APPENDIX B

M.D. of Foothills No. 31

Stormwater Management Guidelines

Municipal District of Foothills No. 31
Public Works and Engineering

To determine the level of stormwater report requirement, the following guidelines shall apply:

The Stormwater Management Standards shall not apply to:

(1) A single-family house development and first parcel out
(2) Residential development and redevelopment projects comprised of three or fewer parcels/lots provided that no stormwater discharge that may affect existing drainage pattern, quality and quantity;
(3) Commercial development or subject to a development permit creating imperviousness 1% or less of the lot size/parcel, not susceptible to any contamination and stormwater discharge not affecting existing drainage pattern, quality and quantity;

The developer's Engineer must confirm in writing when no stormwater report is required satisfying the above conditions.

NOTE: if the balanced parcel/land is subdivided into multiple lots/parcels for further developments, full stormwater plan will be required and all existing development shall include with the proposed development as post development stage

A comprehensive drainage plan will be required to irrespective of all size developments where stormwater management plan is not warranted. The plan will include to a minimum; a plan showing 0.5 meter contours, locating existing and proposed development/building envelope, existing overland drainage patterns, slough/dugout, drainage structures to adjacent roads and properties. Drainage plan with all details shall be signed and stamped by a Professional Engineer in Alberta.

The Stormwater Management Standards shall apply to the maximum extent practicable to the following:

(1) Residential development and redevelopment projects comprised of detached single-family dwellings on three or fewer lots that have a stormwater discharge that may affect existing drainage pattern and discharge quality and quantity;
(2) Residential development and redevelopment projects, with four or more units, including condominiums, cooperatives, apartment buildings, and townhouses,
(3) Residential development and redevelopment projects comprised of detached single-family dwellings on four or more lots/parcel;
(4) All industrial development.
(5) All commercial development susceptible to contamination and creating imperviousness more than 1% of the lot/parcel size

For phased projects, the Stormwater Management Standards apply is made on the entire project as a whole including all phases. When proposing a development or redevelopment project subject to the Stormwater Management requirements, developer shall consider designing best stormwater management practices.

MD encourages using Computer Model to all developing lands irrespective to sizes and topography. Rational method can be used subject to land sizes (less than or equal to 5 acre) and topography, where no retention/detention pond will require and no natural/unnatural/existing drainage course will change.

General Conditions for Stormwater Management:

A. Natural or unnatural or existing drainage course or water bodies either permanent or seasonal will not allow to change unless it is absolutely necessary and approved by Alberta Environment and other authorities. It is the design's responsibility to ensure that all other authorities are consulted.

B. Post development discharge directly or indirectly to any water bodies will require approval from all concerned authorities and the designer is responsible to carry out such approval.

C. The developer must address all concerns to neighboring landowner/owners and obtain written consent with respect to discharge onto their property and will be responsible to mitigate and compensate for all damages, if the rate of discharge is changed to a particular location.

D. Pre and Post development peak flow, runoff volume calculation shall be based on 1 in 100-years 24-hours rainfall event.

E. Stormwater storage shall be designed for 1/100 year 24 hours rainfall and shall hold for 24 hours.

F. Design storm shall use Calgary International Airport Rainfall data provided by Meteorological Service of Canada.

G. All downstream properties including creek, river, ravine must be protected from erosion and silting

H. Post development rate of discharge to a point must be the same as predevelopment rate at that point.

I. Road side ditches shall not be used as stormwater detention/retention area at any situation.

J. If stormwater management plan is required as well as road construction, the road design shall not be reviewed without SWMP

K. Contaminated materials from proposed or existing development that seems to hazard for public health or environment shall not be allowed to flow through stormwater conveyances or treatment facilities.

L. Post development runoff to adjacent lands will be no greater than predevelopment quantities. Post development discharge rate may be limited subject to the receiving land characteristics.

M. No untreated water will be allowed to discharge off site or allowed to infiltrate underground.

N. Post development runoff to adjacent lands will be best quality as possible

O. BMP will be used to estimate quantity and quality of stormwater runoff

P. A security 100% of Stormwater construction cost shall be deposited prior to a Development Agreement or a Development permit.

Q. All drainage area must be protected by an Easement or ROW and surveyed out.

R. Any development prior to stormwater plan will be considered as post development condition.

S. No infiltration pond/dry pond will be allowed for industrial and commercial development.

T. All stormwater pond for industrial or commercial development must have appropriate liner

U. All industrial and commercial development must have self containment and disposal system.

V. Any construction made prior to the proposed development without building permit or grading permit, those development will be treated as post development condition while analyzing stormwater calculation for the proposed development.

W. Any discharge onto Municipal property, the developer must address all concern and will borne all costs to mitigate or update the existing condition.

X. Berming or stockpiling shall comply with lot grading By-Laws,

Y. Setback distance of stormwater pond

    a. From any water body or wastewater treatment facility shall meet Provincial/Municipal guidelines.
    b. From centre line of Road Right of Way (existing or future road plan) or centre line of the existing road to the toe of the pond (Outside) shall be at least 30 meter.

Z. Stormwater report must be undertaken by a competent Professional Engineer accredited by APEGGA and a construction completion certificate must be issued by a competent Professional Engineer indicating that all works are completed as per design drawing and specs. Report prepared and submitted other than competent professional engineer, MD will not consider for reviewing.

AA. In such cases where original design is required to change, the Developer's Engineer must obtain new approval from all authorities prior to construction.

BB. The proposed study will require revisiting if any additional development happens on same study areas in future.

CC. Failures to properly assess, design, construct and maintain a storm water management system will result in long term or short term problems for the development. All remedial works that may be required for which the cost shall be borne by the developer/landowner.

DD. It is the responsibility of the developer/landowner to carryout all operation and maintenance works pertinent to all stormwater facilities.

EE. EPEA registration or Water License or both approval as may necessary

FF. All design criteria, materials, installation and testing shall be in accordance with the latest editions of the followings:

- Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems by Alberta Environment
- Stormwater Management & Design Manual- The City of Calgary
- Environmental Guidelines for the Review of subdivisions in Alberta
- AEP Standards and Guidelines for the approval and design of natural and constructed treatment wetlands for water quality improvement
- Plumbing and Drainage Act of Alberta
- Code of Practice for Outfall structures on water bodies

<u>STORMWATER REPORT REQUIREMENTS</u>:

All Report should follow chronologically along with information as mentioned below:

Title Page:

Name of the Development and Legal address
Name of the Developer
Consultant contact information
Date of issue and revision number

Part 1: Introduction

1.1 Development location site referencing the nearest major road and Legal description of the land, municipality, lot
1.2 Property and development size
1.3 Type of development
1.4 Existence, date of creation, and phase of development in a Master Development Plan where applicable
1.5 Proposed development phasing and its impact on the system as a whole

Part 2. Existing site conditions Hydrologic Analysis

2.1 **A narrative description including supportive calculations of the pre-development conditions of the site as related to stormwater management should be provided to determine the current characteristics of the site.**
2.1.1 Site history past and present
2.1.2 Information on existing development/land use
2.1.3 Description of all types of pervious and impervious surfaces present including buildings, roads, and landscapes including trees, ponds, and waterways etc.
2.1.4 Name of the receiving water/creek/ravine identification, location relative to the site, existing condition/issues.
2.1.5 Analysis of runoff provided by off-site areas upstream of the project site
2.1.6 Geotechnical properties including permeability, depth of bedrock etc.
2.1.7 Groundwater table records through spring to fall
2.1.8 Site constraint if any
2.1.9 Methodologies, equations, assumptions, variable, constant, site parameter-amount of impervious/pervious surface, slope and supporting design calculations used in the analyzing the existing conditions site hydrology

2.2 Existing site conditions Map/drawing- a map documenting the following elements should be provided with all applicable information:
2.2.1 Topography of the existing site conditions with contours 1.0 meter or less
2.2.2 Perennial/intermittent streams, wetlands, lakes and other surface water features
2.2.3 Plan that identify and delineates the watershed area, subcatchment area and construction phases.
2.2.4 Existing stormwater conveyance and structural control facilities
2.2.5 Direction of flow and discharge points from the site including sheet flow areas.
2.2.6 All drawings must be computer generated

2.3 Existing Conditions Tables – tables documenting the following information shall be provided:
2.3.1 A table listing the peak runoff rates and total runoff volumes from each catchment/sub-catchment areas that will includes area, % impervious, rate of discharge, vloume
2.3.2 A table listing the peak runoff rates and total runoff volumes for each drainage area upstream of the project site.

Part 3. Post Development Hydrologic Analysis

3.1 A narrative description including supportive calculations of the post development site conditions to determine the future stormwater characteristics

3.1.1 Written description of the proposed site development, development type and characteristics, anticipated effluent quality, including amount of pervious/imperviousness
3.1.2 Mention methodologies, appropriate storm, runoff coefficient, assumptions, equations, site parameters, and supporting design calculations used in the analyzing the post development conditions site hydrology.
3.1.3 Table showing existing and anticipated amount of imperviousness in each lot and catchment areas
3.1.4 List of all input data for pre and post development analysis.
3.1.5 Calculations to show that post development peak discharge rates to the offsite do not exceed predevelopment rates during the 100-year 24-hours storms
3.1.6 All surface runoff conveyance systems and retention/detention facilities shall be designed to manage runoff from storm event 1/100 years. Wet pond shall have capacity to store 1 in 100 year storm within 2 meter above the normal/permanent pool with detention time 24 hours.
3.1.7 Calculation for all drainage conveyance: swales, ditches, pipes, catch basins, culverts
3.1.8 All quality control pond should have sediment forebays at each inlet into the pond
3.1.9 The bottom of the pond to be lined with 0.5 meter clay liner in areas where high groundwater table, permeable soils or bed rocks or where infiltration of underground is undesirable.
3.1.10 Consideration of the potential for groundwater contamination will be required when infiltration is proposed.
3.1.11 Minimum freeboard of 0.3 shall be used
3.1.12 Outlets shall be designed so that no erosion or scour to adjacent lands and no untreated water discharges.
3.1.13 Stage-Storage and Stage-Discharge curve for ponds
3.1.14 Measures proposed to protect existing downstream drainage system and /or receiving water bodies from release of post development runoff
3.1.15 Mitigation of the effect of stormwater on sewage/water supply if any.
3.1.16 The method of quality control and analysis

3.2 Post Development conditions Drawing with the following information;

3.2.1 Topography of the proposed site development contour 1.0 m interval
3.2.2 Plan showing surface water features stream, lakes, ponds, natural/unnatural drainage course etc.
3.2.3 Drainage area delineations showing the location of each drainage catchment/sub catchment and delineations of each contributing drainage area upstream of the project
3.2.4 Proposed strormwater conveyances and structural control facilities
3.2.5 Plan, cross sections and details of all stormwater facilities, control structures.
3.2.6 Profile, longitudinal slope, cross sections, subsurface drainage, rock/ditch check, erosion control blanket etc. for the channel/swales.
3.2.7 Access road to Detention/Retention/Wet ponds
3.2.8 Erosion and sedimentation control measures in all stormwater conveyance
3.2.9 Direction of flow and discharge points from the site including sheet flow areas
3.2.10 Location and boundaries of proposed natural feature protection areas
3.2.11 100-year 24-hour flood plain in all areas including conveyance and ponds
3.2.12 All drawings must be computer generated.

3.3 Post Development Conditions Tables- Tables documenting the following information shall be provided if applicable.

3.3.1 A table listing the acreage, soil types, impervious surface area and land cover characteristics for each catchment/sub-catchment area
3.3.2 A table listing the peak runoff rates and total runoff volumes from each catchment areas
3.3.3 A table listing the peak runoff rates and total runoff volumes for each catchment area upstream of the project site

3.3.4 A table listing the peak discharge rates, total runoff volumes and peak elevations for all detention/retention ponds.
3.3.5 A table listing the area, depth, slopes, and volume of detention, retention pond for normal water level, 1/100 years 24-hour storm level and high water level.
3.3.6 A table listing discharge rate, velocity, volume of all drainage swales, ditches and outlet

Part 4. Stormwater Management System

4.1 The stormwater management system shall provide a comprehensive description of the proposed system components on site. A narrative and supportive calculations describing the onsite stormwater management controls to be utilized including tables demonstrating compliance with the AENV guidelines and manuals**.**
4.1.1 Narrative describing that appropriate and effective structural stormwater controls have been selected.
4.1.2 Design Calculations and elevations for all existing and proposed stormwater conveyance elements including stormwater drains, pipes culverts, catch basins, channels, swales and areas of overland flow

Part 5. Downstream Analysis

5.1 The downstream analysis should provide a comprehensive picture of the downstream areas and their capacity to accommodate stormwater runoff from the proposed development
5.2 A narrative and supportive calculations for downstream peak flow analysis to show that post development design flow is less than predevelopment discharge flow. This narrative shall include appropriate description/tables for the points of interest such as culvert and channel constrictions downstream of the project where stormwater discharge could be of concern
5.3 A map illustrating the location, type and specifications of all stormwater management components to provide stormwater management for the proposed development.

Part 6 Erosion and sedimentation control measures:

The erosion and sedimentation control plan shall include in the report demonstrating the plan to effectively mitigate stormwater impacts during and after construction as per standard and guidelines. The following elements shall be included. Even if the Stormwater Management Standards do not apply, the developer/landowner still must implement erosion and sedimentation control plan in any situations.

6.1 Construction sequencing plan and temporary stabilization measures
6.2 Temporary structures that will converted into permanent stormwater controls
6.3 Construction period Operation and Maintenance plan and schedule
6.4 Construction period pollution prevention measures
6.5 Erosion and sedimentation control plan drawings

Part 7 Operation and Maintenance Manual:

A narrative maintenance tasks will be required for the stormwater controls and management program for site specific design and development. O & M manual shall be used by the future landowners/Developer as responsible parties. The report will also to identify access and safety issues and emergency procedures for the site.

Part 8 Recommendations and conclusion:

9.1 A comprehensive recommendation based on actual site conditions, analyses performed and findings that will protect downstream and environment.
9.2 Confirming that all aspect of design meet Alberta Environment's Standards and Guidelines and MD's requirements.

9.3 Measures to protect the drainage as designed.
9.4 Long term maintenance and monitoring plan addressing monitoring provisions and frequency of stormwater controls
9.5 Recommended notices to the land purchasers or on title regarding special setback as may needed during high flow period
9.6 Signature and Seal of the Professional Engineer having prepared report.

Part 9 Appendices:

10.1 Computer model input and output files
10.2 All input parameters for pre and post developments
10.3 Additional plan or drawings
10.4 Full calculation sheet
10.5 Reports from other agencies

APPENDIX C

Pre-Development and Post-Development

Hydrological Analysis

APPENDIX C-1

Pre-Development

Hydrological Analysis

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*  ****************             Q   H   M          ********************
*
*                          VERSION 3.0 for MS Windows
*                                MPE Engineering Ltd.
*                       MD of Foothills--Highway 2A ASP- Drainage Plan
*                          Pre-Development Model
*                          Calgary 1960-2007 Precip File
*                          Using cal-rain.pre file
*                          Pre-Development Release Rates
*
*         Flows from ASP Catchments HW-1, TCHW, HW-2, HW-3 & SR
*        AND Offsite Catchments HW1-Off, TCHW-Off, HW2-Off & HW3-Off
*
*        ======  Revised December 15, 2009  ======
*                Updated; January 25, 2010
*                          UPDATED CATCHMENTS & PARAMETERS
* ASSUMING CN OF 72 FOR ALL CATCHMENTS>>>SMAX = 271 & SMIN = 41
* ACCOUNTED OFFSITE CATCHMENTS (WHICH ARE NOT PART OF TONGUE CREEK
* CATCHMENT) IN THE MODEL
*  *******************************************************************
*
*  *******************************************************************
*
START                   START DATE OF SIMULATION        60 05 01
                        END DATE OF SIMULATION          07 11 01
                        PRECIP IS IN AEC HOURLY FORMAT  IPFORM 1
                        SET EVAPORATION FLAG OFF        ICASE  0
                        DUMMY FLAG                      IFLAG  0
                        SET POLLUTANT FLAG OFF          IFDECA 0
                        SET SEDIMENTATION FLAG ON       IFSEDT 1
                        SETTLING VELOCITIES ARE
                            0.0005  0.000025  0.000008  0.0000025  0.0000007
                        FOR SIZE FRACTIONS
                            0.89  0.058  0.012  0.012  0.028
*
*                   PARTICLE SIZES ASSOCIATED WITH THE ABOVE SETTLING
*                   VELOCITIES ARE : 75, 45, 15, 7.5, 3.5 um RESPECTIVELY
*
POLLUTANT SERIES        JCASE = 3 (SEDIMENT, IMPERVIOUS AREA)
                        WASHOFF METHOD (IWM) = 2 (BUILDUP/WASHOFF)
                        BUILD*AREA*3.39*Q**1.0
                        BUILDUP METHOD (IBM) = 1 (POWER LINEAR)
                        EQUIVALENT INITIAL ACCUMUMLATION (DAYSIN) = 30 DAYS
                        MAXIMUM BUILDUP (PMAX) = 0.000020 KG PER HA
                        BUILDUP RATE (PKONE) =
                         .003 KG PER SQ M PER 1.0 DAYS
*
*
POLLUTANT SERIES        JCASE = 4 (SEDIMENT,PERVIOUS AREA)
                        WASHOFF METHOD (IWM) =2 (BUILDUP/WASHOFF)
                        BUILD*AREA*1.7*Q**1.0
                        BUILDUP METHOD (IBM) = 1 (POWER LINEAR)
                        EQUIVALENT INITIAL ACCUMUMLATION (DAYSIN) = 30 DAYS
                        MAXIMUM BUILDUP (PMAX) = 0.00002 KG PER HA
                        BUILDUP RATE (PKONE) =
                         .00055 KG PER SQ M PER 1.0 DAYS
*
*
*RUNOFF/WASHOFF GENERATION
*
** Offsite Catchment draining Highwood River HW1-Off
*
GENERATE                ID=1 ISER=501 DT=1.0 HR  DA=30 HA
                        ABSIMP=0     FRIMP=0.02
                        ====IMPERVIOUS AREA====
                        WILLIAMS UNIT HYD AA=2    XK=0.41  TP=0.29 HRS
                        IA=1.7 MM     RUNOFF COEF=0.95
                        ====PERVIOUS AREA=====
```

```
                    WILLIAMS UNIT HYD AA=2     XK=0.35  TP=0.30 HRS
                    SMIN=41 MM   SMAX=271 MM  SK=0.04
                    APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                    ====BASE FLOW  DATA====
                    NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                    MINIMUM BASE FLOW                BASMIN=0.0
                    BASE FLOW DEPLETION FACTOR       BFACR=2.0
                    STARTING SOIL MOISTURE           SVOL=2.0 MM
                    SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
                    SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
                    BASE RECESSION CONSTANT          SLOSKA=0.00001
                    BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
                    ====SNOW MELT DATA====
                    ANNUAL COEFFICIENT METHOD ISNOW=1
                    BASE TEMPERATURE BASET=2
                    CALIBRATION COFFICIENT SNOFAC=0.038
                    INITIAL SNOWPACK DEPTH PACDEP=0
                    WATER EQUIVALENT
                    UPWARD GROUND HEAT FLUX
                    CALIBRATION COEFFICIENT ALPHAA=2.5
                    AVG THERMAL SOIL CONDTIVITY XKL=15
                    DOWNWARD DAILY AVG SOIL HEAT FLUX
                    PROPORTIONALITY CONSTANT BCOEF=1.1
                    SNOW PACK
                    THERMAL INSULATION FACTOR XNCOEF=150
                    KFLAG = 0
*
* ASP Catchment draining via Highwood River tributary HW-1
**
GENERATE            ID=2 ISER=101 DT=1.0 HR  DA=690 HA
                    ABSIMP=0     FRIMP=0.01
                    ====IMPERVIOUS AREA====
                    WILLIAMS UNIT HYD AA=2     XK=3.78  TP=2.58 HRS
                    IA=1.7 MM      RUNOFF COEF=0.95
                    ====PERVIOUS AREA=====
                    WILLIAMS UNIT HYD AA=2     XK=3.15  TP=2.67 HRS
                    SMIN=41 MM   SMAX=271 MM  SK=0.04
                    APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                    ====BASE FLOW  DATA====
                    NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                    MINIMUM BASE FLOW                BASMIN=0.0
                    BASE FLOW DEPLETION FACTOR       BFACR=2.0
                    STARTING SOIL MOISTURE           SVOL=2.0 MM
                    SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
                    SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
                    BASE RECESSION CONSTANT          SLOSKA=0.00001
                    BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
                    ====SNOW MELT DATA====
                    ANNUAL COEFFICIENT METHOD ISNOW=1
                    BASE TEMPERATURE BASET=2
                    CALIBRATION COFFICIENT SNOFAC=0.038
                    INITIAL SNOWPACK DEPTH PACDEP=0
                    WATER EQUIVALENT
                    UPWARD GROUND HEAT FLUX
                    CALIBRATION COEFFICIENT ALPHAA=2.5
                    AVG THERMAL SOIL CONDTIVITY XKL=15
                    DOWNWARD DAILY AVG SOIL HEAT FLUX
                    PROPORTIONALITY CONSTANT BCOEF=1.1
                    SNOW PACK
                    THERMAL INSULATION FACTOR XNCOEF=150
                    KFLAG = 0
*
* ADDING HW1 OFFSITE & ASP CATCHMENTS
*
ADD SERIES          OUTPUT ID is 3, SERIES NAME IS 1203
                    INPUT IDS ARE 1 AND 2
*
```

```
** Offsite Catchment draining via Tongue Creek tributary TCHW-Off
*
GENERATE            ID=4 ISER=502 DT=1.0 HR  DA=120 HA
                    ABSIMP=0      FRIMP=0.02
                    ====IMPERVIOUS AREA====
                    WILLIAMS UNIT HYD AA=2    XK=0.77  TP=0.54 HRS
                    IA=1.7 MM       RUNOFF COEF=0.95
                    ====PERVIOUS AREA=====
                    WILLIAMS UNIT HYD AA=2    XK=0.67  TP=0.56 HRS
                    SMIN=41 MM   SMAX=271 MM  SK=0.04
                    APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                    ====BASE FLOW  DATA====
                    NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                    MINIMUM BASE FLOW                BASMIN=0.0
                    BASE FLOW DEPLETION FACTOR       BFACR=2.0
                    STARTING SOIL MOISTURE           SVOL=2.0 MM
                    SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
                    SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
                    BASE RECESSION CONSTANT          SLOSKA=0.00001
                    BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
                    ====SNOW MELT DATA====
                    ANNUAL COEFFICIENT METHOD ISNOW=1
                    BASE TEMPERATURE BASET=2
                    CALIBRATION COFFICIENT SNOFAC=0.038
                    INITIAL SNOWPACK DEPTH PACDEP=0
                    WATER EQUIVALENT
                    UPWARD GROUND HEAT FLUX
                    CALIBRATION COEFFICIENT ALPHAA=2.5
                    AVG THERMAL SOIL CONDTIVITY XKL=15
                    DOWNWARD DAILY AVG SOIL HEAT FLUX
                    PROPORTIONALITY CONSTANT BCOEF=1.1
                    SNOW PACK
                    THERMAL INSULATION FACTOR XNCOEF=150
                    KFLAG = 0
*
** ASP Catchment draining via Tongue Creek tributary TCHW
*
GENERATE            ID=5 ISER=102 DT=1.0 HR  DA=882 HA
                    ABSIMP=0      FRIMP=0.10
                    ====IMPERVIOUS AREA====
                    WILLIAMS UNIT HYD AA=2    XK=1.27  TP=1.08 HRS
                    IA=1.7 MM       RUNOFF COEF=0.95
                    ====PERVIOUS AREA=====
                    WILLIAMS UNIT HYD AA=2    XK=1.46  TP=1.24 HRS
                    SMIN=41 MM   SMAX=271 MM  SK=0.04
                    APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                    ====BASE FLOW  DATA====
                    NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
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                    BASE FLOW DEPLETION FACTOR       BFACR=2.0
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                    SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
                    SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
                    BASE RECESSION CONSTANT          SLOSKA=0.00001
                    BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
                    ====SNOW MELT DATA====
                    ANNUAL COEFFICIENT METHOD ISNOW=1
                    BASE TEMPERATURE BASET=2
                    CALIBRATION COFFICIENT SNOFAC=0.038
                    INITIAL SNOWPACK DEPTH PACDEP=0
                    WATER EQUIVALENT
                    UPWARD GROUND HEAT FLUX
                    CALIBRATION COEFFICIENT ALPHAA=2.5
                    AVG THERMAL SOIL CONDTIVITY XKL=15
                    DOWNWARD DAILY AVG SOIL HEAT FLUX
                    PROPORTIONALITY CONSTANT BCOEF=1.1
                    SNOW PACK
                    THERMAL INSULATION FACTOR XNCOEF=150
```

