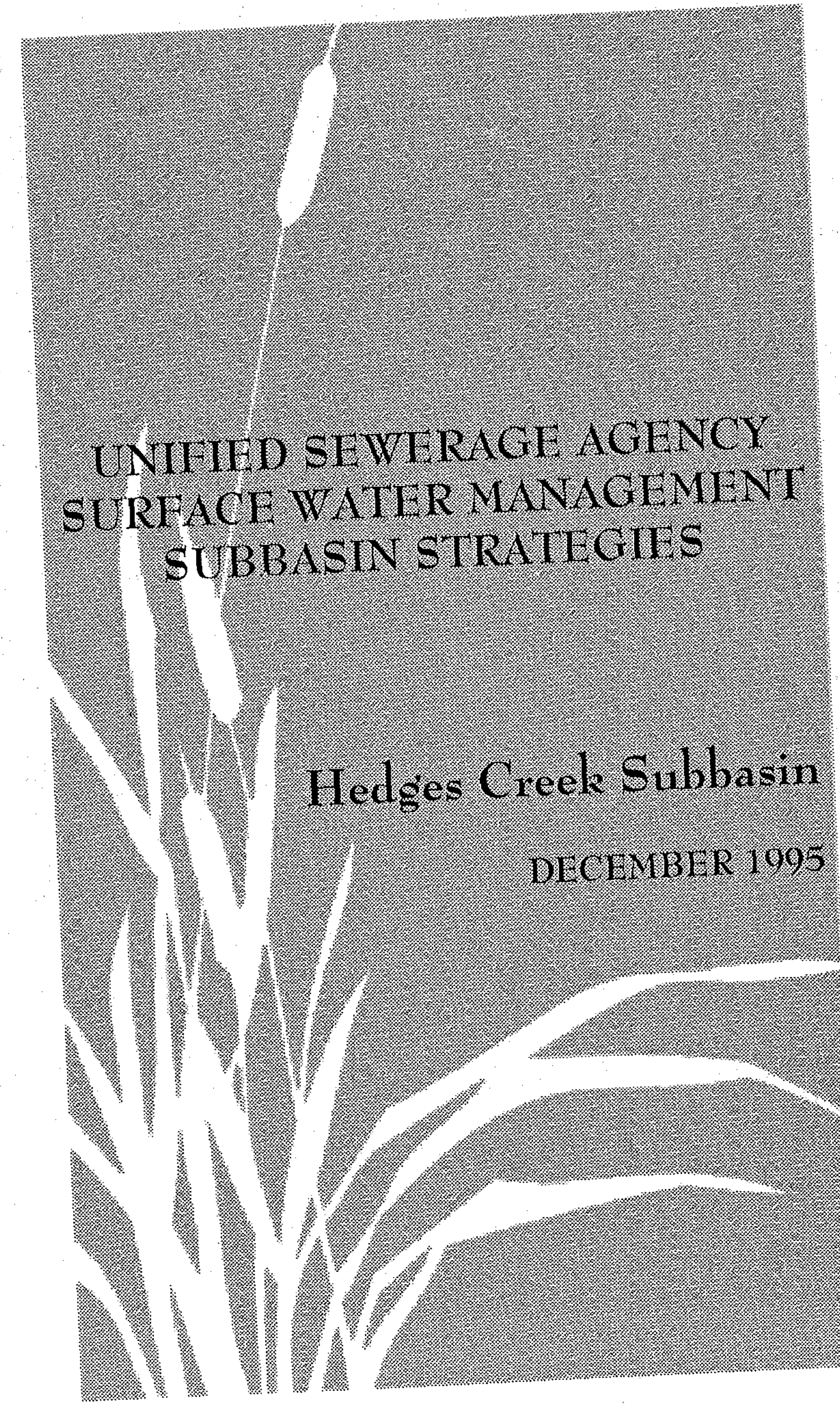

UNIFIED SEWERAGE AGENCY
SURFACE WATER MANAGEMENT
SUBBASIN STRATEGIES

Hedges Creek Subbasin

DECEMBER 1995

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DECEMBER 1995

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CHAPTER I

CHAPTER I

CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations presented herein were developed based on technical information presented within this report and nonpoint source pollution research and planning currently underway within the Tualatin Basin. This chapter includes four subsections as follows:

- Purpose
- Recommended Subbasin Strategies
- Schedule
- Goals, Objectives, Strategies, and Findings

PURPOSE

The Hedges Creek Subbasin Strategies report is the third in a series of Unified Sewerage Agency (USA) storm water and nonpoint source pollution plans. The first entitled Surface Water Management Plan provided the overall framework for planning and focused on the USA maintenance activities. The second entitled Tualatin Basinwide Report and Technical Guidelines, presents the planning and technical guidance for use in developing individual subbasin plans.

The Hedges Creek Subbasin Strategies outlines the specific management activities and facilities recommended to manage water quality and quantity problems within the subbasin. The original management plan was completed in October 1992 by USA assisted by their technical consultant team led by Brown and Caldwell Consultants. A hydraulic study of the Hedges Creek Marsh was completed by Montgomery Watson in February 1995. The Hedges Creek Marsh, for the purposes of this study, is defined as the City of Tualatin Wetland Protection District, which is located between Tualatin Road and Pascuzzi Pond, along the creek south channel. The focus of the hydraulic study was to develop and evaluate alternatives for solving drainage problems within the Marsh and develop management activities for protecting the Hedges Creek Marsh. The results of the hydraulic study are presented in Appendix B and incorporated into this management plan.

RECOMMENDED SUBBASIN STRATEGIES

The recommended subbasin strategies for the Hedges Creek subbasin are management techniques designed to control water quantity and quality problems associated with urban storm water runoff. Water quantity control measures focus on a combination of storm water conveyance system improvements and onsite detention storage. Water quality control measures center on sedimentation and biofiltration processes to remove suspended particles and the pollutants associated with these particles.

The recommended Hedges Creek subbasin strategies consist of the following programs:

- Implement Requirement for Onsite Detention for New Development Upstream of Hedges Creek Marsh
- Continue Non-Structural Activities, such as Public Education
- Implement a Visual Assessment Program for the Hedges Creek Marsh
- Implement Recommended Drainage System Improvements
- Develop Pre-Treatment Facilities and Pollution Reduction Facilities (PRFs) for Hedges Creek Marsh
- Implement Water Quality Facilities Demonstration Projects
- Continue Water Quality Monitoring
- Implement Beaver Management Strategy

A brief discussion of each of the program elements is presented in the following paragraphs.

Onsite Detention

This element involves revising ordinances for new development as needed to require onsite stormwater detention for areas upstream of the Hedges Creek Marsh. New development sites would be required to release stormwater from the sites at a rate no greater than that existing prior to development for storms up to and including the 25-year event. This requirement will reduce future flood flows and will help protect the downstream creek channels and marsh form erosive flow velocities during storms.

Non-Structural Activities

This element involves continuation of existing surface water management (SWM) programs being conducted by USA. The existing programs consist of ideas, practices, and approaches that are generally applicable throughout the Tualatin River basin, yet are a critical component of each subbasin strategy. They are programs that could be considered the "software" of USA's surface water management, as compared with the subbasin specific "hardware" that will include constructed items such as pipes, culverts, detention basins, sedimentation ponds, grass swales, wet ponds, constructed wetlands, etc. Examples of USA's surface water management "software" programs are listed below with a short description of what each program accomplishes.

Parks Program -- USA coordinates with various park agencies within the Tualatin River Basin to protect open areas, stream corridors, and wetlands.

Coordinate Publications -- USA works with other government agencies as well as private individuals to produce publications such as the Surface Water Quality Facilities Technical Guidance Handbook and Tualatin River Brochure.

USGS/OGI River Study -- USA works with the US Geological Survey and the Oregon Graduate Institute to study the soil/water/groundwater interaction to determine the best technical approach to solving water quality problems in the Tualatin River which will lead to the most cost beneficial solutions.

Training -- USA obtains training for its personnel and makes training available for city personnel in the most technically advanced and cost-effective approaches to achieving water quality goals and objectives set forth by the State and the public. Examples include erosion control training and surface water maintenance programs.

Event Support -- USA supports regional events such as the Tualatin River Discovery Day by participating in the planning, and by funding, printing materials, providing guides and speakers.

Conference Participation -- USA staff participates in many regional conferences such as "Country in the City", "Governors Watershed Enhancement Board Conference", "Pacific Northwest Pollution Control Association", "American Public Works Association", "Oregon Community Foundation/Tualatin Basin Endowment Fund", and others by funding and by providing staff for informational booths and as speakers.

Technical Support -- USA provides technical support, data, and information to citizen's organizations such as The Wetlands Conservancy and citizen's participation organizations (CPOs).

Development Review -- USA and city staff review and determine conditions of all proposed development plans to verify compliance with water quantity and quality ordinances.

Dredge and Fill Permits -- USA reviews and comments on wetland dredge and fill permits administered through the Oregon Division of State Lands and the US Army Corps of Engineers.

Public Involvement -- USA holds public involvement committee meetings for each specific Surface Water Management program in order to incorporate citizen input into the planning process.

Public Awareness/Education Programs -- Effective control of nonpoint source pollution prior to entering the receiving waters is one of the most cost-effective control strategies. Public information and education programs will continue to play an important role in preventing pollution at the source:

- *Tualatin River Rangers* -- elementary education program provides presentations and booklets to over 5,000 4th graders in our basin (and potentially 10,000 adults) each year.

- *Storm Drain Stenciling* -- USA set the County Guidelines for stenciling the message "DUMP NO WASTE, DRAINS TO STREAM" as a community service project. Materials and coordination are a service by USA for volunteer groups who can leverage pollution prevention efforts.

- *Newspaper Inserts* -- Twice yearly USA will continue to send a flier to all homes in its district to present pollution prevention progress and tips.

- *Billing Inserts* -- Informational billing inserts are included with many utility bills.

- *Pamphlets* -- Surface Water Management informational pamphlets with pollution prevention tips are distributed at USA, some cities and at presentations and environmental fairs.

- *Displays* -- USA will continue to have informational displays at every event the staff can attend. Staff currently attends each environmental fair, county fair, city event, and education event possible.

- *Volunteers* -- USA is setting up procedures and guidelines for any volunteer groups who can help "spread the word" by managing: storm drain stenciling, stream cleanups, streamwalk programs, citizen monitoring, and workshops.

Aerial Imaging -- The agency will continue to identify nonpoint source pollution through aerial imaging, aerial analysis and through site observations where pollution problems exist and address the situation through letters and personal visits or other means.

Source Control -- USA staff will be reviewing industries located near streams and wetlands to determine if they are in compliance with the Agency's industrial site regulations. Sites will also be reviewed to determine if they have received a National Pollution Discharge Elimination System (NPDES) general stormwater permits from the Oregon Department of Environmental Quality (DEQ) if needed. If not USA will send the industries a letter referring them to DEQ. This has already been preformed by USA for the Hedges Marsh area between Teton and Tualatin Roads.

Marsh Visual Assessment Program

This program element involves implementing a regular, seasonal, visual monitoring of the Hedges Marsh at key locations. The visual monitoring data forms and map are presented in Appendix B. Collected information should be reviewed and compared annually to evaluate relative marsh health over time. If significant negative trends are detected, the marsh should be evaluated further to try to determine causes and potential needs for new or revised water quality /quantity protective measures.

Drainage System Improvements

Improvements to the Hedges Creek drainage system are recommended to solve existing drainage problems and provide for future development. Most of the recommended projects are located in the lower areas of the subbasin and are recommended to solve existing drainage problems. The total cost associated with conveyance system capital improvements is $1,374,325. The projects are prioritized with lower priority projects driven by development trends.

Many of the recommended improvements presented in the 1992 edition of the subbasin plan have already been implemented as part of highway improvements. This is particularly true for the Tualatin-Sherwood Road where a number of culvert replacement projects were completed as part of a road widening and upgrade project.

Approximately $362,500 was identified for planning, design, and construction of stream enhancement projects. The focus of these projects is to stabilize existing channels and prevent erosion and sedimentation within the channels as well as restoring riparian areas. This estimate was based on approximately 5000 linear feet of potential creek restoration/enhancement between Pascuzzi Pond and southwest Ibach Street. The actual length of needed and feasible enhancement projects will be confirmed during plan implementation.

Pretreatment Facilities and Pollution Reduction Facilities

The Hedges Creek Marsh lies in the lower eastern area of the subbasin just upstream from the Tualatin River. The marsh is a valuable natural wetland which supports a wide variety of vegetation, aquatic species, and wildlife. Storm water from upland areas currently enters the Hedges Creek Marsh as well as direct inputs from development adjacent to the Marsh. In order to protect the marsh from urban storm water pollutants, pretreatment facilities are recommended to treat storm water runoff prior to entering the Marsh.

Pre-treatment facilities fall in two categories:

- Onsite facilities for development adjacent to the Marsh
- Regional Pollution Reduction Facilities (PRF's)

Onsite facilities may be implemented by the industrial and light manufacturing development adjacent to the Marsh as part of their National Pollutant Discharge Elimination System (NPDES) permitting requirements from the Oregon Department of Environmental Quality (DEQ). The onsite facilities would be designed to control sediment loads and oils and grease. Source control activities would also be required to prevent toxic chemical spills. Storm water management plans developed by these industries as part of Industrial Storm Water NPDES Permitting Process should include measures to effectively protect the Hedges Creek Marsh. The NPDES process provides an avenue to ensure adequate control measures are implemented by these industries.

It is also recommended that areas of residential, commercial, and industrial development which currently discharge directly into the marsh or creek be evaluated by the City for opportunities and feasibility to construct pretreatment facilities. Runoff from residential and light commercial development can be pretreated through relatively simple facilities such as sedimentation manholes equipped with oil/water separator baffles or elbows.

Additionally, new development in the basin will continue to be required to construct onsite water quality facilities to meet Tualatin Basin Total Maximum Daily Loads (TMDL) regulations.

Limited sites are available within the subbasin for regional water quality facilities; these were identified as part of the subbasin strategies. The estimated capital cost for three recommended regional facilities is $221,200. Stream enhancement projects are also recommended to stabilize stream banks and reduce erosion and sedimentation.

Additionally, the existing Hedges Creek Marsh will, in effect, serve as a regional "nutrient polishing" natural wetland. Soluble nutrient loads will continue to flow into and provide the marsh with sufficient nutrient levels to sustain vegetative growth. Suspended particulates and associated pollutant and nutrient loads will be removed via pretreatment facilities.

Demonstration Projects

A broad cross-section of the storm water facilities presented in the Surface Water Quality Facilities Technical Guidance Handbook will be implemented as demonstration projects to determine which are the most efficient and cost-effective. These demonstration projects are intended to expand upon the database being developed from existing or recently planned demonstration projects. In addition to USA facilities, data from demonstration projects implemented by other jurisdictions and developers will be evaluated and integrated within the program to determine the most efficient and cost effective control measures. This data will be used in the design process for capital improvements to ensure that the most efficient and cost-effective management techniques are implemented.

Water Quality Monitoring

This element involves continuing USA's extensive water quality monitoring program. The water quality monitoring program provides data which will:

- Aid in the identification of pollutant sources
- Monitor the effectiveness of implemented activities in meeting surface water management objectives
- Provide baseline water quality data to establish water quality trends

The initial objectives of the water quality monitoring program are to aid in the identification of pollutant sources within the subbasin and monitor the effectiveness of implemented activities in meeting surface water management objectives. Water quality data will provide valuable insight into the pollutant sources within the subbasin and the effectiveness of measures implemented to control them.

Water quality data will also be valuable in quantifying pollutant trends. This information is important when determining cost effective design and implementation of capital intensive pollution reduction facilities.

Beaver Management

This element involves implementation of a beaver dam maintenance program for the Hedges Creek marsh area and North channel. Beaver frequent this area and beaver dams can cause flooding concerns in some locations. Beaver dams should be restricted to the south channel and marsh area such that backwater from dams does not extend any further west than 500 feet east of Teton Avenue (approximate cross-section 10 in the HEC-2 hydraulic model of the marsh area). The height of beaver dams should be such that they do not extend into over-bank areas. Beaver dams should be removed if they appear in the south channel between cross-section 10 and Pascuzzi Pond or in the North channel.

It is additionally recommended that a plug be constructed in the south end of the north-south channel located at the west side of the Zian property, and any necessary maintenance preformed to allow local drainage to drain to the north channel. This will reduce concerns by local property owners about backwater flooding from beaver dams in the marsh and south channel.

Subbasin Strategy Implementation

The surface water management program elements described above are all elements of the subbasin strategies which have been implemented or will be implemented based on development trends and priorities within the subbasin. The recommended implementation schedule for the subbasin focuses on those measures which provide the highest benefits. In general, solving existing drainage problems and implementing source control activities are the highest priority activities. Preliminary design of a regional water quality facility at Avery Street has also been initiated. The Phase I capital improvement projects presented in Table I-1 and the overall management program elements represent those measures. Capital projects listed in Table I-1 are identified by a project number (for reference to Figure I-1) and by a priority number (1= highest priority).

Table I-1 Hedges Creek Subbasin Recommended Projects

Project No./ Priority	Description	Construction Cost ($)	Engineering (25%)	Permitting (10%)	S&A* (10%)	Subtotal ($)	Cont. (25%)	Total Project Cost ($)
CONVEYANCE PROJECTS								
1/6	9'X18' Arch Culvert at Tualatin Road	246,000	62,000	25,000	25,000	358,000	89,500	447,500
3/2	48" RCP Culvert at Herman Road, channel improvements to Tualatin Rd and Sweek Pond outlet modifications as necessary	250,000	62,500	25,000	25,000	362,500	90,625	453,125
6/3	New Channel (1300 LF) & upstream channel improvements and new diversion weir at Pascuzzi Pond	50,000	13,000	5,000	5,000	73,000	18,250	91,250
7/1	Two 5.5'x5.5' Box Culverts in South Channel at Teton Avenue and channel improvements upstream and downstream	90,000	22,500	9,000	9,000	130,500	32,625	163,125
8/5	Two 54" RCP Culverts at Herman Road	75,000	18,750	7,500	7,500	108,750	27,200	135,950
21/4	Two 36" RCP Culverts at Cipole Road	22,000	5,500	2,200	2,200	31,900	7,975	39,875
26/7	48" RCP Culvert at Ibach Road	24,000	6,000	2,400	2,400	34,800	8,700	43,500
Subtotal								$1,374,325
WATER QUALITY AND DETENTION PROJECTS								
	Stream Enhancement, various locations	200,000	50,000	20,000	20,000	290,000	72,500	362,500
10/1	Combined Detention and PRF at Avery and Tualatin-Sherwood Rd	35,000	8,750	3,500	3,500	50,750	12,750	63,500
14/2	PRF - Pond outlet improvements at Tri-County Industrial Park Pond	25,000	6,250	2,500	2,500	36,250	9,050	45,300
11/3	PRF - South of Tualatin-Sherwood Rd, East of 120th	62,000	15,500	6,200	6,200	89,900	22,500	112,400
Subtotal								$583,700
TOTAL								$1,958,025

*Supervision and administration during construction.

GOALS, OBJECTIVES, STRATEGIES, AND FINDINGS

The goals and objectives adopted by the USA advisory committees for surface water management presented in following sections were used to guide the development of the Hedges Creek Subbasin recommendations. These goals/objectives and the associated strategies form the foundation of the USA surface water management program.

A discussion of the Hedges Creek Subbasin Strategies in terms of meeting the USA Tualatin Basin goals and objectives is presented in the following section. The purpose of these findings are to identify those objectives and strategies which will be achieved during the implementation phase of the subbasin strategies or as part of the basinwide surface water management program.

Program Goal: *To provide and maintain a regional system of urban-surface water management facilities, policies, practices, and controls that will protect the public's safety, health and property; conserve - and - where possible - enhance the natural systems of the Tualatin River basin; and comply with local, state, and federal regulations.*

Objective #1. Enhance and maintain water quality for the Tualatin River and its tributaries to support beneficial uses of the water.

Strategy: Conserve, enhance, and maximize the source, volume, and efficient use of useable water resources.

Finding: *The surface water management plans focus on drainage control and maintaining acceptable levels of water quality through management of surface water runoff. These elements are key components in comprehensive management of available water resources.*

Strategy: Identify all major surface water pollutants and pollution sources and develop programs to meet Objective #10.

Finding: *Typical surface water pollutants such as total solids, nutrients, metals, and fecal coliform are identified through aerial imaging and water quality monitoring. These and other programs such as erosion control ordinances and the public information program are examples of programs developed and implemented to meet Objective 10.*

Strategy: Use implementing measures which are flexible enough to provide the option for use of new, innovative, and creative technologies and practices (e.g. seasonal variations due to different rainfall conditions) in the future so long as performance standards are met.

Finding: *Implementation of the surface water management plan is based on providing flexibility for incorporation of additional data, technologies, or practices which prove to be effective measures in meeting performance standards. This flexibility will be achieved through "phasing' of implementation activities. Those measures which provide proven benefits will be implemented initially. Additional data will be collected for water quality projects via demonstration projects and water quality monitoring to guide implementation of lower priority elements.*

Strategy: Analyze local Comprehensive plans for their efficacy regarding water quality objectives under Goal 5 and make appropriate recommendations during Periodic Review to incorporate water quality values into local Goal 5 programs.

Finding: *Local comprehensive plans will be reviewed as part of the subbasin management plans implementation process to ensure consistency between the plans and the subbasin strategies. Adopted plans will be recommended for incorporation during the periodic review.*

Strategy: Be integrated with local comprehensive plans to require protection of existing streams and wetlands to achieve water quality objectives.

Finding: *Protection of existing streams and wetlands is recommended within the subbasin plans which is consistent with local comprehensive plans.*

Strategy: Distribute responsibility for addressing water quality issues proportionally among agricultural, forest, and urban lands according to their contribution to the problem.

Finding: *Work is currently underway to quantify the pollutant loadings from agricultural, forest, and urban lands. This data will be used to distribute responsibility for water quality issues proportionally to those responsible.*

Strategy: Require basin-wide protection of existing tributaries and the Tualatin River and their associated wetlands to achieve water quality objectives.

Finding: *Erosion control ordinances and buffer strip requirements are currently in place and enforced to protect existing tributaries, the Tualatin River, and associated wetlands. Wetland inventories have been completed for Hedges Creek subbasin.*

Objective #2. Coordinate plans, systems, and policies of the program with those of other jurisdictions and governmental agencies within the Tualatin River watershed.

Strategy: Be coordinated with affected jurisdictions outside the USA's service territory.

Finding: Coordination efforts with other jurisdictions occurs through monthly Tualatin River basin meetings which include representatives from Oregon Department of Agriculture (ODA), Oregon State Department of Forestry (OSDF), Multnomah County, Clackamas County, Unified Sewerage Agency (USA) and the cities of Lake Oswego, West Linn, and Portland. This committee focuses on basin-wide issues such as responsibility distribution, funding requirements, and sharing of technical information.

Strategy: Be coordinated with open space, parks and recreation programs to ensure multiple objective management is being pursued on all urban stream corridors within USA's service territory. A multi-objective management program should integrate water quality objectives with parks and open space as well as other beneficial uses of urban streams and the Tualatin River.

Finding: The City of Tualatin Parks Department has reviewed the plan and determined that it is compatible with their plans and objectives.

Strategy: Be coordinated with relevant state and federal standards.

Finding: Subbasin strategies were developed to meet state and federal standards for surface water management and water quality objectives.

Objective #3. Provide for long-term drainage control needs of the Tualatin River basin.

Strategy: Distribute responsibility for addressing water quantity issues proportionally among agricultural, forest and urban lands according to their contribution to the problem.

Finding: The subbasin plans outline responsibility for drainage problems between existing and future urban development within the subbasin. Division of responsibility between agricultural, forest, and urban lands should be achieved through a basin-wide flood control program.

Objective #4. Protect the physical and biological integrity of wetlands, stream corridors, and fish and wildlife habitat.

Strategy: Monitor and comment on the Goal 5 element of local comprehensive plans to ensure that the Tualatin River and its tributaries are adequately protected to ensure multiple benefits, including water quality, are retained through time.

Finding: *Review and coordination with Goal 5 elements of local comprehensive plans will be completed as a part of the implementation of the surface water management plan. USA is currently commenting on Oregon Division of State Lands (DSL) and Corps of Engineers (COE) permit applications for wetlands and stream corridor modifications.*

Strategy: Assist all local jurisdictions in adopting consistent, effective stream corridor management policies regarding buffers for fish, wildlife, and water quality benefits.

Finding: *Meeting water quality objectives set for the Tualatin River subbasins requires effective management of stream corridors. Passive management measures presented within the plan focus on retention of natural systems for both drainage and water quality. These measures will provide the guidelines for effective water quality and quantity management which in turn provides positive benefits for fish and wildlife. Any additional regulations and ordinances necessary to achieve these objectives will be developed as part of the regulation and review process identified on the program schedule.*

Strategy: Utilize the best available data to continue long-term monitoring of all streams in the Tualatin basin to assess the effectiveness of local comprehensive plans in protection of stream corridors. If trends indicate cumulative degradation of urban stream corridors, remedial action should be taken in all jurisdictions to alleviate sources of stream degradation.

Finding: *On-going water quality monitoring program provides data on the water quality trends occurring within the Tualatin basin. Remedial actions necessary to control pollution sources are being developed based on this data.*

Strategy: Be integrated with the Division of State Lands and the US Army Corps of Engineers programs to ensure early action on the part of USA with respect to water quality issues.

Finding: *USA currently comments in DSL and COE wetlands permit review process and will reflect discussions and issues in subbasin strategies.*

Strategy: Minimize discharges of potential pollutants which might degrade any stream or natural corridor.

Finding:	*Control of nonpoint source pollutants is achieved through primarily source control via erosion control ordinances and public information programs. Source control efforts are enhanced through aerial imaging and water quality monitoring activities. These activities are also effective in monitoring the effectiveness of water quality management measures. Activities to eliminate non-permitted point sources are also underway as part of the NPDES storm water permitting process.*
Strategy:	Emphasize the use of passive water quality treatment facilities.
Finding:	*Passive water quality facilities are the primary type of facility recommended throughout the basin.*
<u>Objective #5.</u>	Encourage compliance with regulations relating to development in floodplains and wetlands and encourage identification of potential regional facility sites.
Strategy:	Minimize the amount of developable land needed for water quality and quantity facilities to the greatest extent possible, consistent with regional open space and wildlife habitat programs, local comprehensive lands to protect Goal 5 resources, and Objective #12.
Finding:	*Management plans focus on minimizing impacts on developable land for water quality and quantity purposes. These plans focus on enhancing existing passive opportunities which are consistent with the objectives of regional and local open space and wildlife habitat programs.*
Strategy:	Make sure development in western areas of the County (i.e. areas not included in the targeted first part of Subbasins projects) does not eliminate options for regional facilities.
Finding:	*This strategy does not apply to the Hedges Creek Subbasin Strategy Plan.*
<u>Objective #6.</u>	Establish funding mechanisms that equitably distribute cost.
Strategy:	Distribute payment for the system according to responsibility for creating water quality and quantity problems. For example, new and existing users; agricultural, forest, and urban lands; and current development and future developments should all pay a fair share. Implementation methods for systems developments charge may provide guidelines for establishing equitable fee structures in some cases.

Finding: *Distribution of payment for the urbanized areas has been made between existing and future development via monthly service and system development charges. Equitable distribution of costs between urban, forest, and agricultural lands is the responsibility of the State and will be expressed in terms of the wasteload allocations (WLA) and load allocations (LA). USA's monitoring and research will contribute to an equitable distribution of allocations and responsibility.*

Strategy: Be integrated with other programs to cost share and otherwise reduce overall costs of the program. This can be achieved to some extent by combining stream restoration efforts, fish recovery programs, parks and open space planning, sanitary sewer, road projects and other beneficial uses with other water quality objectives.

Finding: *Implementation of the surface water management plans will be coordinated with other programs throughout the basin to reduce overall program costs. Sharing costs and/or information on data collection, research, pollutant source identification, and public information programs are activities which present potential cost savings through inter-jurisdictional coordination.*

Objective #7. Encourage the development of regulations that are consistent, predictable, and equitable region-wide.

Strategy: Provide standards that are the same throughout the system.

Finding: *Design standards for water quality facilities are based on technical guidance provided within the technical guidance handbook developed by Clackamas County, USA, and the cities of Lake Oswego and Portland. Consistent standards for development of subbasin strategies is presented in the USA Tualatin Basin-wide Report and Technical Guidelines. Current erosion control ordinances and construction standards also maintain consistency within the basin.*

Strategy: Be consistent with each other.

Finding: *Inter-jurisdiction coordination focuses on sharing of data and ideas to maintain consistency between programs. One example is the development of a surface water quality technical guidance handbook by Clackamas County, USA, and the cities of Portland and Lake Oswego.*

Strategy: Field-test ideas whenever possible to ensure they work before implementing throughout the entire service area.

Finding: *Demonstration projects are currently being designed, implemented, and monitored for effectiveness prior to complete implementation of subbasin plans.*

Strategy: Promote cooperative action among jurisdictions in field-testing, program implementation, and monitoring.

Finding: *Inter-jurisdictional cooperation is currently occurring through demonstration projects, water quality monitoring, and data collection. Coordination activities will continue through the program planning and implementation process.*

Strategy: Apply water quality and quantity solutions within the subbasin in which the problem originates.

Finding: *Subbasin plans identify water quality and quantity problems within the subbasin, and measures to control those problems. In most cases, these solutions are applied within the subbasin boundaries. Measures may be required outside subbasin boundaries, however, in areas where insufficient opportunities are available within the subbasin.*

<u>Objective #8.</u> Ensure that the costs of program elements are commensurate with their benefits.

Strategy: Use the best available data about the costs and benefits to make decisions (need the facts).

Finding: *The best available data was used in addition to the capital cost information developed within the subbasin plans to determine the preferred management measures. The effectiveness of surface management measures for water quality facilities was based on data presented in USA's <u>Surface Water Quality Facilities Technical Guidance Handbook</u> and on-going research efforts. Economic costs were developed based on standard industry cost estimating techniques. Environmental impacts were estimated based on professional judgement and coordination with advisory committees.*

Strategy: Provide an assessment of the impacts of the subbasin plans on environmental quality, housing availability, and economic competitiveness. To the greatest extent possible the plans should maximize positive impacts and minimize negative impacts in these areas.

Finding: *The subbasin plans were developed to maximize water quality and quantity benefits with minimal impacts both in terms of capital and environmental costs. An assessment of the subbasin plan was made to determine the relative impact to such elements as environmental quality and the affordability.*

Strategy: Give priority to measures with a high benefit-to-cost ratio (i.e. high value) measured over the long-term using life cycle costing. Realistic operations and maintenance costs should be included in the economic analysis. At least one of the economic tests applied should be a net present value calculation. Dollar (quantified) values and non-dollar (unquantifiable) values should both be considered.

Finding: *Developing an accurate benefit to cost analysis is not feasible at this time for surface water management programs because there are many factors for which dollar values are not available. However, the recommended plan was selected based on a qualitative comparison of alternatives for capital costs, ease of maintenance, water quality and flood control benefits.*

Objective #9. Build public understanding of surface water management problems as well as responsibilities and opportunities for individuals to improve water quality and drainage.

Strategy: Use public awareness programs as an integral and long-term part of the Subbasin plans. Materials regarding program implementation, results of monitoring, cost and benefits studies, and other relevant information should be distributed on a regular basis.

Finding: *A public awareness program has been established and is successful in the distribution of data for public information purposes. This program presents information to residents and businesses within the Tualatin basin on their role in protecting and enhancing the Tualatin River. The public information program is considered to be a critical link in the long-term success of the subbasin plans.*

Strategy: Promote and reward good examples of development and practices by businesses and citizens which protect water features and use them as an amenity.

Finding: *The on-going public information program promotes the use of practices and development plans which protect water quality features through activities such as preserving existing streams, ponds, or vegetation.*

Objective #10. Design and implement the Urban Watershed Management Plan in a timely manner consistent with DEQ guidelines and schedules.

Finding: *Extensions to the current DEQ guidelines and schedules are anticipated to allow for incorporation of additional technical data on phosphorus sources and control. Urban watershed plans will be implemented within the revised DEQ guidelines and schedule. The Tualatin River Basin remains on schedule to meet the Federal Stormwater NPDES permit requirements.*

Objective #11. Provide a management system that allows for participation by municipalities.

Strategy: Provide clear lines of responsibility for maintaining facilities.

Finding: *Responsibility for maintenance of drainage and water quality facilities is shared between USA and the cities within the service district, and is defined through intergovernmental agreements. In general, all facilities in the unincorporated areas are maintained by USA, and facilities within the larger cities are maintained by the city, with USA maintaining a small portion within each city. The specific operation and maintenance responsibility within each city is defined in the individual agreement USA has with each city.*

Strategy: Be based on a realistic appraisal of government's ability to administer a program.

Finding: *The management plan represents a realistic, cost effective program which falls within the ability of government to administer; however, adequate funding to support the program will always be an issue. The subbasin strategies focus on passive measures which minimize impacts on developable land, the economy, and the basin residents.*

Objective #12. Emphasize use of natural systems and nonstructural methods that focus on preventing and controlling run-off and pollution at the source.

Strategy: Use measures which provide multiple benefits.

Finding: Identified water quality and to some degree, water quantity, measures provide multiple benefits in terms of water quality preservation, stream corridor enhancement, and recreation. The phased approach presented within the subbasin strategies provides flexibility to allow incorporation of additional technical information and cost-effective control measures.

CHAPTER II

CHAPTER II

BACKGROUND

This chapter consists of five subsections as follows:

- Purpose
- Chronology of Key Events
- Planning Methodology
- Project Mapping
- Related Projects

PURPOSE

In 1990, the Unified Sewerage Agency (USA) began subbasin planning work on the Hedges Creek and Butternut Creek subbasins. The Hedges Creek subbasin was selected to identify water quality issues and outline the management practices developed to address these issues. The Butternut Creek subbasin was selected because of flooding issues within the subbasin. The purpose of the subbasin plan was to outline management activities to reduce nonpoint source pollution. A limited drainage study was also completed which identified restrictions in the drainage system which needed to be updated to meet future flow conditions.

The original Hedges Creek subbasin plan was completed in October, 1992. Since the Hedges Creek subbasin plan was completed, USA became aware of local drainage issues in the marsh area. These drainage issues were amplified during the February 24, 1994 storm. As a result, USA conducted a hydraulic study of the Hedges Creek Marsh designed to develop and evaluate alternatives for solving drainage issues while also protecting the Hedges Marsh resource. The results of this study were incorporated into the Hedges subbasin plan.

The original Hedges Creek subbasin strategy plan was developed by USA and their technical consultant team led by Brown and Caldwell. The hydraulic study of the Hedges Creek Marsh was completed by Montgomery Watson. Montgomery Watson also assisted USA in updating the overall management plan which is presented within this report.

CHRONOLOGY OF KEY EVENTS

Hedges Creek has a long history of water quality issues. The primary issue within the subbasin is improving water quality in conjunction with preserving the Hedges Creek Marsh. Table II-1 contains the key events leading up to the current USA planning efforts for the Hedges Creek subbasin.

Table II-1 Hedges Creek Subbasin Chronology of Key Events

Date	Event
1850s	John E. Hedges, Sr., settles with other early pioneers on 320 acres near the west end of what is now known as Hedges Creek Marsh.
1852	General Land Office Survey published indicating the location of Hedges Creek Marsh.
1960-1975	Average annual growth rate in Tualatin was 50.2 percent, compared to 7.6 percent in surrounding areas.
1972	City of Tualatin develops drainage master plan for the city service area including Hedges Creek Subbasin.
1976	Local Tualatin citizens, conservation organizations, and state/federal natural resource agencies begin effort to protect Hedges Creek Marsh from draining and filling for industrial development.
1976-1981	City of Tualatin acts as mediator and facilitator in a series of good faith negotiation sessions between representatives of the industrial property owners, the local citizen representatives, Oregon Department of Fish and Wildlife, and the Corps of Engineers.
1981	Final Wetlands Protection District Ordinance was agreed upon by all parties and an in-the field agreement reached on the exact location of the Wetlands Protected Area boundary.
November 1981	A General Permit was issued by the Corps of Engineers to the City of Tualatin to facilitate development around the Marsh.
September 1988	A cultural Resource Inventory of the Tualatin Wetlands Protection District is prepared by the City of Tualatin.
December 1988	City of Tualatin's 404 Permit form Corps of Engineers renewed.
August 1989	A Hydraulic Analysis for Hedges Creek Wetlands Protection District Drainage Plan is completed for the City of Tualatin.
arch 1990	A cooperative agreement between Emery N. Zidell and members of the Hedges Creek Ad Hoc Committee is developed to establish a Hedges Creek Marsh management plan and an acceptable program for mitigation of potential wetland impacts. The Zidell property constitutes one-third of the City's wetland protection district.
October 1992	USA completes initial Subbasin Strategy Plan for the Hedges Creek Watershed.
May 1995	USA completes Hydraulic Study and completes draft updated Hedges Creek Strategy Plan. Public process initiated in City of Tualatin to consider plan elements for adoption into City Comprehensive Plan.
1991/92	USA's consultant Brown and Caldwell, prepared the Hedges Creek Subbasin Strategy Plan, focusing on water quality improvement. USA's Subbasin Strategies Advisory Committee recommends the plan for implementation.
1994/95	USA's consultant Montgomery Watson, USA staff and City staff updated the Hedges Creek Subbasin Strategy Plan to reflect flood control needs and to better address creek hydraulics and water quality. Property owners in the vicinity of Hedges Marsh and citizens are invited to provide input to the process.

PLANNING METHODOLOGY

The planning methodology for the Hedges Creek subbasin can be summarized as follows:

- Characterization of the subbasins regarding engineering, hydrologic, and facility information.
- Inventory sensitive lands and pollution sources through field review supplemented by aerial video plus 35 mm standard and infrared photography.
- Perform hydrologic and hydraulic analysis of the major drainage/flooding constraints and facility options in the subbasins.
- Evaluate pollutant reduction facilities (PRF) options and the pollutant transport implications, assuming various conditions for future conditions.
- Evaluate alternatives for reducing future drainage/flood control problems and improving water quality, particularly the phosphorus loading.
- Interact with the public and policy makers to select the recommended alternative(s) and the subbasin strategies approach.

PROJECT MAPPING

The base map for this project was prepared based on US Geological Survey (USGS) 7-1/2 minute quad sheet topography supplemented by Oregon Department of Transportation (ODOT) cultural information. The revised existing facilities and recommended Capital Improvement Program (CIP) maps were prepared with a 1993 aerial base map with AutoCAD based overlays.

RELATED PROJECTS

The following projects are of specific importance to the Hedges Creek subbasin plan and are in addition to those projects presented in the Tualatin Basinwide Report and Technical Guidelines:

- Jenkins, P.C. and Soper, D.L., "A Cultural Resource Inventory of the Tualatin Wetlands Protection District," prepared for the City of Tualatin, 1988.
- Robert E. Meyer Consultants, Inc., "Hydraulic Analysis for Hedges Creek Wetlands Protection District Drainage Plan," prepared for the City of Tualatin, 1989.

- U.S. Army Corps of Engineers, "Technical Supplement No. 3, Water Quality Aspects of Urban Stormwater Runoff," prepared for Columbia Region Association of Governments, Portland, Oregon, November, 1977.

- Washington County, Department of Land Use and Transportation, "Final EIS, Tualatin-Sherwood/Edy Road Project," June, 1990.

- The Wetlands Conservancy, "Management Plan for the Hedges Creek Marsh, Tualatin, Oregon," May 1983.

- R.A. Wright Engineering, "Tualatin Drainage Plan," prepared for the City of Tualatin, 1972.

- "Zian Inc. Property Wetland Protection Area Resource Management Plan, Hedges Creek, Tualatin, Oregon," prepared for Zian Inc. by Fishman Environmental Services, August 1993.

CHAPTER III

CHAPTER III

SUBBASIN CHARACTERIZATION

The purpose of this chapter is to discuss the characteristics of the Hedges Creek subbasin of the Tualatin River basin. This chapter includes two subsections as follows:

- Tualatin River Watershed
- Hedges Creek Subbasin Characterization

TUALATIN RIVER WATERSHED

The Tualatin River lies in the northwest corner of Oregon and is one of the principal tributaries of the Willamette River. The basin is 43-miles long by 29 miles wide with a total drainage area of 698 square miles. The river flows generally from northwest to southeast and discharges into the Willamette River at West Linn. The basin is contained almost entirely within Washington County and is bounded by the Tualatin Mountains to the northeast and east, the Chehalem and Parrett Mountains to the south, and the Coast range on the west and northwest.

Throughout most of its 83-mile length, the Tualatin River flows in a slow, meandering manner. The lower reaches of the river are characterized by very flat slopes surrounded by gently rolling and flat agricultural and urban land. The gradient increases quickly above Gaston to over 100 feet per mile. The upper watershed is predominately narrow, steep forested valleys.

Five principal tributaries feed the Tualatin River: Scoggins, Gales, Dairy, Rock, and Fanno Creeks. Smaller tributaries draining into the Tualatin include Chicken, Hedges, McFee, Davis, and Butternut Creeks. This chapter discusses the Hedges Creek subbasin characteristics. A complete description of the Tualatin River basin is contained in Chapter I of the Tualatin Basinwide Report and Technical Guidelines.

CLIMATE

The climate in the Tualatin Valley varies from the Coast Range Mountains to the lowlands. Precipitation in the Coast Range often exceeds 100 inches per year, but stations in the valley report average precipitation amounts between 42 and 48 inches per year. The local climate is affected by marine weather patterns. The annual pattern has wet winters and dry summers.

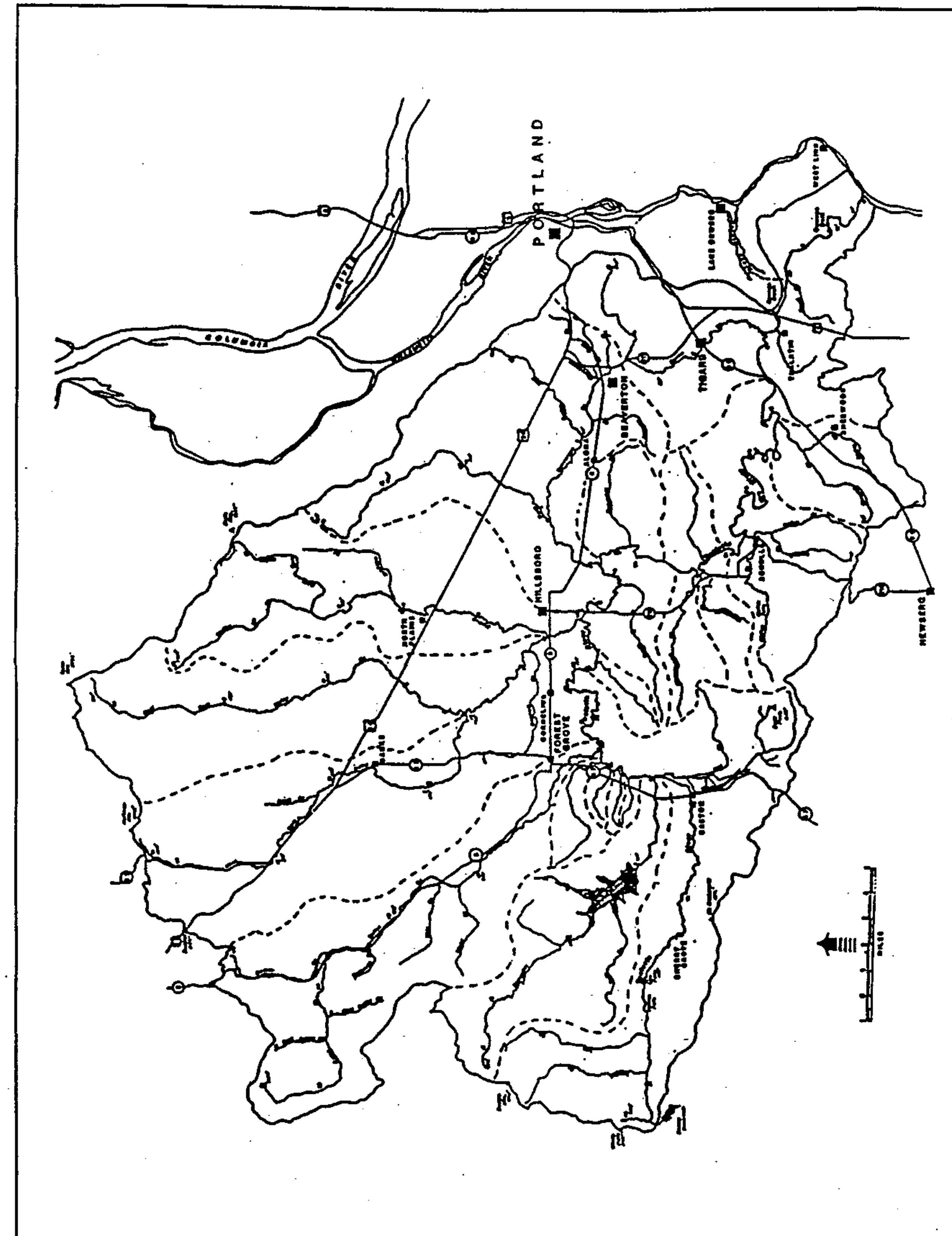


Figure III-1. Tualatin River Watershed

Average monthly temperatures are mild due to moderation by the marine influence, but daily temperature fluctuations are relatively large. Daily ranges of 30 degrees are common during clear-sky summer conditions. The average frost free season in the Tualatin Valley is 180 days at lower elevations and 145 days in the Coast Range.

HEDGES CREEK SUBBASIN CHARACTERIZATION

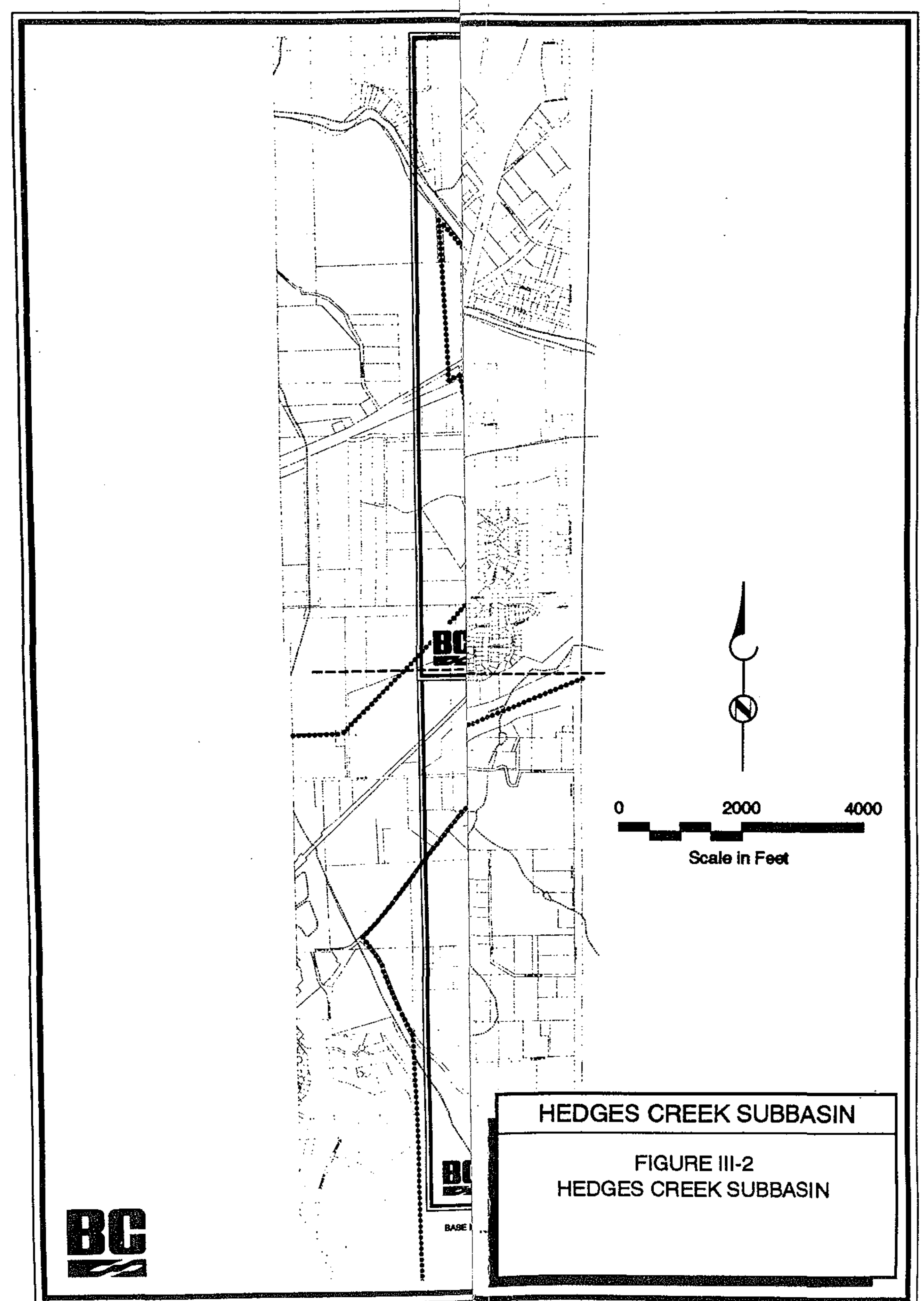
Hedges Creek subbasin consists of 2856 acres of urban and undeveloped land located entirely within Washington County's boundaries (see Figure III-2). Undeveloped portions of the subbasin are predominately forest and agricultural lands. Existing development consists primarily of single-family residential and light manufacturing concentrated in the south hills and lower reaches of the subbasin.

Natural, open channels with culverts at roadway crossings serve as the major drainage ways within the subbasin. Curb and gutter storm drain systems are generally found in residential areas. These systems feed into the Hedges Creek Marsh where Hedges Creek splits into a north and south channel.

Hedges Creek Marsh is bounded by Tualatin Road on the east, Herman Road on the north, Tualatin-Sherwood Road on the south, and private property on the west (approximately 6,600 feet west of Tualatin Road). Hedges Creek splits into a north and south channel at the west end of the marsh. The north channel flows from west to east and extends along the north side of the Wetlands Protection District from the diversion point upstream of Pascuzzi Ponds east to Teton Avenue. A 72-inch diameter culvert extends under Teton Avenue. At the time of this study, the north channel had been filled and replaced with an 18-inch diameter culvert immediately east of Teton Avenue. Most recently (early 1995), a small channel had been excavated from Teton Avenue directly east to the south channel. The north channel continues east to a discharge point at Sweek Pond. The south channel flows west to east from Pascuzzi Pond to Tualatin Road. Two 24-inch diameter culverts carry flow under Teton Avenue. Both north and south channels merge just west of Tualatin Road and flow is carried under Tualatin Road through a 72-inch diameter culvert. An open channel carries flow from Tualatin Road approximately 1700 feet to the Tualatin River.

TOPOGRAPHY, GEOLOGY, AND SOILS

The geology, soils, and topography of the Hedges Creek subbasin are summarized in the following paragraphs.



HEDGES CREEK SUBBASIN

FIGURE III-2
HEDGES CREEK SUBBASIN

SUBBASIN MAP

Topography

The Hedges Creek subbasin lies in a relatively shallow valley bounded by low hills on the north, south, and west. The subbasin is primarily flat from Hedges Creek Marsh (east end of the basin) west to Cipole Road. South of the Tualatin-Sherwood Highway, forested foothills rise to 250-300 feet in elevation. The area north of Herman Road consists of flat or gently rolling hills.

Geology

In general, the Willamette silt material is the primary geologic unit exposed within the Hedges Creek subbasin. This material covers the entire Tualatin Valley floor up to elevation 250 feet. The silty materials composing the Willamette unit were deposited by major floods that occurred when the Columbia River basin was inundated with water from glacial Lake Missoula. Above 250 feet, thinner silt deposits occur which appear to be both fluvial and loessal in nature.

Soils

Soil interpretation map overlays were prepared as part of this planning effort to detail soil erosion potential and soil phosphorus availability for the Hedges Creek subbasin. As shown in Table III-1, twenty-two soil types are found within the Hedges Creek subbasin. Of these, the Hillsboro soil is the most predominant. The Hillsboro soil textures range from loam and silt loam to silty clay loam, clay, and mucky clay. The high percentage of silt size particles in the loam and silt loams account for the erodible nature of these soils.

Most of the soils within the project area have a dense subsurface layer, termed fragipan, that restricts water flow and root penetration. The depth of the layer varies from 2 to 4 feet, and can extend to 5 feet or greater. Soils with fragipans have restricted subsoil permeability that markedly affect their hydrologic response. Potential for lateral water movement exists above or below the fragipan, but not within the layer itself. The degree to which lateral water flow, piping, and vertical flow below the fragipan occur depends on the specific bedrock conditions. Consequently, quantifying subsurface water movement requires specific on-site investigations and analysis.

Table III-1. Soils of Hedges Creek Subbasin

Map Symbol	Soil Name	Hydrologic Soil Group	Approximate Acreage	Soil Erosion K Factor	Restrictive Layer	Depth to Restrictive Layer (In)	Permeability (In/Hr)
1	Aloha silt loam	C	86	0.43	none		
2	Amity silt loam	C	34	0.32	none		
5B	Briedwell stony silt loam, 0 to 7% slopes	B	98	0.28	none		
5C	Briedwell stony silt loam, 7 to 12% slopes	B	11	0.28	none		
5D	Briedwell stony silt loam, 12 to 20% slopes	B	19	0.28	none		
10	Chehalis silt loam, occasional overflow	B	30	0.32	none		
13	Cove silty clay loam	D	96	0.28	clay	8-60	<0.06
14	Cove clay	D	89	0.28	clay	8-60	<0.06
15	Dayton silt loam	D	4	0.43	clay	16-39	<0.06
21A	Hillsboro loam, 0 to 3% slopes	B	333	0.49	none		
21B	Hillsboro loam, 3 to 7% slopes	B	742	0.49	none		
21C	Hillsboro loam, 7 to 12% slopes	B	48	0.49	none		
21D	Hillsboro loam, 12 to 20% slopes	B	57	0.49	none		
22	Huberly silt loam	D	144	0.37	Fragipan	25-60	0.06-0.2
27	Labish mucky clay	D	52	0.20	mucky clay	0-36	0.06-0.2
30	McBee silt loam	B	16	0.28	none		
37A	Quatama loam, 0 to 3% slopes	C	211	0.32	none		
37B	Quatama loam, 3 to 7% slopes	C	115	0.32	none		
37C	Quatama loam, 7 to 12% slopes	C	53	0.32	none		
38B	Saum silt loam, 2 to 7% slopes	C	106	0.32	Basalt Bedrock	50	
38C	Saum silt loam, 7 to 12% slopes	C	169	0.32	Basalt Bedrock	50	
38D	Saum silt loam, 12 to 20% slopes	C	41	0.32	Basalt Bedrock	50	
38E	Saum silt loam, 20 to 30% slopes	C	20	0.32	Basalt Bedrock	50	
42	Verboort silty clay loam	D	49		clay	19-33	<0.06
43	Wapato silty clay loam	D	73	0.32	none		
45A	Woodburn silt loam, 0 to 3% slopes	C	89		Fragipan	31-60	0.06-0.2
45B	Woodburn silt loam, 3 to 7% slopes	C	31	0.43	Fragipan	31-60	
46F	Xerochrepts and Haploxerolls, very steep	B	9	0.43	None	15	
47D	Xerochrepts - Rock outcrop complex	D	31		Basalt Bedrock		
			2856				

Soil Hydrologic Characteristics

Most soils within the Hedges Creek study area are classified by the Soil Conservation Service (SCS) as belonging within hydrologic group "B" (48 percent). The remaining soils fall within groups "C" (33 percent) and "D" (19 percent).

WATER QUALITY

Water quality data was obtained from a USA monitoring station located on Hedges Creek at Tualatin Park Community Center (River Mile 0.2), below the Hedges Creek marsh. Grab samples were taken and lab analyses completed for 25 samples taken between May and October 1990.

Figures III-3, III-4, III-5, and III-6 present a graphical representation of the Hedges Creek water quality through this time period. A brief summary of this data is as follows:

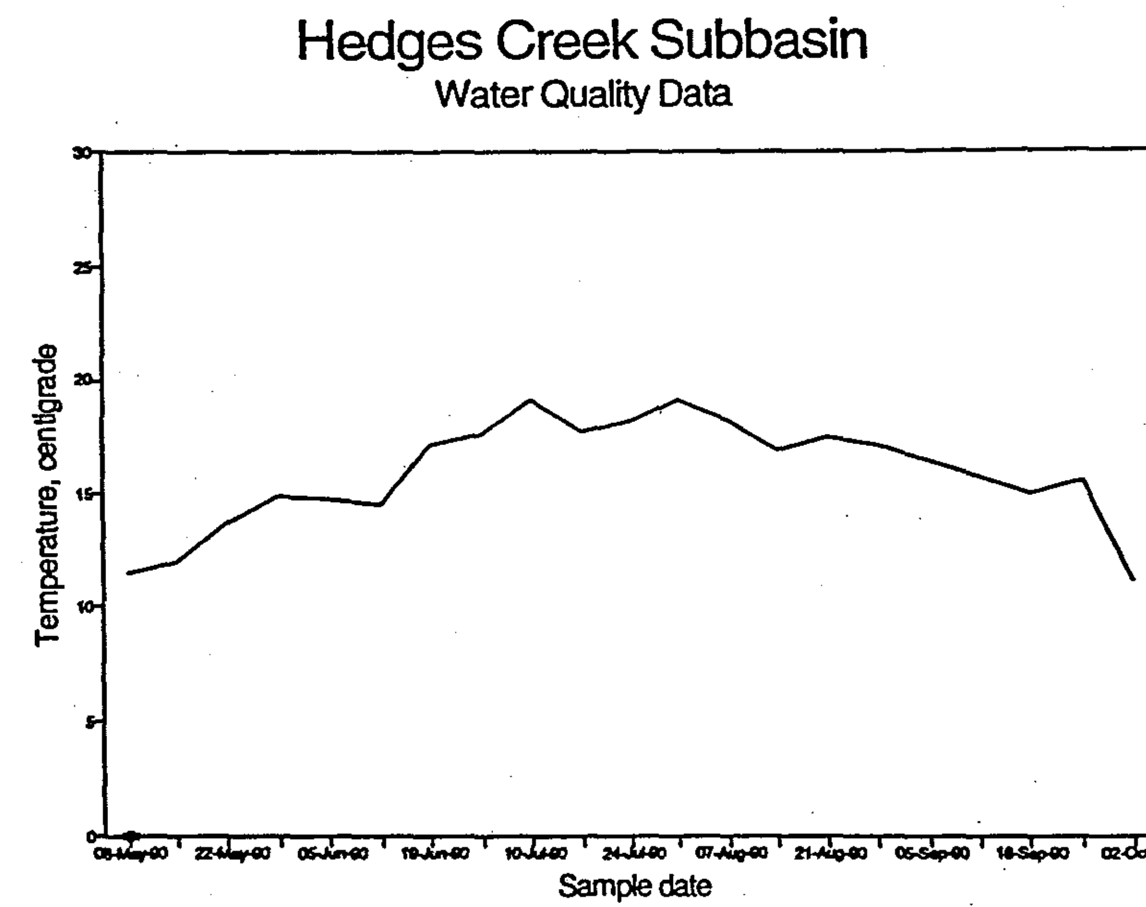
- Water temperature trends showed an increase from 11.5°C in May to a peak of 19.1°C in July (Figure III-3). Temperatures remained above 15°C throughout the summer and began decreasing in the fall months.

- Dissolved oxygen levels fell below 0.5 mg/l from mid-June to September. This trend is most likely attributable to lower flows from the subbasin and significant oxygen demands (Figure III-4).

- Figure III-5 suggests that the majority of the settleable solids are removed in Hedges Creek Marsh. Total dissolved solids (TDS) concentrations ranged from a minimum of 120 mg/l to a maximum of 262 mg/l with a mean value of 176 mg/l over the sampling period. Total suspended solids (TSS) experienced a minimum of 2 mg/l and a maximum of 88 mg/l over the same period.

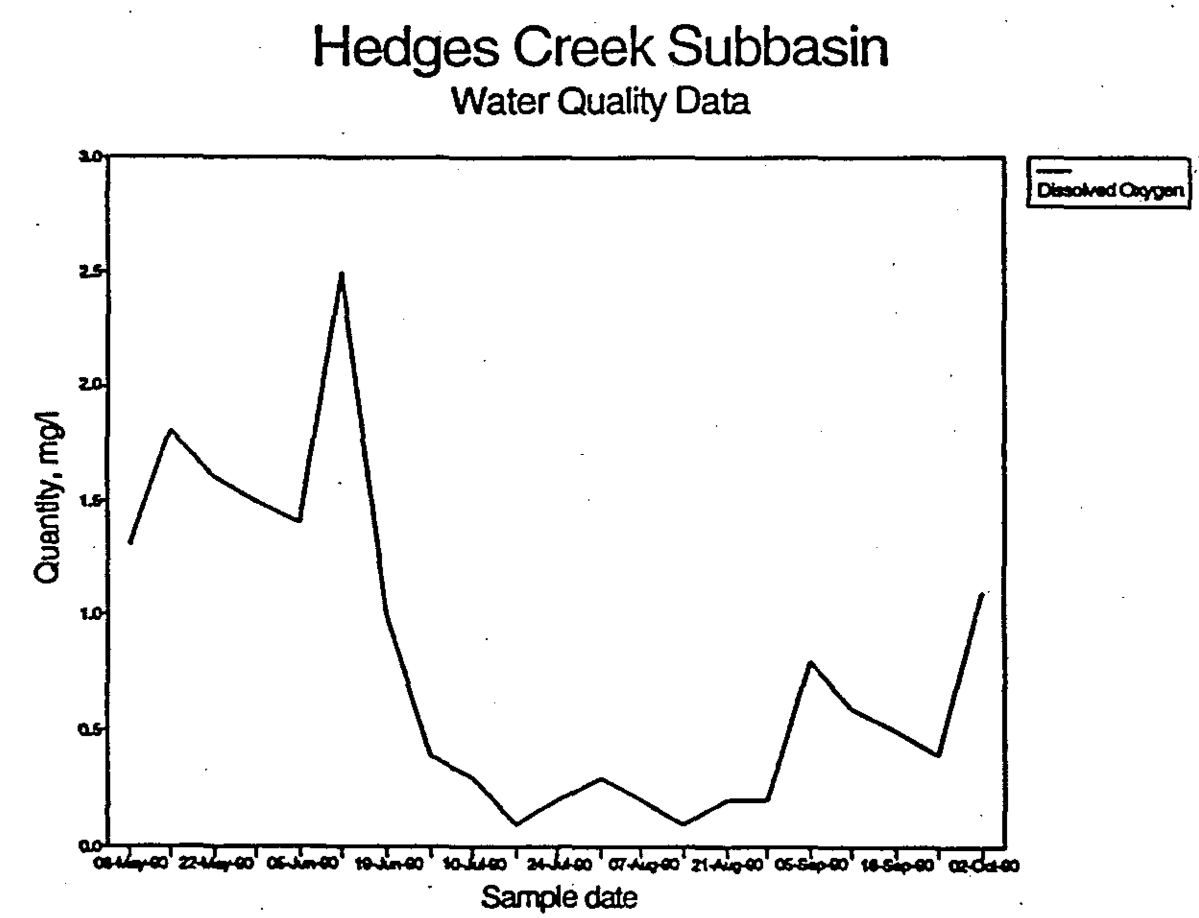
- Nitrogen and phosphorus levels are shown in Figure III-6. Total phosphorus concentrations ranged from a low of 0.11 mg/l to a high of 0.58 mg/l with a mean value of 0.30 mg/l. Ammonia-nitrogen (NH_3-N) and nitrite-nitrate nitrogen (NO_2NO_3-N) averaged 0.073 and 0.079 mg/l, respectively, over the same time period.

- Water quality data obtained for the Hedges Creek Marsh by the Oregon Graduate Institute (OGI, 1989) found phosphorus levels (PO_4-P) in December ranged from 0.058 to 0.165 mg/l, and those collected in February ranged from 0.012 to 0.144 mg/l.



* Samples taken at Tualatin Park Community Center, RM 0.2; See Appendix C.

Figure III-3. Hedges Creek Subbasin - Temperature Fluctuations



*Samples taken at Tualatin Park Community Center, RM 0.2; See Appendix C.

Figure III-4. Hedges Creek Subbasin - Dissolved Oxygen Levels

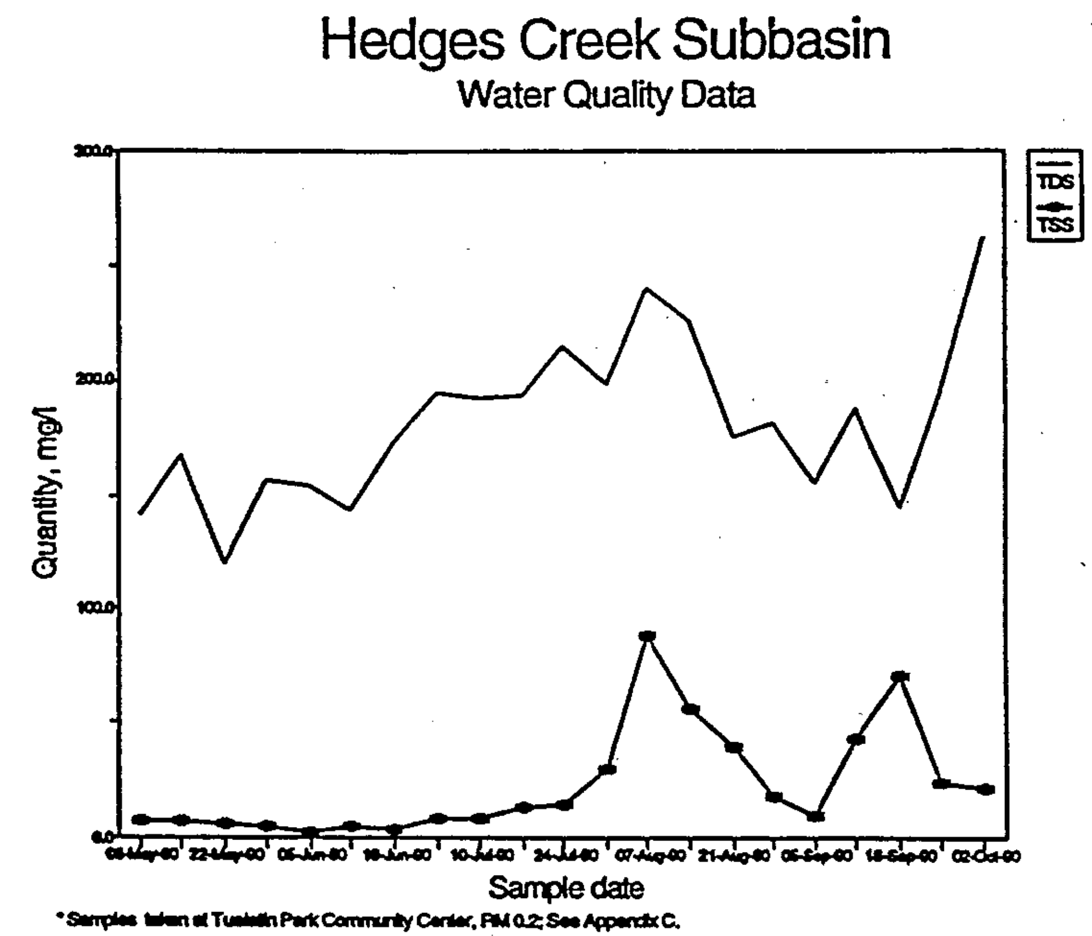


Figure III-5. Hedges Creek Subbasin - Total Dissolved Solids and Total Suspended Solids

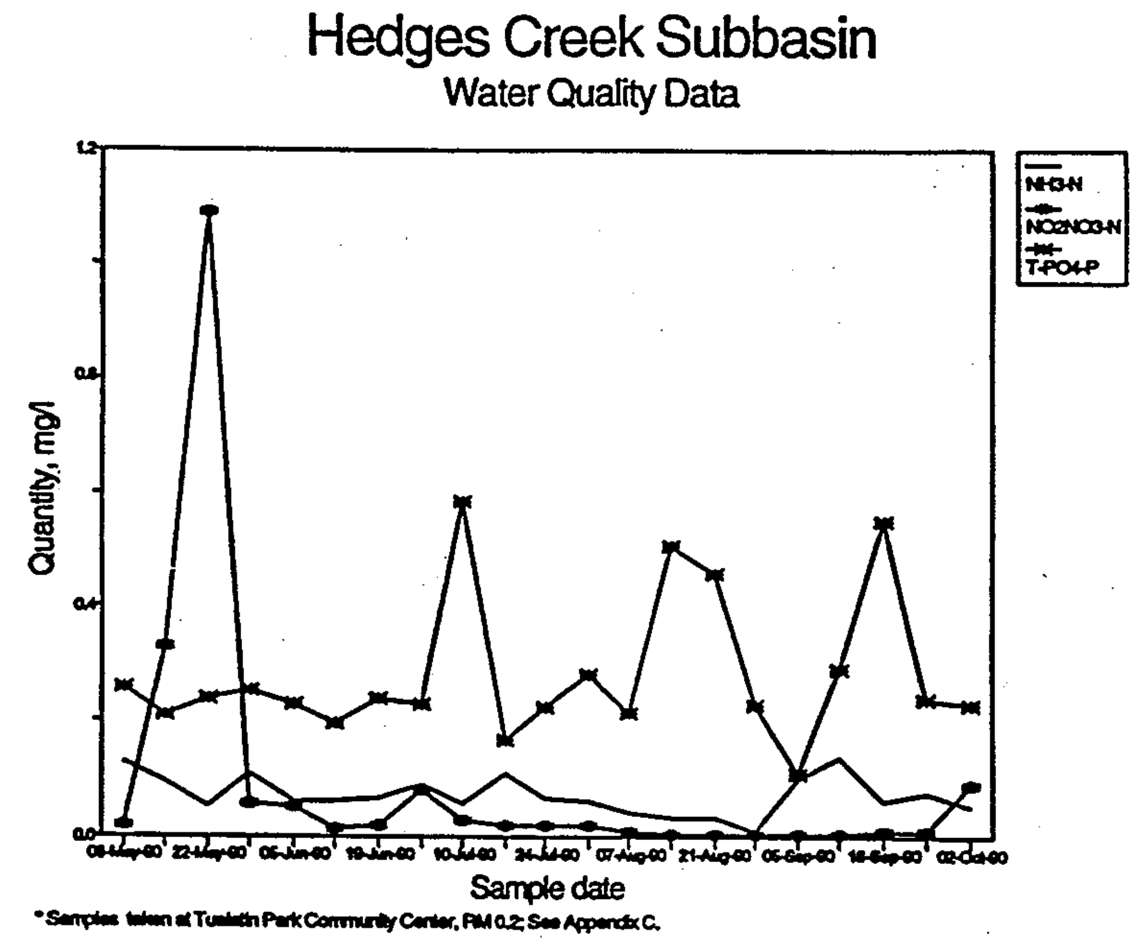


Figure III-6. Hedges Creek Subbasin - NH_3-N, NO_2NO_3-N, T-PO_4-P

- A seasonal decrease in phosphorus levels is apparent in the Hedges Creek Marsh. OGI found water in a newly-constructed pond in Hedges' marsh contained the lowest phosphorus concentration (0.010 mg/l PO_4-P) late in the dry season when algal growth was far more evident. Apparently the algae effectively utilized most of the soluble P that had entered the pond from surface waters or groundwater recharge. However, by December, soluble P levels in the pond were among the highest in the marsh (0.140 mg/l) and remained that way in February (0.082 mg/l). Only the groundwater levels of soluble P in the marsh were higher. The algae appeared to have decomposed and released phosphorus after cool weather set in. So, the algae may remove P in the summer and become a "source" in winter.

WATERCOURSES

Floodplains

The primary water course within the subbasin is Hedges Creek. Heading upstream from Tualatin Road, the creek splits into a north and south channel through the Hedges Creek Marsh before combining at the west end of the Pascuzzi Pond. The creek then splits into an east and west tributary in the upper areas of the basin. The east tributary extends into the hills south of the Tualatin-Sherwood Road. The west tributary of Hedges Creek extends west to Cipole Road. Other drainage courses within the basin are limited to small, localized ditches.

Floodplain maps were prepared for the Tualatin River and several of its tributaries by the Army Corps of Engineers in 1969 and updated in 1982-1987. Floodplain maps for Washington County and for each city are available from the Federal Emergency Management Agency (FEMA).

URBAN DEVELOPMENT

Urban development has a significant impact on runoff characteristics of a watershed. As a basin urbanizes, the fraction of impervious ground surface increases, reducing the overall permeability of the land surface and thus increasing the surface runoff. The actual percentage of impervious area found in a basin varies with land use. Consequently, urban development must be considered with respect to development trends and land use planning to effectively evaluate future drainage requirements.

Existing Land Use

As indicated in Table III-2, the Hedges Creek subbasin was less than 40 percent developed for the 1989 data used for this study. Most of the development consists of single-family residential units in the south hills of the basin, and commercial/manufacturing facilities adjacent to the Tualatin-Sherwood Road and Herman Road. The west end of the subbasin contains primarily agricultural land with isolated single-family residential and light manufacturing developments. Of the existing development, approximately 20 percent is residential and 13 percent is light manufacturing and commercial.

Projected Land Use

The Hedges Creek subbasin is almost completely contained within the Tualatin city limits. For this reason, land use projections were based on the current city zoning maps. This information is presented in Table III-2. Residential development accounts for approximately 30 percent of the subbasin area of 2856 acres. The predominant land use at buildout will be light manufacturing and commercial at 53 percent of the total subbasin area. The remaining 17 percent will be maintained as parks, greenways, or protected wetlands. Impacts of development on the existing Hedges Creek drainage system will be amplified by the predominance of manufacturing and commercial development. This is due to the larger percentages of impervious areas normally associated with manufacturing and commercial land use.

INSTITUTIONAL

The City of Tualatin provides general governmental services to most of the Hedges Creek subbasin. The exceptions are the wastewater and storm water services shared with USA.

Table III-2. Land Use in Hedges Creek Subbasin

Land Use Category	Acre (acres)			
	Existing (1989)	Percent of Total	Projected	Percent of Total
RESIDENTIAL				
LD (5-6 DU/AC)	567	19.9	812	28.4
MD (9-15 DU/AC)	13	0.5	62	2.4
HD (24 + DU/AC)	2	<0.01	5	<0.01
COMMERCIAL/INDUSTRIAL	370	13.0	1504	52.6
INSTITUTIONAL	---		---	
OPEN	1904	66.6	473	16.6
TOTAL	2856	100.0	2856	100.0

LD: Low Density
MD: Medium Density
HD: High Density
DU/AC: Dwelling Units per Acre

CHAPTER IV

CHAPTER IV

POLLUTION SOURCES

The purpose of this chapter is to discuss the potential nonpoint pollution sources which exist within the Hedges Creek subbasin. The major items discussed in this chapter include:

- Sources of Storm Water Pollutants
- Soil Erodibility and Phosphorus Availability
- Hedges Creek Subbasin Pollution Sources

SOURCES OF STORM WATER POLLUTANTS

Potential Pollutant Sources

Many potential sources of nonpoint pollutants exist within a drainage basin. The importance of the source varies with the basin physical characteristics, such as slope and soil type, and land use. Control or treatment of nonpoint source pollutants is important in maintaining the quality of the receiving water, particularly in a sensitive area such as the Hedges Creek Marsh The first step in developing an effective water quality management approach is identification of potential pollutant sources. The principal sources of stormwater pollutants which could be found in the Hedges Creek subbasin include:

- Leaves, grass clippings, and other *vegetation* which is deposited within the storm drainage system through a variety of natural and physical processes as well as by human disposal of these materials.

- *Erosion* of natural channels, roadside ditches, and unstable soils.

- *Construction sites* which can contribute significant levels of sediment through exposed soils.

- *Road pavement* and *driveways* including aggregate, binder, fillers, oils and greases, and gasoline spills.

- *Motor vehicles* which contribute a wide variety of materials such as fuels, lubricants, heavy metals from tire and brake wear, and particles from exhaust emissions.

- *Atmospheric fallout* containing air pollutants from automobiles and from exposed land surfaces (dust).

- Fertilizers and pesticides from local *owner landscaping* and *garden* care.

- *Domestic animals* which can contribute significant bacteria from animal wastes.

- *Dumping* of chemicals and waste products into the storm drain system.

The type of pollutants associated with the potential sources listed above varies, but can include phosphorus, oil and grease, suspended solids, fecal bacteria, heavy metals such as zinc, copper and cadmium, and biological oxygen demand (BOD) and chemical oxygen demand (COD). Their impact on the receiving water varies, but the beneficial uses of the water body are almost always impaired. Many pollutants pose a threat to both aquatic and human health. Specific impacts which could be expected include:

- Excessive *nutrient* loadings from phosphorus and nitrogen can accelerate the eutrophication process with a resulting decrease in dissolved oxygen levels.

- *Bacteria* which often exceed public health standards for water contact recreation. Since most of the Hedges Creek Subbasin area is served by sanitary sewers, bacteria pollutants would most likely be attributed to animal sources such as domestic pets and water fowl.

- *Oxygen demand* which produces anoxic (zero oxygen) conditions commonly found in shallow, slow-moving, or poorly flushed receiving waters that have a high organic content.

- *Oil and grease* which contain a wide variety of hydrocarbon compounds known to be toxic to aquatic life at low concentrations. Hydrocarbons have an affinity for sediment and as a result often collect in the sediment on the bottom of a lake or river and result in negative impacts on ethnic communities.

- *Heavy metals* which have a toxic effect on aquatic life and can potentially contaminate drinking water supplies. Copper, lead, and zinc are the most prevalent metals found in urban runoff.

- *Suspended solids* which can cause many adverse conditions including increased turbidity, reduced light penetration, clogging of gills/filters of fish and aquatic invertebrates, and carry other pollutants attached to the soil particle, such as metals.

- *Pesticides and fertilizers* used to control diseases and pest organisms can be toxic to most aquatic organisms. Fertilizers contribute nutrients to the receiving water which may increase algal bloom within the receiving water.

- *Toxic* pollutants such as cleaning solvents, if introduced into storm runoff, can severely impact resident fish or vegetation.

The industrial and light manufacturing development which is located adjacent to the Hedges Creek Marsh poses water quality risks and management challenges. The potential for toxic spills and contamination of storm water entering the marsh is quite high. As a result, effective source control activities and on-site water quality treatment facilities are a necessary component of the overall Hedges Creek subbasin water quality management strategy.

Soil Erodibility and Phosphorus Availability

As part of this study, soil erodibility and phosphorus availability map overlays were prepared depicting the soil erosion potential for the Hedges Creek subbasin. The map overlays were based on published Soil Conservation Service soil survey base maps, soil samples to characterize soil phosphorus, field reconnaissance, aerial photography interpretation, and professional soil science methods. The map overlays were prepared to aid in the planning and evaluation of nonpoint source pollution issues.

The methods used to develop the map overlays are presented in a complete report contained in Appendix B. A summary of the results is presented herein.

Soil Erosion Categories

Five soil erosion hazard categories were developed to delineate the soils with the highest potential for erosion (category 5) through soils with the lowest potential (category 1). These categories were developed using a modification of the Universal Soil Loss Equation (USLE) approach (Wischmeir and Smith, 1978). The soil erosion categories and corresponding map units are shown in Table IV-1. Soil map units normally occurred within the category shown, but could fall into those marked with parentheses depending on location-specific factors.

Table IV-1. Soil Erosion Categories for Soil Map Units in the Project Area

Hedges Creek	
Erosion Category	Soil Map Units[a]
5	21D, 38E, 46F, 47D
4	5D, 38D, (21D)
3	5C, 21C, 37C, 38C, (5D), (45B)
2	5B, 21B, 37B, 38B, 45B, (5C), (38C)
1	1, 2, 10, 13, 14, 15, 21A, 22, 27, 30, 37A, 43, 45A, (5B)

[a] Map Symbols and Soil Names:

1:	Aloha	27:	Labish
2:	Amity	30:	McBee
5:	Briedwell	37:	Quatama
10:	Chehalis	38:	Saum
13:	Cove Silty Clay Loam	43:	Wapato
14:	Cove Clay	45:	Woodburn
15:	Dayton	46:L	Xerochrepts & Haploxerolls
21:	Hillsboro	47:	Xerochrepts - Rock outcrop
22:	Huberly		

The areas shown in category 1, the lowest erodibility class, are among the most reliably mapped because the map unit slope is small (0-3 percent). Variability occurs with the five map units in the 3-7, 7-12, and 12-20 percent slope classes which fall into erodibility categories 2, 3, or 4 according to soil type and hydrology, landscape position, and the actual slope as determined from stereo aerial photographs.

Soil Phosphorus Availability Categories

Phosphorus availability is a general term that has been quantified in a number of ways. Traditionally, phosphorus availability was used to determine phosphorus fertilizer requirements. Numerous field and laboratory studies have resulted in a variety of chemical procedures to extract phosphorus from soil (Wischmeir and Sommers, 1982) causing some confusion for phosphorus availability studies associated with soil erosion. Availability in this case is not necessarily the amount of phosphorus that can be present in the soil solution, but it may be the total amount in the soil or in a particular form. The concept of availability becomes even more complex when eroded soil is incorporated into the phosphorus budget of a stream system (Klotz, 1988).

For the purpose of this study, several methods were used to quantify soil phosphorus availability:

- *Total phosphorus* which sets the upper limit of phosphorus (though all phosphorus is not available);
- *Total organic phosphorus* which allows separation of organic and inorganic forms;
- *Water soluble phosphorus* which provides information on the effect of soil on P concentration in the water or soil solution.

The laboratory results from soil horizon A samples are summarized in Table IV-2. The results represent the average of soil samples taken in the Hedges and Butternut Creek subbasins, as well as samples taken in the nearby Fanno Creek subbasin.

Table IV-2. Soil Phosphorus Analyses

Soil Series	Total P	Inorganic P	Organic P	Water Soluble P		
------ mg P/kg soil -----				mg P/kg Soil	ppm sol'n	Rank
Aloha[a]	1457	1175	282	3.7	0.183	3
Cornelius[a]	1675	1371	304	2.4	0.12	3
Hillsboro[b]	1350	1130	220	2.4	0.12	3
Huberly[c]	915	764	151	1.4	0.07	2
Quatama[b]	1518	1295	223	3.5	0.175	4
Saum[b]	1130	795	335	0.7	0.035	1
Wapato[c]	925	662	263	2.075	0.104	2
Woodburn[b]	1693	1485	208	9.65	0.483	5

[a]Average of 3 samples [b]Average of 2 samples [c]Average of 4 samples

Soil phosphorus availability rankings are also shown in Table IV-2. The rankings are based on the inorganic and water soluble P values. These rankings provide an estimate of the relative amount of phosphorus that would be available to readily move out of the soil into solution during saturated soil conditions. The rankings were developed by separately ranking the values for inorganic P and water soluble P for each sample from 1 to 5. An average rank was given to each sample and the ranking for a soils series is an average of the samples taken for that series. Woodburn soil, which has the highest phosphorus ranking, tends to be on flat to gentle terrain with a subsequently low erosion hazard. The soils with moderately high erosion hazards tend to have low to moderate phosphorus availability.

