WOOD RODGERS

February 6, 2006

Mr. Gary Wegener
City of Woodland
300 First Street
Woodland, California 95695

Dear Mr. Wegener:

Subject: City of Woodland, Storm Drainage Facilities Master Plan Update and Preliminary Engineering (8164.004) – Report

Wood Rodgers, Inc. is pleased to submit its report to the City of Woodland (City) entitled, "Storm Drainage Facilities Master Plan Update and Preliminary Engineering." This report has been prepared in three volumes as follows:

1. Main Report, Volume 1 of 3
2. Appendices, Volume 2 of 3
3. Preliminary Engineering Drawings, Volume 3 of 3

As previously discussed, all three volumes of the report are being submitted to Brownie's Blueprint in Sacramento. Copies of the report can be obtained from Brownie's at:

Brownie's Blueprint Digital Imaging Department
1322 V Street
Sacramento, CA 95818
Tel: 916-443-1322
Ref: City of Woodland, Master Plan Update

Any costs incurred in copying the report will be borne by the requesting party.

Wood Rodgers appreciates the opportunity to work on this project related to planning and implementing regional storm drainage facilities within the City.

Sincerely,

Francis E. Borcalli, P.E.
Program Manager

Michael C. Nowlan, P.E.
Project Engineer

Enclosures

c: Dick Donnelly (w/o encls)
Douglas Baxter (w/o encls)
Mark Cocke (w/o encls)

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City of Woodland
Storm Drainage Facilities Master Plan Update and Preliminary Engineering

Draft

Main Report
Volume 1 of 3

February 2006

WOOD RODGERS
DEVELOPING INNOVATIVE DESIGN SOLUTIONS

VOLUME 1 OF 3

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ACRONYMS

BMPs	Best Management Practices
CCSB	Cache Creek Settling Basin
CEQA	California Environmental Quality Act
EMAD	East Main Assessment District
EMPS	East Main Pump Station
EIR	Environmental Impact Report
ESA	Endangered Species Act
FCC	Farmer's Central Channel
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
MPRA	Master Plan Remainder Area
NEPA	National Environmental Protection Act
NCPS	North Canal Pump Station
NFIP	National Flood Insurance Program
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
RCB	Reinforced Concrete Box
RCP	Reinforced Concrete Pipe
SCPS	South Canal Pump Station
SDFMP	Storm Drainage Facilities Master Plan
SLSPA	Spring Lake Specific Plan Area
USACOE	U.S. Army Corps of Engineers

I. INTRODUCTION

In December 1999, the City of Woodland (City) completed its Storm Drainage Facilities Master Plan (SDFMP) consistent with the 1996 General Plan. Subsequent to preparing the SDFMP, significant events occurred or were being proposed that dictated updating the SDFMP. These events included the following:

1. The City executed a 20-year agreement to continue to utilize Dubach Park for recreation, which is not compatible with its use as a detention pond, as proposed in the SDFMP.

2. The U. S. Army Corps of Engineers (USACOE), in performing its feasibility investigation of alternatives to protect the City from the risk of flooding from Cache Creek, as an alternative, proposed to construct a flood barrier along the north boundary of the City's General Plan boundary. If implemented, the project could affect the SDFMP.

3. The City was interested in utilizing the site of the Beamer-Kentucky Detention ponds for other purposes.

4. Phasing the SDFMP to accommodate development within the Spring Lake Specific Plan Area (SLSPA) of the South Urban Growth Area was deemed, by the development community, not feasible.

5. The City determined the gravity connections from the South Canal and North Canal to the East Main Pump Station are temporary and should be eliminated as soon as possible.

6. As part of the USACOE's work on the feasibility investigation of alternatives to protect the City from flooding from Cache Creek, topographic mapping with a two-foot contour interval was developed, which provided greater detail than the mapping available for preparation of the SDFMP.

Concurrent with the SDFMP update, the City deemed it appropriate to perform preliminary engineering for the master storm drain facilities, thus this document is a report on the Storm Drainage Facilities Master Plan Update and Preliminary Engineering (Master Plan Update).

During the preparation of the Master Plan Update, considerable attention was given to initiating development within the SLSPA and the phasing of drainage infrastructure to accommodate the phased development of the area. Accordingly, the storm drainage facilities for the South Urban Growth Area were identified, and Phase 1 of the storm drainage facilities for the area were designed and constructed.

Additionally, development interest precipitated the development of the Woodland Park Specific Plan within the North Urban Growth Area. Accordingly, storm drainage facilities were identified to facilitate the phasing of development with this area.

The facilities for the SLSPA and the Wood Park Specific Plan Area are integrated into the City's Master Plan Update, and described in subsequent sections of this document.

For reference, the areas comprising the South Urban Growth Area, the North Urban Growth Area, the Woodland Park Specific Plan Area, and the SLSPA are presented on Map 1.

As part of this Master Plan Update a geotechnical assessment was performed by Kleinfelder, Inc. (Appendix A) of the south levee of the Outfall Channel. This levee is the "old" south levee of the Cache Creek Settling Basin (CCSB) and anecdotal information suggested the integrity of the levee may be questionable.

Also, an environmental assessment was made by EIP Associates (Appendix B) to determine environmental constraints and permitting strategies related to the Outfall Channel.

Best Management Practices (BMPs) for handling storm drainage was prepared by Larry Walker Associates (Appendix C).

II. ITEMS OF SPECIAL CONSIDERATION

This section is provided to draw attention to items that are significant from the standpoint of affecting the design, operation, and/or maintenance of storm drainage facilities to serve the City. Presented on Map 2 are the general locations of certain of the facilities discussed below.

A. Cache Creek Settling Basin (CCSB)

The CCSB, which includes approximately 3,600 acres, was constructed by the USACOE in 1937, as part of the Sacramento River Flood Control Project. The basin's fundamental purpose is to preserve the floodway capacity of the Yolo Bypass, a major feature of the Sacramento River Flood Control Project, by entrapping the heavy sediment load carried by Cache Creek. The primary beneficiary of the settling basin is the City and County of Sacramento and South Sutter County.

In 1992, the USACOE completed improvements to the settling basin that consisted of replacing the cobble weir and raising the levees by an average of 12 feet to provide an estimated 50 years of effective sediment storage. The new weir along the east levee is designed to pass a maximum flow of 30,000 cfs. The weir was constructed with the crest at El. 32.5 NGVD 29, and will be raised in about 2117 to El. 38.5. Due to modifications in the settling basin, the elevation of the water surface within the basin will increase over time to approximately El. 44. As part of the improvement project, the south levee of the original basin was abandoned as a project feature and a new "south" levee was constructed north of the low flow channel within the original basin. As a result, the low flow channel is now the main channel for conveying all runoff pumped by the City's North Canal Pump Station (NCPS), South Canal Pump Station (SCPS), and East Main Pump Station (EMPS).

Issues surrounding the CCSB as related to the City and Yolo County (County), are noted below.

1. The settling basin serves no useful purpose for the City or County yet, significantly exacerbates the ability and cost for the City to deal with storm drainage. Because of the settling basin, 100 percent of the storm drainage from the City and surrounding agricultural land is required to be pumped into the Outfall Channel.

2. The increase in water level within the settling basin will undoubtedly result in seepage related problems along the north and west perimeter levees.

3. The south levee of the original basin was part of the authorized flood control project and has not been de-authorized. Additionally, the Outfall Channel is effectively part of the Yolo Bypass by virtue of the ungated hydraulic

connection between the Outfall Channel and the Yolo Bypass, thus should continue to be a responsibility of the USACOE and State Reclamation Board.

4. Under 100-year storm event in Woodland, the limited capacity of the culverts at the end of the Outfall Channel results in overtopping of the south levee. It is unlikely this condition existed prior to construction of the basin improvement project.

In summary, there is justification for the City, in conjunction with the County, to lobby effectively for assistance in mitigating the adverse impacts of the CCSB.

B. Lower Cache Creek Overflow Barrier Project

The USACOE, with the State Reclamation Board and the City as cost-sharing partners, performed a flood damage reduction feasibility study for the lower Cache Creek area with a primary focus on providing flood protection for the City. The two preferred alternatives resulting from the investigation were identified as a "Setback Levee Project" and the "Lower Cache Creek Overflow Barrier Project."

With the Overflow Barrier Project as a potential solution to the existing flood problem, the question emerged as to how it would impact the City's SDFMP.

Accordingly, the impact from constructing the Overflow Barrier Project to the facilities identified for Master Plan Update was evaluated to determine if the storm drainage facilities would be rendered oversized or undersized. It was determined that the floodplain storage that exists immediately west of the west levee of the settling basin and just north of the City, effectively attenuates s runoff from northern agricultural land into the system. Therefore, redirecting runoff from this area with the construction of the barrier would have virtually no impact.

C. Reclamation District No. 2035 Highline Ditch

South of Interstate 5 and parallel and immediately east of the City's South Canal Reclamation District No. 2035 (RD 2035) constructed, and owns and operates a canal, the Highline Ditch, to convey water for irrigation of land within the CCSB. This facility, similar to the settling basin, serves as a barrier to the flow of storm drainage to the east as it would have done prior to construction of the facility. As a result, land is flooded along the west side of the South Canal near the City's wastewater treatment ponds.

The sizing and layout of the facilities for the City's storm drainage master plan is based on mitigating the impact that development within the South Urban Growth Area might have on RD 2035.

D. Beamer/Kentucky Detention Ponds

The flooding along Kentucky Avenue has been a problem within the City for some time. There is not sufficient capacity within the current drainage facilities to handle the runoff generated by upstream land. Accommodating additional development on the upstream land would only exacerbate the situation. The 1999 SDFMP addressed this issue by diverting water from the Kentucky Trunk upstream, through the proposed Volkl Pond and extending the North Canal along the northern urban limit boundary of the City, thus ultimately relieving pressure on the Kentucky Trunk downstream.

According to the City, Kentucky Avenue has flooded in the past, and specifically overflowed near the northwest corner of the Beamer/Kentucky ponds. This overflow, in particular, is likely created by a number of limitations in conveyance/storage capacity downstream. The Kentucky Trunk and crossing under Kentucky Avenue have limited capacity. Capacity limitations also exist at the crossing under County Road 102. To the west of the Beamer/Kentucky ponds, the Kentucky Trunk is a concrete-lined channel located along the northern side of Kentucky Avenue, crossing under the roadway (via two culverts) near the northwest corner of the Beamer/Kentucky ponds and continuing along the south side of Kentucky Avenue in an earthen channel. From this portion of the channel water is able to flow into and out of the Beamer/Kentucky ponds storage quite freely through an opening in the embankment that otherwise "contains" most of the pond area. This same embankment separates storage from channel conveyance along the western boundary of the site, allowing drainage from Beamer Avenue to flow north to Kentucky Avenue before accessing the storage within the ponds.

The storm runoff entering the site comes from two primary sources, the southwest corner from Beamer Street drainage, and the northwest corner from Kentucky Avenue drainage. The Beamer Street drainage is limited by the pipe capacity underground, as there is overland flow along Beamer Street that is not entering the ponds when the capacity of the pipe is exceeded. The piped flow from the Beamer Street drainage enters a channel that flows northward along the western boundary of the ponds, and remains separated from storage on the site by means of the embankment referenced above.

All water from the Beamer Street and Kentucky Avenue drainage must flow through a single 5-foot-diameter pipe under County Road 102 to the east. When the flow exceeds the capacity of the pipe, water backs up and enters the Beamer/Kentucky ponds.

The condition of the separating embankment does not meet general structural flood control design requirements. The side slope of the separating embankment adjacent to the channel is very steep and somewhat eroded at places, particularly at the northwest corner of the site where the Beamer Avenue runoff meets the Kentucky Avenue runoff and turns eastward.

As currently configured, the storage available at Beamer/Kentucky ponds is not effectively utilized in relation with the downstream pumping facilities. The existing configuration diverts early runoff to storage before pumping capacity is fully realized in the North Canal, thereby not utilizing the available pumping capacity. The opportunity exists to reconfigure the ponds to increase flow downstream until pumping capacity is reached and then spill into the Beamer/Kentucky ponds storage closer to the peak runoff condition, ideally only during larger storm events. In other words, once water quality volume is exceeded, runoff from smaller and medium-sized storms could flow to the pumped outlet of the system earlier, saving flood control storage for the most intense portion of a storm.

Existing Storm Water Quality Treatment – In meetings with City staff and the development community within the City, there has been discussion regarding the current operation of the Beamer/Kentucky detention site for storm water quality treatment. It is clear that the City does not want any storm water quality benefit to be removed that is benefiting the existing areas within the City. From a field reconnaissance of the site and reviewing the modeling and current City Guidelines Manual there appears to be very limited treatment occurring under existing conditions. The very lowest flow continues to flow into the channel and under County Road 102 without entering the pond area, as evidenced during a field reconnaissance on August 13, 2004.

The "first flush" storm is the typical term for describing the first significant rainfall of the season that washes away the majority of the pollutants that have accumulated on impervious surfaces during the summer. The current system is not configured to allow this type of event to flow first through the ponds, and then "drawn down" or detained over an extended time. Currently, the runoff partially spills laterally out the side of the channel and into the pond storage, with a portion of the runoff continuing eastward into the North Canal and then pumped into the outfall channel. The Beamer/Kentucky ponds essentially "float" with the adjacent channel while receiving lateral flow. As soon as there is capacity within the pump system downstream, the lower portions of these ponds would drain toward the North Canal resulting in short detention/treatment times.

This pond was constructed prior to the City adopting Storm Water Treatment Guidelines, so it is not appropriate to expect it to meet these guidelines. However, the goal of this evaluation is to assess the impacts of retrofitting this site to accommodate development impacts.

Given the limited flood control (timing) and water quality treatment benefits of the current configuration, eliminating the storage ponds under a "conveyance-based" solution has minimal effect on the size of the facilities required. If the City chooses to reconfigure the ponds to provide enhanced storm water quality treatment, the City would have to reconfigure the Master Plan Update as well as the storm drainage facilities were configured to be consistent with the Woodland Park Specific Plan, which shows the ponds to be reclaimed for development.

E. City-County Drainage Agreement

Agreement No. 70-274 between the County of Yolo and the City of Woodland which was filed with the County Clerk on April 9, 1970, provides for the County and City to share in the cost of construction of facilities to collect and dispose of storm drainage in the proportion of 30 percent and 70 percent, respectively. The agreement provides for the County and City to share the cost for operation and maintenance of the facilities in the same proportion. It appears however, that although this agreement was executed the cost sharing provisions have not been exercised, and according to the City, the agreement was never dissolved.

With respect to the overall drainage area contributing to the complex of City pump stations, i.e., the NCPS, EMPS, and SCPS, there are approximately 39 square miles, 100 percent of which is disposed of by pumping. Of this total area, approximately 17 square miles are urban land and 22 square miles are agricultural land.

F. Yolo Shortline Railroad Trestle

Following completion of the improvements to the CCSB in 1992, the Yolo Shortline Railroad Company (currently owned by Sierra Railroad) claimed that storm runoff from the City was causing erosion along the railroad trestle and jeopardizing the integrity of the trestle.

In response to the claim, the general condition of the drainage across the Yolo Bypass and along the Yolo Shortline Railroad trestle was evaluated to determine the extent and cause of the erosion cited as a problem. A field reconnaissance was conducted along the trestle.

During the summer months drainage discharged by the City through the Outfall Channel is generally captured and directed into RD 2035's irrigation system and does not drain overland to the Tule Canal. During the winter months, slide gates on culverts under County Road 22 are closed. Under this condition, drainage from the City is directed to flow parallel to and beneath the railroad trestle. Along the western portions of the trestle, there is no indication of erosion. A small berm was constructed just to the north of the railroad to direct the majority of the outflow from the settling basin across the Yolo Bypass. A second isolation gate structure appears to allow drainage into the RD 2035 system under controlled conditions, similar to the gates at County Road 22 for the City's drainage. According to City staff, after the Cache Creek low-flow outlet was reconfigured in the early 1990s, the trestle experienced more flooding problems. The property to the north of railroad trestle across the entire Yolo Bypass is owned by the City and was formerly used as ponds for wastewater treatment. The use of these ponds was abandoned some time ago but with the remnant containment embankments left in place, the Cache Creek low-flow was forced toward the railroad trestle. City staff informed Wood Rodgers, Inc. that in the mid-1990s these pond containment embankments were breached to allow water to flow more freely. Since that time, the outflow from the CCSB has cut a channel across the Yolo Bypass, and this flow no longer substantially affects the railroad trestle. The City's outflow has now been relegated to a corridor essentially beneath the railroad the trestle. The small embankment and channel to the north are relatively inaccessible for the City's drainage to access under low-flow conditions, and with the gates shut under County Road 22, the City's outfall must flow directly eastward between County Road 22 and the railroad. Despite this, there does not appear to be any evidence of significant erosion along the railroad trestle in the western portions of the Yolo Bypass where the main influence is the City's outflow.

An examination of the eastern portion of the railroad trestle revealed considerable debris accumulation on the upstream side of the trestle and significant erosion in a north-south direction through the railroad trestle. This erosion is not caused by the City, but more likely is caused by water flowing over the Fremont weir and from the CCSB prior to the bypass being flooded. The early flow in the bypass along the east side of the bypass is topographically lower than the west side.

To alleviate the potential for impacts from the City's storm drainage discharge once the master plan facilities are implemented, it is recommended that storm drainage discharged from the Outfall Channel be directed to and commingled with the low flow discharge from the settling basin which flows overland to the Tule Canal north of the trestle.

G. East Main Pump Station (EMPS) and North Canal/South Canal Connections

The EMPS was intended to service an area known as the East Main Assessment District (EMAD). The land within the EMAD is assessed for construction and operation of the EMPS; however, land outside the EMAD also drains to the EMPS and is pumped to the Outfall Channel. The majority of the drainage from outside the EMAD enters the EMPS through a gravity pipe connection from both the North Canal and South Canal. The City has determined that the existing hydraulic connection of the North Canal and South Canal to the EMPS is to be discontinued; however, the time for this to occur has not been established.

In addition, there is land within the EMAD that does not drain to the EMPS. Instead, this particular parcel of land drains north to the Beamer/Kentucky ponds via the channel along the western boundary of the ponds.

There appears to be a mismatch between properties that, by design, are to drain to the EMAD facilities and the properties that are being assessed as part of the EMAD. There are several properties immediately west of County Road 102 between Beamer Street and East Main Street, which have not been included in the EMAD, but drain into the EMAD drainage facilities at County Road 102 and East Main Street. Additionally, properties immediately east of Pioneer Avenue and off of Tide Court are shown as being assessed as part of the EMAD but do not drain directly to the EMPS through EMAD's facilities. Wood Rodgers met with the City to discuss these drainage issues. Wood Rodgers assumes that the properties that are draining to the EMAD facilities without contributing were likely already developed and draining along East Main Street before the EMAD was formed, so the EMAD was not able to force this land to drain elsewhere but was forced to take in this drainage as an existing condition.

H. Water Quality

Runoff from agricultural land enters the City's storm drainage system under certain storm events. In view of the Phase II National Pollutant Discharge Elimination System (NPDES) regulatory requirements and the attention given to runoff from agricultural land by the Regional Water Quality Control Board, the fundamental guidelines for handling storm runoff is to keep the runoff from the City separate from the agricultural land. The master plan facilities were configured to accomplish this upstream from the North Canal and South Canal, except for an area of approximately 129 acres in the southwest part of the South Urban Growth Area, which will drain into the Farmers Central Trunk.

III. DESIGN CRITERIA

Guidelines and criteria were developed for the City as part of the SDFMP. Since that time the City has developed a manual entitled, "Standard Specifications & Details, 2002," with a recent amendment (#1) in July 2004. Much of the guidelines and criteria in the 1999 SDFMP were incorporated into the storm drainage section of the City Standards (Section 4). As part of this Master Plan Update, the guidelines and criteria were reevaluated.

In October 2002, a preliminary draft of the revised guidelines and criteria were distributed to the City and development community. Comments were received on the preliminary draft and responses were prepared to the comments. Subsequent to the 2002 review, criteria for retention storage were developed. A discussion/overview of the major differences (additions/deletions) between the 1999 guidelines and criteria and the current document is provided in this section. The revised criteria are presented in Appendix D. It is important to note that the governing document for design remains the City's Standard Specification & Details (latest revision). It is the City's decision to incorporate any new or changed criteria from this Master Plan Update into its standards.

The changes to the 1999 design criteria are highlighted as follows:

1. A new standard was developed for sizing retention storage versus detention storage, and a combination referred to as "hybrid" storage as part of a specific evaluation for the South Area drainage. Storm water retention storage, as an option, does not generally provide the most cost-effective drainage solution, but the use of such an option could be left to the discretion of the City if a project within the City considers this option.

2. Special attention was given to identifying and controlling overland runoff and street flooding. Communication was made with the City's Police Department and Fire Department in this regard. A section of the criteria were revised to clarify that the City desires to minimize street flooding to allow for vehicular traffic in most areas, at least at a reduced speed, during larger storm events. Therefore, flooding depths and flow parameters are designated for using street corridors and greenbelts for overland release paths.

3. In recent years, the City has experienced failure and collapse of cast-in-place concrete pipe installed for drainage along East Main Street. As a result, the City requested stricter language on the allowable use of cast-in-place concrete pipe from a foundational and groundwater perspective. The section of the City's standards was not revised in the 2004 Amendment, though the request for greater emphasis on the language in this section was after the original distribution of the document in 2002.

4. Hydrologic and hydraulic modeling have been enhanced in recent years. Accordingly, the guidelines and criteria have been revised to include the use of HEC-HMS and HEC-RAS for developing runoff calculations.

5. One of the more significant additions to the hydrologic section of the document relates to the evaluation of long-duration storm events. Wood Rodgers has incorporated the temporal distribution patterns established in the Sacramento City/County Drainage Manuals for storms greater than 36 hours, while utilizing the rainfall amounts presented in the report entitled, "Yolo County Design Rainfall," which was prepared by Mr. James Goodridge. The application of rainfall over a 10-day period can affect the sizing of drainage system components, particularly where detention storage is employed. The shorter duration storms may govern the design where conveyance is employed. The application utilizes the widely accepted temporal distribution patterns that were developed for use in the Sacramento County area. This pattern distributes rainfall from longer duration storms into multiple cloudbursts over the desired storm period. This temporal distribution of rainfall for longer duration storms is deemed more appropriate than a single cloudburst-type distribution.

   In addition to the guidelines and criteria changes cited above, a separate and detailed evaluation was made of the relationship between flow and stages in the Yolo Bypass and precipitation/runoff from the City. The evaluation, presented in Appendix E, establishes a basis for design for gravity drainage from the City to the Yolo Bypass as part of this Master Plan Update.

IV. HYDROLOGIC AND HYDRAULIC ANALYSIS

A. EXISTING CONDITIONS

1. *Land Use*

Land use within the City with respect to drainage was defined for existing conditions as part of the 1999 SDFMP. Updates to reflect changes since the 1999 report were considered based upon a review of the drainage parameters where development has occurred since 1999; however, the baseline land use conditions within the City were left unchanged. The intent is to maintain (not worsen) flooding conditions with new development, therefore reflecting in-fill development without improving downstream facilities would be unfairly raising "existing" conditions levels and potentially reducing mitigation requirements. It is important to note that the Sycamore Ranch development was evaluated as fully constructed under existing conditions for the 1999 SDFMP, even though it was completed after this time (Map 3).

2. *Hydrology*

Since the 1999 SDFMP was completed, the drainage sheds and subareas within the City have remained relatively unchanged. Since completing the 1999 SDFMP, the USACOE developed topographic mapping as part of the feasibility study on the Cache Creek overflow. This topography provides significant detail regarding the interconnectivity of existing (undeveloped) ground and refinement of drainage shed boundaries (ridge lines and shed breaks) (see Map 4 for drainage shed boundaries).

The basis for the majority of the hydrologic modeling is found in the HEC-1 models and Runoff SWMM models that were originally developed for the 1999 SDFMP. The more updated HEC-HMS program was utilized for a portion of the South Area (revised) analysis, but HEC-HMS is really an improved version of the HEC-1 program capabilities for implementing the same hydrologic methodologies.

All hydrologic modeling has been conducted in accordance with current City Standards with the addition of several key elements outlined in the Drainage Criteria section of this Master Plan Update. The most important addition to the criteria relates to using the temporal distribution of longer duration storm modeling, which is consistent with the methodology applied in Sacramento County. The evaluation of the relationship between the Yolo Bypass and Woodland rainfall (noted in the Design Criteria section and described in Appendix E) is primarily a hydrologic evaluation with impact to the hydraulic aspects of the existing system. Both 10-year and 100-year conditions (24-hour and 10-day durations) were evaluated.

3. *Hydraulics*

The basis for the City-wide hydraulic modeling is found in the SWMM models that were originally developed for the 1999 SDFMP. Since that time, upgraded interactive computer programs and base information have allowed many changes to the original modeling and system geometry, but the modeling has not changed calculationally. One of the most significant changes is related to the evaluation of longer duration storms for parts of the system that are governed by storm volume rather than rainfall intensity. The SWMM hydraulic model accounts for the dynamic relationships between storage and its influences on inflow and outflow conditions. Another significant benefit of the new topography was identifying a better understanding of the drainage areas outside the City, contributing to the runoff reaching City facilities. In addition, with a better understanding of the worst-case hydrologic condition in relation to the Yolo Bypass, a more detailed evaluation was performed of the hydraulic relationship between capacities in the Yolo Bypass and local City facilities.

Within the City, the additional topographic mapping provided significant detail regarding the interconnectivity of existing (undeveloped) ground, providing accurate relationships between existing floodplain storage and outflow over roadways and railroads. The major areas that were revised using the updated topography were located west of County Road 98, north of Kentucky Avenue, east of County Road 102, and south of Gibson Road, also including the Beamer/Kentucky ponds west of County Road 102. The subbasin delineations and SWMM model configuration are shown on Map 5 and Map 6, respectively. Both 10-year and 100-year conditions were evaluated.

B. ULTIMATE CONDITIONS

1. *Land Use*

Land use within the City was defined in the General Plan and has been updated (2002) and changes have been approved within the SLSPA and will be updated for the Woodland Park Specific Plan Area. Ultimate conditions are defined as the full build out of the City's General Plan land uses. The SLSPA did not cover the entire South Urban Growth Area, so the land outside of the SLSPA has been referred to as the Master Plan Remainder Area (MPRA). While the SLSPA was technically not officially delineating land use within the MPRA, it showed some land use assumptions that have been unofficially accepted as the projected land uses for the MPRA until another specific plan changes it. In general, the Woodland Park Specific Plan Area is proposing land uses with very similar runoff coefficients as the City's General Plan (2002). A City-wide land use map is included on Map 7, with detailed land use for the Woodland Park Specific Plan Area and SLSPA as shown on Map 8 and Map 9, respectively.

2. *Hydrology*

The drainage sheds and subareas within the City were modified to reflect build out (development) of the City's General Plan (Map 10). As mentioned under Existing Conditions above, the digital topographic mapping developed by the USACOE was used for the analysis as part of the feasibility study on the Cache Creek overflow. This topography provided significant detail regarding the interconnectivity of existing (undeveloped) ground, providing accurate relationships between floodplain storage and outflow over roadways and railroads. This detail was instrumental in the evaluations of routing storm runoff from agricultural land around the City as well as refining the interaction of developed runoff and City drainage facilities with flooding outside of the City.

The basis for the hydrologic modeling is found in the HEC-1 models and Runoff SWMM models that were originally developed for the 1999 SDFMP with appropriate land use changes. It is important to note that much of the land use changes from the 1996 General Plan to the 2002 General Plan have little or no effect on runoff as the changed areas have similar runoff characteristics. The more updated HEC-HMS program was utilized for a portion of the South Area (revised) analysis, but HEC-HMS is really an improved version of the HEC-1 program capabilities for implementing the same hydrologic methodologies.

All hydrologic modeling for ultimate conditions has been done in accordance with current City Standards with the addition of several key elements as noted under existing conditions hydrology.

3. *Hydraulics*

The basis for the City-wide hydraulic modeling of ultimate conditions are the SWMM models that were originally developed for the 1999 SDFMP, as well as the revised Existing Conditions models. The HEC-RAS computer modeling program, developed by the USACOE, was also utilized as a design tool to size some channel and crossing facilities for portions of the City's system that could be evaluated in an isolated fashion. The output from the HEC-RAS program, in hydrograph format, was appropriately "injected" into the SWMM models to evaluate the effects of design on the regional drainage conditions.

The subbasin delineations and SWMM model configuration for ultimate conditions are shown on Map 11 and Map 12, respectively. Both 10-year and 100-year conditions were evaluated for the entire City. Worst-case hydraulic evaluations for the downstream ends of the improved system also included evaluations of the 25-year local storm event (Appendix E).

V. EXISTING FLOODPLAIN

At a time when a solution is implemented to mitigate the flood risk associated with flooding from Cache Creek in and around the City, it will be important for the City, as the Administrator of the National Flood Insurance Program (NFIP), to know the residual floodplain. Accordingly, the 100-year floodplain was identified for purposes of administering the NFIP and for designing master plan facilities to mitigate flooding because of changed land use. The existing 100-year floodplain is presented on Map 13.

A. Floodplain Outside the City

Numerous areas currently flood outside of the City limits that favorably impact the City in that they attenuate upstream runoff with floodplain storage. If these areas did not "flood" as they do, but the same runoff otherwise drained to the same downstream locations within the City, the floodplain within the City would be worse, given the fixed discharge, i.e., pumping at the downstream end of the City's existing system.

Presented below is a brief description of the existing floodplain outside the City.

Area 1 – The first such existing floodplain storage has been referred to as the North Stormwater Retention Pond in the 1999 SDFMP and was originally created as a borrow area for fill placement along the Interstate 5 construction corridor some time ago. It is a large, roughly rectangular, basin just east of County Road 98, and south of Interstate 5. It currently collects runoff from a large tributary area to the west of County Road 98 and is large enough to retain the entire 100-year peak storm from these tributary areas.

Area 2 – The second existing floodplain area is located to the north of the City's Urban Limit line just east of East Street along a railroad spur turning north-northeast just north of the City. The railroad acts as a barrier to overland runoff and forces storm water to store to the west of the railroad. As water backs up, it spills into (and fills) the Dubach Park area (just north of Interstate 5 and west of East Street) before finally overtopping the railroad and spilling eastward toward the CCSB.

Area 3 – The third existing floodplain area is located just north of the City's future northeast corner, against the west levee of the CCSB. This area receives runoff from Area 2 as well as additional tributary area both west and east of County Road 102.

Area 4 – The fourth existing floodplain area is along County Road 98 along the western edge of the City. County Road 98 acts as a barrier to flow and will back up under large storm events and create a shallow lake. Flooding along County

Road 98 can be broken up into zones, where the road redirects runoff to the north and into Area 1, or directs overflow into the City along Main Street.

Area 5 – The fifth existing floodplain area is located just west of Highway 113 and south of Gibson Road. While this area is not extensive, it is restricted by the Highway 113 roadway and by the hydraulic capacity of the culverts draining beneath the roadway. This area is intended to drain to an interceptor/conveyance channel in the future, to be routed around the future City to the South Canal.

Area 6 – The sixth existing floodplain area is created by County Road 102 to the south of Gibson Road. This land immediate west of County Road 102 backs up behind the raised roadway during larger events. This area is further inundated by an overflow condition from the adjacent southerly Willow Slough shed. The culvert crossing of Willow Slough under County Road 102 is severely undersized to handle the100-year event. As water backs up at this crossing it spills northward along County Road 102. Prior to development, it collected and spilled across the low point in the road just north of the City's Regional Park site and County Road 25. With the construction of the lower part of the Interceptor/ Conveyance, this overflow is captured and directed eastward along the south side of the Regional Park. It is important to note that a portion of this floodplain storage is within the future development of the SLSPA.

Area 7 – The last major existing floodplain (Area 7) outside of the City is along the western side of the Highline Ditch, owned and operated by RD 2035. The City's drainage system directs all of the drainage from the South Area into the South Canal, which drains Area 7 to the SCPS and the EMAD Pump Station. The majority of the floodplain storage for Area 7 is located south of Interstate 5 around the perimeter of the City's Wastewater Treatment Facility. Contributions from Area 5 and Area 6 as well as the entire Gibson Canal Trunk system collect in this area before being pumped out. Some water will overflow eastward under very large events onto RD 2035 land over the Highline Ditch levees.

All seven of these areas influence the flooding conditions within the City and are therefore important to the operation of the City's current and future drainage system. While these areas are outside of the City's General Plan area and are not subject to the City's drainage standards, they could have a negative effect if they are filled in. To guarantee these areas do not conduct activities that are detrimental to the City's concerns, the City would have to purchase either the property or a flood easement on each of these areas. This is not realistic as it would be very costly, too costly a burden to be placed on development within the City. Therefore, it is recommended that the City coordinate with the County to monitor the activities in these areas that could alter the storm runoff conditions. If any activity is observed that could worsen flooding, conditions downstream (within the City), the property owner should be notified immediately that they are harming the City and will have to mitigate the downstream impacts. The City and County could also elect to jointly notify the property owners in a proactive attempt to stave off negative impacts.

B. Floodplain Within and Near the City

The current floodplain issues in the City are dominated by floodwater originating from the overflow and levee-failure of the Cache Creek system, producing a flow with a magnitude larger than the City can afford to construct facilities to mitigate as part of the Master Plan Update. Federal assistance will likely be available to the City for constructing a flood control project that prevents Cache Creek from flooding the City, though the technically preferred alternative does not currently boast public support, the City is confident that some solution can be reached with consensus amongst the citizens. In addition to the Cache Creek floodplain, there is an underlying floodplain created by the runoff from local watersheds (with the Cache Creek flooding removed). This underlying floodplain must be addressed as part of the Master Plan Update to ensure drainage facilities are sized to prevent flooding while accommodating future development within the City's General Plan.

As stated in the 1999 SDFMP, the City designated the older existing City to remain unimproved as drainage infrastructure improvements were considered too difficult and costly to implement, particularly since the cost would have to be borne by the existing City development. This does not preclude determining the existing condition floodplain in other areas, including the influences from the existing City on these other areas. The local underlying floodplain has been refined by Wood Rodgers at several locations, predominantly outside of the developed areas of the City. These locations are described below.

Area 1 – The first location is north of Main Street along the North Canal alignment, reaching westward to include the Beamer/Kentucky pond area as well as the land immediately north of Kentucky Avenue and west of County Road 102, encompassing much of the area within the Woodland Park Specific Plan. This flooded area has several flooding constraints beginning with the pumping capacity of the NCPS. This area is also currently indirectly served by the EMPS, by being connected via a gravity pipeline to the sump of the EMPS, however, this gravity pipeline competes with another gravity connection from the south area drainage before reaching the EMPS. Ultimately, the City plans to disconnect the North Canal (and South Canal) from the EMPS, as this pump station was sized to provide protection for the EMAD only. Once the north area is disconnected, the limited NCPS capacity (approximately 170 cfs) will produce higher flooding if the EMPS disconnection is left unmitigated by the City. A second major constraint in the northeast area of the City is the crossing of County Road 102 with a single 5-foot-diameter pipe to drain the Kentucky Avenue channel. Under a 100-year event, County Road 102 will overtop because of the limited flow capacity of this pipe. Of course, if this pipe capacity were to be increased, the flooding problem would simply move downstream and worsen flooding at the NCPS.

Area 2 – The second location is south of Interstate 5 along the South Canal alignment, extending west of the South Canal to the west of County Road 102. There are numerous factors affecting flooding in this area. This area is bounded by the Highline Ditch, owned and operated by RD 2035, to the east, which acts as a barrier and forces flooding north under Interstate 5 and into the SCPS, and the existing gravity connection to the EMPS mentioned above. The SCPS capacity (32 cfs) is much less than the NCPS and will significantly impair drainage if left unmitigated when the EMPS is disconnected. Wood Rodgers has identified that the mitigation for the City's disconnection is best achieved by installing a total pumping capacity of 125 cfs. Aside from the pumping capacity limitation, this area receives overflow from the Willow Slough that is created by the limited flow capacity of the Willow Slough crossing of County Road 102. Once this road culvert is inundated, storm water backs up, ponds, and overflows northward toward Gibson Road. Before reaching Gibson Road, however, this water overflows County Road 102 flowing eastward just north of the City's Regional Park site and County Road 25, significantly increasing the volume of floodwater that is ponded behind the Highline Ditch. There are several other small culverts at select locations that, in general, restrict flow downstream and worsen ponding upstream in the south area because they did not account for 100-year flow from such a large tributary area.

Area 3 – The land north of the City between Cache Creek and the City's urban limit line is primarily agricultural and is severely restricted by a railroad line that parallels East Street until it turns northeastward after passing under Interstate 5. This railroad alignment blocks overland flow from land west of the railroad draining eastward. While the City has abandoned the Dubach Park site from being considered a flood control facility as part of the Master Plan Update, the existing 100-year flooding from outside of the City will back up behind the railroad and fill the Dubach site from the north. The low spot along the top of the railroad is at El. 54 (NAVD 88) to the north, but there is a second place, where East Street crosses under Interstate 5, that is also at El. 54. A permanent barrier could be constructed across this low spot to prevent local runoff from land north from overflowing into the City. While Dubach Park will have to fill up and overflow before this will happen, it is still worth the City's consideration to reconstruct drainage under Interstate 5 at this location to stem the flow from this northerly floodplain. The area to the north of Interstate 5 that is proposed to be in the City is located immediately west of the low spot in the railroad and will be very expensive to protect from local flooding, let alone the impact to the Cache Creek flood solution. City staff has agreed that this "finger" of land within the City's General Plan will have to have a separate solution for resolving flooding from larger events.

Area 4 – One of the more significant local flooding impacts is the storm runoff from agricultural land to the west of County Road 98 and its impact to property within the City. The City has documentation of sediment-laden floodwater entering the City near the intersection of Main Street and County Road 98. Storm water collects and ponds behind County Road 98 north of where County Road 98 crosses the Maple Canal (just south of Main Street). Wood Rodgers has determined whatever runoff that does not flow toward the Main Street intersection, will flow parallel to County Road 98 northward until it overflows County Road 98 north of the City. This northerly overtopping of County Road 98 will drain directly into the North Retention Pond, as referenced in the 1999 SDFMP. This pond was a borrow pit during the construction of Interstate 5. The pit now captures runoff during the winter months, and is currently farmed (along the bottom) during the growing season. This pond captures a significant amount of water and prevents this water from flowing into and across portions of the City, and acts as a flood control device that benefits the City. Maintaining the flood control capacity of this pond should be identified and preserved in any SDFMP for the City.

There are several smaller areas where existing flooding is a problem for the City. As identified in the 1999 SDFMP, the Kentucky Avenue drainage facilities are not large enough to accommodate large storm events, overflowing existing pipe and channel capacities to flow aboveground and parallel to the paved roadway. Similarly, and as mentioned previously, street flooding is commonplace in older parts of the City, as the pipe design capacity does not meet current City Standards and criteria.

VI. MASTER PLAN FACILITIES

A. General

The drainage system serving the City collects runoff directly from approximately 17.0 square miles. In addition, there are several large areas (approximately 22 square miles west and south of the City), which drain around the City under low-flow conditions but cannot drain adequately in large storms and spill into and/or across the City's drainage sheds. Other drainage areas that once bypassed City land is now forced to drain into or through the City's facilities because of the CCSB (levee) to the north and the RD 2035 Highline Ditch to the south. As such, the total drainage area served by the City during large storm events is approximately 39 square miles. Unfortunately, the City has expanded to the east and closer to the downstream flooding constraints, exacerbating the flooding issues with the more recent delineation of the flood risk associated with Cache Creek. It is important to note that the CCSB and Highline Ditch levees were already constructed for some time before the City expanded eastward, but the local runoff influences were always considered mitigable, and are still considered mitigable once the Cache Creek influences are removed.

During the development of the Master Plan Update, there were several changes to the work that have influenced the outcome. The most substantial changes have come as part of the South Urban Growth Area planning process, more specifically the SLSPA. The 1999 SDFMP collected the south area drainage via a gravity connection to the Outfall Channel and an emergency back-up pump to drain the Outfall Channel into the Yolo Bypass when the bypass stages were up. As part of this report, the relationship between the Yolo Bypass and local City runoff was evaluated to identify design constraints for sizing storm drainage facilities. As noted in the Design Criteria section of this report, the hydraulic relationship between the Yolo Bypass and the City drainage is important. It proved expensive enough and potentially environmentally sensitive enough to warrant investigating storage alternatives in the south area, rather than bearing the burden of a costly and difficult downstream solution up front. Several Technical Memoranda were submitted to the City with various storage sites and configurations. These Technical Memoranda serve as documentation of the alternatives Wood Rodgers evaluated to demonstrate that the best solution for the South Area was fully identified.

B. Alternative Analysis

Part of the effort of developing the best drainage solutions for the City is to evaluate alternatives solutions to compare and determine which provides the desired result at the least cost. Given the size and variability of the drainage areas that are tributary to the City, there can be thousands of different combinations of adding flood control storage, pumping, diversion, and/or channelization. Wood Rodgers' efforts were focused primarily on regional alternatives for the downstream portion of the City's system along the North Canal and South Canal and their interconnection with the EMAD drainage.

With storage added to a system the peak flow downstream can be significantly reduced, even with the addition of urban runoff from new development, but storage areas can take up a lot of land, which might otherwise be developable, and can be costly to construct/excavate.

Pumping (as conveyance at the end of channels) becomes necessary if the downstream elevations are high enough that gravity discharge cannot be accomplished without flooding. Pumping at peak flow levels can become very expensive to construct and to operate (electricity demands). Pumping allows land on the upstream side of the pumping to remain at lower elevations and still be below the 100-year peak flood elevations downstream of the pump. Pumping when used together with storage can be an effective means of metering storm runoff into constrained downstream facilities, such as narrow channels.

Diversion and channelization are methods of conveying storm runoff either away from or through the City. If downstream peak flow is not a major issue then conveying large storm runoff can be a very effective way of controlling flooding.

The entire City's drainage is currently pumped to the Outfall Channel at one of three pump stations. The pump stations have been handling the City's existing runoff with some ponding upstream of the pumps, primarily because the City has interconnected the North Canal and South Canal to the EMAD Pump Station, which has the largest pumping capacity. The South Area in particular benefits from this interconnection but still has significant floodplain inundation, even with the pumping.

The easternmost portions of the City, in both the North and South areas have existing ground elevations that are below downstream 100-year flood stages in the Yolo Bypass. If the pump stations were removed and the ends of these systems were drained by gravity to the Yolo Bypass then these areas would flood higher than they currently do with pumping. Developable areas within the North Area would be more impacted as planned development is further to the east than the South Area. The South Area would also flood worse than existing. While the impacted areas are not planned for residential/commercial development, the impacted areas do contain the City's Wastewater Treatment Plant and privately owned land in the County.

South Area Alternatives – Wood Rodgers completed an alternatives analysis for the South Area in a separate report (Technical Memorandum) entitled "South Area Alternatives."