```
                  KFLAG = 0
*
* ADDING TCHW OFFSITE & ASP CATCHMENTS
*
ADD SERIES        OUTPUT ID is 6, SERIES NAME IS 4506
                  INPUT IDS ARE 4 AND 5
*
*ADDING HW1 AND TCHW WATERSHEDS (SUM OF DRAINAGE AREA)
*
ADD SERIES        OUTPUT ID is 7, SERIES NAME IS 3607
                  INPUT IDS ARE 3 AND 6
*
** Offsite Catchment "HW2-Off" draining via HW-2 ASP Catchment
*
GENERATE          ID=8 ISER=503 DT=1.0 HR  DA=740 HA
                  ABSIMP=0     FRIMP=0.03
                  ====IMPERVIOUS AREA====
                  WILLIAMS UNIT HYD AA=2    XK=1.30  TP=0.93 HRS
                  IA=1.7 MM       RUNOFF COEF=0.95
                  ====PERVIOUS AREA=====
                  WILLIAMS UNIT HYD AA=2    XK=1.16  TP=0.98 HRS
                  SMIN=41 MM   SMAX=271 MM  SK=0.04
                  APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                  ====BASE FLOW  DATA====
                  NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                  MINIMUM BASE FLOW                BASMIN=0.0
                  BASE FLOW DEPLETION FACTOR       BFACR=2.0
                  STARTING SOIL MOISTURE           SVOL=2.0 MM
                  SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
                  SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
                  BASE RECESSION CONSTANT          SLOSKA=0.00001
                  BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
                  ====SNOW MELT DATA====
                  ANNUAL COEFFICIENT METHOD ISNOW=1
                  BASE TEMPERATURE BASET=2
                  CALIBRATION COFFICIENT SNOFAC=0.038
                  INITIAL SNOWPACK DEPTH PACDEP=0
                  WATER EQUIVALENT
                  UPWARD GROUND HEAT FLUX
                  CALIBRATION COEFFICIENT ALPHAA=2.5
                  AVG THERMAL SOIL CONDTIVITY XKL=15
                  DOWNWARD DAILY AVG SOIL HEAT FLUX
                  PROPORTIONALITY CONSTANT BCOEF=1.1
                  SNOW PACK
                  THERMAL INSULATION FACTOR XNCOEF=150
                  KFLAG = 0
*
*
* ASP Catchment draining via Highwood River Tributary HW-2
**
GENERATE          ID=9 ISER=103 DT=1.0 HR  DA=985.6 HA
                  ABSIMP=0     FRIMP=0.07
                  ====IMPERVIOUS AREA====
                  WILLIAMS UNIT HYD AA=2    XK=1.39  TP=1.09 HRS
                  IA=1.7 MM       RUNOFF COEF=0.95
                  ====PERVIOUS AREA=====
                  WILLIAMS UNIT HYD AA=2    XK=1.42  TP=1.21 HRS
                  SMIN=41 MM   SMAX=271 MM  SK=0.04
                  APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                  ====BASE FLOW  DATA====
                  NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                  MINIMUM BASE FLOW                BASMIN=0.0
                  BASE FLOW DEPLETION FACTOR       BFACR=2.0
                  STARTING SOIL MOISTURE           SVOL=2.0 MM
                  SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
                  SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
                  BASE RECESSION CONSTANT          SLOSKA=0.00001
                  BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
```

```
                    ====SNOW MELT DATA====
                    ANNUAL COEFFICIENT METHOD ISNOW=1
                    BASE TEMPERATURE BASET=2
                    CALIBRATION COFFICIENT SNOFAC=0.038
                    INITIAL SNOWPACK DEPTH PACDEP=0
                    WATER EQUIVALENT
                    UPWARD GROUND HEAT FLUX
                    CALIBRATION COEFFICIENT ALPHAA=2.5
                    AVG THERMAL SOIL CONDTIVITY XKL=15
                    DOWNWARD DAILY AVG SOIL HEAT FLUX
                    PROPORTIONALITY CONSTANT BCOEF=1.1
                    SNOW PACK
                    THERMAL INSULATION FACTOR XNCOEF=150
                    KFLAG = 0
*
* ADDING HW-2 OFFSITE & ASP CATCHMENTS
*
ADD SERIES          OUTPUT ID is 10, SERIES NAME IS 8910
                    INPUT IDS ARE 8 AND 9
*
*ADDING HW1, TCHW & HW2 WATERSHEDS (SUM OF DRAINAGE AREA)
*
ADD SERIES          OUTPUT ID is 11, SERIES NAME IS 1007
                    INPUT IDS ARE 10 AND 7
*
** Offsite Catchment "HW3-Off" draining via HW-3 ASP Catchment
*
GENERATE            ID=12 ISER=504 DT=1.0 HR  DA=690 HA
                    ABSIMP=0     FRIMP=0.03
                    ====IMPERVIOUS AREA====
                    WILLIAMS UNIT HYD AA=2    XK=0.98  TP=0.70 HRS
                    IA=1.7 MM       RUNOFF COEF=0.95
                    ====PERVIOUS AREA=====
                    WILLIAMS UNIT HYD AA=2    XK=0.87  TP=0.74 HRS
                    SMIN=41 MM   SMAX=271 MM  SK=0.04
                    APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                    ====BASE FLOW  DATA====
                    NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                    MINIMUM BASE FLOW                BASMIN=0.0
                    BASE FLOW DEPLETION FACTOR       BFACR=2.0
                    STARTING SOIL MOISTURE           SVOL=2.0 MM
                    SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
                    SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
                    BASE RECESSION CONSTANT          SLOSKA=0.00001
                    BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
                    ====SNOW MELT DATA====
                    ANNUAL COEFFICIENT METHOD ISNOW=1
                    BASE TEMPERATURE BASET=2
                    CALIBRATION COFFICIENT SNOFAC=0.038
                    INITIAL SNOWPACK DEPTH PACDEP=0
                    WATER EQUIVALENT
                    UPWARD GROUND HEAT FLUX
                    CALIBRATION COEFFICIENT ALPHAA=2.5
                    AVG THERMAL SOIL CONDTIVITY XKL=15
                    DOWNWARD DAILY AVG SOIL HEAT FLUX
                    PROPORTIONALITY CONSTANT BCOEF=1.1
                    SNOW PACK
                    THERMAL INSULATION FACTOR XNCOEF=150
                    KFLAG = 0
*
* ASP Catchment draining via Highwood River Tributary HW-3
**
GENERATE            ID=13 ISER=104 DT=1.0 HR  DA=962 HA
                    ABSIMP=0     FRIMP=0.08
                    ====IMPERVIOUS AREA====
                    WILLIAMS UNIT HYD AA=2    XK=0.84  TP=0.67 HRS
                    IA=1.7 MM       RUNOFF COEF=0.95
                    ====PERVIOUS AREA=====
```

```
                    WILLIAMS UNIT HYD AA=2    XK=0.89  TP=0.75 HRS
                    SMIN=41 MM   SMAX=271 MM  SK=0.04
                    APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                    ====BASE FLOW  DATA====
                    NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                    MINIMUM BASE FLOW                BASMIN=0.0
                    BASE FLOW DEPLETION FACTOR       BFACR=2.0
                    STARTING SOIL MOISTURE           SVOL=2.0 MM
                    SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
                    SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
                    BASE RECESSION CONSTANT          SLOSKA=0.00001
                    BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
                    ====SNOW MELT DATA====
                    ANNUAL COEFFICIENT METHOD ISNOW=1
                    BASE TEMPERATURE BASET=2
                    CALIBRATION COFFICIENT SNOFAC=0.038
                    INITIAL SNOWPACK DEPTH PACDEP=0
                    WATER EQUIVALENT
                    UPWARD GROUND HEAT FLUX
                    CALIBRATION COEFFICIENT ALPHAA=2.5
                    AVG THERMAL SOIL CONDTIVITY XKL=15
                    DOWNWARD DAILY AVG SOIL HEAT FLUX
                    PROPORTIONALITY CONSTANT BCOEF=1.1
                    SNOW PACK
                    THERMAL INSULATION FACTOR XNCOEF=150
                    KFLAG = 0
*
* ADDING HW-3 OFFSITE & ASP CATCHMENTS
*
ADD SERIES          OUTPUT ID is 14, SERIES NAME IS 1400
                    INPUT IDS ARE 12 AND 13
*
*ADDING HW1,TCHW, HW2 & HW3 WATERSHEDS (SUM OF DRAINAGE AREA)
*
ADD SERIES          OUTPUT ID is 15, SERIES NAME IS 1500
                    INPUT IDS ARE 11 AND 14
*
* ASP Catchment draining via THE SHEEP RIVER
**
GENERATE            ID=16 ISER=105 DT=1.0 HR  DA=172.9 HA
                    ABSIMP=0      FRIMP=0.10
                    ====IMPERVIOUS AREA====
                    WILLIAMS UNIT HYD AA=2    XK=0.57  TP=0.49 HRS
                    IA=1.7 MM       RUNOFF COEF=0.95
                    ====PERVIOUS AREA=====
                    WILLIAMS UNIT HYD AA=2    XK=0.66  TP=0.56 HRS
                    SMIN=41 MM   SMAX=271 MM  SK=0.04
                    APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                    ====BASE FLOW  DATA====
                    NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                    MINIMUM BASE FLOW                BASMIN=0.0
                    BASE FLOW DEPLETION FACTOR       BFACR=2.0
                    STARTING SOIL MOISTURE           SVOL=2.0 MM
                    SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
                    SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
                    BASE RECESSION CONSTANT          SLOSKA=0.00001
                    BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
                    ====SNOW MELT DATA====
                    ANNUAL COEFFICIENT METHOD ISNOW=1
                    BASE TEMPERATURE BASET=2
                    CALIBRATION COFFICIENT SNOFAC=0.038
                    INITIAL SNOWPACK DEPTH PACDEP=0
                    WATER EQUIVALENT
                    UPWARD GROUND HEAT FLUX
                    CALIBRATION COEFFICIENT ALPHAA=2.5
                    AVG THERMAL SOIL CONDTIVITY XKL=15
                    DOWNWARD DAILY AVG SOIL HEAT FLUX
                    PROPORTIONALITY CONSTANT BCOEF=1.1
```

```
                    SNOW PACK
                    THERMAL INSULATION FACTOR XNCOEF=150
                    KFLAG = 0
*
*ADDING HW1,TCHW,HW2,HW3,& SR WATERSHEDS (SUM OF TOTAL DRAINAGE AREA)
*
ADD SERIES          OUTPUT ID is 17, SERIES NAME IS 1700
                    INPUT IDS ARE 15 AND 16
*
*
*ANNUAL MAXIMUM/MINIMUM STATS FOR PEAK FLOWS (ALL OFFSITE & ASP CATCHMENTS)
MAXMIN              ID IN = 17 IS FLOW
                    IOPT = 1 ANNUAL SERIES
                    IFY = 60 STARTING YEAR
                    IFM = 6 STARTING MONTH
                    IFD = 2 STARTING DAY
                    ITY = 07 ENDING YEAR
                    ITM = 05 ENDING MONTH
                    ITD = 31 ENDING DAY
*
FINISH
```

```
           * * * *   *     *   **    **
           *     *   *     *   * *  * *
           *     *   * * * *   *  *   *
           *     *   *     *   *      *
           *   * *   *     *   *      *
           * * * *   *     *   *      *
                   *
```

```
========================================================================
===        Q u a l i t y   H y d r o l o g i c   M o d e l          ===
===              R e l e a s e   3.1    ***   2 0 0 5                ===
===              Centre for Water Resources Studies                  ===
===                    Dalhousie University                          ===
===                      P. O. Box 1000                              ===
===                    Halifax, Nova Scotia                          ===
===                      Canada  B3J 2X4                             ===
===                    Email:  salahma@dal.ca                        ===
===                    Tel:   (902)494-6107                          ===
=== Program Execution Started on  Jan.  25, 2010.  Time: 16:45:08.95 ===
========================================================================


QHM Project Name:          Hy2A_Pre
Pimary Input File Name:    C:\Program Files\Q H M\Projects\HWY2A\PRE_HY2A.INP
Pimary Output File Name:   C:\Program Files\Q H M\Projects\HWY2A\PRE_HY2A.OUT
Precipitation File Name:   C:\Program Files\Q H M\Projects\HWY2A\cal-rain.pre


 *  *****************            Q   H   M          *********************
 *
 *                     VERSION 3.0 for MS Windows
 *                      MPE Engineering Ltd.
 *                     MD of Foothills--Highway 2A ASP- Drainage Plan
 *                     Pre-Development Model
 *                     Calgary 1960-2007 Precip File
 *                     Using cal-rain.pre file
 *                     Pre-Development Release Rates
 *
 *         Flows from ASP Catchments HW-1, TCHW, HW-2, HW-3 & SR
 *        AND Offsite Catchments HW1-Off, TCHW-Off, HW2-Off & HW3-Off
 *
 *        ======  Revised December 15, 2009  ======
 *                Updated; January 25, 2010
 *                     UPDATED CATCHMENTS & PARAMETERS
 * ASSUMING CN OF 72 FOR ALL CATCHMENTS>>>SMAX = 271 & SMIN = 41
 * ACCOUNTED OFFSITE CATCHMENTS (WHICH ARE NOT PART OF TONGUE CREEK
 * CATCHMENT) IN THE MODEL
 *  **********************************************************************
 *
 *  **********************************************************************
 *
 START                START DATE OF SIMULATION         60 05 01
                      END DATE OF SIMULATION           07 11 01
                      PRECIP IS IN AEC HOURLY FORMAT   IPFORM 1
                      SET EVAPORATION FLAG OFF         ICASE  0
                      DUMMY FLAG                       IFLAG  0
                      SET POLLUTANT FLAG OFF           IFDECA 0
                      SET SEDIMENTATION FLAG ON        IFSEDT 1
                      SETTLING VELOCITIES ARE
                          0.0005  0.000025  0.000008  0.0000025  0.0000007
                      FOR SIZE FRACTIONS
                          0.89  0.058  0.012  0.012  0.028
HOULY PRECIPITATION IS READ IN AES CONDENSED FORMAT
    *
    *          PARTICLE SIZES ASSOCIATED WITH THE ABOVE SETTLING
    *          VELOCITIES ARE : 75, 45, 15, 7.5, 3.5 um RESPECTIVELY
    *
```

```
POLLUTANT SERIES     JCASE = 3 (SEDIMENT, IMPERVIOUS AREA)
                     WASHOFF METHOD (IWM) = 2 (BUILDUP/WASHOFF)
                     BUILD*AREA*3.39*Q**1.0
                     BUILDUP METHOD (IBM) = 1 (POWER LINEAR)
                     EQUIVALENT INITIAL ACCUMUMLATION (DAYSIN) = 30 DAYS
                     MAXIMUM BUILDUP (PMAX) = 0.000020 KG PER HA
                     BUILDUP RATE (PKONE) =
                      .003 KG PER SQ M PER 1.0 DAYS
*
*
POLLUTANT SERIES     JCASE = 4 (SEDIMENT,PERVIOUS AREA)
                     WASHOFF METHOD (IWM) =2 (BUILDUP/WASHOFF)
                     BUILD*AREA*1.7*Q**1.0
                     BUILDUP METHOD (IBM) = 1 (POWER LINEAR)
                     EQUIVALENT INITIAL ACCUMUMLATION (DAYSIN) = 30 DAYS
                     MAXIMUM BUILDUP (PMAX) = 0.00002 KG PER HA
                     BUILDUP RATE (PKONE) =
                      .00055 KG PER SQ M PER 1.0 DAYS
*
*
*RUNOFF/WASHOFF GENERATION
*
** Offsite Catchment draining Highwood River HW1-Off
*
GENERATE             ID=1 ISER=501 DT=1.0 HR  DA=30 HA
                     ABSIMP=0      FRIMP=0.02
                     ====IMPERVIOUS AREA====
                     WILLIAMS UNIT HYD AA=2    XK=0.41  TP=0.29 HRS
                     IA=1.7 MM      RUNOFF COEF=0.95
                     ====PERVIOUS AREA=====
                     WILLIAMS UNIT HYD AA=2    XK=0.35  TP=0.30 HRS
                     SMIN=41 MM   SMAX=271 MM  SK=0.04
                     APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                     ====BASE FLOW  DATA====
                     NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                     MINIMUM BASE FLOW                 BASMIN=0.0
                     BASE FLOW DEPLETION FACTOR        BFACR=2.0
                     STARTING SOIL MOISTURE            SVOL=2.0 MM
                     SOIL MOISTURE AT WILTING PT       SWILT=0.01 MM
                     SOIL MOISTURE AT FIELD CAPACITY   SFIELD=0.1 MM
                     BASE RECESSION CONSTANT           SLOSKA=0.00001
                     BASE FLOW REDUCTION FACTOR        SLOSKB=0.15
                     ====SNOW MELT DATA====
                     ANNUAL COEFFICIENT METHOD ISNOW=1
                     BASE TEMPERATURE BASET=2
                     CALIBRATION COFFICIENT SNOFAC=0.038
                     INITIAL SNOWPACK DEPTH PACDEP=0
                     WATER EQUIVALENT
                     UPWARD GROUND HEAT FLUX
                     CALIBRATION COEFFICIENT ALPHAA=2.5
                     AVG THERMAL SOIL CONDTIVITY XKL=15
                     DOWNWARD DAILY AVG SOIL HEAT FLUX
                     PROPORTIONALITY CONSTANT BCOEF=1.1
                     SNOW PACK
                     THERMAL INSULATION FACTOR XNCOEF=150
                     KFLAG = 0

====== IMPERVIOUS AREA UNIT HYDROGRAPH DATA ======

 - SHAPE CONSTANT, N =  2.566          - UNIT PEAK,QP =   .0022 CMS
 - THE UH YIELDS   1.3960 MM VOL SO MULT BY    .7163 WILL ENSURE A 1 MM UH.

======= PERVIOUS AREA UNIT HYDROGRAPH DATA =======

 - SHAPE CONSTANT, N =  3.040          - UNIT PEAK,QP =   .1202 CMS
 - THE UH YIELDS   1.5055 MM VOL SO MULT BY    .6642 WILL ENSURE A 1 MM UH.

API REDUCTION FACTOR IS   .991E+00 PER TIME STEP OR   .800E+00 PER DAY
```

```
ID SERIES FILE INFORMATION:
The QHM Command Generate      Created
Output Time Series File Named: ID01.SER


Provided  Input  Value for ID:     1
User Designated Series # ISER:  501
Time Step  in the Series File: 1.00 hour


 W A T E R   M A S S   B A L A N C E
 A-TOTAL RAINFALL                =     16207.51 MM
 B-TOTAL RUNOFF IMPRV+PERV       =       689.01 MM
 C-ALL INITIAL ABSTRACTIONS      =     11641.69 MM
 D-TOTAL INFILTERATED WATER      =      3876.80 MM
 TOTAL GROUNDWATER ACCRETION     =      3296.97 MM
 E-TOTAL BASE FLOW               =       581.82 MM
 F-CHANGE IN GROUNDWATER STORAGE=        -2.00 MM
 G-EVAPORATION FROM SOIL WATER  =          .00 MM
 H-LOSS TO DEEP GROUNDWATER      =      3296.97 MM
 I-CHANGE IN SNOW PACK STORAGE  =          .00 MM
 G-NET IMPORTED SNOW             =          .00 MM

 SURFACE WATER BALANCE = A - B - C - D        =         .00 MM
 SUBSURFACE WATER BALANCE= D - E - F - G - H =         .02 MM
 TOTAL BALANCE  = A - B - C - E - F - G - H  =         .01 MM

RAINFALL AND DIRECT  RUNOFF TOTALS OVER THE SIMULATION TIME SPAN ==========
  RAINFALL  PERVIOUS  IMPERVIOUS   TOTAL
             RUNOFF     RUNOFF     RUNOFF
    (MM)      (MM)       (MM)       (MM)
 16207.510   468.524  11493.010    689.014
    *

    * ASP Catchment draining via Highwood River tributary HW-1
    **
    GENERATE            ID=2 ISER=101 DT=1.0 HR  DA=690 HA
                        ABSIMP=0     FRIMP=0.01
                        ====IMPERVIOUS AREA====
                        WILLIAMS UNIT HYD AA=2    XK=3.78  TP=2.58 HRS
                        IA=1.7 MM       RUNOFF COEF=0.95
                        ====PERVIOUS AREA=====
                        WILLIAMS UNIT HYD AA=2    XK=3.15  TP=2.67 HRS
                        SMIN=41 MM   SMAX=271 MM  SK=0.04
                        APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                        ====BASE FLOW  DATA====
                        NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                        MINIMUM BASE FLOW                BASMIN=0.0
                        BASE FLOW DEPLETION FACTOR       BFACR=2.0
                        STARTING SOIL MOISTURE           SVOL=2.0 MM
                        SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
                        SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
                        BASE RECESSION CONSTANT          SLOSKA=0.00001
                        BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
                        ====SNOW MELT DATA====
                        ANNUAL COEFFICIENT METHOD ISNOW=1
                        BASE TEMPERATURE BASET=2
                        CALIBRATION COFFICIENT SNOFAC=0.038
                        INITIAL SNOWPACK DEPTH PACDEP=0
                        WATER EQUIVALENT
                        UPWARD GROUND HEAT FLUX
                        CALIBRATION COEFFICIENT ALPHAA=2.5
                        AVG THERMAL SOIL CONDTIVITY XKL=15
                        DOWNWARD DAILY AVG SOIL HEAT FLUX
                        PROPORTIONALITY CONSTANT BCOEF=1.1
                        SNOW PACK
```

```
                    THERMAL INSULATION FACTOR XNCOEF=150
                    KFLAG = 0

====== IMPERVIOUS AREA UNIT HYDROGRAPH DATA ======

 - SHAPE CONSTANT, N =  2.492           - UNIT PEAK,QP =    .0027 CMS
 - THE UH YIELDS     .9183 MM VOL SO MULT BY   1.0890 WILL ENSURE A 1 MM UH.

