Geo-Logic
ASSOCIATES
Geologists, Hydrogeologists and Engineers

MEMORANDUM

TO: Patrick O'Neill, HDR

FROM: Sarah J. Battelle, Geo-Logic Associates

DATE: September 7, 2010

SUBJECT: **ESTIMATE OF AVAILABLE GROUNDWATER**
TULE WIND PROJECT
EAST SAN DIEGO COUNTY, CALIFORNIA

At your request, this memorandum presents a summary of the water needs identified for the Tule Wind Project construction and the availability of local water, both on site and from adjacent water providers. The data presented herein is based on a site reconnaissance and inquiries made of water suppliers. Construction water supply requirements are provided from discussions with Iberdrola Renewables (IBR), the project proponent.

The project will include the construction of up to 134 wind turbines and associated roads, transmission lines and support facilities. Based on information provided by IBR, the following water requirements have been estimated for the project construction (all work is anticipated to be performed over five-day work weeks):

1. Road Construction – Up to 120,000 gallons per work day will be required over a 72-day construction period. With continuous water storage, 24-hours per day, seven days per week, it is estimated that well production of 59.5 gallons per minute (gpm) will be required to support this work.
2. Turbine Foundation Concrete Mixing – Depending on the turbine, each foundation will require 7,500 to 15,000 gallons of water per foundation. Assuming that two foundations are constructed each day in accordance with the 72-day work schedule; up to 30,000 gallons of water per day would be required. The maximum continuous pumping rate (24-hours per day, seven days per week), required to support concrete mixing for three turbine foundations per day is equivalent to 14.8 gpm.
3. Dust Control – During construction, 50,000 to 100,000 gallons per working day will be required for dust control on project roads. The maximum continuous pumping rate required for dust control would be 49.6 gpm for an estimated nine-month construction period.

As indicated above, it is anticipated that the water supply source will be available 24 hours per day, seven days per week. The contractors on the project will provide temporary water storage to ensure that there is adequate water supply available for required project water needs.

IBR has indicated that there will be some overlap of water uses as the project progresses. The initial road construction alone will be conducted until there is sufficient access to begin turbine foundation construction. At that time, with the combination of road construction, turbine foundation concrete mixing and dust control, the estimated peak water use will be approximately 250,000 gallons per day, requiring continuous pumping of 124 gpm (24-hours per day, seven days per week). This peak water demand will drop quickly after the initial road building activity is completed. Once road construction is complete, the peak water demand level is estimated to be about 130,000 gallons of water per day (equivalent to a 65 gpm pumping rate with pumping 24-hours per day, seven days per week). Once the subsequent 72-day turbine foundation work is complete, water demand will be reduced further to a maximum of 100,000 gallons of water per day (50 gpm of continuous pumping 24-hours per day, seven days per week) for the remainder of the nine month construction period requiring water. Subsequent site work is not expected to require additional groundwater supply. Further, when the Tule Wind Project turbines become operational, only a limited quantity of water will be required, estimated at 2,500 gallons per day to supply the operations and maintenance building services and support staff.

Based on the conservative peak water use requirements of 250,000 gallons per day (associated with road construction, concrete mixing and dust control activities), an estimated continuous supply of water (24-hours per day, seven days per week) will be required from wells pumping at a cumulative continuous rate of 124 gpm. Although there are several wells on the project site, two wells on the project site have been identified as readily available for project use:

1. One well is located on Rough Acres Ranch approximately one to two miles north of Interstate 8 between Ribbonwood Road and McCain Valley Road. Drilled in 2009, data provided on the well log for this well indicates that the estimated well yield is 60 gpm. A 72-hour constant rate aquifer pumping test was performed at this well at 50 gpm utilizing the existing pump. Based on the current preliminary test data, there was very little response from pumping in the adjacent observation well, about 30 feet from the pumping well, and therefore it is reasonable to assume that sustained pumping at 50 gpm, at a minimum can be achieved from this well. Further, with a higher volume pump it may be possible to pump at greater volumes without significant impacts to other adjacent groundwater users;
2. One well is located on the Ewiiaapaayp Reservation, about 7 miles north of Interstate 8 on La Posta Road. A 72-hour constant rate aquifer pumping test was conducted at this well at 80 gpm. Based on the preliminary test results it is reasonable to assume that sustained pumping at 80 gpm is feasible at this well location.

Therefore, based on the preliminary data from two recent pumping tests with a combined total pumping rate of 130 gpm, it is likely that the necessary water supply requirements for the project (124 gpm of continuous pumping, seven days a week) can be met from these two wells.

There are four potential additional water supply sources available for the project. The State Correctional Facility is located about one half mile north of Interstate 8 off of McCain Road. This correctional facility maintains two wells with estimated production of 45 and 65 gpm. The Live Oak Springs Resort located south of Interstate 8 on Old Highway 80 about ¾-mile northwest of the intersection with Highway 94 may provide a source of water supply. This resort (and water company) operates a well that pumps about 40,000 gallons per day (25 to 30 gpm) and maintains a 100,000 gallon pond, and two large tanks with an additional 50,000 gallons of storage capacity. They have committed to providing 40,000 for immediate use and up to 80,000 gallons per day with additional storage tanks (pers. comm., September 8, 2010); equivalent to 28 to 55 gpm. The Jacumba Community Service District (CSD) also has indicated that their well produces 200 gpm and they will commit up to 40,000 gallons per day to the project (pers. comm., September 8, 2010); equivalent to about 28 gpm. Will serve letters from the Live Oak Springs Resort and Jacumba CSD are attached. Finally, the City of El Centro has indicated that they are willing to sell wastewater plant effluent to the project for use during the construction phase.

In summary, as outlined above, the available on-site groundwater can provide the required project water requirements through continuous pumping at a rate of 124 gpm. Current pumping test results indicate at least 130 gpm can be achieved from the two tested wells, and potential greater volumes with a higher volume pump at the Rough Acres Ranch test well. However, with off-site water from the State Correctional Facility, Live Oak Springs Resort, and Jacumba CSD for purchase, an additional 80,000 to 120,000 gallons of water per day, or approximately 55 to 83 gpm of water could be available to support the project water supply needs; ample water for the nine-month construction period. With these additional off-site sources, the combined on-site and off-site water could be equivalent to an estimated 213 gpm could be made available in support of the project. In addition, wastewater plant effluent may be available from the City of El Centro for purchase. It is concluded that there is ample water available from on- and off-site sources to support the project water supply needs.

If you have any questions, please call me at (858) 451-1136.

TULE WIND PROJECT

PRELIMINARY DRAINAGE REPORT

DRAFT

Prepared for:

Iberdrola Renewables, Inc.
1125 NW Couch Street, Suite 700
Portland, Oregon

Prepared by:

HDR Engineering, Inc.
8690 Balboa Avenue, Suite 200
San Diego, California 92123
858-712-8400

September 2010

Table of Contents

1.0 Project Description 1

2.0 Drainage Patterns 5

2.1 Existing Drainage Patterns 5
2.1.1 Tule Creek Basin 5
2.1.2 Bow Willow Creek North 6
2.1.3 Bow Willow Creek South 6
2.1.4 Unnamed Northern Wash 6
2.1.5 Unnamed Eastern Wash 7
2.1.6 Unnamed Western Wash 7
2.1.7 Simmons Canyon 7
2.1.8 Basin 100 and 200 7
2.1.9 Basins 300 to 800 8
2.1.10 Basin 900 and 1000 8
2.1.11 Basin 1100 8
2.1.12 Basin 1200 8
2.2 Proposed Drainage Patterns 9
2.2.1 Tule Creek Basin 9
2.2.2 Bow Willow Creek North 9
2.2.3 Bow Willow Creek South 10
2.2.4 Unnamed Northern Wash Basin 10
2.2.5 Unnamed Eastern Wash Basin 11
2.2.6 Unnamed Western Basin Drainage Pattern 11
2.2.7 Simmons Canyon Basin 12
2.2.8 Basin 100 12
2.2.9 Basin 200 13
2.2.10 Basin 300 13
2.2.11 Basin 400 14
2.2.12 Basin 500 14
2.2.13 Basin 600 15
2.2.14 Basin 700 15
2.2.15 Basin 800 16
2.2.16 Basin 900 16
2.2.17 Basin 1000 17
2.2.18 Basin 1100 17
2.2.19 Basin 1200 17

3.0 Hydrology 19

3.1 Hydrology Methodology 19
3.2 Existing Conditions 19
3.2.1 Universal Unit Hydrograph 19
3.2.2 Rational Method 20
3.3 Proposed Conditions 20

3.3.1 Universal Unit Hydrograph 20
3.3.2 Rational Method 20
3.4 Hydrology Results 21

4.0 Conclusion 22

Tables

Table 2: Hydrology Methodology 19
Table 3: Existing Conditions Hydrology Results, Unit Hydrograph 21
Table 4: Existing Conditions Hydrology Results, Rational Method 21

Figures

Figure 1: Vicinity Map 2
Figure 2: Project Configuration Alternatives 4

Appendices

Appendix A – San Diego County Hydrology Manual Figures
Appendix B – Existing Conditions Hydrology Summary Tables
Appendix C – Existing Conditions CivilD Output
Appendix D – Proposed Conditions Hydrology Summary Tables

Exhibits

Exhibit A – Northern Existing Conditions Drainage Map
Exhibit B – Southern Existing Conditions Drainage Map
Exhibit C –Northern Proposed Conditions Drainage Map
Exhibit D – Southern Proposed Conditions Drainage Map

Executive Summary

The purpose of this Preliminary Hydrology Report is to investigate the hydrologic impacts of developing approximately 573 acres in eastern San Diego County. Results from hydrologic analysis will be included in the Tule Wind Environmental Impact Statement (EIS)/Environmental Impact Report (EIR). Analysis detail is appropriate for an EIR level hydrology study.

This report discusses the methodology and assumptions for the hydrologic analysis performed for the Project. Discussion and comparison of existing and proposed hydrologic conditions identifies qualitative and quantitative Project impacts on local hydrologic conditions.

The hydrologic analysis was completed per the June 2003 *San Diego County Hydrology Manual.* Existing conditions hydrologic modeling was completed. Proposed conditions were determined to be identical within the accuracy of hydrology calculations, therefore, no impacts were identified.

1.0 PROJECT DESCRIPTION

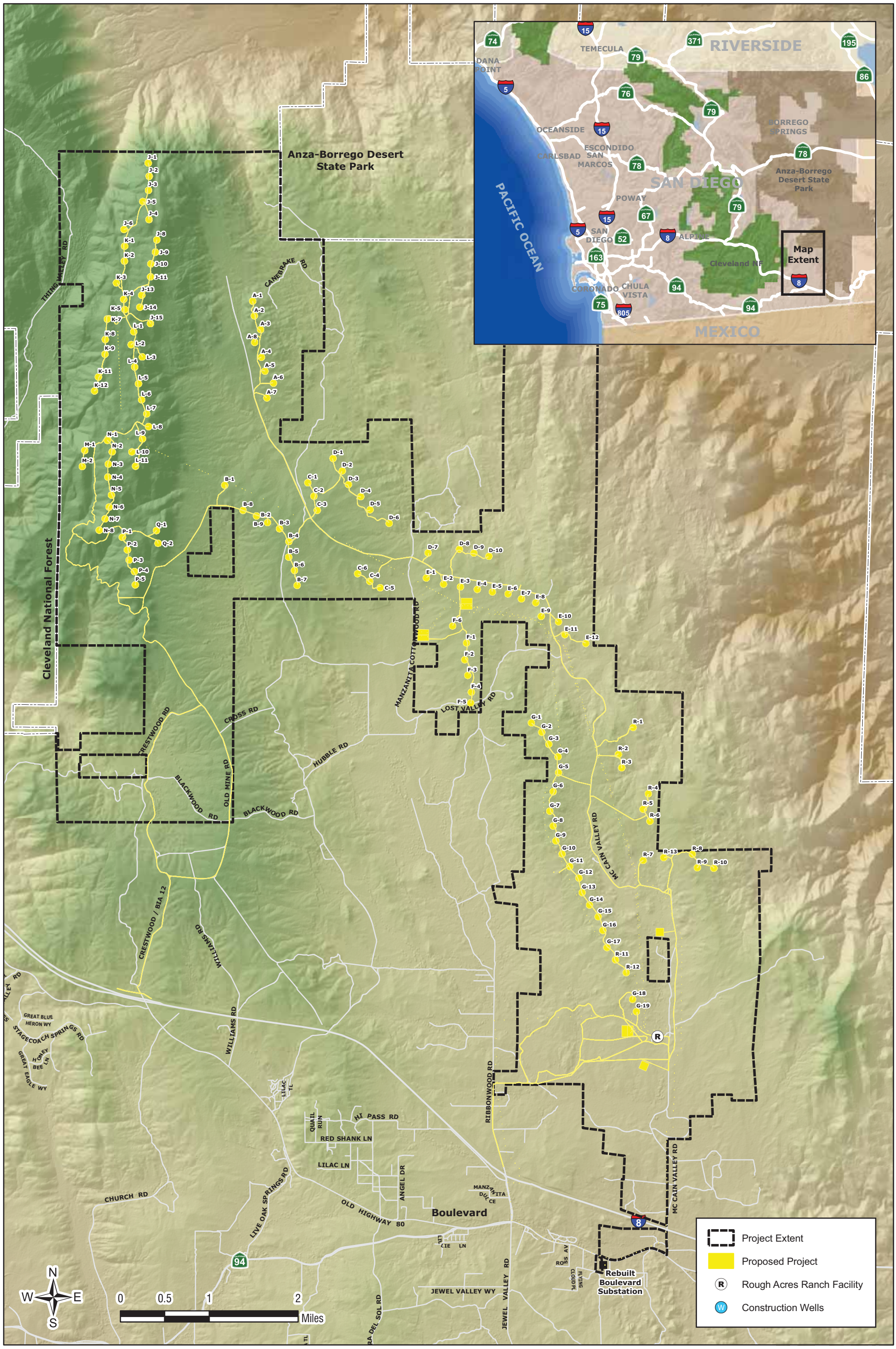
The Tule Wind Project proposes to develop a wind turbine "farm" for power generation, in the County of San Diego in the State of California. The project area is located in the eastern portion of San Diego County, approximately 50 miles east of City of San Diego, 90 miles west of Arizona, and north of the community of Boulevard (see Figure 1). The area is accessible via Interstate 8 (I-8), State Route 94 (SR-94) and Ribbonwood Road junction, and McCain Valley Road off of Old Highway 80. The majority of the project area lies in the In-Ko-Pah Mountains adjacent to the Tecate Divide, south of the Cleveland National Forest. The topography of the area is gently-to-steep sloping with an elevation ranging between about 3,600 and 5,600 feet above mean sea level. The project area contains lands administered by the BLM, the Ewiiaapaayp Reservation, the Campo and Manzanita Reservations (access only), the California State Lands Commission (CSLC), and privately-owned parcels under the jurisdiction of the County of San Diego.

Under existing conditions the Project site is mainly undeveloped naturally vegetated rocky hills. A number of existing access roads traverse the area, providing service routes to existing utility facilities, rural houses, agricultural facilities, and a landing strip. Naturally occurring native vegetation is predominant throughout the site, with periodic scattered unvegetated rock outcroppings.

Development will consist of up to 134 wind turbines, 34.5 kilovolt (kV) overhead and underground collector lines, 138 kV overhead transmission line, 5-acre collector substation site, 5-acre operation and maintenance building site, access road between turbines, improvements to existing roads to provide site access, 5-acre temporary batch plant, 10-acre temporary parking lot, 19 2-acre lay down areas, two meteorological towers, and a sonic detection and ranging system (SODAR) unit. A number of site configuration alternatives have been prepared, which differ by the location of the operation and maintenance facility, substation, and transmission line (see Figure 2). All Project alternatives were evaluated as one development in order to conservatively account for all potential improvements.

Project development proposes up to 134 wind turbines, ranging in size between 328 feet in height to 492 feet in height, to produce 200 megawatts total power. Turbines are constructed with a 48-foot diameter concrete foundation. Concrete foundations slope away from the centrally located turbine and will be buried greater than half a foot, so that exposed concrete foundations are approximately 6-inches to 8-inches thick and 18-feet to 20-feet in diameter. Turbines also include five-foot by nine-foot concrete pads for transformer foundations. Graded dirt pads around the turbines will be approximately 200-feet in radius.

Access roads between turbines will be 36-feet wide to accommodate self propelled cranes and supply trucks, while access roads to the turbine strings will only need to be 24-feet wide, as the crane and other assembly equipment can be brought onsite in pieces. Thirty-six foot access roads between turbines are intended to be temporary for construction activities and will be allowed to revegetate to a 20-foot width, pending construction completion. Roads under San Diego County jurisdiction will revegetate to a 24-foot width to comply with County standards. Proposed access road alignments will follow existing access roads to the maximum extent practicable to limit the amount of additional disturbed areas. New access roads will follow existing contours to maximum extent practicable to limit the amount of disturbed areas resulting from grading cuts.



Vicinity Map

FIGURE 1

Iberdrola | Tule Wind Project

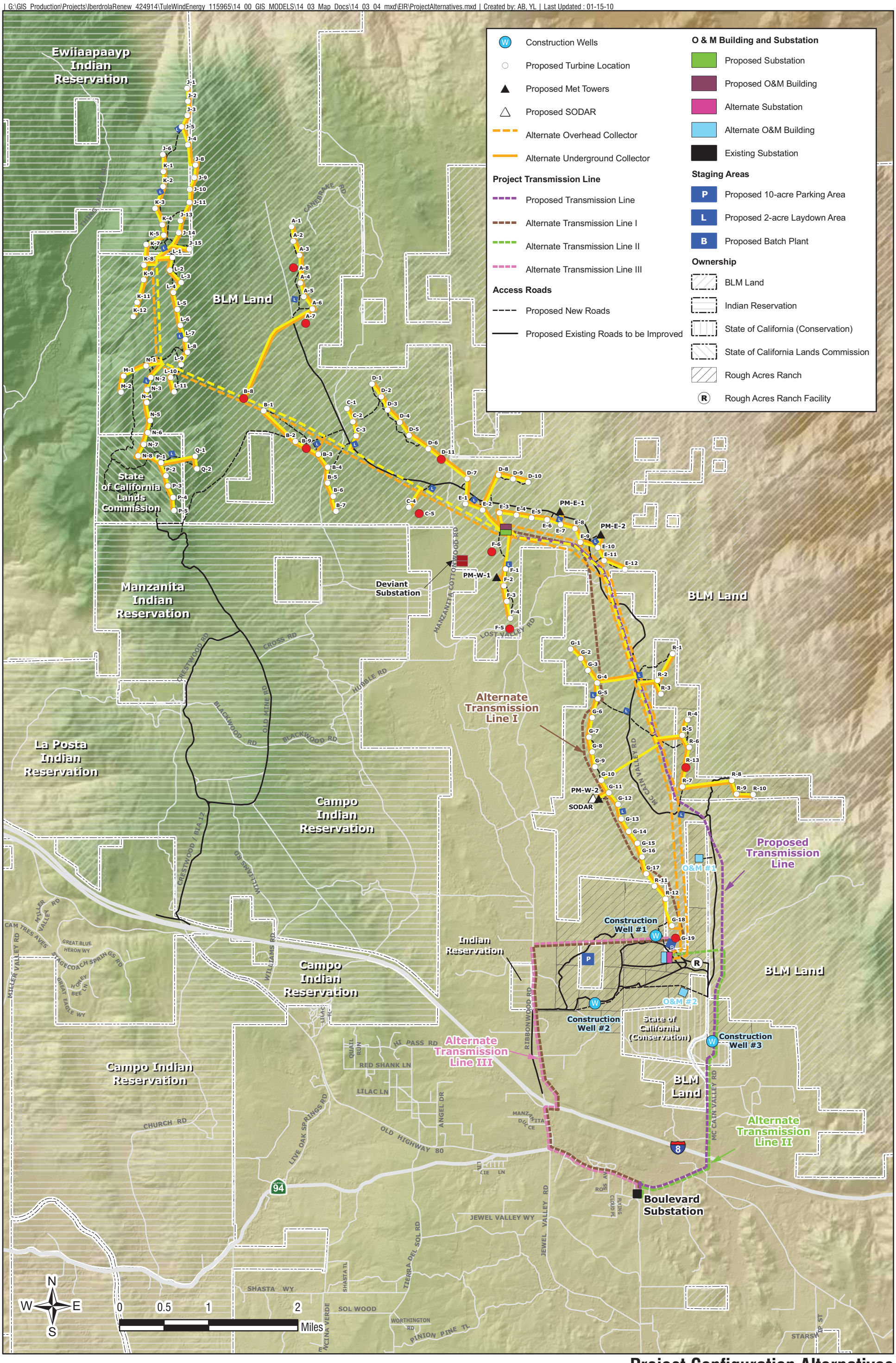
HDR
ONE COMPANY | *Many Solutions*℠

Electrical collector lines for the Project will be a combination of overhead and buried, with a majority being buried. Overhead collector lines will be supported by single steel or wood poles; typically 60-feet to 80-feet in height. Foundation footprints for collector line poles will be similar to the diameter of the pole itself. Collector line temporary disturbed widths are assumed to be 24-feet to allow construction vehicle access and trenching or pole erection. Transmission lines will be carried by approximately 75-foot tall poles spaced 600-feet to 700-feet. Temporary transmission line disturbed areas are assumed to be 24-feet to allow construction vehicle access and pole erection. After construction native vegetation will be established over collector line and transmission line access roads. All buried collector lines will be completely re-vegetated.

Temporary parking lot, batch plant, and lay down areas will be re-vegetated to existing conditions and are not deemed a permanent impact. In addition, all naturally occurring vegetation around proposed grading and facilities will be returned to a naturally vegetated state upon completion of construction activities.

Project development will increase impervious areas by a very small amount. Each turbine pad represents approximately 360 square feet of impermeable area. Overall Project development proposes to increase impervious area by approximately 85,127 square feet or 0.3% for the overall 573 acre site. Permanent Project impacts investigated for drainage are approximately 573-acres, which conservatively assume development of all siting alternatives.

| G:\GIS_Production\Projects\IberdrolaRenew_424914\TuleWindEnergy_115965\14_00_GIS_MODELS\14_03_Map_Docs\14_03_04_mxd\EIR\ProjectAlternatives.mxd | Created by: AB, YL | Last Updated : 01-15-10



Project Configuration Alternatives

FIGURE 2

Iberdrola | Tule Wind Project

HDR
ONE COMPANY | *Many Solutions*℠

2.0 DRAINAGE PATTERNS

Existing and proposed drainage patterns are defined below.