Generally the report determined that gravity connection of the South Area to the Outfall Channel and Yolo Bypass would place undue pressure on the City's Wastewater Treatment facility (south of Interstate 5) and could raise 100-year flooding approximately one foot in the South Area, while also greatly increasing spilling eastward over the

RD 2035 Highline Ditch embankments. The full path of this spill is unknown but would pond up against the west levee of the Yolo Bypass and potentially weaken this levee and potentially create significant damage to RD 2035 lands. Maintaining a pumped floodplain that is lower than the Yolo Bypass is a much more controllable and feasible solution.

The large South Urban Growth Area requires a large storm water quality treatment feature, which is efficiently located in the already constructed East Regional Pond site. Storm water quality volume must be constructed low enough to not block flood control conveyance so the East Regional Pond contains an increment of flood control storage above the treatment volume.

We evaluated the additional storage necessary to mitigate full build out of the South Urban Growth Area and the volume was very large. The pumping necessary to mitigate full development and separate the South Area from the EMAD, combined with the capacity in the East Regional Detention Pond, is 250 cfs. Routing this pumped flow to the Yolo Bypass necessitates some improvement to the Outfall Channel and its connection to the Yolo Bypass.

In the final comparison, the pumping alternative was over one-half the price of the nearest storage alternative, given the costs of land and excavation for huge volumes. The pumping alternative created a balance of conveyance out of the system with storage, while maintaining a hydraulic separation between the South Area and the influences of the Yolo Bypass.

Diversion of flow from the South Area system is not feasible given the physical barrier to the south (Willow Slough), the north (the existing City) and the east (RD 2035 land), which cannot receive additional drainage due to fixed drainage capacity into the Yolo Bypass.

<u>North Area Alternatives</u> – Wood Rodgers evaluated the North Area drainage from storage, pumping and conveyance perspectives. Diversion of flow from the system is not feasible given the barrier to the north (Cache Creek), the south (the existing City), and the east (CCSB), which cannot receive gravity drainage due to lack of capacity or high downstream flood levels.

The existing detention storage in the North Area is not sufficient to mitigate build out of the City's General Plan. Wood Rodgers evaluated the storage necessary to mitigate development for just the Woodland Park Specific Plan Area and determined that the footprint of a pond would need to be approximately 170 acres (1,360 acre-feet of volume), utilizing the existing NCPS capacity to drain the pond. This detention storage alternative is governed by longer duration storms and was sized using the 10-day duration 100-year storm. The size of the detention pond necessary to mitigate full build out of the City's General Plan, which includes the diversion of runoff volume from agricultural land (west of County Road 98), would likely be much larger and utilize more developable land in the Woodland Park Specific Plan Area. It is important to note that the detention storage was placed in its most effective location in relation to the existing pump station. It becomes very clear that the City cannot store the 100-year event without excessively large detention facilities, increasing facilities costs while at the same time reducing fee-generating property.

The use of pumping as conveyance is being utilized by the EMAD so we evaluated pumping the peak flow from the North Area without significant storage upstream. The outlet of this pumping could be directed to one of two places, the Outfall Channel or the CCSB. The CCSB could receive the pumped outflow but it creates a worse downstream constraint for pumping because it is designed to catch sediment and fill up with water to much higher levels than the Outfall Channel and the Yolo Bypass. Pumping facilities would need to be sized to pump to a either an empty or a full Settling Basin, increasing power and installation costs.

Pumping to the Outfall Channel is much simpler, but still requires the Outfall Channel improvements and the bridge outlet configuration to pass the City's build out peak flow while maintaining freeboard on the Outfall Channel's south levee. A new pump station does not eliminate the need for downstream improvements to the Outfall Channel. Even if all North Area flow is directed to the CCSB, the Outfall Channel outlet bridge must still be constructed to accommodate the build out flow from the South Area and the EMAD. Pumping to the CCSB does eliminate the need to widen and deepen the Outfall Channel and to raise grade elevations in the Woodland Park Specific Plan Area. However, these costs do not offset one another.

The peak-flow pump station for the North Area would need to be sized to pump over 900 cfs. This roughly equates to a construction cost of $15-$20 million. As will be shown in more detail in the Opinion of Probable Cost section, the Outfall Channel improvements are approximately $5 million. Fill is not being considered a SDFMP cost. Only pipe/channel conveyances, ponds, and pumping are being considered part of the required SDFMP facilities. Wood Rodgers recognizes that it is a cost that is incurred because of the facilities configuration. While the filling and grading to raise the lower areas of the Woodland Park Specific Plan are approximately another $5 million. Opening up the North Area connection to drain to the Outfall Channel by gravity and raising ground elevations to above anticipated flood levels is the most feasible way of developing the most land in the North Area for the least cost.

C. <u>Facilities Description</u>

This section describes the specific features of the City's SDFMP, the design criteria, and the phasing of construction of the respective facilities. The facilities are identified below and are shown generally on Map 14. Preliminary engineering drawings for the respective facilities are presented in Volume 3 of this report. The layout of the Type 2 facilities is presented on Map 15. A description of the respective facilities follows:

North Area Facilities:

- Northwest Interceptor With Sediment Basins
- Volkl Pond Improvements
- Volkl Trunk Facilities
- Kentucky Trunk Diversions to Volkl
- Volkl Outlet Works (Connection to North Canal)
- North Canal Improvements (Including Extension)
- Beamer/Kentucky Channel
- North Canal Bridge and RD 2035 Facilities Relocation
- North Area Storm Drain Network Improvements (Backbone)
- North Area Floodplain Fill

South Area Facilities – Planned Facilities:

- South Canal Pump Station Replacement/Upgrade
- West Regional Detention Facility
- Southwest Interceptor With Sediment Basin
- Gibson Canal Crossing
- Interstate 5 Crossing Capacity Increase
- Extension of Interceptor/Conveyance Facility (Beginning 2,500 Feet West of County Road 102)
- Extension of Inlet Channel (City's Regional Park Site)
- South Area Storm Drain Network Improvements (Backbone)

South Area Facilities – Constructed Facilities:

- Interceptor/Conveyance Facility (Downstream)
- Inlet Channel (Downstream)
- East Regional Pond
- Outlet Channel

Common Facilities:

- Outfall Channel Improvements
- Outfall Channel Outlet Bridge
- South Levee Certification
- Outfall Channel – Yolo Bypass Transition

1. North Area Facilities

Northwest Interceptor With Sediment Basins

Purpose

The purpose of the Northwest Interceptor is to capture and divert storm runoff and sediment loads from land west (outside of) the City around the northwest corner of the City Limits to connect to the proposed Volkl Outlet Works and be conveyed downstream around the interior City storm drain system and into the Yolo Bypass. These facilities will alleviate an existing flooding and sediment/debris problem the City has on lands just east of County Road 98.

Description

The facilities associated with the Northwest Interceptor consist of an earth-lined conveyance channel, a levee/embankment, culvert road-crossing structures, and sediment basins. The land tributary to the Northwest Interceptor is bounded by the Maple Canal on the south, Cache Creek on the west and north, and County Road 98 on the east, with a second area north of the City's Urban Limit between County Road 98 (on the west) and Interstate 5 (on the north and east).

The earth-lined channel is proposed to be constructed with a 10' bottom width and 3:1 side slopes beginning south of Main Street (at the upstream end) crossing under Main Street through a double 4.5'x8' box culvert, flowing north under six (separate) 4'x4' box culverts (proposed farm access culvert crossings), crossing under Kentucky Avenue through a double 7'x6' box culvert, proceeding to a point near the northwest corner of the City's Urban Limit Line, turning eastward and flowing under County Road 98 through a 4'x4' box culvert, transitioning to an earth-lined channel with a 5-foot bottom width and 3:1 side slopes, flowing eastward through a single 6'x6' box culvert under West Street and lastly through a 6-foot-diameter circular pipe beneath the railroad before combining with the Volkl Pond outflow.

The levee/embankment will allow for storm water to store in the floodplain that is currently created by County Road 98, while also connecting the Main Street drainage to the north and protecting the homestead/ranch residences along the west side of County Road 98. While no negotiations or discussions have taken place with any property owners it is anticipated that any channelization of drainage by the City through their property will be met with resistance unless the City also protects the homes from flooding as well. This could be accomplished by making a larger channel, but that would be less economical than a smaller channel with a levee, as the levee can be constructed at the same time as the conveyance channel from the spoils of the channel.

The sediment basins are located in-line to the channel and generally upstream of larger crossings to maximize the controlled sediment removal to better maintain main road crossings and keep them at full capacity for as long as possible.

Design Parameters

Hydraulic – The hydraulic design for the Northwest Interceptor facilities will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

A Manning's "n" value of 0.07 will be used for earth-lined channels to allow volunteer vegetation to be established. Concrete box and pipe culverts will be designed using the Manning's equation, with a value of .015 for concrete.

Structural – Reinforced concrete structures will be designed for Caltrans HS-20 loadings and will incorporate concrete minimum compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A615. The structures will be designed consistent with the geotechnical design parameters set forth in the Section "Geologic Conditions."

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- ACPA, "Concrete Pipe Design Manual"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- ASTM C76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe"
- ASTM C443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"
- California Stormwater Quality Association, California Stormwater BMP Handbook, "Sediment Basin," January 2003

- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

Volkl Pond Improvements

Purpose

The purpose of the Volkl Pond Improvements is to provide storm water quality treatment and flood control detention volume to attenuate runoff to mitigate downstream impacts resulting from development of the North Urban Growth Area (within the City urban limit) upstream (west) of the Volkl Pond.

Description

The Volkl Pond, under full build-out conditions, consists of two pond cells that will be interconnected so they act as a single pond. The existing pond (created by rainwater and high groundwater) is currently owned by the City but is not receiving runoff from land west of the railroad. The improvements to the Volkl Pond are not likely to occur in phases to mitigate the impact of development as it progresses.

This improved pond will provide the volume required for water quality treatment for the entire upstream North Urban Growth Area as well as a portion of the existing development within the Kentucky Avenue drainage shed that will be diverted to the Volkl Trunk system upstream of the ponds. It is important to note that the Northwest Interceptor flow will not enter the ponds, but will bypass them. To drain the pond, an outlet structure will be constructed to connect to the Volkl Outlet Works described below.

The entire pond bottom will incorporate a passive wet pond for storm water quality treatment in accordance with current City-adopted guidelines.

Design Parameters

Hydraulic – Hydraulic design parameters for the pond are set by containment fill elevations adjacent to the ponds, the tailwater requirements for the upstream facilities, and the drainage capacity of downstream conveyance facilities competing with runoff from the Northwest Interceptor. On-site drainage facilities, as the maximum hydraulic grade lines upstream of the pond must be selected so the fill material over on-site drainage facilities is minimized. The area of the pond has been designed to fully utilize the land available on the City's property. The total footprint of the ponds will not be expanded and the ponds have existed for some time now, therefore no additional buffer is assumed to be required to adjacent properties.

The pond footprint encompasses approximately 20.5 acres. The corresponding 10-year and 100-year design water surface elevations are 44.61 and 44.72 (NAVD 88), respectively. The total flood control volume for the pond at the 100-year water level is 50.0 acre-feet. Pond side slopes will be 4:1.

A wet storm water quality detention basin will be incorporated to provide water quality treatment for the lands upstream, designed to conform to the City-adopted Technical Guidance Manual for Stormwater Quality Control Measures. The permanent water quality pool should be sized based upon 75 percent of the full development area, in accordance with the criteria. The remaining 25 percent will be integral with the pond's storm water detention volume, sized as necessary to achieve a draw down period no greater than 40 hours. The total water quality treatment volume is 44.3 acre-feet, of which 33.2 acre-feet will be contained within the permanent water quality pool.

<u>Structural</u> – Reinforced concrete structures will be designed for Caltrans H-20 loadings and will incorporate minimum concrete compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM 615.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- City of Woodland, "Technical Guidance Manual for Stormwater Quality Control Measures"
- ACI 318, "Building Code Requirements for Structural Concrete"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"

<u>Volkl Trunk Facilities</u>

Purpose

The purpose of the Volkl Trunk Facilities is to provide conveyance of storm runoff to downstream storm water quality treatment and flood control volume in the Volkl Pond without flooding development of the North Urban Growth Area during the worst-case 100-year event.

Description

The Volkl Trunk Facilities, under full build out conditions, consist of underground regional storm drains, grading for directing overland runoff to downstream channels, a reach of earth-lined open channel with a bottom width of 10 feet, a culvert crossing under the railroad through two 84-inch-diameter circular conduits.

Design Parameters

Hydraulic – Hydraulic design parameters for storm drains are set by City Standards for on-site drainage facilities, as the maximum hydraulic grade lines upstream of the Volkl Trunk Facilities must be selected so the fill material over on-site drainage facilities is minimized.

The hydraulic design for the Volkl Trunk Facilities will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

A Manning's "n" value of 0.07 will be used for earth-lined channels to allow volunteer vegetation to be established. Concrete box and pipe culverts will be designed using the Manning's equation, with a value of .015 for concrete.

Structural – Reinforced concrete structures will be designed for Caltrans H-20 loadings and will incorporate minimum concrete compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A615.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"

Kentucky Trunk Diversions to Volkl

Purpose

The purpose of the Kentucky Trunk diversions to Volkl is to provide conveyance of storm runoff from existing development in the Kentucky trunk to downstream storm water quality treatment and flood control volume in the Volkl Pond thereby relieving pressure on existing Kentucky Trunk facilities downstream during the worst-case 100-year event.

Description

The Kentucky Trunk Diversions to Volkl, under full build out conditions, consist of underground regional storm drain connections from Kentucky Avenue facilities to the Volkl trunk at two locations. The first location is at the intersection of West Street and Kentucky Avenue with the construction of a 72-inch-diameter circular concrete culvert northward to connect with the upstream end of the Volkl Trunk channel. The second location is at the projected intersection of Kentucky Avenue due south of the eastern edge of the southeastern Volkl Pond cell. This second diversion is a 48-inch-diameter pipe draining directly to the southwest corner of the pond and entering the proposed water quality treatment forebay.

Design Parameters

Hydraulic – Hydraulic design parameters for drain pipelines are set by City Standards for on-site drainage facilities, however, these diversion pipes are not intended to be a standard sized pipe, given their function as diversion pipelines to bleed off extra flow from an undersized system.

The hydraulic design for the Kentucky Diversion facilities will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

Concrete box and pipe culverts will be designed using the Manning's equation, with a value of .015 for concrete.

Structural – Reinforced concrete structures will be designed for Caltrans H-20 loadings and will incorporate minimum concrete compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A615.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- ACPA, "Concrete Pipe Design Manual"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- ASTM C76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe"
- ASTM C443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"

Volkl Outlet Works (Connection to North Canal)

Purpose

The purpose of the Volkl Outlet Works is to provide conveyance of storm runoff from Volkl Pond and the Northwest Interceptor Facilities under Interstate 5 to connect with downstream storm water conveyance facilities in the North Canal.

Description

The Volkl Outlet Pipe, under full build out conditions, consists of an underground regional storm drain 84-inch-diameter pipe installed under a combination of boring and jacking and open cut excavation along the approximate alignment described as follows: north under Interstate 5, then northeast to the northwest corner of the Dubach Park site, then due east along the northern boundary of the Dubach Park site crossing under East Street and the California Railroad twice. The pipe takes two major bends and one minor bend before discharging into the extension of the North Canal, just east of the California Northern Railroad spur line to the east of East Street. At each of the major bends, there is a proposed manhole access box to facilitate the turn in flow while using standard straight sections of 84-inch pipe and allowing added venting capability to promote steady flow conditions when the outlet may be submerged.

Design Parameters

Hydraulic – Hydraulic design parameters for the Volkl Outlet pipe are different from City Standards for on-site drainage facilities, as the maximum hydraulic grade lines are being dictated by fact that it is draining storage and channel conveyance located upstream of it.

The hydraulic design for the Volkl Outlet Pipe will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

Concrete box and pipe culverts will be designed using the Manning's equation, with a value of .015 for concrete.

Structural – Reinforced concrete structures will be designed for Caltrans H-20 loadings and will incorporate minimum concrete compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A615.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- ACPA, "Concrete Pipe Design Manual"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- ASTM C76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe"
- ASTM C443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"

North Canal Improvements (Including Extension)

Purpose

The purpose of the North Canal Improvements is to provide a single channel conveyance of all combined City (and upstream) runoff from the North Urban Growth Area across the northern and northeastern boundaries of the City to drain to the Outfall Channel.

Description

The facility will be a trapezoidal, earth-lined channel section with a variable bottom width from its outlet works just south of the southwest corner of the CCSB (near the hypothetical intersection of East Main Street and a projection of County Road 103), along the west side of the west CCSB levee, turning at City's North urban limit and flowing parallel to the North urban limit to begin at a point just east of East Street and north of Churchill Downs at the outlet of the Volkl outlet pipe.

The North Canal currently exists as an earth-lined channel with limited conveyance capacity drained at its outlet by the NCPS and an additional connection to the EMAD Pump Station. Its primary alignment is located along the west side of the west levee of the CCSB. The channel is less defined north of where Beamer Street drainage connects and even less defined north of where Kentucky Avenue drainage connects, however it still drains overland storm runoff from agricultural land north of the City's North Urban Growth Boundary.

The reach of the improved North Canal between Beamer Street and its confluence with the Outfall Channel will have to be supported by a floodwall installation along the west side of the new channel to protect already developed land within the EMAD from future flooding conditions once the North Canal is opened up to a gravity drainage connection to the Yolo Bypass. Secondly, the bank slopes of the proposed channel will require the installation of filter fabric and rock in certain locations to allow seepage to freely occur, without removal of supporting soil material. The channel may be subjected to such seepage influences when the CCSB is full and seeping through the west levee and/or when wet winters produce high groundwater conditions. Lastly, a portion of this downstream reach will require concrete lining in order to fit the necessary conveyance capacity between the existing CCSB levee and existing development.

The proposed channel has a bottom width of 10 feet with 3:1 side slopes from its upstream end to approximately 12,700 feet downstream where it meets the west levee of the CCSB. Two double box culvert crossings, one at County Road 101 and at County Road 102, will be constructed along this upper reach with 7-foot x 7-foot openings. Once it reaches the CCSB levee, the North Canal then would turn southward to flow through a new double box culvert (5.5-foot x 5.5-foot openings) through an earth-lined channel with a bottom width of 15 feet and 3:1 side slopes approximately 2300 feet then transitioning (widening) over several hundred feet to a bottom width of 54 feet then turning southwest to continue along the toe of the west levee of the CCSB. The North Canal, through this section, will consist of a combination of trapezoidal, earth-lined flood control channel sections with a fixed bottom width together with a series of parallel linear storm water quality treatment ponds adjacent to the channel. This section will continue for approximately 2,700 feet where it will transition to a concrete lined channel with a bottom width of 20 feet and vertical (wall) side slopes. The western wall of the channel will extend above ground to become part of the floodwall protecting land within the EMAD (mentioned above). The concrete-lined channel with rectangular cross section will have a length of approximately 880 feet before transitioning to a trapezoidal channel with a bottom width of 20 feet and 3:1 side slopes. This last reach of the North Canal will have concrete lining along the bottom of the channel and the western bank side slope before entering the Outfall Channel.

Design Parameters

Hydraulic – The hydraulic design of the open channel, Reinforced Concrete Box (RCB) culverts, and Reinforced Concrete Pipe (RCP) will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

A Manning's "n" value of 0.07 will be used for natural grass-lined channels and a value of 0.015 for areas with concrete lining. Side slopes will be 3:1. The channel hydraulics of the North Canal are governed by two worst-case conditions under overall 100-year conditions.

A variable backwater condition at the outlet of the North Canal at the Outfall Channel influences the North Canal's ability to drain. This backwater condition is described in more detail in the hydraulic section of the Outfall Channel.

The worst-case combination of City outflow from the North Canal and Outfall Channel water levels can be described in terms of recurrence. When the City is experiencing a 100-year local storm (peak flow = 1,250 cfs under Ultimate Build Out), the worst-case expected flood stage in the Outfall Channel is at El. 32.0 (NAVD88). When the Yolo Bypass is experiencing a 100-year event (El. 34.0 (NAVD88), the City could experience up to a 25-year local storm (peak flow = 800 cfs under Ultimate Build Out). The first condition will produce a higher flow in the North Canal with a lower tailwater condition, while the second condition will produce a lower flow (compared to the 100-year) in the North Canal but with a higher tailwater condition. It is important to note that the hydraulic constraints of the proposed North Canal influence the hydraulic sizing of upstream facilities as well itself being influenced by downstream constraints.

Where vegetative canal lining is utilized, it will be designed to provide slope stability, improve water quality, and improve ultimate aesthetics. Seed mix for the lining will consist of native species for the project area. Hydroseeding is the anticipated method for installing vegetative linings. The long-term vegetative lining will change as volunteer species are allowed to fill in.

Structural – Reinforced concrete structures will be designed for Caltrans H-20 loadings and will incorporate minimum concrete compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A615.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- City of Woodland, "Technical Guidance Manual for Stormwater Quality Control Measures"
- ACI 318, "Building Code Requirements for Structural Concrete"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- U.S. Army Corps of Engineers, EM 1110-2-2007, "Structural Design of Concrete Lined Flood Control Channels"
- U.S. Army Corps of Engineers, EM 1110-2-2502, "Retaining and Flood Walls"
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

Beamer/Kentucky Channel

Purpose

The purpose of the Beamer/Kentucky Channel is to provide a single channel conveyance of all combined City (and upstream) runoff originating from or flowing through the Woodland Park Specific Plan Area to drain eastward to the North Canal.

Description

The facility will be a combination of trapezoidal, earth-lined flood control channel section with a fixed bottom width together with a series of parallel linear storm water quality treatment ponds adjacent to the channel. The upstream end of the Beamer/Kentucky Channel is located approximately 2,030 feet west of the intersection of Beamer Street and County Road 102. The channel will flow north approximately 2,300 feet to Kentucky Avenue as an earth-lined channel with a bottom width of 128 feet with flood control capacity extending across the top of the water quality features in a benched flow fashion. The channel then will turn eastward, flowing along the south side of Kentucky Avenue, crossing under County Road 102 in five 6-foot by 5-foot box culverts, to continue eastward until it drains into the North Canal. The main flood control channel will move from side to side (meander) depending upon the side of the channel designated for treatment features, as developing land on both sides of the channel requires treatment.

Design Parameters

Hydraulic – The hydraulic design of the open channel, RCB culverts, and RCP will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

A Manning's "n" value of 0.07 will be used for natural grass-lined channels. Side slopes will be 3:1. The channel hydraulics of the Beamer/Kentucky Channel are governed by two worst-case conditions under overall 100-year conditions.

A variable backwater condition at the outlet of the Beamer/Kentucky Channel at the North Canal influences the Beamer/Kentucky Channel's ability to drain. This backwater condition is described in more detail in the hydraulic section of the Outfall Channel.

The worst-case combination of City outflow from the Beamer/Kentucky Channel and North Canal water levels can be described in terms of recurrence. When the City is experiencing a 100-year local storm (peak flow = 508 cfs under Ultimate Build Out), the worst-case expected flood stage in the North Canal is at El. 33.39 (NAVD88)).

When the Yolo Bypass is experiencing a 100-year event (El. 34.0 (NAVD88), the City could experience up to a 25-year local storm (peak flow = 508 cfs under Ultimate Build Out). The first condition will produce a higher flow in the Beamer/Kentucky Channel with a lower tailwater condition, while the second condition will produce a lower flow (compared to the 100-year) in the Beamer/Kentucky Channel but with a higher tailwater condition. It is important to note that the hydraulic constraints of the proposed Beamer/Kentucky Channel may influence the hydraulic sizing of upstream facilities as well itself being influenced by downstream constraints. The majority of the drainage upstream of the Beamer/Kentucky Channel is from existing drainage; however, there will be facilities connecting to the Beamer/Kentucky Channel within the Woodland Park Specific Plan Area that will have to account for the unique downstream constraints created by the City's proposed downstream system.

Where vegetative canal lining is utilized, it will be designed to provide slope stability, improve water quality, and improve ultimate aesthetics. Seed mix for the lining will consist of native species for the project area. Hydroseeding is the anticipated method for installing vegetative linings. The long-term vegetative lining will change as volunteer species are allowed to fill in.

Structural – Reinforced concrete structures will be designed for Caltrans H-20 loadings and will incorporate minimum concrete compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A615.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- City of Woodland, "Technical Guidance Manual for Stormwater Quality Control Measures"
- ACI 318, "Building Code Requirements for Structural Concrete"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

North Canal Bridge and RD 2035 Facilities Relocation

Purpose

The purpose of the North Canal Bridge and RD 2035 Facilities Relocation is to provide a clear and open hydraulic connection to the Outfall Channel from the City's North Canal with the least amount of head loss under the 100-year condition, while providing/replacing an access to the CCSB levee system (to the north of the Outfall Channel) for the DWR, and providing/replacing conveyance facilities owned and operated by RD 2035 that currently connect the CCSB (north of the Outfall Channel) to RD 2035's High Line Ditch (south of Main Street). In addition, the City's EMAD Pump Station will need to have its outlet piping reconfigured as a result of this project.

Description

The North Canal Bridge and RD 2035 Facilities Relocation will consist of four major components. The first component is the channelized connection between the North Canal and the Outfall Channel, allowing the North Area of the City to freely drain by gravity. The second component is the replacement of access to the CCSB levee via a new reinforced concrete bridge structure with supporting piers and abutments. This bridge configuration provides the most economical bridge design with sufficient hydraulic capacity to limit head loss through the structure. The third component is the replacement of the pipeline capacity connection between the CCSB and RD 2035's Highline Ditch. Replacement of the existing capacity will be with a 60-inch-diameter siphon pipeline with appurtenant inlet/outlet structures to control flow through the pipeline. The siphon crossing itself will be armored with rock to protect against exposure of the pipe under high flow conditions. The fourth component will be the extension of the outlet pipes from the EMAD pump station to properly connect with the channel transition section including the excavation and armoring of the transition to minimize erosion and obstruction to flow.

Design Parameters

Hydraulic – The hydraulic conditions of the North Canal Bridge and RD 2035 Facilities Relocation is similar to the upstream open channel, and will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

A Manning's "n" value of 0.04 will be used for rock-lined channel areas. Side slopes under the bridge will be 3:1; however, as the side slopes are supporting the abutments, which are supporting the bridge, rock-slope protection is required from a short distance upstream to downstream of the bridge to maintain the long-term structural reliability of the installation.

Structural – Reinforced concrete structures will be designed for Caltrans HS-20 loadings and will incorporate concrete minimum compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A615. Geotechnical design parameters should be obtained for the site before structural design can begin.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- ACPA, "Concrete Pipe Design Manual"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- ASTM C76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe"
- ASTM C443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"
- Caltrans "Bridge Design Aids Manual"
- Caltrans "Bridge Design Practice Manual"
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

North Area Storm Drain Network Improvements (Backbone)

Purpose

The purpose of the North Area Storm Drain Network Improvements is to provide conveyance (serving areas greater than 30 acres) of storm runoff from new development in the North Area to regional facilities such as trunk drainage facilities like channels and detention ponds.

Description

The North Area has two major areas that are currently undeveloped. Each area will require lateral storm drains to connect on-site drainage facilities to storm drain trunk drainage and regional facilities. The final layout (location) of these storm drains will be determined when design of the buildings, parking areas and other areas are planned and submitted as improvement plans to the City. Until such details are decided exact sizes and lengths cannot be predicted; however, an estimate of the minimum pipe layout must be performed as part of the master plan process to assign costs and determine reasonable fees. Therefore, Wood Rodgers estimated the lateral sizes and lengths to serve areas greater than 30 acres for the North Area.

Design Parameters

Hydraulic – Hydraulic design parameters for drain pipelines are set by City Standards for on-site drainage facilities as well as storm drain laterals connecting to downstream channels and ponds. The design flow is the 10-year peak flow determined using the *Rational Method.* All the flow information for each pipe is shown on Map 15.

The hydraulic design for the North Area Storm Drain Network facilities will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

Concrete box and pipe culverts will be designed using the Manning's equation, with a value of .015 for concrete.

Structural – Reinforced concrete structures will be designed for Caltrans H-20 loadings and will incorporate minimum concrete compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A615.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- ACPA, "Concrete Pipe Design Manual"

- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- ASTM C76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe"
- ASTM C443, "Standard Specification for Joints for Concrete Pipe and manholes, Using Rubber Gaskets"

North Area Floodplain Fill

Purpose

The purpose of the North Area Floodplain Fill is to sufficiently raise developable areas above the worst-case expected 100-year water surface elevation within the Woodland Park Specific Plan Area to convey (serving areas greater than 30 acres) storm runoff from new development in the North Area to regional facilities such as trunk drainage facilities like channels and detention ponds.

Description

The North Area Floodplain Fill consists of compacted earth material placed in all locations within the Woodland park Specific Plan Area that are currently below expected maximum 100-year water surface elevations, which also require future protection/separation from these flood elevations. All future structures that must be protected from the 100-year flood within the Woodland Park Specific Plan Area must be constructed at least one foot above worst-case 100-year flood elevations. The intended drainage of the Woodland Park Specific Plan Area is to drain by gravity through open channels into the Yolo Bypass. The Yolo Bypass has 100-year peak stages, resulting from spills from the Sacramento River, which will backwater into the Woodland Park Specific Plan Area at El. 34.0 (NAVD 88). The hydraulics of draining the Woodland Park Specific Plan Area into such downstream constraints essentially requires raising all areas within the Woodland Park Specific Plan Area above an average elevation of 36.5.

Design Parameters

Hydraulic – Much of the fill used to raise the Woodland Park Specific Plan Area will be covered with a variety of materials including buildings, pavement, and vegetation. As such, the hydraulic properties of overland conveyance will be more specific to the character of the coverage and not on the compacted underlying material. Therefore, no hydraulic design parameters are required for fill, as fill itself is not a hydraulic structure.

Structural – The material used for compacted fill must be free from all natural, organic, man-made contaminants or larger sized aggregate, as prohibited by law and/or City standards and specifications. The earthen material must be of textural consistency that allows full compaction to be achieved and construction placement to be achieved without jeopardizing the structural integrity of whatever is placed on the fill. The soil cannot produce long-term consolidation or shrink/swell conditions that will stress the structural integrity of any structure it is intended to support. It is anticipated that a maximum plasticity of 12 will be allowable. Since a myriad of structures may be constructed atop fill material, the structural design parameters may vary depending upon the requirements of each structure. It is anticipated that a minimum of 85% density at optimum moisture content as measured in accordance with ASTM D1557 will be required at all locations, with more stringent requirements as design-level calculations are performed.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)

2. South Area Facilities

The South Urban Growth Area is shown on Map 1 and encompasses 5,550 acres of developable land generally west of County Road 102 and south of Gibson Road. This area has been used for agriculture in the past, being provided irrigation water through the Farmer's Central Channel (FCC), which is owned and operated by the Yolo County Flood Control & Water Conservation District. As part of the transition to accommodate development, the FCC would be utilized as a drainage channel as there would ultimately be no agricultural users along the FCC when development is fully implemented. The conveyance facilities between County Road 102 and Highway 113 were more closely evaluated by engineering consultants of the developers during the Specific Plan process. After this review, the City and Wood Rodgers elected to utilize the sizing and layout from the developers' consultants to provide much of the details for trunk drainage facilities west of County Road 102. Some of the upstream analyses (upstream of Highway 113) that Wood Rodgers developed remains unchanged.

Planned Facilities

South Canal Pump Station (SCPS) Replacement/Upgrade

Purpose

The purpose of the SCPS Replacement/Upgrade is to provide a dedicated 250 cfs flood pumping capacity and connection from the downstream end of the South Canal to the Outfall Channel. This proposed pumping capacity, in combination with upstream detention storage in the South Area, evacuates the worst-case 100-year runoff from existing and proposed development and mitigates all local flood impacts. The addition of the dedicated 250 cfs pumping capacity for the South Area also enhances the system's ability to drain under smaller storm events given the 100-year pump capacity design, thereby relieving pressure on the City's upstream wastewater containment embankments.

Description

The SCPS Replacement/Upgrade will remove the existing 32 cfs pump station and will replace it with a reinforced concrete sump structure with individual bays for each proposed pump, discharging to an isolated receiving bay that connects to the Outfall Channel by gravity through two buried 66-inch reinforced concrete pipes crossing under Main Street. The total installed pumping will consist of five pumps each with 25% of the total capacity with one pump acting as a redundant (back-up) pump. The intake portion of the pump station structure will be outfitted with self-cleaning trash racks that will lift accumulating debris to a concrete platform (catchment area) that can easily be loaded and hauled away by City staff. The electrical controls for the proposed pumps will be housed in a CMU building adjacent to the sump area. The site will also be outfitted with a backup power generator with capacity to operate the pumps at full capacity during emergency power outages. The entire site will be fenced and lighted for security.

Design Parameters

Hydraulic – The hydraulic conditions of the SCPS Replacement/Upgrade intake and pumping portion were designed utilizing the Hydraulic Institute Standards. Once the pumps discharge to gravity conditions the hydraulic conditions are governed by open channel and pipe flow (gravity) conditions and will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

A Manning's "n" value of 0.015 will be used for flow across all concrete surfaces. Roughness and friction losses for pumped flow are in accordance with HI Standards.

Structural – Reinforced concrete structures will be designed for Caltrans HS-20 loadings and will incorporate concrete minimum compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A615. Geotechnical design parameters should be obtained for the site before structural design can begin.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- ACPA, "Concrete Pipe Design Manual"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- ASTM C76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe"
- ASTM C443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"
- Hydraulic Institute - ANSI/HI 9.8-1998, "American National Standard for Centrifugal and Vertical Pump Intake Design"
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

West Regional Detention Facility

Purpose

The purpose of the West Regional Detention Facility is to attenuate peak storm flow downstream of Highway 113 to at or below existing peak 100-year conditions, accounting for increased inflow from upstream development within the South Urban Growth Area. No storm water quality treatment is proposed as part of this facility, as storm water quality treatment is already designed in the downstream East Regional Detention Facility (already constructed).

Description

The West Regional Detention Facility is proposed to be located as close to the upstream end of the FCC crossing under Highway 113 as possible, as the FCC is proposed as a major drainage corridor in the South Area infrastructure layout.

Design Parameters

<u>Hydraulic</u> – Hydraulic design parameters for the pond are set by containment fill elevations adjacent to the ponds, the tailwater requirements for the upstream facilities and the drainage capacity of downstream conveyance facilities competing with runoff from the Northwest Interceptor. On-site drainage facilities, as the maximum hydraulic grade lines upstream of the pond must be selected so the fill material over on-site drainage facilities is minimized. The area of the pond has been designed to fully utilize the land available on the City's property. The total footprint of the ponds will not be expanded and the ponds have existed for some time now, therefore no additional buffer is assumed to be required to adjacent properties.

The pond footprint encompasses approximately 7.71 acres. The corresponding 10-year and 100-year design water surface elevations are 52.3 and 55.4 (NAVD 88), respectively. The total flood control volume for the pond at the 100-year water level is 67 acre-feet. Pond side slopes will be 4:1 in accordance with City Standards.

<u>Structural</u> – Reinforced concrete structures will be designed for Caltrans H-20 loadings and will incorporate minimum concrete compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A615.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"

Southwest Interceptor With Sediment Basin

Purpose

The purpose of the Southwest Interceptor is to capture and divert storm runoff and sediment loads from land south (outside of) the City around the southwest side of the City Limits to connect to the proposed Farmer's Central Trunk facilities and be conveyed downstream through the South Area drainage system and into the Yolo Bypass. These facilities will alleviate an existing flooding and sediment/debris problem the City has on lands just south of the existing City boundary to the west of East Street.

Description

The facilities associated with the Southwest Interceptor consist of an earth-lined conveyance channel and a sediment basin with outlet structure. The land tributary to the Southwest Interceptor is bounded by the Maple Canal on the west and natural grade breaks (ridge line contours) to the south.

The earth-lined channel is proposed to be constructed with a bottom width of 10 feet and 3:1 side slopes beginning just south of Amherst Way, approximately 2,000 feet west of West Street, along the southern boundary of the City.

The sediment basin will be located in-line to the channel and upstream of the transition to downstream pipe reaches to maximize the controlled sediment removal to better maintain City storm drain facilities and keep them at full capacity for as long as possible.

Design Parameters

Hydraulic – The hydraulic design for the Southwest Interceptor facilities will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

A Manning's "n" value of 0.07 will be used for earth-lined channels to allow volunteer vegetation to be established. Concrete box and pipe culverts will be designed using the Manning's equation, with a value of 0.015 for concrete.

Structural – Reinforced concrete structures will be designed for Caltrans HS-20 loadings and will incorporate concrete minimum compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A615. The structures will be designed consistent with the geotechnical design parameters set forth in the Section "Geologic Conditions."

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- ACPA, "Concrete Pipe Design Manual"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed Plain and Billet-Steel Bars for Concrete Reinforcement"
- ASTM C76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe"
- ASTM C443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"
- Caltrans "Bridge Design Aids Manual"
- Caltrans "Bridge Design Practice Manual"
- California Stormwater Quality Association, California Stormwater BMP Handbook, "Sediment Basin," January 2003
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

Gibson Canal Crossing

Purpose

The purpose of the Gibson Canal Crossing is to mitigate the impacts of increases to maximum water surface at the upstream face of the existing crossing from increases in storm runoff from land within the City's South Area.

Description

The facilities associated with the Gibson Canal Crossing consist of RCB culvert structures.

The box culvert structure is proposed to be constructed as a three parallel 5-foot by 8-foot conduits with appurtenant cut-off walls and wing walls (abutments). There are existing utilities crossing the channel that will have to be rerouted as a result of the new crossing.

Design Parameters

Hydraulic – The hydraulic design for the Gibson Canal Crossing will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

Concrete box and pipe culverts will be designed using the Manning's equation, with a value of 0.015 for concrete.

Structural – Reinforced concrete structures will be designed for Caltrans HS-20 loadings and will incorporate concrete minimum compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A615. The structures will be designed consistent with the geotechnical design parameters set forth in the Section "Geologic Conditions."

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- ACPA, "Concrete Pipe Design Manual"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- ASTM C76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe"
- ASTM C443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"

- Caltrans "Bridge Design Aids Manual"
- Caltrans "Bridge Design Practice Manual"
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

Interstate 5 Crossing Capacity Increase

Purpose

The purpose of the Interstate 5 Crossing Capacity Increase is to enhance the hydraulic capacity under Interstate 5 from the South Canal to the proposed SCPS. There are two existing pipes, one of which is purposely blocked, under Interstate 5. The second pipe should remain blocked until the SCPS is constructed.

Description

The facilities associated with the Interstate 5 Crossing Capacity Increase consist of an existing reinforced concrete culvert structure. The structure is currently blocked at the upstream end of the culvert. The effort to unblock and clean the culvert is something the City's O&M staff can be directed to do at the appropriate time.

Design Parameters

Hydraulic – The hydraulic design for the Gibson Canal Crossing will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

Concrete box and pipe culverts will be designed using the Manning's equation, with a value of 0.015 for concrete.

Structural – Reinforced concrete structures will be designed for Caltrans HS-20 loadings and will incorporate concrete minimum compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A 615. The structures will be designed consistent with the geotechnical design parameters set forth in the Section "Geologic Conditions."

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- Caltrans "Bridge Design Aids Manual"
- Caltrans "Bridge Design Practice Manual"

Extension of Interceptor/Conveyance Facility (Beginning 2,500 Feet West of County Road 102

Purpose

The purpose of the Interceptor/Conveyance facility is to capture and divert storm runoff and sediment loads from land west (outside of) the City around the south side of the future City Limits to connect to the proposed South Canal and be conveyed downstream around the interior City storm drain system and into the Yolo Bypass.

Description

The facilities associated with the Interceptor/Conveyance facility have been partially constructed as part of the Phase 1A contract in 2004 as an open channel from its downstream end (crossing County Road 25) near the RD 2035 Highline Ditch, upstream around the south side of the City's Regional Park Site, crossing under County Road 102 (double box culvert) to approximately 2,000 feet west of County Road 102. For extension upstream from this point, the remainder of the facility will consist of either an earth-lined conveyance channel or a RCP. The land tributary to the future (completed) Interceptor/Conveyance facility reaches west of Highway 113 and south of the MPRA. In the interim, the open channel receives greater runoff from undeveloped lands, which will one day be developed and rerouted to the East Regional Detention Facility as part of the SLSPA and the MPRA.

The proposed earth-lined channel would be constructed with a 10-foot bottom width and 3:1 side slopes ending 2,000 feet west of County Road 102, beginning north of County Road 25A along the east side of Highway 113, flowing south/southwest toward County Road 25A and flowing along the south side of County Road 25A. If the facility is constructed as a channel, then there will need to be at least one crossing (County Road 25A) with a 60-inch diameter RCP, and potentially more crossings depending upon future development needs. The alignment of the channel will fall south of and parallel to the future County Road 25A alignment. If the facility is to be constructed as a pipe it will be a 60-inch diameter RCP for the entire extension length as the entire tributary area is west of Highway 113. The alignment of a pipeline could be constructed within the road right-of-way and beneath the pavement to save room.

Wood Rodgers designed the pipe portion of the interceptor/conveyance facility to be RCP.

Design Parameters

Hydraulic – The hydraulic design for the Interceptor/Conveyance facilities will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

A Manning's "n" value of 0.07 will be used for earth-lined channels to allow volunteer vegetation to be established. Concrete box and pipe culverts will be designed using the Manning's equation, with a value of .015 for concrete.

Structural – Reinforced concrete structures will be designed for Caltrans HS-20 loadings and will incorporate concrete minimum compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A 615. The structures will be designed consistent with the geotechnical design parameters set forth in the Section "Geologic Conditions."

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- ACPA, "Concrete Pipe Design Manual"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- ASTM C76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe"

- ASTM C443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"
- Caltrans "Bridge Design Aids Manual"
- Caltrans "Bridge Design Practice Manual"
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

Extension of Inlet Channel (City's Regional Park Site)

Purpose

The purpose of the inlet channel is to collect storm drainage from the developed and undeveloped areas immediately east of County Road 102 and convey it to the East Regional Pond.

Description

The extension of the inlet channel will be a trapezoidal channel with varying bottom width, and a short (275-foot) section of reinforced concrete flume. Recent environmental developments have necessitated a change in the alignment for this facility, which is now routed between existing landfill mounds and just east of the City's water supply well to avoid the northwest corner of the Regional Park site. A concrete base slab has been incorporated adjacent to the water supply well to allow for a narrower section, reducing the encroachment of this facility on the adjacent property.

Storm drainage originating within the proposed South Urban Growth Area development will be conveyed to regional facilities through storm drain pipelines and overland conveyance drainage ways and conveyed across County Road 102 to the inlet channel via reinforced concrete transition and box structures. The remaining regional facility associated with the Inlet Channel to be constructed is located at County Road 25A, and consists of a reinforced concrete structure. The inlet transition structure will contain RCP stub outs on the west face to accept reinforced concrete pipes carrying on-site drainage. The connection structure will also incorporate a drop inlet with grating to accept surface drainage, as collected and channeled to these structures by a swale located in the greenbelt west of County Road 102. The alignment of this swale has yet to be provided by the designer of the on-site facilities, and could affect the length of RCB structures as currently designed.