======= PERVIOUS AREA UNIT HYDROGRAPH DATA =======

 - SHAPE CONSTANT, N =  3.008           - UNIT PEAK,QP =    .3111 CMS
 - THE UH YIELDS     .9315 MM VOL SO MULT BY   1.0736 WILL ENSURE A 1 MM UH.

API REDUCTION FACTOR IS    .991E+00 PER TIME STEP OR   .800E+00 PER DAY


    ID SERIES FILE INFORMATION:
    The QHM Command Generate      Created
    Output Time Series File Named: ID02.SER


    Provided  Input  Value for ID:    2
    User Designated Series # ISER:  101
    Time Step  in the Series File: 1.00 hour


     W A T E R   M A S S   B A L A N C E
     A-TOTAL RAINFALL                =    16207.51 MM
     B-TOTAL RUNOFF IMPRV+PERV       =      578.77 MM
     C-ALL INITIAL ABSTRACTIONS      =    11718.55 MM
     D-TOTAL INFILTERATED WATER      =     3910.18 MM
     TOTAL GROUNDWATER ACCRETION     =     3325.35 MM
     E-TOTAL BASE FLOW               =      586.83 MM
     F-CHANGE IN GROUNDWATER STORAGE=        -2.00 MM
     G-EVAPORATION FROM SOIL WATER   =         .00 MM
     H-LOSS TO DEEP GROUNDWATER      =     3325.35 MM
     I-CHANGE IN SNOW PACK STORAGE   =         .00 MM
     G-NET IMPORTED SNOW             =         .00 MM

     SURFACE WATER BALANCE = A - B - C - D        =        .01 MM
     SUBSURFACE WATER BALANCE= D - E - F - G - H =         .00 MM
     TOTAL BALANCE   = A - B - C - E - F - G - H  =        .01 MM

 RAINFALL AND DIRECT  RUNOFF TOTALS OVER THE SIMULATION TIME SPAN ==========
   RAINFALL  PERVIOUS  IMPERVIOUS   TOTAL
              RUNOFF    RUNOFF      RUNOFF
     (MM)      (MM)      (MM)        (MM)
  16207.510    468.524  11493.010    578.769
     *
     * ADDING HW1 OFFSITE & ASP CATCHMENTS
     *
     ADD SERIES          OUTPUT ID is 3, SERIES NAME IS 1203
                         INPUT IDS ARE 1 AND 2

    ID SERIES FILE INFORMATION:
    The QHM Command Add Series    Created
    Output Time Series File Named: ID03.SER


    Provided  Input  Value for ID:    3
    User Designated Series # ISER: 1203
    Time Step  in the Series File: 1.00 hour

      ADD BEGINS AT 1960   5  1
      USES TIME STEP OF   .100E+01 HOURS
      AND ENDS AT   2007  11  1

     *
```

```
** Offsite Catchment draining via Tongue Creek tributary TCHW-Off
*
GENERATE              ID=4 ISER=502 DT=1.0 HR  DA=120 HA
                      ABSIMP=0      FRIMP=0.02
                      ====IMPERVIOUS AREA====
                      WILLIAMS UNIT HYD AA=2     XK=0.77  TP=0.54 HRS
                      IA=1.7 MM        RUNOFF COEF=0.95
                      ====PERVIOUS AREA=====
                      WILLIAMS UNIT HYD AA=2     XK=0.67  TP=0.56 HRS
                      SMIN=41 MM   SMAX=271 MM  SK=0.04
                      APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                      ====BASE FLOW  DATA====
                      NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                      MINIMUM BASE FLOW                BASMIN=0.0
                      BASE FLOW DEPLETION FACTOR       BFACR=2.0
                      STARTING SOIL MOISTURE           SVOL=2.0 MM
                      SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
                      SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
                      BASE RECESSION CONSTANT          SLOSKA=0.00001
                      BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
                      ====SNOW MELT DATA====
                      ANNUAL COEFFICIENT METHOD ISNOW=1
                      BASE TEMPERATURE BASET=2
                      CALIBRATION COFFICIENT SNOFAC=0.038
                      INITIAL SNOWPACK DEPTH PACDEP=0
                      WATER EQUIVALENT
                      UPWARD GROUND HEAT FLUX
                      CALIBRATION COEFFICIENT ALPHAA=2.5
                      AVG THERMAL SOIL CONDTIVITY XKL=15
                      DOWNWARD DAILY AVG SOIL HEAT FLUX
                      PROPORTIONALITY CONSTANT BCOEF=1.1
                      SNOW PACK
                      THERMAL INSULATION FACTOR XNCOEF=150
                      KFLAG = 0

====== IMPERVIOUS AREA UNIT HYDROGRAPH DATA ======

 - SHAPE CONSTANT, N =  2.548          - UNIT PEAK,QP =   .0046 CMS
 - THE UH YIELDS     .9300 MM VOL SO MULT BY    1.0752 WILL ENSURE A 1 MM UH.

======= PERVIOUS AREA UNIT HYDROGRAPH DATA =======

 - SHAPE CONSTANT, N =  2.970          - UNIT PEAK,QP =   .2525 CMS
 - THE UH YIELDS     .9571 MM VOL SO MULT BY    1.0449 WILL ENSURE A 1 MM UH.

API REDUCTION FACTOR IS   .991E+00 PER TIME STEP OR   .800E+00 PER DAY


    ID SERIES FILE INFORMATION:
    The QHM Command Generate      Created
    Output Time Series File Named: ID04.SER


    Provided  Input  Value for ID:    4
    User Designated Series # ISER:  502
    Time Step  in the Series File: 1.00 hour


     W A T E R   M A S S   B A L A N C E
     A-TOTAL RAINFALL               =    16207.51 MM
     B-TOTAL RUNOFF IMPRV+PERV      =      689.01 MM
     C-ALL INITIAL ABSTRACTIONS     =    11641.69 MM
     D-TOTAL INFILTERATED WATER     =     3876.80 MM
     TOTAL GROUNDWATER ACCRETION    =     3296.97 MM
     E-TOTAL BASE FLOW              =      581.82 MM
     F-CHANGE IN GROUNDWATER STORAGE=       -2.00 MM
     G-EVAPORATION FROM SOIL WATER  =         .00 MM
     H-LOSS TO DEEP GROUNDWATER     =     3296.97 MM
```

```
    I-CHANGE IN SNOW PACK STORAGE  =          .00 MM
    G-NET IMPORTED SNOW            =          .00 MM

    SURFACE WATER BALANCE = A - B - C - D          =          .00 MM
    SUBSURFACE WATER BALANCE= D - E - F - G - H =          .02 MM
    TOTAL BALANCE   = A - B - C - E - F - G - H  =          .01 MM

 RAINFALL AND DIRECT  RUNOFF TOTALS OVER THE SIMULATION TIME SPAN ==========
   RAINFALL  PERVIOUS  IMPERVIOUS   TOTAL
             RUNOFF     RUNOFF      RUNOFF
    (MM)      (MM)       (MM)        (MM)
  16207.510    468.524  11493.010    689.014
    *
    ** ASP Catchment draining via Tongue Creek tributary TCHW
    *
    GENERATE                ID=5 ISER=102 DT=1.0 HR  DA=882 HA
                            ABSIMP=0      FRIMP=0.10
                            ====IMPERVIOUS AREA====
                            WILLIAMS UNIT HYD AA=2     XK=1.27  TP=1.08 HRS
                            IA=1.7 MM       RUNOFF COEF=0.95
                            ====PERVIOUS AREA=====
                            WILLIAMS UNIT HYD AA=2     XK=1.46  TP=1.24 HRS
                            SMIN=41 MM   SMAX=271 MM  SK=0.04
                            APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                            ====BASE FLOW  DATA====
                            NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                            MINIMUM BASE FLOW                 BASMIN=0.0
                            BASE FLOW DEPLETION FACTOR        BFACR=2.0
                            STARTING SOIL MOISTURE            SVOL=2.0 MM
                            SOIL MOISTURE AT WILTING PT       SWILT=0.01 MM
                            SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
                            BASE RECESSION CONSTANT           SLOSKA=0.00001
                            BASE FLOW REDUCTION FACTOR        SLOSKB=0.15
                            ====SNOW MELT DATA====
                            ANNUAL COEFFICIENT METHOD ISNOW=1
                            BASE TEMPERATURE BASET=2
                            CALIBRATION COFFICIENT SNOFAC=0.038
                            INITIAL SNOWPACK DEPTH PACDEP=0
                            WATER EQUIVALENT
                            UPWARD GROUND HEAT FLUX
                            CALIBRATION COEFFICIENT ALPHAA=2.5
                            AVG THERMAL SOIL CONDTIVITY XKL=15
                            DOWNWARD DAILY AVG SOIL HEAT FLUX
                            PROPORTIONALITY CONSTANT BCOEF=1.1
                            SNOW PACK
                            THERMAL INSULATION FACTOR XNCOEF=150
                            KFLAG = 0

====== IMPERVIOUS AREA UNIT HYDROGRAPH DATA ======

 - SHAPE CONSTANT, N =  3.018          - UNIT PEAK,QP =   .0996 CMS
 - THE UH YIELDS     .8965 MM VOL SO MULT BY   1.1154 WILL ENSURE A 1 MM UH.

======= PERVIOUS AREA UNIT HYDROGRAPH DATA =======

 - SHAPE CONSTANT, N =  3.014          - UNIT PEAK,QP =   .7796 CMS
 - THE UH YIELDS     .9204 MM VOL SO MULT BY   1.0864 WILL ENSURE A 1 MM UH.

API REDUCTION FACTOR IS   .991E+00 PER TIME STEP OR   .800E+00 PER DAY


    ID SERIES FILE INFORMATION:
    The QHM Command Generate      Created
    Output Time Series File Named: ID05.SER


    Provided  Input  Value for ID:    5
    User Designated Series # ISER:  102
```

```
Time Step  in the Series File: 1.00 hour

 W A T E R   M A S S   B A L A N C E
 A-TOTAL RAINFALL                   =    16207.51 MM
 B-TOTAL RUNOFF IMPRV+PERV          =     1570.97 MM
 C-ALL INITIAL ABSTRACTIONS         =    11026.81 MM
 D-TOTAL INFILTERATED WATER         =     3609.70 MM
 TOTAL GROUNDWATER ACCRETION        =     3069.94 MM
 E-TOTAL BASE FLOW                  =      541.75 MM
 F-CHANGE IN GROUNDWATER STORAGE=           -2.00 MM
 G-EVAPORATION FROM SOIL WATER  =             .00 MM
 H-LOSS TO DEEP GROUNDWATER     =         3069.94 MM
 I-CHANGE IN SNOW PACK STORAGE  =             .00 MM
 G-NET IMPORTED SNOW            =             .00 MM

 SURFACE WATER BALANCE = A - B - C - D        =          .02 MM
 SUBSURFACE WATER BALANCE= D - E - F - G - H =          .00 MM
 TOTAL BALANCE  = A - B - C - E - F - G - H  =          .02 MM

RAINFALL AND DIRECT  RUNOFF TOTALS OVER THE SIMULATION TIME SPAN ==========
  RAINFALL  PERVIOUS  IMPERVIOUS   TOTAL
             RUNOFF     RUNOFF     RUNOFF
    (MM)       (MM)       (MM)       (MM)
 16207.510    468.524  11493.010   1570.975
    *
    * ADDING TCHW OFFSITE & ASP CATCHMENTS
    *
    ADD SERIES          OUTPUT ID is 6, SERIES NAME IS 4506
                        INPUT IDS ARE 4 AND 5

   ID SERIES FILE INFORMATION:
   The QHM Command Add Series    Created
   Output Time Series File Named: ID06.SER


   Provided  Input  Value for ID:    6
   User Designated Series # ISER: 4506
   Time Step  in the Series File: 1.00 hour

     ADD BEGINS AT 1960    5  1
     USES TIME STEP OF    .100E+01 HOURS
     AND ENDS AT    2007  11  1

    *
    *ADDING HW1 AND TCHW WATERSHEDS (SUM OF DRAINAGE AREA)
    *
    ADD SERIES          OUTPUT ID is 7, SERIES NAME IS 3607
                        INPUT IDS ARE 3 AND 6

   ID SERIES FILE INFORMATION:
   The QHM Command Add Series    Created
   Output Time Series File Named: ID07.SER


   Provided  Input  Value for ID:    7
   User Designated Series # ISER: 3607
   Time Step  in the Series File: 1.00 hour

     ADD BEGINS AT 1960    5  1
     USES TIME STEP OF    .100E+01 HOURS
     AND ENDS AT    2007  11  1

    *
    ** Offsite Catchment "HW2-Off" draining via HW-2 ASP Catchment
    *
    GENERATE            ID=8 ISER=503 DT=1.0 HR  DA=740 HA
                        ABSIMP=0      FRIMP=0.03
```

```
====IMPERVIOUS AREA====
WILLIAMS UNIT HYD AA=2    XK=1.30  TP=0.93 HRS
IA=1.7 MM       RUNOFF COEF=0.95
====PERVIOUS AREA=====
WILLIAMS UNIT HYD AA=2    XK=1.16  TP=0.98 HRS
SMIN=41 MM   SMAX=271 MM  SK=0.04
APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
====BASE FLOW  DATA====
NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
MINIMUM BASE FLOW                BASMIN=0.0
BASE FLOW DEPLETION FACTOR       BFACR=2.0
STARTING SOIL MOISTURE           SVOL=2.0 MM
SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
BASE RECESSION CONSTANT          SLOSKA=0.00001
BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
====SNOW MELT DATA====
ANNUAL COEFFICIENT METHOD ISNOW=1
BASE TEMPERATURE BASET=2
CALIBRATION COFFICIENT SNOFAC=0.038
INITIAL SNOWPACK DEPTH PACDEP=0
WATER EQUIVALENT
UPWARD GROUND HEAT FLUX
CALIBRATION COEFFICIENT ALPHAA=2.5
AVG THERMAL SOIL CONDTIVITY XKL=15
DOWNWARD DAILY AVG SOIL HEAT FLUX
PROPORTIONALITY CONSTANT BCOEF=1.1
SNOW PACK
THERMAL INSULATION FACTOR XNCOEF=150
KFLAG = 0

====== IMPERVIOUS AREA UNIT HYDROGRAPH DATA ======

 - SHAPE CONSTANT, N =  2.591           - UNIT PEAK,QP =   .0253 CMS
 - THE UH YIELDS     .8620 MM VOL SO MULT BY   1.1601 WILL ENSURE A 1 MM UH.

======= PERVIOUS AREA UNIT HYDROGRAPH DATA =======

 - SHAPE CONSTANT, N =  2.999           - UNIT PEAK,QP =   .8883 CMS
 - THE UH YIELDS     .8918 MM VOL SO MULT BY   1.1214 WILL ENSURE A 1 MM UH.

API REDUCTION FACTOR IS   .991E+00 PER TIME STEP OR   .800E+00 PER DAY


    ID SERIES FILE INFORMATION:
    The QHM Command Generate      Created
    Output Time Series File Named: ID08.SER


    Provided  Input  Value for ID:    8
    User Designated Series # ISER:  503
    Time Step  in the Series File: 1.00 hour


     W A T E R   M A S S   B A L A N C E
     A-TOTAL RAINFALL                 =     16207.51 MM
     B-TOTAL RUNOFF IMPRV+PERV        =       799.26 MM
     C-ALL INITIAL ABSTRACTIONS       =     11564.83 MM
     D-TOTAL INFILTERATED WATER       =      3843.41 MM
     TOTAL GROUNDWATER ACCRETION      =      3268.61 MM
     E-TOTAL BASE FLOW                =       576.81 MM
     F-CHANGE IN GROUNDWATER STORAGE=          -2.00 MM
     G-EVAPORATION FROM SOIL WATER    =          .00 MM
     H-LOSS TO DEEP GROUNDWATER       =      3268.61 MM
     I-CHANGE IN SNOW PACK STORAGE    =          .00 MM
     G-NET IMPORTED SNOW              =          .00 MM

     SURFACE WATER BALANCE = A - B - C - D       =         .00 MM
```

```
    SUBSURFACE WATER BALANCE= D - E - F - G - H =        -.01 MM
    TOTAL BALANCE  = A - B - C - E - F - G - H  =        -.01 MM

RAINFALL AND DIRECT  RUNOFF TOTALS OVER THE SIMULATION TIME SPAN ==========
  RAINFALL  PERVIOUS  IMPERVIOUS   TOTAL
             RUNOFF     RUNOFF     RUNOFF
    (MM)      (MM)       (MM)       (MM)
 16207.510    468.524  11493.010    799.259
    *
    *
    * ASP Catchment draining via Highwood River Tributary HW-2
    **
    GENERATE             ID=9 ISER=103 DT=1.0 HR  DA=985.6 HA
                         ABSIMP=0      FRIMP=0.07
                         ====IMPERVIOUS AREA====
                         WILLIAMS UNIT HYD AA=2    XK=1.39  TP=1.09 HRS
                         IA=1.7 MM      RUNOFF COEF=0.95
                         ====PERVIOUS AREA=====
                         WILLIAMS UNIT HYD AA=2    XK=1.42  TP=1.21 HRS
                         SMIN=41 MM   SMAX=271 MM  SK=0.04
                         APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                         ====BASE FLOW  DATA====
                         NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                         MINIMUM BASE FLOW                BASMIN=0.0
                         BASE FLOW DEPLETION FACTOR       BFACR=2.0
                         STARTING SOIL MOISTURE           SVOL=2.0 MM
                         SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
                         SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
                         BASE RECESSION CONSTANT          SLOSKA=0.00001
                         BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
                         ====SNOW MELT DATA====
                         ANNUAL COEFFICIENT METHOD ISNOW=1
                         BASE TEMPERATURE BASET=2
                         CALIBRATION COFFICIENT SNOFAC=0.038
                         INITIAL SNOWPACK DEPTH PACDEP=0
                         WATER EQUIVALENT
                         UPWARD GROUND HEAT FLUX
                         CALIBRATION COEFFICIENT ALPHAA=2.5
                         AVG THERMAL SOIL CONDTIVITY XKL=15
                         DOWNWARD DAILY AVG SOIL HEAT FLUX
                         PROPORTIONALITY CONSTANT BCOEF=1.1
                         SNOW PACK
                         THERMAL INSULATION FACTOR XNCOEF=150
                         KFLAG = 0

====== IMPERVIOUS AREA UNIT HYDROGRAPH DATA ======

 - SHAPE CONSTANT, N =  2.804          - UNIT PEAK,QP =    .0723 CMS
 - THE UH YIELDS     .8983 MM VOL SO MULT BY    1.1132 WILL ENSURE A 1 MM UH.

======= PERVIOUS AREA UNIT HYDROGRAPH DATA =======

 - SHAPE CONSTANT, N =  3.023          - UNIT PEAK,QP =    .9250 CMS
 - THE UH YIELDS     .9203 MM VOL SO MULT BY    1.0866 WILL ENSURE A 1 MM UH.

API REDUCTION FACTOR IS    .991E+00 PER TIME STEP OR    .800E+00 PER DAY


    ID SERIES FILE INFORMATION:
    The QHM Command Generate      Created
    Output Time Series File Named: ID09.SER


    Provided  Input  Value for ID:    9
    User Designated Series # ISER:  103
    Time Step  in the Series File: 1.00 hour
```

```
W A T E R   M A S S   B A L A N C E
A-TOTAL RAINFALL                 =    16207.51 MM
B-TOTAL RUNOFF IMPRV+PERV        =     1240.24 MM
C-ALL INITIAL ABSTRACTIONS       =    11257.39 MM
D-TOTAL INFILTERATED WATER       =     3709.86 MM
TOTAL GROUNDWATER ACCRETION      =     3155.09 MM
E-TOTAL BASE FLOW                =      556.78 MM
F-CHANGE IN GROUNDWATER STORAGE=         -2.00 MM
G-EVAPORATION FROM SOIL WATER  =           .00 MM
H-LOSS TO DEEP GROUNDWATER       =     3155.09 MM
I-CHANGE IN SNOW PACK STORAGE  =           .00 MM
G-NET IMPORTED SNOW              =         .00 MM

SURFACE WATER BALANCE = A - B - C - D        =        .02 MM
SUBSURFACE WATER BALANCE= D - E - F - G - H =       -.01 MM
TOTAL BALANCE   = A - B - C - E - F - G - H  =        .01 MM

RAINFALL AND DIRECT  RUNOFF TOTALS OVER THE SIMULATION TIME SPAN =========
  RAINFALL  PERVIOUS  IMPERVIOUS   TOTAL
            RUNOFF     RUNOFF      RUNOFF
    (MM)     (MM)       (MM)        (MM)
 16207.510    468.524  11493.010   1240.235
    *
    * ADDING HW-2 OFFSITE & ASP CATCHMENTS
    *
    ADD SERIES            OUTPUT ID is 10, SERIES NAME IS 8910
                          INPUT IDS ARE 8 AND 9

   ID SERIES FILE INFORMATION:
   The QHM Command Add Series    Created
   Output Time Series File Named: ID10.SER


   Provided  Input  Value for ID:   10
   User Designated Series # ISER: 8910
   Time Step  in the Series File: 1.00 hour

     ADD BEGINS AT 1960   5  1
     USES TIME STEP OF   .100E+01 HOURS
     AND ENDS AT   2007  11  1

    *
    *ADDING HW1, TCHW & HW2 WATERSHEDS (SUM OF DRAINAGE AREA)
    *
    ADD SERIES            OUTPUT ID is 11, SERIES NAME IS 1007
                          INPUT IDS ARE 10 AND 7

   ID SERIES FILE INFORMATION:
   The QHM Command Add Series    Created
   Output Time Series File Named: ID11.SER


   Provided  Input  Value for ID:   11
   User Designated Series # ISER: 1007
   Time Step  in the Series File: 1.00 hour

     ADD BEGINS AT 1960   5  1
     USES TIME STEP OF   .100E+01 HOURS
     AND ENDS AT   2007  11  1

    *
    ** Offsite Catchment "HW3-Off" draining via HW-3 ASP Catchment
    *
    GENERATE              ID=12 ISER=504 DT=1.0 HR  DA=690 HA
                          ABSIMP=0     FRIMP=0.03
                          ====IMPERVIOUS AREA====
                          WILLIAMS UNIT HYD AA=2    XK=0.98  TP=0.70 HRS
                          IA=1.7 MM       RUNOFF COEF=0.95
```

```
====PERVIOUS AREA=====
WILLIAMS UNIT HYD AA=2    XK=0.87  TP=0.74 HRS
SMIN=41 MM   SMAX=271 MM  SK=0.04
APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
====BASE FLOW  DATA====
NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
MINIMUM BASE FLOW                BASMIN=0.0
BASE FLOW DEPLETION FACTOR       BFACR=2.0
STARTING SOIL MOISTURE           SVOL=2.0 MM
SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
BASE RECESSION CONSTANT          SLOSKA=0.00001
BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
====SNOW MELT DATA====
ANNUAL COEFFICIENT METHOD ISNOW=1
BASE TEMPERATURE BASET=2
CALIBRATION COFFICIENT SNOFAC=0.038
INITIAL SNOWPACK DEPTH PACDEP=0
WATER EQUIVALENT
UPWARD GROUND HEAT FLUX
CALIBRATION COEFFICIENT ALPHAA=2.5
AVG THERMAL SOIL CONDTIVITY XKL=15
DOWNWARD DAILY AVG SOIL HEAT FLUX
PROPORTIONALITY CONSTANT BCOEF=1.1
SNOW PACK
THERMAL INSULATION FACTOR XNCOEF=150
KFLAG = 0

====== IMPERVIOUS AREA UNIT HYDROGRAPH DATA ======

 - SHAPE CONSTANT, N =  2.587          - UNIT PEAK,QP =   .0313 CMS
 - THE UH YIELDS    .8735 MM VOL SO MULT BY   1.1449 WILL ENSURE A 1 MM UH.