2.1 EXISTING DRAINAGE PATTERNS

A number of existing streams will convey flows generated by the Project. A majority of the Project drains to the east ultimately discharging into the Salton Sea. Approximately one sixth of the Project drains runoff to the west, ultimately discharging into the Pacific Ocean at the Tijuana Estuary.

A northeastern ridgeline crosses the easterly draining portions of the Project, dividing Salton Sea bound flows southwest into Tule Creek and northeast into Carrizo Wash, Bow Willow Creek, and Canebrake Wash. Approximately one third of the Project drains to Tule Creek via McCain Valley and Lark Canyon. Tule Creek flows are conveyed southeast into Tule Lake, which discharges into Tule Canyon, then converges with Carrizo Wash in Carrizo Gorge. Basin No. 100 and 200 drain to Canebrake Wash, a tributary to Vallecito Creek, which conveys flows into Carrizo Wash. All flows in Carrizo Wash are then conveyed into San Felipe Creek and the Salton Sea. The Salton Sea is a minimum of approximately 45 miles downstream of the Project.

Westerly draining flows (Simmons Canyon, Unnamed Western Wash, and Basin No. 300 - 1000) are conveyed into La Posta Creek, which conveys flows into Cottonwood Creek, discharging into Lake Morena. The dam at Lake Morena discharges back into Cottonwood Creek, which then discharges into Barrett Lake. Barrett Lake dam releases flows back into Cottonwood Creek, which discharges into the Tijuana River and into the Pacific Ocean. Cottonwood creek is a natural unconfined stream. Lake Morena is a minimum of approximately 14 miles downstream of the Project.

Southerly draining flow (Basin No. 1100) is conveyed into Miller Creek, which conveys flows into Campo Creek, which then conveys into Tijuana River and into the Pacific Ocean. Both the Miller Creek and Campo Creek are natural streams.

2.1.1 Tule Creek Basin

Tule Creek Basin containing the Project site includes an expansive upstream area draining approximately 18,250 acres and has an approximately 12.1 mile long flow path. The highest upstream point in the basin is at approximately 5,800 feet and the downstream most point is at approximately 3,475feet. Upper reaches of Tule Creek and its tributaries are generally fairly steep and confined to mountainous gullies. Tule Creek in the vicinity of the Project flattens out and takes on the form of a meandering stream in a wider valley with floodplains and flatter fields.

Runoff sheet flows across the ground surface until it encounters rivulets which then discharge into larger streams which ultimately discharge into Tule Creek. Precipitation that falls on typical access roads sheet flows off the side of the road where it is collected either in swales running parallel to the road or sheet flows across the surrounding terrain. Swales carry runoff to streams crossing the access road, where it is then conveyed to Tule Creek. There are no major improvements to the drainage features within the basin. However, a number of culverts have been installed on the northeast portion of the drainage basin to facilitate the construction of access roads across the smaller drainage features. An unnamed tributary to Tule Creek along the northeastern edge of the basin crosses a number of public and private roads via culverts just east of the landing strip. Crossings relevant to this Project include two 36-inch culverts for a private road and one 36-inch culvert for McCain Valley Road. Several access roads utilize a depressed

on grade type crossing, where flows are conveyed across the top of the road, rather than constructing culverts to carry flows under the road. An existing access road crossing Tule Creek within the Project limits near the downstream half of the basin has this type of crossing.

2.1.2 Bow Willow Creek North

Northern portions of the Project site lie within an approximately 2,747 acre basin, having an approximately 4.9 mile long flow path. The highest upstream point in the basin is at approximately 5,620 feet and the downstream most point is at approximately 3,930 feet. Upper reaches of Bow Willow Creek North and its tributaries are generally fairly steep and confined to mountainous gullies. The stream makes its way across a north to south fractured landscape, gaining flow from numerous tributaries. Flow continues generally to the southeast, where it leaves the limits of this study and merges with other washes to form Bow Willow Creek.

Runoff sheet flows across the ground surface until it encounters rivulets which then discharge into larger streams which ultimately discharge into Bow Willow Creek North. Precipitation that falls on typical access roads sheet flows off the side of the road where it is collected either in swales running parallel to the road or sheet flows across the surrounding terrain. Swales carry runoff to streams crossing the access road, where it is then conveyed to natural drainages. There are no major improvements to the drainage features within the basin.

2.1.3 Bow Willow Creek South

Northern portions of the Project site lie within an approximately 5197 acre basin, having an approximately 6.55 mile long flow path. The highest upstream point in the basin is at approximately 5,640 feet and the downstream most point is at approximately 3,410 feet. Upper reaches of Bow Willow Creek South and its tributaries are generally fairly steep and confined to mountainous gullies. The stream makes its way across a north to south fractured landscape, gaining flow from numerous tributaries. Flow continues generally to the southeast, where it leaves the limits of this study and merges with other washes to form Bow Willow Creek.

Runoff sheet flows across the ground surface until it encounters rivulets which then discharge into larger streams which ultimately discharge into Bow Willow Creek South. Precipitation that falls on typical access roads sheet flows off the side of the road where it is collected either in swales running parallel to the road or sheet flows across the surrounding terrain. Swales carry runoff to streams crossing the access road, where it is then conveyed to natural drainages. There are no major improvements to the drainage features within the basin.

2.1.4 Unnamed Northern Wash

Eastern portions of the Project site lie within an approximately 1542 acre basin that drains to an unnamed wash. Basin drainage has a maximum flow path of approximately 2.5 miles, with a maximum elevation of 4156 feet and a minimum elevation of 3765 feet. The Unnamed Northern Wash basin drains to confined mountainous gullies that are steep and rocky.

Drainage patterns are similar to the previously discussed basins; precipitation will sheet flow into small rivulets that will join with surrounding streams and eventually discharge into Carrizo Wash. Roads in the

Unnamed Northern Wash basin are primarily double track trails and do not have any associated drainage improvements.

2.1.5 Unnamed Eastern Wash

Eastern portions of the Project site lie within an approximately 734 acre basin that drains to an unnamed wash. Basin drainage has a maximum flow path of approximately 1.9 miles, with a maximum elevation of 4,125 feet and a minimum elevation of 3,620 feet. The Unnamed Eastern Wash basin drains to confined mountainous gullies that are steep and rocky.

Drainage patterns are similar to the previously discussed basins; precipitation will sheet flow into small rivulets that will join with surrounding streams and eventually discharge into Carrizo Wash. Roads in the Unnamed Eastern Wash basin are primarily double track trails and do not have any associated drainage improvements.

2.1.6 Unnamed Western Wash

Western portions of the Project site lie within an approximately 1440 acre basin that drains to an unnamed wash. Basin drainage has a maximum flow path of 2.06 miles, with a maximum elevation of 4,795 feet and a minimum elevation of 4,140 feet. Upper reaches of Unnamed Western Wash and its tributaries are generally fairly steep and confined to mountainous gullies. The lower reaches are significantly less steep and are crossed numerous times by unimproved dirt tracks. A small earthen impoundment just outside of the study area creates ponding in the extreme lower reach.

Drainage patterns are similar to the previously discussed basins; precipitation will sheet flow into small rivulets that will join with surrounding streams and eventually leave the analyzed portion of the basin and discharge into La Posta Creek. Roads in the Unnamed Western Wash basin are primarily double track trails and do not have any associated drainage improvements.

2.1.7 Simmons Canyon

Western portions of the Project site lie within an approximately 878 acre basin that drains to Simmons Canyon Creek. Basin drainage has a maximum flow path of 2.19 miles, with a maximum elevation of 5,652 feet and a minimum elevation of 4,120 feet. The entire reach of Simmons Canyon and its tributaries are generally fairly steep and confined to mountainous gullies.

Drainage patterns are similar to the previously discussed basins; precipitation will sheet flow into small rivulets that will join with surrounding streams and eventually discharge into La Posta Creek. Roads in the Simmons Canyon basin are primarily double track trails and do not have any associated drainage improvements.

2.1.8 Basin 100 and 200

Basins 100 and 200 are approximately 86 and 375 acres, respectively in size and drain to Canebrake Wash, a tributary of Carrizo Wash. Both generally drain mountainous and rocky terrain to the north of the Project site and have maximum elevations of around 5665 feet.

Drainage patterns are similar to the previously discussed basins; precipitation will sheet into small rivulets, combing with other runoff, into larger and larger flows. These flows confluence into the major drainages of these basins and confluence to the major course of flow for the analyzed basin. There are few current roads in these basins and have no improved drainage features.

2.1.9 Basins 300 to 800

Basins 300 to 800 range in size from 73 to 475 acres and lie west of the Tecate Divide These basins drain western portions of the project area, contributing flows to La Posta Creek. Beginning in confined mountain ravines, these flows meet La Posta Creek in Thing Valley. Basins 300 to 500 are first to join La Posta Creek, and do so within a reach of less than 2000 feet. Basin 600 empties to La Posta Creek 4,500 feet below Basin 500, followed by Basin 700 1200 feet downstream. Basin 800 is the last to directly join La Posta Creek about a mile downstream of Basin 700.

Drainage patterns are similar to the previously discussed basins; precipitation will sheet into small rivulets, combing with other runoff, into larger and larger flows. These flows confluence into the major drainages of these basins and confluence to the major course of flow for the analyzed basin. There are few current roads in these basins and have no improved drainage features.

2.1.10 Basin 900 and 1000

Basins 900 and 100 are approximately 188 and 101 acres, respectively and drain western portions of the Project site. These basins contribute flows to Simmons Canyon Creek, a tributary to La Posta Creek. Both drain mountainous and rocky terrain, with maximum elevations of over 5600 feet. There two systems converge shortly downstream of the studied area, where they flow for approximately 2.5 miles prior to meeting Simmons Canyon Creek. After joining Simmons Canyon, these flows continue another 1.5 miles before joining La Posta Creek.

Drainage patterns are similar to the previously discussed basins; precipitation will sheet into small rivulets, combing with other runoff, into larger and larger flows. These flows confluence into the major drainages of these basins and confluence to the major course of flow for the analyzed basin. There are few current roads in these basins and have no improved drainage features.

2.1.11 Basin 1100

Basin 1100 is 635 acres in size and drains southern portions of the Project site, specifically an alternative access road leading from Interstate-8. The basin has a maximum elevation of 4,580 feet and a flow path of 1.52 miles. The main flow path flows through an open and gently sloped valley. The studied basin terminates upon intersection with Interstate-8, where flows pass via culvert.

Drainage patterns are similar to the previously discussed basins; precipitation will sheet flow into small rivulets that will join with surrounding streams and eventually merge to form the main flow leaving the studied area. Roads in the basin vary from double track trails to improved surface roads.

2.1.12 Basin 1200

A portion of the Project site is located in an approximately 484 acre basin that drains to Carrizo Gorge. The drainage basin has a maximum flow path of 1.5 miles with a maximum elevation of 4,065 feet and a minimum elevation of 3,200 feet. A ridge divides the basin into a northern and southern portion, each draining into two respective streams. Both streams then join at a confluence at the bottom of the drainage basin, as shown on Exhibit A. Topography for Basin 1200 is mountainous with streams confined in steep gullies.

Generally, drainage is similar to the Unnamed Basin East and other easterly draining basins; Rainfall sheet flows into rivulets and then into larger streams. Terrain is predominantly rocky and steep and will not provide substantial opportunity for infiltration. There are an extremely limited number of roads in the basin; most are single track trails. There are no existing improvements to the drainage features in the basin, given the limited amount of development in the basin.

2.2 PROPOSED DRAINAGE PATTERNS

Proposed Project improvements will aim to mimic existing drainage patterns and will minimize redirection of any flows. Improvements include graded pads, access roads, utility lines, and engineered crossings at each drainage feature. Project improvements propose minimal additional impervious areas. Any increase in runoff resulting from these impacts is assumed to be negligible, from a flood impact standpoint, with water quality impacts addressed in the Storm Water Management Plan published under a separate cover by HDR.

2.2.1 Tule Creek Basin

Tule Creek Basin drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 1.4% of the area. Existing drainage patterns within the basin will be substantially maintained.

Access roads will be improved or created throughout the basin connecting multiple strings of turbines. McCain Valley road serves as a central corridor for this access. Drainage of access roads will be facilitated by brow ditches/swales parallel to proposed roads, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 45,559 square feet impervious areas or 0.006% of basin total area). Impervious areas include the area of 49 turbine pads, 4 operational and maintenance (O&M) facilities, and 2 substations. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located mainly in the northeastern corner of the basin. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.2 Bow Willow Creek North

Bow Willow Creek North drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 1.2% of the area. Existing drainage patterns within the basin will be substantially maintained.

Two main roads are proposed to provide access to two strings of turbines. One parallels McCain Valley Road and the other is to follow the ridge on the western edge of the basin. Drainage of access roads will

be facilitated by brow ditches/swales parallel to proposed roads, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 3,412 square feet impervious areas or 0.003% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 9.5 turbine pads (some pads are located on basin boundaries). Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located mainly in the western and center of the basin, following the two strings of turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.3 Bow Willow Creek South

Bow Willow Creek South drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 1.6% of the area. Existing drainage patterns within the basin will be substantially maintained.

Access roads connect multiple strings of turbines, mainly to the west and south, roughly along the present course of McCain Valley Road. Drainage of access roads will be facilitated by brow ditches/swales parallel to proposed roads, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 7,902 square feet impervious areas or 0.003% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 22 turbine pads. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located mainly in the western and southern portions of the basin, connecting the strings of turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.4 Unnamed Northern Wash Basin

Unnamed Northern Wash Basin drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 4.0% of the area. Existing drainage patterns within the basin will be substantially maintained.

Access roads connect multiple strings of turbine, mainly along the northern and western boundaries. As with most of the east basins, McCain Valley Road serves as the main corridor to which strings of turbines connect. Drainage of access roads will be facilitated by brow ditches/swales parallel to proposed roads, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 13,669 square feet impervious areas or 0.02% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 13 turbine pads, 1 O&M facility and 1 substation. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines and the substation. Transmission lines leaving the substation are also proposed. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.5 Unnamed Eastern Wash Basin

Unnamed Eastern Wash Drainage Basin drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 2.8% of the area. Existing drainage patterns within the basin will be substantially maintained.

Access roads connect two strings of turbines, located roughly in the center of the basin. These connect to McCain Valley Road. Drainage of access roads will be facilitated by brow ditches/swales parallel to proposed roads, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 1,796 square feet impervious areas or 0.006% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 5 turbine pads. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines. Transmission lines traverse the basin. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.6 Unnamed Western Basin Drainage Pattern

Unnamed Western Wash Drainage Basin drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements

taking up less than 0.68% of the area. Existing drainage patterns within the basin will be substantially maintained.

Two existing access roads cross the site, North to South, and represent the only project improvements in the basin. There are no turbines, facilities, or transmission lines located in this basin. Precipitation falling on the exposed portions of the roads will sheet flow off the roads as under current conditions and flow into surrounding brow ditches/swales.

2.2.7 Simmons Canyon Basin

Simmons Canyon Basin drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 2.6% of the area. Existing drainage patterns within the basin will be substantially maintained.

Access roads connect two strings of turbines, located in the northern portion of the basin. Two other access roads cross the basin to the south. Drainage of access roads will be facilitated by brow ditches/swales parallel to proposed roads, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 1,975 square feet impervious areas or 0.005% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 5.5 turbine pads. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.8 Basin 100

Basin 100 drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 7.4% of the area. Existing drainage patterns within the basin will be substantially maintained.

Access roads connect a single string of turbines, located in the western edge of the basin. Drainage of access roads will be facilitated by brow ditches/swales parallel to proposed roads, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 718 square feet impervious areas or 0.019% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 2 turbine pads. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be

directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.9 Basin 200

Basin 200 drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 2.9% of the area. Existing drainage patterns within the basin will be substantially maintained.

Access roads connect a single string of turbines, located in the eastern edge of the basin. Drainage of this access road will be facilitated by brow ditches/swales parallel to proposed roads, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 1,275 square feet impervious areas or 0.008% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 3.5 turbine pads. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.10 Basin 300

Basin 300 drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 7.1% of the area. Existing drainage patterns within the basin will be substantially maintained.

Access roads connect two strings of turbines, located in the center and eastern edge of the basin. Drainage of access roads will be facilitated by brow ditches/swales parallel to proposed roads, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 1,975 square feet impervious areas or 0.019% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 5.5 turbine pads. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.11 Basin 400

Basin 400 drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 1.5% of the area. Existing drainage patterns within the basin will be substantially maintained.

A single access road connects one turbine located on the basin boundary. Drainage of this access road will be facilitated by brow ditches/swales parallel to the proposed road, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 180 square feet impervious areas or 0.006% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 0.5 turbine pads. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.12 Basin 500

Basin 500 drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 6.6% of the area. Existing drainage patterns within the basin will be substantially maintained.

Access roads connects two strings of turbines located though the center and on the basin's eastern boundary. Drainage of these access roads will be facilitated by brow ditches/swales parallel to proposed roads, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 1,257 square feet impervious areas or 0.015% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 3.5 turbine pads. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or

buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.13 Basin 600

Basin 600 drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 2.3% of the area. Existing drainage patterns within the basin will be substantially maintained.

A single access road connects one string of turbines located on the basin's eastern boundary. Drainage of this access road will be facilitated by brow ditches/swales parallel to the proposed road, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 359 square feet impervious areas or 0.005% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 1 turbine pad. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.14 Basin 700

Basin 700 drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 3.6% of the area. Existing drainage patterns within the basin will be substantially maintained.

A single access road connects one string of turbines located on the basin's eastern boundary. Drainage of this access road will be facilitated by brow ditches/swales parallel to the proposed road, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 539 square feet impervious areas or 0.01% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 1.5 turbine pads. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.15 Basin 800

Basin 800 drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 4.9% of the area. Existing drainage patterns within the basin will be substantially maintained.

Multiple access roads connect strings of turbines located on the basin's northern, eastern, and southern boundary. Drainage of these access roads will be facilitated by brow ditches/swales parallel to proposed roads, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 2,155 square feet impervious areas or 0.01% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 6 turbine pads. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.16 Basin 900

Basin 900 drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 7.9% of the area. Existing drainage patterns within the basin will be substantially maintained.

A single access road connects one string of turbines located on the basin's northern boundary. Drainage of this access road will be facilitated by brow ditches/swales parallel to the proposed road, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 359 square feet impervious areas or 0.004% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 1 turbine pad. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.17 Basin 1000

Basin 1000 drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 1.8% of the area. Existing drainage patterns within the basin will be substantially maintained.

A single access road connects one string of turbines located on the basin's northern boundary. Another access road traverses the basin north to south through the center. Drainage of these access roads will be facilitated by brow ditches/swales parallel to proposed roads, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 1,257 square feet impervious areas or 0.028% of basin total area) to surrounding brow ditches/swales. Impervious areas include the area of 3.5 turbine pads. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

2.2.18 Basin 1100

Basin 1100 drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 5.2% of the area. Existing drainage patterns within the basin will be substantially maintained.

A single access road connects traverses the basin from north to south, roughly in the center. The road is to be improved, but currently exists. Drainage of this access road will be facilitated by brow ditches/swales parallel to the road, which will convey flows to existing surface drainage features, as it does currently. There are no turbines, facilities, or transmission lines located in this basin.

2.2.19 Basin 1200

Basin 1200 drainage patterns will not be altered significantly in proposed conditions. Almost all flow generated by the basin is from existing areas with proposed improvements taking up less than 1.3% of the area. Existing drainage patterns within the basin will be substantially maintained.

A single access road connects one string of turbines located on the basin's northern boundary. Drainage of this access road will be facilitated by brow ditches/swales parallel to the proposed road, which will convey flows to existing surface drainage features.

Precipitation falling on the exposed portions of the turbine pads will sheet flow off the proposed features and finished surfaces (a total of roughly 718 square feet impervious areas or 0.003% of basin total area)

to surrounding brow ditches/swales. Impervious areas include the area of 2 turbine pads. Runoff from exposed turbine pads will drain through a layer of gravel surrounding each pad. Runoff will then be directed into the surrounding existing natural drainage features, with overall flow patterns intended to mimic existing drainage features.

Proposed collector lines will be located in conjunction with the turbines. Minor effects on drainage patterns will only be prevalent during construction. Once the collector lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions. In the long term, existing drainage patterns within the basin will be maintained.

3.0 HYDROLOGY

Hydrologic analysis was completed for the entire project area in order to determine a baseline existing condition and to account for changes due to proposed development. The three distinct watersheds dividing the project area were studied for existing and proposed conditions. Sub-basins formed by grading and requiring a hydraulically designed road crossing structure were analyzed under proposed conditions.

3.1 HYDROLOGY METHODOLOGY

Existing and proposed hydrology calculations were both completed per the *San Diego County Hydrology Manual*, June 2003 Rational Method criteria. A summary of the hydrology criteria is presented in Table 2. Appendix A contains *County of San Diego Hydrology Manual* runoff coefficient, rainfall intensity, and overland flow time of concentration figures used in calculations.

Table 1: Hydrology Methodology

Land Use:	SANDAG provided land use overlay dated 2009 and associated cover descriptions in Table 4-2 of 2003 *County of San Diego Hydrology Manual.*
Precipitation Zone Number	Per PZN Map (Appendix C) of 2003 *County of San Diego Hydrology Manual.*
Design Storm:	100 year.
Rainfall Intensity:	Per Isopluvial Maps (Appendix B) of 2003 *County of San Diego Hydrology Manual.*
Soil Data:	NRCS, SSURGO Database
Topographic Data:	2' Project Flown Contours 20' IFSAR Topo provided by SANDAG

Land use was defined based on data provided by SANDAG, which was then used to select the runoff coefficient from Table 4-2 of the *County of San Diego Hydrology Manual*. Soil type data was derived from the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) Database for California. Rainfall intensities and Precipitation Zone Numbers (PZN) were taken from Appendices B and C of the *County of San Diego Hydrology Manual*, respectively.