Aerial Evaluation of Nonpoint Pollution Sources

Aerial imaging aided in the evaluation of nonpoint pollution sources. A discussion of the aerial imaging methods is presented in Chapter II of the Tualatin Basinwide Report and Technical Guidelines. A summary of the Aerial Shoreline Analysis (ASA) and Aerial Video Analysis (AVA) is presented in this chapter for the Hedges subbasin. A detailed discussion of the ASA and AVA is presented in the following support document:

> "Aerial Evaluation of Nonpoint Source Pollution in Nine Selected Subbasins of the Tualatin River Watershed, Washington County, Oregon - Part I: Aerial Shoreline Analysis, Part II: Aerial Video Analysis"; prepared for the Unified Sewerage Agency (USA) and Brown and Caldwell Consultants; August 1991.

HEDGES CREEK SUBBASIN POLLUTION SOURCE IDENTIFICATION

Soil Erosion Map Overlay

Figures IV-1a and IV-1b contain the soil erosion hazard categories for the Hedges Creek subbasin. Three soil types comprise more than half of all the project area surrounding Hedges Creek (see Chapter II for discussion of soil distribution). The soils are composed of silt loam and loam surface horizons with clay contents varying between 4 and 40 percent depending on the soil type and horizon. Soils with higher subsurface clay contents are typically dense. These soils restrict drainage and are generally more conducive to surface runoff than deep percolation.

The greatest soil erosion hazard occurs in the southern portions of the drainage basin because of relatively steep slopes. The northern area of Hedges Creek consists of level to gently rolling topography. The soil erosion hazard is generally low in this area.

Soil Phosphorus Availability Map Overlay

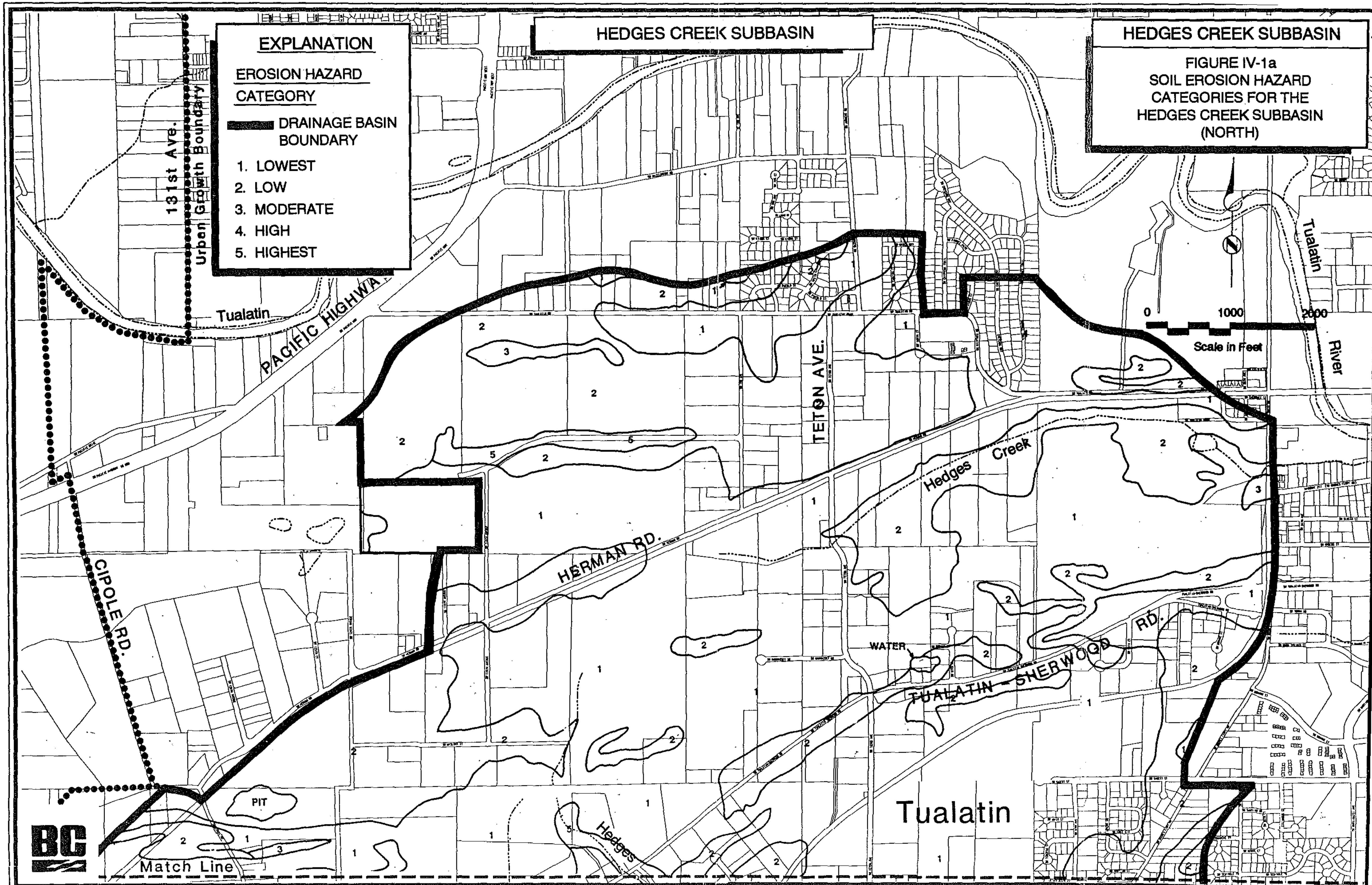
Figures IV-2a and IV-2b are the soil phosphorus availability maps for the Hedges Creek subbasin. In general, soil phosphorus availability shows less complex patterns than those of the erosion categories. Categories 1 and 3 form the predominate group in Hedges Creek.

Aerial Shoreline Analysis (ASA)

Several sites with direct runoff to Hedges Creek showed serious toxic potential, and sediment sources were also evident. The creek bank imagery ASA was collected on February 21, 1991, when streamflow was high, and water turbidity appeared high along most of the creek. The ASA imaging was performed for the creek from its mouth upstream west and south to SW 105th Avenue.

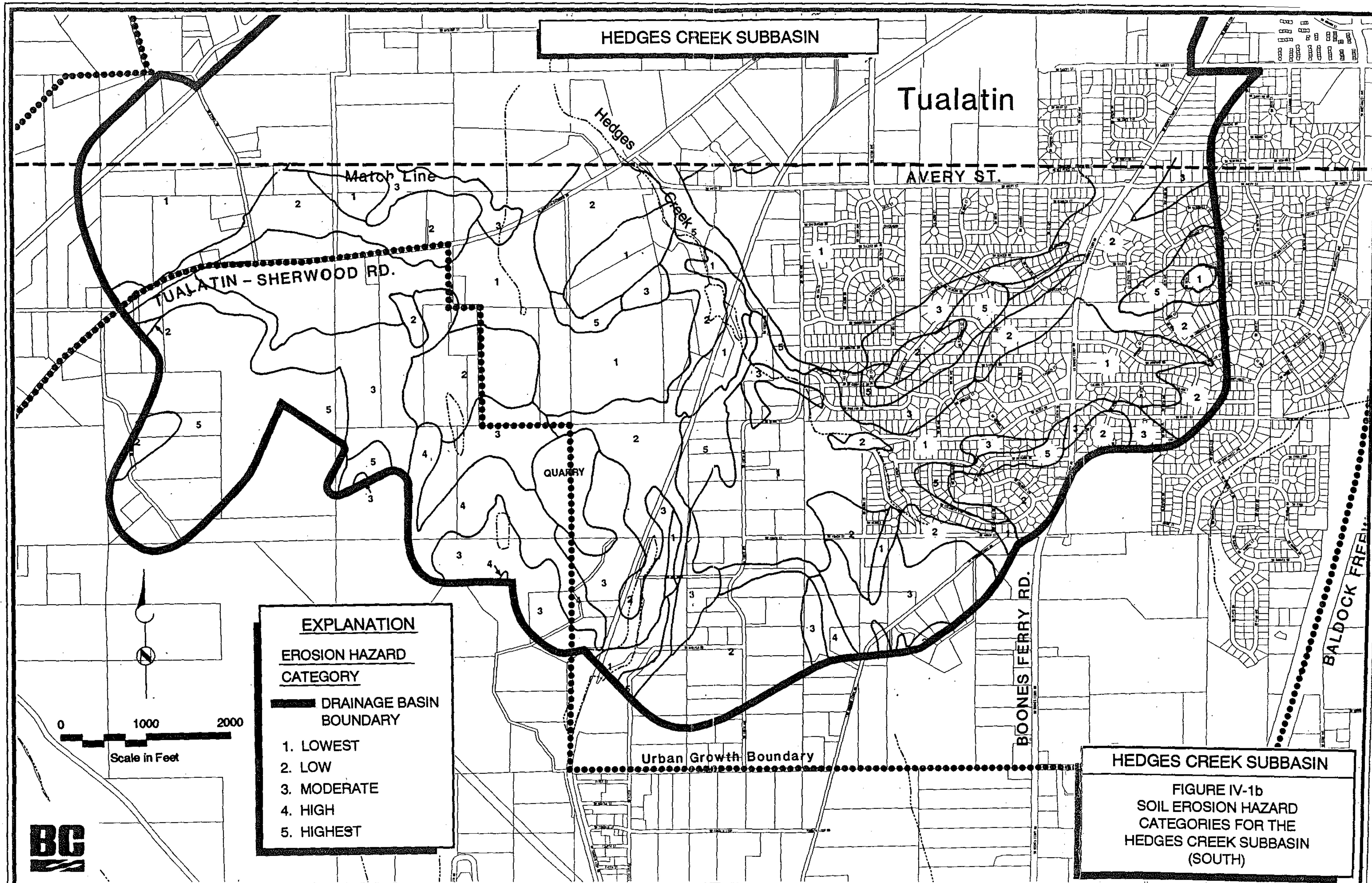
The imaging showed several industrial sites with outdoor storage yards, 55 gallon drums, and storage tanks near the creek indicating potential for toxic sources. Field stream walks in 1994 indicated that several of these sites had been cleaned up and or re-developed since 1991. However, some industrial sites continued to have outdoor storage and potential for stormwater runoff impacts to the adjacent creek. Some of the agricultural lands that were providing apparent sediment and animal access to the creek in 1991 have since been developed into industrial sites or constructed wetlands, and appeared to have reduced their potential impacts. Eroded, channelized creek sections were evident in several areas in both the 1991 ASA survey and the 1994 stream walks. Filling of some wetlands areas has also been evident.

Based on the ASA results and concerns regarding potential pollutant sources to the Hedges Marsh from nearby individual sites, USA inventoried industrial sites adjunct to Hedges Marsh in 1994 to determined which sites would potentially need to obtain Natural Pollutant Discharge Elimination System (NPDES) Industrial Stormwater permits from the Oregon Department of Environmental Quality (DEQ). The list of sites was compared to DEQ's list of permits. The USA sent letters to those industries on the list that did not have permits informing them of the potential need to obtain such permits.



BASE MAP PROVIDED BY METRO, REGIONAL MAP SERVICE, MARCH 1992

MAP A

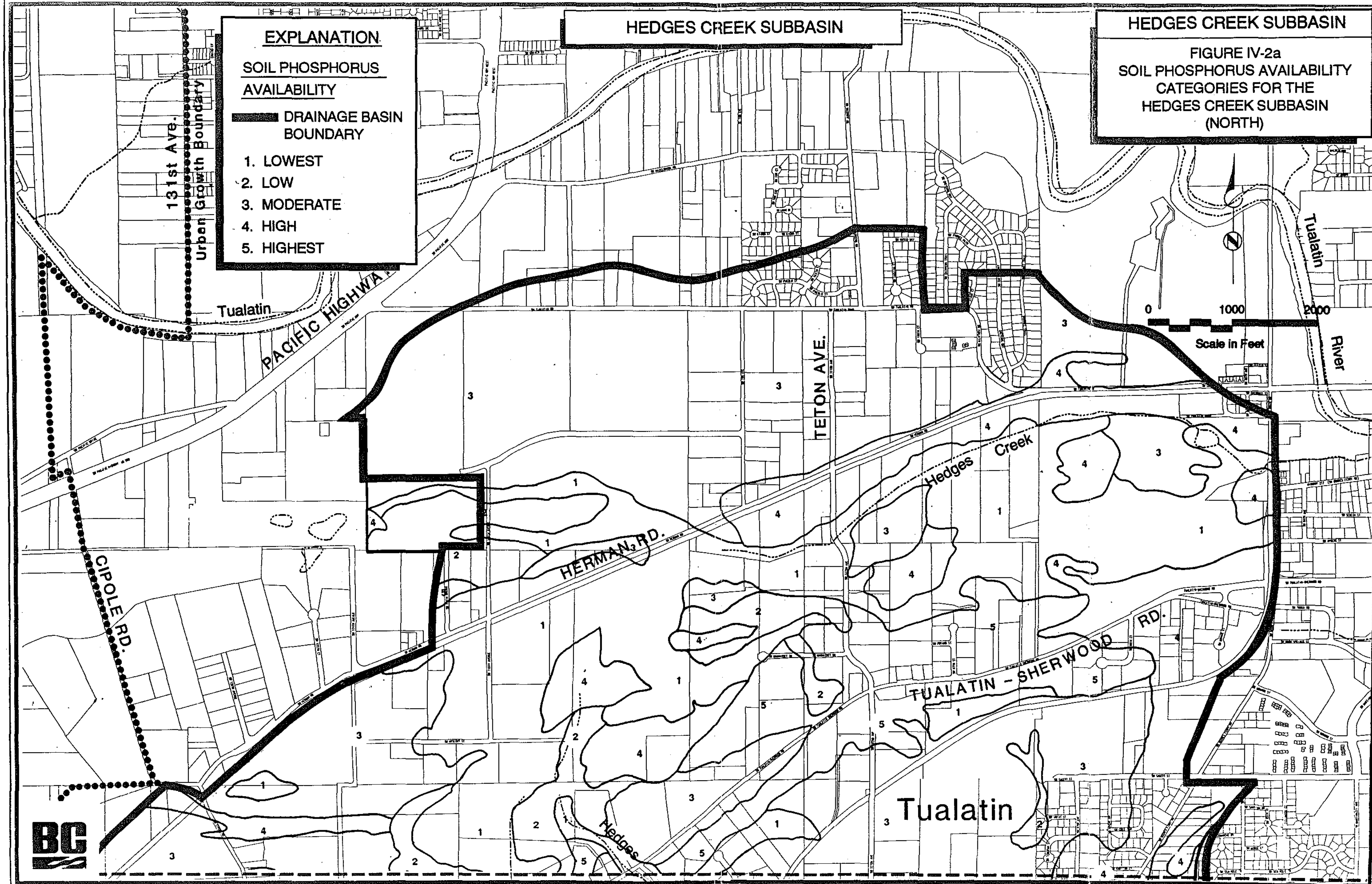


HEDGES CREEK SUBBASIN

FIGURE IV-1b
SOIL EROSION HAZARD CATEGORIES FOR THE HEDGES CREEK SUBBASIN (SOUTH)

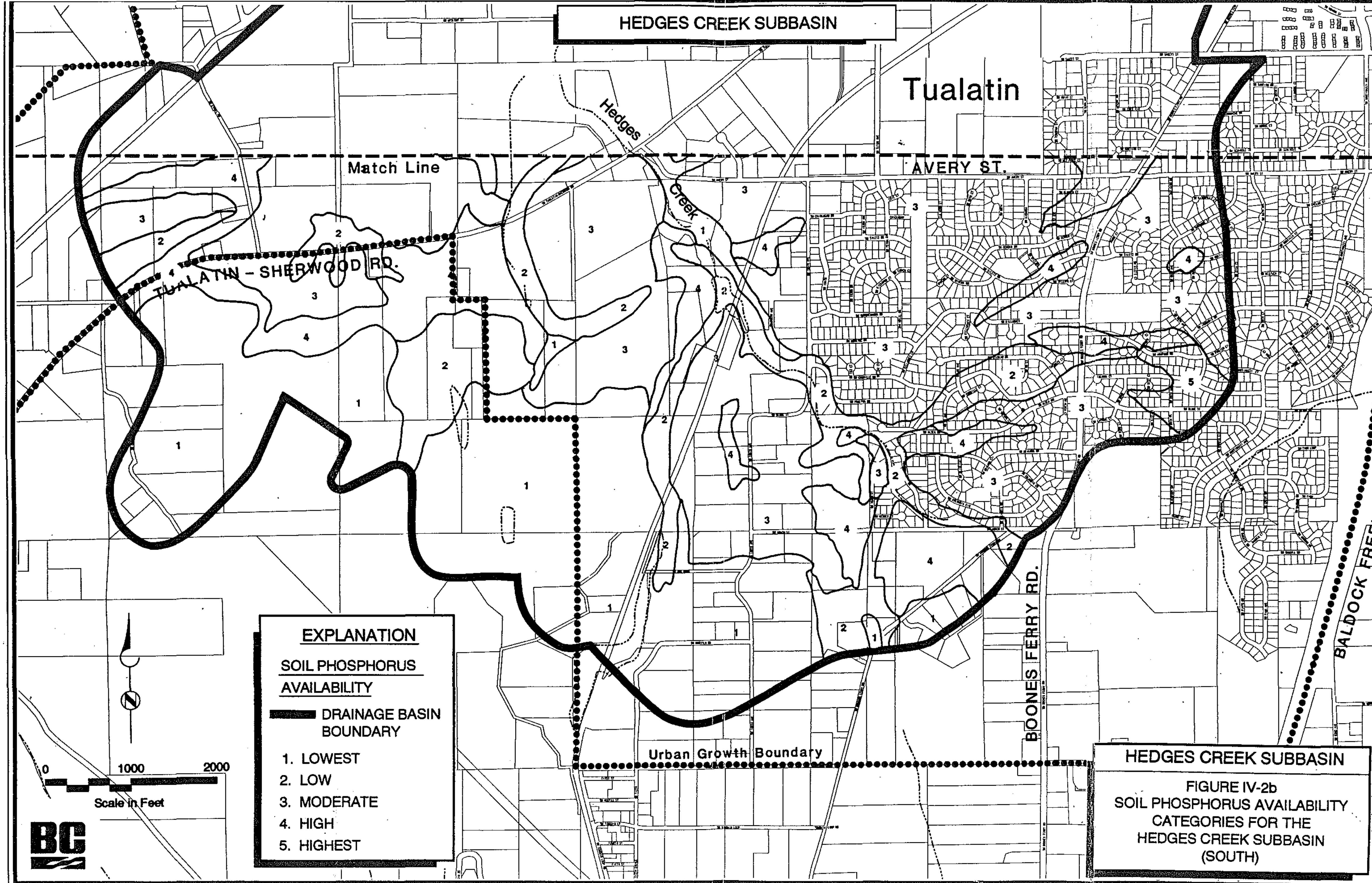
BASE MAP PROVIDED BY METRO, REGIONAL MAP SERVICE, MARCH 1992

MAP B



BASE MAP PROVIDED BY METRO, REGIONAL MAP SERVICE, MARCH 1992

MAP A



HEDGES CREEK SUBBASIN

FIGURE IV-2b
SOIL PHOSPHORUS AVAILABILITY
CATEGORIES FOR THE
HEDGES CREEK SUBBASIN
(SOUTH)

BASE MAP PROVIDED BY METRO, REGIONAL MAP SERVICE, MARCH 1992

MAP B

CHAPTER V

CHAPTER V

DRAINAGE AND WATER QUALITY CONDITIONS

INTRODUCTION

The purpose of this chapter is to provide information on the existing drainage and water quality facilities found within the Hedges Creek subbasin. The subjects covered in this chapter include:

- Introduction
- Hydrologic-Hydraulic Modeling
- Hedges Creek Subbasin Option Evaluation

HYDROLOGIC-HYDRAULIC MODELING

Hydrologic Modeling

As undeveloped areas urbanize, the amount of impervious area increases producing a corresponding increase in flood-event runoff volumes and peak flows. The end result is overtaxing of the existing conveyance system. For the Hedges Creek subbasin, a HEC-1 hydrologic model was developed to aid in determining where constrictions in the conveyance system will occur at projected buildout. The model was also used to evaluate potential detention sites and the effect of providing in-stream storage on the peak discharges occurring at the subbasin outlets. A detailed discussion on the HEC-1 model is contained in Chapter II of the Tualatin Basinwide Report and Technical Guidelines.

HEC-2 Hydraulic Model

A hydraulic analysis of the Hedges Creek Marsh was completed in October of 1994 to evaluate local flooding problems and develop alternatives for solving these flooding problems while protecting the Hedges Creek Marsh. A HEC-2 backwater analysis model was used to estimate the water surface profiles from Tualatin Road to the west end of the Hedges Creek Marsh. A technical memorandum presenting the approach and results of the hydraulic analysis is presented in Appendix B. A brief description of the HEC-2 model is presented in the following paragraph.

A HEC-2 backwater model was originally developed by Robert E. Meyer Consultants for the Hedges Creek Marsh area. This model extended from Tualatin Road to approximately Teton Avenue. As part of the current hydraulic analysis, this HEC-2 model was modified to include additional cross-sections and increase the model reach to include the Hedges Creek Marsh from Teton Avenue west to the upstream end of the Pascuzzi Pond. This modified HEC-2 model was used to estimate water surface profiles for four alternatives over a range of storm runoff events.

FACILITIES DESIGN CRITERIA

The hydraulic capacity of existing conveyance structures requires site specific analysis. In general, allowable ponding upstream of a hydraulic structure depends on the structural integrity of the embankment and impacts on adjacent landowners. Several types of flow control may exist for a specific structure depending on the discharge occurring at the structure. For this reason, hydraulic design criteria for conveyance structures is based primarily on accepted hydraulic analysis techniques. Basic design criteria are presented in Volume II of the USA-SWM plans, the Tualatin Basinwide Report and Technical Guidelines.

Design storm events selected for this project were based on USA or local jurisdiction requirements (which ever was more stringent). In general, conveyance facilities such as culverts were evaluated for 25-year design storm event. Facilities located in the 100-year flood plain of the Tualatin River were evaluated for the 100-year event. Detention ponds were designed to maximize the available storage at a site.

HEDGES CREEK SUBBASIN CONDITIONS

Background

An analysis of the drainage and water quality aspects of the subbasin, shown in Figures V-1a and V-1b, was completed to aid in developing storm water management alternatives for the subbasin. As part of this analysis, an inventory of the existing storm water drainage system was completed with the focus on major structures of the system. The inventoried facilities were used in conjunction with a HEC-1 model to evaluate the ability of the existing system to convey storm discharges from both existing and projected land development.

Water quality facilities and wetlands were also inventoried and mapped. These facilities and other potential pollutant reduction facilities (PRFs) form the basis for evaluating the level of pollutant transport which may be expected from the subbasin.

Existing Storm Water Facilities

Open ditches or creeks, combined with culverts at road crossings, constitute the predominate storm drainage system within the Hedges Creek subbasin. Table V-1 contains an inventory of the primary storm drainage facilities found within the subbasin. Facility locations are shown in Figures V-1a and V-1b.

Hedges Creek flows in a relatively well defined channel between Boones Ferry Road and the Tualatin River. West of Lower Boones Ferry Road, Hedges Creek flows through a flat, low area where the channel is shallow or nonexistent. Just east of Teton Avenue, Hedges Creek turns south and crosses the Tualatin- Sherwood Road near Avery Road extending into the low hills located on the south side of Hedges Creek subbasin. One fork of Hedges Creek originates at a shallow pond-marsh area in the Tonquin area. Two railroad trestles were constructed across the creek allowing the creek to meander from one side of the railroad to the other. At the last downstream crossing of the creek, however, no trestle was constructed and the railroad embankment serves as a dam creating a pond-marsh. The embankment does not appear to have any formal outlet, but a small amount of leakage is evident.

The second fork of Hedges Creek extends north into a residential development. The storm drainage from both the north and south forks of Hedges Creek enter a small reservoir in an industrial area just upstream from the Tualatin-Sherwood Road. The operating outlet of the dam is 48-inch CMP standpipe that discharges to the creek at the downstream toe of the dam. A 48-inch CMP pipe is located near the east end of the dam to serve as an emergency spillway.

Table V-1 Hedges Creek Storm Drain Inventory

Facility	Location	USA Map	Type	Size	Material	Length	Slope	Age/Cond.	Comments
HC-1	Hedges Creek at Tualatin Road	NA	CIRC	72	CM	94	0.0011	M/G	Culvert
HC-3	Near Mohave Ct. & Tualatin-Sherwood Hwy.	NA	CIRC	24	CONC	121	0.0083	M/G	Culvert
HC-4	Herman Rd., east of 108th	NA	CIRC	12	CONC	NA	NA	M/G	CB/Culvert/Storm Drain
HC-5	West of Teton Ave. on N. Herman Rd.	NA	CIRC	12	CM	575	NA	M/G	Channel/Storm Drain
HC-6	Teton Ave. & N. Hedges Creek channel	NA	CIRC	72	CM	100	0.0001	M/F	Culvert
HC-7	South channel, Hedges Creek at Teton Ave.	NA	CIRC	2-24	CONC	64	0	M/F	Culverts
HC-8	Detention pond & culvert, west of 108th	NA	O	42	---	60		N/G	Detention pond and series of culverts.
HC-9	S.W. Tualatin-Sherwood Hwy. & S.W. Teton Ave.	NA	CONC	24	CONC	5	---	M/G	Detention pond/culvert outlet
HC-10	Avery Rd. & Tualatin-Sherwood Hwy.	NA	CIRC	60	CONC	147	0.0001	N/G	Culvert
HC-11	Tualatin-Sherwood Hwy.	NA	CIRC	36	CONC	125	0.016	N/G	Culvert
HC-12	Tualatin-Sherwood Hwy.	NA	CIRC	2-36	CONC	120	NA	M/F	Culvert
HC-13	East of Cipole Rd. & Tualatin-Sherwood Hwy.	NA	CIRC	1-36	CONC	120	0.0440	M/F	Culvert
HC-14	Tualatin-Sherwood Hwy.	NA	O	48	CM	100	---	M/G	Detention pond with vertical CM riser outlet
HC-15	Outlet from gravel pit pond	NA	CIRC	16	CM	38	0.0263	M/F	Outlet pipe from rock quarry.

LEGEND — NA = Not Available — NE = Not Existing (not found)

Column 1: HC- HEDGES CREEK

Column 2: CROSS STREET LOCATION

Column 3: USA QTR. SEC. MAP ID

Column 4: CIRCULAR- CIRC
BOX CULVERT- BOX
BRIDGE- BRDG
ELLIPTICAL-ELLIP
OTHER- O

Column 5: CIRC- DIA (IN.)
BOX-
H (FT.), W (FT.)
BRDG-
L (FT.) ABOVE CENTERLINE OF CHANNEL
H (FT.) ABOVE GROUND AT BRIDGE SUPPORTS
ELLIP-H(IN.) W(IN.)

Column 6: CONCRETE- CONC
POLYVINYLCHLORIDE- PVC
CORRUGATED METAL- CM
OTHER- O

Column 7: LENGTH IN FEET

Column 8: FT./FT.
C- CALCULATED FROM FIELD DATA
A-ASSUMED FROM AVAILABLE DATA

Column 9: AGE:
NEW (1-5 YEARS)-N
MED (6-20 YEARS)-M
OLD (20 YEARS PLUS)-O
COND:
POOR-P
FAIR-F
GOOD-G

Column 10: COMMENTS:
DESCRIBE ORIENTATION OF FACILITY TO DIRECTION OF FLOW, ETC.

Table V-1 Hedges Creek Storm Drain Inventory (continued)

Facility	Location	USA Map	Type	Size	Material	Length	Slope	Age/Cond.	Comments
HC-16	RR culvert behind Commerce Park	NA	CIRC	24	CM	32	0.0469	M/F	
HC-17	Tualatin-Sherwood Hwy.	NA	CIRC	20	CM	215	0.0116	N/G	
HC-18	North end of 118th	NA	0	48 IN W	---	140	---	---	Existing drainage ditch with no culvert under road.
HC-19	118th (south crossing)	NA	CIRC	33 IN	CONC	50	0.030	N/G	Inlet/Culvert
HC-20	Culvert behind Commerce Park	NA	CIRC	30	CONC	100	0.001	M/F	Culvert
HC-21	South of bend in Cipole Rd., N. of Sherwood Rd.	NA	CIRC	18	CONC	45	0.0185	M/F	Inlet/Culvert
HC-22	98th & 99th Ave.	NA	CIRC	18	CONC	60	---	N/G	Culvert
HC-23	S.W. Alsea Ct.	NA	CIRC	42	CM	150	0.027	N/G	Culvert
HC-24	S.W. Alsea Ct.	NA	CIRC	36	CONC	30	0.011	N/G	Culvert
HC-25	S.W. Ibach Ave. & S.W. Hedges Rd.	NA	CIRC	33	CONC	180	0.0001	N/G	Culvert
HC-26	S.W. Ibach Ave. & Grahmns Dr.	NA	CIRC	24	CONC	65	0.0231	M/G	Culvert
HC-27	S.W. Boones Ferry Rd.	NA	ELLIP	24 x 48	CM	300	NA	M/F	Culvert

LEGEND NA = Not Available NE = Not Existing (not found)

Column 1: HC- HEDGES CREEK

Column 2: CROSS STREET LOCATION

Column 3: USA QTR. SEC. MAP ID

Column 4: CIRCULAR- CIRC
BOX CULVERT- BOX
BRIDGE- BRDG
ELLIPTICAL-ELLIP
OTHER- O

Column 5: CIRC- DIA (IN.)
BOX-
H (FT.), W (FT.)
BRDG-
L (FT.) ABOVE CENTERLINE OF CHANNEL
H (FT.) ABOVE GROUND AT BRIDGE SUPPORTS
ELLIP-H(IN.) W(IN.)

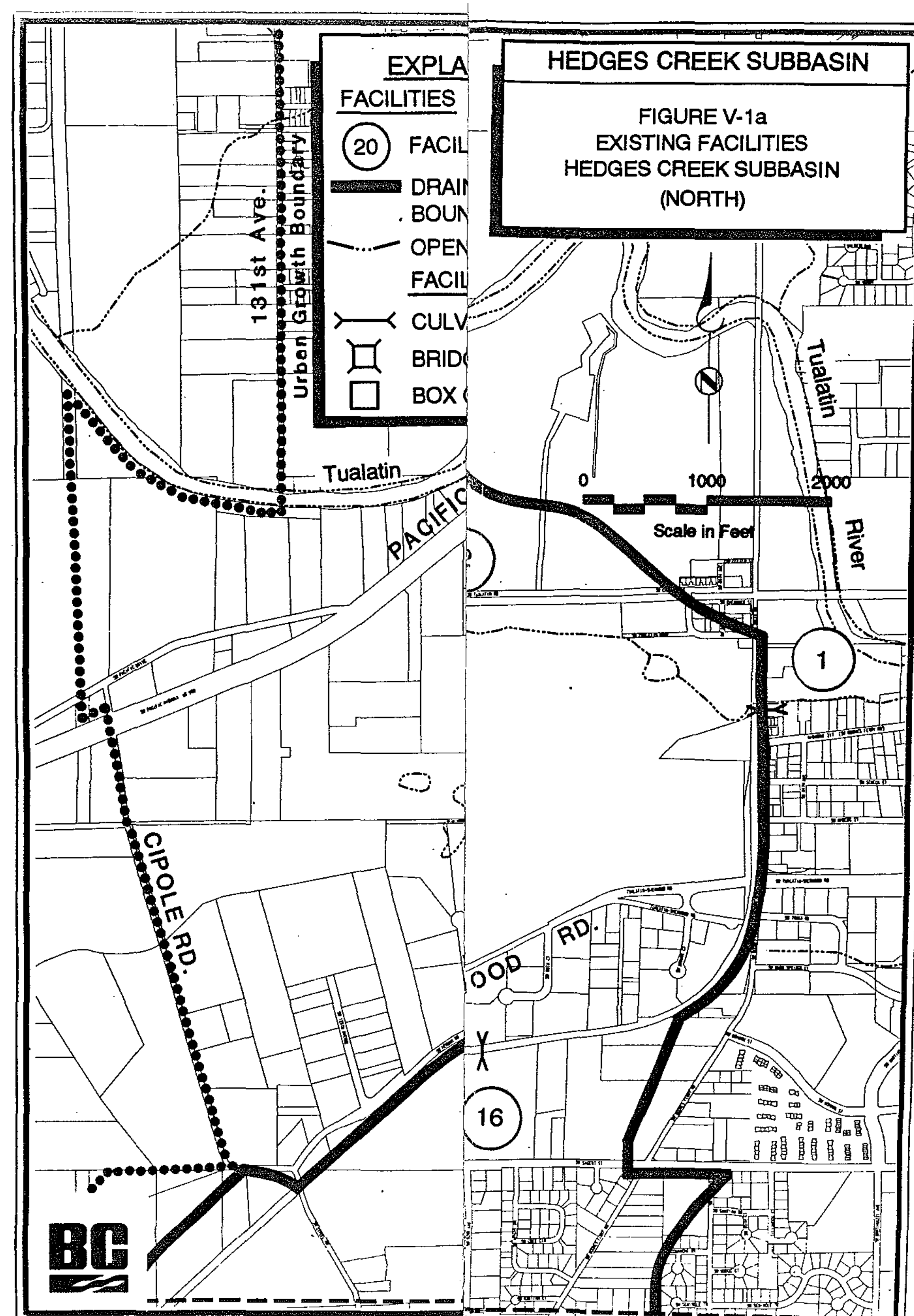
Column 6: CONCRETE- CONC
POLYVINYLCHLORIDE- PVC
CORRUGATED METAL- CM
OTHER- O

Column 7: LENGTH IN FEET

Column 8: FT./FT.
C- CALCULATED FROM FIELD DATA
A-ASSUMED FROM AVAILABLE DATA

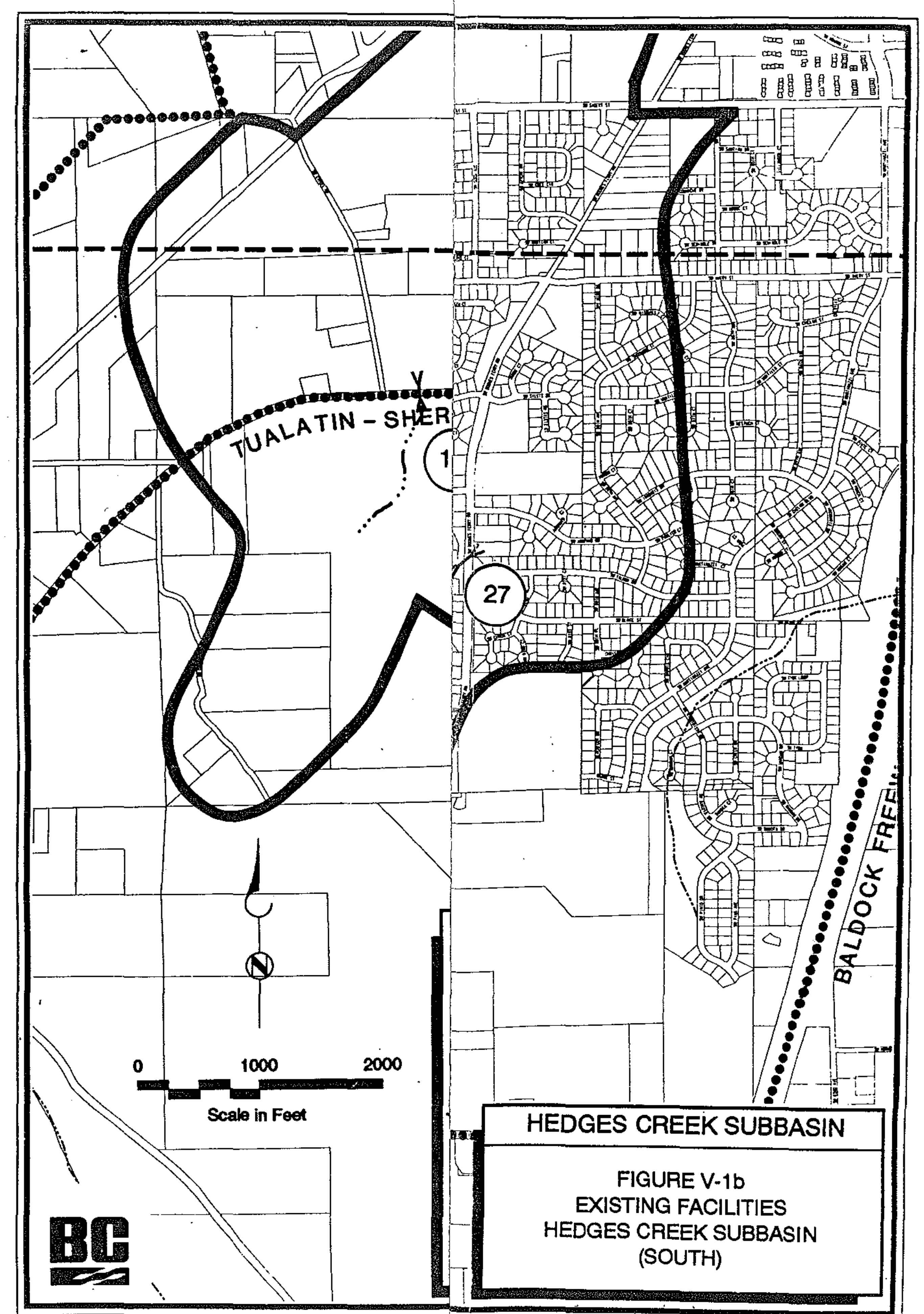
Column 9: AGE:
NEW (1-5 YEARS)-N
MED (6-20 YEARS)-M
OLD (20 YEARS PLUS)-O
COND:
POOR-P
FAIR-F
GOOD-G

Column 10: COMMENTS:
DESCRIBE ORIENTATION OF FACILITY TO DIRECTION OF FLOW, ETC.



BASE MAP PROVIDED BY METRO, REGIONAL MAP

MAP A



BASE MAP PROVIDED BY METRO, REGIONAL M

MAP B

Existing Drainage Facilities Inventory

An inventory of existing drainage facilities in the subbasin (Figures V-1a and V-1b) was conducted using inventory criteria provided on the standard fact sheets developed for the project (see Chapter II of the Tualatin Basinwide Report and Technical Guidelines). The primary focus of the inventory was to provide supporting baseline data and observations for the hydrologic modelling phases and tasks of the larger project. The secondary focus of the inventory was to identify drainage patterns and conditions throughout the basin and to identify potential pollution reduction facility (PRF) sites.

A pre-inventory identification of existing drainage facilities was conducted in January, February, and March of 1991. A total of 27 facilities in the subbasin were inventoried; facility No. 2 was believed to be present but was not found during the field phases of the work. Figures V-1a and V-1b show the approximate locations of each facility inventoried. These maps represent the northern and southern portions of the subbasin (see "match-line"). The subbasin was split so as to show the necessary locational information.

As Figures V-1a and V-1b indicate, a number and variety of data and descriptive observations were recorded in the field for each facility. Quantitative measurements were made from permanent, stable, benchmarks (e.g., roadbed centers, curb edges, etc) to culvert and pipe inverts. Estimates of facility length were made by distance pacing or by hip-chain measurements. Other vertical and horizontal distances were visually estimated, such as allowable headwater/tailwater and historic water depth. More qualitative information was made on facility condition and PRF opportunities and constraints.

For each facility, a plan view map and cross sectional diagram were drawn to graphically detail facility characteristics. In addition, a series of photographs were taken to document site conditions and system design. These photographs were later mounted and described in captions. The individual facility data forms tied to Figures V-1a and V-1b are presented in a separately-bound appendix.

Since the original inventory was completed in 1991, a number of drainage improvements have been completed within the basin. These improvements occurred primarily along the Tualatin-Sherwood Road. These improvements were taken into account during development of the recommended capital improvements.

Existing System Capacity

The size and capacity of the existing storm drainage facilities are listed in Table V-2. These capacities represent the maximum flow which the facility may carry without overtopping the roadway or flow diversion occurring.

Table V-2 Hedges Creek Existing Storm System Capacity

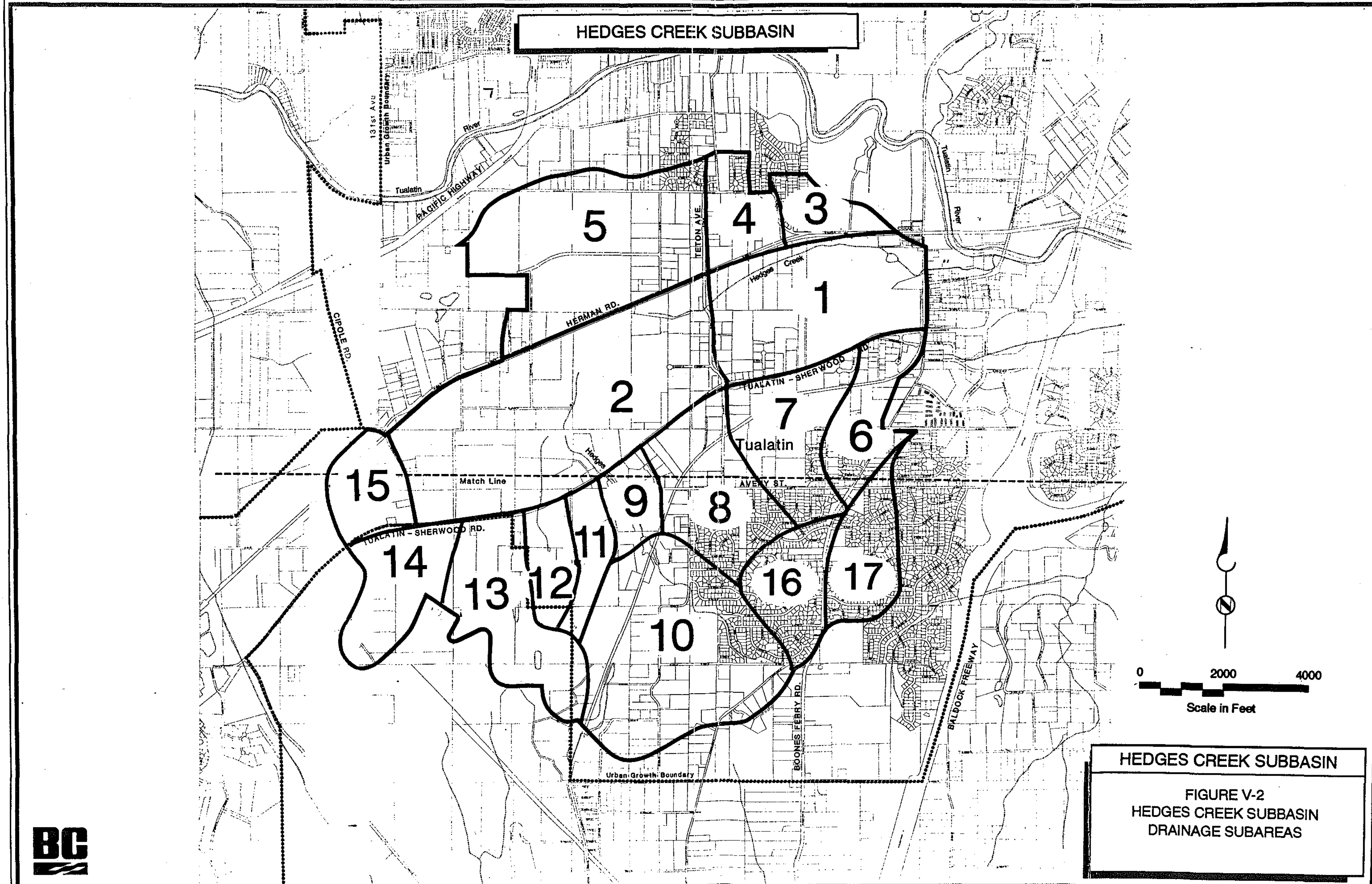
Structure ID	Hedges Creek	Existing Capacity (CFS)
HC-1	Hedges Creek at Boones Ferry Road	280
HC-2	Golf Course on Lower Boones Ferry Road	NA
HC-3	Near Mohave Ct. & Tualatin-Sherwood Road	15
HC-4	Herman Rd., east of 108th	4
HC-5	West of Teton Ave. on N. Herman Road.	8
HC-6	Teton Ave. & N. Hedges Creek channel	100
HC-7	South channel, Hedges Creek at Teton Avenue	94
HC-8	Detention pond & culvert, west of 108th	68
HC-9	S.W. Tualatin-Sherwood Road & S.W. Teton Avenue	17
HC-10	Avery Rd. & Tualatin-Sherwood Road	150
HC-11	Tualatin-Sherwood Road	80
HC-12	Tualatin-Sherwood Road	140
HC-13	East of Cipole Rd. & Tualatin-Sherwood Road	90
HC-14	Tualatin-Sherwood Road	170
HC-15	Outlet from gravel pit pond	5
HC-16	RR culvert behind Commerce Park	22
HC-17	Tualatin-Sherwood Road	25
HC-18	North end of 118th	0
HC-19	118th (south crossing)	10
HC-20	Culvert behind Commerce Park	28
HC-21	South of bend in Cipole Road., N. of Sherwood Road	25
HC-22	98th & 99th Avenue	23
HC-23	S.W. Alsea Court.	80
HC-24	S.W. Alsea Court	135
HC-25	S.W. Ibach Avenue & S.W. Hedges Road	70
HC-26	S.W. Ibach Ave. & Grahams Ferry Road	18
HC-27	S.W. Boones Ferry Road	50

HYDROLOGIC ANALYSIS

A hydrologic analysis was completed for the Hedges Creek subbasin using the HEC-1 model and procedure described previously.

Drainage Subareas

The Hedges Creek subbasin was divided into 17 subareas based on topographic and drainage characteristics as shown in Figure V-2. The outlet of each subarea corresponds with an existing drainage facility. Herman Road and Tualatin-Sherwood Road form the boundaries of the lower two subareas which are separated by Teton Avenue. Subareas 3 through 17 ultimately drain into subarea 1 either directly or via subarea 2. Storm flows discharge at the east side of Hedges Creek Marsh through an existing culvert under Lower Boones Ferry Road and travel in a well defined creek channel to the Tualatin River.



HEDGES CREEK SUBBASIN

FIGURE V-2
HEDGES CREEK SUBBASIN
DRAINAGE SUBAREAS

BASE MAP PROVIDED BY METRO, REGIONAL MAP SERVICE, MARCH 1992

SUBBASIN MAP

Basin Parameters

Table V-3 lists the subarea characteristics and HEC-1 model input parameters discussed previously. Most of the subbasin is in the early stages of development as shown by the large increases in effective impervious areas occurring at projected buildout. The decrease in subarea lag times associated with urbanization is also evident from review of Table V-3. Subareas encompassing the south side of the Hedges Creek subbasin exhibit the lowest lag times for both existing and future conditions mainly due to steeper land slopes found in these areas.

Subarea Peak Discharges

Peak subarea discharges were computed for the 2-, 5-, 10-, 25-, 50-, and 100-year storm recurrence intervals. Table V-4 contains the peak discharges associated with the 5-, 10-, 25-, and 100-year events for existing and projected land uses. These events represent the primary design storm events for both conveyance and detention facilities used by USA and the City of Tualatin.

Capacity of Existing System

An evaluation of the existing Hedges Creek storm drainage system was performed to determine system constraints which currently exist and those which will occur at projected buildout. In general, the drainage subareas were defined with a major drainage facility at the outlet. Consequently, the drainage area served by the facility corresponds directly with the area and the HEC-1 model peak discharges were used directly. The area and resulting peak discharges served by intermediate facilities was estimated using the SCS Method via hand computations.

The existing capacity of the facility and the estimated storm event at which the facility becomes deficient is presented in Table V-5 and is discussed in the following paragraphs:

> Existing Land Use: Twelve of the existing inventoried drainage facilities do not have sufficient capacity to handle the runoff associated with the current level of development. Of these, the capacity of ten of these facilities will be exceeded at the 10-year event and two at the 25 year event. There is no current drainage outlet for subarea 3 which is represented by facility 2. This area currently exhibits flooding problems during heavy rainfall events. Facility 18 is an open channel which has been cut by a roadway. Located adjacent to facility 18, facility 19 has limited capacity mainly due to its inlet design and significant potential for sedimentation. Neither facility 18 or 19 pose significant flooding hazards, however.

Projected Land Use: The existing drainage system will be severely stressed at projected buildout. The capacities of all but eight of the existing drainage facilities will be exceeded at the 10-year event. Recently installed culverts under the Tualatin-Sherwood Road (facilities 10, 11 and 14) have sufficient capacity to pass the 25 year peak discharge. Most of the facilities in the residential developments located in the south hills of the basin also have adequate capacity to pass the 25 year peak storm discharge. The vertical pipe riser serving as the outlet works for the small reservoir (facility 14) will safely discharge the 25 year peak discharge.

Table V-3 Hedges Creek Subbasin Parameters

Subbasin	Drainage Area		Impervious Area (%)						Main Channel Length		Channel Slope	Existing Lag Time	Future Lag Time
			Existing		Future			Curve Number					
	(Acres)	(Sq.Mi.)	MIA	EIA	MIA	EIA	% INCRS		(FT.)	(MI.)	(FT/MI)	(Hours)	(Hours)
HC-1	291	0.45	13	3	58	39	346	88	5386	1.02	7.8	4.28	0.63
HC-2	516	0.81	15	4	67	51	347	92	6970	1.32	13.1	3.89	0.42
HC-3	56	0.09	14	2	37	14	164	83	1478	0.28	57.1	1.37	0.48
HC-4	84	0.13	51	51	61	61	20	91	2006	0.38	7.0	0.52	0.34
HC-5	348	0.54	9	2	74	61	722	91	3696	0.07	80.0	2.42	0.14
HC-6	108	0.17	49	49	55	55	12	86	3749	0.71	135.2	0.36	0.28
HC-7	161	0.25	24	24	69	69	188	91	3485	0.66	145.5	1.04	0.15
HC-8	178	0.28	52	33	60	42	15	85	3643	0.69	125.6	0.32	0.23
HC-9	50	0.08	25	10	80	69	220	89	1478	0.28	47.6	0.84	0.08
HC-10	385	0.60	27	11	42	23	56	75	4435	0.84	63.5	1.26	0.64
HC-11	54	0.08	1	1	80	80	7900	95	3485	0.66	143.4	3.41	0.09
HC-12	64	0.10	1	0	80	69	7900	95	2957	0.56	174.4	3.05	0.08
HC-13	167	0.26	3	2	80	69	2567	95	3960	0.75	39.1	4.21	0.14
HC-14	126	0.20	1	0	80	69	7300	95	3010	0.57	56.1	3.90	0.11
HC-15	76	0.12	7	1.2	80	69	1043	95	2534	0.48	75	2.30	0.09
HC-16	104	0.16	28	12	35	17	25	83	1742	0.33	32.3	0.88	0.65
HC-17	89	0.14	31	14	32	15	3	83	1900	0.36	70.4	0.66	0.63

Table V-4 Hedges Creek Peak Subbasin Discharges

Subbasin	Drainage Area		Peak Subbasin Flow (CFS)												
			Existing Conditions				Future Conditions							
	(Acres)	(Sq.Mi.)	Q5	Q10	Q25	Q100	Q5	% CHG	Q10	% CHG	Q25	% CHG	Q100	% CHG
HC-1	291	0.45	179	186	211	236	456	155	465	150	542	157	566	140
HC-2	516	0.81	115	127	184	241	417	263	443	249	561	205	671	178
HC-3	56	0.09	6	7	10	14	13	117	14	100	19	90	25	79
HC-4	84	0.13	32	34	43	51	33	3	36	6	47	9	56	10
HC-5	348	0.54	21	24	37	51	131	524	140	483	179	384	215	322
HC-6	93	0.14	21	23	32	41	26	24	28	22	38	19	47	15
HC-7	161	0.25	21	23	34	45	63	200	67	191	86	153	103	129
HC-8	178	0.28	33	36	53	69	50	52	55	53	74	40	92	33
HC-9	50	0.08	33	37	55	73	52	58	57	54	83	51	107	47
HC-10	385	0.60	31	36	59	82	71	129	79	119	119	102	157	91
HC-11	54	0.08	1	1	2	3	24	2300	25	2400	31	1450	36	1100
HC-12	64	0.10	2	2	3	4	30	1400	32	1500	39	1200	45	1025
HC-13	167	0.26	7	8	12	17	77	1000	82	925	100	733	117	588
HC-14	126	0.20	9	10	15	19	60	567	63	530	77	413	91	379
HC-15	76	0.12	5	5	8	11	36	620	38	660	46	475	54	391
HC-16	104	0.16	27	30	43	52	29	7	32	7	45	5	59	13
HC-17	89	0.14	15	16	23	26	15	0	16	0	23	0	26	0

Table V-5 Hedges Creek Subbasin Capacity of Existing System

Structure ID	Hedges Creek	DIA or Bottom	Material	Structure Type	Length (FT)	Drainage Area (AC)	Existing Capacity (CFS)	Existing Flows (CFS) 10 YR	Existing Flows (CFS) 25 YR	Future Flows (CFS) 10 YR	Future Flows (CFS) 25 YR	When Deficient
HC-1	Hedges Creek at Boones Ferry Rd.	72 in	CM	CULVERT	94	2,857	280	186	211	465	542	FUT-10
HC-2	Golf Course on Lower Boones Ferry Rd.	–	–	NE	–	56	0	7	10	14	19	EXT-10
HC-3	Near Mohave Ct. & Tualatin-Sherwood Hwy.	24 in	CONC	CULVERT	121	108	15	23	32	25	38	EXT-10
HC-4	Herman Rd., east of 108th.	12 in	CONC	CB/ CULVERT	NA	61	4	5	7	36	42	EXT-10
HC-5	West of Teton Ave. on N. Herman Rd.	12 in	CM	CHANNEL/ CULVERT	575	84	8	41	48	46	54	EXT-10
HC-6	Teton Ave. & N. Hedges Creek channel	48 in	CM	CULVERT	100	970	100	51	74	177	224	FUT-10
HC-7	South channel, Hedges Creek at Teton Ave.	2-24 in	CM	CULVERT	64	1,456	94	76	110	226	337	EXT-25
HC-8	Detention pond and culvert, west of 108th.	42 in	CM	CULVERT	60	348	68	28	38	140	179	FUT-10
HC-9	S.W. Tualatin-Sherwood Hwy. & S.W. Teton Ave.	24 in	CONC	CULVERT	5	139	17	39	51	63	77	EXT-10
HC-10	Avery Rd. & Tualatin-Sherwood Hwy.	60 in	CONC	CULVERT	147	628	150	37	55	57	83	OK
HC-11	Tualatin-Sherwood Hwy.	36 in	CONC	CULVERT	125	54	80	1	2	25	31	OK
HC-12	Tualatin-Sherwood Hwy.	2-36 in	CONC	CULVERT	120	167	140	8	12	82	100	OK
HC-13	East of Ciple Rd. & Tualatin-Sherwood Hwy.	1-36 in	CONC	CULVERT	36	126	90	10	15	63	77	OK
HC-14	Tualatin-Sherwood Hwy.	48 in	CM	OUTLET RISER	100	578	170	36	59	79	119	OK
HC-15	Outlet from gravel pit pond	16 in	CM	CULVERT	38	98	5	6	8	69	80	EXT-10
HC-16	RR culvert behind Commerce Park	24 in	CM	CULVERT	32	109	22	18	23	71	84	EXT-25
HC-17	Tualatin-Sherwood Hwy.	20 in	CM	CULVERT	215	39	25	7	8	19	23	OK
HC-18	North end of 118th	48 in W	EARTH	CHANNEL	141	100	0	9	13	63	74	EXT-10
HC-19	118th (south crossing)	33 in	CM	CULVERT	50	129	10	12	16	81	96	EXT-10
HC-20	Culvert behind Commerce Park	24 in	CM	CULVERT	100	161	45	23	34	67	86	FUT-10
HC-21	South of bend in Cipole Rd., N. of Sherwood Rd.	18 in	CONC	CULVERT	45	75	25	6	7	62	72	FUT-10
HC-22	98th & 99th Ave.	24 in	CM	CULVERT	NA	140	23	26	32	30	38	EXT-10
HC-23	S.W. Alsea Ct.	40 in	CM	CULVERT	150	193	80	32	40	37	47	OK
HC-24	S.W. Alsea Ct.	48 in	CONC	CULVERT	50	332	135	48	61	58	74	OK
HC-25	S.W. Ibach Ave. & S.W. Hedges Rd.	33 in	CM	CULVERT	180	150	70	26	33	43	55	OK
HC-26	S.W. Ibach Ave. & Grahmns Dr.	24 in	CM	CULVERT	65	133	18	19	26	61	75	EXT-10
HC-27	S.W. Boones Ferry Rd.	24 in H 48 inW	CM	CULVERT	300	89	50	23	28	24	31	OK

WATER QUALITY OF RUNOFF

Pollutant loads in runoff usually increase as an area becomes more urban in character. This is a result of both the increased volume and rate of runoff and the change in land use. Major urban nonpoint source pollutants include sediments, nutrients, metals, oxygen-demanding substances, bacteria, and hydrocarbons. These pollutants may be either dissolved or bound to particulates.

Different land uses influence the type and quantity of pollutants found in the runoff (Table V-6). Undeveloped land contributes the highest total suspended solids (TSS) concentration to runoff, for instance, while residential land adds the most nutrients. Another way different land uses affect runoff is the form, dissolved or particulate, that the pollutant is in. Thus, although undeveloped and commercial areas contribute almost equal concentrations of total phosphorus to runoff, only about 25 percent of phosphorus in undeveloped areas runoff is in dissolved or soluble form as compared to about 40 percent in commercial runoff.

Moreover, even within the same broad category of land use, pollutant types and concentrations may vary. Topography, soil type, vegetation, and population and traffic density all affect runoff. Construction activity may increase total suspended solids (TSS) in runoff by a factor of 10,000. Water quality monitoring, therefore, provides the most accurate way to determine pollutant loadings.

Table V-6 Mean Pollutant Concentrations(mg/l) from EPA National Urban Runoff Program (NURP) Study

	Land Use			
Pollutant	Undeveloped	Residential	Mixed	Commercial
Chemical Oxygen Demand	51	83	75	81
Total Suspended Solids	216	140	101	90
Total Nitrogen	2.09	3.31	2.11	2.03
Soluble Phosphorus	0.06	0.16	0.07	0.098
Total Phosphorus	0.23	0.46	0.33	0.24
Lead (Pb)	0.054	0.18	0.19	0.13
Zinc (Zn)	0.23	0.18	0.19	0.33

WATER QUALITY IMPROVEMENT

Many types of pollutant removal mechanisms can be used to improve the quality of runoff. These mechanisms include settling, filtration, adsorption, and biological uptake. Depending on runoff quantity and quality, a pollutant reduction facility (PRF) can be designed to incorporate one or more of these removal mechanisms.

Pollutant Reduction Facilities

Detention ponds, marshes, infiltration facilities, and vegetated swales are the main types of PRFs. A brief summary of these facilities is included below. Further details about the design and operation of these facilities is found in the Surface Water Quality Facilities Technical Guidance Handbook (Brown and Caldwell, 1991).

Detention ponds store runoff and slow down its rate of flow. Depending on the storage time, many different physical, chemical, and biological processes may occur. However, the main removal mechanism is settling of solids and pollutants attached to these solids. Therefore, they tend to be most effective at removing TSS and those pollutants, such as metals and phosphorus, that are bound to the sediments. Detention ponds are not effective at removing soluble nutrients and floatable hydrocarbons such as oil and grease. Correctly designed, they are relatively easy to maintain.

Marshes, like detention ponds, provide for settling by pollutants in runoff, but they also provide biological uptake and increased surface for adsorption. Thus, they are effective at removing both dissolved and particulate pollutants. Large amounts of sediments or toxic substances may, however, harm vegetation and wildlife in the marsh.

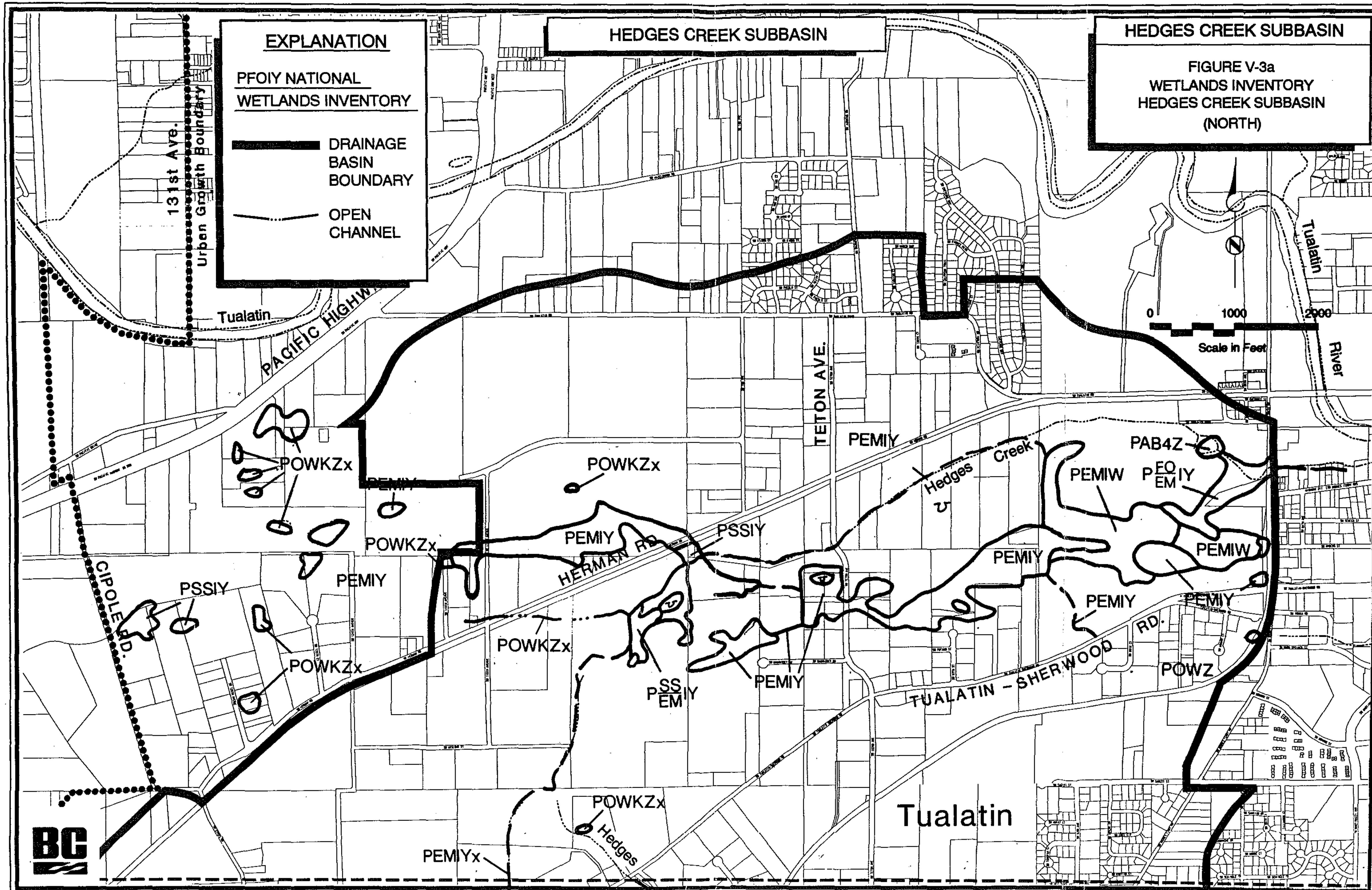
Infiltration facilities are the most effective at removing dissolved pollutants, but they are prone to clogging by sediments. The infiltration of polluted water into subsurface soils also raises concerns about groundwater contamination. The considerable maintenance requirements for infiltration facilities also present problems.

Vegetated swales slow down runoff, providing some settling and adsorption benefits. They are not as effective as marsh facilities and have a tendency to build up large sediment deposits during small rain events only to have them washed downstream during large events. They are inexpensive, however, especially when compared to conventional structural storm drainage conveyance systems.

Hedges Creek subbasin is a relatively undeveloped basin, but urbanization is occurring at a rapid rate along with an increased need for PRFs. At the current level of development, most drainage is still conveyed via vegetated swales which helps improve water quality.

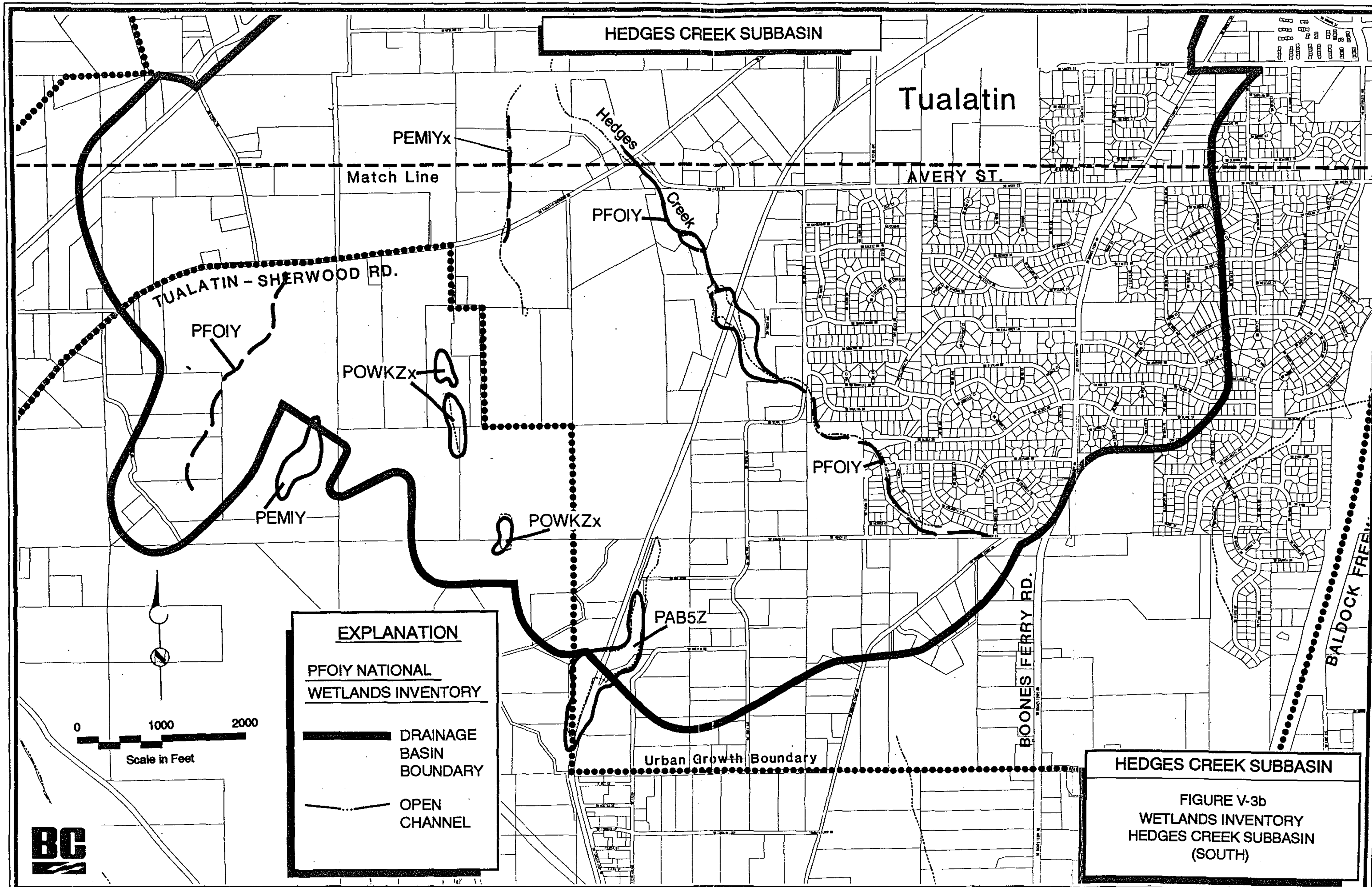
Wetlands within the Hedges Creek Subbasin

A compilation of identified wetland areas was made to graphically represent the distribution of wetlands in the subbasin (Figures V-3a and V-3b). The primary sources from which mapped information was drawn was the U.S. Fish and Wildlife Service National Wetland Inventory.



BASE MAP PROVIDED BY METRO, REGIONAL MAP SERVICE, MARCH 1992

MAP A



HEDGES CREEK SUBBASIN

FIGURE V-3b
WETLANDS INVENTORY
HEDGES CREEK SUBBASIN
(SOUTH)

BASE MAP PROVIDED BY METRO, REGIONAL MAP SERVICE, MARCH 1992

MAP B

Subbasin Wetland Descriptions

There are two types of wetlands directly associated with Hedges Creek: 1) those that are part of the riparian corridor in its upper reaches extending from Ibach and Boones Ferry to just below the Tualatin-Sherwood Road; and, 2) the wetlands in the broad flood plain that trends northeasterly between Tualatin-Sherwood Road and Herman Road to Boones Ferry Road on the east. This area has come to be known as Hedges Creek Marsh. Within the Hedges Creek watershed, but away from the creek, other small wetland patches (small ponded areas, marshes) have been identified. Many of the subbasin wetlands have been evaluated as potential in-stream PRFs.

The wetlands and pond areas within the riparian corridor include a man-made impoundment located at Industrial Way and a number of beaver dams. Along with the other riparian vegetation, the wetlands have created a diversity of habitats, providing excellent homes for a variety of species.

Reed canarygrass (Phalaris arundinacea), grows along the stream channel in low-lying areas that tend to dry during the summer. Along steep banks, red alder (*Alnus rubra*), Oregon ash (*Fraxinus latifolia*), and Douglas fir (*Pseudotsuga menziesii*) are common members of the top layer of trees. Red elderberry (*Sambucus racemosa*), salmonberry (*Rubus spectabilis*), vine maple (*Acer circinatum*), and hazel (*Corylus cornuta*) are found in the shrub layer. In and around the water, the following herbs are common: horsetail (*Equisetum arvense*), waterleaf (*Hydrophyllum occidentale*), youth-on-age (*Tolmiea menziesii*), skunk cabbage (*Lysichitum americanum*), candy flower (*Claytonia siberica*), and mannagrass (*Glyceria occidentalis*).

A different set of plants exist within the water itself. Elodea (*Elodea densa*) forms dense masses around the perimeter of the ponds and is found rooting at a maximum depth of about 7-8 feet, indicating water of generally low transparency. Water lily (*Nuphar polysepalum*) thrives along the waters edge along with some *Equisetum*, *Juncus* and *Ranunculus spp*. On the surface and amongst the *Elodea* and *Nuphar*, filamentous algae is common.

In contrast to the diversity of the riparian corridor, the wetlands of the lower Hedges Creek flood plain are dominated by reed canarygrass. The wet-weather biofiltering capability of reed canarygrass may be excellent, though water quality monitoring data to confirm this is not available. The area from just above Teton Road to Boones Ferry Road has been designated a wetland protection district by the City of Tualatin and has a regional permit regulating wetland management and filling. This area is commonly known as Hedges Creek Marsh.

Over the past 5 years, the Wetlands Conservancy, which owns portions of this area, have pressed to diversify this type of wetland. Shallow ponded areas have been created to provide habitat for different kinds of vegetation and related wildlife. Expected diversification is occurring. These shallow ponds may provide increased habitats for the growth of soft rush (*Juncus effusus*) which is very common downstream of I-5 in the area known as Nyberg Slough. These ponded areas may also provide increased biofiltering capacity.

The Hedges Creek Marsh is an excellent example of a regional resource that can provide a "nutrient polishing". Its large size relative to expected runoff flows and abundant vegetation should remove many of the dissolved nutrients remaining after pretreatment by upstream facilities.

Pretreatment

As noted above, marshes are susceptible to large amounts of sediments and toxic substances. Sediment deposits, along with oil and grease, may smother many marsh plants, especially after large storms. Many toxic substances, such as metals, are taken up by some of the same processes as nutrients. Other pollutants, such as herbicides, pesticides, and PCBs may cause toxicity or bioaccumulate and harm wildlife present in the marsh.

Due to the number and importance of existing marshes in the Hedges Creek subbasin, pretreatment of runoff is extremely important. Pretreatment facilities include trapped catch basins or sedimentation manholes and detention basins to remove suspended solids, and baffles or elbows to skim oil and floating debris from runoff. Certain types of land use activities are often associated with pollutants, as Table V-6 demonstrates, and pretreatment facilities can often be customized and located expressly for dealing with certain types of pollutants.

In the case of Hedges Creek, many light industrial sites are located next to Hedges Creek Marsh. A number of these industries presently discharge storm water directly into the marsh. With their high potential for harming the marsh, these industries may require complete on-site storm water control facilities, including ponds, oil/water separators, and chemical storage areas.

The National Pollutant Source Discharge Elimination System (NPDES) requires most of these industries to develop storm water management plans to obtain discharge permits. The plans should include the means to adequately protect Hedges Creek Marsh.

POLLUTION REDUCTION FACILITIES (PRF) INVENTORY

In conjunction with the drainage facility inventory, potential pollution reduction facilities (PRF) were identified within the subbasin. In general, the PRF opportunities were limited to the physical modification of drainage ditches, ditch/culvert systems, or existing ponds. The suitability of a site for PRF applications was judged based on sedimentation, sediment entrainment by vegetation (either existing or planted), and storm runoff retention capabilities.

Detailed descriptions of each potential PRF site that was evaluated are contained in Appendix C. All potential PRFs identified within the subbasin are shown on Figures V-4a and V-4b. PRF evaluations are discussed in Chapter VI.

CHAPTER VI

CHAPTER VI

OPTION EVALUATION AND STRATEGY RECOMMENDATIONS

This chapter describes the methods used to evaluate drainage\flood control and phosphorus reduction options and presents the results of the study. Items contained in this chapter include:

- The Evaluation Systems
- Hedges Creek Subbasin Option Evaluation

THE EVALUATION SYSTEMS

The following evaluation systems were developed to aid in evaluating available options for managing drainage\flood control and water quality within the USA-SWM subbasins. A detailed discussion of the evaluation systems is presented in Chapter II of the Tualatin Basinwide Report and Technical Guidelines.

DRAINAGE/FLOOD CONTROL

The evaluation system used to estimate the impacts and costs associated with drainage and flood control options consisted of the following steps:

- Step 1 - Develop management alternatives.
- Step 2 - Conduct a hydrologic and hydraulic analysis to determine runoff impacts.
- Step 3 - Estimate total project costs for each alternative
- Step 4 - Determine the best management alternative.
- Step 5 - Integrate drainage and flood control best management alternatives with water quality alternatives.

This process was used to evaluate combinations of three primary drainage and flood control options:

(1) Conveyance system improvements
(2) Regional storage detention
(3) Onsite storage detention for new development

The HEC-1 model was used to estimate the impacts on storm runoff peak flows and volumes for conveyance system improvements, regional storage detention, and onsite storage detention. A HEC-2 backwater model was used to determine water surface profiles through the Hedges Creek Marsh for various options. The complete hydraulic evaluation is presented in a technical memorandum presented in Appendix B. A summary of the option analysis is presented in a subsequent section.

WATER QUALITY

The evaluation system used to estimate the water quality achieved through implementing nonpoint source controls within the subbasin consists of three major parts:

Model Analysis Using Simplified Particulate Transport Model (SIMPTM)

The first step was to evaluate certain watershed management practices using the urban runoff and pollutant transport model SIMPTM, Simplified Particulate Transport Model (see Tualatin Basinwide Report and Technical Guidelines, Chapter II). The watershed management practices evaluated included revisions of future development densities as related to impervious surface, new street and drainage system design criteria, street sweeping, and the installation and cleaning of trapped catch basins and/or sedimentation manholes.

Pollutant Reduction Facility (PRFs) Evaluation

Second, potential sites for area-wide pollutant reduction facilities (PRFs) were identified and evaluated within the subbasin area using an initial screening and matrix evaluation process. A normalized rating was produced for each site which allows grouping and ranking for implementation purposes.

Basin Impact Analysis of PRFs

Finally, since SIMPTM does not address PRFs, an additional basin analysis was required to estimate the water quality results of the high priority PRFs in addition to the watershed management practices evaluated by SIMPTM. A spreadsheet model was used to project pollutant removals that could be achieved by PRFs throughout the subbasin.

DRAINAGE/FLOOD CONTROL ANALYSIS

The existing storm drainage system is inadequate to pass the storm discharges expected at projected buildout. Feasible options for improving the drainage system center on improving the conveyance system, providing detention storage within the system, providing onsite detention for future development, or combinations of conveyance system improvements and detention storage. Two primary alternatives were evaluated as part of the 1992 subbasin planning work:

(1) Improve the conveyance system without providing detention storage in the drainage system.

(2) Maximize available detention storage and provide required conveyance system improvements.

A third alternative was analyzed as part of the hydraulic study of the Hedges Creek Marsh completed in October 1994. This alternative involved implementing onsite detention requirements for all future development. The analysis was based on the hydrologic analyses prepared by Brown and Caldwell in the original 1992 subbasin plan which was based on 1989 land use conditions.

Each of these alternatives were analyzed with the HEC-2 model to determine peak system discharges. All analyses were completed based on the model parameters presented in Chapter V. Culvert sizes were determined based on standard open channel and pipe hydraulics engineering and design criteria presented in Chapter II of the Tualatin Basinwide Report and Technical Guidelines. A brief discussion of each alternative is presented in the following sections.

Conveyance System Improvements

The first alternative consisted of improving all restrictions within the existing storm drainage system. The primary assumption in this alternative was that no detention storage would be maintained anywhere in the drainage system. All culverts were sized to pass the peak subarea discharge with no ponding occurring at the pipe inlets.

The net effect of improving the conveyance system and removing system detention is an increase in the peak discharge through the Hedges Creek Marsh. Removal of the system detention and associated flooding problems significantly reduces the lag time in the subbasin. As a result, storm runoff reaches the Hedges Creek Marsh much more rapidly and the peak discharges are increased.

Removing restrictions in the upper areas of the subbasin creates larger peak flows in the lower areas. Consequently, larger culverts and drainage ditches are required to pass the peak design flows which increases the overall capital improvement cost. This approach also has a major impact on the Hedges Creek Marsh itself. Increased flows routed through the marsh leads to more frequent and severe hydrologic cycling within the wetlands area. More importantly, the channel velocities are increased significantly, particularly in areas where the channel is restricted, such as the south channel of Hedges Creek downstream from Teton Avenue. High velocities will erode the natural vegetation and result in damage to the Hedges Creek Marsh. As outlined in the hydraulic analysis (see Appendix B), it is important that peak flows and their associated high velocities be minimized as much as possible, particularly in the south channel of Hedges Creek which flows through the Wetlands Protection District. Diversion of as much flow as possible to a new channel was also found to be important in minimizing impacts to the south channel and Hedges Creek Marsh.

Based on the initial hydrologic analysis and subsequent hydraulic analysis of the Hedges Creek Marsh, a management option composed of strictly conveyance improvements was not found to be the most effective management option. This is because conveyance system improvements will allow velocities to increase, causing erosion problems in the creek channel and the marsh.

Regional Detention

The Hedges Creek subbasin has limited opportunities available which provide regional detention storage opportunities. In general, regional detention storage would require areas where a pond could be excavated with no influence from groundwater or constructed with a berm or road embankment behind which ponding could occur. A preliminary site assessment found several potential detention sites. A brief description of each site is as follows (sites are referenced in relation to the existing drainage facility located at the outlet, i.e. detention site DS 1 is located upstream of facility 1):

- DS 1. This site is located upstream of facility 1 at Tualatin Road. This area currently ponds water in a portion of Hedges Creek Marsh at larger storm events and could be used to enhance the maximum available storage.
- DS 6-7. Located upstream of Teton Avenue, if excavated, this site would allow storage over approximately a 10-acre surface area with an average depth from 1 to 3 feet.
- DS 8. This existing detention pond serves less than 30 percent of the total drainage area. Modifications to the site would allow this pond to serve a larger drainage area.
- DS 10. The embankment of the Tualatin-Sherwood Road provides an opportunity for storing runoff from subareas 9, 10, 16, and 17.
- DS 11. Located southwest of DS 10, this site also provides limited storage behind the Tualatin-Sherwood Road embankment.

An evaluation of the effectiveness of each of these sites was conducted assuming the sites could be provide the maximum detention storage volume available. The evaluation found that the sites upstream of the Hedges Creek Marsh (DS 8, 10, and 11) in general provided minimal detention benefits because of insufficient size. Sites 8 and 11 provide little reduction in peak runoff except for small runoff events and were subsequently removed from further analysis. Site 10 provides limited detention benefits for storm events up to the 25-year event. This site also has significant opportunities as a potential water quality facility or combination detention/water quality facility. For this reason, Site 10 was recommended as a detention site.

Sites 1 and 6-7 are located within the Hedges Creek Marsh and provide the most opportunity for detention storage. Similar to the upstream sites, DS's 1 and 6-7 are limited to storm events up to approximately the 25-year storm. Additional analysis completed as part of the hydraulic study of the lower marsh also provided the following conclusions.

- The water surface in the marsh downstream from Teton Avenue is controlled by the backwater from the Tualatin River. The backwater that occurs at lower storm events (5-year and 10-year) are limited to the lower 700 feet of the marsh. The 100-year storm event backs water slightly west of Teton Avenue.

- Releasing the peak flows from the Hedges Creek subbasin prior to the Tualatin River flood peaks reaching the confluence will be required to minimize head loss across the culverts under Tualatin Road. The influence of the Tualatin River floodplain on DS 1 would actually increase flooding upstream of Tualatin Road.

- Site DS 6-7 has been filled. It appeared to be considerably more expensive to excavate this site for detention than to enlarge downstream culverts.

- Based on this analysis, DS 6-7 and DS 1 were removed from further analysis as detention sites. As a result, regional detention within the Hedges Creek subbasin is limited to two relatively small sites: DS 10 and DS 11. Both of these sites, however, provide opportunities for improving water quality and should be considered for potential combined water quality/detention facilities.

Onsite Detention

As part of the hydraulic study of the Hedges Creek Marsh, onsite detention requirements for future development upstream of the marsh was evaluated as a possible quantity management alternative. The primary objective of this alternative was to reduce future peak storm water runoff discharges entering the marsh in an attempt to lower velocities in downstream creek channels and within the marsh itself. This alternative was analyzed in conjunction with flow splitting between the existing north and south channels of Hedges Creek. A complete discussion of the hydraulic analysis and alternatives analysis is presented in Appendix B.

In general, onsite detention was found to be effective for reducing future peak discharges entering the marsh. The analysis was conducted assuming that all new development upstream of the Hedges Creek Marsh would be required to provide a detention facility capable of restricting storm runoff from the site to the pre-development levels for all storm events up to and including the 25-year storm event. Larger storm events would be released with no detention. Based on this analysis, it was recommended that onsite detention be implemented on new development to the maximum extent possible.