======= PERVIOUS AREA UNIT HYDROGRAPH DATA =======

 - SHAPE CONSTANT, N =  3.018          - UNIT PEAK,QP =  1.1028 CMS
 - THE UH YIELDS    .8817 MM VOL SO MULT BY   1.1342 WILL ENSURE A 1 MM UH.

API REDUCTION FACTOR IS   .991E+00 PER TIME STEP OR   .800E+00 PER DAY

    ID SERIES FILE INFORMATION:
    The QHM Command Generate      Created
    Output Time Series File Named: ID12.SER

    Provided  Input  Value for ID:   12
    User Designated Series # ISER:  504
    Time Step  in the Series File: 1.00 hour

     W A T E R   M A S S   B A L A N C E
     A-TOTAL RAINFALL                 =    16207.51 MM
     B-TOTAL RUNOFF IMPRV+PERV        =      799.26 MM
     C-ALL INITIAL ABSTRACTIONS       =    11564.83 MM
     D-TOTAL INFILTERATED WATER       =     3843.41 MM
     TOTAL GROUNDWATER ACCRETION      =     3268.61 MM
     E-TOTAL BASE FLOW                =      576.81 MM
     F-CHANGE IN GROUNDWATER STORAGE=         -2.00 MM
     G-EVAPORATION FROM SOIL WATER  =           .00 MM
     H-LOSS TO DEEP GROUNDWATER     =       3268.61 MM
     I-CHANGE IN SNOW PACK STORAGE  =           .00 MM
     G-NET IMPORTED SNOW            =           .00 MM

     SURFACE WATER BALANCE = A - B - C - D        =         .00 MM
     SUBSURFACE WATER BALANCE= D - E - F - G - H =        -.01 MM
     TOTAL BALANCE  = A - B - C - E - F - G - H  =        -.01 MM
```

```
RAINFALL AND DIRECT  RUNOFF TOTALS OVER THE SIMULATION TIME SPAN ==========
  RAINFALL  PERVIOUS  IMPERVIOUS   TOTAL
             RUNOFF     RUNOFF     RUNOFF
    (MM)       (MM)       (MM)       (MM)
 16207.510    468.524  11493.010    799.259
    *
    * ASP Catchment draining via Highwood River Tributary HW-3
    **
    GENERATE              ID=13 ISER=104 DT=1.0 HR  DA=962 HA
                          ABSIMP=0     FRIMP=0.08
                          ====IMPERVIOUS AREA====
                          WILLIAMS UNIT HYD AA=2    XK=0.84  TP=0.67 HRS
                          IA=1.7 MM      RUNOFF COEF=0.95
                          ====PERVIOUS AREA=====
                          WILLIAMS UNIT HYD AA=2    XK=0.89  TP=0.75 HRS
                          SMIN=41 MM   SMAX=271 MM  SK=0.04
                          APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
                          ====BASE FLOW  DATA====
                          NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
                          MINIMUM BASE FLOW                 BASMIN=0.0
                          BASE FLOW DEPLETION FACTOR        BFACR=2.0
                          STARTING SOIL MOISTURE            SVOL=2.0 MM
                          SOIL MOISTURE AT WILTING PT       SWILT=0.01 MM
                          SOIL MOISTURE AT FIELD CAPACITY   SFIELD=0.1 MM
                          BASE RECESSION CONSTANT           SLOSKA=0.00001
                          BASE FLOW REDUCTION FACTOR        SLOSKB=0.15
                          ====SNOW MELT DATA====
                          ANNUAL COEFFICIENT METHOD ISNOW=1
                          BASE TEMPERATURE BASET=2
                          CALIBRATION COFFICIENT SNOFAC=0.038
                          INITIAL SNOWPACK DEPTH PACDEP=0
                          WATER EQUIVALENT
                          UPWARD GROUND HEAT FLUX
                          CALIBRATION COEFFICIENT ALPHAA=2.5
                          AVG THERMAL SOIL CONDTIVITY XKL=15
                          DOWNWARD DAILY AVG SOIL HEAT FLUX
                          PROPORTIONALITY CONSTANT BCOEF=1.1
                          SNOW PACK
                          THERMAL INSULATION FACTOR XNCOEF=150
                          KFLAG = 0

====== IMPERVIOUS AREA UNIT HYDROGRAPH DATA ======

 - SHAPE CONSTANT, N =  2.847          - UNIT PEAK,QP =   .1330 CMS
 - THE UH YIELDS     .8926 MM VOL SO MULT BY   1.1204 WILL ENSURE A 1 MM UH.

======= PERVIOUS AREA UNIT HYDROGRAPH DATA =======

 - SHAPE CONSTANT, N =  2.992          - UNIT PEAK,QP =  1.4282 CMS
 - THE UH YIELDS     .8769 MM VOL SO MULT BY   1.1404 WILL ENSURE A 1 MM UH.

API REDUCTION FACTOR IS   .991E+00 PER TIME STEP OR   .800E+00 PER DAY


    ID SERIES FILE INFORMATION:
    The QHM Command Generate      Created
    Output Time Series File Named: ID13.SER


    Provided  Input  Value for ID:   13
    User Designated Series # ISER:  104
    Time Step  in the Series File: 1.00 hour


     W A T E R    M A S S   B A L A N C E
     A-TOTAL RAINFALL                 =    16207.51 MM
     B-TOTAL RUNOFF IMPRV+PERV        =     2119.03 MM
     C-ALL INITIAL ABSTRACTIONS       =     2575.67 MM
```

```
   D-TOTAL INFILTERATED WATER     =    11512.71 MM
   TOTAL GROUNDWATER ACCRETION    =     9787.38 MM
   E-TOTAL BASE FLOW              =     1727.19 MM
   F-CHANGE IN GROUNDWATER STORAGE=       -1.91 MM
   G-EVAPORATION FROM SOIL WATER  =         .00 MM
   H-LOSS TO DEEP GROUNDWATER     =     9787.38 MM
   I-CHANGE IN SNOW PACK STORAGE  =         .00 MM
   G-NET IMPORTED SNOW            =         .00 MM

   SURFACE WATER BALANCE = A - B - C - D         =        .09 MM
   SUBSURFACE WATER BALANCE= D - E - F - G - H =        .06 MM
   TOTAL BALANCE  = A - B - C - E - F - G - H  =        .15 MM

RAINFALL AND DIRECT  RUNOFF TOTALS OVER THE SIMULATION TIME SPAN =========
  RAINFALL  PERVIOUS  IMPERVIOUS   TOTAL
             RUNOFF     RUNOFF     RUNOFF
    (MM)      (MM)       (MM)       (MM)
 16207.510  1006.254  14915.970   2119.031
    *
    * ADDING HW-3 OFFSITE & ASP CATCHMENTS
    *
    ADD SERIES          OUTPUT ID is 14, SERIES NAME IS 1400
                        INPUT IDS ARE 12 AND 13

   ID SERIES FILE INFORMATION:
   The QHM Command Add Series    Created
   Output Time Series File Named: ID14.SER


   Provided  Input  Value for ID:   14
   User Designated Series # ISER: 1400
   Time Step  in the Series File: 1.00 hour

     ADD BEGINS AT 1960   5  1
     USES TIME STEP OF   .100E+01 HOURS
     AND ENDS AT   2007  11  1

    *
    *ADDING HW1,TCHW, HW2 & HW3 WATERSHEDS (SUM OF DRAINAGE AREA)
    *
    ADD SERIES          OUTPUT ID is 15, SERIES NAME IS 1500
                        INPUT IDS ARE 11 AND 14

   ID SERIES FILE INFORMATION:
   The QHM Command Add Series    Created
   Output Time Series File Named: ID15.SER


   Provided  Input  Value for ID:   15
   User Designated Series # ISER: 1500
   Time Step  in the Series File: 1.00 hour

     ADD BEGINS AT 1960   5  1
     USES TIME STEP OF   .100E+01 HOURS
     AND ENDS AT   2007  11  1

    *
    * ASP Catchment draining via THE SHEEP RIVER
    **
    GENERATE            ID=16 ISER=105 DT=1.0 HR  DA=172.9 HA
                        ABSIMP=0      FRIMP=0.10
                        ====IMPERVIOUS AREA====
                        WILLIAMS UNIT HYD AA=2    XK=0.57  TP=0.49 HRS
                        IA=1.7 MM       RUNOFF COEF=0.95
                        ====PERVIOUS AREA=====
                        WILLIAMS UNIT HYD AA=2    XK=0.66  TP=0.56 HRS
                        SMIN=41 MM   SMAX=271 MM  SK=0.04
                        APIK=0.8 PER DAY  API=150 MM   ABSPER=10.0 MM
```

```
====BASE FLOW  DATA====
NUMBER OF GROUNDWATER RESERVOIRS NSVOL=0
MINIMUM BASE FLOW                BASMIN=0.0
BASE FLOW DEPLETION FACTOR       BFACR=2.0
STARTING SOIL MOISTURE           SVOL=2.0 MM
SOIL MOISTURE AT WILTING PT      SWILT=0.01 MM
SOIL MOISTURE AT FIELD CAPACITY  SFIELD=0.1 MM
BASE RECESSION CONSTANT          SLOSKA=0.00001
BASE FLOW REDUCTION FACTOR       SLOSKB=0.15
====SNOW MELT DATA====
ANNUAL COEFFICIENT METHOD ISNOW=1
BASE TEMPERATURE BASET=2
CALIBRATION COFFICIENT SNOFAC=0.038
INITIAL SNOWPACK DEPTH PACDEP=0
WATER EQUIVALENT
UPWARD GROUND HEAT FLUX
CALIBRATION COEFFICIENT ALPHAA=2.5
AVG THERMAL SOIL CONDTIVITY XKL=15
DOWNWARD DAILY AVG SOIL HEAT FLUX
PROPORTIONALITY CONSTANT BCOEF=1.1
SNOW PACK
THERMAL INSULATION FACTOR XNCOEF=150
KFLAG = 0
```

```
====== IMPERVIOUS AREA UNIT HYDROGRAPH DATA ======

 - SHAPE CONSTANT, N =  3.048           - UNIT PEAK,QP =   .0434 CMS
 - THE UH YIELDS   1.0493 MM VOL SO MULT BY    .9530 WILL ENSURE A 1 MM UH.

======= PERVIOUS AREA UNIT HYDROGRAPH DATA =======

 - SHAPE CONSTANT, N =  3.011           - UNIT PEAK,QP =   .3382 CMS
 - THE UH YIELDS    .9637 MM VOL SO MULT BY   1.0376 WILL ENSURE A 1 MM UH.

API REDUCTION FACTOR IS   .991E+00 PER TIME STEP OR   .800E+00 PER DAY


    ID SERIES FILE INFORMATION:
    The QHM Command Generate      Created
    Output Time Series File Named: ID16.SER


    Provided  Input  Value for ID:   16
    User Designated Series # ISER:  105
    Time Step  in the Series File: 1.00 hour


     W A T E R   M A S S   B A L A N C E
     A-TOTAL RAINFALL                 =    16207.51 MM
     B-TOTAL RUNOFF IMPRV+PERV        =     2386.95 MM
     C-ALL INITIAL ABSTRACTIONS       =     2285.57 MM
     D-TOTAL INFILTERATED WATER       =    11534.86 MM
     TOTAL GROUNDWATER ACCRETION      =     9806.26 MM
     E-TOTAL BASE FLOW                =     1730.51 MM
     F-CHANGE IN GROUNDWATER STORAGE=         -1.91 MM
     G-EVAPORATION FROM SOIL WATER  =           .00 MM
     H-LOSS TO DEEP GROUNDWATER     =       9806.26 MM
     I-CHANGE IN SNOW PACK STORAGE  =           .00 MM
     G-NET IMPORTED SNOW            =           .00 MM

     SURFACE WATER BALANCE = A - B - C - D        =         .12 MM
     SUBSURFACE WATER BALANCE= D - E - F - G - H =         .00 MM
     TOTAL BALANCE  = A - B - C - E - F - G - H  =         .12 MM

 RAINFALL AND DIRECT  RUNOFF TOTALS OVER THE SIMULATION TIME SPAN =========
   RAINFALL  PERVIOUS  IMPERVIOUS   TOTAL
             RUNOFF     RUNOFF     RUNOFF
    (MM)      (MM)       (MM)       (MM)
```

```
16207.510    988.122  14976.500   2386.954
   *
   *ADDING HW1,TCHW,HW2,HW3,& SR WATERSHEDS (SUM OF TOTAL DRAINAGE AREA)
   *
   ADD SERIES          OUTPUT ID is 17, SERIES NAME IS 1700
                       INPUT IDS ARE 15 AND 16

  ID SERIES FILE INFORMATION:
  The QHM Command Add Series    Created
  Output Time Series File Named: ID17.SER


  Provided  Input  Value for ID:   17
  User Designated Series # ISER: 1700
  Time Step  in the Series File: 1.00 hour

    ADD BEGINS AT 1960   5  1
    USES TIME STEP OF   .100E+01 HOURS
    AND ENDS AT   2007  11  1

   *
   *
   *ANNUAL MAXIMUM/MINIMUM STATS FOR PEAK FLOWS (ALL OFFSITE & ASP CATCHMENTS)
   MAXMIN              ID IN = 17 IS FLOW
                       IOPT = 1 ANNUAL SERIES
                       IFY = 60 STARTING YEAR
                       IFM = 6 STARTING MONTH
                       IFD = 2 STARTING DAY
                       ITY = 07 ENDING YEAR
                       ITM = 05 ENDING MONTH
                       ITD = 31 ENDING DAY

    ANNUAL MAXIMUM AND MINIMUM VALUES IN SERIES


Maximum Value  CMS, M^3, or M : .874450E+01  Date (yrmody):  1960   7 20
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1960   6  2
Maximum Value  CMS, M^3, or M : .813426E+01  Date (yrmody):  1961   7 21
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1961   1  1
Maximum Value  CMS, M^3, or M : .735043E+01  Date (yrmody):  1962   8  5
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1962   1  1
Maximum Value  CMS, M^3, or M : .203202E+02  Date (yrmody):  1963   7 25
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1963   1  1
Maximum Value  CMS, M^3, or M : .314927E+02  Date (yrmody):  1964   7  5
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1964   1  1
Maximum Value  CMS, M^3, or M : .429005E+02  Date (yrmody):  1965   7 21
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1965   1  1
Maximum Value  CMS, M^3, or M : .366394E+02  Date (yrmody):  1966   7  2
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1966   1  2
Maximum Value  CMS, M^3, or M : .911014E+01  Date (yrmody):  1967   6 16
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1967   1  1
Maximum Value  CMS, M^3, or M : .152183E+02  Date (yrmody):  1968   7 20
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1968   1  1
Maximum Value  CMS, M^3, or M : .135274E+02  Date (yrmody):  1969   6 25
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1969   1  1
Maximum Value  CMS, M^3, or M : .744584E+01  Date (yrmody):  1970   7 27
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1970   1  1
Maximum Value  CMS, M^3, or M : .109871E+02  Date (yrmody):  1971   6  5
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1971   1  1
Maximum Value  CMS, M^3, or M : .332036E+02  Date (yrmody):  1972   6 10
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1972   1  1
Maximum Value  CMS, M^3, or M : .643780E+01  Date (yrmody):  1973   8  7
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1973   1  2
Maximum Value  CMS, M^3, or M : .108271E+02  Date (yrmody):  1974   4 26
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1974   1  1
Maximum Value  CMS, M^3, or M : .755943E+01  Date (yrmody):  1975   7 21
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1975   1  1
Maximum Value  CMS, M^3, or M : .177867E+02  Date (yrmody):  1976   8  9
```

```
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1976   1  3
Maximum Value  CMS, M^3, or M : .157295E+02  Date (yrmody):  1977   7 12
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1977   1  2
Maximum Value  CMS, M^3, or M : .228401E+02  Date (yrmody):  1978   8 16
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1978   1  1
Maximum Value  CMS, M^3, or M : .962667E+01  Date (yrmody):  1979   6 20
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1979   1  1
Maximum Value  CMS, M^3, or M : .216986E+02  Date (yrmody):  1980   5 24
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1980   1  1
Maximum Value  CMS, M^3, or M : .994396E+01  Date (yrmody):  1981   7 14
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1981   1  1
Maximum Value  CMS, M^3, or M : .112564E+02  Date (yrmody):  1982   6 30
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1982   1  1
Maximum Value  CMS, M^3, or M : .114447E+02  Date (yrmody):  1983   8 18
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1983   1  1
Maximum Value  CMS, M^3, or M : .103117E+02  Date (yrmody):  1984   9  6
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1984   1  1
Maximum Value  CMS, M^3, or M : .439274E+02  Date (yrmody):  1985   9 12
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1985   1  1
Maximum Value  CMS, M^3, or M : .238139E+02  Date (yrmody):  1986   6 29
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1986   1  1
Maximum Value  CMS, M^3, or M : .129961E+02  Date (yrmody):  1987   7 22
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1987   1  1
Maximum Value  CMS, M^3, or M : .210688E+02  Date (yrmody):  1988   8  1
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1988   1  1
Maximum Value  CMS, M^3, or M : .555302E+01  Date (yrmody):  1989   7 10
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1989   1  1
Maximum Value  CMS, M^3, or M : .112065E+02  Date (yrmody):  1990   8 18
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1990   1  1
Maximum Value  CMS, M^3, or M : .149046E+02  Date (yrmody):  1991   8 11
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1991   1  1
Maximum Value  CMS, M^3, or M : .252197E+02  Date (yrmody):  1992   6 13
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1992   1  1
Maximum Value  CMS, M^3, or M : .182609E+02  Date (yrmody):  1993   8 13
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1993   1  1
Maximum Value  CMS, M^3, or M : .100423E+02  Date (yrmody):  1994   6  6
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1994   1  1
Maximum Value  CMS, M^3, or M : .415398E+02  Date (yrmody):  1995   7  4
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1995   1  1
Maximum Value  CMS, M^3, or M : .809114E+01  Date (yrmody):  1996   6 18
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1996   1  1
Maximum Value  CMS, M^3, or M : .391616E+02  Date (yrmody):  1997   6 11
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1997   1  2
Maximum Value  CMS, M^3, or M : .351586E+02  Date (yrmody):  1998   7  4
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1998   1  1
Maximum Value  CMS, M^3, or M : .735992E+01  Date (yrmody):  1999   4 21
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  1999   1  1
Maximum Value  CMS, M^3, or M : .142668E+02  Date (yrmody):  2000   7  9
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  2000   1  1
Maximum Value  CMS, M^3, or M : .294738E+02  Date (yrmody):  2001   6  6
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  2001   1  1
Maximum Value  CMS, M^3, or M : .506281E+01  Date (yrmody):  2002   6  3
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  2002   1  1
Maximum Value  CMS, M^3, or M : .122619E+02  Date (yrmody):  2003   8  5
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  2003   1  1
Maximum Value  CMS, M^3, or M : .111066E+02  Date (yrmody):  2004   6  7
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  2004   1  1
Maximum Value  CMS, M^3, or M : .309233E+02  Date (yrmody):  2005   6  8
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  2005   1  1
Maximum Value  CMS, M^3, or M : .153448E+02  Date (yrmody):  2006   6 22
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  2006   1  1
Maximum Value  CMS, M^3, or M : .522928E+00  Date (yrmody):  2007   4 11
Minimum Value  CMS, M^3, or M : .000000E+00  Date (yrmody):  2007   1  1
    *
    FINISH