ArcMap 9.3.1 was utilized to process all geographic data and to determine appropriate inputs for hydrologic modeling. Existing and proposed drainage basins, flow paths and basin area centroids were all developed within ArcMap. The hydrologic modeling was completed through the use of Civil Design Hydrology software (CivilD) and the San Diego County specific module.

3.2 EXISTING CONDITIONS

3.2.1 Universal Unit Hydrograph

The Universal Unit Hydrograph Method was used to analyze all nodes with basins larger than 640 acres. Basin areas, flow path lengths and length to centroid values were all determined using ArcMap.

Area averaged rainfall intensities were determined for each individual basin for the 100-year 24-hour and 100-year 6-hr events. Precipitation zone numbers (PZN), important in San Diego County's method for curve number adjustment, were interpolated for each basin using the basin area centroid.

An area averaged composite runoff curve number (CN) was determined for each basin through tabulating data for combinations of land use and soil type. Land use information was matched to the cover descriptions assigned in the *County of San Diego Hydrology Manual,* Table 4-2 and were verified through site visits. Curve numbers were manually adjusted per Tables 4-6 and Table 4-10 of the *County of San Diego Hydrology Manual*, using the interpolated PZN values.

Basin lag time was entered into CivilD directly and calculated independently using the United States Army Corps of Engineers (Corps lag) empirical equation, as referenced in *County of San Diego Hydrology Manual*.

Separate hydrologic models were created for the 100-year 24-hour and 100-year 6-hr events, with the intent of determining the maximum peak discharge of the two.

3.2.2 Rational Method

The San Diego County 2003 Rational Method program within CivilD was utilized in calculating runoff for all basins smaller than 640 acres in size. Initial areas and basin subareas were developed within ArcMap per the *County of San Diego Hydrology Manual*.

The 6-hr and 24-hour rainfall intensities were determined through the interpolation of isopluvial information using the basin area centroid.

Land use development type was assumed to be low density residential, specifically, one density unit per acre or less, with an impervious fraction of 10%. Per the *County of San Diego Hydrology Manual* this is the land use type to be used for open undeveloped areas. Soil type data was again derived from the NRCS SSURGO Database and analyzed for each basin subarea for model input.

3.3 PROPOSED CONDITIONS

3.3.1 Universal Unit Hydrograph

Identical methods and assumptions were made for proposed conditions Unit Hydrograph analysis. Disturbed areas due to proposed conditions were assumed to be bare earth for the cover description. Composite curve numbers were recalculated to account for proposed conditions. It was determined that the PZN adjusted curve numbers for input into CivilD were within rounding error of the existing condition curve numbers and therefore proposed conditions results did not vary from existing conditions results (see Appendix D). As stated in the Section 1.0 Project Description, drainage analysis conservatively included the cumulative proposed impacts from multiple alternatives. This is a further indication that actual differences between existing and proposed conditions are even closer than the rounding errors determined in this study, and again indicating that drainage patterns within the Project area will be maintained. See Appendices B and D to review existing and proposed summaries.

3.3.2 Rational Method

Identical methods and assumptions were made for proposed conditions Rational Method analysis. Existing conditions assumed a land use development type of low density residential, specifically, one density unit per acre or less, with an impervious fraction of 10%. Proposed conditions would not

increase developed density or impervious fraction past the 10% threshold, and therefore proposed condition results would not vary from existing conditions results. Existing drainage patterns within the Project area will be maintained.

3.4 HYDROLOGY RESULTS

Existing condition hydrology results are summarized for each major drainage basin/system in Table 3 and Table 4. Per *County of San Diego Hydrology Manual* methodology, inputs for modeling proposed conditions did not vary from existing conditions. As such existing and proposed runoff was identical. Due to small overall project footprint, even smaller impervious area increases, and the imprecise nature of current hydrologic modeling, this conclusion is justified. See Appendix C for CivilD output.

Table 2: Existing Conditions Hydrology Results, Unit Hydrograph

Basin	Area (acres)	Adjusted PZN (>35yr)	Adjusted CN (>35yr)	Peak Flow (cfs)
Tule Creek	18250	2.58	82	12730
Bow Willow Creek North	2747	2.63	90	3058
Bow Willow Creek South	5197	2.60	88	8127
Northern Unnamed Wash	1542	2.49	83	1428
Eastern Unnamed Wash	734	2.45	85	808
Western Unnamed Wash	1440	2.70	80	2052
Simmons Canyon	878	2.77	89	1684

Table 3: Existing Conditions Hydrology Results, Rational Method

Basin / System	Area (acres)	Effective C Value	Discharge (cfs)
100	86.22	0.36	138.5
200	375.45	0.384	736.254
300	241.52	0.358	239.447
400	73.46	0.372	195.488
500	191.71	0.365	320.324
600	164.61	0.345	412.396
700	122.03	0.342	295.442
800	475.25	0.351	710.737
900	188.92	0.355	336.506
1000	101.85	0.36	200.22
1100	635.56	0.315	759.278
1200	485.64	0.393	422.228

4.0 CONCLUSION

Based on a preliminary investigation of the proposed Project plan and the existing drainage patterns, impacts from proposed development are less than significant. Project development will not significantly affect existing drainage patterns and the amount of redirected flows will be minimal. Increases in runoff resulting from low frequency storm events associated with flooding will be less than significant, due to the limited amount of proposed impervious area.

Additional hydrologic and hydraulic analysis will be completed for the Project to determine flow rates at specific locations within the studied basins in order to size proposed drainage facilities. .

APPENDIX A – Hydrology Exhibits

Exhibits A-1: Soils

Exhibits A-2: Land Use

Legend

Flowpaths

Basin Boundary

Hydrologic Soil Group

A

B

C

D

Hydrologic Soil Group "D" was used for Unit Hydrograph analysis in this area.

System 100
86.2 Acres

System 200
375.5 Acres

System 300
241.5 Acres

System 400
73.5 Acres

System 500
191.7 Acres

Bow Willow Creek North
2746.9 Acres

System 600
164.6 Acres

System 700
122 Acres

System 800
475.2 Acres

Bow Willow Creek South
5197.4 Acres

System 1000
101.8 Acres

System 900
188.9 Acres

Simmons Canyon
877.8 Acres

Unnamed Northern Wash
1541.6 Acres

Unnamed Western Wash
1439.9 Acres

Unnamed Eastern Wash
734.4 Acres

Tule Creek
18250.1 Acres

0.6 Acres

211.8 Acres

System 1200

272.6 Acres

0.6 Acres

System 1100
635.6 Acres

N

W

E

S

0 0.25 0.5 1 Miles

| Path: G:\GIS Production\Projects\IberdrolaRenew 424914\TuleWindEnergy_1159651\14 00 GIS MODELS\14 03 Map Docs\14 03 04 mxd\WaterQuality\Exhibits\EIR EIS Exhibits 08312010\Exhibit A1 Soils Map.mxd | Created by: SMargolis | Last Updated: 09-01-10

HDR
ONE COMPANY | *Many Solutions*™

Soils Map

EXHIBIT A1

Tule Wind Project | Preliminary EIR EIS Drainage Report

Legend

- Flowpaths
- Basin Boundary

Landuse

- Airstrip
- Casino
- Communications and Utilities
- Elementary School
- Field Crops
- Fire/Police Station
- Freeway
- Hotel/Motel (Low-Rise)
- Junkyard/Dump/Landfill
- Lake/Reservoir/Large Pond
- Landscape Open Space
- Mobile Home Park
- Open Space Park or Preserve
- Other Group Quarters Facility
- Other Health Care
- Other Public Services
- Other Recreation - High
- Other Retail Trade and Strip
- Other Transportation
- Railroad Right of Way
- Religious Facility
- Residential Under Construction
- Road Right of Way
- Single Family Detached
- Single Family Residential Without Units
- Spaced Rural Residential
- Vacant and Undeveloped Land

System 100
86.2 Acres

System 200
375.5 Acres

System 300
241.5 Acres

System 400
73.5 Acres

System 500
191.7 Acres

System 600
164.6 Acres

System 700
122 Acres

System 800
475.2 Acres

System 900
188.9 Acres

System 1000
101.8 Acres

Bow Willow Creek North
2746.9 Acres

Bow Willow Creek South
5197.4 Acres

Simmons Canyon
877.8 Acres

Unnamed Northern Wash
1541.6 Acres

Unnamed Western Wash
1439.9 Acres

Unnamed Eastern Wash
734.4 Acres

Tule Creek
18250.1 Acres

System 1100
635.6 Acres

System 1200
485.6 Acres

N
W E
S

0 0.25 0.5 1
Miles

| Path: G:\GIS Production\Projects\IberdrolaRenew_424914\TuleWindEnergy_115965\14 00 GIS MODELS\14 03 Map Docs\14 03 04 mxd\WaterQuality\Exhibits\EIR EIS Exhibits 08312010\Exhibit A2 Landuse Map.mxd | Created by: SMuppala | Last Updated: 08-31-10

HDR
ONE COMPANY | *Many Solutions*™

Landuse Map

EXHIBIT A2

Tule Wind Project | Preliminary EIR EIS Drainage Report

APPENDIX B – Existing Conditions Hydrology Summary Tables

Project: Tule Wind
Subject: Drainage Report
Task: 21
Job#: 115965
No: Rev 1

Existing Conditions, Unit Hydrograph

Watershed Loss

Watershed	A (mi^2)	A (ac)	CN (AMC II)	PZN	PZN (>35yr)	CN (>35yr)	Soil Type
Tule Creek	28.52	18250	74	3.42	2.58	82	2.1
Bow Willow Creek North	4.29	2747	84	3.37	2.63	90	3.3
Bow Willow Creek South	8.12	5197	81	3.40	2.60	88	3.0
Northern Unnamed Wash	2.41	1542	76	3.51	2.49	83	2.1
Eastern Unnamed Wash	1.15	734	80	3.55	2.45	85	2.7
Western Unnamed Wash	2.25	1440	69	3.30	2.70	80	2.0
Simmons Canyon	1.37	878	80	3.23	2.77	89	2.5

Watershed Lag Time

Watershed	Elev US (ft)	Elev DS (ft)	L (mi)	Lca (mi)	Slope (ft/mi)	Basin n	m	lag (hr)
Tule Creek	5802.5	3473	12.13	5.14	192	0.040	0.38	1.70
Bow Willow Creek North	5620	3930	4.91	2.33	344	0.040	0.38	0.80
Bow Willow Creek South	5642	3410	6.55	2.65	341	0.040	0.38	0.94
Northern Unnamed Wash	4156	3765	2.51	0.83	156	0.040	0.38	0.49
Eastern Unnamed Wash	4125	3620	1.91	0.74	265	0.040	0.38	0.38
Western Unnamed Wash	4795	4140	2.06	0.43	318	0.040	0.38	0.31
Simmons Canyon	5652	4120	2.19	0.79	701	0.040	0.38	0.34

Precipitation Data

Watershed	100Yr 6Hr	100Yr 24Hr
Tule Creek	3.36	6.41
Bow Willow Creek North	3.26	6.43
Bow Willow Creek South	3.37	9.70
Northern Unnamed Wash	3.00	6.31
Eastern Unnamed Wash	3.00	5.40
Western Unnamed Wash	3.92	5.01
Simmons Canyon	4.12	8.00

$$lag = 24n\left(\frac{L \bullet L_{ca}}{S^{0.5}}\right)^{m}$$

Hydrology Results (Civil D), cfs

Watershed	100Yr 6Hr	100Yr 24Hr
Tule Creek	8790.33	12729.94
Bow Willow Creek North	3058.28	2843.87
Bow Willow Creek South	5059.61	8126.84
Northern Unnamed Wash	1328.54	1428.08
Eastern Unnamed Wash	808.32	597.93
Western Unnamed Wash	2051.85	909.54
Simmons Canyon	1683.55	1240.35

Project: Tule Wind
Subject: Drainage Report
Task: 21
Job#: 115965 No: Rev 1

Existing Conditions, Rational Method

System	Leg (HDR Node to HDR Node)	Acres	Reach Length	US Elevation	DS Elevation	Soil Group	Soil Group Fraction	Precip 100Yr-6Hr	Precip 100Yr-24Hr	100 Year Runoff
100	Initial Area	0.09	76.2	5664.0	5644.0	C	1.00	3.53	7.84	138.5
	100.2 to 100.3	3.96	456.0	5644.0	5557.0	C	1.00			
	100.3 to 100.4	38.30	2269.6	5557.0	5380.0	C	1.00			
	100.4 to 100.5	43.87	2897.5	5380.0	4272.0	C	1.00			
	Total Basin Area	86.22								
200	Initial Area	0.10	68.1	5677.0	5665.4	C	1.00	3.75	8.60	736.3
	200.2 to 200.3	5.00	639.0	5665.4	5460.0	C	1.00			
	200.3 to 200.4	58.69	2637.2	5460.0	4797.3	C	0.89			
						D	0.11			
	200.4 to 200.5	311.66	3957.3	4797.3	3885.0	A	0.03			
	Total Basin Area					B	0.04			
						C	0.29			
						D	0.65			
300	Initial Area	0.04	44.6	5636.0	5623.5	C	1.00	3.82	8.82	239.45
	300.2 to 300.3	3.70	772.3	5623.5	5460.0	C	1.00			
	300.3 to 300.4	70.36	2622.1	5460.0	5347.3	C	1.00			
	300.4 to 300.5	167.42	3682.2	5347.3	4840.0	A	0.11			
	Total Basin Area	241.52				C	0.75			
						D	0.14			
400	Initial Area	0.04	75.2	5513.5	5501.0	C	1.00	3.98	9.31	195.5
	400.2 to 400.3	8.45	739.5	5501.0	5346.8	C	1.00			
	400.3 to 400.4	64.98	1933.8	5346.8	4800.0	A	0.11			
	Total Basin Area	73.46				C	0.41			
						D	0.48			
500	Initial Area	0.07	71.9	5535.0	5529.5	C	1.00	4.06	9.44	320.3
	500.2 to 500.3	17.34	1056.7	5529.5	5491.5	B	0.24			
						C	0.76			
	500.3 to 500.4	59.58	2216.7	5491.5	5361.5	B	0.03			
						C	0.97			
	500.4 to 500.5	114.72	2975.1	5361.5	4800.0	A	0.09			
	Total Basin Area	191.71				C	0.53			
						D	0.39			
600	Initial Area	0.06	69.4	5666.7	5656.0	C	1.00	4.24	10.00	412.4
	600.2 to 600.3	7.27	749.7	5656.0	5480.5	C	1.00			
	600.3 to 600.4	157.28	2981.0	5480.5	4740.0	B	0.48			
	Total Basin Area	164.61				C	0.44			
						D	0.08			
700	Initial Area	0.04	85.6	5566.0	5558.0	C	1.00	4.27	9.95	295.4
	700.2 to 700.3	4.61	671.7	5558.0	5292.3	C	1.00			
	700.3 to 700.4	117.37	2270.0	5292.3	4740.5	B	0.46			
	Total Basin Area	122.03				C	0.54			
800	Initial Area	0.09	71.7	5675.0	5658.5	C	1.00	4.19	9.56	710.7
	800.2 to 800.3	3.46	759.0	5658.5	5519.3	C	1.00			
	800.3 to 800.4	35.24	2005.0	5519.3	5451.8	C	1.00			
	800.4 to 800.5	286.60	2536.5	5451.8	5341.8	B	0.13			
						C	0.87			
	800.5 to 800.6	149.86	3795.3	5341.8	4670.0	B	0.47			
	Total Basin Area	475.25				C	0.53			
900	Initial Area	0.06	76.5	5646.5	5634.8	C	1.00	4.25	9.55	336.5
	900.2 to 900.3	6.99	788.8	5634.8	5455.7	C	1.00			
	900.3 to 900.4	74.82	2298.3	5455.7	5217.5	B	0.10			
						C	0.90			
	900.4 to 900.5	107.05	3731.4	5217.5	4931.7	B	0.14			
	Total Basin Area	188.92				C	0.86			
1000	Initial Area	0.04	74.9	5684.0	5674.5	C	1.00	4.32	9.76	200.2
	1000.2 to 1000.3	10.59	1283.0	5674.5	5350.0	C	1.00			
	1000.3 to 1000.4	91.22	3982.2	5350.0	4927.5	C	1.00			
	Total Basin Area	101.85								
1100	Initial Area	0.15	76.5	4580.0	4570.8	B	1.00	3.76	7.38	759.3
	1100.2 to 1100.3	26.79	1661.7	4570.8	4441.0	B	1.00			
	1100.3 to 1100.4	278.62	2733.0	4441.0	4230.3	A	0.12			
						B	0.87			
						C	0.01			
	1100.4 to 1100.5	330.00	3542.3	4230.3	4140.0	A	0.15			
	Total Basin Area	635.56	8013.5			B	0.83			
						C	0.03			
						D	0.02			
1200	Initial Area	0.63	307.19	4047.50	4025.00			3.00	5.05	422.2
	1200.2 to 1200.5	211.79	7965.33	4025.00	3200.0	A	0.07			
						B	0.13			
						D	0.80			
	Initial Area	0.6	203.19	3965.00	3935.00					
	1200.4 to 1200.5	272.62	6390.38	3935.00	3200.0	A	0.04			
	Total Basin Area	485.64				B	0.12			
						D	0.84			

APPENDIX C – Existing Conditions CivilD Output

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: tule100yr6hr.out

++

Program License Serial Number 4055

Tule Wind Project
Tule Creek
Existing 100 Year 6 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
18250.00	3.36

Rainfall Distribution pattern used in study:
Type B for SCS (small dam) or San Diego 6 hour storms

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
18250.00	1.000	82.0	82.0	0.050	B

Area-averaged catchment SCS Curve Number AMC(2) = 81.960
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   18250.00(Ac.)
Catchment Lag time =   1.700 hours
Unit interval = 15.000 minutes
Unit interval percentage of lag time = 14.7059
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 81.960

Rainfall depth area reduction factors:
Using a total area of   18250.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 0.974
Rainfall entered for study =   3.360(In)
Adjusted rainfall =   3.272(In)

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

(K = 73608.33 (CFS))

0.15	0.250	0.016	179.694	0.002
0.29	0.500	0.051	575.802	0.010
0.44	0.750	0.117	1315.646	0.028
0.59	1.000	0.256	2889.871	0.067
0.74	1.250	0.632	7133.846	0.164
0.88	1.500	0.934	10536.976	0.307
1.03	1.750	1.000	11283.813	0.461
1.18	2.000	0.830	9370.747	0.588
1.32	2.250	0.571	6441.859	0.676
1.47	2.500	0.453	5115.019	0.745
1.62	2.750	0.355	4007.166	0.800
1.76	3.000	0.283	3187.900	0.843
1.91	3.250	0.229	2582.427	0.878
2.06	3.500	0.187	2104.743	0.906
2.21	3.750	0.152	1711.233	0.930
2.35	4.000	0.124	1401.420	0.949
2.50	4.250	0.098	1107.826	0.964
2.65	4.500	0.077	868.940	0.976
2.79	4.750	0.060	671.923	0.985
2.94	5.000	0.043	484.343	0.991
3.09	5.250	0.033	375.400	0.996
3.24	5.500	0.018	198.006	0.999
3.38	5.750	0.006	63.670	1.000
3.53	6.000	0.000	0.061	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In)	Total SCS Runoff (In)	Rainfall Amount (In)	Runoff Amount (In)	Infiltr-ation (In)	Revised Runoff Min Loss Rate

	P	Q	dP	dQ	dP-dQ	
0.25	0.0573	0.0000	0.0573	0.0000	0.0573	--------
0.50	0.1145	0.0000	0.0573	0.0000	0.0573	--------
0.75	0.1914	0.0000	0.0769	0.0000	0.0769	--------
1.00	0.2683	0.0000	0.0769	0.0000	0.0769	--------
1.25	0.3632	0.0000	0.0949	0.0000	0.0949	--------
1.50	0.4581	0.0001	0.0949	0.0001	0.0948	--------
1.75	0.6054	0.0115	0.1473	0.0114	0.1359	--------
2.00	0.7527	0.0388	0.1473	0.0273	0.1200	--------
2.25	1.3580	0.2701	0.6054	0.2313	0.3741	--------
2.50	1.9634	0.6230	0.6054	0.3529	0.2525	--------
2.75	2.1271	0.7319	0.1636	0.1089	0.0547	--------
3.00	2.2907	0.8452	0.1636	0.1133	0.0503	--------
3.25	2.4232	0.9398	0.1325	0.0947	0.0379	--------
3.50	2.5557	1.0368	0.1325	0.0970	0.0356	--------
3.75	2.6441	1.1026	0.0884	0.0658	0.0225	--------
4.00	2.7325	1.1694	0.0884	0.0667	0.0216	--------
4.25	2.8061	1.2256	0.0736	0.0562	0.0174	--------
4.50	2.8797	1.2824	0.0736	0.0568	0.0168	--------
4.75	2.9501	1.3372	0.0704	0.0548	0.0156	--------
5.00	3.0204	1.3924	0.0704	0.0552	0.0151	--------
5.25	3.0810	1.4403	0.0605	0.0479	0.0127	--------
5.50	3.1415	1.4885	0.0605	0.0482	0.0124	--------
5.75	3.2070	1.5409	0.0654	0.0524	0.0130	--------
6.00	3.2724	1.5937	0.0654	0.0528	0.0127	--------

Total soil rain loss = 1.68(In)
Total effective runoff = 1.59(In)

