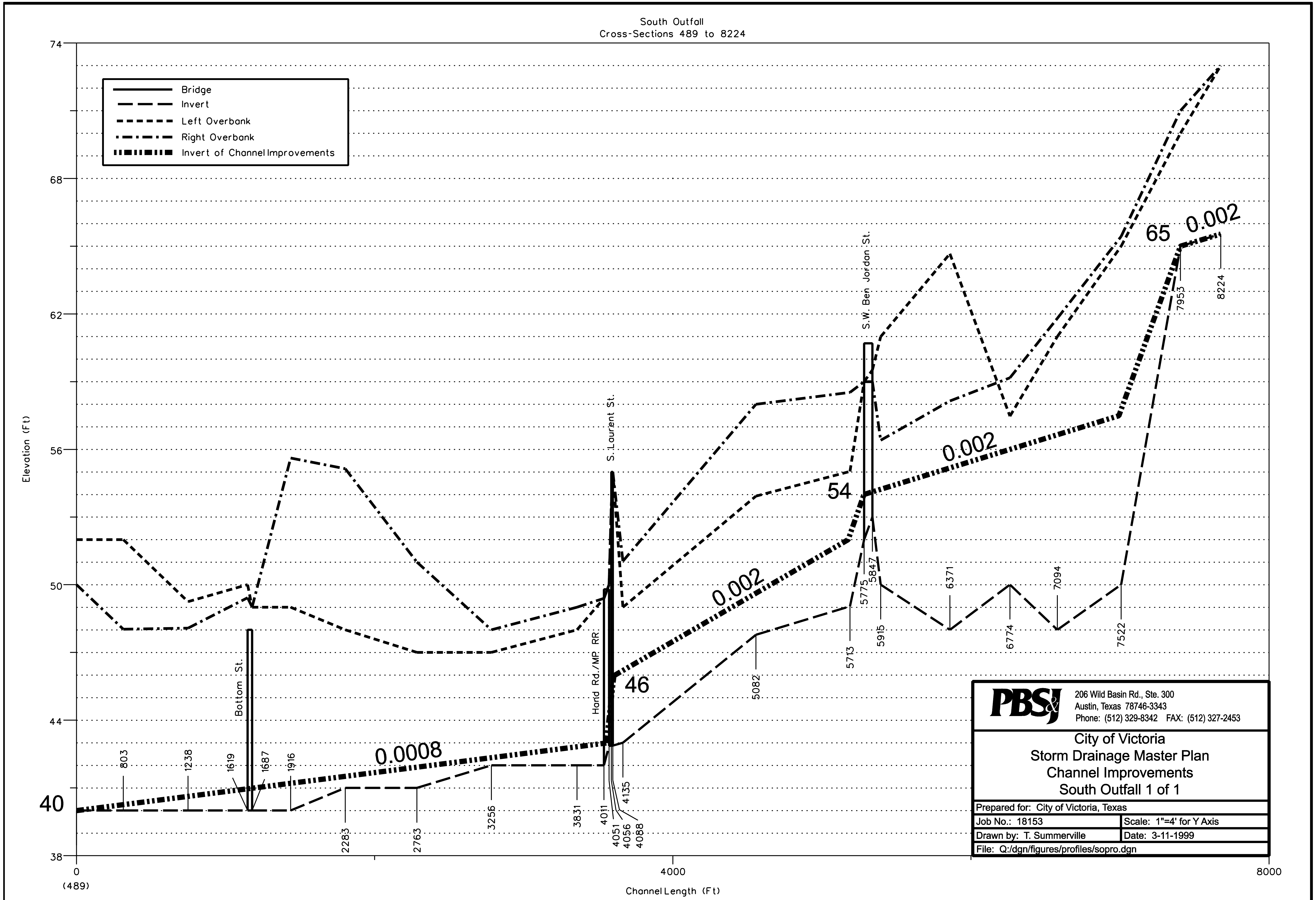

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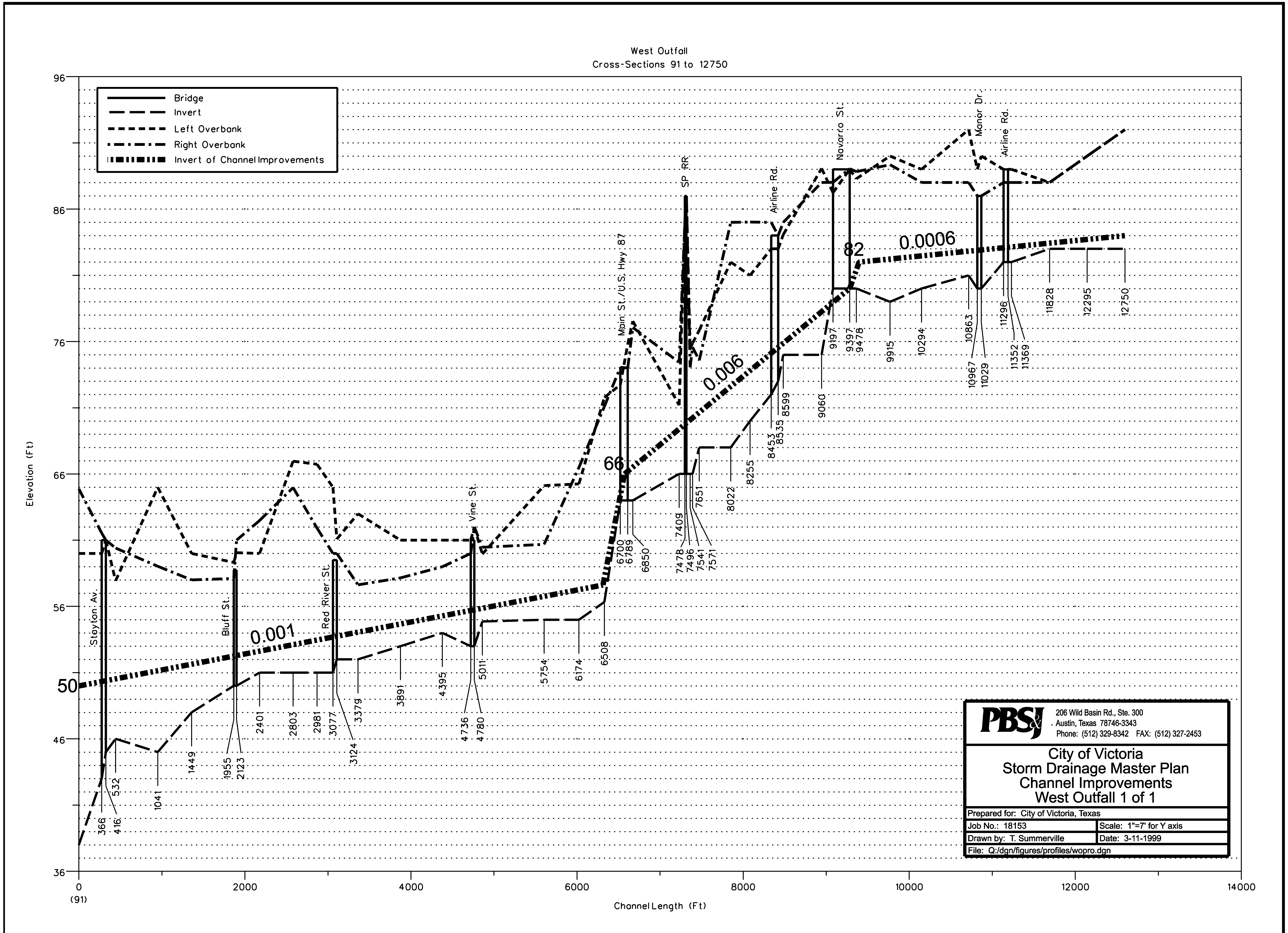

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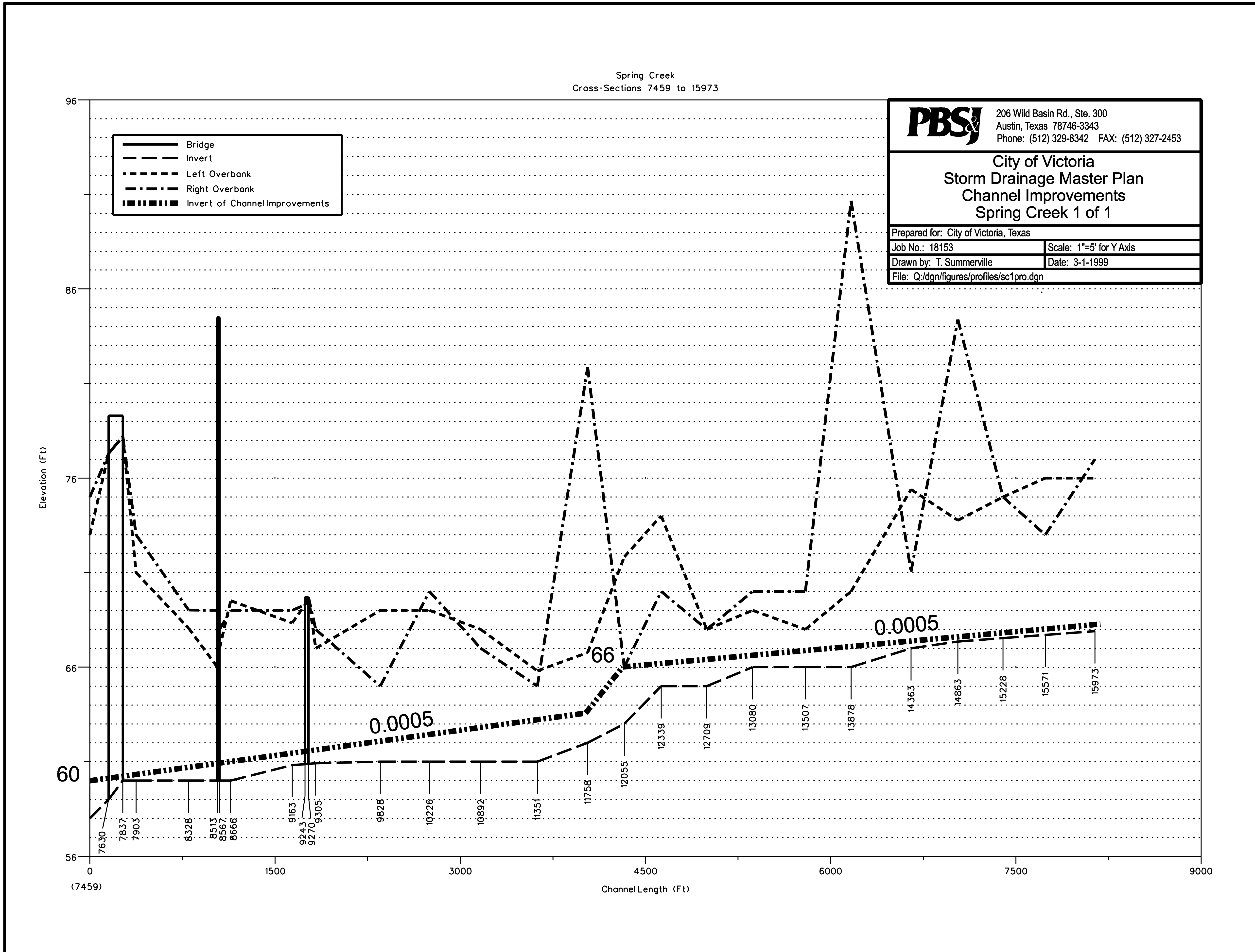

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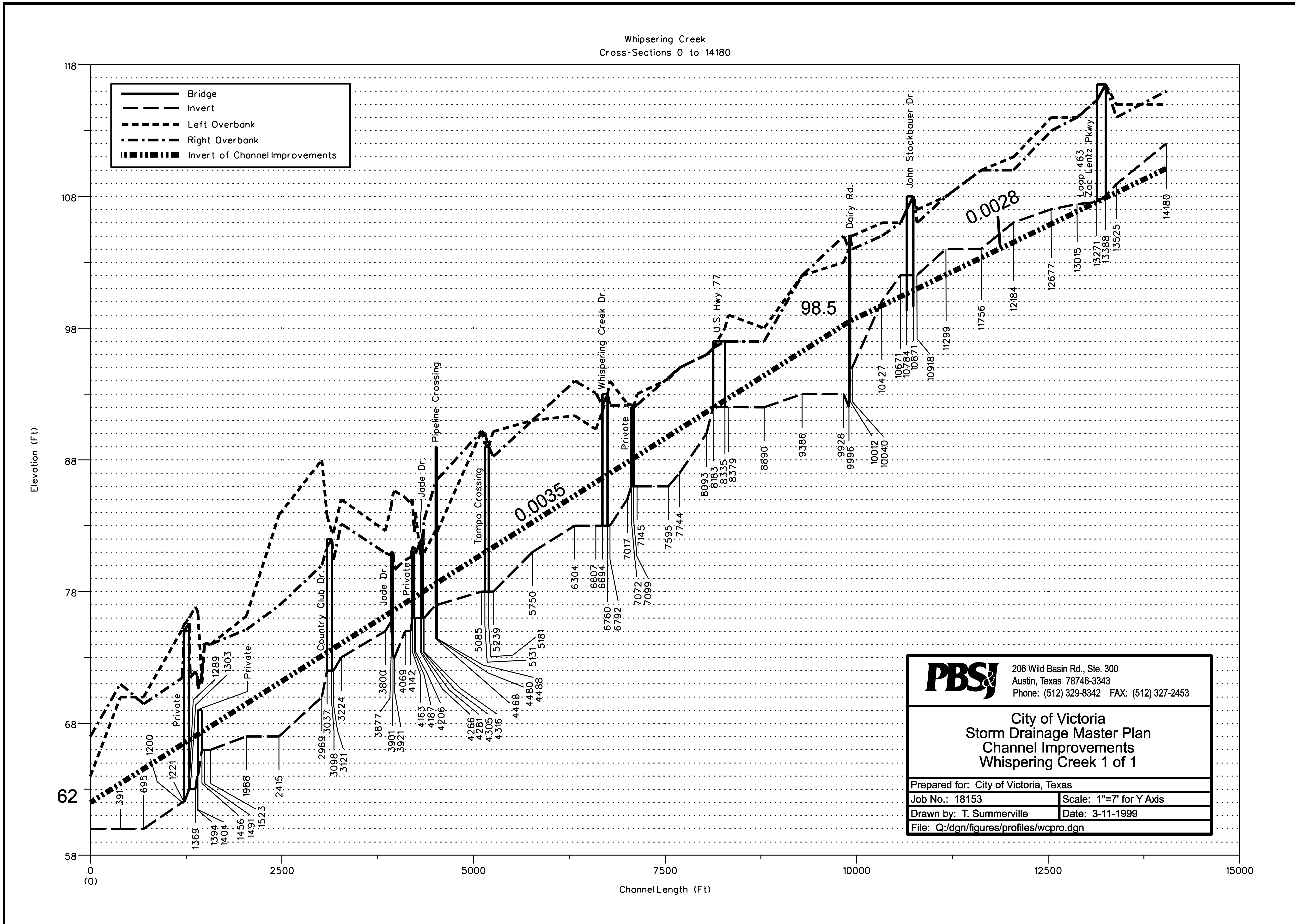

Whispering Creek
Cross-Sections 0 to 14180
Bridge
Invert
Left Overbank
Right Overbank
Invert of Channel Improvements
Elevation (Ft)
Channel Length (Ft)
118
108
98
88
78
68
58
62
0
(0)
2500
5000
7500
10000
12500
15000
0.0035
0.0028
98.5
Private
Country Club Dr.
Jade Dr.
Private
Jade Dr.
Pipeline Crossing
Tampa Crossing
Whispering Creek Dr.
Private
U.S. Hwy 77
Dairy Rd.
John Stockbauer Dr.
Loop 463
Zac Lentz Pkwy.
391
695
1200
1221
1289
1303
1369
1394
1404
1456
1491
1523
1988
2415
2969
3037
3098
3121
3224
3800
3877
3901
3921
4069
4142
4163
4187
4206
4266
4281
4305
4316
4468
4480
4488
5085
5131
5181
5239
5750
6304
6607
6694
6760
6792
7017
7072
7099
7145
7595
7744
8093
8183
8335
8379
8890
9386
9928
9996
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10040
10427
10671
10784
10871
10918
11299
11756
12184
12677
13015
13271
13388
13525
14180
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City of Victoria
Storm Drainage Master Plan
Channel Improvements
Whispering Creek 1 of 1
Prepared for: City of Victoria, Texas
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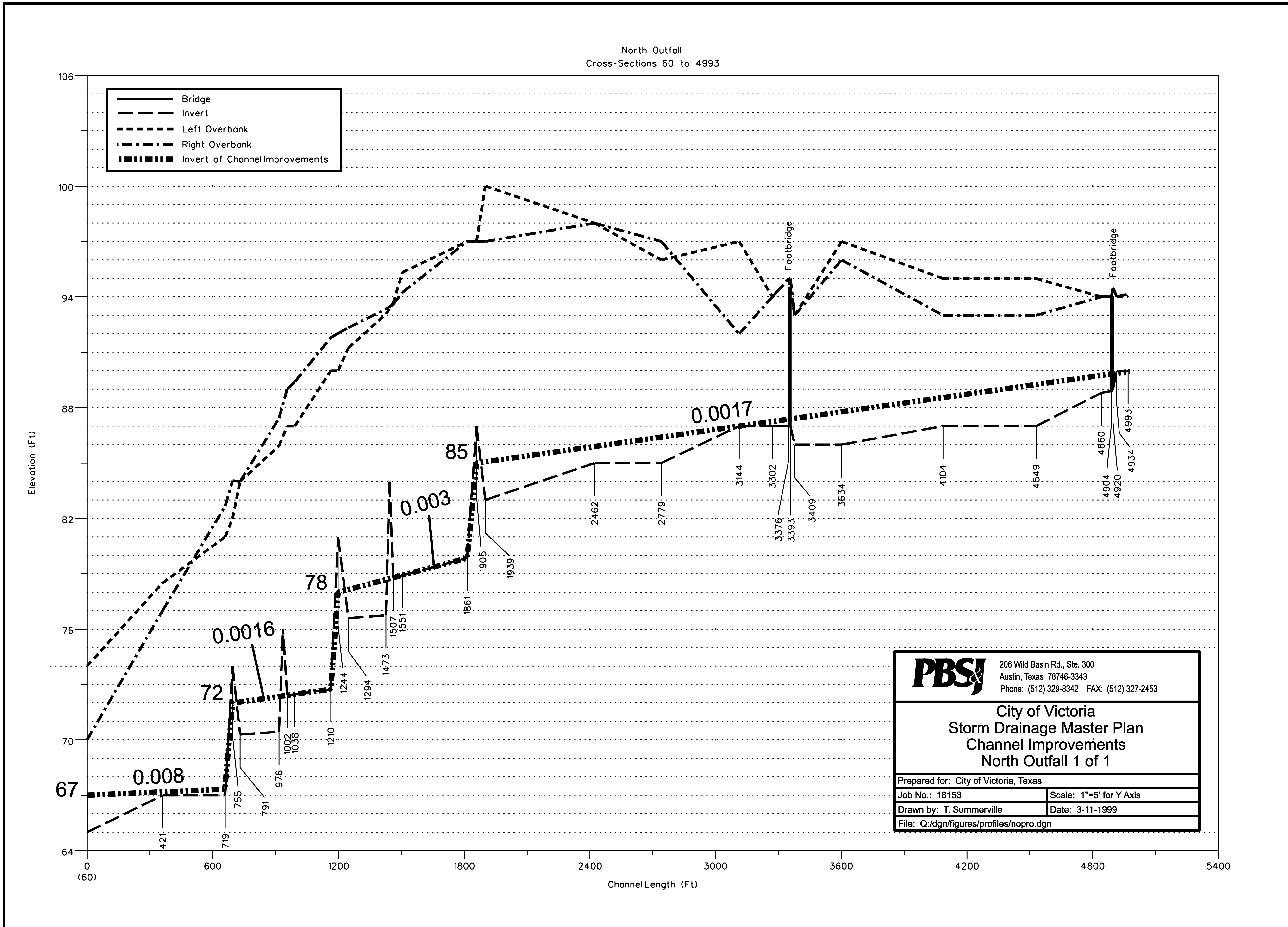
Date: 3-11-1999
File: Q:/dgn/figures/profiles/wcpro.dgn



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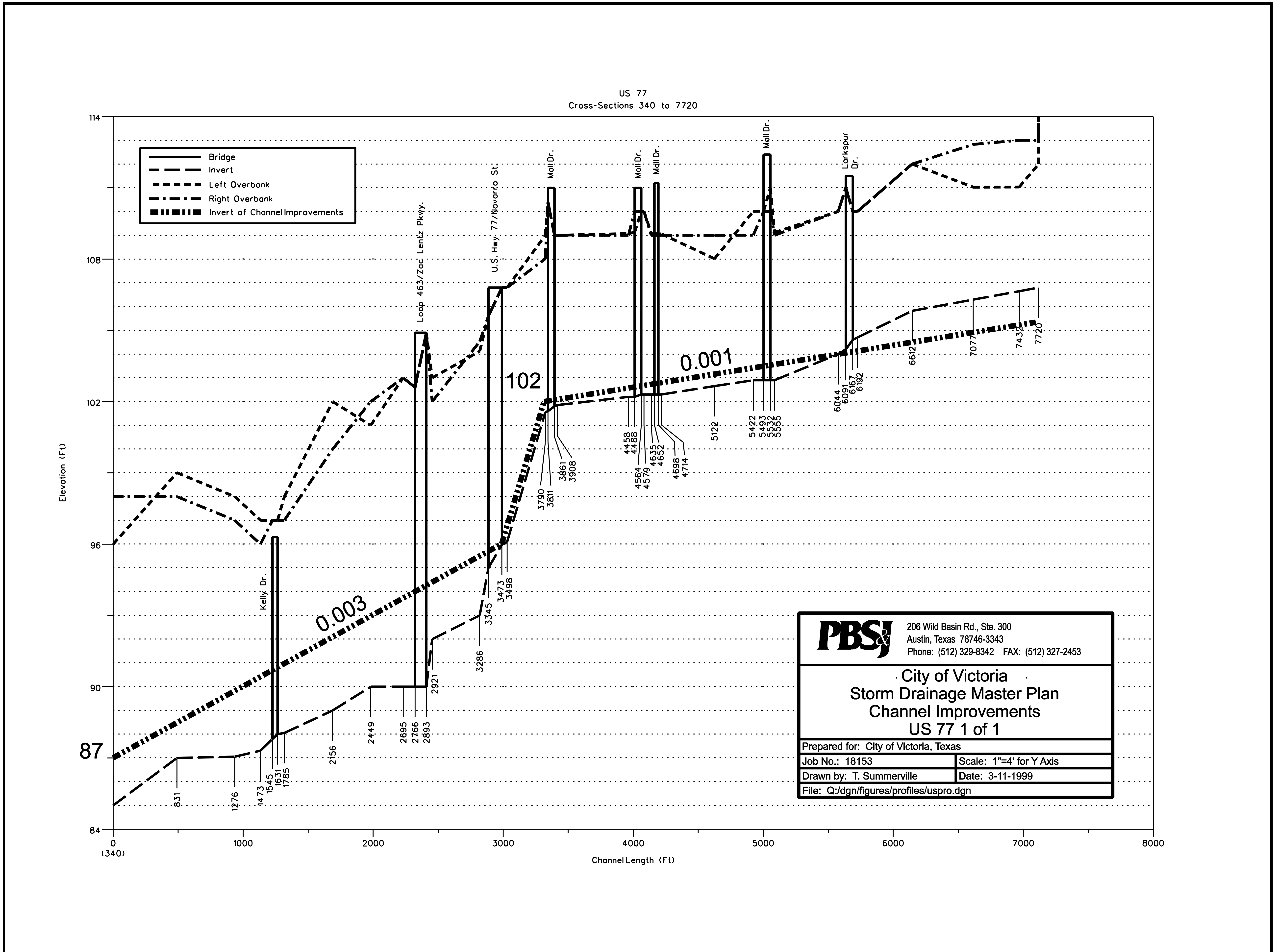

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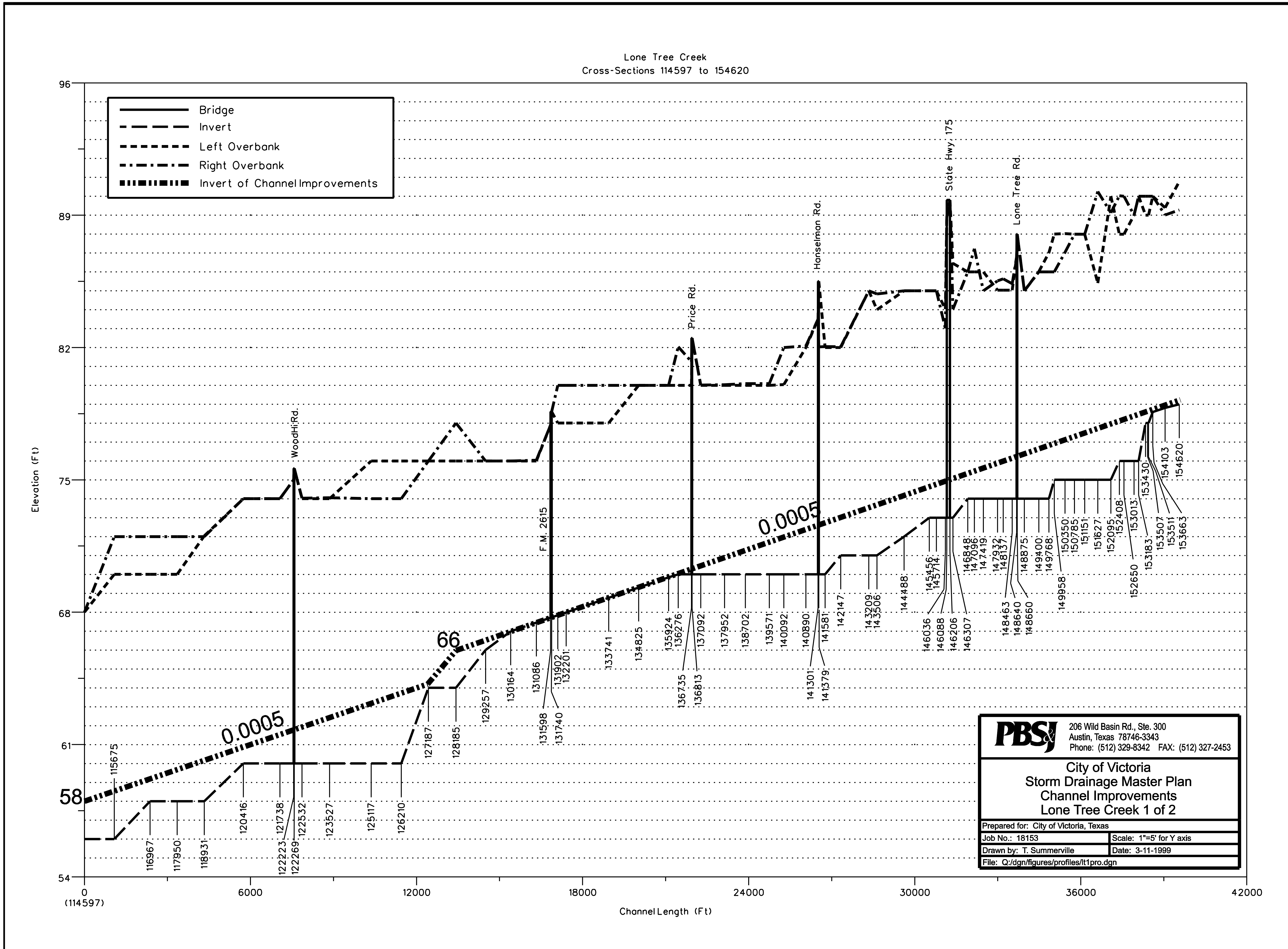

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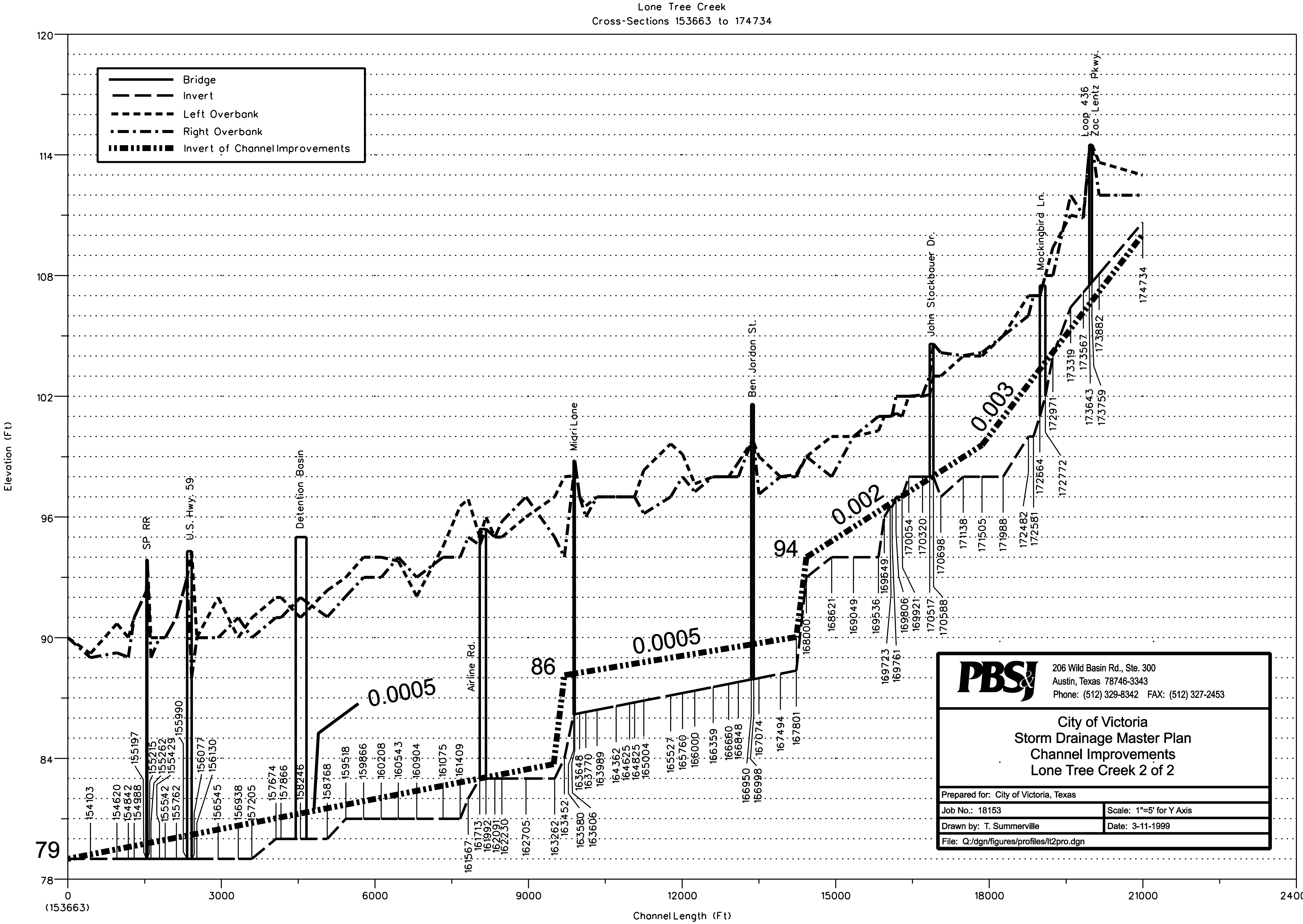

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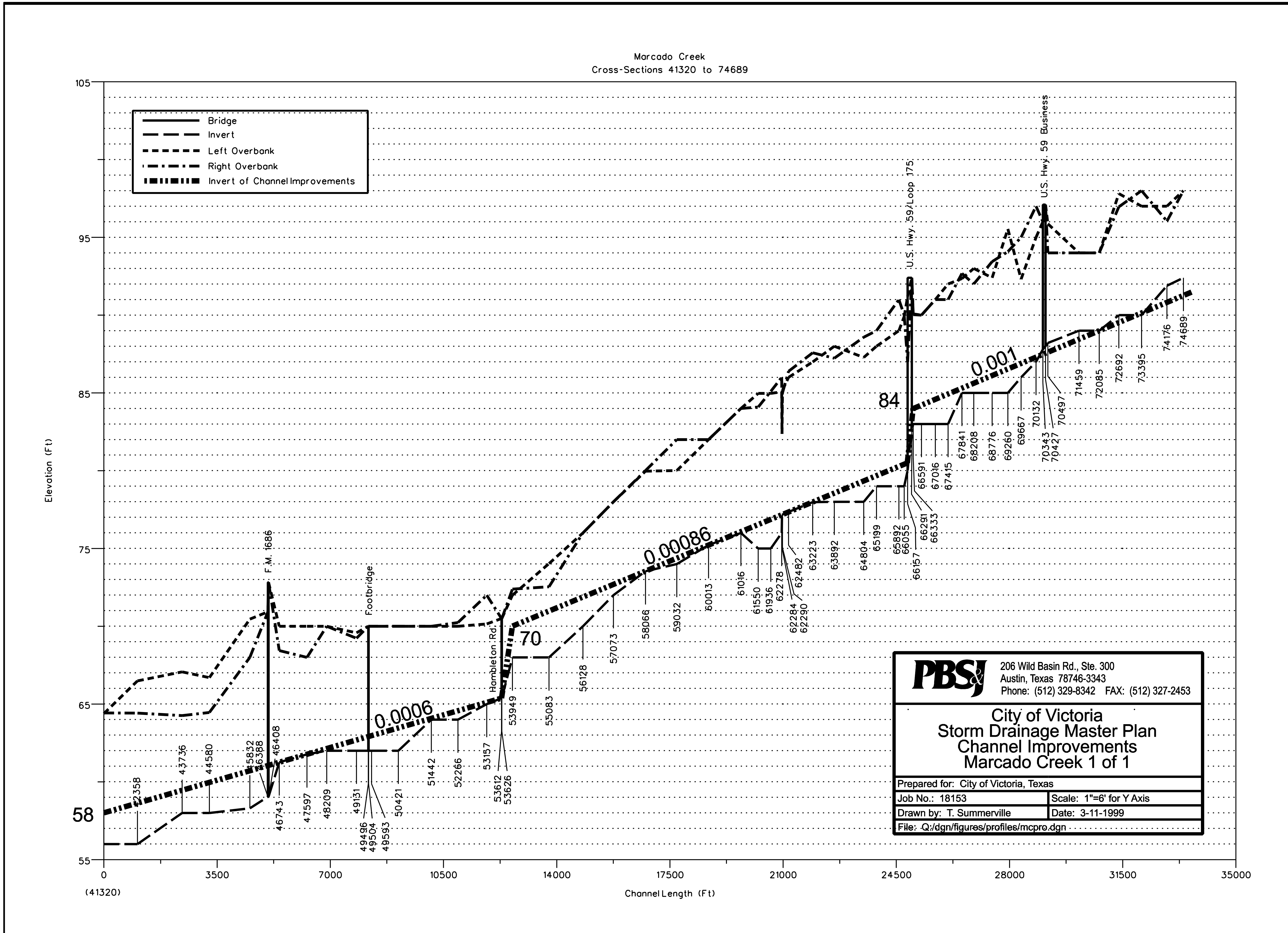
City of Victoria
Storm Drainage Master Plan
Channel Improvements
Lone Tree Creek 2 of 2

Prepared for: City of Victoria, Texas

Job No.: 18153	Scale: 1"=5' for Y Axis
Drawn by: T. Summerville	Date: 3-11-1999

File: Q:/dgn/figures/profiles/lt2pro.dgn


Marcado Creek
Cross-Sections 41320 to 74689
Bridge
Invert
Left Overbank
Right Overbank
Invert of Channel Improvements
Elevation (Ft)
Channel Length (Ft)
(41320)
F.M. 1686
Footbridge
Hambleton Rd.
U.S. Hwy. 59/Loop 175
U.S. Hwy. 59 Business
0.0006
0.00086
0.001
58
70
84
43736
44580
46408
46743
47597
48209
49131
49496
49504
49593
50421
51442
52266
53157
53612
53626
53949
55083
56128
57073
58066
59032
60013
61016
61550
61936
62278
62284
62290
62482
63223
63892
64804
65199
65892
66055
66157
66291
66333
66591
67016
67415
67841
68208
68776
69260
69667
70132
70343
70427
70497
71459
72085
72692
73395
74176
74689
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Austin, Texas 78746-3343
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City of Victoria
Storm Drainage Master Plan
Channel Improvements
Marcado Creek 1 of 1
Prepared for: City of Victoria, Texas
Job No.: 18153
Scale: 1"=6' for Y Axis
Drawn by: T. Summerville
Date: 3-11-1999
File: Q:/dgn/figures/profiles/mcpro.dgn

unique section number included with a “tag line” along the profile. This allows the user to criss cross between the information in this figure and the actual models.

The key item in Figure 4.3 is the presentation of the proposed “invert of the channel improvement” which is shown as a heavy dashed line on the figure. This invert, as described below, refers to the flow line of the “benched” channel and not the low flow flowline. The vertical elevation at the major “break points” is also presented in bold type as a major component of the design. Please note that the proposed flowline of the channel improvement is at an elevation slightly higher than the actual flowline of the existing channel. Figure 4.4 shows a generic representation of how the channel improvements are “benched” n the existing section. This decision was made in an effort to address the requests of the Federal and State review agencies which were put forth during a joint meeting in Corpus Christi. The primary purpose of the meeting was to review the permitting needs of the SDMP. This “benched” design leaves the “low flow” sections of the existing channel intact. Therefore, the low flow geomorphology and habitat characteristics of the existing channel are preserved. This appeared to be a major goal and concern of the Agencies. Another benefit of the “benched” channel design is that it allows for multiple use as a hike and bike trail by the Parks Department.

The profiles show that the “flowline” elevation of the benched flood control channel is at a constant grade throughout a long reach even though the actual flowline of the existing creek varies along the route. It should be noted that in the vast majority of the channel reaches, the flood channel “invert” is *above* the existing creek from 1 to 5 feet (ft), however, in a few instances, the flood channel flowline elevation is *below* the existing creek. In these few situations excavation will be required across the entire width of the reach with a new “pilot channel” or “low flow” channel incised into the flood channel for that reach to accommodate the Agency environmental concerns.

After establishment of the flowlines for the benched flood channels, the hydraulic models were modified to “excavate” new and wider channels along all the creek corridors. Again, the goal of this process was to create a Future drainage system that would be able to convey the Future stormwater discharges at a 100-year water surface elevation that was equal to or less than the FIS (where available) or the Present land use in the Present drainage system (P/P). This was an iterative process the results of which are presented in Table 4.2

These Tables present a great deal of information in a very compact format. The specific watershed name is presented at the top of each individual Table sheet. The left half of the Table presents the “P/P Conditions” and the “F/F Conditions” for easy comparison. The cross section number (SECNO) is listed down the left side of the Table. This number can be found along the flood channel profile presented in Figure 4.3 discussed above. The general location of these cross sections can also be located on the plan view sheets in Map Packet 4 which presents the hydrologic network information. The user is

FIGURE 4.4
TYPICAL SECTION FOR "BENCHED" OPEN CHANNEL IMPROVEMENT

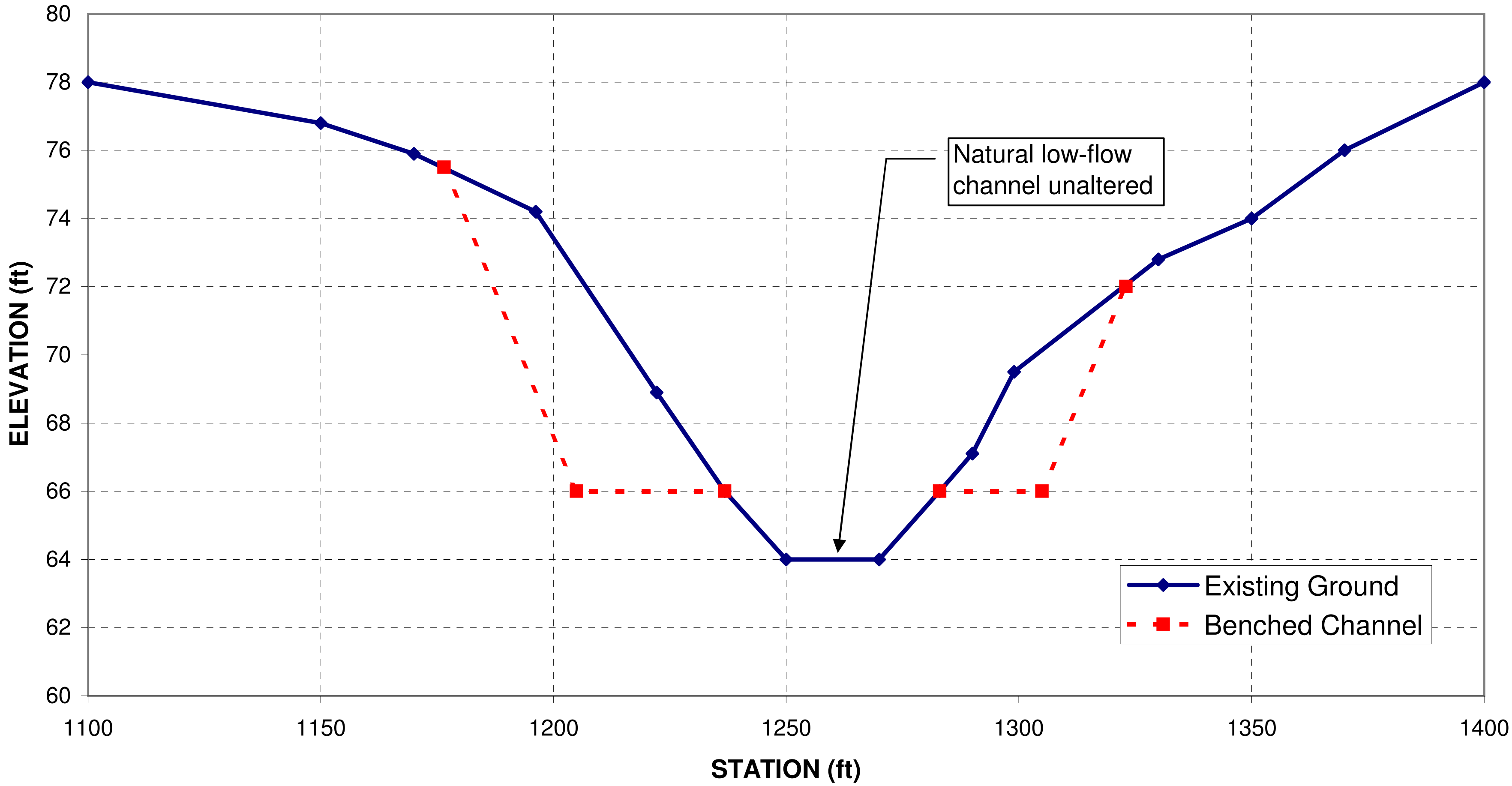


TABLE 4.2

OPEN CHANNEL HYDRAULIC (HEC-2)
COMPARISONS OF WATER SURFACE ELEVATIONS

City of Victoria- Jim Branch Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
700	2977	43.71	700	4197	49.8	200		6.09			F/F starting WSEL is 10-yr Guadalupe
1130	2977	43.91	1130	4197	49.8	200		5.89			
1524	2977	43.24	1524	4197	49.8	200		6.56			
1544	2977	43.07	1544	4197	49.8	200		6.73			Improved bridge- Bottom St.
1847	2977	45.35	1847	4197	49.81	200		4.46			
2284	2977	45.36	2284	4197	49.81	200		4.45			
2757	2977	45.38	2757	4197	49.81	200		4.43			
3331	3228	45.42	3331	4160	49.81	200		4.39			
3837	3228	47.19	3837	4160	49.81	200		2.62			
3903	3228	50.44	3903	4160	49.29	200		-1.15			Improved bridge- Hand Rd./MPRR
4195	3228	50.46	4195	4160	49.98	200		-0.48			
4635	3228	50.46	4635	4160	49.99	200		-0.47			
5164	3228	50.46	5164	4160	49.99	200	51	-0.47	-1.01	-0.54	
5654	3228	49.56	5654	4160	50.23	200		0.67			
5960	3228	53.36	5960	4160	50.56	200		-2.8			Guadalupe River 100-yr is 51.0
5979	3228	53.96	5979	4160	52.9	200		-1.06			
6052	3228	54.26	6052	4160	54.36	200		0.1			
6097	3228	54.82	6097	4160	54.71	200	54.8	-0.11	-0.09	0.02	
6157	3228	54.47	6157	4160	54.88	200		0.41			
6177	3228	55.62	6177	4160	55.14	200		-0.48			
6254	3228	56.43	6254	4160	55.54	150		-0.89			
6292	3228	56.68	6292	4160	55.8	150		-0.88			
6351	3228	56.89	6351	4160	56.14	150		-0.75			
6365	3228	57.04	6365	4160	56.29	150		-0.75			
6496	3842	58.05	6496	4283	57.19	150	56.5	-0.86	0.69	1.55	
6531	3842	57.72	6531	4283	57.12	150		-0.6			
6606	3842	65.49	6606	4283	57.15	150		-8.34			Improved bridge- S. Laurent St.
6670	3842	65.6	6670	4283	59.44	125		-6.16			
7131	3842	66.15	7131	4283	60.72	125		-5.43			
7419	3842	66.23	7419	4283	61.58	125		-4.65			
7837	3842	66.48	7837	4283	63.03	125	66	-3.45	-2.97	0.48	
8091	3842	66.76	8091	4283	63.84	125		-2.92			
8148	3842	66.83	8148	4283	64.06	125		-2.77			
8184	3842	66.62	8184	4283	63.97	125	66.5	-2.65	-2.53	0.12	

City of Victoria- Jim Branch Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
8225	3842	68.54	8225	4283	64.12	125		-4.42			Improved bridge- Carver St.
8403	3842	69.35	8403	4283	65.98	125	68.8	-3.37	-2.82	0.55	
8446	3842	69.33	8446	4283	66.04	125		-3.29			
8891	3842	69.76	8891	4283	67	125		-2.76			
9190	3842	70.25	9190	4283	67.8	125		-2.45			
9491	3842	70.66	9491	4283	68.67	125	70	-1.99	-1.33	0.66	
9546	3842	70.74	9546	4283	68.83	125		-1.91			
9591	3842	70.33	9591	4283	68.83	125		-1.5			
9637	3842	70.76	9637	4283	68.83	125		-1.93			Improved bridge- Pleasant Green Dr.
9754	3842	72.4	9754	4283	69.98	125		-2.42			
10127	3350	72.85	10127	3693	70.88	125	71	-1.97	-0.12	1.85	
10210	3350	72.24	10210	3693	71.2	125		-1.04			
10260	3350	73.39	10260	3693	71.21	125		-2.18			Improved bridge- Callis St.
10350	3350	74.98	10350	3693	71.86	125		-3.12			
10776	3350	75.21	10776	3693	72.67	125		-2.54			
11092	3350	75.49	11092	3693	73.3	125		-2.19			
11569	3350	75.7	11569	3693	74.21	125	74.8	-1.49	-0.59	0.9	
12090	3067	76.32	12090	3335	75.24	125		-1.08			
12236	3067	76.14	12236	3335	75.34	125	75	-0.8	0.34	1.14	
12306	3067	77.13	12306	3335	75.37	125		-1.76			Improved bridge- Port Lavaca Dr.
12349	3067	77.17	12349	3335	75.49	125		-1.68			
12367	3067	78.38	12367	3335	75.52	125		-2.86			Improved bridge- SPRR
12418	3067	78.83	12418	3335	76.25	125	75.8	-2.58	0.45	3.03	
12840	3067	78.81	12840	3335	76.76	125		-2.05			
13286	3067	78.95	13286	3335	77.39	125	77	-1.56	0.39	1.95	
13344	3067	78.96	13344	3335	77.46	125		-1.5			
13369	3067	79.52	13369	3335	77.42	125		-2.1			Improved bridge- Juan Linn St.
13424	3067	80.08	13424	3335	77.78	125		-2.3			
13999	3067	80.26	13999	3335	78.57	125		-1.69			
14446	3067	80.4	14446	3335	79.2	125	79.5	-1.2	-0.3	0.9	
14774	2668	80.45	14774	2908	79.56	125		-0.89			Ben Jordan Confluence
15189	2668	80.51	15189	2908	79.83	125		-0.68			
15540	2668	80.59	15540	2908	80.16	125		-0.43			
16100	2668	80.87	16100	2908	80.77	125		-0.1			
0	1856	80.45	0	1943	80.12	100		-0.33			Jim Branch Confluence

City of Victoria- Jim Branch Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
254	1856	80.66	254	1943	80.16	100		-0.5			
658	1856	80.8	658	1943	80.21	100		-0.59			
1009	1856	80.91	1009	1943	80.26	100		-0.65			
1254	1543	80.97	1254	1505	80.3	100		-0.67			
1304	1543	81.03	1304	1505	79.44	100		-1.59			
1366	1543	81.32	1366	1505	79.19	100		-2.13			Unimproved bridge- Ben Wilson St.
1397	1543	81.49	1397	1505	81.83	100		0.34			
1736	1543	81.61	1736	1505	81.85	100		0.24			
2247	1543	81.82	2247	1505	81.9	100		0.08			
2767	1543	81.93	2767	1505	81.94	100		0.01			
3230	1543	82.07	3230	1505	81.99	100		-0.08			
3603	1543	82.27	3603	1505	82.06	100		-0.21			

City of Victoria- South Outfall Computed Water Surface Elevation Comparison								
PP Conditions			FF Conditions					
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	F/F-P/P	Notes
489	1077	46.4	489	1175	50	75	3.6	F/F Starting WSEL is 10-yr Guadalupe
803	1077	46.72	803	1175	50.01	75	3.29	
1238	1077	47.25	1238	1175	50.02	75	2.77	Improved bridge- Bottom St.
1619	1077	47.79	1619	1175	50.04	75	2.25	
1687	1077	48.26	1687	1175	50.05	75	1.79	
1916	1077	48.68	1916	1175	50.06	75	1.38	
2283	1077	48.72	2283	1175	50.06	75	1.34	
2763	1077	48.74	2763	1175	50.06	75	1.32	
3256	1077	48.74	3256	1175	50.06	75	1.32	
3831	1358	48.75	3831	1556	50.06	75	1.31	Improved bridge- Hand Rd./MPRR
4011	1358	50.09	4011	1556	50	75	-0.09	
4051	1358	50.49	4051	1556	50.05	75	-0.44	Improved bridge- S. Laurent St.
4056	1358	50.65	4056	1556	49.99	75	-0.66	
4088	1358	50.69	4088	1556	50.08	75	-0.61	
4135	1358	50.74	4135	1556	50.39	75	-0.35	
5082	1358	52.09	5082	1556	51.77	75	-0.32	Guadalupe River 100-yr is 52
5713	1358	54.07	5713	1556	53.47	75	-0.6	Improved bridge- S.W. Ben Jordan St.
5775	1358	57.6	5775	1556	56.25	75	-1.35	
5847	1358	59.12	5847	1556	61.36	75	2.24	
5915	1358	60.81	5915	1556	61.78	75	0.97	
6371	1358	60.81	6371	1556	62.57	75	1.76	
6774	1358	60.82	6774	1556	62.65	75	1.83	
7094	1358	60.82	7094	1556	62.65	75	1.83	
7522	1358	60.83	7522	1556	62.73	75	1.9	
7953	1358	68.46	7953	1556	67.3	75	-1.16	

Note: No FIS Study available for this watershed.