   ==========================================================================
```

```
===        Q u a l i t y   H y d r o l o g i c   M o d e l        ===
===  Execution was terminated on Jan.  25, 2010. Time: 16:45:49.81  ===
======================================================================
```

1/25/2010 Revision Date

EXISTING CONDITION

MD of Foothills--Highway 2A ASP--Drainage Plan

Existing Conditions

QHM Parameters - Calculation of k and Tp (Pervious and Impervious Catchments) using HYMO/OTTHYMO method

2210-026-00

To be Used in Williams Unit Hydrograph

LOOKUP: REDUCTION FACTOR FOR TP & DELTA FACTOR FOR K

							Pervious Areas		Impervious Areas		Reduction	Delta	Check!!! MTO Manual Imperial Units
ASP Catchments	**NHYD**	Impervious	Drainage	Slope	Length	Width	Tp, hrs	K (=1.18Tp)	Modified Tp	Modified K	Factor for Tp	Factor for K	Tp, hrs
		%	Area, ha	m/m				hrs	hrs	hrs			
HW-1	101	1	690.0	0.0023	5000	1200	2.67	3.15	2.58	3.78	0.969	1.414	2.68
TCHW	102	10	882.0	0.0113	3500	2500	1.24	1.46	1.08	1.27	0.87	1	1.24
HW-2	103	7	985.6	0.0137	3500	2200	1.21	1.42	1.09	1.39	0.903	1.138	1.21
HW-3	104	8	962.0	0.0318	4000	1000	0.75	0.89	0.67	0.84	0.892	1.092	0.76
SR	105	10	172.9	0.0200	1600	900	0.56	0.66	0.49	0.57	0.87	1	0.56
			3,692.5										

Offsite Catchments

HW1-Off	501	2	30	0.01	600	600	0.30	0.35	0.29	0.41	0.958	1.368	0.30
TCHW-Off	502	2	120	0.0133	1500	400	0.56	0.67	0.54	0.77	0.958	1.368	0.57
HW2-Off	503	3	740	0.0188	3800	1500	0.98	1.16	0.93	1.30	0.947	1.322	0.99
HW3-Off	504	3	690	0.0270	3500	1300	0.74	0.87	0.70	0.98	0.947	1.322	0.74
			1,580										

All ASP Catchments and Offsite Catchments

Year	Flow (cms)
1960	8.74E+00
1961	8.13E+00
1962	7.35E+00
1963	2.03E+01
1964	3.15E+01
1965	4.29E+01
1966	3.66E+01
1967	9.11E+00
1968	1.52E+01
1969	1.35E+01
1970	7.45E+00
1971	1.10E+01
1972	3.32E+01
1973	6.44E+00
1974	1.08E+01
1975	7.56E+00
1976	1.78E+01
1977	1.57E+01
1978	2.28E+01
1979	9.63E+00
1980	2.17E+01
1981	9.94E+00
1982	1.13E+01
1983	1.14E+01
1984	1.03E+01
1985	4.39E+01
1986	2.38E+01
1987	1.30E+01
1988	2.11E+01
1989	5.55E+00
1990	1.12E+01
1991	1.49E+01
1992	2.52E+01
1993	1.83E+01
1994	1.00E+01
1995	4.15E+01
1996	8.09E+00
1997	3.92E+01
1998	3.52E+01
1999	7.36E+00
2000	1.43E+01
2001	2.95E+01
2002	5.06E+00
2003	1.23E+01
2004	1.11E+01
2005	3.09E+01
2006	1.53E+01
2007	5.23E-01

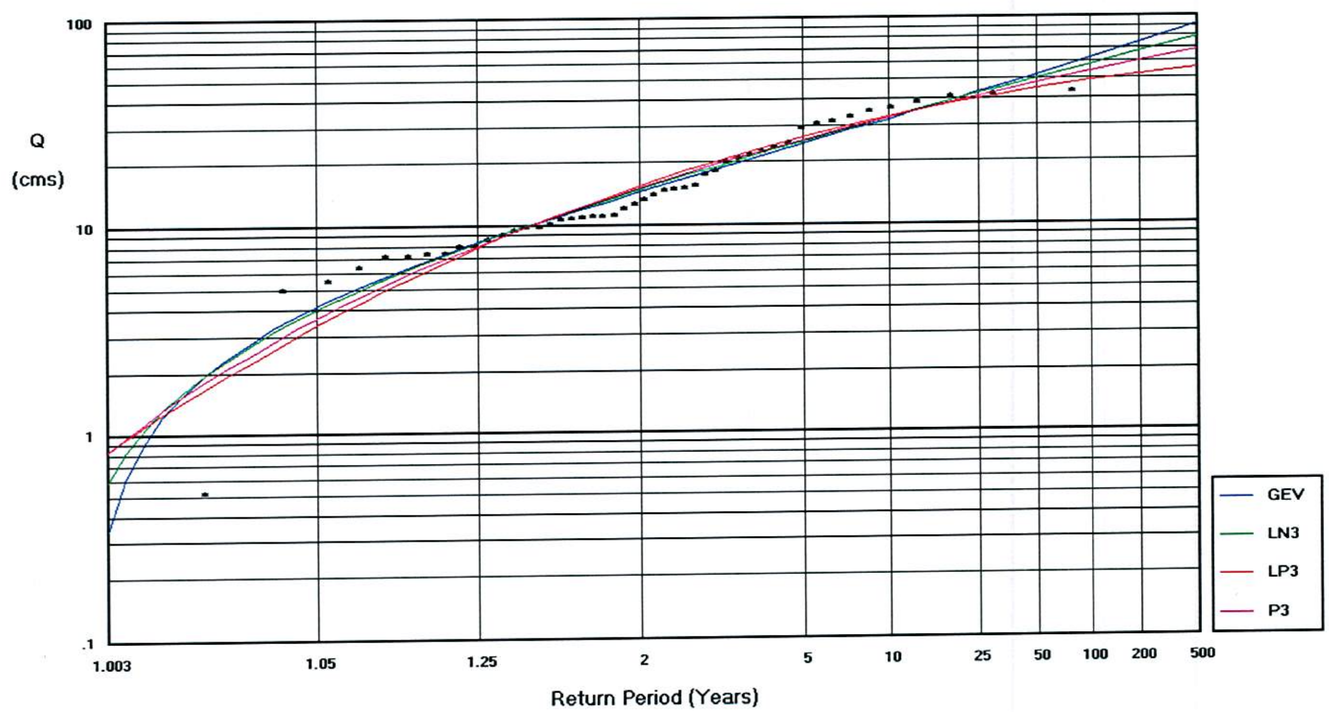
	Flows	Log of Flows	Hist Wt. Flows	
Mean	17.45	2.63		
St. Dev	11.3	0.76		
Skew	1.3	-1.46		
RP	GEV	LN3	LP3	P3
2	14.55	14.87	15.53	15.13
5	24.39	25.06	**26.34**	25.52
10	31.97	32.42	32.84	32.48
20	40.16	39.87	38.39	39.09
25	42.97	42.32	40.01	41.18
50	52.29	50.11	44.59	47.54
100	62.66	58.22	**48.58**	53.8
200	74.23	66.7	52.06	59.98
500	91.63	78.55	55.98	68.05
Fit Method	L Moments	Max. Like	Max. Like	Moments
Location	11.74	2.94	4.29	17.45
Scale	7.45	0.51	-0.34	11.3
Shape	-0.16	-4.03	4.88	1.3

LP3 Distribution as the Best-fit Distribution

Total Area = **5,272.5 ha**

1:100 Year Pre-dev Flow = **9.21 L/s/ha**

1:5 Year Pre-dev Flow = **5.00 L/s/ha**



C:\Program Files\Q H M\Projects\HWY2A\MAXPRE_FLOW.xls\PRE_HY2A _Off_SheepR

APPENDIX C-2

Post-Development

Hydrological Analysis

```
2     Metric units
*#*************************************************************************
*#  Project Name: [Highway 2A--ASP]    Project Number: [ 2210-026-00]
*#  Date          : 07-12-2009
*#  Updated       : Jan 26, 2010
*#  Modeller      : [  KNP       ]
*#  Company       : MPE Engineering Ltd.
*#  License #     :  3023779
*# Determining 1:100 year flow and volume for 4 Sub-Catchments
*# Developments (POST-DEVELOPMENT CONDITION)
*# USING 24 HOUR STORM DISTRIBUTION (DT =24 HRS)
*# Used the CN value of 72 for SWMHYMO/Post-dev condition as per City of Calgary
*# Stormwater Management Guidelines (Dec 2000) in STANDHYD Command (P 3-23)
*# USED XIMP = TIMP AS PER CITY OF CALGARY GUIDELINES (P 3-24)
*#*************************************************************************
START                TZERO=[0.0],  METOUT=[2],  NSTORM=[0],  NRUN=[0]
*%                    [  ] <--storm filename, one per line for NSTORM time
*%-----------------|-------------------------------------------------------|
*100-year storm using City of Calgary's ABCs
CHICAGO STORM        IUNITS=[2],  TD=[24](hrs), TPRAT=[0.333],  CSDT=[10 ](min),
                     ICASEcs=[1],
                      A=[663.1  ],  B=[ 1.87  ], and C=[  0.712 ],
*%-----------------|-------------------------------------------------------|
*#  Catchment HW-1 --Southern Catchment within the ASP Study Area
*##########################################################################
*%-----------------|-------------------------------------------------------|
*# Industrial/ Natural Land Use (Gravel Pit)
CALIB STANDHYD       ID=[ 1 ], NHYD=["INHW-1"], DT=[ 5 ](min), AREA=[ 65.2](ha),
                     XIMP=[0.50], TIMP=[0.50], DWF=[ 0 ](cms), LOSS=[2],
                     SCS curve number CN=[ 72 ],
                     Pervious   surfaces: IAper=[ 3.4 ](mm), SLPP=[ 0.5 ](%),
                                          LGP=[100](m), MNP=[0.25], SCP=[0](min),
                     Impervious surfaces: IAimp=[ 1.0 ](mm), SLPI=[ 0.5 ](%),
                                          LGI=[800](m),MNI=[0.013],SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------|
*# Traditional Low Intensity Land Use
CALIB NASHYD         ID=[2], NHYD=["TLIHW-1"],DT=[5]min, AREA=[361.3](ha),
                     DWF=[0](cms),  CN/C=[78], IA=[10](mm),
                     N=[3], TP=[2.28]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|-------------------------------------------------------|
*# Residential Land Use
CALIB STANDHYD       ID=[ 3 ], NHYD=["REHW-1"], DT=[ 5 ](min), AREA=[ 3.6](ha),
                     XIMP=[0.50], TIMP=[0.50], DWF=[ 0 ](cms), LOSS=[2],
                     SCS curve number CN=[ 72 ],
                     Pervious   surfaces: IAper=[ 5 ](mm), SLPP=[ 1.0 ](%),
                                          LGP=[50](m), MNP=[0.25], SCP=[0](min),
                     Impervious surfaces: IAimp=[ 1.0 ](mm), SLPI=[ 1.0 ](%),
                                          LGI=[200](m),MNI=[0.013],SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------|
*# Industrial/ Commercial Land Use Including Planned Development
CALIB STANDHYD       ID=[ 4 ], NHYD=["ICHW-1"], DT=[ 5 ](min), AREA=[ 242.5](ha),
                     XIMP=[0.80], TIMP=[0.80], DWF=[ 0 ](cms), LOSS=[2],
                     SCS curve number CN=[ 72 ],
                     Pervious   surfaces: IAper=[ 5 ](mm), SLPP=[ 1.0 ](%),
                                          LGP=[100](m), MNP=[0.25], SCP=[0](min),
                     Impervious surfaces: IAimp=[ 1.0 ](mm), SLPI=[ 1.0 ](%),
                                          LGI=[400](m),MNI=[0.013],SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|-------------------------------------------------------|
*# High River Waste Water Treatment Plant
CALIB STANDHYD       ID=[ 5 ], NHYD=["WWTHW-1"], DT=[ 5 ](min), AREA=[ 17.4](ha),
                     XIMP=[0.80], TIMP=[0.80], DWF=[ 0 ](cms), LOSS=[2],
```

```
                     SCS curve number CN=[ 72 ],
                     Pervious   surfaces: IAper=[ 5 ](mm), SLPP=[ 0.3 ](%),
                                          LGP=[200](m), MNP=[0.25], SCP=[0](min),
                     Impervious surfaces: IAimp=[ 1.0 ](mm), SLPI=[ 0.3 ](%),
                                          LGI=[400](m),MNI=[0.013],SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|----------------------------------------------------------|
*#ADDING ALL SUB-CATCHMENTS
ADD HYD              IDsum=[6], NHYD=[605], IDs to add=[1+2+3+4+5]
*%-----------------|----------------------------------------------------------|
COMPUTE DUALHYD      IDin=[6], CINLET=[3.45](cms), NINLET=[1],
                     MAJID=[7], MajNHYD=["MAJ-HW1"],
                     MINID=[8], MinNHYD=["MIN-HW1"],
                     TMJSTO=[0](cu-m)
*%-----------------|----------------------------------------------------------|
*# END OF CATCHMENT HW-1
*############################################################################
*#  Catchment TCHW --TONGUE CREEK & HIGHWOOD RIVER Catchment in ASP Study Area
*############################################################################
*%-----------------|----------------------------------------------------------|
*# Residential Land Use
CALIB STANDHYD       ID=[ 1 ], NHYD=["RETCHW"], DT=[ 5 ](min), AREA=[ 36.1](ha),
                     XIMP=[0.50], TIMP=[0.50], DWF=[ 0 ](cms), LOSS=[2],
                     SCS curve number CN=[ 72 ],
                     Pervious   surfaces: IAper=[ 5 ](mm), SLPP=[ 1.0 ](%),
                                          LGP=[50](m), MNP=[0.25], SCP=[0](min),
                     Impervious surfaces: IAimp=[ 1.0 ](mm), SLPI=[ 1.0 ](%),
                                          LGI=[200](m),MNI=[0.013],SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|----------------------------------------------------------|
*# Industrial/ Commercial Land Use Including Planned Development
CALIB STANDHYD       ID=[ 2 ], NHYD=["ICTCHW"], DT=[ 5 ](min), AREA=[ 538.8](ha),
                     XIMP=[0.80], TIMP=[0.80], DWF=[ 0 ](cms), LOSS=[2],
                     SCS curve number CN=[ 72 ],
                     Pervious   surfaces: IAper=[ 5 ](mm), SLPP=[ 1.0 ](%),
                                          LGP=[100](m), MNP=[0.25], SCP=[0](min),
                     Impervious surfaces: IAimp=[ 1.0 ](mm), SLPI=[ 1.0 ](%),
                                          LGI=[400](m),MNI=[0.013],SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|----------------------------------------------------------|
*# Flood Fringe Land Use
CALIB NASHYD         ID=[3], NHYD=["FFTCHW"],DT=[5]min, AREA=[164.2](ha),
                     DWF=[0](cms),  CN/C=[67], IA=[10](mm),
                     N=[3], TP=[3.8]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|----------------------------------------------------------|
*# Traditional Low Intensity Land Use
CALIB NASHYD         ID=[4], NHYD=["TLITCHW"],DT=[5]min, AREA=[142.9](ha),
                     DWF=[0](cms),  CN/C=[78], IA=[10](mm),
                     N=[3], TP=[1.34]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|----------------------------------------------------------|
*#ADDING ALL SUB-CATCHMENTS
ADD HYD              IDsum=[5], NHYD=[505], IDs to add=[1+2+3+4]
*%-----------------|----------------------------------------------------------|
COMPUTE DUALHYD      IDin=[5], CINLET=[4.4](cms), NINLET=[1],
                     MAJID=[1], MajNHYD=["MAJ-TCHW"],
                     MINID=[2], MinNHYD=["MIN-TCHW"],
                     TMJSTO=[0](cu-m)
*%-----------------|----------------------------------------------------------|
*# END OF CATCHMENT TCHW
*############################################################################
*#  Catchment HW-2 --Saddlebrook & Other in the ASP Study Area
*############################################################################
*%-----------------|----------------------------------------------------------|
```

```
*# Industrial/ Commercial Land Use Including Planned Development
CALIB STANDHYD        ID=[ 3 ], NHYD=["ICHW-2"], DT=[ 5 ](min), AREA=[ 770](ha),
                      XIMP=[0.80], TIMP=[0.80], DWF=[ 0 ](cms), LOSS=[2],
                      SCS curve number CN=[ 72 ],
                      Pervious   surfaces: IAper=[ 5 ](mm), SLPP=[ 1.0 ](%),
                                           LGP=[100](m), MNP=[0.25], SCP=[0](min),
                      Impervious surfaces: IAimp=[ 1.0 ](mm), SLPI=[ 1.0 ](%),
                                           LGI=[400](m),MNI=[0.013],SCI=[0](min),
                      RAINFALL=[ ,   ,   ,   , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# Traditional Low Intensity Land Use
CALIB NASHYD          ID=[4], NHYD=["TLIHW-2"],DT=[5]min, AREA=[124.9](ha),
                      DWF=[0](cms),  CN/C=[78], IA=[10](mm),
                      N=[3], TP=[0.6]hrs,
                      RAINFALL=[ ,   ,   ,   , ](mm/hr),  END=-1
*%-----------------|-----------------------------------------------------------|
*# Residential Land Use
CALIB STANDHYD        ID=[ 5 ], NHYD=["REHW-2"], DT=[ 5 ](min), AREA=[ 90.7](ha),
                      XIMP=[0.50], TIMP=[0.50], DWF=[ 0 ](cms), LOSS=[2],
                      SCS curve number CN=[ 72 ],
                      Pervious   surfaces: IAper=[ 5 ](mm), SLPP=[ 1.0 ](%),
                                           LGP=[50](m), MNP=[0.25], SCP=[0](min),
                      Impervious surfaces: IAimp=[ 1.0 ](mm), SLPI=[ 1.0 ](%),
                                           LGI=[200](m),MNI=[0.013],SCI=[0](min),
                      RAINFALL=[ ,   ,   ,   , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*#ADDING ALL SUB-CATCHMENTS
ADD HYD               IDsum=[6], NHYD=[616], IDs to add=[3+4+5]
*%-----------------|-----------------------------------------------------------|
COMPUTE DUALHYD       IDin=[6], CINLET=[4.93](cms), NINLET=[1],
                      MAJID=[3], MajNHYD=["MAJ-HW2"],
                      MINID=[4], MinNHYD=["MIN-HW2"],
                      TMJSTO=[0](cu-m)
*%-----------------|-----------------------------------------------------------|
*# END OF CATCHMENT HW-2
*%##############################################################################
FINISH
```

```
==========================================================================

 SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999   =========
 S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
 SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9  Ver. 4.02
     S   W W   M   M  H   H    Y    M   M  O   O       9999   9999  July 1999
 SSSSS   W W   M   M  H   H    Y    M   M   OOO           9      9  =========
                                                      9   9  9   9  # 3023779
      StormWater Management HYdrologic Model           999    999   =========

 ***************************************************************************
 ************************** SWMHYMO-99 Ver/4.02 ****************************
 *******  A single event and continuous hydrologic simulation model  *******
 *******     based on the principles of HYMO and its successors     *******
 *******                 OTTHYMO-83 and OTTHYMO-89.                 *******
 ***************************************************************************
 ******* Distributed by:  J.F. Sabourin and Associates Inc.          *******
 *******                  Ottawa,  Ontario: (613) 727-5199          *******
 *******                  Gatineau, Quebec: (819) 243-6858          *******
 *******                  E-Mail: swmhymo@jfsa.Com                  *******
 ***************************************************************************

 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++ Licensed user: MPE Engineering Ltd.                        +++++++
 +++++++                Calgary              SERIAL#:3023779        +++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 ***************************************************************************
 *******            ++++++ PROGRAM ARRAY DIMENSIONS ++++++          *******
 *******            Maximum value for ID numbers  :      10         *******
 *******            Max. number of rainfall points:  15000          *******
 *******            Max. number of flow points    :  15000          *******
 ***************************************************************************


 ********************   D E T A I L E D   O U T P U T   ********************
 ***************************************************************************
 *       DATE: 2010-01-26     TIME: 15:16:07     RUN COUNTER: 000746       *
 ***************************************************************************
 * Input   filename: C:\HWY2AASP\POST\PST_Vol.dat                          *
 * Output  filename: C:\HWY2AASP\POST\PST_Vol.out                          *
 * Summary filename: C:\HWY2AASP\POST\PST_Vol.sum                          *
 * User comments:                                                          *
 * 1:______________________________________________________________________*
 * 2:______________________________________________________________________*
 * 3:______________________________________________________________________*
 ***************************************************************************

-------------------------------------------------------------------------------
001:0001-----------------------------------------------------------------------
*#*****************************************************************************
*#  Project Name: [Highway 2A--ASP]    Project Number: [ 2210-026-00]
*#  Date         : 07-12-2009
*#  Updated      : Jan 26, 2010
*#  Modeller     : [  KNP       ]
*#  Company      : MPE Engineering Ltd.
*#  License #    :  3023779
*# Determining 1:100 year flow and volume for 4 Sub-Catchments
*# Developments (POST-DEVELOPMENT CONDITION)
*# USING 24 HOUR STORM DISTRIBUTION (DT =24 HRS)
*# Used the CN value of 72 for SWMHYMO/Post-dev condition as per City of Calgary
*# Stormwater Management Guidelines (Dec 2000) in STANDHYD Command (P 3-23)
*# USED XIMP = TIMP AS PER CITY OF CALGARY GUIDELINES (P 3-24)
*#*****************************************************************************
--------------------
```

```
| START              |  Project  dir.: C:\HWY2AASP\POST\
--------------------  Rainfall dir.: C:\HWY2AASP\POST\
    TZERO =    .00 hrs on       0
    METOUT=   2 (output = METRIC)
    NRUN  = 001
    NSTORM=   0
-------------------------------------------------------------------------------
001:0002-----------------------------------------------------------------------
*100-year storm using City of Calgary's ABCs
--------------------
| CHICAGO STORM    |     IDF curve parameters: A= 663.100
| Ptotal= 89.67 mm |                           B=   1.870
--------------------                           C=    .712
                         used in:   INTENSITY =  A / (t + B)^C