Maintenance access to the facilities will be provided by a removable safety rack on the downstream end of the RCB, and through the drop inlet grating on the connection structure. These entrances will be locked, as necessary, to prevent unauthorized entry. Preliminary drawings for this facility are presented in Volume 3 of this report. A single 5'x8' RCB will be designed to convey 269 cfs at County Road 25A. All box structures will contain provisions for draining the median of County Road 102. A concrete riser is incorporated into the roof slab of the box, designed to accommodate the future installation of pre-cast concrete grade rings to allow for its extension to the future finish grade. Once constructed, the riser will be covered with a steel plate and buried approximately twelve inches below grade.

A 15-foot-wide, gravel-surfaced operating road will be constructed on the east side of the inlet channel. A 15-foot, unsurfaced maintenance road will be constructed on the west side of the channel.

A 10-foot-wide strip between County Road 102 and the unsurfaced operating road will be provided to plant trees or other landscaping.

Design Parameters

Hydraulic – The hydraulic design for the Inlet Channel facilities will be based upon open channel flow using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

A Manning's "n" value of 0.07 will be used for earth-lined channels to allow volunteer vegetation to be established. Concrete box and pipe culverts will be designed using the Manning's equation, with a value of .015 for concrete.

The inlet channel will have a 10-foot bottom width south of Parkway Drive. The channel side slopes for earth lined portions will be 3:1.

A vegetative canal lining will be designed to provide slope stability, improve water quality, and improve channel aesthetics. Seed mix design for the lining will consist of native species for the project area. Hydroseeding is the anticipated method for installing vegetative linings.

To provide an appropriate factor of safety to account for the partial blockage of connection structure drop inlets, the inlets will be designed to convey the full 100-year storm event flow, where under actual 100-year storm conditions, approximately 50 percent of the flow will be conveyed by the buried pipeline. The need for bicycle-proof gratings was established for previously constructed crossings and is anticipated to be unnecessary for the yet to be constructed inlet grating along County Road 102.

Structural – The connection structure will incorporate a drop inlet with grating to accept surface drainage, as collected and channeled to these structures by a swale located in the greenbelt west of County Road 102. RCB structures and connection structures, including drop inlet gratings, will be rated for a Caltrans HS-20 alternative and P-loading, as appropriate. RCB structures will be pre-cast or cast-in-place reinforced concrete conforming to Caltrans standard details. Concrete will have a design minimum compressive strength of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A 615. The structures will be designed consistent with the geotechnical design parameters set forth in the Section "Geologic Conditions."

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- ACPA, "Concrete Pipe Design Manual"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- ASTM C76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe"
- ASTM C443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"
- Caltrans "Bridge Design Aids Manual"
- Caltrans "Bridge Design Practice Manual"
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

South Area Storm Drain Network Improvements (Backbone)

Purpose

The purpose of the South Area Storm Drain Network Improvements is to provide conveyance (serving areas greater than 30 acres) of storm runoff from new development in the South Area to regional facilities such as trunk drainage facilities like channels and detention ponds.

Description

These facilities in the South Area are also shown on Map 15. Refer to the details provided under the section "North Area Storm Drain Network Improvements (Backbone)" for design details on hydraulics and structure.

Constructed Facilities

Interceptor/Conveyance Facility (Downstream)

Purpose

The purpose of the interceptor/conveyance facility is to intercept storm runoff from agricultural land originating east of State Highway 113, and south of County Road 25A, and convey it around the South Urban Growth Area, west of County Road 102.

Description

The constructed portion of this facility is a trapezoidal, earth-lined channel section from its headworks approximately 2,000 feet west of County Road 102 to a point just upstream of its crossing with County Road 25A. The City and the developer utilized an open channel configuration south of the roadway in lieu of a pipeline. This substitution required to interface with an existing fiber-optic cable, a Pacific Gas and Electric (PG&E) gas line, PG&E overhead utilities and existing black walnut trees in the area of County Road 25A. Plan and Profile information for this facility is provided in the Volume 3 of this report.

At County Road 102, the interceptor consists of a double 5x8 RCB. Just upstream of this box structure, south of the future extension of County Road 25A and west of County Road 102, a small basin was constructed to settle out overland flow coming from the south prior to entering the box. This basin accommodates an outlet for the channel south of County Road 25A.

The existing roadside drain carrying flow adjacent to County Road 102 can also be directed to convey flow to this basin.

East of County Road 102, the facility is an open channel, situated 15 feet north of the Regional Park site's south property line (this 15-foot buffer constitutes the facilities secondary operating road). North of the channel, the primary operating road also serves as an access road for existing leaseholders and personnel of the City's Department of Parks and Recreation. This alignment required relocating existing electrical and water service utilities on the property. At the eastern property line, the facility's current alignment turns north for a short stretch, then northeast parallel to and south of the existing 6 5/8-inch Calpine gas line. The channel crosses this line just east of the Regional Park site and again near the intersection of County Road 103 and County Road 25. As the gas line is approximately six feet deep, it will require relocation. The PG&E gas line, which runs diagonally through this property as well, will also require deepening. The portions of the channel facility downstream of the City's Regional Park (Maupin property) will be constructed without a levee or berm along the right side of the channel to allow water, during high runoff events, to flow "out of bank" and inundate the adjacent property similar to what occurs under existing conditions. For low flow conditions, the drainage will be contained within the channel, and directed to the South Canal.

Interim Facilities – Interim facilities associated with the interceptor/conveyance facility will likely be required during early development Stages in the South Urban Growth Area. These facilities will include a temporary agricultural interceptor channel situated along the west boundary of each development stage to convey storm runoff from agricultural land around the development area to the future extension of County Road 25A. If property can be obtained south of the future extension of the roadway where needed, this interim facility, where it parallels the future alignment, can be designed to serve as the permanent master plan interceptor/conveyance facility. If property cannot be purchased, and the developer is unwilling to dedicate land to construct the channel, a pipeline will need to be constructed within the roadway to support the ultimate interceptor/conveyance facility.

East of County Road 102, the interceptor was constructed as described above. Although flow routed through this facility during staged development will be greater than the design flow for the facility under ultimate conditions, by incorporating a program of routine maintenance (for removing debris and mowing the vegetative lining), a more hydraulically efficient section can be maintained thereby eliminating the need to oversize the facility for interim conditions.

Design Parameters

Hydraulic – The hydraulic design of the open channel, RCB culverts, and RCP was based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

A Manning's "n" value of 0.07 was used for natural grass-lined channels for the permanent condition. Side slopes are3:1. As noted above, a more efficient roughness coefficient may be incorporated for the interim agricultural interceptor facilities, to the extent it is maintained during the course of development. Box culverts and pipe were designed using the Manning's equation, with a value of .015 for concrete.

A vegetative canal lining was constructed to provide slope stability, improve water quality, and improve ultimate aesthetics. Seed mix for the lining consists of native species for the project area. Hydroseeding was method used for installing vegetative linings.

<u>Structural</u> – Reinforced concrete structures were designed for Caltrans HS-20 loadings and incorporated concrete minimum compressive strengths of 3,500 psi. Reinforcing steel is 60,000 psi deformed, billet steel bars conforming to ASTM A615. The structures were designed consistent with the geotechnical design parameters set forth in the Section "Geologic Conditions."

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- ACPA, "Concrete Pipe Design Manual"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM C76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe"
- ASTM C443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"
- Caltrans "Bridge Design Aids Manual"
- Caltrans "Bridge Design Practice Manual"
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

Inlet Channel (Downstream)

Purpose

The purpose of the inlet channel is to collect storm drainage from the developed and undeveloped areas immediately east of County Road 102 and convey it to the East Regional Pond.

Description

The constructed portion of the inlet channel is a trapezoidal channel with varying bottom width.

Storm drainage originating within the proposed South Urban Growth Area development is conveyed to regional facilities through storm drain pipelines and overland conveyance drainage ways and conveyed across County Road 102 to the inlet channel via reinforced concrete transition and box structures. These regional facilities are located at the FCC, a point 400 feet south of the FCC and Parkway Drive, and consist of reinforced concrete structures. The inlet transition structures contain RCP stub outs on the west face to accept reinforced concrete pipes carrying on-site drainage. The connection structure also incorporates a drop inlet with grating to accept surface drainage, as collected and channeled to these structures by a swale located in the greenbelt west of County Road 102.

Maintenance access to the facilities is provided by a removable safety rack on the downstream end of the RCB, and through the drop inlet grating on the connection structure. These entrances will be locked, as necessary, to prevent unauthorized entry. Drawings for these three facilities are presented on the Drawings at the end of this report. A double 5'x8' RCB was designed to convey 583 cfs from the FCC, a single 5'x5' RCB will convey the 100-year peak flow (158 cfs) from the facility 400 feet south of the FCC, a double 5x8 RCB was designed to convey 419 cfs at Parkway Drive. Box structures contain provisions for draining the median of County Road 102. A concrete riser is incorporated into the roof slab of the box, designed to accommodate the future installation of pre-cast concrete grade rings to allow for its extension to the future finish grade. Once constructed, the riser was covered with a steel plate and buried approximately 12 inches below grade.

At the Parkway Drive box, Wood Rodgers incorporated a 60-inch RCP stub out into the box sidewall for future connection of on-site facilities. The pipe stub out was capped.

A 15-foot-wide, gravel-surfaced operating road was constructed on the east side of the inlet channel. A 15-foot, unsurfaced maintenance road was constructed on the west side of the channel.

A 10-foot-wide strip between County Road 102 and the unsurfaced operating road will be provided to plant trees or other landscaping.

Design Parameters

Hydraulic – The inlet channel was designed as an open channel using the Manning's equation:

$$Q = (1.486AR^{2/3}S^{1/2})/n$$

A value of 0.07 will be used for Manning's "n" for natural lined canals with little or no maintenance. A value of .015 will be used for concrete-lined channels. A composite n value of .058 will be used for channels with a concrete base. Concrete base lined channels are also designed for little or no maintenance.

The inlet channel has a 30-foot bottom width north of Parkway Drive. The channel side slopes are 3:1.

A vegetative canal lining was designed to provide slope stability, improve water quality, and improve channel aesthetics. Seed mix design for the lining consists of native species for the project area. Hydroseeding was the method used for installing vegetative linings.

To provide an appropriate factor of safety to account for the partial blockage of connection structure drop inlets, the inlets were designed to convey the full 100-year storm event flow, where under actual 100-year storm conditions, approximately 50 percent of the flow will be conveyed by the buried pipeline.

Structural – The connection structure incorporates a drop inlet with grating to accept surface drainage, as collected and channeled to these structures by a swale located in the greenbelt west of County Road 102. RCB structures and connection structures, including drop inlet gratings, should be rated for a Caltrans HS-20 alternative and P-loading, as appropriate. RCB structures were essentially pre-cast reinforced concrete conforming to Caltrans standard details. Wood Rodgers assumes that all constructed concrete should have a design minimum compressive strength of 3,500 psi in accordance with the plans and specifications, though we were not contracted to perform construction inspection. Reinforcing steel is assumed to meet 60,000 psi deformed, billet steel bars conforming to ASTM A615, also in accordance with the plans and specifications.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)

- ACI 318, "Building Code Requirements for Structural Concrete"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- Caltrans "Bridge Design Aids Manual"
- Caltrans "Bridge Design Practice Manual"
- Caltrans Standard Specifications, "Roadway Subbases, Bases, Surfacings and Pavements"
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

East Regional Pond

Purpose

The purpose of the East Regional Pond is to provide storm water quality treatment and flood control volume to attenuate runoff to mitigate downstream impacts resulting from development of the South Urban Growth Area.

Description

The East Regional Pond, under full build out conditions, consists of two pond cells that are interconnected so they act as a single pond.

During development the first increments of SLSPA development, both pond cells (1 and 2) were determined to be required. The pond provides the volume required for water quality treatment for the entire South Urban Growth Area. The flood control volume will only be adequate for Stages 1 through 4, without additional downstream pumping at the SCPS. Wood Rodgers worked with PG&E to perform the relocation (lowering) of the 20-inch gas main. The pond outlet structure currently controls flow into the Outlet Channel.

The northwest corner of the west pond incorporates a passive recreation viewing area. This area contains an island, walking path, and landscaping improvements. A 5-foot fence was located two feet from the top of the pond's embankment, to restrict access to the pond. Lockable gates were installed to control access to the pond's perimeter operating road.

Design Parameters

Hydraulic – Hydraulic design parameters for the pond were set by fill requirements for on-site drainage facilities, as the maximum hydraulic grade lines upstream of the pond must be selected so the fill material over on-site drainage facilities is minimized. The area of the pond has been designed to fully utilize the land available on the Brauner property. The south boundary for both the east and west portions of the pond are configured to maintain a 250-foot buffer to existing wetlands on the site as stipulated by Foothill Associates' Preserve Management Plan.

Based upon discussions with PG&E, shared use of an operating road within the gas line easement is acceptable, and therefore the eastern top of bank Pond 1 and the western top of bank for Pond 2 have been situated to coincide with PG&E's gas line easement. The City's concerns that they maintain operational jurisdiction over the operating roads has been conveyed to PG&E. A 30-foot setback from the northern and eastern property lines has been maintained as requested by the developer's engineer.

The ultimate pond design allows for berms to be constructed around the perimeter of the pond to allow maximum flood control storage availability. However, this bermed condition cannot be implemented until a Cache Creek overflow solution is implemented, because the berms would obstruct the Cache Creek overflow. The pond footprint encompasses approximately 21 acres for Pond 1 and 23 acres for Pond 2. The corresponding 10-year and 100-year design water surface elevations are 32.75 and 35.5 msl, respectively for the ultimate bermed condition. The total flood control volume for the pond at the 100-year water level is 333 acre-feet.

Pond side slopes are 4:1, with the exception of the passive recreation areas, which are 6:1.

A wet detention basin has been incorporated to provide water quality treatment in the pond for urban runoff, designed to conform to Larry Walker Associates' Technical Guidance Manual for Stormwater Quality Control Measures. The permanent water quality pool has been sized based upon 75 percent of the full storm water quality treatment volume, in accordance with the criteria. The remaining 25 percent will be integral with the pond's storm water detention volume, sized as necessary to achieve a draw down period no greater than twelve hours. The total water quality treatment volume is 33.8 acre-feet, of which 26 acre-feet will be contained within the permanent water quality pool.

Structural – Reinforced concrete structures were designed for Caltrans H-20 loadings and presumably incorporated minimum concrete compressive strengths of 3,500 psi, in accordance with the plans and specifications. Reinforcing steel was specified at a minimum 60,000 psi deformed, billet steel bars conforming to ASTM A615. Wood

Rodgers was not involved in construction inspection and so assumes that the project was constructed appropriately for purposes of this report.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- Larry Walker Associates, Inc., "Technical Guidance Manual for Stormwater Quality Control Measures,"
- ACI 318, "Building Code Requirements for Structural Concrete"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- Caltrans "Bridge Design Aids Manual"
- Caltrans "Bridge Design Practice Manual"

Outlet Channel

Purpose

The purpose of the outlet channel is to transport flow from the East Regional Pond to the Gibson Channel (Canal).

Description

The outlet channel consists of a combination trapezoidal earth-lined channel and trapezoidal concrete-lined channel bottom. From where the channel moves onto property to be acquired from the Barton parcel, to the outlet structure for the East Regional Pond, a concrete base slab is incorporated to minimize the width of the facility. This reduced section will allow the facility to remain on the WWTP property where property is not available at the Barton parcel.

Under current conditions, the Barton property drains to its northeast corner where two existing culverts direct the flow to the Gibson Channel. As the outlet channel disrupts this previous drainage routing, a new drainage swale and two new culverts was constructed just west of the outlet channel's western embankment. As County

Road 24 is overtopped from the Gibson Canal during the 100-year event, these culverts were designed to convey 10-year flow.

Design Parameters

Hydraulic – Canals will be designed as open channels using the Manning's equation:

$$Q = (1.486AR^{2/3}S^{1/2})/n$$

A value of 0.07 was used for Manning's "n" for natural grass-lined channels. A value of .015 was used for concrete-lined channels. A composite n value of .058 was used for channels with a concrete base. Concrete base lined channels were also designed for little or no maintenance.

The outlet channel has a varying bottom width and 2:1 side slopes where a concrete base is incorporated. Where there is not a concrete base, the channel has 3:1 side slopes. A 15-foot wide operating road was constructed on the western embankment. The WWTP levee operating roads serves as maintenance access on the east side of the channel.

A vegetative canal lining was designed to provide slope stability, improve water quality, and improve aesthetics. Seed mix design for the lining consisted of native species for the project area. Hydroseeding was the method utilized for installing vegetative linings.

Structural – Concrete structures were designed for Caltrans H-20 loadings and incorporated minimum concrete compressive strengths of 3,500 psi.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- Caltrans "Bridge Design Aids Manual"
- Caltrans "Bridge Design Practice Manual"
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

3. *Common Facilities*

Outfall Channel Improvements

Purpose

The purpose of the Outfall Channel is to provide a single channel conveyance of all combined City (and upstream) runoff (from the North Area, South Area and EMAD) from the eastern edge of the City approximately two miles eastward to the Yolo Bypass.

Description

The facility would be a trapezoidal, earth-lined channel section with a bottom width of 25 feet from its headworks just south of the southwest corner of the CCSB the hypothetical intersection of East Main Street and a projection of County Road 103) to a point just upstream of the west levee of the Yolo Bypass.

The Outfall Channel currently exists as a non-uniform channel with limited conveyance capacity that once served as the low-flow channel within the old CCSB. The Outfall Channel receives all inflow as pumped from the City's three pump stations. The limitations of both the inlet and outlet conditions of the Outfall Channel are more fully described in their respective stand-alone sections. The conveyance capacity of the channel itself is limiting, even with inlet and outlet constraints removed. The invert of the existing channel is at an adverse grade for a portion of the upstream end of the channel and so all flow must get beyond this "high-point" before it can effectively drain to the Yolo Bypass. The existing cross-sectional geometry does not provide enough capacity to convey the projected worst-case flood conditions to the Yolo Bypass without severely encroaching on the allowable freeboard of the South Levee.

Design Parameters

Hydraulic – The hydraulic design of the open channel, RCB culverts, and RCP would be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

A Manning's "n" value of 0.07 would be used for natural grass-lined channels. Side slopes would be 3:1. The channel hydraulics of the Outfall Channel is governed by two worst-case conditions under overall 100-year conditions.

A variable backwater condition at the outlet of the Outfall Channel (the Yolo Bypass) influences the Outfall Channel's ability to drain. The two drainage systems, the Yolo

Bypass and the Outfall Channel, have been determined to be essentially independent but can nonetheless have some level of simultaneous occurrence. The worst-case combination of City outflow and Yolo Bypass water levels can be described in terms of recurrence. When the City is experiencing a 100-year local storm (peak flow = 1,250 cfs under Ultimate Build Out), the worst-case expected flood stage in the Yolo Bypass is a 25-year stage (El. 32.0 (NAVD88)). When the Yolo Bypass is experiencing a 100-year event (El. 34.0 (NAVD88)), the City could experience up to a 25-year local storm (peak flow = 800 cfs under Ultimate Build Out). The first condition would produce a higher flow in the Outfall Channel with a lower tailwater condition, while the second condition would produce a lower flow (compared to the 100-year) in the Outfall Channel but with a higher tailwater condition. It is important to note that the hydraulic constraints of the proposed Outfall Channel influence the hydraulic sizing of upstream facilities as well itself being influenced by downstream constraints.

A vegetative canal lining would be designed to provide slope stability, improve water quality, and improve ultimate aesthetics. Seed mix for the lining would consist of native species for the project area. Hydroseeding is the anticipated method for installing vegetative linings. The long-term vegetative lining would change as volunteer species are allowed to fill in.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

Outfall Channel Outlet Bridge

Purpose

The purpose of the Outfall Channel Outlet Bridge is to provide a clear and open hydraulic connection to the Yolo Bypass from the City's Outfall Channel with the least amount of head loss under the 100-year condition, while also providing access to the CCSB levee system for levee surveillance and maintenance.

Description

The facility would be a single-span reinforced concrete bridge structure with supporting abutments. This bridge configuration provides the most unimpeded hydraulic capacity without exposure of bridge supports to flood forces (erosion/scour or debris loading)

Design Parameters

Hydraulic – The hydraulic conditions of the outlet bridge are similar to the upstream open channel, and would be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

A Manning's "n" value of 0.04 would be used for rock-lined channels. Side slopes under the bridge would be 3:1; however, as the side slopes are supporting the abutments that are supporting the bridge, rock-slope protection is required from a short distance upstream to downstream of the bridge to maintain the long-term structural reliability of the installation.

Structural – Reinforced concrete structures would be designed for Caltrans HS-20 loadings and would incorporate concrete minimum compressive strengths of 3,500 psi. Reinforcing steel would be 60,000 psi deformed, billet steel bars conforming to ASTM A615. The structures would be designed consistent with the geotechnical design parameters set forth in the Section "Geologic Conditions."

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- ACPA, "Concrete Pipe Design Manual"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- Caltrans "Bridge Design Aids Manual"
- Caltrans "Bridge Design Practice Manual"
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

South Levee Certification

Purpose

The purpose of the South Levee certification is to provide 100-year flood protection for land to the south of the South Levee from flood risk due to water within the Outfall Channel resulting from runoff from the City as well as backwater from the Yolo Bypass under Ultimate Conditions. In effect, the South Levee becomes part of the Yolo Bypass and would have to meet all federal and state stability requirements before responsibility is officially accepted by any entity other than the City.

Description

The existing (and proposed) facility is a compacted earth embankment with a constant top width, buttressed by a railroad embankment continuous and parallel to the land side of the South Levee for the entire length. The South Levee was evaluated for structural stability, through-seepage and under-seepage by Kleinfelder, Inc. as part of these Master Plan Update efforts. According to their report, the railroad buttressing condition allows the South Levee to remain intact under future 100-year conditions. Under seepage was identified as a potential issue that would need to be addressed if development was proposed along the south side.

Design Parameters

Hydraulic – The hydraulic conditions affecting the South Levee are identical to the Outfall Channel above. Once channel improvements are made for the Outfall Channel, it is anticipated there will need to be spot repairs and/or placement of riprap along the toe of levee at specific locations. A boat survey has not yet been conducted, but Wood Rodgers anticipates that small areas along the existing levee will be identified during the design phases, that will require the placement of rock.

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- US Army Corps of Engineers – EM 1110-2-1913, "Design and Construction of Levees"
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

Outfall Channel–Yolo Bypass Transition

Purpose

The purpose of the Outfall Channel-Yolo Bypass Transition to provide an open channel controlled hydraulic connection from the western side to the eastern side of the Yolo Bypass and into the Tule Canal to allow City outflow to reach the Tule Canal without damage to the Railroad Trestle or County Road 22.

Description

Improvements in the Yolo Bypass will consist of a concrete training structure to direct City outlet flow slightly northward as it enters the Yolo Bypass, and force it to combine with the low-flow outlet flow from the CCSB, to flow together through a self-cutting channel alignment parallel and north of the railroad across to the Tule Canal. Part of the training structure will be outfitted with gated pipeline to allow control of summertime diversion southward, as it does today.

In the mid-1990's water was redirected across the Bypass after evidence of scour at the base of the Railroad Trestle supports was discovered. The land immediately to the north of the trestle (across the entire Yolo Bypass) was and is owned by the City and once operated as a series of evaporation/infiltration ponds according to City officials. Though the operation had been abandoned for some time, remnant bermed cells remained. Sections of the north/south berms that impeded west-to-east flow were removed and a small east-west berm was constructed at the upstream end to steer the flow through the City-owned property and avoid the Railroad Trestle. Field observations in 2004 indicate that the desired alternative flow path has successfully been established. However, the current discharge location from the City was not connected to utilize this alternative flow path and currently forced to flow under the Railroad Trestle and across the Yolo Bypass under winter low-flow conditions, when irrigation facilities are shut down.

Wood Rodgers has made several attempts through RD 2035's consultant engineer (West Yost) to obtain an understanding of RD 2035's summertime water rights and wintertime operations. No response or communication has been provided to the City or Wood Rodgers to know what RD 2035 needs to maintain in this area of the Yolo Bypass. The self-cutting overflow channel has not been altered since it was first created which implies that it has not created a problem for summertime diversion capability, therefore we recommend matching and replacing the functionality of existing structures. Given the current flow condition does not worsen RD 2035's ability to capture its summertime water from the Cache Creek system we assume that adding the City's outflow to the cross channel will be met with similar response.

Design Parameters

Hydraulic – The hydraulic conditions of the Yolo Bypass Improvements are a combination of City outflow and CCSB outflow, and will be based upon using the Manning's equation:

$$Q = (1.486AR^{2/3}s^{1/2})/n$$

A Manning's "n" value of 0.04 will be used for rock-lined and earthen embankment channels. It is not anticipated that much vegetation will establish in this self-cutting channel, however, if vegetation does flourish it is expected the system will be self-correcting and high flows will spread out with little impact to City hydraulics or to the Railroad Trestle. Side slopes will vary through transition areas, where turning flows will require rock slope protection. Side slopes will be constructed at 3:1 or flatter wherever possible.

Structural – Reinforced concrete structures will be designed for Caltrans HS-20 loadings (adjacent to walls or on top of spanning/drivable structures) and will incorporate concrete minimum compressive strengths of 3,500 psi. Reinforcing steel will be 60,000 psi deformed, billet steel bars conforming to ASTM A615. The structures will be designed consistent with the geotechnical design parameters set forth in the Section "Geologic Conditions."

Reference Codes and Standards

- City of Woodland, "2002 Standard Specifications and Details" (Includes Amendment #1, July 2004)
- ACI 318, "Building Code Requirements for Structural Concrete"
- ACPA, "Concrete Pipe Design Manual"
- AISC, Manual of Steel Construction, "Allowable Stress Design," Ninth Edition
- ASTM A615, "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement"
- ASTM C76, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe"
- ASTM C443, "Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets"

- Caltrans "Bridge Design Aids Manual"
- Caltrans "Bridge Design Practice Manual"
- E.F. Brater & H.W. King, "Handbook of Hydraulics," McGraw Hill Book Co., Inc., 1963

4. *Comparative Hydraulic (HGL) Evaluation*

With the implementation of the proposed storm drainage facilities described above, a comparative evaluation was performed at specific locations within the City's existing and proposed (Ultimate) system facilities. The purpose is to determine the impact of the build out of the General Plan on local flooding within the City, to ensure that in implementing the Master Plan facilities existing flooding problems are not made worse.

Presented on Map 16 are the locations within the system where stage hydrograph comparisons are being made. The hydrograph comparisons can be found in the Figures section of this report with corresponding node labeling on both the map and the figures for easy reference. It is important to note that at several locations within the system the worst-case flooding is occurring under a longer storm duration for Existing Conditions versus Ultimate Conditions. For instance, with the transition from limited existing pump capacity to proposed open-channel gravity drainage to the North Area, the lower part of the system is no longer governed by longer duration storms (higher volume/lower peak). Conveyance capacity is governing the North Canal system and so the 24-hour storm creates the highest stages in this facility.

An increase is noted within the EMAD storm drainage system upstream of the pump station under Ultimate Conditions. This increase is due to the build out of developable land within the EMAD that is tributary to the system. Even with the system isolated from the North Canal and South Canal in the future, the pumping capacity of the EMAD pump station is not enough to handle the peak flow conditions generated by the 100-year event. Information provided by the City indicates that the design of the pump station was based upon a 10-year peak flow, so this response of the system under the 100-year flow is predictable. Wood Rodgers estimates that the flooding created by this pumping capacity limitation will be of short duration and will not create damage to buildings but will only create shallow flooding in lower elevation areas such as parking lots and swales. These areas should drain back through drainage inlets fairly quickly after the storm subsides.

The remainder of the city system is at or below Existing Conditions elevations with no flooded areas within newly developed areas.

D. Environmental Compliance

All aspects of the proposed storm drainage facilities associated with this plan must be constructed in compliance with current environmental laws and restrictions. Compliance with the law is dependent upon a clear understanding of what environmental impacts are created by the implementation of the plan, as well as an understanding of what the law requires. EIP Associates addresses these specific areas and developed reports outlining these issues of importance. These reports are contained in Appendix B.

A main focus of EIP's efforts was to evaluate the potential environmental impact of the Outfall Channel improvements, originally identified as part of the 1999 SDFMP. The efforts under this Master Plan Update were intended to identify any critical environmental constraints along the Outfall Channel that would prevent or severely impair the implementation of this critical downstream drainage element. EIP's report concludes that the channel can be constructed with certain environmental mitigation measures (outlined in EIP's report in Appendix B). EIP also identified permitting strategies for the implementation of the overall Master Plan Update. Once implementation of the elements of the Master Plan Update are imminent, a more thorough and site-specific analysis must be conducted to identify wetlands and habitat/species impacts associated with construction on a site-specific level.

VII. ON-SITE FACILITIES

This section of the Master Plan Update is to clarify that the defined SDFMP facilities in the report do not include all drainage facilities within the City, but only regional drainage facilities that must be constructed for the overall system to work. In the 1999 SDFMP, the threshold for a facility to be considered was set at 30 acres. This criteria has been maintained by the City. All drainage facilities that serve less than 30 acres are considered "on site" and are not included in the costs of facilities within this Master Plan Update. On-site facilities do have to be constructed, but are considered a cost for each site developer and do not need to be financially administered by the City through the drainage fee and capital improvements project process.

VIII. STORM DRAINAGE WATER QUALITY MONITORING

The City was recently designated an MS4 Community as part of the implementation of the NPDES administered by the California Regional Water Quality Control Board for adherence to the Clean Water Act. As part of the City's obligation to abide by the statewide permit for urban discharges, the City requested that Wood Rodgers include the development of storm water treatment guidelines for new development as part of the Master Plan Update. As part of this Master Plan Update, a guidance manual was developed for the City, which the City adopted in early 2004. These guidelines are also included in Appendix C.

In general, the City elected to require all new development to perform standard levels of storm water quality treatment as part of its mitigation requirements. The City also elected to include features within the Master Plan Update to enhance and consolidate the treatment of larger areas, with a more regional approach to treatment measures wherever possible. While it is not mandated, Wood Rodgers identified one area within the City and two areas outside of the City where large-scale storm water quality treatment measures can be retrofitted to treat runoff from large areas of existing (upstream) development. These three areas are the Beamer/Kentucky ponds, the Heidrick property, and the City's property within the Yolo Bypass.

The first location (Beamer/Kentucky ponds) already has a flood detention pond on-site, however, the existing storm water quality treatment within the ponds is very limited and does not meet current design standards, because it was never configured to flow low-flow runoff through the ponds. This location would have to be excavated further with inlet and outlet control facilities as well. The second location (Heidrick property) is located just north of the Gibson Road drainage canal system and could be constructed to receive all of the Gibson Road drainage shed for treatment in a wet or dry pond configuration. The third location (Yolo Bypass) is capable of receiving all of the City's runoff as well as the runoff from land within the County that is flowing through the City by constructing a treatment pond system just north of the Railroad trestle and County Road 22. This third location would require constructing a bypass channel to separate Cache Creek low-flow (exiting the CCSB) and isolate the City's discharge.

Part of the effort in treating the City's discharge is identifying the sources of contamination. A significant obstacle to treating the City's discharge is that it commingles with storm runoff from agricultural land that may be sediment-laden, include fertilizer/pesticide/herbicide residues, or other deleterious organic material. It can be difficult for the City to clearly show they are improving storm water quality that is exiting the City if it mixes with untreated storm runoff from unregulated non-urban land before draining into the Yolo Bypass. While storm runoff from agricultural land may be a detriment to treatment efforts, there is an existing operation downstream that helps the City's overall efforts. Low-flow runoff from the City flows into the outfall channel and into the Yolo Bypass where RD 2035 has the ability to receive all Cache

Creek and City low-flow into its irrigation delivery system and utilize it to supplement irrigation supply. Once this water is recaptured and used for irrigation the City can no longer be held directly responsible for the finished water quality. While this configuration aids the City in some ways, it is not able to operate when the City needs it most, which is when the "first-flush" rainfall is expected to occur, which is generally in late fall, when irrigation for agriculture is dwindling. The gates which allow low-flow to enter the RD 2035 system are typically shut during the winter season and the City's discharge must find its way across the Yolo Bypass and into the Tule Canal.

Given the complexities of trying to formulate a comprehensive approach to storm water quality treatment, attention was given to configuring the storm drainage facilities to assist the City's efforts in storm water quality treatment while also meeting storm drainage/flood control objectives. Constructing water quality treatment measures as an integral part of a detention pond is one way of combining efforts. Another way is to isolate the City's discharge and treat it before commingling with other untreated runoff, allowing the City to easily monitor and document, if necessary, its water quality treatment efforts. The configuration of the Master Plan facilities will allow the City to monitor its urban runoff before being commingled with runoff from surrounding agriculture land. While the City is not required to monitor specific constituents/pollutants in its discharge, the future ability to do so, offers the City an advantage in meeting future, more targeted, requirements. Even so, the City has initiated sampling of storm drainage at select locations taking a pro-active approach to have the ability to deal with water quality issues in the future.

IX. OPINION OF PROBABLE COSTS

A. Construction

Detailed estimates of the construction quantities including materials, labor and overhead/profit as well as administration, engineering design, and construction management efforts were developed to formulate an opinion of probable cost for all elements of this update to the Storm Drainage Facilities Master Plan (see "Tables" section, Table 1 through Table 16). Numerous factors can affect cost that cannot be accurately predicted. For example, just recently concrete, steel, and even fuel costs have escalated beyond what most would have predicted a few years ago, increasing unit costs for everything constructed with concrete, rebar and steel. The time that a construction project is bid and the overall construction activity can impact construction costs as well.

A summary of costs for the entire Storm Drainage Facilities Master Plan is provided in Table 1. A Cost Allocation Report (January 2006) was prepared by Wood Rodgers wherein the costs presented in this report were allocated to the urban growth area and existing City.

The following discussion for each major element of the Storm Drainage Facilities Master Plan is intended to provide known or assumed construction constraints that were used as the basis for the detailed cost estimates provided in the Master Plan Update tables (see "Tables" section).

1. North Area Facilities

Northwest Interceptor

This project facility could be phased with the construction of sediment basins prior to the construction of the channel, which will drain around the City. This will alleviate some of the problem the City is having without eliminating the flooding problems. Dewatering efforts are assumed minimal for all the channel and basin excavation.

The construction of the levee is assumed coincident with the channel, as the spoil from the channel excavation will provide the material for the levee embankment. The levee is considered non-riverine.

The hauling and dumping of material is considered short distance as much of the excavation is assumed to be spoilable either as levee construction or spread in the adjacent fields. Part of the negotiation with the landowners to construct the Northwest Interceptor will be to convince them that there will be better recapturing/recycling of top soil over the long-term. With this being part of the discussion early on, it is highly likely that it will agreeable for the excess material to be placed in the fields, especially if there are low spots that need to be filled in anyway.

Volkl Pond Improvements

The detention pond configuration is fitted to maximize the footprint of the pond on the site; however, the southeastern cell is currently benched higher, while the northwestern cell is lower and collects rainwater as well as potential seepage if the groundwater levels are high enough. The excavation of the pond on the site will require some dewatering and will potentially require a permitting process with the potential groundwater extraction from the existing excavated northwestern cell. If this pond has been closed from overland release for some time, the water quality of the standing water in the pond could be worse than the surrounding groundwater, which already has been tested and found to have consistently higher electrical conductivity (EC) levels. It could also have significant bacteriological contamination with the populations of waterfowl that have been witnessed occupying the site.

Assuming dewatering issues are worked out; the excavation on the site is straightforward with the anticipated destination of the spoil material to be adjacent Volkl Trunk developing land. As the property is owned by the City, the spoil could be sold to the highest bidder, if there is a market for it at the time. The value of such material is difficult to estimate and is highly driven by demand and the proximity of such demand.

Volkl Trunk Facilities

Construction conditions for the Volkl Trunk and the associated pipes and laterals are anticipated to be relatively straightforward with no dewatering requirements during the anticipated construction season of May-October. The trunk will be required to convey flow under an active railroad line running west of the Volkl Pond. This crossing was estimated to require boring and jacking operations to keep the railroad line active during construction. No major utilities crossings or adverse subsurface conditions are expected. Wood Rodgers assumed that the excess excavated material could be incorporated into the adjacent development that is requiring the construction of the drainage facilities in the first place.

Kentucky Trunk Diversions to Volkl Trunk

Construction conditions for the diversion pipelines from the Kentucky Trunk to the Volkl Trunk are anticipated to be relatively straightforward with no dewatering requirements during the anticipated construction season of May-October. The diversion pipelines will be making no significant crossings relative to utilities, roadways, or railways, though the inlet of the diversion will require some grading modifications to allow the Kentucky roadway overflow to enter the diversions. The destination of the spoil of excess excavated material is the same as other Volkl trunk facilities where the owner of the property will be developing the property and triggering the construction of the diversion facilities.

Volkl Outlet

The outlet facilities are designated to be constructed at the same time as improvements to the Volkl Pond. The operation for installation of the portion of the Volkl Outlet beneath Interstate 5 is to bore and jack a large carrier pipe. With boring and jacking operations, both ends of the operation must be excavated and the pits must be kept dry for equipment to safely perform the installation. Groundwater is expected to be present in the bottom portions of the excavations. Dewatering operations have been conducted continuously by the company that is operating Dubach Park, just adjacent to north side of the Volkl Outlet at Interstate 5. Dubach Park is situated in an old borrow pit with the bottom of the pit serving as the playing surface with sports fields. The bottom of Dubach Park must be kept unsaturated for it to effectively operate, and it has experienced standing water in the winters requiring pumping operations to remove the standing water. According to the City, these operations have recently been rendered more difficult as the groundwater extraction has been tested positive for higher levels of electrical conductivity and can no longer discharge to the City's wastewater collection system. It is uncertain whether in the future the difficulties with groundwater extraction and treatment could prevent Dubach Park from operating in an economical fashion. It is anticipated, however, that the dewatering wells that are in place now will remain there and be usable for future dewatering needs associated with the construction of the Volkl Outlet. If the Park is abandoned, the potential exists to store pumped groundwater in the park and allow it to evaporate or to seep back in over time. If this option proves infeasible, then we recommend applying the extracted groundwater to adjacent fields by striking agreements with adjacent agricultural landowners. The last option is to treat the water for discharging it, but this would be the most expensive option. We assume that land application will be a feasible option and have reflected estimation of this in the cost.

Other than the handling of groundwater, there are no foreseeable obstacles to conducting the construction of the open cut excavation or the boring and jacking operations. Depending upon the final location of the ends of the bored and jacked sections, there may need to be temporary foundations constructed for properly stabilizing the boring and jacking equipment. Disposal of all excavated earth is anticipated to be disposed of locally.

North Canal Improvements

The length of the North Canal improvements are such that construction conditions will vary considerably. No detailed geotechnical evaluations are available for the alignment and should be conducted as part of the final design. The reach of the North Canal between the Volkl Outlet and the CCSB levee is anticipated to be primarily above the groundwater table. The construction of this reach of channel will occur concurrent with the Volkl

Outlet, as there is no need for the channel to be in place unless drainage in the Volkl Trunk generates the need. If there is a portion of the bottom of the excavation that is at or near the water table, it is anticipated that the remainder of the excavation can be done in the wet from equipment placed above the groundwater elevations. Such material will have to be dried before it is effectively placed. Much of the dry excavated material could be used as fill base for the future Churchill Downs road alignment, and should be coordinated with the City's Department of Transportation. Depending upon when this construction takes place in relation to development within the Woodland Park Specific Plan the spoil of excavated material could be stockpiled or placed within either the developable portions of the Woodland Park Plan or within the Agricultural Buffer zone designated as a wide band along the north edge of the Woodland Park Specific Plan Area, and immediately adjacent to this reach of the North Canal.

As the construction approaches the lower reaches and the west levee of the CCSB, the potential for water in the excavation increases, particularly if the CCSB is full later in the rainy season.

As all downstream improvements to the North Canal will likely be triggered by the Woodland Park development, all excavated material from these downstream reaches of the North Canal is assumed usable as fill in the Woodland Park Specific Plan Area, and will be needed to raise foundation elevations above the maximum ultimate 100-year flooded water surfaces. There are no known major utility crossings. The channel alignment will cross under County Road 102 and will include the construction of a bridge (discussed in more detail in its own section below). The County Road 102 crossing will be constructed as an open excavation, with a temporary bypass roadway for continuous two-lane traffic around the site during installation.

A portion of the downstream North Canal will be lined with concrete and may be subjected to uplifting pressures if groundwater levels come up during the winter. Therefore, such concrete will be constructed with back drainage to relieve pressures. The concrete is assumed as cast-in-place for the concrete lining as well as the floodwall protecting the land within the EMAD.

Beamer/Kentucky Channel

This facility is an integral part of development within the Woodland Park Specific Plan, providing gravity flood control conveyance and storm water quality treatment. Surface water runoff entering the upstream end of the existing channel (at Beamer Street) and further downstream at Kentucky Avenue will have to be captured and routed around the construction site. It is anticipated that the majority will not require dewatering efforts once the upstream surface water is prevented from entering the areas to be excavated.

The new channel alignment is roughly parallel to existing facilities though it is much wider. Some of the excavation is in areas where much of the capacity is already excavated because of the existing channel and the existing Beamer/Kentucky Ponds on the City's property. Much of the site is dry in the summer time as the Beamer/Kentucky Ponds are fully drained to the existing NCPS. The ultimate right bank containment of the overall channel conveyance is not in place, but will be constructed as fill. It is assumed that the Beamer/Kentucky Channel will be constructed simultaneous with development in Woodland Park, so lack of containment should not become an issue.

Part of the Beamer/Kentucky Channel construction will include a new crossing under County Road 102. This County Road 102 crossing will be constructed as an open excavation with a temporary bypass roadway for continuous two-lane traffic around the construction site during installation.

North Canal Bridge and RD 2035 Facilities Relocation

The Outfall Headworks consists of the construction of the North Canal Bridge and the RD 2035 Siphon Replacement together with channel excavation to connect the North Canal to gravity outflow to the upstream end of the improved Outfall Channel.

The bridge will be constructed on driven piles and will not require dewatering. The existing NCPS outlet piping must be demolished before the bridge construction can begin as the pipes conflict with the proposed pile supports. The bridge deck and abutments should be constructed with the existing ground as a foundation, with the channel excavated afterwards. The RD 2035 siphon will be constructed several feet lower than the invert of the proposed channel and could potentially be under groundwater influences. The excavation can be open cut but could require sheet pile walls on either side of the trench to isolate and dewater to stabilize the soil foundation conditions. Any groundwater removed from the trench is anticipated to have electrical conductivity problems

North Area Storm Drain Network Improvements (Backbone)

All of the storm drainage pipelines, manholes and drainage inlets that must be constructed within the North Area to drain development to storm water quality treatment facilities and ultimately to flood control conveyance is anticipated to be above the groundwater table. Conflicts with utility crossings are expected to be minimal as the majority of the network improvements are pipelines for developing previously undeveloped areas. Any such utilities issues will be determined during final design. Grading of excess material should be easily incorporated into roadway and site grading for new development with no hauling or dumping required.