City of Victoria- West Outfall Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
91	3209	60.5	91	2119	60.5	300	59.3	0	1.2	1.13	F/F Starting WSEL is 10-yr Guadalupe
366	3209	60.43	366	2119	60.49	300		0.06			FEMA didn't consider Guadalupe
416	3209	61.64	416	2119	60.49	300		-1.15			Improved bridge- Stayton Av.
532	3115	61.84	532	1944	60.54	300		-1.3			
1041	3115	61.87	1041	1944	60.55	300	61.3	-1.32	-0.75	0.61	
1449	3115	61.91	1449	1944	60.55	300		-1.36			
1955	3115	61.97	1955	1944	60.57	300	61.4	-1.4	-0.83	0.86	
2123	3115	62.26	2123	1944	60.6	300	61.4	-1.66	-0.8	0.91	Improved bridge- Bluff St.
2401	2915	62.31	2401	1689	60.64	300		-1.67			
2803	2915	62.34	2803	1689	60.65	300		-1.69			
2981	2640	62.42	2981	1555	60.65	300	61.6	-1.77	-0.95	1.03	
3077	2640	62.63	3077	1555	60.65	300		-1.98			
3124	2640	62.69	3124	1555	60.64	300		-2.05			Improved bridge- Red River St.
3379	2640	62.73	3379	1555	60.69	300	61.9	-2.04	-1.21	0.84	
3891	2640	62.74	3891	1555	60.7	300	62	-2.04	-1.3	0.78	
4395	2605	62.78	4395	1600	60.71	300		-2.07			
4736	2605	62.79	4736	1600	60.72	300	62.2	-2.07	-1.48	0.44	
4780	2605	62.64	4780	1600	60.72	300		-1.92			Improved bridge- Vine St.
5011	2605	62.86	5011	1600	60.84	300	63	-2.02	-2.16	-0.1	
5754	2605	62.9	5754	1600	60.89	300	63.2	-2.01	-2.31	-0.58	
6174	2605	62.62	6174	1600	60.93	200		-1.69			
6508	2548	63.38	6508	1591	61.01	200	63.8	-2.37	-2.79	4.63	Guadalupe River 100-yr is 62.2
6700	2548	68.43	6700	1591	66.91	200	72	-1.52	-5.09	-1.1	
6789	2548	70.9	6789	1591	67.6	200		-3.3			Improved bridge- Main St./HWY 87
6850	2548	72.43	6850	1591	68.82	200	72.2	-3.61	-3.38	1.3	
7409	2548	73.5	7409	1591	71.23	200		-2.27			
7478	2548	73.25	7478	1591	71.7	200	75.4	-1.55	-3.7	-1.87	
7496	2548	73.53	7496	1591	71.72	200		-1.81			Improved bridge- SPRR
7541	2548	74.51	7541	1591	72.38	200		-2.13			
7571	2548	74.5	7571	1591	72.45	200		-2.05			
7651	2548	74.53	7651	1591	72.73	200		-1.8			

City of Victoria- West Outfall Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
8022	2548	76.64	8022	1591	74.9	100	75.7	-1.74	-0.8	1.71	
8255	2742	77.41	8255	1747	76	100		-1.41			
8453	2742	78.77	8453	1747	77.64	100		-1.13			
8535	2742	84.47	8535	1747	77.71	100		-6.76			Improved bridge- Airline Rd.
8599	2742	84.87	8599	1747	79.42	100	83.8	-5.45	-4.38	1.97	
9060	2742	85.77	9060	1747	82.4	100	84.8	-3.37	-2.4	4.22	
9197	2742	89.02	9197	1747	83.07	100		-5.95			
9397	2742	90.08	9397	1747	83.24	100	90.3	-6.84	-7.06	-0.23	Improved bridge- Navarro St.
9478	2742	90.07	9478	1747	86.41	100		-3.66			
9915	2368	90.7	9915	1641	87.35	100		-3.35			
10294	2368	91.1	10294	1641	88.17	100		-2.93			
10863	1972	91.33	10863	1385	88.9	100		-2.43			
10967	1972	91.33	10967	1385	88.98	100		-2.35			
11029	1972	91.31	11029	1385	88.96	100		-2.35			Improved bridge- Manor Dr.
11296	1972	91.48	11296	1385	89.44	100		-2.04			
11352	1972	91.29	11352	1385	89.15	100		-2.14			Improved bridge- Airline Rd.
11369	1425	91.61	11369	1078	89.46	100		-2.15			
11828	1425	91.71	11828	1078	90.6	100		-1.11			
12295	1425	91.77	12295	1078	91.21	100		-0.56			
12750	1425	92.01	12750	1078	92.05	100		0.04			

City of Victoria- Spring Creek Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
7459	12030	67.53	7459	12214	67.6	0.1	76.7	0.07	-9.1	-9.17	Guadalupe River 10-yr is 67
7630	12030	67.38	7630	12214	67.41	0.1		0.03			
7837	12030	69.3	7837	12214	69.38	0.1		0.08			Unimproved bridge- Main St.
7903	12030	70.33	7903	12214	70.4	0.1		0.07			Guadalupe River 100-yr is 70.5
8328	11969	70.64	8328	12081	70.7	0.1		0.06			Whispering Creek Confluence
8513	11969	70.55	8513	12081	70.55	0.1		0			
8567	11969	70.76	8567	12081	70.78	0.1		0.02			Unimproved bridge- SPRR
8666	11969	71.53	8666	12081	71.54	0.1		0.01			
9163	11969	72.3	9163	12081	72.25	0.1		-0.05			
9243	11969	72.42	9243	12081	72.31	0.1		-0.11			
9270	11969	72.2	9270	12081	72.28	0.1		0.08			
9305	11969	73.4	9305	12081	73.51	0.1	79.1	0.11	-5.59	-5.7	Improved bridge- Spring Creek Dr.
9828	11969	73.62	9828	12081	73.71	0.1		0.09			
10226	11969	73.68	10226	12081	73.76	0.1		0.08			
10892	11797	73.76	10892	10231	73.84	0.1		0.08			
11351	11797	73.88	11351	10231	73.92	0.1		0.04			
11758	11797	73.97	11758	10231	73.99	0.1	79.3	0.02	-5.31	-5.33	
12055	11797	74.07	12055	10231	74.05	0.1		-0.02			
12339	10239	74.17	12339	10138	74.08	0.1		-0.09			North Outfall Confluence
12709	10239	74.84	12709	10138	74.75	0.1		-0.09			
13080	10239	75.1	13080	10138	74.98	0.1		-0.12			
13507	10239	75.46	13507	10138	75.35	0.1	81.2	-0.11	-5.85	-5.74	
13878	10239	74.97	13878	10138	74.69	0.1		-0.28			
14363	10239	77.64	14363	10138	77.55	0.1		-0.09			
14863	9481	79.17	14863	7835	79.13	0.1		-0.04			
15228	9481	79.48	15228	7835	79.34	0.1		-0.14			
15571	9481	79.69	15571	7835	79.48	0.1		-0.21			
15973	9481	80.16	15973	7835	79.81	0.1		-0.35			
16410	9481	81.53	16410	7835	80.41	0.01	84.1	-1.12	-3.69	-2.57	No Channel Improvements
16842	9481	81.81	16842	7835	80.82	0.01		-0.99			
17041	9481	81.94	17041	7835	80.97	0.01		-0.97			
17202	9481	82.07	17202	7835	81.22	0.01		-0.85			
17424	9481	82.07	17424	7835	81.22	0.01		-0.85			Unimproved bridge- Loop 463/Zac Lentz Pkwy.

City of Victoria- Spring Creek Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
17492	9481	82.61	17492	7835	81.74	0.01		-0.87			
17838	9481	82.75	17838	7835	81.88	0.01		-0.87			
17936	9481	82.77	17936	7835	81.9	0.01		-0.87			
17952	9481	82.78	17952	7835	81.91	0.01		-0.87			
18246	9417	82.81	18246	7812	81.95	0.01		-0.86			
18637	9417	82.88	18637	7812	82.03	0.01		-0.85			
19097	9417	83.15	19097	7812	82.31	0.01	88.8	-0.84	-6.49	-5.65	
19241	9417	83.26	19241	7812	82.42	0.01		-0.84			
19387	9417	82.99	19387	7812	82.24	0.01		-0.75			
19397	9417	83.15	19397	7812	82.3	0.01		-0.85			Unimproved bridge- Clark School Rd.
19429	9417	84.31	19429	7812	83.01	0.01		-1.3			
19439	9417	84.4	19439	7812	83.46	0.01		-0.94			
19573	9417	85.29	19573	7812	84.22	0.01		-1.07			
20238	9228	85.48	20238	6202	84.45	0.01		-1.03			
20811	9228	86.44	20811	6202	85.23	0.01		-1.21			
21170	9228	86.57	21170	6202	85.37	0.01		-1.2			
21685	9228	87.35	21685	6202	86.13	0.01	92.5	-1.22	-6.37	-5.15	
21991	9228	87.67	21991	6202	86.44	0.01		-1.23			
22054	9228	87.71	22054	6202	86.48	0.01		-1.23			
22458	9125	88.02	22458	6168	86.78	0.01		-1.24			
22836	9125	88.34	22836	6168	87.05	0.01		-1.29			
23132	9125	88.41	23132	6168	87.16	0.01	94.3	-1.25	-7.14	-5.89	
23386	9125	88.83	23386	6168	87.53	0.01		-1.3			
23670	9125	89.21	23670	6168	87.92	0.01		-1.29			
23946	9125	89.49	23946	6168	88.2	0.01		-1.29			
24378	9125	90	24378	6168	88.69	0.01		-1.31			
24731	9125	90.32	24731	6168	88.98	0.01		-1.34			
24970	9125	90.5	24970	6168	89.13	0.01		-1.37			
25549	9089	90.73	25549	6168	89.18	0.01		-1.55			
26120	9089	92.37	26120	6168	91.04	0.01		-1.33			
26867	9089	93.35	26867	6168	91.95	0.01		-1.4			
27875	9089	94.76	27875	6168	93.39	0.01		-1.37			
28728	9089	95.56	28728	6168	94.28	0.01		-1.28			
29720	9089	96.45	29720	6168	95.23	0.01		-1.22			
31162	9089	97.63	31162	6168	96.34	0.01		-1.29			
32069	9089	98.65	32069	6168	97.32	0.01		-1.33			

City of Victoria- Spring Creek Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
32627	9089	99.52	32627	6168	98.06	0.01		-1.46			
33469	8994	100.42	33469	6167	98.9	0.01		-1.52			
34549	8994	101.08	34549	6167	99.55	0.01		-1.53			
34887	8994	101.2	34887	6167	99.64	0.01		-1.56			
34933	8994	100.92	34933	6167	99.47	0.01		-1.45			Improved bridge- Parsons Rd.
35228	8994	102.31	35228	6167	100.71	0.01		-1.6			
35874	8856	102.68	35874	8618	107.61	0.01		4.93			Detention Pond
36772	8856	103.19	36772	8618	107.67	0.01		4.48			
37892	8856	103.9	37892	8618	107.75	0.01		3.85			
38783	8856	104.95	38783	8618	108	0.01		3.05			
39734	8856	105.97	39734	8618	108.35	0.01		2.38			
40750	8856	107.48	40750	8618	108.99	0.01		1.51			
41866	8167	108.16	41866	8179	109.37	0.01		1.21			
42974	8167	108.58	42974	8179	109.66	0.01		1.08			
43665	8167	108.87	43665	8179	109.85	0.01		0.98			
43708	8167	109.26	43708	8179	109.97	0.01		0.71			Improved bridge- Oliver Rd.
43909	8167	109.8	43909	8179	110.38	0.01		0.58			
44580	8167	110.1	44580	8179	110.63	0.01		0.53			
45346	8167	110.45	45346	8179	110.91	0.01		0.46			
46046	8091	110.98	46046	8141	111.35	0.01		0.37			
47114	8091	111.71	47114	8141	111.99	0.01		0.28			

Notes: During design phase Parsons Rd. bridge and the detention pond could be combinec into one structure.
Conceptual design for the detention pond assumes residential development 1/2 mile beyond the ETJ and the remainder of the watershed has present (1998) conditions. Any development beyond this will need additional mitigation.

City of Victoria- Whispering Creek Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
0	2927	71.18	0	3017	71.53	75		0.35			Spring Creek Confluence
391	2927	71.21	391	3017	71.56	75		0.35			
695	2927	70.78	695	3017	71.54	75	73.1	0.76	-1.56	-2.32	
1200	2927	72.54	1200	3017	71.98	75		-0.56			
1221	2927	72.41	1221	3017	71.78	75		-0.63			
1289	2927	72.49	1289	3017	71.84	75	73.2	-0.65	-1.36	-0.71	Improved bridge- Private
1303	2927	72.91	1303	3017	72.48	75		-0.43			
1369	2927	72.88	1369	3017	72.54	75		-0.34			
1394	2927	72.87	1394	3017	72.56	75		-0.31			
1404	2927	72.75	1404	3017	72.48	75		-0.27			
1456	2927	73.2	1456	3017	73.86	75	74.5	0.66	-0.64	-1.3	Unimproved bridge- Private
1491	2927	74.12	1491	3017	74.24	75		0.12			
1523	2696	74.54	1523	2789	74.4	75		-0.14			
1988	2696	75.92	1988	2789	75.06	75	76.9	-0.86	-1.84	-0.98	
2415	2696	77.41	2415	2789	75.96	75	79.2	-1.45	-3.24	-1.79	
2969	2696	79.84	2969	2789	77.46	75		-2.38			
3037	2696	81.72	3037	2789	79.67	75		-2.05			
3098	2696	83.23	3098	2789	83.03	75		-0.20			Unimproved bridge- Country Club Dr.
3121	2696	84.33	3121	2789	84.33	75		0.00			
3224	1626	84.51	3224	1704	84.4	75	85.1	-0.11	-0.7	-0.59	
3800	1626	84.67	3800	1704	84.46	75	85.5	-0.21	-1.04	-0.83	
3877	1626	84.69	3877	1704	84.45	75		-0.24			
3901	1626	84.79	3901	1704	84.49	75		-0.30			Unimproved bridge- Jade Dr.
3921	1626	84.82	3921	1704	84.55	75		-0.27			
4069	1626	84.84	4069	1704	84.56	75		-0.28			
4142	1626	84.85	4142	1704	84.57	75		-0.28			
4163	1626	84.84	4163	1704	84.54	75		-0.30			
4187	1626	84.87	4187	1704	84.54	75		-0.33			Unimproved bridge- Private
4206	1626	84.89	4206	1704	84.67	75		-0.22			
4266	1626	84.95	4266	1704	84.68	75	86.7	-0.27	-2.02	-1.75	
4281	1626	84.98	4281	1704	84.61	75		-0.37			
4305	1626	85.09	4305	1704	84.71	75		-0.38			Unimproved bridge- Jade Rd.
4316	1626	85.07	4316	1704	84.8	75		-0.27			
4468	1626	85.01	4468	1704	84.84	75		-0.17			
4480	1626	85.34	4480	1704	84.84	75		-0.50			
4481	1626	85.35	4481	1704	84.84	75		-0.51			

City of Victoria- Whispering Creek Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
4488	1626	85.37	4488	1704	84.85	75		-0.52			Unimproved bridge- Pipeline Crossing
5085	1626	86.9	5085	1704	85.19	75		-1.71			
5131	1626	87.86	5131	1704	85.72	75	89.4	-2.14	-3.68	-1.54	
5181	1626	88.81	5181	1704	88.19	75		-0.62			Unimproved bridge- Tampa Dr.
5239	1626	90.38	5239	1704	90.19	75		-0.19			
5750	1431	90.59	5750	1533	90.27	75	92.8	-0.32	-2.53	-2.21	
6304	1431	90.95	6304	1533	90.42	75	93	-0.53	-2.58	-2.05	
6607	1431	91.39	6607	1533	90.58	75		-0.81			
6694	1431	92.76	6694	1533	92.57	75		-0.19			
6760	1431	91.54	6760	1533	93.63	75		2.09			Unimproved bridge- Whispering Creek Dr.
6792	1431	94.37	6792	1533	94.05	75	95.7	-0.32	-1.65	-1.33	
7017	1431	94.45	7017	1533	94.09	75		-0.36			
7072	1431	94.48	7072	1533	94.07	75		-0.41			
7099	1431	94.54	7099	1533	94.12	75		-0.42			Unimproved bridge- Private
7145	1431	94.59	7145	1533	94.23	75		-0.36			
7595	1756	94.7	7595	1946	94.32	75	95.9	-0.38	-1.58	-1.2	
7744	1756	94.69	7744	1946	94.36	75		-0.33			
8093	1756	95.79	8093	1946	94.88	75	96.9	-0.91	-2.02	-1.11	
8183	1756	97.51	8183	1946	94.56	75	97.4	-2.95	-2.84	0.11	
8335	1756	95.44	8335	1946	95	75		-0.44			Unimproved bridge- U.S. Hwy. 77
8379	1756	98.35	8379	1946	97.58	75		-0.77			
8890	1609	99.04	8890	1763	98.04	75	101.1	-1.00	-3.06	-2.06	
9386	1466	100.39	9386	1610	98.81	75		-1.58			
9928	1466	101.74	9928	1610	100.01	75	105.7	-1.73	-5.69	-3.96	
9996	1466	102.2	9996	1610	100	75		-2.20			
10012	1466	102.54	10012	1610	100.31	50		-2.23			Unimproved bridge- Dairy Rd.
10040	1466	103.01	10040	1610	101.87	50		-1.14			
10427	1466	103.29	10427	1610	102.76	50		-0.53			
10671	1271	106.19	10671	1374	103.57	50	107.2	-2.62	-3.63	-1.01	
10784	1271	106.33	10784	1374	103.62	50		-2.71			
10871	1271	106.97	10871	1374	104.57	50		-2.40			Unimproved bridge- John Stockbauer Dr.
10918	1271	107.82	10918	1374	105.13	50	108	-2.69	-2.87	-0.18	
11299	1271	108.69	11299	1374	105.63	50		-3.06			
11756	1271	109.72	11756	1374	106.48	50		-3.24			

City of Victoria- Whispering Creek Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
12184	1271	111.8	12184	1374	107.48	50	113.6	-4.32	-6.12	-1.8	
12677	1271	113.39	12677	1374	108.79	50		-4.60			
13015	1271	114.1	13015	1374	109.72	50	115.9	-4.38	-6.18	-1.8	
13271	1271	114.33	13271	1374	110.45	50		-3.88			
13388	1271	114.66	13388	1374	111.63	50		-3.03			Unimproved bridge- Loop 463/Zac Lentz Pkwy.
13525	1271	115.16	13525	1374	112.29	50		-2.87			
14180	1271	115.96	14180	1374	113.3	50		-2.66			

Notes: Although the channel improvements in the creek between Dairy Rd. and Loop 463 have attained the goal of dropping the WSELs well below FEMA elevations, it may be necessary to consider bridge improvements along this reach to regain land still located in the improved floodplain.

City of Victoria- North Outfall Computed Water Surface Elevation Comparison												
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
60	2551	74.35	60	2627	74.46	75		0.11			Spring Creek Confluence
421	2551	74.11	421	2627	74.4	75		0.29			
719	2551	74.78	719	2627	74.7	75	76.1	-0.08	-1.4	-1.32	
755	2551	78.02	755	2627	75.21	75		-2.81			Took out the sediment dam
791	2551	79.22	791	2627	76.45	75	79.5	-2.77	-3.05	-0.28	
976	2551	79.65	976	2627	77.31	75		-2.34			
1002	2551	81.09	1002	2627	77.38	75		-3.71			Took out the sediment dam
1038	2551	82.18	1038	2627	77.56	75	82.7	-4.62	-5.14	-0.52	
1210	2551	82.76	1210	2627	78.21	75		-4.55			
1244	2551	84.43	1244	2627	81.22	75		-3.21			Took out the sediment dam
1294	2551	85.84	1294	2627	82.56	75	85.8	-3.28	-3.24	0.04	
1473	2551	86.19	1473	2627	83.39	75		-2.8			
1507	2551	87.5	1507	2627	83.42	75		-4.08			
1551	2551	88.81	1551	2627	83.69	75	89.2	-5.12	-5.51	-0.39	Took out the sediment dam
1861	2551	89.39	1861	2627	85.05	75		-4.34			
1905	2551	90.52	1905	2627	88.22	75		-2.3			Took out the sediment dam
1939	2551	91.8	1939	2627	89.6	75	95.2	-2.2	-5.6	-3.4	
2462	2551	92.25	2462	2627	91.08	75		-1.17			
2779	2426	92.61	2779	2528	91.86	75	95.3	-0.75	-3.44	-2.69	U.S. 77 Confluence
3144	2426	92.85	3144	2528	92.5	75	95.4	-0.35	-2.9	-2.55	
3302	2426	93.11	3302	2528	92.97	75		-0.14			
3376	2426	93.16	3376	2528	93.08	75		-0.08			
3393	2426	93.41	3393	2528	93.26	75		-0.15			Improved bridge- Footbridge
3409	2426	93.49	3409	2528	93.33	75	95.5	-0.16	-2.17	-2.01	
3634	2426	93.7	3634	2528	93.73	75	95.5	0.03	-1.77	-1.8	
4104	2426	94.19	4104	2528	94.49	75	95.7	0.3	-1.21	-1.51	
4549	2426	94.56	4549	2528	94.99	75		0.43			
4860	2426	94.7	4860	2528	95.23	75		0.53			
4904	2426	94.65	4904	2528	95.24	75		0.59			
4920	2426	94.01	4920	2528	94.38	75		0.37			Unimproved bridge- Footbridge
4934	2426	95.58	4934	2528	95.75	75		0.17			
4993	2426	95.63	4993	2528	95.79	75		0.16			

Notes: Present WSEL with sediment dams in place contain the water within the overbanks. The Future flows are only slightly greater than the present flows, therefore future WSEL may also be contained within the overbanks. However the goal was to reduce WSEL below FEMA. Therefore improvements were proposed.

City of Victoria- US 77 Computed Water Surface Elevation Comparison												
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
340	2426	92.61	340	2528	91.86	100	93.9	-0.75	-2.04	-1.29	North Outfall Confluence
831	2426	94.11	831	2528	92.98	100	94.4	-1.13	-1.42	-0.29	
1276	2426	95.1	1276	2528	94.07	100	94.8	-1.03	-0.73	0.3	
1473	1652	95.62	1473	1868	94.63	100		-0.99			
1545	1652	95.41	1545	1868	94.74	100		-0.67			
1631	1652	95.56	1631	1868	94.75	100		-0.81			Improved bridge- Kelly Dr.
1785	1652	96.56	1785	1868	94.86	100	95.6	-1.7	-0.74	0.96	
2156	1652	96.8	2156	1868	95.49	100		-1.31			
2449	1652	96.95	2449	1868	96.25	100	96.2	-0.7	0.05	0.75	
2695	1652	97.69	2695	1868	96.97	100		-0.72			
2766	1652	97.24	2766	1868	97.2	100		-0.04			
2893	1652	97.24	2893	1868	97.2	100		-0.04			Improved bridge- Loop 463/Zac Lentz Pkwy.
2921	1652	99.22	2921	1868	97.35	100	96.9	-1.87	0.45	2.32	
3286	1564	99.13	3286	1782	98.38	100		-0.75			
3345	1564	99.01	3345	1782	98.61	100		-0.4			
3473	1564	101.01	3473	1782	98.65	100		-2.36			Improved bridge- U.S. 77 Hwy/Navarro St.
3498	1564	101.76	3498	1782	100.03	100		-1.73			
3790	1564	105.96	3790	1782	105.79	31		-0.17			
3811	1564	105.87	3811	1782	106.24	31		0.37			
3861	1564	107	3861	1782	107.5	31		0.5			Unimproved bridge- Mall Dr.
3908	1564	108.37	3908	1782	109.15	31		0.78			
4458	1564	108.71	4458	1782	109.33	31		0.62			
4488	1564	108.51	4488	1782	109	31		0.49			
4564	1564	108.75	4564	1782	109.27	31		0.52			Unimproved bridge- Mall Dr.
4579	1564	109.56	4579	1782	110.34	31		0.78			
4635	1564	109.61	4635	1782	110.36	31		0.75			
4652	1564	109.37	4652	1782	110.06	31		0.69			
4698	1564	109.53	4698	1782	110.07	31		0.54			Unimproved bridge- Mall Dr.
4714	1564	110.27	4714	1782	110.98	31		0.71			
5122	1564	110.42	5122	1782	111.08	31		0.66			
5422	1564	110.43	5422	1782	111.08	31		0.65			
5493	1564	110.21	5493	1782	110.79	31		0.58			
5532	1564	110.53	5532	1782	111.37	31		0.84			Unimproved bridge- Mall Dr.
5555	1564	111.22	5555	1782	112.17	31		0.95			
6044	1521	111.27	6044	1754	112.19	31		0.92			

City of Victoria- US 77 Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
6091	1521	110.96	6091	1754	112.08	31		1.12			
6167	1521	110.52	6167	1754	111.01	31		0.49			Unimproved Bridge- Larkspur Dr.
6192	1521	112.09	6192	1754	112.77	31		0.68			
6612	1521	112.29	6612	1754	112.89	31		0.6			
7077	1521	111.97	7077	1754	112.83	31		0.86			
7432	1521	113.06	7432	1754	113.01	31		-0.05			
7590	1521	113.15	7590	1754	113.02	31		-0.13			
7720	1521	115.4	7720	1754	112.93	31		-2.47			

Notes: WSELs upstream of Navarro bridge are out of the banks with channel improvements. However given the space between the buildings anc no further channel improvements have been proposed.

City of Victoria- Lone Tree Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
114597	8700	70.65	114597	11266	70.55	100		-0.1			
115675	8700	71.36	115675	11266	71.24	100		-0.12			
116967	8700	72.36	116967	11266	72.28	100		-0.08			
117950	8700	72.91	117950	11266	72.85	100		-0.06			
118931	8700	73.51	118931	11266	73.44	100		-0.07			
120416	8700	74.12	120416	11266	74.12	100		0			
121738	8700	74.52	121738	11266	74.48	100		-0.04			
122223	8700	74.89	122223	11266	74.61	100		-0.28			
122269	8700	75.39	122269	11266	73.82	100		-1.57			Improved bridge- WoodHi Rd.
122532	8700	76.65	122532	11266	76.19	100		-0.46			
123527	8700	76.83	123527	11266	76.57	100		-0.26			
125117	9293	77.06	125117	11398	76.89	100		-0.17			
126210	9293	77.32	126210	11398	77.13	100		-0.19			
127187	9293	77.83	127187	11398	77.58	100		-0.25			
128185	9293	78.41	128185	11398	78.22	100		-0.19			
129257	9293	78.83	129257	11398	78.71	100		-0.12			
130164	9293	79.11	130164	11398	78.99	100		-0.12			
131086	9040	79.29	131086	9722	79.19	100		-0.1			
131598	9040	79.38	131598	9722	79.26	100		-0.12			
131740	9040	80.08	131740	9722	79.83	100		-0.25			Improved bridge- F.M. 2615
131902	9040	80.18	131902	9722	79.97	100		-0.21			
132201	9040	80.27	132201	9722	80.06	100		-0.21			
133741	9040	80.6	133741	9722	80.4	100		-0.2			
134825	9040	80.83	134825	9722	80.56	100		-0.27			
135924	9040	82.25	135924	9722	81.64	100		-0.61			
136276	8920	82.5	136276	9743	81.89	100		-0.61			
136735	8920	82.86	136735	9743	82.3	100		-0.56			
136813	8920	81.41	136813	9743	81.59	100		0.18			Improved bridge- Price Rd.
137092	8920	83.43	137092	9743	82.84	100		-0.59			
137952	8920	83.49	137952	9743	82.94	100		-0.55			
138702	8920	83.56	138702	9743	83.03	100		-0.53			
139571	8920	83.66	139571	9743	83.17	100		-0.49			
140092	8920	83.74	140092	9743	83.24	100		-0.5			
140890	8920	84.14	140890	9743	83.61	100		-0.53			
141301	8920	84.57	141301	9743	83.89	100		-0.68			

City of Victoria- Lone Tree Computed Water Surface Elevation Comparison												
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
141379	8920	83.53	141379	9743	84.51	100		0.98			Improved bridge- Hanselman Rd.
141581	8920	85.22	141581	9743	85.4	100		0.18			
142147	8920	85.39	142147	9743	85.5	100		0.11			
143209	8920	85.91	143209	9743	85.82	100		-0.09			
143506	8601	86.12	143506	9615	86.02	100		-0.1			
144488	8601	86.37	144488	9615	86.22	100		-0.15			
145456	7005	86.76	145456	7438	86.57	100		-0.19			
145714	7005	86.83	145714	7438	86.61	100		-0.22			
146036	7005	86.96	146036	7438	86.71	100	87	-0.25	-0.29	-0.04	
146088	7005	86.66	146088	7438	86.51	100		-0.15			
146206	7005	86.82	146206	7438	86.57	100		-0.25			Improved bridge- State Hwy. 175
146307	7005	87.66	146307	7438	87.2	100		-0.46			
146848	7005	87.91	146848	7438	87.45	100	88.4	-0.46	-0.95	-0.49	
147096	6848	87.97	147096	7269	87.52	100		-0.45			
147419	6848	88.07	147419	7269	87.62	100		-0.45			
147932	6848	88.19	147932	7269	87.75	100		-0.44			
148137	6848	88.24	148137	7269	87.82	100		-0.42			
148463	6685	88.38	148463	7050	87.97	100		-0.41			
148640	6685	88.44	148640	7050	88.02	100		-0.42			
148660	6685	88.57	148660	7050	88.19	100		-0.38			Improved bridge- Lone Tree Rd.
148875	6685	88.87	148875	7050	88.57	100		-0.3			
149400	6685	88.95	149400	7050	88.65	100		-0.3			
149768	6685	89.01	149768	7050	88.71	100		-0.3			
149958	6685	89.03	149958	7050	88.71	100		-0.32			
150350	6685	89.09	150350	7050	88.79	100		-0.3			
150785	6437	89.68	150785	6748	89.1	100		-0.58			
151151	6437	89.92	151151	6748	89.25	100		-0.67			
151627	6437	90.21	151627	6748	89.45	100		-0.76			
152095	6437	90.45	152095	6748	89.65	100	91.4	-0.8	-1.75	-0.95	
152408	6437	90.56	152408	6748	89.71	75		-0.85			
152650	6376	90.76	152650	6640	89.94	75		-0.82			
153013	6376	90.93	153013	6640	90.14	75		-0.79			
153183	6376	91.01	153183	6640	90.27	75	91.8	-0.74	-1.53	-0.79	
153430	6376	91.14	153430	6640	90.41	75		-0.73			

City of Victoria- Lone Tree Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
153507	6376	91.32	153507	6640	90.62	75		-0.7			
153511	6089	91.36	153511	6123	90.68	75		-0.68			
153663	6089	91.33	153663	6123	90.69	75		-0.64			
154103	6089	91.85	154103	6123	91.03	75		-0.82			
154620	6089	92.39	154620	6123	91.39	75		-1			
154842	6089	92.89	154842	6123	91.64	75	92.4	-1.25	-0.76	0.49	
154988	5830	92.97	154988	5669	91.78	75		-1.19			Southern Pacific Confluence
155197	5830	93.1	155197	5669	91.88	75		-1.22			
155215	5830	93.53	155215	5669	91.88	75		-1.65			Improved bridge- SPRR
155262	5830	94.05	155262	5669	92.48	75		-1.57			
155429	5830	94.07	155429	5669	92.54	75		-1.53			
155542	5830	94.09	155542	5669	92.6	75		-1.49			
155762	5410	94.14	155762	4824	92.73	75		-1.41			
155990	5410	94.14	155990	4824	92.69	75		-1.45			
156077	5410	94.03	156077	4824	92.7	75		-1.33			Improved bridge- U.S. Hwy. 59
156130	5410	94.59	156130	4824	93.06	75	93.9	-1.53	-0.84	0.69	
156545	5410	94.6	156545	4824	93.1	75		-1.5			
156938	5410	94.62	156938	4824	93.14	75		-1.48			
157205	5410	94.63	157205	4824	93.16	75		-1.47			
157674	5410	94.66	157674	4824	93.22	75	94.2	-1.44	-0.98	0.46	
157866	5680	94.67	157866	8386	93.18	75		-1.49			East Branch Confluence
158246	5680	94.74	158246	8386	92.37	75		-2.37			Detention pond- Upper
158768	5680	94.77	158768	8386	92.72	75		-2.05			
159518	5680	94.86	159518	8386	93.31	75	95.7	-1.55	-2.39	-0.84	
159866	3598	94.98	159866	4917	93.82	75		-1.16			
160208	3598	95.02	160208	4917	93.94	75		-1.08			
160543	3598	95.07	160543	4917	94.08	75		-0.99			
160904	3598	95.14	160904	4917	94.21	75		-0.93			
161075	3598	95.21	161075	4917	94.4	75	97.2	-0.81	-2.8	-1.99	
161409	3598	95.29	161409	4917	94.58	75		-0.71			
161567	3880	95.36	161567	4785	94.68	75	97.7	-0.68	-3.02	-2.34	
161713	3880	95.41	161713	4785	94.73	75		-0.68			
161992	3880	95.32	161992	4785	94.76	75		-0.56			Improved bridge- Airline Rd.
162091	3880	95.62	162091	4785	95.26	75		-0.36			
162230	5397	95.63	162230	4567	95.29	75		-0.34			
162705	5397	95.72	162705	4567	95.34	75		-0.38			

City of Victoria- Lone Tree Computed Water Surface Elevation Comparison

PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
163262	5397	96.52	163262	4567	95.53	75		-0.99			
163452	5397	96.86	163452	4567	95.77	75		-1.09			
163580	5397	95.93	163580	4567	95.62	75		-0.31			
163606	5397	95.93	163606	4567	95.62	75		-0.31			Unimproved bridge- Miori Lane
163648	5397	99.08	163648	4567	96.54	75		-2.54			
163770	5397	99.11	163770	4567	96.66	75		-2.45			
163989	5397	99.36	163989	4567	96.89	75		-2.47			
164362	5397	99.64	164362	4567	97.27	75	100.3	-2.37	-3.03	-0.66	
164625	5397	99.81	164625	4567	97.51	75		-2.3			
164825	4578	99.88	164825	3648	97.67	75		-2.21			
165004	4578	99.96	165004	3648	97.76	75		-2.2			
165527	4578	100.22	165527	3648	97.98	75		-2.24			
165760	4578	100.45	165760	3648	98.09	75	101.1	-2.36	-3.01	-0.65	
166000	2370	100.67	166000	3029	98.24	75		-2.43			
166359	2370	100.77	166359	3029	98.37	75	101.3	-2.4	-2.93	-0.53	
166660	2370	100.85	166660	3029	98.49	75		-2.36			
166848	2370	100.89	166848	3029	98.55	75		-2.34			
166950	2284	100.99	166950	2922	98.15	75		-2.84			
166998	2284	101.5	166998	2922	98.15	75		-3.35			Improved bridge- Ben Jordan St.
167074	2284	101.55	167074	2922	99.88	75		-1.67			
167494	2284	101.6	167494	2922	99.95	75	101.4	-1.65	-1.45	0.2	
167801	2284	101.63	167801	2922	100	75		-1.63			
168000	2284	101.65	168000	2922	99.96	75		-1.69			
168621	2244	101.7	168621	2804	100.54	75		-1.16			
169049	2244	101.75	169049	2804	100.79	75		-0.96			
169536	2244	101.88	169536	2804	101.55	75	102.2	-0.33	-0.65	-0.32	
169649	2244	102.13	169649	2804	101.89	75		-0.24			
169723	2244	102.32	169723	2804	102.27	75		-0.05			
169761	2244	102.16	169761	2804	101.97	75		-0.19			Unimproved Bridge- Timberlane Rd. Bridge
169806	2244	102.46	169806	2804	102.6	75		0.14			
169921	2244	102.63	169921	2804	102.74	75		0.11			
170054	2244	102.9	170054	2804	102.93	75	105.7	0.03	-2.77	-2.8	
170320	2244	103.2	170320	2804	103.21	75		0.01			
170517	1601	102.98	170517	2067	103.26	75		0.28			

City of Victoria- Lone Tree Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
170588	1601	102.28	170588	2067	103.28	75		1			Improved bridge- John Stockbauer Dr.
170698	1601	105.15	170698	2067	103.92	75		-1.23			
171138	1601	105.2	171138	2067	104.19	75		-1.01			
171505	1601	105.28	171505	2067	104.68	75		-0.6			
171988	679	105.51	171988	705	105.33	75		-0.18			
172482	679	105.78	172482	705	105.61	75		-0.17			
172581	679	105.92	172581	705	105.75	75		-0.17			
172664	679	106	172664	705	105.84	75		-0.16			
172772	679	106.02	172772	705	105.85	75		-0.17			Improved bridge- Mockingbird Ln.
172971	679	108.14	172971	705	106.88	75		-1.26			
173319	679	111.17	173319	705	109.01	75		-2.16			
173567	679	111.64	173567	705	109.71	75		-1.93			
173643	679	111.53	173643	705	110.08	75		-1.45			
173759	679	111.63	173759	705	110.16	75		-1.47			Improved bridge- Loop 463/Zac Lentz Pkwy.
173882	679	113.08	173882	705	111.31	75		-1.77			
174734	679	113.12	174734	705	112.42	75		-0.7			

City of Victoria- Southern Pacific Computed Water Surface Elevation Comparison								
PP Conditions			FF Conditions					
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	F/F-P/P	Notes
78	1137	92.97	78	1244	91.78	0.1	-1.19	Lone Tree Confluence
541	1137	92.97	541	1244	91.78	0.1	-1.19	Difference in starting WSEL due to detention
982	1137	92.98	982	1244	91.87	0.1	-1.11	
1491	1137	93	1491	1244	92.04	0.1	-0.96	
2000	1137	93.06	2000	1244	92.24	0.1	-0.82	
2531	1137	93.15	2531	1244	92.42	0.1	-0.73	
3104	1137	93.34	3104	1244	92.68	0.1	-0.66	
3560	1137	93.46	3560	1244	92.92	0.1	-0.54	
3863	1137	93.57	3863	1244	93.06	0.1	-0.51	
3976	1137	93.44	3976	1244	92.99	0.1	-0.45	
4116	1137	94.1	4116	1244	93.72	0.1	-0.38	Unimproved bridge- Railroad Crossing
4172	1137	94.84	4172	1244	94.7	0.1	-0.14	
4509	1137	94.87	4509	1244	94.78	0.1	-0.09	
4854	1121	95.05	4854	1150	94.94	0.1	-0.11	
4960	1121	94.97	4960	1150	94.83	0.1	-0.14	Unimproved bridge- Delmar Dr.
5022	1121	94.69	5022	1150	94.52	0.1	-0.17	
5081	1121	95.63	5081	1150	95.55	0.1	-0.08	
5569	1121	95.67	5569	1150	95.61	0.1	-0.06	
6020	1121	95.7	6020	1150	95.65	0.1	-0.05	
6501	1121	95.76	6501	1150	95.74	0.1	-0.02	
6896	1121	95.84	6896	1150	95.86	0.1	0.02	
7335	1121	95.99	7335	1150	96.09	0.1	0.1	
7762	1121	96.39	7762	1150	96.63	0.1	0.24	
7831	1121	98.48	7831	1150	98.29	0.1	-0.19	
7892	1121	98.48	7892	1150	100.49	0.1	2.01	Unimproved bridge- Ben Wilson St.
8012	1121	103.01	8012	1150	100.53	0.1	-2.48	
8250	1121	103.01	8250	1150	100.53	0.1	-2.48	
8688	1121	103.01	8688	1150	100.54	0.1	-2.47	
9168	1121	103.03	9168	1150	100.55	0.1	-2.48	

Note: No FIS Study available for this watershed.

City of Victoria- East Branch Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	Notes
64	2262	94.74	64	3439	93.18	0.01		-1.56			Lone Tree Confluence
607	2262	94.75	607	3439	93.27	0.01		-1.48			Diff in starting WSEL due to LT detention
907	2262	94.75	907	3439	93.2	0.01	95	-1.55	-1.8	-0.25	
1121	2262	94.78	1121	3439	93.62	0.01		-1.16			
1434	2262	94.83	1434	3439	94.01	0.01		-0.82			
1818	2262	94.99	1818	3439	94.81	0.01	96.3	-0.18	-1.49	-1.31	
1941	2262	94.84	1941	3439	94.87	0.01		0.03			
2057	2262	95.72	2057	3439	94.87	0.01		-0.85			Improved bridge- John Stockbauer Dr.
2101	2262	96.19	2101	3439	95.29	0.01		-0.9			
2542	2262	96.34	2542	3439	95.78	0.01	97.1	-0.56	-1.32	-0.76	
2640	2262	96.23	2640	3439	95.67	0.01		-0.56			
2722	2262	95.95	2722	3439	95.72	0.01		-0.23			Improved bridge- Colony Creek Dr.
2855	2092	96.46	2855	3176	96.06	0.01		-0.4			
3321	2092	96.49	3321	3176	96.15	0.01	97.7	-0.34	-1.55	-1.21	
3738	1167	96.5	3738	1761	96.18	0.01		-0.32			
4066	1167	96.5	4066	1761	96.19	0.01	98.2	-0.31	-2.01	-1.7	
4412	1167	96.51	4412	1761	96.21	0.01		-0.3			
4773	1167	96.55	4773	1761	96.33	0.01		-0.22			
4808	1167	97.33	4808	1761	97.87	0.01		0.54			
4823	1167	97.49	4823	1761	98.11	0.01		0.62			Unimproved bridge- Footbridge
4858	1167	98.47	4858	1761	99.21	0.01		0.74			Elevations don't change
5198	1167	98.53	5198	1761	99.27	0.01		0.74			unless bridge is improved
5278	1167	98.55	5278	1761	99.29	0.01		0.74			
5293	1167	98.48	5293	1761	99.25	0.01		0.77			Unimproved bridge- Footbridge
5328	1167	98.61	5328	1761	99.29	0.01	99	0.68	0.29	-0.39	
5652	1167	98.92	5652	1761	99.58	0.01		0.66			
5693	1130	98.88	5693	1662	99.55	0.01		0.67			
5735	1130	98.86	5735	1662	99.74	0.01		0.88			
5962	1130	98.86	5962	1662	99.74	0.01		0.88			Improved bridge- Loop 463/Zac Lentz Pkwy.
6032	1130	99.97	6032	1662	100.25	0.01		0.28			
6095	1130	100.45	6095	1662	100.62	0.01		0.17			

City of Victoria- East Branch Computed Water Surface Elevation Comparison											
PP Conditions			FF Conditions				May 1990	Elev. Differences Between Models			Notes
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	FIS Study	F/F-P/P	F/F-FEMA	P/P-FEMA	
6972	1130	102.14	6972	1662	102.5	0.01		0.36			
7753	1130	103.07	7753	1662	103.38	0.01		0.31			
8805	1130	104.99	8805	1662	105.27	0.01		0.28			

City of Victoria-Marcado Computed Water Surface Elevation Comparison								
PP Conditions			FF Conditions					
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	F/F-P/P	Notes
41320	6840	68.47	41320	9697	68.01	150	-0.46	
42358	6840	69.23	42358	9697	68.75	150	-0.48	
43736	6840	70.23	43736	9697	69.73	150	-0.5	
44580	6840	70.61	44580	9697	70.16	150	-0.45	
45832	6840	71.46	45832	9697	70.92	150	-0.54	
46388	6840	72.45	46388	9697	71.38	150	-1.07	
46408	6840	72.13	46408	9697	71.46	150	-0.67	Improved bridge- F.M. 1686
46743	6840	74.91	46743	9697	73.53	150	-1.38	
47597	6687	75.15	47597	9500	73.87	150	-1.28	
48209	6687	75.24	48209	9500	73.99	150	-1.25	
49131	6687	75.51	49131	9500	74.34	150	-1.17	
49496	6687	75.64	49496	9500	74.56	150	-1.08	
49504	6687	75.63	49504	9500	74.54	150	-1.09	Improved bridge- Footbridge
49593	6687	75.65	49593	9500	74.61	150	-1.04	
50421	6687	75.79	50421	9500	74.86	150	-0.93	
51442	6687	75.89	51442	9500	75.06	150	-0.83	
52266	6687	75.97	52266	9500	75.22	150	-0.75	
53157	6000	76.03	53157	8614	75.35	150	-0.68	
53612	6000	76.06	53612	8614	75.44	150	-0.62	
53626	6000	76.06	53626	8614	75.43	150	-0.63	Unimproved bridge- Hambleton Rd.
53949	6000	76.09	53949	8614	75.51	150	-0.58	
55083	6000	76.22	55083	8614	75.85	150	-0.37	
56128	6000	77.17	56128	8614	77.21	150	0.04	
57073	3763	78.93	57073	5977	78.73	150	-0.2	
58066	3763	80.11	58066	5977	79.94	150	-0.17	
59032	3763	81.34	59032	5977	80.98	150	-0.36	
60013	3763	83.02	60013	5977	82.3	150	-0.72	
61016	3649	84.77	61016	5351	83.94	100	-0.83	
61550	3649	85.56	61550	5351	84.94	100	-0.62	
61936	3649	85.99	61936	5351	85.46	100	-0.53	
62278	3649	86.3	62278	5351	85.74	100	-0.56	
62284	3649	86.44	62284	5351	85.74	100	-0.7	Unimproved bridge- Footbridge
62290	3649	86.37	62290	5351	85.75	100	-0.62	
62482	3649	86.94	62482	5351	86.26	100	-0.68	
63223	3584	86.87	63223	4644	86.59	100	-0.28	
63892	3584	88.78	63892	4644	87.34	75	-1.44	
64804	3584	89.48	64804	4644	88.61	75	-0.87	

City of Victoria-Marcado Computed Water Surface Elevation Comparison								
PP Conditions			FF Conditions					
SECNO	Q	CWSEL	SECNO	Q	CWSEL	BW	F/F-P/P	Notes
65199	3584	89.73	65199	4644	88.98	75	-0.75	
65892	3584	90.39	65892	4644	89.66	75	-0.73	
66055	3596	90.71	66055	4405	89.87	75	-0.84	
66157	3596	90.06	66157	4405	89.73	75	-0.33	
66291	3596	93.04	66291	4405	90.11	75	-2.93	Improved bridge- Hwy. 59/Loop 175
66333	3596	93.32	66333	4405	91.81	75	-1.51	
66591	3596	93.36	66591	4405	92.1	75	-1.26	
67016	3596	93.42	67016	4405	92.38	75	-1.04	
67415	3485	93.65	67415	4306	92.85	75	-0.8	
67841	3485	93.96	67841	4306	93.38	75	-0.58	
68208	3485	94.48	68208	4306	93.93	75	-0.55	
68776	3485	94.92	68776	4306	94.4	75	-0.52	
69260	3485	95.55	69260	4306	94.96	75	-0.59	
69667	3485	96.14	69667	4306	95.58	75	-0.56	
70132	3485	96.5	70132	4283	96.04	75	-0.46	
70343	3485	96.6	70343	4283	96.13	75	-0.47	
70427	3485	97.59	70427	4283	96.51	75	-1.08	Improved bridge- Hwy. 59 Business
70497	3485	97.87	70497	4283	97.59	75	-0.28	
71459	3485	97.95	71459	4283	97.69	75	-0.26	
72085	3485	97.99	72085	4283	97.75	75	-0.24	
72692	3485	98.03	72692	4283	97.81	75	-0.22	
73395	3485	98.19	73395	4283	98	75	-0.19	
74176	3485	98.61	74176	4283	98.49	75	-0.12	
74689	3485	98.92	74689	4283	98.78	75	-0.14	

Notes: No FIS Study available for this watershed.
The WSEL's for the F/F condition, which includes channel improvements, is not contained within the overbanks. However the goal was to drop the WSEL below FEMA. In order to reach this goal channel improvements were required, although they didn't bring the WSEL's withing overbanks.

reminded of the numbering system employed throughout the SDMP (discussed in detail in previous sections) which allows criss cross referencing between the models for a watershed. Therefore, if the user is interested in tabular floodplain information in the SDMP at a particular location (remember that detailed information is available in electronic format on the CDS presented in Appendix 1), the location of the area on the plan view maps or on the profile relative to a known bridge location will allow the user to find the appropriate section (SECNO) in Table 4.2.