WATER QUALITY ANALYSIS

As discussed previously, a water quality analysis was completed for the Hedges Creek Subbasin. The purpose of the analysis was to evaluate alternatives for controlling storm water pollutants commonly found in urban runoff. The focus of the analysis was control of phosphorus via sedimentation and biofiltration. Phosphorus was selected as the indicator pollutant because of its impact on algae bloom in the Tualatin River the state regulatory requirements to reduce total phosphorus in the Tualatin River. In general, alternatives implemented to control phosphorus will also prove effective in controlling other urban storm water pollutants such as suspended solids, oils/greases, and metals.

Pollutant Transport Analysis

The first storm water quality aspect modeled for the Hedges Creek subbasin was the generation and transport of pollutants. To characterize the pollutant loadings, the Simplified Particulate Transport Model (SIMPTM) was used in conjunction with its companion rainfall analysis program RAINEV. This program generates storm water volumes and pollutant loadings for urban basins or subbasin areas. SIMPTM simulates pollutant washoff based on established sediment transport equations and includes the interaction of non-point source control measures such as street sweeping, catchbasin cleaning, and on-site retention of storm water.

Five alternatives representing different levels of development and implementation of Best Management Practices (BMPs) were modeled. The BMPs included street sweeping, use of grassy swales, and catch basins. These five defined alternatives are identified in Table VI-1. Each alternative is described in detail in Chapter II of the Tualatin Basinwide Report and Technical Guidelines.

Table VI-1. Defined BMP Alternatives for Hedges Creek Subbasin

Alternative	Title
1	Existing Development Conditions
2	Full Development - Maximum Potential Loading
3	Current Trends - Apply the Current Strategies for Controlling Storm Water Quality
4	Revised Trends - Increase Application of Strategies for Controlling Storm Water Quality
5	Retrofit Existing Development - Maximum Effort to Reduce Pollutant Loads

The projected total phosphorus (TP) loadings from the Hedges Creek subbasin for each of the defined alternatives are summarized in Table VI-2 as follows:

Table VI-2. Hedges Creek Annual Pollutant Transport Summary

Alternative	Subbasin Area (acres)		TP	TP lbs/acre	TP	Runoff Volume
	Total	Developed Acres	lbs		mg/l	(acre-ft)
1	2856	952	189	0.066	0.31	223
2	2856	2383	660	0.23	0.35	689
3	2856	2383	237	0.083	0.13	689
4	2856	2383	112	0.039	0.066	627
5	2856	2383	89	0.031	0.053	617
Percentage (%) of Existing Conditions (Alternative 1)						
2		250	350	350	121	309
3		250	126	126	41	309
4		250	30	60	21	282
5		250	47	47	17	277

Alternative 1: Existing Conditions - The pounds per acre of total phosphorus (TP) from developed land was dependant upon the land use. (The SIMPTM model assumes that undeveloped land does not contribute to storm water pollutant loading.) Subbasins where the developed land is entirely single-family residential generated 0.07 pounds per acre. Subbasins where developed land use is entirely industrial generated 0.39 pounds per acre.

Concentrations of phosphorus for the subbasins ranged from 0.10 mg/l to 0.38 mg/l. Here, undeveloped subbasins had the lowest concentration, derived entirely from arterial roads, and, once again, industrial subbasins had the highest concentrations of phosphorus in storm water runoff.

Under existing conditions, Alternative 1, the Hedges Creek subbasin generates 189 pounds of phosphorus during the regulated dry season period of May 1 through October 31. This equals 0.066 pounds per acre or 0.31 milligrams per liter. The water quality monitoring data presented in Chapter III indicated an average total phosphorus concentration of 0.30 mg/l which reveals a close correlation between the model and actual measured phosphorus loads.

A similar analysis was completed in 1990 for the Fanno Creek and Multnomah basins lying within the Portland City limits (BES, 1990). That analysis showed a load of 0.13 pounds per acre and an average concentration of 0.25 milligrams per liter.

A comparison of the present study with the Portland study shows that Hedges Creek generates fewer pounds per acre of phosphorus, but its runoff contains a higher phosphorus concentration. One possible reason for this is Hedges Creek is relatively flat compared to the Portland basin areas; thus, it has considerably less runoff per developed acre.

Alternative 2: Full Development - Fully developed, Hedges Creek shows a large increase in the pounds of phosphorus washed off during the regulated season. This is over 350 percent of the mass generated under existing conditions. The increase in phosphorus concentration is much less — 121 percent of the present load. This is due to the runoff volume increasing at a much faster rate than the phosphorus mass.

Alternative 3: Current Trends - Under full development conditions, but with current BMP trends continued, the phosphorus mass and concentration do not increase nearly as much. Table VI-5 shows the increases would be on the order of 126 percent for phosphorus mass and would actually decrease for phosphorus concentration. The decrease results from the same increased runoff volume from future development as in Alternative 2, coupled with the smaller mass.

Alternative 4: Revised Trends - Increased application of BMPs beyond those currently being used would reduce both mass and concentration of phosphorus to below their existing levels. The volume of storm water runoff would still be greater than at present, but less than under Alternatives 2 and 3.

Alternative 5: Maximum Effort - The maximum effort alternative differs only slightly from Alternative 4. Its main new component is retrofitting existing single family residential areas with trapped catch basins. Alternative 5 further decreases the volume of runoff and the mass and concentration of phosphorus, but the reduction is slight.

PRF Site Evaluation

As discussed in Chapter V, potential pollutant reduction facilities were identified and mapped for the Hedges Creek subbasin (see Figures V-4a and V-4b). A total of 18 sites were initially evaluated for PRF potential using an initial screening tool and a numerical evaluation matrix. A summary of the matrix site evaluation is presented in Table VI-6 (see Appendix C for evaluation sheets).

The primary focus of the site evaluation was (1) eliminate unsuitable sites in an initial screening process, and (2) develop a ranking to prioritize suitable sites. Those sites scoring less than 60 were eliminated from further consideration.

A total of 10 sites were considered to be candidates for implementation. Of these, four sites received a ranking greater than 80 on a scale of 100. Only one site scored less than 60. These sites were then evaluated for pollutant reduction effectiveness with the PRF spreadsheet model as discussed in the following section.

Pollutant Reduction Facilities Analysis

To quantify the effectiveness of various PRF configurations within Hedges Creek, an improved version of the computer model developed for the Fanno Creek and Multnomah Basin studies for the City of Portland was used. This spreadsheet model, referred to as the PRF model, is dynamically linked to the pollutant transport analysis output described in the earlier section. The model routes, the runoff volume and pollutant loads from subbasin to subbasin and calculates removal of pollutants by any PRFs present. A detailed discussion of the model parameters is presented in Chapter II of the Tualatin Basinwide Report and Technical Guidelines.

Two PRF scenarios were analyzed with the PRF spreadsheet model:

Scenario 1: Wetlands included as part of storm water quality system.
Scenario 2: Wetlands not included as part of storm water quality system.

These scenarios were developed to evaluate the impact the Hedges Creek Marsh and other existing subbasin wetlands have on the pollutant loads from the subbasin.

The projected pollutant loadings from the Hedges Creek subbasin for Scenario 1 are presented in Table VI-4 and Figures VI-1 and VI-2. The results for Scenario 2 are presented in Table VI-5 and Figures VI-3 and VI-4. A summary of the results for each alternative is as follows:

Table VI-3 Hedges Creek Matrix Summary of PRF Site Evaluation

Site	Evaluation Parameter											Total
	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	Score
1	9	5	6	15	9	8	5	6	5	5	10	83
5	--	--	--	--	--	--	--	--	--	--	--	*
6	10	2	6	15	15	8	5	6	5	5	8	85
7	10	5	6	15	15	4	5	6	5	5	8	88
9	10	1	4	9	12	4	5	10	3	1	8	67
10	2	4.5	6	15	3	6	4	8	5	3	4	58.5
11	10	4	2	6	15	6	4	8	2	2	6	65
13	10	4	2	9	3	4	4	8	2	2	8	58
14	6	4	4	15	6	6	5	8	5	5	8	70
15	7	1.5	4	6	12		4	8	4	3	8	66.5
18	--	--	--	--	--	--	--	--	--	--	--	*
19	10	4	4	9	15	8	5	8	5	5	10	83
20	--	--	--	--	--	--	--	--	--	--	--	*
22	--	--	--	--	--	--	--	--	--	--	--	*
23	--	--	--	--	--	--	--	--	--	--	--	*
24	--	--	--	--	--	--	--	--	--	--	--	*
25	--	--	--	--	--	--	--	--	--	--	--	*
28	--	--	--	--	--	--	--	--	--	--	--	*

* Removed from consideration in initial screening.

A. Watershed Soils Erodibility.
B. Watershed Soils Phosphorus Availability.
C. Water Quality (PO_4 Concentrations).
D. Watershed Area.
E. Wetland Surface Area Ration (Aa/An).
F. Facility Soils Stability.
G. Access Potential.
H. Land Acquisition Potential.
I. Provides/Enhances Amenity Values.
J. Wildlife Potential.
K. Safe Edge Shape.

Alternative 1: Existing Conditions

Scenario 1: Existing PRFs and wetlands remove 63 percent of the phosphorus mass that would otherwise be exported from the Hedges Creek subbasin. Thus, 69 pounds reach the Tualatin rather than 189 pounds (Figure VI-1). The resulting phosphorus concentration is 0.12 mg/l. This is still above the standard of 0.07 mg/l for the Lower Tualatin, as shown on Figure VI-2.

Scenario 2: Existing wetlands account for approximately 78 percent of the total pollutant load reduction. Bypassing the wetlands results in only 14 percent removal (26 lbs) of the influent pollutant load (189 lbs).

Alternative 2: Full Development

Scenario 1: At full development, 660 pounds of phosphorus would be exported from the basin, over three times the present amount. The concentration of phosphorus would decrease by 0.005 mg/l.

Scenario 2: Existing wetlands account for approximately 88 percent of the total pollutant load reduction. Figure VI-3 indicates that bypassing the wetlands results in only 8 percent removal (52 lbs) of the influent pollutant load (660 lbs).

Alternative 3: Current Trends

Scenario 1: If current trends were continued with BMPs and if all possible PRFs were added, the pounds of exported phosphorus would rise only 16 percent from existing conditions. The concentration of phosphorus would decrease dramatically to 0.037 mg/l. This concentration is below the Lower Tualatin standard as shown on Figure VI-2.

Scenario 2: Existing wetlands account for approximately 70 percent of the total pollutant load reduction. Bypassing the wetlands results in only 21 percent removal (50 lbs) of the influent pollutant load (237 lbs).

Alternative 4: Revised Trends

Scenario 1: Using all possible PRFs at the same time as using additional BMPs, the exported phosphorus drops to 50 percent of the existing load. The concentration drops to 18 percent of existing values to 0.020, well below the Lower Tualatin standard. Just using the BMPs without any PRFs also falls below the standard.

Scenario 2: Existing wetlands account for approximately 67 percent of the total pollutant load reduction. Bypassing the wetlands results in only 22 percent removal (25 lbs) of the influent pollutant load (112 lbs).

Alternative 5: Maximum Effort

Scenario 1: As expected, a maximum effort which includes retrofitting residential areas with catch basins further decreases the phosphorus load and concentration, although not much further than Alternative 4. The load would drop to 27 pounds and the concentration to 0.016 mg\l.

Scenario 2: Existing wetlands account for approximately 69 percent of the total pollutant load reduction. Bypassing the wetlands results in only 21 percent removal (19 lbs) of the influent pollutant load (89 lbs.).

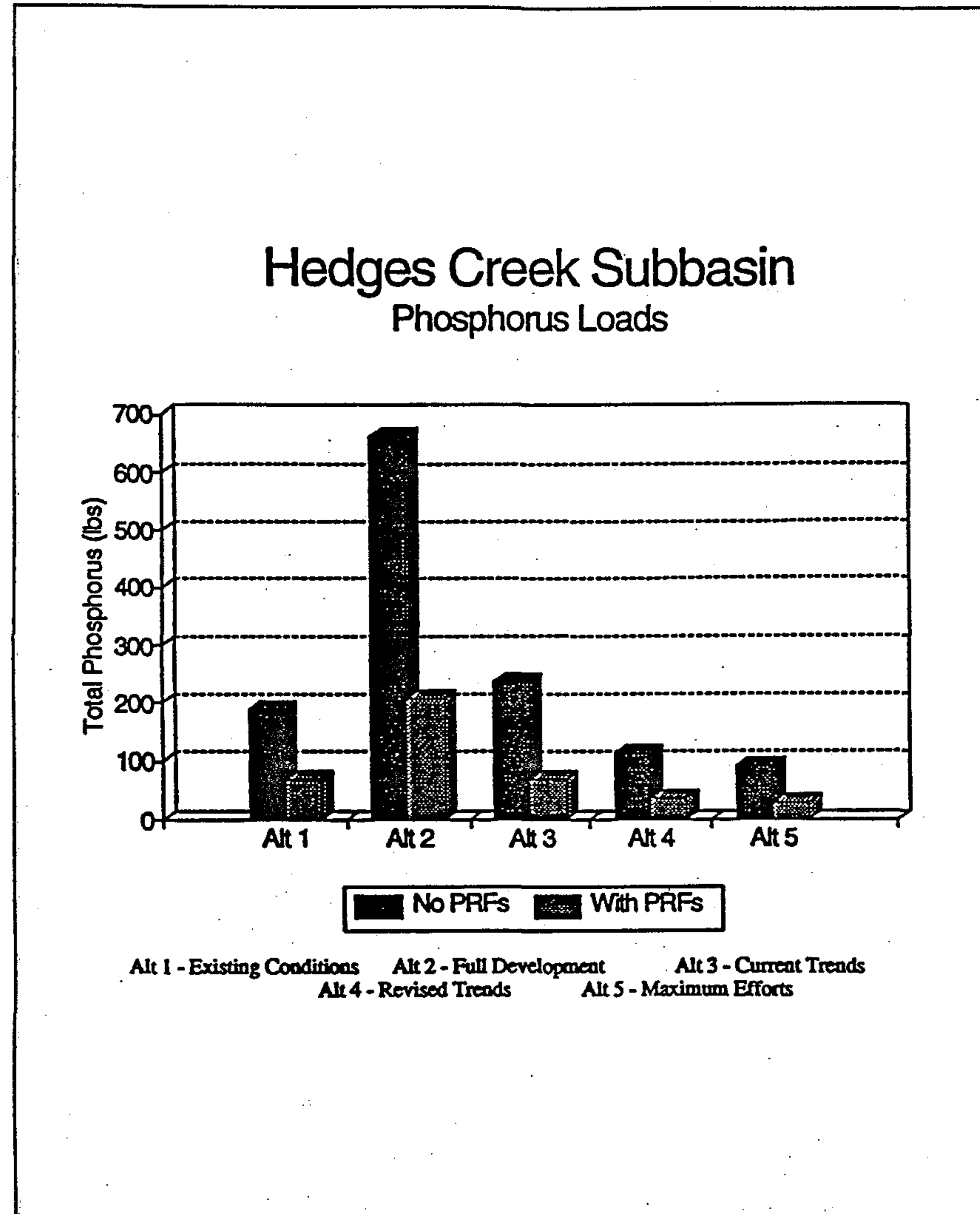


Figure VI-1 Scenario 1: Phosphorus Loads (lbs) from Hedges Creek Subbasin with Wetlands Included.

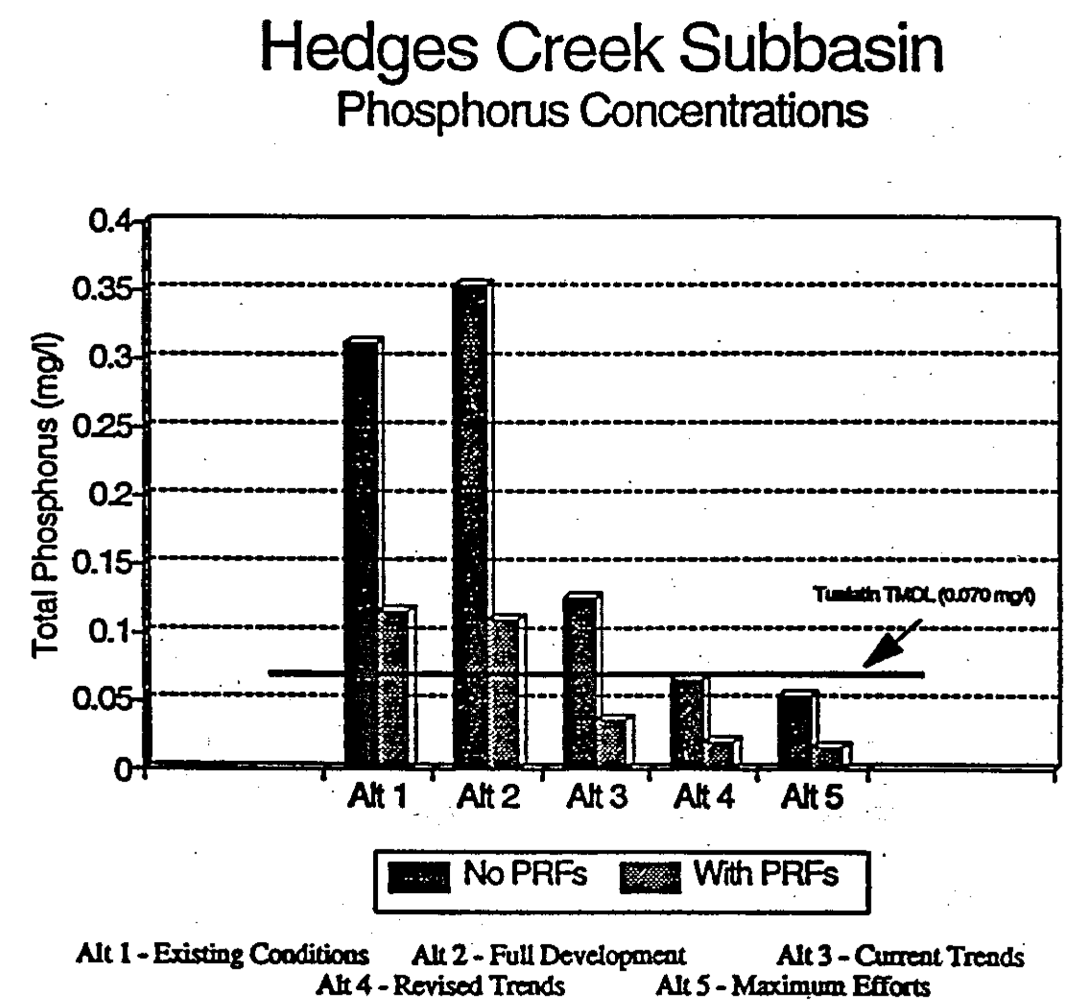


Figure VI-2 Scenario 1: **Phosphorus Concentrations (mg/l) from Hedges Creek Subbasin with Wetlands Included.**

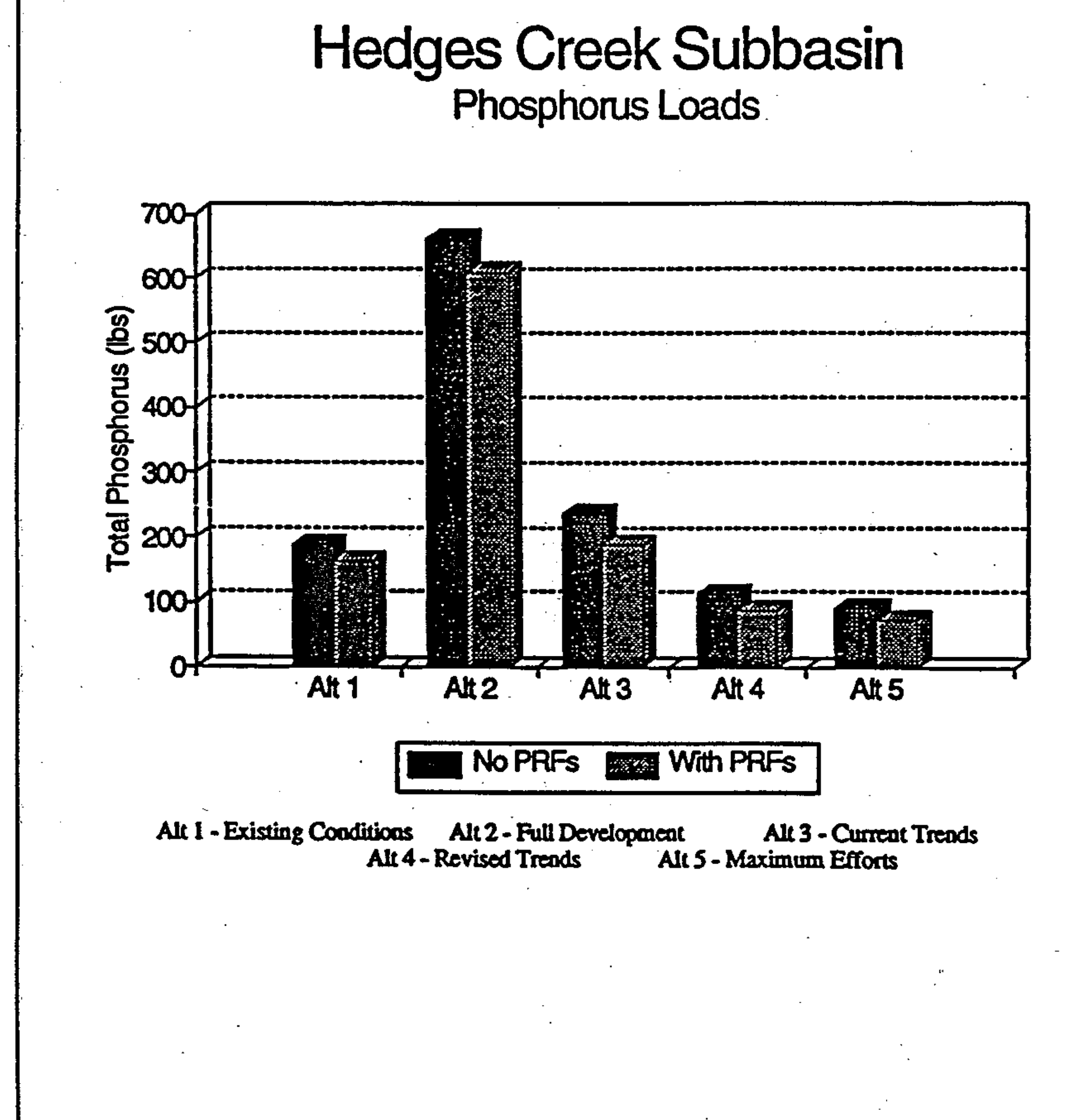


Figure VI-3 **Scenario 2: Phosphorus Loads (lbs) from Hedges Creek Subbasin without Wetlands.**

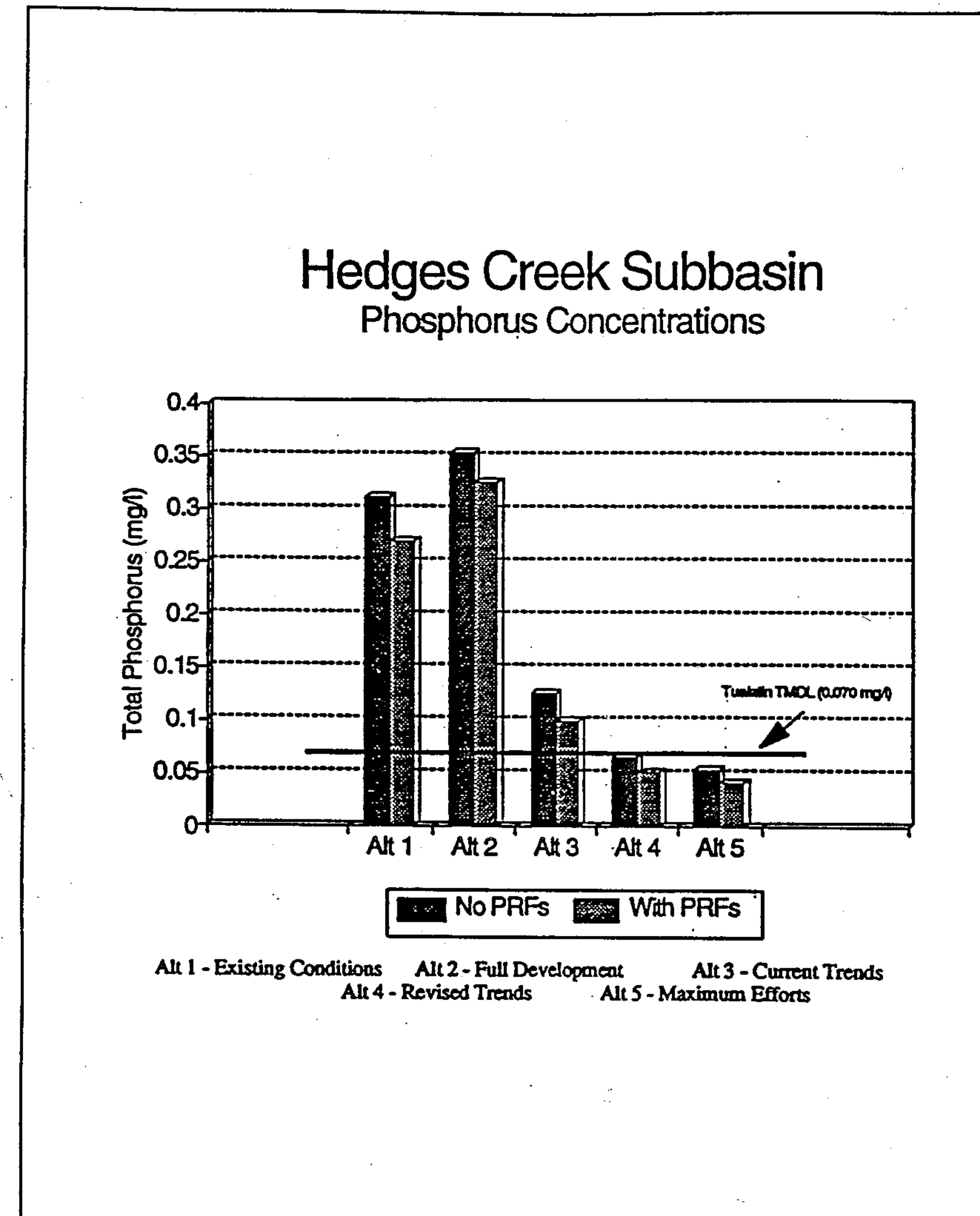


Figure VI-4 **Scenario 2: Phosphorus Concentrations (mg/l) from Hedges Creek Subbasin without Wetlands.**

Table VI-4 Hedges Creek PRF Spreadsheet Analysis - Scenario 1: Wetlands Included in Pollutant Removal Analysis

Alternative	Total Subbasin Area (acres)	Developed Subbasin Area (acres)	Pollutant Transport in Subbasin Runoff			Pollutant Transport with PRFs Installed			Runoff Volume (ac-ft)
			(lbs)	(lbs/ac)	(mg/l)	(lbs)	(lbs/ac)	(mg/l)	
1	2856	952	189	0.066	0.31	69	0.024	0.12	223
2	2856	2383	660	0.231	0.35	205	0.072	0.11	689
3	2856	2383	237	0.083	0.13	69	0.024	0.037	689
4	2856	2383	112	0.039	0.066	35	0.012	0.020	627
5	2856	2383	89	0.031	0.053	27	0.009	0.016	617
Percent of Existing Conditions (Alternative 1)									
2		250	350	350	113	296	296	96	309
3		250	126	126	41	99	99	32	309
4		250	60	60	21	50	50	18	282
5		250	47	47	17	39	39	14	277

Table VI-5 Hedges Creek PRF Spreadsheet Analysis - Scenario 2: Wetlands Not Considered in Pollutant Removal Analysis

Alternative	Total Subbasin Area (acres)	Developed Subbasin Area (acres)	Pollutant Transport in Subbasin Runoff			Pollutant Transport with PRFs Installed			Runoff Volume (ac-ft)
			(lbs)	(lbs/ac)	(mg/l)	(lbs)	(lbs/ac)	(mg/l)	
1	2856	952	189	0.066	0.31	163	0.057	0.27	223
2	2856	2383	660	0.22	0.35	608	0.21	0.33	689
3	2856	2383	237	0.083	0.13	187	0.066	0.10	689
4	2856	2383	112	0.039	0.066	87	0.030	0.051	627
5	2856	2383	89	0.031	0.053	70	0.025	0.042	617
Percent of Existing Conditions (Alternative 1)									
2		250	350	350	113	374	374	121	309
3		250	126	126	41	115	115	37	309
4		250	60	60	21	53	53	19	282
5		250	47	47	17	43	43	16	277

Conclusions

Scenario 1 - In lieu of a goal to meet for the permissible mass of phosphorus to discharge to the Tualatin River, examining the concentrations resulting from the different alternatives gives an indication of their effectiveness. The key alternatives appear to be 3 and 4. Alternative 3 will drop the phosphorus concentration below 0.07 mg/l using both BMPs and PRFs.

Alternative 4 would be under this concentration using only BMPs. Obviously, a number of different combinations of BMPs and PRFs might meet this concentration goal. A limited amount of additional modeling indicated that most of the additional PRFs are unnecessary to meet the 0.07 mg/l concentration. Dropping PRFs 8, 10, 11, 13, and 20 in Alternative 3 would only increase the phosphorus mass discharge by about four pounds. The concentration would rise only 0.002 mg/l, from 0.037 to 0.039 mg/l.

The reasons for this seeming unimportance of these additional PRFs is twofold. First, the alternatives are assuming ideal efficiencies for BMPs such as street sweeping and catch basins. Unfortunately, ideal conditions seldom occur. A poorly maintained catch basin or a storm immediately before scheduled street sweeping may result in higher than expected loads. Second, the large marshes in subbasins 1 and 2 are large enough to efficiently remove much of the sediment and phosphorus originating in subbasins further upstream. In general, more detailed site surveys and water quality monitoring information is required for the pre-design evaluation of the PRF sites.

Scenario 2 - Removing the existing wetlands found within the Hedges Creek subbasin from consideration as potential pollution reduction facilities significantly increases the projected pollutant loads leaving the subbasin. These wetlands account for over 70 percent of the total pollutant removal achieved through PRFs.

Wetlands may also be adversely affected by some pollutants, such as metals, which are often found in urban runoff. For this reason, pretreatment sedimentation basins should be used for removing sediment-bound pollutants. Wetlands may then be used in a "polishing" function to uptake nutrients. PRF sites 10, 11, 13, and 15 could all serve as effective pretreatment facilities. PRF site 8 is an existing detention pond. While it shows potential for modification to provide some pretreatment, this would reduce the available flood control detention storage which is needed at this location. PRF site 14 is an existing fire pond for an industrial park and provides some existing pretreatment functions. This site could potentially be modified to increase its water quality benefits.

Recommendations

As shown in the previous water quality analysis, implementing water quality facilities to reach the in-stream water quality standard for total phosphorus on the Lower Tualatin River would require implementation of every available PRF site throughout the basin. The Hedges Creek Marsh would also be required to serve as a nutrient polishing wetland to remove soluble nutrients prior to discharging to the Tualatin River.

The option of purchasing Sites 1 and 6-7 for water quality purpose is in effect not realistic since the Hedges Creek Marsh is a sensitive area and one of the prime objectives of the management planning effort is to protect this valuable resource. The analysis does illustrate the historic importance of wetland systems in controlling soluble nutrient loadings to river systems. The Hedges Creek Marsh has historically and is currently serving this purpose and should be protected to maintain the quality of the resource. For this reason, constructing PRFs at Sites 1 and 6-7 is not considered to be consistent with the overall goals of the Hedges Creek subbasin strategy plan.

Protecting the Hedges Creek Marsh does, however, support the development of PRFs at Sites 10, and 11, and possible water quality enhancement projects at Site 14, including outlet modification and site re-vegetation. PRF site 11 should only be constructed if and when the upstream drainage area to this site develops. Since sites 13 and 15 currently fall outside the Urban Growth Boundary (UGB), USAor the City may not have the authority to construct facilities at these locations. It is recommended, however, that USA and the City work with the gravel pit operator near Site 15 to maintain an effective sedimentation basin at this location to prevent sediment runoff from entering the Hedges Creek drainage system.

RECOMMENDED SUBBASIN STRATEGY

The recommended subbasin strategies for the Hedges Creek subbasin are management techniques designed to control water quantity and quality problems associated with urban storm water runoff. Water quantity control measures focus on primarily conveyance system improvements with onsite detention implemented to the maximum extent possible. Water quality control measures center on sedimentation and biofiltration processes to remove suspended particles and the pollutants associated with these particles. Both quantity and quality management practices are required to protect the Hedges Creek Marsh which receives drainage from all upland areas within the basin.

The recommended Hedges Creek subbasin strategies consist of the following programs:

- Implement Requirements for Onsite Detention for New Development Upstream of the Marsh
- Continue Non-Structural Activities such as Public Education
- Implement a Visual Assessment Program for the Hedges Creek Marsh
- Implement Recommended Drainage System Improvements
- Develop Pre-Treatment Facilities and Pollution Reduction Facilities (PRFs) for the Hedges Creek Marsh

- Implement Water Quality Facilities Demonstration Projects

- Expand Water Quality Monitoring to Include Evaluation of the Effectiveness of Source Control Activities and Demonstration Projects

- Implement a Beaver Management Strategy

These elements are described in detail in Chapter I.

APPENDIX A

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APPENDIX B

OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI / RAJ, JVS Weather: Clear / Sunny

Date: 3/27/91 Time: 10:15

Location: Hedges Creek at Boones Ferry USA Map Reference: ______

Type of Facility: ✓ Culvert ____ Pipe ____ Bridge ____ Other

Describe Other: Corrugated mP surrounded by concrete

Material: ✓ CMP (Metal Pipe) ✓ Concrete ____ PVC ____ Other

Number and Size: 1 CmP (WA Co. #1567) and 6' (72") (Diameter, Inches)

If not circular, describe and provide key dimensions: ______

Invert Data[1/]: 10' Upstream 10' Downstream

Length: 94' Feet

Inlet Configuration: ____ Mitered ____ Bevelled ✓ Flush

____ Projecting ____ Headwalls/Wingwalls

Evidence of Historic Water Depth[2/]: 5'5" Below RP Headwater 8' Below RP Tailwater

Condition[3/]: Good structural condition, new debris fence, 3" of silt in CmP

Allowable Headwater: 5' Below RP At Roadway ____ Other

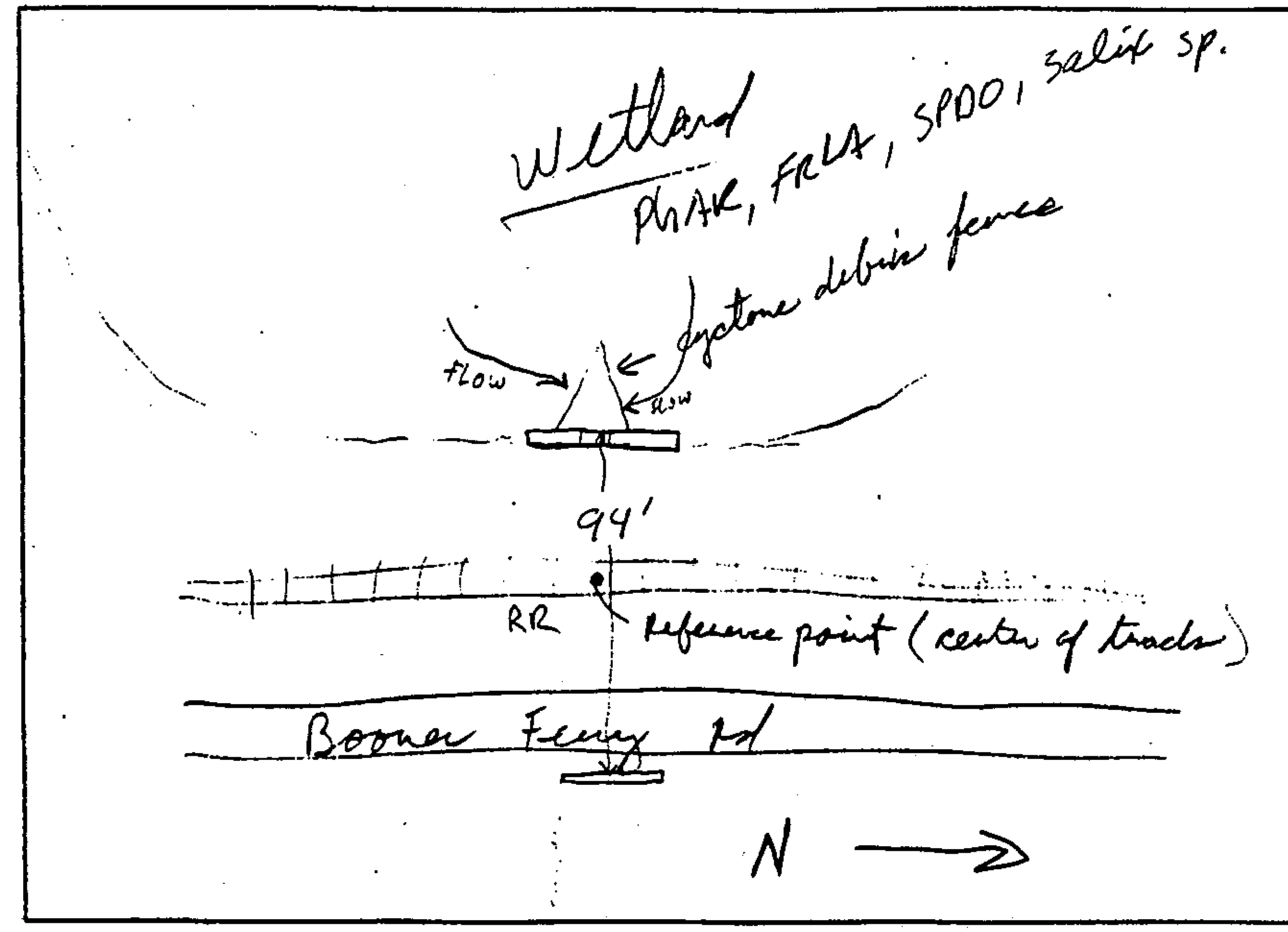
Bridge Data: ____ Width ____ Height[4/]

COMMENTS[5/]: Present water depth = 31"; High quality wetland upstream. Wetland conservancy office adjacent. Moderate to moderately high quality wildlife habitat. RR Reference point is ~2' higher than Boones Ferry Road bed.
—Possible PRF

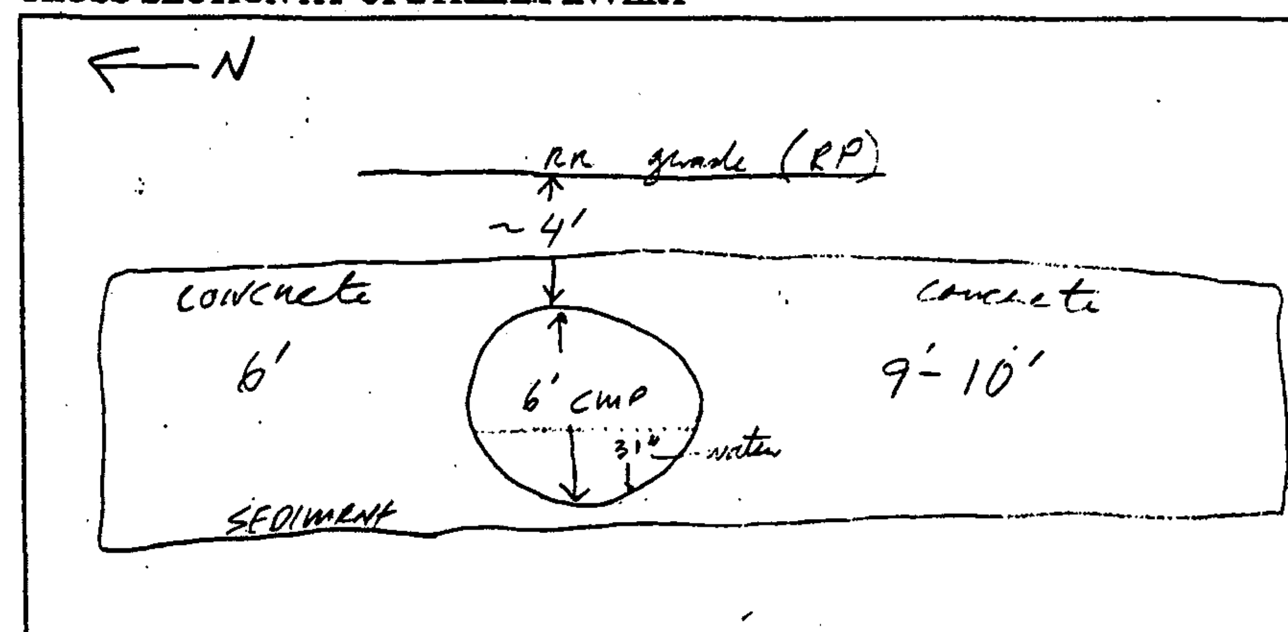
[1/] Est. elevation below a reference point such as top of roadway at crossing.
[2/] Est. Elevation from previous point used for invert data.
[3/] Depth of silt (if present), age, structural condition.
[4/] Distance from upstream invert to low chord of bridge.
[5/] Describe special features unique to facility.

(SEE REVERSE SIDE)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



(3)

OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: RWK/JAG (SRI) Weather: Sunny/Clear

Date: 3/27/91 Time: 11:08

Location: Near Mohave Ct. and Tualatin-Sherwood Highway USA Map Reference: ________

Type of Facility: √ Culvert ____ Pipe ____ Bridge ____ Other

Describe Other: ________

Material: ____ CMP (Metal Pipe) ____ Concrete √ PVC ____ Other

Number and Size: 1 and 24" (Diameter, Inches)

If not circular, describe and provide key dimensions: ________

Invert Data[1/]: 2.5' Upstream 3.5' Downstream
Invert measured from bottom of grate from road.

Length: 121' Feet

Inlet Configuration: ____ Mitered √ Bevelled ____ Flush (Slanted)

____ Projecting ____ Headwalls/Wingwalls

Evidence of Historic Water Depth[2/]: 4-6" Headwater 2.5' Tailwater

Condition[3/]: Good working order

Allowable Headwater: 1.5' At Roadway ____ Other

Bridge Data: ____ Width ____ Height[4/]

COMMENTS[5/]:

Appears to be only a drainage ditch with very little opportunities for stormwater retention facilities. Doesn't appear that this area gets very much drainage. Drainage ditch appears well-vegetated. There is 1.7' of water in culvert.

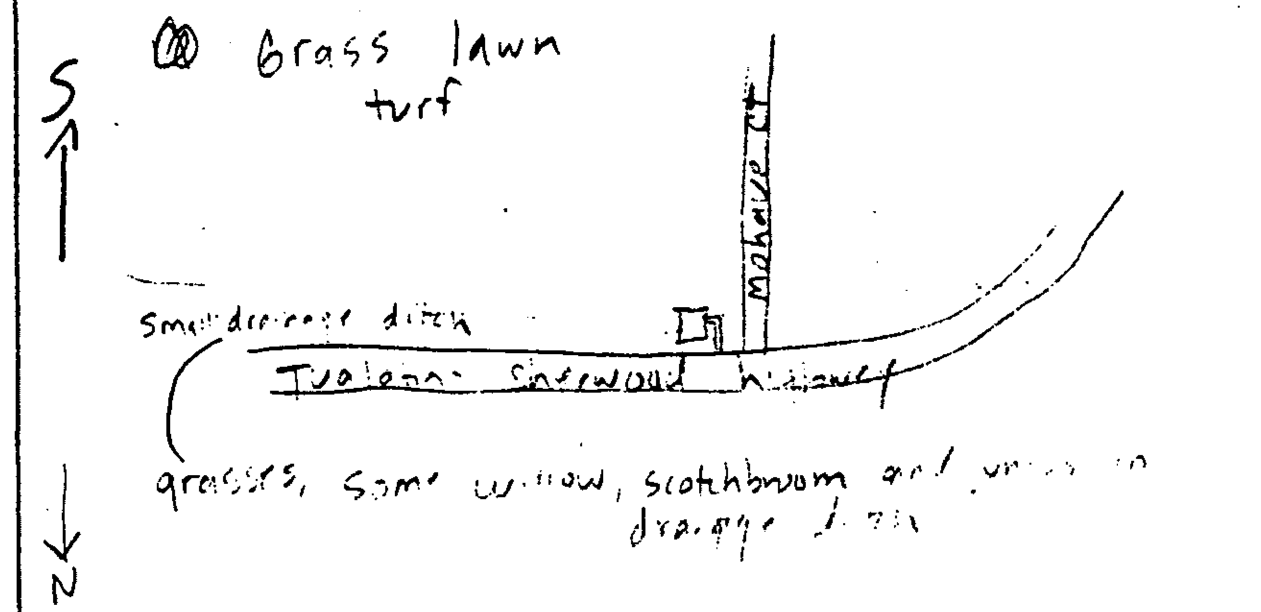
[1/] Est. elevation below a reference point such as top of roadway at crossing.
[2/] Est. Elevation from previous point used for invert data.
[3/] Depth of silt (if present), age, structural condition.
[4/] Distance from upstream invert to low chord of bridge.
[5/] Describe special features unique to facility.

(SEE REVERSE SIDE)

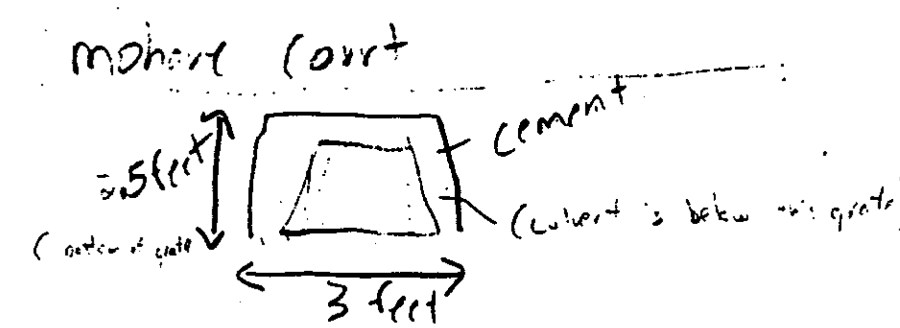
8135\FACT.SHT
191.15

3

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



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(4)

OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI / RAS, JVS   Weather: Sunny / Clear

Date: 3/27/91   Time: 12:40

Location: Herman Rd. just east of 108th   USA Map Reference: ______

Type of Facility: ✓ Culvert ______ Pipe ______ Bridge ✓ Other

Describe Other: Storm drain catchment junction outlet

Material: ______ CMP (Metal Pipe) ✓ Concrete ______ PVC ______ Other

Number and Size: 1 and 12" (Diameter, Inches)

If not circular, describe and provide key dimensions: ______

Invert Data[1/]: 2'4" Upstream ______ Downstream

Length: N/A Feet

Inlet Configuration: ______ Mitered ______ Bevelled ✓ Flush

______ Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2/]: 12" BRP Headwater N/A Tailwater

Condition[3/]: 5.5" Sediment

Allowable Headwater: N/A At Roadway ______ Other

Bridge Data: ______ Width ______ Height[4/]

COMMENTS[5/]:

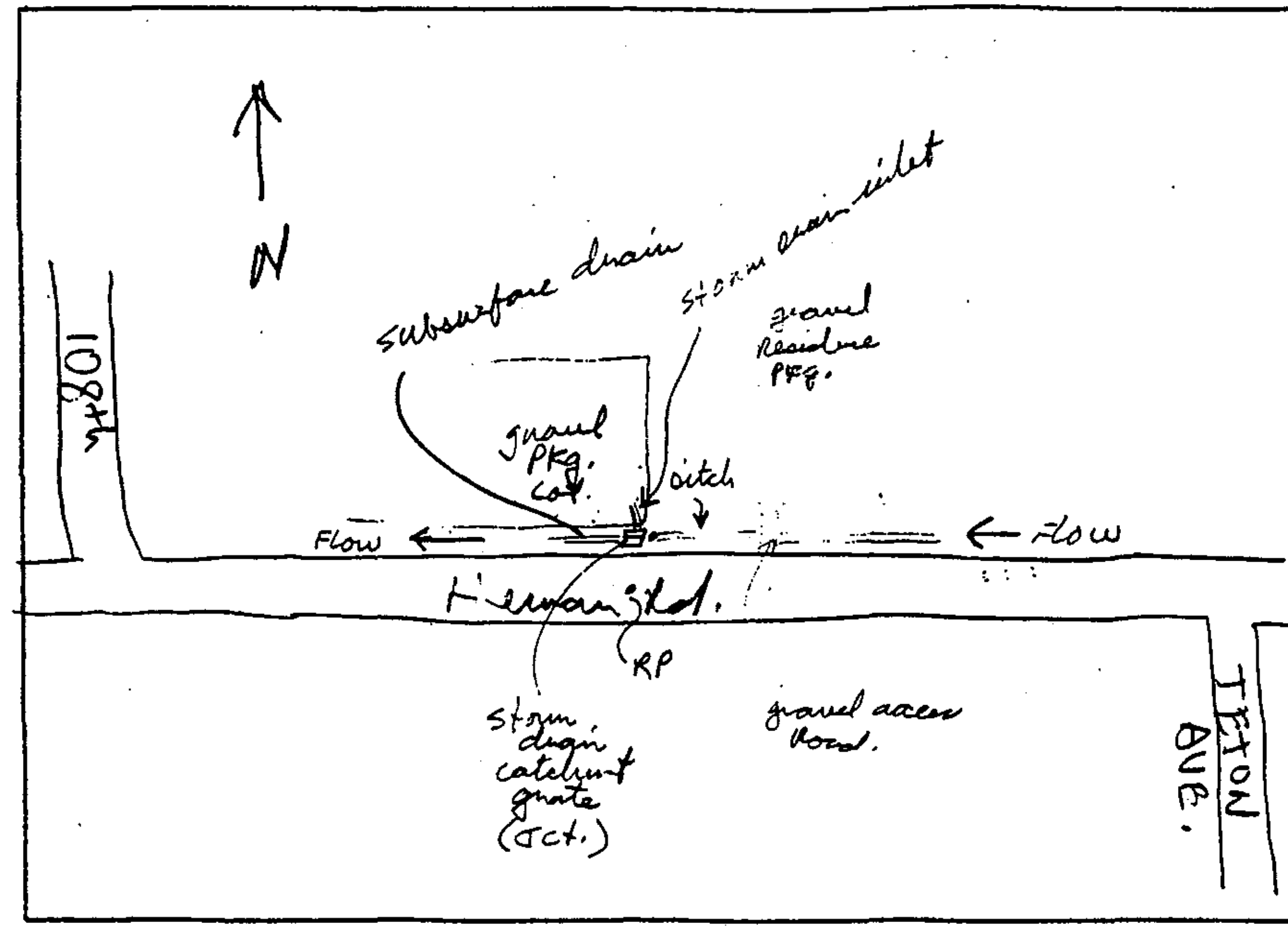
Reference point is center of Herman Rd. Ditch below culvert is level with invert and ~2' wide (max.).

[1/] Est. elevation below a reference point such as top of roadway at crossing.
[2/] Est. Elevation from previous point used for invert data.
[3/] Depth of silt (if present), age, structural condition.
[4/] Distance from upstream invert to low chord of bridge.
[5/] Describe special features unique to facility.

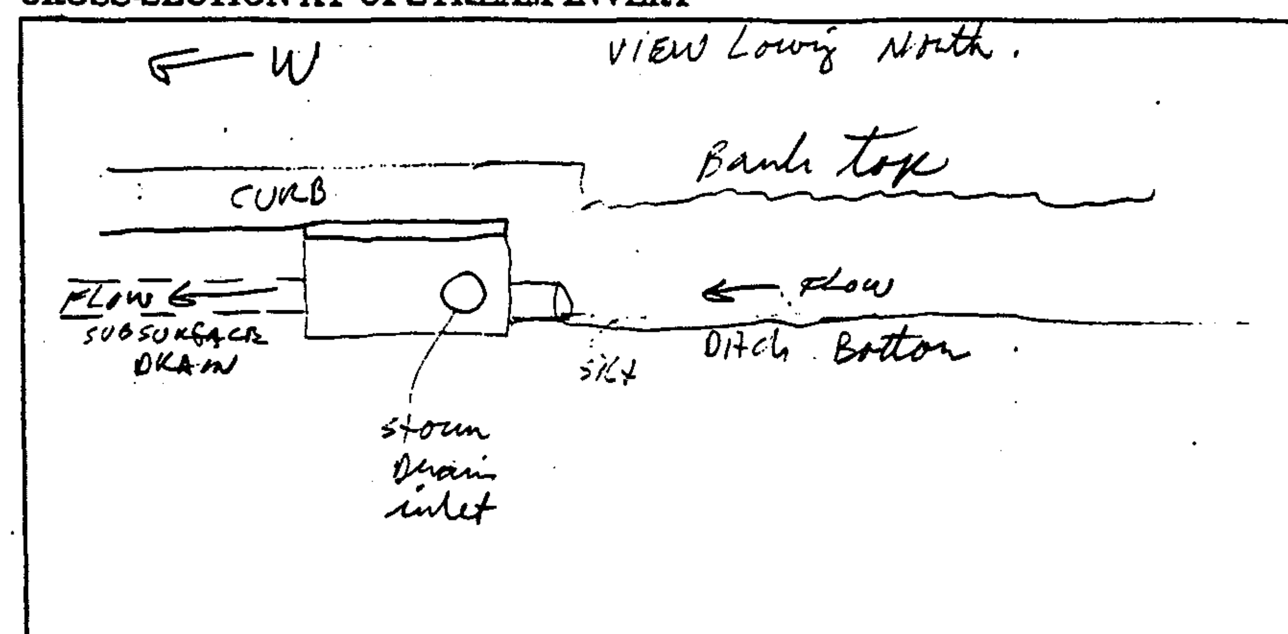
(SEE REVERSE SIDE)

(4)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI / RAJ, JVS Weather: Clear/Sunny

Date: 3/27/91 Time: 11:15

Location: Just west of Teton on N. of Herman USA Map Reference: ______

Type of Facility: ✓ Culvert ______ Pipe ______ Bridge ______ Other

Describe Other: Facility includes both a rocked landscaped swale and roadside ditch.

Material: ✓ CMP (Metal Pipe) ______ Concrete ______ PVC ______ Other

Number and Size: 2 (outfall) and each 12" (Diameter, Inches)

If not circular, describe and provide key dimensions: ______

Invert Data[1]: 2.5' BRP Upstream 2.5' (30") Downstream at culvert East of outfall culverts (12" concrete)

Length: 575 Feet (landscaped ditch) 235' at roadside ditch

Inlet Configuration: ______ Mitered ______ Bevelled ______ Flush

______ Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2]: None Headwater 6" ~~Tailwater~~ Roadside ditch

Condition[3]: Sediment 2" deep in each CMP

Allowable Headwater: 1.5' At Roadway 1' Below Other Parking lot to NW

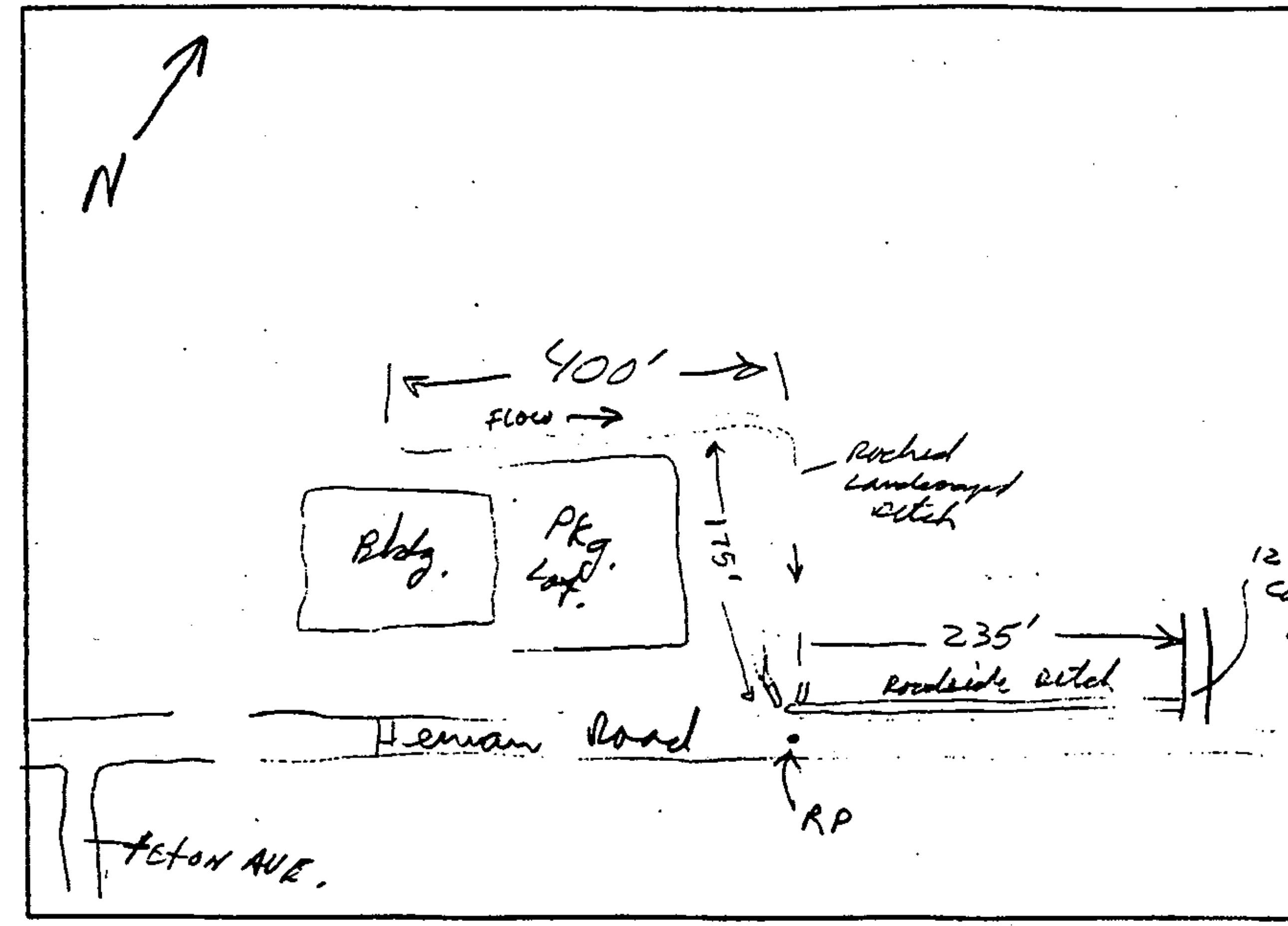
Bridge Data: ______ Width ______ Height[4]

COMMENTS[5]: Reference point is center of Herman Rd. Roadside ditch Channel bottom is ~3' BRP. Culverts empty into ditch.
Invert data pertains to outfalls at Herman Rd. Landscaped ditch is ~2.5-3' wide with max. app. of 6' wide water area (1' deep).
Diameter of roadside ditch downstream culvert = 8 inches.

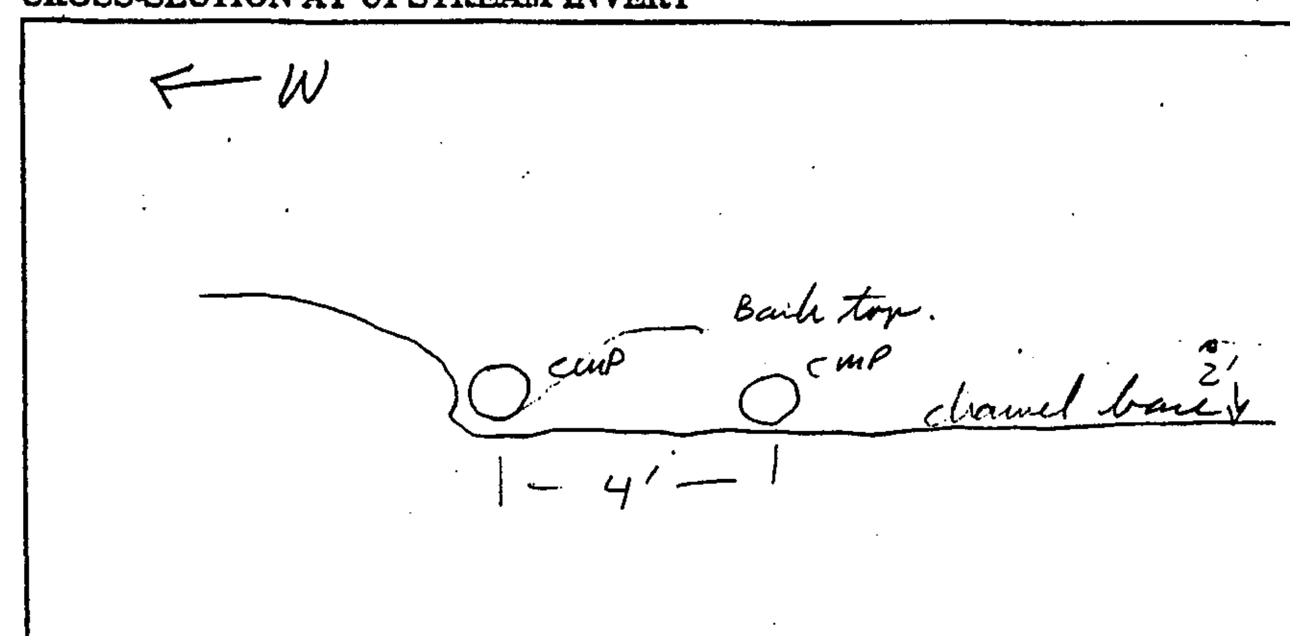
[1] Est. elevation below a reference point such as top of roadway at crossing.
[2] Est. Elevation from previous point used for invert data.
[3] Depth of silt (if present), age, structural condition.
[4] Distance from upstream invert to low chord of bridge.
[5] Describe special features unique to facility.

(SEE REVERSE SIDE)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT ~~UPSTREAM~~ INVERT oufalls at Heman road.



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(6)

OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI / RAJ, JVS   Weather: Sunny/Clear/Calm

Date: 3/27/91   Time: 11:40

Location: Teton Ave. and N. Hedges Creek Channel   USA Map Reference: ______

Type of Facility: ✓ Culvert ____ Pipe ____ Bridge ____ Other

Describe Other: ______

Material: ✓ CMP (Metal Pipe) ____ Concrete ____ PVC ____ Other

Number and Size: 1 Corrugated and 4' (48") (Diameter, Inches)

If not circular, describe and provide key dimensions: ______

Invert Data[1]: 6.5' Upstream 6.5' Downstream

Length: 100' Feet

Inlet Configuration: ____ Mitered ____ Bevelled ____ Flush

✓ (4') Projecting ____ Headwalls/Wingwalls

Evidence of Historic Water Depth[2]: 20" BRP Headwater 2.5' Tailwater

Condition[3]: 5" Sediment in bottom of upstream CMP, good repair, but inundated to top.

*Allowable Headwater: 20" BRP At Roadway ____ Other

Bridge Data: ____ Width ____ Height[4]

COMMENTS[5]: Reference point is center of Teton Ave. No flow observed.
* If figure for allowable headwater above roadway is used, a portion of the area south of the channel would be flooded. (There is approx. 20± ac. available for PRF/Detention).

[1] Est. elevation below a reference point such as top of roadway at crossing.
[2] Est. Elevation from previous point used for invert data.
[3] Depth of silt (if present), age, structural condition.
[4] Distance from upstream invert to low chord of bridge.
[5] Describe special features unique to facility.

(SEE REVERSE SIDE)

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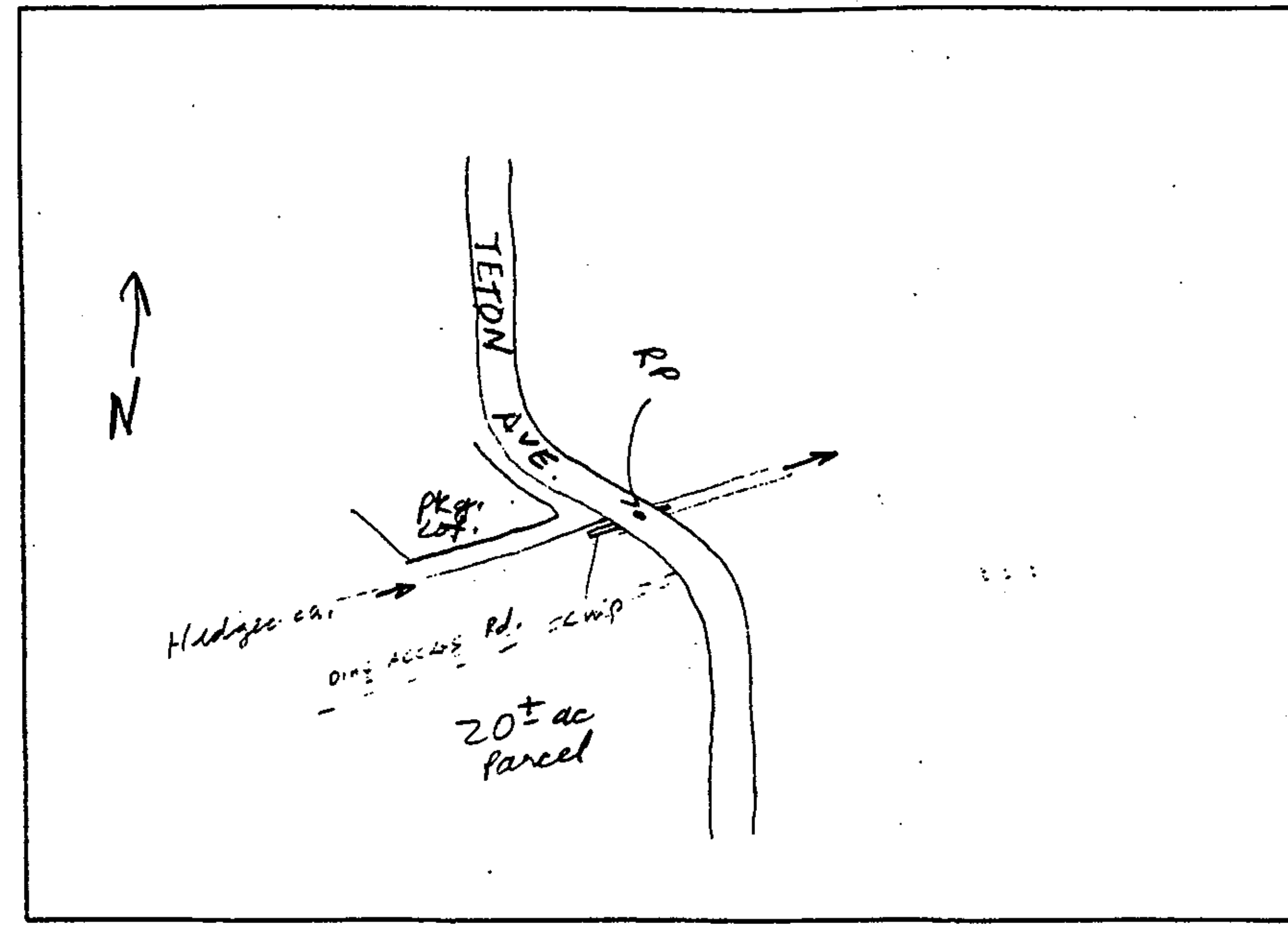
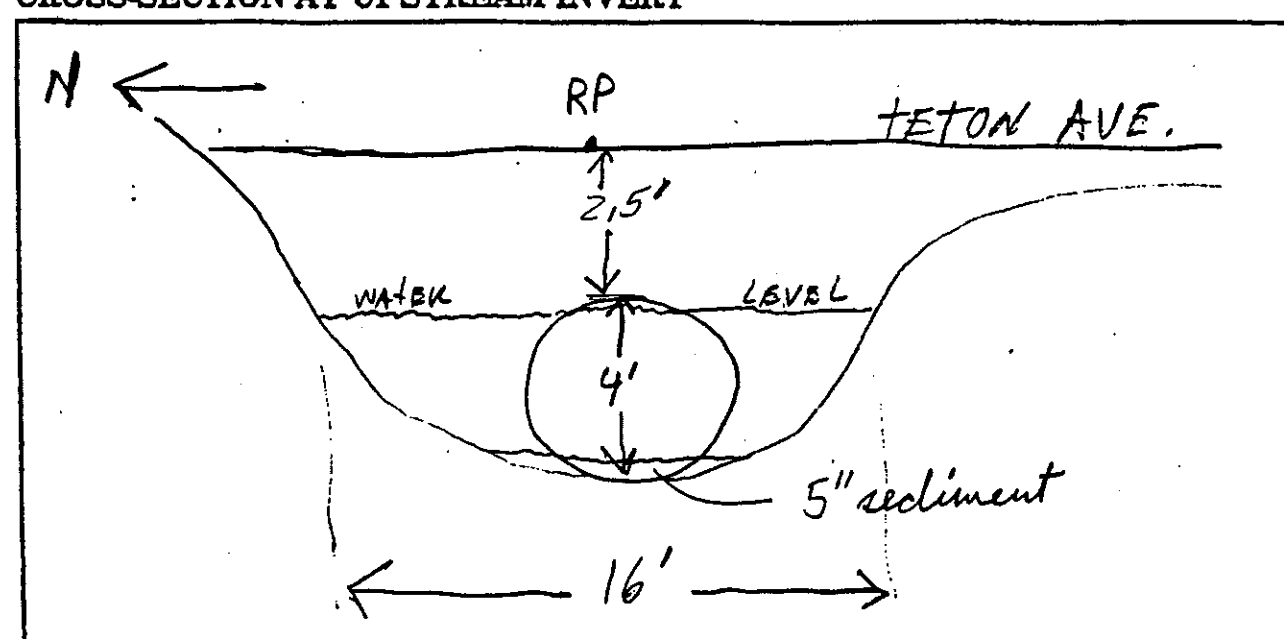
6

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI / RAJ, JVS   Weather: Clear/Sunny

Date: 3/27/91   Time: 12:05

Location: S. Channel Hedges Creek at Teton Ave.   USA Map Reference: ______

Type of Facility: ✓ Culvert ______ Pipe ______ Bridge ______ Other

Describe Other: ______

Upstream Material: ______ CMP (Metal Pipe) ✓ (upstream) Concrete ______ PVC ______ Other

Number and Size: 2 and 28" S., 28" N. (Diameter, Inches)

If not circular, describe and provide key dimensions: ______

Invert Data[1/]: 55" S., 53" N. Upstream 55" S. and N. Downstream

Length: 64' Feet S., 60' North

Inlet Configuration: ______ Mitered ______ Bevelled South Flush

North (1') Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2/]: 2.5' S., 2.5' N. Below RP Headwater 2.5' S. and N. Tailwater

Condition[3/]: Good Condition, no sediment in culverts, old.

Allowable Headwater: 2.5' S., 2.5' N. BRP At Roadway ______ Other

Bridge Data: ______ Width ______ Height[4/]

COMMENTS[5/]:

Present water depth 18" from S. invert to water line, concrete culvert is 3" thick (at S. culvert). Channelized drainage both upstream and downstream (max. width is 7' upstream). Present water depth is 21" from N. culvert invert.

S. culvert downstream appears near 21" CMP (corrugated).

Water depth at S. culvert downstream is 15" from invert.

[1/] Est. elevation below a reference point such as top of roadway at crossing.
[2/] Est. Elevation from previous point used for invert data.
[3/] Depth of silt (if present), age, structural condition.
[4/] Distance from upstream invert to low chord of bridge.
[5/] Describe special features unique to facility.

(SEE REVERSE SIDE)

3135\FACT.SHT
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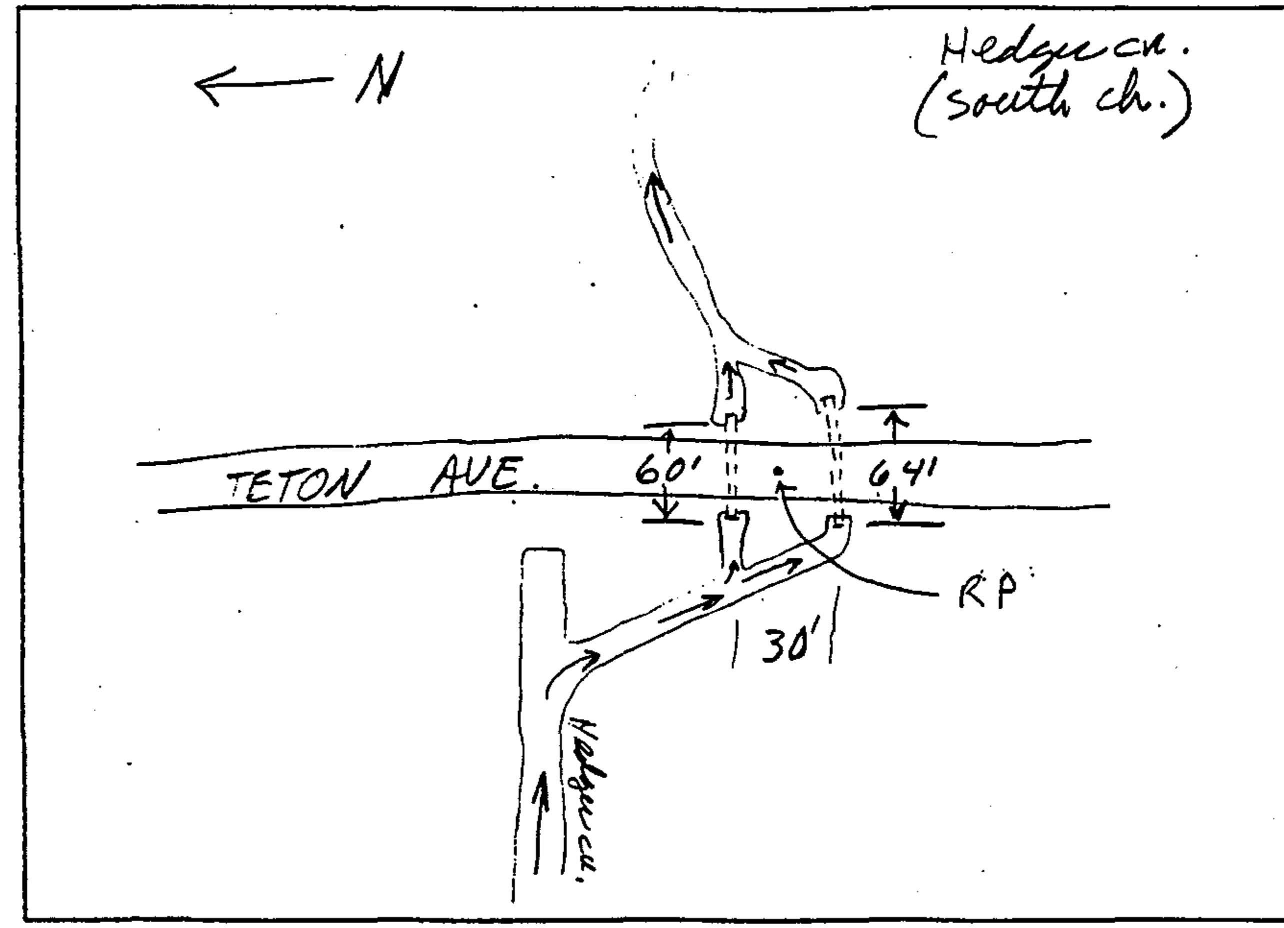
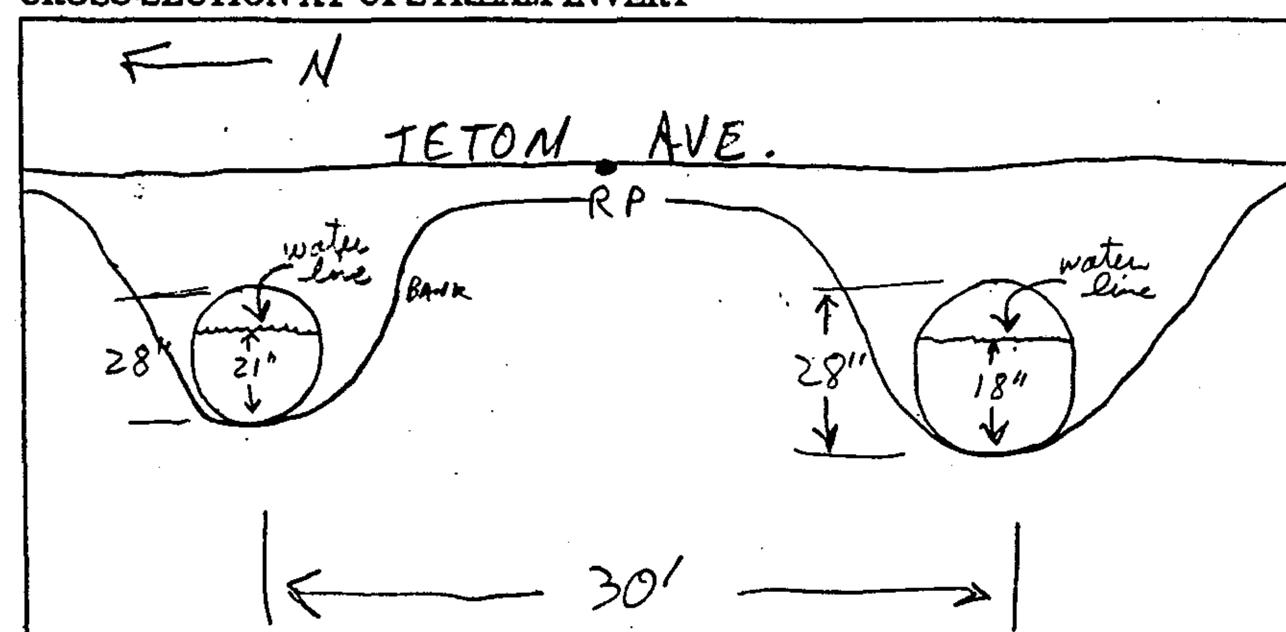
7

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



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OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI / RAJ, JVS   Weather: Sunny, Clear

Date: 3/27/91   Time: 12:50

Location: Detention pond and culverts W. of 108th   USA Map Reference: /

Type of Facility: ✓ Culvert ____ Pipe ____ Bridge ✓ Other

Describe Other: Concrete weirs also.

Material: ✓ CMP (Metal Pipe) ✓ Concrete ____ PVC ____ Other

Number and Size: ____ and ____ (Diameter, Inches)

If not circular, describe and provide key dimensions: ____

Invert Data[1]: ____ Upstream ____ Downstream

Length: ____ Feet

Inlet Configuration: ____ Mitered ____ Bevelled ____ Flush

____ Projecting ____ Headwalls/Wingwalls

Evidence of Historic Water Depth[2]: ____ Headwater ____ Tailwater

Condition[3]: ____

Allowable Headwater: ____ At Roadway ____ Other

Bridge Data: ____ Width ____ Height[4]

COMMENTS[5]:

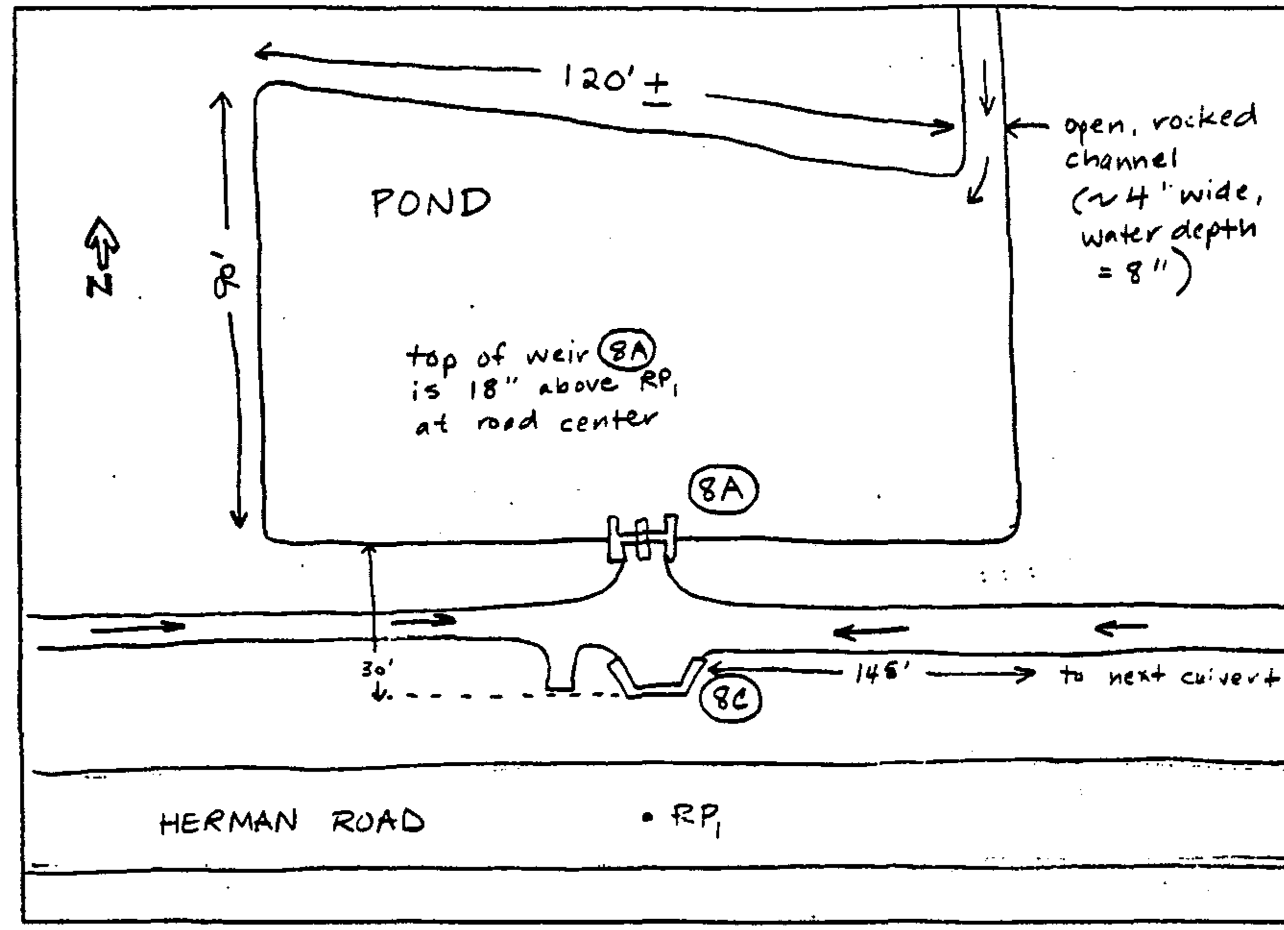
Refer to sketch map

[1] Est. elevation below a reference point such as top of roadway at crossing.
[2] Est. Elevation from previous point used for invert data.
[3] Depth of silt (if present), age, structural condition.
[4] Distance from upstream invert to low chord of bridge.
[5] Describe special features unique to facility.