2. *South Area Facilities*

South Canal Pump Station Replacement/Upgrade

The South Canal Pump Station will include significant excavation for the pump sump structure as well as the outlet pipe connecting to the Yolo Bypass. The site will likely require some dewatering that is a mixture of surface water from the South Canal as well as groundwater. The concrete structure of the pump station itself has very few conflicts with existing utilities, as the sump will be sited over the existing South Canal. The pump station outlet piping will have to cross several existing utilities alignments. Immediately adjacent to the South Canal Pump Station structure is the RD 2035 Highline Ditch, which will be in operation during the construction season. The capacity of the Highline Ditch will have to be rerouted during the outlet pipe construction to allow the RD 2035 flow to be unimpeded during the project installation. Once the RD 2035 facility is crossed the outlet pipe will cross beneath an SBC Telephone conduit on the south side of County Road 22, then County Road 22 itself, then a 48-inch City Sewer Main (which carries effluent from the City's Wastewater Treatment Plant), then a MCI fiber optic cable, and finally the Sierra Railroad (formerly Yolo Shortline) and South Levee. Open excavation is contemplated for the entire alignment except the railroad/levee portion. This downstream portion will be bored and jacked beneath the railroad with an open excavation and dewatering wells (if necessary) in the Outfall Channel itself. The surface water flow (low-flow during construction) in the Outfall Channel should be blocked by placement of sandbags and plastic to prevent this water from entering the excavation for the outlet structure.

West Regional Detention Facility

The detention storage in the West Regional Detention pond is all flood control storage with no storm water quality treatment, but routed down to treatment capacity in the existing East Regional Detention Pond. The West Regional Pond is primarily excavation above the groundwater table. The outlet for the pond will have to be constructed to control (throttle) the outflow to not exceed the existing conditions peak flow under Highway 113. There are no known conflicts with utilities in the location selected. The spoiling of excess material should be local, as the construction of the West Pond is being driven by development to the west of Highway 113 in the South Urban Growth Area and will be constructed just prior to or concurrent with grading for development.

Southwest Interceptor w/ Sediment Basin

The channel and sediment basin associated with this facility will be primarily excavation above the groundwater table. Spoil of the excess material is assumed to be placed in areas within the South Urban Growth Area, as construction of the Southwest Interceptor will only occur when the development downstream is approved and the Farmer's Central Trunk is slated for installation.

Gibson Canal Crossing

This structure is required to mitigate increases in flood stage in the Gibson Canal resulting from build out of the South Urban Growth Area and the maximum outflow from the Outlet Channel is realized.

The existing crossing will have to be removed, with the provision for a temporary crossing to provide access to the existing wastewater treatment pond cells north of the Gibson Canal during construction. The replacement crossing will be larger than the existing crossing and will have to accommodate relocation of an existing water main crossing the canal. Construction is anticipated to be above summer groundwater levels, with dewatering the site involving primarily blockage of upstream surface water flow and temporary rerouting around the site.

Extension of Interceptor/Conveyance Facility

Cost estimates for this facility are taken from the report entitled, "Preliminary Engineering Report, South Urban Growth Area, Regional Storm Drainage Facilities (SLSPA – Phase 1)," prepared by Wood Rodgers with construction constraints described accordingly.

Extension of Inlet Channel

Cost estimates for this facility are taken from the report entitled, "Preliminary Engineering Report, South Urban Growth Area, Regional Storm Drainage Facilities (SLSPA – Phase 1)," prepared by Wood Rodgers with construction constraints described accordingly.

South Area Storm Drain Network Improvements (Backbone)

All of the storm drainage pipelines, manholes and drainage inlets that must be constructed within the South Area to drain development to storm water quality treatment facilities and ultimately to flood control conveyance is anticipated to be above the groundwater table. Conflicts with utility crossings are expected to be minimal as the majority of the network improvements are pipelines for developing previously undeveloped areas. Any such utilities issues will be determined during final design. Grading of excess material should be easily incorporated into roadway and site grading for new development with no hauling or dumping required.

3. Common Facilities

Outfall Channel Improvements

The improvements for the Outfall Channel cannot realistically be phased in but should be constructed at one time. When the channel improvements are triggered, the construction of the ultimate channel prism should be imminent, as the channel improvements can be left for the last phase of construction. Notwithstanding, the duplication of costs and environmental impacts makes phasing this element unrealistic.

With the construction of the Outfall Channel Improvements could come significant dewatering efforts depending upon how wet the year is, and whether the CCSB takes a long time to drain. We estimated from the groundwater encountered in the borings by Kleinfelder, in the adjacent South Levee, that the groundwater will likely be below the proposed invert of the future channel during the construction season. There is low-flow present along the invert of the Outfall Channel during most of the year, assumedly due to nuisance watering in the City system since the invert of the Outfall Channel is well above the encountered groundwater level in the geotechnical borings.

Dewatering should involve collecting and pumping upstream nuisance (surface) water from the North Canal, South Canal, and EMAD Pump Station, as well as an existing 36-inch gravity storm drain that carries runoff from a portion of Main Street around the EMAD Pump Station and directly to the Outfall Channel. A cofferdam should be constructed to block upstream nuisance water and reroute (pump) this water around the excavation. Once all surface water is cut off, the channel should dry up. There is also an existing overflow connection to the Outfall Channel from the RD 2035 pipe connecting the CCSB and the RD 2035 Highline Ditch that must be coordinated as "shut off" during the construction.

All of the upstream drainage can potentially be captured and pumped into the CCSB during the summer months. This water will then end up in the same place in the Yolo Bypass as it would through the outfall channel; it simply gets there via a different route. Similarly, the downstream end of the Outfall Channel should be outfitted with a cofferdam to drain the surface water remaining in the Outfall Channel into the Yolo Bypass while maintaining the Cache Creek low-flow entering the RD 2035 irrigation system along the west edge of the Yolo Bypass, while not backing up into the new excavation.

No anticipated problems are foreseeable for using the spoiled earth from the excavation as fill once it is dewatered. Encountered flora and fauna for this area are described in the reports in Appendix B.

Outfall Channel Outlet Bridge

This structure is proposed as a spanning bridge structure, supported only by the abutments. The crossing currently exists as a levee, which can be used as the foundation for forming the spanning portion of the structure during the construction. The abutments should be constructible as well, while maintaining the existing culvert drainage at the base of the levee. Once the structure is in place, the earth channel beneath the spanning portion of the structure can be constructed. Dewatering beneath the new bridge can be accomplished by cofferdam construction with either sheet piles or sand bags on both ends of the excavation and pumping of the accumulated surface water out of and around the proposed excavation. In the case of this particular construction site, the dewatering may be simplified if the existing flood control gates and berms can be used to isolate the construction area. The area should dry out in a 2-3 week period of warmer temperatures enough to allow excavation equipment to unearth the proposed conveyance channel beneath the bridge and to construct stone protection on the slopes.

South Levee Certification – No construction is contemplated for this task. This will be based upon the geotechnical work that Kleinfelder performed (Appendix A) and will require consultant time and reporting to certify the South Levee for meeting levee certification requirements of the USACOE and the Federal Emergency Management Agency (FEMA).

Yolo Bypass Improvements

The improvements in the Yolo Bypass are immediately downstream of the outlet bridge and should be constructed at the same time as the outlet bridge as the trigger for the outlet bridge will increase outflow from the outfall channel and require the Yolo Bypass be improved to appropriately mitigate. During the construction, the existing gates and berms can be used to help isolate a portion of the construction site from nuisance surface water, namely the short diverting wall structure that is proposed to steer flow north and into the existing overflow path across the Bypass. Once the wall is constructed, further excavation will be required to "daylight" the City's outflow toward the existing cross conveyances. The existing berm and gate structure can be retained as the seasonal cut-off structure, with the City's channel connection coming around the upstream end of this gate from the west. Additional isolation of surface water with sand bags or sheet piles will be required to isolate the excavation of this channel connection section.

B. Land Acquisition

The City of Woodland currently owns several properties inside and outside of the current City Limit. Some of these properties are where planned drainage facilities are slated for improvement or new installation. This section details the extent of land acquisition requirements for each of the planned facilities.

For land within the City a unit cost of $40,000/acre was used.

For land outside of the City a unit cost of $15,000/acre was used.

The acreages have been estimated for each of the footprints of the facilities. There may be overlap of land that is already under the control of the City, owned or in easement, but in some cases it is difficult to discern where the new facilities are in relation to older easements. Where detail is clear, such as the Volkl Pond site, for example, we were able to estimate the need for additional land. Detailed surveys will be required during design to more exactly identify the extent of existing land ownership and easements under the control of the City.

The land acquisition estimates for each main facility and the associated cost for each are presented on the cost tables (see "Tables" section). Pipelines in public roadways associated with new development were not assigned land acquisition costs. This gage can be used to adjust the maintenance of each basin according to the actual sediment load being deposited. The City should explore, with each landowner, whether the sediment can be spread out over the adjacent field to recycle the topsoil back to where it came from. Wood Rodgers assumes that the adjacent landowners will agree to his situation. If the soil must be hauled away, then it could prove costly to maintain the sediment basins operation.

C. Operations and Maintenance (O&M)

The City is responsible for performing all activities associated with the O&M of storm drainage facilities within the City. This Master Plan Update outlines the future required facilities to mitigate the worst-case 100-year storm conditions affecting the City as development within the urban growth areas develop. City staff currently operating and maintaining facilities should be aware of such future requirements as well as the limitations of the existing systems, the intended use of each facility, and the interaction of upstream land outside of the City and their affect on City systems. This section is intended to give an overview of the future drainage facilities and the types of O&M activities to be expected to service the City's drainage infrastructure in the future. Wood Rodgers' efforts in this Master Plan Update does not include a comprehensive evaluation of the City's entire existing O&M department including staff, payroll, equipment, and other budget details. Wood Rodgers' efforts focused on the types of facilities being proposed and the associated character and frequency of monitoring, cleaning, and/or repairing activities associated with such facilities. Wood Rodgers recommends that the City develop an O&M Plan that evaluates manpower, budget, equipment, funding, etc., assessing the current and future needs of the City and the City's ability to meet those needs.

1. General

The existing drainage system is comprised primarily of storm drains (with inlets and manholes included), open channels, bridges/box culverts, detention basins, and pump stations. The future system will include additional facilities of the same types, with the introduction of additional (different) types of facilities as well the removal of key existing facilities.

In general, existing detention basins and open channels within the City have certain O&M criteria; however, newer facilities may be designed differently which may affect how newer facilities are operated in the future. For instance, most detention ponds being proposed under the updated plan have a combined water quality treatment component which will affect the vegetation and cleaning of the facility. All recommendations for cleaning and maintenance are from an engineering perspective only. If a detention pond also serves a recreational area or park area, then there may be cleaning, repair, landscaping, etc., that will be required to maintain such a dual use.

2. Maintenance Required According to Facility Type

Open Channels

Most proposed open channels in this Master Plan Update reflect a higher roughness coefficient that allows for "natural channel" vegetation to establish and thrive without needing to be removed. An n-value of 0.07 was established by the City for designing all channels shown on Map 14 labeled as "Proposed Channels" or "Improved Existing Channels" with the exception of a portion of the North Canal that must be constructed as a concrete-lined channel, as well as the Outlet Channel connecting the East Regional Detention Pond to the Gibson Canal. Generally, exceptions were made where site constraints warranted a narrower channel width. The channel connecting the sediment basins along County Road 98 will also need to be treated differently. Specific roughness coefficients for each reach of channel are described under the Section VI. of this Master Plan Update.

Where roughness is described as 0.07 ("natural channel") the vegetation can be allowed to grow without mowing or spraying. There will need to be periodic inspection on an annual basis, with some select removal of larger plant species every 2-5 years. Trees and large choking shrubs cannot be allowed to establish into mature obstructions. Once some species are allowed to grow larger than a certain size it may trigger permit approval of the California Department of Fish and Game to have them removed. It is important to note that if vegetation is allowed to grow in a voluntary manner, it may take many years for conditions to establish where vegetation removal is warranted.

For reaches where there is a concrete lining, along the channel bottom or the side walls, the accumulation of sediment, debris, and/or vegetation should be inspected annually and removed annually, or after a very large storm event. It is difficult to predict what the debris and sediment loading in the downstream channels will be once the City is fully developed. Wood Rodgers assumes that much of the sediment in the system now is attributable to the exposed earth within the Woodland Park Specific Plan Area. Once this area is developed with pavement and landscaping, the sediment loads should decrease. With additional development there may be a higher risk of debris entering the channel from errant operation and disposal of palettes or other distribution materials. The introduction of dumped material may go down, however, if private property fencing and security are present compared to the un-patrolled open land that is currently present.

The open channels that connect the sediment basins proposed as part of the Northwest Interceptor can be allowed to vegetate to 0.07 n-value levels; however, there may be areas where the channel accumulates sediment that will require removal as explained under the sediment basin section.

Pump Stations

The City currently operates several pump stations, with the majority of the existing pumping capacity located where the South Canal, North Canal, and East Main drainage system come together before discharging into the Outfall Channel. The existing NCPS is scheduled for removal and so the O&M responsibility for it will no longer be required. It is Wood Rodgers' opinion that the new South Canal Pump Station will have O&M efforts roughly equivalent to the combined activity now expended by the City for both separate existing facilities (North Canal and South Canal). The types of O&M activities will be very similar to those already experienced. The motors proposed for the pump station will be electric-driven with automatic turn-on and turn-off and cycling programmed into a Programmable Logic Control (PLC).

The existing EMAD Pump Station will remain unimproved (equipment), although the water entering this pump station from the North Canal and South Canal will be eliminated and runoff from the EMAD area will be limited to drainage only under ultimate conditions.

Detention Basins

Detention storage facilities are located throughout the City. The regional detention basins that are proposed as part of this Master Plan Update are shown on Map 14, including the East Regional Detention Pond, the West Regional Detention Pond, and the Volkl Pond. The East Regional Detention Pond will operate as a storm water quality basin during lower flow conditions. The bottom of the basin will likely be wet most of the year with some vegetation growing around the edges. It is important to note that excessive vegetation cannot be allowed to thrive along the entire bottom of the basin. Over time, the organic load would accumulate and would slowly deplete the storage volume. Where the water quality treatment feature is located, the western portion of the East Regional Pond site will act as a passive recreation area and so will have O&M that is required separate from flood control maintenance, presumably funded through Parks and Recreation. All inlet and outlet structures to the pond should be maintained as clean (unobstructed) as possible to ensure the water flows into the pond without overly backing up within the pond or upstream. Inspection should be performed annually as a minimum, with spot inspection after larger events, with cleaning as required.

For detention ponds that do not have water quality treatment features the O&M of the pond bottom and inlet/outlet structures is the same.

Storm Water Quality Basins

The only basins that are dedicated for storm water quality treatment only are located along the Beamer/Kentucky channel corridor through the Woodland Park Specific Plan Area. These basins should receive low flow from the Woodland Park developments and temporarily slow down and filter runoff before being discharged to the adjacent flood control channel.

Storm Drains

The City is expected to have satisfactory procedures in place for inspection and maintenance of storm drains, therefore no further direction or recommendation is warranted by Wood Rodgers under this Master Plan Update other than the provision of estimates of future storm drain lengths under ultimate build-out conditions. Even so, such estimates should only be used as guides for future O&M responsibilities, since development generally is finally constructed in different configurations than originally planned.

Control Gates

There are a several locations where the design intention is to have a slide gate or sluice gate for shut-off during maintenance. Gates that are left normally open during the flood season should be inspected and periodically exercised biannually to ensure their reliable operation.

Activities by Others

As described in Section V. of this Master Plan Update, there are several areas outside of the City Limits that affect runoff reaching City facilities. It is very important for the City and the O&M staff to be vigilant in monitoring the activities of landowners or other jurisdictions' activities within the watershed areas shown on Map 4 and the flooded areas shown on Map 13 of this Master Plan Update. The activities outside of the City are outside of its jurisdiction, however, some activities could increase or redirect runoff, sediment, and/or debris to the detriment of the City, potentially increasing maintenance and cleaning if these activities by others are allowed to proceed unchallenged.

Another issue relating to the activities of others is the future operation of the CCSB, its outlet, and the proposed control structure outlined in Section VI. under the Outfall Channel-Yolo Bypass Transition facility. The structure, which will shut off water during the winter season from flowing southward, steering runoff across the Yolo Bypass, will have to be coordinated between RD 2035 and the City. The time of year that this gate is closed will need to be agreed upon including who will be allowed to open and close the gate. The City should make every effort to ensure that its runoff is directed away from the railroad trestle during winter storm conditions.

Northwest Interceptor Channel

The Northwest Interceptor channel will likely accumulate some sediment over time as well. Therefore, Wood Rodgers recommends the placement of periodic channel gages to monitor channel deposition. Simple plastic slats with labels are not preferable as they are more easily ripped out or damaged by flooding or vandals. There is not likely going to be deposition immediately downstream of a sediment basin, so the channel gages should be placed further downstream. The inverts at the outlet of the pipes leaving each basin should provide enough of a gage at this type of location. The channel monitoring could be done with the construction of a concrete slab placed at the design invert. This will create little obstruction but will require someone to enter the channel to probe the deposited soil depth on top of the slab. Instead a short section of 12-inch (or 18-inch) pipe could be placed (with concrete foundation) along the centerline of the channel, and prove to be an easier visual gage as deposition can more easily be estimated in relation to the visible crown, without having to enter the channel.

D. Cost Allocation

With respect to the allocation of costs for the facilities presented in this Master Plan Update, Wood Rodgers prepared a Cost Allocation Report for the City in January 2006. The methodology and assumptions for allocating costs according to various land uses are presented therein.

X. IMPLEMENTATION PROGRAM

A. General

The storm drainage facilities described in this report and presented on Map 14 are largely for mitigating impacts to drainage to accommodate ultimate build out of the General Plan area for the City. Certain features, however, such as the facilities in the west and southwest part of the City are designed to mitigate the impacts of storm drainage from agricultural land. Each facility has its own unique positive impact to the system and therefore can be quantified; however, different combinations of drainage facilities can achieve similar mitigation, depending upon where development occurs. Development will occur over an extended time, thus phasing considerations and implementation strategies should be considered as part of the planning process. Feasibility is ultimately tied to funding and the ability for a system to be constructed in phases to mitigate potential impacts from development as it progresses.

Much of the drainage infrastructure being proposed as part of this Master Plan Update will require compliance with environmental and regulatory permitting prior to construction.

B. Drainage Facilities Phasing Predictions

A condition of the City's prior to approving new development is that storm drainage facilities shall be constructed in advance to ensure that adverse impacts to storm drainage and flooding are mitigated. Many of the facilities that are defined in the Master Plan Update benefit specific areas of development; however, many of the downstream facilities may be triggered differently, depending upon where the development occurs within the City. Downstream facilities refer to the SCPS and proposed improvements associated with the Outfall Channel.

Phasing scenarios have been developed by the City and the development community for both the SLSPA and the Woodland Park Specific Plan Area. With this information Wood Rodgers identified the facilities that are required to accommodate development that will likely proceed in the next five years for the north and south areas of the City. This focuses entirely upon development within the urban growth areas and not "in-fill development."

The phasing analysis that Wood Rodgers performed for the North Urban Growth Area and the South Urban Growth Area provides a basis for understanding what phases of development will "trigger" downstream improvements. Upstream improvements are generally tied to development as it occurs. Map 17 shows the anticipated development phasing within the North Urban Growth Area and the South Urban Growth Area, respectively.

1. North Area Phasing

   Development within the North Area, especially within the Woodland Park Specific Plan Area, is significantly impacted by the potential for flooding from Cache Creek. While Cache Creek does not flood Woodland under smaller more frequent storm events, when the Cache Creek watershed experiences a larger storm event, the potential for flooding the north and east parts of the City and Urban Growth Area does exist. The current overflow is shown to flow through the northern portions of the City and much of the Woodland Park Specific Plan Area.

   The City has, in conjunction with the USACOE, investigated alternatives for mitigating the potential flooding from Cache Creek. Currently the City, as a member of the Water Resources Association of Yolo County, is working on an Integrated Regional Water Management Plan (IRWMP) that will give consideration to other potential mitigation measures through a locally sponsored public outreach program. A solution to this problem will require several years, thus, in the short term the North Area is left with the prospect of limiting development and mitigating its local flooding impacts while not adversely affecting the Cache Creek overflow floodplain. In other words, facilities constructed for containing local flood waters cannot create obstruction to the overland flow of the Cache Creek overflow floodplain. The phasing of facilities often requires some interim facilities to be constructed to "fill the gaps," however, such facilities are generally considered "throw-away" costs and are not generally reflected in the overall fee structure developed by the City to pay for the ultimate facilities configuration.

   The development phasing for the North Area shown on Map 17 requires the construction of interim and ultimate facilities. The master plan facilities are shown on Map 18 through Map 20. Interim facilities are not shown as these are regarded as "throw-away" costs.

2. South Area Phasing

   For the City's South Area, the Cache Creek floodplain is less problematic because it does not actually flow through the Urban Growth Area; however, it still creates constraints to local floodplain solutions. The East Regional Detention Pond, a significant feature in this Master Plan Update, was constructed in 2004. It was critical that the facilities contained no "aboveground" obstruction that would adversely impact the Cache Creek floodplain. The flood detention storage that was constructed below ground allows for the construction of early development within the South Area without adverse impact to the South Canal and downstream systems.

   In general, additional runoff from development eventually requires improving downstream facilities. The implementation of downstream facilities could be postponed with the early construction of the East Regional Detention Pond.

Phasing of the South Area was evaluated under a separate Technical Memorandum dated July 22, 2005. The phasing shown on Map 17 was evaluated and the conceptual facilities layout of the permanent facilities is shown on Map 18 through Map 21, for the respective phases.

3. Existing Development

Wood Rodgers has identified several facilities that are designed to greatly reduce or eliminate sediment and storm drainage from agricultural land from entering areas within the City. Such facilities have been identified in the Cost Allocation Report prepared by Wood Rodgers dated January 2006.

C. Implementation Schedule

Presented on Figure 19 is the year or time that the respective storm drainage facilities are anticipated to be completed. For those facilities noted to be completed through 2010, it is expected that the facilities would be operational by November of that year. As indicated on the Implementation Schedule on Figure 19, certain facilities serving the South Urban Growth Area have already been constructed.

In scheduling for implementation of the facilities to serve the respective phases, construction should be planned to require two construction seasons. Generally, May 1 of the first season through October 31 of the second season. A period of nine to 12 months should be provided for preparing the construction plans and specifications. A minimum of six weeks should be allowed for bidding and contract award.

D. Environmental Compliance and Regulatory Permitting

Accompanying any planning process for the construction of drainage facilities includes environmental analysis and compliance reporting.

It is anticipated that a Programmatic Environmental Impact Report (Programmatic EIR) would be prepared for the Master Plan Update. While the Master Plan Update is merely a plan and is not an action-oriented program. It essentially lays the ground work for projects that may be implemented in the future to mitigate adverse impacts from development. Depending upon when the Programmatic EIR is performed, it may be appropriate or necessary to perform a project-specific EIR to meet desired construction schedules. The time for preparing the Programmatic EIR may be in the order of one year.

Compliance with the California Environmental Quality Act and the National Environmental Protection Act may be required in view of the work plan on and in the vicinity of the Federal Sacramento River Flood Control Projects, such as the CCSB, the

Outfall Channel South Levee, and the Yolo Bypass. To the extent Endangered Species Act consultation may be involved, additional time may be required.

E. FEMA Coordination

The City currently participates in the National Flood Insurance Program (NFIP) and acts as the floodplain administrator for flooding issues within its city limits. A large portion of the City is now mapped under an overflow condition from Cache Creek, which this Master Plan Update purposely does not address, given the magnitude of the problem and the corresponding magnitude of the solution.

Many of the southern areas in the future City urban growth limits are not influenced by Cache Creek but have their own local floodplain problems. Many of the areas are undeveloped and can be best characterized as flooding behind roadways, where the flood water ponds behind raised roadway profiles and overflows during large storm events. Many of these areas are not currently shown on the FEMA Flood Insurance Rate Maps (FIRMs).

Although local flooding within and surrounding the City was mapped, it was not intended to be submitted to FEMA but used as the "best available" information in administering the NFIP. Many of the mapped areas would not be mapped on a FIRM with elevations as there often was not sufficient information to fully meet FEMA criteria for accuracy, and so these areas would likely be mapped as Approximate Zone A. Getting these areas represented on a FEMA map would establish the existence of these floodplain areas and could provide the City with a basis for taking action to prevent changes to these floodplains by local ordinance or oversight.

Tables

TABLE 1

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE
AND PRELIMIANRY ENGINEERING

SUMMARY OF OPINION OF PROBABLE COSTS

	Facilities With Public Land Contribution	Total, $
	NORTH AREA	
1.	Northwest Interceptor with Sediment Basins (A to B)	$7,157,165
2.	Volkl Pond Improvements	$2,374,607
3.	Volkl Trunk Facilities	$2,765,427
4.	Kentucky Trunk Diversions to Volkl	$737,550
5.	Volkl Outlet (B to C)	$3,488,585
6.	North Canal Improvements (C to D)	$3,575,775
7.	North Canal Improvements (D to E)	$3,898,576
8.	Beamer/Kentucky Channel	$4,819,295
9.	North Canal Bridge & RD2035 Facilities Relocation	$709,500
10.	North Area Storm Drain Network Improvements	
	a. Volkl Trunk	$3,527,865
	b. Beamer/Kentucky Trunk	$11,375,752
11.	North Area Fill	$12,116,066
	Subtotal	$56,546,163
	SOUTH AREA	
12.	South Canal Pump Station	$5,622,374
13.	Farmer's Central Trunk (West Hwy 113)	$1,686,465
14.	West Regional Detention Pond	$2,350,246
15.	Farmer's Central Trunk (East of Hwy 113)[1]	$2,394,975
16.	Southwest Interceptor	$264,000
17.	Gibson Trunk Crossing	$429,000
18.	Interstate 5 Crossing Capacity Increase	$1,650
19.	Extension of Interceptor/Conveyance Facility	$1,887,600
20	Extension of Inlet Channel	$1,544,400
21.	South Area Facilities - Constructed (Phase 1)	
	a. South Interceptor/Conveyance	$2,777,156
	b. Inlet Channel	$654,779
	c. East Regional Detention Pond	$10,528,835
	d. Outlet Channel	$1,432,639
	e. Farmer's Central Culvert	$684,979
	f. County Road 102 Culvert	$344,211
	g. Parkway Trunk Culvert	$559,343
22.	South Area Storm Drain Network Improvements	
	a. Farmer's Central Trunk (West)	$1,304,325
	b. Farmer's Central Trunk (East)	$2,821,500
	c. Parkway Trunk	$3,432,083
	d. County Road 25A Trunk	$4,561,425
	e. County Road 102 Trunk	$656,700
	f. Zone S4B Trunk	$843,563
	Subtotal	$46,782,248
	COMMON FACILITIES	
23.	Outfall Channel Improvements	$5,145,937
24.	Outfall Bridge and Yolo Bypass Improvements	$1,324,676
	OTHER PROJECTS	
25.	SD5 - Upgrade Kentucky Avenue Ditch	$262,812
26.	SD11 - Enclose Open Channel from Commerce to I-5	$412,650
27.	SD13 - Tanforan Avenue Trunk Line	$1,150,090
28.	SD21 - Enclose Open Channels N. & E. Kentucky Avenue 1-5 Overpass	$531,165
29.	SD27 - Update Master Plan	$975,000
30.	SD28 - Cache Creek Levee Improvements	$8,000,000
31.	SD102 - Pump Station Flood Protection - Phase 1 (Design)	$20,000
32.	SD105 - Annual Storm Drainage System Maintenance Repair & Upgrade	$1,400,000
33.	SD114 - Storm Drainage System Maintenance, Testing & Inspection	$2,275,000
34.	SD116 - SCADA for Storm Drain Pump Stations	$70,000
35.	SD117/957 - Flood Protection Feasibility Study - Phase 2	$1,000,000
TOTAL COSTS		$125,895,741

[1]Provided by Cunningham Engineering.

TABLE 2

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
NORTHWEST INTERCEPTOR

OPINION OF PROBABLE COST

Item			Quantity	Unit	Unit Cost, $[1]	Cost, $
1.	Northwest Interceptor					
	a.	Channel and Sediment Basin Excavation (no Haul & Dump included)	389,412	cy	4.47	1,740,672
	b.	Place and Shape Fill	447,824	cy	2.35	1,052,386
	c.	Sediment Basin Outlet	5	ea	1,500.00	7,500
	d.	Dewatering	1	ls	30,000.00	30,000
	e.	Aggregate Surface - Access Road Along Channel	25,083	sy	3.38	84,782
	f.	Bore & Jack Under Railroad	100	lf	350.00	35,000
	g.	Box Culverts at Multiple Locations - Reinforced Concrete	1,066	cy	462.36	492,876
	h.	Traffic Control - Temporary Road Bypass	3	ls	50,000.00	150,000
	i.	Mobilization and Demobilization (1% Construction)	1	ls	172,161.00	172,161
	Subtotal					3,765,376
Construction Contingency @ 25%						941,344
Preliminary Engineering @ 5%						188,269
Engineering/Design @ 15%						564,806
Construction Management and Inspection @ 10%						376,538
Administration @ 5%						188,269
Project Management @ 5%						188,269
Total (Construction Costs Only)						6,212,870
Land Acquisition						
	a.	Northwest Interceptor	57.2	ac	15,000	858,450
	b.	Habitat Mitigation (Estimate)	57.2	ac	1,500	85,845
	Subtotal					944,295
TOTAL						7,157,165

[1]Unit costs are based upon 2003 price levels.

Wood Rodgers, Inc.
February 2006

TABLE 3

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
VOLKL POND IMPROVEMENTS

OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost, $[1]	Cost, $
1. Volkl Pond Improvements				
a. Pond Excavation (no Haul & Dump included)	65,822	cy	4.47	294,224
b. Haul & Dump to Landfill	75,695	cy	6.00	454,172
c. Dewatering	1	ls	100,000.00	100,000
d. Pipe Connection to Outlet Structure	64	lf	260.00	16,640
e. Miscellaneous Reinforced Concrete	40	lf	462.36	18,494
f. Stone Protection	129	tons	28.18	3,635
g. Mobilization and Demobilization (1% Construction)	1	ls	42,420.00	42,420
Subtotal				929,586
Construction Contingency @ 25%				232,396
Preliminary Engineering @ 5%				46,479
Engineering/Design @ 15%				139,438
Construction Management and Inspection @ 10%				92,959
Administration @ 5%				46,479
Project Management @ 5%				46,479
Total (Construction Costs Only)				1,533,817
Land Acquisition				
a. Volkl Pond	20.3	ac	40,000	810,400
b. Habitat Mitigation (Estimate)	20.3	ac	1,500	30,390
Subtotal				840,790
TOTAL				2,374,607

[1]Unit costs are based upon 2003 price levels.

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February 2006

TABLE 4

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
VOLKL TRUNK CHANNEL

OPINION OF PROBABLE COST

Item			Quantity	Unit	Unit Cost, $[1]	Cost, $
1.	Volkl Trunk Channel					
	a.	Channel Excavation (no Haul & Dump included)	187,118	cy	4.47	836,417
	b.	Dewatering	1	ls	30,000.00	30,000
	c.	Railroad Crossing (66" RCP)	200	lf	215.00	43,000
	d.	Bore & Jack Under Railroad	200	lf	1,000.00	200,000
	e.	Culvert Outlet Structures at Multiple Locations - Reinforced Concrete	258	cy	462.36	119,289
	c.	Stone Protection	1,386	tons	28.18	39,057
	c.	Access Road	5,500	sy	3.38	18,590
	f.	Mobilization and Demobilization (1% Construction)	1	ls	61,435.00	61,435
	Subtotal					1,347,789
Construction Contingency @ 25%						336,947
Preliminary Engineering @ 5%						67,389
Engineering/Design @ 15%						202,168
Construction Management and Inspection @ 10%						134,779
Administration @ 5%						67,389
Project Management @ 5%						67,389
Total (Construction Costs Only)						2,223,852
Land Acquisition						
	a.	Volkl Trunk Channel	13.1	ac	40,000	522,000
	b.	Habitat Mitigation (Estimate)	13.1	ac	1,500	19,575
	Subtotal					541,575
TOTAL						2,765,427

[1]Unit costs are based upon 2003 price levels.

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February 2006

TABLE 5

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
KENTUCKY DIVERSIONS TO VOLKL

OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost, $[1]	Cost, $
1. Storm Drains - Kentucky Diversions to Volkl				
a. 30" Diameter RCP	0	lf	85.00	0
b. 33" Diameter RCP	0	lf	95.00	0
c. 36" Diameter RCP	0	lf	100.00	0
d. 39" Diameter RCP	0	lf	110.00	0
e. 42" Diameter RCP	0	lf	120.00	0
f. 48" Diameter RCP	1,000	lf	140.00	140,000
g. 54" Diameter RCP	0	lf	175.00	0
h. 60" Diameter RCP	0	lf	195.00	0
i. 66" Diameter RCP	0	lf	215.00	0
j. 72" Diameter RCP	1,000	lf	235.00	235,000
k. 78" Diameter RCP	0	lf	300.00	0
l. 84" Diameter RCP	0	lf	350.00	0
m. 90" Diameter RCP	0	lf	400.00	0
n. Manhole - large diameter	0	ls	10,000.00	0
o. Manhole - small diameter	9	ls	8,000.00	72,000
Construction Subtotal				447,000
Construction Contingency @ 25%				111,750
Preliminary Engineering @ 5%				22,350
Engineering/Design @ 15%				67,050
Construction Management and Inspection @ 10%				44,700
Administration @ 5%				22,350
Project Management @ 5%				22,350
Item Total				737,550
Land Acquisition				
a. ***Farmers Central Channel***	0.0	ac	40,000.00	0
Subtotal				0
TOTAL				737,550

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TABLE 6

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
VOLKL OUTLET

OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost, $[1]	Cost, $
1. Volkl Outlet				
a. Pipeline Excavation (no Haul & Dump included)	15,165	cy	4.47	67,788
b. Dewatering	1	ls	100,000.00	100,000
c. Outlet Pipe (84" RCP)	2,837	lf	350.00	992,950
d. Bore & Jack Under Interstate 5	400	lf	1,100.00	440,000
d. Bore & Jack Under Interstate 5	120	lf	1,100.00	132,000
d. Bore & Jack Under Interstate 5	120	lf	1,100.00	132,000
e. Culvert Transition Structures at Multiple Locations - Reinforced Concrete	159	cy	462.36	73,515
c. Structural Recompaction	15,165	cy	4.11	62,328
f. Mobilization and Demobilization (1% Construction)	1	ls	96,913.00	96,913
Subtotal				2,097,494
Construction Contingency @ 25%				524,373
Preliminary Engineering @ 5%				104,875
Engineering/Design @ 15%				314,624
Construction Management and Inspection @ 10%				209,749
Administration @ 5%				104,875
Project Management @ 5%				104,875
Total (Construction Costs Only)				3,460,865
Land Acquisition				
a. Volkl Outlet	1.7	ac	15,000	25,200
b. Habitat Mitigation (Estimate)	1.7	ac	1,500	2,520
Subtotal				27,720
TOTAL				3,488,585

[1]Unit costs are based upon 2003 price levels.

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TABLE 7

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
NORTH CANAL (C to D)

OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost, $[1]	Cost, $
1. North Canal (C to D)				
a. Channel Excavation (no Haul & Dump included)	169,605	cy	4.47	758,134
b. Place & Shape Fill	195,046	cy	2.35	458,358
c. Dewatering	1	ls	30,000.00	30,000
d. Aggregate Surface - Access Road Along Channel	16,667	sy	3.38	56,333
e. Box Culvert Crossings - Reinforced Concrete	670	cy	462.36	309,781
f. Traffic Control	2	ls	50,000.00	100,000
g. Mobilization and Demobilization (1% Construction)	1	ls	85,630.00	85,630
Subtotal				1,798,236
Construction Contingency @ 25%				449,559
Preliminary Engineering @ 5%				89,912
Engineering/Design @ 15%				269,735
Construction Management and Inspection @ 10%				179,824
Administration @ 5%				89,912
Project Management @ 5%				89,912
Total (Construction Costs Only)				2,967,090
Land Acquisition				
a. North Canal (C to D)	36.9	ac	15,000	553,350
b. Habitat Mitigation (Estimate)	36.9	ac	1,500	55,335
Subtotal				608,685
TOTAL				3,575,775

[1]Unit costs are based upon 2003 price levels.

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TABLE 8

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
NORTH CANAL (D to E)

OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost, $[1]	Cost, $
1. North Canal (D to E)				
a. Channel Excavation (no Haul & Dump included)	59,151	cy	4.47	264,405
b. Place & Shape Fill	68,024	cy	2.35	159,856
c. Dewatering	1	ls	100,000.00	100,000
d. Aggregate Surface - Access Road Along Channel	8,333	sy	3.38	28,167
e. Concrete Flume	1,480	cy	462.36	684,293
f. Floodwall	800	cy	462.36	369,888
g. Lined Channel	1,890	cy	200.00	378,000
h. Stone Protection	8,100	ton	28.18	228,258
i. Mobilization and Demobilization (1% Construction)	1	ls	99,230.00	99,230
Subtotal				2,312,096
Construction Contingency @ 25%				578,024
Preliminary Engineering @ 5%				115,605
Engineering/Design @ 15%				346,814
Construction Management and Inspection @ 10%				231,210
Administration @ 5%				115,605
Project Management @ 5%				115,605
Total (Construction Costs Only)				3,814,958
Land Acquisition				
a. North Canal (D to E)	1.6	ac	40,000	64,000
b. Habitat Mitigation (Estimate)	13.1	ac	1,500	19,618
Subtotal				83,618
TOTAL				3,898,576

[1]Unit costs are based upon 2003 price levels.

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TABLE 9

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
BEAMER/KENTUCKY CHANNEL

OPINION OF PROBABLE COST

Item			Quantity	Unit	Unit Cost, $[1]	Cost, $
1.	Beamer/Kentucky Channel					
	a.	Channel and WQ Pond Excavation (no Haul & Dump included)	253,156	cy	4.47	1,131,605
	b.	Dewatering	1	ls	100,000.00	100,000
	c.	Aggregate Surface - Access Road Along Channel	11,667	sy	3.38	39,433
	d.	Box Culvert Crossing Under County Road 102	1	ls	600,000.00	600,000
	e.	Traffic Control	1	ls	50,000.00	50,000
	f.	Mobilization and Demobilization (1% Construction)	1	ls	96,052.00	96,052
	Subtotal					2,017,091
Construction Contingency @ 25%						504,273
Preliminary Engineering @ 5%						100,855
Engineering/Design @ 15%						302,564
Construction Management and Inspection @ 10%						201,709
Administration @ 5%						100,855
Project Management @ 5%						100,855
Total (Construction Costs Only)						3,328,200
Land Acquisition						
	a.	Beamer/Kentucky Channel	35.9	ac	40,000	1,437,200
	b.	Habitat Mitigation (Estimate)	35.9	ac	1,500	53,895
	Subtotal					1,491,095
TOTAL						4,819,295

[1]Unit costs are based upon 2003 price levels.

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TABLE 10

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
RD 2035 SIPHON REPLACEMENT

OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost, $[1]	Cost, $
1. RD2035 Siphon Replacement				
a. Site Preparation	1	ac	1,118.90	1,119
b. Structural Excavation	1,500	cy	11.43	17,145
c. 78" RCP Pipeline	157	lf	300.00	47,100
d. Outfall Structure Concrete	70	cy	462.36	32,365
e. Miscellaneous Metals & Gates	1	ls	10,000.00	10,000
f. Pipe Bedding	100	cy	38.00	3,800
g. Structural Backfill	1,207	cy	4.11	4,961
h. Landscaping - Hydroseeding	1	ls	1,000.00	1,000
i. Stone Protection	150	cy	45.08	6,762
j. Mobilization and Demobilization (5% Construction)	1	ls	6,213.00	6,213
Subtotal				130,465
Construction Contingency @ 25%				32,616
Preliminary Engineering @ 5%				6,523
Engineering/Design @ 15%				19,570
Construction Management and Inspection @ 10%				13,047
Administration @ 5%				6,523
Project Management @ 5%				6,523
TOTAL				215,267

[1]Unit costs are based upon 2003 price levels.

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TABLE 11

CITY OF WOODLAND

STORM DRAINAGE FACILITIES MASTER PLAN

AND PRELIMINARY ENGINEERING

NORTH AREA STORM DRAIN NETWORK

OPINION OF PROBABLE COST

Item			Quantity	Unit	Unit Cost, $[1]	Cost, $
1.	Storm Drains - Volkl Trunk					
	a.	30" Diameter RCP	2,673	lf	85.00	227,205
	b.	33" Diameter RCP	0	lf	95.00	0
	c.	36" Diameter RCP	0	lf	100.00	0
	d.	39" Diameter RCP	0	lf	110.00	0
	e.	42" Diameter RCP	0	lf	120.00	0
	f.	48" Diameter RCP	1,315	lf	140.00	184,100
	g.	54" Diameter RCP	1,733	lf	175.00	303,275
	h.	60" Diameter RCP	0	lf	195.00	0
	i.	66" Diameter RCP	3,732	lf	215.00	802,380
	j.	72" Diameter RCP	1,724	lf	235.00	405,140
	k.	78" Diameter RCP	0	lf	300.00	0
	l.	84" Diameter RCP	0	lf	350.00	0
	m.	90" Diameter RCP	0	lf	400.00	0
	n.	Manhole - large diameter	4	ls	10,000.00	40,000
	o.	Manhole - small diameter	22	ls	8,000.00	176,000
	Construction Subtotal					2,138,100
Construction Contingency @ 25%						534,525
Preliminary Engineering @ 5%						106,905
Engineering/Design @ 15%						320,715
Construction Management and Inspection @ 10%						213,810
Administration @ 5%						106,905
Project Management @ 5%						106,905
	Item Total					3,527,865
2.	Storm Drains - Woodland Park Trunk					
	a.	30" Diameter RCP	0	lf	85.00	0
	b.	33" Diameter RCP	0	lf	95.00	0
	c.	36" Diameter RCP	0	lf	100.00	0
	d.	39" Diameter RCP	0	lf	110.00	0
	e.	42" Diameter RCP	0	lf	120.00	0
	f.	48" Diameter RCP	0	lf	140.00	0
	g.	54" Diameter RCP	3,244	lf	175.00	567,700
	h.	60" Diameter RCP	10,452	lf	195.00	2,038,140
	i.	66" Diameter RCP	8,693	lf	215.00	1,868,995
	j.	72" Diameter RCP	8,296	lf	235.00	1,949,560
	k.	78" Diameter RCP	0	lf	300.00	0
	l.	84" Diameter RCP	0	lf	350.00	0
	m.	90" Diameter RCP	0	lf	400.00	0
	n.	Manhole - large diameter	15	ls	10,000.00	150,000
	o.	Manhole - small diameter	40	ls	8,000.00	320,000
	Construction Subtotal					6,894,395

TABLE 11

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
NORTH AREA STORM DRAIN NETWORK

OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost, $[1]	Cost, $
Construction Contingency @ 25%				1,723,599
Preliminary Engineering @ 5%				344,720
Engineering/Design @ 15%				1,034,159
Construction Management and Inspection @ 10%				689,440
Administration @ 5%				344,720
Project Management @ 5%				344,720
Item Total				11,375,752
Land Acquisition				
a. ***Volkl Storm Drain Alignments***	0.0	ac	0.00	0
b. ***Woodland Park Storm Drain Alignments***	0.0	ac	0.00	0
Subtotal				0
TOTAL				14,903,617

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TABLE 12

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
NORTH AREA FLOODPLAIN FILL

OPINION OF PROBABLE COST

Item			Quantity	Unit	Unit Cost, $[1]	Cost, $
1.	North Area Fill Mitigation					
	a.	Site Preparation	410	ls	1,118.90	458,749
	b.	Purchase and Excavation (no Haul & Dump included)	377,939	cy	5.47	2,067,326
	c.	Haul and Dump to Woodland Park	434,630	cy	2.92	1,267,670
	d.	Excavation from City Pond Site to NW Woodland Park	75,000	cy	4.47	335,250
	e.	Place and Shape Fill (Hauled from offsite)	509,630	cy	2.35	1,197,630
	f.	Place and Shape Fill (from onsite)	531,532	cy	2.35	1,249,100
	g.	Dewatering (at fill source)	1	ls	500,000.00	500,000
	h.	Temporary Aggregate Surfacing	28,000	sy	3.38	94,640
	i.	Environmental Restoration	1	ls	100,000.00	100,000
	j.	Mobilization and Demobilization (1% Construction)	1	ls	72,704.00	72,704
	Subtotal					7,343,070
Construction Contingency @ 25%						1,835,768
Preliminary Engineering @ 5%						367,154
Engineering/Design @ 15%						1,101,461
Construction Management and Inspection @ 10%						734,307
Administration @ 5%						367,154
Project Management @ 5%						367,154
Total (Construction Costs Only)						12,116,066
Land Acquisition						
	a.	Woodland Park Area	0.0	ac	15,000	0
	b.	Habitat Mitigation (Estimate)	0.0	ac	1,500	0
	Subtotal					0
TOTAL						12,116,066

[1]Unit costs are based upon 2003 price levels.