To the right of the SECNO is the 100-year discharge (Q) in cfs from the HEC1 hydrologic model for the P/P condition and the associated computed water surface elevation (CWSEL). Further to the right is the Q and CWSEL for the F/F conditions. The next column presents the Bottom Width (BW) in feet of the "benched channel" discussed above. Please note that if the value listed is one hundredth (0.01) then there is *NO new channel improvement* in that reach (the existing channel is not modified at all)

The right half of Table 4.2 presents the results of the water surface comparisons for the proposed channel improvement compared with either the old FIS (where available) or to the P/P condition water surface elevations (WSEL) created in the SDMP. For comparison, the FIS value is listed at certain key locations. The next three columns following the FIS values present the differences between the indicated water surface elevations. Please recall that the goal is to have the F/F condition be equal to or less than the FIS (or the P/P). Further to the right is a columns for "notes" that clarify the conditions at a particular location. For example, a note could indicate "F/F starting WSEL is 10-yr Guadalupe" which was the agreed criteria for the open channel design. Some notes include the names of the various bridges along the reach to help keep the orient the user as to the location along the creek based simply upon this tabular data. If the user has located a known bridge, then by using the difference in section number (SECNO) stations which are measured in feet, a WSEL at a location a given distance upstream or downstream of that bridge can also be identified. Please note that in the watersheds that discharge to the Guadalupe River, several of the first few rows of the Table may be shaded. This indicates the reach of the watershed that is affected by the 100-year WSEL from the River itself. The estimated 100-year WSEL for the River is listed in the last shaded row under the "notes" column.

Although the main focus of the open channel improvements was upon the vertical elevation of the 100-year floodplain relative to the existing FIS elevation, with the reduction of the F/F water surface elevation came a reduction in the width of the floodplain itself. As an example to the reader of the plan view information that is available electronically in the models included on the CDS in Appendix 1, two examples are included herein. Map Packet 6 presents the Present/Present (P/P) condition for the upper portions of the Whispering Creek watershed. The blue lines are a general representation of the "edge of water" for the 100-year floodplain. The red line represents the approximate boundary of the line where the floodwater is 1 ft deep ("shallow flooding"). Please note that in the electronic models the user can select or "define" this line to be 2 ft, or ½ ft, or whatever is desired. The area along Loop 463 is shown to have a wide area impacted by both the blue and red lines. Map Packet 7 shows the same area after the open channel improvements (F/F condition) had been modeled. Note that the area around Loop 463 is now contained within the channel and does not spread out over the surrounding area. Please note that the "bubble" effect of the lines along the creek corridor show the areas where the stormwater has slightly come up out of the channel itself and that the areas in between the "bubbles" do indeed have a floodplain width associated with them that is less than the top of the channel banks (so it was not depicted with blue lines).

Map Packet 8 presents a similar "before and after" view of an area in the Lone Tree Creek watershed. In the P/P condition the area along US Highway 59 has a wide floodplain as depicted by the blue line. Map Packet 9 presents the same corridor after the open channel improvements (F/F condition) had been modeled. Note that the floodplain area around US Highway 59 is dramatically reduced in width. Again, these two examples (four maps) have been presented simply as an example to the reader of the type of plan view information that is available electronically throughout the City and are included on the CDS in Appendix 1.

Structural Solutions - Closed System Improvements

As mentioned earlier, the first structural solutions to be evaluated were the regional detention basins (since they reduced the downstream peak flow rates). The second step was to establish a solution for the open channels that would convey the resulting discharges in a manner that was equal to or better than the existing conditions. The third step described in this section was to then examine the closed system (pipes and box culverts) which are tributaries to the major open channels or the Guadalupe River.

The creation of the closed system models was discussed in Section 3. The nomenclature for the various watersheds, "service areas," and "strip" ID numbers was also previously discussed. For example, the Jim Branch watershed has two "service areas," each of which has multiple "strips." A separate closed system model was created for each of the two service areas. As an example of the system naming convention, for Jim Branch (JB), the portion of the model that was for service area two (2) and strip four (4) would be referred to as JB 2:4 in the various tables and maps and service area one (1) and strip three (3) would be JB 1:3. Each of the various models had their own "boundary conditions" from which to start. As mentioned above, this was usually the F/F water surface condition computed from the previous step in the analysis of the required open channel improvements. These downstream conditions are included as Appendix 7 for reference.

The conveyance system improvements resulting from the closed system modeling are presented in Table 4.3. Please recall that Table 3.7 presents the specific design storm (10-year or 25-year) and other tabular information about the particular closed system infrastructure. Each watershed is listed on its own sheet(s). The service area and strip are listed in the first two columns along with the total length

TABLE 4.3

CLOSED SYSTEM HYDRAULIC (AVSAND)
MODELING RESULTS

Table 4.3A: Jim Branch Storm Sewer Improvements

Service Area	Strip	Total Length (ft)	Pipe	Notes	Inlets		
					Single	Double	Triple
2	1	5697	12'x6'	Parallel to Existing	20	30	30
2	1	1150	8'x6'	Parallel to Existing			
2	1	861	6'x6'	Parallel to Existing			
2	1	532	8'x6'				
2	1	1891	60"				
1	2	1361	6'x6'			20	
1	2	817	5'x5'				
1	2	566	54"				
1	2	1409	42"				
1	3			Inlets Only	10	10	
2	4	160	12'x6'		20	15	10
2	4	1170	6'x6'				
2	4	1178	48"				
2	5	816	6'x6'		20	10	10
2	5	1366	48"				
2	5	718	36"				
2	6	707	24'x6'	Parallel to Existing	30	30	20
2	6	1771	12'x6'	Parallel to Existing			
2	6	1029	8'x6'				
2	6	1051	5'x5'				
2	6	222	48"				
2	7	1335	60"		10	10	
2	7	258	36"				
2	8	1813	60"		11	5	
2	8	616	36"				
2	9	521	6'x6'		10	10	
2	9	733	5'x5'				
2	9	852	48"				
2	9	519	36"				
2	10	1377	5'x5'	Parallel to Existing	15	10	5

Table 4.3B: South Outfall Storm Sewer Improvements

Service Area	Strip	Total Length (ft)	Pipe	Notes	Inlets Single	Inlets Double	Inlets Triple
1	1	3248	8'x6'	Parallel to Existing	20	15	20
1	1	1550	5'x5'	Parallel to Existing			
1	1	1807	5'x5'				
1	1	775	54"				
1	1	564	24"				
1	2	2476	8'x6'		20	20	10
1	2	1492	6'x6'				
1	2	644	5'x5'				
1	2	711	36"				
1	2	746	24"				
1	3	1174	6'x6'		10	5	2
1	3	1167	42"				
1	4	1202	54"		6	4	
1	4	751	36"				

Table 4.3C: Second Street Outfall Storm Sewer Improvements

Service Area	Strip	Total Length (ft)	Pipe	Notes	Inlets Single	Inlets Double	Inlets Triple
1	1	1259	12'x6'		5	10	5
1	1	347	8'x6'				
1	1	1168	6'x6'				
1	1	658	48"				
1	1	347	36"				
1	2	1626	8'x6'		16	20	10
1	2	939	36"				
1	3	1442	60"		11	8	
2	1	3690	5'x5'	Parallel to Existing	20	20	20
2	1	983	6'x6'				
2	1	262	48"				
2	1	1315	36"				
2	1	360	5'x5'	Diversion to Pump			
2	1	655	5'x5'	Diversion 2:1 to 1:1			
2	2			Inlets Only	3	2	
2	3	330	48"		3	3	3
2	3	1028	42"				
2	3	335	36"				
2	3	335	24"				
2	4	369	42"		3	3	3
2	5	1320	60"		4	4	3
2	5	1002	42"				
2	6	717	6'x6'		15	15	5
2	6	678	72"				
2	7	725	42"		5	5	
2	7	660	36"				
2	8	996	60"		5	8	2
2	8	666	48"				
2	8	661	42"				
2	8	329	36"				

Table 4.3D: West Outfall Storm Sewer Improvements

Service Area	Strip	Total Length (ft)	Pipe	Notes	Inlets Single	Inlets Double	Inlets Triple
1	1	1845	8'x6'		10	10	10
1	1	1679	5'x5'				
1	1	837	42"				
1	2			Inlets Only	4	3	
1	3	1412	54"		5	5	5
1	3	616	48"				
1	3	743	36"				
2	2			Inlets Only	5	5	
2	3	3162	5'x5'		7	10	5
2	3	691	54"				
2	3	496	48"				
2	4	2398	60"		5	5	5
2	4	1404	48"				
2	5	3624	12'x6'	Parallel to Existing	10	20	15
2	5	997	6'x6'				
2	5	1647	54"				
2	6	755	6'x6'		7	5	5
2	6	310	5'x5'				
2	6	366	54"				
2	7	1015	5'x5'		6	6	6
2	7	963	54"				
3	1	3276	24'x6'	Crown Span	30	40	30
3	1	1339	12'x6'	Parallel to Existing			
3	1	948	8'x6'				
3	1	1585	72"				
3	8	1481	6'x6'	Parallel to Existing	10	20	10
3	8	1786	5'x5'	Parallel to Existing			
3	9	2458	8'x6'		13	12	10
3	9	1314	6'x6'				
3	10			Inlets Only	4	3	
3	11	608	5'x5'		6	5	4
3	11	1315	60"				
3	11	892	60"				
3	11	552	36"				
3	12	776	42"		4	2	
3	12	296	24"				
3	13	558	36"		2	2	
3	14	1217	36"		2	2	
3	15	1502	5'x5'		6	3	2
3	16	1164	5'x5'		6	4	2
3	16	1031	54"				
3	17	952	5'x5'		8	6	4
3	18			Plugged			
3	19			Plugged			
3	20			Plugged			
3	21			Plugged			

Table 4.3E: Spring Creek Storm Sewer Improvements

Service Area	Strip	Total Length (ft)	Pipe	Notes	Inlets		
					Single	Double	Triple
2	1	2976	8'x6'	Parallel to Existing	20	15	15
2	1	1578	8'x6'				
2	1	303	72"				
2	2	523	6'x6'				
2	3	2539	12'x6'		10	15	10
2	4	920	5'x5'		9	10	2
2	4	759	48"				
2	4	1649	42"				
2	5	747	36"		4	4	

Table 4.3F: Mockingbird Outfall Storm Sewer Improvements

Service Area	Strip	Total Length (ft)	Pipe	Notes	Inlets Single	Inlets Double	Inlets Triple
1	1	4184	6'x6'	Parallel to Existing	21	25	20
1	1	522	5'x5'	Parallel to Existing			
1	1	1392	5'x5'				
1	1	1116	36"				
1	2			Inlets Only	3	1	
1	3			Inlets Only	3	1	

Table 4.3G: Whispering Creek Storm Sewer Improvements

Service Area	Strip	Total Length (ft)	Pipe	Notes	Inlets Single	Inlets Double	Inlets Triple
1	8	685	42"		6	4	
1	8	298	36"				
1	9			Inlets Only	6	4	2
2	2	2749	6'x6'	Parallel to Existing	14	15	8
2	2	2017	8'x6'				
2	2	1575	5'x5'				
2	2	1225	54"				
2	2	643	36"				
2	3	535	6'x6'		16	12	8
2	3	743	72"				
2	3	807	60"				
2	3	983	54"				
2	3	1071	42"				
2	3	882	36"				
2	4	1334	60"		9	8	2
2	4	179	48"				
2	5	3258	36"		5	2	
2	5	905	24"				
2	6	1534	60"		6	6	4
2	6	600	48"				
2	7	1409	54"		4	4	2
2	7	690	36"				

Table 4.3H: Lone Tree Creek Storm Sewer Improvements

Service Area	Strip	Total Length (ft)	Pipe	Notes	Inlets Single	Inlets Double	Inlets Triple
1	1	2710.2	12'x6'		14	15	16
1	1	2838	8'x6'	Parallel to Existing			
2	1	6500		(SP) Improved Channel			
2	1			(SP) RR Spur Bridge			
2	1			(SP) Delmar Dr. Bridge			
2	2	3051	5'x5'	Parallel to Existing	11	10	10
2	2	325	48"				
2	3	647	5'x5'		4	6	2
2	4			Inlets Only	4		
2	5	1101	8'x6'		12	10	6
2	5	591	6'x6'				
2	5	879	5'x5'				
2	5	576	42"				
3	1	921	5'x5'		6	6	2
3	1	607	48"				
3	1	303	36"				
4	1	50	6'x6'		5	5	2
4	1	447	6'x6'				
4	1	221	6'x6'				
4	1	703	6'x6'				
4	2	569	54"		5	5	
4	2	691	36"				
4	3	1961	54"		6	5	
4	4			Inlets Only	6	2	
5	1	1579	72"	Miori Lane has already been improved	9	10	6
5	1	997	54"				
5	1	1042	36"				
6	1	755	5'x5'		5	5	
6	1	843	42"				
6	2			Inlets Only	5	4	
6	3	546	36"		5	4	
7	1	1303	6'x6'		6	7	5
7	1	1063	60"				
7	1	496	36"				
8	1	44	24'x6'	Crown Span - Leary Ln. Bridge	10	14	10
8	1	96	24'x6'	Crown Span - Mockingbird Ln. Bridge			
8	1	54	24'x6'	Crown Span - Gettsyburg Dr. Bridge			
9	1	2832	24'x6'		5	5	4
9	2	1357	54"		6	5	
9	2	76	24"				

Table 4.3H: Lone Tree Creek Storm Sewer Improvements

Service Area	Strip	Total Length (ft)	Pipe	Notes	Inlets		
					Single	Double	Triple
10	1	846	60"	(EB)	8	6	4
10	1	707	48"				
10	1	846	42"				
11	1	447	60"	(EB)	5	4	2
11	1	230	48"				
11	1	795	36"				
11	2	683	42"	(EB)	4	2	2
11	2	580	36"				
11	3	840	48"		5	5	

of the model (feet) in the third column. The next two columns present the proposed infrastructure improvements with notes about the recommendations. In most cases the proposed pipe/box will be a replacement to an existing conveyance structure. However, in some situations the proposed improvement is to be installed "parallel" to the existing infrastructure which should remain in place.

Please note that the results of the modeling presented herein are "conceptual." That is to say that during actual design there may be other constraints that would make the proposed structure unfeasible. The results presented herein should be viewed as predictions of the proposed system "conveyance" that is needed to handle the particular stormwater event. The engineer conducting the actual design should use these recommendations as a point of beginning in the analysis. Similarly, for those systems that are to be replaced by the proposed system (not the parallel system), the actual design process may be determine that a parallel system would indeed work and the design engineer simply needs to create a combined system that would have the total "conveyance" of the proposed system in the Table.

Table 4.3 also presents information about stormwater "collection" system improvements. The last three columns include information about the additional inlets that will be needed. Whereas the section of the Table to the left presents the "conveyance" part of the overall stormwater system, the section to the right presents the "collection" part of the system. The two must be balanced or the results will either be an abundant collection system with no place to deliver the stormwater or an abundant conveyance system with no way to get the stormwater into the pipes/boxes. Table 4.3 presents a general estimate of the number of additional inlets that will be required to insure that the proposed peak flow rates (Future condition) will drain from the streets into the pipes/boxes. Please note that these inlets are NOT simply to be located along the specific length of the service area/strip being modeled. There are smaller diameter pipes that were not modeled but do exist within the service area of the particular watershed being modeled. The proposed number of inlets should be dispersed throughout the service area during the actual design phase of the particular project. The final design will refine the location and the number of inlets that are required. The estimates included in this Table are intended as a guide to help project the actual cost of the improvement in the service area.

Structural Solutions - Pump Station - Second Street

As mentioned in the discussion of Table 4.1, there are several alternative solutions to various drainage problems. The three previous sections discussed regional detention basins, open channel improvements and closed system improvements. This section will review options for the Second Street (SS) watershed, one of which would involve pumping stormwater over a leveed area. The particular area in question includes a number of homes along Second Street near the eastern levee of the Guadalupe River and north of the high railroad embankment across from the Central Power and Light plant. One alternative to for flooding situation is to create a closed system "bypass" structure that would take the flood flow stormwater from near the intersection of Navarro Street and Third Street and carry it *under* the railroad tracks and to the south. For reference, the system is referred to as service area 1 and strip 1 (SS 1:1) in Table 4.3. The low flow stormwater would be allowed to flow along the normal route under Second Street and then out through the flap gates into the River. Whenever, the flow in the system (at Navarro and

Third) is 1 ft deep in the box, then the "bypass" would be activated and stormwater would be able to overflow to the south (in the new box) toward Cameron Street, and from there along a route to the Guadalupe River.

Since a permit to install a large box under the railroad track could be very time consuming to obtain (and out of the City's ability to control), a second alternative for this particular problem areas was explored. The solution involved the creation of a small pump station (lift station) and small detention pond on the east side of the levee just north of the railroad track embankment. Depending on the severity of the event, localized flooding can be eliminated or appreciably reduced by the installation of a detention pond system and pumping station. The primary pump would be a 15,000 to 25,000 gallon per minute pump operating at 95 to 150 horsepower. Runoff from most events would be discharged over the levee to the Guadalupe River in less than four hours. Small amounts of runoff would be discharged using a "sump pump" of three to five horsepower.

Due to the high probability of loss of electric power during a severe storm event, the proposed main pumping system should be completely "self contained" and work regardless of the external power availability during the storm. The use of internal combustion (IC) engines rather than electric motors to drive storm water pumps is recommended. Gasoline and diesel engines are, in order, the least expensive options. The major problems with these engines involve maintenance of the fuel system. Gasoline and diesel fuels both have distinct storage lives and must be changed out on a regular basis.

Natural gas and Liquid Propane (LP) gas do not have fuel storage problems and, in addition, do not tend to contaminate the lube oil in the engines. There are, however, some disadvantages. Due to the available heat energy in the fuel, natural gas fired engines are comparatively large and horsepower for horsepower, relatively expensive. LP fired engines are essentially less expensive gasoline engines; however, the fuel must be stored in a pressure tank. While these propane tanks have a long and very good safety record, many municipalities regulate their presence within the city limits. In addition to pumps, the station would need an equipment building, a concrete sump and pump support structure, a slope protection slab on the levee, and a small spillway structure.

The detention basin would be located in the vacant lots south of Second Street bisected by Main Street. The purpose of this temporary "holding area" would be to provide a place for the excess stormwater to go (other than the neighborhood) and to dampen the peak flow rate so that a smaller pump can be used. The basin would consist of two connected ponds with a total surface area slightly over 1.25 acres and a depth of overflow of slightly over 9 ft. The side slopes would be gently graded to as not to provide a safety hazard or concern. This would provide a capacity of just under 300,000 cubic feet or approximately 2.1 million gallons. Estimated cost of construction of the detention ponds complete with slope stabilization and vegetation would be approximately $40,000.

The civil works for the pump would include a metal building shelter for the engine selected to drive the storm water pump, the control system, and telemetry required as well as sumps, pump support pads, and discharge splash pads. A concrete containment structure would be required if either diesel or gasoline was selected as a fuel source. Some form of a minor concrete protective structure may be required if LP gas is selected as a fuel source just to serve a source of protection to the neighborhood. It should be noted that as with all the other "structural improvements" this alternative has a specific design storm event past which there will be flooding. This structure has been "conceptually designed" for the 25-year event, therefore, events such as the 50-year and 100-year will still cause flooding in the neighborhood streets. The difference being that the initial portions of the larger storms will already have been pumped over the levee in to the River, and that after the larger events are over, the stormwater will stand in the neighborhood for less than half a day it too is pumped over the levee.

Structural Solutions - Cost Estimates

The previous sections have discussed the structural solutions to the Future land use drainage problems within the major creeks and thoroughfares in the watersheds of the City. Table 4.4 presents a summary of the estimated construction costs by watershed for the proposed SDMP improvements. The overall multiyear total construction cost is estimated to be around $170 million dollars for all the projects in each watershed throughout the Study Area. Detailed cost information associated with each of the structural solutions is presented in both Table 4.5 and Appendix 8. Please note that the detail presented in Appendix 8 is tabulated by watershed with multiple pages presented for all the projects in some of the larger watersheds. Again please note that these cost estimate spreadsheet files are included in the CDS presented in Appendix 1 for reference and future use. Please note that any cost for the acquisition of right-of-way or project design would need to be added to the totals in Table 4.4.

Table 4.5 presents the list of construction items and their unit prices that were used in the SDMP. The first column is simply a sequential numbering of the line items. The second and third columns present the Texas Department of Transportation (TxDOT) specification number and unique "descriptor code" that provides additional specific information to the contractor about the particular bid item. The next column provides the "item" description for the type of work that is to be performed. To the right of the description column are the units of measurement for that particular item such as Lump Sum (LS), square yard (SY), and Each (EA) for example. Lastly is the estimated unit price in 1999 dollars. Local unit prices have been incorporated into the cost estimate.

TABLE 4.4
SUMMARY OF CONSTRUCTION COST BY WATERSHED

Watershed	Cost Estimate (Open and Closed Systems)
Lone Tree including East Branch and Southern Pacific Tributaries	$44,198,775
Spring Creek	$24,615,805
Whispering Creek	$10,059,177
North Outfall	$703,461
U.S. 77 Outfall	$1,979,028
Mockingbird Outfall	$3,365,141
Jim Branch including Ben Jordan Tributary	$24,757,518
South Outfall	$9,433,829
Second Street Outfall	$10,624,373
West Outfall	$32,371,681
Marcado Creek	$7,695,560
Total	$169,804,348

Table 4.5
Construction Cost Unit Prices

CITY OF VICTORIA
Stormwater Master Drainage Plan - construction cost estimates (cost for geotech, row, engineering, etc NOT included)
UNIT PRICES only - enter the unit prices here for use throughout all the worksheets (1999 estimates)
SPECIFICATION line items entered here will be automatically transferred to other worksheets (add at bottom of the section)

	COA or TxDOT Spec	TxDOT Descrip. Code	**These line items, specs nos, descriptor codes and units will be used throughtout** Item	Units	**Fill this column** Unit Price	Price Source City? TxDOT?
1	100	none	Preparing Right of Way - General	LS	4.0%	new b
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	new b
3	500	501	Mobilization	LS	2.5%	new b
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	new b
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00	aj
6	110	502	Excavation - channel	CY	$4.00	txdot
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00	aj
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00	new b
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	txdot
10	162	509	Block sod (St. Augustine)	SY	$2.00	austin
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	berg + cont.
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	berg + cont.
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00	aj
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00	txdot
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00	frank + cont.
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50	sa
17	402	501	Trench Safety Protection	LF	$1.25	sa
18	423	508	Retaining walls (cast in place)	SF	$25.00	txdot + cont.
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00	sa
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00	aj
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00	
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00	
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00	
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00	
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00	
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00	
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00	giff hill
28	422	501	Bridge 1 - straightforward	SF	$35.00	amy
29	422	501	Bridge 2 - straightforward	SF	$35.00	amy
30	422	501	Bridge 3 - straightforward	SF	$35.00	amy
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00	amy
32	464	505	RCP - Class III - 24"	LF	$40.00	new b + cont.
33	464	509	RCP - Class III - 36"	LF	$50.00	new b + cont.
34	464	510	RCP - Class III - 42"	LF	$70.00	
35	464	511	RCP - Class III - 48"	LF	$90.00	
36	464	512	RCP - Class III - 54"	LF	$120.00	
37	464	513	RCP - Class III - 60"	LF	$150.00	
38	464	514	RCP - Class III - 66"	LF	$175.00	
39	464	515	RCP - Class III - 72"	LF	$200.00	
40	464	516	RCP - Class III - 78"	LF	$225.00	
41	464	517	RCP - Class III - 84"	LF	$275.00	
42	464	518	RCP - Class III - 96"	LF	$325.00	
43	465	547	Inlet - Single	EA	$7,000.00	new b + cont.
44	465	548	Inlet - Double	EA	$10,000.00	new b + cont.
45	465	549	Inlet - Triple	EA	$13,000.00	new b + cont.
46	465	536	Drainage MH or JB	EA	$5,000.00	new b + cont.
47	466	501	Headwall - small	EA	$2,500.00	new b + cont.
48	466	501	Headwall - large	EA	$4,000.00	new b + cont.
49	529	511	Concrete Curb and Gutter	LF	$6.50	new b + cont.
50	529	521	Concrete Valley Gutter	LF	$10.00	new b + cont.

Table 4.5
Construction Cost Unit Prices

CITY OF VICTORIA
Stormwater Master Drainage Plan - construction cost estimates (cost for geotech, row, engineering, etc NOT included)
UNIT PRICES only - enter the unit prices here for use throughout all the worksheets (1999 estimates)
SPECIFICATION line items entered here will be automatically transferred to other worksheets (add at bottom of the section)

	COA or TxDOT Spec	TxDOT Descrip. Code	**These line items, specs nos, descriptor codes and units will be used throughtout** Item	Units	**Fill this column** Unit Price	Price Source City? TxDOT?
51	530	604	Remove & Replace Driveway	EA	$3,000.00	new b + cont.
52	531	502	Sidewalk	SY	$50.00	new b + cont.
53	550	501	Chain Link Fence - 6ft.	LF	$10.00	new b + cont.
54	560	501	Mailbox Assembly	EA	$400.00	aj
55	580	none	Project Maintenance (subsidiary)			
56	COA-594	none	Gabions	CY	$150.00	new b + cont.
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00	aj
58	639	none	Rock Berm	LF	$900.00	aj
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	aj
60	1610	none	Preservation of Trees (Type C)	EA	$100.00	aj
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	aj
62	Special	none	Conlock II pavers	SY	$27.00	pavestone
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00	aj
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00	
65	420	none	Pump		$175,000.00	
66						

End of Current BASE BID specification items and unit prices

Contingency = 15%

Please note that in the spreadsheet file, this sheet is the first sheet that the user will access. All other sheets in the file make calculations and text entries from this main sheet. The intent in this "design" is to provide the City with the flexibility to create future year cost estimates very easily. The user simply goes to this first sheet and enters the projected unit prices for the various items, and the cost estimates are automatically updated to reflect the changes. Where the current file is saved as "est$99," the future year file could be saved as a unique "est$2000" or "est$2001" file to reflect that year's cost estimation. Additionally, as the various projects are completed, the projected quantities in that job (currently included in the "est$99" file) can be zeroed out so that the true remaining "future needs" are included in the watershed cost estimate totals. The Design Team's goal was to provide the City with a flexible and dynamic tool to track and project the financial need of the SDMP.

As mentioned above, Table 4.5 presents the list of construction items and their unit prices that were used in the SDMP. The actual construction cost estimates should be viewed as "conceptual" and not refined for preparation of an actual bid (which will come from the "design" process). The intent of these cost estimates is to generally reflect the amount of funding that each project could require so as to assist the City in the short term and long term financial planning processes. With that in mind, the following paragraphs discuss the various "assumptions" that were made in the estimation of each of the specific line items in the cost estimation spreadsheet. The design engineer can refer to these assumptions and modify them as needed once the actual design is underway for a particular project from the SDMP.

For example, "Preparing Right of Way - General" was assumed to be four (4) percent of the total bid amount. Similarly, "Relocation of utilities - gas, telephone, power, others" was assumed to be one (1) percent of the total bid amount, "Mobilization" was assumed to be two and one-half (2.5) percent of the total bid amount, and "Barricades, Signs and Traffic Handling" was assumed to be one and one-half (1.5) percent of the total bid amount. Again, a change to these percentage assumptions can easily be made in the "unit$" column and all the estimates will be immediately updated.

The line item for "Removing concrete (unusual items not a part of general ROW prep)" was for larger items that could not comfortably be considered as "general" ROW preparation above. The "Excavation - channel" line item is for the quantity of dirt that would need to be cut from the existing channel in order to create the "benched channel" previously discussed. The quantity (CY) for this line item came directly out of the open channel hydraulic model. "Embankment - berms, dikes, detention basin dams" represents the quantity of fill material (CY) estimated to create the detention basin structures or other fill areas. It is was assumed to be an "in place" quantity with no shrinkage factor applied at this time. "Specialized Excavation Work (hard to reach areas, more difficult)" is a line item reserved for any excavation that could not be handled by the large moving equipment and would most likely require more specialized (smaller) equipment and more time to complete.

The next few items dealt with the erosion and sediment control aspect for all the projects. "Furnishing and Placing Topsoil" was used only in those situations where a "cut section" could end up exposing soil that did not have much nutrient source and therefore, would need assistance before planting could take place successfully. The quantities were assumed to cover the entire bottom width of the benched channel, the side slopes, and horizontally 10 ft either side of the top of bank of the existing channel. "Block sod (St. Augustine)" was used primarily in neighborhood setting (not in the cross country channels) where front yards could be disturbed by the installation of new pipe or box culverts. For this conceptual estimate, it was assumed that one-fourth (25%) of the entire project length would require this special vegetative cover. The majority of the revegetation effort (both urban and open channel) would be handled with "Seeding for Erosion Control (to include fertilizer & watering, subsidiary)." The area covered would be the same as the "topsoil" line item discussed above.

Continuing with the erosion and sediment control line items, in some places there appeared to be the need for "Soil Retention Blanket - Temporary (ECRM)." If the shear stress in the open channel was under 3 pounds per square foot (psf) then a quantity was estimated equal half the surface area estimated for the "topsoil" and the "seeding" line items. This will provide the project with temporary, biodegradable matting to assist in the growth of grasses. This product should be installed as the project progresses (not waiting until the end of the job) so as to protect all the slopes that have been final graded, covered with topsoil and seeded. In some channels, the velocity was a little higher than unprotected grass could take on its own. Therefore, if the shear stress in the channel was over 3 psf, then a "Soil Retention Blanket - Permanent (TRM)" was recommended with a quantity estimated to be one-third (33%) of the entire surface discussed in the "topsoil" and the "seeding" line items above. This quantity should provide the design engineer with enough material to protect those areas in need of "soft armor" (not hard armor rip rap). The control of sediment during construction and the establishment of healthy vegetative cover along the channel should make these projects significant contributors to the overall water quality in the watersheds.

In the urban areas, as the pipes and boxes are installed, there will most likely be a need for "Flexible Base - assume 12" Thickness" to repair the streets. For the purposed of these "conceptual" cost estimates, it was assumed a width of 15 ft along the entire project length would require this type of work. Similarly, after the base was installed, "HMAC - Type D - assume 2" Thickness" was estimated to be needed to repave the street. Certainly, as the urban projects are actually designed, these quantities may slightly increase or decrease depending upon the final route of the new pipe/box and if any of the work could be performed behind the curb (not require repaving).

A quantity was estimated for "Excavation and Backfill for Structures (headwalls, junction boxes)" that was for the excavation work around the drainage structures, whereas another line item is for the concrete work to install the structure. "Trench Safety Protection" is a critical item and as such was assumed to be equal to the entire length of the pipe/box project. As the individual project is designed this item may be reduced somewhat since the requirement is only for those regions where the project depth exceeds the Federal requirements.

In some locations there was an estimate for "Retaining walls (cast in place)" to assist in minimizing the ROW requirements and overall "footprint" width of the project. Please note that near the top of the worksheet is a row that makes a prediction as to the total project right-of-way (ROW) in feet that will be required. In the open channel sections, the ROW estimate assumes the full top width of the excavated channel plus an additional 10 ft on either side as a maintenance access. As with the cost estimates, the final design could dictate that the required ROW would be more or less than this "conceptual" estimate. It is simply included here as a reference for land acquisition purposes.

In some open channels there may be a need for "Riprap - Stone (Channel) (assume 18" thick)" for in-line energy dissipation or for use just downstream of a bridge or headwall structure that has high exit velocities. The need for this item can best be evaluated during final design and is included primarily as a reminder. Many times there are needs for "Steel Structures (pedestrian hand rails, others)" to provide safety to the general public and to the maintenance staff. There are a series of "Concrete Box Culverts" listed for use primarily in the urban system. These also can be used in bridge structures or in the outlet structures of detention basins. A quick comparison was made among the many width and height options available for precast box culverts. An examination of the square feet of opening compared to the linear foot price for each size indicated that there were some basic sizes that provided the most area for the price (i.e., the wide boxes that are short are more expensive than the more square shaped boxes of the same open area). Therefore, in this SDMP hydraulic analysis the only box structures examined were as follows:

Concrete Box Culverts - 5 x 5
Concrete Box Culverts - 6 x 6
Concrete Box Culverts - 8 x 6
Concrete Box Culverts - 9 x 7
Concrete Box Culverts - 12 x 6
Concrete Box Culverts - 12 x 8

During the actual design of a particular project, a wider variety of box sizes and requirements (utility conflicts and other similar items) can be evaluated that could make one of the six "basic sizes" mentioned above not the final choice. The SDMP models should be considered predictors of the "system conveyance" that will be needed. Again, these "basic sizes" were selected based upon the best cost for the open area provided. Changes to other sizes will most likely increase the project cost somewhat.

One additional precast product (that is actually made in Victoria) was added to the choices called "Precast CROWNSPAN culvert structures (assume 24 ft wide by 6 ft tall)." This product is used in situations where multiple boxes would normally be used. However, since multiple structures many times prove to be maintenance problems with trees and trash collecting on the vertical members where multiple boxes are placed side by side, the Crownspan product provides an unobstructed open area for the stormwater to pass (no vertical members out in the channel). The hydraulic efficiency of this section allows it to be narrower than a multiple box section of the same conveyance capacity. The cost effective use of these structures proves out when multiple boxes can be replaced with a single unit. The height of the

Crownspan units varies from 2 to 12 ft (in 2 ft increments) and the width ranges from 16 ft to 40 ft (in increments of 2 to 4 ft). A refined product size other than the dimension proposed (24 ft x 6 ft) could be evaluated during detailed design.

Where improved open channels met an existing bridge structure, an evaluation was performed to determine the size required for a new bridge to provide the necessary conveyance. The construction was assumed to be "poured in place" and the unit price includes all piling, deck, and subsidiary items required. The cost for the bridges was divided into the two categories of "Bridge - straightforward" and "Bridge - more difficult and involved" with an appropriate unit cost for each based upon many similar type structures for the TxDOT.

There were several "basic sizes" of circular concrete pipe evaluated in the SDMP. The sizes for these pipes are as follows:

RCP - Class III - 24"
RCP - Class III - 36"
RCP - Class III - 42"
RCP - Class III - 48"
RCP - Class III - 54"
RCP - Class III - 60"
RCP - Class III - 66"
RCP - Class III - 72"
RCP - Class III - 78"
RCP - Class III - 84"
RCP - Class III - 96"

Again, as with the concrete box culverts, during actual design there may be a situation where a odd size would be required due to utility conflicts (for example) or to where one of the larger diameter structures could be replaced with a box culvert. For the "conceptual" construction cost purposes of the SDMP, only the eleven sizes listed were evaluated. The recommendations will provide the final design team with an initial estimate of the conveyance required for a particular reach.

Where the concrete box culverts and the concrete pipe bid items reflect the proposed systems "conveyance" the next bid items reflect the proposed systems "collection" requirements. Certainly the two need to be balanced and compatible for the entire system to function properly. The collection system was analyzed using the following three "basic sizes":

Inlet - Single
Inlet - Double
Inlet - Triple

The single inlet has a throat width of 5 ft and the "double" and "triple" are multiples of this base dimension. The information for the estimate of the required numbers for these items came from the hydrologic models. None of the inlets were assumed to be in a "sump condition." For the "conceptual" analysis, it was assumed that the single inlet capacity was 5 cfs, and the double and triple are multiples. Where the conveyance system has peak flows that are combinations and routings for the entire watershed down to that point (the time of concentration gets longer the further downstream in the system), the evaluation of the inlets is based upon the discharge from the individual watersheds each having their own unique time of concentration. For example, if 40 cfs is being generated by a subbasin, then there is a need for 8 single inlets each assumed to be capable of removing 5 cfs. The exact location of these inlets is not in the scope of the conceptual design of the SDMP but will be identified during the final design phase. Double and triple inlets were used when the required flow removal increased. As mentioned in the discussion about the boxes and the pipes, the intent is to simply provide an idea about the general "collection" capacity requirements for a particular watershed and an estimate of the construction funding required to provide that capacity. .

Within the closed system design there will be needs for "Drainage manholes (MH) or junction boxes (JB)." Again, the hydraulic analyses provided an estimate of these types of structures. Final design may reveal that an existing structure can simply be modified to accommodate a parallel pipe or another larger pipe without the need to totally build a new MH of JB structure in which case the cost estimate could be reduced. Similarly, at some point there will be a need for either a "Headwall - small" or a "Headwall - large" to allow the flow from the closed system to exit into the open channel system. Refinements and unique design structures can be evaluated during the final design phase.

For the closed system projects, it was assumed that half of the project length would require new "Concrete Curb and Gutter." Some portions of the existing system will most likely be able to be reused and the new pipes may be placed toward the centerline of the street. However, in other sections the new structures may need to be placed under/near the existing curb dictating removal and replacement. In some situations stormwater may be able to be passed across a street section with the use of a "Concrete Valley Gutter" which is included as a reminder for the final design phase.

In each closed system projects there was an estimate made for the number of “Remove & Replace Driveway” efforts that may be needed. For this conceptual estimate it was assumed that every 100 ft along the project there would be a need for this type of work. This assumed that the impact of the new project would be along just one side of the entire route. Again, final design may reveal that there may be slightly more or less than this. Similarly, there was an assumption that, as the new structure went down a road, the major sidewalk would not be damaged and that only the individual sidewalk segments extending to the street could possibly be impacted. Therefore, every 100 ft it was assumed that 20 square yards (sq yd) of 4 inch “Sidewalk” paving would be required. Again assuming that the majority of the work would take place out in the street right-of-way the need for “Chain Link Fence - 6 ft” would be minimal but could be needed in final design on a site by site basis. Certainly, if a closed system project went down one side of a street, there would be a need for some work on a “Mailbox Assembly.” One was assumed every 100 ft of the total project length.

For final design, the contractor needs to be reminded about their responsibility to preform routine “Project Maintenance” as a subsidiary item to all others in the bid package. It is important to the safety of the citizens and the workers that this type of effort be monitored.

In the open channel design there may be use for “Gabions” or “Reno Revetment Mattress” in the final design. These design elements provide environmentally sensitive structures that allow for the exchange of stormwater and groundwater as well as providing a very “flexible” structure that can move and shift as needed to offset poor geotechnical conditions at a particular project site. For the management of construction erosion and sedimentation there is a need to include the use of “Rock Berms” and “Silt Fence” in the project. The use of round excelsior “logs” (approximately 1 ft to 1½ ft in diameter) in lieu of the standard vertical silt fence should be considered. The round products can be more easily moved along with the project as grading proceeds and seem to actually collect the sediment. The quantity was assumed to equal one-third (33%) of the total project length. Another environmental concern is the “Preservation of Trees (Type C)” along the creek corridors and along the urban streets. This line item would provide for orange fencing along the circumference of the “drip line” of the tree to keep truck traffic away from the trunk and root zone. An allowance has been made for a “Capital Improvement Project Sign” for each project to inform the public of the contractors name and that the project is a part of the SDMP.

As discussed in previous sections, the open channels design includes a “benched channel” concept where the low flow section of the existing channel (approximately 1 to 3 ft deep) is preserved or armored to maintain its shape and environmental importance. Along these lines a quantity has been included for “Conlock II pavers” to serve as that armoring agent. These square pavers are individual concrete sections about 18 inches on a side with “dog ears” and “slot” sections allowing for the individual pieces to articulate as needed. This system provides a combination of the necessary armoring yet still allows for the exchange of stormwater and groundwater in this “low flow” area. The assumption was that a strip 20 ft wide along the entire reach length would be needed. Certainly in final design if a particular reach is stable then this quantity would not be needed. However, in the unstable areas or the reaches where a new low flow channel would need to be cut then this type of reinforcement (or a similar bioengineering solution) would be needed.

The final item on the cost estimate is “Concrete Structures (drop, energy dissipation, special)” which could be needed at major bridge crossings, outlet works for detention basins, and in-line drop structures along the reach of a channel.

Appendix 8 presents the detailed estimate of probable costs for the various projects. There are additional rows near the top of the individual columns that contain the “input” information transferred from the actual open channel models (channel bottom width, side slopes, and so forth) that were “hidden” in the printing of these construction cost numbers but are available to the user in electronic format.

Structural Solutions - Project Priorities

One of the more critical features of the SDMP is the prioritization of the individual projects. A key element to the SDMP is that adverse downstream impacts due to the construction of an individual project must be avoided or at least minimized to the greatest degree possible. Hydrologic modeling was used to set this hydrologically-based prioritization process. This section of the report outlines the priorities and provides guidance for the allowable sequence in construction of the individual drainage improvements. Considerable flexibility has been afforded to the City Administration/Staff with this proposed prioritization method.

Map Packet 10 presents the “Drainage Improvement Priority Map” for the entire SDMP study area. Again, please recall that the electronic files for this priority map is included in the CDs in Appendix 1. Each of the major watersheds boundaries are identified with a bold black line. Within each watershed are colored lines which represent the various projects that were evaluated in the SDMP. The construction cost estimates for each project are included in the detail of Appendix 8. The projects will either be an open channel “reach” designated with a capital R and then a number (e.g., R1453), or they will be a closed system project designated with two numbers representing the “service area” and the “strip number” separated by a colon (e.g., 2:1). The numbering system methodology for both the open and the closed systems were previously discussed in Section 2 and Section 3. Also included on the Map are the various hydrologic “combination points” (e.g., C1508) which can serve as a criss-cross reference back to Appendix 5 which presents the discharge values throughout the SDMP.

By referring to Map Packet 10 the user can locate a physical area of interest in a particular watershed and then identify the project that runs through the area or is near the specific location. The project ID number can then be located in the individual watershed’s cost estimate tabulation. The user now knows which project(s) is in the area and the estimated construction costs. The real purpose of the Map, however, is to provide the user with some sense of the hydrologic “priority” for implementation of the particular project in question.

As mentioned above, each of the various SDMP projects is presented with a color code associated to the project length. The red lines indicate the projects that can be completed as Priority One. That is to say, these projects need to be completed before any other projects are completed within that particular watershed. The Priority Two projects are presented in a dark blue color. Orange is used for Priority Three and purple for Priority Four. The other color used to identify a particular project priority is green. These projects are difficult to exactly prioritize. Since they are in the lower reaches of certain watershed, the hydrologic impacts are not as serious as are the erosion impacts. Therefore, the recommendation is to "monitor downstream conditions in these reaches" for evidence of increased erosion damages. If the reach is relatively stable then the priority can remain low, however, if some conditions become unmanageable, then the need for that improvement should be raised. In all cases the hydrologic prioritization will be affected by any downstream erosion that may occur.

Therefore, if the particular project that the user is considering is color coded with orange, then it is an indication that within that subwatershed all the red coded projects need to be completed as well as the blue coded projects downstream of the specific project, before the particular orange colored project should be implemented. Please note that this Map presents the "recommended" implementation strategy for the drainage projects. It is possible that there are other iterations and combinations from this basic prioritization scheme. The flexible and dynamic computer models created for the SDMP will provide data and information to assist the City in the evaluation of these other scenario conditions. There are a very large number of possible implementation schemes and strategies that could unfold over time for the City. After evaluation with the models there may be a situation where a blue reach (upstream section) could be constructed slightly ahead of all the red reaches (downstream sections) being completed. The Map Packet 10 simply presents the basic priorities. Also please note that it was assumed that the channel improvements within a specific color/prioritization reach will be constructed from downstream to upstream. Also it was assumed that in the closed system the existing culverts that interconnect adjacent watersheds were assumed to be plugged (disconnected).

Structural Solutions - Implementation Plan

Developing an implementation strategy for the SDMP involved bringing the results of the previous institutional, administrative, engineering, environmental and funding work efforts together to develop an achievable program of actions and improvements that makeup the Drainage Master Plan. The authority (ordinances) and methods/procedures (policy and drainage design manual), prioritized improvement plans and funding capabilities were brought together as an implementation plan or strategy.

Of key importance is Map Packet 10 which presents the hydrologic priorities within each watershed. Each watershed has Priority One, Priority Two, Priority Three and Priority Four projects. The City has the flexibility to decide which of the projects are to be included on a Citywide basis based upon a variety of issues unique to the City of Victoria. The flexibility that Map Packet 10 provides is that it presents general guidance within a watershed but does not dictate the implementation of the plan across the City. This Citywide implementation will reflect the input received from the public during the three Public Hearings discussed in Section 3, the road construction improvements by the Texas Department of Transportation, short range and long range growth patterns, funding availability, coordination with Drainage District #3, and many other factors.

It is recommended that the City create a "three year plan" which would specify the particular projects that are being considered for funding over that period. Then this list would be able to be reviewed on an annual basis continually providing a moving "window" of upcoming improvements. This would allow for alterations and modifications as the conditions in the City continue to change. This also would allow the City to fund some "preliminary" design work for specific projects which would then in turn allow the City to begin to target the right-of-way requirement well ahead of construction. Then as the multiyear plan begins to unfold, there would be constant work on either preliminary design, ROW acquisition, utility relocation, final design, or construction of the various projects.

One major item that needs to be addressed very early in the implementation of the SDMP projects is the issue of "permitting" requirements from the various State and Federal Agencies. One very critical part of the implementation of the Storm Drainage Master Plan (SDMP) is the coordination of the Clean Water Act Section 404 permitting through the U.S. Army Corps of Engineers (COE). This is a task that cannot be avoided or eliminated. One of the completed tasks in the SDMP was to meet (in Corpus Christi) with the reviewing Agencies and determine the key environmental features they would like to have included in the SDMP (as discussed in Section 3). Concerns were voiced by the Agencies that included but were not limited to the following:

a) respecting the "low flow channel" and including it in the design template of the channel improvements,

b) including erosion and sediment controls during construction, and

c) avoiding the wetland areas in the lower reaches of Spring Creek.

Although all of these items have been included in the SDMP, the "official review" of the SDMP by the appropriate federal and state agencies still needs to take place. Based upon the Corpus Christi meeting and from other telephone conversations with the COE, the main objective for the City will be to obtain a "General Permit" (GP). The GP is the most probable permitting approach the Agencies will want to take in order to accomplish the implementation of the various storm drainage projects. The GP will include the general guidelines that all the various Agencies want to see during the construction and implementation of the various drainage Capital Improvement Projects.

There are some parts of this process that are clear at this point in time, while some portions cannot be estimated until the "kickoff" meeting with the Agencies takes place. Copies of the final SDMP report must be prepared for the Agencies to review. As a broad brush overview, the Agencies will be able to see the proposed impacts of the various projects (construction and maintenance) throughout the entire City. Therefore, a "kickoff" meeting is required (perhaps in Corpus Christi again) to have this multiagency orientation. From that meeting, a list of the specific items the Agencies will want to see can be created.

For example, they will most likely want to know the magnitude and type of impacts to various habitats along the creek corridors. They will want to discuss these impacts (minimal, moderate and major) and be reassured that their environmental concerns are being addressed. This will necessitate interpretation of aerial photography and field investigations to identify and delineate wetland areas that may be impacted by various projects addressed in the SDMP. Therefore, following the "kickoff" meeting, there will most likely be a requirement to identify wetland areas along the primary priority project routes (indicated with the red lines on the "Hydrologic Priority" maps). The COE has indicated that they will need to field verify (in detail) these wetland locations. There will likely need to be an "iterative review" of the SDMP with the Agencies and then a response to a variety of questions they will have as they draft the GP conditions. The COE will also need to publish the GP in various newspapers and solicit (and then respond to) public comment.

Overall, the intent is for the City of Victoria to receive the GP and then simply notify the COE of specific CIP projects as they are scheduled. There still may be a possibility for an "Individual Permit" (IP) to be issued if a particular project has a very large impact or if the public concern is large, but for the most part, the specific projects should be handled very smoothly as long as they meet the conditions of the GP. The advantage to the City of Victoria in having the GP is to help streamline the implementation of the overall drainage CIP. The GP could come up for review approximately every five years. There may be additional regulations added or changes made to the original GP at these times, but it is hard to predict if this will happen. However, by using the GP approach, the implementation of the individual drainage projects should be greatly enhanced.

REFERENCES

Birmingham, W.W. and T.R. Hester, *Late Pleistocene Aboriginal Remains from the Johnston-Heller Site, Texas Coastal Plain*. Special Report 3, Center for Archaeological Research, The University of Texas as San Antonio. 1976.

Birmingham, W.W. and J.A. Huebner, Incised Bone and Conch Shell Artifacts from the Texas West Indies Site (41VT19), *La Tierra* 18(3):8-20. 1991.

Black, S.L. Central Texas Plateau Prairie in *From the Gulf to the Rio Grande: Human Adaptation in Central, South, and Lower Pecos Texas* by T.R. Hester, S.L. Black, D.G. Steele, B.W. Olive, A.A. Fox, K.J. Reinhard, and L.C. Bement, pp 17-38. Arkansas Archeological Survey Research Series No. 33. 1989.

Brown, D.O., 1983. *The Berger Bluff Site 41GD30A: Excavations in the Upper Deposits, 1979*. Archaeological Survey Report 13, Center for Archaeological Research, The University of Texas at San Antonio.

Campbell, T.N., Archeological Investigation at the Morhiss Site, Victoria County, Texas, 1932-1940. In *An Archaeological Survey of Coleto Creek, Victoria and Goliad Counties, Texas*. Edited By A.A. Fox and T.R. Hester, pp. 81-85. Archaeological Survey Report 18, Center for Archaeological Research, The University of Texas at San Antonio. 1976.

Cloud, W.A., R.J. Mallouf, E.A. Vogt Jr., W.W. Birmingham, and E.H. Schmiedlin, 1994. The River Spur Site: Paleoindian Occupation in the Texas Coastal Prairie in *Current Research in the Pleistocene*, Vol. 11, pp. 24-26.

Fox, A.A., E.H. Schmiedlin, and J.L. Mitchell, 1978. Preliminary Report on the J-2 Ranch Site 41VT6, Victoria County, Texas. *La Tierra* 53:2-14. .

Fox, A.A. and T.R. Hester, 1976. *An Archaeological Survey of Coleto Creek, Victoria and Goliad Counties, Texas*. Archaeological Survey Report 18, Center for Archaeological Research, The University of Texas at San Antonio.