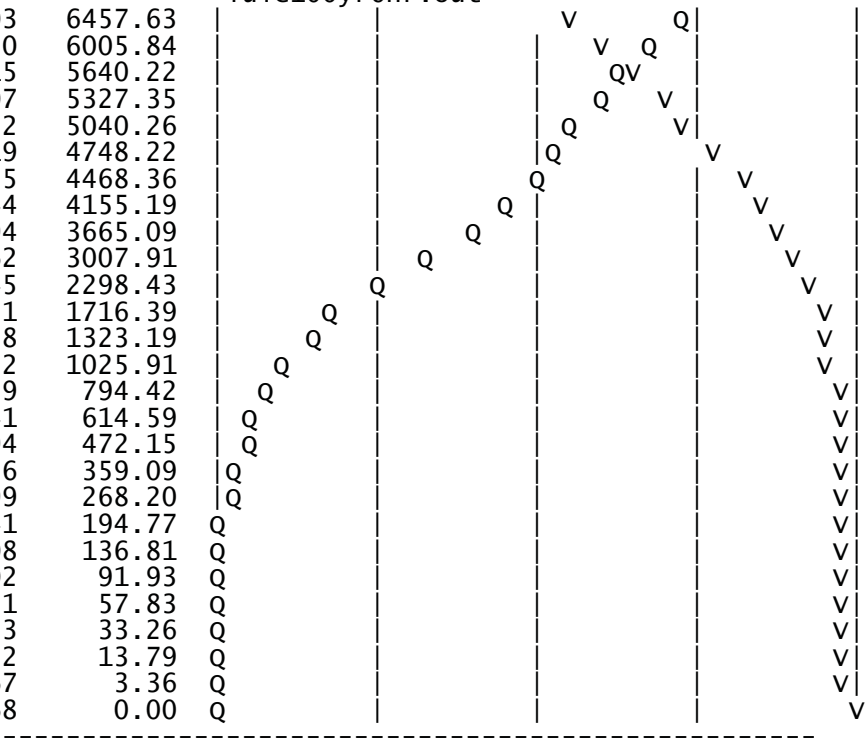
Peak flow rate this hydrograph = 8790.33(CFS)
Total runoff volume this hydrograph = 105575794.9(Ft3)

++

6 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 15 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	2200.0	4400.0	6600.0	8800.0
0+15	0.0000	0.00	Q				
0+30	0.0000	0.00	Q				
0+45	0.0000	0.00	Q				
1+ 0	0.0000	0.00	Q				
1+15	0.0000	0.00	Q				
1+30	0.0005	0.03	Q				
1+45	0.0445	2.13	Q				
2+ 0	0.2853	11.65	Q				
2+15	1.7869	72.68	Q				
2+30	7.2918	266.44	VQ				
2+45	21.5208	688.68	V Q				
3+ 0	53.1750	1532.06	V Q				
3+15	121.6185	3312.66	| V	Q			
3+30	243.6367	5905.68	| V		Q		
3+45	407.9811	7954.27	| V			Q	
4+ 0	589.5995	8790.33	| V				Q |
4+15	765.1249	8495.43	| V				Q |
4+30	928.5726	7910.87	| V			Q	|
4+45	1083.1311	7480.63	| V			Q	|
5+ 0	1226.9882	6962.68	| V			Q	|

5+15	1360.4103	6457.63	
5+30	1484.4980	6005.84	
5+45	1601.0315	5640.22	
6+ 0	1711.1007	5327.35	
6+15	1815.2382	5040.26	
6+30	1913.3419	4748.22	
6+45	2005.6635	4468.36	
7+ 0	2091.5144	4155.19	
7+15	2167.2394	3665.09	
7+30	2229.3862	3007.91	
7+45	2276.8745	2298.43	
8+ 0	2312.3371	1716.39	
8+15	2339.6758	1323.19	
8+30	2360.8722	1025.91	
8+45	2377.2859	794.42	
9+ 0	2389.9841	614.59	
9+15	2399.7394	472.15	
9+30	2407.1586	359.09	
9+45	2412.6999	268.20	
10+ 0	2416.7241	194.77	
10+15	2419.5508	136.81	
10+30	2421.4502	91.93	
10+45	2422.6451	57.83	
11+ 0	2423.3323	33.26	
11+15	2423.6172	13.79	
11+30	2423.6867	3.36	
11+45	2423.6868	0.00	

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: tule100yr24hr.out

++

Program License Serial Number 4055

Tule Wind Project
Tule Creek
Existing 100 Year 24 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
18250.00	6.41

Rainfall Distribution pattern used in study:
Type B for San Diego area of California

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
18250.00	1.000	82.0	82.0	0.050	B

Area-averaged catchment SCS Curve Number AMC(2) = 81.960
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   18250.00(Ac.)
Catchment Lag time =   1.700 hours
Unit interval = 15.000 minutes
Unit interval percentage of lag time = 14.7059
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 81.960

Rainfall depth area reduction factors:
Using a total area of   18250.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 0.974
Rainfall entered for study =   6.410(In)
Adjusted rainfall =   6.243(In)

++

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

++

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

(K = 73608.33 (CFS))

0.15	0.250	0.016	179.694	0.002
0.29	0.500	0.051	575.802	0.010
0.44	0.750	0.117	1315.646	0.028
0.59	1.000	0.256	2889.871	0.067
0.74	1.250	0.632	7133.846	0.164
0.88	1.500	0.934	10536.976	0.307
1.03	1.750	1.000	11283.813	0.461
1.18	2.000	0.830	9370.747	0.588
1.32	2.250	0.571	6441.859	0.676
1.47	2.500	0.453	5115.019	0.745
1.62	2.750	0.355	4007.166	0.800
1.76	3.000	0.283	3187.900	0.843
1.91	3.250	0.229	2582.427	0.878
2.06	3.500	0.187	2104.743	0.906
2.21	3.750	0.152	1711.233	0.930
2.35	4.000	0.124	1401.420	0.949
2.50	4.250	0.098	1107.826	0.964
2.65	4.500	0.077	868.940	0.976
2.79	4.750	0.060	671.923	0.985
2.94	5.000	0.043	484.343	0.991
3.09	5.250	0.033	375.400	0.996
3.24	5.500	0.018	198.006	0.999
3.38	5.750	0.006	63.670	1.000
3.53	6.000	0.000	0.061	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In)	Total SCS Runoff (In)	Rainfall Amount (In)	Runoff Amount (In)	Infiltr-ation (In)	Revised Runoff Min Loss Rate

	P	Q	dP	dQ	dP-dQ	
0.25	0.0281	0.0000	0.0281	0.0000	0.0281	--------
0.50	0.0562	0.0000	0.0281	0.0000	0.0281	--------
0.75	0.0780	0.0000	0.0219	0.0000	0.0219	--------
1.00	0.0999	0.0000	0.0219	0.0000	0.0219	--------
1.25	0.1280	0.0000	0.0281	0.0000	0.0281	--------
1.50	0.1561	0.0000	0.0281	0.0000	0.0281	--------
1.75	0.1842	0.0000	0.0281	0.0000	0.0281	--------
2.00	0.2123	0.0000	0.0281	0.0000	0.0281	--------
2.25	0.2466	0.0000	0.0343	0.0000	0.0343	--------
2.50	0.2809	0.0000	0.0343	0.0000	0.0343	--------
2.75	0.3090	0.0000	0.0281	0.0000	0.0281	--------
3.00	0.3371	0.0000	0.0281	0.0000	0.0281	--------
3.25	0.3715	0.0000	0.0343	0.0000	0.0343	--------
3.50	0.4058	0.0000	0.0343	0.0000	0.0343	--------
3.75	0.4432	0.0000	0.0375	0.0000	0.0375	--------
4.00	0.4807	0.0007	0.0375	0.0007	0.0367	--------
4.25	0.5213	0.0029	0.0406	0.0021	0.0384	--------
4.50	0.5619	0.0064	0.0406	0.0035	0.0371	--------
4.75	0.6056	0.0116	0.0437	0.0052	0.0385	--------
5.00	0.6493	0.0181	0.0437	0.0066	0.0371	--------
5.25	0.6992	0.0273	0.0499	0.0091	0.0408	--------
5.50	0.7491	0.0380	0.0499	0.0108	0.0392	--------
5.75	0.8022	0.0511	0.0531	0.0131	0.0400	--------
6.00	0.8553	0.0659	0.0531	0.0147	0.0383	--------
6.25	0.9177	0.0851	0.0624	0.0193	0.0432	--------
6.50	0.9801	0.1064	0.0624	0.0212	0.0412	--------
6.75	1.0519	0.1330	0.0718	0.0267	0.0451	--------
7.00	1.1237	0.1620	0.0718	0.0289	0.0429	--------
7.25	1.2174	0.2028	0.0936	0.0408	0.0528	--------
7.50	1.3110	0.2468	0.0936	0.0441	0.0496	--------
7.75	1.4515	0.3183	0.1405	0.0715	0.0690	--------
8.00	1.5919	0.3956	0.1405	0.0773	0.0632	--------
8.25	1.8011	0.5199	0.2091	0.1243	0.0848	--------
8.50	2.0102	0.6536	0.2091	0.1337	0.0754	--------
8.75	2.2849	0.8411	0.2747	0.1875	0.0872	--------
9.00	2.5596	1.0396	0.2747	0.1986	0.0761	--------
9.25	2.8592	1.2666	0.2997	0.2269	0.0727	--------
9.50	3.1589	1.5024	0.2997	0.2358	0.0639	--------
9.75	3.4149	1.7096	0.2560	0.2073	0.0487	--------
10.00	3.6708	1.9215	0.2560	0.2118	0.0441	--------
10.25	3.7988	2.0289	0.1280	0.1074	0.0205	--------
10.50	3.9268	2.1373	0.1280	0.1084	0.0196	--------
10.75	4.0111	2.2091	0.0843	0.0718	0.0124	--------
11.00	4.0953	2.2813	0.0843	0.0722	0.0121	--------
11.25	4.1671	2.3431	0.0718	0.0618	0.0100	--------
11.50	4.2389	2.4051	0.0718	0.0620	0.0098	--------
11.75	4.3045	2.4619	0.0656	0.0568	0.0087	--------
12.00	4.3700	2.5190	0.0656	0.0570	0.0085	--------
12.25	4.4325	2.5734	0.0624	0.0545	0.0080	--------
12.50	4.4949	2.6280	0.0624	0.0546	0.0078	--------
12.75	4.5542	2.6801	0.0593	0.0520	0.0073	--------
13.00	4.6135	2.7322	0.0593	0.0522	0.0071	--------
13.25	4.6666	2.7790	0.0531	0.0468	0.0063	--------
13.50	4.7196	2.8259	0.0531	0.0469	0.0062	--------
13.75	4.7696	2.8701	0.0499	0.0442	0.0057	--------
14.00	4.8195	2.9145	0.0499	0.0443	0.0056	--------
14.25	4.8757	2.9644	0.0562	0.0500	0.0062	--------
14.50	4.9319	3.0145	0.0562	0.0501	0.0061	--------
14.75	4.9631	3.0423	0.0312	0.0279	0.0034	--------
15.00	4.9943	3.0702	0.0312	0.0279	0.0033	--------
15.25	5.0443	3.1149	0.0499	0.0447	0.0053	--------

15.50	5.0942	3.1596	0.0499	0.0448	0.0052
15.75	5.1410	3.2017	0.0468	0.0420	0.0048
16.00	5.1878	3.2438	0.0468	0.0421	0.0047
16.25	5.2315	3.2831	0.0437	0.0393	0.0044
16.50	5.2752	3.3225	0.0437	0.0394	0.0043
16.75	5.3221	3.3648	0.0468	0.0423	0.0046
17.00	5.3689	3.4071	0.0468	0.0423	0.0045
17.25	5.4063	3.4410	0.0375	0.0339	0.0036
17.50	5.4438	3.4750	0.0375	0.0339	0.0035
17.75	5.4844	3.5118	0.0406	0.0368	0.0038
18.00	5.5250	3.5486	0.0406	0.0369	0.0037
18.25	5.5562	3.5770	0.0312	0.0284	0.0028
18.50	5.5874	3.6054	0.0312	0.0284	0.0028
18.75	5.6186	3.6338	0.0312	0.0284	0.0028
19.00	5.6498	3.6623	0.0312	0.0284	0.0028
19.25	5.6779	3.6879	0.0281	0.0256	0.0025
19.50	5.7060	3.7135	0.0281	0.0256	0.0025
19.75	5.7372	3.7421	0.0312	0.0285	0.0027
20.00	5.7684	3.7706	0.0312	0.0285	0.0027
20.25	5.8028	3.8020	0.0343	0.0314	0.0029
20.50	5.8371	3.8334	0.0343	0.0314	0.0029
20.75	5.8683	3.8621	0.0312	0.0286	0.0026
21.00	5.8995	3.8907	0.0312	0.0286	0.0026
21.25	5.9276	3.9165	0.0281	0.0258	0.0023
21.50	5.9557	3.9423	0.0281	0.0258	0.0023
21.75	5.9838	3.9681	0.0281	0.0258	0.0023
22.00	6.0119	3.9939	0.0281	0.0258	0.0023
22.25	6.0400	4.0198	0.0281	0.0258	0.0022
22.50	6.0681	4.0456	0.0281	0.0259	0.0022
22.75	6.0962	4.0715	0.0281	0.0259	0.0022
23.00	6.1243	4.0974	0.0281	0.0259	0.0022
23.25	6.1555	4.1262	0.0312	0.0288	0.0024
23.50	6.1867	4.1550	0.0312	0.0288	0.0024
23.75	6.2148	4.1809	0.0281	0.0259	0.0021
24.00	6.2429	4.2069	0.0281	0.0260	0.0021

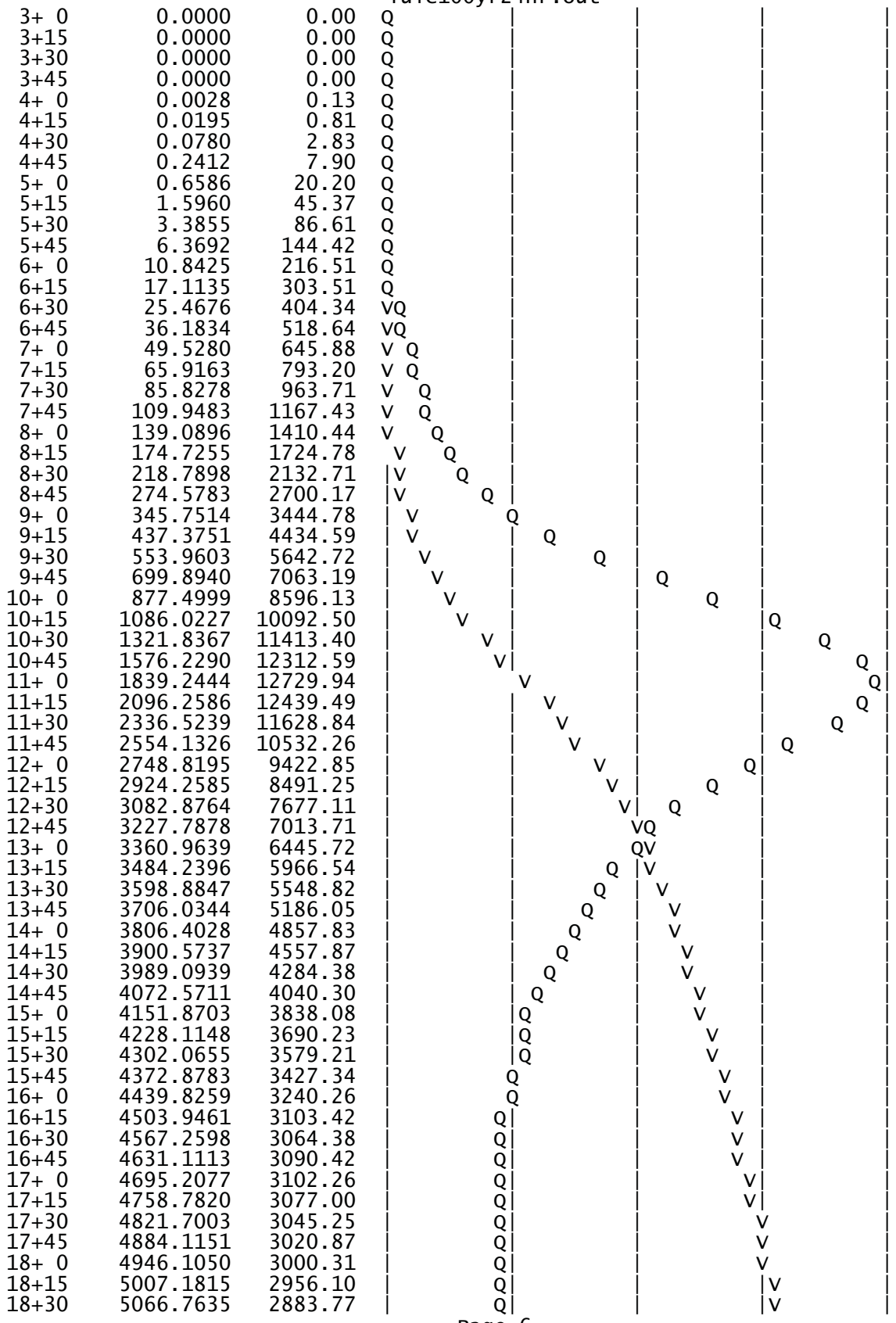
Total soil rain loss = 2.04(In)
Total effective runoff = 4.21(In)

Peak flow rate this hydrograph = 12729.94(CFS)
Total runoff volume this hydrograph = 278697131.9(Ft3)

24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 15 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	3200.0	6400.0	9600.0	12800.0
0+15	0.0000	0.00	Q				
0+30	0.0000	0.00	Q				
0+45	0.0000	0.00	Q				
1+ 0	0.0000	0.00	Q				
1+15	0.0000	0.00	Q				
1+30	0.0000	0.00	Q				
1+45	0.0000	0.00	Q				
2+ 0	0.0000	0.00	Q				
2+15	0.0000	0.00	Q				
2+30	0.0000	0.00	Q				
2+45	0.0000	0.00	Q				



3+ 0	0.0000	0.00	
3+15	0.0000	0.00	
3+30	0.0000	0.00	
3+45	0.0000	0.00	
4+ 0	0.0028	0.13	
4+15	0.0195	0.81	
4+30	0.0780	2.83	
4+45	0.2412	7.90	
5+ 0	0.6586	20.20	
5+15	1.5960	45.37	
5+30	3.3855	86.61	
5+45	6.3692	144.42	
6+ 0	10.8425	216.51	
6+15	17.1135	303.51	
6+30	25.4676	404.34	
6+45	36.1834	518.64	
7+ 0	49.5280	645.88	
7+15	65.9163	793.20	
7+30	85.8278	963.71	
7+45	109.9483	1167.43	
8+ 0	139.0896	1410.44	
8+15	174.7255	1724.78	
8+30	218.7898	2132.71	
8+45	274.5783	2700.17	
9+ 0	345.7514	3444.78	
9+15	437.3751	4434.59	
9+30	553.9603	5642.72	
9+45	699.8940	7063.19	
10+ 0	877.4999	8596.13	
10+15	1086.0227	10092.50	
10+30	1321.8367	11413.40	
10+45	1576.2290	12312.59	
11+ 0	1839.2444	12729.94	
11+15	2096.2586	12439.49	
11+30	2336.5239	11628.84	
11+45	2554.1326	10532.26	
12+ 0	2748.8195	9422.85	
12+15	2924.2585	8491.25	
12+30	3082.8764	7677.11	
12+45	3227.7878	7013.71	
13+ 0	3360.9639	6445.72	
13+15	3484.2396	5966.54	
13+30	3598.8847	5548.82	
13+45	3706.0344	5186.05	
14+ 0	3806.4028	4857.83	
14+15	3900.5737	4557.87	
14+30	3989.0939	4284.38	
14+45	4072.5711	4040.30	
15+ 0	4151.8703	3838.08	
15+15	4228.1148	3690.23	
15+30	4302.0655	3579.21	
15+45	4372.8783	3427.34	
16+ 0	4439.8259	3240.26	
16+15	4503.9461	3103.42	
16+30	4567.2598	3064.38	
16+45	4631.1113	3090.42	
17+ 0	4695.2077	3102.26	
17+15	4758.7820	3077.00	
17+30	4821.7003	3045.25	
17+45	4884.1151	3020.87	
18+ 0	4946.1050	3000.31	
18+15	5007.1815	2956.10	
18+30	5066.7635	2883.77	

18+45	5124.7593	2807.00	Q | | | V |
19+ 0	5181.4172	2742.24	Q | | | V |
19+15	5236.5097	2666.48	Q | | | V |
19+30	5289.5151	2565.46	Q | | | V |
19+45	5340.2574	2455.93	Q | | | V |
20+ 0	5389.0775	2362.89	Q | | | V |
20+15	5436.3614	2288.54	Q | | | V |
20+30	5482.2650	2221.74	Q | | | V |
20+45	5527.2068	2175.19	Q | | | V |
21+ 0	5571.7227	2154.57	Q | | | V |
21+15	5616.3609	2160.49	Q | | | V |
21+30	5661.2815	2174.16	Q | | | V |
21+45	5706.2140	2174.73	Q | | | V |
22+ 0	5750.7873	2157.35	Q | | | V |
22+15	5794.5535	2118.29	Q | | | V |
22+30	5837.3825	2072.92	Q | | | V |
22+45	5879.3752	2032.45	Q | | | V |
23+ 0	5920.6972	1999.99	Q | | | V |
23+15	5961.5664	1978.07	Q | | | V |
23+30	6002.1275	1963.15	Q | | | V |
23+45	6042.5090	1954.46	Q | | | V |
24+ 0	6082.8470	1952.36	Q | | | V |
24+15	6123.2897	1957.43	Q | | | V |
24+30	6163.7649	1959.00	Q | | | V |
24+45	6203.6977	1932.75	Q | | | V |
25+ 0	6241.9407	1850.96	Q | | | V |
25+15	6276.0107	1648.99	Q | | | V |
25+30	6304.1245	1360.71	Q | | | V |
25+45	6325.9961	1058.59	Q | | | V |
26+ 0	6342.6965	808.30	Q | | | V |
26+15	6355.8389	636.09	Q | | | V |
26+30	6366.1678	499.92	Q | | | V |
26+45	6374.2965	393.43	Q | | | V |
27+ 0	6380.6774	308.83	Q | | | V |
27+15	6385.6401	240.20	Q | | | V |
27+30	6389.4444	184.13	Q | | | V |
27+45	6392.3067	138.53	Q | | | V |
28+ 0	6394.3956	101.10	Q | | | V |
28+15	6395.8735	71.53	Q | | | V |
28+30	6396.8689	48.18	Q | | | V |
28+45	6397.4858	29.85	Q | | | V |
29+ 0	6397.8312	16.72	Q | | | V |
29+15	6397.9716	6.79	Q | | | V |
29+30	6398.0058	1.65	Q | | | V |
29+45	6398.0058	0.00	Q | | | V |