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TABLE 13

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
SOUTH CANAL PUMP STATION

OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost, $[1]	Cost, $
1. South Canal Pump Station				
a. Site Preparation	1	ac	1,119	1,119
b. Concrete Structure/Pipe Demolition (Existing Structure)	1	ls	7,500	7,500
c. Structural Excavation	7,625	cy	11	87,154
d. Sheet Piling (along Main St. and High Line Ditch)	8,000	sf	22	176,000
e. Reinforced Concrete	1,110	cy	462	513,220
f. Pump (62.5 cfs) and Motor (125 hP)	5	ea	70,000	350,000
g. Low flow Pump and Motor (8 cfs)	1	ea	12,000	12,000
h. Backup Generator and Pad	1	ls	132,000	132,000
i. Electrical Building (12'x20' CMU)	1	ls	50,000	50,000
j. Switchboard MCC	1	ls	180,000	180,000
k. Underground Conduit and Cablework	1	ls	50,000	50,000
l. Control Panel	1	ls	30,000	30,000
m. Lighting Grounding Instruments, Misc	1	ls	18,000	18,000
n. PG&E Connection Fee**	1	ls	100,000	100,000
o. Dupron Flex Rake (Self Cleaning Trashrack)	2	ea	75,000	150,000
p. Miscellaneous Metals	1	ls	50,000	50,000
q. Flap Gates	5	ea	5,000	25,000
r. Temporary Traffic Control (Incl Barrier)	1	ls	25,000	25,000
s. Dewatering	1	ls	115,000	115,000
t. Aggregate Surface	1,889	sy	3	6,384
u. Landscaping	1	ls	5,000	5,000
v. Fencing	700	lf	15	10,500
w. Miscellaneous Utilities Relocations	1	ls	15,000	15,000
x. Mobilization and Demobilization	1	ls	105,444	105,444
Subtotal				2,214,321
2. Outlet Pipeline (connecting SC Pump Station to Outfall Channel)				
a. Site Preparation	2	ac	1,119	2,238
b. Boring and Jacking Carrier Pipe	360	lf	900	324,000
c. Railroad Fees and Coordination	1	ls	15,000	15,000
d. Structural Excavation	13,275	cy	11	151,733
e. 72" RCP Pipeline	1,180	lf	193	227,740
f. Outfall Structure Concrete	96	cy	462	44,387
g. Miscellaneous Metals & Gates	1	ls	25,000	25,000
h. Dewatering	1	ls	121,450	121,450
i. Pipe Bedding	1,200	cy	38	45,600
j. Structural Backfill	10,393	cy	4	42,716
k. Pavement Removal	200	sy	4	890
l. Temporary Pavement	1	ls	38,000	38,000
m. Road Base Material	200	sy	13	2,566
n. Pavement Replacement	41	ton	84	3,417
o. Traffic Control	1	ls	10,000	10,000
p. Landscaping - Hydroseeding	1	ls	3,000	3,000
q. Stone Protection	150	cy	45	6,762
r. Mobilization and Demobilization (5% Construction)	1	ls	53,225	53,225
Subtotal				1,117,724
SUBTOTAL CONSTRUCTION				3,332,044
Construction Contingency @ 25%				833,011
Preliminary Engineering @ 5%				166,602
Engineering/Design @ 15%				499,807
Construction Management and Inspection @ 10%				333,204
Administration @ 5%				166,602
Project Management @ 5%				166,602
Total (Construction Costs Only)				5,497,873
Land Acquisition				
a. South Canal Pump Station	3.0	ac	40,000	120,000
b. Habitat Mitigation (Estimate)	3.0	ac	1,500	4,500
Subtotal				124,500
TOTAL				5,622,373

[1]Unit costs are based upon 2003 price levels.
**Estimate must be verified after official PG&E application and determination

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TABLE 14

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
FARMERS CENTRAL TRUNK EAST

OPINION OF PROBABLE COST

Item		Quantity	Unit	Unit Cost, $[1]	Cost, $
1.	Storm Drains - Farmers Central Trunk East				
a.	30" Diameter RCP	0	lf	85.00	0
b.	33" Diameter RCP	0	lf	95.00	0
c.	36" Diameter RCP	0	lf	100.00	0
d.	39" Diameter RCP	0	lf	110.00	0
e.	42" Diameter RCP	0	lf	120.00	0
f.	48" Diameter RCP	0	lf	140.00	0
g.	54" Diameter RCP	0	lf	175.00	0
h.	60" Diameter RCP	1,700	lf	195.00	331,500
i.	66" Diameter RCP	0	lf	215.00	0
j.	72" Diameter RCP	1,300	lf	235.00	305,500
k.	78" Diameter RCP	0	lf	300.00	0
l.	84" Diameter RCP	0	lf	350.00	0
m.	90" Diameter RCP	0	lf	400.00	0
n.	Manhole - large diameter	0	ls	10,000.00	0
o.	Manhole - small diameter	9	ls	8,000.00	72,000
p.	Channel Construction	1	ls	742,500.00	742,500
	Construction Subtotal				1,451,500
Construction Contingency @ 25%					362,875
Preliminary Engineering @ 5%					72,575
Engineering/Design @ 15%					217,725
Construction Management and Inspection @ 10%					145,150
Administration @ 5%					72,575
Project Management @ 5%					72,575
	Item Total				2,394,975
Land Acquisition					
a.	***Farmers Central Channel***	0.0	ac	40,000.00	0
	Subtotal				0
TOTAL					2,394,975

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TABLE 15

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
SOUTH AREA STORM DRAIN NETWORK

OPINION OF PROBABLE COST

Item	Quantity	Unit	Unit Cost, $[1]	Cost, $
1. Storm Drains - Farmer's Central East				
a. 30" Diameter RCP	1,000	lf	85.00	85,000
b. 33" Diameter RCP	0	lf	95.00	0
c. 36" Diameter RCP	2,700	lf	100.00	270,000
d. 39" Diameter RCP	0	lf	110.00	0
e. 42" Diameter RCP	1,450	lf	120.00	174,000
f. 48" Diameter RCP	2,500	lf	140.00	350,000
g. 54" Diameter RCP	600	lf	175.00	105,000
h. 60" Diameter RCP	1,500	lf	195.00	292,500
i. 66" Diameter RCP	900	lf	215.00	193,500
j. 72" Diameter RCP	0	lf	235.00	0
k. 78" Diameter RCP	0	lf	300.00	0
l. 84" Diameter RCP	0	lf	350.00	0
m. 90" Diameter RCP	0	lf	400.00	0
n. Manhole - large diameter	0	ls	10,000.00	0
o. Manhole - small diameter	30	ls	8,000.00	240,000
Construction Subtotal				1,710,000
Construction Contingency @ 25%				427,500
Preliminary Engineering @ 5%				85,500
Engineering/Design @ 15%				256,500
Construction Management and Inspection @ 10%				171,000
Administration @ 5%				85,500
Project Management @ 5%				85,500
Item Total				2,821,500
2. Storm Drains - Parkway Trunk				
a. 30" Diameter RCP	480	lf	85.00	40,800
b. 33" Diameter RCP	0	lf	95.00	0
c. 36" Diameter RCP	2,475	lf	100.00	247,500
d. 39" Diameter RCP	0	lf	110.00	0
e. 42" Diameter RCP	1,475	lf	120.00	177,000
f. 48" Diameter RCP	750	lf	140.00	105,000
g. 54" Diameter RCP	300	lf	175.00	52,500
h. 60" Diameter RCP	400	lf	195.00	78,000
i. 66" Diameter RCP	5,150	lf	215.00	1,107,250
j. 72" Diameter RCP	0	lf	235.00	0
k. 78" Diameter RCP	0	lf	300.00	0
l. 84" Diameter RCP	0	lf	350.00	0
m. 90" Diameter RCP	0	lf	400.00	0
n. Manhole - large diameter	0	ls	10,000.00	0
o. Manhole - small diameter	34	ls	8,000.00	272,000
Construction Subtotal				2,080,050
Construction Contingency @ 25%				520,013
Preliminary Engineering @ 5%				104,003
Engineering/Design @ 15%				312,008
Construction Management and Inspection @ 10%				208,005
Administration @ 5%				104,003
Project Management @ 5%				104,003
Item Total				3,432,083

TABLE 15

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
SOUTH AREA STORM DRAIN NETWORK

OPINION OF PROBABLE COST

Item			Quantity	Unit	Unit Cost, $[1]	Cost, $
3.	Storm Drains - County Road 25A Trunk					
	a.	30" Diameter RCP	1,050	lf	85.00	89,250
	b.	33" Diameter RCP	0	lf	95.00	0
	c.	36" Diameter RCP	650	lf	100.00	65,000
	d.	39" Diameter RCP	0	lf	110.00	0
	e.	42" Diameter RCP	1,950	lf	120.00	234,000
	f.	48" Diameter RCP	750	lf	140.00	105,000
	g.	54" Diameter RCP	11,150	lf	175.00	1,951,250
	h.	60" Diameter RCP	0	lf	195.00	0
	i.	66" Diameter RCP	0	lf	215.00	0
	j.	72" Diameter RCP	0	lf	235.00	0
	k.	78" Diameter RCP	0	lf	300.00	0
	l.	84" Diameter RCP	0	lf	350.00	0
	m.	90" Diameter RCP	0	lf	400.00	0
	n.	Manhole - large diameter	0	ls	10,000.00	0
	o.	Manhole - small diameter	40	ls	8,000.00	320,000
	Construction Subtotal					2,764,500
Construction Contingency @ 25%						691,125
Preliminary Engineering @ 5%						138,225
Engineering/Design @ 15%						414,675
Construction Management and Inspection @ 10%						276,450
Administration @ 5%						138,225
Project Management @ 5%						138,225
	Item Total					4,561,425
4.	Storm Drains - County Road 102 Trunk					
	a.	30" Diameter RCP	0	lf	85.00	0
	b.	33" Diameter RCP	0	lf	95.00	0
	c.	36" Diameter RCP	0	lf	100.00	0
	d.	39" Diameter RCP	0	lf	110.00	0
	e.	42" Diameter RCP	0	lf	120.00	0
	f.	48" Diameter RCP	0	lf	140.00	0
	g.	54" Diameter RCP	2,000	lf	175.00	350,000
	h.	60" Diameter RCP	0	lf	195.00	0
	i.	66" Diameter RCP	0	lf	215.00	0
	j.	72" Diameter RCP	0	lf	235.00	0
	k.	78" Diameter RCP	0	lf	300.00	0
	l.	84" Diameter RCP	0	lf	350.00	0
	m.	90" Diameter RCP	0	lf	400.00	0
	n.	Manhole - large diameter	0	ls	10,000.00	0
	o.	Manhole - small diameter	6	ls	8,000.00	48,000
	Construction Subtotal					398,000
Construction Contingency @ 25%						99,500
Preliminary Engineering @ 5%						19,900
Engineering/Design @ 15%						59,700
Construction Management and Inspection @ 10%						39,800
Administration @ 5%						19,900
Project Management @ 5%						19,900
	Item Total					656,700

TABLE 15

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
SOUTH AREA STORM DRAIN NETWORK

OPINION OF PROBABLE COST

Item			Quantity	Unit	Unit Cost, $[1]	Cost, $
5.	Storm Drains - Farmer's Central West					
	a.	30" Diameter RCP	1,050	lf	85.00	89,250
	b.	33" Diameter RCP	0	lf	95.00	0
	c.	36" Diameter RCP	0	lf	100.00	0
	d.	39" Diameter RCP	0	lf	110.00	0
	e.	42" Diameter RCP	1,350	lf	120.00	162,000
	f.	48" Diameter RCP	2,000	lf	140.00	280,000
	g.	54" Diameter RCP	750	lf	175.00	131,250
	h.	60" Diameter RCP	0	lf	195.00	0
	i.	66" Diameter RCP	0	lf	215.00	0
	j.	72" Diameter RCP	0	lf	235.00	0
	k.	78" Diameter RCP	0	lf	300.00	0
	l.	84" Diameter RCP	0	lf	350.00	0
	m.	90" Diameter RCP	0	lf	400.00	0
	n.	Manhole - large diameter	0	ls	10,000.00	0
	o.	Manhole - small diameter	16	ls	8,000.00	128,000
	Construction Subtotal					790,500
Construction Contingency @ 25%						197,625
Preliminary Engineering @ 5%						39,525
Engineering/Design @ 15%						118,575
Construction Management and Inspection @ 10%						79,050
Administration @ 5%						39,525
Project Management @ 5%						39,525
	Item Total					1,304,325
6.	Storm Drains - Zone S4B					
	a.	30" Diameter RCP	0	lf	85.00	0
	b.	33" Diameter RCP	0	lf	95.00	0
	c.	36" Diameter RCP	0	lf	100.00	0
	d.	39" Diameter RCP	0	lf	110.00	0
	e.	42" Diameter RCP	0	lf	120.00	0
	f.	48" Diameter RCP	1,200	lf	140.00	168,000
	g.	54" Diameter RCP	0	lf	175.00	0
	h.	60" Diameter RCP	1,350	lf	195.00	263,250
	i.	66" Diameter RCP	0	lf	215.00	0
	j.	72" Diameter RCP	0	lf	235.00	0
	k.	78" Diameter RCP	0	lf	300.00	0
	l.	84" Diameter RCP	0	lf	350.00	0
	m.	90" Diameter RCP	0	lf	400.00	0
	n.	Manhole - large diameter	0	ls	10,000.00	0
	o.	Manhole - small diameter	10	ls	8,000.00	80,000
	Construction Subtotal					511,250
Construction Contingency @ 25%						127,813
Preliminary Engineering @ 5%						25,563
Engineering/Design @ 15%						76,688
Construction Management and Inspection @ 10%						51,125
Administration @ 5%						25,563
Project Management @ 5%						25,563
	Item Total					843,563

TABLE 15

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
SOUTH AREA STORM DRAIN NETWORK

OPINION OF PROBABLE COST

Item			Quantity	Unit	Unit Cost, $[1]	Cost, $
Land Acquisition						
	a.	*Farmer's Central East Trunk*	0.0	ac	40,000.00	0
	b.	*Parkway Trunk*	0.0	ac	40,000.00	0
	c.	*County Road 25A Trunk*	0.0	ac	40,000.00	0
	d.	*County Road 102 Trunk*	0.0	ac	40,000.00	0
	e.	*Farmer's Central West Trunk*	0.0	ac	40,000.00	0
	Subtotal					0
TOTAL						13,619,595

Wood Rodgers, Inc.
February 2006

TABLE 16

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN
AND PRELIMINARY ENGINEERING
OUTFALL CHANNEL

OPINION OF PROBABLE COST

Item			Quantity	Unit	Unit Cost, $[1]	Cost, $
1.	Outfall Channel Improvements					
	a.	Site Preparation	48.2	ac	1,119	53,941
	b.	Excavation (no Haul & Dump included)	191,373	cy	4	855,437
	c.	Haul and Dump to Woodland Park	220,079	cy	3	641,897
	d.	Place and Shape Fill	220,079	cy	2	517,186
	e.	Dewatering Upstream Diversion to Settling Basin	1	ls	298,000	298,000
	f.	Aggregate Surface - Access Road Along Channel	28,000	sy	3	94,640
	g.	Environmental Restoration	1	ls	50,000	50,000
	h.	Mobilization and Demobilization (1% Construction)	1	ls	125,555	125,555
	Subtotal					2,636,656
Construction Contingency @ 25%						659,164
Preliminary Engineering @ 5%						131,833
Engineering/Design @ 15%						395,498
Construction Management and Inspection @ 10%						263,666
Administration @ 5%						131,833
Project Management @ 5%						131,833
Total (Construction Costs Only)						4,350,483
Land Acquisition						
	a.	Outfall Channel	48.2	ac	15,000	723,140
	b.	Habitat Mitigation (Estimate)	48.2	ac	1,500	72,314
	Subtotal					795,455
TOTAL						5,145,937

[1]Unit costs are based upon 2003 price levels.

Wood Rodgers, Inc.
February 2006

Figures

FIGURE 1

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
K-1 (NODE 64340) - KENTUCKY AVENUE TRUNK WEST OF INTERSTATE 5
100-YEAR STORM EVENT

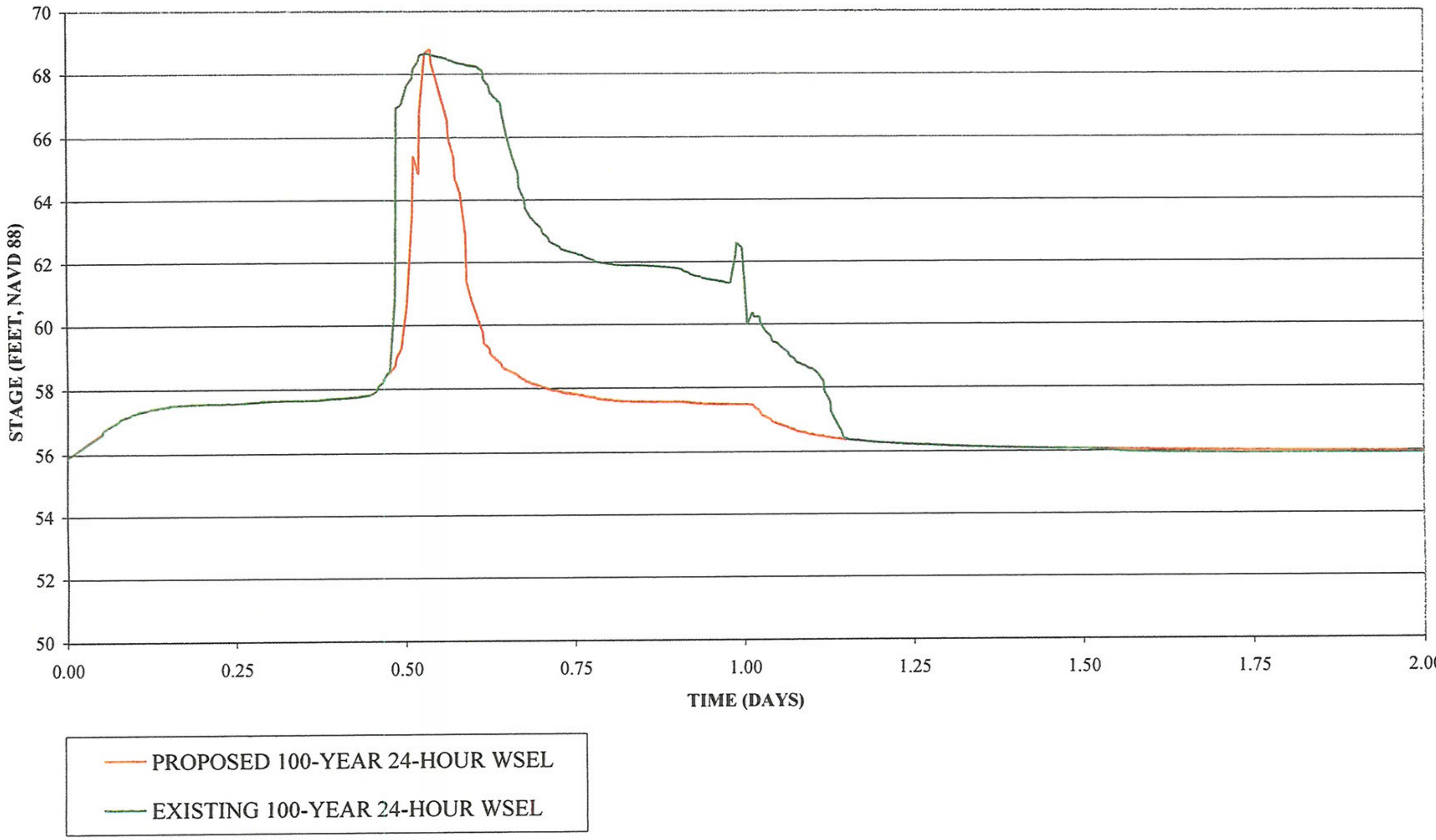


FIGURE 2

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
K-2 (NODE 64400) - KENTUCKY AVENUE TRUNK WEST OF INTERSTATE 5
100-YEAR STORM EVENT

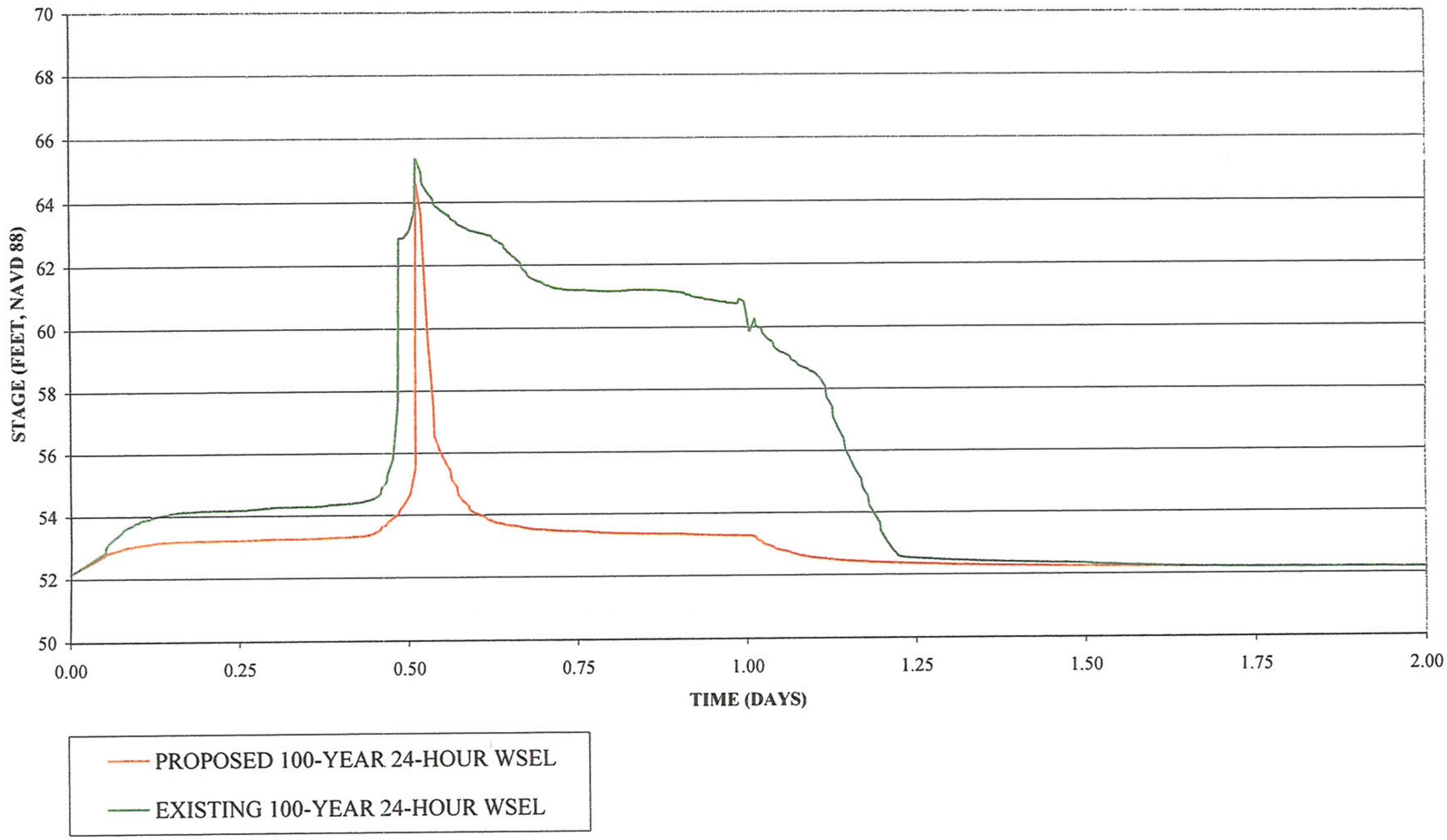


FIGURE 3

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
K-3 (NODE 64600) - KENTUCKY AVENUE TRUNK EAST OF INTERSTATE 5
100-YEAR STORM EVENT

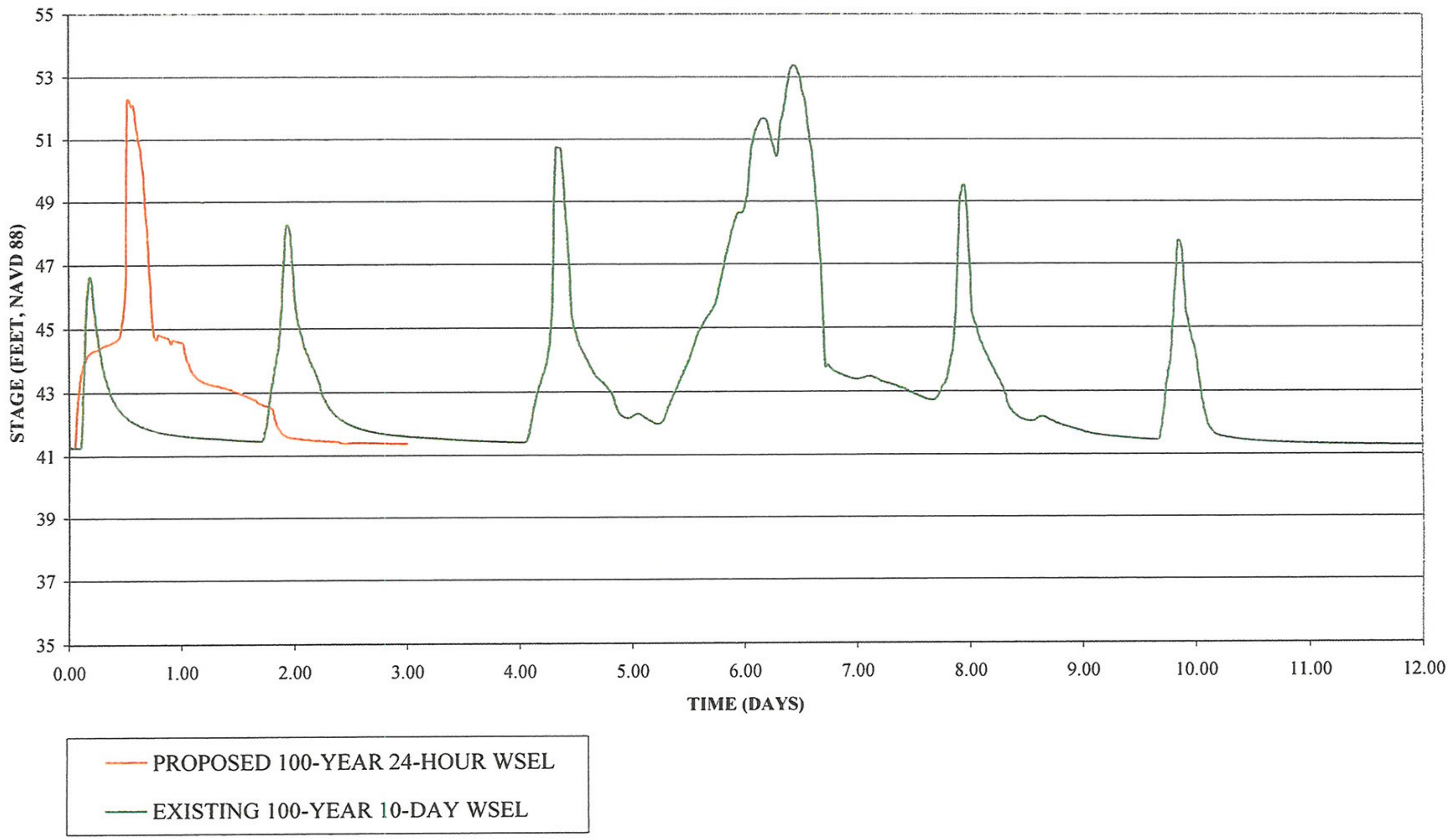


FIGURE 4

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
K-4 (NODE 64802) - KENTUCKY AVENUE TRUNK EAST OF INTERSTATE 5
100-YEAR STORM EVENT

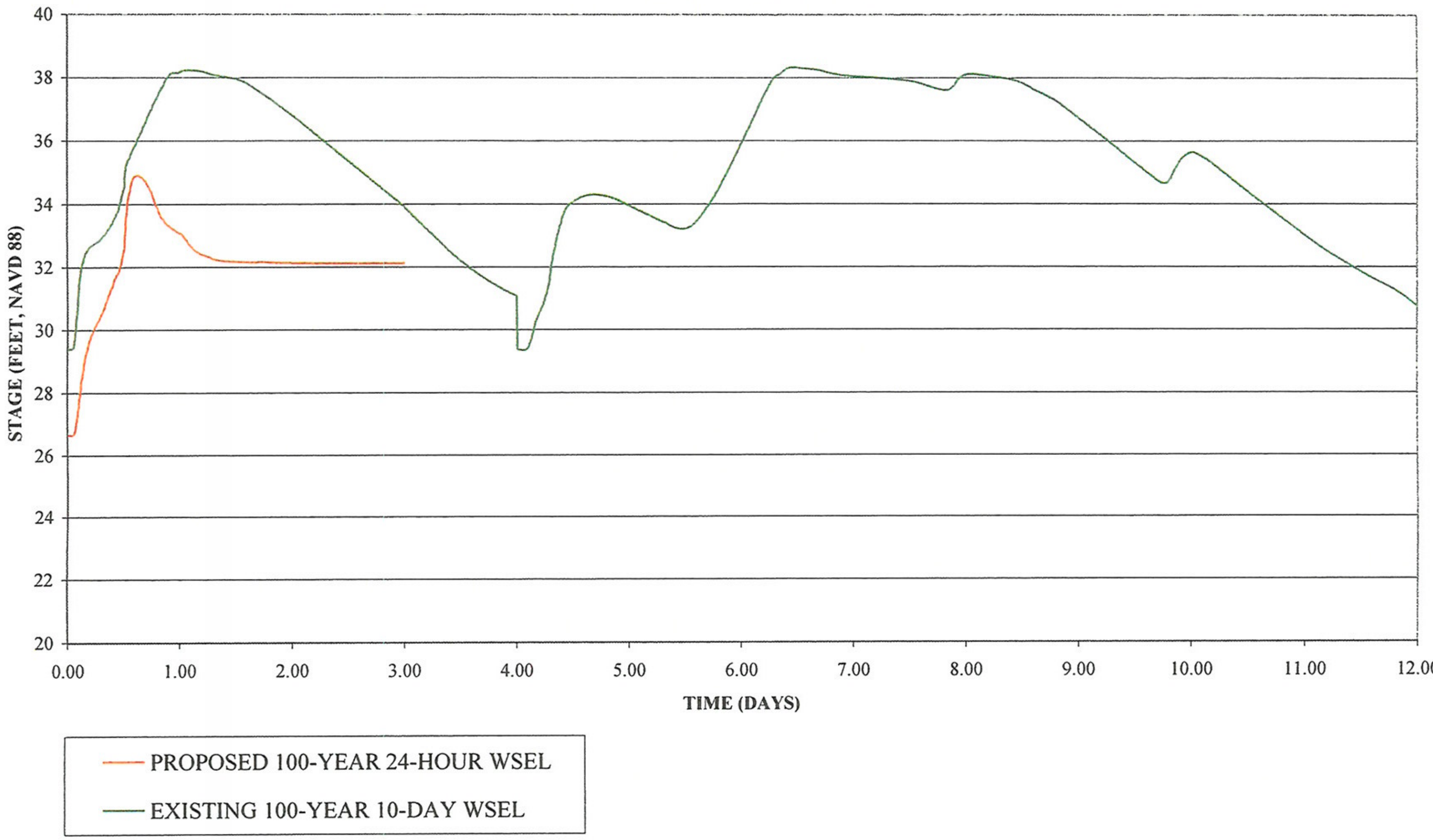


FIGURE 5

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
V-1 (NODE 64460) - VOLKL STORMWATER DETENTION POND
100-YEAR STORM EVENT

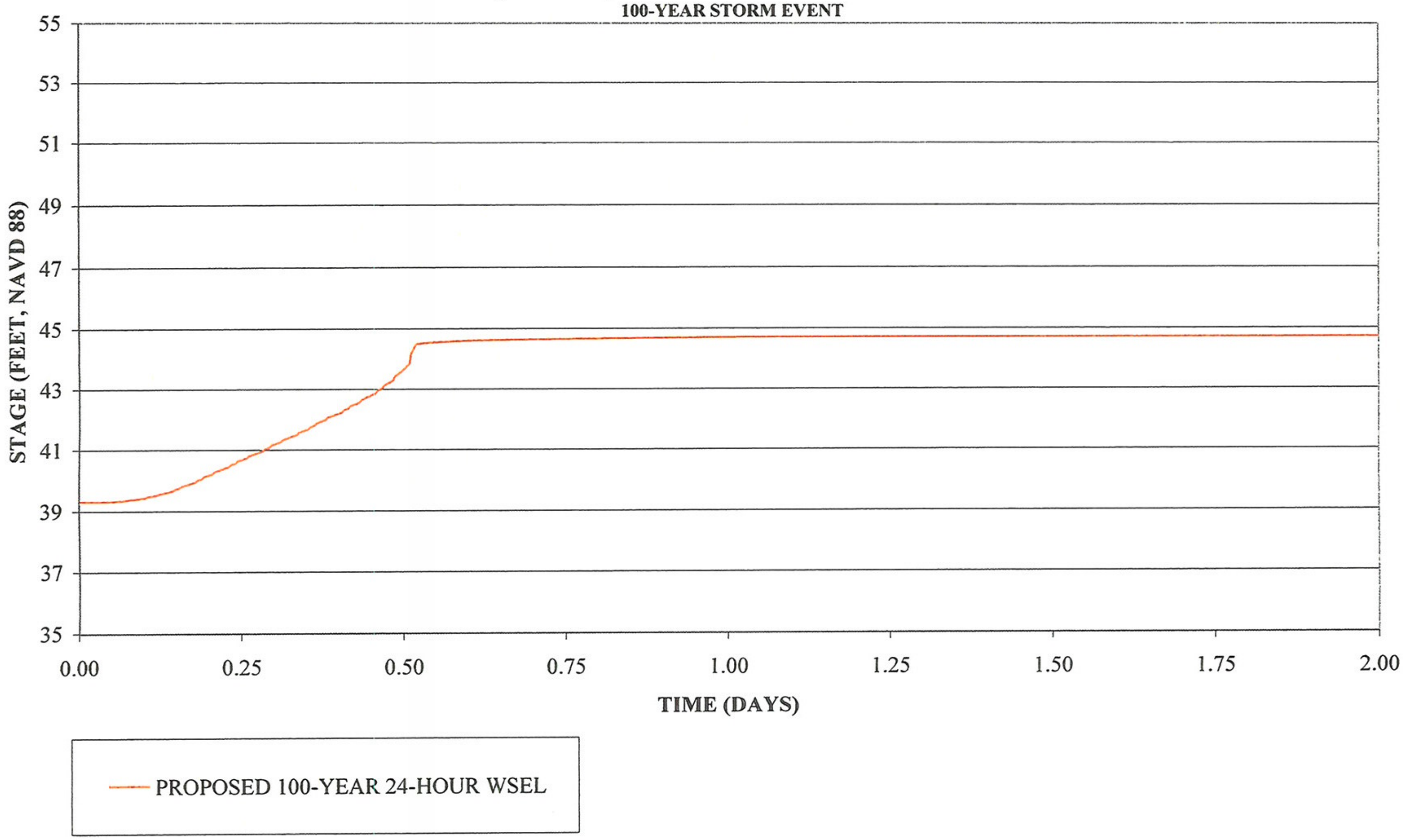


FIGURE 6

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
NC-1 (NODE 64838) POND NORTH OF CHURCHILL DOWNS AVENUE
100-YEAR STORM EVENT

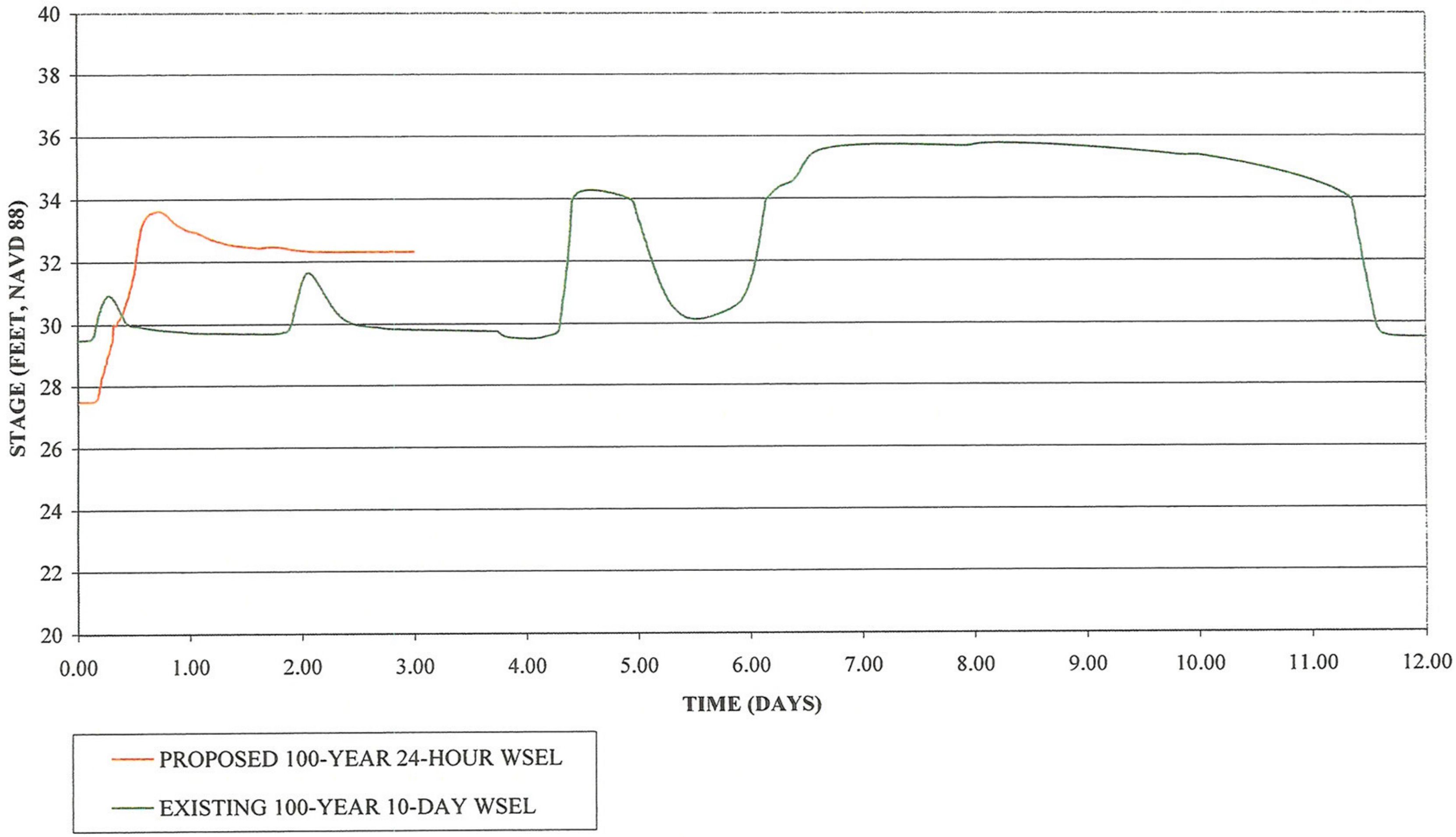


FIGURE 7

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
NC-2 (NODE 64834) NORTH CANAL UPSTREAM OF KENTUCKY AVENUE
100-YEAR STORM EVENT