Hester, T.R. A Survey of Paleo-Indian Archaeological Remains Along the Texas Coast. In Papers on the Archaeology of the Texas Coast, edited by L. Highley and T.R. Hester, pp. 1-2. Special Report 11, Center for Archaeological Research, The University of Texas at San Antonio. 1980.

Hindes, V.K., A.A. Fox, and E.H. Schmiedlin, 1997, Test Excavations and Documentary Research at 41VT10, The Tonkawa Bank Archeological Site Victoria City Park, Victoria, Texas in *South Texas Studies 1997*, Victoria College Press, Victoria.

Huebner, J.A. 1987. Archaeological Test Excavations at the Burris Site 41VT66, Victoria County, Texas: A Preliminary Summary. *Newsletter, Friends of Archaeology* 4:13-16.

Mercado-Allinger, P.A., N.A. Kenmotsu, and T.K Perttula, Archeology in the Central and Southern Planning Region, Texas: A Planning Document. A joint publication of the Office of the State Archeologist Special Report 35 and the Division of Antiquities Protection Cultural Resource Management Report 7, Texas Historical Commission. 1996.

Ricklis, R.A. *A Model of Environmental and Human Adaptive Change on the Central Texas Coast: Geoarchaeological Investigations at White's Point, Nueces Bay, and Surrounding Area*. Coastal Archaeological Studies, Inc., Corpus Christi.

Schmiedlin, E.H., 1979. A Preliminary Report on the Burris Site (41VT66), Victoria County, Texas. *La Tierra* 6(1):25-27.

Story, D.A., 1968. Archeological Investigations at Two Cental Texas Gulf Coast Site. State Building Commission, Archeological Program Report 13, Austin.

Tunnell, C., The Cannons of Fort Saint Louis in *Heritage*. The Texas Historical Foundation, Summer 1997.

Tyler, R., 1996. The New Handbook of Texas. Vol 6. Austin.

Webb, W.P., 1952. Handbook of Texas. Vol. II. Texas State Historical Association, Austin.

Woolsey, A.M. Explorations in Victoria County, 1932. Field Notes on South Texas. Department of Anthropology, University of Texas, Austin. 1932.

APPENDIX 1

ELECTRONIC FILES (CD's) FOR ALL
MODELS, GRAPHICS, AND SPREADSHEETS

APPENDIX 2

FINANCIAL RESOURCES REPORT -
RIMROCK CONSULTANTS

OVERVIEW OF FUNDING OPTIONS
EXECUTIVE SUMMARY

E1.0 USE OF DECISION MATRIX TO EVALUATE FINANCING ALTERNATIVES

A critical aspect of enacting a Storm Drainage Master Plan is selecting an appropriate array of financing mechanisms to establish the program. The City is faced with a variety choices, any of which may be beneficial to the community under certain conditions. Thus, EH&A determined that a "Decision Matrix" technique for policy analysis was the most appropriate to provide summary analytical results to City decision-makers.

Through this approach, various alternative policy actions are defined and each is portrayed according to a selected array of characteristics of importance to the community. This methodology is initially useful to provide a concise comparison of the various mechanisms available to the City in order to narrow the focus of the alternatives review. After City representatives have selected one or more alternatives as potentially useful in funding a Storm Drainage Master Plan, an in-depth analysis of both quantifiable and subjective characteristics can be performed in a more detailed alternatives analysis.

In the Decision Matrix, results are displayed in a summary table which plots criteria against policy alternatives so that all choices can be reviewed simultaneously. The following text discusses each option separately, but a single method of generating funds will most likely not be capable of meeting the needs of an expanded and comprehensive stormwater management program. A combination of methods is generally necessary to generate sufficient funds for a comprehensive program, including major capital improvements to drainage systems and an adequate maintenance program.

Decision Matrix results are shown in Table E-1.

TABLE E-1

STORM DRAINAGE MASTER PLAN FUNDING DECISION MATRIX

EVALUATION CRITERIA	GENERAL FUND (E3.1)	DRAINAGE UTILITY (E3.2)	DRAINAGE DISTRICT (E3.3)	STORMWATER DISTRICT (E3.4)	PUBLIC IMPROVEMENT DIST. (E3.5)	IMPACT FEES (E3.6)	INSPECTION FEES (E3.7)	STAND-BY FEES (E3.8)	GRANTS (E3.9)
A. FACILITIES FUNDED (Section E2.1)									
Drainage	X	X	X		X	X		X	
Stormwater	X	X		X	X	X			
Parks in Detention/Retention Areas	X			X					
Growth-Related Facilities	X	X	X	X	X	X		X	
Facilities for Existing Development	X	X	X	X	X				
B. TYPES OF COSTS FUNDED (Section E2.2)									
Capital	X	X	X	X	X	X		X	
Renovation/Replacement/Repair	X	X	X						
Operations and Maintenance	X	X	X		X				
Administration	X	X	X		X		X	X	
Organizational/Study Costs	X	X	X		X	X		X	
C. CAPITAL FUNDING MECHANISMS (Section E2.3)									
General Obligation Bonds	X		X	X	X				
Revenue Bonds		X			X				
Current Tax/Rate Revenues (Cash-Funding)	X	X	X	X	X				
Fees						X		X	
Grant									X

TABLE E-1

STORM DRAINAGE MASTER PLAN FUNDING DECISION MATRIX

EVALUATION CRITERIA	GENERAL FUND (E3.1)	DRAINAGE UTILITY (E3.2)	DRAINAGE DISTRICT (E3.3)	STORMWATER DISTRICT (E3.4)	PUBLIC IMPROVEMENT DIST. (E3.5)	IMPACT FEES (E3.6)	INSPECTION FEES (E3.7)	STAND-BY FEES (E3.8)	GRANTS (E3.9)
D. ALLOCATION OF COSTS TO RESIDENTS (Sect. E2.4)									
None									X
Cost-Based		X				X	X	X	
Benefit-Based			X		X				
Property Value-Based	X		X	X					
Sales Tax	X								
E. LEGAL BASIS (Section E2.5)									
Home-Rule Authority (Article X1, Section 5, Texas Constitution; Chapter 51, Tex. Local Govt. Code)	X	X			X	X	X	X	
Article VIII, Section 9, Texas Constitution	X								
Title 1, Subtitle D, Section 26, Texas Tax Code	X								
Article III, Section 52, Texas Constitution			X						
Article XVI, Section 59, Texas Constitution			X	X					
Chapter 49, Texas Water Code			X	X					
Chapter 56, Texas Water Code			X						
Chapter 66, Texas Water Code				X					
Chap 402, Subchapter C, Texas Local Govt Code		X							
Chapter 395, Texas Local Government Code						X			
Chapter 372, Texas Local Government Code					X				

TABLE E-1

STORM DRAINAGE MASTER PLAN FUNDING DECISION MATRIX

EVALUATION CRITERIA	**GENERAL FUND** (E3.1)	**DRAINAGE UTILITY** (E3.2)	**DRAINAGE DISTRICT** (E3.3)	**STORMWATER DISTRICT** (E3.4)	**PUBLIC IMPROVEMENT DIST.** (E3.5)	**IMPACT FEES** (E3.6)	**INSPECTION FEES** (E3.7)	**STAND-BY FEES** (E3.8)	**GRANTS** (E3.9)
F. ADMINISTRATIVE/LEGAL CONTROL (Section E2.6)									
City	X	X			X	X	X	X	
County			X	X					
TNRCC			X	X					
District			X	X					
G. GENERATIONAL EQUITY (Section E2.7)									
Subsidy to Following Generations	X	X	X	X	X				
Reduces Generational Cross-Subsidies						X	X	X	
H. GEOGRAPHIC EQUITY (Section E2.8)									
Allows Differential Costs by Area		X	X	X	X	X	X	X	
ETJ Areas Included				X	X	X	X		
Outside-City Areas Through Interlocal Agreement			X						
I. OTHER EQUITY (EXEMPTIONS) (Section E2.9)									
Other Governments Exempted	X	X	X	X					
Undeveloped Areas Exempted		X							
Religious Properties Exempted	X	X	X	X					
J. RATE/TAX EFFECTS (Section E2.10)									
Mitigates City-Wide Rates/Taxes			X	X	X	X	X	X	X
Payments Deductible on Income Taxes	X		X	X	X	X			

TABLE E-1

STORM DRAINAGE MASTER PLAN FUNDING DECISION MATRIX

EVALUATION CRITERIA	GENERAL FUND (E3.1)	DRAINAGE UTILITY (E3.2)	DRAINAGE DISTRICT (E3.3)	STORMWATER DISTRICT (E3.4)	PUBLIC IMPROVEMENT DIST. (E3.5)	IMPACT FEES (E3.6)	INSPECTION FEES (E3.7)	STAND-BY FEES (E3.8)	GRANTS (E3.9)
K. START-UP REQUIREMENTS (Section E2.11)									
Petition			X	X	X				
Notice/Hearing		X	X	X	X	X			
Creation/Bond Election	X		X	X					
Organization of Special District			X	X	X				
Board/Committee Appointment/Election			X	X	X	X			
Special Surveys		X	X						
Technical Studies (Feasibility, Planning, Engr.)		X	X	X	X	X	X	X	X
Establishment of Accounts		X	X		X	X			
Establishment of Enterprise Fund		X							
New Collection Procedures					X	X		X	
L. ADMINISTRATIVE EASE (Section E2.12)									
Separate Accounts Required		X	X	X	X	X			
Collection with Other Taxes	X		X	X	X				
Collection with Other Utility Rates		X							
Collection with Other Fees						X	X		
Special Reporting Required			X			X			
Special Record-keeping Required						X			

PBSJ

TABLE E-1

STORM DRAINAGE MASTER PLAN FUNDING DECISION MATRIX

EVALUATION CRITERIA	**GENERAL FUND** (E3.1)	**DRAINAGE UTILITY** (E3.2)	**DRAINAGE DISTRICT** (E3.3)	**STORMWATER DISTRICT** (E3.4)	**PUBLIC IMPROVEMENT DIST.** (E3.5)	**IMPACT FEES** (E3.6)	**INSPECTION FEES** (E3.7)	**STAND-BY FEES** (E3.8)	**GRANTS** (E3.9)
M. REVENUE PREDICTABILITY (Section E2.13)									
Lump-Sum									**X**
Regular Periodic Collection	**X**	**X**	**X**	**X**	**X**			**X**	
Collection Erratic	**X**					**X**	**X**		
N. REVENUE TIMING (Section E2.14)									
Up-Front									**X**
Annually	**X**		**X**	**X**	**X**				
Monthly		**X**			**X**			**X**	
Erratic	**X**					**X**	**X**		
O. SOCIAL EFFECTS (Section E2.15)									
Increase in Home/Business Property Costs						**X**	**X**		
Increase in Home/Business Operational Costs	**X**	**X**	**X**	**X**	**X**			**X**	
P.PUBLIC UNDERSTANDING/ACCEPTANCE ISSUES (Section E2.16)									
Technical Difficulty		**X**			**X**	**X**		**X**	
Segregation of Benefitted Properties		**X**	**X**	**X**	**X**	**X**	**X**	**X**	
Reduction of Cross-Subsidies		**X**	**X**	**X**	**X**	**X**	**X**	**X**	

E1.1 EVALUATION CRITERIA

A number of criteria were identified which distinguish one type of funding mechanism from the others and which are potentially of concern to the community. Each funding alternative was characterized by all of these criteria, although in some instances a particular criteria may have no relevance for a defined option. The evaluation criteria considered were:

- Types of Capital Facilities Funded (Drainage, Stormwater, Growth-Related vs. Existing Development)
- Types of Costs Funded (Capital, O&M, Administration, etc.)
- Capital Funding Mechanisms Available (General Obligation Bonds, Revenue Bonds, Fees, etc.)
- Method of Allocating Costs to Residents (Cost-Based, Benefit-Based, Value-Based, etc.)
- Legal Basis
- Administrative/Legal Control (City, County, TNRCC, District)
- Generational Equity
- Geographic Equity
- Other Equity (Exemptions)
- Rate/Tax Effects
- Start-Up Requirements
- Administrative Ease
- Revenue Predictability
- Revenue Timing
- Social Effects (Home and Business Property vs. Operational Costs)
- Public Understanding and Acceptance Issues

These criteria are described more completely in Section E2.0.

E1.2 FUNDING OPTIONS

There are a number of options used by local governments for funding stormwater management. The number of options has increased as more cities and counties look for methods to expand the base of financial support but also to localize the cost for some projects when appropriate. The options considered in this review include:

- General Fund Appropriations
- Drainage Utility
- Drainage District
- Stormwater District
- Public Improvement District
- Impact Fees
- Stand-by Fees

- Engineering Review and Inspection Fees
- Grants

Each option is evaluated in Section E3.0 below.

E2.0 EVALUATION CRITERIA

This section discusses the various analytical criteria use to characterize each funding alternative. Each approach has its own restrictions and requirements, to varying degrees of complexity. However, these criteria identify major areas of concern which can be compared from one approach to the next and will enable the City to narrow its focus in choosing alternatives to examine in greater detail for specific feasibility.

E2.1 FACILITIES FUNDED

Each of the funding alternatives arises out of specific or general legislation, some of which are very specific about the types of facilities which can be financed under that particular approach. Some allow more flexibility than other in the array of facilities that can be funded, not only in regard to particular functions (drainage, stormwater management, affiliated parklands), but also in regard to whether funding is for existing development or for growth.

E.2.2 TYPES OF COSTS FUNDED

Various types of costs were identified for a Storm Drainage Plan, and different funding mechanisms vary in their ability to finance these costs. Costs examined were capital costs, renovation/replacement/repair costs, operations and maintenance (O&M), administration, and organizational and technical study costs.

E2.3 CAPITAL FUNDING MECHANISM

A variety of capital funding mechanisms will likely be used to finance various aspects of a Storm Drainage Plan, and specific approaches are associated with different funding programs. The types of funding approaches examined include general obligation bonding, revenue bonding, cash-funding through current rate/tax revenues, fees and grants. One of the alternatives examined, engineering review and inspection fees, does not recover capital costs, but rather recovers administrative expenses.

E2.4 ALLOCATION OF COSTS TO RESIDENTS

Depending on the manner in which costs are allocated to residents and property owners, various funding mechanisms may have differing impacts on different community groups. One approach to allocating costs is on the basis of cost causation. Cost-based approaches assign cost responsibility to each element of the community according to the cost that group imposes on the community as a whole. Cost-based approaches typically use such factors as impervious cover, acreage, land use or other cost causation determine to allocate costs.

A second approach is the so-named “benefit”-based method of allocation. Various determinants could be used to assess the relative benefit that each customer or each group of customers receives from the Storm Drainage improvements. Such determinants include relative increases in property value, absolute property value, acreage, etc.

Many approaches use taxes to fund improvements; taxes are purely revenue-generating devices and are divorced from any notion of cost causation or relative benefit. Property taxes are based solely on assessed valuation (a.v.) of properties within a defined area. Sales taxes are also used to fund improvements.

E2.5 LEGAL BASIS

Most of the identified funding alternatives are made possible by specific enabling legislation, and all are governed to some extent by State law and provisions of the Texas Constitution. These are identified for each alternative.

E2.6 ADMINISTRATIVE/LEGAL CONTROL

Of considerable concern to the City will be the locus of administrative and decision-making control. Many of the alternatives are under the nearly exclusive jurisdiction of the City. However, special districts are frequently under the control of a combination of governmental entities, including the County, the Texas Natural Resource and Conservation Commission (TNRCC) and the District itself. The City may or may not have any jurisdiction in the case of special districts. Thus, the Decision Matrix identifies the controlling governments for each alternative.

E2.7 GENERATIONAL EQUITY

A policy concern which frequently arises is “generational” equity. There are basically two approaches to this concern. In one case, there is frequently a sentiment in the community to require new development to “pay for itself”. In this instance, there will be a definitive effort to shift the cost of new development to developers and builders in order to insulate existing residents from the costs imposed by new urban land uses.

On the other hand, a more traditional approach is that each generation of residents makes improvements for the next generation, which in turn assumes some of the cost responsibility for the following generations of residents. This is similar to the manner in which schools are financed, and is the most typical approach for most community improvements. Moreover, many communities recognize that although growth imposes certain costs on the community at large, it also provides benefits which the community may be willing to help finance.

The Decision Matrix thus examines whether each funding alternative results in one generation subsidizing following growth, or whether growth costs are segregated and funded by new development, thus reducing generational cross-subsidies.

E.2.8 GEOGRAPHIC EQUITY

Another equity issue that sometimes arises is whether all the beneficiaries of capital improvements share in paying the costs of those improvements, and, as a corollary, whether non-benefitted development is exempted from cost sharing. Thus, this criteria examines whether each funding mechanism allows the City to derive different costs for various geographic areas; whether areas in the extraterritorial jurisdiction (ETJ) of the City are included in the funding of improvements; and whether other benefitted areas may be included, whether in the County or other City.

E2.9 OTHER EQUITY ISSUES (EXEMPTION)

A third equity issue concerns whether the special status of some properties allows them to receive benefits without making funding contributions. This occurs particularly when taxing options are used to fund improvements, thus exempting all tax-exempt properties such as government and religious property. In some instances, other properties will also be specifically exempted.

E2.10 RATE/TAX EFFECTS

In all cases except grant-funding, some elements of the community will necessarily fund the improvements and management of the Storm Drainage Plan, typically either through taxes or monthly utility rates, although fees are an additional alternative. Two questions arise, however, in regard to tax and rate effects. The first is whether the mechanism used will tend to mitigate the rate/tax increases of the community as a whole, or whether rate/tax effects will be limited to benefitted properties. The second question regards how the funding alternative affects individual income taxes; generally, local taxes are deductible from federal income tax calculations, while monthly utility rates are not. In regard to fees, if we assume that fees paid during the development process are added into the cost of a home or business, then the private financing costs of these fees are deductible from income tax calculations.

E2.11 START-UP REQUIREMENTS

Irrespective of the relative benefits of each funding approach, some may have organizational requirements that are significant and which should be considered in the selection of a financing approach. These are identified in a summary form in the Decision Matrix.

E2.12 ADMINISTRATIVE EASE

Similarly, the administrative requirements of some approaches is much greater than others. The Matrix examines administrative *requirements* of various legislation, such as the establishment of separate accounts, special reporting, special record-keeping, etc. However, the absence of mandated requirements does not necessarily mean that the City would not choose, for example, to establish separate accounts for a particular funding technique even though it might not be explicitly mandated. Therefore, depending on City preferences, these differences in some instances may be more theoretical than actual.

Also examined is the manner in which funds would be collected from residents, including collection of costs with other City taxes, collection with other utility billing, or collection with other development-related fees. Some approaches may necessitate entirely new programs of collection.

E2.13 REVENUE PREDICTABILITY

Some revenue streams offer more certain predictability than others. Taxes and utility rates are relatively predictable from one month to the next and from one year to the next (provided rates are not based on a variable such as water consumption). On the other hand, sales taxes and growth-related fees (impact fees, inspection fees) vary with economic trends and provide less reliable revenue streams.

E2.14 REVENUE TIMING

It is important that the City also have reasonable expectations about the timing of the revenue stream. Tax and rate revenue is collected routinely at relatively predictable points in the City's annual and monthly budget cycles. On the other hand, fee revenues often are collected significantly after expenses have been incurred, although the fees are lump-sum amounts. Other revenues (grants) may be obtained prior to City funding of improvements.

E2.15 SOCIAL EFFECTS

During the development of a new funding mechanism, there is often considerable public discussion concerning the relative effects on affordable housing, fixed income residents, business development, job creation, etc. Often, especially undesirable effects can be somewhat mitigated in the crafting of a particular program in regard to the cost allocation methodology, exemptions allowed by the City and other techniques. However, in this report, social effects will be portrayed broadly as affecting either home and business property costs, or as affecting monthly operational costs. In the first instance, the funding mechanism will tend to drive up property costs due to the imposition of greater costs during development (impact fees, inspection fees); in the second instance, the ultimate user of the property (the homeowner or business owner) will pay additional utility rates or taxes and thus see an increase in operational costs.

E2.16 ISSUES AFFECTING PUBLIC UNDERSTANDING AND ACCEPTANCE

There are several issues which are likely to affect public understanding of the funding mechanism and public acceptance. First is the degree of technical difficulty. For example, additional property taxes may not be especially equitable, but they do not pose any particular technical difficulty for the layperson. On the other hand, allocation of costs based on cost-causation (as with impact fees and a drainage utility) can be highly complex, although arguably more equitable.

Other issues include perceptions of equity: whether benefitted properties are the only ones which assume the cost burden, and whether cross-subsidies are reduced so that the beneficiaries are proportionally charged for improvements.

E3.0 FINANCING ALTERNATIVES

The following sections describe each financing alternative according to the various evaluation criteria discussed above. Each discussion is accompanied with a table which summarizes the major characteristics of that approach. Table E-1 above, the Decision Matrix, offers an overall summary of all the alternatives.

E3.1 GENERAL FUND

The general fund is the primary fund for financing traditional municipal facilities and services. The usual sources of general fund revenues are property taxes; sales taxes; business, franchise and other miscellaneous taxes; fines; fees for services, licenses and permits; and other miscellaneous sources. Victoria derives its power to generate funds in this manner through its Home Rule Authority (Article XI, Section 5, Texas Constitution; Chapter 51, Texas Local Government Code), as well as tax provisions in the Texas Constitution (Article VII, Section 9) and in the Texas Tax Code (Title 1, Subtitle D, Section 26).

The City may fund any municipal improvements and provide any municipal services with General Fund monies, thus it has more flexibility with this technique than with any other. Capital funding mechanisms primarily include general obligation bonds and cash-funding with tax and other general fund revenues.

Various equity problems arise in using tax revenues to fund community improvements. Like all other services provided through the General Fund, costs are recovered from City property-owners based on the relative assessed valuation of property, rather than on the basis of cost causation or relative benefits provided. Moreover, to the extent that the General Fund is supported with sales tax revenues, taxation tends to be regressive.

In regard to geographic equity, it is possible that some drainage/stormwater improvements may benefit areas outside the City, which do not contribute property taxes. They do, however, contribute sales taxes and make other contributions to the City's General Fund (various fines and fees), as do other non-local residents who shop in the City or pass through the City. Some properties, by virtue of their tax-exempt status (government, religious properties), do not make property or sales tax contributions, although they may receive benefits from the improvements.

GENERAL FUND

FACILITIES FUNDED
- All

TYPES OF COSTS FUNDED
- Capital
- Renovation/Repair/Replacement
- Operations & Maintenance
- Administration
- Study Costs

CAPITAL FUNDING MECHANISMS
- General Obligation Bonds
- Cash-Funding from Current Tax Revenues

ALLOCATION OF COSTS
- Property-Value Based
- Sales Taxes

LEGAL BASIS
- Home-Rule Authority
- Art VII, Sec 9, Texas Constitution
- Title 1, Subtitle D, Sec 26, Texas Tax Code

CONTROL
- City

GENERATIONAL EQUITY
- Subsidy to Following Generations

GEOGRAPHIC EQUITY
- Some Sales Tax From Outside City

EXEMPTIONS
- Government
- Religious

RATE/TAX EFFECTS
- Payments Income-Tax Deductible

START-UP REQUIREMENTS
- None

ADMINISTRATIVE EASE
- Standard Tax Collection

REVENUE PREDICTABILITY
- Periodic Collection (Property Taxes)
- Erratic Collection (Sales Taxes)

REVENUE TIMING
- Annual (Property Taxes)
- Erratic (Sales Taxes)

SOCIAL EFFECTS
- Increase in Home Operating Costs
- Sales Tax Regressive

UNDERSTANDING/ACCEPTANCE
- Property/Sales Tax Increases

Although the imposition of additional property or sales taxes is administratively easy, requiring no new collection procedures, increases in taxes are generally unpopular, in spite of the fact that property taxes are deductible on federal income tax returns. On the positive side, property tax revenues are a highly predictable and dependable source of revenues; sales tax revenues are somewhat more erratic and vary with economic cycles.

E3.2 DRAINAGE UTILITY

In 1987, the Texas Legislature passed specific enabling legislation giving cities explicit power to organize drainage utilities (Chapter 402, Subchapter C, Texas Local Government Code). Under this law, cities can fund drainage and stormwater facilities for all development within the City with revenue bonds and cover all costs of operating the utility with cost-based monthly user rates. Although the legislation allows differential costs to different areas, based on cost of providing service, certain properties are explicitly exempted: government properties, religious properties and undeveloped areas.

There are some technical and administrative requirements for the development of the utility, including a detailed inventory of lots (used to establish differential rates), development of a capital improvements program, a public hearing on utility creation, and establishment of dedicated accounts. The City would likely want to establish an enterprise fund for this purpose.

A drainage rate can be assessed against all properties in the jurisdiction. There are a number of methodologies for setting rates. All are based in some manner on the degree of benefit received from the program. The degree of benefit is represented by some relationship to the property's contribution to the drainage system. The contribution of stormwater in excess of natural conditions occurs when natural conditions are altered and impervious areas are increased. The factors used in the methodologies include gross area, slope, and intensity of development with varying emphasis and modifications to each.

The methodologies generally result in a rate structure which has a base unit or equivalent service unit (ESU), usually an average single-family residence with a defined area. A service charge is set for the base unit, and other types of property are assessed in multiples of the base fee. The multiples are calculated differently in the various methodologies, using the area and a run-off coefficient or extent of impervious area.

DRAINAGE UTILITY

FACILITIES FUNDED
- Drainage
- Stormwater
- Growth-Related
- Existing Development

TYPES OF COSTS FUNDED
- Capital
- Renovation/Repair/Replacement
- Operations & Maintenance
- Administration
- Study Costs

CAPITAL FUNDING MECHANISMS
- Revenue Bonds
- Cash-Funding from Current Rate Revenues

ALLOCATION OF COSTS
- Cost Based

LEGAL BASIS
- Home-Rule Authority
- Chapter 402, Subchapter C, Texas Local Government Code

CONTROL
- City

GENERATIONAL EQUITY
- Subsidy to Following Generations

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area

EXEMPTIONS
- Government
- Religious
- Undeveloped Areas

RATE/TAX EFFECTS
- Payments Not Income-Tax Deductible

START-UP REQUIREMENTS
- Notice/Hearing
- Special Surveys
- Technical Studies
- Establishment of Accounts
- Establishment of Enterprise Fund

ADMINISTRATIVE EASE
- Collection with Other Utility Rates
- Separate Accounts Required

REVENUE PREDICTABILITY
- Periodic Collection

REVENUE TIMING
- Monthly Collection

SOCIAL EFFECTS
- Increase in Home Operating Costs

UNDERSTANDING/ACCEPTANCE
- Technical Difficulty
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

Revenues would be highly predictable, being fixed monthly payments for each property within the City. The City would likely collect drainage rates on the same billing system as its other monthly utility charges.

The establishment of a drainage utility would reduce the need for City property or sales taxes; however, unlike property taxes, utility rates would not be income-tax deductible, thus increasing home and business operating expenses. In regard to public acceptance, there would be considerable technical complexity in assigning relative costs to different properties. However, residential properties are typically all charged a single rate, with business properties differing by some determinant, such as acreage, impervious cover, or other cost-based characteristic. In spite of the technical complexity, the utility might be seen as more equitable than taxes, since costs are assigned on a cost causation basis, thus reducing cross-subsidies among different types of customers.

E3.3 DRAINAGE DISTRICT

The community has the opportunity to make use of several types of special districts authorized by the Texas Water Code in order to fund drainage and stormwater improvements. Two of those are addressed in this report: Drainage Districts and Stormwater Districts. The community could also organize such districts as Water Control and Improvement Districts (WCID's) or Municipal Utility Districts (MUD's); however, all such special districts are outside the administrative and policy control of the City, and since there is no obvious benefit to the City of these other types of special districts, they are not covered in this report.

Drainage districts are authorized by Chapter 56 of the Texas Water Code and governed by that Chapter and Chapter 49 (pertaining to districts generally). Drainage districts are permitted to construct and maintain canals, drains, ditches, levees and other related facilities through general obligation bonds. Districts are supported by taxes, which may be collected on a typical ad valorem basis or on a "benefit" basis (uniform rate or a rate per acre). Different costs may be calculated for different areas or for different drainages. The District may enter into interlocal agreements with other jurisdictions to provide regional facilities.

Of primary concern to the City is the fact that such districts are beyond the control of City government. They are a creation of County government, with oversight from the TNRCC. Initially, the County Commissioners Court serves as the District Board of Directors, but this may change to an elected board. The

DRAINAGE DISTRICT

FACILITIES FUNDED
- Drainage
- Growth-Related
- Existing Development

TYPES OF COSTS FUNDED
- Capital
- Renovation/Repair/Replacement
- Operations & Maintenance
- Administration
- Study Costs

CAPITAL FUNDING MECHANISMS
- General Obligation Bonds
- Cash-Funding from Current Tax Revenues

ALLOCATION OF COSTS
- Property-Value Based
- Benefit-Based

LEGAL BASIS
- Texas Constitution: Article III, Section 52; Article XVI, Section 59
- Texas Water Code: Chapters 49, 56

CONTROL
- County
- TNRCC
- District

GENERATIONAL EQUITY
- Subsidy to Following Generations

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area
- Interlocal Agreements Allowed

EXEMPTIONS
- Government
- Religious

RATE/TAX EFFECTS
- Payments Income-Tax Deductible
- Mitigates City-Wide Rates/Taxes

START-UP REQUIREMENTS
- Petition
- Notice/Hearing
- Creation/Bond Election
- Organization of Special District
- Board Appointment/Election
- Special Surveys
- Technical Studies
- Establishment of Accounts

ADMINISTRATIVE EASE
- Collection with Other Taxes
- Separate Accounts Required
- Special Reporting Required

REVENUE PREDICTABILITY
- Periodic Collection

REVENUE TIMING
- Periodic Collection

SOCIAL EFFECTS
- Increase in Home/Business Operating Costs

UNDERSTANDING/ACCEPTANCE
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

County Treasurer serves as District treasurer. Thus, decision making by the District is controlled either by the County or by the District itself, with oversight by the TNRCC.

There is an involved creation process, requiring a petition for creation, feasibility study, detailed engineering studies, public notice and hearing, and district creation. Two types of tax rates are set -- debt and O&M -- and separate accounts must be set up for each. Bond elections are held for financing improvements. The Board is required to make semiannual reports of Board actions and maintenance activities.

Creation of such a district offers the possibility of mitigating City taxes or rates; however, as stated above, the City has no control over the dispensation of funds.

E3.4 STORMWATER DISTRICT

Stormwater districts are authorized by Chapter 66 of the Texas Water Code and are similar to the organization of drainage districts, albeit with less administrative complexity. These districts are authorized to provide regional stormwater detention and retention ponds, outfall drainage districts, and parks on stormwater retention/detention sites. Taxes are based solely on assessed valuation, without the potential of "benefit"-based taxation.

The formation of stormwater districts follows a somewhat simpler mandated process than drainage districts, although the process is controlled by the County and TNRCC. Of significant difference from drainage districts, however, is the fact that stormwater districts are only permitted to fund capital improvements; once the improvements are complete, they are deeded to the County for operation and maintenance.

Because stormwater districts are regional in nature (including benefitted parts of the City and ETJ areas), they are more equitable than city-wide funding of facilities which may benefit a limited array of properties or benefit ETJ properties which make no contribution to cost recovery.

STORMWATER DISTRICT

FACILITIES FUNDED
- Stormwater
- Parks in Detention/Retention Areas
- Growth-Related
- Existing Development

TYPES OF COSTS FUNDED
- Capital

CAPITAL FUNDING MECHANISMS
- General Obligation Bonds
- Cash-Funding from Current Tax Revenues

ALLOCATION OF COSTS
- Property-Value Based

LEGAL BASIS
- Texas Constitution Article XVI, Section 59
- Texas Water Code: Chapters 49, 66

CONTROL
- County
- TNRCC
- District

GENERATIONAL EQUITY
- Subsidy to Following Generations

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area
- ETJ Areas Included

EXEMPTIONS
- Government
- Religious

RATE/TAX EFFECTS
- Payments Income-Tax Deductible
- Mitigates City-Wide Rates/Taxes

START-UP REQUIREMENTS
- Petition
- Notice/Hearing
- Creation/Bond Election
- Organization of Special District
- Board Appointment/Election
- Technical Studies

ADMINISTRATIVE EASE
- Collection with Other Taxes
- Separate Accounts Required

REVENUE PREDICTABILITY
- Periodic Collection

REVENUE TIMING
- Periodic Collection

SOCIAL EFFECTS
- Increase in Home Operating Costs

UNDERSTANDING/ACCEPTANCE
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

E3.5 PUBLIC IMPROVEMENT DISTRICTS

Public Improvement Districts are another type of special district which may or may not include the entirety of the City limits and the ETJ, but unlike other special districts, it is under the control of the City. Under this approach, the City defines an area which will receive certain benefits, which may include drainage and stormwater management, as well as other services. Improvements may be wholly or partially funded by the District (with the remainder funded by other City revenue sources), provided at least 10% of improvement costs are funded by the District. A special assessment is made against each property in the District, which contains only benefitted properties. The assessment is to be made on the basis of relative benefits provided to each property. No explicit exemptions are identified in the enabling legislation (Chapter 372 of the Texas Local Government Code); the City must pay into the fund on behalf of City departments that are affected, and the City may enter into contracts with other governmental entities which are included in the District (although in practice this may be difficult to do).

The administrative requirements of such a district are considerable, although fewer than many other types of special districts. The City may initiate the formation of the District, or it may consider a petition brought forward by property owners. A public hearing is conducted, after public notice, and a study of relative benefits is performed in order to determine assessments to District properties. Separate accounts must be established and collection procedures may either be integrated with other tax collection procedures or established independently.

E3.6 IMPACT FEES

Under Texas law (Chapter 395 of the Texas Local Government Code), impact fees include all manner of cash or in-kind contributions for water, sewer, drainage and streets, aside from on-site subdivision facilities which are required by ordinance and dedicated to the City. Thus, impact fees include the concepts of contributions in aid of construction, developer contributions, system development charges, etc.

Impact fees are "up-front" fees or contributions for major, primarily off-site facilities provided by the City as a part of the City's capital improvements program. Impact fees are used only to fund the growth-related portion of major facilities, with other funding mechanisms used for financing facilities for existing development. Impact fees can be used only for capital expenditures and to pay for the technical studies performed in development of the fees; they cannot be used for renovation or for operations.

PUBLIC IMPROVEMENT DISTRICT

FACILITIES FUNDED
- Drainage
- Stormwater
- Growth-Related
- Existing Development

TYPES OF COSTS FUNDED
- Capital
- Operations & Maintenance
- Administration
- Study Costs

CAPITAL FUNDING MECHANISMS
- General Obligation Bonds
- Revenue Bonds
- Cash-Funding from Current Tax Revenues

ALLOCATION OF COSTS
- Benefit-Based

LEGAL BASIS
- Home Rule Authority
- Chapter 372, Texas Local Govt Code

CONTROL
- City

GENERATIONAL EQUITY
- Subsidy to Following Generations

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area
- ETJ Areas Included

EXEMPTIONS
- None

RATE/TAX EFFECTS
- Payments Income-Tax Deductible
- Mitigates City-Wide Rates/Taxes

START-UP REQUIREMENTS
- Petition
- Notice/Hearing
- Organization of Special District
- Committee Appointment
- Technical Studies
- Establishment of Accounts
- New Collection Procedures

ADMINISTRATIVE EASE
- Collection with Other Taxes
- Separate Accounts Required

REVENUE PREDICTABILITY
- Periodic Collection

REVENUE TIMING
- Periodic Collection

SOCIAL EFFECTS
- Increase in Operating Costs

UNDERSTANDING/ACCEPTANCE
- Technical Difficulty
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

Because impact fees are used to fund growth-related facilities, these fees differ from many other funding mechanisms because they shift the cost responsibility to new development, rather than spreading growth costs over the entire tax base of the community. Thus their attractive quality for many communities is that they provide a form of generational equity not possible with traditional tax-based funding mechanisms. Unlike taxes, impact fees increase up-front property costs, rather than monthly operational costs. Generally, however, this is manifested in higher monthly mortgage payments, the interest portion of which is income-tax deductible.

The enactment of an impact fee program requires a detailed technical study and public process, including two public hearings. The process is under the control of the City, and requires semi-annual reports to the City by an Advisory Committee, and an update of technical aspects of the fee at least once every three years.

Impact fees are strictly based on relative cost imposed by different properties, and these costs are defined by watershed (including both in-City areas and the ETJ), thus providing geographic equity. There are no exemptions provided in Chapter 395; thus other governmental jurisdictions and other typically tax-exempted properties are subject to assessment of this fee (although many such properties vigorously protest these). As noted above, existing development is not subject to these fees, and undeveloped property does not have to pay fees until the property is either platted or developed (at the City's option).

Separate dedicated accounts are required and fees are typically collected at the same time as other development-related fees. Because impact fees are related to development, they are a somewhat uncertain source of revenue on an annual basis. Moreover, for the most part, impact fees are used to recoup costs the City has already incurred; initial funding of facilities must be provided through bonding or other traditional means.

E3.7 ENGINEERING REVIEW AND INSPECTION FEES

Plan review and inspection fees are a common secondary source of revenue. The fees are designed to recover at least a portion of the cost of regulation and administration of private development projects. The review of plans, construction inspection, and periodic checks of maintenance of private projects are required to ensure compliance with standards and regulations and they ensure that regulatory costs of development are borne by the new generation of growth, rather than by the community at large.

IMPACT FEES

FACILITIES FUNDED
- Drainage
- Stormwater
- Growth-Related

TYPES OF COSTS FUNDED
- Capital
- Study Costs

CAPITAL FUNDING MECHANISMS
- Fees and In-Kind Contributions

ALLOCATION OF COSTS
- Cost-Based

LEGAL BASIS
- Home Rule Authority
- Chapter 395, Texas Local Govt Code

CONTROL
- City

GENERATIONAL EQUITY
- Reduces Generational Cross-Subsidies

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area
- ETJ Areas Included

EXEMPTIONS
- None

RATE/TAX EFFECTS
- Mortgage Interest Income-Tax Deductible
- Mitigates City-Wide Rates/Taxes

START-UP REQUIREMENTS
- Notice/Hearing
- Committee Appointment
- Technical Studies
- Establishment of Accounts
- May Require New Collection Procedures

ADMINISTRATIVE EASE
- Possible Collection with Other Fees
- Separate Accounts Required
- Semi-Annual Reports
- Special Record-Keeping
- Update Every Three Years

REVENUE PREDICTABILITY
- Dependent on Development Activity

REVENUE TIMING
- After City Funding Through Other Means

SOCIAL EFFECTS
- Increase in Home/Business Purchase Cost

UNDERSTANDING/ACCEPTANCE
- Technical Difficulty
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

These fees are set by ordinance and usually are related to the category and size of the project. They are typically assessed at the time of development approvals, and are ideally based upon relative cost. Unlike all the other funding mechanisms discussed in this report, these fees are intended only to recover the administrative cost of reviewing projects, rather than capital funding. They should be included as a part of the overall funding regime, although they are a relatively minor source of revenue.

E3.8 STAND-BY FEES

Stand-by fees are generally used in conjunction with the establishment of a utility. They are monthly or periodic fees which are assessed to undeveloped properties which will benefit in the future from the facilities funded by a utility, but which are not current customers. As noted above, a municipal drainage utility would exempt all undeveloped property, by State law. It is uncertain whether the City would be able to then charge a stand-by fee to those exempted properties.

Assuming that such a mechanism were possible, stand-by fees would be assessed only to undeveloped properties within each drainage, and would be used to pay for the prorata share of capital facilities which were constructed for the ultimate benefit of that property. Maintenance costs and administrative costs could also be included. Stand-by fees for water and sewer utilities, as a matter of practice, typically set stand-by fees at the same amount as the minimum monthly charge for an active utility customer. Like other rate charges, stand-by fees are not income-tax deductible.

Stand-by fees may provide greater equity in sharing costs among all benefitted properties. However, their collection might present administrative difficulties. There would have to be a special billing system established for these customers, since they would not be typical utility customers.

ENGINEERING REVIEW AND INSPECTION FEES

FACILITIES FUNDED
- None

TYPES OF COSTS FUNDED
- Administration

CAPITAL FUNDING MECHANISMS
- None

ALLOCATION OF COSTS
- Cost-Based

LEGAL BASIS
- Home Rule Authority

CONTROL
- City

GENERATIONAL EQUITY
- Reduces Generational Cross-Subsidies

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area
- ETJ Areas Included

EXEMPTIONS
- None

RATE/TAX EFFECTS
- Mortgage Interest Income-Tax Deductible
- Mitigates City-Wide Rates/Taxes

START-UP REQUIREMENTS
- Technical Studies

ADMINISTRATIVE EASE
- Collection with Other Fees

REVENUE PREDICTABILITY
- Dependent on Development Activity

REVENUE TIMING
- At Time Service is Provided

SOCIAL EFFECTS
- Increase in Home/Business Purchase Cost

UNDERSTANDING/ACCEPTANCE
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

E3.9 GRANTS

Federal funding assistance is not considered a likely or feasible source of funds for a comprehensive stormwater management program. State funding assistance may be possible for certain projects.

Federal funds have been available through the United States Corps of Engineers for flood control projects. Funds are limited and projects must undergo a lengthy feasibility analysis.

State funding has been available to some extent through the Texas Water Development Board. The Research and Planning Fund provides matching grant funds for flood protection planning. The amount of funds available is dependent on the annual appropriation for that purpose by the state.

The Water Development Fund has been eligible since November 1985 to make loans for flood control projects. The loans are made pursuant to an application process. The loans are available for structural and nonstructural purposes. Priority is given for projects which will alleviate existing flooding problems in developed areas rather than projects for allowing development of areas with flooding problems.

The State Water Pollution Control Revolving Fund has also recently been made eligible for providing loan assistance for nonpoint source pollution control projects.

STAND-BY FEES

FACILITIES FUNDED
- Drainage
- Growth-Related

TYPES OF COSTS FUNDED
- Capital
- Maintenance
- Administration
- Study Costs

CAPITAL FUNDING MECHANISMS
- Monthly Fees

ALLOCATION OF COSTS
- Cost-Based

LEGAL BASIS
- Home Rule Authority
- Legal Basis Uncertain

CONTROL
- City

GENERATIONAL EQUITY
- Reduces Generational Cross-Subsidies

GEOGRAPHIC EQUITY
- Allows Differential Costs by Area

EXEMPTIONS
- None

RATE/TAX EFFECTS
- Mitigates City-Wide Rates/Taxes

START-UP REQUIREMENTS
- Technical Studies
- May Require New Collection Procedures

ADMINISTRATIVE EASE
- May Be Difficult to Collect

REVENUE PREDICTABILITY
- Monthly

REVENUE TIMING
- Monthly

SOCIAL EFFECTS
- Increase in Property Operational Cost

UNDERSTANDING/ACCEPTANCE
- Legal Basis Uncertain
- Segregation of Benefitted Properties
- Reduction of Cross-Subsidies

APPENDIX 3

DRAINAGE COMPLAINT QUESTIONNAIRE FORM

Special Drainage Problem Survey
City of Victoria – Public Works Department

The City of Victoria, in conjunction with the Quarter Cent Sales Tax Board, has authorized a city-wide Storm Drainage Master Plan Study. The Public Works Department keeps a current list of all reported drainage problems within the City. Your participation in the drainage survey will help us gather the necessary information regarding unreported drainage problems in your area. Your input is critical to the success of developing the overall master plan.

The majority of the projects identified in the master plan are awaiting future funding, however, there may be some of the Special Problems that would be funded and completed in the near future. Please answer the following questions as they pertain to the property referenced in the utility bill. You may return the survey to the city in one of three ways: simply fold the form and return it in the enclosed envelope with your payment; bring the form in when you pay at the counter; or bring the form with you to one of the soon-to-be scheduled neighborhood meetings in your area.

Addressor Subdivision Name: ____

How long have you lived at your current address? ________ years

Does your street have ponded water during a severe rainstorm? yes _____ no _____

Has your street been impassable during a severe rainstorm? yes _____ no _____

If so, how many times a year does this happen? ________ times

Does your garage or parking are flood? yes _____ no _____

Does your storage area flood? yes _____ no _____

Does your home experience flooding? yes _____ no _____

If so, how many times? not sure ______ ________ times

Do you line in a floodplain area? yes _____ no _____

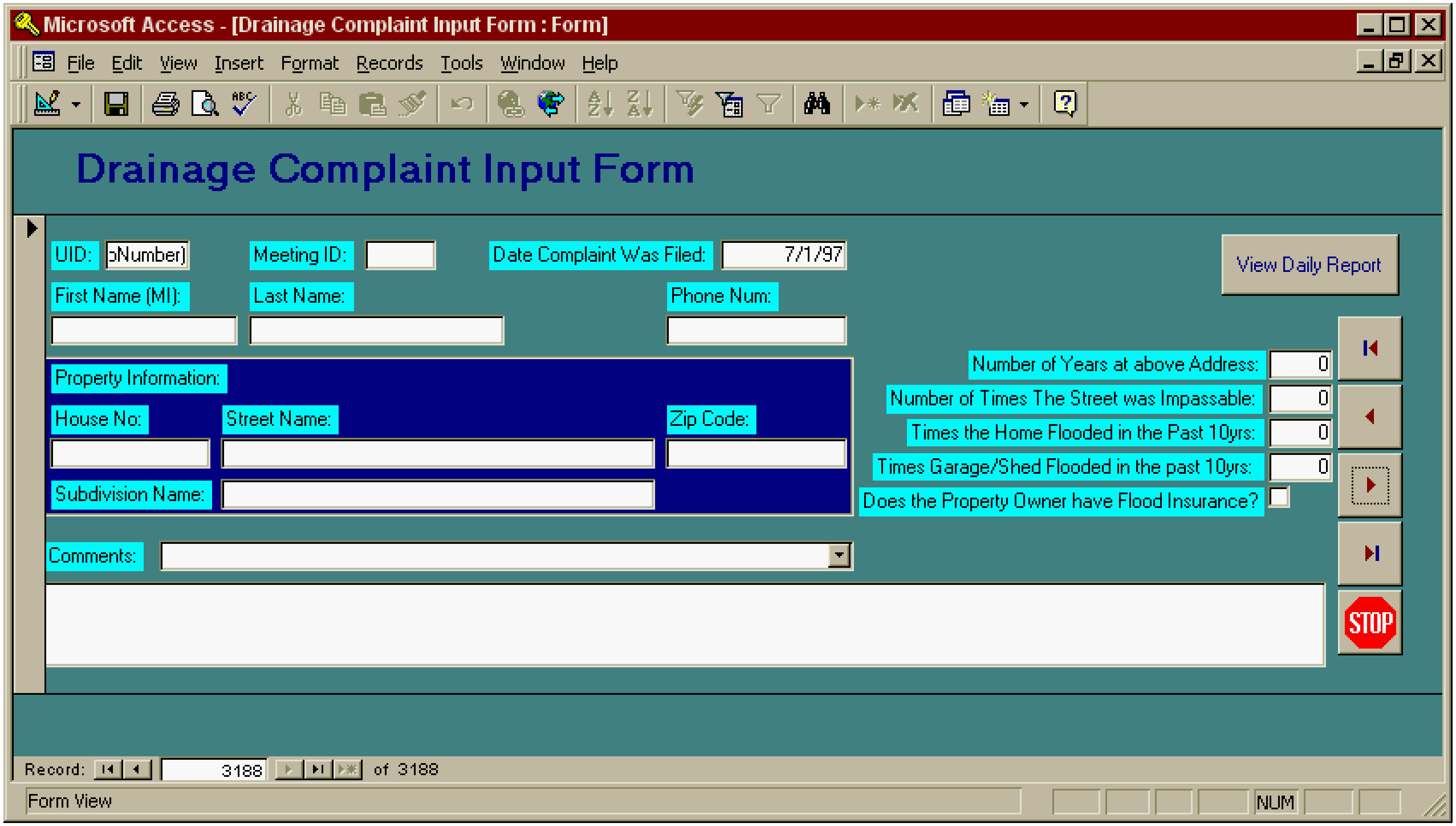
Do you have flood insurance? yes _____ no _____

Additional Comments: ____

Thank you very much for your feedback and involvement in this citywide effort.