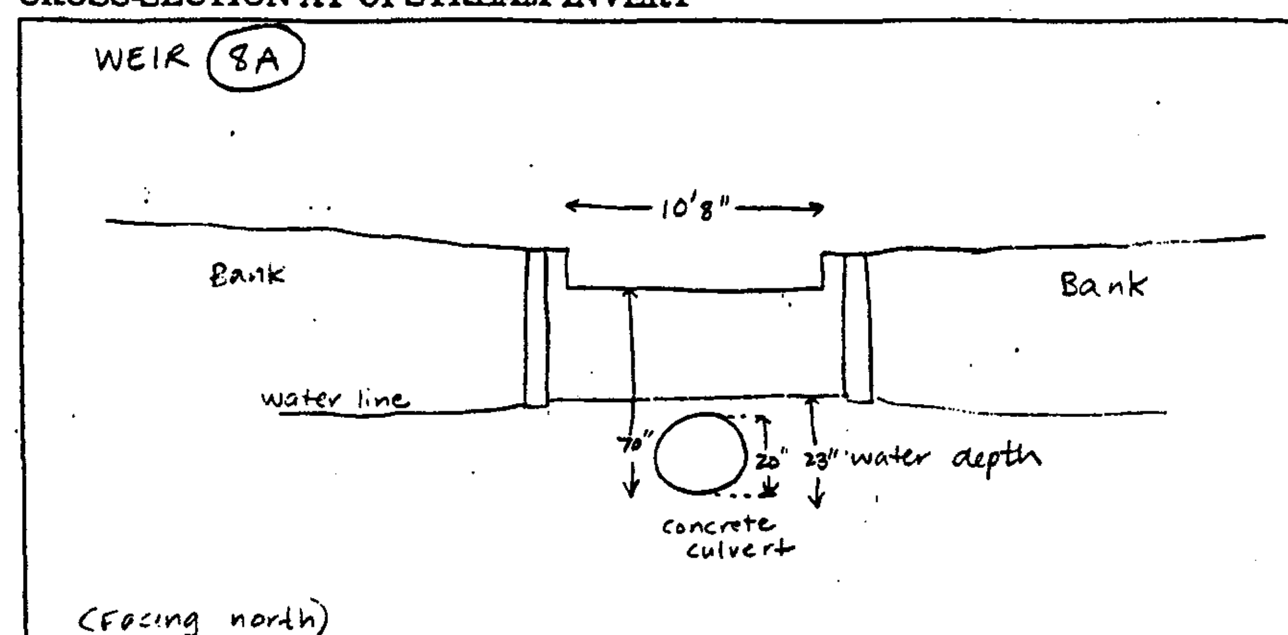
(SEE REVERSE SIDE)

8

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



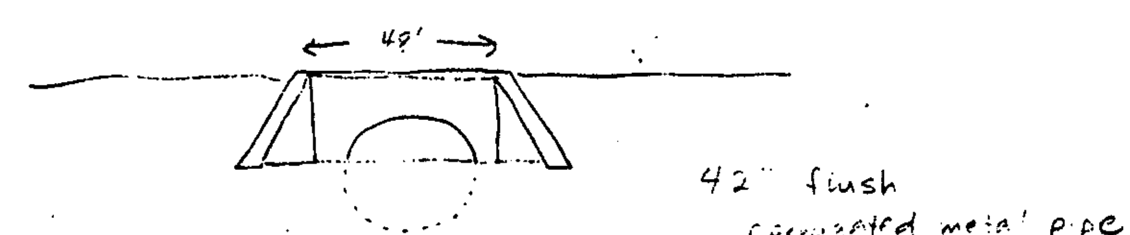
8

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)

See map for (8A) and (8C)

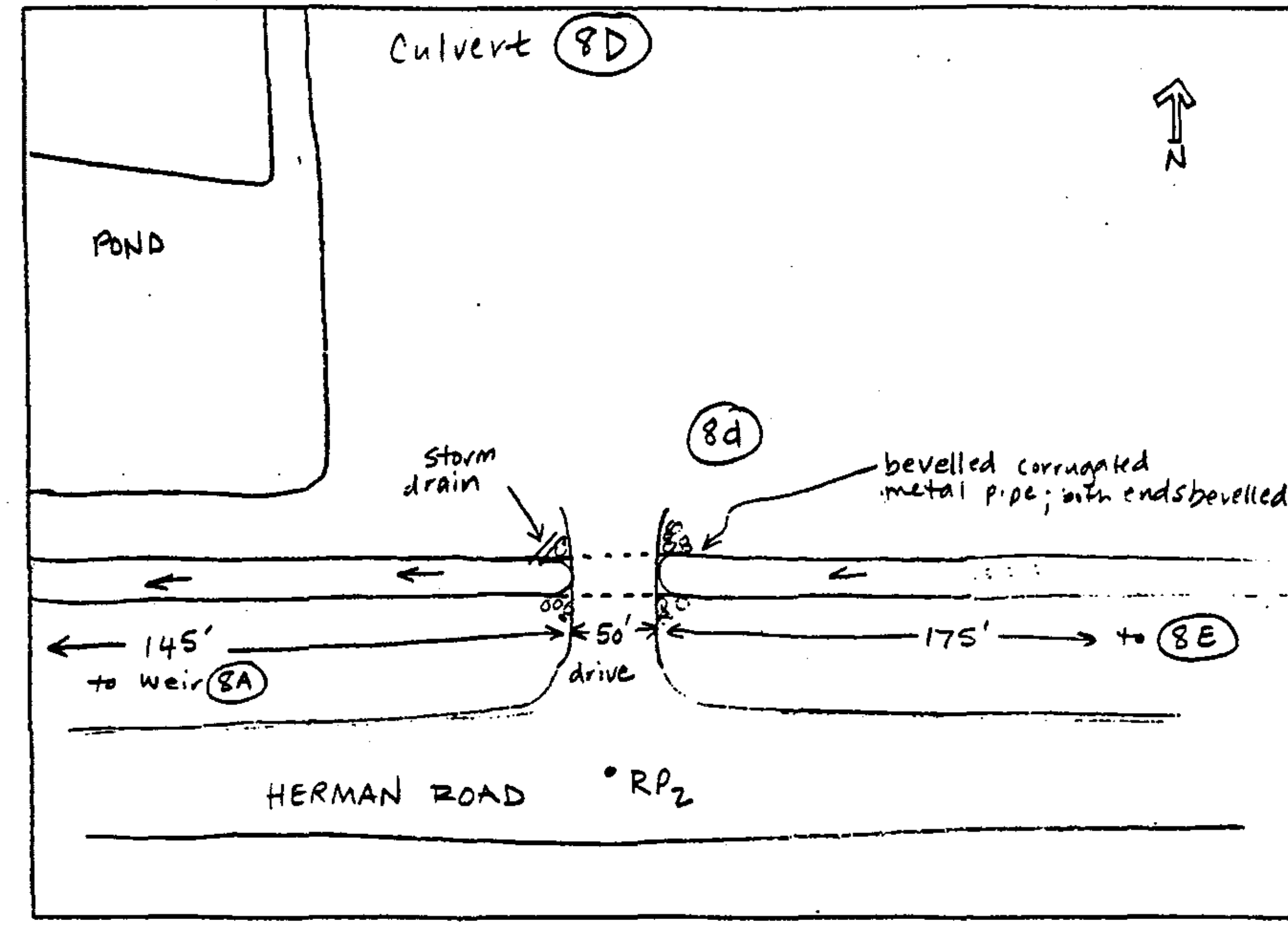
CROSS-SECTION AT UPSTREAM INVERT

Weir (8C)

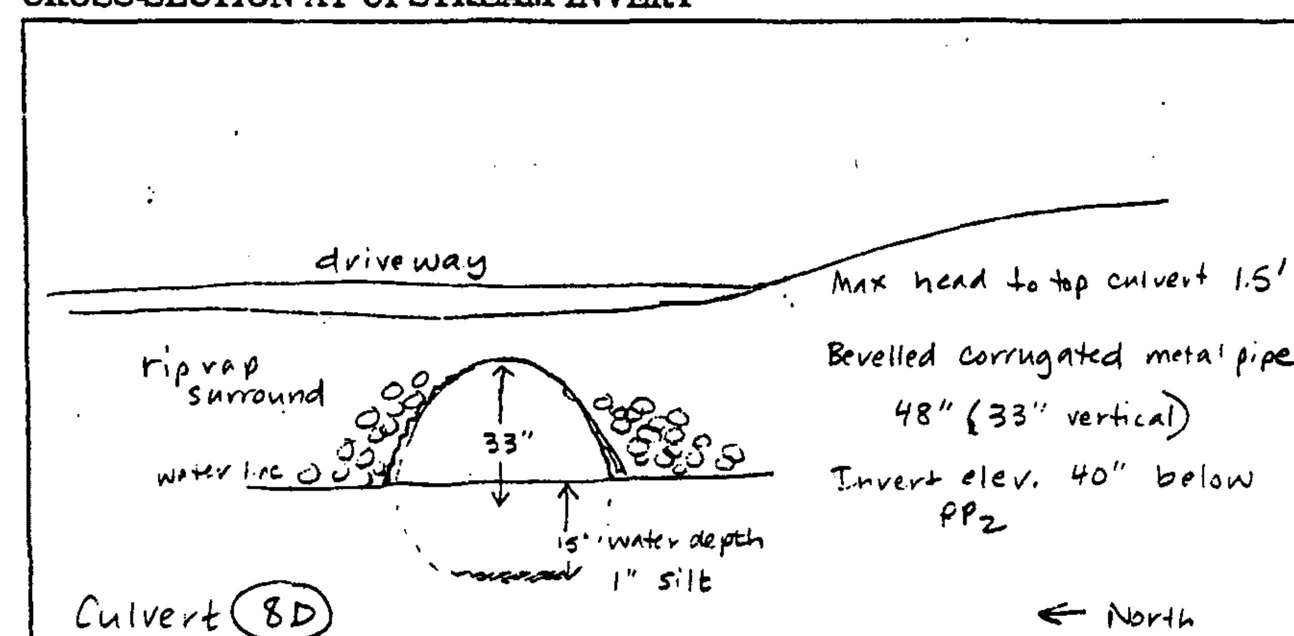


8

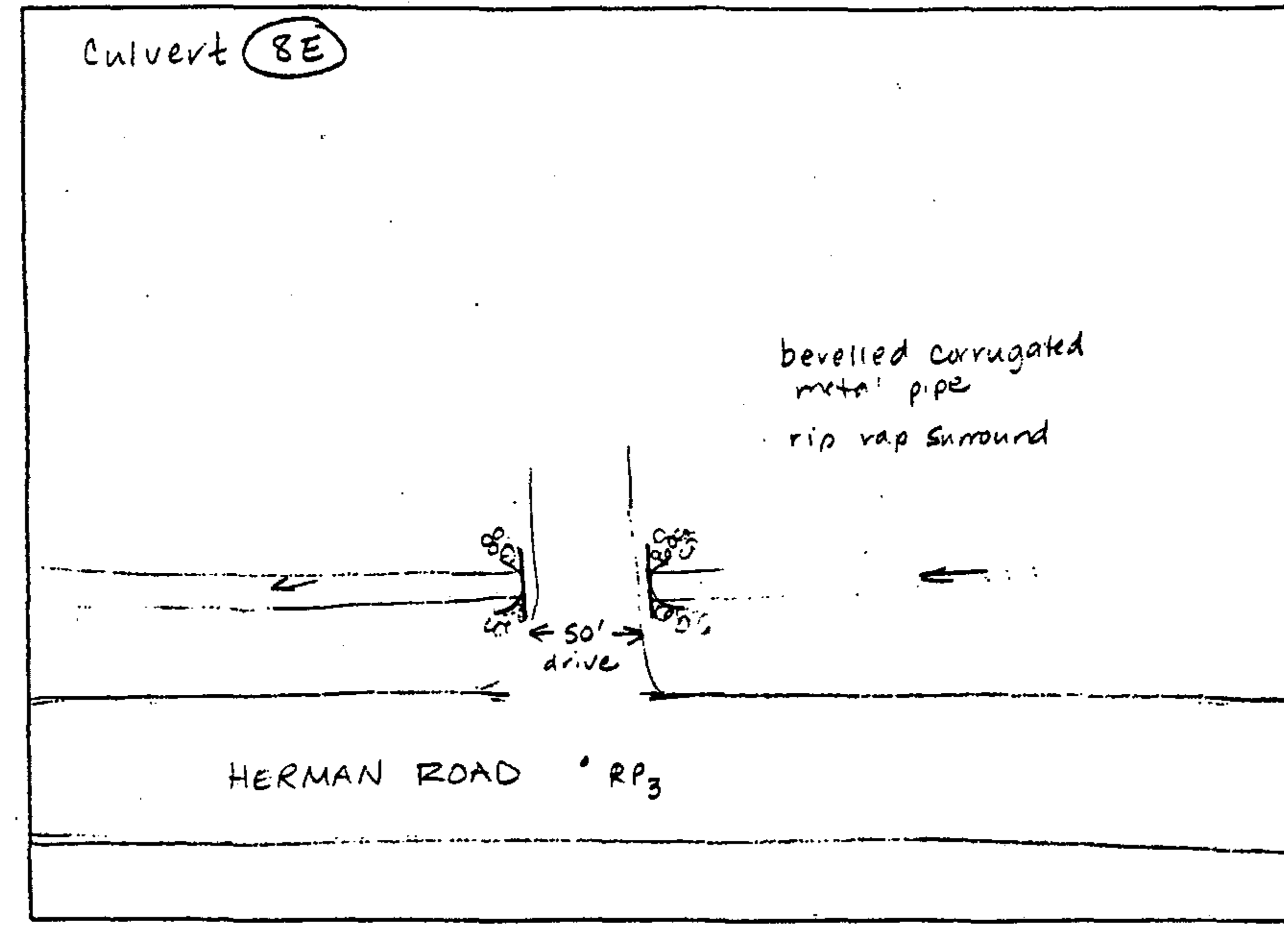
PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



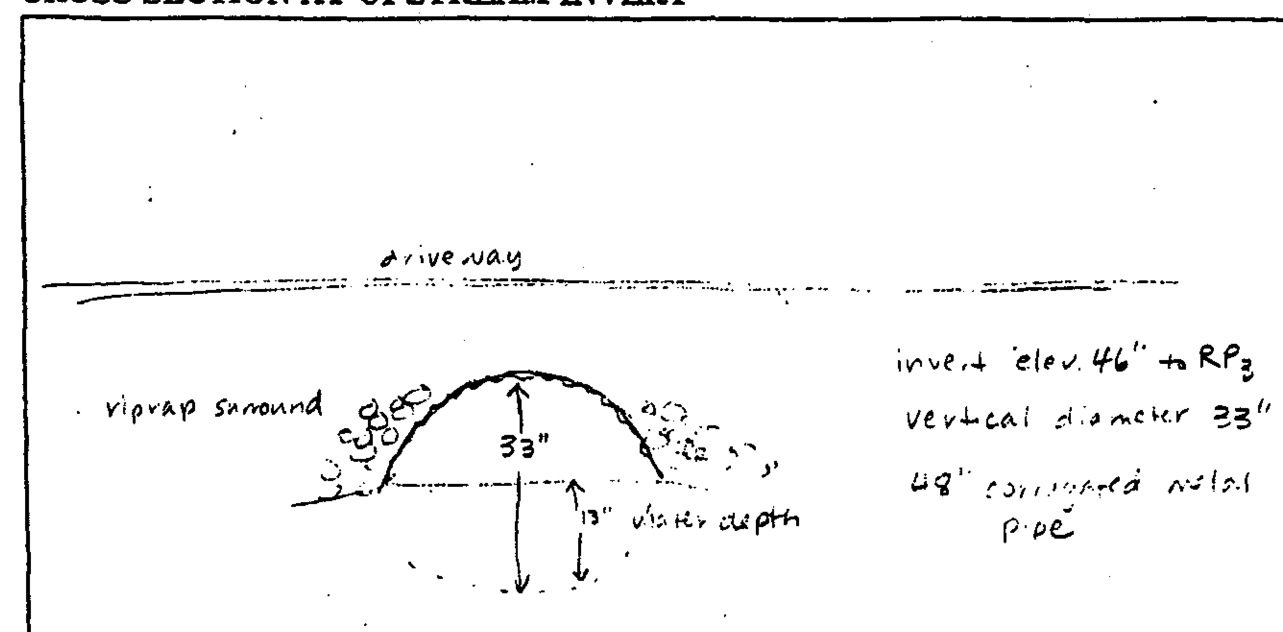
CROSS-SECTION AT UPSTREAM INVERT



PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)

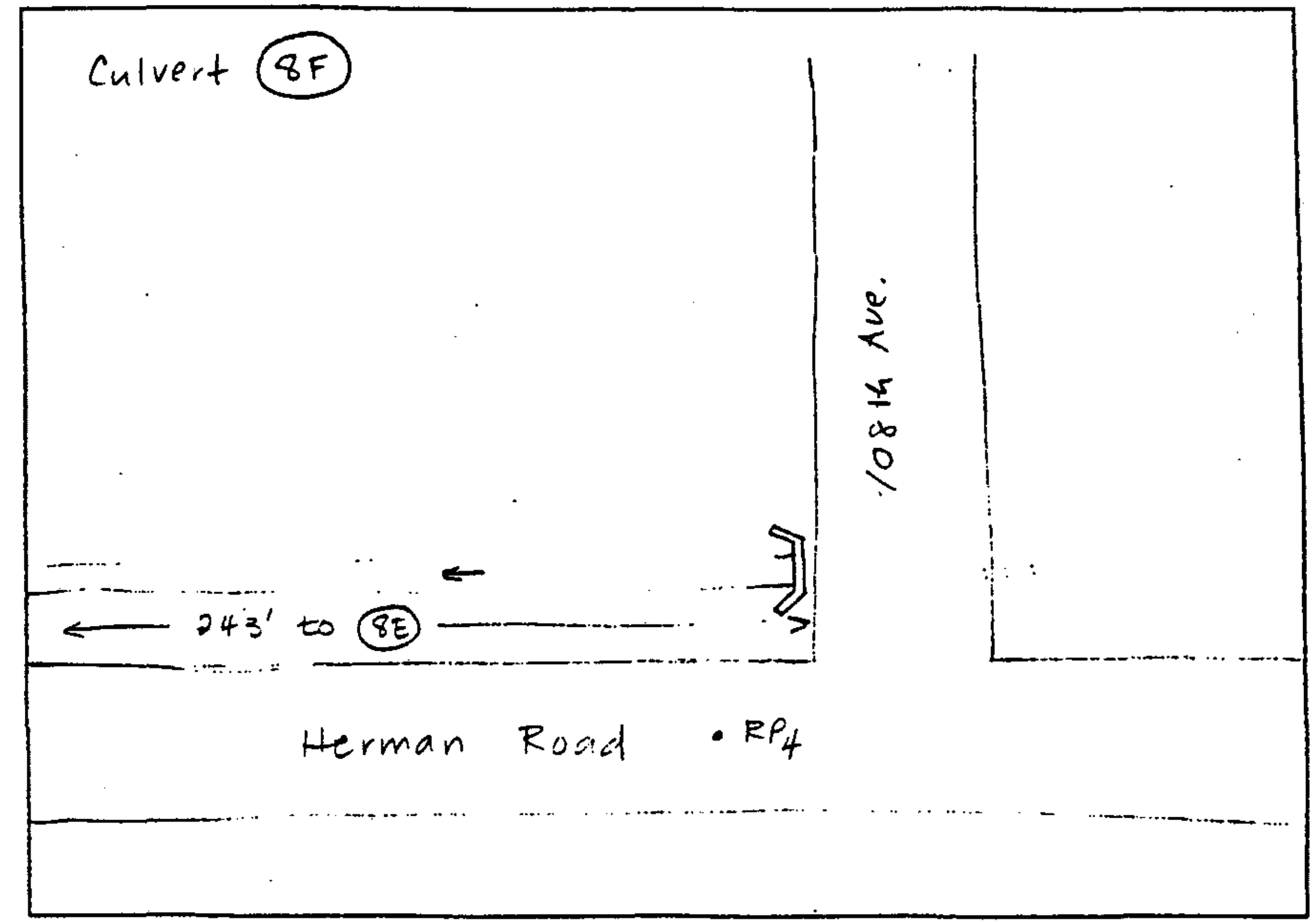


CROSS-SECTION AT UPSTREAM INVERT

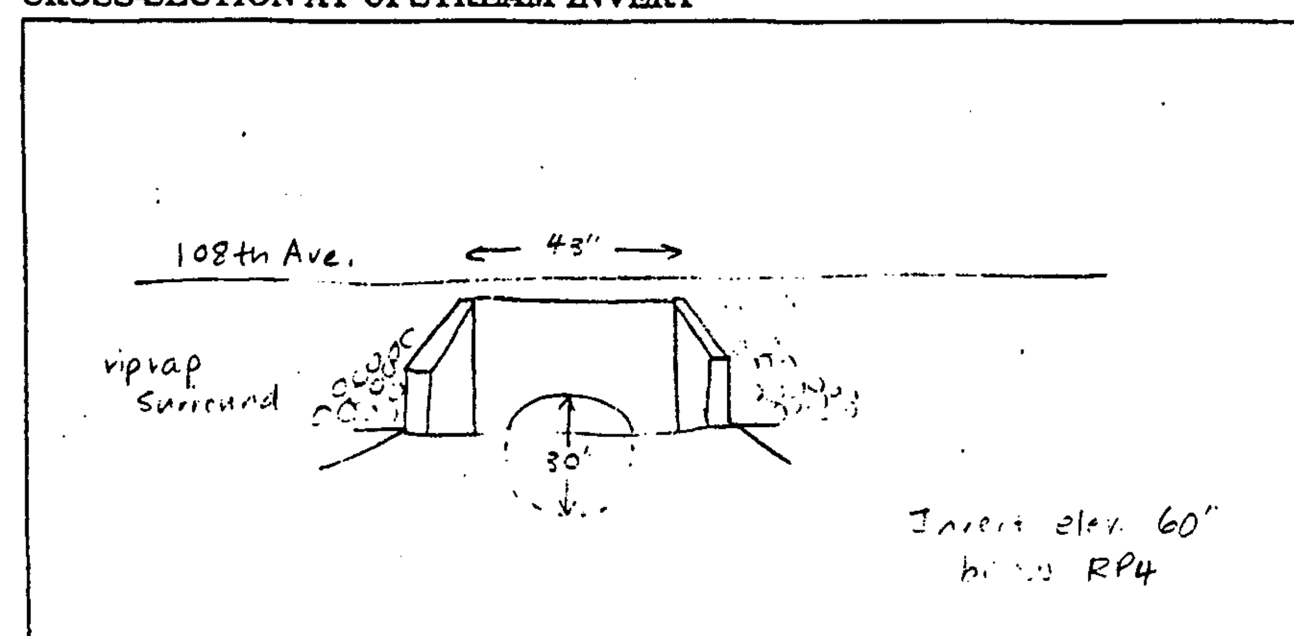


8

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)

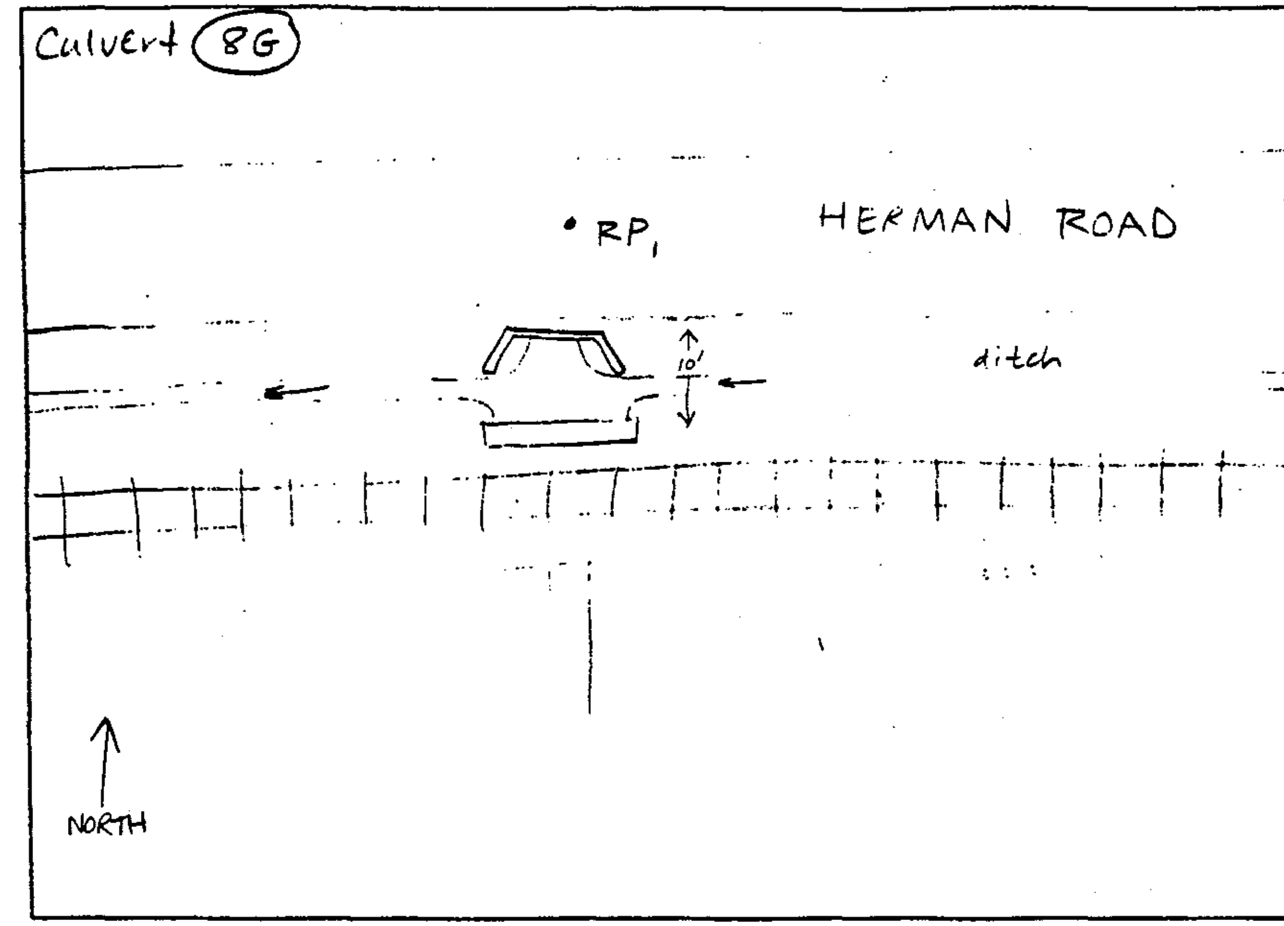


CROSS-SECTION AT UPSTREAM INVERT

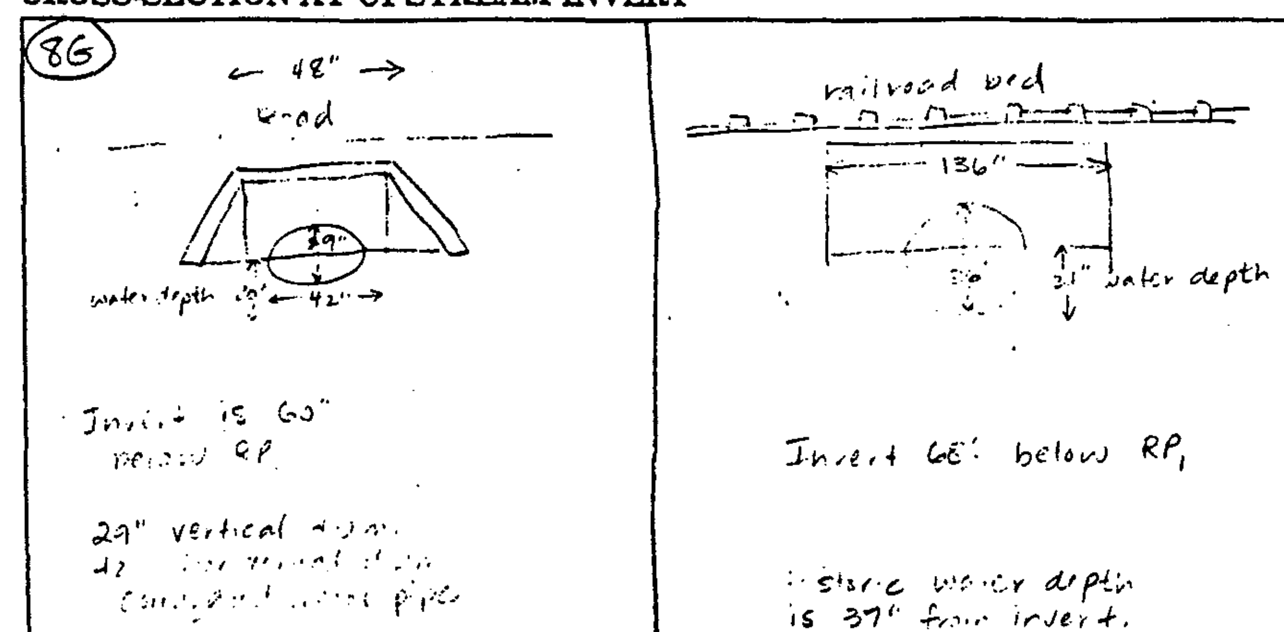


(8)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



VIEW FACING NORTH

VIEW FACING SOUTH

3135\FACT.SHT
191.15

9

OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI / RWK, JAG　　Weather: Sunny, clear

Date: 3/27/91　　Time: 12:46

Location: SW Teton Ave. and Tualatin-Sherwood Road　　USA Map Reference: ______

Type of Facility: ✓ Culvert ______ Pipe ______ Bridge ______ Other

Describe Other: A dike and water control structure is present

Material: ______ CMP (Metal Pipe) ✓ Concrete ______ PVC ______ Other

Number and Size: 1 and 2.3' x 3.7' Grate Size (Diameter, Inches) Culvert below - could not get diameter (filled with water)

If not circular, describe and provide key dimensions: Rectangular grate

Invert Data[1/]: 4' Upstream 4' Downstream

Length: 25' Feet (measured from top of drainage grate to top of nearby water control structure) culvert is about 4 feet below top of grate.

Inlet Configuration: ______ Mitered ✓ Bevelled ______ Flush

______ Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2/]: 2.5' Headwater 2' Tailwater

Condition[3/]: Everything is in good work.

Allowable Headwater: Additional 2.5' At Roadway ______ Other

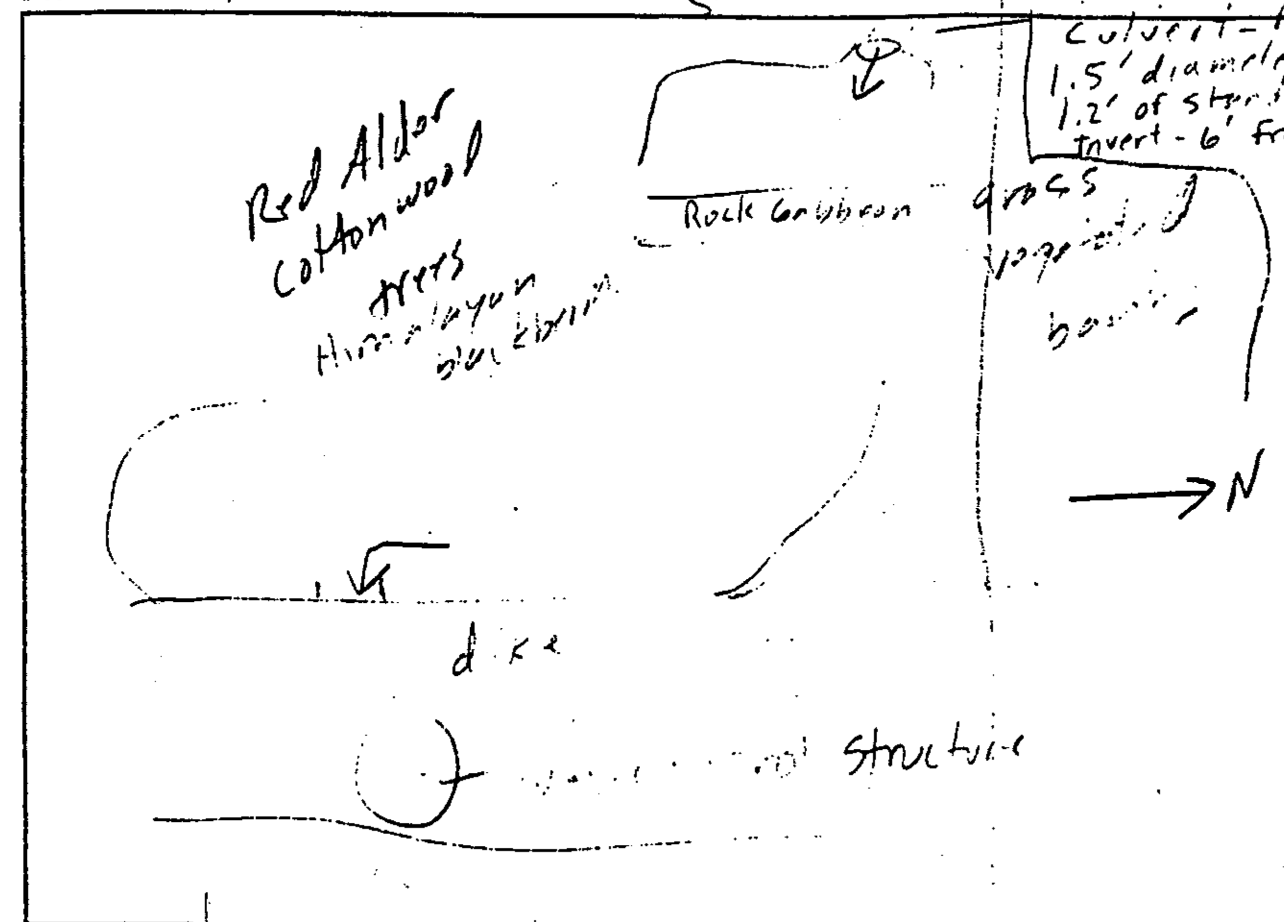
Bridge Data: ______ Width ______ Height[4/]

COMMENTS[5/]: Existing pond has been created by a dike and water control structure; Pond is acting as superb sediment basin with outflow going into a large semi-flooded reed canarygrass field. Ducks currently use pond and tailwater portions.

[1/] Est. elevation below a reference point such as top of roadway at crossing.
[2/] Est. Elevation from previous point used for invert data.
[3/] Depth of silt (if present), age, structural condition.
[4/] Distance from upstream invert to low chord of bridge.
[5/] Describe special features unique to facility.

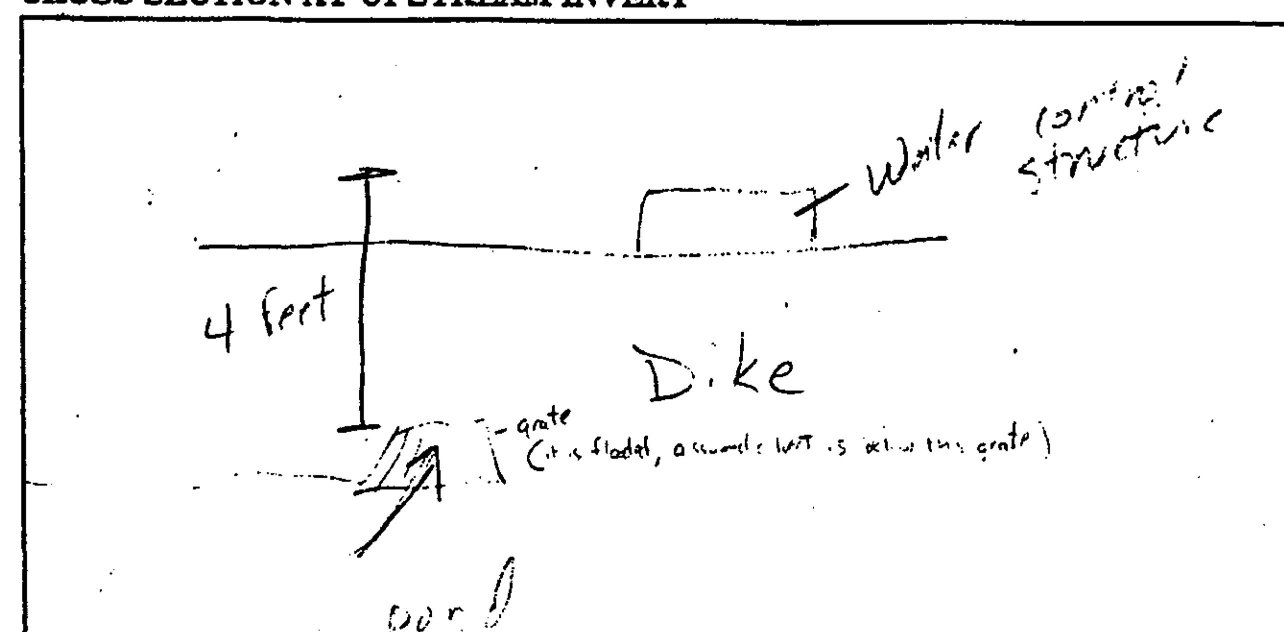
(SEE REVERSE SIDE)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



outlet drainage area

CROSS-SECTION AT UPSTREAM INVERT



OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI / RWK, JAG Weather: Sunny / Clear

Date: 3/27/91 Time: 14:05

Location: W. of SW Tualatin-Sherwood Rd. and SW Avery St. intersection USA Map Reference: ______

Type of Facility: ✓ Culvert ______ Pipe ______ Bridge ______ Other

Describe Other: ______

Material: ______ CMP (Metal Pipe) ✓ Concrete ______ PVC ______ Other

Number and Size: 1 and 60" (Diameter, Inches)

If not circular, describe and provide key dimensions: ______

Invert Data[1/]: 7' Upstream 7' Downstream

Length: 147' Feet Invert measured from top of Culvert to road

Inlet Configuration: ______ Mitered ______ Bevelled ______ Flush

✓ Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2/]: ______ Headwater ______ Tailwater

Condition[3/]: Excellent condition; recently installed

Allowable Headwater: 6' At Roadway ______ Other

Bridge Data: ______ Width ______ Height[4/]

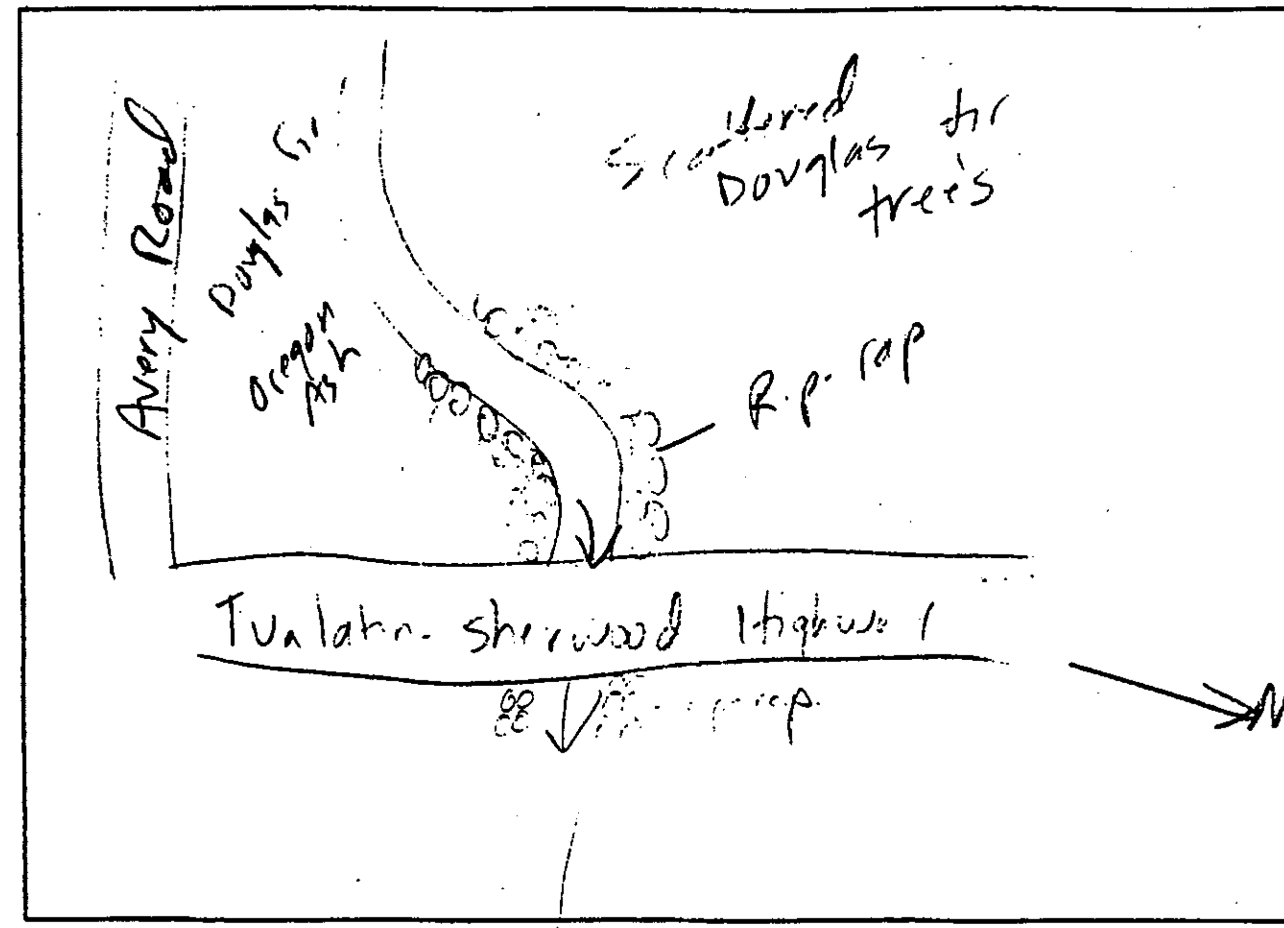
COMMENTS[5/]: Culvert appears to be recently installed; riprap has been placed along streambanks for stabilization. Upstream sections have scattered trees; retention opportunities appear good; streambank stabilization downstream is good with slight sedimentation buildup. Upstream portions of Creek are meandering within a small flood plain. One nice wildlife snag is present upstream approximately 100 feet from culvert.

1/ Est. elevation below a reference point such as top of roadway at crossing.
2/ Est. Elevation from previous point used for invert data.
3/ Depth of silt (if present), age, structural condition.
4/ Distance from upstream invert to low chord of bridge.
5/ Describe special features unique to facility.

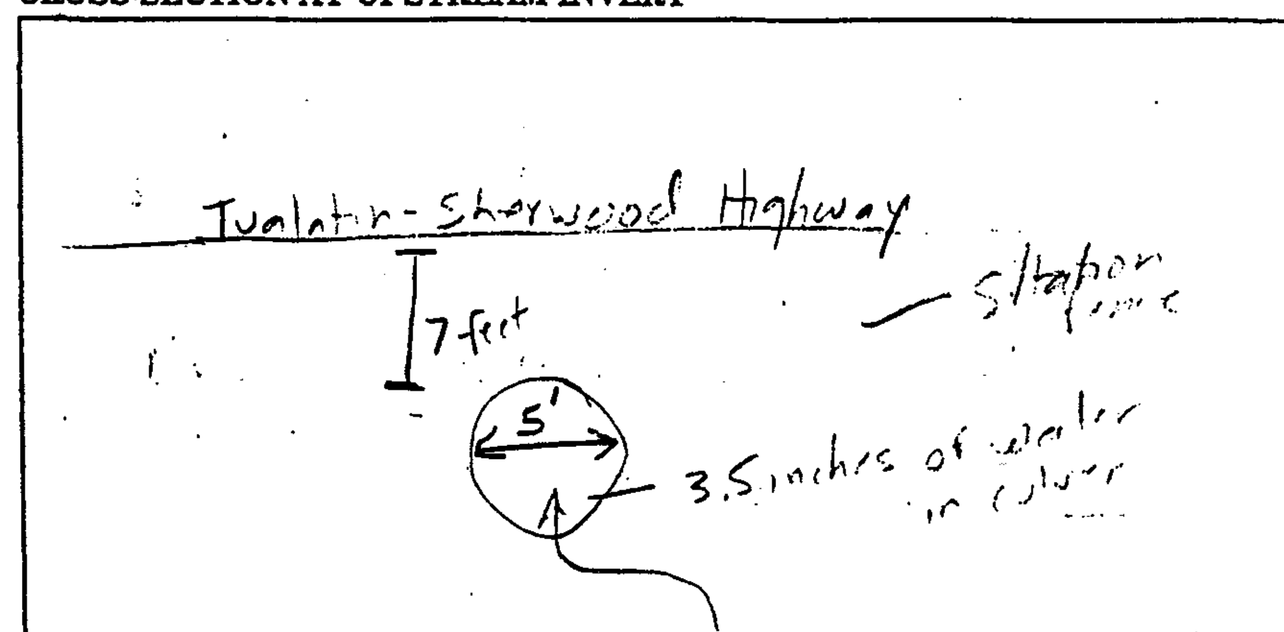
(SEE REVERSE SIDE)

10

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI / JAG, RWK　　Weather: Clear, Sunny

Date: 3/27/91　　Time: 15:00

Location: E. of Tualatin-Sherwood Rd. and SW 120th Ave. intersection　　USA Map Reference: ______

Type of Facility: ✓ Culvert ______ Pipe ______ Bridge ______ Other

Describe Other: ______

Material: ______ CMP (Metal Pipe) ✓ Concrete ______ PVC ______ Other

Number and Size: 2 and 36" (Diameter, Inches)

If not circular, describe and provide key dimensions: 2-4" diameter PVC (black) corrugated tubing

Invert Data[1]: ~13' Upstream ~15' Downstream

Length: ~125' Feet　　Invert taken from top of culvert to reference point.

Inlet Configuration: ______ Mitered ______ Bevelled ______ Flush

______ Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2]: ~6" Headwater ~1' Tailwater

Condition[3]: Good structural condition

Allowable Headwater: ~9' At Roadway ______ Other

Bridge Data: ______ Width ______ Height[4]

COMMENTS[5]:

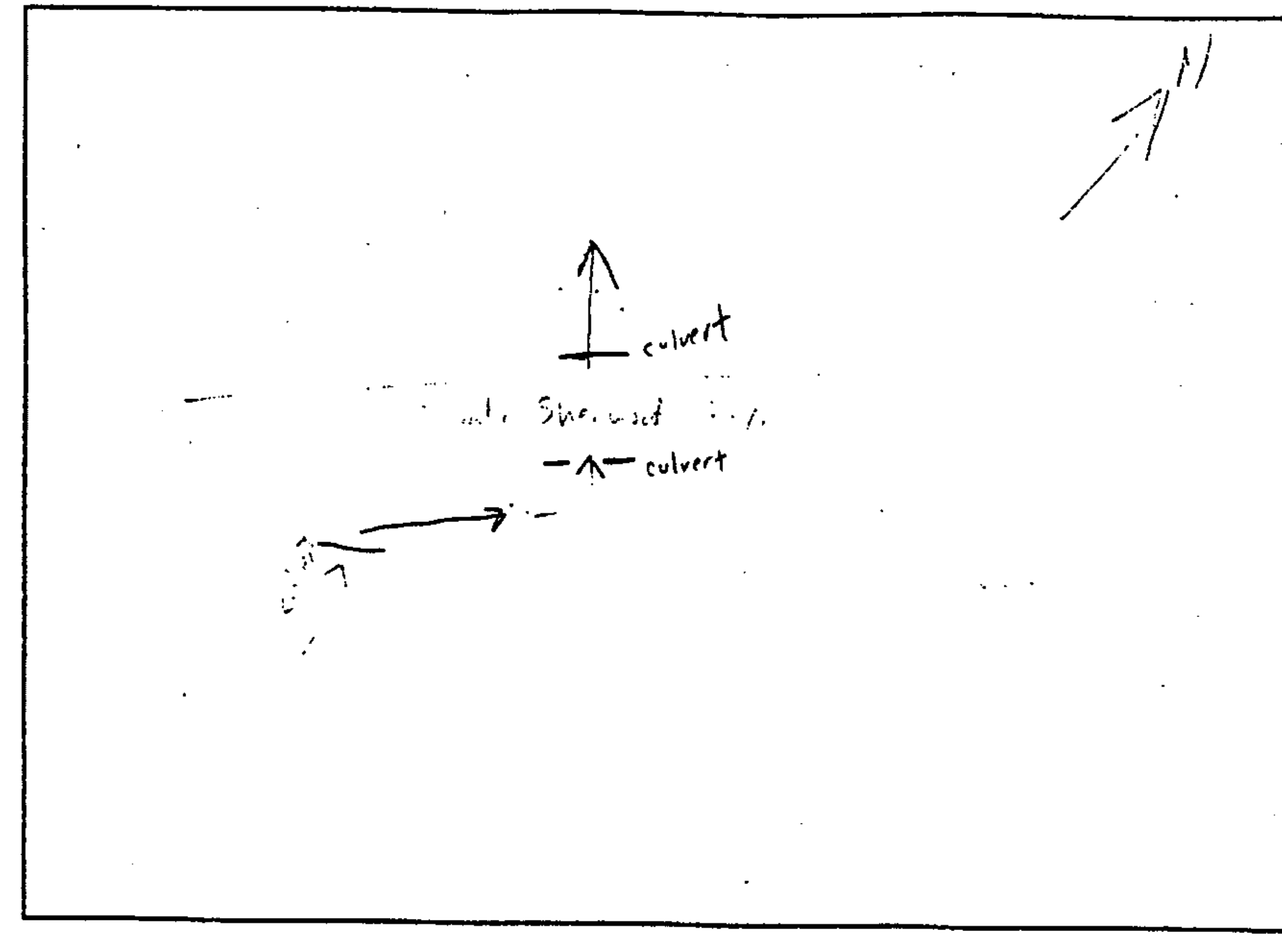
Reference point #1 to center of Tualatin-Sherwood Rd. Silt accumulation downstream of culvert. ½" of water in downstream end of culvert. Boulders placed at upstream end. Only ~15' of running water then you hit another culvert. Unsure of how it may be engineered to make a good PRF. Surrounded by open grassy areas with a few trees.

[1] Est. elevation below a reference point such as top of roadway at crossing.
[2] Est. Elevation from previous point used for invert data.
[3] Depth of silt (if present), age, structural condition.
[4] Distance from upstream invert to low chord of bridge.
[5] Describe special features unique to facility.

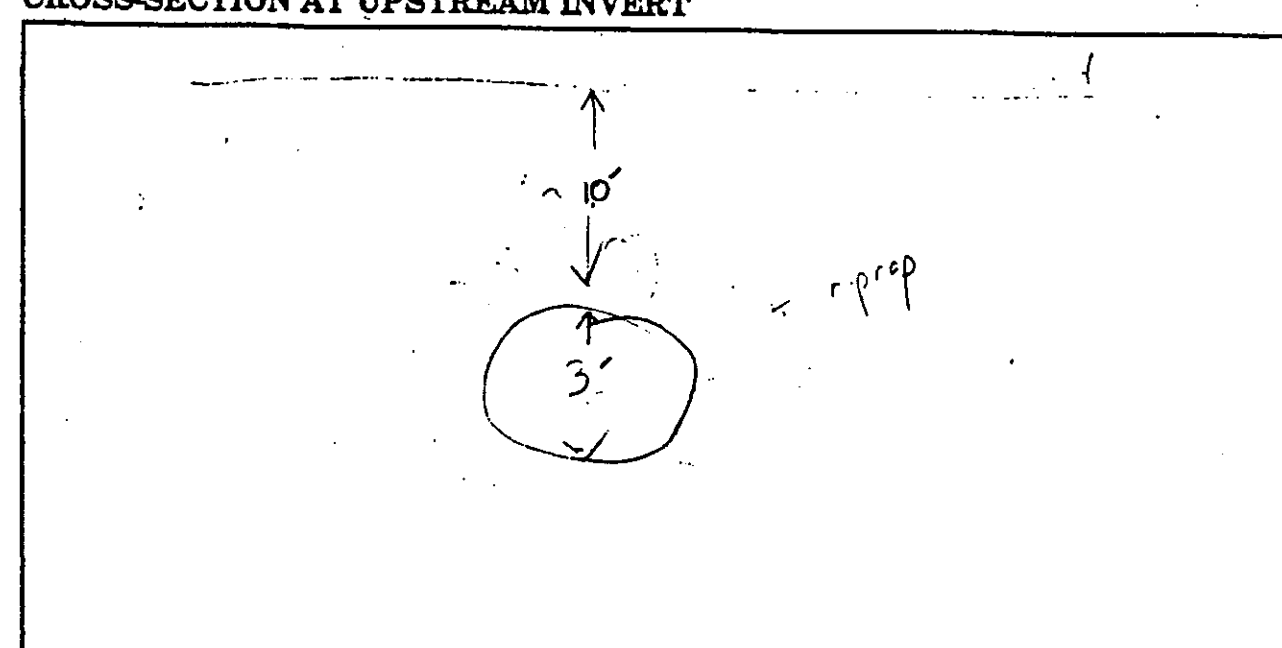
(SEE REVERSE SIDE)

(11)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: RWK/JAG (SRI) Weather: Sunny/Clear

Date: 3/27/91 Time: 15:20

Location: W. of 120th and Tualatin-Sherwood Rd. intersection USA Map Reference: ______

Type of Facility: ✓ Culvert ______ Pipe ______ Bridge ______ Other

Describe Other: ______

Material: ✓ CMP (Metal Pipe) ______ Concrete ______ PVC ______ Other

Number and Size: 1 and ______ (Diameter, Inches)

If not circular, describe and provide key dimensions: ______

Invert Data[1]: Could not locate Upstream 6' Downstream

Length: Estimated Feet

Inlet Configuration: ______ Mitered ______ Bevelled ______ Flush

______ Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2]: ______ Headwater ______ Tailwater

Condition[3]: ______

Allowable Headwater: ______ At Roadway ______ Other

Bridge Data: ______ Width ______ Height[4]

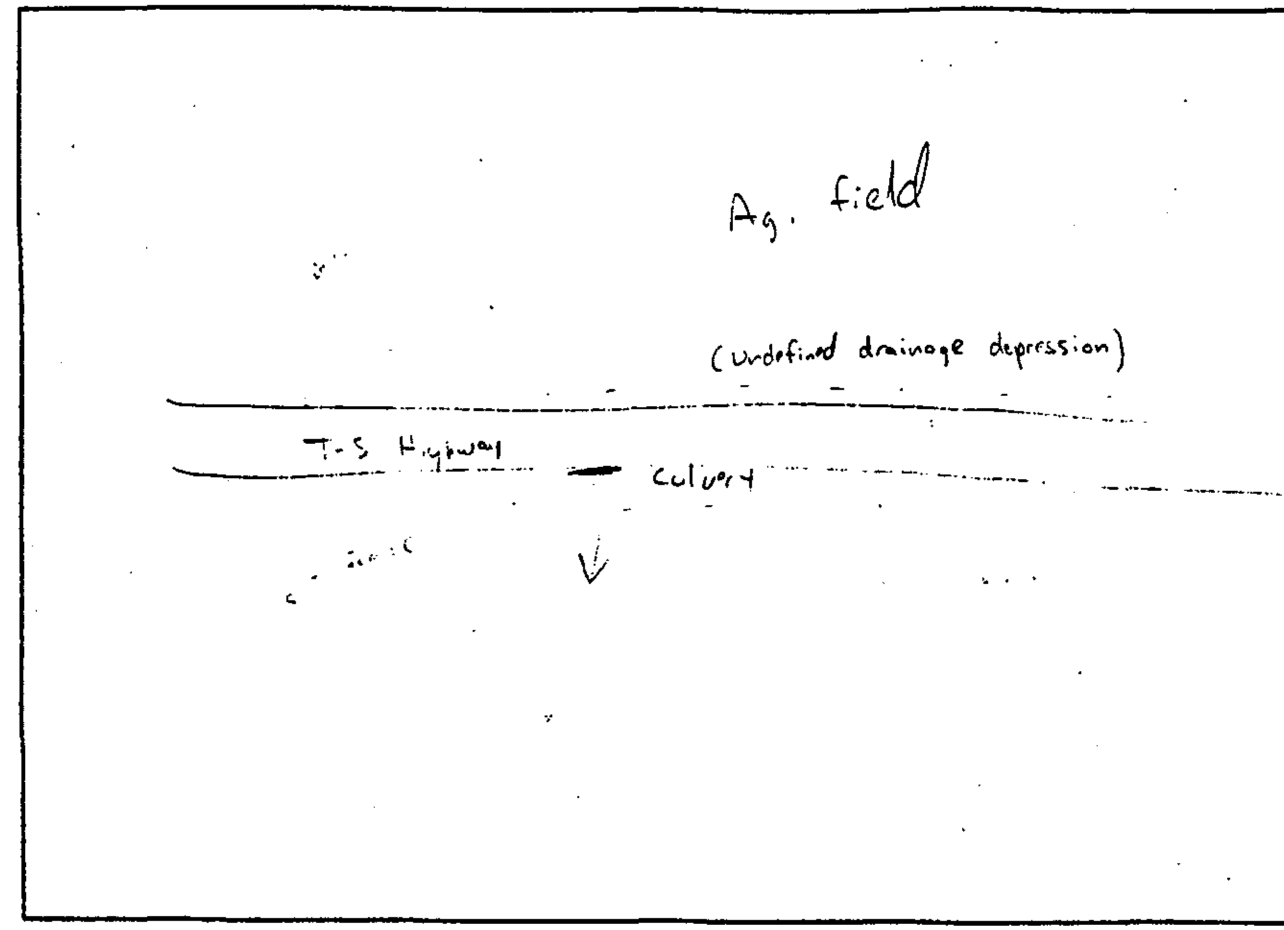
COMMENTS[5]:

Upstream inlet portion of culvert was not located, possibly buried because of new road construction. Water is flowing out the outlet.

[1] Est. elevation below a reference point such as top of roadway at crossing.
[2] Est. Elevation from previous point used for invert data.
[3] Depth of silt (if present), age, structural condition.
[4] Distance from upstream invert to low chord of bridge.
[5] Describe special features unique to facility.

(SEE REVERSE SIDE)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT

could not locate
upstream culvert

OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI/ RAJ, JVS   Weather: Clear/Sunny

Date: 3/27/91   Time: 15:00

Location: E. of Cipole Rd. and Tualatin-Sherwood Rd. USA Map Reference: ____

Type of Facility: ✓ Culvert ____ Pipe ____ Bridge ____ Other

Describe Other: ____

Material: ____ CMP (Metal Pipe) ✓ Concrete ____ PVC ____ Other

Number and Size: 3 and 18" at N. Road, 18" at S. Road, 12" at Sump (Diameter, Inches)

If not circular, describe and provide key dimensions: ____

Invert Data[1]: 43" Upstream 62" at Road, 73" at Sump Downstream

Length: 36' Feet under roadway

Inlet Configuration: ____ Mitered ____ Bevelled ____ Flush

____ Projecting ____ Headwalls/Wingwalls

Evidence of Historic Water Depth[2]: None Headwater None Tailwater

Condition[3]: System has obviously been modified, used to have terra cotta clay tile at Sump.

Allowable Headwater: 10" above inlet invert At Roadway ____ Other

Bridge Data: ____ Width ____ Height[4]

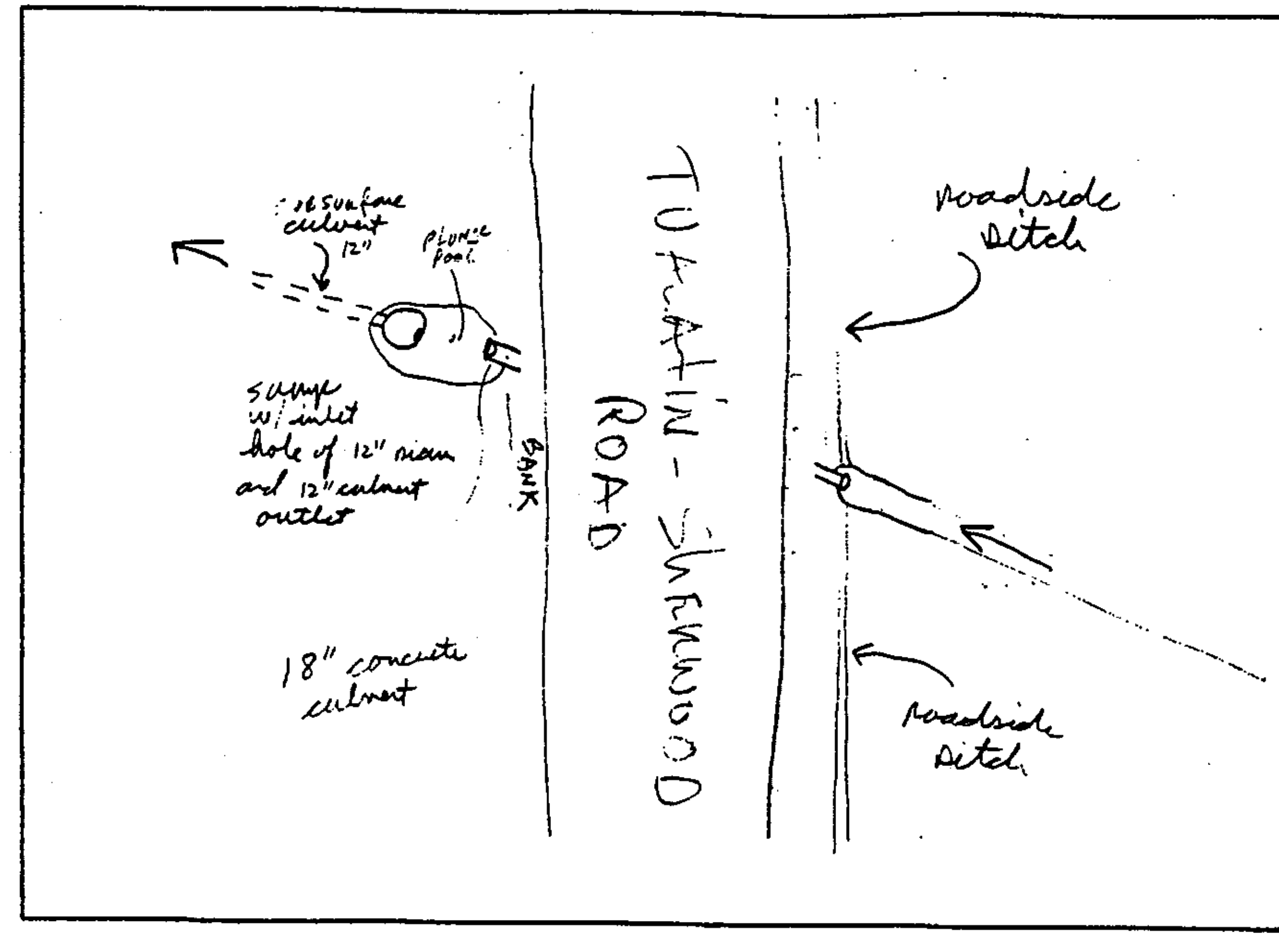
COMMENTS[5]:

- water depth is 12" in plunge pool, 3" in culvert in sump.
- Significant slope to culvert under road.
- water flowing strongly out of downstream road culvert.
- 2" of water in inlet culvert
- If headwater was allowed to 10" above inlet invert, water would extend at least 50' E. and W. up roadside ditches, but would be contained in them. (Possibly could go to top of inlet culvert, 18").

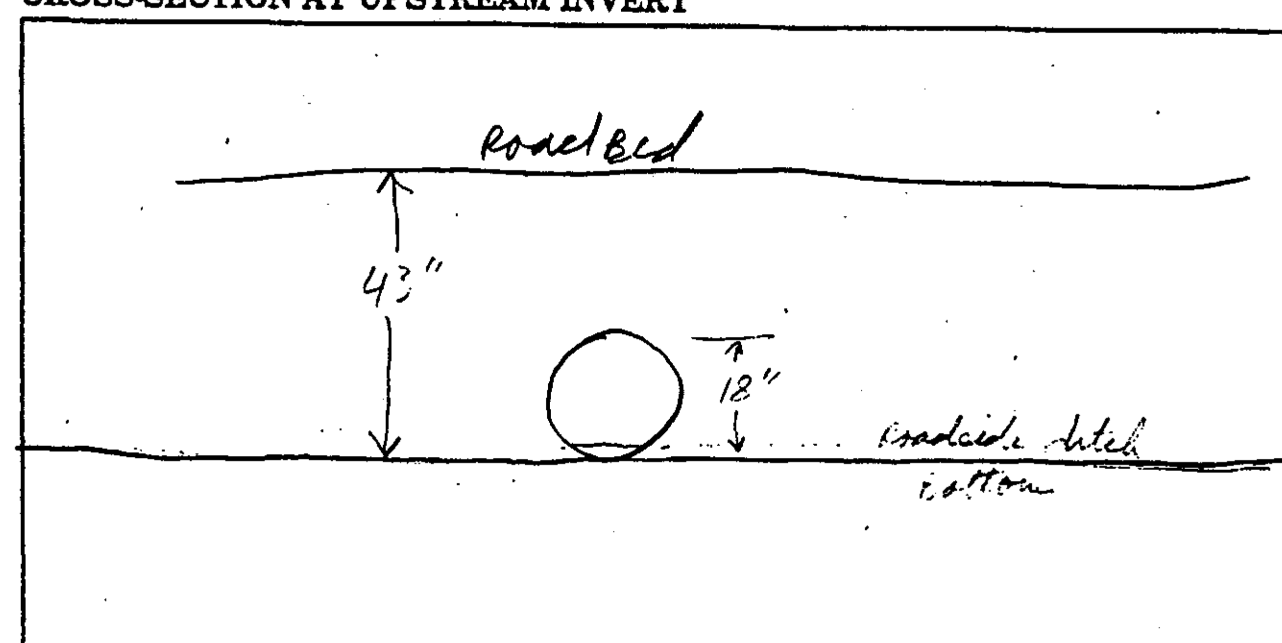
[1] Est. elevation below a reference point such as top of roadway at crossing.
[2] Est. Elevation from previous point used for invert data.
[3] Depth of silt (if present), age, structural condition.
[4] Distance from upstream invert to low chord of bridge.
[5] Describe special features unique to facility.

(SEE REVERSE SIDE)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



(14)

OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI / RWK, JAG Weather: Sunny/Clear

Date: 3/27/91 Time: 14:34

Location: Behind Coca-Cola processing plant on 105th Ave. USA Map Reference: ____

Type of Facility: ____ Culvert ____ Pipe ____ Bridge ✓ Other

Describe Other: Vertical overflow culvert in pond to regulate water depth

Material: ✓ CMP (Metal Pipe) ____ Concrete ____ PVC ____ Other

Number and Size: 2 and 4" (Diameter, Inches)

If not circular, describe and provide key dimensions: ____

Invert Data[1/]: 10' Upstream 20' Downstream

Length: 100' Feet Invert taken from top of culvert to road

Inlet Configuration: ____ Mitered ____ Bevelled ✓ Vertically Flush

✓ Emergency overflow culvert Projecting ____ Headwalls/Wingwalls

Evidence of Historic Water Depth[2/]: 2' above present waterline Headwater 2.5' Tailwater

Condition[3/]: Excellent

Allowable Headwater: 4' At Roadway ____ Other

Bridge Data: ____ Width ____ Height[4/]

COMMENTS[5/]:

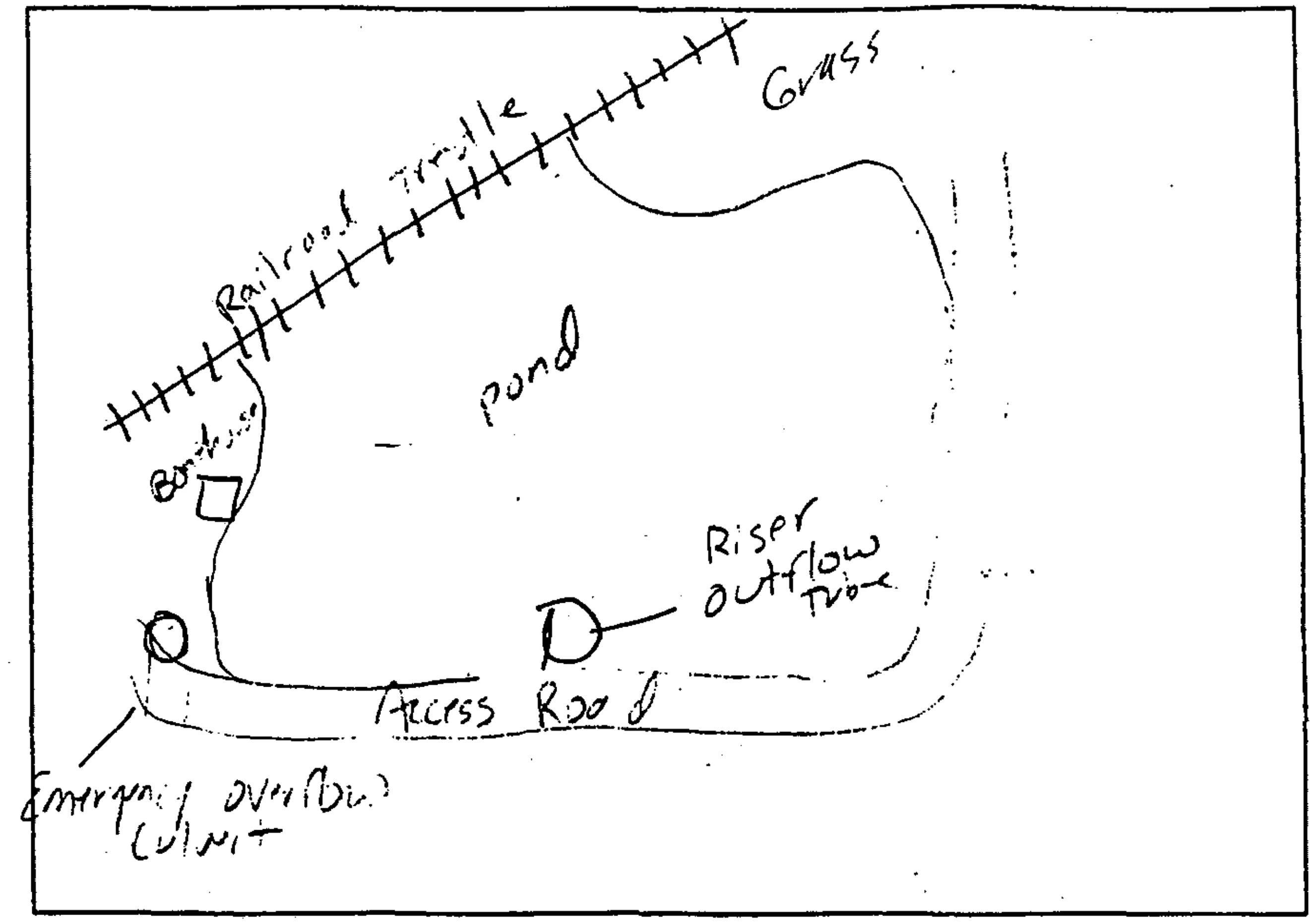
Rather large pond area approximately 300' x 100' seems to be already functioning as a catchment basin; ducks and geese use the pond. Downstream riparian corridor is good quality habitat, snags are present.
Did not find Riser pipe.

[1/] Est. elevation below a reference point such as top of roadway at crossing.
[2/] Est. Elevation from previous point used for invert data.
[3/] Depth of silt (if present), age, structural condition.
[4/] Distance from upstream invert to low chord of bridge.
[5/] Describe special features unique to facility.

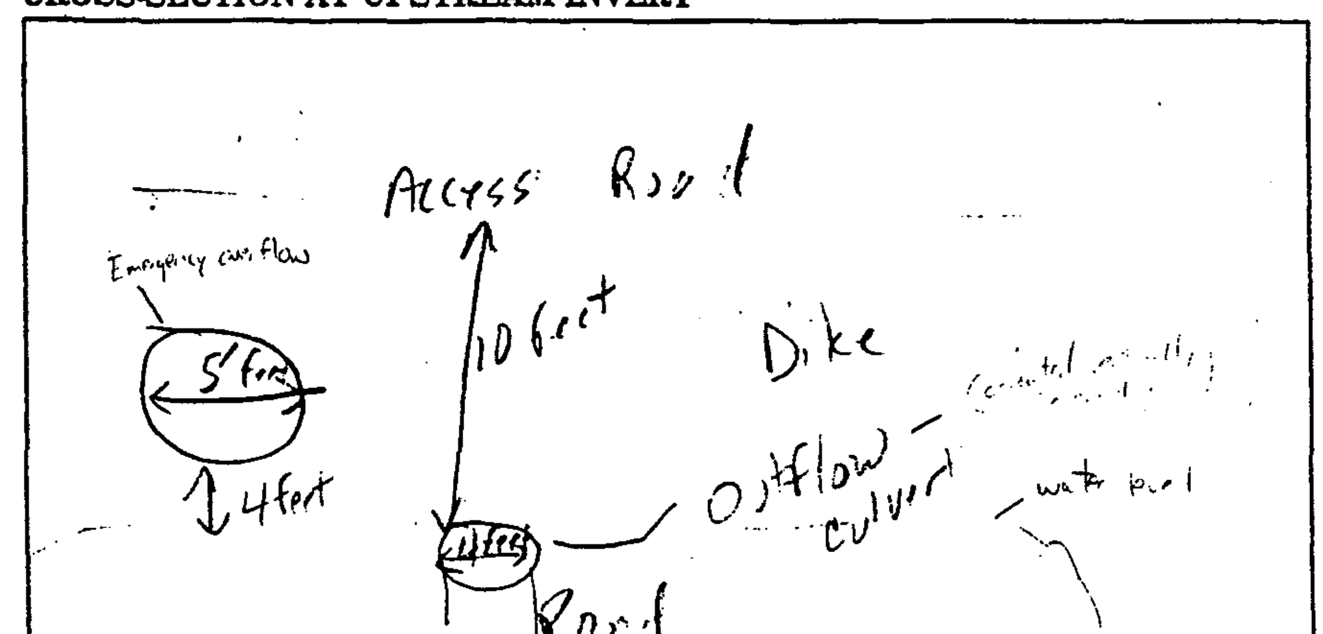
(SEE REVERSE SIDE)

(14)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI / RWK, JAG Weather: Sunny/Clear

Date: 3/27/91 Time: 15:37

Location: SW 120th Ave. USA Map Reference: ______

Type of Facility: ✓ Culvert ______ Pipe ______ Bridge ______ Other

Describe Other: ______

Material: ✓ CMP (Metal Pipe) ______ Concrete ______ PVC ______ Other

Number and Size: 1 and 16" (Diameter, Inches)

If not circular, describe and provide key dimensions: ______

Invert Data[1]: 1' Upstream 2' Downstream

Length: 38' Feet

Inlet Configuration: ______ Mitered ______ Bevelled ______ Flush

✓ Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2]: 4" above present level Headwater ______ Tailwater

Condition[3]: Moderate, appears to be getting run down, but functioning properly

Allowable Headwater: 1' At Roadway ______ Other

Bridge Data: ______ Width ______ Height[4]

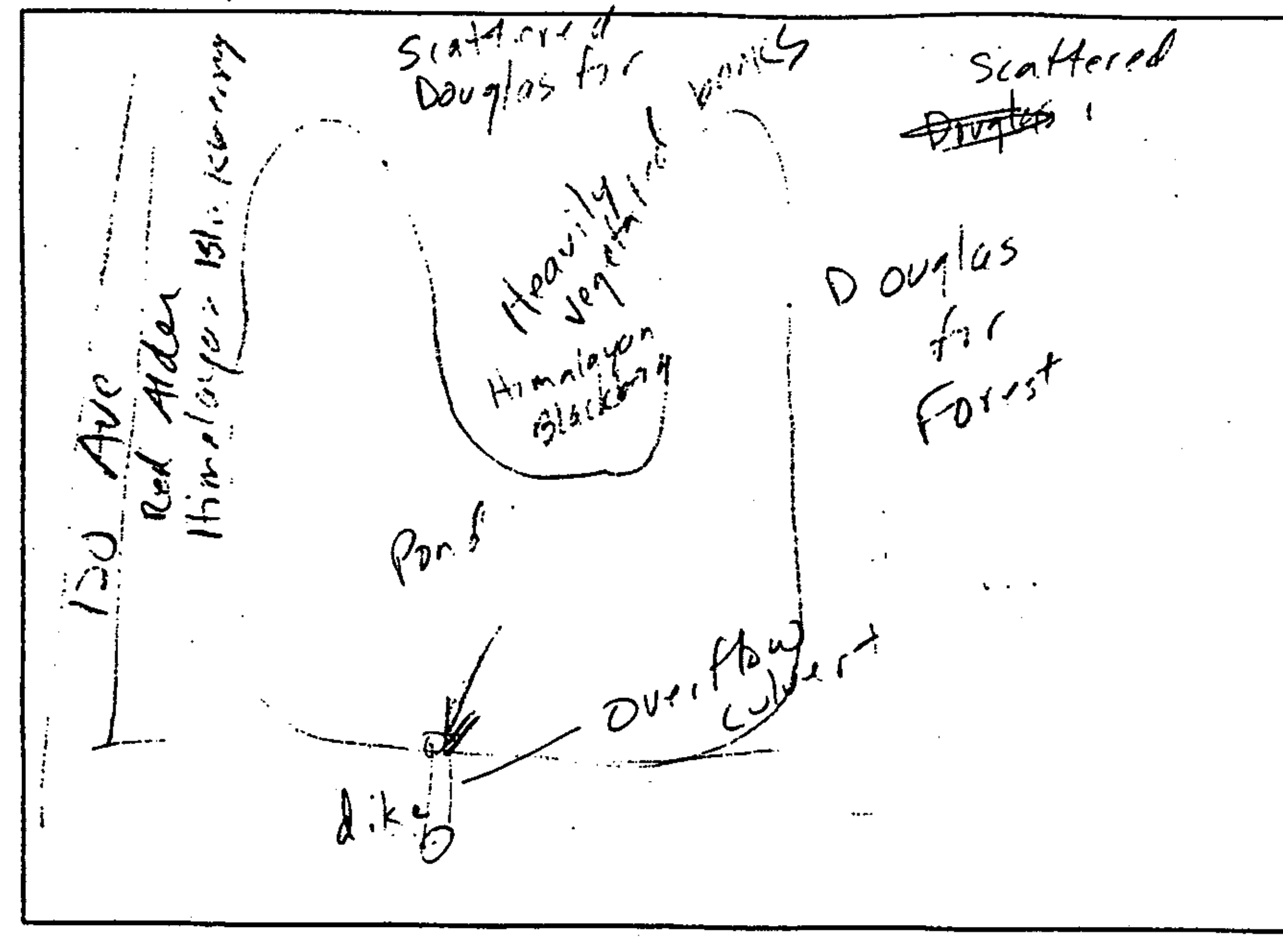
COMMENTS[5]:
Ponded area that has only an emergency overflow culvert - pond has well-vegetated banks and is used by ducks: Currently functioning as a good sediment retention pond. Does not appear to be much outflow; although some seepage is occurring at bottom of banks.

[1] Est. elevation below a reference point such as top of roadway at crossing.
[2] Est. Elevation from previous point used for invert data.
[3] Depth of silt (if present), age, structural condition.
[4] Distance from upstream invert to low chord of bridge.
[5] Describe special features unique to facility.

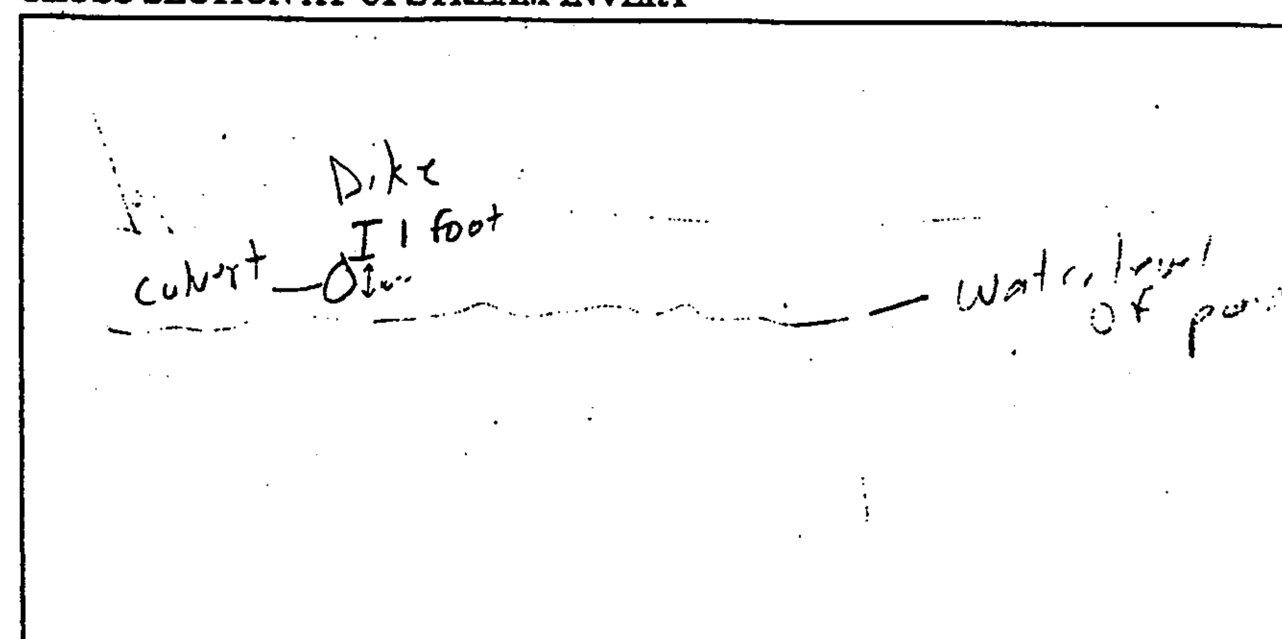
(SEE REVERSE SIDE)

15

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



(16)

OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI / JAG, RWK Weather: Clear, Sunny

Date: 3/27/91 Time: 11:45

Location: R.R. Culvert behind Commerce Park USA Map Reference: ______

Type of Facility: ✓ Culvert ______ Pipe ______ Bridge ______ Other

Describe Other: ______

Material: ✓ CMP (Metal Pipe) ______ Concrete ______ PVC ______ Other

Number and Size: 1 and 2' (24") (Diameter, Inches)

If not circular, describe and provide key dimensions: ______

Invert Data[1/]: * 2' Upstream 3.5' Downstream

Length: 32' Feet * reference point - railroad bed - measurement taken from top of culvert.

Inlet Configuration: ______ Mitered ______ Bevelled ______ Flush

______ Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2/]: ~1.5-2' Headwater 1.5-2' Tailwater (eroded Channel ~4.5 deep)

Condition[3/]: Culvert in fair shape; Some mud/silt accumulation (~2" deep)

Allowable Headwater: ~2¼' At Roadway ______ Other

Bridge Data: ______ Width ______ Height[4/]

COMMENTS[5/]:

No walls at culvert; basically just a ditch by the side of the railroad; ditch has encised, eroded banks. No veg. in ditch. Mowed upland graminoids on adjacent areas. Some Cirsium sp. No flowing water at present time. No water upstream; Some ponded areas downstream. Intense erosion immediately downstream of Culvert.