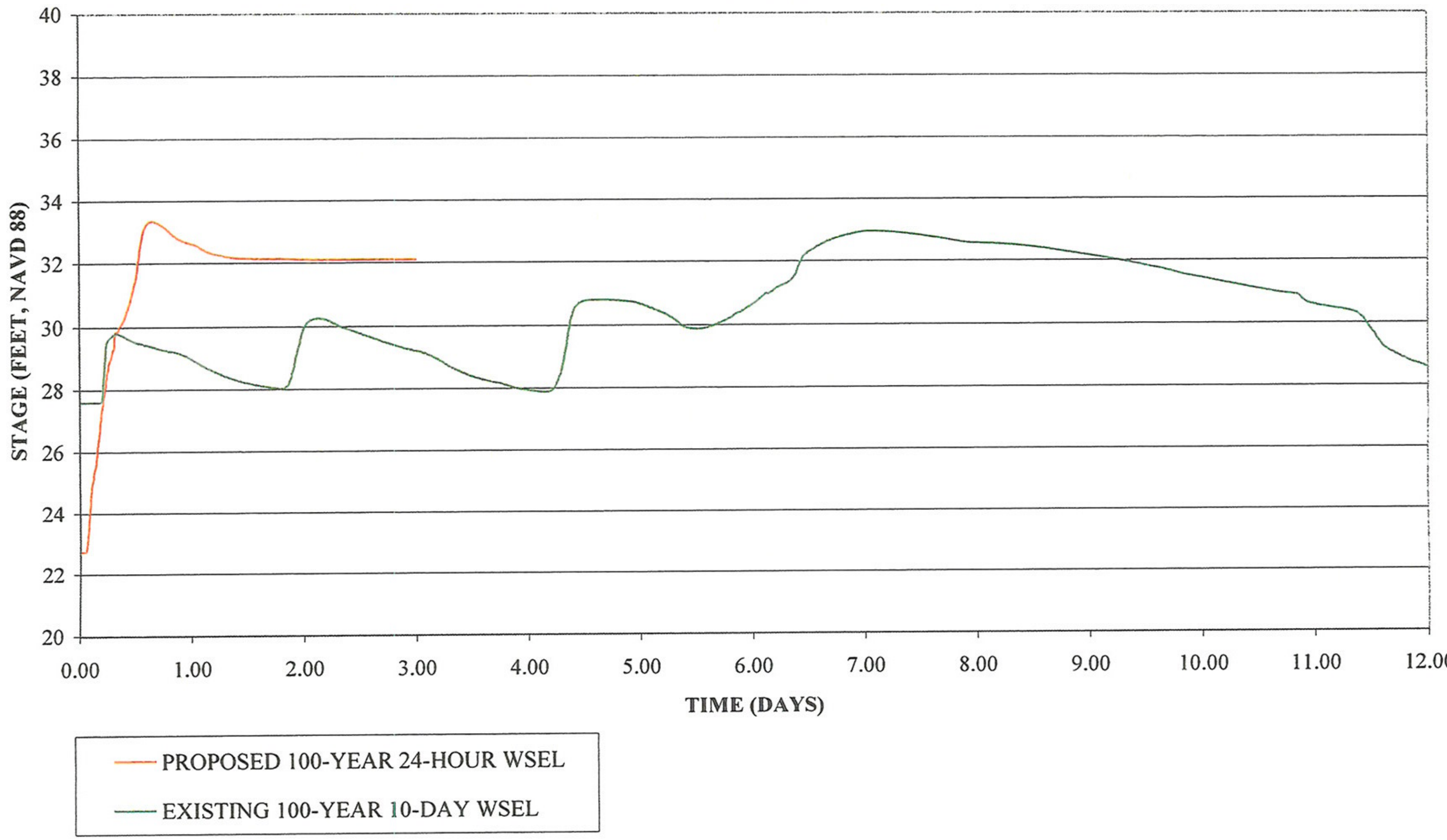


FIGURE 8

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
NC-3 (NODE 64864) NORTH CANAL DOWNSTREAM OF BEAMER STREET DITCH
100-YEAR STORM EVENT

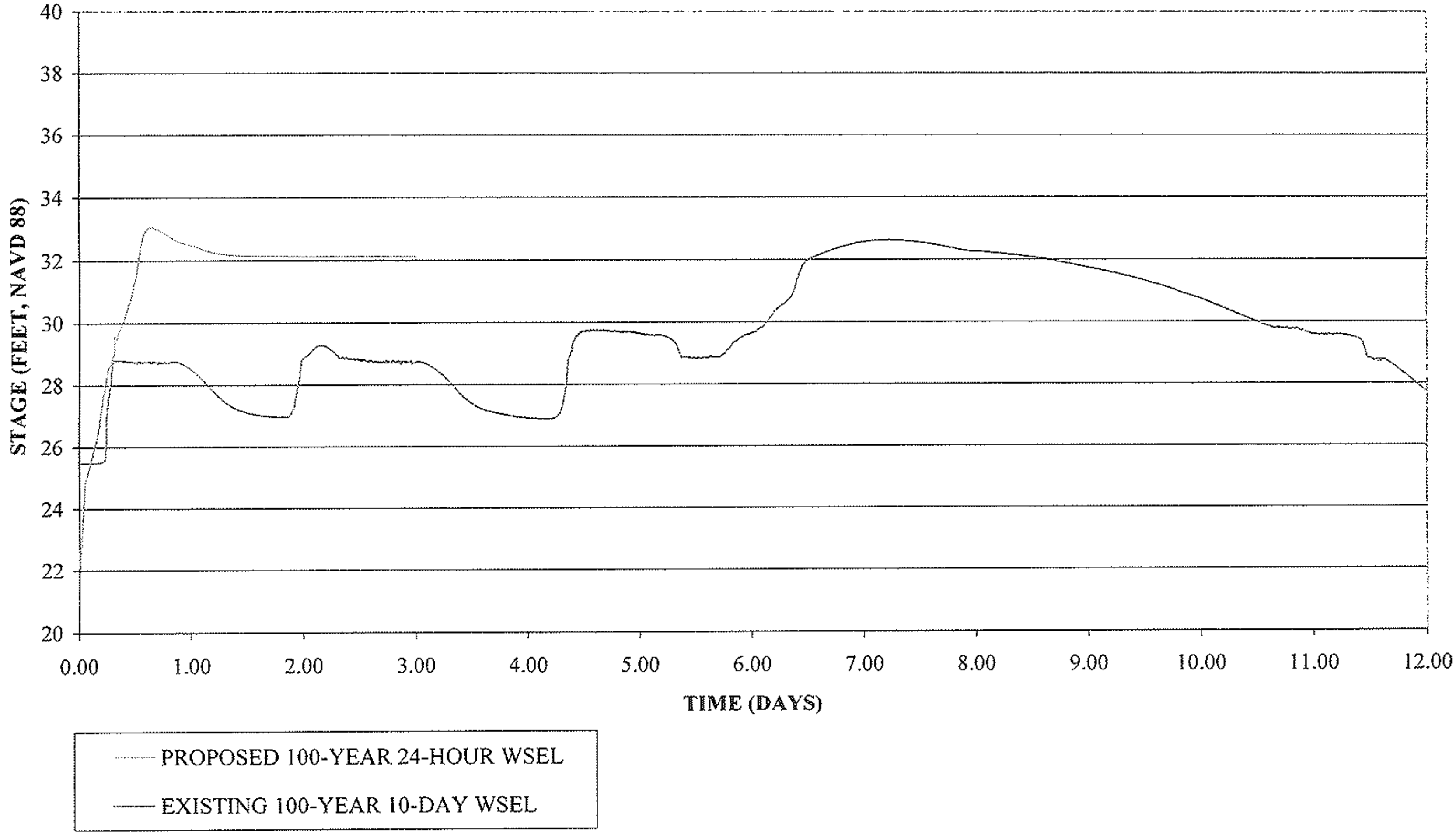


FIGURE 9

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
NC-4 (NODE 63850) NORTH CANAL UPSTREAM OF MAIN STREET
100-YEAR STORM EVENT

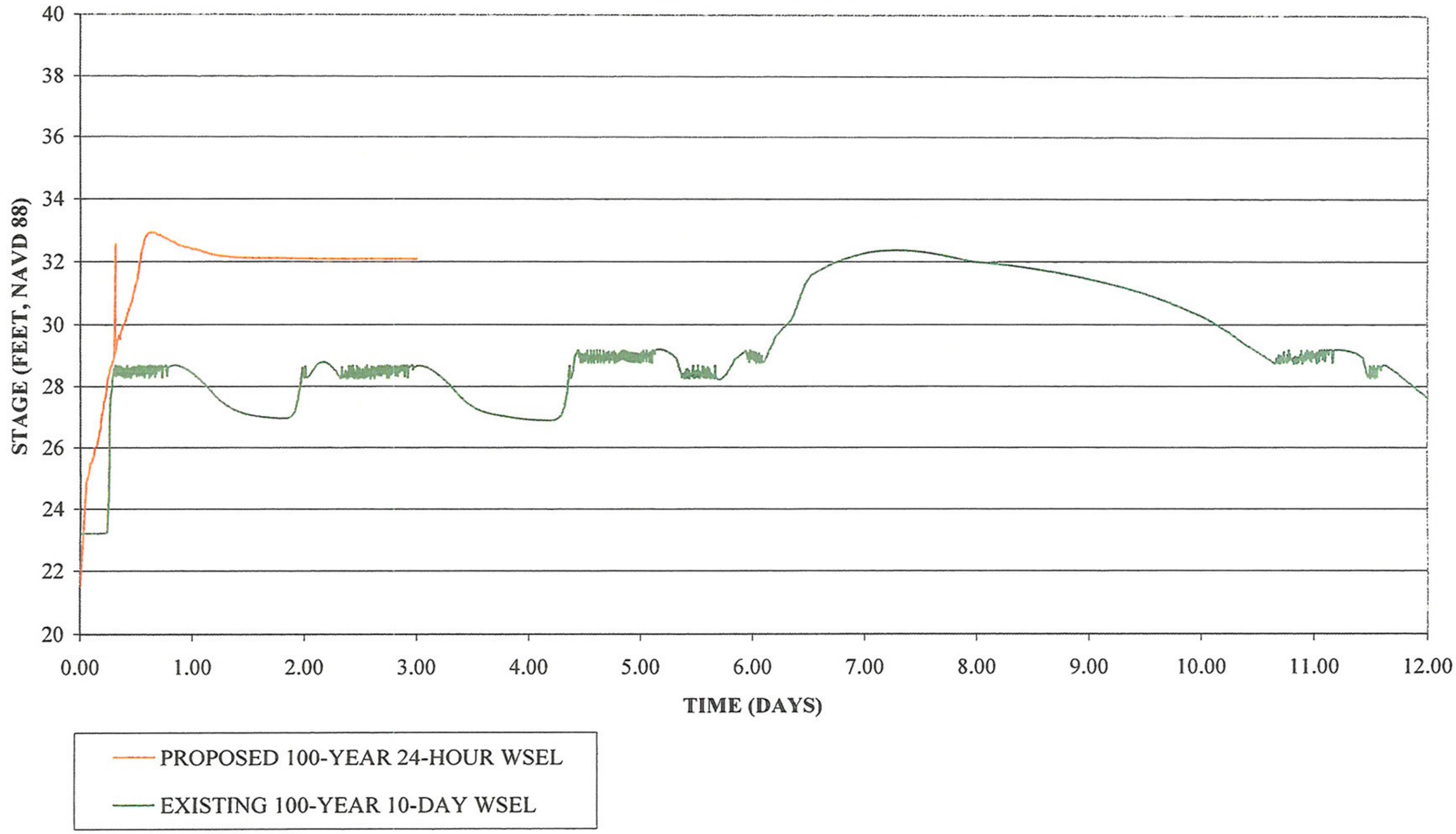


FIGURE 10

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
M-1 (NODE 62602) MAIN STREET TRUNK EAST OF COUNTY ROAD 102
100-YEAR STORM EVENT

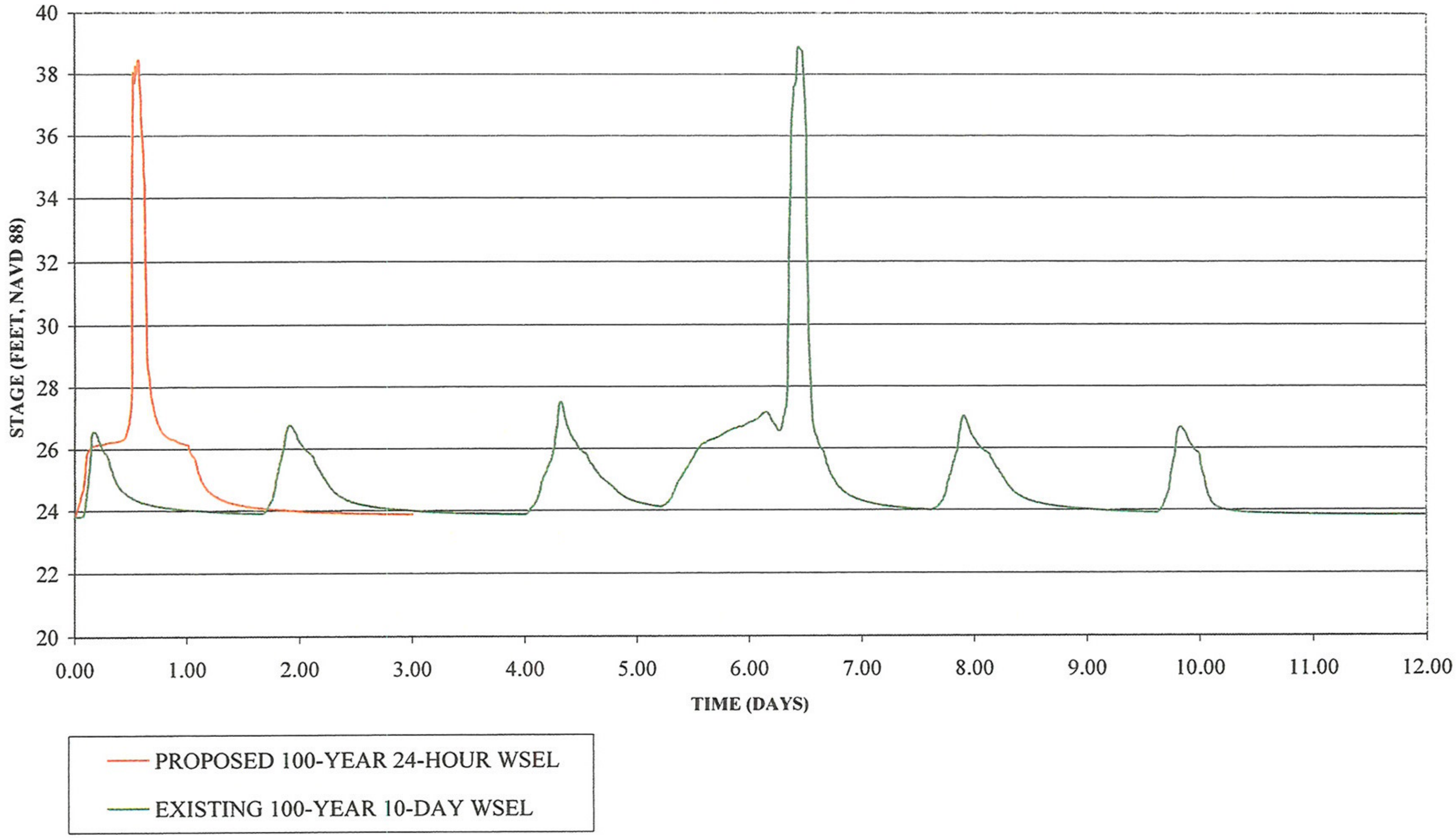


FIGURE 11

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
M-2 (NODE 62654) MAIN STREET TRUNK WEST OF COUNTY ROAD 103
100-YEAR STORM EVENT

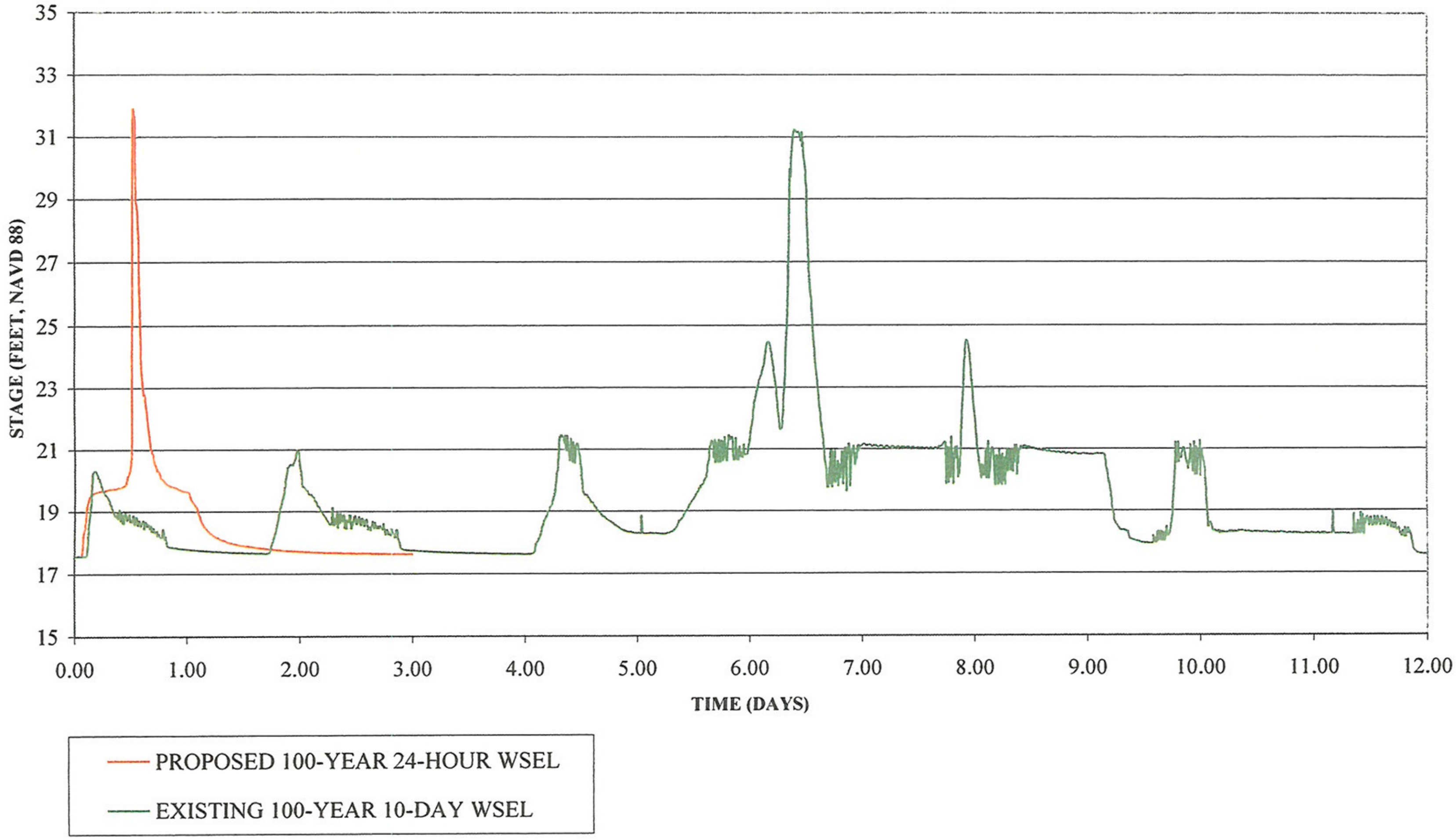


FIGURE 12

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
G-1 (NODE 61310) GIBSON STREET TRUNK NEAR SPRUCE DRIVE EAST OF WEST STREET
100-YEAR STORM EVENT

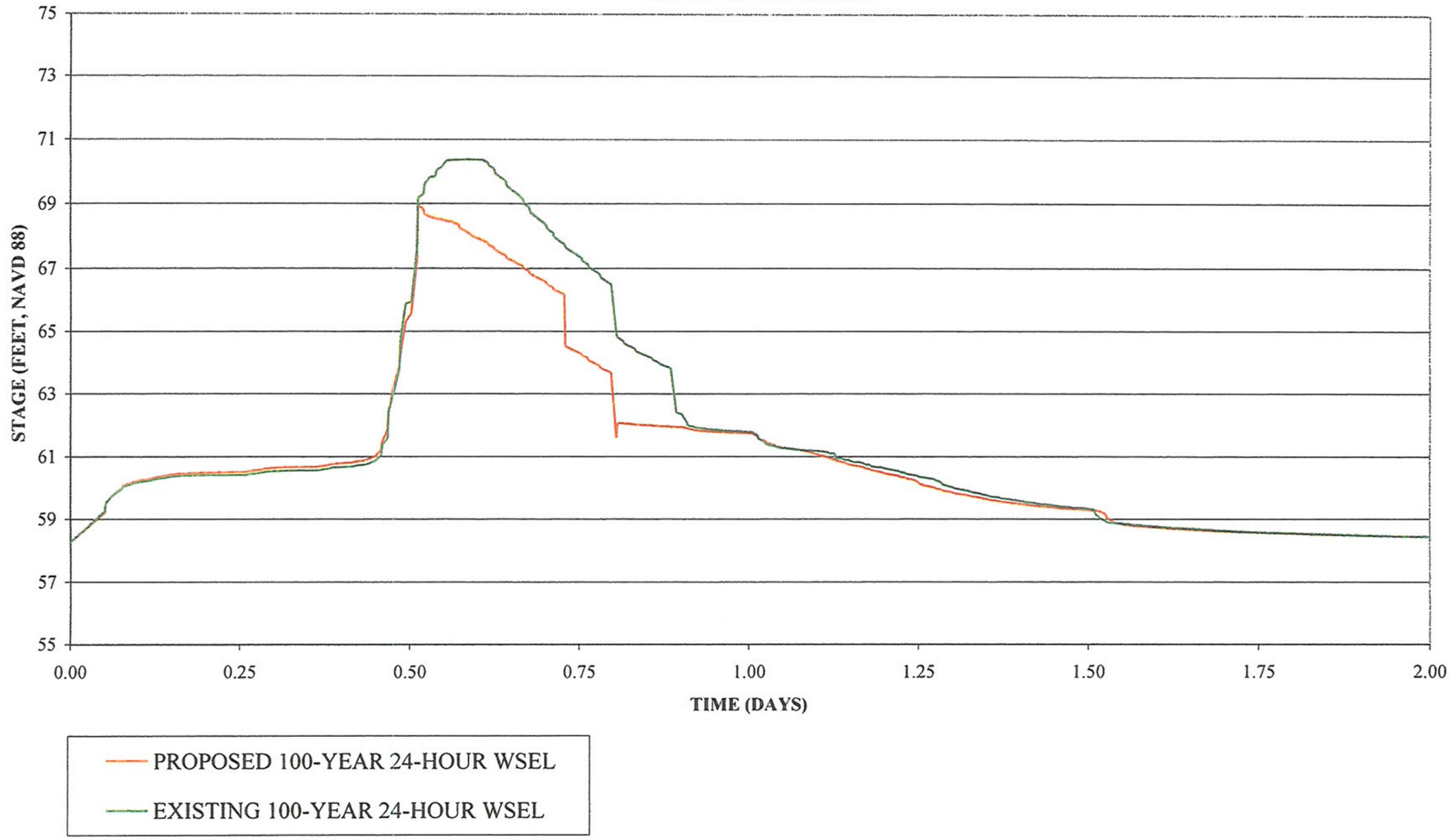


FIGURE 13

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
B-1 (NODE 90130) FARMER'S CENTRAL TRUNK WEST OF HIGHWAY 113
100-YEAR STORM EVENT

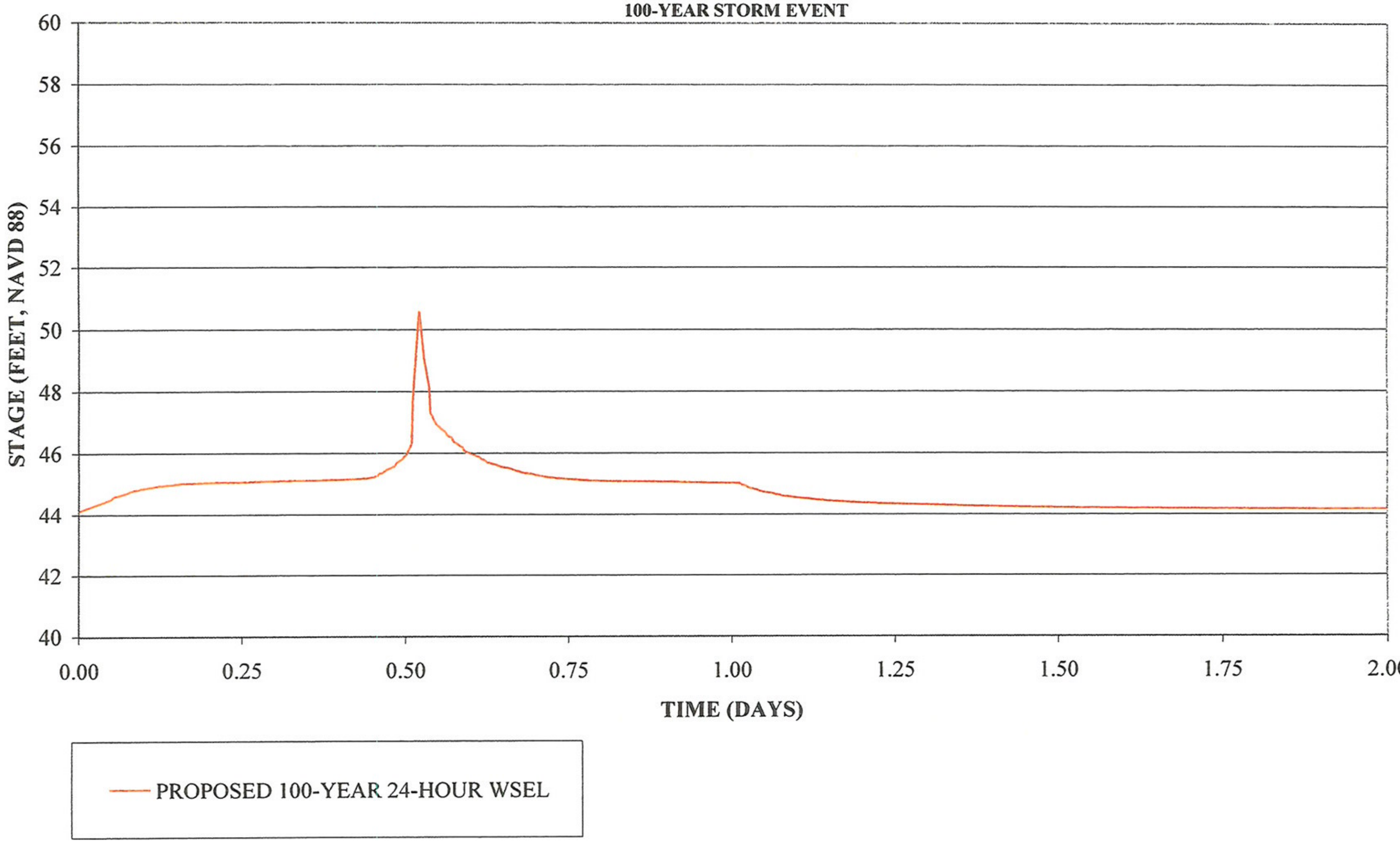


FIGURE 14

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
P-1 (NODE 91110) PARKWAY TRUNK EAST OF HIGHWAY 113
100-YEAR STORM EVENT

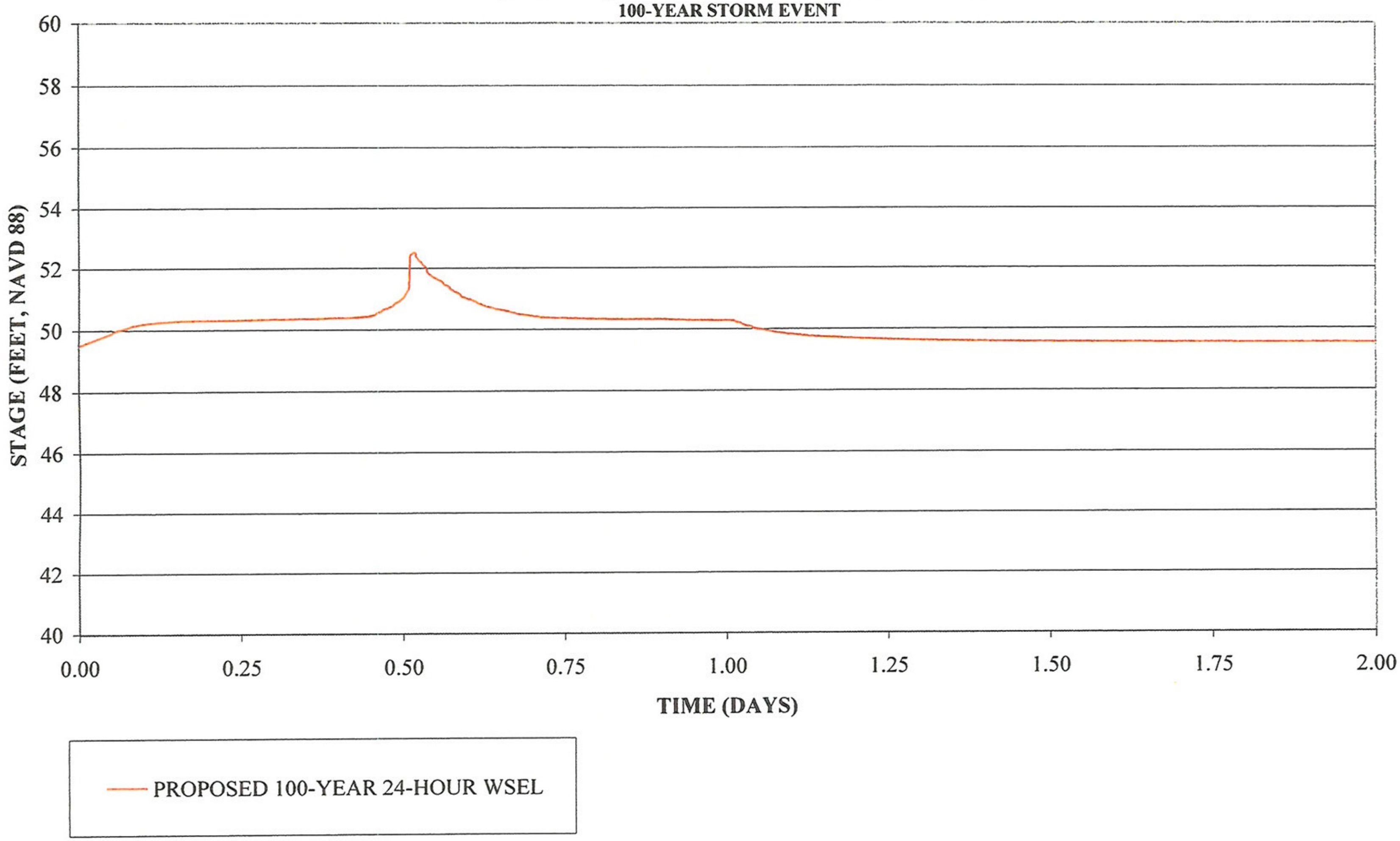


FIGURE 15

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
SP-1 (NODE 65195) ROAD 25 POND
100-YEAR STORM EVENT

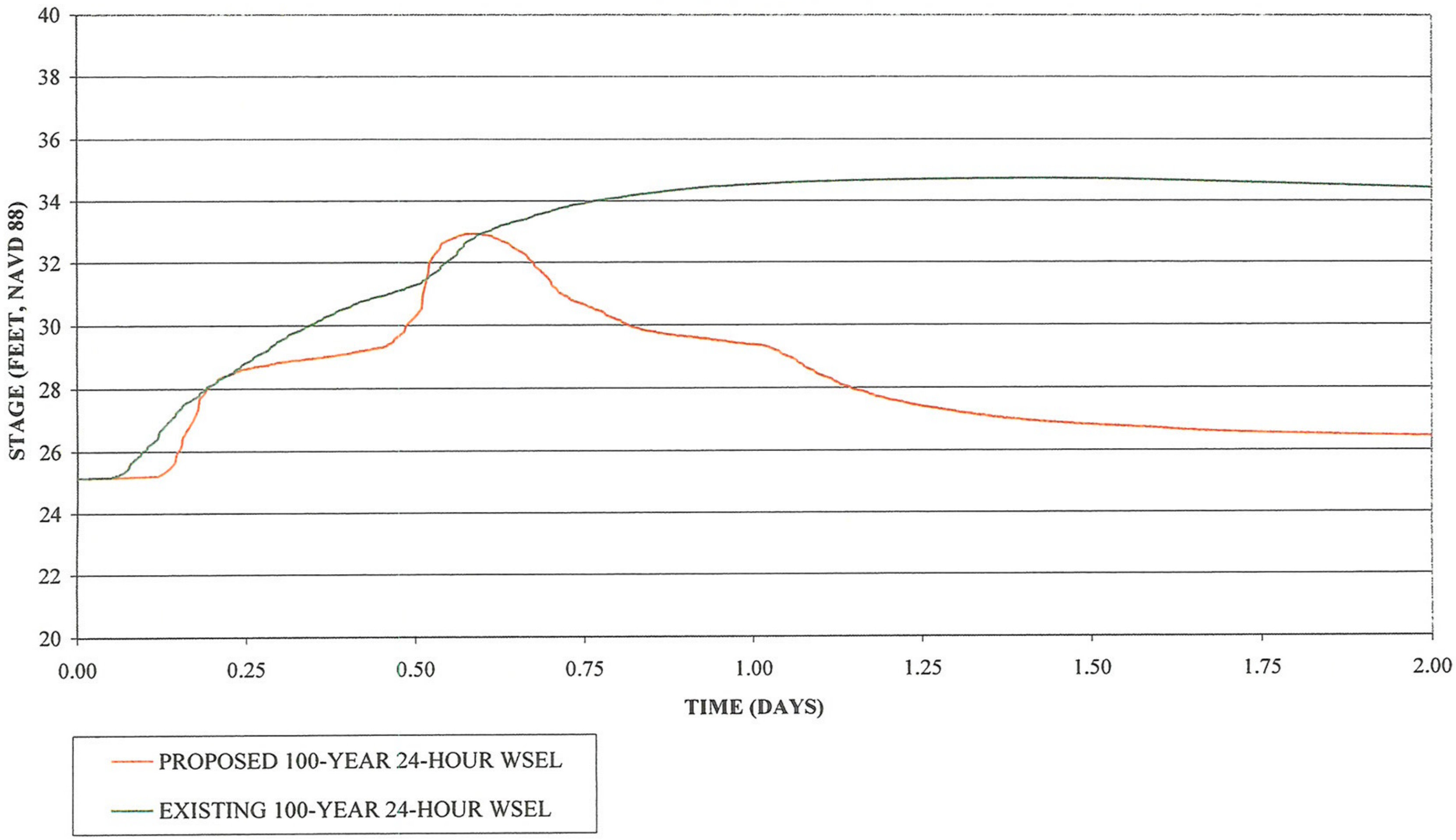


FIGURE 16

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
SC-1 (NODE 65190) SOUTH CANAL UPSTREAM OF GIBSON AVENUE TRUNK
100-YEAR STORM EVENT

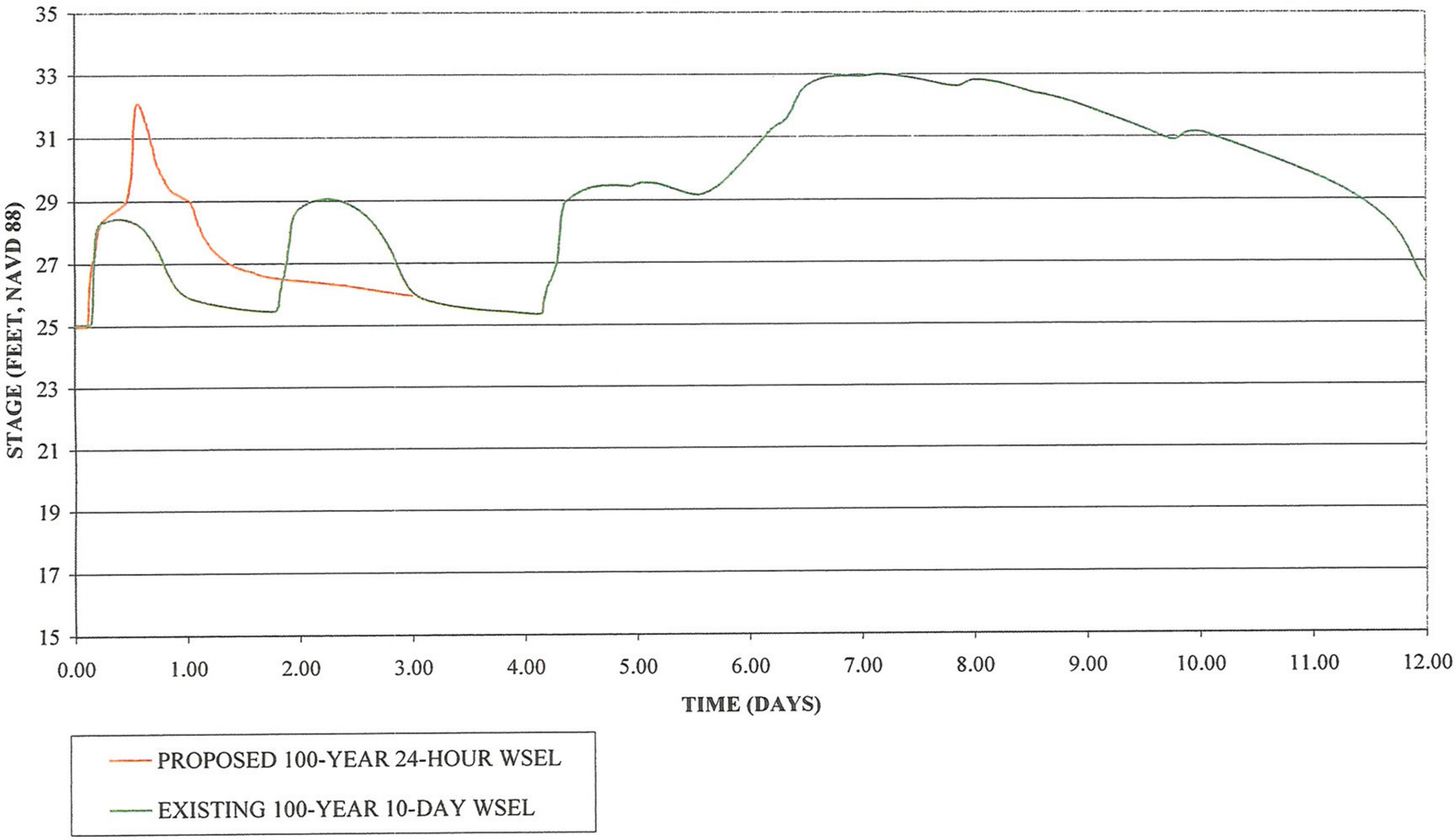


FIGURE 17

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
SC-2 (NODE 65600) SOUTH CANAL UPSTREAM OF MAIN STREET
100-YEAR STORM EVENT