APPENDIX 4

DRAINAGE COMPLAINT DATABASE INPUT FORM


Microsoft Access - [Drainage Complaint Input Form : Form]
File Edit View Insert Format Records Tools Window Help
Drainage Complaint Input Form
UID:
pNumber)
Meeting ID:
Date Complaint Was Filed:
7/1/97
View Daily Report
First Name (MI):
Last Name:
Phone Num:
Property Information:
House No:
Street Name:
Zip Code:
Subdivision Name:
Number of Years at above Address:
0
Number of Times The Street was Impassable:
0
Times the Home Flooded in the Past 10yrs:
0
Times Garage/Shed Flooded in the past 10yrs:
0
Does the Property Owner have Flood Insurance?
Comments:
STOP
Record:
3188
of 3188
Form View
NUM

APPENDIX 5

DISCHARGE VALUES FOR ALL
"COMBINATION POINTS" IN HYDROLOGIC MODELS

Appendix 5
HEC-1 Discharge Values

Jim Branch and Ben Jordan HEC-1 Peak Flow for 5 to 500 Year Storm Events															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
Jim Branch	C0	4.64	700	1752	2235	2039	2590	2363	3008	2659	3523	2977	4197	3676	4864
	C38	4.14	3331	1767	2265	2077	2645	2404	3085	2796	3576	3228	4160	3671	4956
	C66	3.84	6496	2151	2337	2572	2763	3000	3246	3348	3682	3842	4283	4593	5291
	C102	3.33	10127	1943	2041	2290	2462	2670	2898	2980	3212	3350	3693	3973	4607
	C122	3.03	12090	1765	1852	2077	2287	2420	2685	2714	2963	3067	3335	3710	4172
	C148	2.43	14774	1441	1459	1798	1803	2103	2189	2360	2518	2668	2908	3309	3654
	C148A	0.49	16100	372	473	471	587	581	714	675	823	785	949	1023	1223
Ben Jordan	C148B	1.78	0	1066	1017	1288	1252	1476	1515	1640	1719	1856	1943	2357	2343
	C163	1.43	1254	884	843	1031	1039	1162	1251	1332	1374	1543	1505	1993	1839
	C189	1.18	NA	760	787	938	965	1138	1163	1307	1331	1505	1528	1933	1953
	C212A	0.9	NA	628	650	775	796	939	960	1080	1099	1243	1262	1597	1613
	C245	0.61	NA	473	490	585	601	709	724	815	829	938	952	1205	1217

Jim Branch and Ben Jordan HEC-1 Peak Flow Per Acre for 5 to 500 Year Storm Events															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
Jim Branch	C0	4.64	700	0.59	0.75	0.69	0.87	0.80	1.01	0.90	1.19	1.00	1.41	1.24	1.64
	C38	4.14	3331	0.67	0.85	0.78	1.00	0.91	1.16	1.06	1.35	1.22	1.57	1.39	1.87
	C66	3.84	6496	0.88	0.95	1.05	1.12	1.22	1.32	1.36	1.50	1.56	1.74	1.87	2.15
	C102	3.33	10127	0.91	0.96	1.07	1.16	1.25	1.36	1.40	1.51	1.57	1.73	1.86	2.16
	C122	3.03	12090	0.91	0.96	1.07	1.18	1.25	1.38	1.40	1.53	1.58	1.72	1.91	2.15
	C148	2.43	14774	0.93	0.94	1.16	1.16	1.35	1.41	1.52	1.62	1.72	1.87	2.13	2.35
	C148A	0.49	16100	1.19	1.51	1.50	1.87	1.85	2.28	2.15	2.62	2.50	3.03	3.26	3.90
Ben Jordan	C148B	1.78	0	0.94	0.89	1.13	1.10	1.30	1.33	1.44	1.51	1.63	1.71	2.07	2.06
	C163	1.43	1254	0.97	0.92	1.13	1.14	1.27	1.37	1.46	1.50	1.69	1.64	2.18	2.01
	C189	1.18	NA	1.01	1.04	1.24	1.28	1.51	1.54	1.73	1.76	1.99	2.02	2.56	2.59
	C212A	0.9	NA	1.09	1.13	1.35	1.38	1.63	1.67	1.88	1.91	2.16	2.19	2.77	2.80
	C245	0.61	NA	1.21	1.26	1.50	1.54	1.82	1.85	2.09	2.12	2.40	2.44	3.09	3.12

Appendix 5
HEC-1 Discharge Values

South Outfall HEC-1 Peak Flow for 5 to 500 Year Storm Events															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
South Outfall	C0	1.59	489	621	752	760	910	896	1066	977	1197	1077	1303	1347	1534
	C40	1.34	3831	612	767	833	995	1019	1235	1174	1706	1358	1917	1706	2321
	C70	0.71	7094	527	551	650	674	789	811	907	929	1045	1065	1343	1361
	C106	0.36	NA	321	337	397	412	481	495	553	566	636	649	817	828

South Outfall HEC-1 Peak Flow Per Acre for 5 to 500 Year Storm Events															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
South Outfall	C0	1.59	489	0.61	0.74	0.75	0.89	0.88	1.05	0.96	1.18	1.06	1.28	1.32	1.51
	C40	1.34	3831	0.71	0.89	0.97	1.16	1.19	1.44	1.37	1.99	1.58	2.24	1.99	2.71
	C70	0.71	7094	1.16	1.21	1.43	1.48	1.74	1.78	2.00	2.04	2.30	2.34	2.96	3.00
	C106	0.36	NA	1.39	1.46	1.72	1.79	2.09	2.15	2.40	2.46	2.76	2.82	3.55	3.59

Appendix 5
HEC-1 Discharge Values

West Outfall HEC-1 Peak Flow for 5 to 500 Year Storm Events															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
West Outfall	C0	3.6	91	1938	1018	2578	1240	2802	1558	2802	1830	3209	2119	3988	2544
	C6	3.47	532	1883	992	2613	1184	2774	1464	2722	1701	3115	1944	3869	2360
	C6A	0.19	NA	183	186	225	229	273	276	314	316	361	364	463	466
	C20	3.17	2401	1746	950	1978	1123	2247	1316	2553	1481	2915	1689	3631	2146
	C20A	0.4	NA	168	168	228	228	297	297	358	358	430	430	590	590
	C32	2.77	3077	1609	890	1808	1053	2049	1231	2323	1381	2640	1555	3281	1958
	C48	2.45	4736	1516	902	1770	1076	2017	1260	2300	1413	2605	1600	3179	2015
	C67	2.35	6700	1491	902	1731	1077	1977	1261	2254	1414	2548	1591	3139	1996
	C85	2.13	8453	1519	948	1788	1158	2075	1372	2428	1546	2742	1747	3316	2236
	C85A	0.22	NA	167	172	207	211	251	255	289	292	333	336	429	431
	C100	1.8	9915	1261	871	1534	1076	1827	1300	2155	1466	2368	1641	2810	2024
	C100A	0.42	NA	388	394	481	486	584	589	671	676	773	778	994	999
	C100B	0.27	NA	266	270	329	333	399	403	459	462	529	532	679	682
	C100C	0.19	NA	204	208	252	256	305	308	351	354	403	406	517	520
	C101	1.33	10863	960	742	1151	908	1382	1094	1725	1233	1972	1385	2409	1715
	C101A	0.21	NA	198	210	247	258	302	313	348	359	403	413	520	529
	C101C	0.15	NA	149	158	186	194	226	235	261	269	302	310	390	397
	C113	0.98	11296	720	600	887	732	1076	874	1238	966	1425	1078	1769	1330
	C128	0.84	12750	678	696	839	856	1018	1035	1171	1187	1349	1364	1735	1748
	C147	0.57	NA	491	507	608	623	737	752	848	862	977	990	1256	1268
	C174	0.24	NA	235	247	292	303	355	365	408	418	471	480	606	614

Appendix 5
HEC-1 Discharge Values

West Outfall HEC-1 Peak Flow Per Acre for 5 to 500 Year Storm Events																
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
West Outfall	C0	3.6	91	0.84	0.44	1.12	0.54	1.22	0.68	1.22	0.79	1.39	0.92	1.73	1.10
	C6	3.47	532	0.85	0.45	1.18	0.53	1.25	0.66	1.23	0.77	1.40	0.88	1.74	1.06
	C6A	0.19	NA	1.50	1.53	1.85	1.88	2.25	2.27	2.58	2.60	2.97	2.99	3.81	3.83
	C20	3.17	2401	0.86	0.47	0.97	0.55	1.11	0.65	1.26	0.73	1.44	0.83	1.79	1.06
	C20A	0.4	NA	0.66	0.66	0.89	0.89	1.16	1.16	1.40	1.40	1.68	1.68	2.30	2.30
	C32	2.77	3077	0.91	0.50	1.02	0.59	1.16	0.69	1.31	0.78	1.49	0.88	1.85	1.10
	C48	2.45	4736	0.97	0.58	1.13	0.69	1.29	0.80	1.47	0.90	1.66	1.02	2.03	1.29
	C67	2.35	6700	0.99	0.60	1.15	0.72	1.31	0.84	1.50	0.94	1.69	1.06	2.09	1.33
	C85	2.13	8453	1.11	0.70	1.31	0.85	1.52	1.01	1.78	1.13	2.01	1.28	2.43	1.64
	C85A	0.22	NA	1.19	1.22	1.47	1.50	1.78	1.81	2.05	2.07	2.37	2.39	3.05	3.06
	C100	1.8	9915	1.09	0.76	1.33	0.93	1.59	1.13	1.87	1.27	2.06	1.42	2.44	1.76
	C100A	0.42	NA	1.44	1.47	1.79	1.81	2.17	2.19	2.50	2.51	2.88	2.89	3.70	3.72
	C100B	0.27	NA	1.54	1.56	1.90	1.93	2.31	2.33	2.66	2.67	3.06	3.08	3.93	3.95
	C100C	0.19	NA	1.68	1.71	2.07	2.11	2.51	2.53	2.89	2.91	3.31	3.34	4.25	4.28
	C101	1.33	10863	1.13	0.87	1.35	1.07	1.62	1.29	2.03	1.45	2.32	1.63	2.83	2.01
	C101A	0.21	NA	1.47	1.56	1.84	1.92	2.25	2.33	2.59	2.67	3.00	3.07	3.87	3.94
	C101C	0.15	NA	1.55	1.65	1.94	2.02	2.35	2.45	2.72	2.80	3.15	3.23	4.06	4.14
	C113	0.98	11296	1.15	0.96	1.41	1.17	1.72	1.39	1.97	1.54	2.27	1.72	2.82	2.12
	C128	0.84	12750	1.26	1.29	1.56	1.59	1.89	1.93	2.18	2.21	2.51	2.54	3.23	3.25
	C147	0.57	NA	1.35	1.39	1.67	1.71	2.02	2.06	2.32	2.36	2.68	2.71	3.44	3.48
	C174	0.24	NA	1.53	1.61	1.90	1.97	2.31	2.38	2.66	2.72	3.07	3.13	3.95	4.00

Appendix 5
HEC-1 Discharge Values

Spring Creek HEC-1 Peak Flow for 2 to 500 Year Storm Events																	
	Hec-1	Area	Hec-2	2-Year (cfs)		5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
Spring Ck.	C0A	46.93	NA	3395	3890	5526	6316	7097	8266	9448	10431	11546	12246	13656	14289	18167	18625
	C18	46.79	NA	3395	3960	5523	6463	7095	8498	9470	10719	11574	12562	13723	14621	18322	18979
	C18A	2.23	NA	337	621	574	987	752	1255	957	1556	1135	1814	1346	2115	1807	2768
	C18B	0.79	NA	129	301	222	471	292	595	372	733	441	851	524	989	704	1287
	C53	44.28	NA	3267	3871	5316	6311	6840	8315	9089	10408	11023	12114	12922	13983	17202	17967
	C76	43.88	7459	3256	3896	5301	6420	6822	8487	10253	10545	12030	12214	13197	14040	17213	17964
	C87	43.64	8328	3247	3872	5288	6363	6806	8407	11379	10437	11969	12081	13095	13891	17037	17770
	C15A2	0.58	NA	294	311	446	463	554	571	675	692	779	794	899	914	1159	1172
	C111	42.29	10892	3129	3426	5123	5524	6612	7202	10798	8862	11797	10231	12301	11764	15340	15099
	C124	42.08	12339	3126	3450	5118	5500	6606	7152	8642	8789	10239	10138	12021	11653	15308	14957
	C150	37.87	14863	2935	2905	4830	4480	6278	5615	7967	6821	9481	7835	11246	8994	13200	13341
	C183	37.49	18246	2935	3106	4826	4598	6277	5647	7945	6817	9417	7812	11177	8956	15177	13371
	C183C	1.92	NA	724	782	1129	1191	1421	1484	1748	1811	2028	2090	2354	2415	3062	3119
	C183D	1.17	NA	452	501	713	766	902	956	1114	1169	1297	1350	1509	1561	1969	2019
	C203	35.32	20238	2874	2567	4736	4261	6164	5212	7801	5828	9228	6202	10896	6887	14565	13247
	C203C	1.14	NA	430	532	671	814	846	1015	1042	1240	1210	1432	1405	1655	1828	2139
	C226	33.86	22458	2835	2557	4682	4245	6096	5162	7714	5820	9125	6168	10774	6885	14402	13194
	C257	33.26	25549	2825	2559	4667	4245	6075	5160	7683	5820	9089	6168	10731	6888	14343	13206
	C335	32.32	33469	2796	2560	4627	4248	6022	5153	7604	5820	8994	6167	10612	6902	14178	13278
	C360	30.97	35874	2751	2759	4556	4506	5930	5809	7488	7322	8856	8618	10450	10141	13961	13498
	C360C	3.82	NA	751	1225	1259	1869	1638	2332	2069	2851	2444	3296	2884	3815	3846	4942
	C360N	0.63	NA	142	333	238	505	310	627	391	764	461	882	544	1018	724	1312
	C360D	2.75	NA	563	915	951	1407	1242	1762	1574	2161	1862	2504	2201	2902	2942	3770
	C360E	1.3	NA	295	379	501	599	655	760	832	942	985	1099	1164	1283	1557	1684
	C360F	0.93	NA	210	253	366	417	483	538	618	676	735	795	873	935	1175	1239
	C360G	0.83	NA	192	222	333	370	440	480	563	606	670	714	796	841	1071	1120
	C421	26.07	41866	2526	2588	4202	4257	5469	5503	6911	6942	8167	8179	9642	9634	12882	12827
	C463	25.34	46046	2499	2573	4167	4243	5417	5486	6847	6908	8091	8141	9554	9590	12769	12769
	C489	24.25	NA	2464	2546	4114	4204	5349	5440	6764	6853	7995	8078	9442	9519	12622	12679
	C489C	5.17	NA	701	731	1200	1232	1575	1608	2008	2038	2384	2411	2827	2850	3802	3813
	C489D	4.5	NA	627	664	1078	1125	1419	1471	1812	1867	2154	2210	2556	2615	3442	3502
	C489E	3.97	NA	576	610	991	1033	1305	1350	1665	1713	1979	2029	2348	2400	3161	3215

Appendix 5
HEC-1 Discharge Values

Spring Creek HEC-1 Peak Flow for 2 to 500 Year Storm Events - Continued																		
	Hec-1	Area	Hec-2	2-Year (cfs)		5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
	C489F	3.01	NA	470	483	804	820	1056	1073	1345	1363	1597	1615	1893	1912	2543	2563
	C489FA	1.9	NA	337	344	567	574	738	746	933	942	1103	1111	1302	1310	1738	1747
	C489G	1.52	NA	256	256	431	431	563	563	713	713	844	844	997	997	1332	1332
	C543	17.97	NA	2051	2137	3435	3537	4472	4583	5661	5778	6694	6814	7910	8033	10581	10706
	C543C	2.98	NA	365	380	635	653	840	861	1078	1100	1285	1308	1530	1553	2069	2094
	C543D	2.42	NA	302	312	534	546	712	725	917	931	1096	1112	1309	1325	1778	1795
	C543E	1.76	NA	217	225	390	402	523	536	679	693	815	830	977	993	1334	1351
	C630	12.72	NA	1672	1739	2812	2893	3668	3756	4650	4744	5505	5601	6510	6610	8720	8821
	C656	11.69	NA	1596	1650	2679	2746	3494	3566	4428	4505	5241	5320	6197	6279	8299	8382
	C656C	2.28	NA	441	462	749	774	981	1007	1246	1272	1476	1503	1746	1773	2337	2364
	C717	7.91	NA	1151	1186	1923	1966	2502	2548	3164	3213	3740	3790	4417	4469	5904	5956
	C761	6.97	NA	1046	1080	1757	1798	2290	2335	2901	2948	3432	3479	4056	4105	5427	5476
	C761C	1.49	NA	275	302	463	496	604	639	764	802	904	942	1068	1107	1427	1466
	C842	3.46	NA	577	577	971	971	1267	1267	1605	1605	1900	1900	2247	2247	3007	3007
	C917	1.33	NA	315	315	509	509	652	652	814	814	954	954	1117	1117	1475	1475

Spring Creek HEC-1 Peak Flow Per Acre for 2 to 500 Year Storm Events																		
	Hec-1	Area	Hec-2	2-Year (cfs)		5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
Spring Ck.	C0A	46.93	NA	0.11	0.13	0.18	0.21	0.24	0.28	0.31	0.35	0.38	0.41	0.45	0.48	0.60	0.62
	C18	46.79	NA	0.11	0.13	0.18	0.22	0.24	0.28	0.32	0.36	0.39	0.42	0.46	0.49	0.61	0.63
	C18A	2.23	NA	0.24	0.44	0.40	0.69	0.53	0.88	0.67	1.09	0.80	1.27	0.94	1.48	1.27	1.94
	C18B	0.79	NA	0.26	0.60	0.44	0.93	0.58	1.18	0.74	1.45	0.87	1.68	1.04	1.96	1.39	2.55
	C53	44.28	NA	0.12	0.14	0.19	0.22	0.24	0.29	0.32	0.37	0.39	0.43	0.46	0.49	0.61	0.63
	C76	43.88	7459	0.12	0.14	0.19	0.23	0.24	0.30	0.37	0.38	0.43	0.43	0.47	0.50	0.61	0.64
	C87	43.64	8328	0.12	0.14	0.19	0.23	0.24	0.30	0.41	0.37	0.43	0.43	0.47	0.50	0.61	0.64
	C15A2	0.58	NA	0.79	0.84	1.20	1.25	1.49	1.54	1.82	1.86	2.10	2.14	2.42	2.46	3.12	3.16
	C111	42.29	10892	0.01	0.02	0.02	0.04	0.03	0.05	0.04	0.06	0.04	0.07	0.05	0.08	0.07	0.10
	C124	42.08	12339	0.00	0.01	0.01	0.02	0.01	0.02	0.01	0.03	0.02	0.03	0.02	0.04	0.03	0.05
	C150	37.87	14863	0.13	0.16	0.22	0.26	0.28	0.34	0.38	0.43	0.45	0.50	0.53	0.58	0.71	0.74

Appendix 5
HEC-1 Discharge Values

Spring Creek HEC-1 Peak Flow Per Acre for 2 to 500 Year Storm Events - Continued																		
	Hec-1	Area	Hec-2	2-Year (cfs)		5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
	C183	37.49	18246	0.12	0.13	0.20	0.19	0.26	0.24	0.33	0.28	0.39	0.33	0.47	0.37	0.63	0.56
	C183C	1.92	NA	0.59	0.64	0.92	0.97	1.16	1.21	1.42	1.47	1.65	1.70	1.92	1.97	2.49	2.54
	C183D	1.17	NA	0.60	0.67	0.95	1.02	1.20	1.28	1.49	1.56	1.73	1.80	2.02	2.08	2.63	2.70
	C203	35.32	20238	0.13	0.11	0.21	0.19	0.27	0.23	0.35	0.26	0.41	0.27	0.48	0.30	0.64	0.59
	C203C	1.14	NA	0.59	0.73	0.92	1.12	1.16	1.39	1.43	1.70	1.66	1.96	1.93	2.27	2.51	2.93
	C226	33.86	22458	0.13	0.12	0.22	0.20	0.28	0.24	0.36	0.27	0.42	0.28	0.50	0.32	0.66	0.61
	C257	33.26	25549	0.13	0.12	0.22	0.20	0.29	0.24	0.36	0.27	0.43	0.29	0.50	0.32	0.67	0.62
	C335	32.32	33469	0.14	0.12	0.22	0.21	0.29	0.25	0.37	0.28	0.43	0.30	0.51	0.33	0.69	0.64
	C360	30.97	35874	0.14	0.14	0.23	0.23	0.30	0.29	0.38	0.37	0.45	0.43	0.53	0.51	0.70	0.68
	C360C	3.82	NA	0.31	0.50	0.51	0.76	0.67	0.95	0.85	1.17	1.00	1.35	1.18	1.56	1.57	2.02
	C360N	0.63	NA	0.35	0.83	0.59	1.25	0.77	1.56	0.97	1.89	1.14	2.19	1.35	2.52	1.80	3.25
	C360D	2.75	NA	0.32	0.52	0.54	0.80	0.71	1.00	0.89	1.23	1.06	1.42	1.25	1.65	1.67	2.14
	C360E	1.3	NA	0.35	0.46	0.60	0.72	0.79	0.91	1.00	1.13	1.18	1.32	1.40	1.54	1.87	2.02
	C360F	0.93	NA	0.35	0.43	0.61	0.70	0.81	0.90	1.04	1.14	1.23	1.34	1.47	1.57	1.97	2.08
	C360G	0.83	NA	0.36	0.42	0.63	0.70	0.83	0.90	1.06	1.14	1.26	1.34	1.50	1.58	2.02	2.11
	C421	26.07	41866	0.15	0.16	0.25	0.26	0.33	0.33	0.41	0.42	0.49	0.49	0.58	0.58	0.77	0.77
	C463	25.34	46046	0.15	0.16	0.26	0.26	0.33	0.34	0.42	0.43	0.50	0.50	0.59	0.59	0.79	0.79
	C489	24.25	NA	0.16	0.16	0.27	0.27	0.34	0.35	0.44	0.44	0.52	0.52	0.61	0.61	0.81	0.82
	C489C	5.17	NA	0.21	0.22	0.36	0.37	0.48	0.49	0.61	0.62	0.72	0.73	0.85	0.86	1.15	1.15
	C489D	4.5	NA	0.22	0.23	0.37	0.39	0.49	0.51	0.63	0.65	0.75	0.77	0.89	0.91	1.20	1.22
	C489E	3.97	NA	0.23	0.24	0.39	0.41	0.51	0.53	0.66	0.67	0.78	0.80	0.92	0.94	1.24	1.27
	C489F	3.01	NA	0.24	0.25	0.42	0.43	0.55	0.56	0.70	0.71	0.83	0.84	0.98	0.99	1.32	1.33
	C489FA	1.9	NA	0.28	0.28	0.47	0.47	0.61	0.61	0.77	0.77	0.91	0.91	1.07	1.08	1.43	1.44
	C489G	1.52	NA	0.26	0.26	0.44	0.44	0.58	0.58	0.73	0.73	0.87	0.87	1.02	1.02	1.37	1.37
	C543	17.97	NA	0.18	0.19	0.30	0.31	0.39	0.40	0.49	0.50	0.58	0.59	0.69	0.70	0.92	0.93
	C543C	2.98	NA	0.19	0.20	0.33	0.34	0.44	0.45	0.57	0.58	0.67	0.69	0.80	0.81	1.08	1.10
	C543D	2.42	NA	0.19	0.20	0.34	0.35	0.46	0.47	0.59	0.60	0.71	0.72	0.85	0.86	1.15	1.16
	C543E	1.76	NA	0.19	0.20	0.35	0.36	0.46	0.48	0.60	0.62	0.72	0.74	0.87	0.88	1.18	1.20
	C630	12.72	NA	0.21	0.21	0.35	0.36	0.45	0.46	0.57	0.58	0.68	0.69	0.80	0.81	1.07	1.08
	C656	11.69	NA	0.21	0.22	0.36	0.37	0.47	0.48	0.59	0.60	0.70	0.71	0.83	0.84	1.11	1.12
	C656C	2.28	NA	0.30	0.32	0.51	0.53	0.67	0.69	0.85	0.87	1.01	1.03	1.20	1.22	1.60	1.62
	C717	7.91	NA	0.23	0.23	0.38	0.39	0.49	0.50	0.63	0.63	0.74	0.75	0.87	0.88	1.17	1.18

Appendix 5
HEC-1 Discharge Values

Spring Creek HEC-1 Peak Flow Per Acre for 2 to 500 Year Storm Events - Continued																		
	Hec-1	Area	Hec-2	2-Year (cfs)		5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
	C761	6.97	NA	0.23	0.24	0.39	0.40	0.51	0.52	0.65	0.66	0.77	0.78	0.91	0.92	1.22	1.23
	C761C	1.49	NA	0.29	0.32	0.49	0.52	0.63	0.67	0.80	0.84	0.95	0.99	1.12	1.16	1.50	1.54
	C842	3.46	NA	0.26	0.26	0.44	0.44	0.57	0.57	0.72	0.72	0.86	0.86	1.01	1.01	1.36	1.36
	C917	1.33	NA	0.37	0.37	0.60	0.60	0.77	0.77	0.96	0.96	1.12	1.12	1.31	1.31	1.73	1.73

Appendix 5
HEC-1 Discharge Values

Whispering Creek HEC-1 Peak Flow for 5 to 500 Year Storm Events																	
	Hec-1	Area	Hec-2	2-Year (cfs)		5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
Whispering	WC0A	2.79	0	1008	1055	1527	1579	1876	1926	2252	2305	2562	2622	2927	3017	3740	3953
Creek	WC15A	2.62	1523	943	990	1412	1467	1733	1787	2077	2134	2360	2425	2696	2789	3463	3650
	WC33	2.03	3224	592	629	879	917	1070	1107	1268	1312	1428	1481	1626	1704	2091	2255
	WC57A	1.45	5750	533	585	775	833	942	1001	1118	1182	1253	1330	1431	1533	1918	2204
	WC15B	0.49	NA	248	263	374	390	465	480	566	580	652	665	752	765	969	980
	WC15C	0.31	NA	166	176	250	260	311	320	378	387	436	444	503	511	647	655
	WC77	1.3	7595	548	659	865	973	1089	1200	1323	1456	1533	1696	1756	1946	2245	2445
	WC86A	1.2	8890	500	586	784	885	987	1098	1207	1337	1401	1540	1609	1763	2055	2231
	WC95	1.12	9386	457	538	714	812	898	1007	1101	1225	1277	1411	1466	1610	1872	2035
	WC108	0.99	10671	404	461	624	696	779	864	956	1051	1102	1210	1271	1374	1622	1734
	WC132	0.67	13015	295	305	452	462	564	574	690	699	797	806	921	930	1191	1199

Whispering Creek HEC-1 Peak Flow Per Acre for 5 to 500 Year Storm Events																	
	Hec-1	Area	Hec-2	2-Year (cfs)		5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
Whispering	WC0A	2.79	0	0.56	0.59	0.86	0.88	1.05	1.08	1.26	1.29	1.43	1.47	1.64	1.69	2.09	2.21
Creek	WC15A	2.62	1523	0.56	0.59	0.84	0.87	1.03	1.07	1.24	1.27	1.41	1.45	1.61	1.66	2.07	2.18
	WC33	2.03	3224	0.46	0.48	0.68	0.71	0.82	0.85	0.98	1.01	1.10	1.14	1.25	1.31	1.61	1.74
	WC57A	1.45	5750	0.57	0.63	0.84	0.90	1.02	1.08	1.20	1.27	1.35	1.43	1.54	1.65	2.07	2.38
	WC15B	0.49	NA	0.79	0.84	1.19	1.24	1.48	1.53	1.80	1.85	2.08	2.12	2.40	2.44	3.09	3.13
	WC15C	0.31	NA	0.84	0.89	1.26	1.31	1.57	1.61	1.91	1.95	2.20	2.24	2.54	2.58	3.26	3.30
	WC77	1.3	7595	0.66	0.79	1.04	1.17	1.31	1.44	1.59	1.75	1.84	2.04	2.11	2.34	2.70	2.94
	WC86A	1.2	8890	0.65	0.76	1.02	1.15	1.29	1.43	1.57	1.74	1.82	2.01	2.10	2.30	2.68	2.90
	WC95	1.12	9386	0.64	0.75	1.00	1.13	1.25	1.40	1.54	1.71	1.78	1.97	2.05	2.25	2.61	2.84
	WC108	0.99	10671	0.64	0.73	0.98	1.10	1.23	1.36	1.51	1.66	1.74	1.91	2.01	2.17	2.56	2.74
	WC132	0.67	13015	0.69	0.71	1.05	1.08	1.32	1.34	1.61	1.63	1.86	1.88	2.15	2.17	2.78	2.80

Appendix 5
HEC-1 Discharge Values

North Outfall and US 77 HEC-1 Peak Flow for 5 to 500 Year Storm Events

Basin Name	Hec-1 Combo	Area (sq. mi)	Hec-2 Station	2-Year (cfs)		5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
				P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
North Outfall	NC0A	2.49	60	714	865	1201	1323	1544	1659	1911	2020	2230	2320	2551	2627	3110	3261
	NC28	3.68	2779	680	834	1145	1273	1473	1595	1822	1941	2127	2230	2426	2528	2943	3135
US 77	NC47	2.18	1473	528	661	825	978	1039	1202	1265	1444	1465	1649	1652	1868	2057	2444
	NC61	2.03	3286	503	621	778	929	975	1142	1194	1374	1360	1572	1564	1782	1971	2339
	NC86	1.87	6044	475	590	739	890	931	1102	1141	1328	1326	1523	1521	1754	1926	2294
	NC86C	0.25	NA	91	149	143	222	181	274	223	332	260	381	302	439	395	564
	NC103	1.51	7720	410	497	641	750	808	930	996	1132	1157	1305	1344	1506	1751	1941
	NC114	1.25	NA	352	427	550	640	694	792	856	962	994	1107	1155	1276	1506	1642
	NC150	0.8	NA	245	313	390	473	494	587	612	715	713	824	831	951	1087	1226

North Outfall and US 77 HEC-1 Peak Flow Per Acre for 5 to 500 Year Storm Events

Basin Name	Hec-1 Combo	Area (sq. mi)	Hec-2 Station	2-Year (cfs)		5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
				P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
North Outfall	NC0A	2.49	60	0.45	0.54	0.75	0.83	0.97	1.04	1.20	1.27	1.40	1.46	1.60	1.65	1.95	2.05
	NC28	2.4	2779	0.44	0.54	0.75	0.83	0.96	1.04	1.19	1.26	1.38	1.45	1.58	1.65	1.92	2.04
US 77	NC47	2.29	1473	0.36	0.45	0.56	0.67	0.71	0.82	0.86	0.99	1.00	1.13	1.13	1.27	1.40	1.67
	NC61	2.03	3286	0.39	0.48	0.60	0.72	0.75	0.88	0.92	1.06	1.05	1.21	1.20	1.37	1.52	1.80
	NC86	1.87	6044	0.40	0.49	0.62	0.74	0.78	0.92	0.95	1.11	1.11	1.27	1.27	1.47	1.61	1.92
	NC86C	0.25	NA	0.57	0.93	0.89	1.39	1.13	1.71	1.39	2.08	1.63	2.38	1.89	2.74	2.47	3.53
	NC103	1.51	7720	0.42	0.51	0.66	0.78	0.84	0.96	1.03	1.17	1.20	1.35	1.39	1.56	1.81	2.01
	NC114	1.25	NA	0.44	0.53	0.69	0.80	0.87	0.99	1.07	1.20	1.24	1.38	1.44	1.60	1.88	2.05
	NC150	0.8	NA	0.48	0.61	0.76	0.92	0.96	1.15	1.20	1.40	1.39	1.61	1.62	1.86	2.12	2.39

Appendix 5
HEC-1 Discharge Values

Lone Tree HEC-1 Peak Flow for 2 to 500 Year Storm Events

Basin Name	Hec-1 Combo	Area (sq. mi)	Hec-2 Station	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
				P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
Lone Tree	C1211A	22.07	120416	4168	7456	5009	8699	6232	9919	7303	10767	8700	11266	12037	12810
	C1249A	20.69	125117	4060	7242	5101	8377	6475	9495	7774	10388	9293	11398	12352	13386
	C1249B	1.55	NA	611	881	764	1097	936	1337	1084	1542	1256	1781	1630	2299
	C1316A	17.74	131598	3916	6324	5006	7280	6427	8154	7660	8888	9040	9722	11567	11820
	C1362A	16.55	136276	3911	6111	4965	7369	6394	8166	7578	8894	8920	9743	11198	11619
	C1362B	1.14	NA	513	654	638	808	777	979	897	1126	1036	1296	1339	1666
	C1362C	0.81	NA	389	516	485	637	592	772	685	887	792	1021	1026	1312
	C1362D	0.3	NA	164	226	208	279	258	339	301	390	351	449	460	577
	C1434A	13.99	143506	4134	5328	5197	6539	6423	7774	7409	8637	8601	9615	10844	11766
	C1434B	1.89	NA	617	914	772	1131	946	1372	1095	1579	1269	1820	1648	2342
	C1434C	1.19	NA	408	595	514	734	632	889	734	1022	852	1176	1110	1511
	C1434D	0.91	NA	331	502	416	621	512	754	594	867	689	999	897	1285
	C1434E	0.41	NA	189	313	235	390	287	475	332	548	383	633	496	816
	C1453A	11.19	145456	3378	4220	4252	5146	5281	6119	6069	6741	7005	7438	8919	9063
	C1470A	10.88	147096	3271	4152	4153	5050	5163	5986	5930	6601	6848	7269	8889	8835
	C1486A	10.51	148640	3163	4069	4053	4933	5042	5824	5786	6420	6685	7050	8815	8530
	C1508A	9.95	150785	3042	3937	3940	4747	4876	5568	5588	6122	6437	6748	8603	8147
	C1527A	9.77	152650	2996	3910	3902	4702	4833	5509	5534	6040	6376	6640	8558	7976
	C1535A	9.3	153511	2856	3730	3718	4477	4607	5188	5282	5626	6089	6123	8194	7550
	C1535B	0.25	NA	114	191	142	238	172	290	198	334	228	386	294	498
	C1550A	8.8	154988	2719	3589	3542	4297	4398	4923	5050	5269	5830	5669	7892	7304
	C1560A	7.83	15590	2469	3252	3214	3898	3997	4360	4672	4636	5410	4824	7379	6739
	C1580A	7.34	157866	2565	4189	3385	5242	4088	6415	4873	7355	5680	8386	7385	10539
	C1596A	4.47	159866	1575	2487	2031	3118	2499	3812	3160	4343	3598	4917	4668	6102
	C1615A	4.33	161567	1553	2435	1984	3053	2486	3734	3607	4240	3880	4785	5187	5917
	C1623A	4.16	162230	1499	2348	1905	2942	2379	3592	5060	4060	5397	4567	5849	5624
	C1649A	3.44	164825	1280	1986	1611	2468	1997	2987	4337	3304	4578	3648	4991	4389
	C1659A	2.94	166000	1115	1680	1415	2079	1751	2480	2043	2701	2370	3029	3081	3726
	C1670A	2.81	166950	1074	1614	1363	1998	1686	2368	1966	2595	2284	2922	2967	3608
	C1686A	2.43	168621	1112	1429	1357	1768	1666	2141	1937	2453	2244	2804	2905	3520
	C1686B	0.46	NA	317	328	395	405	482	491	556	565	642	651	829	836
	C1686C	0.28	NA	237	244	296	301	361	366	416	421	481	485	621	623

Appendix 5
HEC-1 Discharge Values

Lone Tree HEC-1 Peak Flow for 2 to 500 Year Storm Events - Continued															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
	C1705C	1.81	NA	784	1052	981	1303	1202	1575	1385	1800	1601	2067	2071	2649
	C1705B	0.41	NA	215	356	270	438	332	529	385	606	447	697	581	893
	C1705A	1.4	170517	583	735	728	911	890	1104	1030	1265	1190	1455	1539	1869
	C1705D	0.64	NA	246	346	305	428	371	520	428	598	494	689	638	886
	C1721A	0.55	171988	332	354	415	438	508	532	587	612	679	705	879	906

Lone Tree HEC-1 Peak Flow Per Acre for 2 to 500 Year Storm Events															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
Lone Tree	C1211A	22.07	120416	0.30	0.53	0.35	0.62	0.44	0.70	0.52	0.76	0.62	0.80	0.85	0.91
	C1249A	20.69	125117	0.31	0.55	0.39	0.63	0.49	0.72	0.59	0.78	0.70	0.86	0.93	1.01
	C1249B	1.55	NA	0.62	0.89	0.77	1.11	0.94	1.35	1.09	1.55	1.27	1.80	1.64	2.32
	C1316A	17.74	131598	0.34	0.56	0.44	0.64	0.57	0.72	0.67	0.78	0.80	0.86	1.02	1.04
	C1362A	16.55	136276	0.37	0.58	0.47	0.70	0.60	0.77	0.72	0.84	0.84	0.92	1.06	1.10
	C1362B	1.14	NA	0.70	0.90	0.87	1.11	1.06	1.34	1.23	1.54	1.42	1.78	1.84	2.28
	C1362C	0.81	NA	0.75	1.00	0.94	1.23	1.14	1.49	1.32	1.71	1.53	1.97	1.98	2.53
	C1362D	0.3	NA	0.85	1.18	1.08	1.45	1.34	1.77	1.57	2.03	1.83	2.34	2.40	3.01
	C1434A	13.99	143506	0.46	0.60	0.58	0.73	0.72	0.87	0.83	0.96	0.96	1.07	1.21	1.31
	C1434B	1.89	NA	0.51	0.76	0.64	0.94	0.78	1.13	0.91	1.31	1.05	1.50	1.36	1.94
	C1434C	1.19	NA	0.54	0.78	0.67	0.96	0.83	1.17	0.96	1.34	1.12	1.54	1.46	1.98
	C1434D	0.91	NA	0.57	0.86	0.71	1.07	0.88	1.29	1.02	1.49	1.18	1.72	1.54	2.21
	C1434E	0.41	NA	0.72	1.19	0.90	1.49	1.09	1.81	1.27	2.09	1.46	2.41	1.89	3.11
	C1453A	11.19	145456	0.47	0.59	0.59	0.72	0.74	0.85	0.85	0.94	0.98	1.04	1.25	1.27
	C1470A	10.88	147096	0.47	0.60	0.60	0.73	0.74	0.86	0.85	0.95	0.98	1.04	1.28	1.27
	C1486A	10.51	148640	0.47	0.60	0.60	0.73	0.75	0.87	0.86	0.95	0.99	1.05	1.31	1.27
	C1508A	9.95	150785	0.48	0.62	0.62	0.75	0.77	0.87	0.88	0.96	1.01	1.06	1.35	1.28
	C1527A	9.77	152650	0.48	0.63	0.62	0.75	0.77	0.88	0.89	0.97	1.02	1.06	1.37	1.28
	C1535A	9.3	153511	0.48	0.63	0.62	0.75	0.77	0.87	0.89	0.95	1.02	1.03	1.38	1.27
	C1535B	0.25	NA	0.71	1.19	0.89	1.49	1.08	1.81	1.24	2.09	1.43	2.41	1.84	3.11
	C1550A	8.8	154988	0.48	0.64	0.63	0.76	0.78	0.87	0.90	0.94	1.04	1.01	1.40	1.30
	C1560A	7.83	15590	0.49	0.65	0.64	0.78	0.80	0.87	0.93	0.93	1.08	0.96	1.47	1.34

Appendix 5
HEC-1 Discharge Values

Lone Tree HEC-1 Peak Flow Per Acre for 2 to 500 Year Storm Events - Continued															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
	C1580A	7.34	157866	0.55	0.89	0.72	1.12	0.87	1.37	1.04	1.57	1.21	1.79	1.57	2.24
	C1596A	4.47	159866	0.55	0.87	0.71	1.09	0.87	1.33	1.10	1.52	1.26	1.72	1.63	2.13
	C1615A	4.33	161567	0.56	0.88	0.72	1.10	0.90	1.35	1.30	1.53	1.40	1.73	1.87	2.14
	C1623A	4.16	162230	0.56	0.88	0.72	1.11	0.89	1.35	1.90	1.52	2.03	1.72	2.20	2.11
	C1649A	3.44	164825	0.58	0.90	0.73	1.12	0.91	1.36	1.97	1.50	2.08	1.66	2.27	1.99
	C1659A	2.94	166000	0.59	0.89	0.75	1.10	0.93	1.32	1.09	1.44	1.26	1.61	1.64	1.98
	C1670A	2.81	166950	0.60	0.90	0.76	1.11	0.94	1.32	1.09	1.44	1.27	1.62	1.65	2.01
	C1686A	2.43	168621	0.72	0.92	0.87	1.14	1.07	1.38	1.25	1.58	1.44	1.80	1.87	2.26
	C1686B	0.46	NA	1.08	1.11	1.34	1.38	1.64	1.67	1.89	1.92	2.18	2.21	2.82	2.84
	C1686C	0.28	NA	1.32	1.36	1.65	1.68	2.01	2.04	2.32	2.35	2.68	2.71	3.47	3.48
	C1705C	1.81	NA	0.68	0.91	0.85	1.12	1.04	1.36	1.20	1.55	1.38	1.78	1.79	2.29
	C1705B	0.41	NA	0.82	1.36	1.03	1.67	1.27	2.02	1.47	2.31	1.70	2.66	2.21	3.40
	C1705A	1.4	170517	0.65	0.82	0.81	1.02	0.99	1.23	1.15	1.41	1.33	1.62	1.72	2.09
	C1705D	0.64	NA	0.60	0.84	0.74	1.04	0.91	1.27	1.04	1.46	1.21	1.68	1.56	2.16
	C1721A	0.55	171988	0.94	1.01	1.18	1.24	1.44	1.51	1.67	1.74	1.93	2.00	2.50	2.57

Appendix 5
HEC-1 Discharge Values

Southern Pacific HEC-1 Peak Flow for 5 to 500 Year Storm Events															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
Southern Pacific	C1550B	0.86	78	564	612	707	761	867	929	1003	1078	1137	1244	1353	1600
	C1550C	0.72	4584	554	588	690	723	841	873	971	1001	1121	1150	1447	1473

Southern Pacific HEC-1 Peak Flow Per Acre for 5 to 500 Year Storm Events															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
Southern Pacific	C1550B	0.86	78	1.02	1.11	1.28	1.38	1.58	1.69	1.82	1.96	2.07	2.26	2.46	2.91
	C1550C	0.72	4584	1.20	1.28	1.50	1.57	1.83	1.89	2.11	2.17	2.43	2.50	3.14	3.20

Appendix 5
HEC-1 Discharge Values

East Branch HEC-1 Peak Flow for 5 to 500 Year Storm Events															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
East Branch	C1580I	2.8	64	1147	1701	1427	2124	1733	2605	1996	3000	2262	3439	2869	4413
	C1580B	2.54	2855	1046	1571	1301	1958	1588	2393	1830	2756	2092	3176	2683	4080
	C1580H	0.86	NA	305	518	380	642	465	780	538	899	622	1036	806	1335
	C1580C	1.25	3738	591	871	732	1084	889	1328	1025	1528	1167	1761	1491	2253
	C1580D	1.16	5693	564	837	699	1035	850	1255	980	1443	1130	1662	1456	2136
	C1580G	0.23	NA	139	209	173	258	211	312	243	358	281	411	363	528
	C1580E	0.67	7753	328	497	405	616	492	748	566	861	652	992	839	1277
	C1580F	0.46	NA	225	375	279	464	338	564	390	648	449	747	578	961

East Branch HEC-1 Peak Flow Per Acre for 5 to 500 Year Storm Events															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
East Branch	C1580I	2.8	64	0.64	0.95	0.80	1.19	0.97	1.45	1.11	1.67	1.26	1.92	1.60	2.46
	C1580B	2.54	2855	0.64	0.97	0.80	1.20	0.98	1.47	1.13	1.70	1.29	1.95	1.65	2.51
	C1580H	0.86	NA	0.55	0.94	0.69	1.17	0.84	1.42	0.98	1.63	1.13	1.88	1.46	2.43
	C1580C	1.25	3738	0.74	1.09	0.92	1.36	1.11	1.66	1.28	1.91	1.46	2.20	1.86	2.82
	C1580D	1.16	5693	0.76	1.13	0.94	1.39	1.14	1.69	1.32	1.94	1.52	2.24	1.96	2.88
	C1580G	0.23	NA	0.94	1.42	1.18	1.75	1.43	2.12	1.65	2.43	1.91	2.79	2.47	3.59
	C1580E	0.67	7753	0.76	1.16	0.94	1.44	1.15	1.74	1.32	2.01	1.52	2.31	1.96	2.98
	C1580F	0.46	NA	0.76	1.27	0.95	1.58	1.15	1.92	1.32	2.20	1.53	2.54	1.96	3.26

Appendix 5
HEC-1 Discharge Values

Marcado HEC-1 Peak Flow for 5 to 500 Year Storm Events															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
Marcado	C418A	17.46	41320	3310	4887	4102	6046	5042	7373	5869	8445	6840	9697	9030	12339
	C474A	16.92	47597	3244	4765	4020	5905	4932	7205	5743	8270	6687	9500	8828	12097
	C474B	1.16	NA	434	640	547	793	674	965	783	1112	910	1283	1186	1653
	C538A	14.54	53157	2921	4243	3609	5312	4443	6491	5162	7472	6000	8614	7826	11084
	C538G	0.93	NA	366	595	466	739	580	899	677	1036	792	1196	1040	1542
	C538F	0.74	NA	311	539	397	670	495	816	579	941	677	1086	891	1400
	C538H	2.05	NA	742	1030	950	1281	1186	1562	1390	1801	1627	2080	2145	2684
	C538B	1.71	NA	681	984	872	1224	1090	1493	1277	1723	1495	1990	1970	2569
	C538C	1.38	NA	595	906	763	1128	953	1376	1117	1588	1308	1835	1723	2370
	C538D	1.02	NA	464	757	595	945	744	1155	873	1334	1023	1543	1350	1995
	C538E	0.67	NA	315	496	403	620	504	760	590	879	690	1018	908	1320
	C567A	11.11	57073	1875	2874	2283	3637	2813	4493	3251	5193	3763	5977	5137	7692
	C611A	10.22	61016	1682	2521	2050	3218	2505	3985	3027	4649	3649	5351	5006	6957
	C631A	9.59	63223	1536	2290	1880	2769	2378	3410	2977	3975	3584	4644	4890	6042
	C662A	9.32	66055	1498	2276	1872	2755	2384	3338	2993	3846	3596	4405	4883	5581
	C677A	8.52	67415	1447	2220	1810	2690	2313	3261	2904	3758	3485	4306	4712	5340
	C707A	8.21	70132	1442	2203	1805	2672	2319	3240	2910	3734	3485	4283	4693	5310
	C707B	0.94	NA	532	539	650	658	781	792	894	906	1024	1039	1308	1328
	C707C	0.66	NA	454	460	555	563	668	677	764	775	876	889	1119	1135
	C707D	0.47	NA	406	411	497	503	598	606	684	694	785	796	1003	1018
	C751A	6.69	NA	1593	2136	2016	2653	2496	3232	2909	3727	3393	4304	4451	5557
	C824A	5.9	NA	1490	2100	1891	2608	2345	3179	2737	3667	3196	4235	4199	5469
	C824C	0.78	NA	285	461	356	571	435	695	503	800	583	923	755	1190
	C824B	0.61	NA	227	418	284	520	348	633	404	729	468	841	608	1085
	C891A	4.43	NA	1209	1900	1545	2362	1926	2880	2255	3324	2641	3840	3484	4960
	C933A	3.69	NA	1038	1740	1334	2164	1671	2639	1962	3045	2304	3518	3051	4544
	C948A	2.47	NA	620	1242	810	1544	1028	1883	1217	2172	1440	2509	1929	3240

Appendix 5
HEC-1 Discharge Values

Marcado HEC-1 Peak Flow Per Acre for 5 to 500 Year Storm Events															
	Hec-1	Area	Hec-2	5-Year (cfs)		10-Year (cfs)		25-Year (cfs)		50-Year (cfs)		100-Year (cfs)		500-Year (cfs)	
Basin Name	Combo	(sq. mi)	Station	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F	P/P	F/F
Marcado	C418A	17.46	41320	0.30	0.44	0.37	0.54	0.45	0.66	0.53	0.76	0.61	0.87	0.81	1.10
	C474A	16.92	47597	0.30	0.44	0.37	0.55	0.46	0.67	0.53	0.76	0.62	0.88	0.82	1.12
	C474B	1.16	NA	0.58	0.86	0.74	1.07	0.91	1.30	1.05	1.50	1.23	1.73	1.60	2.23
	C538A	14.54	53157	0.31	0.46	0.39	0.57	0.48	0.70	0.55	0.80	0.64	0.93	0.84	1.19
	C538G	0.93	NA	0.61	1.00	0.78	1.24	0.97	1.51	1.14	1.74	1.33	2.01	1.75	2.59
	C538F	0.74	NA	0.66	1.14	0.84	1.41	1.05	1.72	1.22	1.99	1.43	2.29	1.88	2.96
	C538H	2.05	NA	0.57	0.79	0.72	0.98	0.90	1.19	1.06	1.37	1.24	1.59	1.63	2.05
	C538B	1.71	NA	0.62	0.90	0.80	1.12	1.00	1.36	1.17	1.57	1.37	1.82	1.80	2.35
	C538C	1.38	NA	0.67	1.03	0.86	1.28	1.08	1.56	1.26	1.80	1.48	2.08	1.95	2.68
	C538D	1.02	NA	0.71	1.16	0.91	1.45	1.14	1.77	1.34	2.04	1.57	2.36	2.07	3.06
	C538E	0.67	NA	0.73	1.16	0.94	1.45	1.18	1.77	1.38	2.05	1.61	2.37	2.12	3.08
	C567A	11.11	57073	0.26	0.40	0.32	0.51	0.40	0.63	0.46	0.73	0.53	0.84	0.72	1.08
	C611A	10.22	61016	0.26	0.39	0.31	0.49	0.38	0.61	0.46	0.71	0.56	0.82	0.77	1.06
	C631A	9.59	63223	0.25	0.37	0.31	0.45	0.39	0.56	0.49	0.65	0.58	0.76	0.80	0.98
	C662A	9.32	66055	0.25	0.38	0.31	0.46	0.40	0.56	0.50	0.64	0.60	0.74	0.82	0.94
	C677A	8.52	67415	0.27	0.41	0.33	0.49	0.42	0.60	0.53	0.69	0.64	0.79	0.86	0.98
	C707A	8.21	70132	0.27	0.42	0.34	0.51	0.44	0.62	0.55	0.71	0.66	0.82	0.89	1.01
	C707B	0.94	NA	0.88	0.90	1.08	1.09	1.30	1.32	1.49	1.51	1.70	1.73	2.17	2.21
	C707C	0.66	NA	1.07	1.09	1.31	1.33	1.58	1.60	1.81	1.83	2.07	2.10	2.65	2.69
	C707D	0.47	NA	1.35	1.37	1.65	1.67	1.99	2.01	2.27	2.31	2.61	2.65	3.33	3.38
	C751A	6.69	NA	0.37	0.50	0.47	0.62	0.58	0.75	0.68	0.87	0.79	1.01	1.04	1.30
	C824A	5.9	NA	0.39	0.56	0.50	0.69	0.62	0.84	0.72	0.97	0.85	1.12	1.11	1.45
	C824C	0.78	NA	0.57	0.92	0.71	1.14	0.87	1.39	1.01	1.60	1.17	1.85	1.51	2.38
	C824B	0.61	NA	0.58	1.07	0.73	1.33	0.89	1.62	1.03	1.87	1.20	2.15	1.56	2.78
	C891A	4.43	NA	0.43	0.67	0.54	0.83	0.68	1.02	0.80	1.17	0.93	1.35	1.23	1.75
	C824B	0.61	NA	2.66	4.46	3.42	5.54	4.28	6.76	5.03	7.80	5.90	9.01	7.82	11.64
	C891A	4.43	NA	0.22	0.44	0.29	0.54	0.36	0.66	0.43	0.77	0.51	0.88	0.68	1.14