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: bwn100yr6hr.out

++

Program License Serial Number 4055

Tule Wind Project
Bow Willow Creek North
Existing 100 Year 6 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
2747.00	3.26

Rainfall Distribution pattern used in study:
Type B for SCS (small dam) or San Diego 6 hour storms

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
2747.00	1.000	89.8	89.8	0.050	C

Area-averaged catchment SCS Curve Number AMC(2) = 89.800
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   2747.00(Ac.)
Catchment Lag time =   0.800 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 10.4167
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 89.800

Rainfall depth area reduction factors:
Using a total area of   2747.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 1.000
Rainfall entered for study =   3.260(In)
Adjusted rainfall =   3.260(In)

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

(K = 33238.70 (CFS))

0.10	0.083	0.015	57.476	0.002
0.21	0.167	0.033	123.457	0.005
0.31	0.250	0.075	283.934	0.014
0.42	0.333	0.112	424.234	0.027
0.52	0.417	0.218	825.528	0.052
0.63	0.500	0.390	1480.878	0.096
0.73	0.583	0.700	2656.186	0.176
0.83	0.667	0.884	3353.690	0.277
0.94	0.750	1.000	3794.500	0.391
1.04	0.833	0.889	3374.694	0.493
1.15	0.917	0.794	3012.105	0.583
1.25	1.000	0.557	2113.850	0.647
1.35	1.083	0.486	1842.943	0.702
1.46	1.167	0.413	1566.606	0.749
1.56	1.250	0.341	1292.615	0.788
1.67	1.333	0.296	1122.607	0.822
1.77	1.417	0.243	922.165	0.850
1.87	1.500	0.219	831.642	0.875
1.98	1.583	0.184	697.224	0.896
2.08	1.667	0.162	614.300	0.914
2.19	1.750	0.140	532.443	0.930
2.29	1.833	0.119	452.627	0.944
2.40	1.917	0.107	404.979	0.956
2.50	2.000	0.084	318.914	0.966
2.60	2.083	0.074	281.523	0.974
2.71	2.167	0.061	231.072	0.981
2.81	2.250	0.049	185.702	0.987
2.92	2.333	0.040	150.896	0.991
3.02	2.417	0.032	122.997	0.995
3.13	2.500	0.026	100.032	0.998
3.23	2.583	0.012	43.735	0.999
3.33	2.667	0.006	22.937	1.000
3.44	2.750	0.000	0.207	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal

loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In) P	Total SCS Runoff (In) Q	Rainfall Amount (In) dP	Runoff Amount (In) dQ	Infiltr-ation (In) dP-dQ	Revised Runoff Min Loss Rate
0.08	0.0190	0.0000	0.0190	0.0000	0.0190	--------
0.17	0.0380	0.0000	0.0190	0.0000	0.0190	--------
0.25	0.0571	0.0000	0.0190	0.0000	0.0190	--------
0.33	0.0761	0.0000	0.0190	0.0000	0.0190	--------
0.42	0.0951	0.0000	0.0190	0.0000	0.0190	--------
0.50	0.1141	0.0000	0.0190	0.0000	0.0190	--------
0.58	0.1396	0.0000	0.0255	0.0000	0.0255	--------
0.67	0.1652	0.0000	0.0255	0.0000	0.0255	--------
0.75	0.1907	0.0000	0.0255	0.0000	0.0255	--------
0.83	0.2162	0.0000	0.0255	0.0000	0.0255	--------
0.92	0.2418	0.0002	0.0255	0.0002	0.0254	--------
1.00	0.2673	0.0014	0.0255	0.0012	0.0244	--------
1.08	0.2988	0.0043	0.0315	0.0029	0.0286	--------
1.17	0.3303	0.0086	0.0315	0.0043	0.0272	--------
1.25	0.3619	0.0143	0.0315	0.0057	0.0258	--------
1.33	0.3934	0.0212	0.0315	0.0069	0.0246	--------
1.42	0.4249	0.0293	0.0315	0.0081	0.0234	--------
1.50	0.4564	0.0385	0.0315	0.0092	0.0223	--------
1.58	0.5053	0.0547	0.0489	0.0162	0.0327	--------
1.67	0.5542	0.0731	0.0489	0.0184	0.0305	--------
1.75	0.6031	0.0935	0.0489	0.0204	0.0285	--------
1.83	0.6520	0.1156	0.0489	0.0222	0.0267	--------
1.92	0.7009	0.1394	0.0489	0.0238	0.0251	--------
2.00	0.7498	0.1647	0.0489	0.0253	0.0236	--------
2.08	0.9508	0.2816	0.2010	0.1169	0.0841	--------
2.17	1.1519	0.4150	0.2010	0.1333	0.0677	--------
2.25	1.3529	0.5603	0.2010	0.1454	0.0557	--------
2.33	1.5539	0.7148	0.2010	0.1545	0.0466	--------
2.42	1.7550	0.8763	0.2010	0.1615	0.0395	--------
2.50	1.9560	1.0433	0.2010	0.1670	0.0340	--------
2.58	2.0103	1.0893	0.0543	0.0460	0.0084	--------
2.67	2.0647	1.1355	0.0543	0.0463	0.0081	--------
2.75	2.1190	1.1821	0.0543	0.0465	0.0078	--------
2.83	2.1733	1.2289	0.0543	0.0468	0.0075	--------
2.92	2.2277	1.2760	0.0543	0.0471	0.0073	--------
3.00	2.2820	1.3233	0.0543	0.0473	0.0070	--------
3.08	2.3260	1.3618	0.0440	0.0385	0.0055	--------
3.17	2.3700	1.4005	0.0440	0.0387	0.0054	--------
3.25	2.4140	1.4393	0.0440	0.0388	0.0052	--------
3.33	2.4580	1.4782	0.0440	0.0389	0.0051	--------
3.42	2.5021	1.5173	0.0440	0.0391	0.0049	--------
3.50	2.5461	1.5565	0.0440	0.0392	0.0048	--------
3.58	2.5754	1.5827	0.0293	0.0262	0.0031	--------
3.67	2.6047	1.6089	0.0293	0.0262	0.0031	--------
3.75	2.6341	1.6352	0.0293	0.0263	0.0030	--------
3.83	2.6634	1.6616	0.0293	0.0263	0.0030	--------
3.92	2.6928	1.6880	0.0293	0.0264	0.0029	--------
4.00	2.7221	1.7144	0.0293	0.0264	0.0029	--------
4.08	2.7466	1.7365	0.0245	0.0221	0.0024	--------
4.17	2.7710	1.7586	0.0244	0.0221	0.0023	--------
4.25	2.7954	1.7807	0.0244	0.0221	0.0023	--------
4.33	2.8199	1.8029	0.0244	0.0222	0.0023	--------

4.42	2.8443	1.8251	0.0245	0.0222	0.0023
4.50	2.8688	1.8473	0.0244	0.0222	0.0022
4.58	2.8922	1.8686	0.0234	0.0213	0.0021
4.67	2.9155	1.8899	0.0234	0.0213	0.0021
4.75	2.9389	1.9112	0.0234	0.0213	0.0020
4.83	2.9623	1.9325	0.0234	0.0213	0.0020
4.92	2.9856	1.9539	0.0234	0.0214	0.0020
5.00	3.0090	1.9753	0.0234	0.0214	0.0020
5.08	3.0291	1.9937	0.0201	0.0184	0.0017
5.17	3.0492	2.0121	0.0201	0.0184	0.0017
5.25	3.0693	2.0306	0.0201	0.0185	0.0016
5.33	3.0894	2.0491	0.0201	0.0185	0.0016
5.42	3.1095	2.0676	0.0201	0.0185	0.0016
5.50	3.1296	2.0861	0.0201	0.0185	0.0016
5.58	3.1513	2.1061	0.0217	0.0200	0.0017
5.67	3.1731	2.1261	0.0217	0.0200	0.0017
5.75	3.1948	2.1462	0.0217	0.0201	0.0017
5.83	3.2165	2.1663	0.0217	0.0201	0.0017
5.92	3.2383	2.1864	0.0217	0.0201	0.0016
6.00	3.2600	2.2065	0.0217	0.0201	0.0016

Total soil rain loss = 1.05(In)
Total effective runoff = 2.21(In)

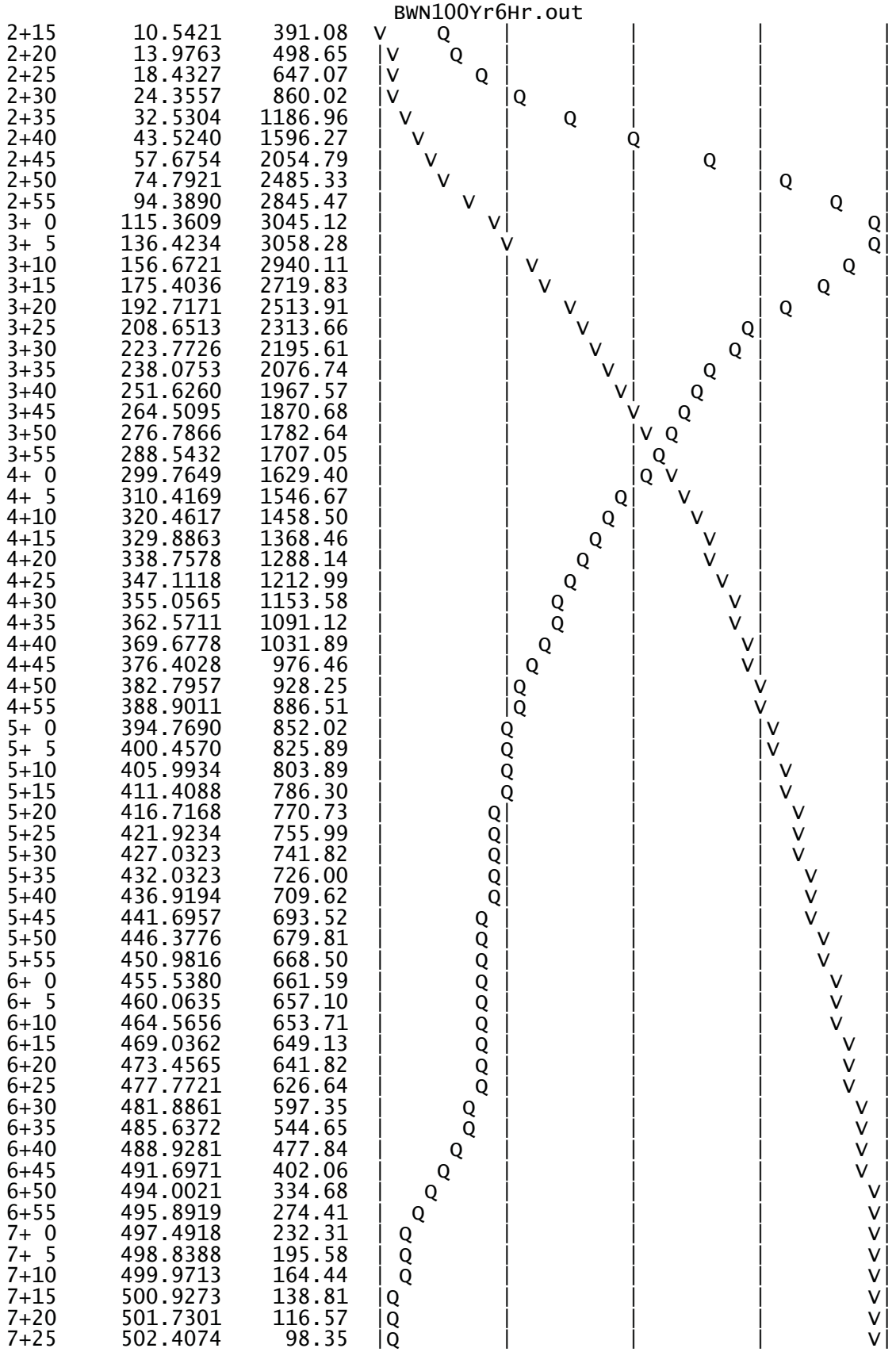
Peak flow rate this hydrograph = 3058.28(CFS)
Total runoff volume this hydrograph = 22001982.2(Ft3)

++

6 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	775.0	1550.0	2325.0	3100.0
0+ 5	0.0000	0.00	Q				
0+10	0.0000	0.00	Q				
0+15	0.0000	0.00	Q				
0+20	0.0000	0.00	Q				
0+25	0.0000	0.00	Q				
0+30	0.0000	0.00	Q				
0+35	0.0000	0.00	Q				
0+40	0.0000	0.00	Q				
0+45	0.0000	0.00	Q				
0+50	0.0000	0.00	Q				
0+55	0.0001	0.01	Q				
1+ 0	0.0007	0.09	Q				
1+ 5	0.0032	0.36	Q				
1+10	0.0102	1.02	Q				
1+15	0.0263	2.34	Q				
1+20	0.0594	4.81	Q				
1+25	0.1242	9.40	Q				
1+30	0.2449	17.53	Q				
1+35	0.4568	30.76	Q				
1+40	0.7981	49.56	Q				
1+45	1.3081	74.05	Q				
1+50	2.0182	103.11	VQ				
1+55	2.9631	137.20	VQ				
2+ 0	4.1836	177.21	V Q				
2+ 5	5.7798	231.76	V Q				
2+10	7.8487	300.41	V Q				



2+15	10.5421	391.08	V Q
2+20	13.9763	498.65	V Q
2+25	18.4327	647.07	V Q
2+30	24.3557	860.02	V Q
2+35	32.5304	1186.96	V Q
2+40	43.5240	1596.27	V Q
2+45	57.6754	2054.79	V Q
2+50	74.7921	2485.33	V Q
2+55	94.3890	2845.47	V Q
3+ 0	115.3609	3045.12	V Q
3+ 5	136.4234	3058.28	V Q
3+10	156.6721	2940.11	V Q
3+15	175.4036	2719.83	V Q
3+20	192.7171	2513.91	V Q
3+25	208.6513	2313.66	V Q
3+30	223.7726	2195.61	V Q
3+35	238.0753	2076.74	V Q
3+40	251.6260	1967.57	V Q
3+45	264.5095	1870.68	V Q
3+50	276.7866	1782.64	V Q
3+55	288.5432	1707.05	Q
4+ 0	299.7649	1629.40	Q V
4+ 5	310.4169	1546.67	Q V
4+10	320.4617	1458.50	Q V
4+15	329.8863	1368.46	Q V
4+20	338.7578	1288.14	Q V
4+25	347.1118	1212.99	Q V
4+30	355.0565	1153.58	Q V
4+35	362.5711	1091.12	Q V
4+40	369.6778	1031.89	Q V
4+45	376.4028	976.46	Q V
4+50	382.7957	928.25	Q V
4+55	388.9011	886.51	Q V
5+ 0	394.7690	852.02	Q V
5+ 5	400.4570	825.89	Q V
5+10	405.9934	803.89	Q V
5+15	411.4088	786.30	Q V
5+20	416.7168	770.73	Q V
5+25	421.9234	755.99	Q V
5+30	427.0323	741.82	Q V
5+35	432.0323	726.00	Q V
5+40	436.9194	709.62	Q V
5+45	441.6957	693.52	Q V
5+50	446.3776	679.81	Q V
5+55	450.9816	668.50	Q V
6+ 0	455.5380	661.59	Q V
6+ 5	460.0635	657.10	Q V
6+10	464.5656	653.71	Q V
6+15	469.0362	649.13	Q V
6+20	473.4565	641.82	Q V
6+25	477.7721	626.64	Q V
6+30	481.8861	597.35	Q V
6+35	485.6372	544.65	Q V
6+40	488.9281	477.84	Q V
6+45	491.6971	402.06	Q V
6+50	494.0021	334.68	Q V
6+55	495.8919	274.41	Q V
7+ 0	497.4918	232.31	Q V
7+ 5	498.8388	195.58	Q V
7+10	499.9713	164.44	Q V
7+15	500.9273	138.81	Q V
7+20	501.7301	116.57	Q V
7+25	502.4074	98.35	Q V

```
    7+30     502.9713     81.87  |Q         |          |          |         V|
    7+35     503.4410     68.20  Q          |          |          |         V|
    7+40     503.8279     56.18  Q          |          |          |         V|
    7+45     504.1433     45.79  Q          |          |          |         V|
    7+50     504.3977     36.94  Q          |          |          |         V|
    7+55     504.5975     29.01  Q          |          |          |         V|
    8+ 0     504.7543     22.77  Q          |          |          |         V|
    8+ 5     504.8726     17.18  Q          |          |          |         V|
    8+10     504.9593     12.58  Q          |          |          |         V|
    8+15     505.0203      8.86  Q          |          |          |         V|
    8+20     505.0604      5.83  Q          |          |          |         V|
    8+25     505.0835      3.36  Q          |          |          |         V|
    8+30     505.0928      1.34  Q          |          |          |         V|
    8+35     505.0960      0.47  Q          |          |          |         V|
    8+40     505.0960      0.00  Q          |          |          |         V|
---------------------------------------------------------------------------
```

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: bwn100yr24hr.out

++

Program License Serial Number 4055

Tule Wind Project
Bow Willow Creek North
Existing 100 Year 24 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
2747.00	6.43

Rainfall Distribution pattern used in study:
Type B for San Diego area of California

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
2747.00	1.000	89.8	89.8	0.050	C

Area-averaged catchment SCS Curve Number AMC(2) = 89.800
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   2747.00(Ac.)
Catchment Lag time =   0.800 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 10.4167
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 89.800

Rainfall depth area reduction factors:
Using a total area of   2747.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 1.000
Rainfall entered for study =   6.430(In)
Adjusted rainfall =   6.430(In)

++

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

++

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

(K = 33238.70 (CFS))

0.10	0.083	0.015	57.476	0.002
0.21	0.167	0.033	123.457	0.005
0.31	0.250	0.075	283.934	0.014
0.42	0.333	0.112	424.234	0.027
0.52	0.417	0.218	825.528	0.052
0.63	0.500	0.390	1480.878	0.096
0.73	0.583	0.700	2656.186	0.176
0.83	0.667	0.884	3353.690	0.277
0.94	0.750	1.000	3794.500	0.391
1.04	0.833	0.889	3374.694	0.493
1.15	0.917	0.794	3012.105	0.583
1.25	1.000	0.557	2113.850	0.647
1.35	1.083	0.486	1842.943	0.702
1.46	1.167	0.413	1566.606	0.749
1.56	1.250	0.341	1292.615	0.788
1.67	1.333	0.296	1122.607	0.822
1.77	1.417	0.243	922.165	0.850
1.87	1.500	0.219	831.642	0.875
1.98	1.583	0.184	697.224	0.896
2.08	1.667	0.162	614.300	0.914
2.19	1.750	0.140	532.443	0.930
2.29	1.833	0.119	452.627	0.944
2.40	1.917	0.107	404.979	0.956
2.50	2.000	0.084	318.914	0.966
2.60	2.083	0.074	281.523	0.974
2.71	2.167	0.061	231.072	0.981
2.81	2.250	0.049	185.702	0.987
2.92	2.333	0.040	150.896	0.991
3.02	2.417	0.032	122.997	0.995
3.13	2.500	0.026	100.032	0.998
3.23	2.583	0.012	43.735	0.999
3.33	2.667	0.006	22.937	1.000
3.44	2.750	0.000	0.207	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal

loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In) P	Total SCS Runoff (In) Q	Rainfall Amount (In) dP	Runoff Amount (In) dQ	Infiltr-ation (In) dP-dQ	Revised Runoff Min Loss Rate
0.08	0.0096	0.0000	0.0096	0.0000	0.0096	--------
0.17	0.0193	0.0000	0.0096	0.0000	0.0096	--------
0.25	0.0289	0.0000	0.0096	0.0000	0.0096	--------
0.33	0.0386	0.0000	0.0096	0.0000	0.0096	--------
0.42	0.0482	0.0000	0.0096	0.0000	0.0096	--------
0.50	0.0579	0.0000	0.0096	0.0000	0.0096	--------
0.58	0.0654	0.0000	0.0075	0.0000	0.0075	--------
0.67	0.0729	0.0000	0.0075	0.0000	0.0075	--------
0.75	0.0804	0.0000	0.0075	0.0000	0.0075	--------
0.83	0.0879	0.0000	0.0075	0.0000	0.0075	--------
0.92	0.0954	0.0000	0.0075	0.0000	0.0075	--------
1.00	0.1029	0.0000	0.0075	0.0000	0.0075	--------
1.08	0.1125	0.0000	0.0096	0.0000	0.0096	--------
1.17	0.1222	0.0000	0.0096	0.0000	0.0096	--------
1.25	0.1318	0.0000	0.0096	0.0000	0.0096	--------
1.33	0.1415	0.0000	0.0096	0.0000	0.0096	--------
1.42	0.1511	0.0000	0.0096	0.0000	0.0096	--------
1.50	0.1608	0.0000	0.0096	0.0000	0.0096	--------
1.58	0.1704	0.0000	0.0096	0.0000	0.0096	--------
1.67	0.1800	0.0000	0.0096	0.0000	0.0096	--------
1.75	0.1897	0.0000	0.0096	0.0000	0.0096	--------
1.83	0.1993	0.0000	0.0096	0.0000	0.0096	--------
1.92	0.2090	0.0000	0.0096	0.0000	0.0096	--------
2.00	0.2186	0.0000	0.0096	0.0000	0.0096	--------
2.08	0.2304	0.0000	0.0118	0.0000	0.0118	--------
2.17	0.2422	0.0002	0.0118	0.0002	0.0116	--------
2.25	0.2540	0.0006	0.0118	0.0004	0.0114	--------
2.33	0.2658	0.0013	0.0118	0.0007	0.0111	--------
2.42	0.2776	0.0021	0.0118	0.0009	0.0109	--------
2.50	0.2894	0.0032	0.0118	0.0011	0.0107	--------
2.58	0.2990	0.0043	0.0096	0.0010	0.0086	--------
2.67	0.3086	0.0055	0.0096	0.0012	0.0085	--------
2.75	0.3183	0.0068	0.0096	0.0013	0.0083	--------
2.83	0.3279	0.0082	0.0096	0.0014	0.0082	--------
2.92	0.3376	0.0098	0.0096	0.0016	0.0081	--------
3.00	0.3472	0.0115	0.0096	0.0017	0.0080	--------
3.08	0.3590	0.0137	0.0118	0.0022	0.0096	--------
3.17	0.3708	0.0161	0.0118	0.0024	0.0094	--------
3.25	0.3826	0.0187	0.0118	0.0026	0.0092	--------
3.33	0.3944	0.0215	0.0118	0.0027	0.0090	--------
3.42	0.4062	0.0244	0.0118	0.0029	0.0089	--------
3.50	0.4179	0.0274	0.0118	0.0031	0.0087	--------
3.58	0.4308	0.0310	0.0129	0.0035	0.0093	--------
3.67	0.4437	0.0347	0.0129	0.0037	0.0092	--------
3.75	0.4565	0.0385	0.0129	0.0039	0.0090	--------
3.83	0.4694	0.0426	0.0129	0.0040	0.0088	--------
3.92	0.4822	0.0468	0.0129	0.0042	0.0087	--------
4.00	0.4951	0.0511	0.0129	0.0044	0.0085	--------
4.08	0.5090	0.0560	0.0139	0.0049	0.0090	--------
4.17	0.5230	0.0611	0.0139	0.0051	0.0089	--------
4.25	0.5369	0.0664	0.0139	0.0052	0.0087	--------
4.33	0.5508	0.0718	0.0139	0.0054	0.0085	--------