                         Duration of storm  = 24.00 hrs
                         Storm time step    = 10.00 min
                         Time to peak ratio =   .33
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.17	1.098	6.17	3.139	12.17	2.819	18.17	1.490
.33	1.115	6.33	3.366	12.33	2.741	18.33	1.473
.50	1.133	6.50	3.638	12.50	2.668	18.50	1.456
.67	1.151	6.67	3.970	12.67	2.600	18.67	1.440
.83	1.170	6.83	4.385	12.83	2.535	18.83	1.424
1.00	1.190	7.00	4.923	13.00	2.474	19.00	1.409
1.17	1.211	7.17	5.653	13.17	2.417	19.17	1.394
1.33	1.232	7.33	6.713	13.33	2.363	19.33	1.379
1.50	1.255	7.50	8.429	13.50	2.311	19.50	1.365
1.67	1.279	7.67	11.827	13.67	2.263	19.67	1.351
1.83	1.303	7.83	23.925	13.83	2.216	19.83	1.337
2.00	1.329	8.00	113.912	14.00	2.172	20.00	1.324
2.17	1.357	8.17	30.181	14.17	2.130	20.17	1.311
2.33	1.385	8.33	17.696	14.33	2.090	20.33	1.299
2.50	1.415	8.50	13.085	14.50	2.051	20.50	1.286
2.67	1.447	8.67	10.590	14.67	2.014	20.67	1.274
2.83	1.480	8.83	8.996	14.83	1.979	20.83	1.262
3.00	1.516	9.00	7.878	15.00	1.945	21.00	1.251
3.17	1.553	9.17	7.045	15.17	1.913	21.17	1.239
3.33	1.593	9.33	6.396	15.33	1.882	21.33	1.228
3.50	1.635	9.50	5.874	15.50	1.852	21.50	1.217
3.67	1.680	9.67	5.444	15.67	1.823	21.67	1.207
3.83	1.728	9.83	5.082	15.83	1.795	21.83	1.196
4.00	1.780	10.00	4.774	16.00	1.769	22.00	1.186
4.17	1.836	10.17	4.507	16.17	1.743	22.17	1.176
4.33	1.895	10.33	4.273	16.33	1.718	22.33	1.167
4.50	1.960	10.50	4.066	16.50	1.694	22.50	1.157
4.67	2.031	10.67	3.882	16.67	1.670	22.67	1.148
4.83	2.108	10.83	3.717	16.83	1.648	22.83	1.138
5.00	2.192	11.00	3.567	17.00	1.626	23.00	1.129
5.17	2.285	11.17	3.432	17.17	1.605	23.17	1.120
5.33	2.387	11.33	3.308	17.33	1.584	23.33	1.112
5.50	2.502	11.50	3.194	17.50	1.564	23.50	1.103
5.67	2.631	11.67	3.089	17.67	1.545	23.67	1.095
5.83	2.777	11.83	2.993	17.83	1.526	23.83	1.087
6.00	2.945	12.00	2.903	18.00	1.508	24.00	1.078

```
-------------------------------------------------------------------------------
001:0003-----------------------------------------------------------------------
*#  Catchment HW-1 --Southern Catchment within the ASP Study Area
*##############################################################################
*# Industrial/ Natural Land Use (Gravel Pit)
----------------------
| CALIB STANDHYD      |    Area    (ha)=   65.20
```

```
| 01:INHW-1 DT= 5.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area      (ha)=      32.60        32.60
     Dep. Storage      (mm)=       1.00         3.40
     Average Slope      (%)=        .50          .50
     Length             (m)=     800.00       100.00
     Mannings n            =       .013         .250

     Max.eff.Inten.(mm/hr)=     113.91        16.92
                over (min)      10.00        50.00
     Storage Coeff.   (min)=      10.40 (ii)   48.12 (ii)
     Unit Hyd. Tpeak  (min)=      10.00        50.00
     Unit Hyd. peak   (cms)=        .11          .02
                                                          *TOTALS*
     PEAK FLOW        (cms)=       6.33          .96       6.611 (iii)
     TIME TO PEAK     (hrs)=       8.08         8.75       8.083
     RUNOFF VOLUME     (mm)=      88.67        40.22      64.442
     TOTAL RAINFALL    (mm)=      89.67        89.67      89.667
     RUNOFF COEFFICIENT   =        .99          .45        .719

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  72.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
001:0004-----------------------------------------------------------------------
*# Traditional Low Intensity Land Use
---------------------
| CALIB NASHYD        |  Area     (ha)=  361.30   Curve Number   (CN)=78.00
| 02:TLIHW- DT= 5.00  |  Ia       (mm)=  10.000   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    2.280

     Unit Hyd Qpeak  (cms)=     6.053

     PEAK FLOW       (cms)=     5.055 (i)
     TIME TO PEAK    (hrs)=    11.000
     RUNOFF VOLUME    (mm)=    41.946
     TOTAL RAINFALL   (mm)=    89.667
     RUNOFF COEFFICIENT   =      .468

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
001:0005-----------------------------------------------------------------------
*# Residential Land Use
---------------------
| CALIB STANDHYD      |  Area     (ha)=    3.60
| 03:REHW-1 DT= 5.00  |  Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
---------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area      (ha)=       1.80         1.80
     Dep. Storage      (mm)=       1.00         5.00
     Average Slope      (%)=       1.00         1.00
     Length             (m)=     200.00        50.00
     Mannings n            =       .013         .250

     Max.eff.Inten.(mm/hr)=     113.91        29.57
                over (min)       5.00        20.00
     Storage Coeff.   (min)=       3.68 (ii)   19.85 (ii)
     Unit Hyd. Tpeak  (min)=       5.00        20.00
     Unit Hyd. peak   (cms)=        .25          .06
                                                          *TOTALS*
```

```
     PEAK FLOW        (cms)=        .54          .09            .581 (iii)
     TIME TO PEAK     (hrs)=       8.00         8.25           8.000
     RUNOFF VOLUME     (mm)=      88.67        39.08          63.872
     TOTAL RAINFALL    (mm)=      89.67        89.67          89.667
     RUNOFF COEFFICIENT    =        .99          .44            .712
      *** WARNING: Storage Coefficient is smaller than DT!
                   Use a smaller DT or a larger area.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  72.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
001:0006-----------------------------------------------------------------------
*# Industrial/ Commercial Land Use Including Planned Development
----------------------
| CALIB STANDHYD      |   Area     (ha)=  242.50
| 04:ICHW-1 DT= 5.00  |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
----------------------
                             IMPERVIOUS   PERVIOUS (i)
     Surface Area      (ha)=    194.00       48.50
     Dep. Storage      (mm)=      1.00        5.00
     Average Slope      (%)=      1.00        1.00
     Length             (m)=    400.00      100.00
     Mannings n            =      .013        .250

     Max.eff.Inten.(mm/hr)=     113.91       20.53
                over (min)        5.00       35.00
     Storage Coeff.  (min)=       5.57 (ii)   33.94 (ii)
     Unit Hyd. Tpeak (min)=       5.00       35.00
     Unit Hyd. peak  (cms)=        .20         .03
                                                            *TOTALS*
     PEAK FLOW        (cms)=      53.14        1.74          53.613 (iii)
     TIME TO PEAK     (hrs)=       8.00        8.50           8.000
     RUNOFF VOLUME     (mm)=      88.67       39.08          78.749
     TOTAL RAINFALL    (mm)=      89.67       89.67          89.667
     RUNOFF COEFFICIENT    =        .99         .44            .878

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  72.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
001:0007-----------------------------------------------------------------------
*# High River Waste Water Treatment Plant
----------------------
| CALIB STANDHYD      |   Area     (ha)=   17.40
| 05:WWTHW- DT= 5.00  |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
----------------------
                             IMPERVIOUS   PERVIOUS (i)
     Surface Area      (ha)=     13.92        3.48
     Dep. Storage      (mm)=      1.00        5.00
     Average Slope      (%)=       .30         .30
     Length             (m)=    400.00      200.00
     Mannings n            =      .013        .250

     Max.eff.Inten.(mm/hr)=     113.91       11.66
                over (min)       10.00       85.00
     Storage Coeff.  (min)=       7.99 (ii)   85.37 (ii)
     Unit Hyd. Tpeak (min)=      10.00       85.00
     Unit Hyd. peak  (cms)=        .13         .01
```

```
                                                                *TOTALS*
     PEAK FLOW         (cms)=        2.95           .07          2.963 (iii)
     TIME TO PEAK      (hrs)=        8.08          9.42          8.083
     RUNOFF VOLUME      (mm)=       88.67         39.07         78.749
     TOTAL RAINFALL     (mm)=       89.67         89.67         89.667
     RUNOFF COEFFICIENT    =          .99           .44           .878

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  72.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
001:0008-----------------------------------------------------------------------
*#ADDING ALL SUB-CATCHMENTS
--------------------
| ADD HYD (000605) | ID: NHYD       AREA      QPEAK    TPEAK    R.V.     DWF
--------------------                (ha)      (cms)    (hrs)    (mm)    (cms)
                  ID1 01:INHW-1     65.20     6.611     8.08   64.44     .000
                 +ID2 02:TLIHW-    361.30     5.055    11.00   41.95     .000
                 +ID3 03:REHW-1      3.60      .581     8.00   63.87     .000
                 +ID4 04:ICHW-1    242.50    53.613     8.00   78.75     .000
                 +ID5 05:WWTHW-     17.40     2.963     8.08   78.75     .000
                  =======================================================
                  SUM 06:000605    690.00    63.240     8.00   58.05     .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
001:0009-----------------------------------------------------------------------
----------------------
| COMPUTE DUALHYD      |   Average inlet capacities    [CINLET] =   3.450  (cms)
| TotalHyd 06:000605 |     Number of inlets in system  [NINLET] =       1
----------------------     Total minor system capacity          =   3.450  (cms)
                           Total major system storage  [TMJSTO] =      0.(cu.m.)

                   ID: NHYD        AREA      QPEAK      TPEAK      R.V.      DWF
                                   (ha)      (cms)      (hrs)      (mm)     (cms)
     TOTAL HYD.    06:000605     690.00     63.240      8.000    58.049     .000
     ========================================================================
     MAJOR SYST    07:MAJ-HW     297.75     59.790      8.000    58.049     .000
     MINOR SYST    08:MIN-HW     392.25      3.450      7.083    58.049     .000

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
001:0010-----------------------------------------------------------------------
*# END OF CATCHMENT HW-1
*##############################################################################
*#  Catchment TCHW --TONGUE CREEK & HIGHWOOD RIVER Catchment in ASP Study Area
*##############################################################################
*# Residential Land Use
----------------------
| CALIB STANDHYD       |   Area     (ha)=    36.10
| 01:RETCHW DT= 5.00 |     Total Imp(%)=    50.00   Dir. Conn.(%)=    50.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area       (ha)=     18.05        18.05
     Dep. Storage       (mm)=      1.00         5.00
     Average Slope       (%)=      1.00         1.00
     Length              (m)=    200.00        50.00
     Mannings n            =       .013         .250

     Max.eff.Inten.(mm/hr)=     113.91        29.57
```

```
                   over (min)        5.00          20.00
     Storage Coeff.  (min)=         3.68 (ii)     19.85 (ii)
     Unit Hyd. Tpeak (min)=         5.00          20.00
     Unit Hyd. peak  (cms)=          .25            .06
                                                                 *TOTALS*
     PEAK FLOW       (cms)=         5.41            .92            5.824 (iii)
     TIME TO PEAK    (hrs)=         8.00           8.25            8.000
     RUNOFF VOLUME    (mm)=        88.67          39.08           63.872
     TOTAL RAINFALL   (mm)=        89.67          89.67           89.667
     RUNOFF COEFFICIENT   =          .99            .44             .712
      *** WARNING: Storage Coefficient is smaller than DT!
                   Use a smaller DT or a larger area.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  72.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0011------------------------------------------------------------------------
*# Industrial/ Commercial Land Use Including Planned Development
----------------------
| CALIB STANDHYD      |   Area    (ha)=  538.80
| 02:ICTCHW DT= 5.00  |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area      (ha)=    431.04        107.76
     Dep. Storage      (mm)=      1.00          5.00
     Average Slope      (%)=      1.00          1.00
     Length             (m)=    400.00        100.00
     Mannings n            =      .013          .250

     Max.eff.Inten.(mm/hr)=     113.91         20.53
                  over (min)      5.00         35.00
     Storage Coeff.  (min)=       5.57 (ii)    33.94 (ii)
     Unit Hyd. Tpeak (min)=       5.00         35.00
     Unit Hyd. peak  (cms)=        .20           .03
                                                               *TOTALS*
     PEAK FLOW       (cms)=     118.07          3.88         119.121 (iii)
     TIME TO PEAK    (hrs)=       8.00          8.50           8.000
     RUNOFF VOLUME    (mm)=      88.67         39.08          78.749
     TOTAL RAINFALL   (mm)=      89.67         89.67          89.667
     RUNOFF COEFFICIENT   =        .99           .44            .878

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  72.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0012------------------------------------------------------------------------
*# Flood Fringe Land Use
----------------------
| CALIB NASHYD        |   Area    (ha)=  164.20   Curve Number   (CN)=67.00
| 03:FFTCHW DT= 5.00  |   Ia      (mm)=  10.000   # of Linear Res.(N)= 3.00
----------------------    U.H. Tp(hrs)=   3.800

     Unit Hyd Qpeak  (cms)=    1.650

     PEAK FLOW       (cms)=    1.150 (i)
     TIME TO PEAK    (hrs)=   13.250
     RUNOFF VOLUME    (mm)=   30.995
     TOTAL RAINFALL   (mm)=   89.667
```

```
     RUNOFF COEFFICIENT    =      .346

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0013------------------------------------------------------------------------
*# Traditional Low Intensity Land Use
----------------------
| CALIB NASHYD         |    Area     (ha)=  142.90   Curve Number    (CN)=78.00
| 04:TLITCH DT= 5.00   |    Ia       (mm)=  10.000   # of Linear Res.(N)= 3.00
----------------------      U.H. Tp(hrs)=    1.340

     Unit Hyd Qpeak  (cms)=     4.073

     PEAK FLOW       (cms)=     2.892 (i)
     TIME TO PEAK    (hrs)=     9.667
     RUNOFF VOLUME    (mm)=    41.946
     TOTAL RAINFALL   (mm)=    89.667
     RUNOFF COEFFICIENT    =      .468

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0014------------------------------------------------------------------------
*#ADDING ALL SUB-CATCHMENTS
--------------------
| ADD HYD (000505) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------              (ha)     (cms)   (hrs)   (mm)    (cms)
                 ID1 01:RETCHW    36.10    5.824    8.00  63.87     .000
                +ID2 02:ICTCHW   538.80  119.121    8.00  78.75     .000
                +ID3 03:FFTCHW   164.20    1.150   13.25  30.99     .000
                +ID4 04:TLITCH   142.90    2.892    9.67  41.95     .000
                 ==================================================
                 SUM 05:000505   882.00  125.180    8.00  63.29     .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
001:0015------------------------------------------------------------------------
----------------------
| COMPUTE DUALHYD      |   Average inlet capacities   [CINLET] =   4.400  (cms)
| TotalHyd 05:000505   |   Number of inlets in system [NINLET] =       1
----------------------     Total minor system capacity         =   4.400  (cms)
                           Total major system storage [TMJSTO] =      0.(cu.m.)

                  ID: NHYD        AREA     QPEAK     TPEAK     R.V.     DWF
                                  (ha)     (cms)     (hrs)     (mm)    (cms)
     TOTAL HYD.   05:000505     882.00   125.180     8.000   63.287     .000
     ===================================================================
     MAJOR SYST   01:MAJ-TC     407.84   120.780     8.000   63.287     .000
     MINOR SYST   02:MIN-TC     474.16     4.400     6.417   63.287     .000

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
001:0016------------------------------------------------------------------------
*# END OF CATCHMENT TCHW
*###############################################################################
*#  Catchment HW-2 --Saddlebrook & Other in the ASP Study Area
*###############################################################################
*# Industrial/ Commercial Land Use Including Planned Development
----------------------
| CALIB STANDHYD       |   Area     (ha)=  770.00
| 03:ICHW-2 DT= 5.00   |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
----------------------
```

```
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area      (ha)=     616.00        154.00
     Dep. Storage      (mm)=       1.00          5.00
     Average Slope      (%)=       1.00          1.00
     Length             (m)=     400.00        100.00
     Mannings n            =       .013          .250

     Max.eff.Inten.(mm/hr)=      113.91         20.53
                over (min)         5.00         35.00
     Storage Coeff.  (min)=        5.57 (ii)    33.94 (ii)
     Unit Hyd. Tpeak (min)=        5.00         35.00
     Unit Hyd. peak  (cms)=         .20           .03
                                                              *TOTALS*
     PEAK FLOW       (cms)=      168.74          5.54        170.235 (iii)
     TIME TO PEAK    (hrs)=        8.00          8.50          8.000
     RUNOFF VOLUME    (mm)=       88.67         39.08         78.749
     TOTAL RAINFALL   (mm)=       89.67         89.67         89.667
     RUNOFF COEFFICIENT   =         .99           .44           .878

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  72.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0017------------------------------------------------------------------------
*# Traditional Low Intensity Land Use
----------------------
| CALIB NASHYD         |   Area    (ha)=  124.90   Curve Number    (CN)=78.00
| 04:TLIHW- DT= 5.00 |   Ia      (mm)=  10.000   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=    .600

     Unit Hyd Qpeak  (cms)=    7.951

     PEAK FLOW       (cms)=    4.388 (i)
     TIME TO PEAK    (hrs)=    8.667
     RUNOFF VOLUME    (mm)=   41.946
     TOTAL RAINFALL   (mm)=   89.667
     RUNOFF COEFFICIENT   =     .468

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0018------------------------------------------------------------------------
*# Residential Land Use
----------------------
| CALIB STANDHYD       |   Area    (ha)=   90.70
| 05:REHW-2 DT= 5.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=    50.00
----------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area      (ha)=      45.35         45.35
     Dep. Storage      (mm)=       1.00          5.00
     Average Slope      (%)=       1.00          1.00
     Length             (m)=     200.00         50.00
     Mannings n            =       .013          .250

     Max.eff.Inten.(mm/hr)=      113.91         29.57
                over (min)         5.00         20.00
     Storage Coeff.  (min)=        3.68 (ii)    19.85 (ii)
     Unit Hyd. Tpeak (min)=        5.00         20.00
     Unit Hyd. peak  (cms)=         .25           .06
                                                              *TOTALS*
     PEAK FLOW       (cms)=       13.60          2.32         14.632 (iii)
     TIME TO PEAK    (hrs)=        8.00          8.25          8.000
```

```
     RUNOFF VOLUME     (mm)=       88.67          39.08          63.872
     TOTAL RAINFALL    (mm)=       89.67          89.67          89.667
     RUNOFF COEFFICIENT   =          .99            .44            .712
      *** WARNING: Storage Coefficient is smaller than DT!
                   Use a smaller DT or a larger area.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  72.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 -------------------------------------------------------------------------------
 001:0019-----------------------------------------------------------------------
 *#ADDING ALL SUB-CATCHMENTS
 --------------------
 | ADD HYD (000616) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
 --------------------               (ha)     (cms)   (hrs)   (mm)    (cms)
                   ID1 03:ICHW-2   770.00  170.235    8.00  78.75    .000
                  +ID2 04:TLIHW-   124.90    4.388    8.67  41.95    .000
                  +ID3 05:REHW-2    90.70   14.632    8.00  63.87    .000
                   =====================================================
                   SUM 06:000616   985.60  185.866    8.00  72.72    .000

    NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 -------------------------------------------------------------------------------
 001:0020-----------------------------------------------------------------------
 ----------------------
 | COMPUTE DUALHYD     |   Average inlet capacities   [CINLET] =   4.930  (cms)
 | TotalHyd 06:000616  |   Number of inlets in system [NINLET] =       1
 ----------------------    Total minor system capacity         =   4.930  (cms)
                           Total major system storage [TMJSTO] =       0.(cu.m.)

                    ID: NHYD        AREA     QPEAK     TPEAK     R.V.      DWF
                                    (ha)     (cms)     (hrs)     (mm)     (cms)
      TOTAL HYD.    06:000616     985.60   185.866     8.000   72.716     .000
      =========================================================================
      MAJOR SYST    03:MAJ-HW     524.01   180.936     8.000   72.716     .000
      MINOR SYST    04:MIN-HW     461.60     4.930     5.750   72.716     .000

      NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 -------------------------------------------------------------------------------
 001:0021-----------------------------------------------------------------------
 *# END OF CATCHMENT HW-2
       FINISH
 -------------------------------------------------------------------------------
 *******************************************************************************
      WARNINGS / ERRORS / NOTES
      -------------------------
  001:0005 CALIB STANDHYD
       *** WARNING: Storage Coefficient is smaller than DT!
                    Use a smaller DT or a larger area.
  001:0010 CALIB STANDHYD
       *** WARNING: Storage Coefficient is smaller than DT!
                    Use a smaller DT or a larger area.
  001:0018 CALIB STANDHYD
       *** WARNING: Storage Coefficient is smaller than DT!
                    Use a smaller DT or a larger area.
    Simulation ended on 2010-01-26     at 15:16:07
 ===============================================================================
```

```
2     Metric units
*#*****************************************************************************
*#  Project Name: [Highway 2A--ASP]    Project Number: [ 2210-026-00]
*#  Date          : 07-12-2009
*#  Updated       : Jan 26, 2010
*#  Modeller      : [  KNP      ]
*#  Company       : MPE Engineering Ltd.
*#  License #     :  3023779
*# Determining 1:100 year flow and volume for 4 Sub-Catchments
*# Developments (POST-DEVELOPMENT CONDITION)
*# USING 24 HOUR STORM DISTRIBUTION (DT =24 HRS)
*# Used the CN value of 72 for SWMHYMO/Post-dev condition as per City of Calgary
*# Stormwater Management Guidelines (Dec 2000) in STANDHYD Command (P 3-23)
*# USED XIMP = TIMP AS PER CITY OF CALGARY GUIDELINES (P 3-24)
*#*****************************************************************************
START                TZERO=[0.0],  METOUT=[2],  NSTORM=[0],  NRUN=[0]
*%                    [  ] <--storm filename, one per line for NSTORM time
*%-----------------|-----------------------------------------------------------|
*100-year storm using City of Calgary's ABCs
CHICAGO STORM        IUNITS=[2],  TD=[24](hrs), TPRAT=[0.333],  CSDT=[10 ](min),
                     ICASEcs=[1],
                      A=[663.1  ],  B=[ 1.87  ], and C=[  0.712 ],
*%-----------------|-----------------------------------------------------------|
*#  Catchment HW-3 --Northern Catchment within the ASP Study Area
*#############################################################################
*%-----------------|-----------------------------------------------------------|
*# Traditional Low Intensity Land Use (HW-3 NW)
CALIB NASHYD         ID=[1], NHYD=["TLIHW-3NW"],DT=[5]min, AREA=[278.6](ha),
                     DWF=[0](cms),  CN/C=[78], IA=[10](mm),
                     N=[3], TP=[0.67]hrs,
                     RAINFALL=[ ,   ,   ,   , ](mm/hr),  END=-1
*%-----------------|-----------------------------------------------------------|
*# Traditional Low Intensity Land Use (HW-3 SOUTH)
CALIB NASHYD         ID=[2], NHYD=["TLIHW-3S"],DT=[5]min, AREA=[112.2](ha),
                     DWF=[0](cms),  CN/C=[78], IA=[10](mm),
                     N=[3], TP=[0.55]hrs,
                     RAINFALL=[ ,   ,   ,   , ](mm/hr),  END=-1
*%-----------------|-----------------------------------------------------------|
*# ER & RECREATIONAL LAND USE (HW-3 ER & R)
CALIB NASHYD         ID=[3], NHYD=["ERHW-3"],DT=[5]min, AREA=[27.7](ha),
                     DWF=[0](cms),  CN/C=[67], IA=[10](mm),
                     N=[3], TP=[0.14]hrs,
                     RAINFALL=[ ,   ,   ,   , ](mm/hr),  END=-1
*%-----------------|-----------------------------------------------------------|
*# Industrial/ Natural Land Use (Gravel Pit)
CALIB STANDHYD       ID=[ 4 ], NHYD=["INHW-3"], DT=[ 5 ](min), AREA=[ 44.8](ha),
                     XIMP=[0.50], TIMP=[0.50], DWF=[ 0 ](cms), LOSS=[2],
                     SCS curve number CN=[ 72 ],
                     Pervious   surfaces: IAper=[ 3.4 ](mm), SLPP=[ 0.5 ](%),
                                          LGP=[100](m), MNP=[0.25], SCP=[0](min),
                     Impervious surfaces: IAimp=[ 1.0 ](mm), SLPI=[ 0.5 ](%),
                                          LGI=[800](m),MNI=[0.013],SCI=[0](min),
                     RAINFALL=[ ,   ,   ,   , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# Residential Land Use
CALIB STANDHYD       ID=[ 5 ], NHYD=["REHW-3"], DT=[ 5 ](min), AREA=[ 118.3](ha),
                     XIMP=[0.50], TIMP=[0.50], DWF=[ 0 ](cms), LOSS=[2],
                     SCS curve number CN=[ 72 ],
                     Pervious   surfaces: IAper=[ 5 ](mm), SLPP=[ 1.0 ](%),
                                          LGP=[50](m), MNP=[0.25], SCP=[0](min),
                     Impervious surfaces: IAimp=[ 1.0 ](mm), SLPI=[ 1.0 ](%),
                                          LGI=[200](m),MNI=[0.013],SCI=[0](min),
                     RAINFALL=[ ,   ,   ,   , ](mm/hr) ,  END=-1
*%-----------------|-----------------------------------------------------------|
*# Industrial/ Commercial Land Use Including Planned Development
```

```
CALIB STANDHYD       ID=[ 6 ], NHYD=["ICHW-3"], DT=[ 5 ](min), AREA=[ 380.4](ha),
                     XIMP=[0.80], TIMP=[0.80], DWF=[ 0 ](cms), LOSS=[2],
                     SCS curve number CN=[ 72 ],
                     Pervious   surfaces: IAper=[ 5 ](mm), SLPP=[ 1.0 ](%),
                                          LGP=[100](m), MNP=[0.25], SCP=[0](min),
                     Impervious surfaces: IAimp=[ 1.0 ](mm), SLPI=[ 1.0 ](%),
                                          LGI=[400](m),MNI=[0.013],SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|---------------------------------------------------------|
*#ADDING ALL SUB-CATCHMENTS
ADD HYD              IDsum=[7], NHYD=[705], IDs to add=[1+2+3+4+5+6]
*%-----------------|---------------------------------------------------------|
COMPUTE DUALHYD      IDin=[7], CINLET=[4.81](cms), NINLET=[1],
                     MAJID=[8], MajNHYD=["MAJ-HW3"],
                     MINID=[9], MinNHYD=["MIN-HW3"],
                     TMJSTO=[0](cu-m)
*%-----------------|---------------------------------------------------------|
*# END OF CATCHMENT HW-3
*%##########################################################################
*# Catchments to the Sheep River
*# ALTHOUGH, TOTAL DRAINAGE AREA TO THE SHEEP RIVER IS +- 173 HA, THERE IS ABOUT
*# 40 HA OF ENVIRONMENTAL RESERVE (ER) THAT DIRECTLY DRAINS TO THE SHEEP RIVER,
*# AND 29.5 HA OF RV PARK HAS BEEN ALREADY DEVELOPED AND LOCATED DOWNSTREAM OF
*# PROPOSED DEVELOPMENTS AS PART OF THE ASP.  HENCE, 40 HA + 29.5 HA = 69.5 HA
*# OF CATCHMENT AREA IS TAKEN OFF TO ESTIMATE POND SIZE WITHIN THE SHEEP RIVER
*# CATCHMENT.
*%##########################################################################
*# Mixture of Industrial/Commercial and
*# Natural Land Use (Gravel Pit)[AREA 5 & 2]
CALIB STANDHYD       ID=[ 1 ], NHYD=["ICSR-N"], DT=[ 5 ](min), AREA=[ 103.4](ha),
                     XIMP=[0.80], TIMP=[0.80], DWF=[ 0 ](cms), LOSS=[2],
                     SCS curve number CN=[ 72 ],
                     Pervious   surfaces: IAper=[ 5 ](mm), SLPP=[ 1.0 ](%),
                                          LGP=[100](m), MNP=[0.25], SCP=[0](min),
                     Impervious surfaces: IAimp=[ 1.0 ](mm), SLPI=[ 1.0 ](%),
                                          LGI=[400](m),MNI=[0.013],SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|---------------------------------------------------------|
*# Estimate Pond Volume (MajNHYd) using DUALHYD Command with 5 L/s/ha as pre-dev
*# 1:100 yr flow rate
COMPUTE DUALHYD      IDin=[1], CINLET=[0.517](cms), NINLET=[1],
                     MAJID=[2], MajNHYD=["MAJ-SRN"],
                     MINID=[3], MinNHYD=["MIN-SRN"],
                     TMJSTO=[0](cu-m)
*%-----------------|---------------------------------------------------------|
*#OTHER TWO CATCHMENTS ARE MODELLED FOR PEAKFLOW ESTIMATION ONLY
*###################################################################
*# Residential Land Use (Existing RV)
CALIB STANDHYD       ID=[ 4 ], NHYD=["RESR-N"], DT=[ 5 ](min), AREA=[ 29.5](ha),
                     XIMP=[0.50], TIMP=[0.50], DWF=[ 0 ](cms), LOSS=[2],
                     SCS curve number CN=[ 72 ],
                     Pervious   surfaces: IAper=[ 5 ](mm), SLPP=[ 1.0 ](%),
                                          LGP=[50](m), MNP=[0.25], SCP=[0](min),
                     Impervious surfaces: IAimp=[ 1.0 ](mm), SLPI=[ 1.0 ](%),
                                          LGI=[200](m),MNI=[0.013],SCI=[0](min),
                     RAINFALL=[ ,  ,  ,  , ](mm/hr) ,  END=-1
*%-----------------|---------------------------------------------------------|
*# ENVIRONMENTAL RESERVE AREA (LIKELY IN THE FLOOD FRINGE AREA OF THE SHEEP RIVE
CALIB NASHYD         ID=[5], NHYD=["ERSR-N"],DT=[5]min, AREA=[40](ha),
                     DWF=[0](cms),  CN/C=[67], IA=[10](mm),
                     N=[3], TP=[0.50]hrs,
                     RAINFALL=[ ,  ,  ,  , ](mm/hr),  END=-1
*%-----------------|---------------------------------------------------------|
*# END OF CATCHMENT SR-N
*%##########################################################################
```

```
FINISH
```

```
=========================================================================

 SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO       999    999   =========
 S      W W W  MM MM  H   H   Y Y   MM MM  O   O     9   9  9   9
 SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9 Ver. 4.02
     S   W W   M   M  H   H    Y    M   M  O   O      9999   9999 July 1999
 SSSSS   W W   M   M  H   H    Y    M   M   OOO          9       9 =========
                                                     9   9  9   9 # 3023779
      StormWater Management HYdrologic Model          999    999   =========

 *************************************************************************
 ************************** SWMHYMO-99 Ver/4.02 *************************
 *******  A single event and continuous hydrologic simulation model  *******
 *******     based on the principles of HYMO and its successors      *******
 *******                 OTTHYMO-83 and OTTHYMO-89.                  *******
 *************************************************************************
 ******* Distributed by:  J.F. Sabourin and Associates Inc.           *******
 *******                  Ottawa,  Ontario: (613) 727-5199            *******
 *******                  Gatineau, Quebec: (819) 243-6858            *******
 *******                  E-Mail: swmhymo@jfsa.Com                    *******
 *************************************************************************

 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++ Licensed user: MPE Engineering Ltd.                         +++++++
 +++++++               Calgary              SERIAL#:3023779          +++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 *************************************************************************
 *******             ++++++ PROGRAM ARRAY DIMENSIONS ++++++          *******
 *******             Maximum value for ID numbers  :     10           *******
 *******             Max. number of rainfall points:  15000           *******
 *******             Max. number of flow points    :  15000           *******
 *************************************************************************


 *******************   D E T A I L E D   O U T P U T   ******************
 *************************************************************************
 *      DATE: 2010-01-26     TIME: 15:16:21     RUN COUNTER: 000747     *
 *************************************************************************
 * Input   filename: C:\HWY2AASP\POST\PST_HW3.dat                        *
 * Output  filename: C:\HWY2AASP\POST\PST_HW3.out                        *
 * Summary filename: C:\HWY2AASP\POST\PST_HW3.sum                        *
 * User comments:                                                        *
 * 1:_____________________________________________________________________*
 * 2:_____________________________________________________________________*
 * 3:_____________________________________________________________________*
 *************************************************************************

-------------------------------------------------------------------------------
001:0001-----------------------------------------------------------------------
*#****************************************************************************
*#  Project Name: [Highway 2A--ASP]    Project Number: [ 2210-026-00]
*#  Date         : 07-12-2009
*#  Updated      : Jan 26, 2010
*#  Modeller     : [  KNP     ]
*#  Company      : MPE Engineering Ltd.
*#  License #    :  3023779
*# Determining 1:100 year flow and volume for 4 Sub-Catchments
*# Developments (POST-DEVELOPMENT CONDITION)
*# USING 24 HOUR STORM DISTRIBUTION (DT =24 HRS)
*# Used the CN value of 72 for SWMHYMO/Post-dev condition as per City of Calgary
*# Stormwater Management Guidelines (Dec 2000) in STANDHYD Command (P 3-23)
*# USED XIMP = TIMP AS PER CITY OF CALGARY GUIDELINES (P 3-24)
*#****************************************************************************
------------------
```

```
| START              |  Project  dir.: C:\HWY2AASP\POST\
--------------------  Rainfall dir.: C:\HWY2AASP\POST\
    TZERO =    .00 hrs on        0
    METOUT=   2 (output = METRIC)
    NRUN  = 001
    NSTORM=   0
-----------------------------------------------------------------------------------
001:0002---------------------------------------------------------------------------
*100-year storm using City of Calgary's ABCs
--------------------
| CHICAGO STORM     |      IDF curve parameters: A= 663.100
| Ptotal= 89.67 mm  |                            B=   1.870
--------------------                             C=    .712
                           used in:    INTENSITY =  A / (t + B)^C

                           Duration of storm  = 24.00 hrs
                           Storm time step    = 10.00 min
                           Time to peak ratio =    .33
```