1/ Est. elevation below a reference point such as top of roadway at crossing.
2/ Est. Elevation from previous point used for invert data.
3/ Depth of silt (if present), age, structural condition.
4/ Distance from upstream invert to low chord of bridge.
5/ Describe special features unique to facility.

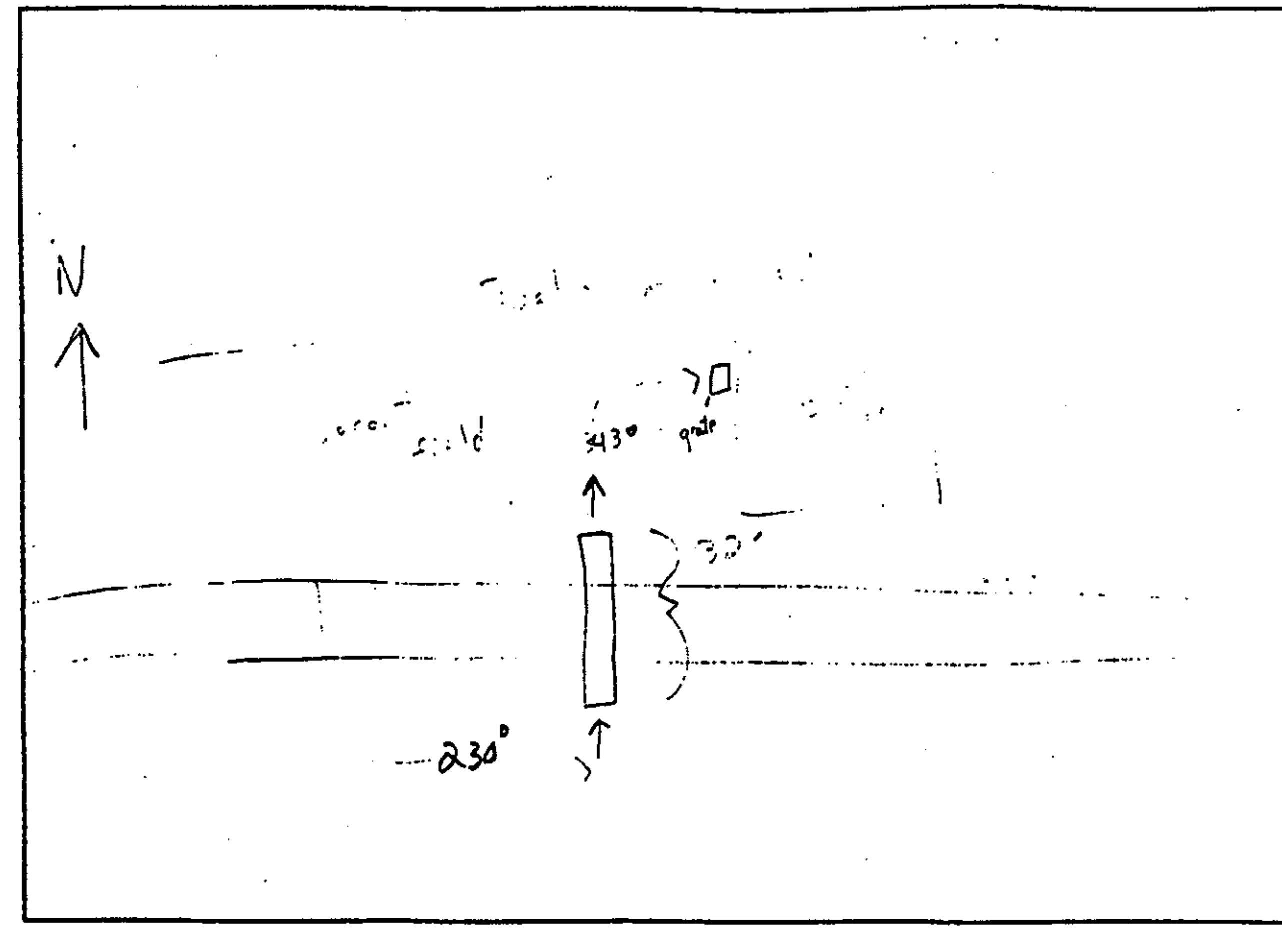
* Storm drain - Downstream ~2'x3' grate (rectangular) bevelled, heavy erosion problems, hay bales set, ½' silt accumulation faces eastward

(SEE REVERSE SIDE)

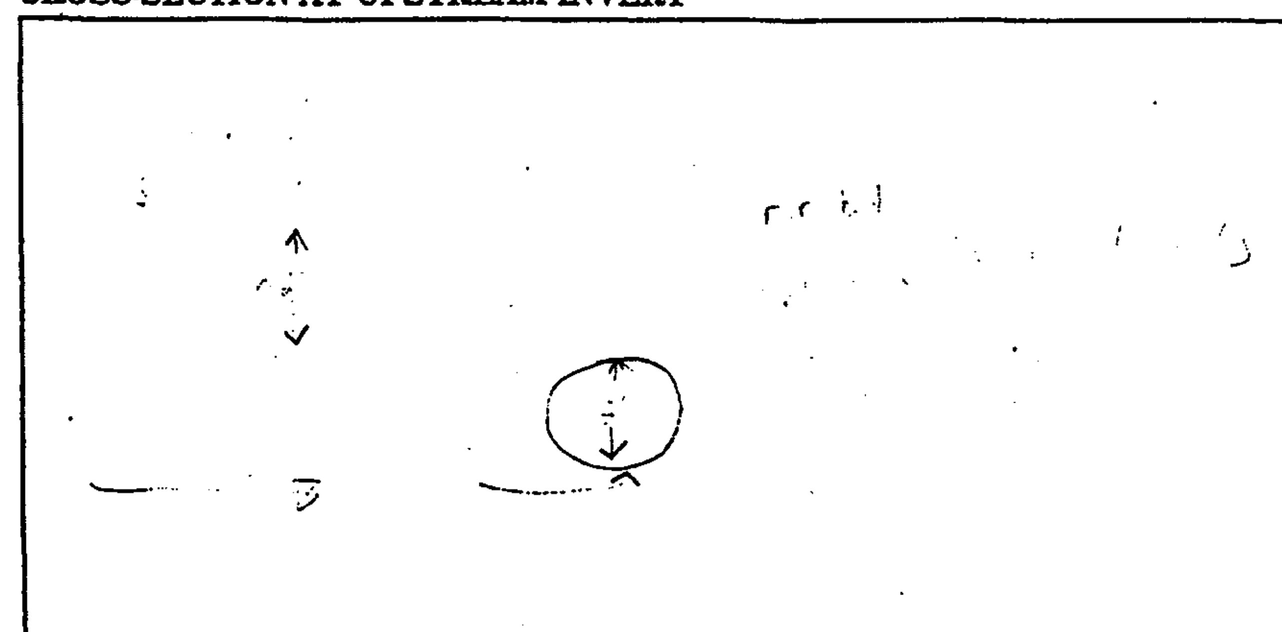
3135\FACT.SHT
191.16

(167)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



(17)

OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: Jag - RWK Weather: Sunny, 50's

Date: 3/27/91 Time: ______

Location: # 17 USA Map Reference: ______

Type of Facility: ✓ Culvert ______ Pipe ______ Bridge ______ Other

Describe Other: ______

Material: ✓ CMP (Metal Pipe) (corrugated) ______ Concrete ______ PVC ______ Other

Number and Size: 1 and 1'8" at downstream (Diameter, Inches) square grate 2.3' x 2.7 grate

If not circular, describe and provide key dimensions: ______

Invert Data[1]: ~4' measured from top a culvert Upstream ~6.5' - measured from top of culvert Downstream ref. pt. (center of road)

Length: ~215 Feet

Inlet Configuration: ______ Mitered ✓ (at upstream) Bevelled (bevelled grate) Flush

______ Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2]: ~4"-6" ? Headwater ~4"-6" Tailwater

Condition[3]: newly constructed

Allowable Headwater: ~1.5' At Roadway ______ Other

Bridge Data: ______ Width ______ Height[4]

COMMENTS[5]:

No water flowing. Basically just a roadside ditch at upstream end. Grass has been seeded and is growing in ditch. Doesn't appear to be much potential for a PRF

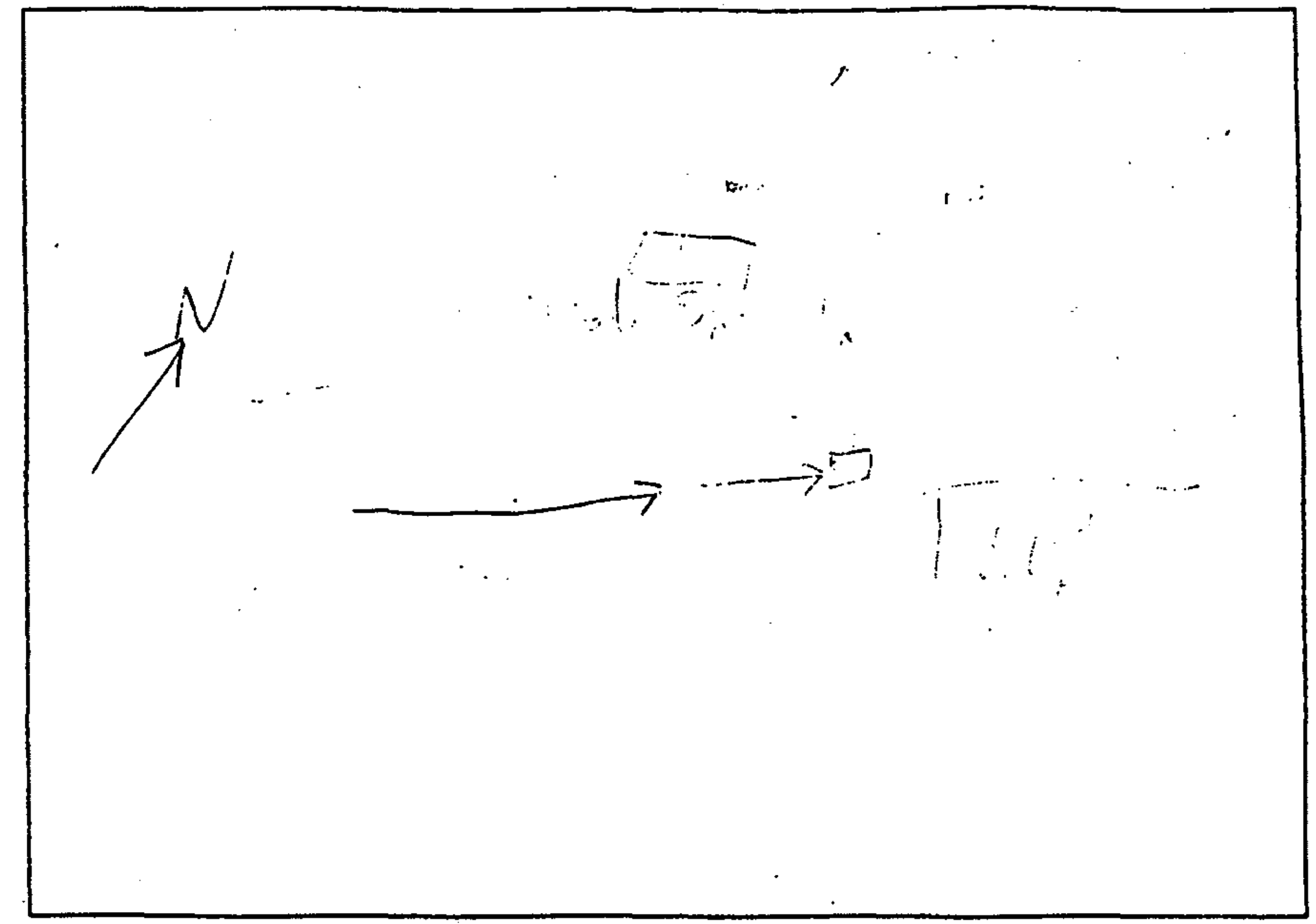
[1] Est. elevation below a reference point such as top of roadway at crossing.
[2] Est. Elevation from previous point used for invert data.
[3] Depth of silt (if present), age, structural condition.
[4] Distance from upstream invert to low chord of bridge.
[5] Describe special features unique to facility.

(SEE REVERSE SIDE)

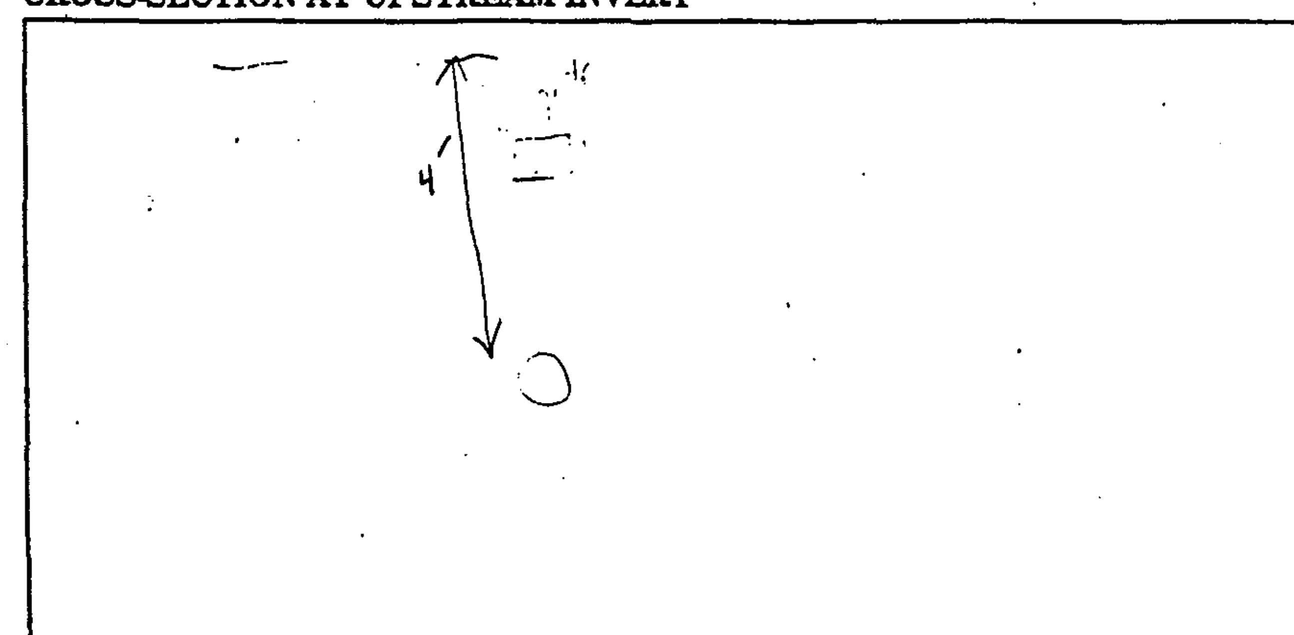
3135\FACT.SHT
191.16

(17)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



(18)

OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI/RAJ, JVS   Weather: Sunny, clear, dry

Date: 3/27/91   Time: 14:30

Location: N. end of 118th   USA Map Reference: ____

Type of Facility: ____ Culvert ____ Pipe ____ Bridge ✓ Other

Describe Other: W. upstream & E. downstream are open field ditches

Material: ____ CMP (Metal Pipe) ____ Concrete ____ PVC ✓ Other (Dirt)

Number and Size: ____ and ____ (Diameter, Inches)

If not circular, describe and provide key dimensions: ____

Invert Data[1/]: 48" W. (Ditch Bottom) Upstream 6.5' Downstream

Length: 141' Feet (across from ditch to ditch).

Inlet Configuration: ____ Mitered ____ Bevelled ____ Flush

____ Projecting ____ Headwalls/Wingwalls

Evidence of Historic Water Depth[2/]: not detectable Headwater ____ Tailwater

Condition[3/]: West ditch in mod. vegetated, while E. ditch is low grass or

Allowable Headwater: 3' for W. ditch At Roadway ____ Other

Bridge Data: ____ Width ____ Height[4/]

COMMENTS[5/]:

Reference point in center of 118th

No connection, now, between ditches.

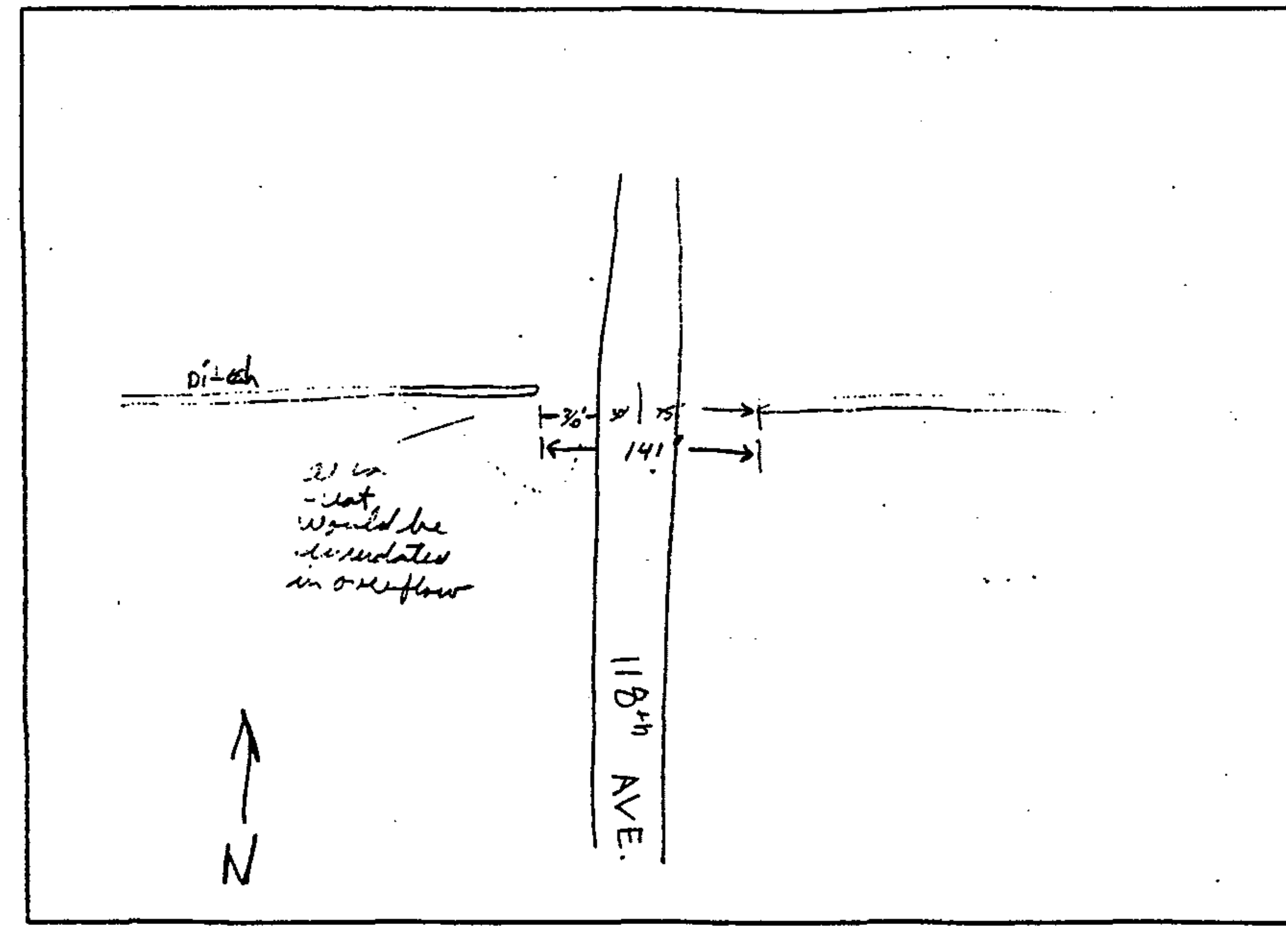
[1/] Est. elevation below a reference point such as top of roadway at crossing.
[2/] Est. Elevation from previous point used for invert data.
[3/] Depth of silt (if present), age, structural condition.
[4/] Distance from upstream invert to low chord of bridge.
[5/] Describe special features unique to facility.

(SEE REVERSE SIDE)

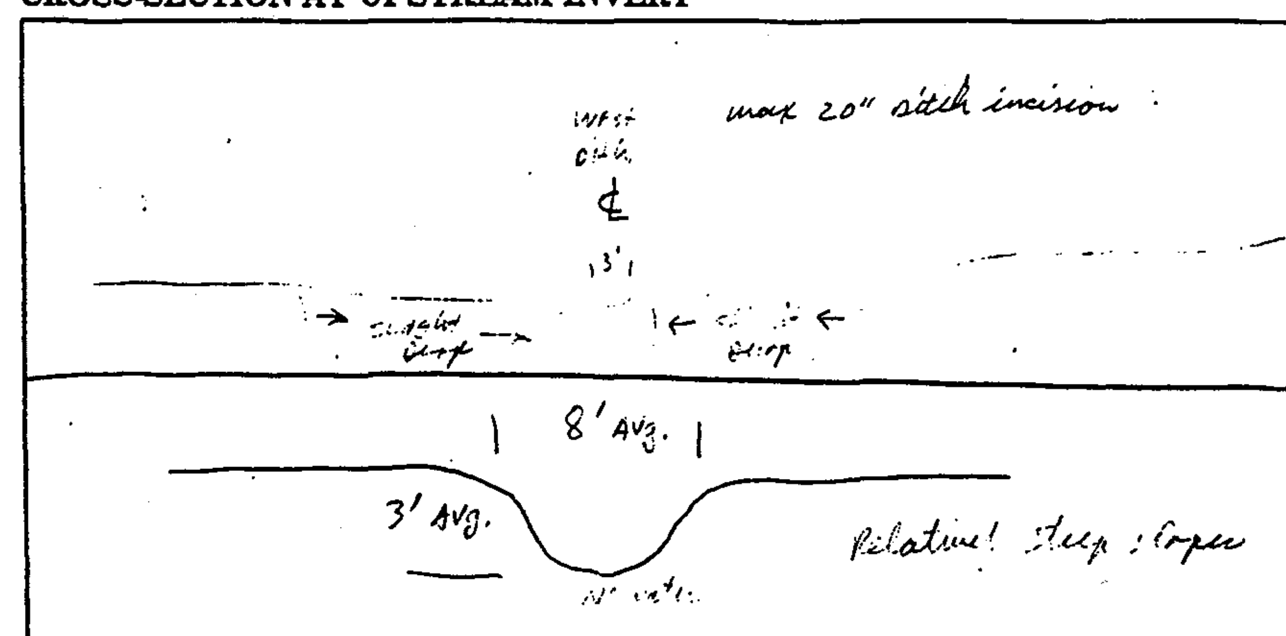
3135\FACT.SHT
191.16

(18)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



(19)

OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI/RAJ, JVS Weather: Sunny, calm, clear

Date: 3/27/91 Time: 1400

Location: 11th #19 (south crossing) USA Map Reference: ______

Type of Facility: ✓ Culvert ___ Pipe ___ Bridge ___ Other

Describe Other: w/wing wall at east end of 118th

Material: ___ CMP (Metal Pipe) ✓ Concrete ___ PVC ___ Other

Number and Size: 2 and 18" (Diameter, Inches)

If not circular, describe and provide key dimensions: ______

Invert Data[1]: 1.0' at grate on W. of 118th Upstream 30"N., 32" S. Downstream

Length: ______ Feet

Inlet Configuration: ___ Mitered ___ Bevelled ___ Flush

___ Projecting ___ Headwalls/Wingwalls ✓ Flat to storm grate

Evidence of Historic Water Depth[2]: ___ Headwater ___ Tailwater

Condition[3]: 3" on N. culvert, 1" of red on S. culvert. New facility (Late 1

Allowable Headwater: ___ At Roadway ___ Other

Bridge Data: ___ Width ___ Height[4]

COMMENTS[5]:

Reference point in center of Headwall.
Water depth on S. culvert is 3.5", W.D. is 1.0" is on N.
Culvert.

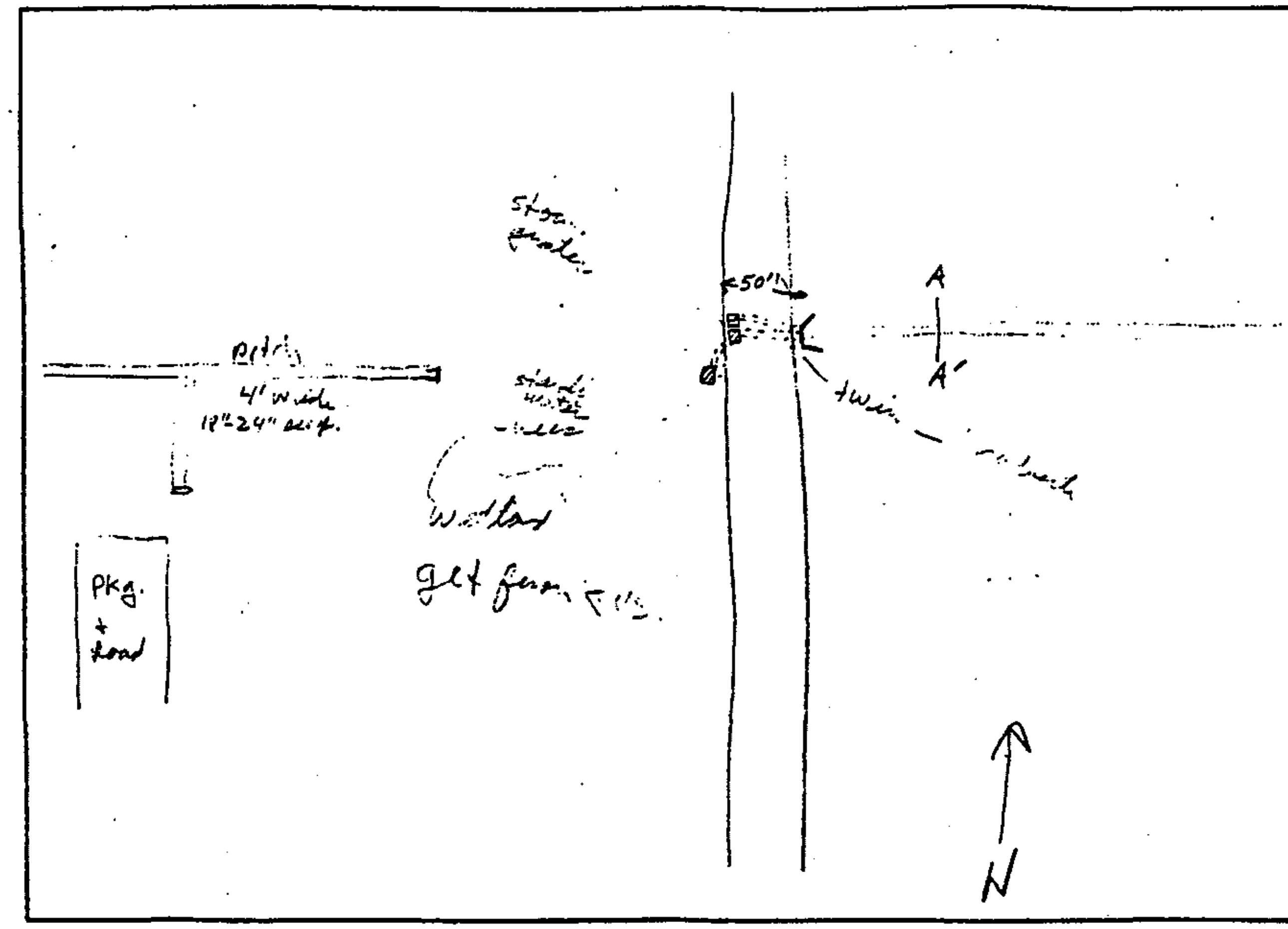
[1] Est. elevation below a reference point such as top of roadway at crossing.
[2] Est. Elevation from previous point used for invert data.
[3] Depth of silt (if present), age, structural condition.
[4] Distance from upstream invert to low chord of bridge.
[5] Describe special features unique to facility.

(SEE REVERSE SIDE)

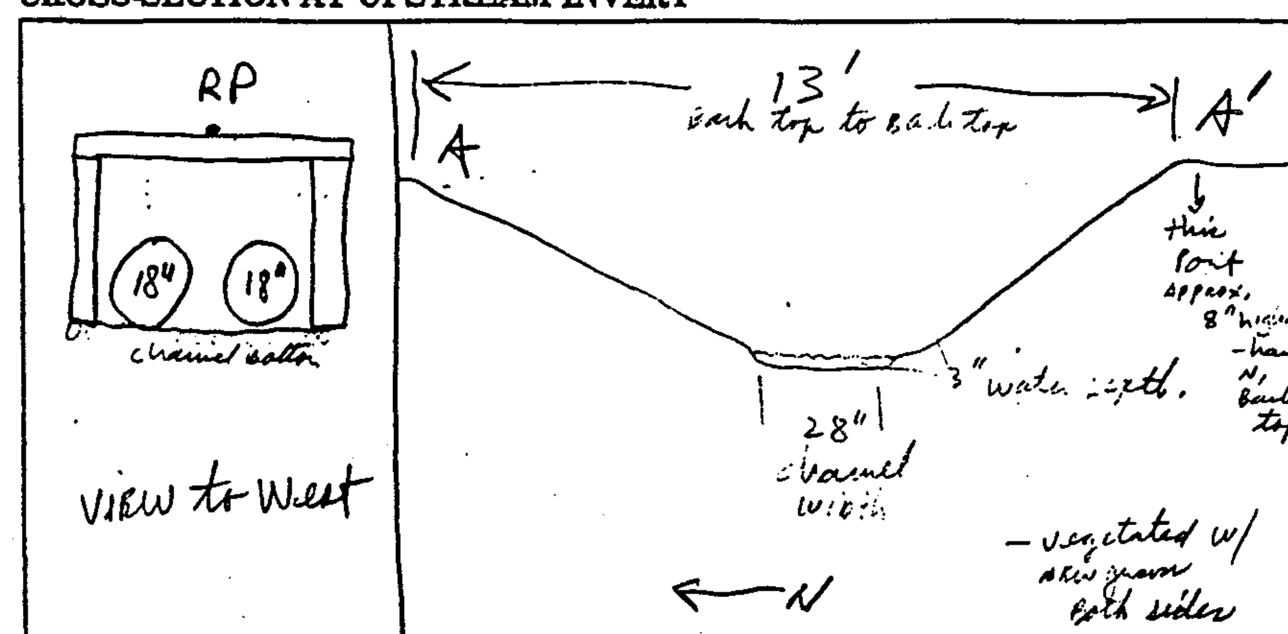
8135\FACT.SHT
191.15

19

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



(21)

OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: SRI / RAJ, JUS Weather: Sunny, dry

Date: 3/27/91 Time: 1525

Location: Just south of bend in Cipole Rd. N. of Sherwood Road. USA Map Reference: ____

Type of Facility: ✓ Culvert ____ Pipe ____ Bridge ____ Other

Describe Other: ____

Material: ____ CMP (Metal Pipe) ✓ Concrete ____ PVC ____ Other

Number and Size: ____ and 18" upstream - 12" downstream (Diameter, Inches)

If not circular, describe and provide key dimensions: ____

Invert Data[1]: 50" below RP Upstream Buried by excavated material but is about 60" Downstream

Length: ____ Feet

Inlet Configuration: ____ Mitered ____ Bevelled ✓ Flush

____ Projecting ____ Headwalls/Wingwalls

Evidence of Historic Water Depth[2]: obscured but max 2.5' Headwater obscured but barbs are ~2.5' ↓ Tailwater

Condition[3]: Inlet collection pool excavated this date by heavy equipment

Allowable Headwater: none At Roadway ____ Other

Bridge Data: ____ Width ____ Height[4]

COMMENTS[5]:

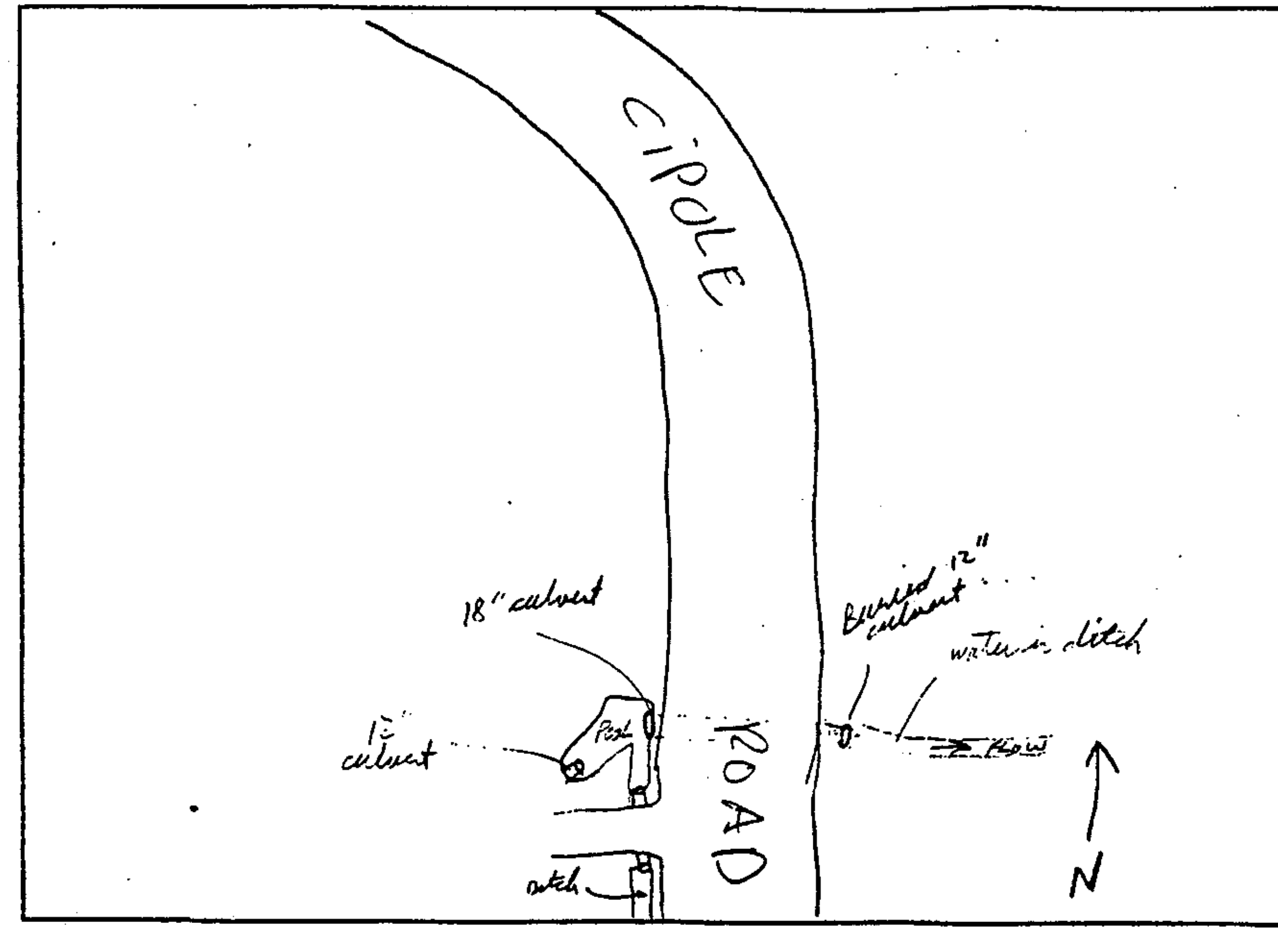
Reference point center of Cipole Rd. - Depth of water is 3" at upstream end, but is about 2" below level of invert. No flow from either 8" or 12" contributing culverts from S. and SW, respectively. However, flow was observed from outlet! This was a swollen culvert also. Outflow water was very cold - not from stagnant water.

[1] Est. elevation below a reference point such as top of roadway at crossing.
[2] Est. Elevation from previous point used for invert data.
[3] Depth of silt (if present), age, structural condition.
[4] Distance from upstream invert to low chord of bridge.
[5] Describe special features unique to facility.

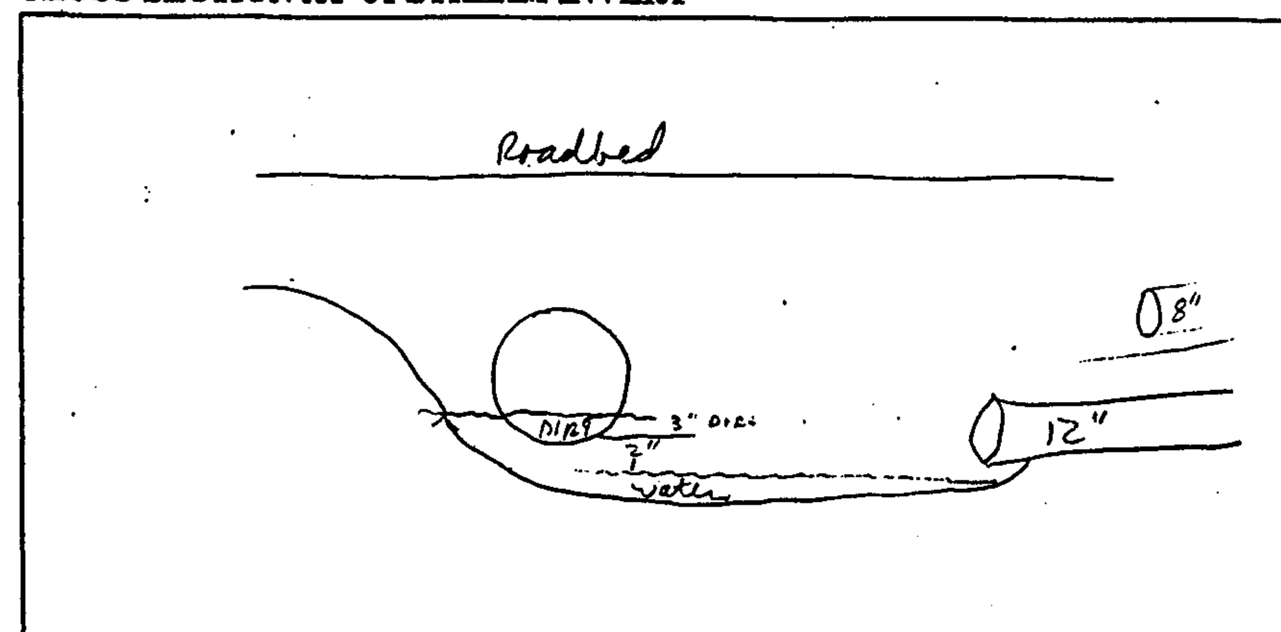
(SEE REVERSE SIDE)

3135\FACT.SHT
191.15

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: RWK Weather: Rain

Date: 6/20/91 Time: 1320

Location: Hedges Creek #22 N. of SW Coquille Ct. + SW 98th Ave. intersection USA Map Reference: ______

Type of Facility: ______ Culvert X Pipe ______ Bridge ______ Other

Describe Other: ______

Material: ______ CMP (Metal Pipe) X Concrete ______ PVC ______ Other

Number and Size: 1 and 24 (Diameter, Inches)

If not circular, describe and provide key dimensions: n/a

Invert Data[1]: 5' Upstream Not located Downstream

Length: n/a Feet Downstream outlet not located

Inlet Configuration: ______ Mitered ______ Bevelled ______ Flush

X Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2]: 4' Headwater not Located Tailwater

Condition[3]: Good working condition: although appears to be some sil- acumulation

Allowable Headwater: 3' At Roadway ______ Other

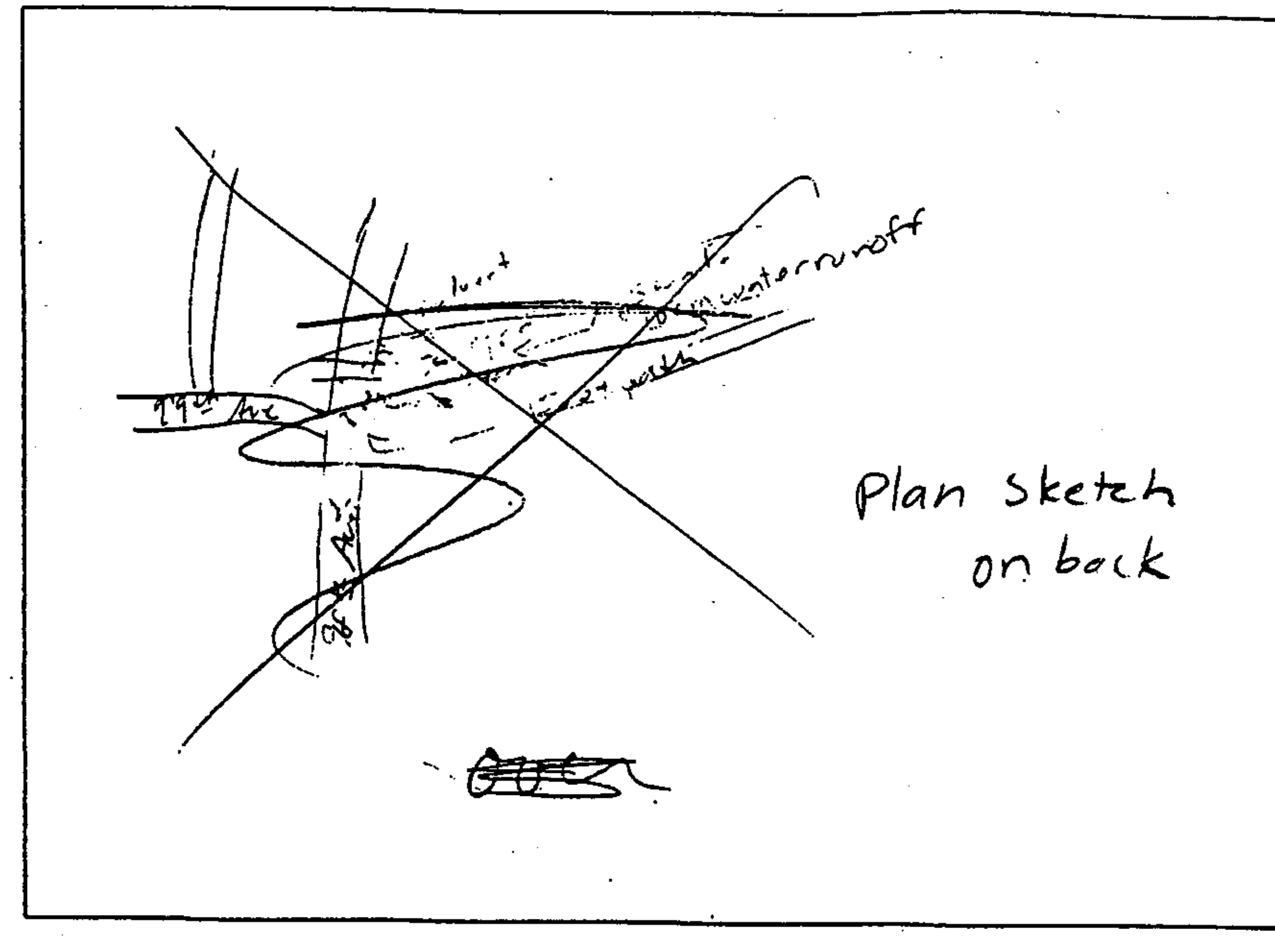
Bridge Data: N/A Width N/A Height[4]

COMMENTS[5]:
PRF potential is good; Site is already acting as a PRF in a limited fashion;. water does get backed up forming a small pool during rainstorm events; This site was evaluated during a rainstorm event. (Approx. 1" in last 24 hours). Som aquatic vegetation is already present in swale area.

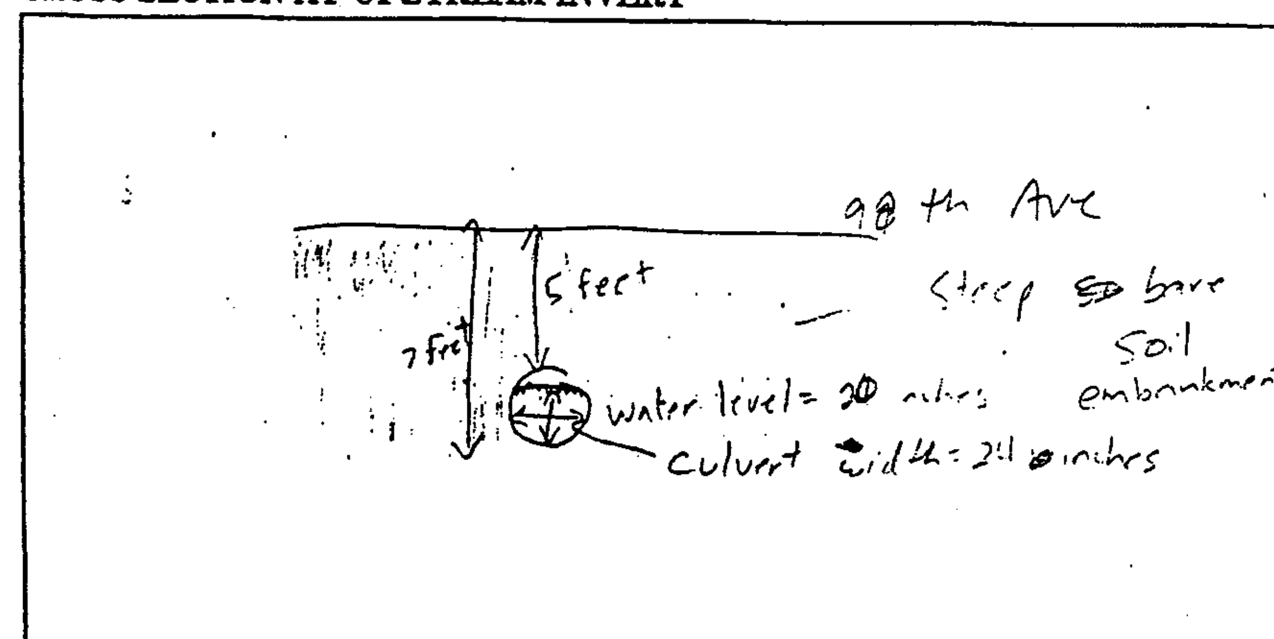
[1] Est. elevation below a reference point such as top of roadway at crossing.
[2] Est. Elevation from previous point used for invert data.
[3] Depth of silt (if present), age, structural condition.
[4] Distance from upstream invert to low chord of bridge.
[5] Describe special features unique to facility.

(SEE REVERSE SIDE)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: RWK Weather: Rain

Date: 6/20/91 Time: 1345

Location: Hedges Creek #23 USA Map Reference: ______

Type of Facility: X Culvert ______ Pipe ______ Bridge ______ Other

Describe Other: ______

Material: X CMP (Metal Pipe) ______ Concrete ______ PVC ______ Other

Number and Size: 1 and 46 (Diameter, Inches)

If not circular, describe and provide key dimensions: ______

Invert Data[1]: 8' Upstream 12' Downstream

Length: 150' Feet

Inlet Configuration: X Mitered ______ Bevelled ______ Flush

X Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2]: 2' Headwater 1' Tailwater

Condition[3]: Excellent working condition

Allowable Headwater: 6' At Roadway ______ Other

Bridge Data: n/a Width n/a Height[4]

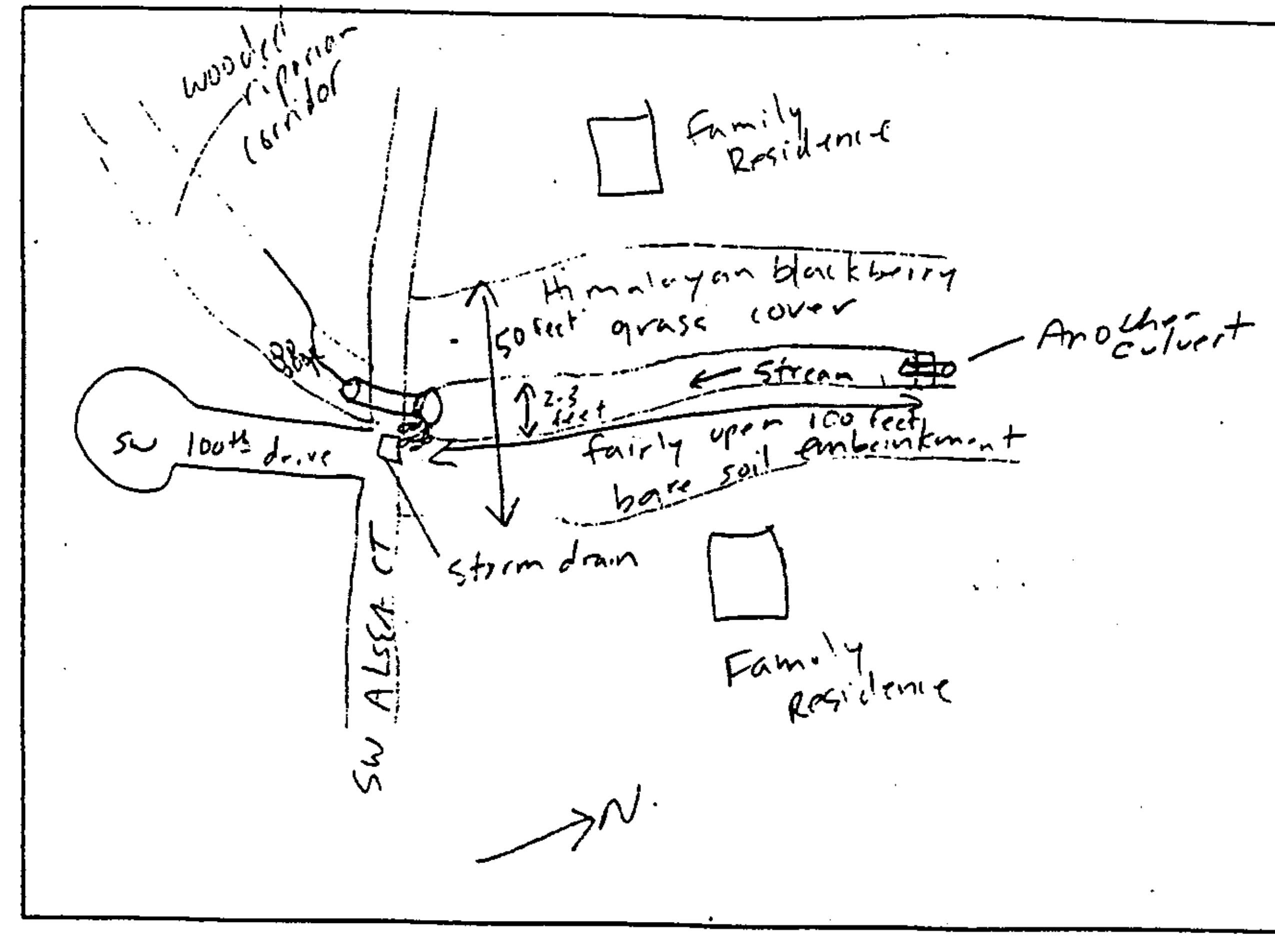
COMMENTS[5]:

Good PRF potential. This site has the capacity to hold significant water volume. The banks are steep-si and residences are located approximately 15 feet above stream channel.

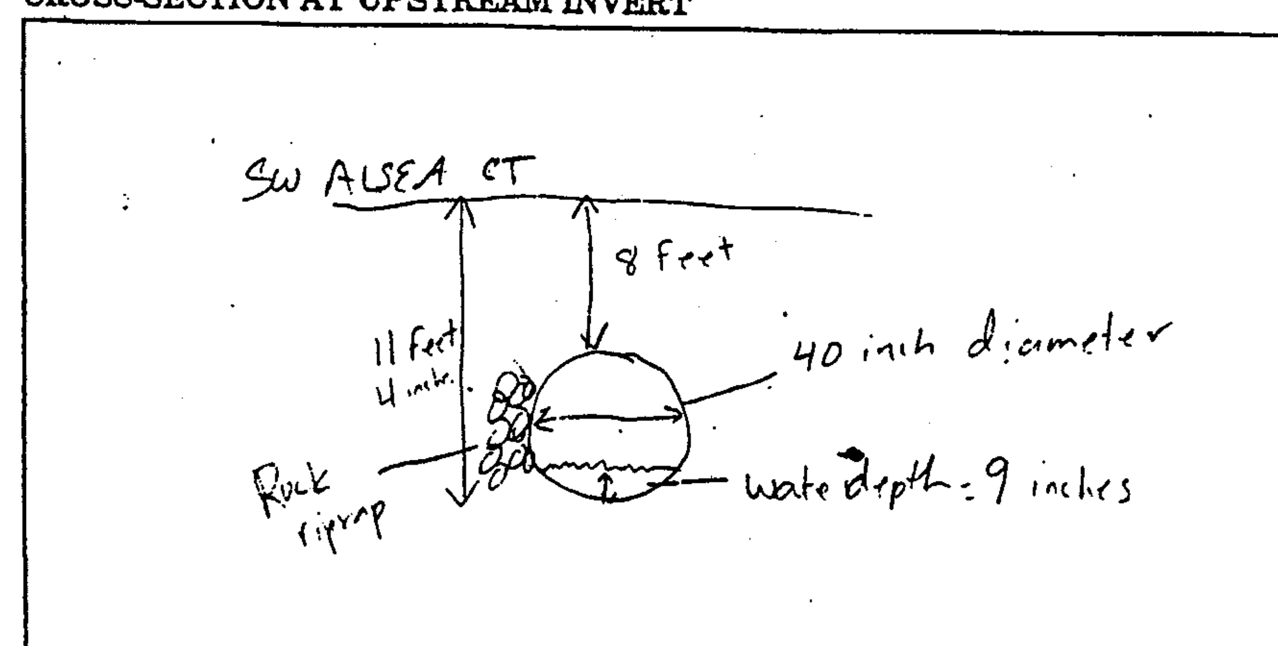
[1] Est. elevation below a reference point such as top of roadway at crossing.
[2] Est. Elevation from previous point used for invert data.
[3] Depth of silt (if present), age, structural condition.
[4] Distance from upstream invert to low chord of bridge.
[5] Describe special features unique to facility.

(SEE REVERSE SIDE)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: RWK Weather: Rain

Date: 6/20/91 South of SW Alsea Ct. Time: 1405

Location: Hedges Creek #24 USA Map Reference: ______

Type of Facility: ______ Culvert X Pipe ______ Bridge ______ Other

Describe Other: ______

Material: ______ CMP (Metal Pipe) X Concrete ______ PVC ______ Other

Number and Size: 2 and 48" + 13" (Diameter, Inches)

If not circular, describe and provide key dimensions: n/a

Invert Data[1]: 20" on large, 4 feet on small culvert. Upstream 24" for big culvert Downstream

Length: 30' (large culvert) Feet Outlet for small culvert could not be located.

Inlet Configuration: ______ Mitered ______ Bevelled ______ Flush

X Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2]: 1' Headwater 1' Tailwater

Condition[3]: Excellent working condition

Allowable Headwater: 2-3' At Roadway ______ Other

Bridge Data: n/a Width n/a Height[4]

COMMENTS[5]:
Excellent PRF opportunities. Two creeks come together at the culvert providing an opportunity to treat two drainages with one facility. Residential areas would no[t] be affected. However, some wildlife habitat would be impacted by PRF implementation. Significant amount o[f] erosion is occurring from the travel lane.

[1] Est. elevation below a reference point such as top of roadway at crossing.
[2] Est. Elevation from previous point used for invert data.
[3] Depth of silt (if present), age, structural condition.
[4] Distance from upstream invert to low chord of bridge.
[5] Describe special features unique to facility.

(SEE REVERSE SIDE)

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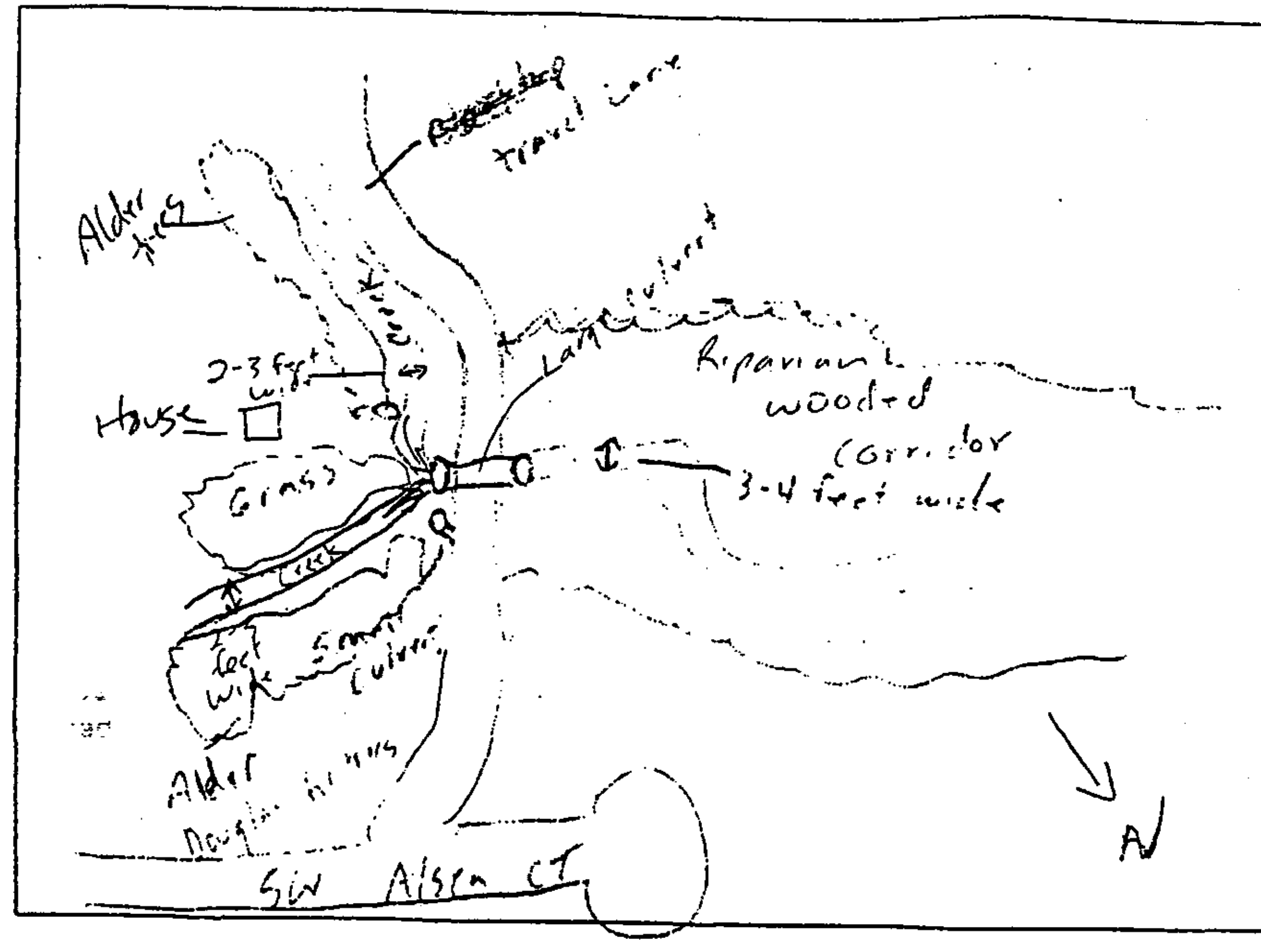
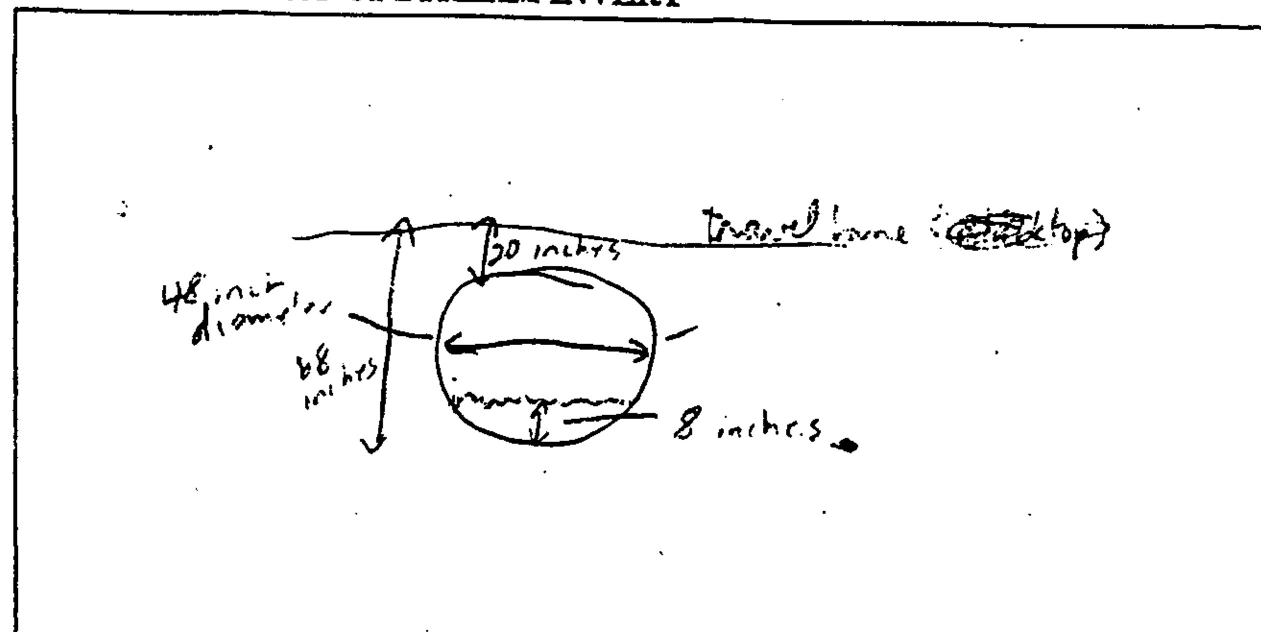
191.15

24

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



(25)

OTAK, INC.
EXISTING DRAINAGE FACILITY INVENTORY
FACT SHEET

Prepared By: RWK Weather: Rain

Date: 10/20/91 North of SW Hedges Drive & SW Ibach St. intersection Time: 1435

Location: Hedges Creek #25 USA Map Reference: ______

Type of Facility: ______ Culvert X Pipe ______ Bridge ______ Other

Describe Other: ______

Material: ______ CMP (Metal Pipe) X Concrete ______ PVC ______ Other

Number and Size: 2 and 40" & 34" (Diameter, Inches)

If not circular, describe and provide key dimensions: ______

Invert Data[1/]: 10' for 40" culvert, 15 feet for 34 inch culvert Upstream 15' Downstream

Length: 180' for 34" culvert Feet (other culvert not located)

Inlet Configuration: ______ Mitered ______ Bevelled ______ Flush

X- Both Projecting ______ Headwalls/Wingwalls

Evidence of Historic Water Depth[2/]: 1' Headwater 1' Tailwater

Condition[3/]: Excellent working condition

Allowable Headwater: 5-6' At Roadway ______ Other

Bridge Data: n/a Width n/a Height[4/]

COMMENTS[5/]:
Good PRF potential. However, PRF implementation will cause significant impacts to wildlife habitat. This riparian corridor is heavily vegetated with ~~Scattered~~ scattered large old-growth Douglas fir.

Significant amounts of sediment are entering the stream in this area from the new housing developments

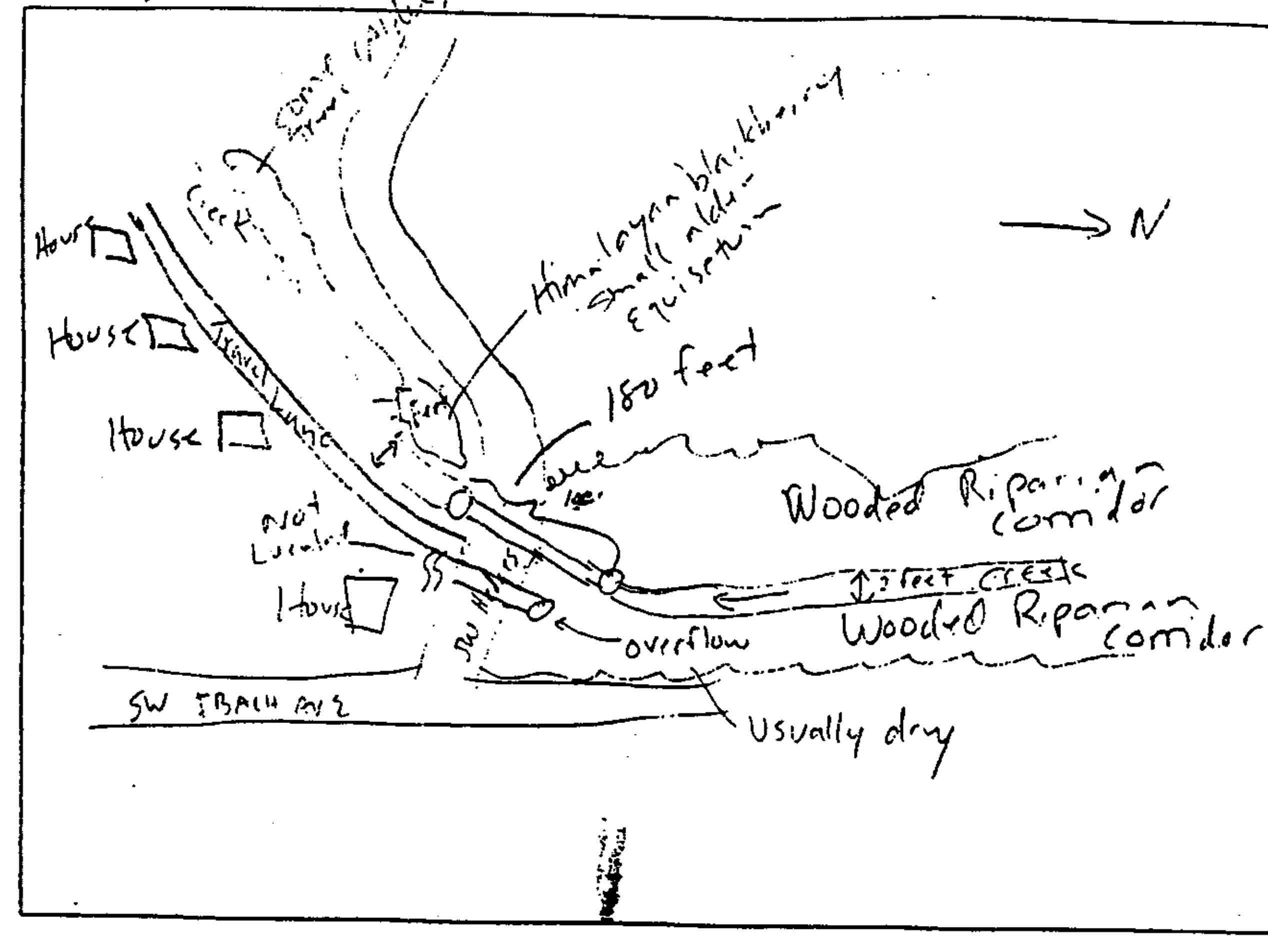
[1/] Est. elevation below a reference point such as top of roadway at crossing.
[2/] Est. Elevation from previous point used for invert data.
[3/] Depth of silt (if present), age, structural condition.
[4/] Distance from upstream invert to low chord of bridge.
[5/] Describe special features unique to facility.

(SEE REVERSE SIDE)

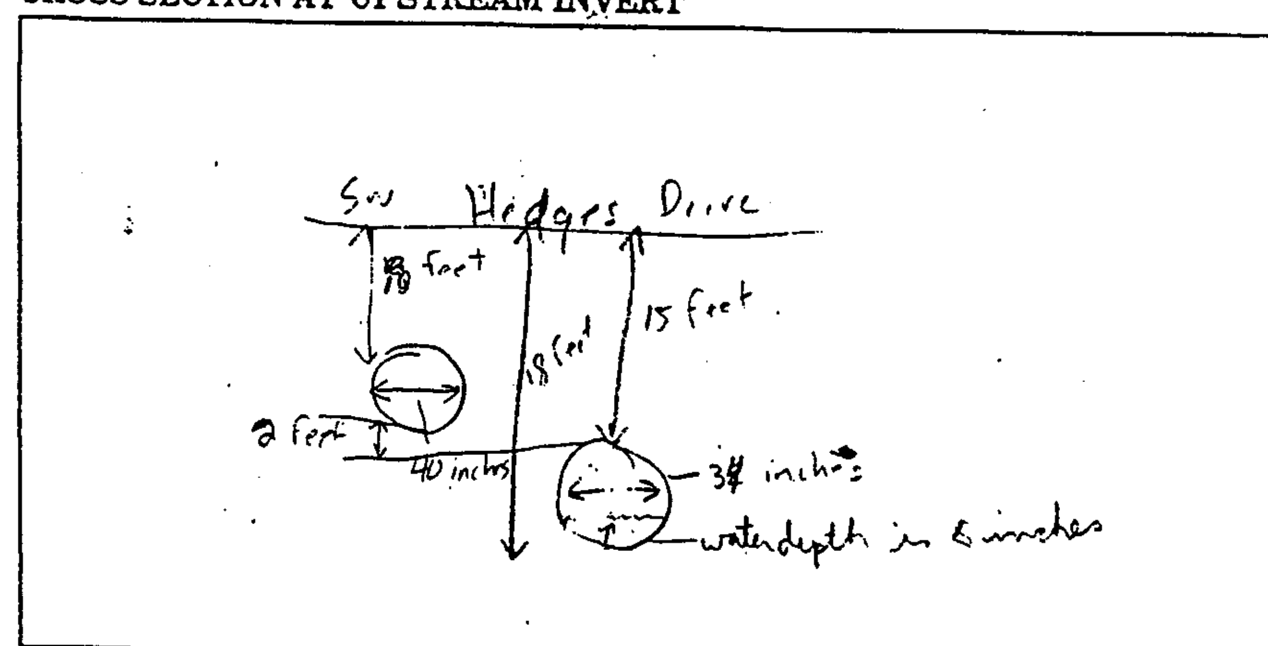
8135\FACT.SHT
191.16

(25)

PLAN VIEW SKETCH OF FACILITY (Include: North Arrow, Direction of Flow, Other Pertinent Data)



CROSS-SECTION AT UPSTREAM INVERT



UNIFIED SEWERAGE AGENCY OF WASHINGTON COUNTY

MEMORANDUM

Subject: Clarifications to Final Technical Memorandum on Hedges Creek Marsh Hydraulic Evaluation

Prepared By: Lori Faha, USA
Mike McKillip, City of Tualatin

Date: September 20, 1995

This memorandum provides clarifications to terminology and recommendations made in the "Final Technical Memorandum, Hedges Creek Marsh Hydraulic Evaluation" (Montgomery Watson, February 24, 1995). The clarifications are based on comments made at the September 11, 1995 Tualatin City Council Public Hearing regarding the Hedges Creek Subbasin Plan.

1. Option 2 on Figure 7 of the Montgomery Watson Technical Memorandum is the recommended plan. The new channel to be constructed east of Teton Avenue, and noted on Figure 7 as "Option 2 - Construct New North Channel Minimum Design Flow 250 cfs", will be re-titled the "New Channel" and will be designed for a design flow of 200 cfs. (200 cfs is the correct design flow, as indicated in paragraph (5) on page 16 of the Technical Memorandum; the 250 cfs indicated on Figure 7 is a typographical error.)

The project to construct the New Channel will also include construction of a diversion weir at the upstream end of Pascuzzi Pond to maintain low flows into the Pond/ South Channel and divert high flows up to 150 cfs to the New Channel. Also, the high flow channel between the diversion weir and Teton Avenue will be improved as necessary to convey the 150 cfs to the New Channel. (The New Channel capacity east of Teton Avenue of 200 cfs includes conveyance of flows from the existing storm sewer located in Teton Avenue, in addition to the 150 cfs from west of Teton.)

2. The segment of the North Channel shown on Figure 7 running to the northeast from Teton Avenue is filled and will be abandoned to the point where the new 48-inch culvert crossing from Herman Road will empty into the North Channel.

3. The project involving construction of the new 48-inch culvert crossing from Herman Road to the North Channel also includes improving and maintaining the North Channel downstream to Sweek Pond and Tualatin Road to convey design flows. The project will

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FAX: 503/640-3525

include consideration of alternative alignments for the North Channel in the vicinity of Durametal. The project may also include alterations to the existing Sweek Pond outlet structure as necessary to accommodate design flows.

4. Replacement of the Teton Avenue culverts at the South Channel also includes improvement of the channel upstream and downstream as necessary to convey design flows and minimize velocities and erosion.

MONTGOMERY WATSON

FINAL
TECHNICAL MEMORANDUM

Subject: Hedges Creek Marsh Hydraulic Evaluation

Prepared By: Mort McMillen

Reviewed By: Dennis Dorratcague
Bob Jossis

Project Name: Unified Sewerage Agency
Hedges Creek Subbasin Strategies Planning

Project No: 892.0020

Date: February 24, 1995

INTRODUCTION

Study Objective

In 1990, the Unified Sewerage Agency (USA) began subbasin planning work and in 1992, completed subbasin plans for two prototype subbasins; Hedges Creek and Butternut Creek. The Hedges Creek basin was selected to identify water quality issues and outline management practices developed to address these issues. The Butternut Creek basin was selected because of the drainage issues within the basin. Since the Hedges Creek Subbasin Strategies Plan was completed, USA became aware of local drainage issues in the marsh area. These drainage issues were amplified during the February 24, 1994 storm.

On April 19, 1994, USA hosted a public meeting at the City of Tualatin Council Chambers. The primary purpose of the meeting was to share information and identify problems associated with the Hedges Creek Marsh. Specific objectives and issues identified by the meeting attendees included:

- Protect property from flooding;
- Maintain natural vegetation;
- Maintain the value of the wetlands;
- Address erosion and siltation problems;
- Maintain water quality control options as outlined in the subbasin plan;
- Identify operation and maintenance issues;

- Develop a monitoring plan for assessing the marsh health on a routine basis;
- Develop a supplement which adds to the subbasin plan to create a comprehensive plan which works with the existing wetlands management plan;
- Provide for long term flood management.

The objective of this project is to identify the drainage issues in the marsh area and develop alternatives to address these issues. The recommended alternative should provide effective drainage management while also maintaining the wildlife benefits of the marsh and enhancing water quality.

Scope of Services

The scope of the Hedges Creek Subbasin hydraulic evaluation consisted of the following workplan:

- Develop a visual assessment program which can be used to assess the health of the Hedges Creek Marsh. The purpose of the assessment program is to allow USA to periodically inspect the Hedges Creek Marsh and track the conditions of the marsh with a standard assessment form.
- Assist USA and the City of Tualatin in updating the existing facilities inventory.
- Perform a hydraulic evaluation of the Hedges Creek Marsh. A HEC-2 model was developed based on the existing model developed by Robert E. Meyer Consultants. Specific features of the evaluation include:

  (1) Storm water runoff inputs to the HEC-2 model were based on the HEC-1 model developed as part of subbasin strategies planning completed in 1992.

  (2) Five flow conditions were evaluated for both the present and future land use conditions: low flow (10 cfs), 5-year, 10-year, 25-year, and 100-year storm events.

  (3) The Tualatin River floodplain elevations from the 1987 FEMA Flood Insurance Study were used as starting water surfaces for the hydraulic analysis to determine the impact of the floodplain on the water surface within the Hedges Creek Marsh.

  (4) An estimate of the Hedges Creek backwater profiles without the Tualatin River floodplain influence was also prepared.

- Assist USA in the preparation of meeting materials for one agency meeting and two stakeholder meetings.
- Attend one agency meeting and two stakeholder meetings.
- Prepare a draft technical memorandum outlining the results of the hydraulic evaluation for USA's and the City of Tualatin review.
- Incorporate comments and prepare a final technical memorandum.

- Assist USA in updating the existing Hedges Creek Subbasin Strategy Plan maps.
- Provide USA with one marked up copy of the existing Hedges Creek Subbasin Strategies Plan outlining recommended modifications to the plan.

BACKGROUND

Subbasin Description

The Hedges Creek subbasin consists of 2856 acres of urban and undeveloped land located within Washington County and is contained almost entirely within the City of Tualatin city limits. The subbasin lies in a relatively shallow valley bounded by low hills on the north, south, and west. The subbasin is primarily flat from its outlet at Tualatin Road west to Cipole Road. South of the Tualatin-Sherwood Highway, forested foothills rise to 250-300 feet in elevation. The area north of Herman Road consists of flat or gently rolling hills. Existing development consists primarily of single-family residential concentrated in the south hills and light manufacturing in the lower reaches of the subbasin and north of Herman Road.

Natural, open channels with culverts at roadway crossings serve as the major drainage ways within the subbasin. Curb and gutter storm drain systems are generally found in residential areas. These systems feed directly into the open channel conveyance system which in turn flows into the Hedges Creek Marsh.

Hedges Creek Marsh

The Hedges Creek Marsh is that area located within the City of Tualatin Wetland Protection District. Hedges Creek splits into a north and south channel at the west end of the marsh. The north channel extends along the north side of the Wetlands Protection District from the diversion point upstream of Pascuzzi Ponds east to Teton Avenue. A 72-inch diameter culvert extends under Teton Avenue. The north channel then turns northeast before continuing east to a discharge point at Sweek Pond. The north channel was recently filled in a section of the channel located on private property on the east side of Teton Road and replaced with an 18-inch diameter culvert.

The south channel is located within the Wetlands Protection District and flows west to east from Pascuzzi Ponds to Tualatin Road. Two 24-inch diameter culverts carry flow under Teton Avenue. Both channels merge just west of Tualatin Road and flow is carried under Tualatin Road through a 72-inch diameter culvert. An open channel carries flow from Tualatin Road approximately 1700 feet to the Tualatin River.

Related Sources

The following sources were used in the development of this technical memorandum:

- "Hydraulic Analysis for Hedges Creek Wetlands Protection District Drainage Plan," prepared for the City of Tualatin by Robert E. Meyer Consultants, Inc., 1989.
- "Tualatin Drainage Plan," prepared for the City of Tualatin by R.A. Wright Engineering, 1972.
- The Wetlands Conservancy, "Management Plan for Hedges Creek Marsh, Tualatin, Oregon," May, 1983.

- "Zian Inc. Property Wetland Protection Area Resource Management Plan, Hedges Creek, Tualatin, Oregon," prepared for Zian Inc. by Fishman Environmental Services, August 1993.

- "Unified Sewerage Agency Surface Water Management Strategies, Hedges Creek Subbasin," prepared for the Unified Sewerage Agency by Brown and Caldwell Consultants, October 1992.

HYDROLOGIC/HYDRAULIC MODELING

HEC-1 Hydrologic Model

USA completed the initial Hedges Creek Subbasin Strategies planning work in October of 1992. A hydrologic analysis was completed as part of this planning work. A HEC-1 hydrologic model was developed by Brown and Caldwell Consultants (BCC) to aid in determining where constrictions in the conveyance system would occur at projected buildout conditions. The model was also used to evaluate potential detention sites and the effectiveness of providing in-stream storage.

The BCC HEC-1 model was used to generate runoff inputs for the backwater analysis. A detailed discussion of the HEC-1 model and hydrologic analysis of the Hedges Creek subbasin is presented in the Hedges Creek Subbasin Strategies Report and will not be repeated here.

HEC-2 Hydraulic Model

A HEC-2 backwater model was developed by Robert E. Meyer Consultants for the Hedges Creek Marsh area. This model extended from Tualatin Road to approximately Teton Avenue. As part of this study, this HEC-2 model was modified to include additional cross-sections and increase the model reach (see Figure 1). The modified model extends from Tualatin Road to the east end of the Hedges Creek Marsh. Cross-section 1 is located just upstream from the point where the north and south channels split.

Cross-sections were taken from aerial topographic mapping provided by the City of Tualatin. The aerial mapping was completed in 1988. Each cross-section was modified to allow for future development by allowing a 40 foot buffer measured from the Wetland Protection Area Boundary. Areas outside the Wetland Protection Area were assumed to be filled to a minimum of 1 foot above the 100-year flood plain. Specific assumptions included in the HEC-2 model development included:

- The north channel was not included in the HEC-2 model. Flow was added and removed from the HEC-2 model at the appropriate cross-sections to reflect flow diversions to the north channel. An estimate of the flow capacity of the north channel was made based on the existing channel features and conditions. Using this approach, a maximum capacity of 150 cfs was assumed for purposes of the evaluation. Improving the channel cross-section and removing accumulated debris and sediment may increase the channel capacity. Additional survey data would be required to make this determination.

- Storm runoff flows were input to the HEC-2 model based on the BCC HEC-1 model results. A summary of the HEC-2 model flow inputs is presented in Table

1. Under existing conditions, there is no storm drain between the north side of Herman Road between Tualatin Road and Teton Avenue and the north channel of Hedges Creek. As a result, storm runoff ponds in this area. This flow condition is reflected in Table 1.

- Mannings roughness values of 0.04 and 0.1 were assumed for the main channel and overbank areas, respectively. At most cross-sections, the water surface profile was not sensitive to changes in roughness values because of low velocities.

- The water surface profiles between cross-sections 7 and 12 were extremely sensitive to Mannings roughness value assumptions at higher flow assumptions. This is due to the reduced channel flow area and resultant high velocities. The flow conditions within this channel reach would be expected to be highly variable depending on vegetation growth within the channel.

- Storm water runoff inputs from north of Herman Road were assumed to be routed to the north channel for all alternatives.

- Storm water runoff inputs from drainage area south of the Hedges Creek Marsh were added at cross-sections 21 and 4.

ALTERNATIVES DEVELOPMENT

On April 19, 1994, USA hosted a meeting to which landowners in and around the Hedges Creek Marsh were invited. The purpose of the meeting was to discuss the key issues associated with the marsh management. The input from this meeting was used by USA and Montgomery Watson to develop alternatives for addressing drainage issues in the marsh. Several alternatives were developed and evaluated for the marsh area. These alternatives consist of an evaluation of existing conditions at current and future levels of development, onsite detention, and flow splitting between the existing south and north channels of Hedges Creek.

It became evident early in the study that the available alternatives would consist of various combinations of onsite detention and flow splitting between the existing south and north channels. Little opportunity was available for regional detention sites or diversion of flows around the marsh. As a result, the alternatives evaluated were:

- Existing Conditions (existing and future levels of development)

- Alternative 1 - Onsite Detention with Minimum North Channel

- Alternative 2 - No Detention and Minimum North Channel

- Alternative 3 - Onsite Detention with Full North Channel

- Alternative 4 - No Detention with Full North Channel

Minimum north channel assumes that only local drainage and flow from north of Herman Road will be routed to the north channel. Full north channel assumes that the maximum diversion (150 cfs) is made to the north channel at the west end of the Pascuzzi Ponds.