4.42	0.5648	0.0773	0.0139	0.0056	0.0084	--------
4.50	0.5787	0.0831	0.0139	0.0057	0.0082	--------
4.58	0.5937	0.0894	0.0150	0.0063	0.0087	--------
4.67	0.6087	0.0959	0.0150	0.0065	0.0085	--------
4.75	0.6237	0.1026	0.0150	0.0067	0.0083	--------
4.83	0.6387	0.1095	0.0150	0.0068	0.0082	--------
4.92	0.6537	0.1164	0.0150	0.0070	0.0080	--------
5.00	0.6687	0.1236	0.0150	0.0071	0.0079	--------
5.08	0.6859	0.1320	0.0171	0.0084	0.0088	--------
5.17	0.7030	0.1405	0.0171	0.0085	0.0086	--------
5.25	0.7202	0.1492	0.0171	0.0087	0.0084	--------
5.33	0.7373	0.1581	0.0171	0.0089	0.0083	--------
5.42	0.7545	0.1672	0.0171	0.0091	0.0081	--------
5.50	0.7716	0.1764	0.0171	0.0092	0.0079	--------
5.58	0.7898	0.1864	0.0182	0.0100	0.0082	--------
5.67	0.8080	0.1965	0.0182	0.0102	0.0081	--------
5.75	0.8263	0.2069	0.0182	0.0103	0.0079	--------
5.83	0.8445	0.2174	0.0182	0.0105	0.0077	--------
5.92	0.8627	0.2280	0.0182	0.0106	0.0076	--------
6.00	0.8809	0.2388	0.0182	0.0108	0.0074	--------
6.08	0.9023	0.2517	0.0214	0.0129	0.0085	--------
6.17	0.9238	0.2648	0.0214	0.0131	0.0083	--------
6.25	0.9452	0.2781	0.0214	0.0133	0.0081	--------
6.33	0.9666	0.2916	0.0214	0.0135	0.0080	--------
6.42	0.9881	0.3052	0.0214	0.0137	0.0078	--------
6.50	1.0095	0.3191	0.0214	0.0138	0.0076	--------
6.58	1.0342	0.3352	0.0246	0.0161	0.0085	--------
6.67	1.0588	0.3515	0.0246	0.0163	0.0083	--------
6.75	1.0835	0.3681	0.0246	0.0165	0.0081	--------
6.83	1.1081	0.3848	0.0246	0.0167	0.0079	--------
6.92	1.1328	0.4017	0.0246	0.0169	0.0077	--------
7.00	1.1574	0.4188	0.0246	0.0171	0.0075	--------
7.08	1.1895	0.4414	0.0321	0.0226	0.0096	--------
7.17	1.2217	0.4643	0.0322	0.0229	0.0093	--------
7.25	1.2538	0.4874	0.0321	0.0231	0.0090	--------
7.33	1.2860	0.5108	0.0321	0.0234	0.0087	--------
7.42	1.3181	0.5345	0.0322	0.0237	0.0085	--------
7.50	1.3503	0.5584	0.0321	0.0239	0.0082	--------
7.58	1.3985	0.5947	0.0482	0.0363	0.0119	--------
7.67	1.4468	0.6315	0.0482	0.0368	0.0114	--------
7.75	1.4950	0.6687	0.0482	0.0372	0.0110	--------
7.83	1.5432	0.7064	0.0482	0.0377	0.0106	--------
7.92	1.5914	0.7444	0.0482	0.0381	0.0101	--------
8.00	1.6397	0.7829	0.0482	0.0385	0.0098	--------
8.08	1.7115	0.8408	0.0718	0.0579	0.0139	--------
8.17	1.7833	0.8995	0.0718	0.0587	0.0131	--------
8.25	1.8551	0.9588	0.0718	0.0594	0.0125	--------
8.33	1.9269	1.0188	0.0718	0.0600	0.0118	--------
8.42	1.9987	1.0794	0.0718	0.0606	0.0112	--------
8.50	2.0705	1.1405	0.0718	0.0611	0.0107	--------
8.58	2.1648	1.2215	0.0943	0.0810	0.0133	--------
8.67	2.2591	1.3033	0.0943	0.0818	0.0125	--------
8.75	2.3534	1.3859	0.0943	0.0825	0.0118	--------
8.83	2.4477	1.4691	0.0943	0.0832	0.0111	--------
8.92	2.5420	1.5529	0.0943	0.0838	0.0105	--------
9.00	2.6363	1.6372	0.0943	0.0844	0.0099	--------
9.08	2.7392	1.7298	0.1029	0.0926	0.0103	--------
9.17	2.8421	1.8230	0.1029	0.0932	0.0097	--------
9.25	2.9449	1.9167	0.1029	0.0937	0.0092	--------
9.33	3.0478	2.0109	0.1029	0.0942	0.0087	--------
9.42	3.1507	2.1055	0.1029	0.0946	0.0083	--------
9.50	3.2536	2.2005	0.1029	0.0950	0.0079	--------
9.58	3.3415	2.2820	0.0879	0.0815	0.0064	--------

9.67	3.4293	2.3637	0.0879	0.0817	0.0061	--------
9.75	3.5172	2.4457	0.0879	0.0820	0.0059	--------
9.83	3.6051	2.5279	0.0879	0.0822	0.0057	--------
9.92	3.6930	2.6103	0.0879	0.0824	0.0055	--------
10.00	3.7808	2.6929	0.0879	0.0826	0.0053	--------
10.08	3.8248	2.7343	0.0439	0.0414	0.0026	--------
10.17	3.8687	2.7757	0.0439	0.0414	0.0025	--------
10.25	3.9127	2.8172	0.0439	0.0415	0.0025	--------
10.33	3.9566	2.8587	0.0439	0.0415	0.0024	--------
10.42	4.0005	2.9003	0.0439	0.0416	0.0024	--------
10.50	4.0445	2.9419	0.0439	0.0416	0.0023	--------
10.58	4.0734	2.9693	0.0289	0.0274	0.0015	--------
10.67	4.1023	2.9968	0.0289	0.0274	0.0015	--------
10.75	4.1313	3.0242	0.0289	0.0275	0.0015	--------
10.83	4.1602	3.0517	0.0289	0.0275	0.0015	--------
10.92	4.1891	3.0792	0.0289	0.0275	0.0014	--------
11.00	4.2181	3.1067	0.0289	0.0275	0.0014	--------
11.08	4.2427	3.1301	0.0246	0.0234	0.0012	--------
11.17	4.2674	3.1536	0.0246	0.0235	0.0012	--------
11.25	4.2920	3.1771	0.0246	0.0235	0.0012	--------
11.33	4.3167	3.2006	0.0246	0.0235	0.0012	--------
11.42	4.3413	3.2240	0.0246	0.0235	0.0012	--------
11.50	4.3660	3.2475	0.0246	0.0235	0.0011	--------
11.58	4.3885	3.2690	0.0225	0.0215	0.0010	--------
11.67	4.4110	3.2905	0.0225	0.0215	0.0010	--------
11.75	4.4335	3.3120	0.0225	0.0215	0.0010	--------
11.83	4.4560	3.3335	0.0225	0.0215	0.0010	--------
11.92	4.4785	3.3550	0.0225	0.0215	0.0010	--------
12.00	4.5010	3.3765	0.0225	0.0215	0.0010	--------
12.08	4.5224	3.3970	0.0214	0.0205	0.0009	--------
12.17	4.5439	3.4175	0.0214	0.0205	0.0009	--------
12.25	4.5653	3.4380	0.0214	0.0205	0.0009	--------
12.33	4.5867	3.4585	0.0214	0.0205	0.0009	--------
12.42	4.6082	3.4790	0.0214	0.0205	0.0009	--------
12.50	4.6296	3.4995	0.0214	0.0205	0.0009	--------
12.58	4.6500	3.5190	0.0204	0.0195	0.0009	--------
12.67	4.6703	3.5385	0.0204	0.0195	0.0008	--------
12.75	4.6907	3.5581	0.0204	0.0195	0.0008	--------
12.83	4.7110	3.5776	0.0204	0.0195	0.0008	--------
12.92	4.7314	3.5971	0.0204	0.0195	0.0008	--------
13.00	4.7518	3.6167	0.0204	0.0195	0.0008	--------
13.08	4.7700	3.6342	0.0182	0.0175	0.0007	--------
13.17	4.7882	3.6516	0.0182	0.0175	0.0007	--------
13.25	4.8064	3.6691	0.0182	0.0175	0.0007	--------
13.33	4.8246	3.6866	0.0182	0.0175	0.0007	--------
13.42	4.8429	3.7042	0.0182	0.0175	0.0007	--------
13.50	4.8611	3.7217	0.0182	0.0175	0.0007	--------
13.58	4.8782	3.7381	0.0171	0.0165	0.0007	--------
13.67	4.8954	3.7546	0.0171	0.0165	0.0007	--------
13.75	4.9125	3.7711	0.0171	0.0165	0.0007	--------
13.83	4.9297	3.7876	0.0171	0.0165	0.0007	--------
13.92	4.9468	3.8041	0.0171	0.0165	0.0006	--------
14.00	4.9640	3.8206	0.0171	0.0165	0.0006	--------
14.08	4.9833	3.8392	0.0193	0.0186	0.0007	--------
14.17	5.0025	3.8578	0.0193	0.0186	0.0007	--------
14.25	5.0218	3.8763	0.0193	0.0186	0.0007	--------
14.33	5.0411	3.8949	0.0193	0.0186	0.0007	--------
14.42	5.0604	3.9135	0.0193	0.0186	0.0007	--------
14.50	5.0797	3.9321	0.0193	0.0186	0.0007	--------
14.58	5.0904	3.9424	0.0107	0.0103	0.0004	--------
14.67	5.1011	3.9528	0.0107	0.0103	0.0004	--------
14.75	5.1119	3.9631	0.0107	0.0103	0.0004	--------
14.83	5.1226	3.9735	0.0107	0.0103	0.0004	--------

14.92	5.1333	3.9838	0.0107	0.0103	0.0004	--------
15.00	5.1440	3.9941	0.0107	0.0103	0.0004	--------
15.08	5.1611	4.0107	0.0171	0.0165	0.0006	--------
15.17	5.1783	4.0272	0.0171	0.0165	0.0006	--------
15.25	5.1954	4.0438	0.0171	0.0166	0.0006	--------
15.33	5.2126	4.0603	0.0171	0.0166	0.0006	--------
15.42	5.2297	4.0769	0.0171	0.0166	0.0006	--------
15.50	5.2469	4.0934	0.0171	0.0166	0.0006	--------
15.58	5.2630	4.1090	0.0161	0.0155	0.0005	--------
15.67	5.2790	4.1245	0.0161	0.0155	0.0005	--------
15.75	5.2951	4.1400	0.0161	0.0155	0.0005	--------
15.83	5.3112	4.1556	0.0161	0.0155	0.0005	--------
15.92	5.3273	4.1711	0.0161	0.0155	0.0005	--------
16.00	5.3433	4.1867	0.0161	0.0155	0.0005	--------
16.08	5.3583	4.2012	0.0150	0.0145	0.0005	--------
16.17	5.3733	4.2157	0.0150	0.0145	0.0005	--------
16.25	5.3883	4.2302	0.0150	0.0145	0.0005	--------
16.33	5.4033	4.2447	0.0150	0.0145	0.0005	--------
16.42	5.4183	4.2592	0.0150	0.0145	0.0005	--------
16.50	5.4333	4.2738	0.0150	0.0145	0.0005	--------
16.58	5.4494	4.2893	0.0161	0.0156	0.0005	--------
16.67	5.4655	4.3049	0.0161	0.0156	0.0005	--------
16.75	5.4816	4.3204	0.0161	0.0156	0.0005	--------
16.83	5.4976	4.3360	0.0161	0.0156	0.0005	--------
16.92	5.5137	4.3516	0.0161	0.0156	0.0005	--------
17.00	5.5298	4.3672	0.0161	0.0156	0.0005	--------
17.08	5.5427	4.3796	0.0129	0.0125	0.0004	--------
17.17	5.5555	4.3921	0.0129	0.0125	0.0004	--------
17.25	5.5684	4.4045	0.0129	0.0125	0.0004	--------
17.33	5.5812	4.4170	0.0129	0.0125	0.0004	--------
17.42	5.5941	4.4295	0.0129	0.0125	0.0004	--------
17.50	5.6070	4.4419	0.0129	0.0125	0.0004	--------
17.58	5.6209	4.4555	0.0139	0.0135	0.0004	--------
17.67	5.6348	4.4690	0.0139	0.0135	0.0004	--------
17.75	5.6488	4.4825	0.0139	0.0135	0.0004	--------
17.83	5.6627	4.4960	0.0139	0.0135	0.0004	--------
17.92	5.6766	4.5095	0.0139	0.0135	0.0004	--------
18.00	5.6906	4.5230	0.0139	0.0135	0.0004	--------
18.08	5.7013	4.5334	0.0107	0.0104	0.0003	--------
18.17	5.7120	4.5438	0.0107	0.0104	0.0003	--------
18.25	5.7227	4.5542	0.0107	0.0104	0.0003	--------
18.33	5.7334	4.5646	0.0107	0.0104	0.0003	--------
18.42	5.7441	4.5750	0.0107	0.0104	0.0003	--------
18.50	5.7549	4.5854	0.0107	0.0104	0.0003	--------
18.58	5.7656	4.5958	0.0107	0.0104	0.0003	--------
18.67	5.7763	4.6063	0.0107	0.0104	0.0003	--------
18.75	5.7870	4.6167	0.0107	0.0104	0.0003	--------
18.83	5.7977	4.6271	0.0107	0.0104	0.0003	--------
18.92	5.8084	4.6375	0.0107	0.0104	0.0003	--------
19.00	5.8191	4.6479	0.0107	0.0104	0.0003	--------
19.08	5.8288	4.6573	0.0096	0.0094	0.0003	--------
19.17	5.8384	4.6666	0.0096	0.0094	0.0003	--------
19.25	5.8481	4.6760	0.0096	0.0094	0.0003	--------
19.33	5.8577	4.6854	0.0096	0.0094	0.0003	--------
19.42	5.8674	4.6947	0.0096	0.0094	0.0003	--------
19.50	5.8770	4.7041	0.0096	0.0094	0.0003	--------
19.58	5.8877	4.7145	0.0107	0.0104	0.0003	--------
19.67	5.8985	4.7250	0.0107	0.0104	0.0003	--------
19.75	5.9092	4.7354	0.0107	0.0104	0.0003	--------
19.83	5.9199	4.7458	0.0107	0.0104	0.0003	--------
19.92	5.9306	4.7562	0.0107	0.0104	0.0003	--------
20.00	5.9413	4.7666	0.0107	0.0104	0.0003	--------
20.08	5.9531	4.7781	0.0118	0.0115	0.0003	--------

20.17	5.9649	4.7896	0.0118	0.0115	0.0003	--------
20.25	5.9767	4.8010	0.0118	0.0115	0.0003	--------
20.33	5.9885	4.8125	0.0118	0.0115	0.0003	--------
20.42	6.0003	4.8240	0.0118	0.0115	0.0003	--------
20.50	6.0121	4.8354	0.0118	0.0115	0.0003	--------
20.58	6.0228	4.8459	0.0107	0.0104	0.0003	--------
20.67	6.0335	4.8563	0.0107	0.0104	0.0003	--------
20.75	6.0442	4.8667	0.0107	0.0104	0.0003	--------
20.83	6.0549	4.8772	0.0107	0.0104	0.0003	--------
20.92	6.0656	4.8876	0.0107	0.0104	0.0003	--------
21.00	6.0763	4.8980	0.0107	0.0104	0.0003	--------
21.08	6.0860	4.9074	0.0096	0.0094	0.0003	--------
21.17	6.0956	4.9168	0.0096	0.0094	0.0003	--------
21.25	6.1053	4.9262	0.0096	0.0094	0.0003	--------
21.33	6.1149	4.9356	0.0096	0.0094	0.0003	--------
21.42	6.1246	4.9450	0.0096	0.0094	0.0003	--------
21.50	6.1342	4.9544	0.0096	0.0094	0.0003	--------
21.58	6.1439	4.9638	0.0096	0.0094	0.0003	--------
21.67	6.1535	4.9732	0.0096	0.0094	0.0002	--------
21.75	6.1632	4.9826	0.0096	0.0094	0.0002	--------
21.83	6.1728	4.9920	0.0096	0.0094	0.0002	--------
21.92	6.1824	5.0014	0.0096	0.0094	0.0002	--------
22.00	6.1921	5.0108	0.0096	0.0094	0.0002	--------
22.08	6.2017	5.0202	0.0096	0.0094	0.0002	--------
22.17	6.2114	5.0296	0.0096	0.0094	0.0002	--------
22.25	6.2210	5.0390	0.0096	0.0094	0.0002	--------
22.33	6.2307	5.0484	0.0096	0.0094	0.0002	--------
22.42	6.2403	5.0578	0.0096	0.0094	0.0002	--------
22.50	6.2500	5.0672	0.0096	0.0094	0.0002	--------
22.58	6.2596	5.0766	0.0096	0.0094	0.0002	--------
22.67	6.2692	5.0860	0.0096	0.0094	0.0002	--------
22.75	6.2789	5.0954	0.0096	0.0094	0.0002	--------
22.83	6.2885	5.1048	0.0096	0.0094	0.0002	--------
22.92	6.2982	5.1142	0.0096	0.0094	0.0002	--------
23.00	6.3078	5.1236	0.0096	0.0094	0.0002	--------
23.08	6.3185	5.1340	0.0107	0.0105	0.0003	--------
23.17	6.3293	5.1445	0.0107	0.0105	0.0003	--------
23.25	6.3400	5.1549	0.0107	0.0105	0.0003	--------
23.33	6.3507	5.1654	0.0107	0.0105	0.0003	--------
23.42	6.3614	5.1758	0.0107	0.0105	0.0003	--------
23.50	6.3721	5.1863	0.0107	0.0105	0.0003	--------
23.58	6.3818	5.1957	0.0096	0.0094	0.0002	--------
23.67	6.3914	5.2051	0.0096	0.0094	0.0002	--------
23.75	6.4011	5.2145	0.0096	0.0094	0.0002	--------
23.83	6.4107	5.2239	0.0096	0.0094	0.0002	--------
23.92	6.4204	5.2334	0.0096	0.0094	0.0002	--------
24.00	6.4300	5.2428	0.0096	0.0094	0.0002	--------

Total soil rain loss = 1.19(In)
Total effective runoff = 5.24(In)

Peak flow rate this hydrograph = 2843.87(CFS)
Total runoff volume this hydrograph = 52278910.3(Ft3)