APPENDIX 6

FORTRAN SOURCE CODE AND KEY FILE FOR CONVERSION OF HEC-1 OUTPUT TO AVSAND INPUT FORMAT

APPENDIX 6
FORTRAN SOURCE CODE FOR CONVERSION OF HEC-1 OUTPUT TO AVSAND INPUT FORMAT

```
      PROGRAM SANDQ
C **********************************************************************
C  THIS PROGRAM WILL CONVERT HYDROGRAPH OUTPUT FROM THE HEC-1 TAPE 22
C  FILE TO THE INPUT FORMAT REQUIRED BY THE AVSAND MODEL.  THE HEC-1
C  OUTPUT IS IN THE FORM OF A HEADER LINE AND THE HYDROGRAPH ORDINATES
C  FOR EACH SPECIFIED OUTPUT POINT.
C  THE PROGRAM CAN HANDLE TIME INTERVALS GREATER THAN OR EQUAL TO 6
C  MINUTES (PROVIDED THEY YIELD AN EVEN NUMBER OF 10 DATA POINT ROWS).
C
C  FILE NAME = AVSANDQ.FOR
C  LAST EDITED BY KEM 3-30-99
C **********************************************************************
C
C VARIABLE DECLARATIONS
C
      CHARACTER*20 TAPE22, KEY, SAND, PEAK
      CHARACTER*2 WSID
      CHARACTER*72 HEADER
      CHARACTER*6 B1, B2, CHECK
      INTEGER SA, STRIP, SEWSYS, NODE, NOMAP, NUMPNT, TEMPID
      INTEGER I, J, CNT, RECUR
      REAL P1, P2, TIME, TINT, DUR, QPEAK, TPEAK
      REAL HYD1(300), HYD2(300), HYDF(300), TORD(300)
C ----------------------------------------------------------------------
C OPEN AND INITIALIZE FILES
      WRITE(*,*) 'ENTER THE 2 CHARACTER WATERSHED ID.'
      WRITE(*,*)
      READ(*,*) WSID
5     WRITE(*,*) 'EXECUTE PROGRAM FOR 10- OR 25-YEAR EVENT (10 OR 25)?'
      WRITE(*,*)
      READ(*,*) RECUR
      IF(RECUR.NE.10.AND.RECUR.NE.25) GOTO 5
      IF(RECUR.EQ.10) THEN
         TAPE22=WSID//'H1_10.T22'
         SAND=WSID//'AVS10.DAT'
         PEAK=WSID//'10PEAK.TXT'
      ELSE
         TAPE22=WSID//'H1_25.T22'
         SAND=WSID//'AVS25.DAT'
         PEAK=WSID//'25PEAK.TXT'
      ENDIF
      KEY=WSID//'KEY.PRN'
      OPEN(UNIT=10,FILE=KEY)
      OPEN(UNIT=11,FILE=TAPE22)
      OPEN(UNIT=12,FILE=SAND)
      OPEN(UNIT=13,FILE=PEAK)
      SEWSYS=1
      NOMAP=1
      DUR=30

      TINT=15
      NUMPNT=DUR*60/TINT
```

```
C ---------------------------------------------------------------------
C GENERATE THE TIME ORDINATES FORM THE AVSAND INPUT HYDROGRAPH
C TIME INTERVAL IS BASED ON VARIABLE TINT
      TIME=0
      DO 10 I=1,NUMPNT
         TORD(I)=TIME
         TIME=TIME+TINT/60
10    CONTINUE
C ---------------------------------------------------------------------
C READ THE KEY FILE AND START CALCULATIONS
C-----READ THE TWO HEADER LINES AND WRITE THEM TO THE OUTPUT FILE

      READ(10,500) HEADER
      WRITE(12,500) HEADER
      READ(10,500) HEADER
      WRITE(12,500) HEADER
C ----WRITE THE COLUMN HEADINGS FOR THE OUTPUT FILES
      WRITE(12,505)
      WRITE(13,506)
C ----READ THE COLUMN HEADINGS
      READ(10,*)

      READ(10,*)
20    READ(10,510,END=250) SA, STRIP, TEMPID, NODE, B1, B2, P1, P2
      IF(B1.EQ.'N') GOTO 20
      B1CHK=1
      B2CHK=1
      IF(B2.EQ.'N') B2CHK=2
C ---------------------------------------------------------------------
C READ THROUGH THE TAPE22 FILE TO FIND B1 AND B2
30    READ(11,520,END=200) CHECK
      IF(B1CHK.EQ.2) GOTO 50
      IF(CHECK.EQ.B1) THEN
         CNT=1
         DO 40 I=1,NUMPNT/10
            READ(11,530) (HYD1(J), J=CNT,CNT+9)
            CNT=CNT+10
40       CONTINUE
         B1CHK=2
      ENDIF
50    IF(B2CHK.EQ.2) GOTO 70
      IF(B2.NE.'N') THEN
         IF(CHECK.EQ.B2) THEN
            CNT=1
            DO 60 I=1,NUMPNT/10
               READ(11,530) (HYD2(J), J=CNT,CNT+9)
               CNT=CNT+10
60          CONTINUE
            B2CHK=2
         ENDIF
      ENDIF
70    IF(B1CHK+B2CHK.LT.4) GOTO 30
      REWIND(UNIT=11)
C ---------------------------------------------------------------------
C GENERATE THE AVSAND INPUT HYDROGRAPH AND DETERMINE THE PEAK FLOW
      QPEAK=0
      TPEAK=0
```

```
      DO 100 I=1,NUMPNT
         HYD1(I)=HYD1(I)*P1
         IF(B2.NE.'N') THEN
            HYD2(I)=HYD2(I)*P2
            HYDF(I)=HYD1(I)+HYD2(I)
         ELSE
            HYDF(I)=HYD1(I)
         ENDIF
         IF(HYDF(I).GT.QPEAK) THEN
            QPEAK=HYDF(I)
            TPEAK=TORD(I)
         ENDIF
100   CONTINUE
C -----------------------------------------------------------------------
C WRITE THE HYDROGRAPH TO THE AVSAND INPUT FILE
      CNT=1
C      CNT=10
      DO 110 I=1,NUMPNT/10
C         WRITE(12,540) SA, NODE, NUMPNT, (TORD(I), HYDF(I), I=CNT-9,CNT)
         WRITE(12,540) SA, NODE, NUMPNT, TORD(CNT), HYDF(CNT),
     *TORD(CNT+1), HYDF(CNT+1), TORD(CNT+2), HYDF(CNT+2),
     *TORD(CNT+3), HYDF(CNT+3), TORD(CNT+4), HYDF(CNT+4), TORD(CNT+5),
     *HYDF(CNT+5), TORD(CNT+6), HYDF(CNT+6), TORD(CNT+7), HYDF(CNT+7),
     *TORD(CNT+8), HYDF(CNT+8), TORD(CNT+9), HYDF(CNT+9)
         CNT=CNT+10
110   CONTINUE
      WRITE(13,550) SA, STRIP, TEMPID, NODE, QPEAK, TPEAK
      WRITE(*,*) 'FINISHED NODE ', NODE
      GOTO 20
200   WRITE(*,*) 'BASIN ID NOT FOUND IN TAPE22 FILE. CHECK KEY FILE.'
250   WRITE(*,*) 'FINISHED PROCESSING FILES FOR *',WSID,'* WATERSHED.'
C ***********************************************************************
C FORMAT STATEMENTS
500   FORMAT(A72)
505   FORMAT('   SA NODE NPNT TIME/FLOW PAIRS')
506   FORMAT('      SA   STRIP  TEMPID    NODE    PEAK    TIME')
510   FORMAT(3I8,8X,I8,2X,A6,2X,A6,2F8.2)

520   FORMAT(3X,A6)
530   FORMAT(1X,10F13.3)
540   FORMAT(3I5,20F8.2)
550   FORMAT(4I8,F8.2,F8.2)
      STOP
      END
```

APPENDIX 6
KEY FILE FOR CONVERSION OF HEC-1 OUTPUT TO AVSAND INPUT FORMAT

Jim Branch Outfall AVsand Inflow Data
Victoria Storm Drainage Master Plan (Proj. #18153)

Service		Temporary	AVsand Nodes		Contributing Basins		Contributing Fraction	
Area	Strip	ID	Old Num	New Num	1	2	1	2
2	1	1	2009	8885	265A	N	0.30	
2	1	2	55	8995	265A	N	0.40	
2	1	3	185	8935	265A	245A	0.30	0.25
2	1	4	263	7275	245A	N	0.25	
2	1	5	1230	5775	212A	N	0.30	
2	1	6	9927	5905	212A	N	0.70	
2	1	7	10347	5965	189A	N	0.20	
2	1	8	10210	4845	189A	N	0.80	
1	2	1	30075	1545	102B	N	0.25	
1	2	2	30054	1615	102B	N	0.15	
1	2	3	30073	1665	102B	N	0.35	
1	2	4	45527	1505	102B	N	0.25	
1	3	1	8851	2045	122B	N	0.30	
1	3	2	8877	1955	122B	N	0.30	
1	3	3	30008	2205	122B	N	0.40	
2	4	1	93501	2995	148B	N	0.25	
2	4	2	93566	3075	148B	N	0.25	
2	4	3	23317	3195	148B	N	0.50	
2	4	4	38021	3135	148A	N	0.50	
2	5	1	93559	3215	148C	N	0.10	
2	5	2	93553	3245	148C	N	0.10	
2	5	3	38011	3305	148C	N	0.60	
2	5	4	38019	3345	148C	N	0.20	
2	6	1	89509	4075	163A	N	0.20	
2	6	2	89577	4085	163A	N	0.20	
2	6	3	85578	4165	163A	148D	0.30	0.40
2	6	4	94016	3405	148D	N	0.60	
2	7	1	10178	4205	163A	N	0.10	
2	7	2	10191	4285	163A	N	0.20	
2	8	1	1579	7585	245B	N	0.10	
2	8	2	1595	7575	245B	N	0.20	
2	9	1	2562	7135	245A	N	0.25	
2	9	2	979	7775	245A	N	0.25	
2	10	1	1504	6635	245B	N	0.35	
2	10	2	1632	7995	245B	N	0.15	
2	10	3	1166	7975	245B	N	0.20	

APPENDIX 7

BOUNDARY CONDITIONS FOR AVSAND MODELS

Appendix 7
Downstream Boundary Conditions for AVsand Models

Water-Shed	Service Area	Strip	D/S Node Old ID	D/S Node New ID	HEC-2 Section	Water Surface Elevation P/P	F/P	F/F	Comment
JB	1	2	61511	1295	10210	70.64	71.01	69.88	D/S face of Callis St. bridge
		3	61523	1305	12236	74.62	74.98	74.12	D/S face of Port Lavaca Dr.
	2	4	38530	2965	14774	78.80	79.70	78.27	Confluence of Jim Branch and Ben Jordan Outfalls
		5	38021	3135	16100	79.90	80.37	79.78	Not needed (D/S bound from Strip 4)
		6	38524	2975	1366	78.51	81.01	79.17	Ben Jordan Branch HEC-2
		1	8803	2935	3603	81.72	81.87	80.73	Ben Jordan Branch HEC-2. Section 3603 is ~310 ft D/S from the O/F at Ben Jordan St. Use the WS slope between sections 3230 and 3603 to est. the WSEL at O/F.
SO	1	1	31512	1145	7094	59.82	62.00	59.00	Located at confluence of Strips 1 and 2
		2	545	3035	7953	67.61	67.70	66.54	If started at outfall of 72" pipe. 7094 if started at the confluence of 1 and 2.
SS	1	1	47003	1835				45.00	Estimated from stage at USGS gage and the slope of the channel. FEMA 10-yr on the Guadalupe => 52.5
		3	32508	1825				45.00	"
	2	1	9448	1525				51.00	Estimated from stage at USGS gage for 10,000 cfs (~1.3-yr). FEMA 10-yr on the Guadalupe => 58.
		6	23350	5005				52.00	". FEMA 10-yr on the Guadalupe => 60.
		8	23351	5015				52.00	". FEMA 10-yr on the Guadalupe => 60.
WO	1	1	23411	55	532	61.57		60.51	
	2	2	6742	2345	6700	67.46	67.49	66.47	D/S face
		3	6672	2305	8453	77.16	77.18	76.16	
		5	5373	4995	9915	90.44	90.44	87.75	D/S face
	3	8*	5375	7115	10863	90.77	90.78	88.41	Added pipe - could not have 3-48" connected to outfall (New Node 11119)
		9	5379	7765	11296	90.85	90.86	88.74	D/S face
		11	5641	8785	12750	91.17	91.19	91.27	
		1*	"	"	"	"	"	"	Pipe added to 3:1 => 3:11 does not need D/S WSEL (New Node 11117)
SC	2	1	717	3085				Free	Free Outfall assumed. D/S culverts at Mead Rd. and Mallette Dr. improved to pass 10-yr w/out overtopping.
	4	1	73518	2865	22458	86.64	86.83	85.56	O/F is ~halfway between sections 22054 and 22458 => use 22458 to be conservative.
MO	1	1	39029	195				71.50	Estimated from FEMA 10-year on the Guadalupe.
WC	1	8	53010	2435	5085	85.80	86.00	84.06	2 sections from D/S face of Tampa Dr. bridge
		9	23197	2495	9386	99.24	99.53	97.55	Section 9386 ~176' D/S of O/F, 9928 is ~354' U/S of O/F
	2	2	40001	35	1523	73.29	73.45	73.18	Confluence with main channel

Appendix 7
Downstream Boundary Conditions for AVsand Models

Water-Shed	Service Area	Strip	D/S Node Old ID	D/S Node New ID	HEC-2 Section	Water Surface Elevation P/P	Water Surface Elevation F/P	Water Surface Elevation F/F	Comment
LT	1	1	1710	13305	152650	89.54	90.08	88.60	
	2	2	23024	1885	4960	93.08	93.65	90.84	Southern Pacific Ditch HEC-2
		5	2815	1845	6501	94.62	94.70	91.18	Southern Pacific Ditch HEC-2
	3	1	23345	5595	159866	93.36	94.35	91.47	
	4	1	23092	7965	162230	94.13	95.06	92.96	
	5	1	90046	7785	163580	95.11	95.60	93.67	
	6	1	23074	7955	165004	97.18	97.82	95.36	
	7	1	7384	9765	"	"	"	"	
	8	1	23054	10795	168621	100.71	101.29	99.35	
	9	1	55542	11785	170517	102.77	102.83	102.82	
	10	1	23108	3475	607	93.04	94.08	92.07	East Branch HEC-2
	11	1	45011	5025	3321	94.27	95.46	94.72	East Branch HEC-2

APPENDIX 8

DETAILED CONSTRUCTION COST ESTIMATES

CITY OF VICTORIA
Jim Branch
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999)

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	Reach R0A Quantity	Reach R0A Sheet $	Reach R38A Quantity	Reach R38A Sheet $	Reach R66A Quantity	Reach R66A Sheet $	Reach R102A Quantity	Reach R102A Sheet $	Reach R122A Quantity	Reach R122A Sheet $	Reach R148A Quantity	Reach R148A Sheet $	JB 1:2 Quantity	JB 1:2 Sheet $	JB 1:3 Quantity	JB 1:3 Sheet $	Reach R148B Ben Jordan Quantity	Reach R148B Ben Jordan Sheet $
			Length of individual Reach (feet)			2,631		3,165		3,631		1,963		2,684		1,326		4153				1,254	
			Estimated ROW width needed for excavated open channel (feet)			301		280		228		208		211		208						181	
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$26,944	1	$45,766	1	$52,232	1	$18,761	1	$37,987	1	$4,185	1	$47,388		$6,800	1	$7,317
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$6,736	1	$11,441	1	$13,058	1	$4,690	1	$9,497	1	$1,046	1	$11,847		$1,700	1	$1,829
3	500	501	Mobilization	LS	2.5%	1	$16,840	1	$28,603	1	$32,645	1	$11,726	1	$23,742	1	$2,616	1	$29,617		$4,250	1	$4,573
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$10,104	1	$17,162	1	$19,587	1	$7,035	1	$14,245	1	$1,569	1	$17,770		$2,550	1	$2,744
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																		
6	110	502	Excavation - channel	CY	$4.00	64,000	$256,000	133,250	$533,000	72,580	$290,320	31,030	$124,120	34,340	$137,360	8,180	$32,720					30,900	$123,600
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																		
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																		
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	89,310	$44,655	99,564	$49,782	93,387	$46,694	46,124	$23,062	64,140	$32,070	31,203	$15,602	9,229	$4,614			25,638	$12,819
10	162	509	Block sod (St. Augustine)	SY	$2.00													2,307	$4,614				
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	89,310	$66,983	99,564	$74,673	93,387	$70,040	46,124	$34,593	64,140	$48,105	31,203	$23,402	6,922	$5,191			25,638	$19,228
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00							23,062	$46,124	32,070	$64,140	15,602	$31,203	4,614	$9,229			12,819	$25,638
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00	29,770	$148,850	33,188	$165,939	31,129	$155,645												
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00													6,922	$48,452				
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00													6,922	$41,530				
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50													33	$150				
17	402	501	Trench Safety Protection	LF	$1.25													4,153	$5,191				
18	423	508	Retaining walls (cast in place)	SF	$25.00																		
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																		
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																		
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00													817	$142,975				
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00													1,361	$306,225				
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00																		
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																		
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00																		
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																		
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00																		
28	422	501	Bridge 1 - straightforward	SF	$35.00	4,410	$154,350	8,501	$297,535	9,300	$325,500	6,826	$238,910	9,562	$334,670								
29	422	501	Bridge 2 - straightforward	SF	$35.00					5,481	$191,835			4,949	$173,215								
30	422	501	Bridge 3 - straightforward	SF	$35.00					6,348	$222,180			4,494	$157,290								
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																		
32	464	505	RCP - Class III - 24"	LF	$40.00																		
33	464	509	RCP - Class III - 36"	LF	$50.00																		
34	464	510	RCP - Class III - 42"	LF	$70.00													1,409	$98,630				
35	464	511	RCP - Class III - 48"	LF	$90.00																		
36	464	512	RCP - Class III - 54"	LF	$120.00													566	$67,920				
37	464	513	RCP - Class III - 60"	LF	$150.00																		
38	464	514	RCP - Class III - 66"	LF	$175.00																		
39	464	515	RCP - Class III - 72"	LF	$200.00																		
40	464	516	RCP - Class III - 78"	LF	$225.00																		
41	464	517	RCP - Class III - 84"	LF	$275.00																		
42	464	518	RCP - Class III - 96"	LF	$325.00																		
43	465	547	Inlet - Single	EA	$7,000.00															10	$70,000		
44	465	548	Inlet - Double	EA	$10,000.00													20	$200,000	10	$100,000		
45	465	549	Inlet - Triple	EA	$13,000.00																		
46	465	536	Drainage MH or JB	EA	$5,000.00													8	$41,530				
47	466	501	Headwall - small	EA	$2,500.00																		
48	466	501	Headwall - large	EA	$4,000.00													1	$4,000				
49	529	511	Concrete Curb and Gutter	LF	$6.50													2,077	$13,497				
50	529	521	Concrete Valley Gutter	LF	$10.00																		
51	530	604	Remove & Replace Driveway	EA	$3,000.00													42	$124,590				
52	531	502	Sidewalk	SY	$50.00													831	$41,530				
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																		
54	560	501	Mailbox Assembly	EA	$400.00													42	$16,612				
55	580	none	Project Maintenance (subsidiary)																				
56	COA-594	none	Gabions	CY	$150.00																		
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																		
58	639	none	Rock Berm	LF	$900.00																		
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	868	$2,171	1,044	$2,611	1,198	$2,996	648	$1,619	886	$2,214	438	$1,094	1,384	$3,461			414	$1,035
60	1610	none	Preservation of Trees (Type C)	EA	$100.00													42	$4,153				
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600			1	$600
62	Special	none	Conlock II pavers	SY	$27.00																		
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00			1	$20,000														
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																		
65	420	none	Pump		$175,000.00																		
66	xx	xx																					
End of Current BASE BID specification items and unit prices																							
			Contingency =	15%			$110,135		$187,067		$213,500		$76,686		$155,270		$17,106		$193,698		$27,795		$29,907
			TOTAL BASE BID (suject to revision)				$844,368		$1,434,179		$1,636,833		$587,928		$1,190,406		$131,143		$1,485,015		$213,095		$229,290
			(cost per linear foot =)				$321		$453		$451		$300		$444		$99		$358				$183

CITY OF VICTORIA
Jim Branch
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999)

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	Reach R163A Ben Jordan Quantity	Sheet $	JB 2:1 Ben Jordan Quantity	Sheet $	JB 2:4 Quantity	Sheet $	JB 2:5 Quantity	Sheet $	JB 2:6 Ben Jordan Quantity	Sheet $	JB 2 :7 Ben Jordan Quantity	Sheet $	JB 2:8 Ben Jordan Quantity	Sheet $	JB 2:9 Ben Jordan Quantity	Sheet $	JB 2:10 Ben Jordan Quantity	Sheet $	JIM BRANCH Overall Project Quantity	Total $
			Length of individual Reach (feet)			2,349		10,131		2,508		2,900		4,780		1,593		2,429		2,625		1,377		51,499	
			Estimated ROW width needed for excavated open channel (feet)			179																			
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$11,693	1	$221,995	1	$43,596	1	$38,698	1	$124,732	1	$20,940	1	$25,738	1	$29,961	1	$25,295	17	$790,028
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$2,923	1	$55,499	1	$10,899	1	$9,675	1	$31,183	1	$5,235	1	$6,434	1	$7,490	1	$6,324	17	$197,507
3	500	501	Mobilization	LS	2.5%	1	$7,308	1	$138,747	1	$27,247	1	$24,186	1	$77,958	1	$13,088	1	$16,086	1	$18,726	1	$15,809	17	$493,768
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$4,385	1	$83,248	1	$16,348	1	$14,512	1	$46,775	1	$7,853	1	$9,652	1	$11,235	1	$9,486	17	$296,261
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																				
6	110	502	Excavation - channel	CY	$4.00	32,780	$131,120																	407,060	$1,628,240
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																				
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																				
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	47,546	$23,773	22,513	$11,257	5,573	$2,787	6,444	$3,222	10,622	$5,311	3,540	$1,770	5,398	$2,699	5,833	$2,917	3,060	$1,530	569,127	$284,563
10	162	509	Block sod (St. Augustine)	SY	$2.00			5,628	$11,257	1,393	$2,787	1,611	$3,222	2,656	$5,311	885	$1,770	1,349	$2,699	1,458	$2,917	765	$1,530	18,053	$36,107
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	47,546	$35,660	16,885	$12,664	4,180	$3,135	4,833	$3,625	7,967	$5,975	2,655	$1,991	4,048	$3,036	4,375	$3,281	2,295	$1,721	551,073	$413,305
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00			11,257	$22,513	2,787	$5,573	3,222	$6,444	5,311	$10,622	1,770	$3,540	2,699	$5,398	2,917	$5,833	1,530	$3,060	119,660	$239,319
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00	15,849	$79,244																	109,936	$549,679
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00			16,885	$118,195	4,180	$29,260	4,833	$33,833	7,967	$55,767	2,655	$18,585	4,048	$28,338	4,375	$30,625	2,295	$16,065	54,160	$379,120
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00			16,885	$101,310	4,180	$25,080	4,833	$29,000	7,967	$47,800	2,655	$15,930	4,048	$24,290	4,375	$26,250	2,295	$13,770	54,160	$324,960
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50			81	$365	20	$90	23	$104	38	$172	13	$57	19	$87	21	$95	11	$50	260	$1,170
17	402	501	Trench Safety Protection	LF	$1.25			10,131	$12,664	2,508	$3,135	2,900	$3,625	4,780	$5,975	1,593	$1,991	2,429	$3,036	2,625	$3,281	1,377	$1,721	32,496	$40,620
18	423	508	Retaining walls (cast in place)	SF	$25.00																				
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																				
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																				
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00									1,051	$183,925					733	$128,275	1,377	$240,975	3,978	$696,150
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00			861	$193,725	1,170	$263,250	816	$183,600							521	$117,225			4,729	$1,064,025
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00			1,682	$504,600					1,029	$308,700									2,711	$813,300
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																				
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00			5,697	$2,848,500	160	$80,000			1,771	$885,500									7,628	$3,814,000
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																				
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00									707	$530,250									707	$530,250
28	422	501	Bridge 1 - straightforward	SF	$35.00																			38,599	$1,350,965
29	422	501	Bridge 2 - straightforward	SF	$35.00																			10,430	$365,050
30	422	501	Bridge 3 - straightforward	SF	$35.00																			10,842	$379,470
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																				
32	464	505	RCP - Class III - 24"	LF	$40.00																				
33	464	509	RCP - Class III - 36"	LF	$50.00							718	$35,900			258	$12,900	616	$30,800	519	$25,950			2,111	$105,550
34	464	510	RCP - Class III - 42"	LF	$70.00																			1,409	$98,630
35	464	511	RCP - Class III - 48"	LF	$90.00					1,178	$106,020	1,366	$122,940	222	$19,980					852	$76,680			3,618	$325,620
36	464	512	RCP - Class III - 54"	LF	$120.00																			566	$67,920
37	464	513	RCP - Class III - 60"	LF	$150.00			1,891	$283,650							1,335	$200,250	1,813	$271,950					5,039	$755,850
38	464	514	RCP - Class III - 66"	LF	$175.00																				
39	464	515	RCP - Class III - 72"	LF	$200.00																				
40	464	516	RCP - Class III - 78"	LF	$225.00																				
41	464	517	RCP - Class III - 84"	LF	$275.00																				
42	464	518	RCP - Class III - 96"	LF	$325.00																				
43	465	547	Inlet - Single	EA	$7,000.00			20	$140,000	20	$140,000	20	$140,000	30	$210,000	10	$70,000	11	$77,000	10	$70,000	15	$105,000	146	$1,022,000
44	465	548	Inlet - Double	EA	$10,000.00			30	$300,000	15	$150,000	10	$100,000	30	$300,000	10	$100,000	5	$50,000	10	$100,000	10	$100,000	150	$1,500,000
45	465	549	Inlet - Triple	EA	$13,000.00			30	$390,000	10	$130,000	10	$130,000	20	$260,000							5	$65,000	75	$975,000
46	465	536	Drainage MH or JB	EA	$5,000.00			20	$101,310	5	$25,080	6	$29,000	10	$47,800	3	$15,930	5	$24,290	5	$26,250	3	$13,770	65	$324,960
47	466	501	Headwall - small	EA	$2,500.00																				
48	466	501	Headwall - large	EA	$4,000.00																			1	$4,000
49	529	511	Concrete Curb and Gutter	LF	$6.50			5,066	$32,926	1,254	$8,151	1,450	$9,425	2,390	$15,535	797	$5,177	1,215	$7,894	1,313	$8,531	689	$4,475	16,248	$105,612
50	529	521	Concrete Valley Gutter	LF	$10.00																				
51	530	604	Remove & Replace Driveway	EA	$3,000.00			101	$303,930	25	$75,240	29	$87,000	48	$143,400	16	$47,790	24	$72,870	26	$78,750	14	$41,310	325	$974,880
52	531	502	Sidewalk	SY	$50.00			2,026	$101,310	502	$25,080	580	$29,000	956	$47,800	319	$15,930	486	$24,290	525	$26,250	275	$13,770	6,499	$324,960
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																				
54	560	501	Mailbox Assembly	EA	$400.00			101	$40,524	25	$10,032	29	$11,600	48	$19,120	16	$6,372	24	$9,716	26	$10,500	14	$5,508	325	$129,984
55	580	none	Project Maintenance (subsidiary)																						
56	COA-594	none	Gabions	CY	$150.00																				
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																				
58	639	none	Rock Berm	LF	$900.00																				
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	775	$1,938	3,377	$8,443	836	$2,090	967	$2,417	1,593	$3,983	531	$1,328	810	$2,024	875	$2,188	459	$1,148	17,103	$42,757
60	1610	none	Preservation of Trees (Type C)	EA	$100.00			101	$10,131	25	$2,508	29	$2,900	48	$4,780	16	$1,593	24	$2,429	26	$2,625	14	$1,377	325	$32,496
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	17	$10,200
62	Special	none	Conlock II pavers	SY	$27.00																				
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00	1	$20,000																	2	$40,000
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																				
65	420	none	Pump		$175,000.00																				
66	xx	xx																							
End of Current BASE BID specification items and unit prices																									
			Contingency =	15%			$47,797		$907,404		$178,198		$158,179		$509,843		$85,593		$105,204		$122,465		$103,394		$3,229,241
			TOTAL BASE BID (suject to revision)				$366,442		$6,956,765		$1,366,187		#########		$3,908,797		$656,213		$806,561		$938,900		$792,688		$24,757,518
			(cost per linear foot =)				$156		$687		$545		$418		$818		$412		$332		$358		$576		$481

CITY OF VICTORIA
South Outfall
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999)

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	Reach R0A		Reach R45A		Reach R76A		SO 1:1		SO 1:2		SO 1:3		SO 1:4		**SOUTH OUTFALL Overall Project**	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	**Quantity**	**Total $**
			Length of individual Reach (feet)			3,342		3,263		1,130		7,944		6,069		2,341		1,953		26,042	
			Estimated ROW width needed for excavated open channel (feet)			155		168		143											
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$16,886	1	$26,796	1	$4,632	1	$116,999	1	$90,385	1	$27,913	1	$17,429	7	$301,040
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$4,221	1	$6,699	1	$1,158	1	$29,250	1	$22,596	1	$6,978	1	$4,357	7	$75,260
3	500	501	Mobilization	LS	2.5%	1	$10,553	1	$16,748	1	$2,895	1	$73,124	1	$56,491	1	$17,445	1	$10,893	7	$188,150
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$6,332	1	$10,049	1	$1,737	1	$43,874	1	$33,894	1	$10,467	1	$6,536	7	$112,890
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																
6	110	502	Excavation - channel	CY	$4.00	48,900	$195,600	28,770	$115,080	10,080	$40,320									87,750	$351,000
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	58,903	$29,451	62,486	$31,243	18,501	$9,250	17,653	$8,827	13,487	$6,743	5,202	$2,601	4,340	$2,170	180,572	$90,286
10	162	509	Block sod (St. Augustine)	SY	$2.00							4,413	$8,827	3,372	$6,743	1,301	$2,601	1,085	$2,170	10,171	$20,341
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	58,903	$44,177	62,486	$46,865	18,501	$13,875	13,240	$9,930	10,115	$7,586	3,902	$2,926	3,255	$2,441	170,401	$127,801
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	29,451	$58,903					8,827	$17,653	6,743	$13,487	2,601	$5,202	2,170	$4,340	49,792	$99,585
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00			20,829	$104,144	6,167	$30,834									26,996	$134,978
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00							13,240	$92,680	10,115	$70,805	3,902	$27,312	3,255	$22,785	30,512	$213,582
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00							13,240	$79,440	10,115	$60,690	3,902	$23,410	3,255	$19,530	30,512	$183,070
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50							64	$286	49	$218	19	$84	16	$70	146	$659
17	402	501	Trench Safety Protection	LF	$1.25							7,944	$9,930	6,069	$7,586	2,341	$2,926	1,953	$2,441	18,307	$22,884
18	423	508	Retaining walls (cast in place)	SF	$25.00																
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00							3,357	$587,475	644	$112,700					4,001	$700,175
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00									1,492	$335,700	1,174	$264,150			2,666	$599,850
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00							3,248	$974,400	2,476	$742,800					5,724	$1,717,200
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00																
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00																
28	422	501	Bridge 1 - straightforward	SF	$35.00	2,590	$90,650	2,730	$95,550											5,320	$186,200
29	422	501	Bridge 2 - straightforward	SF	$35.00			2,870	$100,450											2,870	$100,450
30	422	501	Bridge 3 - straightforward	SF	$35.00			3,808	$133,280											3,808	$133,280
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																
32	464	505	RCP - Class III - 24"	LF	$40.00							564	$22,560	746	$29,840					1,310	$52,400
33	464	509	RCP - Class III - 36"	LF	$50.00									711	$35,550			751	$37,550	1,462	$73,100
34	464	510	RCP - Class III - 42"	LF	$70.00											1,167	$81,690			1,167	$81,690
35	464	511	RCP - Class III - 48"	LF	$90.00																
36	464	512	RCP - Class III - 54"	LF	$120.00							775	$93,000					1,202	$144,240	1,977	$237,240
37	464	513	RCP - Class III - 60"	LF	$150.00																
38	464	514	RCP - Class III - 66"	LF	$175.00																
39	464	515	RCP - Class III - 72"	LF	$200.00																
40	464	516	RCP - Class III - 78"	LF	$225.00																
41	464	517	RCP - Class III - 84"	LF	$275.00																
42	464	518	RCP - Class III - 96"	LF	$325.00																
43	465	547	Inlet - Single	EA	$7,000.00							20	$140,000	20	$140,000	10	$70,000	6	$42,000	56	$392,000
44	465	548	Inlet - Double	EA	$10,000.00							15	$150,000	20	$200,000	5	$50,000	4	$40,000	44	$440,000
45	465	549	Inlet - Triple	EA	$13,000.00							20	$260,000	10	$130,000	2	$26,000			32	$416,000
46	465	536	Drainage MH or JB	EA	$5,000.00							16	$79,440	12	$60,690	5	$23,410	4	$19,530	37	$183,070
47	466	501	Headwall - small	EA	$2,500.00																
48	466	501	Headwall - large	EA	$4,000.00																
49	529	511	Concrete Curb and Gutter	LF	$6.50							3,972	$25,818	3,035	$19,724	1,171	$7,608	977	$6,347	9,154	$59,498
50	529	521	Concrete Valley Gutter	LF	$10.00																
51	530	604	Remove & Replace Driveway	EA	$3,000.00							79	$238,320	61	$182,070	23	$70,230	20	$58,590	183	$549,210
52	531	502	Sidewalk	SY	$50.00							1,589	$79,440	1,214	$60,690	468	$23,410	391	$19,530	3,661	$183,070
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																
54	560	501	Mailbox Assembly	EA	$400.00							79	$31,776	61	$24,276	23	$9,364	20	$7,812	183	$73,228
55	580	none	Project Maintenance (subsidiary)																		
56	COA-594	none	Gabions	CY	$150.00																
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																
58	639	none	Rock Berm	LF	$900.00																
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	1,103	$2,757	1,077	$2,692	373	$932	2,648	$6,620	2,023	$5,058	780	$1,951	651	$1,628	8,655	$21,637
60	1610	none	Preservation of Trees (Type C)	EA	$100.00							79	$7,944	61	$6,069	23	$2,341	20	$1,953	183	$18,307
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	7	$4,200
62	Special	none	Conlock II pavers	SY	$27.00																
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00			2	$40,000	1	$20,000									3	$60,000
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																
65	420	none	Pump		$175,000.00																
66	xx	xx																			
End of Current BASE BID specification items and unit prices																					
			Contingency =	15%			$69,020		$109,529		$18,935		$478,232		$369,449		$114,093		$71,241		$1,230,499
			TOTAL BASE BID (suject to revision)				$529,150		$839,724		$145,170		$3,666,444		$2,832,441		$874,714		$546,184		$9,433,829
			(cost per linear foot =)				$158		$257		$128		$462		$467		$374		$280		$362

CITY OF VICTORIA
Second Street Outfall
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999)

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	SS 1:1		SS 1:2		SS 1:3		SS 2:1		SS 2:1 Diversion		SS 2:1 Pump		SS 2:2		SS 2:3		SS 2:4	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $
			Length of individual Reach (feet)			3,779		3,605		1,442		6,250		655						2,028		369	
			Estimated ROW width needed for excavated open channel (feet)																				
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$64,204	1	$56,737	1	$20,016	1	$84,207	1	$6,908	1	$13,490		$1,640	1	$16,013	1	$5,952
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$16,051	1	$14,184	1	$5,004	1	$21,052	1	$1,727	1	$3,373		$410	1	$4,003	1	$1,488
3	500	501	Mobilization	LS	2.5%	1	$40,128	1	$35,460	1	$12,510	1	$52,629	1	$4,317	1	$8,431		$1,025	1	$10,008	1	$3,720
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$24,077	1	$21,276	1	$7,506	1	$31,578	1	$2,590	1	$5,059		$615	1	$6,005	1	$2,232
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																		
6	110	502	Excavation - channel	CY	$4.00											11,000	$44,000						
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																		
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																		
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	8,398	$4,199	8,011	$4,006	3,204	$1,602	13,889	$6,944	1,456	$728					4,507	$2,253	820	$410
10	162	509	Block sod (St. Augustine)	SY	$2.00	2,099	$4,199	2,003	$4,006	801	$1,602	3,472	$6,944	364	$728					1,127	$2,253	205	$410
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	6,298	$4,724	6,008	$4,506	2,403	$1,803	10,417	$7,813	1,092	$819	7,000	$5,250			3,380	$2,535	615	$461
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	4,199	$8,398	4,006	$8,011	1,602	$3,204	6,944	$13,889	728	$1,456					2,253	$4,507	410	$820
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00																		
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00	6,298	$44,088	6,008	$42,058	2,403	$16,823	10,417	$72,917	1,092	$7,642					3,380	$23,660	615	$4,305
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00	6,298	$37,790	6,008	$36,050	2,403	$14,420	10,417	$62,500	1,092	$6,550					3,380	$20,280	615	$3,690
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50	30	$136	29	$130	12	$52	50	$225	5	$24					16	$73	3	$13
17	402	501	Trench Safety Protection	LF	$1.25	3,779	$4,724	3,605	$4,506	1,442	$1,803	6,250	$7,813	655	$819					2,028	$2,535	369	$461
18	423	508	Retaining walls (cast in place)	SF	$25.00																		
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																		
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																		
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00							3,690	$645,750	655	$114,625	360	$63,000						
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00	1,168	$262,800					983	$221,175										
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00	347	$104,100	1,626	$487,800														
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																		
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00	1,259	$629,500																
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																		
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00																		
28	422	501	Bridge 1 - straightforward	SF	$35.00																		
29	422	501	Bridge 2 - straightforward	SF	$35.00																		
30	422	501	Bridge 3 - straightforward	SF	$35.00																		
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																		
32	464	505	RCP - Class III - 24"	LF	$40.00															335	$13,400		
33	464	509	RCP - Class III - 36"	LF	$50.00	347	$17,350	939	$46,950			1,315	$65,750							335	$16,750		
34	464	510	RCP - Class III - 42"	LF	$70.00															1,028	$71,960	369	$25,830
35	464	511	RCP - Class III - 48"	LF	$90.00	658	$59,220					262	$23,580							330	$29,700		
36	464	512	RCP - Class III - 54"	LF	$120.00			1,040	$124,800														
37	464	513	RCP - Class III - 60"	LF	$150.00					1,442	$216,300												
38	464	514	RCP - Class III - 66"	LF	$175.00																		
39	464	515	RCP - Class III - 72"	LF	$200.00																		
40	464	516	RCP - Class III - 78"	LF	$225.00																		
41	464	517	RCP - Class III - 84"	LF	$275.00																		
42	464	518	RCP - Class III - 96"	LF	$325.00																		
43	465	547	Inlet - Single	EA	$7,000.00	5	$35,000	16	$112,000	11	$77,000	20	$140,000					3	$21,000	3	$21,000	3	$21,000
44	465	548	Inlet - Double	EA	$10,000.00	10	$100,000	20	$200,000	8	$80,000	20	$200,000					2	$20,000	3	$30,000	3	$30,000
45	465	549	Inlet - Triple	EA	$13,000.00	5	$65,000	10	$130,000			20	$260,000							3	$39,000	3	$39,000
46	465	536	Drainage MH or JB	EA	$5,000.00	8	$37,790	7	$36,050	3	$14,420	13	$62,500	1	$6,550					4	$20,280	1	$3,690
47	466	501	Headwall - small	EA	$2,500.00																		
48	466	501	Headwall - large	EA	$4,000.00																		
49	529	511	Concrete Curb and Gutter	LF	$6.50	1,890	$12,282	1,803	$11,716	721	$4,687	3,125	$20,313	328	$2,129					1,014	$6,591	185	$1,199
50	529	521	Concrete Valley Gutter	LF	$10.00																		
51	530	604	Remove & Replace Driveway	EA	$3,000.00	38	$113,370	36	$108,150	14	$43,260	63	$187,500	7	$19,650					20	$60,840	4	$11,070
52	531	502	Sidewalk	SY	$50.00	756	$37,790	721	$36,050	288	$14,420	1,250	$62,500	131	$6,550					406	$20,280	74	$3,690
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																		
54	560	501	Mailbox Assembly	EA	$400.00	38	$15,116	36	$14,420	14	$5,768	63	$25,000	7	$2,620					20	$8,112	4	$1,476
55	580	none	Project Maintenance (subsidiary)																				
56	COA-594	none	Gabions	CY	$150.00																		
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																		
58	639	none	Rock Berm	LF	$900.00																		
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	1,260	$3,149	1,202	$3,004	481	$1,202	2,083	$5,208	218	$546					676	$1,690	123	$308
60	1610	none	Preservation of Trees (Type C)	EA	$100.00	38	$3,779	36	$3,605	14	$1,442	63	$6,250	7	$655					20	$2,028	4	$369
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600					1	$600	1	$600
62	Special	none	Conlock II pavers	SY	$27.00																		
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00																		
64	420	none	Pump Housing (metal building, concrete pad, sumps, outlet works)		$50,000.00											1	$50,000						
65	420	none	Pump		$175,000.00											1	$175,000						
66	xx	xx																					
End of Current BASE BID specification items and unit prices																							
			Contingency =	15%			$262,434		$231,911		$81,817		$344,195		$28,235		$55,140		$6,704		$65,454		$24,329
			TOTAL BASE BID (suject to revision)				$2,011,997		$1,777,987		$627,261		$2,638,831		$216,465		$422,743		$51,394		$501,810		$186,524
			(cost per linear foot =)				$532		$493		$435		$422		$330						$247		$505

CITY OF VICTORIA
Second Street Outfall
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	SS 2:5		SS 2:6		SS 2:7		SS 2:8		**Second Street Overall Project**	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	**Quantity**	**Total $**
			Length of individual Reach (feet)			2,322		1,395		1,385		2,652		25,227	
			Estimated ROW width needed for excavated open channel (feet)												
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$23,178	1	$29,596	1	$11,634	1	$25,853		$339,031
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$5,795	1	$7,399	1	$2,909	1	$6,463		$84,758
3	500	501	Mobilization	LS	2.5%	1	$14,486	1	$18,498	1	$7,271	1	$16,158		$211,894
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$8,692	1	$11,099	1	$4,363	1	$9,695		$127,136
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00										
6	110	502	Excavation - channel	CY	$4.00										
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00										
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00										
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	5,160	$2,580	3,100	$1,550	3,078	$1,539	5,893	$2,947		$28,030
10	162	509	Block sod (St. Augustine)	SY	$2.00	1,290	$2,580	775	$1,550	769	$1,539	1,473	$2,947		$28,030
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	3,870	$2,903	2,325	$1,744	2,308	$1,731	4,420	$3,315		$31,534
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	2,580	$5,160	1,550	$3,100	1,539	$3,078	2,947	$5,893		$56,060
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00										
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00	3,870	$27,090	2,325	$16,275	2,308	$16,158	4,420	$30,940		$294,315
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00	3,870	$23,220	2,325	$13,950	2,308	$13,850	4,420	$26,520		$252,270
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50	19	$84	11	$50	11	$50	21	$95		$908
17	402	501	Trench Safety Protection	LF	$1.25	2,322	$2,903	1,395	$1,744	1,385	$1,731	2,652	$3,315		$31,534
18	423	508	Retaining walls (cast in place)	SF	$25.00										
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00										
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00										
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00										$645,750
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00			717	$161,325						$645,300
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00										$591,900
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00										
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00										$629,500
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00										
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00										
28	422	501	Bridge 1 - straightforward	SF	$35.00										
29	422	501	Bridge 2 - straightforward	SF	$35.00										
30	422	501	Bridge 3 - straightforward	SF	$35.00										
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00										
32	464	505	RCP - Class III - 24"	LF	$40.00										$13,400
33	464	509	RCP - Class III - 36"	LF	$50.00					660	$33,000	329	$16,450		$196,250
34	464	510	RCP - Class III - 42"	LF	$70.00	1,002	$70,140			725	$50,750	661	$46,270		$264,950
35	464	511	RCP - Class III - 48"	LF	$90.00							666	$59,940		$172,440
36	464	512	RCP - Class III - 54"	LF	$120.00										$124,800
37	464	513	RCP - Class III - 60"	LF	$150.00	1,320	$198,000					996	$149,400		$563,700
38	464	514	RCP - Class III - 66"	LF	$175.00										
39	464	515	RCP - Class III - 72"	LF	$200.00			678	$135,600						$135,600
40	464	516	RCP - Class III - 78"	LF	$225.00										
41	464	517	RCP - Class III - 84"	LF	$275.00										
42	464	518	RCP - Class III - 96"	LF	$325.00										
43	465	547	Inlet - Single	EA	$7,000.00	4	$28,000	15	$105,000	5	$35,000	5	$35,000		$630,000
44	465	548	Inlet - Double	EA	$10,000.00	4	$40,000	15	$150,000	5	$50,000	8	$80,000		$980,000
45	465	549	Inlet - Triple	EA	$13,000.00	3	$39,000	5	$65,000			2	$26,000		$663,000
46	465	536	Drainage MH or JB	EA	$5,000.00	5	$23,220	3	$13,950	3	$13,850	5	$26,520		$252,270
47	466	501	Headwall - small	EA	$2,500.00										
48	466	501	Headwall - large	EA	$4,000.00										
49	529	511	Concrete Curb and Gutter	LF	$6.50	1,161	$7,547	698	$4,534	693	$4,501	1,326	$8,619		$81,988
50	529	521	Concrete Valley Gutter	LF	$10.00										
51	530	604	Remove & Replace Driveway	EA	$3,000.00	23	$69,660	14	$41,850	14	$41,550	27	$79,560		$756,810
52	531	502	Sidewalk	SY	$50.00	464	$23,220	279	$13,950	277	$13,850	530	$26,520		$252,270
53	550	501	Chain Link Fence - 6ft.	LF	$10.00										
54	560	501	Mailbox Assembly	EA	$400.00	23	$9,288	14	$5,580	14	$5,540	27	$10,608		$100,908
55	580	none	Project Maintenance (subsidiary)												
56	COA-594	none	Gabions	CY	$150.00										
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00										
58	639	none	Rock Berm	LF	$900.00										
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	774	$1,935	465	$1,163	462	$1,154	884	$2,210		$21,023
60	1610	none	Preservation of Trees (Type C)	EA	$100.00	23	$2,322	14	$1,395	14	$1,385	27	$2,652		$25,227
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600		$6,000
62	Special	none	Conlock II pavers	SY	$27.00										
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00										
64	420	none	Pump Housing (metal building, concrete pad, sumps, outlet works)		$50,000.00										
65	420	none	Pump		$175,000.00										
66	xx	xx													
End of Current BASE BID specification items and unit prices															
			Contingency =	15%			$94,740		$120,975		$47,555		$105,674		$1,385,788
			TOTAL BASE BID (suject to revision)				$726,341		$927,476		$364,589		$810,164		$10,624,373
			(cost per linear foot =)				$313		$665		$263		$305		$421

CITY OF VICTORIA
West Outfall
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999)