As discussed previously, storm runoff flows were estimated with the HEC-1 hydrologic model developed as part of the original subbasin planning work. The Tualatin Basin flood water surface elevations were used as the starting water surfaces for the HEC-2 model. The Tualatin River flood elevations were taken from the 1987 revised Federal Emergency Management Agency (FEMA) flood profiles for the Tualatin River. Elevations were determined from the profiles at the Tualatin River confluence with Hedges Creek at the Tualatin River mile 8.6. The water surface in Hedges Marsh east of Teton Avenue is controlled by the Tualatin River flood elevations for all flood events.

Several assumptions were made which were common among the alternatives. These assumptions included:

- A new culvert will be required under Tualatin Road to increase the capacity. Since this area is impacted by the Tualatin River floodplain, a 100-year recurrence interval was selected as the design storm event. A low flow control structure will be required to maintain ponding in the marsh;

- The culverts under Teton Avenue at the south channel were assumed to replaced for all alternatives analyzed. The culverts were assumed to be designed to provide a maximum headwater of 1 foot over the pipe crown. This design criteria was used to minimize headloss across the culvert. A 25-year design storm event was used for sizing culverts at Teton Avenue;

- Drainage from the area north of Herman Road will be collected and routed to the north channel through a culvert under the railroad. Flows from the existing storm sewer in Teton Avenue will also continue to flow into the north channel;

- All recommended storm drainage improvements (except Tualatin Road would be designed to pass the 25-year storm event.

A description of each alternative is presented in the following paragraphs followed by an alternatives evaluation in the subsequent section. Figures 2 through 6 show the specific features of each alternative.

Existing Conditions

The existing flow pattern for the studied portion of the marsh is primarily through the south channel which extends through the marsh itself (see Figure 2). Historically, the north channel skirted the northern edge of the marsh upstream from Teton Avenue, crossed under Teton Avenue in a culvert, then extended across private property to eventually discharge at Sweek Pond. Prior to the February 24, 1994 storm event, the north channel had been filled just downstream from Teton Avenue and replaced with a small 18-inch diameter culvert forcing most of the flow to the south channel. Two 24-inch diameter culverts provide a crossing for the south channel under Teton Avenue. These culverts were designed to pass only local drainage. The southernmost culvert was inspected and found to be slightly restricted with the vertical clearance reduced to approximately 15 inches. This restriction did not reduce the culvert capacity significantly. The north channel was originally intended to handle larger storm events with approximately a 72-inch diameter culvert under Teton Road. The north channel culvert was installed with a flow line elevation to correspond to the 1972 Tualatin Drainage Master Plan which assumed the north channel would be excavated to a lower elevation to accommodate design flows. Due to this constructed elevation and siltation, the effective open depth is only 48 inches. With the north channel constricted to an 18-inch diameter culvert, the culvert capacity in the south channel was exceeded causing flooding over Teton Avenue during the February 24, 1994 storm.

As shown on the attached profile plots, the water surface in the marsh between Teton Avenue and Tualatin Road is controlled by the backwater from the Tualatin River. During smaller storm events on the Tualatin River (5-year, 10-year), the backwater is limited to the lower 700 feet of the marsh (measured from Tualatin Road upstream). The 100-year event backs water slightly beyond Teton Avenue.

The February 1994 flood was estimated to be approximately a 25-year storm event. The HEC-2 model confirmed the water surface measured at Teton Avenue during the February 24, 1994 storm. It was also found that if the north channel had been open, Teton Avenue would not have overtopped causing flooding.

The area north of Herman Road between Teton Avenue and Tualatin Road currently has no storm drainage outlet to the north channel of Hedges Creek. As a result, storm runoff ponds on the north side of Herman Road and the railroad grade. This flow condition is reflected in Table 1 when comparing the flows for the existing conditions and Alternative 1 which assumes a new culvert under Herman Road and the railroad grade.

Existing Conditions - Future Flows

The existing storm drainage system within the Hedges Creek Marsh was evaluated assuming future land use conditions within the Hedges Creek Basin. With this analysis, the existing storm drainage system components described for the existing conditions were assumed with no improvements. Analysis of the existing conditions at future flows allows those drainage facilities which are undersized to be identified. The alternatives described below were then developed to address existing and predicted future flooding conditions.

From this analysis, it was determined that the culvert at Tualatin Road is undersized to convey the 100-year storm event. The 100-year event was selected as the design storm event since this drainage facility is located within the Tualatin River 100-year floodplain. The culverts under Teton Avenue were found to be have inadequate capacity to convey the 25-year storm event in their current configuration, as discussed in the previous section. The drainage system throughout the Hedges Creek basin was evaluated by Brown and Caldwell as part of the subbasin strategies planning. The estimated capacities are presented within the Hedges Creek Subbasin Strategies Plan and will not be repeated within this technical memorandum.

Alternative 1 - Onsite Detention with Minimum North Channel

The first alternative consisted of routing creek flows for all storm events through the south channel of marsh and onsite detention for all new development upstream of the marsh (see Figure 3). Specific assumptions included:

- The north channel will convey only local flows and those from north of Herman Road and east of Teton Avenue. This approach will require re-establishing the north channel east of Teton Avenue to convey flows that are piped down Teton Avenue (see Figure 3);

- New culverts will be installed in the south channel under Teton Avenue to pass the 25-year storm event which has an estimated peak flow of 184 cfs;

- Onsite detention is assumed as a requirement for future development upstream of the Hedges Creek Marsh. The design of the detention facilities will require the release rate to be restricted to the predevelopment flows up to and including the 25-year storm event;

- A new arch culvert would be installed under Tualatin Road to pass the 100-year storm event which has an estimated peak flow of 902 cfs.

This alternative was developed to evaluate the impact of onsite detention on storm runoff peak discharges entering the marsh as well as the hydraulic conditions within the south channel with no main stem creek flows entering the north channel.

Alternative 2 - No Detention and Minimum North Channel

The second alternative consisted of routing all storm runoff through the south channel. Specific assumptions included:

- The north channel will only convey local flows and those from north of Herman Road and east of Teton Avenue. This approach will require re-establishing the north channel east of Teton Avenue to convey flows that are piped down Teton Avenue (see Figure 4);
- New culverts will be installed in the south channel under Teton Avenue to pass the 25-year storm event with an estimated peak discharge of 561 cfs;
- No onsite detention will be required upstream of the Hedges Creek Marsh;
- A new arch culvert will be installed under Tualatin Road to pass the 100-year storm event which has an estimated peak discharge of 902 cfs.

This alternative was developed to evaluate the impact of routing all creek flows through the south channel of the marsh. Channel velocities and flow depths will provide an indication of the potential damage which would occur within the marsh.

Alternative 3 - Onsite Detention with the Full North Channel

Alternative 3 consists of providing onsite detention upstream of the marsh and diverting up to 150 cfs into the north channel (see Figure 5). Specific assumptions include:

- A diversion structure will be installed at the upper end of the Pascuzzi Ponds to split flow between the north and south channel. Up to 150 cfs of the 25-year storm event peak discharge of 265 cfs will be diverted to the north channel with the remaining 115 cfs flow routed through the south channel;
- The north channel between Pascuzzi Ponds and Sweek Pond will be improved as needed and maintained to convey the 150 cfs flow plus local drainage inputs (see Figure 5). An overflow will be installed at Sweek Pond to pass high flows around Sweek Pond;
- The 72-inch culvert in the north channel at Teton Avenue will be cleaned to remove debris and sediment as well as cleaning of the north channel downstream of Teton Avenue to provide a minimum design flow of 200 cfs;
- New culverts will be installed in the south channel under Teton Avenue to pass up to 115 cfs of the 25-year storm event;

- Onsite detention was assumed for future development upstream of the Hedges Creek Marsh up to and including the 25 year storm event. The design of the detention facilities would require the release rate to be restricted to the predevelopment flows;

- A new arch culvert would be installed under Tualatin Road to pass the 100-year storm event with a peak discharge of 902 cfs.

A second option for routing the north channel was also evaluated. As shown on Figure 5, a new north channel could be routed directly east from the existing 72-inch diameter culvert under Teton Avenue approximately 1300 feet to the south channel. The existing north channel would be maintained from approximately 1200 feet east of Teton Avenue to Sweek Pond to convey local drainage and drainage from north of Herman Road to Sweek Pond. This option would reduce the flow directed to the north channel allowing a smaller channel to be maintained. The new north channel could be designed as a vegetated swale to provide water quality treatment benefits.

Alternative 4 - No Detention with the Full North Channel

Alternative 4 is similar to Alternative 3 except that no onsite detention is provided upstream from the marsh. Specific assumptions include (see Figure 6):

- A diversion structure will be installed at the upper end of the Pascuzzi Ponds to split flow between the north and south channel. Up to 150 cfs will be diverted to the north channel with the remaining flow of 411 cfs of the 25-year storm event routed through the south channel;

- The north channel between Pascuzzi Ponds and Sweek Pond will be improved as needed and maintained to convey the 150 cfs flow plus local drainage inputs (see Figure 6). An overflow will be installed at Sweek Pond to pass high flows around Sweek Pond;

- The 72-inch diameter culvert in the north channel will be cleaned to remove debris and sediment as well as cleaning of the north channel to provide a minimum design flow of 200 cfs as shown on Figure 6;

- New culverts will be installed in the south channel under Teton Avenue to pass up to 411 cfs (25-year storm event);

- A new arch culvert would be installed under Tualatin Road to pass the 100-year storm event with a peak discharge of 902 cfs.

A second option for routing the north channel was also evaluated. As shown on Figure 6, a new north channel could be routed directly east from the existing 72-inch diameter culvert under Teton Avenue approximately 1300 feet to the south channel. The existing north channel would be maintained from approximately 1200 feet east of Teton Avenue to Sweek Pond to convey local drainage and drainage from north of Herman Road to Sweek Pond. This option would reduce the flow directed to the north channel allowing a smaller channel to be maintained. The new north channel could be designed as a vegetated swale to provide water quality treatment benefits.

ALTERNATIVES EVALUATION

Observations of Evaluation

As discussed in the previous section, water surface profiles and channel velocities were estimated for the existing conditions and four alternatives for managing water quantity within the Hedges Creek Marsh. Tables 3 through 10 present a summary of the water surface elevations and channel velocities for the low flow condition (10 cfs), 5-, 10-, 25-, and 100-year storm events for each alternative. Water surface profile plots are also attached for each of the alternatives.

Observations which can be made from the evaluation include the following:

- The water surface profiles in the marsh downstream from Teton Avenue (cross-sections 24 through 8) are controlled by the backwater from the Tualatin River. The backwater that occurs at smaller storm events (5-year, 10-year) are limited to the lower 700 feet of the marsh. The 100-year event backs water up slightly upstream of Teton Avenue (cross-section 8).

- Releasing the peak flows from the Hedges Creek basin prior to the Tualatin Basin flood peaks reaching the confluence of Hedges Creek and the Tualatin River will be required to minimize the head drop across the culverts under Tualatin Road. A new arch culvert will be required for all alternatives to pass the peak 100-year Hedges Creek storm event discharge of 902 cfs assuming minimal head drop across the culvert. The 100-year design event was selected to reduce ponding behind the Tualatin Road which would increase the extent of the 100-year floodplain upstream of Tualatin Road.

- Sizing the culverts under Tualatin Road (cross-section 24) for minimal headloss will result in lower water surface profiles in the marsh through the full range of storm flows. This may, however, require a low flow control structure near the outlet to maintain a minimum water surface in the marsh during low flows.

- Onsite detention reduces the peak discharge entering the marsh with a subsequent reduction in the required culvert sizes at Teton Avenue to pass the peak flows. The estimate of the effectiveness of onsite detention is based on assumptions used in preparing the 1992 Subbasin Strategies Plan for the Hedges Creek Basin. The hydrologic analysis completed as part of the plan development used 1989 topographic and land use information which may have changed significantly in past years. As a result, the effectiveness of onsite detention may not be as significant as estimated.

- The velocities in the marsh between cross-sections 24 and 12 are generally less than 2 fps over the full range of storm events. At these velocities, the potential for channel erosion is minimal.

- A constriction in the channel occurs between cross-sections 12 and 7 resulting in high velocities (greater than 4 fps). The constriction appears to be caused by a narrow channel with minimal overbank area. High velocities will cause erosion within the channel with subsequent sedimentation in lower velocity areas downstream. Erosion also leads to damage of the riparian areas reducing the filtration capabilities of the riparian corridor. The end result is water quality degradation from sedimentation and reduction of the riparian areas.

- The constriction between cross-sections 12 and 7 produces unstable flow conditions which are highly dependent on the degree of vegetation, the channel condition, and amount of flow. This is reflected in the computed velocities which vary considerably between the alternatives and assumed flows. Small adjustments in the assumed Mannings roughness values have a significant impact on the water surface profile and computed velocities within this channel reach. As a result, it is important to maintain as much open area within this channel reach as possible.

- The south channel culverts under Teton Avenue were originally sized to pass local drainage under Teton Avenue with the north channel designated to pass larger storm events. The south channel system was not sized to carry the full Hedges Creek Basin flows.

- The existing north channel will have to be maintained from a point approximately 1300 feet east of Teton Avenue to Sweek Pond to convey local drainage and drainage from north of Herman Road.

- The south channel immediately upstream from Teton Avenue (approximately 100 feet) experiences extremely high velocities at larger storm events. As a result, the channel will have to be armored to prevent erosion or lad acquired between the north and south channels to allow the north and south channel to be widened. This analysis assumed the land between the north and south channels would be developed restricting available land area for widening both the north and south channels and reducing velocities. Implementation of onsite detention upstream of the Hedges Creek Marsh and diverting flow to the north channel aid in reducing flows and velocities within the south channel.

- The attached HEC-2 profiles did not include beaver dams or other channel constrictions which occur within the Hedges Creek Marsh. Beaver dams in should be restricted in narrow sections of the south channel. The most critical location is immediately east of Teton Avenue where the channel is severely restricted. Beaver dams in this location will cause flooding at Teton Avenue. The area immediately west of Tualatin Road is more suitable for beaver dams, though larger dams may cause flow to reverse and flow south to north in the cross-drainage ditch adjacent to the existing industrial complex (see Figure 6). A plug installed at the south end of this cross-drainage ditch will prevent this condition from occurring and allow more flexibility in maintaining the beaver dams. In general, backwater from beaver dams should not be allowed to extend west of cross-section 10.

- The north channel could also serve as an effective bypass for up to 150 cfs of the flow entering the upper end of the marsh with minor maintenance to ensure capacity along its length. Up to 150 cfs of additional capacity may be added if the channel is modified to increase the available flow area to provide a total capacity of 300 cfs.

- If the north channel is not maintained, a low flow diversion from the south channel and marsh will have to be provided to maintain flow to Sweek Pond.

- The area immediately upstream from Teton Avenue between the north and south channels provides some detention benefit although much has been lost because the property is being filled. If this area is not available for channel widening, both the north and south channels may have to be armored to pass the peak storm flows without significant erosion for the alternatives considered.

- In general, onsite detention for future development will reduce the peak flows entering the marsh. Lower peak flows result in lower velocities within the marsh and channel areas and smaller fluctuations in water surface elevations within the marsh. Lower velocities are beneficial to the overall water quality within the marsh since the potential for erosion and sedimentation is reduced. Directing high flows through the north channel also provides a similar benefit, though not as well as onsite detention. The diversion structure at the east end of the Hedges Creek Marsh should be designed to bypass a minimum of 150 cfs at storm events ranging from the 5-year to 25-year recurrence interval.

- Rerouting the north channel directly east from the 72-inch diameter culvert under Teton Avenue to meet the south channel approximately 1300 feet east of Teton Avenue appears to provide some advantages for maintenance and implementation. The channel would have access directly from Teton Avenue and would likely have the least impact on local property owners.

Alternatives Comparison

Each alternative was evaluated based on its ability to provide effective water quantity management, maintain and enhance water quality, minimize cost, minimize operation and maintenance, and its ease of implementation. A brief discussion of the effectiveness of each alternative in relation to these criteria is presented in the following paragraphs.

Water Quantity. The four alternatives were developed to provide effective flood control and water quantity management. Overall, each alternative represents an effective approach to managing water quantity and solving local flooding problems though impacts on other aspects of the marsh, such as water quality, are more severe with some alternatives than others. The following observations were made related to water quantity management:

- Requiring onsite detention appears to provide effective reduction of peak flows entering the marsh. This is particularly important in reducing velocities through the south channel constriction from cross-sections 4 through 12.

- Diverting flow into the north channel reduces velocities in the south channel. This is particularly important when onsite detention is not provided.

- Extending the north channel directly east of Teton Avenue will allow the north channel to be more easily accessed for maintenance. This option also appears to be favored by local landowners which may ease the implementation of the project. The existing north channel will have to be maintained from a point approximately 1300 feet east of Teton Avenue to Sweek Pond to convey local drainage and drainage from north Herman Road.

- A new culvert under Herman Road and the railroad grade to the north channel will be required to relieve local flooding problems.

- The flow reductions achieved with onsite detention provide lower water surface profiles throughout the Hedges Creek Marsh area when the Tualatin River floodplain is not considered. If the Hedges Creek Marsh is under the influence of the Tualatin River floodplain, the water surface profiles downstream from Teton Avenue see little variation between the alternatives. The water surface upstream of

Teton Avenue is lower when onsite detention is implemented upstream of the marsh.

Based on these observations, Alternative 3 appears to provide the most effective water quantity management. This alternative provides both upstream onsite detention and maintains the north channel. Routing all of the storm runoff through the south channel is not an acceptable alternative because of high velocities and the high potential for erosion and damage to the Pascuzzi Ponds and Hedges Marsh.

The HEC-2 backwater analysis was completed based on the HEC-1 hydrologic modeling completed by Brown and Caldwell as part of their subbasin planning work in 1990-1992. The 1989 land use conditions were used as the basis of the HEC-1 model. Development has occurred within the Hedges Creek basin since 1989. As a result, the benefits of onsite detention for new development will be less in relation to the benefits predicted as part of the backwater modeling. Additional evaluation is required to determine the actual level onsite detention which can be achieved upstream of the Hedges Creek Marsh. Development which has occurred since the hydrologic analysis was completed and the difficulty in implementing onsite development may reduce the actual flow reductions achieved through onsite detention. As shown in the flow profiles for Alternative 3, maximizing the use of onsite detention limits fluctuations in the water surface within the marsh which is the best condition for preserving the hydrology of the marsh system.

Water Quality. Evaluation of water quality impacts was based primarily on the potential for damage to the channels and riparian areas adjacent to the channels. Implementation of best management practices on properties adjacent to the marsh and upstream development was assumed for all alternatives. The channel velocity was the primary criterion since high velocities cause water quality degradation in several ways. The first is through channel erosion and subsequent sedimentation in lower velocity areas downstream. Erosion increases the turbidity within the stream and sedimentation often fills the channel downstream with subsequent reduction in the channel capacity.

Erosion of the channel also damages the riparian vegetation which is critical for biofiltration. The riparian vegetation serves as an effective filter removing suspended particulate material and nutrients. The riparian vegetation also provides shade for the stream which aids in maintaining lower water temperatures beneficial to many aquatic organisms. In general, velocities exceeding 4 fps have been found to erode a vegetated channel. For this reason, a maximum velocity of 4 fps was selected as the breakpoint beyond which significant water quality degradation would occur.

Alternative 3 provides the best hydraulic conditions to minimize channel erosion and damage to riparian areas. Onsite detention and diverting flow to the north channel effectively reduces the flow entering the south channel and as a result, the lowest overall channel velocities are associated with Alternative 3. Alternative 2 presents the least desirable hydraulic conditions with all storm runoff routed through the south channel and no onsite detention. As a result, high velocities occur from approximately cross-section 10 upstream to the Pascuzzi Ponds. With minor channel widening adjacent to Teton Avenue, the velocities found with Alternative 3 will fall under 4 fps and minimize the potential for channel erosion.

Reducing flows through the marsh will also reduce the frequency of water surface fluctuations within the Hedges Creek Marsh, particularly west of Teton Avenue. Onsite detention in combination with diverting flow to the north channel minimizes the frequency of water surface fluctuations.

Beaver dams provide water quality benefits through sedimentation in the ponds created by the dams, particularly for lower flows. The beaver dams also create habitat along the riparian areas of the ponded water. The dams will have to be monitored, however, to minimize the impact of the dams on flooding. In the marsh east of Teton Avenue, an existing north-south cross-drainage ditch was constructed to convey storm runoff from Herman Road and local drainage to the south channel and marsh. Beaver dams constructed within the marsh may divert storm runoff into this ditch and flood local property. For this reason, a plug should be installed in the south end of this ditch to prevent water from spilling out of the south channel and marsh into this ditch. The ditch slope should be reversed if needed to convey flow to the existing north channel. With this modification, beaver dams would be acceptable in the lower marsh area with backwater effects reaching as far as cross-section 10.

Operation and Maintenance. In general, all four alternatives would require similar levels of operation and maintenance efforts. Alternative 2 would be expected to require the highest level of maintenance since the higher channel velocities will erode the south channel and damage the riparian areas adjacent to the channel. Debris and sediment removal from culverts and channels will be required for all alternatives. Sediment control upstream from the Hedges Marsh is recommended to prevent sediment deposition within the marsh. These control mechanisms would include erosion and sediment control for new development, construction of water quality facilities on development adjacent to the marsh, and stream enhancement projects.

Periodic removal or lowering of beaver dams may also be required to prevent flooding of adjacent landowners. Extending the north channel directly east from Teton Avenue will provide more direct access for maintenance as compared to the current north channel alignment. Overall, Alternative 3 would be expected to require the least amount of operation and maintenance activities.

Implementation. Several elements of each alternative present potential implementation problems. Political support will be required to implement onsite detention throughout the basin. Routing all storm water runoff through the south channel would probably not receive support from the environmental groups and natural resources regulatory agencies. Routing the north channel directly east from Teton Avenue appears to be supported by the stakeholders and provides the best hydraulic conditions. The ditch could also be designed to provide water quality benefits. The existing north channel east of Teton Avenue will need to be excavated and some maintenance performed to ensure conveyance for local flows and drainage from north of Herman Road.

Cost. Capital construction cost estimates were developed for each alternative to allow a relative comparison between alternatives. The precision of the cost estimate is a function of the detail which has been developed and the techniques used in preparing the actual estimate. An order-of-magnitude estimate, as defined by the American Association of Cost Engineers, is appropriate for comparison of alternatives. An order-of-magnitude estimate is approximated and is prepared without detailed engineering data. Techniques such as cost capacity curves, scale-up or scale-down factors, and ratios are used in developing such an estimate. An order-of-magnitude estimate has an expected accuracy of +50 percent to -30 percent. The cost estimates prepared for this technical memorandum are order-of-magnitude estimates. A 25 percent estimating contingency was included for each alternative.

As shown in Table 11, the total project cost of all four alternatives fall within an $175,000 range. Alternative 1 has the lowest project cost at $675,000. This is due primarily to reduction of peak runoff flows from onsite detention. Alternative 3 has the second lowest cost except for construction of a new north channel from Teton Avenue to the marsh.

Overall, the three alternatives have similar costs with the only major cost differences occurring at Teton Avenue and adding a new north channel. Engineering costs were assumed at 25 percent of the construction cost which is often found with small construction projects. Supervision and administration during construction was assumed at 10 percent of the construction cost. A permitting allowance of 10 percent of the construction cost was also included.

Evaluation Matrix

Table 12 presents an evaluation matrix developed to provide a relative ranking of the four alternatives based on the criteria presented above. For each criteria, the alternatives were ranked from 1 to 4. Summing the rankings for each alternative provides a direct comparison of the alternatives with the lowest score representing the best alternative. Based on the evaluation matrix, Alternative 3 is the most effective alternative with a numerical score of 8. Alternative 1 is close to Alternative 3 with a score of 11.

CONCLUSIONS AND RECOMMENDATIONS

A hydraulic analysis of the Hedges Creek Marsh was completed to aid in the development of an effective management approach which would balance water quantity and quality issues within the sub basin. Early in the evaluation, it became evident that alternatives for managing water quantity within the marsh were limited to conveyance improvements, onsite detention on new development upstream from the marsh, and flow splitting between the north and south channels. Four alternatives were developed consisting of various combinations of these features.

Based on the hydraulic evaluation, Alternative 3, which consisted of onsite detention combined with diverting up to 150 cfs to the north channel, proved to be the most effective alternative. The combination of onsite detention and flow diversion to the north channel reduced the amount of runoff entering the south channel and lowered channel velocities which could damage riparian areas. Constructing a north channel from downstream of Teton Avenue directly east to the marsh also appears to be an option which is supported by the key stakeholders and should be considered for implementation.

The following are recommended as part of the planning and implementation of the features of Alternative 3:

(1) Construct a new 9-foot by 18-foot arch culvert under Tualatin Road. The culvert should be designed to pass the 100-year design storm event with a peak discharge of 902 cfs.

(2) Evaluate the need for a low flow control structure at Tualatin Road to maintain a minimum water depth in the marsh during low flow conditions.

(3) Construct a new 48-inch diameter culvert under Herman Road to the north channel. The culvert should be designed to pass a peak 25-year design storm of 66 cfs.

(4) Improve the north channel from the 48-inch culvert outfall to Sweek Pond. The existing channel should be inspected and cleaned to maintain the effective flow area.

(5) Perform a site survey to route a new north channel from downstream of Teton Avenue directly east approximately 1300 feet to the marsh. Key issues which should be addressed include the route, available cross-section, easement requirements, and access for maintenance. The new channel should have a minimum design capacity of 200 cfs. The channel should be designed as a vegetated swale with a maximum channel velocity of 4 fps to minimize erosion during larger storm events.

(6) Construct two new 5.5-foot square box culverts in the south channel at Teton Avenue designed for a peak 25-year storm event discharge of 411 cfs. This will provide for adequate flood control capacity in the event that the benefits from onsite detention for new development are in fact less than predicted by the modeling. The benefits from onsite detention for new development may be less due to development occurring between 1989 and 1995 which would reduce the level of onsite development which could be implemented.

(7) Modify the south channel downstream from Teton Avenue (cross-sections 7 through 12) to provide more overbank area for higher flows and to remove debris from the main channel.

(8) Install a flow diversion system at the existing flow diversion point (just upstream of Pascuzzi Ponds) to allow flow splitting between the north and south channels.

(9) Require onsite detention for all new development upstream of Pascuzzi Ponds including areas south of the Tualatin-Sherwood Highway and north of Herman Road. Onsite detention should be designed to maintain a release rate of predevelopment flows for all storm events up to and including the 25-year storm event. The detention facilities should be designed to maximize the control of smaller storm events. This approach will minimize the frequency of water surface fluctuations within the Hedges Creek Marsh.

(10) Develop a beaver dam maintenance program to control beaver dam locations and heights within the marsh. Beaver dams should be restricted to the main drainage way in the south channel of Hedges Creek within the marsh from Tualatin Road west to approximately cross-section 10. The height of the dams should be maintained to not extend into the overbank area. A plug should be installed in the south end of the existing cross-drainage channel located on the north side of the lower marsh. The ditch should be regraded if needed to convey flow to the existing north channel.

(11) Develop a schedule for periodic visual assessment of the Hedges Creek Marsh. A visual field assessment form is attached.

As shown in Table 11, the recommended drainage conveyance features have an estimated total project cost of $811,250. This cost includes a 25% estimating contingency as well as engineering (25%), supervision and administration (S&A) during construction (10%), and a permitting allowance (10%). The Hedges Creek Subbasin Strategy Plan presents a complete description of the recommended capital cost estimates.

TABLES

Table 1. Summary of HEC-2 Model Flow Inputs.

Alternative	Base Flow	Flow (cfs) 5-yr	10-yr	25-yr	100-yr
Existing Conditions					
Cross-section 24	10	179	186	250	327
Cross-section 23	10	136	150	218	286
Cross-section 7	10	115	127	184	241
Cross-section 4	10	82	91	131	172
Existing Facilities - Future Flows					
Cross-section 24	10	506	538	685	821
Cross-section 23	10	480	510	647	774
Cross-section 7	10	417	443	561	671
Cross-section 4	10	367	388	487	579
Alternative 1 - Onsite Detention with Minimum North Channel					
Cross-section 24	10	179	186	250	902
Cross-section 23	10	136	150	218	774
Cross-section 7	10	115	127	184	671
Cross-section 4	10	82	91	131	579
Alternative 2 - No Onsite Detention and Minimum North Channel					
Cross-section 24	10	552	588	751	902
Cross-section 23	10	480	510	647	774
Cross-section 7	10	417	443	561	671
Cross-section 4	10	367	388	487	579
Alternative 3 - Onsite Detention and Full North Channel					
Cross-section 24	10	179	186	250	902
Cross-section 23	10	136	136	136	624
Cross-section 7	10	115	115	115	521
Cross-section 4	10	82	82	82	429
Alternative 4 - No Onsite Detention and Full North Channel					
Cross-section 24	10	552	588	751	902
Cross-section 23	10	330	360	497	624
Cross-section 7	10	267	293	411	521
Cross-section 4	10	217	238	337	429

Notes:
(1) Hydrology based on HEC-1 model developed by Brown and Caldwell Consultants for the Hedges Creek Subbasin Strategies Management Plan, October 1992.
(2) Existing Facilities-Future Flows assumes that no culverts are in place on the north side of Teton Avenue to carry flow to the north channel. As a result, the flow will be less than shown for Alternative 2 which assumes a new culvert from Teton Avenue to the north channel.
(3) Flow through the north channel is added between cross-sections 23 and 24. Alternatives 3 and 4 with full north channel assume up to 150 cfs is diverted into the north channel. This flow is added between cross-sections 23 and 24.
(4) Hedges Creek flows are based on the assumption of no backwater effect from the Tualatin River.

Table 2. Starting Water Surface Elevations for HEC-2 Model.

Event (year)	Tualatin River Flood Elevation (fmsl) *	Minimum Starting HEC-2 WSEL w/o Tualatin River Backwater (fmsl) **
1	112.8	112.8
2	114.4	114.0
5	116.8	114.5
10	118.6	115.5
25	120.8	116.5
50	122.2	117.5
100	123.8	118.5

* Tualatin River flood elevations were taken from the 1987 revised FEMA flood profiles for the Tualatin River. Elevations were determined from the profiles at the Tualatin River confluence with Hedges Creek at Tualatin River mile 8.6.

** Water surface elevations were estimated based on installing a new arch culvert under the Tualatin Road. The estimated water surfaces may vary with the final design recommendations.

Table 3. Water Surface Profiles for 5-Year Storm Event.

Cross-Section No.	Channel Min. Elev.	Water Surface Elevation (fmsl) Exist.	Exist./Fut	Alt.1	Alt. 2	Alt. 3	Alt. 4
24	112.0	116.8	116.8	116.8	116.8	116.8	116.8
23	112.7	116.8	116.9	116.8	116.9	116.8	116.9
22	113.5	116.8	116.9	116.8	116.9	116.8	116.9
21	113.7	116.8	117.1	116.8	117.1	116.8	117.0
20	114.0	117.0	118.0	117.0	118.0	117.0	117.6
18	114.5	117.4	118.8	117.4	118.8	117.4	118.3
17	116.4	118.0	119.5	118.0	119.5	118.0	118.9
16	117.1	119.8	121.0	119.8	121.0	119.8	120.5
15	117.1	120.4	122.2	120.4	122.2	120.4	121.5
14	118.5	120.8	122.5	120.8	122.5	120.8	121.8
13	118.9	120.8	122.5	120.8	122.5	120.8	121.8
12	120.3	121.6	122.6	121.6	122.6	121.6	122.1
11	120.5	122.6	123.1	122.6	123.1	122.6	123.0
10	122.2	123.3	124.1	123.3	124.1	123.3	123.7
9	122.3	124.0	124.6	124.0	124.6	124.0	124.3
8	122.3	124.4	125.0	124.4	125.0	124.4	124.7
7	121.4	124.6	125.1	124.5	125.1	124.5	124.8
6	122.5	126.3	126.5	124.9	125.0	124.9	124.8
5	121.6	126.3	126.9	125.2	126.6	125.2	125.8
4.5	121.3	126.3	127.0	125.3	126.6	125.3	126.0
4	123.0	126.4	127.0	125.4	126.7	125.4	126.0
3.5	122.9	126.3	126.9	125.3	126.5	125.3	125.8
3	124.1	126.5	127.6	126.2	127.6	126.2	127.1
2.5	124.5	126.8	128.2	126.8	128.2	126.8	127.6
2	124.8	127.2	128.8	127.2	128.8	127.2	128.2
1	125.1	127.4	128.9	127.4	129.0	127.4	128.3

Alternative 1 - Onsite Detention with Minimum North Channel
Alternative 2 - No Onsite Detention and Minimum North Channel
Alternative 3 - Onsite Detention and Full North Channel
Alternative 4 - No Onsite Detention and Full North Channel

Table 4. Water Surface Profiles for 10-Year Storm Event.

Cross-Section No.	Channel Min. Elev.	Water Surface Elevation (fmsl) Exist.	Exist./Fut	Alt.1	Alt. 2	Alt. 3	Alt. 4
24	112.0	118.6	118.6	118.6	118.6	118.6	118.6
23	112.7	118.6	118.6	118.6	118.6	118.6	118.6
22	113.5	118.6	118.6	118.6	118.6	118.6	118.6
21	113.7	118.6	118.6	118.6	118.6	118.6	118.6
20	114.0	118.6	118.8	118.6	118.8	118.6	118.7
18	114.5	118.7	119.2	118.7	119.2	118.7	119.0
17	116.4	118.8	119.7	118.8	119.7	118.7	119.3
16	117.1	119.6	121.0	119.6	121.0	119.5	120.5
15	117.1	120.5	122.3	120.5	122.3	120.4	121.6
14	118.5	120.9	122.5	120.9	122.5	120.8	121.9
13	118.9	120.9	122.6	120.9	122.5	120.8	122.0
12	120.3	121.7	122.7	121.7	122.7	121.6	122.2
11	120.5	122.6	123.2	122.6	123.2	122.6	123.0
10	122.2	123.3	124.1	123.3	124.1	123.3	123.8
9	122.3	124.0	124.6	124.0	124.6	124.0	124.4
8	122.3	124.4	125.0	124.4	125.0	124.4	124.8
7	121.4	124.6	125.2	124.6	125.1	124.5	124.9
6	122.5	126.3	126.5	125.0	125.1	124.9	124.8
5	121.6	126.4	127.0	125.3	126.7	125.2	125.9
4.5	121.3	126.4	127.0	125.4	126.8	125.3	126.1
4	123.0	126.4	127.0	125.5	126.8	125.4	126.1
3.5	122.9	126.4	127.0	125.4	126.7	125.3	125.9
3	124.1	126.6	127.6	126.3	127.7	126.2	127.2
2.5	124.5	126.9	128.3	126.9	128.3	126.8	127.7
2	124.8	127.3	128.9	127.3	128.9	127.2	128.3
1	125.1	127.5	129.0	127.5	129.0	127.4	128.4

Alternative 1 - Onsite Detention with Minimum North Channel
Alternative 2 - No Onsite Detention and Minimum North Channel
Alternative 3 - Onsite Detention and Full North Channel
Alternative 4 - No Onsite Detention and Full North Channel

Table 5. Water Surface Profiles for 25-Year Storm Event.

Cross-Section No.	Channel Min. Elev.	Water Surface Elevation (fmsl) Exist.	Exist./Fut	Alt.1	Alt. 2	Alt. 3	Alt. 4
24	112.0	120.8	120.8	120.8	120.8	120.8	120.8
23	112.7	120.8	120.8	120.8	120.8	120.8	120.8
22	113.5	120.8	120.8	120.8	120.8	120.8	120.8
21	113.7	120.8	120.8	120.8	120.8	120.8	120.8
20	114.0	120.8	120.9	120.8	120.9	120.8	120.8
18	114.5	120.8	120.9	120.8	120.9	120.8	120.9
17	116.4	120.8	121.0	120.8	121.0	120.8	120.9
16	117.1	120.9	121.3	120.9	121.3	120.8	121.1
15	117.1	121.2	122.6	121.2	122.6	121.0	122.2
14	118.5	121.5	122.8	121.5	122.8	121.2	122.5
13	118.9	121.5	122.8	121.5	122.8	121.2	122.5
12	120.3	121.7	123.0	121.9	123.0	121.6	122.6
11	120.5	122.8	123.4	122.8	123.4	122.6	123.1
10	122.2	123.5	124.3	123.5	124.3	123.3	124.0
9	122.3	124.1	124.8	124.1	124.8	124.0	124.6
8	122.3	124.6	125.2	124.6	125.2	124.4	125.0
7	121.4	124.8	125.5	124.7	125.2	124.5	125.1
6	122.5	126.4	126.3	125.4	125.5	124.9	125.0
5	121.6	126.5	127.3	125.7	127.3	125.2	126.5
4.5	121.3	126.5	127.3	125.8	127.4	125.3	126.6
4	123.0	126.5	127.3	125.9	127.4	125.4	126.6
3.5	122.9	126.5	127.2	125.8	127.3	125.3	126.5
3	124.1	126.8	127.9	126.6	127.9	126.2	127.5
2.5	124.5	127.2	128.8	127.1	128.5	126.8	128.1
2	124.8	127.6	129.4	127.6	129.1	127.2	128.7
1	125.1	127.8	129.5	127.8	129.3	127.4	128.9

Alternative 1 - Onsite Detention with Minimum North Channel
Alternative 2 - No Onsite Detention and Minimum North Channel
Alternative 3 - Onsite Detention and Full North Channel
Alternative 4 - No Onsite Detention and Full North Channel

Table 6. Water Surface Profiles for 100-Year Storm Event.

Cross-Section No.	Channel Min. Elev.	Water Surface Elevation (fmsl) Exist.	Exist./Fut	Alt.1	Alt. 2	Alt. 3	Alt. 4
24	112.0	123.8	123.8	123.8	123.8	123.8	123.8
23	112.7	123.8	123.8	123.8	123.8	123.8	123.8
22	113.5	123.8	123.8	123.8	123.8	123.8	123.8
21	113.7	123.8	123.8	123.8	123.8	123.8	123.8
20	114.0	123.8	123.8	123.8	123.8	123.8	123.8
18	114.5	123.8	123.8	123.8	123.8	123.8	123.8
17	116.4	123.8	123.8	123.8	123.8	123.8	123.8
16	117.1	123.8	123.8	123.8	123.8	123.8	123.8
15	117.1	123.8	123.9	123.9	123.9	123.9	123.9
14	118.5	123.8	124.0	124.0	124.0	123.9	123.9
13	118.9	123.8	124.0	124.0	124.0	123.9	123.9
12	120.3	123.8	124.0	124.0	124.0	123.9	123.9
11	120.5	123.8	124.1	124.1	124.1	124.0	124.0
10	122.2	124.0	124.6	124.6	124.6	124.4	124.4
9	122.3	124.2	125.0	125.0	125.0	124.8	124.8
8	122.3	124.7	125.4	125.4	125.4	125.2	125.2
7	121.4	124.8	125.8	125.7	125.3	125.2	125.2
6	122.5	126.6	126.3	126.5	126.3	125.4	125.4
5	121.6	126.6	127.6	127.6	127.6	127.1	127.1
4.5	121.3	126.7	127.7	127.6	127.7	127.2	127.2
4	123.0	126.7	127.7	127.6	127.7	127.2	127.2
3.5	122.9	126.6	127.6	127.6	127.6	127.1	127.1
3	124.1	127.0	128.1	128.1	128.1	127.7	127.7
2.5	124.5	127.4	128.8	128.8	128.8	128.4	128.4
2	124.8	127.9	129.4	129.4	129.4	129.0	129.0
1	125.1	128.1	129.5	129.5	129.5	129.1	129.1

Alternative 1 - Onsite Detention with Minimum North Channel
Alternative 2 - No Onsite Detention and Minimum North Channel
Alternative 3 - Onsite Detention and Full North Channel
Alternative 4 - No Onsite Detention and Full North Channel

Table 7. Channel Velocities for the 5-Year Storm Event.

Cross-Section No.	Channel Velocity (fps) Exist.	Exist./Fut	Alt.1	Alt. 2	Alt. 3	Alt. 4
24	0.37	1.05	0.37	1.15	0.37	1.15
23	0.18	0.62	0.18	0.62	0.18	0.43
22	0.72	2.40	0.72	2.39	0.72	1.68
21	1.20	3.63	1.20	3.62	1.20	2.66
20	1.10	2.21	1.10	2.21	1.10	1.89
18	1.18	1.88	1.18	1.87	1.18	1.66
17	2.91	2.85	2.91	2.84	2.91	2.67
16	2.17	3.71	2.17	3.71	2.17	3.16
15	2.04	2.60	2.04	2.60	2.04	2.79
14	0.81	0.91	0.81	0.91	0.81	0.89
13	1.49	1.00	1.49	1.00	1.49	1.09
12	1.04	1.07	1.04	1.07	1.04	1.24
11	1.76	3.42	1.76	3.42	1.76	2.48
10	0.76	1.22	0.76	1.22	0.76	1.02
9	4.40	2.49	4.40	2.49	4.40	2.83
8	0.90	1.71	0.90	1.71	0.90	1.40
7	2.98	7.67	2.71	4.54	2.71	3.12
6	1.36	4.43	2.48	8.39	2.48	6.01
5	0.34	0.80	1.22	1.03	1.22	1.39
4.5	0.49	1.08	1.32	1.39	1.32	1.69
4	0.08	0.25	0.15	0.30	0.15	0.26
3.5	1.28	3.49	2.91	4.81	2.91	5.02
3	1.50	3.10	2.02	3.02	2.02	2.44
2.5	1.92	3.66	2.00	3.64	2.00	2.99
2	2.05	2.94	2.09	2.93	2.09	2.61
1	1.10	1.15	1.11	1.14	1.11	1.12

Alternative 1 - Onsite Detention with Minimum North Channel
Alternative 2 - No Onsite Detention and Minimum North Channel
Alternative 3 - Onsite Detention and Full North Channel
Alternative 4 - No Onsite Detention and Full North Channel

Table 8. Channel Velocities for the 10-Year Storm Event.

Cross-Section No.	Channel Velocity (fps) Exist.	Exist./Fut	Alt.1	Alt. 2	Alt. 3	Alt. 4
24	0.21	0.61	0.21	0.67	0.21	0.67
23	0.11	0.38	0.11	0.38	0.10	0.27
22	0.33	1.11	0.33	1.11	0.30	0.79
21	0.53	1.79	0.53	1.79	0.48	1.27
20	0.51	1.59	0.51	1.59	0.47	1.17
18	0.61	1.62	0.61	1.62	0.56	1.28
17	1.44	2.63	1.44	2.63	1.34	2.23
16	2.75	3.87	2.75	3.87	2.69	3.42
15	2.15	2.59	2.15	2.59	2.08	2.90
14	0.75	0.92	0.83	0.92	0.82	0.90
13	1.44	1.01	1.44	1.01	1.51	1.07
12	1.08	1.07	1.08	1.07	1.04	1.21
11	1.82	3.51	1.82	3.51	1.76	2.65
10	0.78	1.24	0.78	1.24	0.75	1.06
9	3.84	2.48	3.84	2.48	4.51	2.70
8	0.96	1.76	0.96	1.76	0.90	1.46
7	3.21	7.88	2.95	4.78	2.71	3.38
6	1.49	4.76	2.62	8.66	2.48	6.50
5	0.37	0.83	1.18	0.99	1.22	1.33
4.5	0.53	1.11	1.34	1.33	1.32	1.66
4	0.08	0.26	0.16	0.29	0.15	0.26
3.5	1.38	3.56	3.00	4.46	2.91	5.11
3	1.58	3.18	2.06	3.15	2.02	2.50
2.5	2.02	3.71	2.09	3.71	2.00	3.09
2	2.10	2.98	2.13	2.97	2.09	2.66
1	1.10	1.15	1.11	1.15	1.11	1.11

Alternative 1 - Onsite Detention with Minimum North Channel
Alternative 2 - No Onsite Detention and Minimum North Channel
Alternative 3 - Onsite Detention and Full North Channel
Alternative 4 - No Onsite Detention and Full North Channel

Table 9. Channel Velocities for the 25-Year Storm Event.

Cross-Section No.	Channel Velocity (fps) Exist.	Exist./Fut	Alt.1	Alt. 2	Alt. 3	Alt. 4
24	0.17	0.46	0.17	0.50	0.17	0.50
23	0.10	0.30	0.10	0.30	0.06	0.23
22	0.23	0.69	0.23	0.69	0.15	0.53
21	0.36	1.05	0.36	1.05	0.22	0.81
20	0.33	0.98	0.33	0.98	0.21	0.76
18	0.30	0.85	0.30	0.85	0.19	0.67
17	0.52	1.46	0.52	1.46	0.33	1.11
16	1.74	4.21	1.74	3.87	1.11	3.41
15	2.13	2.58	2.13	2.58	1.50	2.58
14	0.75	1.00	0.75	1.00	0.59	0.90
13	1.01	1.08	1.01	1.08	0.93	0.99
12	1.21	1.09	1.21	1.09	1.13	1.06
11	2.06	3.81	2.06	3.81	1.70	3.40
10	0.89	1.36	0.89	1.36	0.75	1.21
9	3.93	2.54	3.93	2.54	4.41	2.50
8	1.17	1.96	1.17	1.96	0.90	1.70
7	4.20	8.51	4.01	5.85	2.71	4.49
6	2.06	6.67	3.15	9.26	2.48	8.44
5	0.48	0.91	1.00	0.88	1.22	1.04
4.5	0.68	1.21	1.31	1.16	1.32	1.39
4	0.11	0.30	0.17	0.29	0.15	0.27
3.5	1.76	3.78	3.11	3.61	2.91	4.44
3	1.90	3.50	2.19	3.47	2.02	2.95
2.5	2.38	3.88	2.45	3.89	2.00	3.56
2	2.30	3.17	2.32	3.17	2.09	2.87
1	1.11	1.21	1.12	1.21	1.11	1.13

Alternative 1 - Onsite Detention with Minimum North Channel
Alternative 2 - No Onsite Detention and Minimum North Channel
Alternative 3 - Onsite Detention and Full North Channel
Alternative 4 - No Onsite Detention and Full North Channel

Table 10. Channel Velocities for the 100-Year Storm Event.

Cross-Section No.	Exist.	Exist./Fut	Channel Velocity (fps) Alt.1	Alt. 2	Alt. 3	Alt. 4
24	0.13	0.32	0.35	0.35	0.35	0.35
23	0.08	0.21	0.21	0.21	0.17	0.17
22	0.14	0.37	0.37	0.37	0.30	0.30
21	0.23	0.62	0.62	0.62	0.50	0.50
20	0.17	0.46	0.46	0.46	0.37	0.37
18	0.14	0.39	0.39	0.39	0.31	0.31
17	0.19	0.52	0.52	0.52	0.41	0.41
16	0.45	1.24	1.24	1.24	0.97	0.97
15	0.51	0.36	1.36	0.36	1.07	1.07
14	0.26	0.67	0.67	0.67	0.54	0.54
13	0.27	0.71	0.71	0.71	0.57	0.57
12	0.27	0.70	0.70	0.70	0.56	0.56
11	1.13	2.65	2.65	2.65	2.21	2.21
10	0.74	1.37	1.37	1.37	1.20	1.20
9	2.98	2.57	2.57	2.57	2.42	2.42
8	1.33	2.10	2.10	2.10	1.88	1.88
7	5.17	9.02	10.30	6.84	9.43	5.49
6	2.62	7.90	7.01	7.94	8.90	9.06
5	0.57	0.91	0.92	0.91	0.91	0.91
4.5	0.80	1.18	1.20	1.18	1.22	1.21
4	0.14	0.31	0.32	0.31	0.28	0.28
3.5	2.08	3.60	3.65	3.59	3.63	3.60
3	2.16	3.67	3.69	3.67	3.31	3.31
2.5	2.69	3.97	3.98	3.97	3.79	3.80
2	2.46	3.32	3.32	3.32	3.06	3.05
1	1.11	1.26	1.26	1.26	1.18	1.17

Alternative 1 - Onsite Detention with Minimum North Channel
Alternative 2 - No Onsite Detention and Minimum North Channel
Alternative 3 - Onsite Detention and Full North Channel
Alternative 4 - No Onsite Detention and Full North Channel

Table 11. Alternatives Cost Summary.

Description	Construction	Cost ($) Engr (25%)	S&A (10%)	Permit (10%)	Contigency (25%)	Total Project Cost ($)
Alternative 1 - Onsite Detention with Minimum North Channel						
9'x18' Arch Culvert at Tualatin Road	246,000	62,000	25,000	25,000	89,500	$447,500
48" Culvert at Herman Road/North Channel Improvements	60,000	15,000	6,000	6,000	21,750	$108,750
One 5.5'x5.5' Box Culvert at Teton Ave/South Channel Improv.	65,000	16,000	7,000	7,000	23,750	$118,750
	$371,000	$93,000	$38,000	$38,000	135,000	$675,000
Alternative 2 - No Detention and Minimum North Channel						
9'x18' Arch Culvert at Tualatin Road	246,000	62,000	25,000	25,000	89,500	$447,500
48" Culvert at Herman Road/North Channel Improvements	49,000	12,000	5,000	5,000	17,750	$88,750
Three 5.5'x5.5' Box Culverts at Teton Ave/South Channel Improv.	90,000	23,000	9,000	9,000	32,750	$163,750
	$385,000	$97,000	$39,000	$39,000	140,000	$700,000
Alternative 3 - Onsite Detention and Full North Channel						
9'x18' Arch Culvert at Tualatin Road	246,000	62,000	25,000	25,000	89,500	$447,500
48" Culvert at Herman Road/North Channel Improvements	60,000	15,000	6,000	6,000	21,750	$108,750
One 5' Diameter Concrete Culvert/South Channel Improv.	60,000	15,000	6,000	6,000	21,750	$108,750
1300' LF New North Channel Excavation	50,000	13,000	5,000	5,000	18,250	$91,250
	$416,000	$105,000	$42,000	$42,000	151,250	$756,250
Alternative 4 - No Detention and Full North Channel						
9'x18' Arch Culvert at Tualatin Road	246,000	62,000	25,000	25,000	89,500	$447,500
48" Culvert at Herman Road/North Channel Improvements	60,000	15,000	6,000	6,000	21,750	$108,750
Three 5.5'x5.5' Box Culverts at Teton Ave/South Channel Improv.	110,000	28,000	11,000	11,000	40,000	$200,000
1300 LF New North Channel Excavation	50,000	13,000	5,000	5,000	18,250	$91,250
	$466,000	$118,000	$47,000	$47,000	169,500	$847,500
Recommended Alternative - Alt. 3 with Two 5.5' x 5.5' Box Culverts at Teton Avenue						
9'x18' Arch Culvert at Tualatin Road	246,000	62,000	25,000	25,000	89,500	$447,500
48" Culvert at Herman Road/North Channel Improvements	60,000	15,000	6,000	6,000	21,750	$108,750
Two 5.5'x5.5' Box Culverts/South Channel Improvements	90,000	23,000	9,000	9,000	32,750	$163,750
1300' LF New North Channel Excavation	50,000	13,000	5,000	5,000	18,250	$91,250
	$446,000	$113,000	$45,000	$45,000	162,250	$811,250

Note: All estimates are in August 1994 dollars.

Table 12. Alternatives Evaluation Matrix.

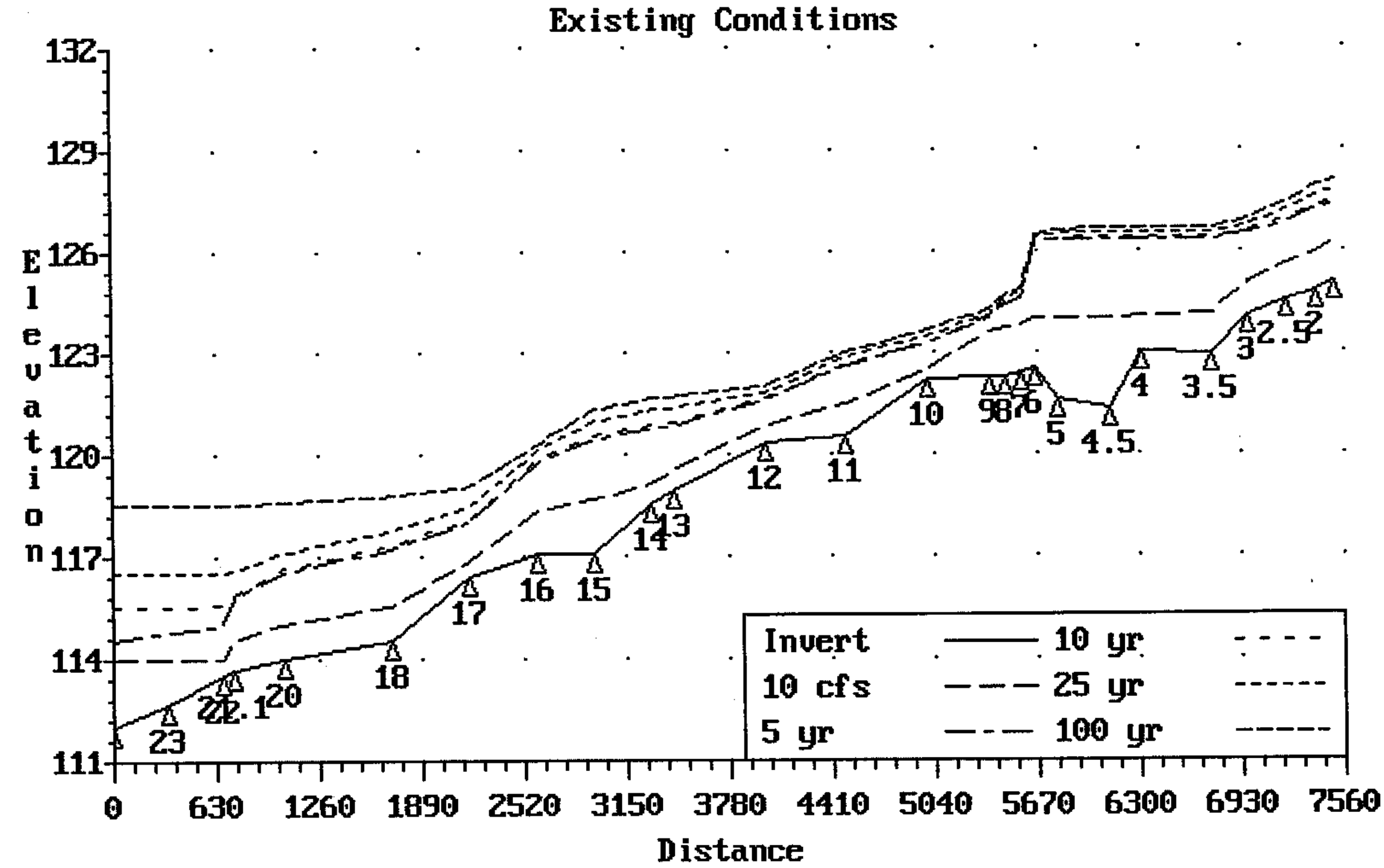
Evaluation Criteria	Ranking *			
	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Flood Control	2	4	1	3
Water Quality	2	4	1	3
Velocity Management	2	4	1	3
Maintenance	2	4	1	3
Cost	1	2	3	4
Implementable	2	2	1	1
Total	11	20	8	17

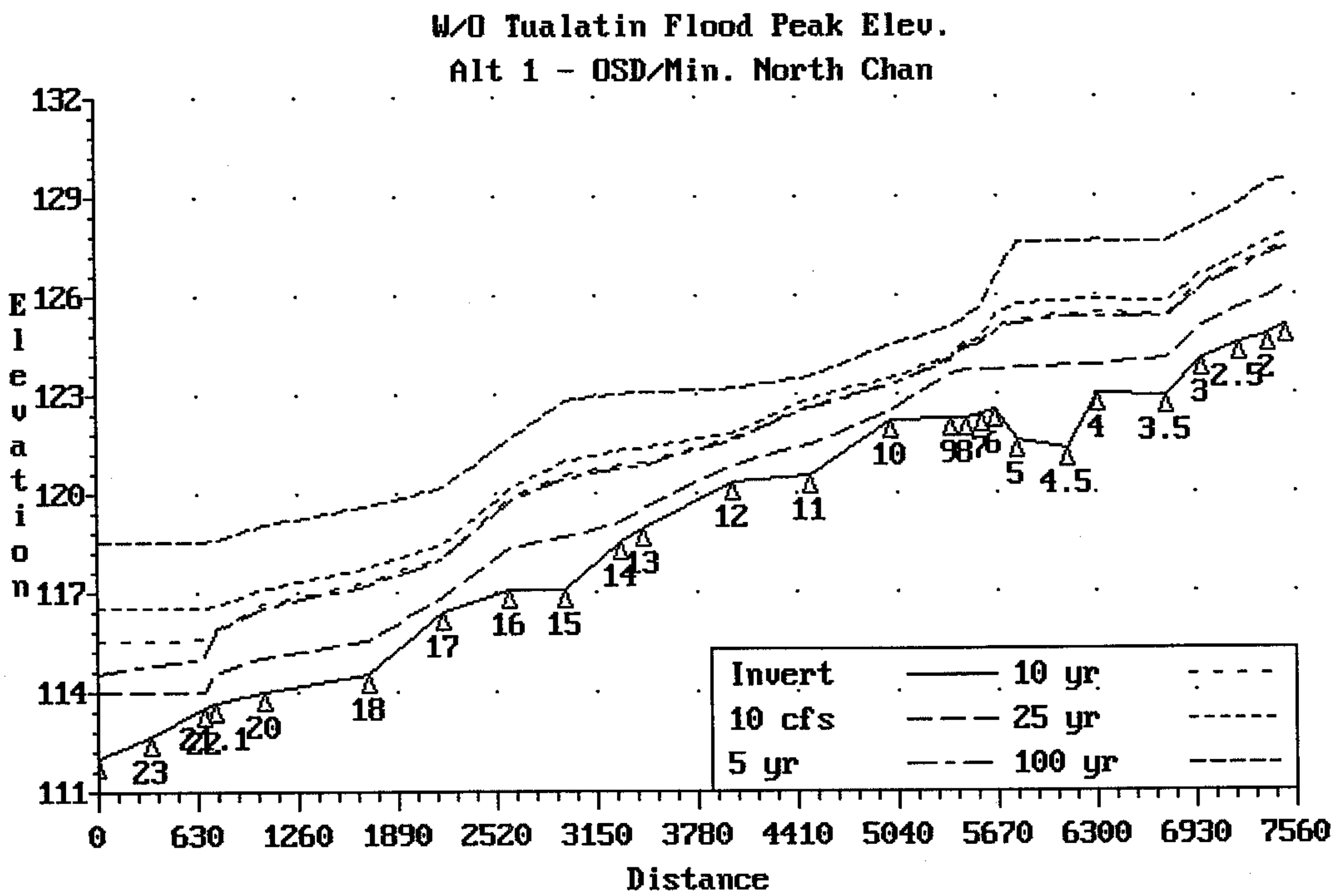
* Lowest score represents the highest ranking.

Alternative 1 - Onsite Detention with Minimum North Channel
Alternative 2 - No Onsite Detention and Minimum North Channel
Alternative 3 - Onsite Detention and Full North Channel
Alternative 4 - No Onsite Detention and Full North Channel

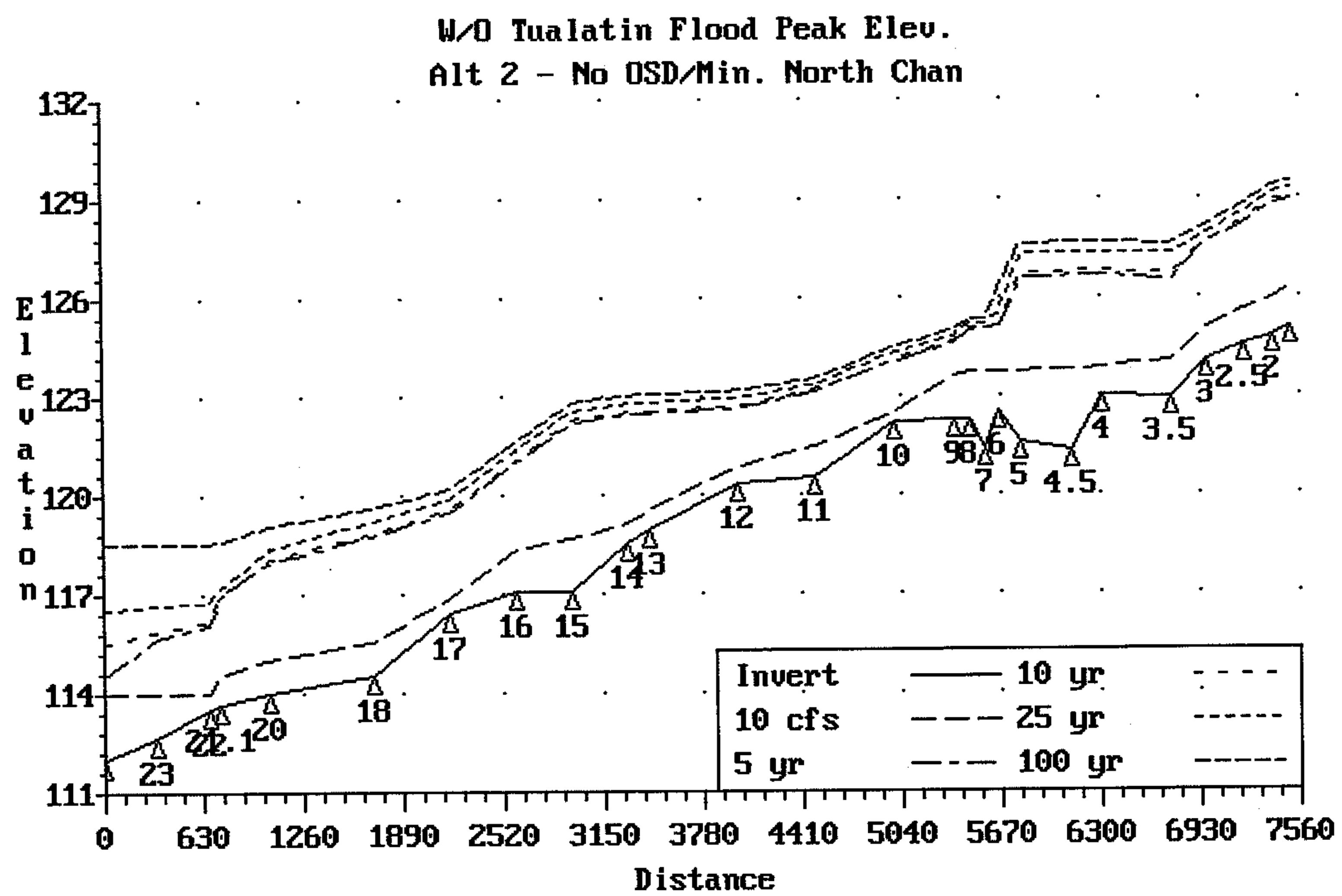
WATER SURFACE PROFILES

W/O Tualatin Flood Peak Elev.
Existing Conditions





W/O Tualatin Flood Peak Elev.
Alt 1 - OSD/Min. North Chan
Elevation
Distance
132
129
126
123
120
117
114
111
0
630
1260
1890
2520
3150
3780
4410
5040
5670
6300
6930
7560
23
22
22.1
20
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4.5
4
3.5
3
2.5
2
Invert
10 cfs
5 yr
10 yr
25 yr
100 yr



W/O Tualatin Flood Peak Elev.
Alt 2 - No OSD/Min. North Chan
Elevation
132
129
126
123
120
117
114
111
0
630
1260
1890
2520
3150
3780
4410
5040
5670
6300
6930
7560
Distance
Invert
10 cfs
5 yr
10 yr
25 yr
100 yr
23
22
22.1
20
18
17
16
15
14
13
12
11
10
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8
7
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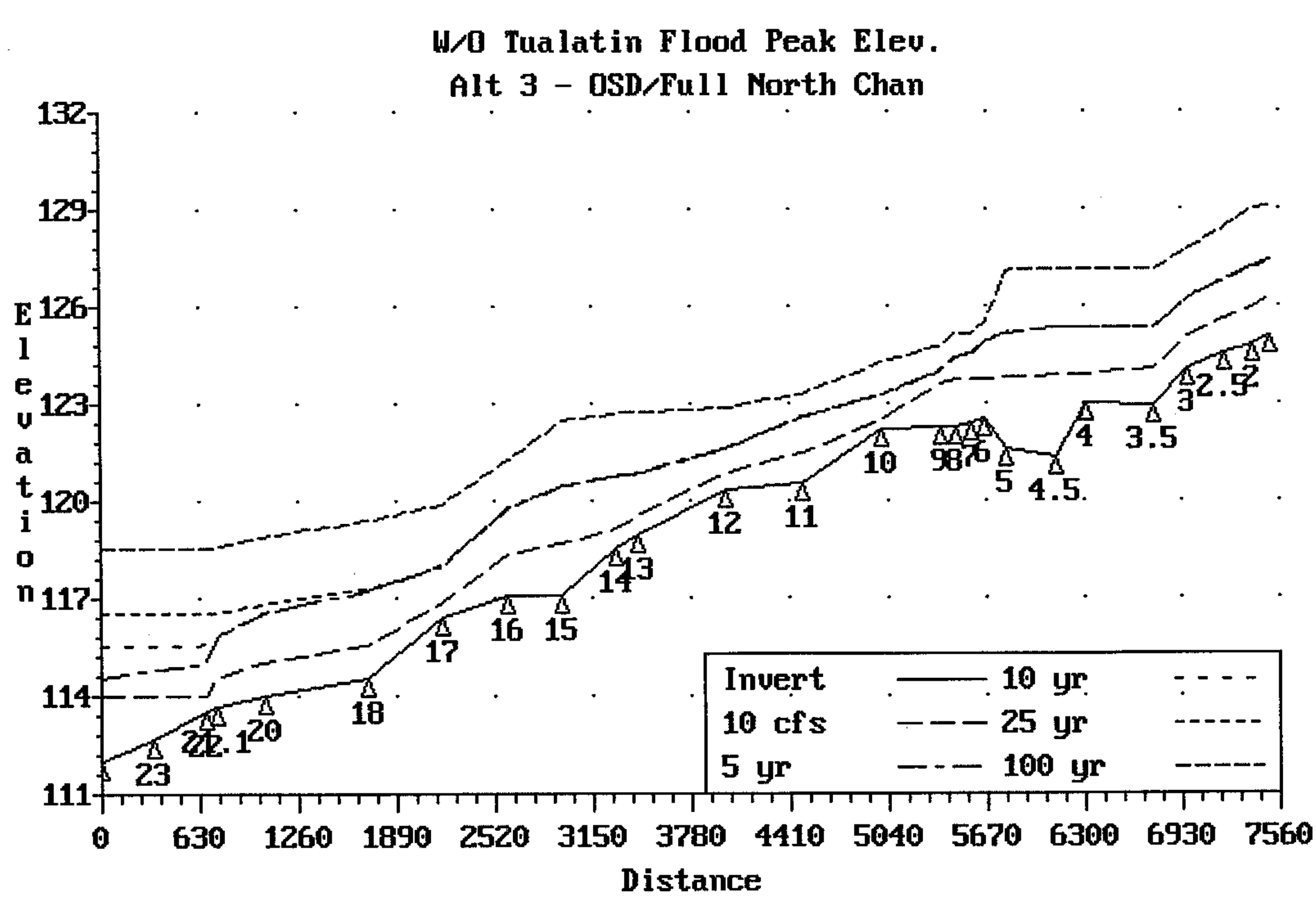
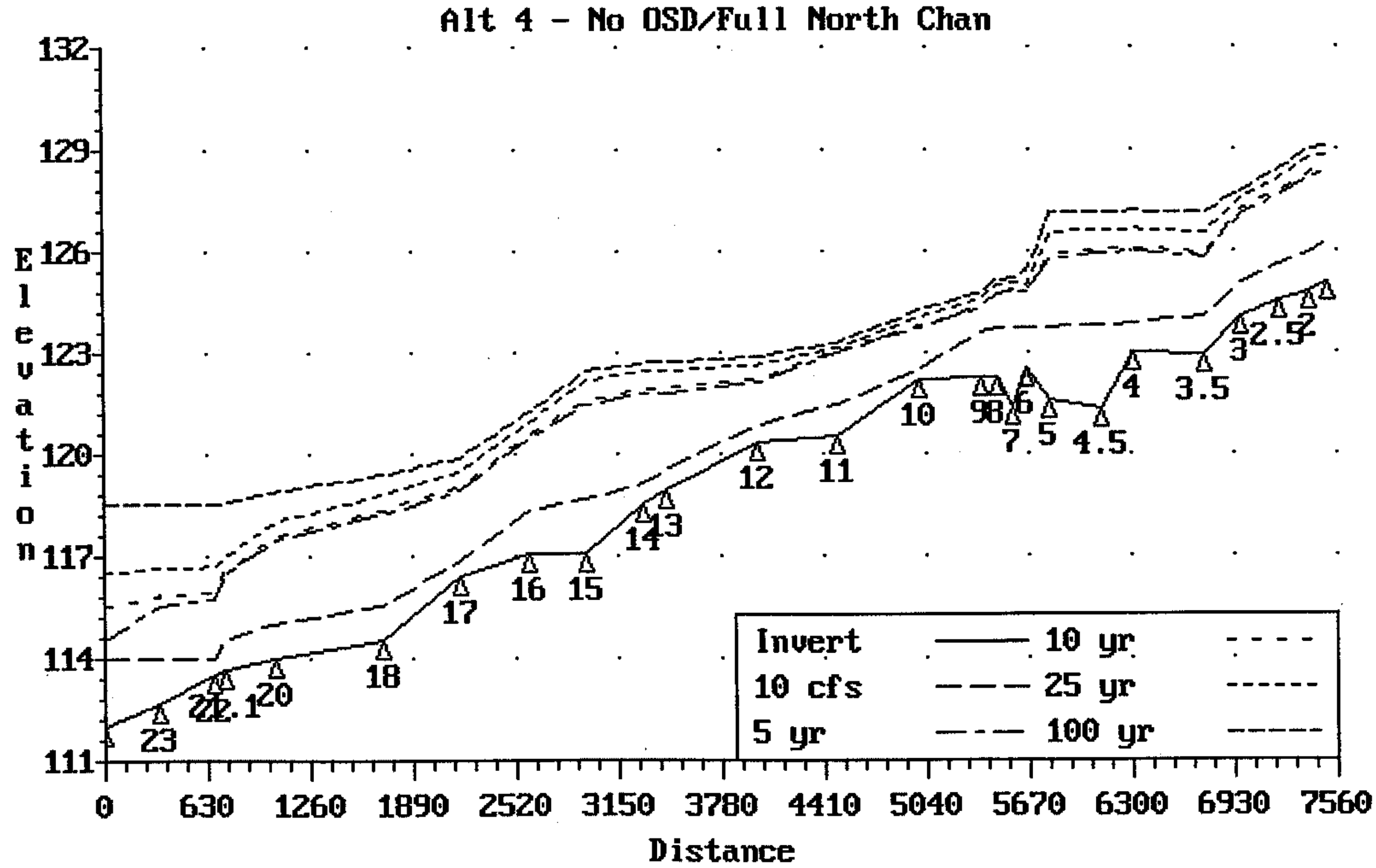
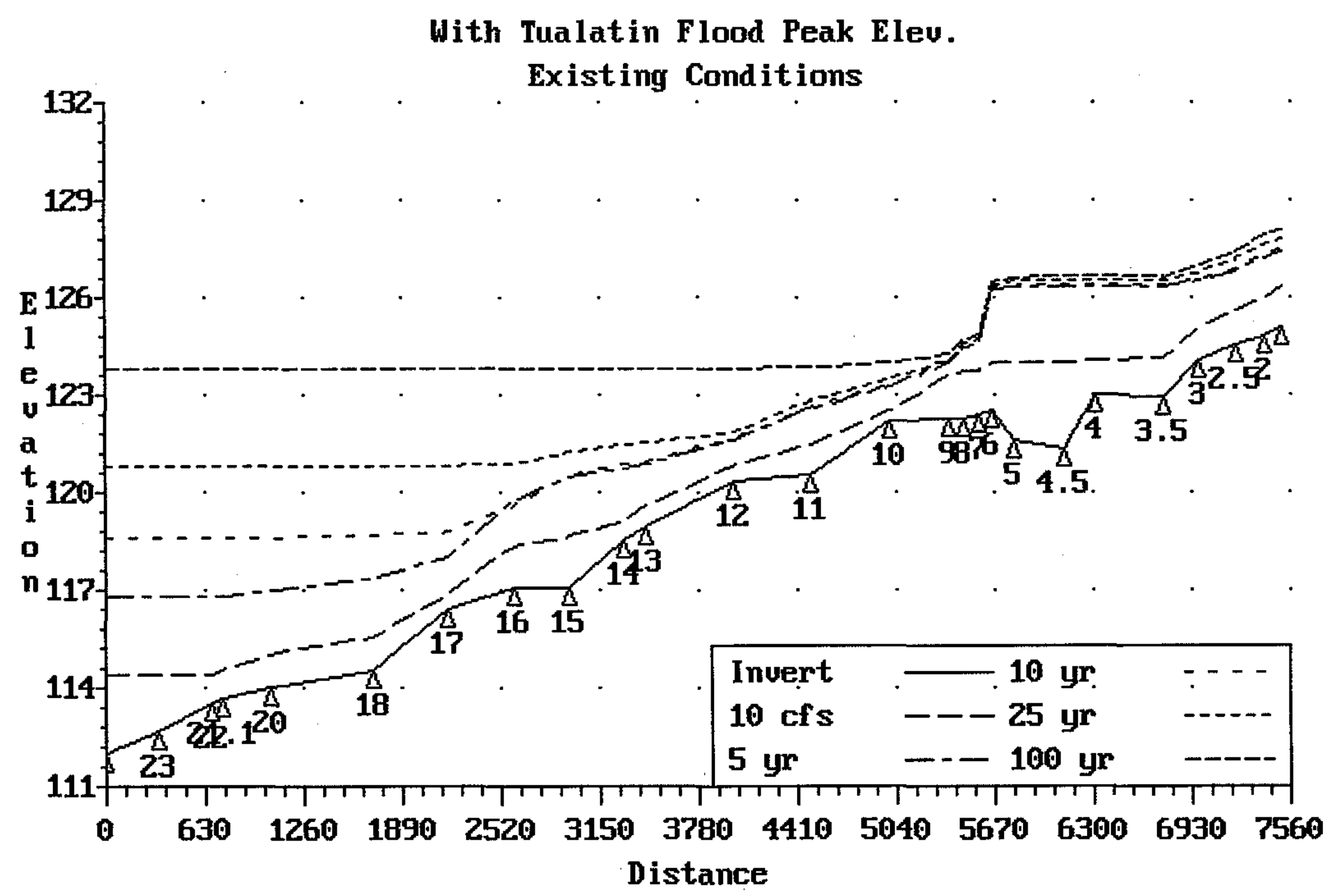
3.5
3
2.5
2

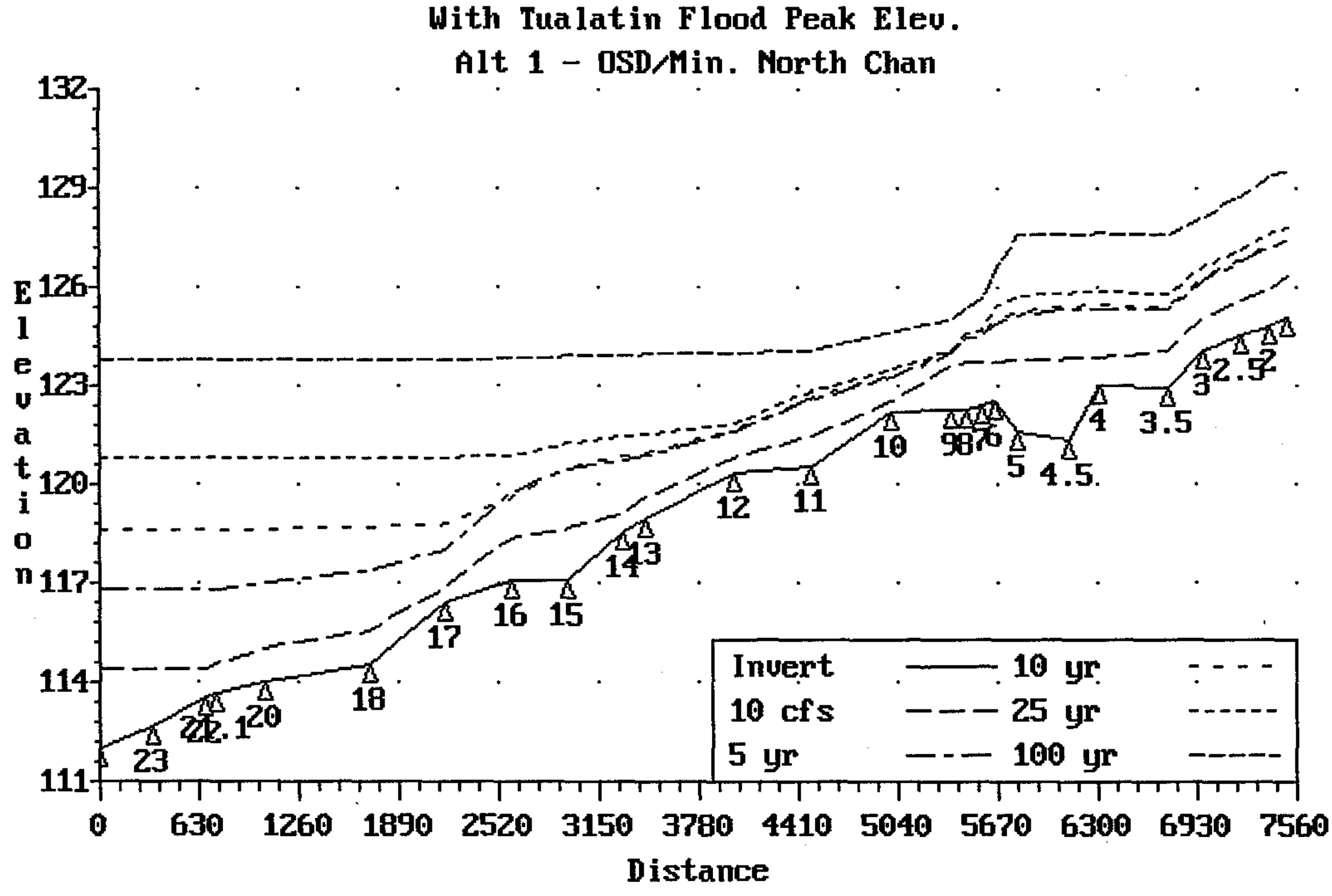

W/O Tualatin Flood Peak Elev.
Alt 3 - OSD/Full North Chan
Elevation
Distance
0 630 1260 1890 2520 3150 3780 4410 5040 5670 6300 6930 7560
111 114 117 120 123 126 129 132
Invert
10 cfs
5 yr
10 yr
25 yr
100 yr
23 22 21.1 20 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4.5 4 3.5 3 2.5 2

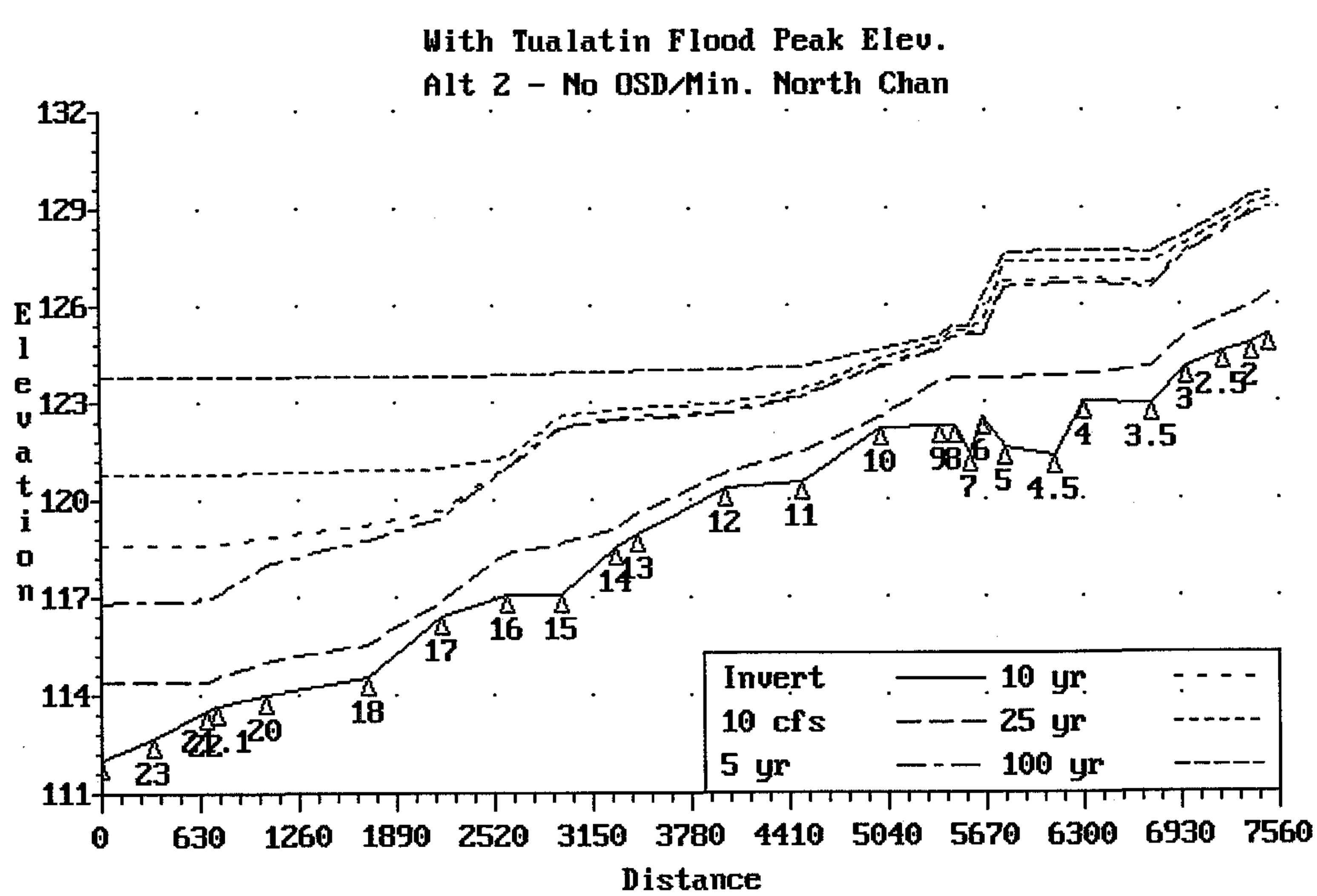
W/O Tualatin Flood Peak Elev.
Alt 4 - No OSD/Full North Chan