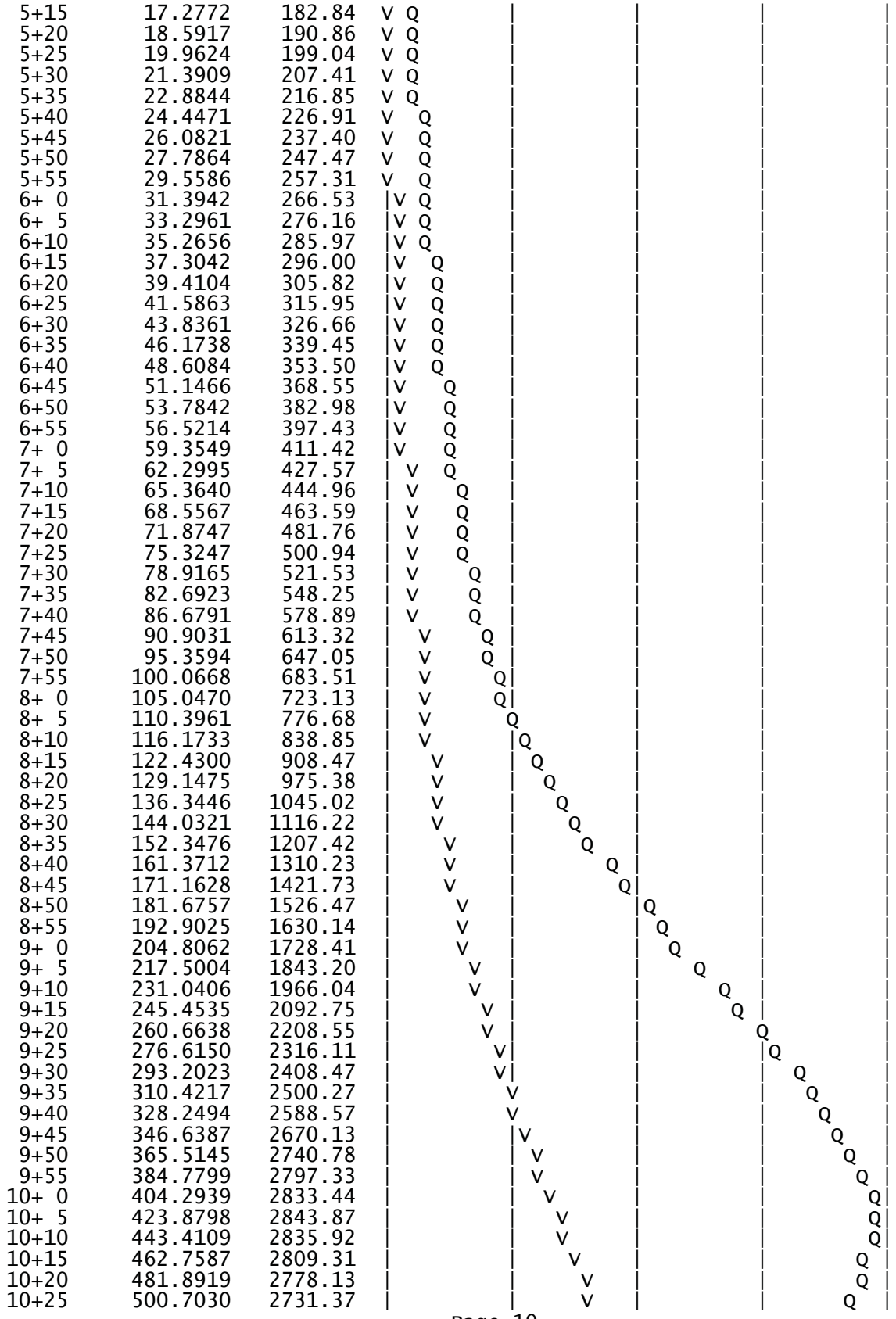
++

24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

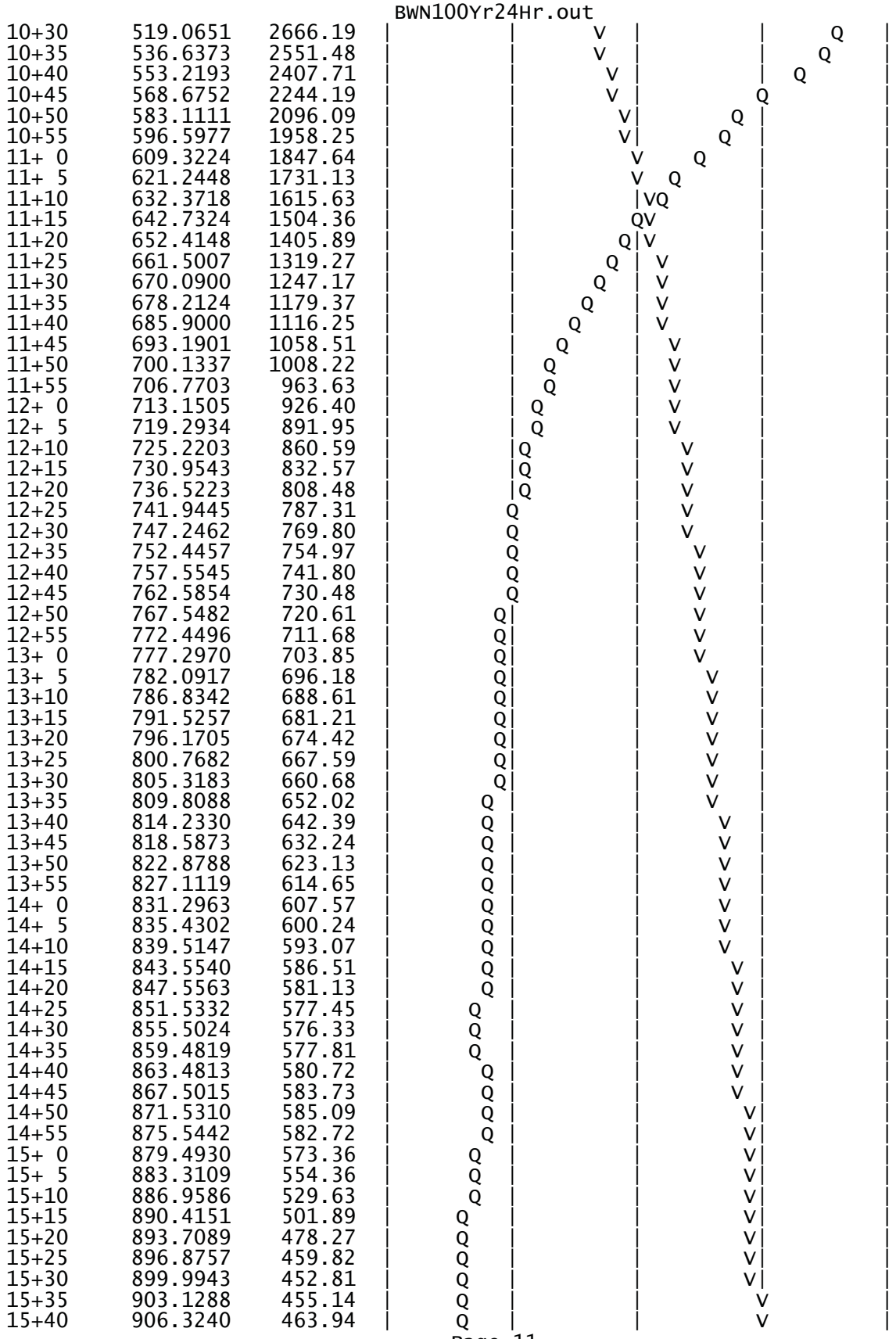
Hydrograph in 5 Minute intervals ((CFS))

Time(h+m) Volume Ac.Ft Q(CFS) 0 725.0 1450.0 2175.0 2900.0

0+ 5	0.0000	0.00	Q				
0+10	0.0000	0.00	Q				
0+15	0.0000	0.00	Q				
0+20	0.0000	0.00	Q				
0+25	0.0000	0.00	Q				
0+30	0.0000	0.00	Q				
0+35	0.0000	0.00	Q				
0+40	0.0000	0.00	Q				
0+45	0.0000	0.00	Q				
0+50	0.0000	0.00	Q				
0+55	0.0000	0.00	Q				
1+ 0	0.0000	0.00	Q				
1+ 5	0.0000	0.00	Q				
1+10	0.0000	0.00	Q				
1+15	0.0000	0.00	Q				
1+20	0.0000	0.00	Q				
1+25	0.0000	0.00	Q				
1+30	0.0000	0.00	Q				
1+35	0.0000	0.00	Q				
1+40	0.0000	0.00	Q				
1+45	0.0000	0.00	Q				
1+50	0.0000	0.00	Q				
1+55	0.0000	0.00	Q				
2+ 0	0.0000	0.00	Q				
2+ 5	0.0000	0.00	Q				
2+10	0.0001	0.01	Q				
2+15	0.0004	0.05	Q				
2+20	0.0014	0.15	Q				
2+25	0.0038	0.34	Q				
2+30	0.0086	0.70	Q				
2+35	0.0180	1.37	Q				
2+40	0.0357	2.56	Q				
2+45	0.0663	4.44	Q				
2+50	0.1152	7.10	Q				
2+55	0.1866	10.37	Q				
3+ 0	0.2834	14.07	Q				
3+ 5	0.4063	17.83	Q				
3+10	0.5551	21.61	Q				
3+15	0.7300	25.40	Q				
3+20	0.9319	29.31	Q				
3+25	1.1622	33.43	Q				
3+30	1.4240	38.02	Q				
3+35	1.7217	43.22	Q				
3+40	2.0584	48.89	Q				
3+45	2.4371	54.99	Q				
3+50	2.8582	61.15	Q				
3+55	3.3227	67.44	Q				
4+ 0	3.8301	73.68	VQ				
4+ 5	4.3829	80.27	VQ				
4+10	4.9826	87.06	VQ				
4+15	5.6301	94.03	VQ				
4+20	6.3252	100.92	VQ				
4+25	7.0677	107.82	VQ				
4+30	7.8577	114.71	VQ				
4+35	8.6975	121.94	VQ				
4+40	9.5885	129.37	VQ				
4+45	10.5318	136.96	VQ				
4+50	11.5261	144.38	VQ				
4+55	12.5713	151.77	V Q				
5+ 0	13.6666	159.04	V Q				
5+ 5	14.8150	166.74	V Q				
5+10	16.0180	174.67	V Q				



5+15	17.2772	182.84	V Q
5+20	18.5917	190.86	V Q
5+25	19.9624	199.04	V Q
5+30	21.3909	207.41	V Q
5+35	22.8844	216.85	V Q
5+40	24.4471	226.91	V Q
5+45	26.0821	237.40	V Q
5+50	27.7864	247.47	V Q
5+55	29.5586	257.31	V Q
6+ 0	31.3942	266.53	V Q
6+ 5	33.2961	276.16	V Q
6+10	35.2656	285.97	V Q
6+15	37.3042	296.00	V Q
6+20	39.4104	305.82	V Q
6+25	41.5863	315.95	V Q
6+30	43.8361	326.66	V Q
6+35	46.1738	339.45	V Q
6+40	48.6084	353.50	V Q
6+45	51.1466	368.55	V Q
6+50	53.7842	382.98	V Q
6+55	56.5214	397.43	V Q
7+ 0	59.3549	411.42	V Q
7+ 5	62.2995	427.57	V Q
7+10	65.3640	444.96	V Q
7+15	68.5567	463.59	V Q
7+20	71.8747	481.76	V Q
7+25	75.3247	500.94	V Q
7+30	78.9165	521.53	V Q
7+35	82.6923	548.25	V Q
7+40	86.6791	578.89	V Q
7+45	90.9031	613.32	V Q
7+50	95.3594	647.05	V Q
7+55	100.0668	683.51	V Q
8+ 0	105.0470	723.13	V Q
8+ 5	110.3961	776.68	V Q
8+10	116.1733	838.85	V Q
8+15	122.4300	908.47	V Q
8+20	129.1475	975.38	V Q
8+25	136.3446	1045.02	V Q
8+30	144.0321	1116.22	V Q
8+35	152.3476	1207.42	V Q
8+40	161.3712	1310.23	V Q
8+45	171.1628	1421.73	V Q
8+50	181.6757	1526.47	V Q
8+55	192.9025	1630.14	V Q
9+ 0	204.8062	1728.41	V Q
9+ 5	217.5004	1843.20	V Q
9+10	231.0406	1966.04	V Q
9+15	245.4535	2092.75	V Q
9+20	260.6638	2208.55	V Q
9+25	276.6150	2316.11	V Q
9+30	293.2023	2408.47	V Q
9+35	310.4217	2500.27	V Q
9+40	328.2494	2588.57	V Q
9+45	346.6387	2670.13	V Q
9+50	365.5145	2740.78	V Q
9+55	384.7799	2797.33	V Q
10+ 0	404.2939	2833.44	V Q
10+ 5	423.8798	2843.87	V Q
10+10	443.4109	2835.92	V Q
10+15	462.7587	2809.31	V Q
10+20	481.8919	2778.13	V Q
10+25	500.7030	2731.37	V Q



10+30	519.0651	2666.19	
10+35	536.6373	2551.48	
10+40	553.2193	2407.71	
10+45	568.6752	2244.19	
10+50	583.1111	2096.09	
10+55	596.5977	1958.25	
11+ 0	609.3224	1847.64	
11+ 5	621.2448	1731.13	
11+10	632.3718	1615.63	
11+15	642.7324	1504.36	
11+20	652.4148	1405.89	
11+25	661.5007	1319.27	
11+30	670.0900	1247.17	
11+35	678.2124	1179.37	
11+40	685.9000	1116.25	
11+45	693.1901	1058.51	
11+50	700.1337	1008.22	
11+55	706.7703	963.63	
12+ 0	713.1505	926.40	
12+ 5	719.2934	891.95	
12+10	725.2203	860.59	
12+15	730.9543	832.57	
12+20	736.5223	808.48	
12+25	741.9445	787.31	
12+30	747.2462	769.80	
12+35	752.4457	754.97	
12+40	757.5545	741.80	
12+45	762.5854	730.48	
12+50	767.5482	720.61	
12+55	772.4496	711.68	
13+ 0	777.2970	703.85	
13+ 5	782.0917	696.18	
13+10	786.8342	688.61	
13+15	791.5257	681.21	
13+20	796.1705	674.42	
13+25	800.7682	667.59	
13+30	805.3183	660.68	
13+35	809.8088	652.02	
13+40	814.2330	642.39	
13+45	818.5873	632.24	
13+50	822.8788	623.13	
13+55	827.1119	614.65	
14+ 0	831.2963	607.57	
14+ 5	835.4302	600.24	
14+10	839.5147	593.07	
14+15	843.5540	586.51	
14+20	847.5563	581.13	
14+25	851.5332	577.45	
14+30	855.5024	576.33	
14+35	859.4819	577.81	
14+40	863.4813	580.72	
14+45	867.5015	583.73	
14+50	871.5310	585.09	
14+55	875.5442	582.72	
15+ 0	879.4930	573.36	
15+ 5	883.3109	554.36	
15+10	886.9586	529.63	
15+15	890.4151	501.89	
15+20	893.7089	478.27	
15+25	896.8757	459.82	
15+30	899.9943	452.81	
15+35	903.1288	455.14	
15+40	906.3240	463.94	

15+45	909.6126	477.50	Q		V	
15+50	912.9844	489.59	Q		V	
15+55	916.4321	500.60	Q		V	
16+ 0	919.9167	505.96	Q		V	
16+ 5	923.4254	509.46	Q		V	
16+10	926.9450	511.05	Q		V	
16+15	930.4638	510.93	Q		V	
16+20	933.9805	510.63	Q		V	
16+25	937.4886	509.38	Q		V	
16+30	940.9905	508.48	Q		V	
16+35	944.4758	506.06	Q		V	
16+40	947.9408	503.13	Q		V	
16+45	951.3844	500.01	Q		V	
16+50	954.8103	497.44	Q		V	
16+55	958.2248	495.80	Q		V	
17+ 0	961.6375	495.52	Q		V	
17+ 5	965.0599	496.93	Q		V	
17+10	968.4972	499.09	Q		V	
17+15	971.9509	501.49	Q		V	
17+20	975.4155	503.05	Q		V	
17+25	978.8802	503.08	Q		V	
17+30	982.3249	500.17	Q		V	
17+35	985.7216	493.20	Q		V	
17+40	989.0540	483.85	Q		V	
17+45	992.3116	473.00	Q		V	
17+50	995.5040	463.54	Q		V	
17+55	998.6410	455.49	Q		V	
18+ 0	1001.7466	450.94	Q		V	
18+ 5	1004.8336	448.23	Q		V	
18+10	1007.9113	446.89	Q		V	
18+15	1010.9853	446.34	Q		V	
18+20	1014.0527	445.40	Q		V	
18+25	1017.1067	443.43	Q		V	
18+30	1020.1281	438.70	Q		V	
18+35	1023.0927	430.46	Q		V	
18+40	1025.9851	419.99	Q		V	
18+45	1028.7956	408.08	Q		V	
18+50	1031.5333	397.51	Q		V	
18+55	1034.2053	387.98	Q		V	
19+ 0	1036.8321	381.41	Q		V	
19+ 5	1039.4184	375.53	Q		V	
19+10	1041.9700	370.50	Q		V	
19+15	1044.4920	366.18	Q		V	
19+20	1046.9870	362.28	Q		V	
19+25	1049.4568	358.62	Q		V	
19+30	1051.8985	354.54	Q		V	
19+35	1054.3079	349.85	Q		V	
19+40	1056.6824	344.77	Q		V	
19+45	1059.0218	339.68	Q		V	
19+50	1061.3316	335.38	Q		V	
19+55	1063.6181	332.00	Q		V	
20+ 0	1065.8942	330.48	Q		V	
20+ 5	1068.1709	330.59	Q		V	
20+10	1070.4568	331.91	Q		V	
20+15	1072.7589	334.27	Q		V	
20+20	1075.0772	336.61	Q		V	
20+25	1077.4140	339.30	Q		V	
20+30	1079.7686	341.90	Q		V	
20+35	1082.1494	345.69	Q		V	
20+40	1084.5600	350.01	Q		V	
20+45	1087.0014	354.49	Q		V	
20+50	1089.4690	358.30	Q		V	
20+55	1091.9562	361.15	Q		V	

21+ 0	1094.4519	362.38		Q			V
21+ 5	1096.9446	361.93		Q			V
21+10	1099.4265	360.37		Q			V
21+15	1101.8911	357.86		Q			V
21+20	1104.3388	355.41		Q			V
21+25	1106.7679	352.70		Q			V
21+30	1109.1789	350.07		Q			V
21+35	1111.5644	346.39		Q			V
21+40	1113.9208	342.14		Q			V
21+45	1116.2459	337.61		Q			V
21+50	1118.5432	333.57		Q			V
21+55	1120.8163	330.05		Q			V
22+ 0	1123.0714	327.44		Q			V
22+ 5	1125.3107	325.15		Q			V
22+10	1127.5364	323.17		Q			V
22+15	1129.7504	321.48		Q			V
22+20	1131.9544	320.02		Q			V
22+25	1134.1499	318.79		Q			V
22+30	1136.3380	317.72		Q			V
22+35	1138.5196	316.76		Q			V
22+40	1140.6954	315.93		Q			V
22+45	1142.8662	315.20		Q			V
22+50	1145.0329	314.60		Q			V
22+55	1147.1959	314.07		Q			V
23+ 0	1149.3560	313.65		Q			V
23+ 5	1151.5144	313.40		Q			V
23+10	1153.6720	313.28		Q			V
23+15	1155.8304	313.41		Q			V
23+20	1157.9910	313.72		Q			V
23+25	1160.1568	314.47		Q			V
23+30	1162.3327	315.94		Q			V
23+35	1164.5271	318.63		Q			V
23+40	1166.7448	322.01		Q			V
23+45	1168.9879	325.70		Q			V
23+50	1171.2523	328.80		Q			V
23+55	1173.5327	331.11		Q			V
24+ 0	1175.8178	331.80		Q			V
24+ 5	1178.0935	330.43		Q			V
24+10	1180.3485	327.42		Q			V
24+15	1182.5672	322.15		Q			V
24+20	1184.7423	315.83		Q			V
24+25	1186.8490	305.89		Q			V
24+30	1188.8506	290.63		Q			V
24+35	1190.6718	264.45		Q			V
24+40	1192.2689	231.89		Q			V
24+45	1193.6145	195.39		Q			V
24+50	1194.7367	162.93		Q			V
24+55	1195.6599	134.05	Q				V
25+ 0	1196.4424	113.62	Q				V
25+ 5	1197.1025	95.84	Q				V
25+10	1197.6583	80.70	Q				V
25+15	1198.1278	68.17	Q				V
25+20	1198.5224	57.30	Q				V
25+25	1198.8552	48.32	Q				V
25+30	1199.1325	40.27	Q				V
25+35	1199.3630	33.46	Q				V
25+40	1199.5521	27.46	Q				V
25+45	1199.7053	22.25	Q				V
25+50	1199.8282	17.84	Q				V
25+55	1199.9239	13.90	Q				V
26+ 0	1199.9982	10.79	Q				V
26+ 5	1200.0540	8.10	Q				V
26+10	1200.0946	5.90	Q				V

```
   26+15    1200.1232      4.15  Q          |          |          |         V|
   26+20    1200.1420      2.73  Q          |          |          |         V|
   26+25    1200.1528      1.57  Q          |          |          |         V|
   26+30    1200.1571      0.63  Q          |          |          |         V|
   26+35    1200.1586      0.22  Q          |          |          |         V|
   26+40    1200.1586      0.00  Q          |          |          |          V
-------------------------------------------------------------------------------
```

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: bws100yr6hr.out

++

Program License Serial Number 4055

Tule Wind Project
Bow Willow Creek South
Existing 100 Year 6 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
5197.00	3.37

Rainfall Distribution pattern used in study:
Type B for SCS (small dam) or San Diego 6 hour storms

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
5197.00	1.000	88.0	88.0	0.050	C

Area-averaged catchment SCS Curve Number AMC(2) = 88.050
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   5197.00(Ac.)
Catchment Lag time =   0.940 hours
Unit interval = 10.000 minutes
Unit interval percentage of lag time = 17.7305
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 88.050

Rainfall depth area reduction factors:
Using a total area of   5197.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 1.000
Rainfall entered for study =   3.370(In)
Adjusted rainfall =   3.370(In)

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

(K = 31441.85 (CFS))

0.18	0.167	0.016	92.543	0.003
0.35	0.333	0.063	364.589	0.015
0.53	0.500	0.167	961.225	0.045
0.71	0.667	0.475	2739.226	0.132
0.89	0.833	0.889	5131.983	0.295
1.06	1.000	1.000	5771.063	0.479
1.24	1.167	0.768	4431.497	0.620
1.42	1.333	0.517	2982.476	0.715
1.60	1.500	0.394	2271.884	0.787
1.77	1.667	0.294	1694.984	0.841
1.95	1.833	0.227	1312.122	0.883
2.13	2.000	0.178	1028.502	0.915
2.30	2.167	0.140	805.323	0.941
2.48	2.333	0.108	622.145	0.961
2.66	2.500	0.080	458.945	0.975
2.84	2.667	0.058	336.197	0.986
3.01	2.833	0.040	232.321	0.993
3.19	3.000	0.027	152.980	0.998
3.37	3.167	0.009	49.538	1.000
3.55	3.333	0.000	2.309	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In) P	Total SCS Runoff (In) Q	Rainfall Amount (In) dP	Runoff Amount (In) dQ	Infiltration (In) dP-dQ	Revised Runoff Min Loss Rate
0.17	0.0393	0.0000	0.0393	0.0000	0.0393	--------
0.33	0.0786	0.0000	0.0393	0.0000	0.0393	--------