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	Reach R0A		Reach R0B		Reach R20A		Reach R32		Reach R48		Reach R67		Reach R85A		Reach R100A		Bridge Reach R101A		Bridge Reach R113A	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $
			Length of individual Reach (feet)			441		1,869		676		1,659		1,964		1,753		1,462		948		433		1,274	
			Estimated ROW width needed for excavated open channel (feet)			455		413		378		378		366		261		128		129					
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$9,007	1	$28,007	1	$17,494	1	$22,139	1	$25,683	1	$34,099	1	$57,536	1	$1,590	1	$8,371	1	$9,788
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$2,252	1	$7,002	1	$4,374	1	$5,535	1	$6,421	1	$8,525	1	$14,384	1	$397	1	$2,093	1	$2,447
3	500	501	Mobilization	LS	2.5%	1	$5,629	1	$17,504	1	$10,934	1	$13,837	1	$16,052	1	$21,312	1	$35,960	1	$993		$5,232		$6,117
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$3,378	1	$10,503	1	$6,560	1	$8,302	1	$9,631	1	$12,787	1	$21,576	1	$596		$3,139		$3,670
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																				
6	110	502	Excavation - channel	CY	$4.00	43,310	$173,240	125,640	$502,560	92,950	$371,800	98,370	$393,480	109,690	$438,760	33,260	$133,040	14,420	$57,680	1,280	$5,120				
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																				
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																				
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	22,653	$11,326	86,877	$43,438	28,620	$14,310	70,237	$35,118	80,486	$40,243	51,351	$25,676	22,526	$11,263	14,772	$7,386				
10	162	509	Block sod (St. Augustine)	SY	$2.00																				
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	22,653	$16,990	86,877	$65,158	28,620	$21,465	70,237	$52,678	80,486	$60,364	51,351	$38,513	22,526	$16,895	14,772	$11,079				
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	11,326	$22,653	43,438	$86,877	14,310	$28,620	35,118	$70,237	40,243	$80,486	25,676	$51,351			7,386	$14,772				
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00													7,509	$37,544						
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00																				
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00																				
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50																				
17	402	501	Trench Safety Protection	LF	$1.25																				
18	423	508	Retaining walls (cast in place)	SF	$25.00																				
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																				
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																				
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00																				
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00																				
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00																				
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																				
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00																				
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																				
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00																				
28	422	501	Bridge 1 - straightforward	SF	$35.00											11,036	$386,260	11,349	$397,215			5,952	$208,320	6,944	$243,040
29	422	501	Bridge 2 - straightforward	SF	$35.00											6,160	$215,600	25,600	$896,000						
30	422	501	Bridge 3 - straightforward	SF	$35.00																				
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																				
32	464	505	RCP - Class III - 24"	LF	$40.00																				
33	464	509	RCP - Class III - 36"	LF	$50.00																				
34	464	510	RCP - Class III - 42"	LF	$70.00																				
35	464	511	RCP - Class III - 48"	LF	$90.00																				
36	464	512	RCP - Class III - 54"	LF	$120.00																				
37	464	513	RCP - Class III - 60"	LF	$150.00																				
38	464	514	RCP - Class III - 66"	LF	$175.00																				
39	464	515	RCP - Class III - 72"	LF	$200.00																				
40	464	516	RCP - Class III - 78"	LF	$225.00																				
41	464	517	RCP - Class III - 84"	LF	$275.00																				
42	464	518	RCP - Class III - 96"	LF	$325.00																				
43	465	547	Inlet - Single	EA	$7,000.00																				
44	465	548	Inlet - Double	EA	$10,000.00																				
45	465	549	Inlet - Triple	EA	$13,000.00																				
46	465	536	Drainage MH or JB	EA	$5,000.00																				
47	466	501	Headwall - small	EA	$2,500.00																				
48	466	501	Headwall - large	EA	$4,000.00																				
49	529	511	Concrete Curb and Gutter	LF	$6.50																				
50	529	521	Concrete Valley Gutter	LF	$10.00																				
51	530	604	Remove & Replace Driveway	EA	$3,000.00																				
52	531	502	Sidewalk	SY	$50.00																				
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																				
54	560	501	Mailbox Assembly	EA	$400.00																				
55	580	none	Project Maintenance (subsidiary)																						
56	COA-594	none	Gabions	CY	$150.00																				
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																				
58	639	none	Rock Berm	LF	$900.00																				
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	146	$364	617	$1,542	223	$558	547	$1,369	648	$1,620	578	$1,446	482	$1,206	313	$782	143	$357	420	$1,051
60	1610	none	Preservation of Trees (Type C)	EA	$100.00																				
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600
62	Special	none	Conlock II pavers	SY	$27.00																				
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00									1	$20,000			1	$20,000						
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																				
65	420	none	Pump		$175,000.00																				
66	xx	xx																							
End of Current BASE BID specification items and unit prices																									
			Contingency =	15%			$36,816		$114,479		$71,507		$90,494		$104,979		$139,381		$235,179		$6,497		$34,217		$40,007
			TOTAL BASE BID (suject to revision)				$282,254		$877,669		$548,221		$693,789		$804,839		$1,068,591		$1,803,038		$49,812		$262,329		$306,720
			(cost per linear foot =)				$640		$470		$811		$418		$410		$610		$1,233		$53		$606		$241

CITY OF VICTORIA
West Outfall
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	WO 1:1		WO 1:2		WO 1:3		WO 2:2		WO 2:3		WO 2:4		WO 2:5		WO 2:6		WO 2:7	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $
			Length of individual Reach (feet)			4,361				2,771				4,349		3,802		6,268		1,431		1,978	
			Estimated ROW width needed for excavated open channel (feet)																				
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$63,564		$2,320	1	$26,229		$3,400	1	$51,082	1	$37,685	1	$129,978	1	$22,327	1	$25,893
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$15,891		$580	1	$6,557		$850	1	$12,770	1	$9,421	1	$32,495	1	$5,582	1	$6,473
3	500	501	Mobilization	LS	2.5%	1	$39,728		$1,450	1	$16,393		$2,125	1	$31,926	1	$23,553	1	$81,236	1	$13,955	1	$16,183
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$23,837		$870	1	$9,836		$1,275	1	$19,156	1	$14,132	1	$48,742	1	$8,373	1	$9,710
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																		
6	110	502	Excavation - channel	CY	$4.00																		
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																		
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																		
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	9,691	$4,846			6,158	$3,079			9,664	$4,832	8,449	$4,224	13,929	$6,964	3,180	$1,590	4,396	$2,198
10	162	509	Block sod (St. Augustine)	SY	$2.00	2,423	$4,846			1,539	$3,079			2,416	$4,832	2,112	$4,224	3,482	$6,964	795	$1,590	1,099	$2,198
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	7,268	$5,451			4,618	$3,464			7,248	$5,436	6,337	$4,753	10,447	$7,835	2,385	$1,789	3,297	$2,473
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	4,846	$9,691			3,079	$6,158			4,832	$9,664	4,224	$8,449	6,964	$13,929	1,590	$3,180	2,198	$4,396
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00																		
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00	7,268	$50,878			4,618	$32,328			7,248	$50,738	6,337	$44,357	10,447	$73,127	2,385	$16,695	3,297	$23,077
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00	7,268	$43,610			4,618	$27,710			7,248	$43,490	6,337	$38,020	10,447	$62,680	2,385	$14,310	3,297	$19,780
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50	35	$157			22	$100			35	$157	30	$137	50	$226	11	$52	16	$71
17	402	501	Trench Safety Protection	LF	$1.25	4,361	$5,451			2,771	$3,464			4,349	$5,436	3,802	$4,753	6,268	$7,835	1,431	$1,789	1,978	$2,473
18	423	508	Retaining walls (cast in place)	SF	$25.00																		
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																		
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																		
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00	1,679	$293,825							3,162	$553,350					310	$54,250	1,015	$177,625
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00													997	$224,325	755	$169,875		
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00	1,845	$553,500																
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																		
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00													3,624	$1,812,000				
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																		
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00																		
28	422	501	Bridge 1 - straightforward	SF	$35.00																		
29	422	501	Bridge 2 - straightforward	SF	$35.00																		
30	422	501	Bridge 3 - straightforward	SF	$35.00																		
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																		
32	464	505	RCP - Class III - 24"	LF	$40.00																		
33	464	509	RCP - Class III - 36"	LF	$50.00					743	$37,150												
34	464	510	RCP - Class III - 42"	LF	$70.00	837	$58,590									1,404	$98,280						
35	464	511	RCP - Class III - 48"	LF	$90.00					616	$55,440			496	$44,640								
36	464	512	RCP - Class III - 54"	LF	$120.00					1,412	$169,440			691	$82,920			1,647	$197,640	366	$43,920	963	$115,560
37	464	513	RCP - Class III - 60"	LF	$150.00											2,398	$359,700						
38	464	514	RCP - Class III - 66"	LF	$175.00																		
39	464	515	RCP - Class III - 72"	LF	$200.00																		
40	464	516	RCP - Class III - 78"	LF	$225.00																		
41	464	517	RCP - Class III - 84"	LF	$275.00																		
42	464	518	RCP - Class III - 96"	LF	$325.00																		
43	465	547	Inlet - Single	EA	$7,000.00	10	$70,000	4	$28,000	5	$35,000	5	$35,000	7	$49,000	5	$35,000	10	$70,000	7	$49,000	6	$42,000
44	465	548	Inlet - Double	EA	$10,000.00	10	$100,000	3	$30,000	5	$50,000	5	$50,000	10	$100,000	5	$50,000	20	$200,000	5	$50,000	6	$60,000
45	465	549	Inlet - Triple	EA	$13,000.00	10	$130,000			5	$65,000			5	$65,000	5	$65,000	15	$195,000	5	$65,000	6	$78,000
46	465	536	Drainage MH or JB	EA	$5,000.00	9	$43,610			6	$27,710			9	$43,490	8	$38,020	13	$62,680	3	$14,310	4	$19,780
47	466	501	Headwall - small	EA	$2,500.00																		
48	466	501	Headwall - large	EA	$4,000.00																		
49	529	511	Concrete Curb and Gutter	LF	$6.50	2,181	$14,173			1,386	$9,006			2,175	$14,134	1,901	$12,357	3,134	$20,371	716	$4,651	989	$6,429
50	529	521	Concrete Valley Gutter	LF	$10.00																		
51	530	604	Remove & Replace Driveway	EA	$3,000.00	44	$130,830			28	$83,130			43	$130,470	38	$114,060	63	$188,040	14	$42,930	20	$59,340
52	531	502	Sidewalk	SY	$50.00	872	$43,610			554	$27,710			870	$43,490	760	$38,020	1,254	$62,680	286	$14,310	396	$19,780
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																		
54	560	501	Mailbox Assembly	EA	$400.00	44	$17,444			28	$11,084			43	$17,396	38	$15,208	63	$25,072	14	$5,724	20	$7,912
55	580	none	Project Maintenance (subsidiary)																				
56	COA-594	none	Gabions	CY	$150.00																		
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																		
58	639	none	Rock Berm	LF	$900.00																		
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	1,454	$3,634			924	$2,309			1,450	$3,624	1,267	$3,168	2,089	$5,223	477	$1,193	659	$1,648
60	1610	none	Preservation of Trees (Type C)	EA	$100.00	44	$4,361			28	$2,771			43	$4,349	38	$3,802	63	$6,268	14	$1,431	20	$1,978
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600			1	$600			1	$600	1	$600	1	$600	1	$600	1	$600
62	Special	none	Conlock II pavers	SY	$27.00																		
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00																		
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																		
65	420	none	Pump		$175,000.00																		
66	xx	xx																					
End of Current BASE BID specification items and unit prices																							
			Contingency =	15%			$259,819		$9,483		$107,212		$13,898		$208,798		$154,038		$531,287		$91,264		$105,836
			TOTAL BASE BID (suject to revision)				$1,991,946		$72,703		$821,959		$106,548		$1,600,782		$1,180,961		$4,073,197		$699,688		$811,410
			(cost per linear foot =)				$457				$297				$368		$311		$650		$489		$410

CITY OF VICTORIA
West Outfall
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	WO 3:1		WO 3:8		WO 3:9		WO 3:10		WO 3:11		WO 3:12		WO 3:13		WO 3:14		WO 3:15	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $
			Length of individual Reach (feet)			7,148		3,267		3,772				3,367		1,072		558		1,217		1,502	
			Estimated ROW width needed for excavated open channel (feet)																				
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$214,224	1	$53,320	1	$68,223		$2,320	1	$36,202	1	$8,352	1	$4,458	1	$8,089	1	$19,729
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$53,556	1	$13,330	1	$17,056		$580	1	$9,050	1	$2,088	1	$1,115	1	$2,022	1	$4,932
3	500	501	Mobilization	LS	2.5%	1	$133,890	1	$33,325	1	$42,639		$1,450	1	$22,626	1	$5,220	1	$2,786	1	$5,055	1	$12,331
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$80,334	1	$19,995	1	$25,584		$870	1	$13,576	1	$3,132	1	$1,672	1	$3,033	1	$7,398
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																		
6	110	502	Excavation - channel	CY	$4.00																		
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																		
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																		
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	15,884	$7,942	7,260	$3,630	8,382	$4,191			7,482	$3,741	2,382	$1,191	1,240	$620	2,704	$1,352	3,338	$1,669
10	162	509	Block sod (St. Augustine)	SY	$2.00	3,971	$7,942	1,815	$3,630	2,096	$4,191			1,871	$3,741	596	$1,191	310	$620	676	$1,352	834	$1,669
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	11,913	$8,935	5,445	$4,084	6,287	$4,715			5,612	$4,209	1,787	$1,340	930	$698	2,028	$1,521	2,503	$1,878
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	7,942	$15,884	3,630	$7,260	4,191	$8,382			3,741	$7,482	1,191	$2,382	620	$1,240	1,352	$2,704	1,669	$3,338
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00																		
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00	11,913	$83,393	5,445	$38,115	6,287	$44,007			5,612	$39,282	1,787	$12,507	930	$6,510	2,028	$14,198	2,503	$17,523
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00	11,913	$71,480	5,445	$32,670	6,287	$37,720			5,612	$33,670	1,787	$10,720	930	$5,580	2,028	$12,170	2,503	$15,020
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50	57	$257	26	$118	30	$136			27	$121	9	$39	4	$20	10	$44	12	$54
17	402	501	Trench Safety Protection	LF	$1.25	7,148	$8,935	3,267	$4,084	3,772	$4,715			3,367	$4,209	1,072	$1,340	558	$698	1,217	$1,521	1,502	$1,878
18	423	508	Retaining walls (cast in place)	SF	$25.00																		
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																		
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																		
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00			1,786	$312,550					608	$106,400							1,502	$262,850
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00			1,481	$333,225	1,314	$295,650												
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00	948	$284,400			2,458	$737,400												
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																		
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00	1,339	$669,500																
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																		
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00	3,276	$2,457,000																
28	422	501	Bridge 1 - straightforward	SF	$35.00																		
29	422	501	Bridge 2 - straightforward	SF	$35.00																		
30	422	501	Bridge 3 - straightforward	SF	$35.00																		
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																		
32	464	505	RCP - Class III - 24"	LF	$40.00											296	$11,840						
33	464	509	RCP - Class III - 36"	LF	$50.00									552	$27,600			558	$27,900	1,217	$60,850		
34	464	510	RCP - Class III - 42"	LF	$70.00											776	$54,320						
35	464	511	RCP - Class III - 48"	LF	$90.00																		
36	464	512	RCP - Class III - 54"	LF	$120.00																		
37	464	513	RCP - Class III - 60"	LF	$150.00									2,207	$331,050								
38	464	514	RCP - Class III - 66"	LF	$175.00																		
39	464	515	RCP - Class III - 72"	LF	$200.00	1,585	$317,000																
40	464	516	RCP - Class III - 78"	LF	$225.00																		
41	464	517	RCP - Class III - 84"	LF	$275.00																		
42	464	518	RCP - Class III - 96"	LF	$325.00																		
43	465	547	Inlet - Single	EA	$7,000.00	30	$210,000	10	$70,000	13	$91,000	4	$28,000	6	$42,000	4	$28,000	2	$14,000	2	$14,000	6	$42,000
44	465	548	Inlet - Double	EA	$10,000.00	40	$400,000	20	$200,000	12	$120,000	3	$30,000	5	$50,000	2	$20,000	2	$20,000	2	$20,000	3	$30,000
45	465	549	Inlet - Triple	EA	$13,000.00	30	$390,000	10	$130,000	10	$130,000			4	$52,000							2	$26,000
46	465	536	Drainage MH or JB	EA	$5,000.00	14	$71,480	7	$32,670	8	$37,720			7	$33,670	2	$10,720	1	$5,580	2	$12,170	3	$15,020
47	466	501	Headwall - small	EA	$2,500.00																		
48	466	501	Headwall - large	EA	$4,000.00																		
49	529	511	Concrete Curb and Gutter	LF	$6.50	3,574	$23,231	1,634	$10,618	1,886	$12,259			1,684	$10,943	536	$3,484	279	$1,814	609	$3,955	751	$4,882
50	529	521	Concrete Valley Gutter	LF	$10.00																		
51	530	604	Remove & Replace Driveway	EA	$3,000.00	71	$214,440	33	$98,010	38	$113,160			34	$101,010	11	$32,160	6	$16,740	12	$36,510	15	$45,060
52	531	502	Sidewalk	SY	$50.00	1,430	$71,480	653	$32,670	754	$37,720			673	$33,670	214	$10,720	112	$5,580	243	$12,170	300	$15,020
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																		
54	560	501	Mailbox Assembly	EA	$400.00	71	$28,592	33	$13,068	38	$15,088			34	$13,468	11	$4,288	6	$2,232	12	$4,868	15	$6,008
55	580	none	Project Maintenance (subsidiary)																				
56	COA-594	none	Gabions	CY	$150.00																		
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																		
58	639	none	Rock Berm	LF	$900.00																		
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	2,383	$5,957	1,089	$2,723	1,257	$3,143			1,122	$2,806	357	$893	186	$465	406	$1,014	501	$1,252
60	1610	none	Preservation of Trees (Type C)	EA	$100.00	71	$7,148	33	$3,267	38	$3,772			34	$3,367	11	$1,072	6	$558	12	$1,217	15	$1,502
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600			1	$600	1	$600	1	$600	1	$600	1	$600
62	Special	none	Conlock II pavers	SY	$27.00																		
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00																		
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																		
65	420	none	Pump		$175,000.00																		
66	xx	xx																					
End of Current BASE BID specification items and unit prices																							
			Contingency =	15%			$875,640		$217,944		$278,861		$9,483		$147,974		$34,140		$18,223		$33,063		$80,642
			TOTAL BASE BID (suject to revision)				$6,713,241		$1,670,903		$2,137,931		$72,703		$1,134,466		$261,740		$139,707		$253,480		$618,253
			(cost per linear foot =)				$939		$511		$567				$337		$244		$250		$208		$412

CITY OF VICTORIA
West Outfall
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	WO 3:16 Quantity	WO 3:16 Sheet $	WO 3:17 Quantity	WO 3:17 Sheet $	WO 3:18 plugged Quantity	WO 3:18 plugged Sheet $	WO 3:19 plugged Quantity	WO 3:19 plugged Sheet $	WO 3:20 plugged Quantity	WO 3:20 plugged Sheet $	WO 3:21 plugged Quantity	WO 3:21 plugged Sheet $	**WEST OUTFALL Quantity**	**WEST OUTFALL Total $**
			Length of individual Reach (feet)			2,195		952										62,489	
			Estimated ROW width needed for excavated open channel (feet)																
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$25,144	1	$16,749									27	$1,033,001
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$6,286	1	$4,187									27	$258,250
3	500	501	Mobilization	LS	2.5%	1	$15,715	1	$10,468									25	$645,626
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$9,429	1	$6,281									25	$387,376
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00														
6	110	502	Excavation - channel	CY	$4.00													518,920	$2,075,680
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00														
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00														
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	4,878	$2,439	2,116	$1,058									488,654	$244,327
10	162	509	Block sod (St. Augustine)	SY	$2.00	1,219	$2,439	529	$1,058									27,783	$55,567
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	3,658	$2,744	1,587	$1,190									460,871	$345,653
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	2,439	$4,878	1,058	$2,116									233,064	$466,128
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00													7,509	$37,544
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00	3,658	$25,608	1,587	$11,107									83,350	$583,450
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00	3,658	$21,950	1,587	$9,520									83,350	$500,100
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50	18	$79	8	$34									400	$1,800
17	402	501	Trench Safety Protection	LF	$1.25	2,195	$2,744	952	$1,190									50,010	$62,513
18	423	508	Retaining walls (cast in place)	SF	$25.00														
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00														
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00														
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00	1,164	$203,700	952	$166,600									12,178	$2,131,150
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00													4,547	$1,023,075
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00													5,251	$1,575,300
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00														
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00													4,963	$2,481,500
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00														
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00													3,276	$2,457,000
28	422	501	Bridge 1 - straightforward	SF	$35.00													35,281	$1,234,835
29	422	501	Bridge 2 - straightforward	SF	$35.00													31,760	$1,111,600
30	422	501	Bridge 3 - straightforward	SF	$35.00														
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00														
32	464	505	RCP - Class III - 24"	LF	$40.00													296	$11,840
33	464	509	RCP - Class III - 36"	LF	$50.00													3,070	$153,500
34	464	510	RCP - Class III - 42"	LF	$70.00													3,017	$211,190
35	464	511	RCP - Class III - 48"	LF	$90.00													1,112	$100,080
36	464	512	RCP - Class III - 54"	LF	$120.00	1,031	$123,720											6,110	$733,200
37	464	513	RCP - Class III - 60"	LF	$150.00													4,605	$690,750
38	464	514	RCP - Class III - 66"	LF	$175.00														
39	464	515	RCP - Class III - 72"	LF	$200.00													1,585	$317,000
40	464	516	RCP - Class III - 78"	LF	$225.00														
41	464	517	RCP - Class III - 84"	LF	$275.00														
42	464	518	RCP - Class III - 96"	LF	$325.00														
43	465	547	Inlet - Single	EA	$7,000.00	6	$42,000	8	$56,000									150	$1,050,000
44	465	548	Inlet - Double	EA	$10,000.00	4	$40,000	6	$60,000									168	$1,680,000
45	465	549	Inlet - Triple	EA	$13,000.00	2	$26,000	4	$52,000									113	$1,469,000
46	465	536	Drainage MH or JB	EA	$5,000.00	4	$21,950	2	$9,520									100	$500,100
47	466	501	Headwall - small	EA	$2,500.00														
48	466	501	Headwall - large	EA	$4,000.00														
49	529	511	Concrete Curb and Gutter	LF	$6.50	1,098	$7,134	476	$3,094									25,005	$162,533
50	529	521	Concrete Valley Gutter	LF	$10.00														
51	530	604	Remove & Replace Driveway	EA	$3,000.00	22	$65,850	10	$28,560									500	$1,500,300
52	531	502	Sidewalk	SY	$50.00	439	$21,950	190	$9,520									10,002	$500,100
53	550	501	Chain Link Fence - 6ft.	LF	$10.00														
54	560	501	Mailbox Assembly	EA	$400.00	22	$8,780	10	$3,808									500	$200,040
55	580	none	Project Maintenance (subsidiary)																
56	COA-594	none	Gabions	CY	$150.00														
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00														
58	639	none	Rock Berm	LF	$900.00														
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	732	$1,829	317	$793									20,788	$51,970
60	1610	none	Preservation of Trees (Type C)	EA	$100.00	22	$2,195	10	$952									500	$50,010
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600									27	$16,200
62	Special	none	Conlock II pavers	SY	$27.00														
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00													2	$40,000
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00														
65	420	none	Pump		$175,000.00														
66	xx	xx																	
End of Current BASE BID specification items and unit prices																			
			Contingency =	15%			$102,774		$68,461										$4,222,393
			TOTAL BASE BID (suject to revision)				$787,935		$524,865										$32,371,681
			(cost per linear foot =)				$359		$551										$518

CITY OF VICTORIA
Spring Creek
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999)

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	Bridge Reach R87A		Bridge Reach R335A		Detention Pond Reach R360A		Bridge Reach R421A		Channel Reach R183B		Mallette Dr. Bridge Reach R183B		Mead Rd. Bridge Reach R183C	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $
			Length of individual Reach (feet)			2,564		2,405		5,992		4,180		438		80		60	
			Estimated ROW width needed for excavated open channel (feet)			20		20		20		20		91		20		20	
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$6,439	1	$6,434	1	$534,563	1	$6,546	1	$852	1	$5,967	1	$4,761
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$1,610	1	$1,609	1	$133,641	1	$1,636	1	$213	1	$1,492	1	$1,190
3	500	501	Mobilization	LS	2.5%		$4,025		$4,021	1	$334,102		$4,091	1	$532		$3,729		$2,976
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%		$2,415		$2,413		$200,461		$2,455	1	$319		$2,237		$1,785
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00														
6	110	502	Excavation - channel	CY	$4.00					3,113,000	$12,452,000			2,540	$10,160				
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00					50,751	$304,506								
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00														
9	160	506	Furnishing and Placing Topsoil	SY	$0.50					13,316	$6,658			4,524	$2,262				
10	162	509	Block sod (St. Augustine)	SY	$2.00														
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75					13,316	$9,987			4,524	$3,393				
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00					6,658	$13,316			2,262	$4,524				
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00					7,608	$38,040								
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00														
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00														
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50														
17	402	501	Trench Safety Protection	LF	$1.25					820	$1,025					400	$500	300	$375
18	423	508	Retaining walls (cast in place)	SF	$25.00														
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00														
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00														
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00														
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00														
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00											400	$120,000	300	$90,000
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00														
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00														
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00					820	$533,000								
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00														
28	422	501	Bridge 1 - straightforward	SF	$35.00	4,522	$158,270	4,522	$158,270			4,560	$159,600						
29	422	501	Bridge 2 - straightforward	SF	$35.00														
30	422	501	Bridge 3 - straightforward	SF	$35.00														
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00														
32	464	505	RCP - Class III - 24"	LF	$40.00														
33	464	509	RCP - Class III - 36"	LF	$50.00														
34	464	510	RCP - Class III - 42"	LF	$70.00														
35	464	511	RCP - Class III - 48"	LF	$90.00														
36	464	512	RCP - Class III - 54"	LF	$120.00														
37	464	513	RCP - Class III - 60"	LF	$150.00														
38	464	514	RCP - Class III - 66"	LF	$175.00														
39	464	515	RCP - Class III - 72"	LF	$200.00														
40	464	516	RCP - Class III - 78"	LF	$225.00														
41	464	517	RCP - Class III - 84"	LF	$275.00														
42	464	518	RCP - Class III - 96"	LF	$325.00														
43	465	547	Inlet - Single	EA	$7,000.00														
44	465	548	Inlet - Double	EA	$10,000.00														
45	465	549	Inlet - Triple	EA	$13,000.00														
46	465	536	Drainage MH or JB	EA	$5,000.00														
47	466	501	Headwall - small	EA	$2,500.00														
48	466	501	Headwall - large	EA	$4,000.00											2	$8,000	2	$8,000
49	529	511	Concrete Curb and Gutter	LF	$6.50														
50	529	521	Concrete Valley Gutter	LF	$10.00														
51	530	604	Remove & Replace Driveway	EA	$3,000.00														
52	531	502	Sidewalk	SY	$50.00														
53	550	501	Chain Link Fence - 6ft.	LF	$10.00														
54	560	501	Mailbox Assembly	EA	$400.00														
55	580	none	Project Maintenance (subsidiary)																
56	COA-594	none	Gabions	CY	$150.00														
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00														
58	639	none	Rock Berm	LF	$900.00														
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	846	$2,115	794	$1,984	1,977	$4,943	1,379	$3,449	145	$361	26	$66	20	$50
60	1610	none	Preservation of Trees (Type C)	EA	$100.00														
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600
62	Special	none	Conlock II pavers	SY	$27.00														
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00											1	$20,000	1	$20,000
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00														
65	420	none	Pump		$175,000.00														
66	xx	xx																	
End of Current BASE BID specification items and unit prices																			
			Contingency =	15%			$26,321		$26,300		$2,185,026		$26,757		$3,482		$24,389		$19,461
			TOTAL BASE BID (suject to revision)				$201,795		$201,631		$16,751,867		$205,133		$26,699		$186,980		$149,197
			(cost per linear foot =)				$79		$84		$2,796		$49		$61		$2,337		$2,487

CITY OF VICTORIA
Spring Creek
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	SC 2:1 Quantity	SC 2:1 Sheet $	SC 2:2 No Improvements Quantity	SC 2:2 Sheet $	SC 2:3 Quantity	SC 2:3 Sheet $	SC 2:4 Quantity	SC 2:4 Sheet $	SC 2:5 Quantity	SC 2:5 Sheet $	SC 4 :1 Quantity	SC 4 :1 Sheet $	**SPRING CREEK Overall Project Quantity**	**Total $**
			Length of individual Reach (feet)			4,857		523		2,539		3,328		747		281		27,994	
			Estimated ROW width needed for excavated open channel (feet)																
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$93,540	1	$6,566	1	$73,714	1	$33,052	1	$6,859	1	$6,212	13	$785,506
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$23,385	1	$1,642	1	$18,428	1	$8,263	1	$1,715	1	$1,553	13	$196,377
3	500	501	Mobilization	LS	2.5%	1	$58,463	1	$4,104	1	$46,071	1	$20,658	1	$4,287	1	$3,883	8	$490,941
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$35,078	1	$2,462	1	$27,643	1	$12,395	1	$2,572	1	$2,330	7	$294,565
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00														
6	110	502	Excavation - channel	CY	$4.00													3,115,540	$12,462,160
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00													50,751	$304,506
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00														
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	10,793	$5,397	1,162	$581	5,642	$2,821	7,396	$3,698	1,660	$830	624	$312	45,117	$22,558
10	162	509	Block sod (St. Augustine)	SY	$2.00	2,698	$5,397	291	$581	1,411	$2,821	1,849	$3,698	415	$830	156	$312	6,819	$13,639
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	8,095	$6,071	872	$654	4,232	$3,174	5,547	$4,160	1,245	$934	468	$351	38,298	$28,723
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	5,397	$10,793	581	$1,162	2,821	$5,642	3,698	$7,396	830	$1,660	312	$624	22,558	$45,117
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00													7,608	$38,040
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00	8,095	$56,665	872	$6,102	4,232	$29,622	5,547	$38,827	1,245	$8,715	468	$3,278	20,458	$143,208
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00	8,095	$48,570	872	$5,230	4,232	$25,390	5,547	$33,280	1,245	$7,470	468	$2,810	20,458	$122,750
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50	39	$175	4	$19	20	$91	27	$120	6	$27	2	$10	98	$442
17	402	501	Trench Safety Protection	LF	$1.25	4,857	$6,071	523	$654	2,539	$3,174	3,328	$4,160	747	$934	281	$351	13,795	$17,244
18	423	508	Retaining walls (cast in place)	SF	$25.00														
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00														
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00														
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00							920	$161,000					920	$161,000
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00			523	$117,675									523	$117,675
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00	4,554	$1,366,200											5,254	$1,576,200
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00														
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00					2,539	$1,269,500							2,539	$1,269,500
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00													820	$533,000
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00														
28	422	501	Bridge 1 - straightforward	SF	$35.00													13,604	$476,140
29	422	501	Bridge 2 - straightforward	SF	$35.00														
30	422	501	Bridge 3 - straightforward	SF	$35.00														
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00														
32	464	505	RCP - Class III - 24"	LF	$40.00														
33	464	509	RCP - Class III - 36"	LF	$50.00									747	$37,350	281	$14,050	1,028	$51,400
34	464	510	RCP - Class III - 42"	LF	$70.00							1,649	$115,430					1,649	$115,430
35	464	511	RCP - Class III - 48"	LF	$90.00							759	$68,310					759	$68,310
36	464	512	RCP - Class III - 54"	LF	$120.00														
37	464	513	RCP - Class III - 60"	LF	$150.00														
38	464	514	RCP - Class III - 66"	LF	$175.00														
39	464	515	RCP - Class III - 72"	LF	$200.00	303	$60,600											303	$60,600
40	464	516	RCP - Class III - 78"	LF	$225.00														
41	464	517	RCP - Class III - 84"	LF	$275.00														
42	464	518	RCP - Class III - 96"	LF	$325.00														
43	465	547	Inlet - Single	EA	$7,000.00	20	$140,000			10	$70,000	9	$63,000	4	$28,000	8	$56,000	51	$357,000
44	465	548	Inlet - Double	EA	$10,000.00	15	$150,000			15	$150,000	10	$100,000	4	$40,000	6	$60,000	50	$500,000
45	465	549	Inlet - Triple	EA	$13,000.00	15	$195,000			10	$130,000	2	$26,000					27	$351,000
46	465	536	Drainage MH or JB	EA	$5,000.00	10	$48,570	1	$5,230	5	$25,390	7	$33,280	1	$7,470	1	$2,810	25	$122,750
47	466	501	Headwall - small	EA	$2,500.00														
48	466	501	Headwall - large	EA	$4,000.00													4	$16,000
49	529	511	Concrete Curb and Gutter	LF	$6.50	2,429	$15,785	262	$1,700	1,270	$8,252	1,664	$10,816	374	$2,428	141	$913	6,138	$39,894
50	529	521	Concrete Valley Gutter	LF	$10.00														
51	530	604	Remove & Replace Driveway	EA	$3,000.00	49	$145,710	5	$15,690	25	$76,170	33	$99,840	7	$22,410	3	$8,430	123	$368,250
52	531	502	Sidewalk	SY	$50.00	971	$48,570	105	$5,230	508	$25,390	666	$33,280	149	$7,470	56	$2,810	2,455	$122,750
53	550	501	Chain Link Fence - 6ft.	LF	$10.00														
54	560	501	Mailbox Assembly	EA	$400.00	49	$19,428	5	$2,092	25	$10,156	33	$13,312	7	$2,988	3	$1,124	123	$49,100
55	580	none	Project Maintenance (subsidiary)																
56	COA-594	none	Gabions	CY	$150.00														
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00														
58	639	none	Rock Berm	LF	$900.00														
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	1,619	$4,048	174	$436	846	$2,116	1,109	$2,773	249	$623	94	$234	9,279	$23,197
60	1610	none	Preservation of Trees (Type C)	EA	$100.00	49	$4,857	5	$523	25	$2,539	33	$3,328	7	$747	3	$281	123	$12,275
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	13	$7,800
62	Special	none	Conlock II pavers	SY	$27.00														
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00													2	$40,000
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00														
65	420	none	Pump		$175,000.00														
66	xx	xx																	
End of Current BASE BID specification items and unit prices																			
			Contingency =	15%			$382,346		$26,840		$301,306		$135,101		$28,038		$25,392		$3,210,757
			TOTAL BASE BID (suject to revision)				$2,931,318		$205,772		$2,310,009		$1,035,776		$214,956		$194,671		$24,615,805
			(cost per linear foot =)				$604		$393		$910		$311		$288		$693		$879

CITY OF VICTORIA
Mockingbird Outfall
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999)

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	MO 1:1		MO 1:2		MO 1:3		**Mockingbird**	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	**Quantity**	**Total $**
			Length of individual Reach (feet)			7,214						7,214	
			Estimated ROW width needed for excavated open channel (feet)										
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$104,904		$1,240		$1,240	1	$107,384
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$26,226		$310		$310	1	$26,846
3	500	501	Mobilization	LS	2.5%	1	$65,565		$775		$775	1	$67,115
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$39,339		$465		$465	1	$40,269
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00								
6	110	502	Excavation - channel	CY	$4.00								
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00								
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00								
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	16,030	$8,015					16,030	$8,015
10	162	509	Block sod (St. Augustine)	SY	$2.00	4,008	$8,015					4,008	$8,015
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	12,023	$9,017					12,023	$9,017
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	8,015	$16,030					8,015	$16,030
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00								
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00	12,023	$84,160					12,023	$84,160
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00	12,023	$72,137					12,023	$72,137
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50	58	$260					58	$260
17	402	501	Trench Safety Protection	LF	$1.25	7,214	$9,017					7,214	$9,017
18	423	508	Retaining walls (cast in place)	SF	$25.00								
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00								
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00								
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00	1,914	$334,950					1,914	$334,950
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00	4,184	$941,400					4,184	$941,400
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00								
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00								
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00								
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00								
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00								
28	422	501	Bridge 1 - straightforward	SF	$35.00								
29	422	501	Bridge 2 - straightforward	SF	$35.00								
30	422	501	Bridge 3 - straightforward	SF	$35.00								
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00								
32	464	505	RCP - Class III - 24"	LF	$40.00								
33	464	509	RCP - Class III - 36"	LF	$50.00	1,116	$55,785					1,116	$55,785
34	464	510	RCP - Class III - 42"	LF	$70.00								
35	464	511	RCP - Class III - 48"	LF	$90.00								
36	464	512	RCP - Class III - 54"	LF	$120.00								
37	464	513	RCP - Class III - 60"	LF	$150.00								
38	464	514	RCP - Class III - 66"	LF	$175.00								
39	464	515	RCP - Class III - 72"	LF	$200.00								
40	464	516	RCP - Class III - 78"	LF	$225.00								
41	464	517	RCP - Class III - 84"	LF	$275.00								
42	464	518	RCP - Class III - 96"	LF	$325.00								
43	465	547	Inlet - Single	EA	$7,000.00	21	$147,000	3	$21,000	3	$21,000	27	$189,000
44	465	548	Inlet - Double	EA	$10,000.00	25	$250,000	1	$10,000	1	$10,000	27	$270,000
45	465	549	Inlet - Triple	EA	$13,000.00	20	$260,000					20	$260,000
46	465	536	Drainage MH or JB	EA	$5,000.00	14	$72,137					14	$72,137
47	466	501	Headwall - small	EA	$2,500.00								
48	466	501	Headwall - large	EA	$4,000.00								
49	529	511	Concrete Curb and Gutter	LF	$6.50	3,607	$23,445					3,607	$23,445
50	529	521	Concrete Valley Gutter	LF	$10.00								
51	530	604	Remove & Replace Driveway	EA	$3,000.00	72	$216,411					72	$216,411
52	531	502	Sidewalk	SY	$50.00	1,443	$72,137					1,443	$72,137
53	550	501	Chain Link Fence - 6ft.	LF	$10.00								
54	560	501	Mailbox Assembly	EA	$400.00	72	$28,855					72	$28,855
55	580	none	Project Maintenance (subsidiary)										
56	COA-594	none	Gabions	CY	$150.00								
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00								
58	639	none	Rock Berm	LF	$900.00								
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	2,405	$6,011					2,405	$6,011
60	1610	none	Preservation of Trees (Type C)	EA	$100.00	72	$7,214					72	$7,214
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600					1	$600
62	Special	none	Conlock II pavers	SY	$27.00								
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00								
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00								
65	420	none	Pump		$175,000.00								
66	xx	xx											
End of Current BASE BID specification items and unit prices													
			Contingency =	15%			$428,794		$5,069		$5,069		$438,931
			TOTAL BASE BID (suject to revision)				$3,287,424		$38,859		$38,859		$3,365,141
			(cost per linear foot =)				$456						$466

CITY OF VICTORIA
Whispering Creek
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999)

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	Reach WR0A		Reach WR15A		Reach WR33A		Reach WR57A		Reach WR77A		Reach WR86A		Reach WR95A		Reach WR108A		Reach WR132A	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $
			Length of individual Reach (feet)			1,523		1,701		2,526		1,845		149		496		1,285		2,344		1,165	
			Estimated ROW width needed for excavated open channel (feet)			164		167		165		165		148		129		141		103		103	
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$15,927	1	$7,894	1	$10,981	1	$7,136	1	$2,389	1	$688	1	$2,461	1	$2,565	1	$1,283
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$3,982	1	$1,974	1	$2,745	1	$1,784	1	$597	1	$172	1	$615	1	$641	1	$321
3	500	501	Mobilization	LS	2.5%	1	$9,955	1	$4,934	1	$6,863	1	$4,460	1	$1,493	1	$430	1	$1,538	1	$1,603	1	$802
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$5,973	1	$2,960	1	$4,118	1	$2,676	1	$896	1	$258	1	$923	1	$962	1	$481
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																		
6	110	502	Excavation - channel	CY	$4.00	10,350	$41,400	25,260	$101,040	33,480	$133,920	18,800	$75,200	12,930	$51,720	6	$26	14	$57	35	$139	15	$61
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																		
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																		
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	28,448	$14,224	32,335	$16,167	47,290	$23,645	34,657	$17,329	2,497	$1,249	7,187	$3,594	20,508	$10,254	27,307	$13,654	13,539	$6,770
10	162	509	Block sod (St. Augustine)	SY	$2.00																		
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	28,448	$21,336	32,335	$24,251	47,290	$35,467	34,657	$25,993	2,497	$1,873	7,187	$5,391	20,508	$15,381	27,307	$20,480	13,539	$10,154
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	14,224	$28,448									3,594	$7,187			13,654	$27,307	6,770	$13,539
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00			10,778	$53,892	15,763	$78,817	11,552	$57,762	832	$4,162			6,836	$34,180				
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00																		
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00																		
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50																		
17	402	501	Trench Safety Protection	LF	$1.25																		
18	423	508	Retaining walls (cast in place)	SF	$25.00																		
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																		
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																		
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00																		
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00																		
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00																		
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																		
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00																		
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																		
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00																		
28	422	501	Bridge 1 - straightforward	SF	$35.00	8,312	$290,920																
29	422	501	Bridge 2 - straightforward	SF	$35.00																		
30	422	501	Bridge 3 - straightforward	SF	$35.00																		
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																		
32	464	505	RCP - Class III - 24"	LF	$40.00																		
33	464	509	RCP - Class III - 36"	LF	$50.00																		
34	464	510	RCP - Class III - 42"	LF	$70.00																		
35	464	511	RCP - Class III - 48"	LF	$90.00																		
36	464	512	RCP - Class III - 54"	LF	$120.00																		
37	464	513	RCP - Class III - 60"	LF	$150.00																		
38	464	514	RCP - Class III - 66"	LF	$175.00																		
39	464	515	RCP - Class III - 72"	LF	$200.00																		
40	464	516	RCP - Class III - 78"	LF	$225.00																		
41	464	517	RCP - Class III - 84"	LF	$275.00																		
42	464	518	RCP - Class III - 96"	LF	$325.00																		
43	465	547	Inlet - Single	EA	$7,000.00																		
44	465	548	Inlet - Double	EA	$10,000.00																		
45	465	549	Inlet - Triple	EA	$13,000.00																		
46	465	536	Drainage MH or JB	EA	$5,000.00																		
47	466	501	Headwall - small	EA	$2,500.00																		
48	466	501	Headwall - large	EA	$4,000.00																		
49	529	511	Concrete Curb and Gutter	LF	$6.50																		
50	529	521	Concrete Valley Gutter	LF	$10.00																		
51	530	604	Remove & Replace Driveway	EA	$3,000.00																		
52	531	502	Sidewalk	SY	$50.00																		
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																		
54	560	501	Mailbox Assembly	EA	$400.00																		
55	580	none	Project Maintenance (subsidiary)																				
56	COA-594	none	Gabions	CY	$150.00																		
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																		
58	639	none	Rock Berm	LF	$900.00																		
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	503	$1,256	561	$1,403	834	$2,084	609	$1,522	49	$123	164	$409	424	$1,060	774	$1,934	384	$961
60	1610	none	Preservation of Trees (Type C)	EA	$100.00																		
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600
62	Special	none	Conlock II pavers	SY	$27.00																		
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00																		
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																		
65	420	none	Pump		$175,000.00																		
66	xx	xx																					
End of Current BASE BID specification items and unit prices																							
			Contingency =	15%			$65,103		$32,267		$44,886		$29,169		$9,765		$2,813		$10,060		$10,483		$5,246
			TOTAL BASE BID (suject to revision)				$499,125		$247,383		$344,127		$223,632		$74,868		$21,569		$77,130		$80,367		$40,219
			(cost per linear foot =)				$328		$145		$136		$121		$502		$43		$60		$34		$35

CITY OF VICTORIA
Whispering Creek
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	WC 1:8 Quantity	WC 1:8 Sheet $	WC 1:9 Quantity	WC 1:9 Sheet $	WC 2:2 Quantity	WC 2:2 Sheet $	WC 2:3 Quantity	WC 2:3 Sheet $	WC 2:4 Quantity	WC 2:4 Sheet $	WC 2:5 Quantity	WC 2:5 Sheet $	WC 2:6 Quantity	WC 2:6 Sheet $	WC 2:7 Quantity	WC 2:7 Sheet $	Whispering Creek Overall Project Quantity	Whispering Creek Overall Project Total $
			Length of individual Reach (feet)			983				8,209		5,021		1,513		4,163		2,134		2,099		37,156	
			Estimated ROW width needed for excavated open channel (feet)																				
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$9,268		$4,320	1	$110,047	1	$56,166	1	$20,742	1	$24,797	1	$25,037	1	$19,293	16	$320,995
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$2,317		$1,080	1	$27,512	1	$14,041	1	$5,185	1	$6,199	1	$6,259	1	$4,823	16	$80,249
3	500	501	Mobilization	LS	2.5%	1	$5,792		$2,700	1	$68,779	1	$35,104	1	$12,964	1	$15,498	1	$15,648	1	$12,058	16	$200,622
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$3,475		$1,620	1	$41,268	1	$21,062	1	$7,778	1	$9,299	1	$9,389	1	$7,235	16	$120,373
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																		
6	110	502	Excavation - channel	CY	$4.00																	100,891	$403,563
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																		
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																		
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	2,184	$1,092			18,242	$9,121	11,158	$5,579	3,362	$1,681	9,251	$4,626	4,742	$2,371	4,664	$2,332	267,374	$133,687
10	162	509	Block sod (St. Augustine)	SY	$2.00	546	$1,092			4,561	$9,121	2,789	$5,579	841	$1,681	2,313	$4,626	1,186	$2,371	1,166	$2,332	13,401	$26,802
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidiary)	SY	$0.75	1,638	$1,229			13,682	$10,261	8,368	$6,276	2,522	$1,891	6,938	$5,204	3,557	$2,668	3,498	$2,624	253,973	$190,480
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	1,092	$2,184			9,121	$18,242	5,579	$11,158	1,681	$3,362	4,626	$9,251	2,371	$4,742	2,332	$4,664	65,043	$130,087
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00																	45,763	$228,813
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00	1,638	$11,468			13,682	$95,772	8,368	$58,578	2,522	$17,652	6,938	$48,568	3,557	$24,897	3,498	$24,488	40,203	$281,423
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00	1,638	$9,830			13,682	$82,090	8,368	$50,210	2,522	$15,130	6,938	$41,630	3,557	$21,340	3,498	$20,990	40,203	$241,220
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50	8	$35			66	$296	40	$181	12	$54	33	$150	17	$77	17	$76	193	$868
17	402	501	Trench Safety Protection	LF	$1.25	983	$1,229			8,209	$10,261	5,021	$6,276	1,513	$1,891	4,163	$5,204	2,134	$2,668	2,099	$2,624	24,122	$30,153
18	423	508	Retaining walls (cast in place)	SF	$25.00																		
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																		
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																		
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00					1,575	$275,625											1,575	$275,625
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00					2,749	$618,525	535	$120,375									3,284	$738,900
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00					2,017	$605,100											2,017	$605,100
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																		
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00																		
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																		
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00																		
28	422	501	Bridge 1 - straightforward	SF	$35.00																	8,312	$290,920
29	422	501	Bridge 2 - straightforward	SF	$35.00																		
30	422	501	Bridge 3 - straightforward	SF	$35.00																		
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																		
32	464	505	RCP - Class III - 24"	LF	$40.00											905	$36,200					905	$36,200
33	464	509	RCP - Class III - 36"	LF	$50.00	298	$14,900			643	$32,150	882	$44,100			3,258	$162,900			690	$34,500	5,771	$288,550
34	464	510	RCP - Class III - 42"	LF	$70.00	685	$47,950					1,071	$74,970									1,756	$122,920
35	464	511	RCP - Class III - 48"	LF	$90.00									179	$16,110			600	$54,000			779	$70,110
36	464	512	RCP - Class III - 54"	LF	$120.00					1,225	$147,000	983	$117,960							1,409	$169,080	3,617	$434,040
37	464	513	RCP - Class III - 60"	LF	$150.00							807	$121,050	1,334	$200,100			1,534	$230,100			3,675	$551,250
38	464	514	RCP - Class III - 66"	LF	$175.00																		
39	464	515	RCP - Class III - 72"	LF	$200.00							743	$148,600									743	$148,600
40	464	516	RCP - Class III - 78"	LF	$225.00																		
41	464	517	RCP - Class III - 84"	LF	$275.00																		
42	464	518	RCP - Class III - 96"	LF	$325.00																		
43	465	547	Inlet - Single	EA	$7,000.00	6	$42,000	6	$42,000	14	$98,000	16	$112,000	9	$63,000	5	$35,000	6	$42,000	4	$28,000	66	$462,000
44	465	548	Inlet - Double	EA	$10,000.00	4	$40,000	4	$40,000	15	$150,000	12	$120,000	8	$80,000	2	$20,000	6	$60,000	4	$40,000	55	$550,000
45	465	549	Inlet - Triple	EA	$13,000.00			2	$26,000	8	$104,000	8	$104,000	2	$26,000			4	$52,000	2	$26,000	26	$338,000
46	465	536	Drainage MH or JB	EA	$5,000.00	2	$9,830			16	$82,090	10	$50,210	3	$15,130	8	$41,630	4	$21,340	4	$20,990	48	$241,220
47	466	501	Headwall - small	EA	$2,500.00																		
48	466	501	Headwall - large	EA	$4,000.00																		
49	529	511	Concrete Curb and Gutter	LF	$6.50	492	$3,195			4,105	$26,679	2,511	$16,318	757	$4,917	2,082	$13,530	1,067	$6,936	1,050	$6,822	12,061	$78,397
50	529	521	Concrete Valley Gutter	LF	$10.00																		
51	530	604	Remove & Replace Driveway	EA	$3,000.00	10	$29,490			82	$246,270	50	$150,630	15	$45,390	42	$124,890	21	$64,020	21	$62,970	241	$723,660
52	531	502	Sidewalk	SY	$50.00	197	$9,830			1,642	$82,090	1,004	$50,210	303	$15,130	833	$41,630	427	$21,340	420	$20,990	4,824	$241,220
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																		
54	560	501	Mailbox Assembly	EA	$400.00	10	$3,932			82	$32,836	50	$20,084	15	$6,052	42	$16,652	21	$8,536	21	$8,396	241	$96,488
55	580	none	Project Maintenance (subsidiary)																				
56	COA-594	none	Gabions	CY	$150.00																		
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																		
58	639	none	Rock Berm	LF	$900.00																		
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	328	$819			2,736	$6,841	1,674	$4,184	504	$1,261	1,388	$3,469	711	$1,778	700	$1,749	12,342	$30,855
60	1610	none	Preservation of Trees (Type C)	EA	$100.00	10	$983			82	$8,209	50	$5,021	15	$1,513	42	$4,163	21	$2,134	21	$2,099	241	$24,122
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600			1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	16	$9,600
62	Special	none	Conlock II pavers	SY	$27.00																		
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00																		
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																		
65	420	none	Pump		$175,000.00																		
66	xx	xx																					
End of Current BASE BID specification items and unit prices																							
			Contingency =	15%			$37,881		$17,658		$449,818		$229,578		$84,782		$101,357		$102,337		$78,860		$1,312,067
			TOTAL BASE BID (suject to revision)				$290,422		$135,378		$3,448,603		$1,760,101		$649,998		$777,072		$784,587		$604,596		$10,059,177
			(cost per linear foot =)				$295				$420		$351		$430		$187		$368		$288		$271

CITY OF VICTORIA
North Outfall
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999)