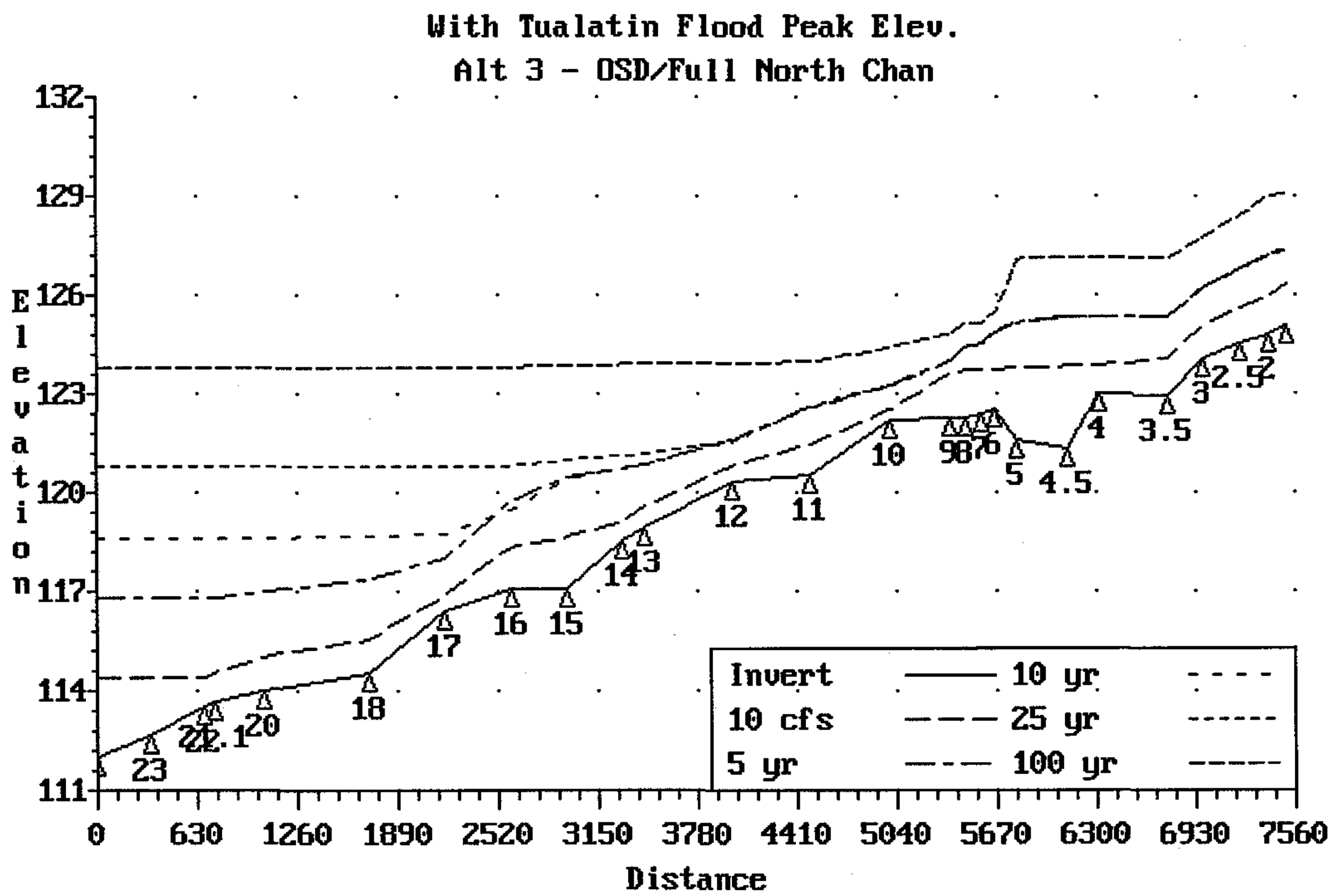


With Tualatin Flood Peak Elev.
Existing Conditions
Elevation
132
129
126
123
120
117
114
111
Distance
0
630
1260
1890
2520
3150
3780
4410
5040
5670
6300
6930
7560
23
22.1
20
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4.5
4
3.5
3
2.5
2
Invert
10 cfs
5 yr
10 yr
25 yr
100 yr

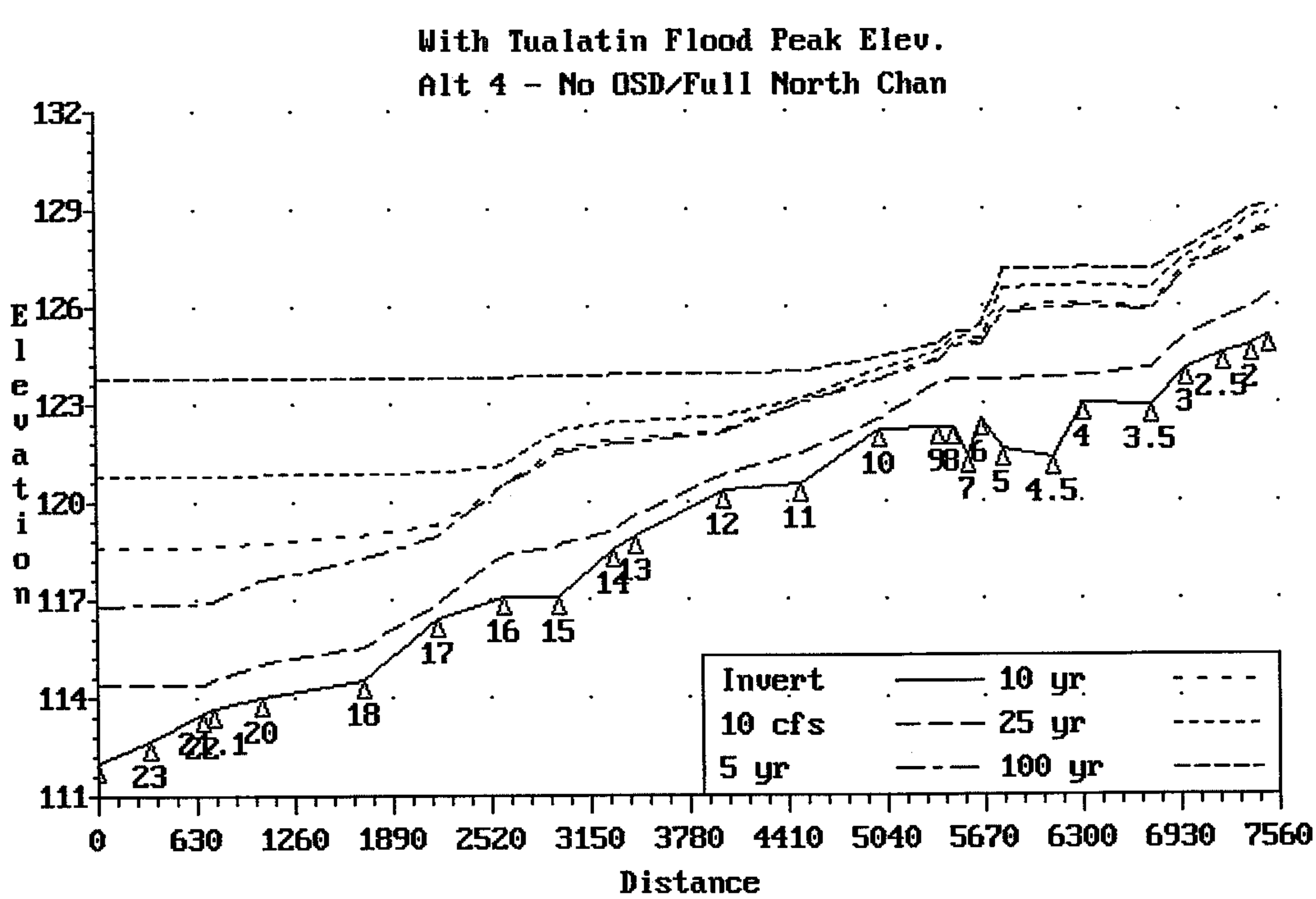

With Tualatin Flood Peak Elev.
Alt 1 - OSD/Min. North Chan
Elevation
Distance
132
129
126
123
120
117
114
111
0
630
1260
1890
2520
3150
3780
4410
5040
5670
6300
6930
7560
23
22
22.1
20
18
17
16
15
14
13
12
11
10
9876
5
4.5
4
3.5
3
2.5
2
Invert
10 cfs
5 yr
10 yr
25 yr
100 yr



With Tualatin Flood Peak Elev.
Alt 2 - No OSD/Min. North Chan
Elevation
Distance
Invert
10 cfs
5 yr
10 yr
25 yr
100 yr

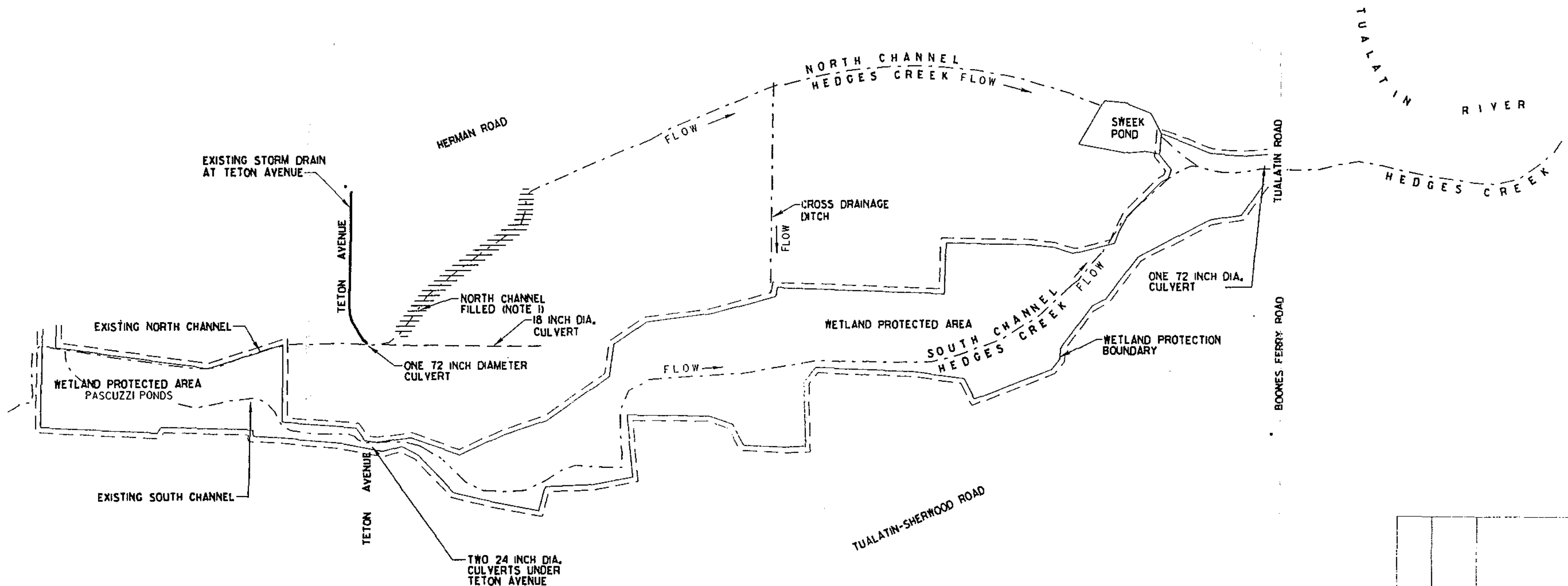


With Tualatin Flood Peak Elev.
Alt 3 - OSD/Full North Chan
Elevation
Distance
132
129
126
123
120
117
114
111
0
630
1260
1890
2520
3150
3780
4410
5040
5670
6300
6930
7560
23
22
22.1
20
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4.5
4
3.5
3
2.5
2
Invert
10 cfs
5 yr
10 yr
25 yr
100 yr



With Tualatin Flood Peak Elev.
Alt 4 - No OSD/Full North Chan
Elevation
Distance
Invert
10 cfs
5 yr
10 yr
25 yr
100 yr

FIGURES



NOTES:

1. THIS AREA OF THE NORTH CHANNEL WAS FILLED AND REPLACED WITH AN 18 INCH DIA. CULVERT.
2. FOR EXISTING CONDITIONS ANALYSIS, THE NORTH CHANNEL WAS ASSUMED TO BE FILLED AND ALL FLOW WAS ROUTED THROUGH THE SOUTH CHANNEL

0 300 600 900
SCALE IN FEET

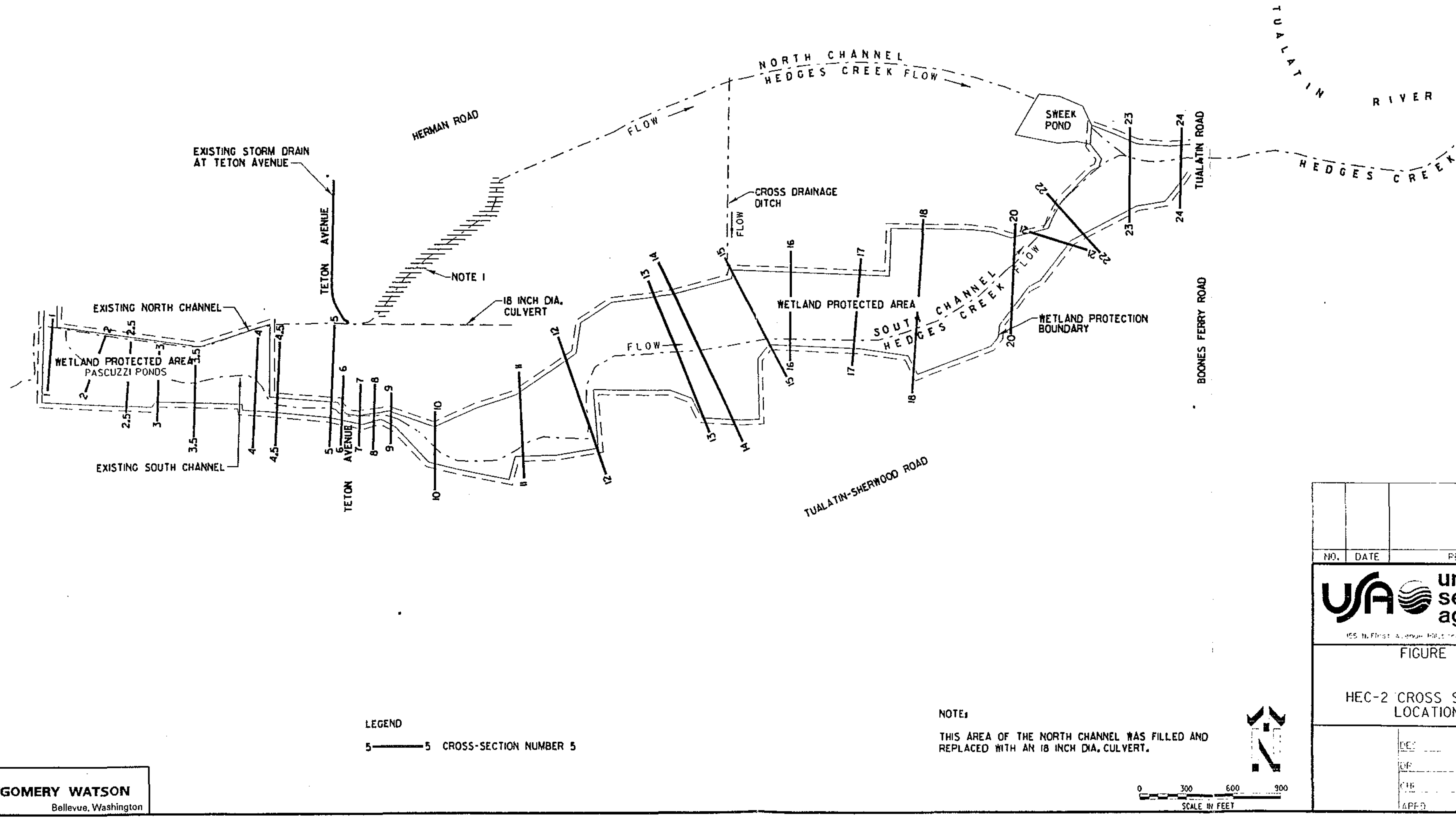
NO.	DATE	REVISION

unified sewerage agency

FIGURE 1

EXISTING CONDITIONS

MONTGOMERY WATSON
Bellevue, Washington



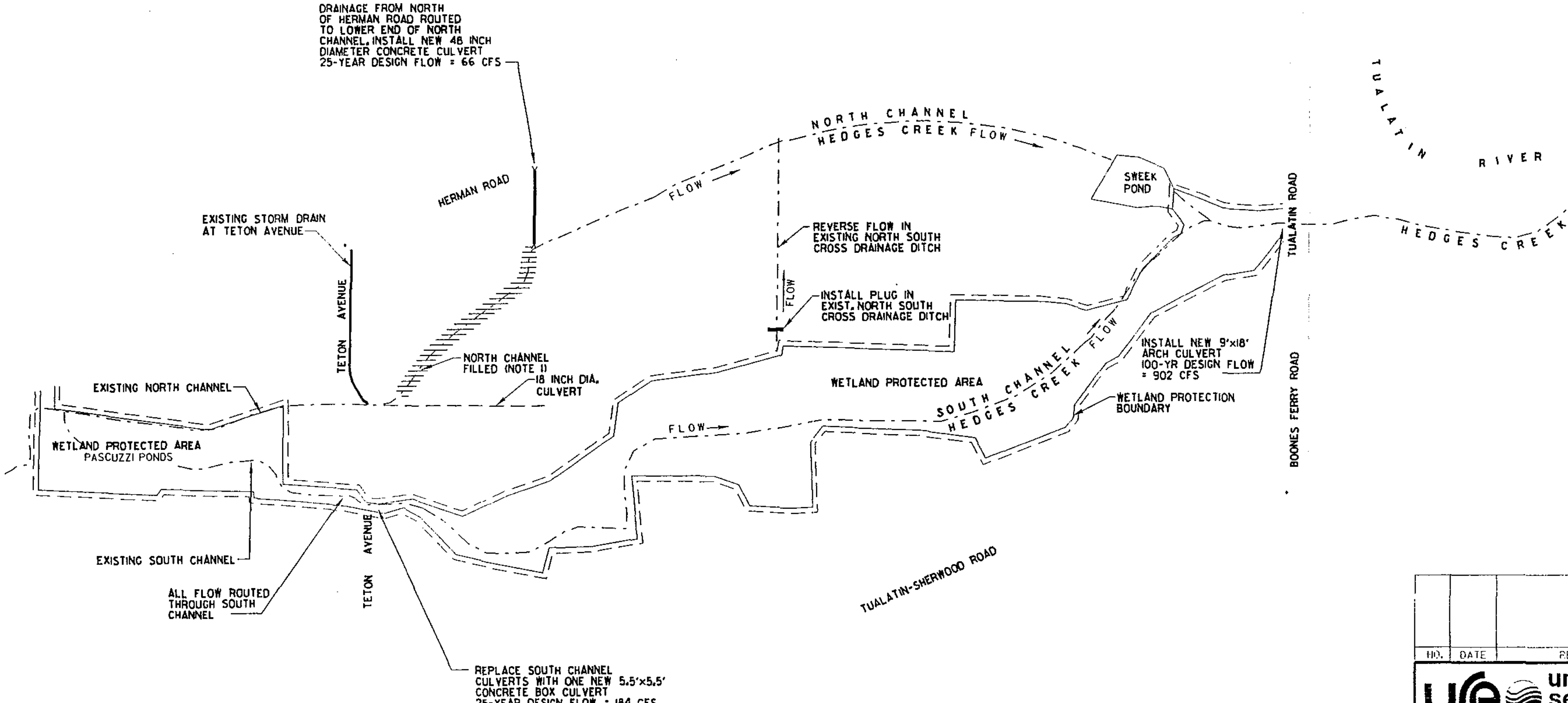
NO.	DATE	REVISION

unified sewerage agency

FIGURE 2

HEC-2 CROSS SECTION LOCATIONS

MONTGOMERY WATSON
Bellevue, Washington



NOTES:

1 THIS AREA OF THE NORTH CHANNEL WAS FILLED AND REPLACED WITH AN 18 INCH DIA. CULVERT.

2 NEW DEVELOPMENT IS REQUIRED TO MAINTAIN ON-SITE DEVELOPMENT DETENTION.

3 DESIGN OF NEW CULVERTS AT TETON AVENUE AND TUALATIN ROAD TO MEET DESIGN CRITERIA OF HEADWATER/PIPE DIAMETER RATIO LESS THAN OR EQUAL TO ONE.

0 300 600 900
SCALE IN FEET

NO.	DATE	REVISION

unified sewerage agency

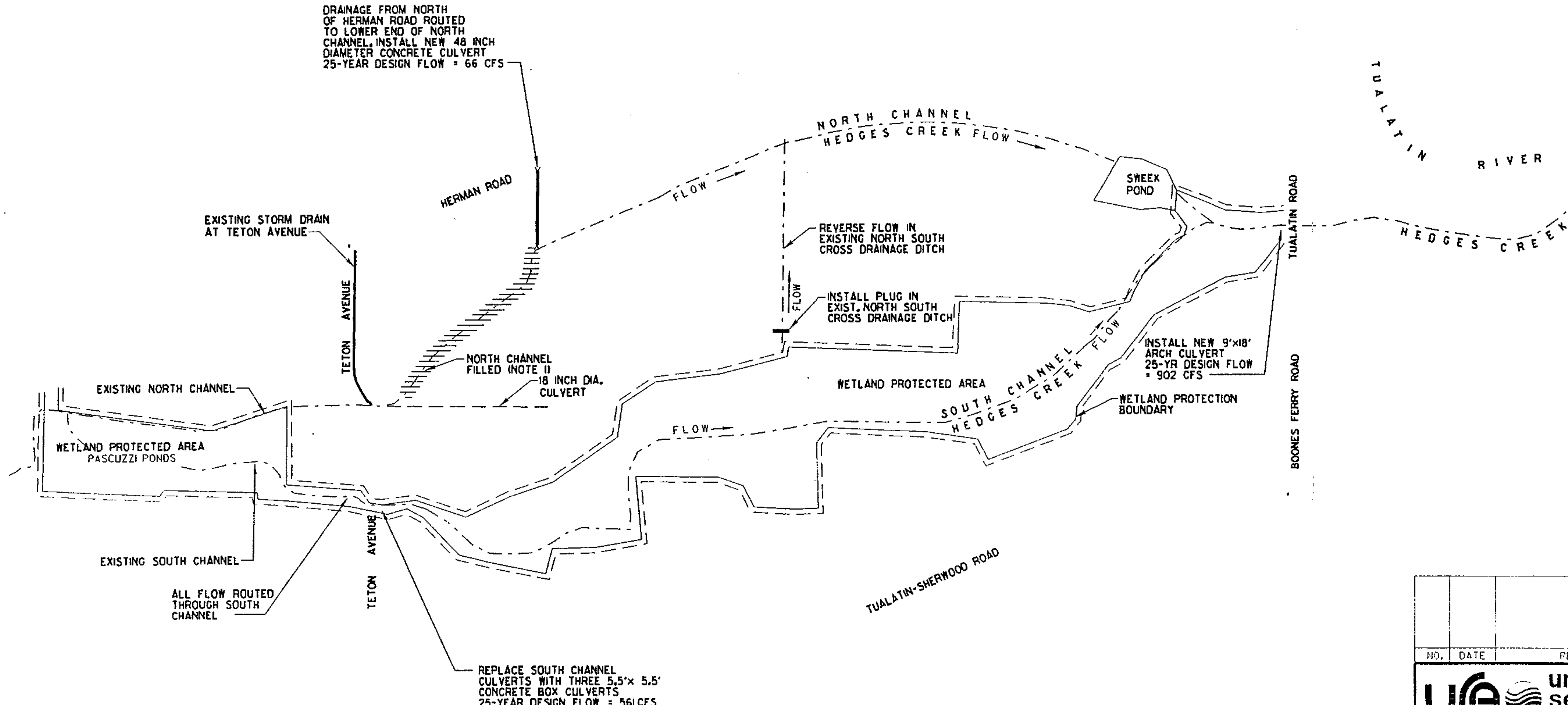
FIGURE 3
ALTERNATIVE I

ONSITE DETENTION WITH MINIMUM NORTH CHANNEL

SHEET

DATE

MONTGOMERY WATSON
Bellevue, Washington



NOTES:

1 THIS AREA OF THE NORTH CHANNEL WAS FILLED AND REPLACED WITH AN 18 INCH DIA. CULVERT.

2 DETENTION IS NOT REQUIRED FOR NEW DEVELOPMENT.

3 DESIGN OF NEW CULVERTS AT TETON AVENUE AND TUALATIN ROAD TO MEET DESIGN CRITERIA OF HEADWATER/PIPE DIAMETER RATIO LESS THAN OR EQUAL TO ONE.

N

0 300 600 900
SCALE IN FEET

NO.	DATE	REVISION

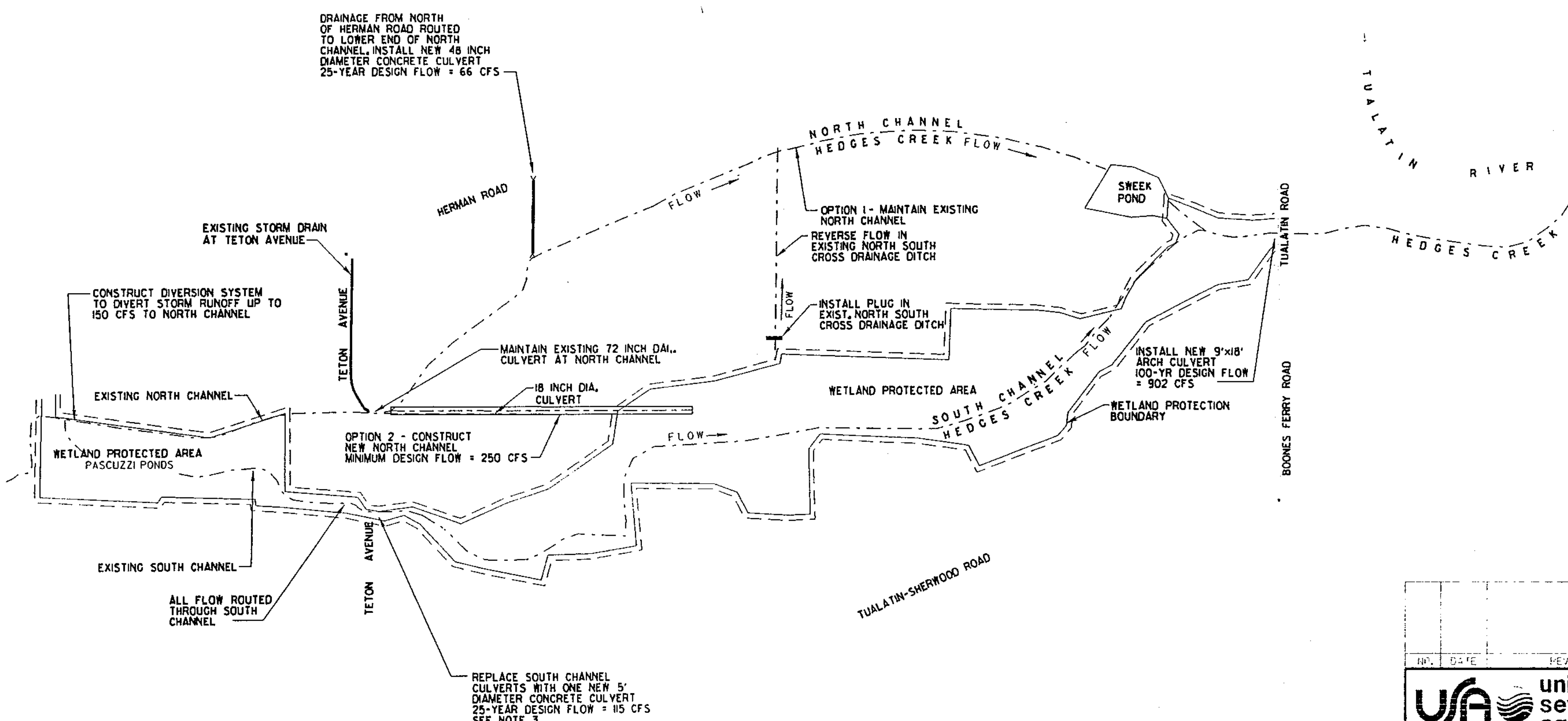
unified sewerage agency

FIGURE 4
ALTERNATIVE 2

NO DETENTION AND MINIMUM NORTH CHANNEL

SHEET

MONTGOMERY WATSON
Bellevue, Washington



NOTE:

1. NEW DEVELOPMENT IS REQUIRED TO MAINTAIN ONSITE DEVELOPMENT DETENTION.
2. DESIGN OF NEW CULVERTS AT TETON AVENUE AND TUALATIN ROAD TO MEET DESIGN CRITERIA OF HEADWATER/PIPE DIAMETER RATIO LESS THAN OR EQUAL TO ONE.
3. THE 25-YEAR DESIGN FLOW IN THE SOUTH CHANNEL IS SIGNIFICANTLY REDUCED BY THE COMBINATION OF ON SITE DETENSION AND FLOW DIVERSION TO THE NORTH CHANNEL.

0 300 600 900
SCALE IN FEET

MONTGOMERY WATSON
Bellevue, Washington

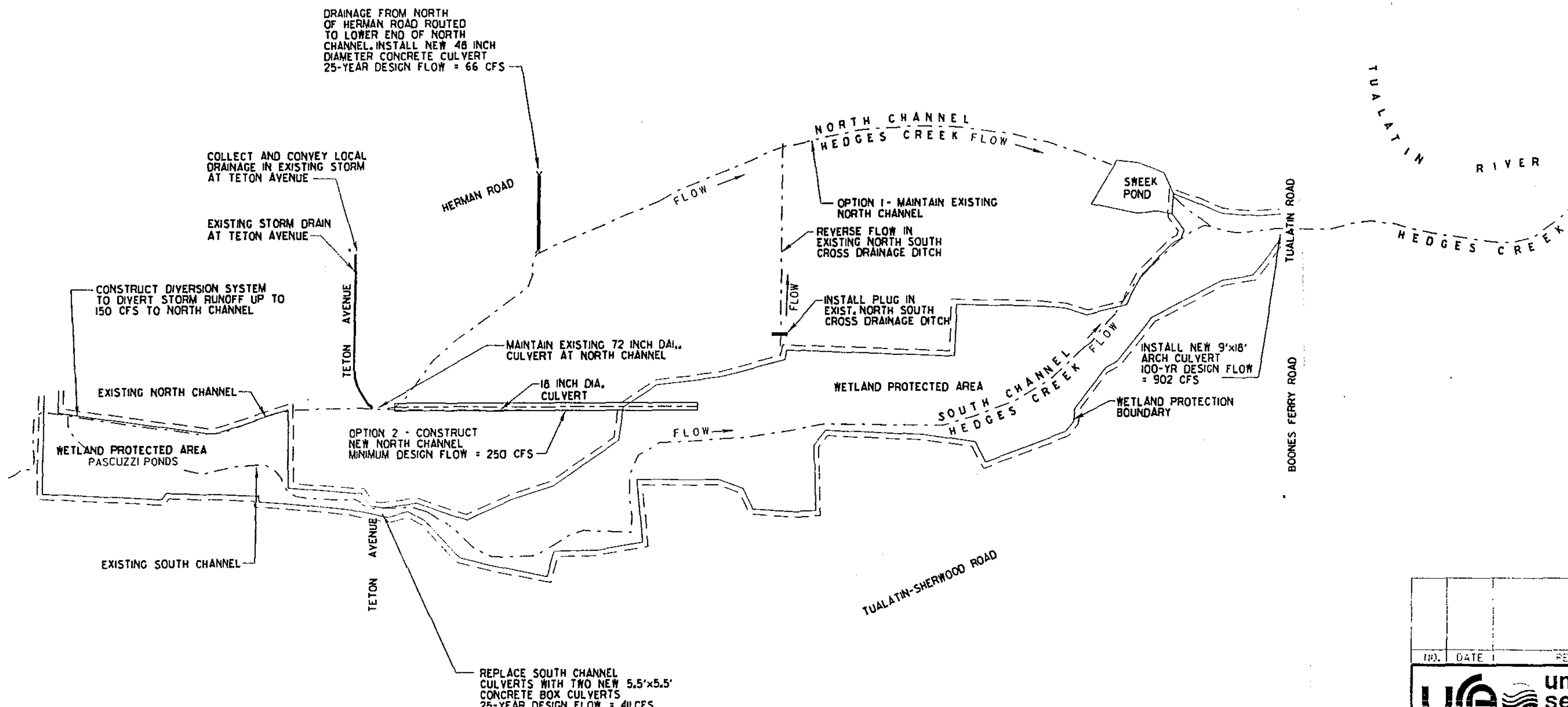
NO.	DATE	REVISION

unified sewerage agency

FIGURE 5
ALTERNATIVE 3

ONSITE DETENTION AND FULL NORTH CHANNEL

SHEET



NOTE:

1 NO ONSITE DETENTION REQUIRED FOR NEW DEVELOPMENT.

2 DESIGN OF NEW CULVERTS AT TETON AVENUE AND TUALATIN ROAD TO MEET DESIGN CRITERIA OF HEADWATER/PIPE DIAMETER RATIO LESS THAN OR EQUAL TO ONE.

0 300 600 900
SCALE IN FEET

NO.	DATE	REVISION

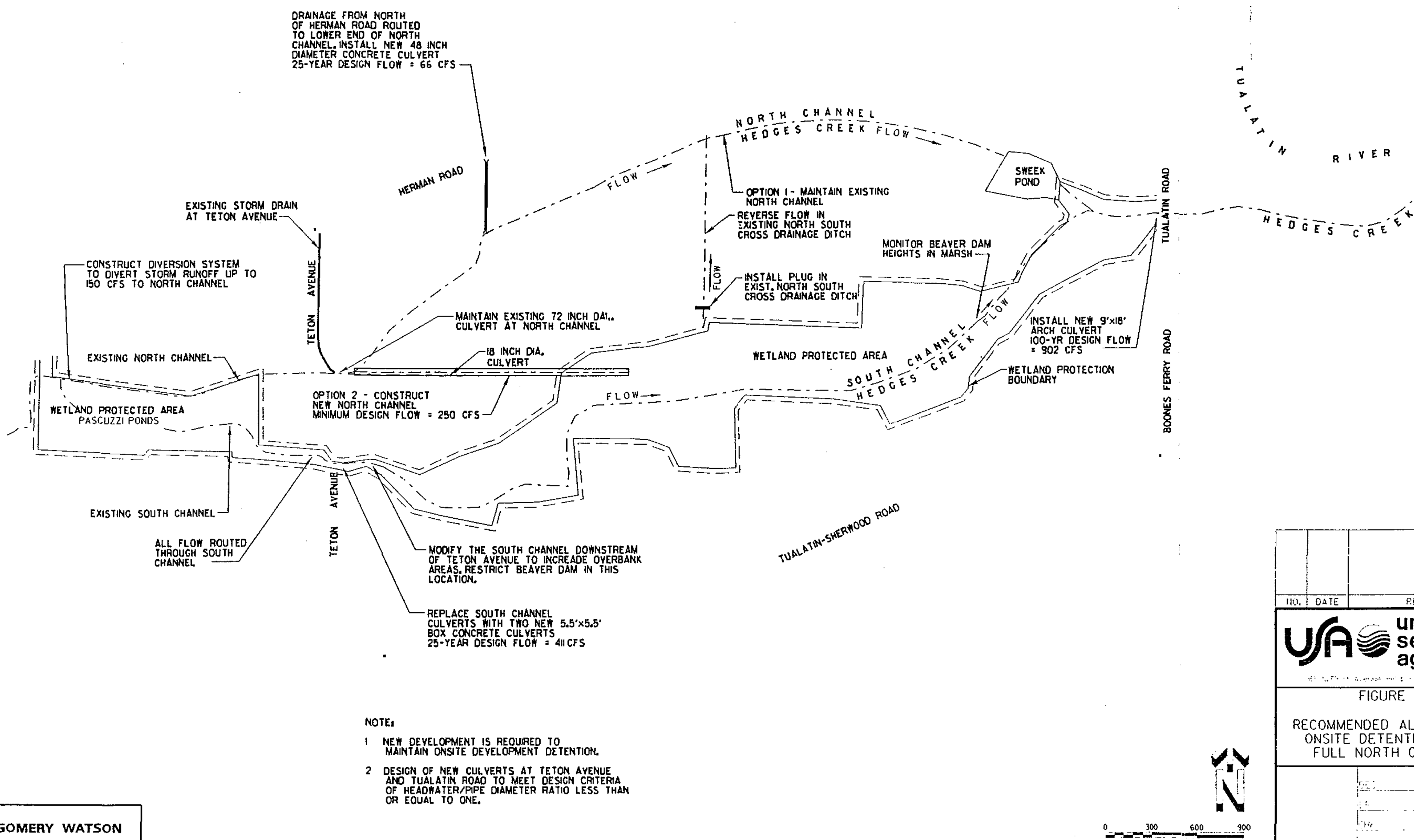
unified sewerage agency

FIGURE 6
ALTERNATIVE 4

NO ONSITE DETENTION AND FULL NORTH CHANNEL

SHEET

MONTGOMERY WATSON
Bellevue, Washington



NOTE:

1 NEW DEVELOPMENT IS REQUIRED TO MAINTAIN ONSITE DEVELOPMENT DETENTION.

2 DESIGN OF NEW CULVERTS AT TETON AVENUE AND TUALATIN ROAD TO MEET DESIGN CRITERIA OF HEADWATER/PIPE DIAMETER RATIO LESS THAN OR EQUAL TO ONE.

MONTGOMERY WATSON
Bellevue, Washington

NO.	DATE	REVISION

unified sewerage agency

FIGURE 7

RECOMMENDED ALTERNATIVE ONSITE DETENTION AND FULL NORTH CHANNEL

SHEET

HEDGES CREEK SUBBASIN PLANNING
STREAM AND WETLANDS MONITORING

PURPOSE

The purpose of this memorandum is to provide guidance in the use of the attached Hedges Creek Stream and Wetlands Monitoring form.

BACKGROUND

The Hedges Creek subbasin consists of 2856 acres of urban and undeveloped land located within Washington County and is contained almost entirely within the City of Tualatin city limits. The subbasin lies in a relatively shallow valley bounded by low hills on the north, south, and west. The Hedges Creek Marsh is that area located within the City of Tualatin Wetland Protection District. Hedges Creek splits into a north and south channel at the west end of the marsh. The north channel extends along the north side of the Wetlands Protection District from the diversion point upstream of Pascuzzi Ponds east to Teton Avenue. The south channel is located within the Wetland Protection District and flows west to east from Pascuzzi Ponds to Tualatin Road.

The Hedges Creek Subbasin Strategies Plan outlines measures to protect the health of the Hedges Creek Marsh. These measures balance flood control with water quality management. In order to assess the efficiency of implemented measures, a visual monitoring program was identified as a critical element in maintaining and enhancing the health of the Hedges Creek Marsh. A monitoring form (attached) was developed to assist local citizens in assessing the marsh on a regular interval.

DESCRIPTION OF MONITORING PARAMETERS

As outlined in the attached monitoring form, a number of parameters were selected for assessing the health of the Hedges Creek Marsh. The monitoring form consists of six distinct sections:

(1) Water Characteristics
(2) Stream Characteristics
(3) Riparian Vegetation
(4) Human Impacts
(5) Photo Points
(6) Wildlife and Habitat

Within each section, a number of characteristics are outlined which will be recorded during periodic inspections of the marsh. The data collected on these periodic inspections will be used to track the overall health of the marsh over time. Using this approach, potential impacts to the marsh can be identified and addressed.

A brief definition of each of the monitoring form parameters is presented in the following paragraphs.

Water Characteristics

The characteristics of the water found in the marsh provides an immediate visual assessment of water quality conditions. Many of the nonpoint source pollutants found in the marsh can be identified by viewing the water in the marsh. These sources include erosion and sedimentation, oil sheens, and floating debris. The monitoring parameters within this group include the following:

- **Depth.** Record the water depth measured from the surface of the water to the channel floor. Where staff gages are installed, record the water level on the staff gage.

- **Flow velocity.** Determine the speed of the water moving through the channel or marsh in terms of rapid, slow, or stagnant (not moving).

- **Temperature.** Using a simple water temperature probe, measure the water temperature. The temperature should be measured at a mid-depth level rather than directly on the surface.

- **Color.** Record the stream color such as clear, brown (turbid), green (algae), or other colors which may be present.

- **Observations.** Note any oil sheens, foam, trash, sediment or other forms of debris which may be present at the monitoring location.

Stream Characteristics

The stream characteristics provide insight into the condition of the drainage structures and stream channels within the marsh. Changes to the stream channel are most often related to flooding conditions and can be monitored and repaired before major impacts, such as erosions and sedimentation, occur within the marsh. The monitoring parameters within this group include:

- **Type of drainage structures.** Record any drainage structures which are observed at the monitoring location including culverts, weirs, ponds, or constructed channels.

- **Condition of drainage structures.** Note the condition of the drainage structure as good, fair, and bad.

- **Substrate type.** Record the stream channel floor (substrate) type as gravel (round or angular), hard mud, or soft mud. Note any recent sedimentation in the stream floor.

- **In-channel debris accumulation.** Record any debris accumulation within the channel. Debris could include litter, trash, limbs, tires, etc.

- **Channel shape.** Note the shape of the channel and position of the water surface within the channel.

- **Vegetation type.** Record the type of vegetation as floating (aquatic), rooted (submergent), and above the water surface (emergent). Roughly estimate the percentage of each vegetation type present at the monitoring location.

- **Dominant species.** If possible, note the most prevalent vegetation species present.

Riparian Vegetation

The riparian vegetation within the stream corridor and marsh are important in maintaining water quality and providing wildlife habitat. The canopy cover is particularly important in shading the stream which helps to control temperatures within the water column. Monitoring parameters within this group include:

- **% Canopy cover.** Estimate the degree of canopy cover over the stream or pond with a total canopy cover as 100% and no cover as 0%.

- **Cover type.** Record the cover type as herbaceous (leafy), shrubs, deciduous trees, or coniferous trees. Estimate the rough percentage of each cover type composing the canopy. If possible, note the species present and the rough percentage present in the canopy.

- **Snags.** Note any standing dead trees present and the relative condition.

Human Impacts

During each periodic inspection, note any trash and litter deposits within the marsh area. Typical deposits may include tires, yard clippings and debris, paper and trash. Note the location and amount so that cleanup efforts can be organized. Also note any direct storm runoff discharges from adjacent development which appears to have poor water quality which may impact the marsh. If possible, take a photograph of each discharge for future reference.

Photo Point

Photographs of the features present at each monitoring station should be taken during each periodic inspection. These photographs will provide a visual record of changes to the marsh over time. The time, date, and location of the photographs should be recorded directly on the photo.

Wildlife and Habitat

A table is provided for recording the location and type of wildlife found at each monitoring location. List the species or a description of the wildlife seen and the location sited such as riparian (r), open water (w), bank (b), and herbaceous (h).

SCHEDULE

Periodic inspections of the Hedges Creek Marsh should be conducted year-round to provide an assessment of the marsh health throughout the range of flow conditions. The frequency of the inspections is dependent on available resources, but a minimum of monthly inspections is recommended. More frequent inspections may be beneficial during heavy storm events or dry periods during the summertime. The date, time, and weather conditions at the time of the inspection should be noted. If possible, the same person or group of people should conduct the inspections. This will allow the inspector to become familiar with the marsh and provide consistency in the assessment data.

HEDGES CREEK - STREAM & WETLANDS MONITORING

Location: ____________________ Date: ______ Time: _____ Observer: ________

Weather (current and previous 24 hours): ______________________________

____

Comments: ____

____

____

WATER CHARACTERISTICS

Depth: _________ **staff gage ht.:** ___________ **secchi depth:** _______

Flow velocity: rapid slow stagnant temperature: _______

Color: clear brown green other ___________

Observations: oil sheen foam trash sediments

other ___________

Algae: floating attached

STREAM CHARACTERISTICS

Types of drainage structures: ________________________________

Condition of drainage structures: ______________________________

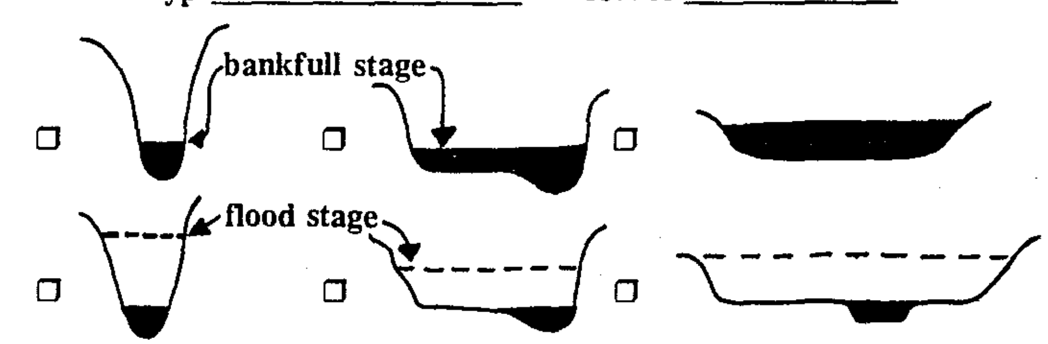
Substrate type: gravel (round or angular) hard mud soft mud

In-channel debris accumulation: type ______________ source ___________

Channel shape:

entrenchment

confinement



Vegetation type: aquatic _______% (floating) submergent ____% (rooted) emergent __% (above water surface)

Dominant species ___________ ___________ ___________

RIPARIAN VEGETATION

% Canopy cover over stream/pond ____% comments ______________________

% Cover on streambanks within floodplain ________%

Cover type (%):__% herbaceous __% shrubs __% deciduous trees __% coniferous tree

trees __%	shrubs __%	herb __%
species	species	species
____%	____%	____%
____%	____%	____%
____%	____%	____%
____%	____%	____%

* = dominant

snags (standing dead trees > 6" dbh)

no. observed:_____; condition:______________________

HUMAN IMPACTS (in water/riparian/adj.uplands)

Trash/litter: ______________________

Observed pollution sources:

drainage pipes yard debris storage drums

street/parking lots other:______________________

PHOTO POINT

(Include location and identifiable landmarks)

comments: ______________________

____

____

____

WILDLIFE & HABITAT (List species & r.w.b.h)

r = riparian w = open water b = bank h = herbaceous

BIRDS	MAMMALS	AMPHIBIANS	REPTILES

DEFINITIONS

Entrenchment - Degree of downcutting by stream channel

Confinement - Floodplain width

Bankfull stage- Normal high water line

Flood stage - Extreme high water line

APPENDIX C

POTENTIAL POLLUTION REDUCTION FACILITY IDENTIFICATION

APPROACH

Of the total drainage facilities inventoried, a total of 17 potential Pollution Reduction Facilities (PRF) were identified in the Hedges Creek subbasin. Generally, the opportunities for siting PRFs in the basin were limited to the physical modification of drainage ditches, ditch/culvert systems, or existing ponds. In making judgements as to the suitability of a given site for a PRF, processes such as sedimentation, sediment entrainment by vegetation (either existing or planted), and stormflow retention were considered.

The following descriptions for PRF opportunities are tied to the locations in Figures VI-6a and VI-6b, and in most cases the number of the PRF matches the drainage facility site number.

PRF NUMBER 1

Site description. This site is located on lower Hedges Creek at the crossing of Boones Ferry Road immediately west of the City of Tualatin Parks and Recreation Department buildings and north of The Wetlands Conservancy offices. Access to the site is from the roadway across the railroad tracks. As described on the data sheet for Facility #1, the large culverted outlet and concrete wingwalls are in excellent condition.

Opportunity(s). Although much of the site upstream of the outlet culvert is wetland, there appears to be an opportunity for installing a low weir at the culvert to increase water depths upstream creating a greater opportunity for sedimentation of particulates (and therefore nutrients) in runoff (Figure VI-6a). The major vegetation types in the wetland are reed canary-grass (*Phalaris arundinacea*) and hardhack (*Spireae douglasii*). Both species can survive brief periods of inundation. Within limits, no apparent headwater constraints were observed.

PRF NUMBER 5

Site Description. This site is located immediately north of and adjacent to Herman Road and just west of Teton Avenue. An existing commercial facility parking lot is adjacent to the west. The site is best described as an existing landscaped swale. The swale begins on the northern margins of the commercial development, arcing south toward herman road where runoff from the swale enters the roadside ditch via a 12-inch CMP. The swale has a very low longitudinal gradient, is quite shallow (maximum depth of 1.5 feet from average surrounding grade) and is lined with washed, large cobbles throughout its length.

Opportunity(s). The pollution reduction opportunity at this site appears to be relatively small and would likely be applicable only for the existing adjacent development. At that scale, however, installing a low rock or concrete weir near the culvert outlet would allow for periodic, but not excessive, ponding after storm events through most of the lower segments of the swale.

PRF NUMBER 6 and 7

Site Description. This is perhaps one of the largest potential PRF sites in the subbasin, and one that may have the highest degree of potential treatment benefits. The site is located immediately west of and adjacent to S.W. Teton Avenue on Hedges Creek. In this area, Hedges Creek is divided into at least two main channels, north and south. The Drainage Facility data sheets for facilities 6 and 7 describe in detail the characteristics of the multiple culverted outlets from the site.

Opportunity(s). Elevations over the site range from approximately 122 feet in the creek bottoms to upward of 129 feet. The average elevations are near 124.5 feet. Much of the site appears to be wetland, however, with reed canary-grass as the dominant vegetation species.

To maximize the effectiveness of the site as a PRF, selected excavation in combination with retainment and/or diversion structures will be required. With retainment (weirs) systems installed at both the north culvert (Facility #6) and the south culverts (Facility #7), there appears to be the opportunity to periodically inundate approximately 8 to 10 acres during winter and spring storm events, as suggested in Figure C-1. With separate main channels, there is also the possibility to divert flows further west of Teton Avenue, rather than rely on weirs at the culvert ends. The allowable headwater is well within the upper limits of a structural retainment system, with the opportunity to periodically pond water up to 1.0 feet above the average grade elevation. Some commercial development was under construction off-site to the southwest at the time of the facility inventory, but it was evident that the final grades were sufficiently above the average PRF site elevation to prevent any flooding conflicts.

PRF NUMBER 8

Site Description. This site is located north of and adjacent to S.W. Herman Road and west of S.W. 108th Avenue at the southeast corner of an extremely large open field zoned and planned for future industrial development. A small industrial facility is sited immediately to the east, with a large commercial center approximately one-quarter mile to the north. This site includes a recently constructed retention-detention pond, large concrete weirs, and culverts under Herman Road and under access driveways to the north off Herman Road. The latter culverts serve to conduct runoff water under the driveways along a recently modified roadside ditch.

The retention-detention pond is roughly rectangular in shape with steep sides formed by large berms. The depth of the pond appears to be approximately 110 to 12 feet from berm top to pond bottom, with water depths on March 27, 1991 of about 4.0 feet. A relatively large, flat-bottomed cobble-lined drainage ditch is connected to the pond, draining from the large commercial development to the north. The outlet from the pond is via both a large, concrete weir with a fixed level floodflow spillway and a lower low flow culvert. Runoff from the pond and from the roadside ditch converge immediately north of Herman Road and flow south under the roadbed to Hedges Creek.

Opportunity(s). The pond functions to some extent now as a PRF. The current primary benefit is from sedimentation of particulates in runoff from the development to the north. As future industrial development occurs in the open filed area to the northwest, there appears to be an excellent opportunity to modify and expand the existing facility to treat the subsequent increases in stormwater runoff.

The pond area could be enlarged and topographically diversified. Varying the bottom contours of the pond to allow for fluctuating water depths, in addition to a dense planting of certain vegetation species in the shallower areas, would increase greatly the biofiltration capacity of the system. It is likely that no modification to the existing pond weir would be necessary. The expansion of the facility could also be tied to the PRF development opportunity at facility #18 and #19 upgradient (see discussion below). Small check dams could be placed in the existing rocked channel to the north of the pond to allow for increased sediment trapping.

The ditch along Herman Road could be developed into a small PRF through the installation of low weirs at the upstream ends of the bevelled culverts under the access driveways. A maximum of 1.0 to 2.0 feet of water could be ponded in ditch segments during storm events, with the weirs acting also to retain the water in the ditch for longer periods. Plantings of wetland plants with dense root mass could be made in the ditch to increase sediment entrainment and nutrient uptake.

PRF NUMBER 9

Description and Access. This facility (pond) is located at the southeast corner of the intersection of S.W. Tualatin-Sherwood Road and S.W. Teton Avenue. The entire area is generally accessible, except the south shoreline of the facility, which is densely vegetated. A water control structure (dike) is used to create the pond which characterizes this facility. The dike is approximately 4 feet high, and the outflow drains into a large field, dominated by reed canary grass (*Phalaris arundinacea*). Ducks likely use the pond and drainage field for breeding and foraging habitat.

Opportunities. PRF opportunities are excellent at this site. Minimal effort would be required to modify the existing condition into an efficient, fully-functioning PRF facility. The pond was characterized by a "safe edge shape", and currently acts as a sedimentation basin. The banks of this facility were well-vegetated which helps to increase bank stability of the site, and allowable headwater volume and watershed area were an appropriate size to have a significant effect on pollution reduction. Flooding of residential areas should not be a problem during stormwater runoff events. The pollution reduction potential of this facility can be enhanced with the establishment of wetland vegetation within the pond area. Wetland vegetation would also enhance wildlife habitat potential.

Constraints. The only potential constraint to PRF development at this site may be potential jurisdictional wetland.

PRF NUMBER 10

Description and Access. This facility (culvert) was located west of the SW Tualatin-Sherwood Road and SW Avery St. intersection. This facility was characterized by one 60 inch diameter culvert approximately 150 feet long. The culvert was located approximately 7 feet below the Tualatin-Sherwood Road. The culvert was in excellent working condition, with riprap providing stability at the inlet and outlet configurations. Facility access was excellent.

Opportunities. This facility provides good PRF opportunities. Allowable headwater volume and watershed area would be adequate to provide significant pollution reduction potential. This site can accommodate the addition of a small sedimentation pond and created wetland without significantly impacting amenity values. Wildlife habitat potential would also be enhanced. Additionally, flooding should not be a significant hazard to industrial sites located adjacent to the proposed PRF facility.

Constraints. The only potential constraint to PRF development at this site may be potential jurisdictional wetland.

PRF NUMBER 11

Description and Access. This facility (culvert) was located east of the SW Tualatin-Sherwood Road and SW 120th Ave. intersection. This facility was characterized by one 36 inch diameter cement culvert approximately 125 feet long. Additionally, two 4 inch diameter PVC pipes were also present. The cement culvert was located approximately 13 feet below the Tualatin-Sherwood Road. The culvert was in excellent working condition, with riprap providing stability at the inlet and outlet configurations. Facility access was excellent.

Opportunities. This facility provides good PRF opportunities. This site provides sufficient area for the construction of a sedimentation pond and adjoining wetland without significantly impacting other issues and concerns. Wildlife habitat potential would be enhanced, and upstream flooding should not significantly impact industrial or residential areas during stormwater runoff events.

Constraints. Possible constraints to PRF development include land acquisition potential. Allowable headwater volume and watershed area also present constraints, although to a much lesser degree. Water volume at this facility was not significant during normal weather conditions. However, during stormwater runoff events, it is estimated that this facility would generate significant allowable headwaters.

PRF NUMBER 13

Site Description. This site is located immediately east of the junction of S.W. Cipole Road and the Tualatin-Sherwood Road, immediately south of the latter roadbed. A small intermittent stream channel that flows through open livestock pasture is culverted under the Tualatin-Sherwood Road, with flows from that point entering an underground culvert or drain tile system. Slope gradients to the south within the potential PRF area are concave, becoming steeper with distance from the roadbed. A shallow roadside ditch is present parallel to the road.

Opportunity(s). The PRF potential at this site is dependent on excavating material from the base of the slopes adjacent to the road. The potential area of the PRF is approximately 1.8 acres if the area of opportunity in Figure ___ can be implemented. However, grading a relatively flat area the site could serve to trap sediments and nutrients both in runoff from the stream and in overland stormflows. A control weir could be placed at the culvert, and check dams placed in the roadside ditch to contain ponded water.

PRF NUMBER 14

Description and Access. This facility (pond) was located behind the Coca-Cola processing plant on SW 105th Avenue. This facility was characterized by one large (approximately 300 feet X 100 feet) pond. Water depth in the pond was regulated by a vertical overflow culvert. Additionally, an emergency overflow culvert (approximately 60 inches in diameter and 100 feet long) drains the pond during high water flows. Invert data for the vertical overflow culvert was approximately 10 feet, and invert data for the emergency overflow culvert was approximately 1 foot. Ducks and geese use the pond for foraging and breeding. Access to the area was restricted to authorized personnel only.

Opportunities. PRF opportunities are excellent. Minimal effort would be required to modify the existing condition into an efficient, fully-functioning PRF facility. The pond was characterized by a "safe edge shape", and currently acts as a sedimentation basin. The banks of this facility were well-vegetated which reduces soil erodibility of the site, and allowable headwater volume and watershed area were an appropriate size to have significant effects on pollution reduction. Flooding of residential areas should not be a problem during stormwater runoff events. The pollution reduction potential of this facility can be enhanced with the establishment of wetland vegetation within the pond area. Wetland vegetation would also enhance wildlife habitat potential.

Constraints. Access potential and land acquisition potential would be the greatest constraints to PRF development at this location. Additionally, potential jurisdictional wetland may be present.

PRF NUMBER 15

Description and Access. This facility (pond) was located on SW 120th Ave. north of the private industrial site. This facility was characterized by a small pond. Water level in the pond was regulated by emergency overflow culvert (approximately 16 inches diameter and 38 feet length) located approximately 1 foot below the top of the dike. Outflow from the pond was largely restricted to seepage occurring at the bottom of the dike. Water volume associated with this seepage was insignificant. The area surrounding the pond is densely vegetated; the west shoreline was dominated by large Douglas-fir (*Psuedotsuga menziesii*) trees. The pond provides breeding and foraging habitat for ducks, and the adjacent uplands also provide important wildlife habitat. Access to the area was restricted to authorized personnel only.

Opportunities. PRF opportunities are excellent. The pond was currently acting as an efficient catchment basin for sediment (Figure C-3). Thus, minimal effort would be required to modify the existing condition into an efficient, fully-functioning PRF facility (Figure C-3). The banks of this facility were well-vegetated which reduces soil erodibility of the site, and allowable headwater volume and watershed area were an appropriate size to have significant effects on pollution reduction. Flooding of adjacent industrial and residential areas should not be a significant problem during stormwater runoff events. Pollution reduction potential of this facility can be enhanced by modifying the shoreline to increase the wetland surface area ratio. Additionally, this will also enhance a "safe edge shape". Wetland vegetation enhancement would also enhance wildlife habitat potential.

Constraints. Access potential and land acquisition potential would be the greatest constraints to PRF development at this location. Additionally, potential jurisdictional wetland may be present.

PRF NUMBER 18

Site Description. Located both sides, east and west, of S.W. 118th Avenue, this site is best described as a wide, level, agricultural field with a long, small, narrow, and shallow swale flowing E-W under the road. The swale nearly connects with facility and PRF #8 to the southeast. No culverts are present under 118th Avenue.

Opportunity(s). While flows in the swale are intermittent, with open water surfaces likely during winter storm events only, the swale is several hundred yards long (high length to width ratio). If future development does occur in the immediate vicinity modifying the existing swale could provide a significant reduction in contaminant and nutrient transport to downstream areas. For example, widening and/or deepening the depression in certain areas in conjunction with small check dams would allow for periodic inundation. Plantings made throughout the system would enhance the passive biofiltration capacity.

PRF NUMBER 19

Site Description. This site is located due south and parallel to PRF #18. However, unlike #18 this potential PRF is located only east of 118th Avenue. West of 118th a small jurisdictional wetland exists, acting as a "sponge" for natural and stormwater surface runoff from the west. As a result, a more sustainable flow (spring into early summer) issues from the wetland and is culverted under the roadway. East of the roadway, the flow enters a long, straight, V-shaped swale with low gradient uniform slopes. This swale is directly connected to facility and PRF #8 to the east.

Opportunity(s). The opportunity to develop a PRF here is focused on slight modifications of the swale morphology, installing low check dams, and on vegetation plantings. In its current condition, the swale is dominated by low-growing field grasses through most of its length. With minor slope and base-grade adjustments through excavation, inundation during winter and spring months by the check dams, and dense plantings in selected segments of appropriate vegetation species and communities an excellent opportunity exists to create an effective PRF.

PRF NUMBER 20

Site Description. This is located near the western end of S.W. 90th Court south of the Tualatin-Sherwood Road. The site consists of a small, shallow stream corridor that drains to a culvert under the highway that, in turn, conducts runoff from the eastern areas of a large agricultural field, at the western most end PRF number 9 is located. Several private residences are located in the immediate vicinity of the culverted outlet.

Opportunity(s). The opportunity to create an effective PRF at this site is limited. The maximum allowable headwater at the culvert is under 2.0 feet, given the location of the houses nearby. Sediments produced from soil erosion in the agricultural field would also limit the longevity of a created system.

PRF NUMBER 22

Description and Access. This facility (pipe) was located north of the SW Coquille Court and SW 98th Ave. intersection. This facility was characterized by a grassy swale drainage approximately 35 feet wide. This grassy swale drains into one 24 inch diameter cement pipe; the outlet was not located. The cement pipe was located approximately 5 feet below SW 98th Ave. The culvert was in fairly good working condition, although some debris has accumulated at the inlet. Facility access was excellent.

Opportunities. This facility provides excellent PRF opportunities (Figure C-4). Allowable headwater volume and watershed area would be adequate to provide significant pollution reduction potential. This site can accommodate the addition of a small sedimentation pond and created wetland without significantly impacting amenity values. Wildlife habitat potential would also be enhanced. Additionally, flooding should not be significant hazards to residences located adjacent to the proposed PRF facility.

Constraints. No constraints were identified with potential PRF development of this facility.

PRF NUMBER 23

Description and Access. This facility (culvert) was located west of the SW Alsea Court and SW 100th Ave. intersection. This facility was characterized by a small riparian drainage approximately 50 feet wide. This riparian area drains into one 40 inch diameter metal culvert approximately 150 feet long. The culvert was located approximately 8 feet below SW Alsea Court. The culvert was in excellent working condition. Facility access was also excellent.

Opportunities. This facility provides good PRF opportunities. Allowable headwater volume and watershed area would be adequate to provide significant pollution reduction potential. The implementation of a catchment basin would be the most cost-efficient alternative because of the relatively small size of the area, as well as the steep banks. This site can accommodate the addition of a small sedimentation pond and without significantly impacting amenity values. Wildlife habitat potential would also be enhanced.

Constraints. Potential jurisdictional wetland is probably present at the site. Access potential and land acquisition potential will need to be addressed. Allowable headwater constraints will also have to be addressed in order to minimize potential flooding of residence during stormwater runoff events. Safety concerns of nearby residences would also require that the steep banks associated with this facility be reconstructed to enhance a "safe edge shape

PRF NUMBER 24

Description and Access. This facility (concrete pipe) was located south of SW Alsea Court. This facility was characterized by the confluence of two small riparian drainageways. This riparian area drains into one 48 inch diameter concrete pipe approximately 30 feet long. The pipe was located approximately 20 inches below the top of the dirt-fill travel lane which crosses Hedges Creek. The culvert was in excellent working condition. Additionally, a 13 inch diameter concrete pipe was present at the inlet; the outlet was not located. This pipe was located approximately 4 feet below the surface of the travel lane. Facility access was excellent.

Opportunities. This facility provides good PRF opportunities. The confluence of two drainages provides a unique opportunity to reduce pollutants from different watersheds at a single location. Allowable headwater volume and watershed area would be adequate to provide significant pollution reduction potential. This site can accommodate the addition of a small PRF without significantly impacting amenity values. Wildlife habitat potential would also be enhanced.

Constraints. Potential jurisdictional wetland is probably present at the site. Access potential and land acquisition potential will need to be addressed. The small size of this area will require a relatively small PRF facility, either a catchment basin or enhanced wetland is recommended. Allowable headwater constraints will also have to be addressed in order to minimize potential flooding of residences during stormwater runoff events.

PRF NUMBER 25

Description and Access. This facility (concrete pipe) was located north of the SW Hedges Drive and SW Ibach Street. intersection. This facility was characterized by a forested riparian drainage. This riparian area drains into one 34 inch diameter concrete pipe approximately 180 feet long. The pipe was located approximately 15 feet below SW Hedges Drive. The culvert was in excellent working condition. Additionally, an emergency overflow pipe was also present. This cement pipe was approximately 40 inches in diameter, and was located approximately 10 feet below SW Hedges Drive. The outlet could not be located, but flow was expected to join the main culvert underneath SW Hedges Drive. The forested riparian corridor contains significant wildlife habitat; scattered old-growth Douglas-fir trees were present. Facility access was also excellent.

Opportunities. This facility provides excellent PRF opportunities (Figure C-5). Allowable headwater volume and watershed area would be adequate to provide significant pollution reduction potential. A relatively large area is available for the construction of a sedimentation pond and/or created wetland. Potential flooding hazards of nearby residences would be minimal during stormwater run-off events.

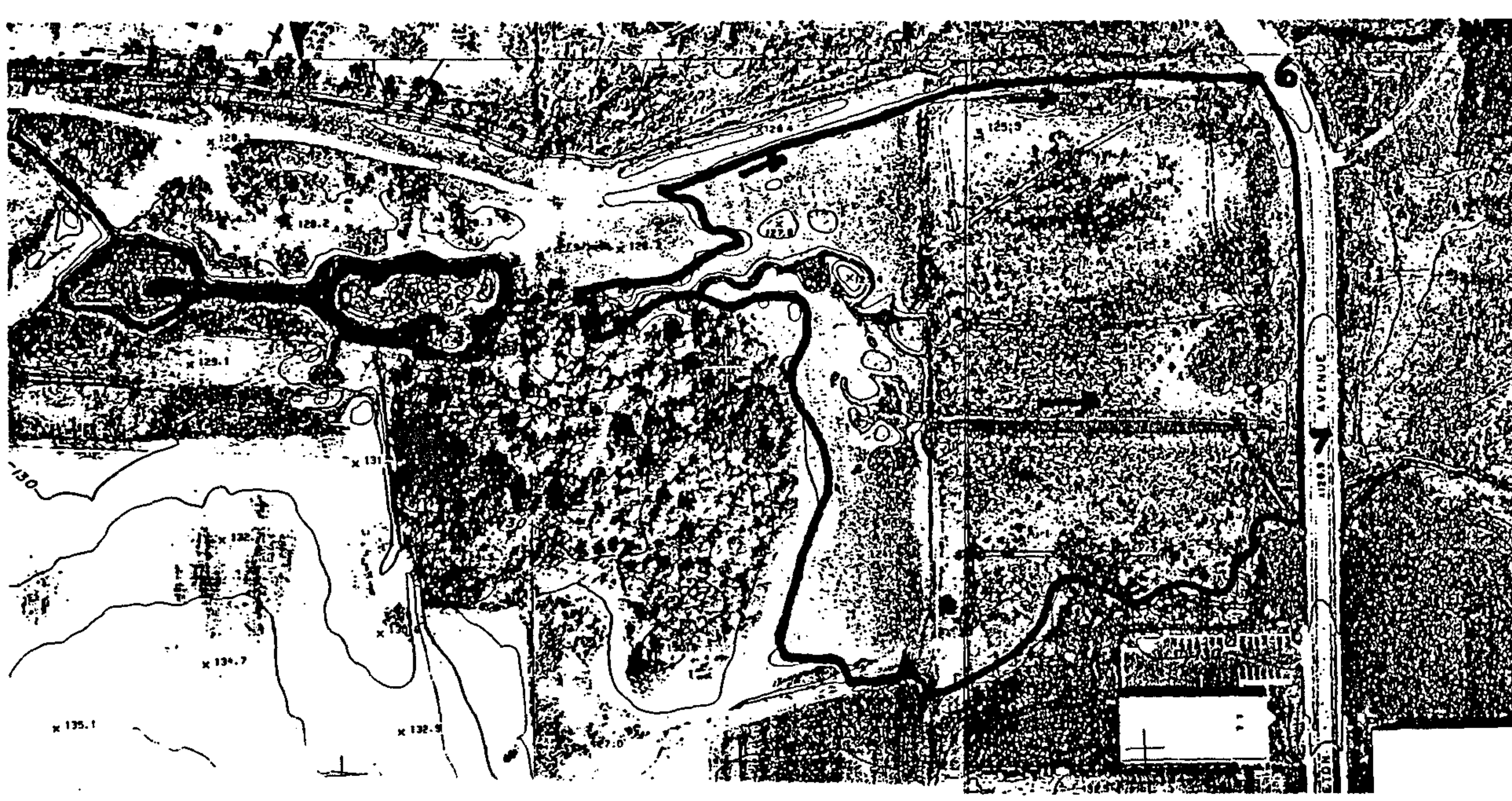
Constraints. Potential jurisdictional wetland is probably present at the site. Additionally, significant wildlife habitat may be impacted during PRF construction. Old-growth Douglas-fir trees are located in this riparian corridor. Mature old-growth trees have been identified in some areas in the Portland metropolitan area as a scarce resource. Access potential and land acquisition potential will need to be addressed.

PRF NUMBER 28

Site Description. This site is located adjacent to the Burlington Northern Electric Railroad grade in the southeast corner of the subbasin. This a broad, low depressional area of over 12 acres situated between the railroad grade and steep hillsides to the east and southeast. The railroad is trestled over the southern portion of the depression. No apparent outflow has been provided for water that collects in the depression.

Opportunity(s). Potentially jurisdictional wetland exists at this site. As part of a wetlands and wildlife tour conducted by the Audubon Society of Portland, this area is one of the stops made in that program. If justification could be provided in regard to wildlife habitat enhancement, the site could function as a PRF. Figure C-6 shows the area of opportunity and the conceptual idea of placing log weirs or rock gabiens at angles throughout the area to divert and disperse channel flow. Water levels could be controlled through installing a control structure (labeled C.S. on aerial photo) with a berm.

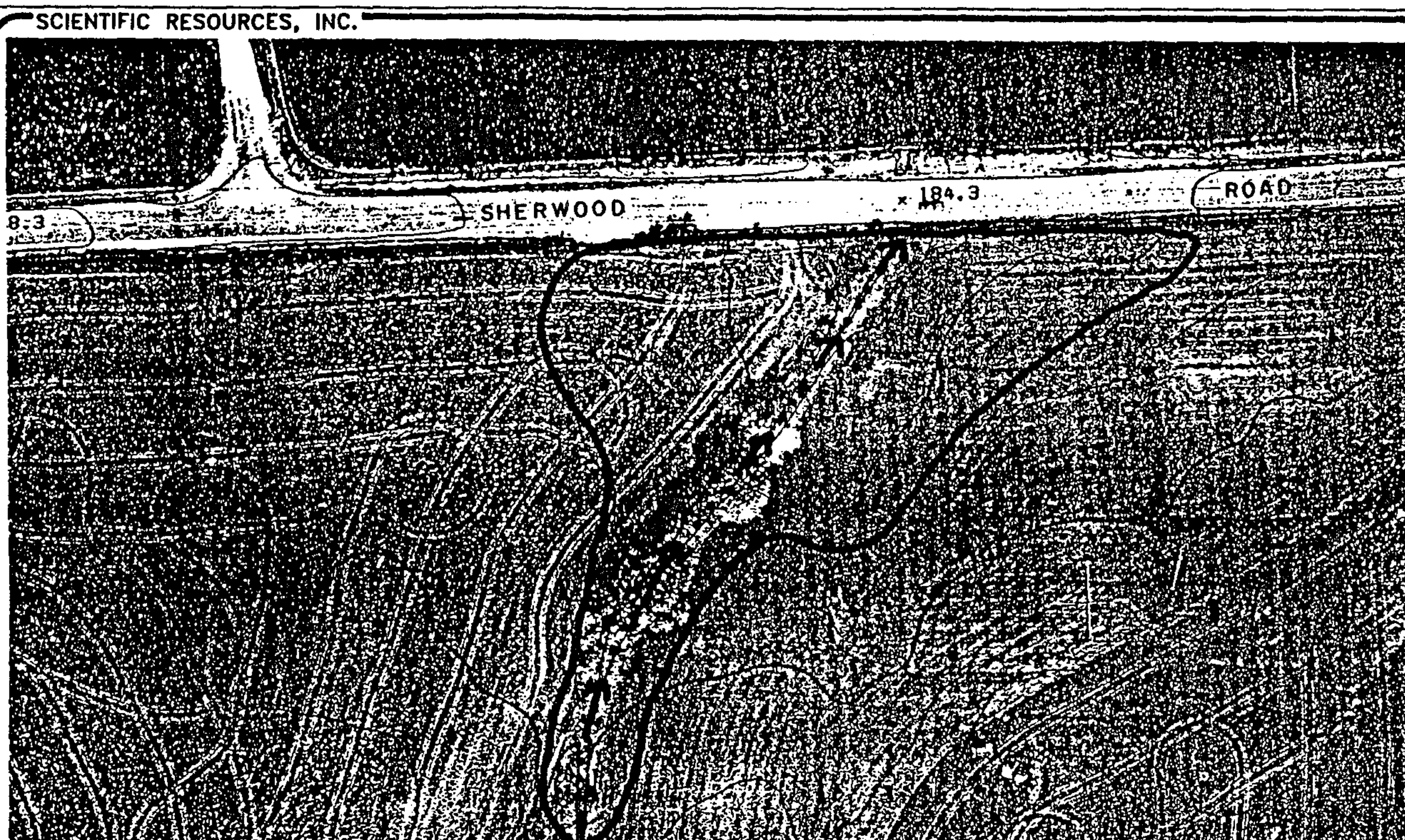
SCIENTIFIC RESOURCES, INC.



Scale: 1" = 200'

Figure C-1. Hedges Creek Subbasin PRF 6 and 7

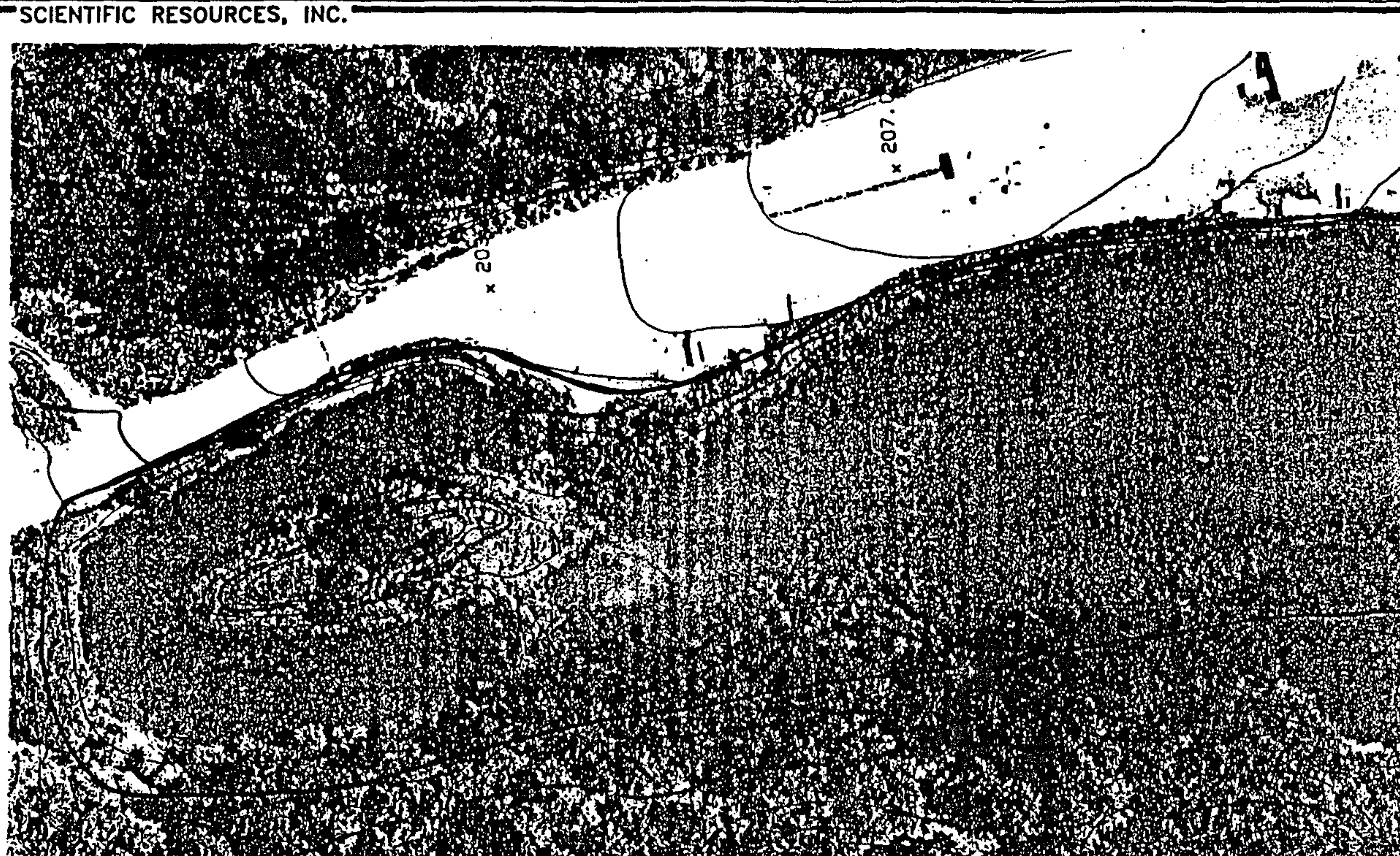
SCIENTIFIC RESOURCES, INC.



Scale: 1" = 100'

Figure C-2. Hedges Creek Subbasin PRF 13

SCIENTIFIC RESOURCES, INC.

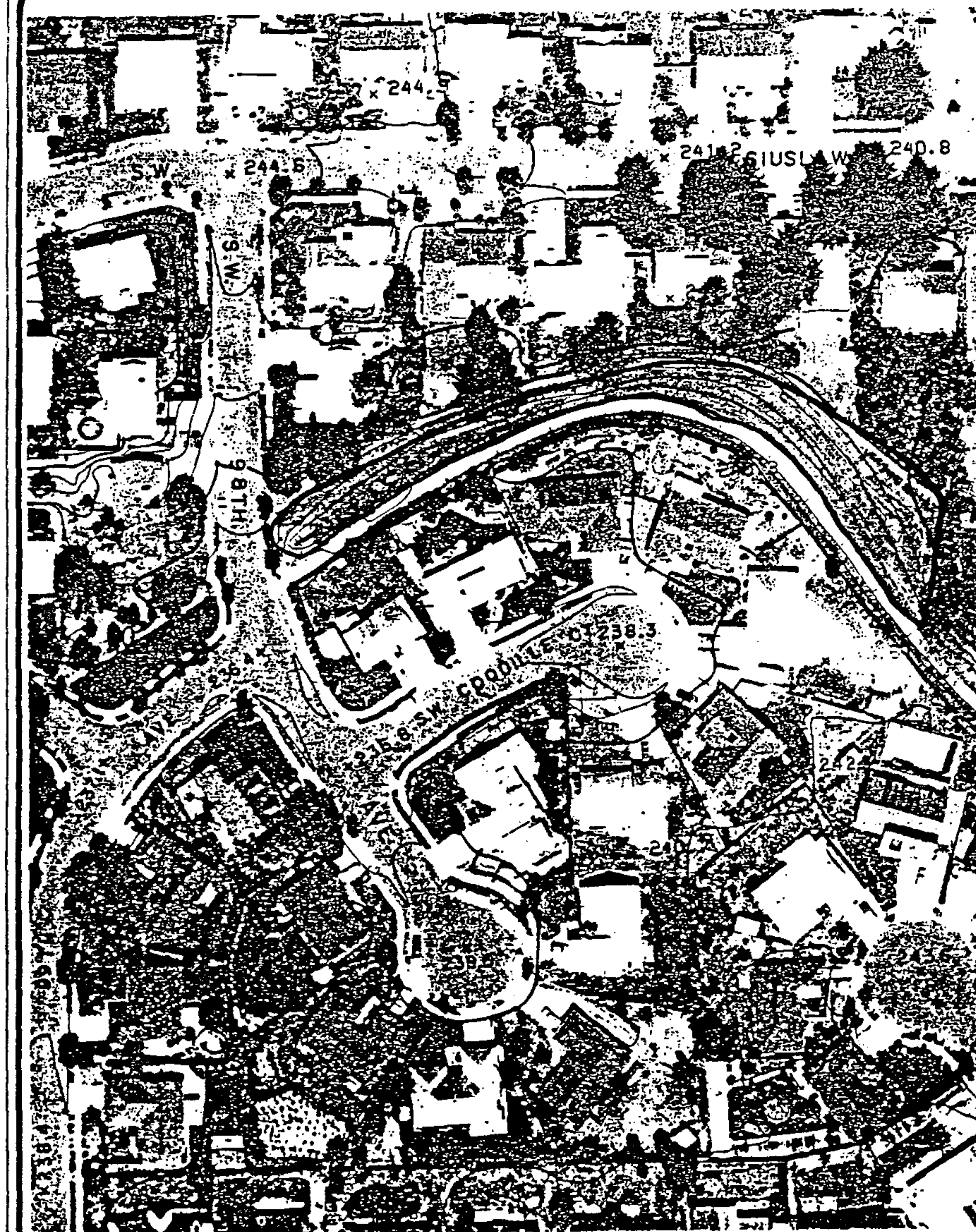


Site 15

Scale: 1" = 100'

Figure C-3. Hedges Creek Subbasin PRF 15

SCIENTIFIC RESOURCES, INC.