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
.17	1.098	6.17	3.139	12.17	2.819	18.17	1.490
.33	1.115	6.33	3.366	12.33	2.741	18.33	1.473
.50	1.133	6.50	3.638	12.50	2.668	18.50	1.456
.67	1.151	6.67	3.970	12.67	2.600	18.67	1.440
.83	1.170	6.83	4.385	12.83	2.535	18.83	1.424
1.00	1.190	7.00	4.923	13.00	2.474	19.00	1.409
1.17	1.211	7.17	5.653	13.17	2.417	19.17	1.394
1.33	1.232	7.33	6.713	13.33	2.363	19.33	1.379
1.50	1.255	7.50	8.429	13.50	2.311	19.50	1.365
1.67	1.279	7.67	11.827	13.67	2.263	19.67	1.351
1.83	1.303	7.83	23.925	13.83	2.216	19.83	1.337
2.00	1.329	8.00	113.912	14.00	2.172	20.00	1.324
2.17	1.357	8.17	30.181	14.17	2.130	20.17	1.311
2.33	1.385	8.33	17.696	14.33	2.090	20.33	1.299
2.50	1.415	8.50	13.085	14.50	2.051	20.50	1.286
2.67	1.447	8.67	10.590	14.67	2.014	20.67	1.274
2.83	1.480	8.83	8.996	14.83	1.979	20.83	1.262
3.00	1.516	9.00	7.878	15.00	1.945	21.00	1.251
3.17	1.553	9.17	7.045	15.17	1.913	21.17	1.239
3.33	1.593	9.33	6.396	15.33	1.882	21.33	1.228
3.50	1.635	9.50	5.874	15.50	1.852	21.50	1.217
3.67	1.680	9.67	5.444	15.67	1.823	21.67	1.207
3.83	1.728	9.83	5.082	15.83	1.795	21.83	1.196
4.00	1.780	10.00	4.774	16.00	1.769	22.00	1.186
4.17	1.836	10.17	4.507	16.17	1.743	22.17	1.176
4.33	1.895	10.33	4.273	16.33	1.718	22.33	1.167
4.50	1.960	10.50	4.066	16.50	1.694	22.50	1.157
4.67	2.031	10.67	3.882	16.67	1.670	22.67	1.148
4.83	2.108	10.83	3.717	16.83	1.648	22.83	1.138
5.00	2.192	11.00	3.567	17.00	1.626	23.00	1.129
5.17	2.285	11.17	3.432	17.17	1.605	23.17	1.120
5.33	2.387	11.33	3.308	17.33	1.584	23.33	1.112
5.50	2.502	11.50	3.194	17.50	1.564	23.50	1.103
5.67	2.631	11.67	3.089	17.67	1.545	23.67	1.095
5.83	2.777	11.83	2.993	17.83	1.526	23.83	1.087
6.00	2.945	12.00	2.903	18.00	1.508	24.00	1.078

```
-----------------------------------------------------------------------------------
001:0003---------------------------------------------------------------------------
*#  Catchment HW-3 --Northern Catchment within the ASP Study Area
*##################################################################################
*# Traditional Low Intensity Land Use (HW-3 NW)
---------------------
| CALIB NASHYD        |    Area     (ha)=  278.60   Curve Number    (CN)=78.00
```

```
| 01:TLIHW- DT= 5.00 |    Ia       (mm)=  10.000   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=     .670

     Unit Hyd Qpeak  (cms)=   15.882

     PEAK FLOW       (cms)=    9.083 (i)
     TIME TO PEAK    (hrs)=    8.750
     RUNOFF VOLUME    (mm)=   41.946
     TOTAL RAINFALL   (mm)=   89.667
     RUNOFF COEFFICIENT   =     .468

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
001:0004--------------------------------------------------------------------
*# Traditional Low Intensity Land Use (HW-3 SOUTH)
---------------------
| CALIB NASHYD       |   Area     (ha)=  112.20   Curve Number   (CN)=78.00
| 02:TLIHW- DT= 5.00 |   Ia       (mm)=  10.000   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=     .550

     Unit Hyd Qpeak  (cms)=    7.792

     PEAK FLOW       (cms)=    4.180 (i)
     TIME TO PEAK    (hrs)=    8.583
     RUNOFF VOLUME    (mm)=   41.946
     TOTAL RAINFALL   (mm)=   89.667
     RUNOFF COEFFICIENT   =     .468

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

----------------------------------------------------------------------------
001:0005--------------------------------------------------------------------
*# ER & RECREATIONAL LAND USE (HW-3 ER & R)
---------------------
| CALIB NASHYD       |   Area     (ha)=   27.70   Curve Number   (CN)=67.00
| 03:ERHW-3 DT= 5.00 |   Ia       (mm)=  10.000   # of Linear Res.(N)= 3.00
---------------------    U.H. Tp(hrs)=     .140

     Unit Hyd Qpeak  (cms)=    7.557

     PEAK FLOW       (cms)=    1.636 (i)
     TIME TO PEAK    (hrs)=    8.083
     RUNOFF VOLUME    (mm)=   30.994
     TOTAL RAINFALL   (mm)=   89.667
     RUNOFF COEFFICIENT   =     .346

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

      *** WARNING: Time step is too large for value of TP.
                   R.V. may be ok.  Peak flow could be off.
----------------------------------------------------------------------------
001:0006--------------------------------------------------------------------
*# Industrial/ Natural Land Use (Gravel Pit)
---------------------
| CALIB STANDHYD     |   Area    (ha)=   44.80
| 04:INHW-3 DT= 5.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
---------------------
                             IMPERVIOUS   PERVIOUS (i)
     Surface Area     (ha)=      22.40       22.40
     Dep. Storage     (mm)=       1.00        3.40
     Average Slope     (%)=        .50         .50
     Length            (m)=     800.00      100.00
     Mannings n           =       .013        .250

```

```
     Max.eff.Inten.(mm/hr)=      113.91          16.92
                  over (min)      10.00          50.00
     Storage Coeff.  (min)=       10.40 (ii)     48.12 (ii)
     Unit Hyd. Tpeak (min)=       10.00          50.00
     Unit Hyd. peak  (cms)=         .11            .02
                                                                *TOTALS*
     PEAK FLOW       (cms)=        4.35            .66            4.542 (iii)
     TIME TO PEAK    (hrs)=        8.08           8.75            8.083
     RUNOFF VOLUME    (mm)=       88.67          40.22           64.442
     TOTAL RAINFALL   (mm)=       89.67          89.67           89.667
     RUNOFF COEFFICIENT   =         .99            .45             .719

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =   72.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-----------------------------------------------------------------------------
001:0007---------------------------------------------------------------------
*# Residential Land Use
----------------------
| CALIB STANDHYD      |   Area    (ha)=  118.30
| 05:REHW-3 DT= 5.00  |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       59.15          59.15
     Dep. Storage     (mm)=        1.00           5.00
     Average Slope     (%)=        1.00           1.00
     Length            (m)=      200.00          50.00
     Mannings n           =        .013           .250

     Max.eff.Inten.(mm/hr)=      113.91          29.57
                  over (min)       5.00          20.00
     Storage Coeff.  (min)=        3.68 (ii)     19.85 (ii)
     Unit Hyd. Tpeak (min)=        5.00          20.00
     Unit Hyd. peak  (cms)=         .25            .06
                                                                *TOTALS*
     PEAK FLOW       (cms)=       17.73           3.03           19.084 (iii)
     TIME TO PEAK    (hrs)=        8.00           8.25            8.000
     RUNOFF VOLUME    (mm)=       88.67          39.08           63.872
     TOTAL RAINFALL   (mm)=       89.67          89.67           89.667
     RUNOFF COEFFICIENT   =         .99            .44             .712
      *** WARNING: Storage Coefficient is smaller than DT!
                   Use a smaller DT or a larger area.

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =   72.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-----------------------------------------------------------------------------
001:0008---------------------------------------------------------------------
*# Industrial/ Commercial Land Use Including Planned Development
----------------------
| CALIB STANDHYD      |   Area    (ha)=  380.40
| 06:ICHW-3 DT= 5.00  |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
----------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=      304.32          76.08
     Dep. Storage     (mm)=        1.00           5.00
     Average Slope     (%)=        1.00           1.00
     Length            (m)=      400.00         100.00
     Mannings n           =        .013           .250
```

```

     Max.eff.Inten.(mm/hr)=     113.91        20.53
                over (min)        5.00        35.00
     Storage Coeff.  (min)=       5.57 (ii)   33.94 (ii)
     Unit Hyd. Tpeak (min)=       5.00        35.00
     Unit Hyd. peak  (cms)=        .20          .03
                                                          *TOTALS*
     PEAK FLOW       (cms)=      83.36         2.74        84.101 (iii)
     TIME TO PEAK    (hrs)=       8.00         8.50         8.000
     RUNOFF VOLUME    (mm)=      88.67        39.08        78.749
     TOTAL RAINFALL   (mm)=      89.67        89.67        89.667
     RUNOFF COEFFICIENT   =        .99          .44          .878

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =   72.0     Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
001:0009-----------------------------------------------------------------------
*#ADDING ALL SUB-CATCHMENTS
--------------------
| ADD HYD (000705) | ID: NHYD     AREA     QPEAK   TPEAK   R.V.     DWF
--------------------               (ha)     (cms)   (hrs)   (mm)    (cms)
                  ID1 01:TLIHW-   278.60    9.083    8.75   41.95    .000
                 +ID2 02:TLIHW-   112.20    4.180    8.58   41.95    .000
                 +ID3 03:ERHW-3    27.70    1.636    8.08   30.99    .000
                 +ID4 04:INHW-3    44.80    4.542    8.08   64.44    .000
                 +ID5 05:REHW-3   118.30   19.084    8.00   63.87    .000
                 +ID6 06:ICHW-3   380.40   84.101    8.00   78.75    .000
                  =======================================================
                  SUM 07:000705   962.00  111.703    8.00   59.93    .000

   NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
001:0010-----------------------------------------------------------------------
---------------------
| COMPUTE DUALHYD     |   Average inlet capacities   [CINLET] =   4.810  (cms)
| TotalHyd 07:000705 |   Number of inlets in system [NINLET] =       1
---------------------    Total minor system capacity          =   4.810  (cms)
                         Total major system storage [TMJSTO] =       0.(cu.m.)

                   ID: NHYD        AREA      QPEAK      TPEAK      R.V.      DWF
                                   (ha)      (cms)      (hrs)      (mm)     (cms)
     TOTAL HYD.    07:000705     962.00    111.703      8.000    59.927     .000
     =========================================================================
     MAJOR SYST    08:MAJ-HW     467.12    106.893      8.000    59.927     .000
     MINOR SYST    09:MIN-HW     494.88      4.810      6.833    59.927     .000

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
001:0011-----------------------------------------------------------------------
*# END OF CATCHMENT HW-3
*# Catchments to the Sheep River
*# ALTHOUGH, TOTAL DRAINAGE AREA TO THE SHEEP RIVER IS +- 173 HA, THERE IS ABOUT
*# 40 HA OF ENVIRONMENTAL RESERVE (ER) THAT DIRECTLY DRAINS TO THE SHEEP RIVER,
*# AND 29.5 HA OF RV PARK HAS BEEN ALREADY DEVELOPED AND LOCATED DOWNSTREAM OF
*# PROPOSED DEVELOPMENTS AS PART OF THE ASP.  HENCE, 40 HA + 29.5 HA = 69.5 HA
*# OF CATCHMENT AREA IS TAKEN OFF TO ESTIMATE POND SIZE WITHIN THE SHEEP RIVER
*# CATCHMENT.
*# Mixture of Industrial/Commercial and
*# Natural Land Use (Gravel Pit)[AREA 5 & 2]
```

```
---------------------
| CALIB STANDHYD      |   Area     (ha)=  103.40
| 01:ICSR-N DT= 5.00 |   Total Imp(%)=   80.00   Dir. Conn.(%)=   80.00
---------------------
                              IMPERVIOUS   PERVIOUS (i)
     Surface Area     (ha)=      82.72        20.68
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         1.00
     Length            (m)=     400.00       100.00
     Mannings n          =        .013         .250

     Max.eff.Inten.(mm/hr)=     113.91        20.53
               over (min)        5.00        35.00
     Storage Coeff.  (min)=       5.57 (ii)   33.94 (ii)
     Unit Hyd. Tpeak (min)=       5.00        35.00
     Unit Hyd. peak  (cms)=        .20          .03
                                                          *TOTALS*
     PEAK FLOW       (cms)=      22.66          .74        22.860 (iii)
     TIME TO PEAK    (hrs)=       8.00         8.50         8.000
     RUNOFF VOLUME    (mm)=      88.67        39.08        78.749
     TOTAL RAINFALL   (mm)=      89.67        89.67        89.667
     RUNOFF COEFFICIENT   =        .99          .44          .878

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN* =  72.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0012------------------------------------------------------------------------
*# Estimate Pond Volume (MajNHYd) using DUALHYD Command with 5 L/s/ha as pre-dev
*# 1:100 yr flow rate
---------------------
| COMPUTE DUALHYD      |   Average inlet capacities    [CINLET] =    .517  (cms)
| TotalHyd 01:ICSR-N |   Number of inlets in system [NINLET] =       1
---------------------   Total minor system capacity          =    .517  (cms)
                         Total major system storage [TMJSTO] =       0.(cu.m.)

                   ID: NHYD        AREA     QPEAK     TPEAK     R.V.      DWF
                                   (ha)     (cms)     (hrs)     (mm)    (cms)
     TOTAL HYD.   01:ICSR-N     103.40    22.860     8.000   78.749     .000
     ===========================================================================
     MAJOR SYST   02:MAJ-SR      57.10    22.343     8.000   78.749     .000
     MINOR SYST   03:MIN-SR      46.30      .517     5.083   78.749     .000

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
001:0013------------------------------------------------------------------------
*#OTHER TWO CATCHMENTS ARE MODELLED FOR PEAKFLOW ESTIMATION ONLY
*###########################################################################
*# Residential Land Use (Existing RV)
---------------------
| CALIB STANDHYD      |   Area     (ha)=   29.50
| 04:RESR-N DT= 5.00 |   Total Imp(%)=   50.00   Dir. Conn.(%)=   50.00
---------------------
                              IMPERVIOUS   PERVIOUS (i)
     Surface Area     (ha)=      14.75        14.75
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         1.00
     Length            (m)=     200.00        50.00
     Mannings n          =        .013         .250

     Max.eff.Inten.(mm/hr)=     113.91        29.57
```

```
                   over (min)          5.00          20.00
     Storage Coeff.  (min)=          3.68 (ii)     19.85 (ii)
     Unit Hyd. Tpeak (min)=          5.00          20.00
     Unit Hyd. peak  (cms)=           .25            .06
                                                                *TOTALS*
     PEAK FLOW        (cms)=         4.42            .76          4.759 (iii)
     TIME TO PEAK     (hrs)=         8.00           8.25          8.000
     RUNOFF VOLUME     (mm)=        88.67          39.08         63.872
     TOTAL RAINFALL    (mm)=        89.67          89.67         89.667
     RUNOFF COEFFICIENT   =           .99            .44           .712
       *** WARNING: Storage Coefficient is smaller than DT!
                    Use a smaller DT or a larger area.

        (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN* =  72.0    Ia = Dep. Storage  (Above)
       (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
            THAN THE STORAGE COEFFICIENT.
      (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0014------------------------------------------------------------------------
*# ENVIRONMENTAL RESERVE AREA (LIKELY IN THE FLOOD FRINGE AREA OF THE SHEEP RIVE
----------------------
| CALIB NASHYD         |   Area     (ha)=   40.00   Curve Number    (CN)=67.00
| 05:ERSR-N DT= 5.00   |   Ia       (mm)=  10.000   # of Linear Res.(N)= 3.00
----------------------     U.H. Tp(hrs)=     .500

     Unit Hyd Qpeak  (cms)=    3.056

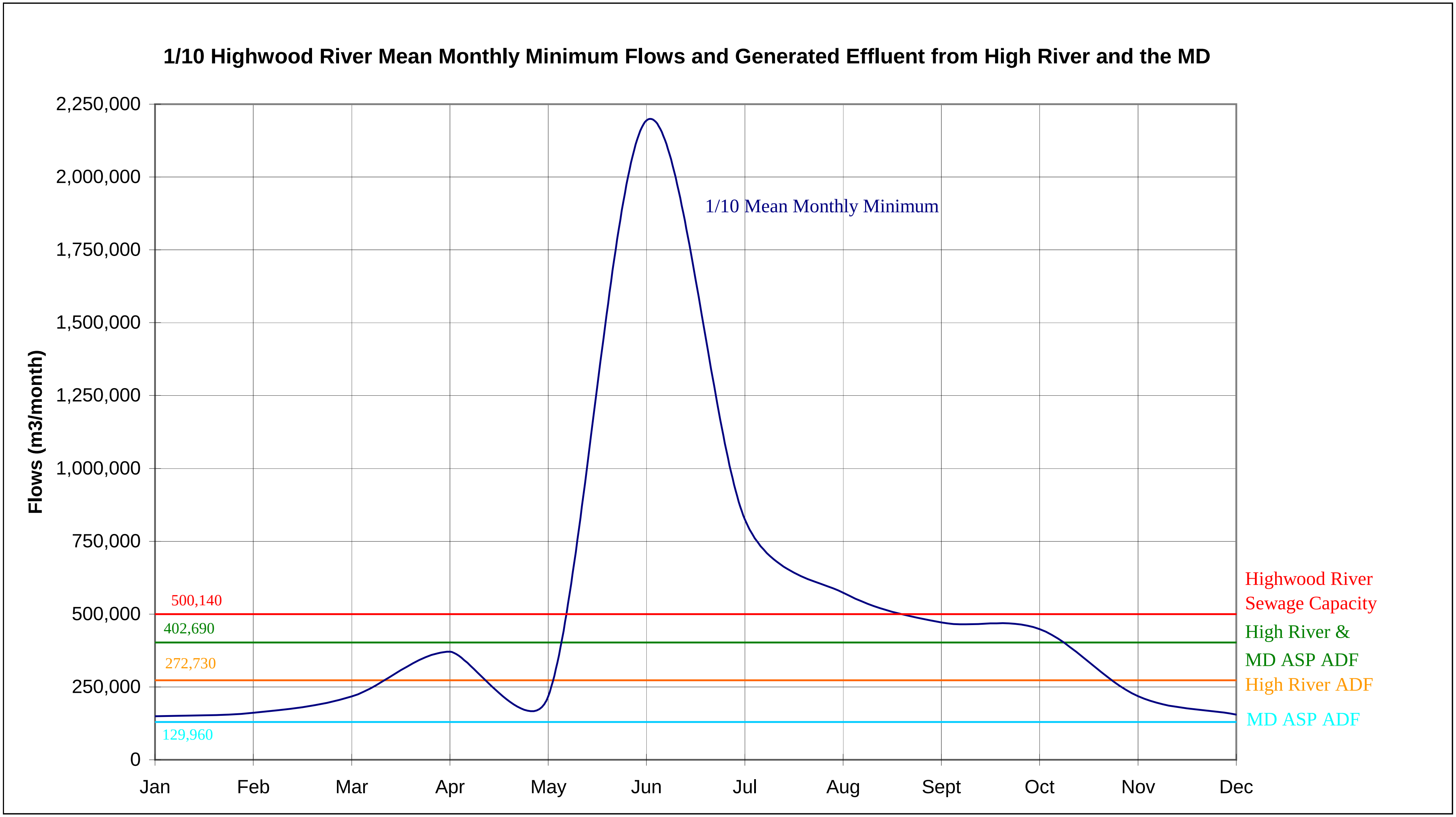
     PEAK FLOW        (cms)=    1.083 (i)
     TIME TO PEAK     (hrs)=    8.583
     RUNOFF VOLUME     (mm)=   30.995
     TOTAL RAINFALL    (mm)=   89.667
     RUNOFF COEFFICIENT   =      .346

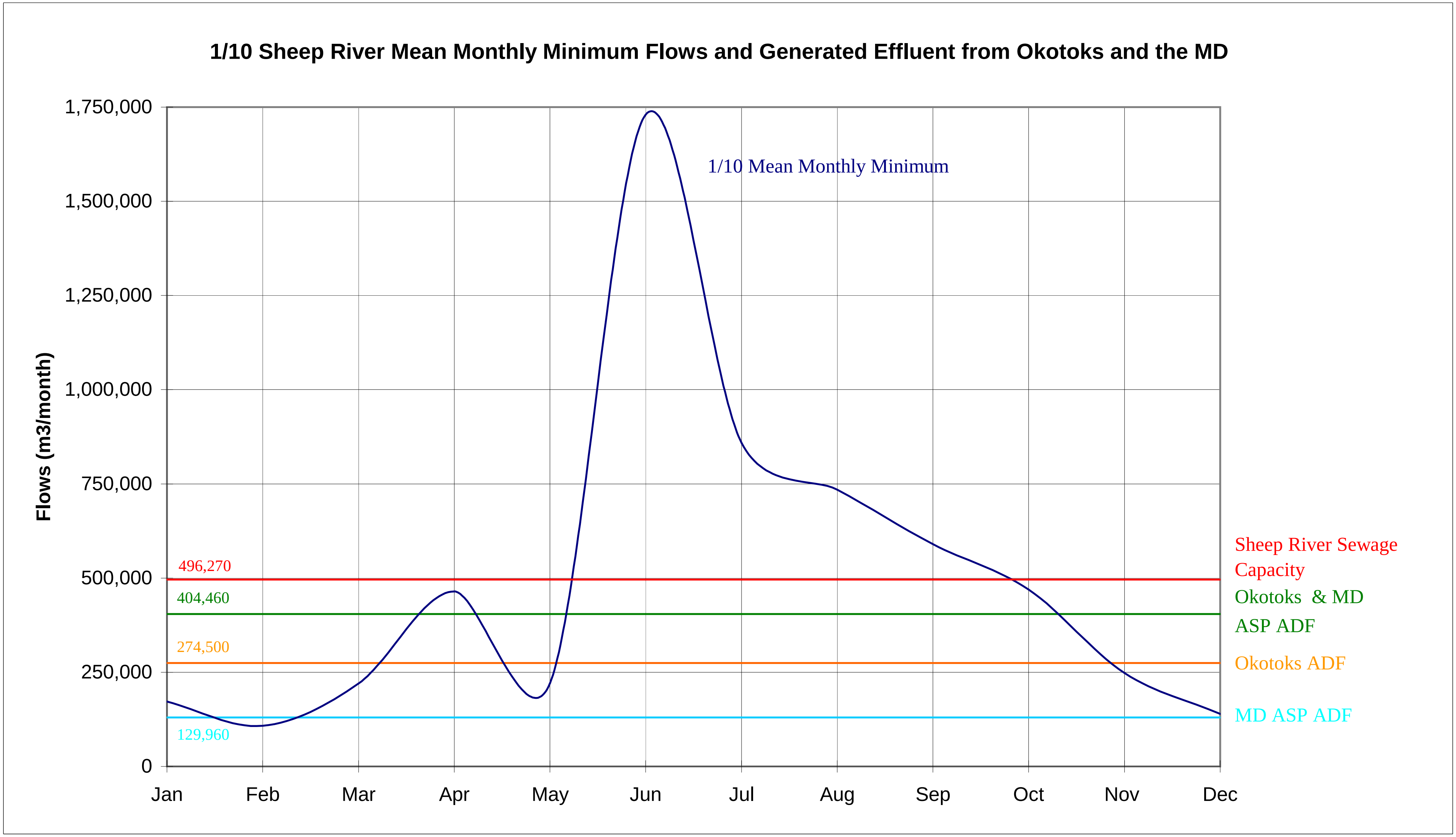
     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
001:0015------------------------------------------------------------------------
*# END OF CATCHMENT SR-N
      FINISH
--------------------------------------------------------------------------------
********************************************************************************
     WARNINGS / ERRORS / NOTES
     -------------------------
 001:0005 CALIB NASHYD
      *** WARNING: Time step is too large for value of TP.
                   R.V. may be ok.  Peak flow could be off.
 001:0007 CALIB STANDHYD
      *** WARNING: Storage Coefficient is smaller than DT!
                   Use a smaller DT or a larger area.
 001:0013 CALIB STANDHYD
      *** WARNING: Storage Coefficient is smaller than DT!
                   Use a smaller DT or a larger area.
   Simulation ended on 2010-01-26    at 15:16:21
================================================================================
```