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	Reach NR0A		Reach NR28B		**NORTH OUTFALL Overall Project**	
						Quantity	Sheet $	Quantity	Sheet $	**Quantity**	**Total $**
			Length of individual Reach (feet)			2,719		2,214		4,933	
			Estimated ROW width needed for excavated open channel (feet)			150		143			
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$13,777	1	$8,671	2	$22,448
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$3,444	1	$2,168	2	$5,612
3	500	501	Mobilization	LS	2.5%	1	$8,610	1	$5,419	2	$14,030
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$5,166	1	$3,252	2	$8,418
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00						
6	110	502	Excavation - channel	CY	$4.00	36,760	$147,040	2,650	$10,600	39,410	$157,640
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00						
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00						
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	46,126	$23,063	35,801	$17,901	81,927	$40,964
10	162	509	Block sod (St. Augustine)	SY	$2.00						
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	46,126	$34,595	35,801	$26,851	81,927	$61,446
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00			17,901	$35,801	17,901	$35,801
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00	15,375	$76,877			15,375	$76,877
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00						
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00						
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50						
17	402	501	Trench Safety Protection	LF	$1.25						
18	423	508	Retaining walls (cast in place)	SF	$25.00						
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00						
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00						
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00						
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00						
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00						
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00						
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00						
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00						
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00						
28	422	501	Bridge 1 - straightforward	SF	$35.00			3,520	$123,200	3,520	$123,200
29	422	501	Bridge 2 - straightforward	SF	$35.00						
30	422	501	Bridge 3 - straightforward	SF	$35.00						
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00						
32	464	505	RCP - Class III - 24"	LF	$40.00						
33	464	509	RCP - Class III - 36"	LF	$50.00						
34	464	510	RCP - Class III - 42"	LF	$70.00						
35	464	511	RCP - Class III - 48"	LF	$90.00						
36	464	512	RCP - Class III - 54"	LF	$120.00						
37	464	513	RCP - Class III - 60"	LF	$150.00						
38	464	514	RCP - Class III - 66"	LF	$175.00						
39	464	515	RCP - Class III - 72"	LF	$200.00						
40	464	516	RCP - Class III - 78"	LF	$225.00						
41	464	517	RCP - Class III - 84"	LF	$275.00						
42	464	518	RCP - Class III - 96"	LF	$325.00						
43	465	547	Inlet - Single	EA	$7,000.00						
44	465	548	Inlet - Double	EA	$10,000.00						
45	465	549	Inlet - Triple	EA	$13,000.00						
46	465	536	Drainage MH or JB	EA	$5,000.00						
47	466	501	Headwall - small	EA	$2,500.00						
48	466	501	Headwall - large	EA	$4,000.00						
49	529	511	Concrete Curb and Gutter	LF	$6.50						
50	529	521	Concrete Valley Gutter	LF	$10.00						
51	530	604	Remove & Replace Driveway	EA	$3,000.00						
52	531	502	Sidewalk	SY	$50.00						
53	550	501	Chain Link Fence - 6ft.	LF	$10.00						
54	560	501	Mailbox Assembly	EA	$400.00						
55	580	none	Project Maintenance (subsidiary)								
56	COA-594	none	Gabions	CY	$150.00						
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00						
58	639	none	Rock Berm	LF	$900.00						
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	897	$2,243	731	$1,827	1,628	$4,070
60	1610	none	Preservation of Trees (Type C)	EA	$100.00						
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	2	$1,200
62	Special	none	Conlock II pavers	SY	$27.00						
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00	3	$60,000			3	$60,000
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00						
65	420	none	Pump		$175,000.00						
66	xx	xx									
End of Current BASE BID specification items and unit prices											
			Contingency =	15%			$56,312		$35,443		$91,756
			TOTAL BASE BID (suject to revision)				$431,728		$271,733		$703,461
			(cost per linear foot =)				$159		$123		$143

CITY OF VICTORIA
U.S. 77
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999)

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	Reach NR28A		Reach NR47A		Reach NR61A		Reach NR86A		Reach NR103A		**U.S. 77 Overall Project**	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	**Quantity**	**Total $**
			Length of individual Reach (feet)			1,133		1,813		2,758		1,388		130		7,222	
			Estimated ROW width needed for excavated open channel (feet)			127		127		170		97		91			
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$2,890	1	$28,769	1	$28,561	1	$2,592	1	$340	5	$63,152
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$723	1	$7,192	1	$7,140	1	$648	1	$85	5	$15,788
3	500	501	Mobilization	LS	2.5%	1	$1,806	1	$17,980	1	$17,851	1	$1,620	1	$212	5	$39,470
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$1,084	1	$10,788	1	$10,711	1	$972	1	$127	5	$23,682
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00												
6	110	502	Excavation - channel	CY	$4.00	8,020	$32,080	11,080	$44,320	9,350	$37,400	7,170	$28,680	1,190	$4,760	36,810	$147,240
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00												
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00												
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	17,176	$8,588	27,484	$13,742	52,918	$26,459	15,278	$7,639	1,344	$672	114,200	$57,100
10	162	509	Block sod (St. Augustine)	SY	$2.00												
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	17,176	$12,882	27,484	$20,613	52,918	$39,688	15,278	$11,459	1,344	$1,008	114,200	$85,650
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	8,588	$17,176	13,742	$27,484			7,639	$15,278	672	$1,344	30,641	$61,282
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00					17,639	$88,197					17,639	$88,197
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00												
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00												
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50												
17	402	501	Trench Safety Protection	LF	$1.25												
18	423	508	Retaining walls (cast in place)	SF	$25.00												
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00												
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00												
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00												
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00												
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00												
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00												
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00												
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00												
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00												
28	422	501	Bridge 1 - straightforward	SF	$35.00			5,192	$181,720	14,269	$499,415					19,461	$681,135
29	422	501	Bridge 2 - straightforward	SF	$35.00			12,264	$429,240							12,264	$429,240
30	422	501	Bridge 3 - straightforward	SF	$35.00												
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00												
32	464	505	RCP - Class III - 24"	LF	$40.00												
33	464	509	RCP - Class III - 36"	LF	$50.00												
34	464	510	RCP - Class III - 42"	LF	$70.00												
35	464	511	RCP - Class III - 48"	LF	$90.00												
36	464	512	RCP - Class III - 54"	LF	$120.00												
37	464	513	RCP - Class III - 60"	LF	$150.00												
38	464	514	RCP - Class III - 66"	LF	$175.00												
39	464	515	RCP - Class III - 72"	LF	$200.00												
40	464	516	RCP - Class III - 78"	LF	$225.00												
41	464	517	RCP - Class III - 84"	LF	$275.00												
42	464	518	RCP - Class III - 96"	LF	$325.00												
43	465	547	Inlet - Single	EA	$7,000.00												
44	465	548	Inlet - Double	EA	$10,000.00												
45	465	549	Inlet - Triple	EA	$13,000.00												
46	465	536	Drainage MH or JB	EA	$5,000.00												
47	466	501	Headwall - small	EA	$2,500.00												
48	466	501	Headwall - large	EA	$4,000.00												
49	529	511	Concrete Curb and Gutter	LF	$6.50												
50	529	521	Concrete Valley Gutter	LF	$10.00												
51	530	604	Remove & Replace Driveway	EA	$3,000.00												
52	531	502	Sidewalk	SY	$50.00												
53	550	501	Chain Link Fence - 6ft.	LF	$10.00												
54	560	501	Mailbox Assembly	EA	$400.00												
55	580	none	Project Maintenance (subsidiary)														
56	COA-594	none	Gabions	CY	$150.00												
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00												
58	639	none	Rock Berm	LF	$900.00												
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	374	$935	598	$1,496	910	$2,275	458	$1,145	43	$107	2,383	$5,958
60	1610	none	Preservation of Trees (Type C)	EA	$100.00												
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600	5	$3,000
62	Special	none	Conlock II pavers	SY	$27.00												
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00					1	$20,000					1	$20,000
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00												
65	420	none	Pump		$175,000.00												
66	xx	xx															
End of Current BASE BID specification items and unit prices																	
			Contingency =	15%			$11,815		$117,592		$116,745		$10,595		$1,388		$258,134
			TOTAL BASE BID (suject to revision)				$90,578		$901,536		$895,042		$81,228		$10,644		$1,979,028
			(cost per linear foot =)				$80		$497		$325		$59		$82		$274

CITY OF VICTORIA
Lone Tree Creek
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999)

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	Reach R1211A		Reach R1249A		Reach R1316A		Reach R1362A		Reach R1434A		Reach R1453A		Reach R1470A		Reach R1486A		Reach R1508A	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $
			Length of individual Reach (feet)			4,701		6,481		4,678		7,230		1,950		1,640		1,544		2,145		1,865	
			Estimated ROW width needed for excavated open channel (feet)			217		218		192		212		210		205		204		208		208	
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$43,963	1	$50,162	1	$41,732	1	$64,206	1	$14,564	1	$34,198	1	$16,741	1	$15,942	1	$15,025
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$10,991	1	$12,540	1	$10,433	1	$16,052	1	$3,641	1	$8,550	1	$4,185	1	$3,985	1	$3,756
3	500	501	Mobilization	LS	2.5%	1	$27,477	1	$31,351	1	$26,083	1	$40,129	1	$9,102	1	$21,374	1	$10,463	1	$9,964	1	$9,391
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$16,486	1	$18,811	1	$15,650	1	$24,077	1	$5,461	1	$12,824	1	$6,278	1	$5,978	1	$5,634
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																		
6	110	502	Excavation - channel	CY	$4.00	89,650	$358,600	119,240	$476,960	89,090	$356,360	111,500	$446,000	35,020	$140,080	27,960	$111,840	22,070	$88,280	38,310	$153,240	40,610	$162,440
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																		
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																		
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	115,966	$57,983	161,014	$80,507	101,657	$50,829	174,643	$87,322	46,582	$23,291	38,232	$19,116	35,799	$17,899	50,773	$25,387	44,067	$22,033
10	162	509	Block sod (St. Augustine)	SY	$2.00																		
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	115,966	$86,974	161,014	$120,761	101,657	$76,243	174,643	$130,982	46,582	$34,937	38,232	$28,674	35,799	$26,849	50,773	$38,080	44,067	$33,050
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	57,983	$115,966	80,507	$161,014	50,829	$101,657	87,322	$174,643	23,291	$46,582	19,116	$38,232	17,899	$35,799	25,387	$50,773	22,033	$44,067
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00																		
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00																		
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00																		
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50																		
17	402	501	Trench Safety Protection	LF	$1.25																		
18	423	508	Retaining walls (cast in place)	SF	$25.00																		
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																		
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																		
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00																		
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00																		
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00																		
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																		
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00																		
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																		
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00																		
28	422	501	Bridge 1 - straightforward	SF	$35.00	5,515	$193,025			4,945	$173,075	4,900	$171,500			15,907	$556,745	4,434	$155,190				
29	422	501	Bridge 2 - straightforward	SF	$35.00							4,410	$154,350										
30	422	501	Bridge 3 - straightforward	SF	$35.00																		
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																		
32	464	505	RCP - Class III - 24"	LF	$40.00																		
33	464	509	RCP - Class III - 36"	LF	$50.00																		
34	464	510	RCP - Class III - 42"	LF	$70.00																		
35	464	511	RCP - Class III - 48"	LF	$90.00																		
36	464	512	RCP - Class III - 54"	LF	$120.00																		
37	464	513	RCP - Class III - 60"	LF	$150.00																		
38	464	514	RCP - Class III - 66"	LF	$175.00																		
39	464	515	RCP - Class III - 72"	LF	$200.00																		
40	464	516	RCP - Class III - 78"	LF	$225.00																		
41	464	517	RCP - Class III - 84"	LF	$275.00																		
42	464	518	RCP - Class III - 96"	LF	$325.00																		
43	465	547	Inlet - Single	EA	$7,000.00																		
44	465	548	Inlet - Double	EA	$10,000.00																		
45	465	549	Inlet - Triple	EA	$13,000.00																		
46	465	536	Drainage MH or JB	EA	$5,000.00																		
47	466	501	Headwall - small	EA	$2,500.00																		
48	466	501	Headwall - large	EA	$4,000.00																		
49	529	511	Concrete Curb and Gutter	LF	$6.50																		
50	529	521	Concrete Valley Gutter	LF	$10.00																		
51	530	604	Remove & Replace Driveway	EA	$3,000.00																		
52	531	502	Sidewalk	SY	$50.00																		
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																		
54	560	501	Mailbox Assembly	EA	$400.00																		
55	580	none	Project Maintenance (subsidiary)																				
56	COA-594	none	Gabions	CY	$150.00																		
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																		
58	639	none	Rock Berm	LF	$900.00																		
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	1,551	$3,878	2,139	$5,347	1,544	$3,859	2,386	$5,965	644	$1,609	541	$1,353	510	$1,274	708	$1,770	615	$1,539
60	1610	none	Preservation of Trees (Type C)	EA	$100.00																		
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600
62	Special	none	Conlock II pavers	SY	$27.00	10,447	$282,060	14,402	$388,860	10,396	$280,680	16,067	$433,800	4,333	$117,000	3,644	$98,400	3,431	$92,640	4,767	$128,700	4,144	$111,900
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00			1	$20,000														
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																		
65	420	none	Pump		$175,000.00																		
66																							
End of Current BASE BID specification items and unit prices																							
			Contingency =	15%			$179,701		$205,037		$170,580		$262,444		$59,530		$139,786		$68,430		$65,163		$61,415
			TOTAL BASE BID (suject to revision)				$1,377,705		$1,571,950		$1,307,781		$2,012,070		$456,398		$1,071,692		$524,628		$499,581		$470,851
			(cost per linear foot =)				$293		$243		$280		$278		$234		$653		$340		$233		$252

CITY OF VICTORIA
Lone Tree Creek
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	Reach R1527A		Reach R1535A		Reach R1550A		Reach R1560A		Upper Detention Basin Reach R1580A		Upper Detention Basin Reach R1596A		Reach R1615A		Reach R1623A		Reach R1649A	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $
			Length of individual Reach (feet)			861		1,477		1,002		1,876		2,000		1,701		663		2,595		1,175	
			Estimated ROW width needed for excavated open channel (feet)			181		171		173		176		20		20		171		170		160	
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$5,411	1	$9,154	1	$13,012	1	$29,145	1	$117,143	1	$100,183	1	$25,818	1	$20,735	1	$9,471
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$1,353	1	$2,288	1	$3,253	1	$7,286	1	$29,286	1	$25,046	1	$6,454	1	$5,184	1	$2,368
3	500	501	Mobilization	LS	2.5%	1	$3,382	1	$5,721	1	$8,133	1	$18,216	1	$73,214	1	$62,614	1	$16,136	1	$12,959	1	$5,919
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$2,029	1	$3,433	1	$4,880	1	$10,930		$43,928		$37,569	1	$9,682	1	$7,775	1	$3,552
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																		
6	110	502	Excavation - channel	CY	$4.00	10,610	$42,440	18,430	$73,720	12,880	$51,520	25,510	$102,040	560,000	$2,240,000	598,000	$2,392,000	6,450	$25,800	56,720	$226,880	29,140	$116,560
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00									14,590	$87,540								
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																		
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	17,722	$8,861	28,752	$14,376	19,723	$9,862	37,665	$18,833	4,444	$2,222	3,780	$1,890	12,906	$6,453	50,241	$25,121	21,395	$10,697
10	162	509	Block sod (St. Augustine)	SY	$2.00																		
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	17,722	$13,292	28,752	$21,564	19,723	$14,793	37,665	$28,249	4,444	$3,333	3,780	$2,835	12,906	$9,680	50,241	$37,681	21,395	$16,046
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	8,861	$17,722	14,376	$28,752	9,862	$19,723	18,833	$37,665	2,222	$4,444	1,890	$3,780	6,453	$12,906	25,121	$50,241	10,697	$21,395
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00									15,605	$78,025								
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00																		
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00																		
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50																		
17	402	501	Trench Safety Protection	LF	$1.25									600	$750								
18	423	508	Retaining walls (cast in place)	SF	$25.00																		
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																		
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																		
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00																		
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00																		
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00																		
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																		
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00																		
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00									600	$390,000								
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00																		
28	422	501	Bridge 1 - straightforward	SF	$35.00					4,796	$167,860	12,204	$427,140					15,705	$549,675				
29	422	501	Bridge 2 - straightforward	SF	$35.00																		
30	422	501	Bridge 3 - straightforward	SF	$35.00																		
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																		
32	464	505	RCP - Class III - 24"	LF	$40.00																		
33	464	509	RCP - Class III - 36"	LF	$50.00																		
34	464	510	RCP - Class III - 42"	LF	$70.00																		
35	464	511	RCP - Class III - 48"	LF	$90.00																		
36	464	512	RCP - Class III - 54"	LF	$120.00																		
37	464	513	RCP - Class III - 60"	LF	$150.00																		
38	464	514	RCP - Class III - 66"	LF	$175.00																		
39	464	515	RCP - Class III - 72"	LF	$200.00																		
40	464	516	RCP - Class III - 78"	LF	$225.00																		
41	464	517	RCP - Class III - 84"	LF	$275.00																		
42	464	518	RCP - Class III - 96"	LF	$325.00																		
43	465	547	Inlet - Single	EA	$7,000.00																		
44	465	548	Inlet - Double	EA	$10,000.00																		
45	465	549	Inlet - Triple	EA	$13,000.00																		
46	465	536	Drainage MH or JB	EA	$5,000.00																		
47	466	501	Headwall - small	EA	$2,500.00																		
48	466	501	Headwall - large	EA	$4,000.00																		
49	529	511	Concrete Curb and Gutter	LF	$6.50																		
50	529	521	Concrete Valley Gutter	LF	$10.00																		
51	530	604	Remove & Replace Driveway	EA	$3,000.00																		
52	531	502	Sidewalk	SY	$50.00																		
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																		
54	560	501	Mailbox Assembly	EA	$400.00																		
55	580	none	Project Maintenance (subsidiary)																				
56	COA-594	none	Gabions	CY	$150.00																		
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																		
58	639	none	Rock Berm	LF	$900.00																		
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	284	$710	487	$1,219	331	$827	619	$1,548	660	$1,650	561	$1,403	219	$547	856	$2,141	388	$969
60	1610	none	Preservation of Trees (Type C)	EA	$100.00																		
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600
62	Special	none	Conlock II pavers	SY	$27.00	1,913	$51,660	3,282	$88,620	2,227	$60,120	4,169	$112,560	4,444	$120,000	3,780	$102,060	1,473	$39,780	5,767	$155,700	2,611	$70,500
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00															1	$20,000		
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																		
65	420	none	Pump		$175,000.00																		
66																							
End of Current BASE BID specification items and unit prices																							
			Contingency =	15%			$22,119		$37,417		$53,187		$119,132		$478,820		$409,497		$105,530		$84,752		$38,711
			TOTAL BASE BID (suject to revision)				$169,581		$286,863		$407,769		$913,344		$3,670,956		$3,139,476		$809,060		$649,769		$296,788
			(cost per linear foot =)				$197		$194		$407		$487		$1,835		$1,846		$1,220		$250		$253

CITY OF VICTORIA
Lone Tree Creek
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	Reach R1659A		Reach R1670A		Reach R1686A		Reach R1705A		Reach R1721A		LT 1:1		LT 2:1 Southern Pacific		Channel Improvements LT 2:1 Southern Pacific	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $
			Length of individual Reach (feet)			950		1,671		1,896		1,471		2,746		5,548				6,500	
			Estimated ROW width needed for excavated open channel (feet)			160		166		140		139		139							
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$8,137	1	$22,089	1	$9,032	1	$19,179	1	$41,231	1	$125,994			1	$9,527
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$2,034	1	$5,522	1	$2,258	1	$4,795	1	$10,308	1	$31,498			1	$2,382
3	500	501	Mobilization	LS	2.5%	1	$5,086	1	$13,805	1	$5,645	1	$11,987	1	$25,769	1	$78,746			1	$5,955
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$3,052	1	$8,283	1	$3,387	1	$7,192	1	$15,461	1	$47,248			1	$3,573
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																
6	110	502	Excavation - channel	CY	$4.00	23,660	$94,640	27,980	$111,920	10,550	$42,200	8,370	$33,480	17,460	$69,840					19,500	$78,000
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	17,285	$8,642	31,589	$15,794	30,073	$15,036	23,104	$11,552	43,130	$21,565	12,329	$6,165			68,542	$34,271
10	162	509	Block sod (St. Augustine)	SY	$2.00											3,082	$6,165				
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	17,285	$12,963	31,589	$23,691	30,073	$22,555	23,104	$17,328	43,130	$32,348	9,247	$6,935			68,542	$51,407
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00					15,036	$30,073	11,552	$23,104	21,565	$43,130	6,165	$12,329			34,271	$68,542
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00	5,762	$28,808	10,530	$52,648												
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00											9,247	$64,729				
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00											9,247	$55,482				
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50											44	$200				
17	402	501	Trench Safety Protection	LF	$1.25											5,548	$6,935				
18	423	508	Retaining walls (cast in place)	SF	$25.00																
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00																
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00																
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00											2,838	$851,400				
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00											2,710	$1,355,100				
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00																
28	422	501	Bridge 1 - straightforward	SF	$35.00			6,455	$225,925			8,684	$303,940	13,117	$459,095						
29	422	501	Bridge 2 - straightforward	SF	$35.00									6,776	$237,160						
30	422	501	Bridge 3 - straightforward	SF	$35.00																
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																
32	464	505	RCP - Class III - 24"	LF	$40.00																
33	464	509	RCP - Class III - 36"	LF	$50.00																
34	464	510	RCP - Class III - 42"	LF	$70.00																
35	464	511	RCP - Class III - 48"	LF	$90.00																
36	464	512	RCP - Class III - 54"	LF	$120.00																
37	464	513	RCP - Class III - 60"	LF	$150.00																
38	464	514	RCP - Class III - 66"	LF	$175.00																
39	464	515	RCP - Class III - 72"	LF	$200.00																
40	464	516	RCP - Class III - 78"	LF	$225.00																
41	464	517	RCP - Class III - 84"	LF	$275.00																
42	464	518	RCP - Class III - 96"	LF	$325.00																
43	465	547	Inlet - Single	EA	$7,000.00											14	$98,000				
44	465	548	Inlet - Double	EA	$10,000.00											15	$150,000				
45	465	549	Inlet - Triple	EA	$13,000.00											16	$208,000				
46	465	536	Drainage MH or JB	EA	$5,000.00											11	$55,482				
47	466	501	Headwall - small	EA	$2,500.00																
48	466	501	Headwall - large	EA	$4,000.00																
49	529	511	Concrete Curb and Gutter	LF	$6.50											2,774	$18,032				
50	529	521	Concrete Valley Gutter	LF	$10.00																
51	530	604	Remove & Replace Driveway	EA	$3,000.00											55	$166,446				
52	531	502	Sidewalk	SY	$50.00											1,110	$55,482				
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																
54	560	501	Mailbox Assembly	EA	$400.00											55	$22,193				
55	580	none	Project Maintenance (subsidiary)																		
56	COA-594	none	Gabions	CY	$150.00																
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																
58	639	none	Rock Berm	LF	$900.00																
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	314	$784	551	$1,379	626	$1,564	485	$1,214	906	$2,265	1,849	$4,624			2,145	$5,363
60	1610	none	Preservation of Trees (Type C)	EA	$100.00											55	$5,548				
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600			1	$600
62	Special	none	Conlock II pavers	SY	$27.00	2,111	$57,000	3,713	$100,260	4,213	$113,760	3,269	$88,260	6,102	$164,760						
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00			1	$20,000												
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																
65	420	none	Pump		$175,000.00																
66																					
End of Current BASE BID specification items and unit prices																					
			Contingency =	15%			$33,262		$90,287		$36,916		$78,395		$168,530		$515,000				$38,943
			TOTAL BASE BID (suject to revision)				$255,008		$692,204		$283,025		$601,026		$1,292,062		$3,948,332				$298,561
			(cost per linear foot =)				$268		$414		$149		$409		$471		$712				$46

CITY OF VICTORIA
Lone Tree Creek
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	LT 2:2 Southern Pacific		LT 2:3 Southern Pacific		LT 2:4 Southern Pacific		LT 2:5 Southern Pacific		LT 3:1		LT 4:1		LT 4:2		LT 4:3	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $
			Length of individual Reach (feet)			3,376		1,294				3,147		1,831		1,421		1,260		1,961	
			Estimated ROW width needed for excavated open channel (feet)																		
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$46,678	1	$16,757		$1,120	1	$47,844	1	$20,808	1	$22,240	1	$11,959	1	$19,998
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$11,670	1	$4,189		$280	1	$11,961	1	$5,202	1	$5,560	1	$2,990	1	$5,000
3	500	501	Mobilization	LS	2.5%	1	$29,174	1	$10,473		$700	1	$29,903	1	$13,005	1	$13,900	1	$7,474	1	$12,499
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$17,504	1	$6,284		$420	1	$17,942	1	$7,803	1	$8,340	1	$4,485	1	$7,499
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																
6	110	502	Excavation - channel	CY	$4.00																
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	7,502	$3,751	2,875	$1,437			6,993	$3,497	4,069	$2,034	3,158	$1,579	2,800	$1,400	4,358	$2,179
10	162	509	Block sod (St. Augustine)	SY	$2.00	1,876	$3,751	719	$1,437			1,748	$3,497	1,017	$2,034	789	$1,579	700	$1,400	1,089	$2,179
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	5,627	$4,220	2,156	$1,617			5,245	$3,934	3,052	$2,289	2,368	$1,776	2,100	$1,575	3,268	$2,451
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	3,751	$7,502	1,437	$2,875			3,497	$6,993	2,034	$4,069	1,579	$3,158	1,400	$2,800	2,179	$4,358
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00																
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00	5,627	$39,387	2,156	$15,093			5,245	$36,715	3,052	$21,362	2,368	$16,578	2,100	$14,700	3,268	$22,878
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00	5,627	$33,760	2,156	$12,937			5,245	$31,470	3,052	$18,310	2,368	$14,210	2,100	$12,600	3,268	$19,610
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50	27	$122	10	$47			25	$113	15	$66	11	$51	10	$45	16	$71
17	402	501	Trench Safety Protection	LF	$1.25	3,376	$4,220	1,294	$1,617			3,147	$3,934	1,831	$2,289	1,421	$1,776	1,260	$1,575	1,961	$2,451
18	423	508	Retaining walls (cast in place)	SF	$25.00																
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00	3,051	$533,925	647	$113,225			879	$153,825	921	$161,175						
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00							591	$132,975			1,421	$319,725				
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00							1,101	$330,300								
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00																
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00																
28	422	501	Bridge 1 - straightforward	SF	$35.00																
29	422	501	Bridge 2 - straightforward	SF	$35.00																
30	422	501	Bridge 3 - straightforward	SF	$35.00																
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																
32	464	505	RCP - Class III - 24"	LF	$40.00																
33	464	509	RCP - Class III - 36"	LF	$50.00									303	$15,150			691	$34,550		
34	464	510	RCP - Class III - 42"	LF	$70.00							576	$40,320								
35	464	511	RCP - Class III - 48"	LF	$90.00	325	$29,250							607	$54,630						
36	464	512	RCP - Class III - 54"	LF	$120.00			647	$77,604									569	$68,280	1,961	$235,320
37	464	513	RCP - Class III - 60"	LF	$150.00																
38	464	514	RCP - Class III - 66"	LF	$175.00																
39	464	515	RCP - Class III - 72"	LF	$200.00																
40	464	516	RCP - Class III - 78"	LF	$225.00																
41	464	517	RCP - Class III - 84"	LF	$275.00																
42	464	518	RCP - Class III - 96"	LF	$325.00																
43	465	547	Inlet - Single	EA	$7,000.00	11	$77,000	4	$28,000	4	$28,000	12	$84,000	6	$42,000	5	$35,000	5	$35,000	6	$42,000
44	465	548	Inlet - Double	EA	$10,000.00	10	$100,000	6	$60,000			10	$100,000	6	$60,000	5	$50,000	5	$50,000	5	$50,000
45	465	549	Inlet - Triple	EA	$13,000.00	10	$130,000	2	$26,000			6	$78,000	2	$26,000	2	$26,000				
46	465	536	Drainage MH or JB	EA	$5,000.00	7	$33,760	3	$12,937			6	$31,470	4	$18,310	3	$14,210	3	$12,600	4	$19,610
47	466	501	Headwall - small	EA	$2,500.00																
48	466	501	Headwall - large	EA	$4,000.00																
49	529	511	Concrete Curb and Gutter	LF	$6.50	1,688	$10,972	647	$4,205			1,574	$10,228	916	$5,951	711	$4,618	630	$4,095	981	$6,373
50	529	521	Concrete Valley Gutter	LF	$10.00																
51	530	604	Remove & Replace Driveway	EA	$3,000.00	34	$101,280	13	$38,811			31	$94,410	18	$54,930	14	$42,630	13	$37,800	20	$58,830
52	531	502	Sidewalk	SY	$50.00	675	$33,760	259	$12,937			629	$31,470	366	$18,310	284	$14,210	252	$12,600	392	$19,610
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																
54	560	501	Mailbox Assembly	EA	$400.00	34	$13,504	13	$5,175			31	$12,588	18	$7,324	14	$5,684	13	$5,040	20	$7,844
55	580	none	Project Maintenance (subsidiary)																		
56	COA-594	none	Gabions	CY	$150.00																
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																
58	639	none	Rock Berm	LF	$900.00																
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	1,125	$2,813	431	$1,078			1,049	$2,623	610	$1,526	474	$1,184	420	$1,050	654	$1,634
60	1610	none	Preservation of Trees (Type C)	EA	$100.00	34	$3,376	13	$1,294			31	$3,147	18	$1,831	14	$1,421	13	$1,260	20	$1,961
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600			1	$600	1	$600	1	$600	1	$600	1	$600
62	Special	none	Conlock II pavers	SY	$27.00																
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00																
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																
65	420	none	Pump		$175,000.00																
66																					
End of Current BASE BID specification items and unit prices																					
			Contingency =	15%			$190,797		$68,494		$4,578		$195,564		$85,051		$90,904		$48,882		$81,743
			TOTAL BASE BID (suject to revision)				$1,462,776		$525,124		$35,098		$1,499,321		$652,057		$696,933		$374,759		$626,699
			(cost per linear foot =)				$433		$406				$476		$356		$490		$297		$320

CITY OF VICTORIA
Lone Tree Creek
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	LT 4:4		LT 5:1		LT 6:1		LT 6:2		LT 6:3		LT 7:1		LT 8:1		LT 9:1	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $
			Length of individual Reach (feet)							1,598				546		2,862		194		2,832	
			Estimated ROW width needed for excavated open channel (feet)																		
1	100	none	Preparing Right of Way - General	LS	4.0%		$2,480		$9,640	1	$16,677		$3,000	1	$6,032	1	$36,245	1	$20,125	1	$100,402
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%		$620		$2,410	1	$4,169		$750	1	$1,508	1	$9,061	1	$5,031	1	$25,101
3	500	501	Mobilization	LS	2.5%		$1,550		$6,025	1	$10,423		$1,875	1	$3,770	1	$22,653	1	$12,578	1	$62,751
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%		$930		$3,615	1	$6,254		$1,125	1	$2,262	1	$13,592	1	$7,547	1	$37,651
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																
6	110	502	Excavation - channel	CY	$4.00																
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																
9	160	506	Furnishing and Placing Topsoil	SY	$0.50					3,551	$1,776			1,213	$607	6,360	$3,180	431	$216	6,293	$3,147
10	162	509	Block sod (St. Augustine)	SY	$2.00					888	$1,776			303	$607	1,590	$3,180	108	$216	1,573	$3,147
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75					2,663	$1,998			910	$683	4,770	$3,578	323	$243	4,720	$3,540
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00					1,776	$3,551			607	$1,213	3,180	$6,360	216	$431	3,147	$6,293
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00																
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00					2,663	$18,643			910	$6,370	4,770	$33,392	323	$2,263	4,720	$33,040
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00					2,663	$15,980			910	$5,460	4,770	$28,622	323	$1,940	4,720	$28,320
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50					13	$58			4	$20	23	$103	2	$7	23	$102
17	402	501	Trench Safety Protection	LF	$1.25					1,598	$1,998			546	$683	2,862	$3,578	194	$243	2,832	$3,540
18	423	508	Retaining walls (cast in place)	SF	$25.00																
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00					755	$132,125										
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00											1,303	$293,175				
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00																
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00																
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00													194	$145,500	2,832	$2,124,000
28	422	501	Bridge 1 - straightforward	SF	$35.00																
29	422	501	Bridge 2 - straightforward	SF	$35.00																
30	422	501	Bridge 3 - straightforward	SF	$35.00																
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																
32	464	505	RCP - Class III - 24"	LF	$40.00																
33	464	509	RCP - Class III - 36"	LF	$50.00									546	$27,300	496	$24,810				
34	464	510	RCP - Class III - 42"	LF	$70.00					843	$59,010										
35	464	511	RCP - Class III - 48"	LF	$90.00																
36	464	512	RCP - Class III - 54"	LF	$120.00																
37	464	513	RCP - Class III - 60"	LF	$150.00											1,063	$159,450				
38	464	514	RCP - Class III - 66"	LF	$175.00																
39	464	515	RCP - Class III - 72"	LF	$200.00																
40	464	516	RCP - Class III - 78"	LF	$225.00																
41	464	517	RCP - Class III - 84"	LF	$275.00																
42	464	518	RCP - Class III - 96"	LF	$325.00																
43	465	547	Inlet - Single	EA	$7,000.00	6	$42,000	9	$63,000	5	$35,000	5	$35,000	5	$35,000	6	$42,000	10	$70,000	5	$35,000
44	465	548	Inlet - Double	EA	$10,000.00	2	$20,000	10	$100,000	5	$50,000	4	$40,000	4	$40,000	7	$70,000	14	$140,000	5	$50,000
45	465	549	Inlet - Triple	EA	$13,000.00			6	$78,000							5	$65,000	10	$130,000	4	$52,000
46	465	536	Drainage MH or JB	EA	$5,000.00					3	$15,980			1	$5,460	6	$28,622	0	$1,940	6	$28,320
47	466	501	Headwall - small	EA	$2,500.00																
48	466	501	Headwall - large	EA	$4,000.00																
49	529	511	Concrete Curb and Gutter	LF	$6.50					799	$5,194			273	$1,775	1,431	$9,302	97	$631	1,416	$9,204
50	529	521	Concrete Valley Gutter	LF	$10.00																
51	530	604	Remove & Replace Driveway	EA	$3,000.00					16	$47,940			5	$16,380	29	$85,866	2	$5,820	28	$84,960
52	531	502	Sidewalk	SY	$50.00					320	$15,980			109	$5,460	572	$28,622	39	$1,940	566	$28,320
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																
54	560	501	Mailbox Assembly	EA	$400.00					16	$6,392			5	$2,184	29	$11,449	2	$776	28	$11,328
55	580	none	Project Maintenance (subsidiary)																		
56	COA-594	none	Gabions	CY	$150.00																
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																
58	639	none	Rock Berm	LF	$900.00																
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50					533	$1,332			182	$455	954	$2,385	65	$162	944	$2,360
60	1610	none	Preservation of Trees (Type C)	EA	$100.00					16	$1,598			5	$546	29	$2,862	2	$194	28	$2,832
61	802-A	none	Capital Improvement Project Sign	LS	$600.00					1	$600			1	$600	1	$600	1	$600	1	$600
62	Special	none	Conlock II pavers	SY	$27.00																
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00																
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																
65	420	none	Pump		$175,000.00																
66																					
End of Current BASE BID specification items and unit prices																					
			Contingency =	15%			$10,137		$39,404		$68,168		$12,263		$24,656		$148,153		$82,260		$410,394
			TOTAL BASE BID (suject to revision)				$77,717		$302,094		$522,620		$94,013		$189,029		$1,135,843		$630,661		$3,146,351
			(cost per linear foot =)								$327				$346		$397		$3,251		$1,111

CITY OF VICTORIA
Lone Tree Creek
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	LT 9:2		LT Upper Det. Basin Reach R1580B East Branch		LT 10:1 East Branch		LT 11:1 East Branch		LT 11:2 East Branch		LT 11:3 East Branch		**LONE TREE Overall Project**	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	**Quantity**	**Total $**
			Length of individual Reach (feet)			3,233		2,791		2,399		1,472		1,263		840		100,686	
			Estimated ROW width needed for excavated open channel (feet)					145											
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$30,325	1	$86,450	1	$25,153	1	$14,330	1	$10,489	1	$9,394	42	$1,419,939
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$7,581	1	$21,613	1	$6,288	1	$3,582	1	$2,622	1	$2,348	42	$354,985
3	500	501	Mobilization	LS	2.5%	1	$18,953	1	$54,032	1	$15,720	1	$8,956	1	$6,555	1	$5,871	42	$887,462
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$11,372	1	$32,419	1	$9,432	1	$5,374	1	$3,933	1	$3,523	40	$532,477
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00														
6	110	502	Excavation - channel	CY	$4.00			513,500	$2,054,000									2,492,710	$10,048,840
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00													14,590	$87,540
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00														
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	7,184	$3,592	46,381	$23,191	5,331	$2,666	3,271	$1,636	2,807	$1,403	1,866	$933	1,239,316	$653,929
10	162	509	Block sod (St. Augustine)	SY	$2.00	1,796	$3,592			1,333	$2,666	818	$1,636	702	$1,403	467	$933	20,598	$41,196
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	5,388	$4,041	46,381	$34,786	3,998	$2,999	2,453	$1,840	2,105	$1,579	1,400	$1,050	1,218,718	$965,445
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00	3,592	$7,184	23,191	$46,381	2,666	$5,331	1,636	$3,271	1,403	$2,807	933	$1,866	595,222	$1,258,985
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00													31,896	$159,480
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00	5,388	$37,718			3,998	$27,988	2,453	$17,173	2,105	$14,735	1,400	$9,797	61,795	$432,563
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00	5,388	$32,330			3,998	$23,990	2,453	$14,720	2,105	$12,630	1,400	$8,397	61,795	$370,768
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50	26	$116			19	$86	12	$53	10	$45	7	$30	297	$1,335
17	402	501	Trench Safety Protection	LF	$1.25	3,233	$4,041			2,399	$2,999	1,472	$1,840	1,263	$1,579	840	$1,050	37,677	$47,096
18	423	508	Retaining walls (cast in place)	SF	$25.00														
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00														
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00														
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00													6,253	$1,094,275
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00													3,315	$745,875
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00													3,939	$1,181,700
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00														
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00													2,710	$1,355,100
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00													600	$390,000
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00													3,026	$2,269,500
28	422	501	Bridge 1 - straightforward	SF	$35.00													96,662	$3,383,170
29	422	501	Bridge 2 - straightforward	SF	$35.00													11,186	$391,510
30	422	501	Bridge 3 - straightforward	SF	$35.00														
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00														
32	464	505	RCP - Class III - 24"	LF	$40.00	76	$3,040											76	$3,040
33	464	509	RCP - Class III - 36"	LF	$50.00							795	$39,750	580	$29,000			3,411	$170,560
34	464	510	RCP - Class III - 42"	LF	$70.00					846	$59,220			683	$47,810			2,948	$206,360
35	464	511	RCP - Class III - 48"	LF	$90.00					707	$63,630	230	$20,700			840	$75,573	2,709	$243,783
36	464	512	RCP - Class III - 54"	LF	$120.00	3,157	$378,840											6,334	$760,044
37	464	513	RCP - Class III - 60"	LF	$150.00					846	$126,900	447	$67,050					2,356	$353,400
38	464	514	RCP - Class III - 66"	LF	$175.00														
39	464	515	RCP - Class III - 72"	LF	$200.00														
40	464	516	RCP - Class III - 78"	LF	$225.00														
41	464	517	RCP - Class III - 84"	LF	$275.00														
42	464	518	RCP - Class III - 96"	LF	$325.00														
43	465	547	Inlet - Single	EA	$7,000.00	6	$42,000			8	$56,000	5	$35,000	4	$28,000	5	$35,000	146	$1,022,000
44	465	548	Inlet - Double	EA	$10,000.00	5	$50,000			6	$60,000	4	$40,000	2	$20,000	5	$50,000	135	$1,350,000
45	465	549	Inlet - Triple	EA	$13,000.00					4	$52,000	2	$26,000	2	$26,000			71	$923,000
46	465	536	Drainage MH or JB	EA	$5,000.00	6	$32,330			5	$23,990	3	$14,720	3	$12,630	2	$8,397	74	$370,768
47	466	501	Headwall - small	EA	$2,500.00														
48	466	501	Headwall - large	EA	$4,000.00														
49	529	511	Concrete Curb and Gutter	LF	$6.50	1,617	$10,507			1,200	$7,797	736	$4,784	632	$4,105	420	$2,729	18,538	$120,500
50	529	521	Concrete Valley Gutter	LF	$10.00														
51	530	604	Remove & Replace Driveway	EA	$3,000.00	32	$96,990			24	$71,970	15	$44,160	13	$37,890	8	$25,191	371	$1,112,304
52	531	502	Sidewalk	SY	$50.00	647	$32,330			480	$23,990	294	$14,720	253	$12,630	168	$8,397	7,415	$370,768
53	550	501	Chain Link Fence - 6ft.	LF	$10.00														
54	560	501	Mailbox Assembly	EA	$400.00	32	$12,932			24	$9,596	15	$5,888	13	$5,052	8	$3,359	371	$148,307
55	580	none	Project Maintenance (subsidiary)																
56	COA-594	none	Gabions	CY	$150.00														
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00														
58	639	none	Rock Berm	LF	$900.00														
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	1,078	$2,694	921	$2,303	800	$1,999	491	$1,227	421	$1,053	280	$700	31,205	$83,375
60	1610	none	Preservation of Trees (Type C)	EA	$100.00	32	$3,233			24	$2,399	15	$1,472	13	$1,263	8	$840	371	$37,077
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	42	$25,800
62	Special	none	Conlock II pavers	SY	$27.00													120,707	$3,259,080
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00													3	$60,000
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00														
65	420	none	Pump		$175,000.00														
66																			
End of Current BASE BID specification items and unit prices																			
			Contingency =	15%			$123,951		$353,366		$102,811		$58,572		$42,872		$38,396		$5,804,000
			TOTAL BASE BID (suject to revision)				$950,294		$2,709,140		$788,220		$449,053		$328,685		$294,372		$44,497,336
			(cost per linear foot =)				$294		$971		$329		$305		$260		$351		$442

CITY OF VICTORIA
Marcado Creek
Engineer's Preliminary Estimate of Costs (Based on Construction Costs in of February 1999)

	TxDOT Spec	TxDOT Descrip. Code	Item	Units	Unit $	Reach R418A		Reach R474A		Reach R538A		Reach R576A		Reach R611A		Reach R631A		Reach R662A		Reach R677A		Reach R707A		**MARCADO Overall Project**	
						Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	Quantity	Sheet $	**Quantity**	**Total $**
			Length of individual Reach (feet)			6,277		5,560		3,916		3,943		2,207		2,832		1,360		2,717		4,557		33,369	
			Estimated ROW width needed for excavated open channel (feet)			247		247		232		218		183		185		155		155		151			
1	100	none	Preparing Right of Way - General	LS	4.0%	1	$55,002	1	$47,041	1	$23,647	1	$26,583	1	$13,007	1	$15,036	1	$27,431	1	$10,435	1	$27,389	9	$245,570
2	100	none	Relocation of utilities - gas, telephone, power, others	LS	1.0%	1	$13,750	1	$11,760	1	$5,912	1	$6,646	1	$3,252	1	$3,759	1	$6,858	1	$2,609	1	$6,847	9	$61,393
3	500	501	Mobilization	LS	2.5%	1	$34,376	1	$29,401	1	$14,779	1	$16,614	1	$8,129	1	$9,397	1	$17,144	1	$6,522	1	$17,118	9	$153,481
4	502	none	Barricades, Signs and Traffic Handling	LS	1.5%	1	$20,626	1	$17,640	1	$8,867	1	$9,969	1	$4,878	1	$5,638	1	$10,287	1	$3,913	1	$10,271	9	$92,089
5	104	520	Removing concrete (unusual items not a part of general ROW prep)	SY	$8.00																				
6	110	502	Excavation - channel	CY	$4.00	175,040	$700,160	170,460	$681,840	81,120	$324,480	110,910	$443,640	55,010	$220,040	59,830	$239,320	37,680	$150,720	37,680	$150,720	56,560	$226,240	784,290	$3,137,160
7	132	518	Embankment - berms, dikes, detention basin dams	CY	$6.00																				
8	158	504	Specialized Excavation Work (hard to reach areas, more difficult)	CY	$6.00																				
9	160	506	Furnishing and Placing Topsoil	SY	$0.50	174,806	$87,403	155,268	$77,634	102,451	$51,225	96,480	$48,240	45,649	$22,825	59,393	$29,696	23,874	$11,937	47,696	$23,848	78,140	$39,070	783,757	$391,879
10	162	509	Block sod (St. Augustine)	SY	$2.00																				
11	164	511	Seeding for Erosion Control (to include fertilizer & watering, subsidary)	SY	$0.75	174,806	$131,105	155,268	$116,451	102,451	$76,838	96,480	$72,360	45,649	$34,237	59,393	$44,545	23,874	$17,906	47,696	$35,772	78,140	$58,605	783,757	$587,818
12	169	501	Soil Retention Blanket - Temporary (ECRM) - (if shear under 3 psf) L/2	SY	$2.00			77,634	$155,268	51,225	$102,451	48,240	$96,480	22,825	$45,649	29,696	$59,393	11,937	$23,874	23,848	$47,696	39,070	$78,140	304,475	$608,951
13	169	513	Soil Retention Blanket - Permanent (TRM) - (if shear over 3 psf) L/3	SY	$5.00	58,269	$291,344																	58,269	$291,344
14	247	505	Flexible Base - assume 12" Thickness	SY	$7.00																				
15	340	none	HMAC - Type D - assume 2" Thickness	SY	$6.00																				
16	400	501	Excavation and Backfill for Structures (headwalls, junction boxes)	CY	$4.50																				
17	402	501	Trench Safety Protection	LF	$1.25					70	$88													70	$88
18	423	508	Retaining walls (cast in place)	SF	$25.00																				
19	432	507	Riprap - Stone (Channel) (assume 18" thick)	SY	$6.00																				
20	441	none	Steel Structures (pedestrian hand rails, others)	EA	$2,000.00																				
21	462	509	Concrete Box Culverts - 5 x 5	LF	$175.00					70	$12,250													70	$12,250
22	462	516	Concrete Box Culverts - 6 x 6	LF	$225.00																				
23	462	523	Concrete Box Culverts - 8 x 6	LF	$300.00																				
24	462	532	Concrete Box Culverts - 9 x 7	LF	$400.00																				
25	462	??	Concrete Box Culverts - 12 x 6	LF	$500.00																				
26	462	??	Concrete Box Culverts - 12 x 8	LF	$650.00																				
27	Special 4306	none	Precast CROWNSPAN culvert structures (assume 24 x 6)	LF	$750.00																				
28	422	501	Bridge 1 - straightforward	SF	$35.00	4,550	$159,250	3,990	$139,650									13,132	$459,620			7,952	$278,320	29,624	$1,036,840
29	422	501	Bridge 2 - straightforward	SF	$35.00																				
30	422	501	Bridge 3 - straightforward	SF	$35.00																				
31	422	501	Bridge 4 - more difficult and involved	SF	$40.00																				
32	464	505	RCP - Class III - 24"	LF	$40.00																				
33	464	509	RCP - Class III - 36"	LF	$50.00																				
34	464	510	RCP - Class III - 42"	LF	$70.00																				
35	464	511	RCP - Class III - 48"	LF	$90.00																				
36	464	512	RCP - Class III - 54"	LF	$120.00																				
37	464	513	RCP - Class III - 60"	LF	$150.00																				
38	464	514	RCP - Class III - 66"	LF	$175.00																				
39	464	515	RCP - Class III - 72"	LF	$200.00																				
40	464	516	RCP - Class III - 78"	LF	$225.00																				
41	464	517	RCP - Class III - 84"	LF	$275.00																				
42	464	518	RCP - Class III - 96"	LF	$325.00																				
43	465	547	Inlet - Single	EA	$7,000.00																				
44	465	548	Inlet - Double	EA	$10,000.00																				
45	465	549	Inlet - Triple	EA	$13,000.00																				
46	465	536	Drainage MH or JB	EA	$5,000.00																				
47	466	501	Headwall - small	EA	$2,500.00																				
48	466	501	Headwall - large	EA	$4,000.00																				
49	529	511	Concrete Curb and Gutter	LF	$6.50																				
50	529	521	Concrete Valley Gutter	LF	$10.00																				
51	530	604	Remove & Replace Driveway	EA	$3,000.00																				
52	531	502	Sidewalk	SY	$50.00																				
53	550	501	Chain Link Fence - 6ft.	LF	$10.00																				
54	560	501	Mailbox Assembly	EA	$400.00																				
55	580	none	Project Maintenance (subsidiary)																						
56	COA-594	none	Gabions	CY	$150.00																				
57	COA-594-B	none	Reno Revetment Mattress	CY	$150.00																				
58	639	none	Rock Berm	LF	$900.00																				
59	642	none	Silt Fence (curlex logs) (assume 33% of total project L)	LF	$2.50	2,071	$5,179	1,835	$4,587	1,292	$3,231	1,301	$3,253	728	$1,821	935	$2,336	449	$1,122	897	$2,242	1,504	$3,760	11,012	$27,529
60	1610	none	Preservation of Trees (Type C)	EA	$100.00																				
61	802-A	none	Capital Improvement Project Sign	LS	$600.00	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	1	$600	9	$5,400
62	Special	none	Conlock II pavers	SY	$27.00																				
63	420	none	Concrete Structures (drop, energy dissipation, special)	EA	$20,000.00					1	$20,000							1	$20,000					2	$40,000
64	420	none	Pump Housing (metal duilding, concrete pad, sumps, outlet works)		$50,000.00																				
65	420	none	Pump		$175,000.00																				
66	xx	xx																							
End of Current BASE BID specification items and unit prices																									
			Contingency =	15%			$224,819		$192,281		$96,655		$108,657		$53,166		$61,458		$112,125		$42,654		$111,954		$1,003,769
			TOTAL BASE BID (suject to revision)				$1,723,612		$1,474,155		$741,022		$833,041		$407,603		$471,178		$859,625		$327,011		$858,313		$7,695,560
			(cost per linear foot =)				$275		$265		$189		$211		$185		$166		$632		$120		$188		$231