Site 22

Scale: 1" = 100'

Figure C-4. Hedges Creek Subbasin PRF 22

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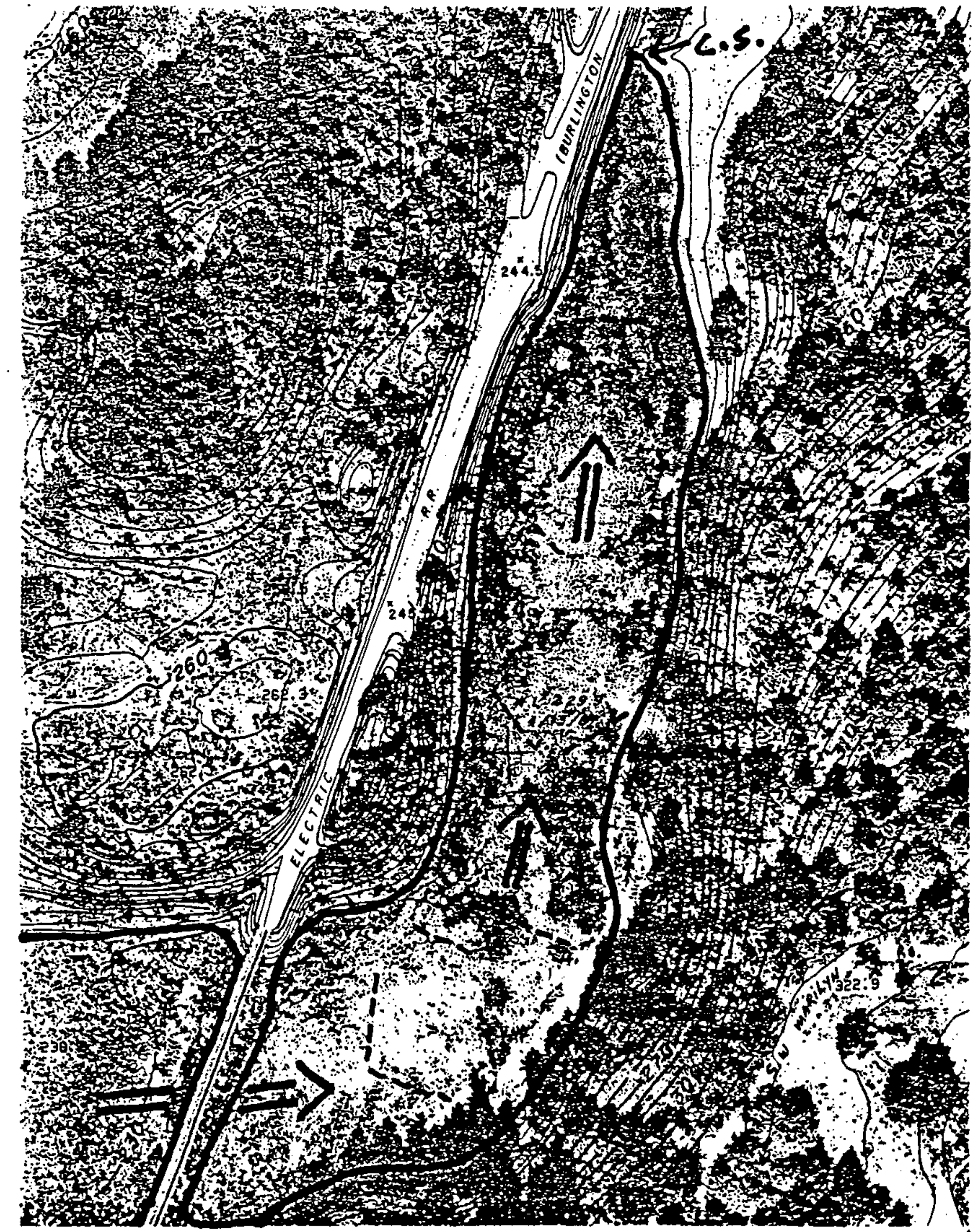
Site 25

Scale: 1" = 100'

Figure C-5. Hedges Creek Subbasin PRF 25

SCIENTIFIC RESOURCES, INC.



Scale: 1" = 137'

Figure C-6. Hedges Creek Subbasin PRF 28

SITE EVALUATION MATRIX
USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 1
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory	X	
Ratio Aa/An > 0.05	X	
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site	X	

—> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max Value
A) Watershed Soils Erodibility	1	5	2	4.5	9	10
B) Watershed Soils Phosphorus Avail.	1	5	1	5	5	5
C) Water Quality (P04 concentrations)	1	5	2	3	6	10
D) Watershed Area	1	5	3	5	15	15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3	3	9	15
F) Facility Soils Stability	1	5	2	4	8	10
G) Access Potential	1	5	1	5	5	5
H) Land Aquisition Potential	1	5	2	3	6	10
I) Provides/Enhances Amenity Values	0	5	1	5	5	5
J) Wildlife Potential	0	5	1	5	5	5
K) Safe Edge Shape	0	5	2	5	10	10
TOTAL POINTS:					83	100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps 4-5

B. See soil phosphorous maps 5

C. Average Total P04 conc. (X) from project data at nearest station:

X ≤ 0.25	1
0.25 < X ≤ 0.35	2
0.35 < X ≤ 0.45	(3) 0.373
0.45 < X ≤ 0.53	4
0.53 < X	5

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1
50 < Aw ≤100	2
100 < Aw ≤180	3
180 < Aw ≤260	4
260 < Aw	(5) 2856

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	1
0.15 < Aa/An ≤ 0.27	2
0.27 < Aa/An ≤ 0.45	(3) 0.43
0.45 < Aa/An ≤ 0.55	4
0.55 < Aa/An	5

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX

USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 5
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory	X	
Ratio Aa/An > 0.05		X
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site	X	

---> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max Value
A) Watershed Soils Erodibility	1	5	2			10
B) Watershed Soils Phosphorus Avail.	1	5	1			5
C) Water Quality (P04 concentrations)	1	5	2			10
D) Watershed Area	1	5	3			15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3			15
F) Facility Soils Stability	1	5	2			10
G) Access Potential	1	5	1			5
H) Land Aquisition Potential	1	5	2			10
I) Provides/Enhances Amenity Values	0	5	1			5
J) Wildlife Potential	0	5	1			5
K) Safe Edge Shape	0	5	2			10
TOTAL POINTS:						100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps

B. See soil phosphorous maps

C. Average Total P04 conc. (X) from project data at nearest station:

X ≤ 0.25	1
0.25 < X ≤ 0.35	2
0.35 < X ≤ 0.45	3
0.45 < X ≤ 0.53	4
0.53 < X	5

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1
50 < Aw ≤100	2
100 < Aw ≤180	3
180 < Aw ≤260	4
260 < Aw	5

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	1
0.15 < Aa/An ≤ 0.27	2
0.27 < Aa/An ≤ 0.45	3
0.45 < Aa/An ≤ 0.55	4
0.55 < Aa/An	5

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX
USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 6
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory	X	
Ratio Aa/An > 0.05	X	
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site	X	

—> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION Value	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max
A) Watershed Soils Erodibility	1	5	2	5	10	10
B) Watershed Soils Phosphorus Avail.	1	5	1	2	2	5
C) Water Quality (PO4 concentrations)	1	5	2	3	6	10
D) Watershed Area	1	5	3	5	15	15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3	5	15	15
F) Facility Soils Stability	1	5	2	4	8	10
G) Access Potential	1	5	1	5	5	5
H) Land Aquisition Potential	1	5	2	3	6	10
I) Provides/Enhances Amenity Values	0	5	1	5	5	5
J) Wildlife Potential	0	5	1	5	5	5
K) Safe Edge Shape	0	5	2	4	8	10
TOTAL POINTS:					85	100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps 5

B. See soil phosphorous maps 2

C. Average Total PO4 conc. (X) from project data at nearest station:

X ≤ 0.25	1
0.25 < X ≤ 0.35	2
0.35 < X ≤ 0.45	(3) 0.380
0.45 < X ≤ 0.53	4
0.53 < X	5

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1
50 < Aw ≤100	2
100 < Aw ≤180	3
180 < Aw ≤260	4
260 < Aw	(5) 970

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	1
0.15 < Aa/An ≤ 0.27	2
0.27 < Aa/An ≤ 0.45	3
0.45 < Aa/An ≤ 0.55	4
0.55 < Aa/An	(5) 2.0

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review:
Steep wetland shore/deep edge - low rating,
Flat wetland shore/shallow edge - high rating,
Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX
USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 7
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory	X	
Ratio Aa/An > 0.05	X	
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site	X	

---> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max Value
A) Watershed Soils Erodibility	1	5	2	5	10	10
B) Watershed Soils Phosphorus Avail.	1	5	1	5	5	5
C) Water Quality (P04 concentrations)	1	5	2	3	6	10
D) Watershed Area	1	5	3	5	15	15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3	5	15	15
F) Facility Soils Stability	1	5	2	4	8	10
G) Access Potential	1	5	1	5	5	5
H) Land Aquisition Potential	1	5	2	3	6	10
I) Provides/Enhances Amenity Values	0	5	1	5	5	5
J) Wildlife Potential	0	5	1	5	5	5
K) Safe Edge Shape	0	5	2	4	8	10
TOTAL POINTS:					88	100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps 5

B. See soil phosphorous maps 5

C. Average Total P04 conc. (X) from project data at nearest station:

X ≤ 0.25	1
0.25 < X ≤ 0.35	2
0.35 < X ≤ 0.45	(3) 0.38
0.45 < X ≤ 0.53	4
0.53 < X	5

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1
50 < Aw ≤100	2
100 < Aw ≤180	3
180 < Aw ≤260	4
260 < Aw	(5) 1456

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	1
0.15 < Aa/An ≤ 0.27	2
0.27 < Aa/An ≤ 0.45	3
0.45 < Aa/An ≤ 0.55	4
0.55 < Aa/An	(5) 0.64

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX
USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 9
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory	X	
Ratio Aa/An > 0.05	X	
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site	X	

—> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION Value	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max
A) Watershed Soils Erodibility	1	5	2	5	10	10
B) Watershed Soils Phosphorus Avail.	1	5	1	1	1	5
C) Water Quality (P04 concentrations)	1	5	2	2	4	10
D) Watershed Area	1	5	3	3	9	15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3	4	12	15
F) Facility Soils Stability	1	5	2	2	4	10
G) Access Potential	1	5	1	5	5	5
H) Land Aquisition Potential	1	5	2	5	10	10
I) Provides/Enhances Amenity Values	0	5	1	3	3	5
J) Wildlife Potential	0	5	1	1	1	5
K) Safe Edge Shape	0	5	2	4	8	10
TOTAL POINTS:					67	100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps 5

B. See soil phosphorous maps 1

C. Average Total PO4 conc. (X) from project data at nearest station:

X ≤ 0.25	1
0.25 < X ≤ 0.35	(2) 0.31
0.35 < X ≤ 0.45	3
0.45 < X ≤ 0.53	4
0.53 < X	5

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1
50 < Aw ≤100	2
100 < Aw ≤180	(3) 139
180 < Aw ≤260	4
260 < Aw	5

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	1
0.15 < Aa/An ≤ 0.27	2
0.27 < Aa/An ≤ 0.45	3
0.45 < Aa/An ≤ 0.55	(4) 0.53
0.55 < Aa/An	5

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX
USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 10
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory	X	
Ratio Aa/An > 0.05	X	
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site	X	

---> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION Value	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max
A) Watershed Soils Erodibility	1	5	2	1	2	10
B) Watershed Soils Phosphorus Avail.	1	5	1	4.5	4.5	5
C) Water Quality (P04 concentrations)	1	5	2	3	6	10
D) Watershed Area	1	5	3	5	15	15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3	1	3	15
F) Facility Soils Stability	1	5	2	2	4	10
G) Access Potential	1	5	1	4	4	5
H) Land Aquisition Potential	1	5	2	4	8	10
I) Provides/Enhances Amenity Values	0	5	1	5	5	5
J) Wildlife Potential	0	5	1	3	3	5
K) Safe Edge Shape	0	5	2	2	4	10
TOTAL POINTS:					58.5	100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps 1

B. See soil phosphorous maps 4.5

C. Average Total PO4 conc. (X) from project data at nearest station:

X ≤ 0.25	1
0.25 < X ≤ 0.35	2
0.35 < X ≤ 0.45	(3) 0.384
0.45 < X ≤ 0.53	4
0.53 < X	5

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1
50 < Aw ≤ 100	2
100 < Aw ≤ 180	3
180 < Aw ≤ 260	4 628
260 < Aw	(5)

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	(1) 0.12
0.15 < Aa/An ≤ 0.27	2
0.27 < Aa/An ≤ 0.45	3
0.45 < Aa/An ≤ 0.55	4
0.55 < Aa/An	5

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX REVISED 5/13/91
USA CIP/NPS PLANNING FACILITY SITE NUMBER: 11
POLLUTANT REDUCTION FACILITIES NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory	X	
Ratio Aa/An > 0.05	X	
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site	X	

—> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max Value
A) Watershed Soils Erodibility	1	5	2	5	10	10
B) Watershed Soils Phosphorus Avail.	1	5	1	4	4	5
C) Water Quality (P04 concentrations)	1	5	2	1	2	10
D) Watershed Area	1	5	3	2	6	15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3	5	15	15
F) Facility Soils Stability	1	5	2	3	6	10
G) Access Potential	1	5	1	4	4	5
H) Land Aquisition Potential	1	5	2	4	8	10
I) Provides/Enhances Amenity Values	0	5	1	2	2	5
J) Wildlife Potential	0	5	1	2	2	5
K) Safe Edge Shape	0	5	2	3	6	10
TOTAL POINTS:					65	100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps 5

B. See soil phosphorous maps 4

C. Average Total P04 conc. (X) from project data at nearest station:

X ≤ 0.25	(1)	
0.25 < X ≤ 0.35	2	0.102
0.35 < X ≤ 0.45	3	
0.45 < X ≤ 0.53	4	
0.53 < X	5	

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1	
50 < Aw ≤100	(2)	
100 < Aw ≤180	3	54
180 < Aw ≤260	4	
260 < Aw	5	

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	1	
0.15 < Aa/An ≤ 0.27	2	
0.27 < Aa/An ≤ 0.45	3	
0.45 < Aa/An ≤ 0.55	4	1.43
0.55 < Aa/An	(5)	

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX
USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 13
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory	X	
Ratio Aa/An > 0.05	X	
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site	X	

---> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION Value	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max
A) Watershed Soils Erodibility	1	5	2	5	10	10
B) Watershed Soils Phosphorus Avail.	1	5	1	4	4	5
C) Water Quality (P04 concentrations)	1	5	2	1	2	10
D) Watershed Area	1	5	3	3	9	15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3	1	3	15
F) Facility Soils Stability	1	5	2	3	6	10
G) Access Potential	1	5	1	4	4	5
H) Land Aquisition Potential	1	5	2	4	8	10
I) Provides/Enhances Amenity Values	0	5	1	2	2	5
J) Wildlife Potential	0	5	1	2	2	5
K) Safe Edge Shape	0	5	2	4	8	10
TOTAL POINTS:					58	100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps 5

B. See soil phosphorous maps 4

C. Average Total PO4 conc. (X) from project data at nearest station:

X ≤ 0.25	(1)	0.102
0.25 < X ≤ 0.35	2	
0.35 < X ≤ 0.45	3	
0.45 < X ≤ 0.53	4	
0.53 < X	5	

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1	
50 < Aw ≤100	2	
100 < Aw ≤180	(3)	126
180 < Aw ≤260	4	
260 < Aw	5	

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	(1)	0.09
0.15 < Aa/An ≤ 0.27	2	
0.27 < Aa/An ≤ 0.45	3	
0.45 < Aa/An ≤ 0.55	4	
0.55 < Aa/An	5	

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX

USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 14
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory	X	
Ratio Aa/An > 0.05	X	
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site	X	

—> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION Value	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max
A) Watershed Soils Erodibility	1	5	2	3	6	10
B) Watershed Soils Phosphorus Avail.	1	5	1	4	4	5
C) Water Quality (P04 concentrations)	1	5	2	2	4	10
D) Watershed Area	1	5	3	5	15	15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3	2	6	15
F) Facility Soils Stability	1	5	2	2	4	10
G) Access Potential	1	5	1	5	5	5
H) Land Aquisition Potential	1	5	2	4	8	10
I) Provides/Enhances Amenity Values	0	5	1	5	5	5
J) Wildlife Potential	0	5	1	5	5	5
K) Safe Edge Shape	0	5	2	4	8	10
TOTAL POINTS:					70	100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps 3

B. See soil phosphorous maps 4

C. Average Total P04 conc. (X) from project data at nearest station:

X ≤ 0.25	1	
0.25 < X ≤ 0.35	(2)	0.251
0.35 < X ≤ 0.45	3	
0.45 < X ≤ 0.53	4	
0.53 < X	5	

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1	
50 < Aw ≤100	2	
100 < Aw ≤180	3	
180 < Aw ≤260	4	
260 < Aw	(5)	578

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	1	
0.15 < Aa/An ≤ 0.27	(2)	0.17
0.27 < Aa/An ≤ 0.45	3	
0.45 < Aa/An ≤ 0.55	4	
0.55 < Aa/An	5	

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX
USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 15
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory	X	
Ratio Aa/An > 0.05	X	
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site	X	

—> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max Value
A) Watershed Soils Erodibility	1	5	2	3.5	7	10
B) Watershed Soils Phosphorus Avail.	1	5	1	4.5	4.5	5
C) Water Quality (P04 concentrations)	1	5	2	2	4	10
D) Watershed Area	1	5	3	2	6	15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3	4	12	15
F) Facility Soils Stability	1	5	2	3	6	10
G) Access Potential	1	5	1	4	4	5
H) Land Aquisition Potential	1	5	2	4	8	10
I) Provides/Enhances Amenity Values	0	5	1	4	4	5
J) Wildlife Potential	0	5	1	3	3	5
K) Safe Edge Shape	0	5	2	4	8	10
TOTAL POINTS:					66.5	100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps 3-4

B. See soil phosphorous maps 4-5

C. Average Total PO4 conc. (X) from project data at nearest station:

X ≤ 0.25	1
0.25 < X ≤ 0.35	② 0.285
0.35 < X ≤ 0.45	3
0.45 < X ≤ 0.53	4
0.53 < X	5

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1
50 < Aw ≤100	② 98
100 < Aw ≤180	3
180 < Aw ≤260	4
260 < Aw	5

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	1
0.15 < Aa/An ≤ 0.27	2
0.27 < Aa/An ≤ 0.45	3
0.45 < Aa/An ≤ 0.55	④ 0.47
0.55 < Aa/An	5

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX

USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 18
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory	X	
Ratio Aa/An > 0.05		X
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site	X	

—> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max Value
A) Watershed Soils Erodibility	1	5	2			10
B) Watershed Soils Phosphorus Avail.	1	5	1			5
C) Water Quality (P04 concentrations)	1	5	2			10
D) Watershed Area	1	5	3			15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3			15
F) Facility Soils Stability	1	5	2			10
G) Access Potential	1	5	1			5
H) Land Aquisition Potential	1	5	2			10
I) Provides/Enhances Amenity Values	0	5	1			5
J) Wildlife Potential	0	5	1			5
K) Safe Edge Shape	0	5	2			10
TOTAL POINTS:						100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps

B. See soil phosphorous maps

C. Average Total P04 conc. (X) from project data at nearest station:

$X \le 0.25$	1
$0.25 < X \le 0.35$	2
$0.35 < X \le 0.45$	3
$0.45 < X \le 0.53$	4
$0.53 < X$	5

D. Watershed acreage (Aw)

$20 < Aw \le 50$	1
$50 < Aw \le 100$	2
$100 < Aw \le 180$	3
$180 < Aw \le 260$	4
$260 < Aw$	5

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

$0.05 < Aa/An \le 0.15$	1
$0.15 < Aa/An \le 0.27$	2
$0.27 < Aa/An \le 0.45$	3
$0.45 < Aa/An \le 0.55$	4
$0.55 < Aa/An$	5

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review:
Steep wetland shore/deep edge - low rating,
Flat wetland shore/shallow edge - high rating,
Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX

USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 19
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory	X	
Ratio Aa/An > 0.05	X	
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site	X	

---> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max Value
A) Watershed Soils Erodibility	1	5	2	5	10	10
B) Watershed Soils Phosphorus Avail.	1	5	1	4	4	5
C) Water Quality (P04 concentrations)	1	5	2	2	4	10
D) Watershed Area	1	5	3	3	9	15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3	5	15	15
F) Facility Soils Stability	1	5	2	4	8	10
G) Access Potential	1	5	1	5	5	5
H) Land Aquisition Potential	1	5	2	4	8	10
I) Provides/Enhances Amenity Values	0	5	1	5	5	5
J) Wildlife Potential	0	5	1	5	5	5
K) Safe Edge Shape	0	5	2	5	10	10
TOTAL POINTS:					83	100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps 5

B. See soil phosphorous maps 4

C. Average Total P04 conc. (X) from project data at nearest station:

X ≤ 0.25	1
0.25 < X ≤ 0.35	(2) 0.344
0.35 < X ≤ 0.45	3
0.45 < X ≤ 0.53	4
0.53 < X	5

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1
50 < Aw ≤100	2
100 < Aw ≤180	(3) 129
180 < Aw ≤260	4
260 < Aw	5

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	1
0.15 < Aa/An ≤ 0.27	2
0.27 < Aa/An ≤ 0.45	3
0.45 < Aa/An ≤ 0.55	4 3.83
0.55 < Aa/An	(5)

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX
USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 20
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory	X	
Ratio Aa/An > 0.05	X	
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site		X

—> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION Value	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Max Value
A) Watershed Soils Erodibility	1	5	2		10
B) Watershed Soils Phosphorus Avail.	1	5	1		5
C) Water Quality (P04 concentrations)	1	5	2		10
D) Watershed Area	1	5	3		15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3		15
F) Facility Soils Stability	1	5	2		10
G) Access Potential	1	5	1		5
H) Land Aquisition Potential	1	5	2		10
I) Provides/Enhances Amenity Values	0	5	1		5
J) Wildlife Potential	0	5	1		5
K) Safe Edge Shape	0	5	2		10
TOTAL POINTS:					100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps

B. See soil phosphorous maps

C. Average Total P04 conc. (X) from project data at nearest station:

X ≤ 0.25	1
0.25 < X ≤ 0.35	2
0.35 < X ≤ 0.45	3
0.45 < X ≤ 0.53	4
0.53 < X	5

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1
50 < Aw ≤100	2
100 < Aw ≤180	3
180 < Aw ≤260	4
260 < Aw	5

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	1
0.15 < Aa/An ≤ 0.27	2
0.27 < Aa/An ≤ 0.45	3
0.45 < Aa/An ≤ 0.55	4
0.55 < Aa/An	5

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX
USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 22
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	____	____
Watershed > or = 20 acres	____	____
Watershed developed/Pot. devel. land	____	____
Regulatory Conditions not Prohibitory	____	____
Ratio Aa/An > 0.05	____	____
No Sig. Flood Damage Impact on Structures	____	____
Phosphorus Contributing Soils not Known at Site	____	____

—> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max Value
A) Watershed Soils Erodibility	1	5	2			10
B) Watershed Soils Phosphorus Avail.	1	5	1			5
C) Water Quality (P04 concentrations)	1	5	2			10
D) Watershed Area	1	5	3			15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3			15
F) Facility Soils Stability	1	5	2			10
G) Access Potential	1	5	1			5
H) Land Aquisition Potential	1	5	2			10
I) Provides/Enhances Amenity Values	0	5	1			5
J) Wildlife Potential	0	5	1			5
K) Safe Edge Shape	0	5	2			10
TOTAL POINTS:						100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps

B. See soil phosphorous maps

C. Average Total P04 conc. (X) from project data at nearest station:

X ≤ 0.25	1
0.25 < X ≤ 0.35	2
0.35 < X ≤ 0.45	3
0.45 < X ≤ 0.53	4
0.53 < X	5

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1
50 < Aw ≤100	2
100 < Aw ≤180	3
180 < Aw ≤260	4
260 < Aw	5

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	1
0.15 < Aa/An ≤ 0.27	2
0.27 < Aa/An ≤ 0.45	3
0.45 < Aa/An ≤ 0.55	4
0.55 < Aa/An	5

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review:
Steep wetland shore/deep edge - low rating,
Flat wetland shore/shallow edge - high rating,
Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX

USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 23
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	______	______
Watershed > or = 20 acres	______	______
Watershed developed/Pot. devel. land	______	______
Regulatory Conditions not Prohibitory	______	______
Ratio Aa/An > 0.05	______	______
No Sig. Flood Damage Impact on Structures	______	______
Phosphorus Contributing Soils not Known at Site	______	______

—> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION	Value Range		Weight	Assigned	Weighted Max
	Low	High	Factor	Value	Value
A) Watershed Soils Erodibility	1	5	2		10
B) Watershed Soils Phosphorus Avail.	1	5	1		5
C) Water Quality (P04 concentrations)	1	5	2		10
D) Watershed Area	1	5	3		15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3		15
F) Facility Soils Stability	1	5	2		10
G) Access Potential	1	5	1		5
H) Land Aquisition Potential	1	5	2		10
I) Provides/Enhances Amenity Values	0	5	1		5
J) Wildlife Potential	0	5	1		5
K) Safe Edge Shape	0	5	2		10
TOTAL POINTS:					100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps

B. See soil phosphorous maps

C. Average Total PO4 conc. (X) from project data at nearest station:

$X \leq 0.25$	1
$0.25 < X \leq 0.35$	2
$0.35 < X \leq 0.45$	3
$0.45 < X \leq 0.53$	4
$0.53 < X$	5

D. Watershed acreage (Aw)

$20 < Aw \leq 50$	1
$50 < Aw \leq 100$	2
$100 < Aw \leq 180$	3
$180 < Aw \leq 260$	4
$260 < Aw$	5

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

$0.05 < Aa/An \leq 0.15$	1
$0.15 < Aa/An \leq 0.27$	2
$0.27 < Aa/An \leq 0.45$	3
$0.45 < Aa/An \leq 0.55$	4
$0.55 < Aa/An$	5

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX REVISED 5/13/91
USA CIP/NPS PLANNING FACILITY SITE NUMBER: 24
POLLUTANT REDUCTION FACILITIES NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	____	____
Watershed > or = 20 acres	____	____
Watershed developed/Pot. devel. land	____	____
Regulatory Conditions not Prohibitory	____	____
Ratio Aa/An > 0.05	____	____
No Sig. Flood Damage Impact on Structures	____	____
Phosphorus Contributing Soils not Known at Site	____	____

—> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION Value	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max
A) Watershed Soils Erodibility	1	5	2			10
B) Watershed Soils Phosphorus Avail.	1	5	1			5
C) Water Quality (P04 concentrations)	1	5	2			10
D) Watershed Area	1	5	3			15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3			15
F) Facility Soils Stability	1	5	2			10
G) Access Potential	1	5	1			5
H) Land Aquisition Potential	1	5	2			10
I) Provides/Enhances Amenity Values	0	5	1			5
J) Wildlife Potential	0	5	1			5
K) Safe Edge Shape	0	5	2			10
TOTAL POINTS:						100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps

B. See soil phosphorous maps

C. Average Total P04 conc. (X) from project data at nearest station:

X ≤ 0.25	1
0.25 < X ≤ 0.35	2
0.35 < X ≤ 0.45	3
0.45 < X ≤ 0.53	4
0.53 < X	5

D. Watershed acreage (Aw)

20 < Aw ≤ 50	1
50 < Aw ≤100	2
100 < Aw ≤180	3
180 < Aw ≤260	4
260 < Aw	5

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

0.05 < Aa/An ≤ 0.15	1
0.15 < Aa/An ≤ 0.27	2
0.27 < Aa/An ≤ 0.45	3
0.45 < Aa/An ≤ 0.55	4
0.55 < Aa/An	5

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX REVISED 5/13/91
USA CIP/NPS PLANNING FACILITY SITE NUMBER: 25
POLLUTANT REDUCTION FACILITIES NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	______	______
Watershed > or = 20 acres	______	______
Watershed developed/Pot. devel. land	______	______
Regulatory Conditions not Prohibitory	______	______
Ratio Aa/An > 0.05	______	______
No Sig. Flood Damage Impact on Structures	______	______
Phosphorus Contributing Soils not Known at Site	______	______

---> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Value	Max Value
A) Watershed Soils Erodibility	1	5	2			10
B) Watershed Soils Phosphorus Avail.	1	5	1			5
C) Water Quality (P04 concentrations)	1	5	2			10
D) Watershed Area	1	5	3			15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3			15
F) Facility Soils Stability	1	5	2			10
G) Access Potential	1	5	1			5
H) Land Aquisition Potential	1	5	2			10
I) Provides/Enhances Amenity Values	0	5	1			5
J) Wildlife Potential	0	5	1			5
K) Safe Edge Shape	0	5	2			10
TOTAL POINTS:						100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps

B. See soil phosphorous maps

C. Average Total P04 conc. (X) from project data at nearest station:

$X \le 0.25$	1
$0.25 < X \le 0.35$	2
$0.35 < X \le 0.45$	3
$0.45 < X \le 0.53$	4
$0.53 < X$	5

D. Watershed acreage (Aw)

$20 < Aw \le 50$	1
$50 < Aw \le 100$	2
$100 < Aw \le 180$	3
$180 < Aw \le 260$	4
$260 < Aw$	5

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

$0.05 < Aa/An \le 0.15$	1
$0.15 < Aa/An \le 0.27$	2
$0.27 < Aa/An \le 0.45$	3
$0.45 < Aa/An \le 0.55$	4
$0.55 < Aa/An$	5

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

SITE EVALUATION MATRIX

USA CIP/NPS PLANNING
POLLUTANT REDUCTION FACILITIES

REVISED 5/13/91
FACILITY SITE NUMBER: 28
NAME:

INITIAL SCREENING	YES	NO
Facility Site Stable or Can be Stabilized	X	
Watershed > or = 20 acres	X	
Watershed developed/Pot. devel. land	X	
Regulatory Conditions not Prohibitory		X
Ratio Aa/An > 0.05	X	
No Sig. Flood Damage Impact on Structures	X	
Phosphorus Contributing Soils not Known at Site	X	

—> NOTE: Any NO above eliminates the site from further consideration.

EVALUATION Value	Value Range Low	Value Range High	Weight Factor	Assigned Value	Weighted Max Value
A) Watershed Soils Erodibility	1	5	2		10
B) Watershed Soils Phosphorus Avail.	1	5	1		5
C) Water Quality (P04 concentrations)	1	5	2		10
D) Watershed Area	1	5	3		15
E) Wetland Surface Area Ratio (Aa/An)	1	5	3		15
F) Facility Soils Stability	1	5	2		10
G) Access Potential	1	5	1		5
H) Land Aquisition Potential	1	5	2		10
I) Provides/Enhances Amenity Values	0	5	1		5
J) Wildlife Potential	0	5	1		5
K) Safe Edge Shape	0	5	2		10
TOTAL POINTS:					100

VALUE ASSIGNMENT GUIDELINES

A. See soil erodibility maps

B. See soil phosphorous maps

C. Average Total PO4 conc. (X) from project data at nearest station:

$X \leq 0.25$	1
$0.25 < X \leq 0.35$	2
$0.35 < X \leq 0.45$	3
$0.45 < X \leq 0.53$	4
$0.53 < X$	5

D. Watershed acreage (Aw)

$20 < Aw \leq 50$	1
$50 < Aw \leq 100$	2
$100 < Aw \leq 180$	3
$180 < Aw \leq 260$	4
$260 < Aw$	5

E. The ratio of the max. wetland surface area avail. at the site to the theoretical wetland surface area needed (Aa/An)

$0.05 < Aa/An \leq 0.15$	1
$0.15 < Aa/An \leq 0.27$	2
$0.27 < Aa/An \leq 0.45$	3
$0.45 < Aa/An \leq 0.55$	4
$0.55 < Aa/An$	5

F. Assign values based on avail. soils information at site.

G. Assign values based on site review.

H. Base assigned values on detention project info. and site review

I & J. Same as G.

K. Values based on field and map review: Steep wetland shore/deep edge - low rating, Flat wetland shore/shallow edge - high rating, Assume linear relationship between ratings and % of shoreline.

APPENDIX D

SOIL EROSION AND PHOSPHORUS AVAILABILITY MAPPING
FOR
HEDGES AND BUTTERNUT CREEK DRAINAGE BASINS

Prepared for
UNIFIED SEWERAGE AGENCY - SWM PROJECT
Portland, Oregon

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June 7, 1991

SOIL EROSION AND PHOSPHORUS AVAILABILITY MAPPING FOR THE PORTLAND - TUALATIN BASIN NONPOINT SOURCE PROJECT

TABLES AND FIGURES

SOIL EROSION AND PHOSPHORUS AVAILABILITY MAPPING FOR HEDGES AND BUTTERNUT CREEK DRAINAGE BASINS

SUMMARY

This report presents soil interpretation map overlays for soil erosion potential and soil phosphorus availability for the drainage basins of Hedges Creek and Butternut Creek in Washington County. The map overlays are based on published Soil Conservation Service soil survey base maps, soil samples to characterize soil phosphorus, field reconnaissance, aerial photograph interpretation, and professional soil science methods. The map overlays provide information appropriate for planning efforts regarding nonpoint source pollution. This information should not be used as a substitute for on-site investigation for projects requiring detailed information.

Methods for developing soil interpretation categories are outlined in the report. Soil erosion potential is based on soil mapping, a modified Universal Soil Loss Equation approach, soil hydrologic properties, and other details visible using stereoscopic aerial photographs. Soil phosphorus availability categories are based on laboratory analysis of soil samples taken in and near the project area. Samples were analyzed for total phosphorus, total organic phosphorus, and water soluble phosphorus. The detail of soil phosphorus availability mapping is directly controlled by the sample database.

The following observations can be made regarding the soil interpretations presented here:

1. All soils in the project area have relatively high phosphorus availability when compared to other soils in the region. Chemical data show that these soils maintain low solution P levels in water because they have a high phosphorus sorption potential.

2. Soil erodibility is low to moderate in most of the project area. Because soil phosphorus availability is relatively uniform, soil erosion potential provides the most useful variations for ranking sites in the project area.

3. Soil disturbance is a critically important factor in erosion. If a site with low erosion potential is disturbed, it is likely to result in more soil movement than an undisturbed soil with high erosion potential. Protecting soils during construction is very important.

4. Three soil types comprise more than half of all the project area surrounding Hedges Creek. They have silt loam and loam surface horizons. The clay contents vary between 5 and 40 percent depending upon soil type and horizon. Soils with higher subsurface clay contents are typically dense and restrict drainage. This condition is more conducive to surface runoff then deep percolation.

5. Four soil types comprise more than half of the Butternut Creek drainage area. They have silt or silty clay loam surface horizons. Clay content varies between 20-40 percent depending upon soil type and horizon.

INTRODUCTION

The soil erodibility and soil phosphorus availability maps presented here are the outcome of analyses undertaken in support of Unified Sewerage Agency's Nonpoint Source Planning efforts. Local knowledge of soil erodibility is important for determining the likelihood of water quality impacts from nonpoint source inputs. A similar logic holds for soil phosphorus availability mapping. Phosphorus is a water quality constituent of importance and knowledge of its availability in soil can be used to assess potential impacts when used in conjunction with soil erodibility maps.

Soil interpretation mapping was performed to provide input to a site evaluation project directed by Brown and Caldwell. The specific objectives of the mapping effort were:

1. Develop map overlays of a) soil erosion hazard and b) soil phosphorus availability for Hedges and Butternut Creek drainages of the Tualatin Basin.
2. Develop and document procedures to create and use erodibility and phosphorus availability categories.

BACKGROUND

The area covered in this project comprises approximately 5670 acres of urban and undeveloped land in Washington County. Geologic background information can be found in published reports and maps (Beeson and Tolan, 1989; Schlicker and Deacon, 1967). More pertinent information for this project is found in references that treat surficial geology, geomorphology, and soils of the area. The most useful references are the soil survey for Washington County (SCS, 1982) and a body of work by R. B. Parsons (eg. Parsons, 1969; Parsons et al., 1970).

Soils of The Project Area

Twenty-two soil types comprise the project areas. The important properties of these soils are given in Table 1 for Hedges Creek, and Table 2 for Butternut Creek. The Hillsboro soil is the most extensive soil in the Hedges Creek basin. The Woodburn soil is the most extensive in the Butternut Creek area.

The soils in the Butternut Creek area are predominantly silt loam, except for Hillsboro Loam, and Verboort and Wapato silty clay loam. The soil textures are more variable in the Hedges Creek area. Soil textures range from loam and silt loam to silty clay loam, clay and mucky clay. The high percentage of silt size particles in the loam and silt loams soils make them easily erodible.

Table 1. Soils of Hedges Creek Basin

Map Symbol	Soil Name	Approximate Acreage	Soil Erosion K Factor	Restrictive Layer	Depth to Restrictive Layer	Permeability
1	Aloha silt loam	65	0.43	none		
2	Amity silt loam	26	0.32	none		
5B	Briedwell stony silt loam, 0 to 7% slopes	74	0.28	none		
5C	Briedwell stony silt loam, 7 to 12% slopes	8	0.28	none		
5D	Briedwell stony silt loam, 12 to 20% slopes	14	0.28	none		
10	Chehalis silt loam, occasional overflow	23	0.32	none	-	-
13	Cove silty clay loam	73	0.28	clay	8-60	<0.06
14	Cove clay	67	0.28	clay	8-60	<0.06
15	Dayton silt loam	3	0.43	clay	16-39	<0.06
21A	Hillsboro loam, 0 to 3% slopes	251	0.49	none	-	-
21B	Hillsboro loam, 3 to 7% slopes	561	0.49	none	-	-
21C	Hillsboro loam, 7 to 12% slopes	35	0.49	none	-	-
21D	Hillsboro loam, 12 to 20% slopes	43	0.49	none	-	-
22	Huberly silt loam	109	0.37	Fragipan	25-60	0.06-0.2
27	Labish mucky clay	39	0.20	mucky clay	0-36	0.06-0.2
30	McBee silt loam	12	0.28	none	-	-
37A	Quatama loam, 0 to 3% slopes	160	0.32	none	-	-
37B	Quatama loam, 3 to 7% slopes	87	0.32	none	-	-
37C	Quatama loam, 7 to 12% slopes	40	0.32	none	-	-
38B	Saum silt loam, 2 to 7% slopes	80	0.32	Basalt Bedrock	50	-
38C	Saum silt loam, 7 to 12% slopes	128	0.32	Basalt Bedrock	50	-
38D	Saum silt loam, 12 to 20% slopes	31	0.32	Basalt Bedrock	50	-
38E	Saum silt loam, 20 to 30% slopes	15	0.32	Basalt Bedrock	50	-
42	Verboort silty clay loam	37		clay	19-33	<0.06
43	Wapato silty clay loam	58	0.32	none	-	-
45A	Woodburn silt loam, 0 to 3% slopes	67		Fragipan	31-60	0.06-0.2
45B	Woodburn silt loam, 3 to 7% slopes	23	0.43	Fragipan	31-60	-
46F	Xerochrepts and Haploxerolls, very steep	7	0.43	None	15	-
47D	Xerochrepts - Rock outcrop complex	25		Basalt Bedrock		

Table 2. Soils of the Butternut Creek Basin

Map Symbol	Soil Name	Approximate Acreage	Soil Erosion Factor	Restrictive Layer	Depth to Restrictive Layer	Permeability
1	Aloha silt loam	435	0.43	Fragipan	None	
7B	Cascade silt loam, 3 to 7% slopes	44	0.37	Fragipan	27-60	0.06-0.2
7C	Cascade silt loam, 7 to 12% slopes	5	0.37	Fragipan	27-60	0.06-0.2
7D	Cascade silt loam, 12 to 20% slopes	7	0.37	Fragipan	27-60	0.06-0.2
11B	Cornelius & Kinton silt loam, 2 to 7% slopes	79	0.37	Fragipan	38-60	0.06-0.2
11C	Cornelius & Kinton silt loam, 7 to 12% slopes	170	0.37	Fragipan	38-60	0.06-0.2
11D	Cornelius & Kinton silt loam, 12 to 20%	109	0.37	Fragipan	38-60	0.06-0.2
11E	slopes	18	0.37	Fragipan	38-60	0.06-0.2
11F	Cornelius & Kinton silt loam, 20 to 30%	67	0.37	Clay	38-60	<0.06
19C	slopes		0.28	None		
21D	Cornelius & Kinton silt loam, 30 to 60%	21	0.32	None		
22	slopes	12	0.32	None		
37A	Helevetia silt loam, 7 to 12% slopes	44	0.49	Fragipan	25-60	0.06-0.2
37B	Hillsboro loam, 12 to 20% slopes	42	0.37	Fract. Basalt bedrock	19-41	-
37C	Huberly silt loam	92	0.15	Basalt bedrock	41	-
37D	Quatama loam, 0 to 3% slopes	67	0.32	None	-	-
42	Quatama loam, 3 to 7% slopes	16	0.32	None	-	-
43	Quatama loam, 7 to 12% slopes	215	0.32	None	-	-
44A	Quatama loam, 12 to 20% slopes	83	0.32	Basalt bedrock	50	-
44C	Verboort silty clay loam	30	0.43	Clay	19-33	<0.06
45A	Wapato silty clay loam	5	0.43	None	-	-
45B	Willamette silt loam, 0 to 3% slopes	344	0.43	None	-	-
45C	Willamette silt loam, 7 to 12% slopes	335				
45D	Woodburn silt loam, 0 to 3% slopes	44	0.43	None	-	-
44B	Woodburn silt loam, 3 to 7% slopes	5	0.43	Fragipan	31-60	0.06-0.2
	Woodburn silt loam, 7 to 12% slopes					
	Woodburn silt loam, 12 to 20% slopes					
	Willamette silt loam, 3 to 7% slopes					

A number of soils in both drainages have a dense subsurface layer (fragipan) that restricts water flow and root penetration. The depth of this layer varies from 2 to 4 feet and extends to 5 feet or greater.

Soils with fragipans have restricted subsoil permeability that markedly affects their hydrologic response. There is some potential for lateral water movement above or below the fragipan but not within it. Water movement above the fragipan is more likely to result in surface runoff from saturated soil than lateral flow and possible soil movement. The amount of lateral water flow, piping, and vertical flow below the fragipan is unknown and depends on specific bedrock conditions at a site.

The soil erosion K factor is an index of soil erodibility (Wischmeier and Smith, 1978). It is intended to be a measure of intrinsic erodibility of the soil material itself and does not account for important factors such as slope, slope length, soil saturation, rainfall intensity, condition of the soil surface, and land management practices. The values presented in Tables 1 and 2 were calculated using standard procedures that account for particle size, organic matter content, soil structure, and profile permeability. The surface horizon K value was used for most soils. The maximum K value for the soil profile was used for those soil areas likely to developed in the near future. This adjustment reflects the variation in soil conditions between those areas which are already developed and less likely to be disturbed, and those area which are undergoing development. The K values range from 0.28 to 0.55. The surface horizon K values for soils of the project area fall in a rather narrow range that is moderate to high in comparison to other soils (Wischmeier and Smith, 1978).

MAPPING PROCEDURES

The published soil survey (Soil Conservation Service, 1982) is used as the basis for development of the soil interpretations overlays presented here. These soil maps were used to develop soil erodibility categories in conjunction with other available soils data, topographic maps, aerial photographs, and professional soil science expertise. Soil phosphorus categories were developed based on published maps and soil samples and laboratory analyses.

The mapping done in the published soil survey was taken to be accurate. Cursory field checking of the soil map was performed during a sampling and reconnaissance trip in the area. In addition, stereo paired aerial photographs for portions of the project area were examined in detail to evaluate map unit slope breaks and other visible features. The soil interpretation map overlays were drawn at a scale of 1:10,000, twice that of the soil survey base map.

Soil Erosion Hazard Categories

Five soil erosion hazard categories were developed to delineate soils with the highest potential for erosion (category 5) through soils with the lowest potential (category 1). The scale developed is relative and, therefore, only suitable for use in this area.

Categories were developed using a modification of the Universal Soil Loss Equation (USLE) approach (Wischmeier and Smith, 1978). This method has been used extensively for agricultural areas of the midwestern United States but has been shown to have quantitative limitations in the Pacific Northwest (Istok et al., 1983; Simmons, 1981). The method does, however, account for the appropriate factors for the relative ranking developed here. The primary reason for using a modified USLE approach is to match the level of detail of the categories to the database available. Since soil interpretations are to be based on soil survey information rather than site specific measurements, the general USLE approach is more appropriate than a detailed soil erosion model (R.G. Knisel, 1980). Consideration of soil hydrology is incorporated in the analysis as discussed below.

The soil erosion K factors (Tables 1 and 2) were used with slope and slope length values developed for soil map unit slope categories (Table 3) to calculate partial USLE soil loss estimates. Rainfall, ground cover, and cropping practices terms were not applied because i) rainfall intensity is approximately constant in the project area and ii) inferences regarding land use were beyond the scope of this map interpretation effort. The resulting categories were modified to account for the potential for saturated soil conditions to increase erosion potential. This modification was based on depth to restrictive layer and minimum profile permeability (Tables 1 and 2).

Table 3. Slope and Slope Length Factors for Soil Map Units in the Project Area

Slope Class %	Map Unit Symbol	LS Factor
0-3	a	0.132
3-8	b	0.561
8-15	c	1.544
15-30	d	2.880
>30	e	>5

The final step in determining soil erosion categories involved using stereo aerial photographs to assess the designations made on the map overlay. Slopes within large map units were checked and particular note was made of any locations where steep banks might result in permanently unvegetated zones.

Soil Phosphorus Availability Categories

Five soil phosphorus availability categories were developed to delineate soils with the highest values (category 5) through soils with the lowest (category 1). The scale developed is relative and, therefore, only suitable for use in this area.

Phosphorus availability is a general term that has been quantified in a number of ways. The use of phosphorus availability has traditionally been to determine phosphorus fertilizer requirements. Numerous field and laboratory studies have resulted in a variety of chemical procedures to extract phosphorus from soil (Olsen and Sommers, 1982). This causes some confusion for phosphorus availability studies that are concerned with soil erosion. Availability in this case is not necessarily the amount of phosphorus that can be present in the soil solution, it may be the total amount in the soil or the amount in a particular chemical form. The concept of availability becomes even more complex when eroded soil is incorporated into the phosphorus budget of a stream system (Klotz, 1988). For the purposes of this project, several methods to quantify soil phosphorus availability were used:

1. **Total phosphorus.** Although all phosphorus is not available, this characterization is of value because it sets an upper limit. The method of Bowman (1988) was selected for this analysis.

2. **Total organic phosphorus.** This determination allows separation of organic and inorganic forms. The ignition method was used (Olsen and Sommers, 1982).

3. **Water soluble phosphorus.** The method is of value because it provides information about the effect of soil on P concentration in water or the soil solution. This extraction was done using a dilute salt solution according to the method recommended by Olsen and Sommers (1982).

Soil samples from the major soil types present were collected for analysis. Because the dataset is small and soil phosphorus generally varies among even similar sites, the results must be extrapolated with caution. Even the process of delineating phosphorus availability categories by soil type based on single samples may be misleading. This step is taken here with these justifications: i) the analyses can be used as benchmark determinations to establish a database for future studies; and ii) the information collected can be compared with similar data for other soils.

RESULTS

The primary results of this project are soil interpretation map overlays for soil erosion and soil phosphorus availability. These maps are based on scientific considerations, published soil survey information, aerial photographs, and analyses of soil samples taken in the area. Limited field checking of the maps has been performed.

Soil Erosion Categories

Soil erosion categories and soil map units are related as shown in Table 4. Soil map units normally occurred in the category shown but could fall into those marked with parentheses depending on location-specific factors.

Table 4. Soil Erosion Categories for Soil Map Units in the Project Area

Hedges Creek	
Erosion Category	Soil Map Units (1)
5	21D, 38E, 46F, 47D
4	5D, 38D, (21D)
3	5C, 21C, 37C, 38C, (5D), (45B)
2	5B, 21B, 37B, 38B, 45B, (5C), (38C)
1	1, 2, 10, 13, 14, 15, 21A, 22, 27, 30, 37A, 43, 45A, (5B)
Butternut Creek	
Erosion Category	Soil Map Units
5	11D, 11E, 11F, 21D, (7D), (37D), (45D)
4	7D, 37D, 45D, (7C), (11C)
3	7C, 11C, 19C, 37C, 44C, 45C, (11B)
2	7B, 11B, 37B, 45B, 44B
1	1, 22, 42, 43, 44A, 45A

(1) Map Symbols and Soil Names:

1: Aloha
2: Amity
5: Briedwell
7: Cascade
10: Chehalis
11: Cornelius & Kinton
13: Cove Silty Clay Loam
14: Cove Clay
15: Dayton
19: Helvetia
21: Hillsboro
22: Huberly
27: Labish
30: McBee
37: Quatama
38: Saum
42: Verboort
43: Wapato
44: Willamette
45: Woodburn
46: Xerochrepts & Haploxerolls
47: Xerochrepts - Rock outcrop

The areas in category 1, the lowest erodibility class, are among the most reliably mapped because the map unit slope range is small (0-3%). Variability occurs with 5 map units in the 3-7%, 7-12%, and 12-20% slope classes. These fall into erodibility categories 2, 3, or 4 according to soil type and hydrology, landscape position, and actual slope as determined from stereo aerial photographs.

Several soils in the Butternut Creek area that are ranked in category 4 could fall into category 5 depending on hydrology, and site-specific conditions. Cascade and Woodburn soils could fall into the higher category because of water percolation restrictions due to a fragipan. The erosion category for Quatama soil was calculated using the maximum K value due to the extensive availability of this soil for current and future disturbance. Cornelius and Kinton soils may also fall into a higher category because of the presence of a fragipan.

Briedwell soil in the Hedges Creek area may fall into a lower erosion category since it does not have a limiting layer and its K value is very low.

The soil erodibility evaluated on the overlays is a product of soil properties, topography, natural soil disturbance, and site hydrology. Although anticipating soil disturbance (such as development or excavation) is beyond the scope of this project, the maximum K value for soils with large areas of disturbance was used. It should be noted that there are still large areas of undeveloped ground which may be developed in the future. Any soil disturbance at a specific site would greatly increase the potential for erosion.

Soil Phosphorus Availability Categories

Laboratory results of A horizon soil samples are summarized in Table 5. The results presented are averages from soil samples taken in the Hedges and Butternut Creek drainages, as well as samples taken in the nearby Fanno Creek drainage.

Soil phosphorus availability rankings are shown in Table 5. The ranking was based on inorganic P and water soluble P values. These values provide an estimate of the relative amount of phosphorus that would be available to readily move out of the soil into solution during saturated soil conditions. The ranking was developed by separately ranking the values for inorganic P and water soluble P for each sample from 1 to 5. An average rank was given to each sample. The ranking for a soil series is an average of the rankings of samples taken for that series. The Woodburn soil had the highest relative availability of phosphorus, while the Saum series had the lowest ranking.

Phosphorus values vary spatially within a soil series, and they vary due to land use. The soils with the highest phosphorus values are those which are most often used for agriculture. Phosphorus fertilization is the most likely cause of these higher values. Samples taken from relatively undisturbed sites had lower phosphorus values.

Table 5. Soil Phosphorus Analyses

Soil Series	Total P	Inorganic P	Organic P	Water Soluble P		
	mg P/kg soil			mg P/kg Soil	ppm sol'n	Rank
Aloha[1]	1457	1175	282	3.7	0.183	3
Cornelius[1]	1675	1371	304	2.4	0.12	3
Hillsboro[2]	1350	1130	220	2.4	0.12	3
Huberly[3]	915	764	151	1.4	0.07	2
Quatama[2]	1518	1295	223	3.5	0.175	4
Saum[2]	1130	795	335	0.7	0.035	1
Wapato[3]	925	662	263	2.075	0.104	2
Woodburn[2]	1693	1485	208	9.65	0.483	5

[1]Average of 3 samples.
[2]Average of 2 samples.
[3]Average of 4 samples.

Map Overlays

Map overlays for soil erosion categories are shown in Figures la-1d. For both Hedges and Butternut Creeks, there is greater erosion hazard in the southern portions of the drainage basins. In both locales the increased erosion hazard is due in part to the steep slopes. In the Butternut area, the soils in the southern section also have fragipans, which increase the erosion potential.

The northern areas of Hedges and Butternut Creek drainages consists of level to gently sloping topography. The soil erosion hazard is generally low in these areas. There is a category 5 area in northern Hedges Creek basin. This is a steep (12 to 20% slopes) area of Hillsboro loam soil. In the Butternut drainage, there are several areas of category 4 erosion potential in the northern section. These areas flow Butternut Creek and its tributaries.

Soil Phosphorus availability mapping shows less complex patterns than those of the erosion categories (Figures 2a-2d). Category 3 represents the most acreage in the Butternut drainage, while categories 1 and 3 dominate Hedges Creek.

Woodburn soil, which as the highest phosphorus ranking, tends to be on flat to gentle terrain, with a subsequently low erosion hazard. The soils with the moderately high erosion hazards tend to have low to moderate phosphorus availability.

CONSIDERATIONS FOR USE OF OVERLAYS

The soil interpretation map overlays presented here are the result of a combination of published soil maps, sample analyses, field reconnaissance, and professional soil science methods. Project objectives, time and money constraints, and the quality of available data were matched to produce an appropriate product.

The map overlays in Figures 1a-1d and 2a-2d provide categories of soil erosion potential and soil phosphorus availability that are based on scientific principles and data. As such, they can be used with confidence for planning purposes. They are not intended for, and should not be used for, soils input for detailed purposes. A site specific interpretation requires site specific background information.

Use of these overlays as input to the site evaluation matrix proposed for the Portland Tualatin Basin NPS Planning Project is appropriate. The overlays were developed for use in providing two rankings regarding the potential for nonpoint source pollution for all locations in the study area. These should be combined with other site attributes of importance to locate potential problem areas.

The soil phosphorus data collected for this project represent an absolute minimum for development of phosphorus availability categories. Soil phosphorus availability maps lack detail because the dataset is so small. Additional soil sampling and analysis would improve the resolution of these interpretations. Because soil phosphorus status varies significantly from point to point even in apparently homogeneous landscapes, extreme care is required in extrapolating the results of point samples. The map overlays that result from this minimum dataset lack detail because there is not sufficient data to support further interpretations. Nevertheless, two useful observations can be made:

1. Soil phosphorus availability is uniformly high for the samples collected in the project area.

2. Soil erosion potential mapping provides more important information regarding the potential for nonpoint source pollution than the soil phosphorus availability maps.

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SOIL EROSION AND PHOSPHORUS AVAILABILITY MAPPING FOR HEDGES AND BUTTERNUT CREEK DRAINAGE BASINS

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UNIFIED SEWERAGE AGENCY - SWM PROJECT
Portland, Oregon

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June 7, 1991

SOIL EROSION AND PHOSPHORUS AVAILABILITY MAPPING FOR THE PORTLAND - TUALATIN BASIN NONPOINT SOURCE PROJECT

TABLES AND FIGURES

SOIL EROSION AND PHOSPHORUS AVAILABILITY MAPPING FOR HEDGES AND BUTTERNUT CREEK DRAINAGE BASINS

SUMMARY

This report presents soil interpretation map overlays for soil erosion potential and soil phosphorus availability for the drainage basins of Hedges Creek and Butternut Creek in Washington County. The map overlays are based on published Soil Conservation Service soil survey base maps, soil samples to characterize soil phosphorus, field reconnaissance, aerial photograph interpretation, and professional soil science methods. The map overlays provide information appropriate for planning efforts regarding nonpoint source pollution. This information should not be used as a substitute for on-site investigation for projects requiring detailed information.

Methods for developing soil interpretation categories are outlined in the report. Soil erosion potential is based on soil mapping, a modified Universal Soil Loss Equation approach, soil hydrologic properties, and other details visible using stereoscopic aerial photographs. Soil phosphorus availability categories are based on laboratory analysis of soil samples taken in and near the project area. Samples were analyzed for total phosphorus, total organic phosphorus, and water soluble phosphorus. The detail of soil phosphorus availability mapping is directly controlled by the sample database.

The following observations can be made regarding the soil interpretations presented here:

1. All soils in the project area have relatively high phosphorus availability when compared to other soils in the region. Chemical data show that these soils maintain low solution P levels in water because they have a high phosphorus sorption potential.

2. Soil erodibility is low to moderate in most of the project area. Because soil phosphorus availability is relatively uniform, soil erosion potential provides the most useful variations for ranking sites in the project area.

3. Soil disturbance is a critically important factor in erosion. If a site with low erosion potential is disturbed, it is likely to result in more soil movement than an undisturbed soil with high erosion potential. Protecting soils during construction is very important.

4. Three soil types comprise more than half of all the project area surrounding Hedges Creek. They have silt loam and loam surface horizons. The clay contents vary between 5 and 40 percent depending upon soil type and horizon. Soils with higher subsurface clay contents are typically dense and restrict drainage. This condition is more conducive to surface runoff then deep percolation.

5. Four soil types comprise more than half of the Butternut Creek drainage area. They have silt or silty clay loam surface horizons. Clay content varies between 20-40 percent depending upon soil type and horizon.

INTRODUCTION

The soil erodibility and soil phosphorus availability maps presented here are the outcome of analyses undertaken in support of Unified Sewerage Agency's Nonpoint Source Planning efforts. Local knowledge of soil erodibility is important for determining the likelihood of water quality impacts from nonpoint source inputs. A similar logic holds for soil phosphorus availability mapping. Phosphorus is a water quality constituent of importance and knowledge of its availability in soil can be used to assess potential impacts when used in conjunction with soil erodibility maps.

Soil interpretation mapping was performed to provide input to a site evaluation project directed by Brown and Caldwell. The specific objectives of the mapping effort were:

1. Develop map overlays of a) soil erosion hazard and b) soil phosphorus availability for Hedges and Butternut Creek drainages of the Tualatin Basin.
2. Develop and document procedures to create and use erodibility and phosphorus availability categories.

BACKGROUND

The area covered in this project comprises approximately 5670 acres of urban and undeveloped land in Washington County. Geologic background information can be found in published reports and maps (Beeson and Tolan, 1989; Schlicker and Deacon, 1967). More pertinent information for this project is found in references that treat surficial geology, geomorphology, and soils of the area. The most useful references are the soil survey for Washington County (SCS, 1982) and a body of work by R. B. Parsons (eg. Parsons, 1969; Parsons et al., 1970).

Soils of The Project Area

Twenty-two soil types comprise the project areas. The important properties of these soils are given in Table 1 for Hedges Creek, and Table 2 for Butternut Creek. The Hillsboro soil is the most extensive soil in the Hedges Creek basin. The Woodburn soil is the most extensive in the Butternut Creek area.

The soils in the Butternut Creek area are predominantly silt loam, except for Hillsboro Loam, and Verboort and Wapato silty clay loam. The soil textures are more variable in the Hedges Creek area. Soil textures range from loam and silt loam to silty clay loam, clay and mucky clay. The high percentage of silt size particles in the loam and silt loams soils make them easily erodible.

Table 1. Soils of Hedges Creek Basin

Map Symbol	Soil Name	Approximate Acreage	Soil Erosion K Factor	Restrictive Layer	Depth to Restrictive Layer	Permeability
1	Aloha silt loam	65	0.43	none		
2	Amity silt loam	26	0.32	none		
5B	Briedwell stony silt loam, 0 to 7% slopes	74	0.28	none		
5C	Briedwell stony silt loam, 7 to 12% slopes	8	0.28	none		
5D	Briedwell stony silt loam, 12 to 20% slopes	14	0.28	none		
10	Chehalis silt loam, occasional overflow	23	0.32	none	-	-
13	Cove silty clay loam	73	0.28	clay	8-60	<0.06
14	Cove clay	67	0.28	clay	8-60	<0.06
15	Dayton silt loam	3	0.43	clay	16-39	<0.06
21A	Hillsboro loam, 0 to 3% slopes	251	0.49	none	-	-
21B	Hillsboro loam, 3 to 7% slopes	561	0.49	none	-	-
21C	Hillsboro loam, 7 to 12% slopes	35	0.49	none	-	-
21D	Hillsboro loam, 12 to 20% slopes	43	0.49	none	-	-
22	Huberly silt loam	109	0.37	Fragipan	25-60	0.06-0.2
27	Labish mucky clay	39	0.20	mucky clay	0-36	0.06-0.2
30	McBee silt loam	12	0.28	none	-	-
37A	Quatama loam, 0 to 3% slopes	160	0.32	none	-	-
37B	Quatama loam, 3 to 7% slopes	87	0.32	none	-	-
37C	Quatama loam, 7 to 12% slopes	40	0.32	none	-	-
38B	Saum silt loam, 2 to 7% slopes	80	0.32	Basalt Bedrock	50	-
38C	Saum silt loam, 7 to 12% slopes	128	0.32	Basalt Bedrock	50	-
38D	Saum silt loam, 12 to 20% slopes	31	0.32	Basalt Bedrock	50	-
38E	Saum silt loam, 20 to 30% slopes	15	0.32	Basalt Bedrock	50	-
42	Verboort silty clay loam	37		clay	19-33	<0.06
43	Wapato silty clay loam	58	0.32	none	-	-
45A	Woodburn silt loam, 0 to 3% slopes	67		Fragipan	31-60	0.06-0.2
45B	Woodburn silt loam, 3 to 7% slopes	23	0.43	Fragipan	31-60	-
46F	Xerochrepts and Haploxerolls, very steep	7	0.43	None	15	-
47D	Xerochrepts - Rock outcrop complex	25		Basalt Bedrock		

Table 2. Soils of the Butternut Creek Basin

Map Symbol	Soil Name	Approximate Acreage	Soil Erosion Factor	Restrictive Layer	Depth to Restrictive Layer	Permeability
1	Aloha silt loam	435	0.43	Fragipan	None	
7B	Cascade silt loam, 3 to 7% slopes	44	0.37	Fragipan	27-60	0.06-0.2
7C	Cascade silt loam, 7 to 12% slopes	5	0.37	Fragipan	27-60	0.06-0.2
7D	Cascade silt loam, 12 to 20% slopes	7	0.37	Fragipan	27-60	0.06-0.2
11B	Cornelius & Kinton silt loam, 2 to 7% slopes	79	0.37	Fragipan	38-60	0.06-0.2
11C	Cornelius & Kinton silt loam, 7 to 12% slopes	170	0.37	Fragipan	38-60	0.06-0.2
11D	Cornelius & Kinton silt loam, 12 to 20%	109	0.37	Fragipan	38-60	0.06-0.2
11E	slopes	18	0.37	Fragipan	38-60	0.06-0.2
11F	Cornelius & Kinton silt loam, 20 to 30%	67	0.37	Clay	38-60	<0.06
19C	slopes		0.28	None		
21D	Cornelius & Kinton silt loam, 30 to 60%	21	0.32	None		
22	slopes	12	0.32	None		
37A	Helevetia silt loam, 7 to 12% slopes	44	0.49	Fragipan	25-60	0.06-0.2
37B	Hillsboro loam, 12 to 20% slopes	42	0.37	Fract. Basalt bedrock	19-41	-
37C	Huberly silt loam	92	0.15	Basalt bedrock	41	-
37D	Quatama loam, 0 to 3% slopes	67	0.32	None	-	-
42	Quatama loam, 3 to 7% slopes	16	0.32	None	-	-
43	Quatama loam, 7 to 12% slopes	215	0.32	None	-	-
44A	Quatama loam, 12 to 20% slopes	83	0.32	Basalt bedrock	50	-
44C	Verboort silty clay loam	30	0.43	Clay	19-33	<0.06
45A	Wapato silty clay loam	5	0.43	None	-	-
45B	Willamette silt loam, 0 to 3% slopes	344	0.43	None	-	-
45C	Willamette silt loam, 7 to 12% slopes	335				
45D	Woodburn silt loam, 0 to 3% slopes	44	0.43	None	-	-
44B	Woodburn silt loam, 3 to 7% slopes	5	0.43	Fragipan	31-60	0.06-0.2
	Woodburn silt loam, 7 to 12% slopes					
	Woodburn silt loam, 12 to 20% slopes					
	Willamette silt loam, 3 to 7% slopes					

A number of soils in both drainages have a dense subsurface layer (fragipan) that restricts water flow and root penetration. The depth of this layer varies from 2 to 4 feet and extends to 5 feet or greater.

Soils with fragipans have restricted subsoil permeability that markedly affects their hydrologic response. There is some potential for lateral water movement above or below the fragipan but not within it. Water movement above the fragipan is more likely to result in surface runoff from saturated soil than lateral flow and possible soil movement. The amount of lateral water flow, piping, and vertical flow below the fragipan is unknown and depends on specific bedrock conditions at a site.

The soil erosion K factor is an index of soil erodibility (Wischmeier and Smith, 1978). It is intended to be a measure of intrinsic erodibility of the soil material itself and does not account for important factors such as slope, slope length, soil saturation, rainfall intensity, condition of the soil surface, and land management practices. The values presented in Tables 1 and 2 were calculated using standard procedures that account for particle size, organic matter content, soil structure, and profile permeability. The surface horizon K value was used for most soils. The maximum K value for the soil profile was used for those soil areas likely to developed in the near future. This adjustment reflects the variation in soil conditions between those areas which are already developed and less likely to be disturbed, and those area which are undergoing development. The K values range from 0.28 to 0.55. The surface horizon K values for soils of the project area fall in a rather narrow range that is moderate to high in comparison to other soils (Wischmeier and Smith, 1978).

MAPPING PROCEDURES

The published soil survey (Soil Conservation Service, 1982) is used as the basis for development of the soil interpretations overlays presented here. These soil maps were used to develop soil erodibility categories in conjunction with other available soils data, topographic maps, aerial photographs, and professional soil science expertise. Soil phosphorus categories were developed based on published maps and soil samples and laboratory analyses.

The mapping done in the published soil survey was taken to be accurate. Cursory field checking of the soil map was performed during a sampling and reconnaissance trip in the area. In addition, stereo paired aerial photographs for portions of the project area were examined in detail to evaluate map unit slope breaks and other visible features. The soil interpretation map overlays were drawn at a scale of 1:10,000, twice that of the soil survey base map.

Soil Erosion Hazard Categories

Five soil erosion hazard categories were developed to delineate soils with the highest potential for erosion (category 5) through soils with the lowest potential (category 1). The scale developed is relative and, therefore, only suitable for use in this area.

Categories were developed using a modification of the Universal Soil Loss Equation (USLE) approach (Wischmeier and Smith, 1978). This method has been used extensively for agricultural areas of the midwestern United States but has been shown to have quantitative limitations in the Pacific Northwest (Istok et al., 1983; Simmons, 1981). The method does, however, account for the appropriate factors for the relative ranking developed here. The primary reason for using a modified USLE approach is to match the level of detail of the categories to the database available. Since soil interpretations are to be based on soil survey information rather than site specific measurements, the general USLE approach is more appropriate than a detailed soil erosion model (R.G. Knisel, 1980). Consideration of soil hydrology is incorporated in the analysis as discussed below.

The soil erosion K factors (Tables 1 and 2) were used with slope and slope length values developed for soil map unit slope categories (Table 3) to calculate partial USLE soil loss estimates. Rainfall, ground cover, and cropping practices terms were not applied because i) rainfall intensity is approximately constant in the project area and ii) inferences regarding land use were beyond the scope of this map interpretation effort. The resulting categories were modified to account for the potential for saturated soil conditions to increase erosion potential. This modification was based on depth to restrictive layer and minimum profile permeability (Tables 1 and 2).

Table 3. Slope and Slope Length Factors for Soil Map Units in the Project Area

Slope Class %	Map Unit Symbol	LS Factor
0-3	a	0.132
3-8	b	0.561
8-15	c	1.544
15-30	d	2.880
>30	e	>5

The final step in determining soil erosion categories involved using stereo aerial photographs to assess the designations made on the map overlay. Slopes within large map units were checked and particular note was made of any locations where steep banks might result in permanently unvegetated zones.

Soil Phosphorus Availability Categories

Five soil phosphorus availability categories were developed to delineate soils with the highest values (category 5) through soils with the lowest (category 1). The scale developed is relative and, therefore, only suitable for use in this area.

Phosphorus availability is a general term that has been quantified in a number of ways. The use of phosphorus availability has traditionally been to determine phosphorus fertilizer requirements. Numerous field and laboratory studies have resulted in a variety of chemical procedures to extract phosphorus from soil (Olsen and Sommers, 1982). This causes some confusion for phosphorus availability studies that are concerned with soil erosion. Availability in this case is not necessarily the amount of phosphorus that can be present in the soil solution, it may be the total amount in the soil or the amount in a particular chemical form. The concept of availability becomes even more complex when eroded soil is incorporated into the phosphorus budget of a stream system (Klotz, 1988). For the purposes of this project, several methods to quantify soil phosphorus availability were used:

1. **Total phosphorus.** Although all phosphorus is not available, this characterization is of value because it sets an upper limit. The method of Bowman (1988) was selected for this analysis.

2. **Total organic phosphorus.** This determination allows separation of organic and inorganic forms. The ignition method was used (Olsen and Sommers, 1982).

3. **Water soluble phosphorus.** The method is of value because it provides information about the effect of soil on P concentration in water or the soil solution. This extraction was done using a dilute salt solution according to the method recommended by Olsen and Sommers (1982).

Soil samples from the major soil types present were collected for analysis. Because the dataset is small and soil phosphorus generally varies among even similar sites, the results must be extrapolated with caution. Even the process of delineating phosphorus availability categories by soil type based on single samples may be misleading. This step is taken here with these justifications: i) the analyses can be used as benchmark determinations to establish a database for future studies; and ii) the information collected can be compared with similar data for other soils.

RESULTS

The primary results of this project are soil interpretation map overlays for soil erosion and soil phosphorus availability. These maps are based on scientific considerations, published soil survey information, aerial photographs, and analyses of soil samples taken in the area. Limited field checking of the maps has been performed.

Soil Erosion Categories

Soil erosion categories and soil map units are related as shown in Table 4. Soil map units normally occurred in the category shown but could fall into those marked with parentheses depending on location-specific factors.

Table 4. Soil Erosion Categories for Soil Map Units in the Project Area

Hedges Creek	
Erosion Category	Soil Map Units (1)
5	21D, 38E, 46F, 47D
4	5D, 38D, (21D)
3	5C, 21C, 37C, 38C, (5D), (45B)
2	5B, 21B, 37B, 38B, 45B, (5C), (38C)
1	1, 2, 10, 13, 14, 15, 21A, 22, 27, 30, 37A, 43, 45A, (5B)
Butternut Creek	
Erosion Category	Soil Map Units
5	11D, 11E, 11F, 21D, (7D), (37D), (45D)
4	7D, 37D, 45D, (7C), (11C)
3	7C, 11C, 19C, 37C, 44C, 45C, (11B)
2	7B, 11B, 37B, 45B, 44B
1	1, 22, 42, 43, 44A, 45A

(1) Map Symbols and Soil Names:

1: Aloha
2: Amity
5: Briedwell
7: Cascade
10: Chehalis
11: Cornelius & Kinton
13: Cove Silty Clay Loam
14: Cove Clay
15: Dayton
19: Helvetia
21: Hillsboro
22: Huberly
27: Labish
30: McBee
37: Quatama
38: Saum
42: Verboort
43: Wapato
44: Willamette
45: Woodburn
46: Xerochrepts & Haploxerolls
47: Xerochrepts - Rock outcrop

The areas in category 1, the lowest erodibility class, are among the most reliably mapped because the map unit slope range is small (0-3%). Variability occurs with 5 map units in the 3-7%, 7-12%, and 12-20% slope classes. These fall into erodibility categories 2, 3, or 4 according to soil type and hydrology, landscape position, and actual slope as determined from stereo aerial photographs.

Several soils in the Butternut Creek area that are ranked in category 4 could fall into category 5 depending on hydrology, and site-specific conditions. Cascade and Woodburn soils could fall into the higher category because of water percolation restrictions due to a fragipan. The erosion category for Quatama soil was calculated using the maximum K value due to the extensive availability of this soil for current and future disturbance. Cornelius and Kinton soils may also fall into a higher category because of the presence of a fragipan.

Briedwell soil in the Hedges Creek area may fall into a lower erosion category since it does not have a limiting layer and its K value is very low.

The soil erodibility evaluated on the overlays is a product of soil properties, topography, natural soil disturbance, and site hydrology. Although anticipating soil disturbance (such as development or excavation) is beyond the scope of this project, the maximum K value for soils with large areas of disturbance was used. It should be noted that there are still large areas of undeveloped ground which may be developed in the future. Any soil disturbance at a specific site would greatly increase the potential for erosion.

Soil Phosphorus Availability Categories

Laboratory results of A horizon soil samples are summarized in Table 5. The results presented are averages from soil samples taken in the Hedges and Butternut Creek drainages, as well as samples taken in the nearby Fanno Creek drainage.

Soil phosphorus availability rankings are shown in Table 5. The ranking was based on inorganic P and water soluble P values. These values provide an estimate of the relative amount of phosphorus that would be available to readily move out of the soil into solution during saturated soil conditions. The ranking was developed by separately ranking the values for inorganic P and water soluble P for each sample from 1 to 5. An average rank was given to each sample. The ranking for a soil series is an average of the rankings of samples taken for that series. The Woodburn soil had the highest relative availability of phosphorus, while the Saum series had the lowest ranking.

Phosphorus values vary spatially within a soil series, and they vary due to land use. The soils with the highest phosphorus values are those which are most often used for agriculture. Phosphorus fertilization is the most likely cause of these higher values. Samples taken from relatively undisturbed sites had lower phosphorus values.

Table 5. Soil Phosphorus Analyses

Soil Series	Total P	Inorganic P	Organic P	Water Soluble P		
	mg P/kg soil			mg P/kg Soil	ppm sol'n	Rank
Aloha[1]	1457	1175	282	3.7	0.183	3
Cornelius[1]	1675	1371	304	2.4	0.12	3
Hillsboro[2]	1350	1130	220	2.4	0.12	3
Huberly[3]	915	764	151	1.4	0.07	2
Quatama[2]	1518	1295	223	3.5	0.175	4
Saum[2]	1130	795	335	0.7	0.035	1
Wapato[3]	925	662	263	2.075	0.104	2
Woodburn[2]	1693	1485	208	9.65	0.483	5

[1]Average of 3 samples.
[2]Average of 2 samples.
[3]Average of 4 samples.

Map Overlays

Map overlays for soil erosion categories are shown in Figures 1a-1d. For both Hedges and Butternut Creeks, there is greater erosion hazard in the southern portions of the drainage basins. In both locales the increased erosion hazard is due in part to the steep slopes. In the Butternut area, the soils in the southern section also have fragipans, which increase the erosion potential.

The northern areas of Hedges and Butternut Creek drainages consists of level to gently sloping topography. The soil erosion hazard is generally low in these areas. There is a category 5 area in northern Hedges Creek basin. This is a steep (12 to 20% slopes) area of Hillsboro loam soil. In the Butternut drainage, there are several areas of category 4 erosion potential in the northern section. These areas flow Butternut Creek and its tributaries.

Soil Phosphorus availability mapping shows less complex patterns than those of the erosion categories (Figures 2a-2d). Category 3 represents the most acreage in the Butternut drainage, while categories 1 and 3 dominate Hedges Creek.

Woodburn soil, which as the highest phosphorus ranking, tends to be on flat to gentle terrain, with a subsequently low erosion hazard. The soils with the moderately high erosion hazards tend to have low to moderate phosphorus availability.

CONSIDERATIONS FOR USE OF OVERLAYS

The soil interpretation map overlays presented here are the result of a combination of published soil maps, sample analyses, field reconnaissance, and professional soil science methods. Project objectives, time and money constraints, and the quality of available data were matched to produce an appropriate product.

The map overlays in Figures 1a-1d and 2a-2d provide categories of soil erosion potential and soil phosphorus availability that are based on scientific principles and data. As such, they can be used with confidence for planning purposes. They are not intended for, and should not be used for, soils input for detailed purposes. A site specific interpretation requires site specific background information.

Use of these overlays as input to the site evaluation matrix proposed for the Portland Tualatin Basin NPS Planning Project is appropriate. The overlays were developed for use in providing two rankings regarding the potential for nonpoint source pollution for all locations in the study area. These should be combined with other site attributes of importance to locate potential problem areas.

The soil phosphorus data collected for this project represent an absolute minimum for development of phosphorus availability categories. Soil phosphorus availability maps lack detail because the dataset is so small. Additional soil sampling and analysis would improve the resolution of these interpretations. Because soil phosphorus status varies significantly from point to point even in apparently homogeneous landscapes, extreme care is required in extrapolating the results of point samples. The map overlays that result from this minimum dataset lack detail because there is not sufficient data to support further interpretations. Nevertheless, two useful observations can be made:

1. Soil phosphorus availability is uniformly high for the samples collected in the project area.

2. Soil erosion potential mapping provides more important information regarding the potential for nonpoint source pollution than the soil phosphorus availability maps.

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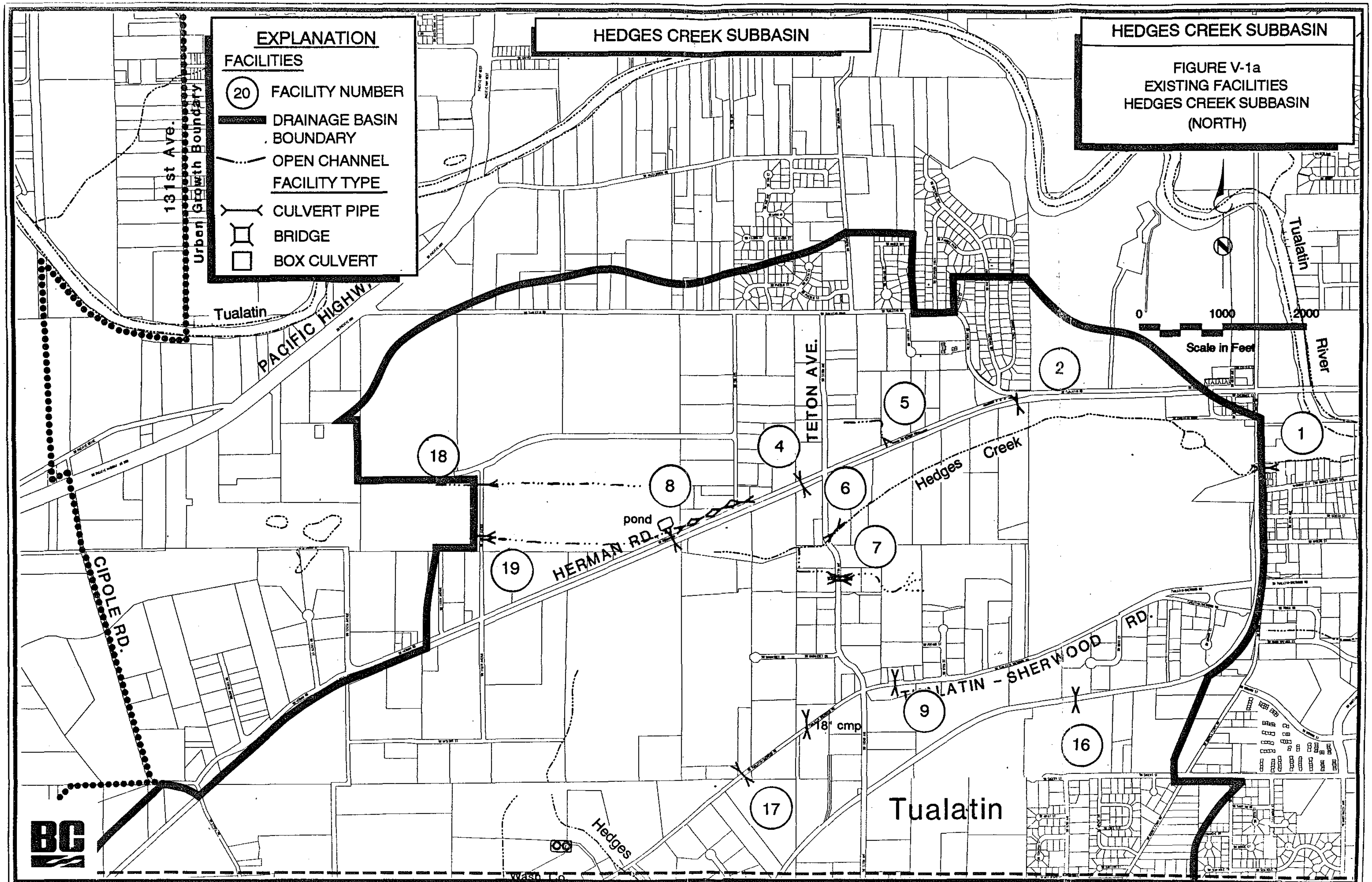
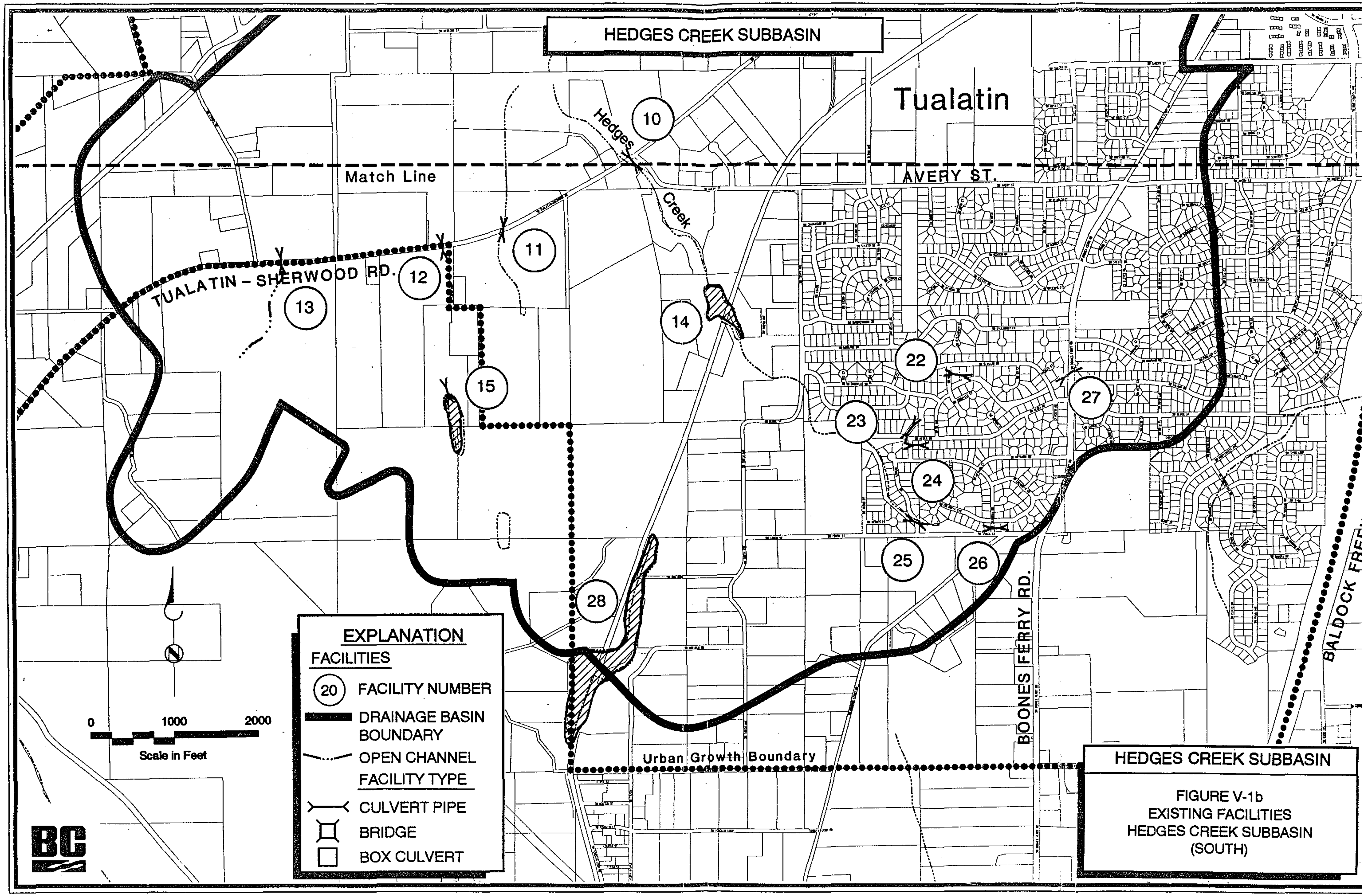


BASE MAP PROVIDED BY METRO, REGIONAL MAP SERVICE, MARCH 1992

MAP A



BASE MAP PROVIDED BY METRO, REGIONAL MAP SERVICE, MARCH 1992

MAP B