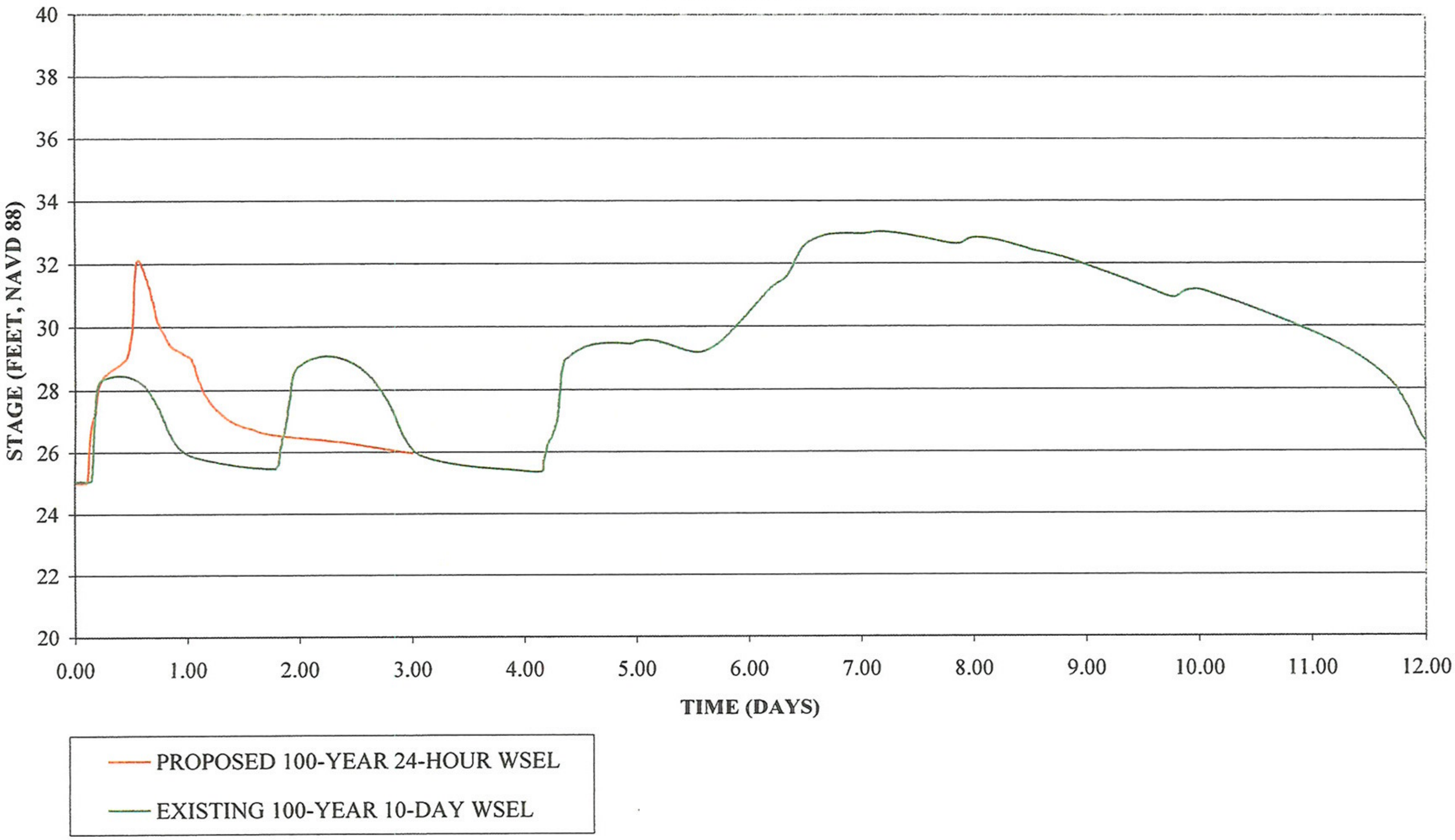


FIGURE 18

CITY OF WOODLAND
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

COMPARITIVE HGL HYDROGRAPH
OC-1 (NODE 60930) OUTFALL CHANNEL NEAR YOLO BYPASS OUTLET
100-YEAR STORM EVENT

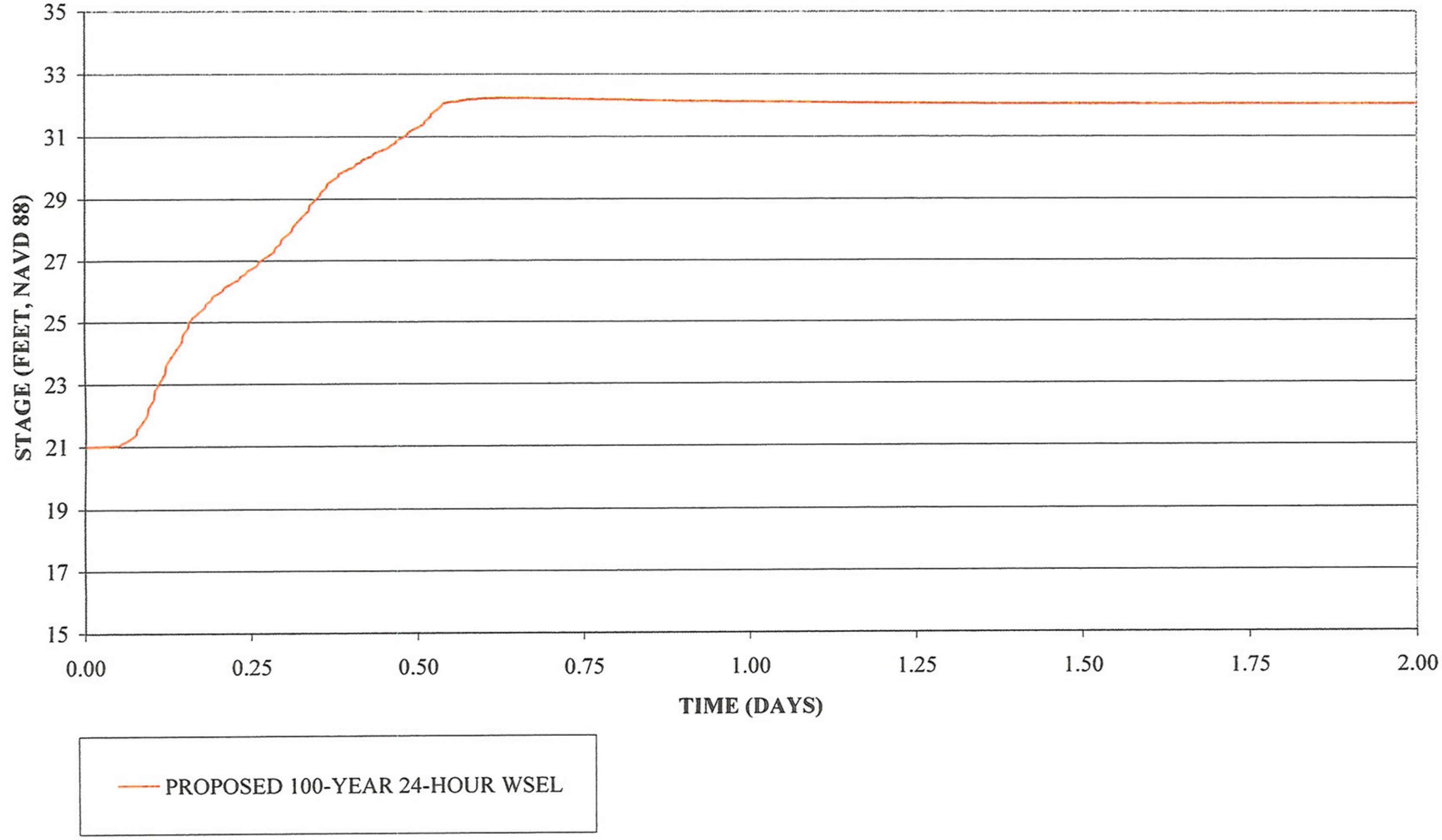


FIGURE 19

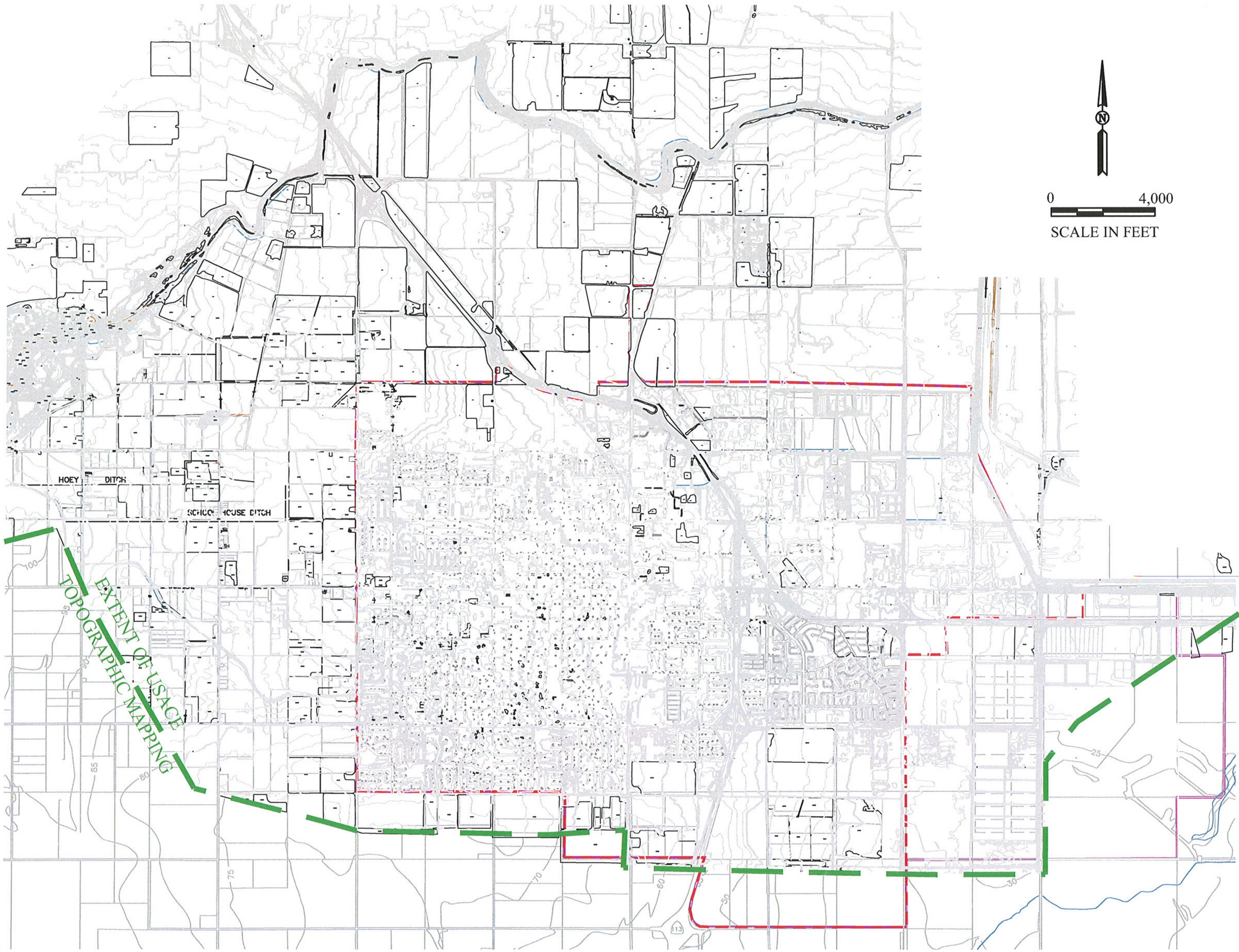
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

IMPLEMENTATION SCHEDULE[1]

		2005	2006	2007	2008	2009	2010	2011-2016	2016-2026
North Urban Growth Area									
Woodland Park Specific Plan Area									
Phase 1	Interim Facilities Only								
Phase 2	Beamer/Kentucky Channel								X
	North Canal (D to E)								X
	North Canal (E to F)								X
	North Canal Bridge								X
	Outfall Channel Improvements								X
	Outfall Bridge and Yolo Bypass Improvements								X
Volkl Area									
Phase 3	Volkl Trunk								X
	Volkl Pond								X
	Volkl Outlet								X
	North Canal C to D								X
South Urban Growth Area									
Spring Lake Specific Plan Area									
Phase 1	East Regional Detention Pond	X							
	Inlet Channel (North of Road 25A)						X		
	Outlet Channel	X							
	Farmer's Central Channel	X							
	South Interceptor Channel (Road 25A to 500 Feet Upstream of Road 102)	X							
	Parkway Trunk	X							
Phase 2	Flow Control at Confluence of Gibson and South Canal				X				
	Outfall Bridge and Yolo Bypass Improvements						X		
Phase 3	South Canal Pump Station						X		
	West Regional Detention Pond						X		
Phase 4	Farmer's Central Trunk							X	
	Southwest Interceptor							X	
	Interceptor Channel (Remaining)							X	
Existing City									
	Northwest Interceptor								X
	Diversions Kentucky Trunk to Volkl Trunk/Pond								X

[1] "X" refers to the year or time in which the facility was or is scheduled to be completed.

Maps



LEGEND

URBAN LIMIT LINE

PLANNING AREA BOUNDARY

N

0 4,000

SCALE IN FEET

SOURCES:

USArmy Corps of Engineers, "Cache Creek Feasibility Study", 2000. Vertical Datum is North American Vertical Datum of 1988 (NAVD 88).

USGS 7.5 Minute Series (Topographic) Woodland Quadrangle, 1952 Series, Photo Revised 1981. Vertical Datum is National Geodetic Vertical Datum of 1929 (NGVD 29).

City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

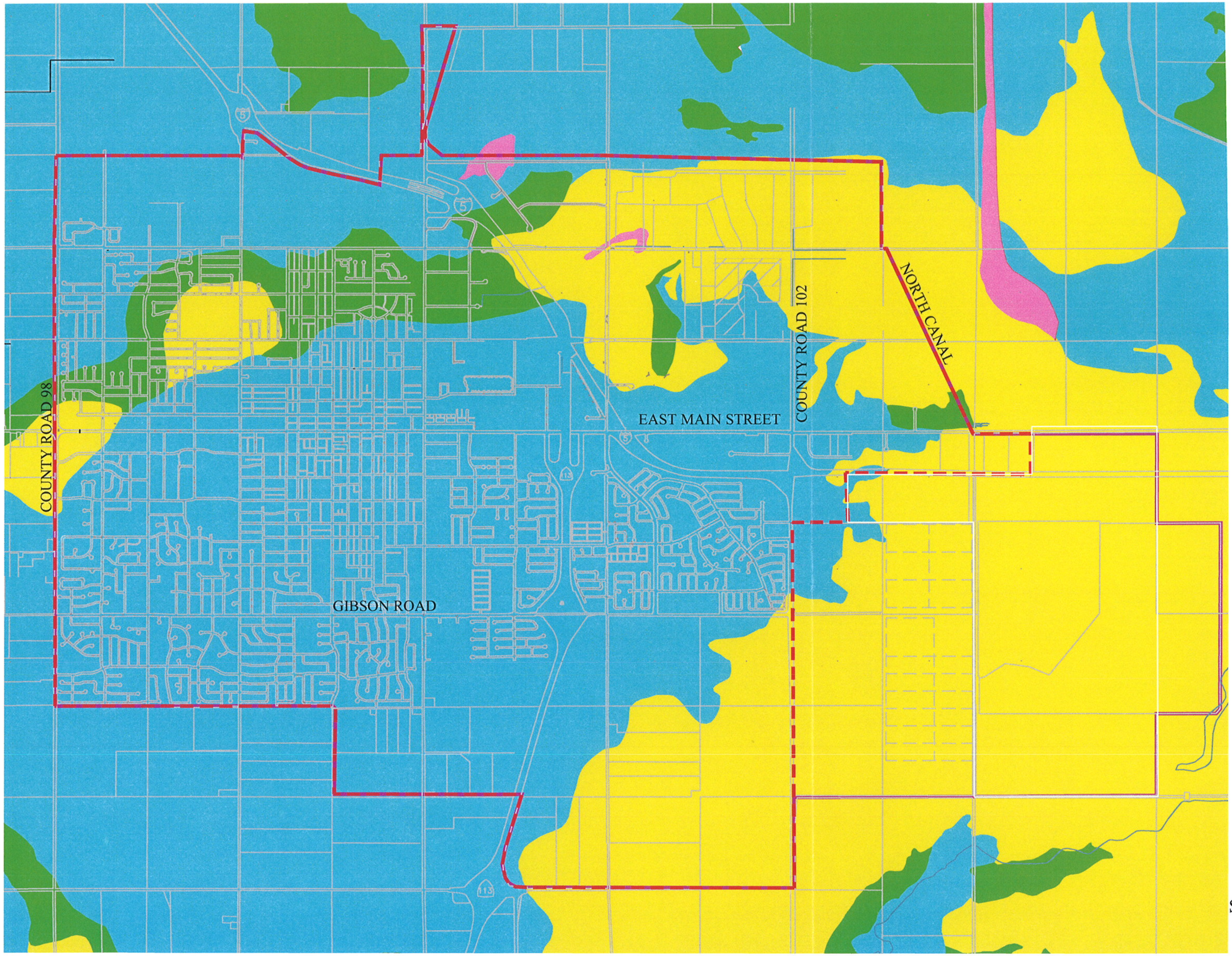
STORM DRAINAGE GUIDELINES AND CRITERIA

EXISTING TOPOGRAPHY

WOOD RODGERS

MAP 1

J:\Jobs\8164 ... Woodland\8164.004-SDFMP\2-06-06_Report_Maps\APPENDIX-MAP1-SDFMP-ExTopo.dwg ... 3/06 10:02am jpritchard



LEGEND

- URBAN LIMIT LINE
- PLANNING AREA BOUNDARY
- GROUP A
- GROUP B
- GROUP C
- GROUP D

SOURCE:

USDA Soil Conservation Service, "Soil Survey of Yolo County, California", 1972.

N

0 3,000

SCALE IN FEET

City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

STORM DRAINAGE GUIDELINES AND CRITERIA

HYDROLOGIC SOIL GROUPS

WOOD RODGERS

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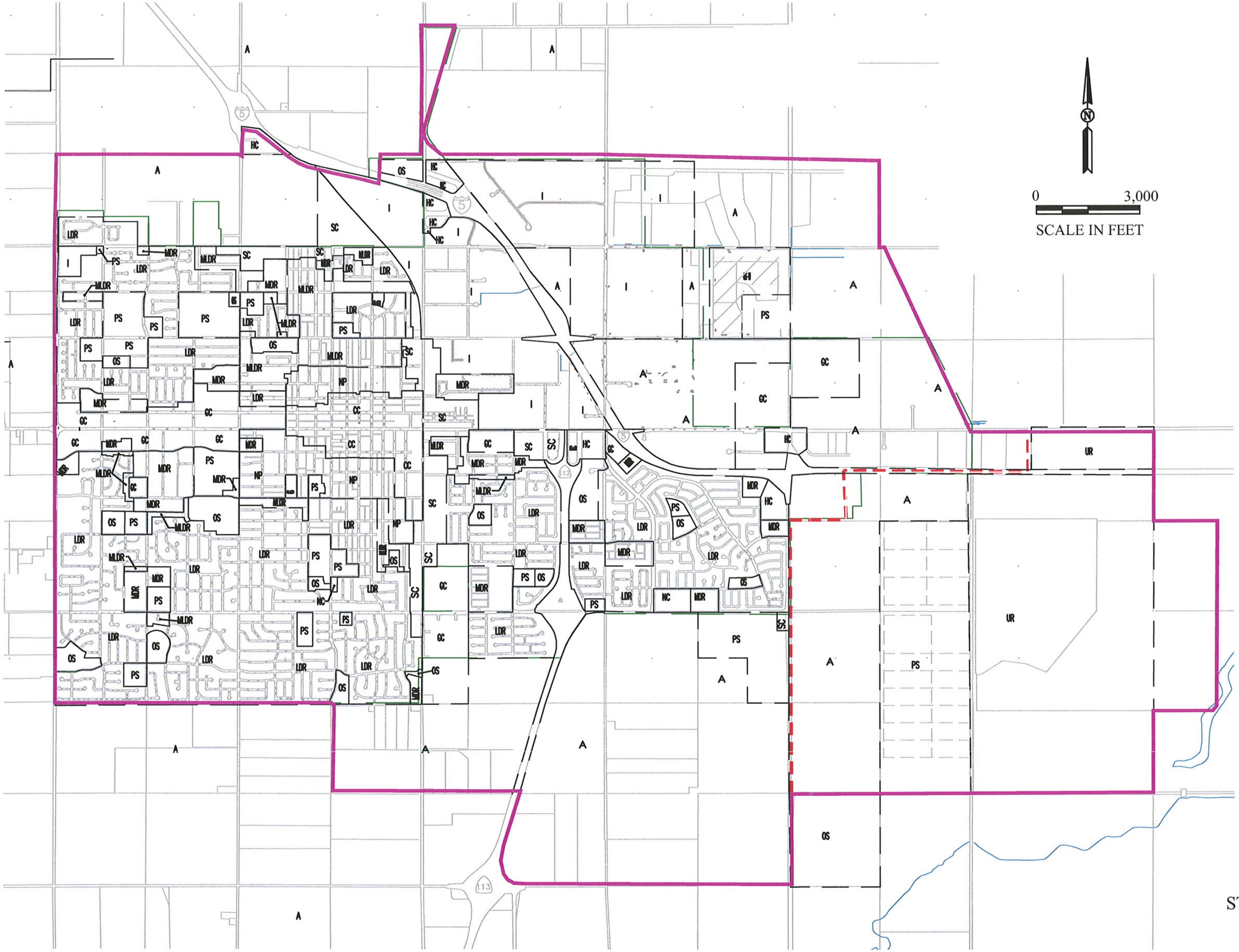


LEGEND

URBAN LIMIT LINE

PLANNING AREA BOUDNARY

AREA LAND USE

RESIDENTIAL

- RR RURAL RESIDENTIAL
- VLDR VERY LOW DENSITY RESIDENTIAL
- LDR LOW DENSITY RESIDENTIAL
- MLDR MEDIUM/LOW DENSITY RESIDENTIAL
- NP NEIGHBORHOOD PRESERVATION
- MDR MEDIUM DENSITY RESIDENTIAL
- PN PLANNED NEIGHBORHOOD

COMMERCIAL

- CC CENTRAL COMMERCIAL
- GC GENERAL COMMERCIAL
- NC NEIGHBORHOOD COMMERCIAL
- HC HIGHWAY COMMERCIAL
- SC SERVICE COMMERCIAL

INDUSTRIAL

- I INDUSTRIAL
- BP BUSINESS PARK

OTHER

- OS OPEN SPACE
- PS PUBLIC SERVICE
- UR URBAN RESERVE
- A AGRICULTURE

SOURCE:

City of Woodland General Plan Policy Document, 2002.

City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

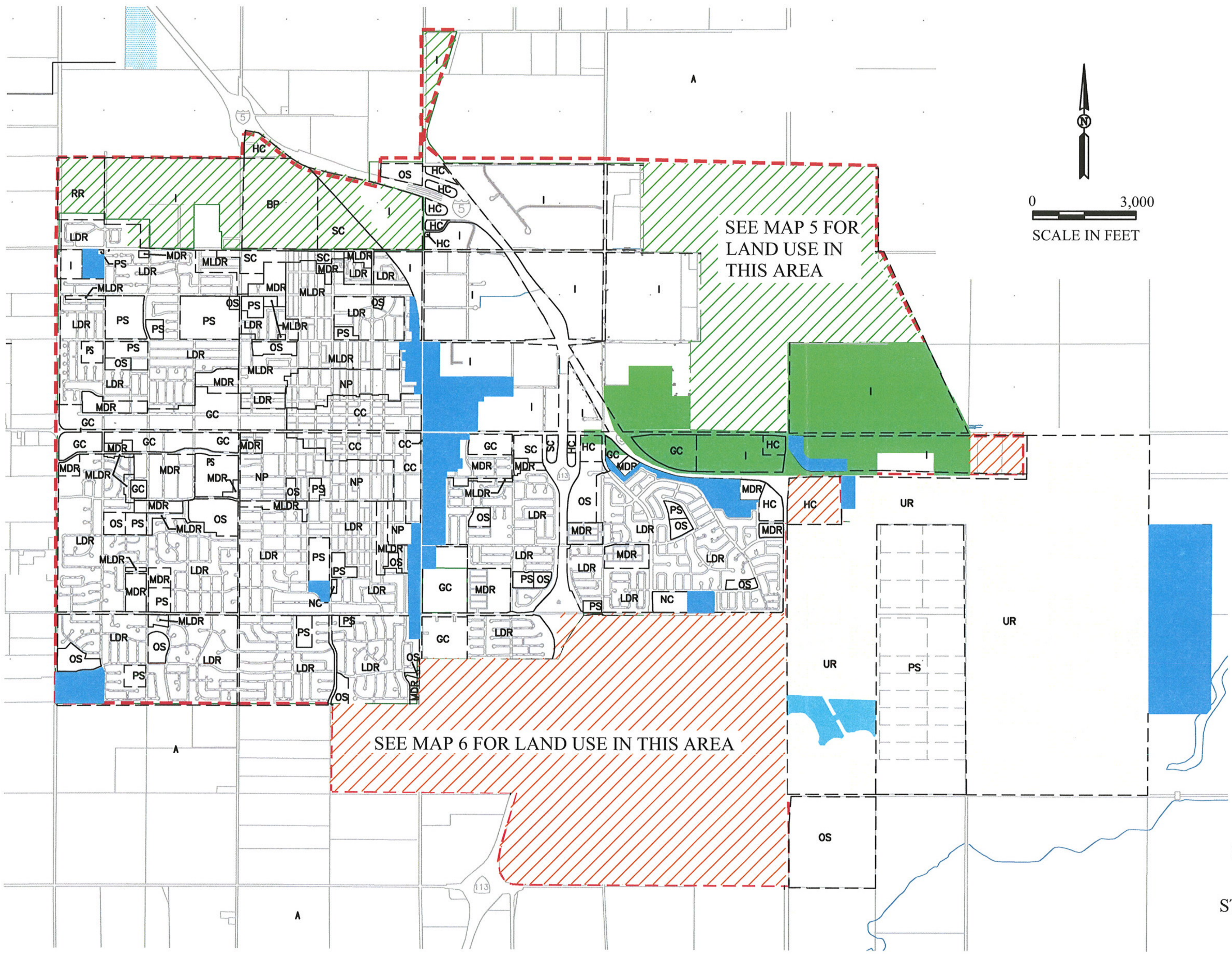
STORM DRAINAGE GUIDELINES AND CRITERIA

EXISTING LAND USE

WOOD RODGERS

MAP 3

J:\Jobs\816 ...Woodland\8164.004-SDFMP\2-06-06_Report_Maps\APPENDIX-MAP3-SDFMP-ExLandUse 2/09/06 10:20am jpritchard



LEGEND

- URBAN LIMIT LINE
- CHANGE IN DESIGNATED LAND USE FROM THE 1996 GENERAL PLAN TO THE 2002 GENERAL PLAN
- NORTH URBAN GROWTH AREA
- SOUTH URBAN GROWTH AREA
- URBAN RESERVE AREA
- EAST MAIN ASSESSMENT DISTRICT

AREA LAND USE

RESIDENTIAL

RR	RURAL RESIDENTIAL
VLDR	VERY LOW DENSITY RESIDENTIAL
LDR	LOW DENSITY RESIDENTIAL
MLDR	MEDIUM/LOW DENSITY RESIDENTIAL
NP	NEIGHBORHOOD PRESERVATION
MDR	MEDIUM DENSITY RESIDENTIAL
PN	PLANNED NEIGHBORHOOD

COMMERCIAL

CC	CENTRAL COMMERCIAL
GC	GENERAL COMMERCIAL
NC	NEIGHBORHOOD COMMERCIAL
HC	HIGHWAY COMMERCIAL
SC	SERVICE COMMERCIAL

INDUSTRIAL

I	INDUSTRIAL
BP	BUSINESS PARK

OTHER

OS	OPEN SPACE
PS	PUBLIC SERVICE
UR	URBAN RESERVE
A	AGRICULTURE

SOURCE:
City of Woodland General Plan Policy Document, 2002.

City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

STORM DRAINAGE GUIDELINES AND CRITERIA

FUTURE LAND USE

WOOD RODGERS

Land Use Category	Phase 1 Acres	Phase 2 Acres	Total Acres	Total % Distribution
Warehouse/Dist.	91	257	348	40%
Medium/Heavy Industrial	71	0	71	8%
LI/Sales Service	91	196	287	33%
Office/R&D Flex	22	88	110	13%
Business Support Retail	0	9.5	9.5	1%
Open Space	15	0	15	2%
Detention	1.5	36	37.5	4%
Total Acreage	**291.5**	**586.5**	**878**	**100%**

LEGEND

WOODLAND PARK SPECIFIC PLAN AREA

0 1,000

SCALE IN FEET

SOURCE:

EDAW, "Woodland Park Specific Plan, Draft Preferred Alternative," October 7, 2004.

City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

STORM DRAINAGE GUIDELINES AND CRITERIA

FUTURE LAND USE - WOODLAND PARK SPECIFIC PLAN AREA

WOOD RODGERS

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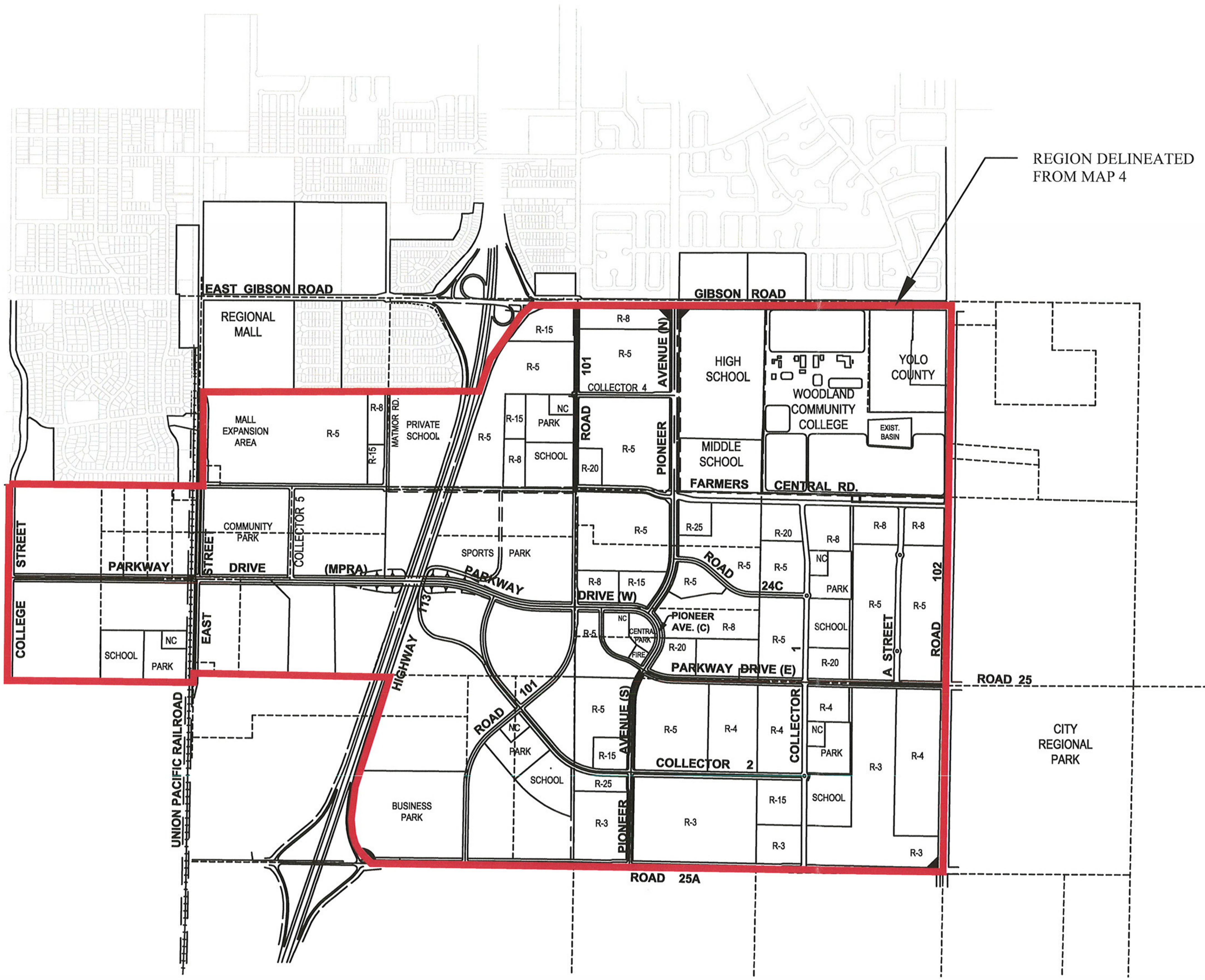


LEGEND

WOODLAND PARK PLAN AREA

LAND USE

R-3	SINGLE FAMILY RESIDENTIAL (3 DU/AC)
R-4	SINGLE FAMILY RESIDENTIAL (4 DU/AC)
R-5	SINGLE FAMILY RESIDENTIAL (5 DU/AC)
R-8	SINGLE FAMILY RESIDENTIAL (8 DU/AC)
R-15	MULTI-FAMILY RESIDENTIAL (15 DU/AC)
R-20	MULTI-FAMILY RESIDENTIAL (20 DU/AC)
R-25	MULTI-FAMILY RESIDENTIAL (25 DU/AC)
NC	NEIGHBORHOOD COMMERICAL

SOURCE:

Cunningham Engineering, "Spring Lake Specific Plan," December, 2003.

N

0 1,500

SCALE IN FEET

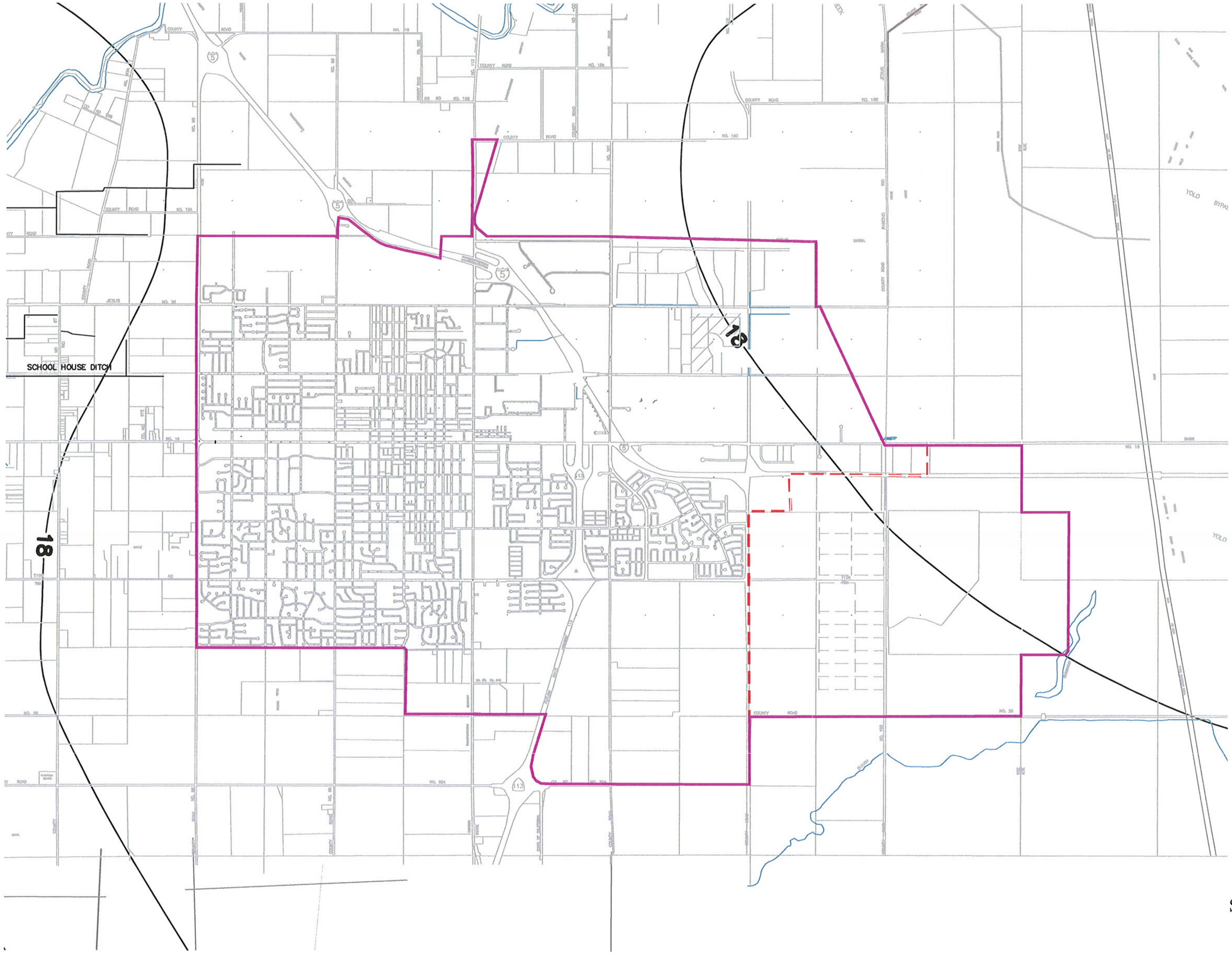
City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN
UPDATE AND PRELIMINARY ENGINEERING

STORM DRAINAGE GUIDELINES AND CRITERIA

FUTURE LAND USE
WOODLAND SOUTH AREA

WOOD RODGERS



LEGEND

URBAN LIMIT LINE

PLANNING AREA BOUNDARY

MEAN ANNUAL PRECIPITATION

SOURCE:

City of Woodland, Storm Drainage Master Plan, April 1985, Revised October 1987.

N

0 4,000

SCALE IN FEET

City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN
UPDATE AND PRELIMINARY ENGINEERING

STORM DRAINAGE GUIDELINES AND CRITERIA

MEAN ANNUAL PRECIPITATION

WOOD RODGERS

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Land Use Category	Phase 1 Acres	Phase 2 Acres	Total Acres	Total % Distribution
Warehouse/Dist.	91	257	348	40%
Medium/Heavy Industrial	71	0	71	8%
LI/Sales Service	91	196	287	33%
Office/R&D Flex	22	88	110	13%
Business Support Retail	0	9.5	9.5	1%
Open Space	15	0	15	2%
Detention	1.5	36	37.5	4%
Total Acreage	**291.5**	**586.5**	**878**	**100%**

LEGEND

WOODLAND PARK SPECIFIC PLAN AREA

SOURCE:
EDAW, "WOODLAND PARK SPECIFIC PLAN, DRAFT PREFERED ALTERNATIVE," OCTOBER 7, 2004.

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SCALE IN FEET

City of Woodland

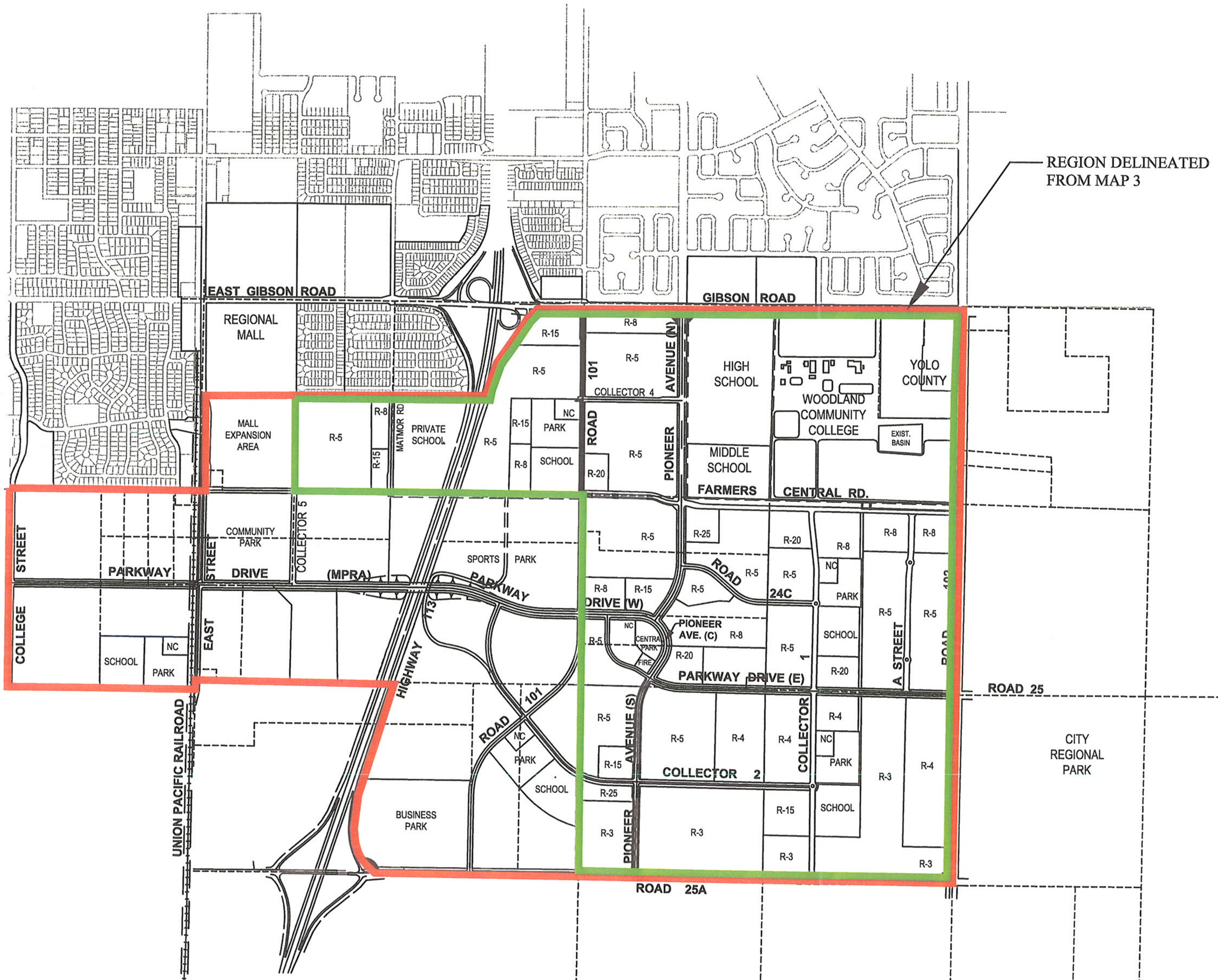
STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

ULTIMATE LAND USE WOODLAND PARK SPECIFIC PLAN AREA

WOOD RODGERS

MAP 8

J:\Jobs\8164 \Woodland\8164.004-SDFMP\2-06-06_Report_Maps\MAP08-SDFMP-WPLandUse.dwg 2/06/06 2:23pm jpritchard



LEGEND

SOUTH URBAN GROWTH AREA

SPRING LAKE SPECIFIC PLAN AREA

LAND USE

R-3	SINGLE FAMILY RESIDENTIAL (3 DU/AC)
R-4	SINGLE FAMILY RESIDENTIAL (4 DU/AC)
R-5	SINGLE FAMILY RESIDENTIAL (5 DU/AC)
R-8	SINGLE FAMILY RESIDENTIAL (8 DU/AC)
R-15	MULTI-FAMILY RESIDENTIAL (15 DU/AC)
R-20	MULTI-FAMILY RESIDENTIAL (20 DU/AC)
R-25	MULTI-FAMILY RESIDENTIAL (25 DU/AC)
NC	NEIGHBORHOOD COMMERICAL

SOURCE:
CUNNINGHAM ENGINEERING, "SPRING LAKE SPECIFIC PLAN," DECEMBER, 2003.

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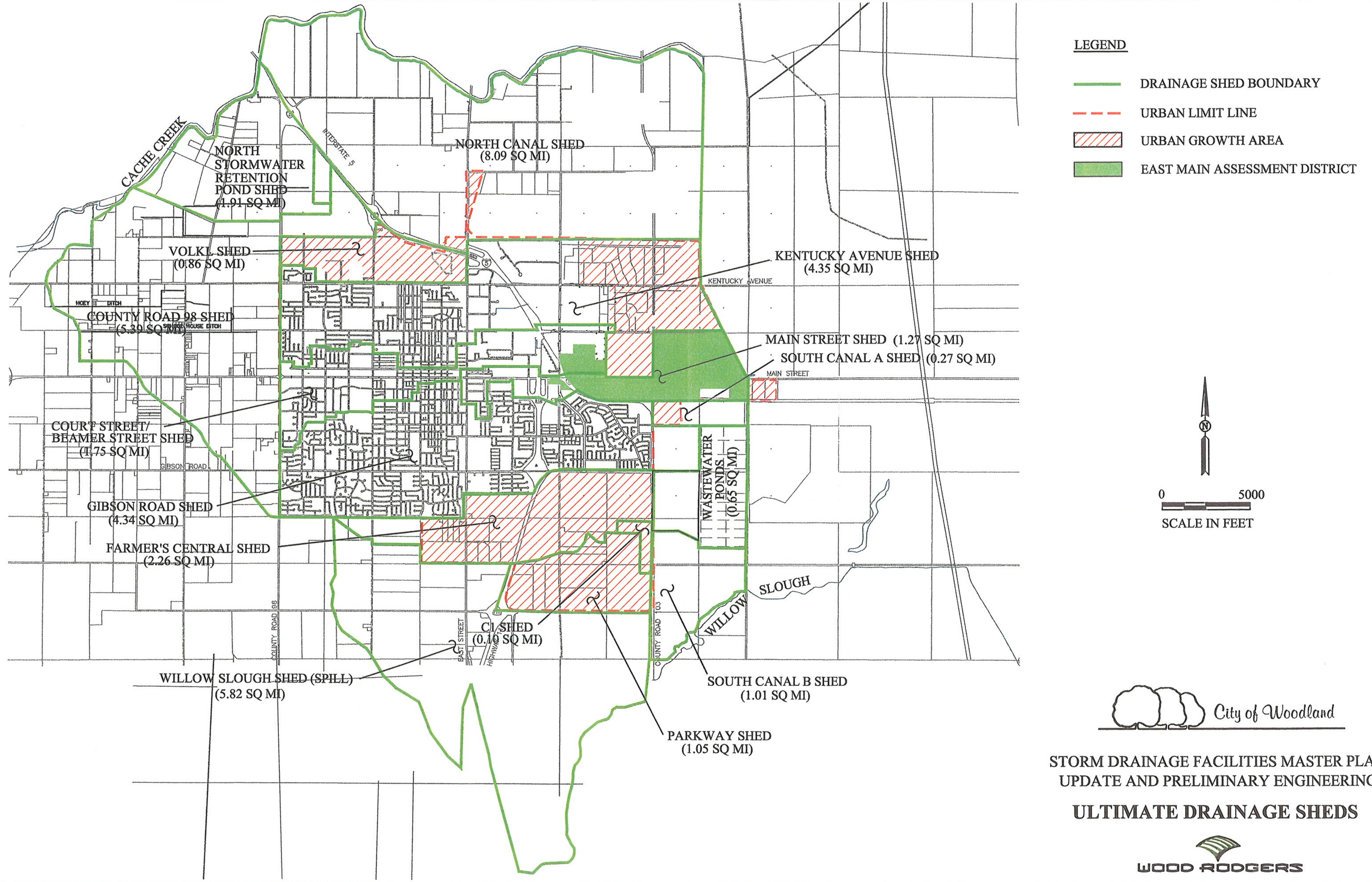
SCALE IN FEET

City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

ULTIMATE LAND USE SOUTH URBAN GROWTH AREA

WOOD RODGERS



City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN
UPDATE AND PRELIMINARY ENGINEERING

ULTIMATE DRAINAGE SHEDS

WOOD RODGERS

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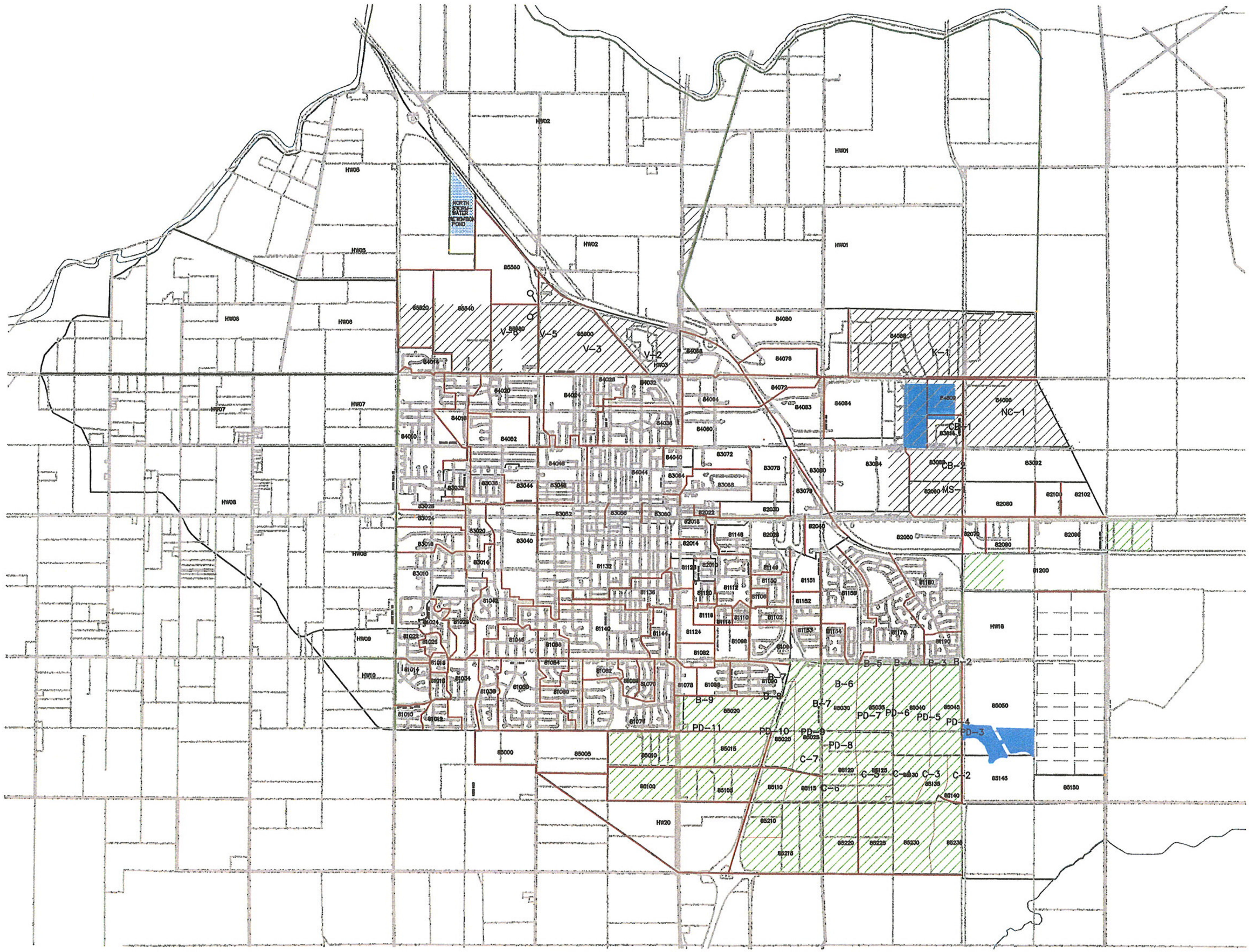

LEGEND

TRUNK SYSTEM DRAINAGE SHED BOUNDARY

SWMM MODEL SUBBASIN BOUNDARY

HEC-1 MODEL SUBBASIN BOUNDARY

NORTH URBAN GROWTH AREA

SOUTH URBAN GROWTH AREA

85035 SUBBASIN NUMBER

PD-4 NEW SUBBASIN NUMBER

NOTE:
FULL-SIZED COPY OF MAP 11 IS AVAILABLE FROM THE CITY OF WOODLAND PUBLIC WORKS DEPARTMENT.