APPENDIX D

River Flows


1/10 Highwood River Mean Monthly Minimum Flows and Generated Effluent from High River and the MD
Flows (m3/month)
2,250,000
2,000,000
1,750,000
1,500,000
1,250,000
1,000,000
750,000
500,000
250,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec
1/10 Mean Monthly Minimum
500,140
402,690
272,730
129,960
Highwood River Sewage Capacity
High River & MD ASP ADF
High River ADF
MD ASP ADF



1/10 Sheep River Mean Monthly Minimum Flows and Generated Effluent from Okotoks and the MD
Flows (m3/month)
1,750,000
1,500,000
1,250,000
1,000,000
750,000
500,000
250,000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1/10 Mean Monthly Minimum
496,270
404,460
274,500
129,960
Sheep River Sewage Capacity
Okotoks & MD ASP ADF
Okotoks ADF
MD ASP ADF

APPENDIX E

Cost Estimates

MD of Foothills
Hwy 2A Servicing Study

Engineering Ltd.

PROJECT COST ESTIMATE - Potable Option 1

DESCRIPTION		QUANTITY	UNIT	UNIT PRICE	COST
Potable Water from High River					
1	PVC 500mm	3400	$/m	$ 403	$ 1,371,580
2	PVC 450mm	10450	$/m	$ 357	$ 3,734,136
3	PVC 300mm	18250	$/m	$ 239	$ 4,368,822
4	PVC 250mm	9000	$/m	$ 233	$ 2,095,236
5	PRV Station	1	LS	$ 15,000	$ 15,000
6	Booster Station	2	ea.	$ 350,000	$ 700,000
7	Potable Water Storage Reservoir (4900m3)	1	LS	$ 900,000	$ 900,000
		SUBTOTAL			$ 13,185,000
CONTINGENCY (25%)					$ 3,296,000
ENGINEERING (15%)					$ 2,472,000
			TOTAL		**$ 18,950,000**

PROJECT COST ESTIMATE - Potable Option 2

DESCRIPTION		QUANTITY	UNIT	UNIT PRICE	COST
Potable Water from Okotoks					
1	PVC 500mm	4000	$/m	$ 403	$ 1,613,623
2	PVC 450mm	11700	$/m	$ 357	$ 4,180,803
3	PVC 300mm	14500	$/m	$ 239	$ 3,471,119
4	PVC 250mm	9000	$/m	$ 233	$ 2,095,236
5	PRV Station	1	LS	$ 5,000	$ 5,000
6	Booster Station	2	ea.	$ 350,000	$ 700,000
7	Potable Water Storage Reservoir (4900m3)	1	LS	$ 900,000	$ 900,000
		SUBTOTAL			$ 12,966,000
CONTINGENCY (25%)					$ 3,242,000
ENGINEERING (15%)					$ 2,431,000
			TOTAL		**$ 18,640,000**

MD of Foothills
Hwy 2A Servicing Study

PROJECT COST ESTIMATE - Sanitary Option 1

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
Sanitary Collection System to High River					
1	PVC 600mm - gravity main	1900	$/m	$ 687	$ 1,305,041
2	PVC 525mm - gravity main	6550	$/m	$ 504	$ 3,300,903
3	PVC 375mm - gravity main	4800	$/m	$ 389	$ 1,865,416
4	PVC 250mm - gravity main	7200	$/m	$ 300	$ 2,161,541
5	PVC 550mm - forcemain	1500	$/m	$ 504	$ 755,932
6	PVC 500mm - forcemain	1800	$/m	$ 758	$ 1,363,784
7	PVC 400mm - forcemain	1600	$/m	$ 513	$ 821,545
8	PVC 350mm - forcemain	3500	$/m	$ 220	$ 769,716
9	PVC 100mm - forcemain	4050	$/m	$ 306	$ 1,239,135
10	Lift Station	8	ea.	$ 80,000	$ 640,000
		SUBTOTAL			$ 14,223,000
CONTINGENCY (25%)					$ 3,556,000
ENGINEERING (15%)					$ 2,667,000
			TOTAL		**$ 20,450,000**

PROJECT COST ESTIMATE - Sanitary Option 2

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
Sanitary Collection System to Okotoks					
1	PVC 600mm - gravity main	900	$/m	$ 687	$ 618,177
2	PVC 525mm - gravity main	6550	$/m	$ 587	$ 3,847,337
3	PVC 400mm - gravity main	3500	$/m	$ 447	$ 1,564,500
4	PVC 375mm - gravity main	4850	$/m	$ 389	$ 1,884,848
5	PVC 250mm - gravity main	7100	$/m	$ 300	$ 2,131,520
6	PVC 550mm - forcemain	5200	$/m	$ 587	$ 3,054,374
7	PVC 500mm - forcemain	3500	$/m	$ 758	$ 2,651,802
8	PVC 400mm - forcemain	1600	$/m	$ 513	$ 821,545
9	PVC 100mm - forcemain	3450	$/m	$ 306	$ 1,055,700
10	Lift Station	8	ea.	$ 80,000	$ 640,000
		SUBTOTAL			$ 18,270,000
CONTINGENCY (25%)					$ 4,568,000
ENGINEERING (15%)					$ 3,426,000
			TOTAL		**$ 26,260,000**

PROJECT COST ESTIMATE - Sanitary Option 3

	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST
Sanitary Collection System Joint Servicing					
1	PVC 600mm - gravity main	900	$/m	$ 687	$ 618,177
2	PVC 525mm - gravity main	10300	$/m	$ 587	$ 6,050,011
3	PVC 400mm - gravity main	3500	$/m	$ 447	$ 1,564,500
4	PVC 375mm - gravity main	3900	$/m	$ 389	$ 1,515,651
5	PVC 250mm - gravity main	6800	$/m	$ 300	$ 2,041,456
6	PVC 550mm - forcemain	3800	$/m	$ 587	$ 2,232,043
7	PVC 500mm - forcemain	1800	$/m	$ 758	$ 1,363,784
8	PVC 100mm - forcemain	3450	$/m	$ 306	$ 1,055,700
9	Lift Station	6	ea.	$ 80,000	$ 480,000
		SUBTOTAL			$ 16,921,000
CONTINGENCY (25%)					$ 4,230,000
ENGINEERING (15%)					$ 3,173,000
			TOTAL		**$ 24,320,000**

APPENDIX F

Stormwater Re-use and

Recycling of Treated Wastewater

As water demands increase and readily available supply decreases, water re-use as a whole will become a necessity. This document provides a summary of current and potential water re-use opportunities.

STORMWATER RE-USE

It has been reported that some regulatory guidance documents for stormwater re-use have been developed in Alberta (Marsalek *et al*, 2002) however, no stormwater specific guidance documents from regulators (Alberta Environment) existed at the time of writing this document. It is understood that AENV is in the process of allowing a regulatory requirement through licensing for stormwater re-use (ALIDP, 2009). More details on licensing requirements and stakeholders' consultations are awaited.

A brief overview of the current stormwater re-use around the Calgary Region that could have some potential implications within the study area is presented below.

A survey study was conducted in 2005 in Calgary to residents living around Inverness Park in southeast Calgary (Hwang *et al*, 2006) to attain public perceptions on stormwater re-use. Major highlights of that study are summarized below.

- Stormwater recycling in Canada is currently in the early stages of development, thus initial projects must be implemented with great care as they are likely to affect perceptions of subsequent water re-use projects.

- The City of Calgary is irrigating the linear park with stormwater, while the high public use areas are irrigated with potable water. The City may eventually consider options to irrigate high use areas as well but it is not clear from the study whether the City will continue.

- The study concluded that 71% (98 out of 138 responses) of respondents supported using stormwater for park irrigation and 79% preferred stormwater for park irrigation during water shortages over other sources of water and alternatives.

- A large number of respondents specified that they would support stormwater recycling but want to be provided with constant communication and information on the quality of the water if it is to be used for irrigation.

Other initiatives on stormwater re-use in Alberta and the Calgary Region are summarized below.

- The City of Calgary Water Use Study for major commercial customers identified some customers where rainfall harvesting is practical due to their large roof size and cost-effective on-site storage. However, there were evidences of roof collapse due to heavy snowpack in Calgary in the past. Hence, stormwater re-use from commercial/industrial buildings is still being reviewed.

- The City of Calgary has experience in using stormwater for golf course irrigation and the City plans to use stormwater for irrigation in Coventry Hills and Citadel areas but how and when are still uncertain (City's Environmental Action Plan, 2007).

- The Edmonton Rain Barrel Project began in 2002 and promotes small-scale domestic rainwater harvesting and the associated benefits of storing stormwater.

- The recent proposal to AENV for licensing the stormwater re-use may provide further guidance on regulatory requirements of this initiative. The details of the proposal are not yet available.

- The University of Calgary and the City of Calgary are currently partnering for two graduate level research studies in the Calgary Region to find out the feasibility of stormwater re-use. These studies include: a) rain garden (bio-retention cell) water monitoring project at Currie Barracks in southwest Calgary and a laboratory pilot project at the University of Calgary, and b) investigation of stormwater re-use in the southeast Calgary golf course from Inverness storm pond from a water quality perspective. The preliminary results from the stormwater re-use potential for golf course irrigation have indicated that: a) stormwater ponds not only be used for runoff storage and settling but also as a storage reservoir to irrigate adjoining parks and golf courses, and b) stormwater withdrawal from the storm ponds should be from as close to the surface as possible and in the early morning hours to mitigate the movement of micro-organisms to the park and golf course (ALIDP, 2009).

- A few projects associated with the Leadership in Energy and Environmental Design (LEED), have proposed to incorporate water re-use technologies in the Calgary Region. These include: the Vento Residential Building adjacent to the Bridgeland-Memorial LRT station, and the new City of Calgary Water Centre (25th Avenue SE and Spiller Road). Both these projects plan on re-using stormwater for toilet flushing and irrigation. The stormwater re-use options for these projects are summarized below.

- The City of Calgary Water Centre plans to collect rainwater from the main roof and the green roof, treat the stormwater in on-site bio-retention ponds, and store in an underground cistern to be used for future irrigation needs.

- The Vento Residential Building plans to collect rainwater from the roof and 78% of the parking spaces and store in the rainwater re-use tank.

  If there is more rainwater than the recycled rainwater tank can hold, stormwater will overflow into the stormwater retention tank and then will be discharged to the City's storm system at a controlled flow rate. If there is too little water to meet the building needs, the recycled rainwater tank signals a valve that draws potable water from the municipal system.

Overall, the above initiatives and technologies that are being tested around the Calgary Region have to pass through the regulatory framework, repair and maintenance hassles, design guidelines, feasibility, cold climate adaptability, and sustainability issues in further detail. In order to incorporate these stormwater re-use options and technologies into new developments; national, provincial and municipal governments should take rigorous initiatives in consultation/collaboration with various stakeholders (developers, consultants, vendors, academic institutions) and come up with regulatory guidance documents. Without regulatory policies, these water conservation strategies may be premature.

RECYCLING OF WASTEWATER

Recycled water consists of tertiary treated wastewater for use as irrigation supply and other non-potable uses. Recycling of wastewater as an alternative non-potable water source affects (reduces) water consumption. Further information on recycling of wastewater is provided in Appendix E.

Recycling of wastewater is utilized in a number of areas in North America. Issues that drive the use of recycled wastewater include:

- Water scarcity
- Desire to ease pressure on a water treatment facility,
- Reduce discharge of wastewater into sensitive receiving streams,
- Environmental protection (aquifer recharge or building of wetlands).

Water recycling will further reduce potable water consumption. There is potential for moving forward with water conservation involving piping systems carrying recycled wastewater for non-potable commercial/industrial and irrigation use. These systems are referred to as "purple pipe" systems. Purple pipe use is commonly used in California for recycled water. Water recycling for non-potable household use has not been implemented in Alberta, but there is potential for working with regulatory authorities towards approval to pilot a "purple pipe" community, using tertiary treated wastewater for non-potable household use and irrigation purposes.

Challenges to implementing recycled wastewater for non-potable consumption include:

1. Costs of infrastructure,
2. Concerns of potential cross-contamination to the potable water supply.

AENV currently permits wastewater irrigation in the Province of Alberta. A summary of the requirements is listed below:

- Minimum required treatment is primary treatment with at least 7 months storage or secondary treatment without storage.
- Permitted May 1 to Sept 30 each year.
- 15 m buffer required between other lands and irrigated parcel.
- Setback of 30 m from seasonal watercourses, roads, railways, water wells.
- 60 m setback between irrigated lands and occupied dwellings.
- 30 m setback from surface water bodies.

The setback requirements listed above would be extremely difficult to achieve and onerous to enforce in an urban environment.

AENV has indicated that effluent irrigation within the flood plain or flood fringe would require the same treatment standard as required for direct discharge into the Highwood River.

In Alberta, recycled water is also used industrially for cooling water and process water. This has potential for the Highway 2A industrial/commercial corridor. Saddlebrook has indicated that they will have no use for a non-potable water supply.

The use of recycled wastewater for any other use is not yet permitted in Alberta. Some of the other North American jurisdictions that do permit recycling of wastewater are discussed below.

California Recycled Water Requirements and Uses

In the State of California recycling of wastewater is legislated under California Title 22 Code of Regulations. Recycled wastewater is also known as recycled water and is defined as follows:

Recycled water is tertiary treated water produced from a three-stage treatment of municipal wastewater. Recycled water is allowable for full-body human contact but **not** for direct human consumption.

Title 22 dictates approved treatment technologies, filtration requirements, disinfection requirements and uses. The following quality parameters are required for tertiary treated recycled water:

- Less than 0.5 NTU for turbidity with less than 0.2 NTU for turbidity 5% of the time (for membrane filtration).
- 5 log removal of F-specific bacteriophage MS2.
- Total coliforms shall be less than 2.2/100ml for the 7 day median with further restriction on maximum coliform counts.

Permitted uses for tertiary treated recycled water include:

- Flushing of toilets and urinals;
- Fire fighting;
- Industrial process water that may come into contact with workers;
- Decorative fountains;
- Commercial laundries;
- Artificial snowmaking;
- Commercial car washes;
- Aquifer injection for groundwater recharge and to minimize saltwater intrusion.

Secondary treated recycled water is permitted for uses that include concrete mixing, soil compaction, street cleaning, dust control and other uses.

Treated wastewater for non-potable uses is crucial in a semi-arid area such as California. The quantity of recycled water used for landscape irrigation in California increased from 40,000 acre-feet per year in 1987 to 111,000 acre-feet per year in 2002. Current estimates indicate that the use of recycled water is increasing by 15% per year in the United States.

British Columbia Recycled Water Uses

The Province of British Columbia has policies in place for the use of recycled wastewater for non-potable purposes. Permitted uses include agricultural irrigation use, park irrigation use (including golf courses, snowmaking, fire fighting, and toilet flushing). Secondary treatment of the effluent is required prior to it being permitted for use. Continuous monitoring of the treated effluent quality is required. In Victoria, British Columbia, recycled water will be used for toilet flushing and lawn irrigation in two experimental communities currently under construction. This effluent will be treated to tertiary standards with an MBR system with nutrient removal and UV disinfection to achieve less than 2.2 cfu/100 ml.

SUMMARY

Municipalities are recognizing that raw water for development is a limiting resource. Conservation measures (including reclaimed water through purple pipe systems) could increase the number of units that may be serviced with the limited availability of raw water.