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SCALE IN FEET

City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

ULTIMATE DRAINAGE SUBBASINS

WOOD RODGERS

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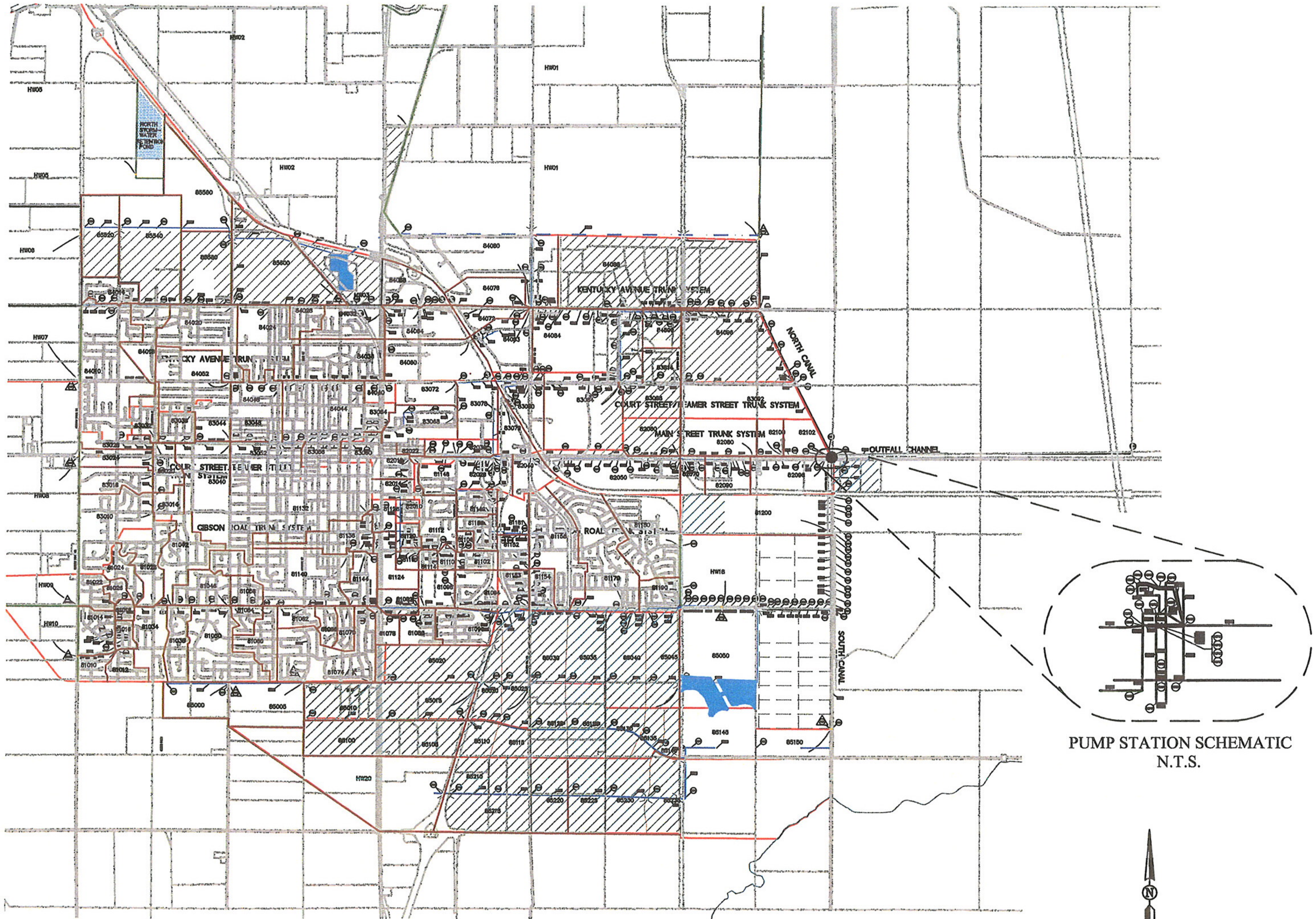

LEGEND

- EXISTING CHANNEL
- IMPROVED EXISTING CHANNEL
- PROPOSED CHANNEL
- PROPOSED STORM DRAIN
- PROPOSED PUMP STATION
- EXISTING STORM WATER DETENTION POND
- PROPOSED STORM WATER DETENTION POND
- PROPOSED STORM WATER RETENTION POND
- PROPOSED CROSSING
- PROPOSED LEVEE
- TRUNK SYSTEM DRAINAGE SHED BOUNDARY
- SWMM MODEL OPEN CHANNEL
- SWMM MODEL SUBAREA BOUNDARY
- HEC-1 MODEL SUBAREA BOUNDARY
- SWMM MODEL STREET OVERFLOW CHANNEL CONVEYING AGRICULTURAL RUNOFF
- 81190 SWMM MODEL SUBAREA NUMBER
- HW01 HEC-1 SUBAREA
- 10058 SWMM MODEL PIPE OR CHANNEL CONDUIT
- 81128 SWMM MODEL JUNCTION
- 81446 SWMM MODEL SUBAREA OUTFLOW JUNCTION
- HEC-1 SUBAREA OUTLET
- 70130 HEC-1 SUBAREA OUTLET AND SWMM INFLOW NODE

City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

ULTIMATE CONDITIONS STORM DRAINAGE SYSTEM MODEL CONFIGURATION

WOOD RODGERS

NOTE:
FULL-SIZED COPY OF MAP 12 IS AVAILABLE FROM THE CITY OF WOODLAND PUBLIC WORKS DEPARTMENT.

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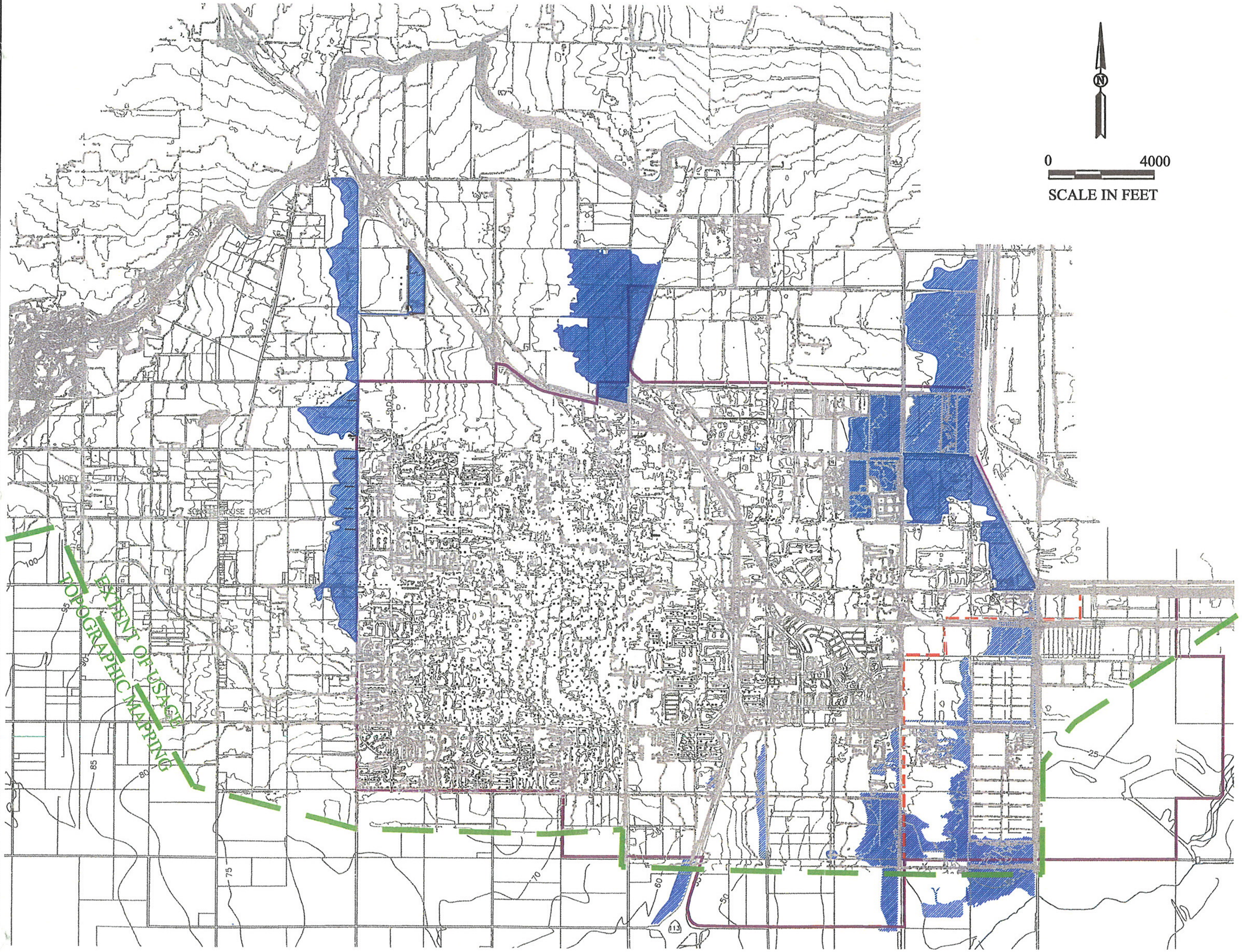

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SCALE IN FEET

LEGEND

URBAN LIMIT LINE

PLANNING AREA BOUNDARY

EXISTING 100-YEAR FLOODING

SOURCES:

1. USACOE, "CACHE CREEK FEASIBILITY STUDY," 2000. VERTICAL DATUM IS NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
2. USGS 7.5 MINUTE SERIES (TOPOGRAPHIC) WOODLAND QUADRANGLE, 1952 SERIES, PHOTO REVISED 1981. VERTICAL DATUM IS NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD 29).

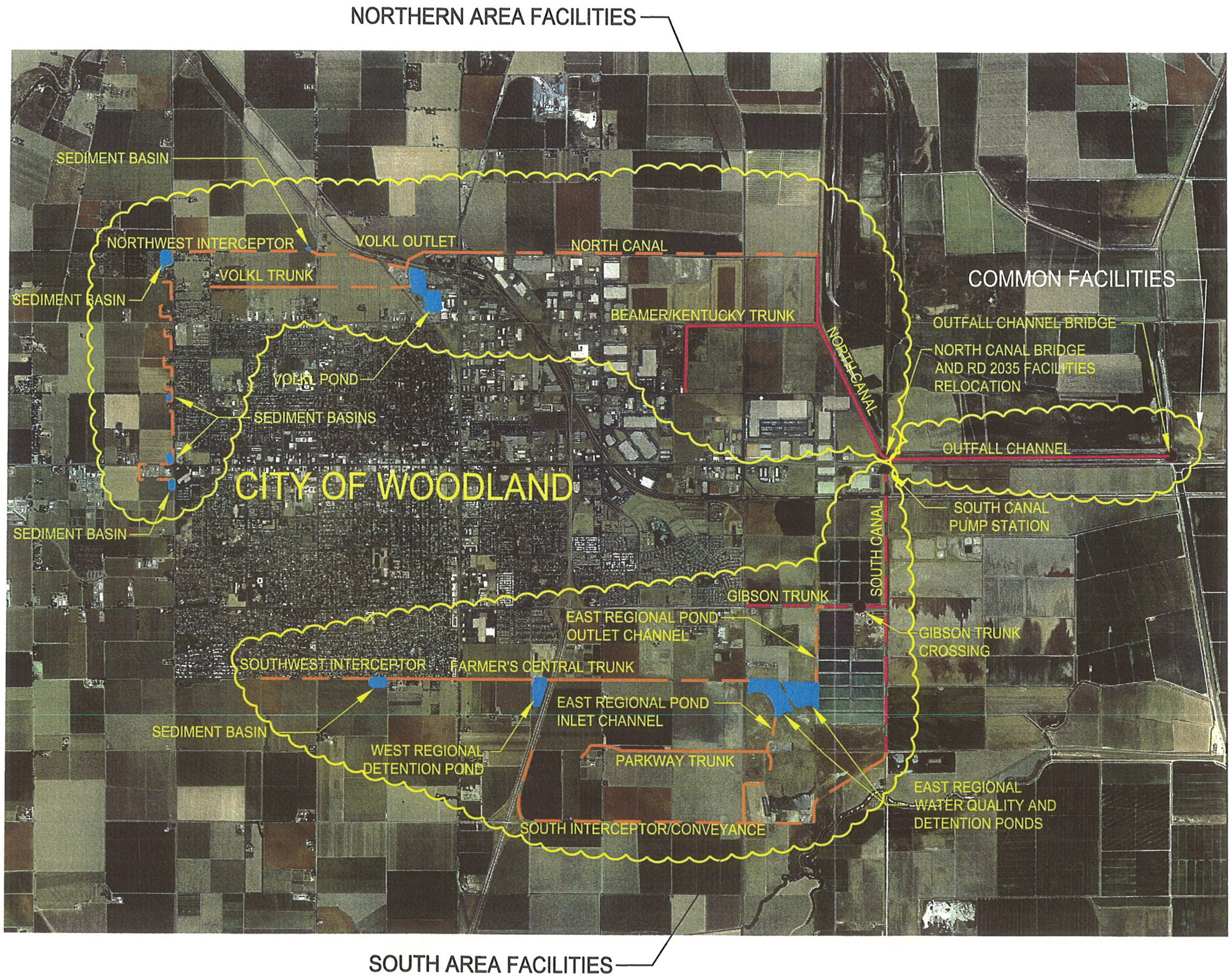
City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

EXISTING 100-YEAR FLOODPLAIN

WOOD RODGERS

MAP 13



LEGEND

- EXISTING CHANNEL
- IMPROVED EXISTING CHANNEL
- PROPOSED CHANNEL
- PROPOSED STORM DRAIN
- ▲ PROPOSED CROSSING
- ● PROPOSED PUMP STATION

SOURCE:
AERIAL PHOTO PROVIDED BY
AERIAL EXPRESS. AREA FLOWN 2002.

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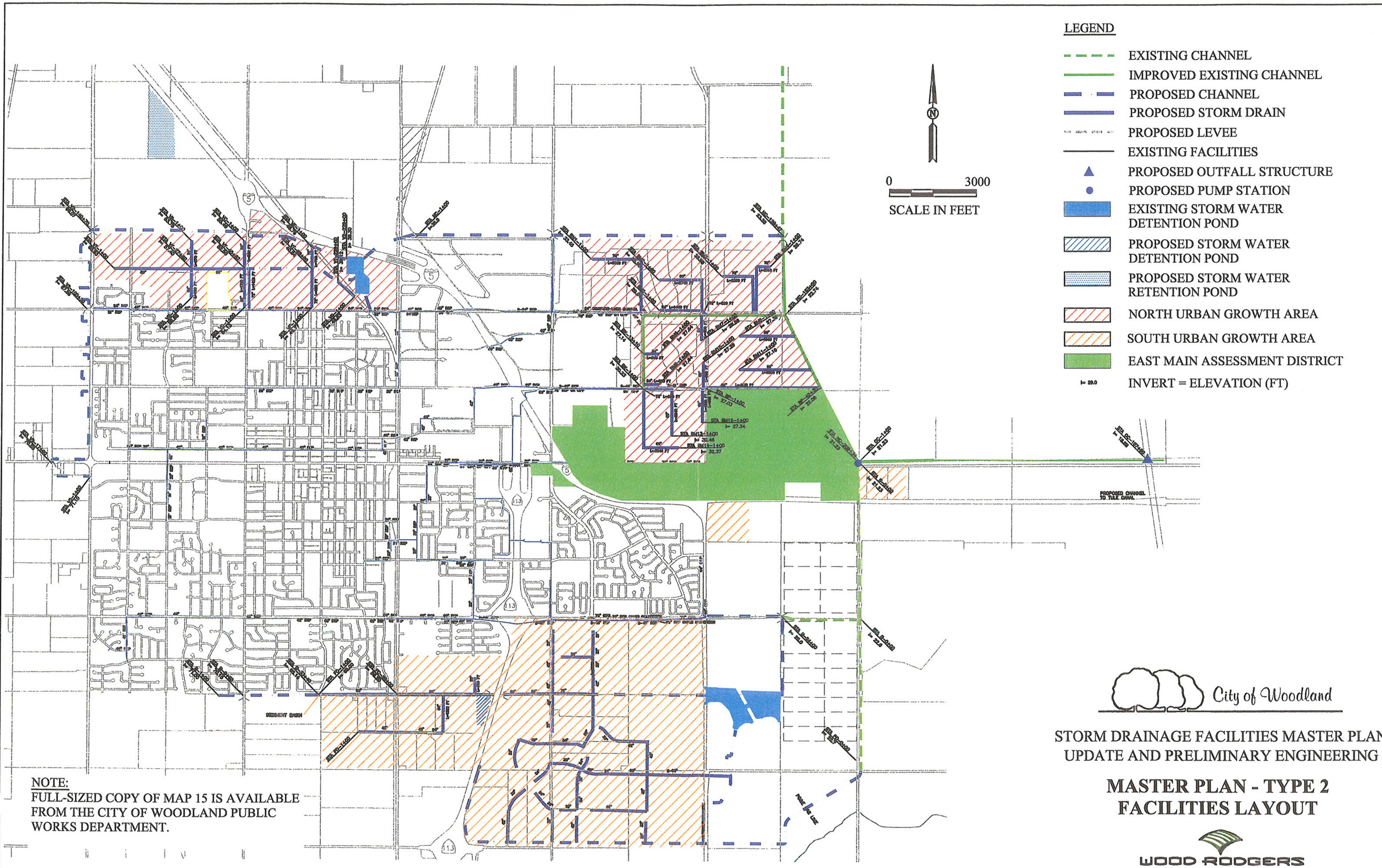
SCALE IN FEET

City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN
UPDATE AND PRELIMINARY ENGINEERING

MASTER PLAN FACILITIES LAYOUT

WOOD RODGERS



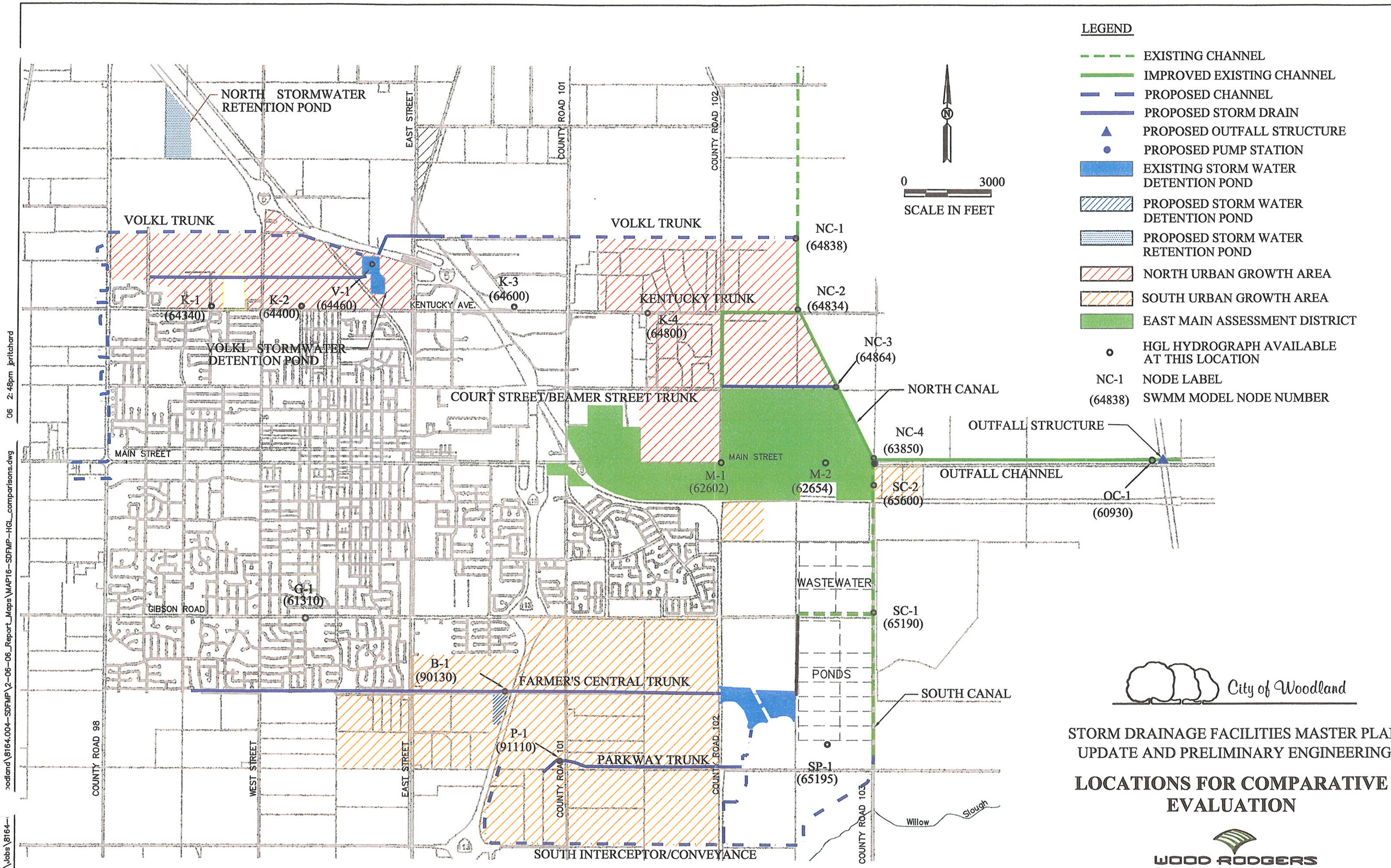
City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN
UPDATE AND PRELIMINARY ENGINEERING

MASTER PLAN - TYPE 2
FACILITIES LAYOUT

WOOD RODGERS

NOTE:
FULL-SIZED COPY OF MAP 15 IS AVAILABLE FROM THE CITY OF WOODLAND PUBLIC WORKS DEPARTMENT.



STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

LOCATIONS FOR COMPARATIVE EVALUATION

LEGEND

PHASE 1 AREA

PHASE 2 AREA

PHASE 3 AREA

PHASE 4 AREA

SOURCE:
AERIAL PHOTO PROVIDED BY
AERIAL EXPRESS. AREA FLOWN 2002.

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City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN
UPDATE AND PRELIMINARY ENGINEERING

DEVELOPMENT PHASING

WOOD RODGERS

MAP 17

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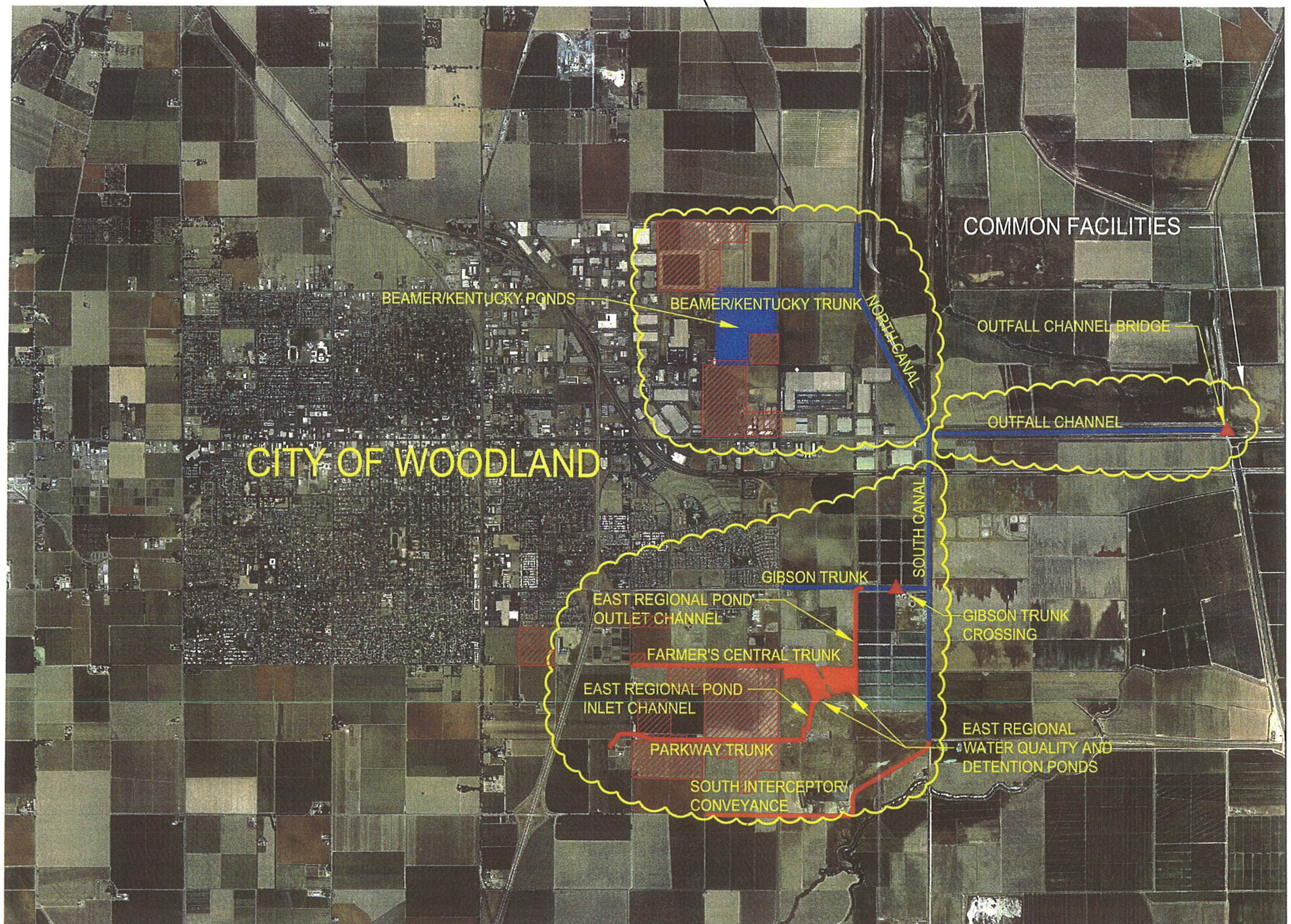
NORTHERN AREA FACILITIES



SOUTH AREA FACILITIES

LEGEND

- EXISTING FACILITY
- PROPOSED PHASE 1 IMPROVEMENT
- PHASE 1 CROSSING IMPROVEMENT
- PHASE 1 AREA

SOURCE:
AERIAL PHOTO PROVIDED BY
AERIAL EXPRESS. AREA FLOWN 2002.

NOTES:

1. TYPE 2 STORM DRAINAGE FACILITIES NOT SHOWN, SEE MAP 15.
2. STORM DRAINAGE FACILITES FOR THE NORTH AREA - PHASE 1 ARE ALL INTERIM FACILITIES

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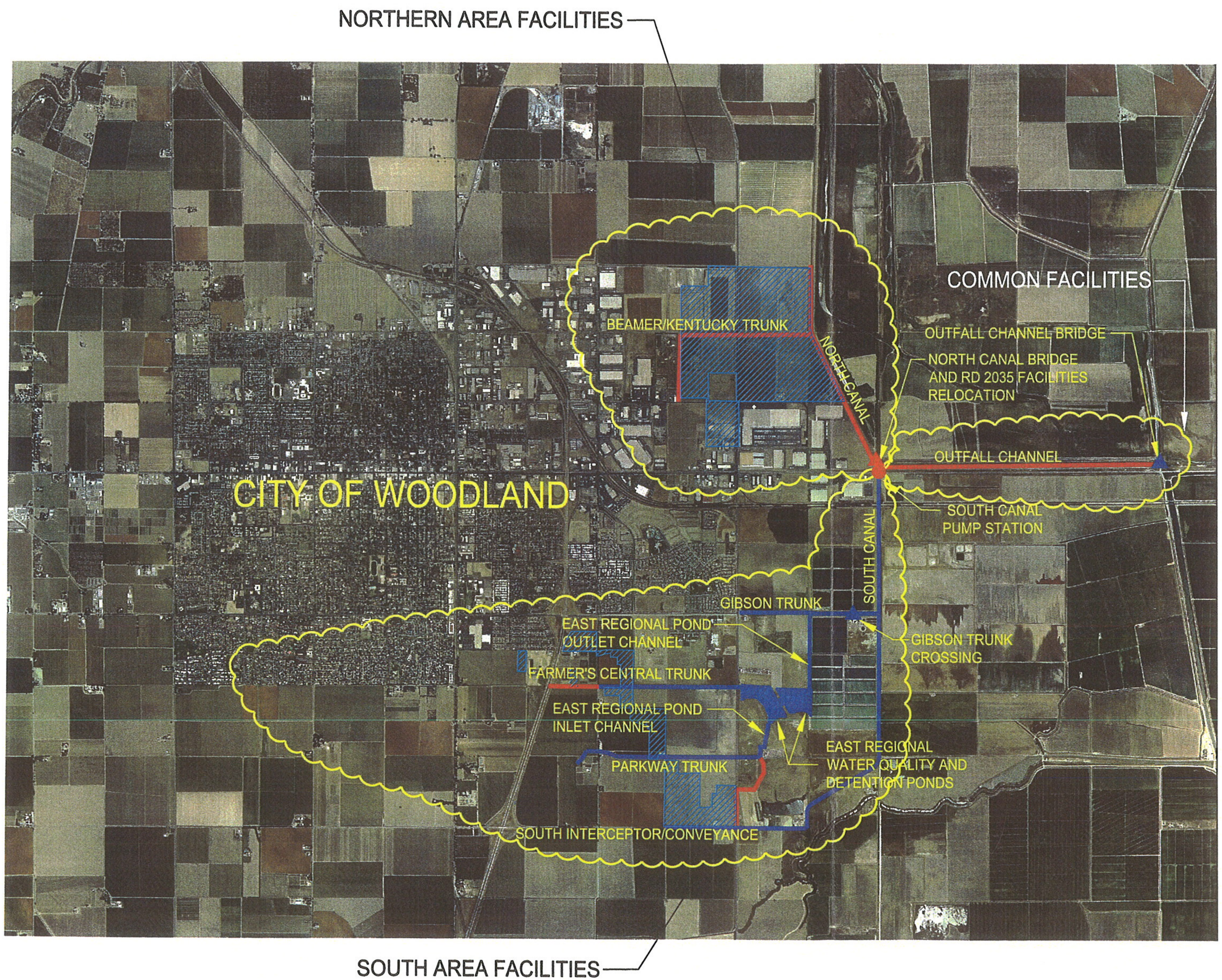
STORM DRAINAGE FACILITIES MASTER PLAN
UPDATE AND PRELIMINARY ENGINEERING

PHASE 1 FACILITIES LAYOUT

WOOD RODGERS



LEGEND

- EXISTING FACILITY (INCLUDES PREVIOUS PHASE)
- PROPOSED PHASE 2 IMPROVEMENT
- EXISTING CROSSING
- PHASE 2 CROSSING IMPROVEMENT
- PHASE 2 PUMP STATION IMPROVEMENT
- PHASE 2 AREA

SOURCE:
AERIAL PHOTO PROVIDED BY AERIAL EXPRESS. AREA FLOWN 2002.

NOTE:
IMPROVEMENTS TO THE NORTH CANAL AND OUTFALL CHANNEL ARE REQUIRED FOR THE NORTH AREA PHASE 2 ONLY.

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STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

PHASE 2 FACILITIES LAYOUT

WOOD RODGERS

MAP 19

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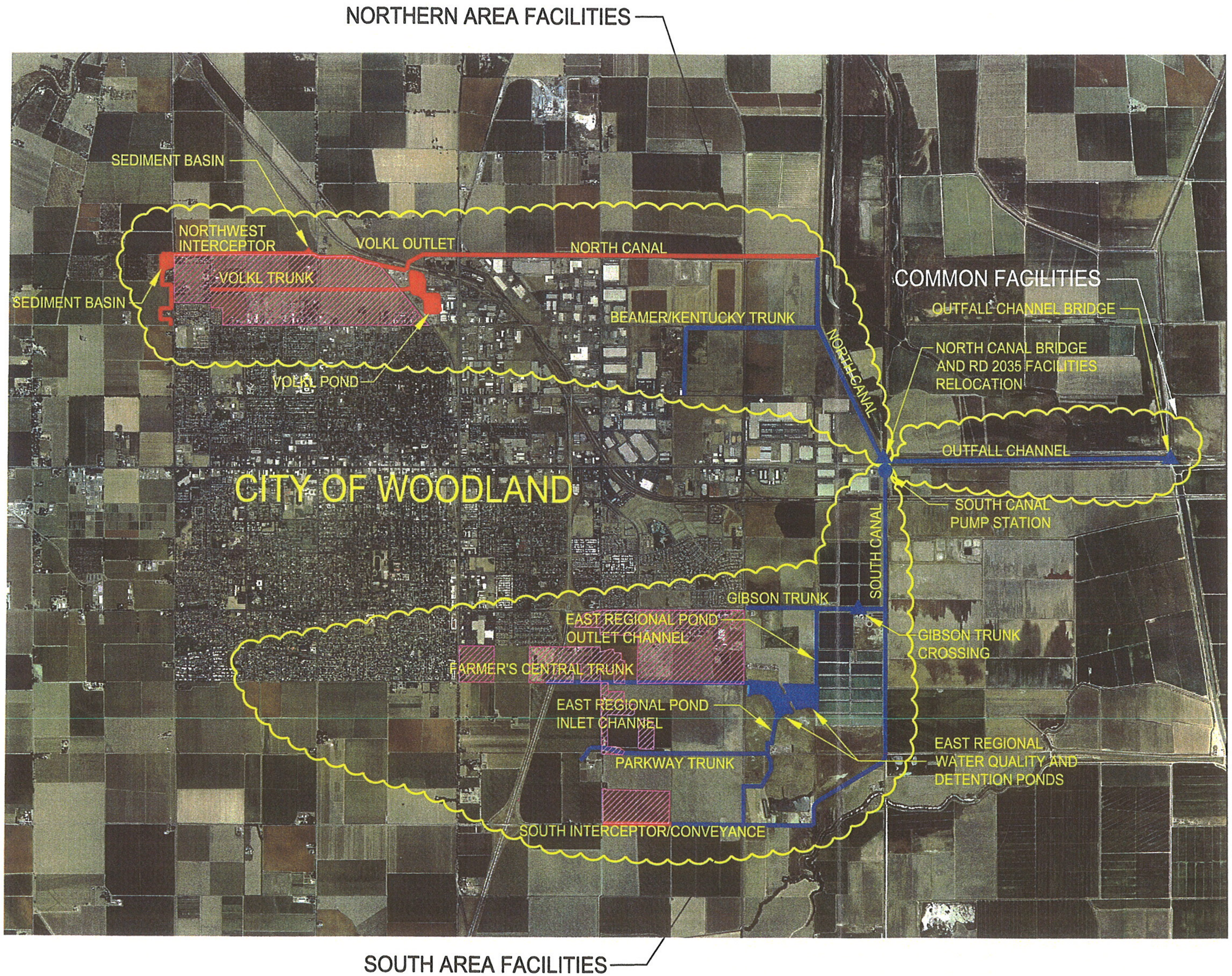

LEGEND

- EXISTING FACILITY (INCLUDES PREVIOUS PHASES)
- PROPOSED PHASE 3 IMPROVEMENT
- EXISTING CROSSING
- EXISTING PUMP STATION
- PHASE 3 AREA

SOURCE:
AERIAL PHOTO PROVIDED BY AERIAL EXPRESS. AREA FLOWN 2002.

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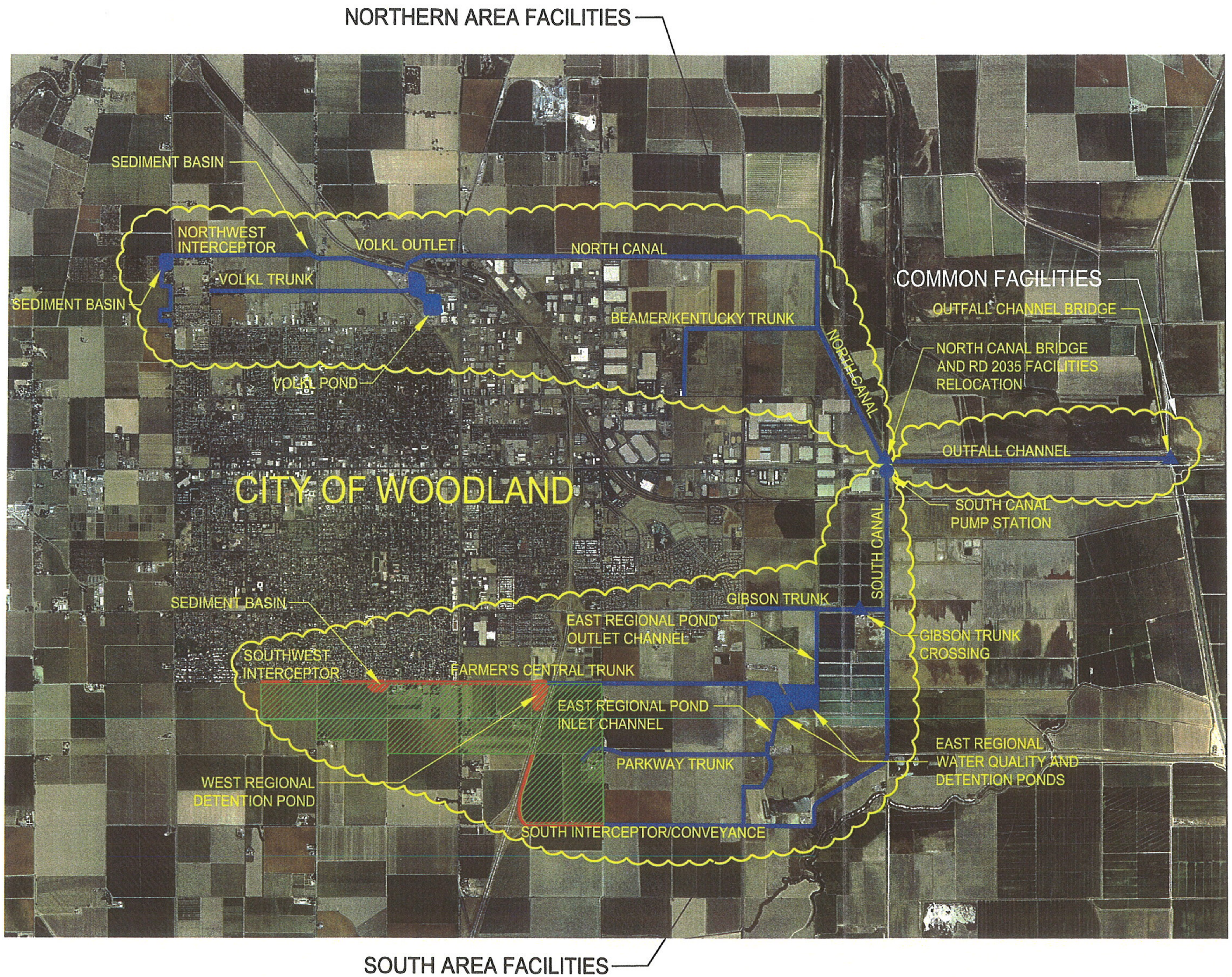
City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

PHASE 3 FACILITIES LAYOUT

WOOD RODGERS

MAP 20



LEGEND

EXISTING FACILITY (INCLUDES PREVIOUS PHASES)

PROPOSED PHASE 4 IMPROVEMENT

EXISTING CROSSING

EXISTING PUMP STATION

PHASE 4 AREA

SOURCE:
AERIAL PHOTO PROVIDED BY AERIAL EXPRESS. AREA FLOWN 2002.

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SCALE IN FEET

City of Woodland

STORM DRAINAGE FACILITIES MASTER PLAN UPDATE AND PRELIMINARY ENGINEERING

PHASE 4 FACILITIES LAYOUT

WOOD RODGERS

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