0.50	0.1180	0.0000	0.0393	0.0000	0.0393	--------
0.67	0.1707	0.0000	0.0528	0.0000	0.0528	--------
0.83	0.2235	0.0000	0.0528	0.0000	0.0528	--------
1.00	0.2763	0.0000	0.0528	0.0000	0.0528	--------
1.17	0.3415	0.0034	0.0652	0.0034	0.0617	--------
1.33	0.4066	0.0122	0.0652	0.0088	0.0563	--------
1.50	0.4718	0.0258	0.0652	0.0135	0.0516	--------
1.67	0.5729	0.0548	0.1011	0.0290	0.0721	--------
1.83	0.6740	0.0921	0.1011	0.0373	0.0638	--------
2.00	0.7751	0.1363	0.1011	0.0442	0.0569	--------
2.17	1.1907	0.3712	0.4156	0.2349	0.1807	--------
2.33	1.6064	0.6619	0.4156	0.2907	0.1249	--------
2.50	2.0220	0.9861	0.4156	0.3241	0.0915	--------
2.67	2.1343	1.0777	0.1123	0.0917	0.0207	--------
2.83	2.2467	1.1708	0.1123	0.0931	0.0193	--------
3.00	2.3590	1.2651	0.1123	0.0943	0.0180	--------
3.17	2.4500	1.3423	0.0910	0.0772	0.0138	--------
3.33	2.5410	1.4202	0.0910	0.0779	0.0131	--------
3.50	2.6320	1.4988	0.0910	0.0786	0.0124	--------
3.67	2.6926	1.5515	0.0607	0.0527	0.0080	--------
3.83	2.7533	1.6045	0.0607	0.0530	0.0077	--------
4.00	2.8140	1.6577	0.0607	0.0532	0.0075	--------
4.17	2.8645	1.7022	0.0505	0.0445	0.0060	--------
4.33	2.9150	1.7468	0.0505	0.0447	0.0059	--------
4.50	2.9656	1.7916	0.0506	0.0448	0.0057	--------
4.67	3.0139	1.8346	0.0483	0.0429	0.0054	--------
4.83	3.0622	1.8776	0.0483	0.0431	0.0052	--------
5.00	3.1105	1.9208	0.0483	0.0432	0.0051	--------
5.17	3.1521	1.9581	0.0416	0.0373	0.0043	--------
5.33	3.1936	1.9954	0.0416	0.0373	0.0042	--------
5.50	3.2352	2.0329	0.0416	0.0374	0.0041	--------
5.67	3.2801	2.0734	0.0449	0.0405	0.0044	--------
5.83	3.3251	2.1140	0.0449	0.0406	0.0043	--------
6.00	3.3700	2.1548	0.0449	0.0407	0.0042	--------

Total soil rain loss = 1.22(In)
Total effective runoff = 2.15(In)

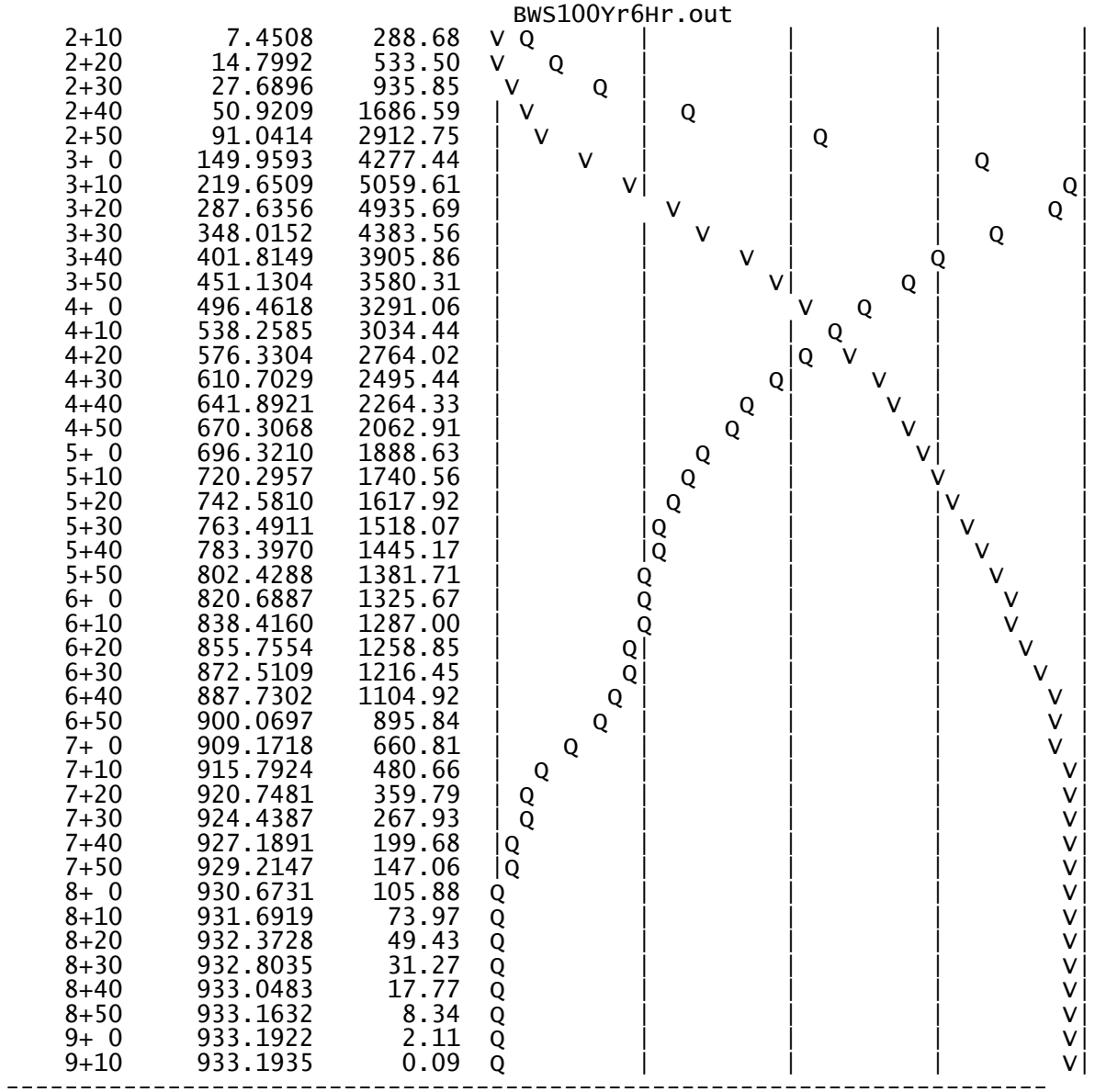
Peak flow rate this hydrograph = 5059.61(CFS)
Total runoff volume this hydrograph = 40649910.3(Ft3)

++

6 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 10 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	1275.0	2550.0	3825.0	5100.0
0+10	0.0000	0.00	Q	|	|	|	|
0+20	0.0000	0.00	Q	|	|	|	|
0+30	0.0000	0.00	Q	|	|	|	|
0+40	0.0000	0.00	Q	|	|	|	|
0+50	0.0000	0.00	Q	|	|	|	|
1+ 0	0.0000	0.00	Q	|	|	|	|
1+10	0.0045	0.32	Q	|	|	|	|
1+20	0.0331	2.08	Q	|	|	|	|
1+30	0.1406	7.80	Q	|	|	|	|
1+40	0.4925	25.55	Q	|	|	|	|
1+50	1.4405	68.83	Q	|	|	|	|
2+ 0	3.4745	147.67	VQ	|	|	|	|



2+10	7.4508	288.68	
2+20	14.7992	533.50	
2+30	27.6896	935.85	
2+40	50.9209	1686.59	
2+50	91.0414	2912.75	
3+ 0	149.9593	4277.44	
3+10	219.6509	5059.61	
3+20	287.6356	4935.69	
3+30	348.0152	4383.56	
3+40	401.8149	3905.86	
3+50	451.1304	3580.31	
4+ 0	496.4618	3291.06	
4+10	538.2585	3034.44	
4+20	576.3304	2764.02	
4+30	610.7029	2495.44	
4+40	641.8921	2264.33	
4+50	670.3068	2062.91	
5+ 0	696.3210	1888.63	
5+10	720.2957	1740.56	
5+20	742.5810	1617.92	
5+30	763.4911	1518.07	
5+40	783.3970	1445.17	
5+50	802.4288	1381.71	
6+ 0	820.6887	1325.67	
6+10	838.4160	1287.00	
6+20	855.7554	1258.85	
6+30	872.5109	1216.45	
6+40	887.7302	1104.92	
6+50	900.0697	895.84	
7+ 0	909.1718	660.81	
7+10	915.7924	480.66	
7+20	920.7481	359.79	
7+30	924.4387	267.93	
7+40	927.1891	199.68	
7+50	929.2147	147.06	
8+ 0	930.6731	105.88	
8+10	931.6919	73.97	
8+20	932.3728	49.43	
8+30	932.8035	31.27	
8+40	933.0483	17.77	
8+50	933.1632	8.34	
9+ 0	933.1922	2.11	
9+10	933.1935	0.09	

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: bws100yr24hr.out

++

Program License Serial Number 4055

Tule Wind Project
Bow Willow Creek South
Existing 100 Year 24 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

 English (in-lb) Input Units Used

 English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
5197.00	9.70

Rainfall Distribution pattern used in study:
Type B for San Diego area of California

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
5197.00	1.000	88.0	88.0	0.050	C

Area-averaged catchment SCS Curve Number AMC(2) = 88.050
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   5197.00(Ac.)
Catchment Lag time =   0.940 hours
Unit interval = 10.000 minutes
Unit interval percentage of lag time = 17.7305
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 88.050

Rainfall depth area reduction factors:
Using a total area of   5197.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 1.000
Rainfall entered for study =   9.700(In)
Adjusted rainfall =   9.700(In)

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

(K = 31441.85 (CFS))

0.18	0.167	0.016	92.543	0.003
0.35	0.333	0.063	364.589	0.015
0.53	0.500	0.167	961.225	0.045
0.71	0.667	0.475	2739.226	0.132
0.89	0.833	0.889	5131.983	0.295
1.06	1.000	1.000	5771.063	0.479
1.24	1.167	0.768	4431.497	0.620
1.42	1.333	0.517	2982.476	0.715
1.60	1.500	0.394	2271.884	0.787
1.77	1.667	0.294	1694.984	0.841
1.95	1.833	0.227	1312.122	0.883
2.13	2.000	0.178	1028.502	0.915
2.30	2.167	0.140	805.323	0.941
2.48	2.333	0.108	622.145	0.961
2.66	2.500	0.080	458.945	0.975
2.84	2.667	0.058	336.197	0.986
3.01	2.833	0.040	232.321	0.993
3.19	3.000	0.027	152.980	0.998
3.37	3.167	0.009	49.538	1.000
3.55	3.333	0.000	2.309	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In) P	Total SCS Runoff (In) Q	Rainfall Amount (In) dP	Runoff Amount (In) dQ	Infiltration (In) dP-dQ	Revised Runoff Min Loss Rate
0.17	0.0291	0.0000	0.0291	0.0000	0.0291	--------
0.33	0.0582	0.0000	0.0291	0.0000	0.0291	--------

0.50	0.0873	0.0000	0.0291	0.0000	0.0291	--------
0.67	0.1099	0.0000	0.0226	0.0000	0.0226	--------
0.83	0.1326	0.0000	0.0226	0.0000	0.0226	--------
1.00	0.1552	0.0000	0.0226	0.0000	0.0226	--------
1.17	0.1843	0.0000	0.0291	0.0000	0.0291	--------
1.33	0.2134	0.0000	0.0291	0.0000	0.0291	--------
1.50	0.2425	0.0000	0.0291	0.0000	0.0291	--------
1.67	0.2716	0.0000	0.0291	0.0000	0.0291	--------
1.83	0.3007	0.0006	0.0291	0.0006	0.0285	--------
2.00	0.3298	0.0024	0.0291	0.0018	0.0273	--------
2.17	0.3654	0.0061	0.0356	0.0037	0.0319	--------
2.33	0.4009	0.0113	0.0356	0.0052	0.0304	--------
2.50	0.4365	0.0179	0.0356	0.0066	0.0289	--------
2.67	0.4656	0.0243	0.0291	0.0064	0.0227	--------
2.83	0.4947	0.0315	0.0291	0.0072	0.0219	--------
3.00	0.5238	0.0396	0.0291	0.0080	0.0211	--------
3.17	0.5594	0.0504	0.0356	0.0108	0.0247	--------
3.33	0.5949	0.0623	0.0356	0.0119	0.0237	--------
3.50	0.6305	0.0751	0.0356	0.0129	0.0227	--------
3.67	0.6693	0.0902	0.0388	0.0151	0.0237	--------
3.83	0.7081	0.1063	0.0388	0.0161	0.0227	--------
4.00	0.7469	0.1234	0.0388	0.0171	0.0217	--------
4.17	0.7889	0.1429	0.0420	0.0195	0.0225	--------
4.33	0.8310	0.1633	0.0420	0.0205	0.0215	--------
4.50	0.8730	0.1847	0.0420	0.0214	0.0206	--------
4.67	0.9183	0.2088	0.0453	0.0240	0.0212	--------
4.83	0.9635	0.2337	0.0453	0.0250	0.0203	--------
5.00	1.0088	0.2596	0.0453	0.0258	0.0194	--------
5.17	1.0605	0.2901	0.0517	0.0305	0.0212	--------
5.33	1.1123	0.3217	0.0517	0.0315	0.0202	--------
5.50	1.1640	0.3541	0.0517	0.0325	0.0193	--------
5.67	1.2190	0.3896	0.0550	0.0354	0.0195	--------
5.83	1.2739	0.4259	0.0550	0.0363	0.0186	--------
6.00	1.3289	0.4631	0.0550	0.0372	0.0178	--------
6.17	1.3936	0.5079	0.0647	0.0448	0.0199	--------
6.33	1.4582	0.5537	0.0647	0.0458	0.0189	--------
6.50	1.5229	0.6004	0.0647	0.0467	0.0179	--------
6.67	1.5973	0.6552	0.0744	0.0548	0.0196	--------
6.83	1.6716	0.7110	0.0744	0.0559	0.0185	--------
7.00	1.7460	0.7678	0.0744	0.0568	0.0175	--------
7.17	1.8430	0.8433	0.0970	0.0755	0.0215	--------
7.33	1.9400	0.9201	0.0970	0.0768	0.0202	--------
7.50	2.0370	0.9982	0.0970	0.0781	0.0189	--------
7.67	2.1825	1.1175	0.1455	0.1192	0.0263	--------
7.83	2.3280	1.2389	0.1455	0.1215	0.0240	--------
8.00	2.4735	1.3624	0.1455	0.1234	0.0221	--------
8.17	2.6901	1.5493	0.2166	0.1869	0.0297	--------
8.33	2.9068	1.7395	0.2166	0.1902	0.0265	--------
8.50	3.1234	1.9324	0.2166	0.1929	0.0237	--------
8.67	3.4079	2.1892	0.2845	0.2568	0.0277	--------
8.83	3.6925	2.4493	0.2845	0.2601	0.0244	--------
9.00	3.9770	2.7122	0.2845	0.2629	0.0217	--------
9.17	4.2874	3.0016	0.3104	0.2894	0.0210	--------
9.33	4.5978	3.2933	0.3104	0.2917	0.0187	--------
9.50	4.9082	3.5869	0.3104	0.2936	0.0168	--------
9.67	5.1733	3.8390	0.2651	0.2521	0.0130	--------
9.83	5.4385	4.0922	0.2651	0.2532	0.0120	--------
10.00	5.7036	4.3463	0.2651	0.2541	0.0110	--------
10.17	5.8362	4.4737	0.1326	0.1274	0.0052	--------
10.33	5.9687	4.6012	0.1326	0.1276	0.0050	--------
10.50	6.1013	4.7290	0.1326	0.1278	0.0048	--------
10.67	6.1886	4.8132	0.0873	0.0842	0.0031	--------
10.83	6.2759	4.8975	0.0873	0.0843	0.0030	--------

11.00	6.3632	4.9819	0.0873	0.0844	0.0029	--------
11.17	6.4376	5.0538	0.0744	0.0719	0.0024	--------
11.33	6.5119	5.1257	0.0744	0.0720	0.0024	--------
11.50	6.5863	5.1978	0.0744	0.0720	0.0023	--------
11.67	6.6542	5.2636	0.0679	0.0658	0.0021	--------
11.83	6.7221	5.3294	0.0679	0.0658	0.0021	--------
12.00	6.7900	5.3953	0.0679	0.0659	0.0020	--------
12.17	6.8547	5.4580	0.0647	0.0628	0.0019	--------
12.33	6.9193	5.5208	0.0647	0.0628	0.0019	--------
12.50	6.9840	5.5836	0.0647	0.0628	0.0018	--------
12.67	7.0454	5.6433	0.0614	0.0597	0.0017	--------
12.83	7.1069	5.7031	0.0614	0.0597	0.0017	--------
13.00	7.1683	5.7628	0.0614	0.0598	0.0017	--------
13.17	7.2233	5.8163	0.0550	0.0535	0.0015	--------
13.33	7.2782	5.8698	0.0550	0.0535	0.0015	--------
13.50	7.3332	5.9234	0.0550	0.0535	0.0014	--------
13.67	7.3849	5.9738	0.0517	0.0504	0.0013	--------
13.83	7.4367	6.0242	0.0517	0.0504	0.0013	--------
14.00	7.4884	6.0746	0.0517	0.0504	0.0013	--------
14.17	7.5466	6.1314	0.0582	0.0568	0.0014	--------
14.33	7.6048	6.1881	0.0582	0.0568	0.0014	--------
14.50	7.6630	6.2449	0.0582	0.0568	0.0014	--------
14.67	7.6953	6.2765	0.0323	0.0316	0.0008	--------
14.83	7.7277	6.3080	0.0323	0.0316	0.0008	--------
15.00	7.7600	6.3396	0.0323	0.0316	0.0008	--------
15.17	7.8117	6.3901	0.0517	0.0505	0.0012	--------
15.33	7.8635	6.4407	0.0517	0.0505	0.0012	--------
15.50	7.9152	6.4912	0.0517	0.0506	0.0012	--------
15.67	7.9637	6.5386	0.0485	0.0474	0.0011	--------
15.83	8.0122	6.5860	0.0485	0.0474	0.0011	--------
16.00	8.0607	6.6335	0.0485	0.0474	0.0011	--------
16.17	8.1060	6.6777	0.0453	0.0443	0.0010	--------
16.33	8.1512	6.7220	0.0453	0.0443	0.0010	--------
16.50	8.1965	6.7663	0.0453	0.0443	0.0010	--------
16.67	8.2450	6.8138	0.0485	0.0475	0.0010	--------
16.83	8.2935	6.8613	0.0485	0.0475	0.0010	--------
17.00	8.3420	6.9088	0.0485	0.0475	0.0010	--------
17.17	8.3808	6.9468	0.0388	0.0380	0.0008	--------
17.33	8.4196	6.9848	0.0388	0.0380	0.0008	--------
17.50	8.4584	7.0228	0.0388	0.0380	0.0008	--------
17.67	8.5004	7.0640	0.0420	0.0412	0.0008	--------
17.83	8.5425	7.1052	0.0420	0.0412	0.0008	--------
18.00	8.5845	7.1464	0.0420	0.0412	0.0008	--------
18.17	8.6168	7.1781	0.0323	0.0317	0.0006	--------
18.33	8.6492	7.2098	0.0323	0.0317	0.0006	--------
18.50	8.6815	7.2415	0.0323	0.0317	0.0006	--------
18.67	8.7138	7.2732	0.0323	0.0317	0.0006	--------
18.83	8.7462	7.3049	0.0323	0.0317	0.0006	--------
19.00	8.7785	7.3366	0.0323	0.0317	0.0006	--------
19.17	8.8076	7.3652	0.0291	0.0286	0.0005	--------
19.33	8.8367	7.3937	0.0291	0.0286	0.0005	--------
19.50	8.8658	7.4223	0.0291	0.0286	0.0005	--------
19.67	8.8981	7.4540	0.0323	0.0317	0.0006	--------
19.83	8.9305	7.4857	0.0323	0.0317	0.0006	--------
20.00	8.9628	7.5175	0.0323	0.0317	0.0006	--------
20.17	8.9984	7.5524	0.0356	0.0349	0.0006	--------
20.33	9.0339	7.5873	0.0356	0.0349	0.0006	--------
20.50	9.0695	7.6223	0.0356	0.0349	0.0006	--------
20.67	9.1018	7.6540	0.0323	0.0318	0.0006	--------
20.83	9.1342	7.6858	0.0323	0.0318	0.0006	--------
21.00	9.1665	7.7175	0.0323	0.0318	0.0006	--------
21.17	9.1956	7.7461	0.0291	0.0286	0.0005	--------
21.33	9.2247	7.7747	0.0291	0.0286	0.0005	--------

21.50	9.2538	7.8033	0.0291	0.0286	0.0005 --------
21.67	9.2829	7.8319	0.0291	0.0286	0.0005 --------
21.83	9.3120	7.8605	0.0291	0.0286	0.0005 --------
22.00	9.3411	7.8891	0.0291	0.0286	0.0005 --------
22.17	9.3702	7.9177	0.0291	0.0286	0.0005 --------
22.33	9.3993	7.9464	0.0291	0.0286	0.0005 --------
22.50	9.4284	7.9750	0.0291	0.0286	0.0005 --------
22.67	9.4575	8.0036	0.0291	0.0286	0.0005 --------
22.83	9.4866	8.0322	0.0291	0.0286	0.0005 --------
23.00	9.5157	8.0608	0.0291	0.0286	0.0005 --------
23.17	9.5480	8.0926	0.0323	0.0318	0.0005 --------
23.33	9.5804	8.1244	0.0323	0.0318	0.0005 --------
23.50	9.6127	8.1562	0.0323	0.0318	0.0005 --------
23.67	9.6418	8.1849	0.0291	0.0286	0.0005 --------
23.83	9.6709	8.2135	0.0291	0.0286	0.0005 --------
24.00	9.7000	8.2422	0.0291	0.0286	0.0005 --------

Total soil rain loss = 1.46(In)
Total effective runoff = 8.24(In)

Peak flow rate this hydrograph = 8126.84(CFS)
Total runoff volume this hydrograph = 155489177.1(Ft3)

++

24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 10 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	2050.0	4100.0	6150.0	8200.0
0+10	0.0000	0.00	Q	|	|	|	|
0+20	0.0000	0.00	Q	|	|	|	|
0+30	0.0000	0.00	Q	|	|	|	|
0+40	0.0000	0.00	Q	|	|	|	|
0+50	0.0000	0.00	Q	|	|	|	|
1+ 0	0.0000	0.00	Q	|	|	|	|
1+10	0.0000	0.00	Q	|	|	|	|
1+20	0.0000	0.00	Q	|	|	|	|
1+30	0.0000	0.00	Q	|	|	|	|
1+40	0.0000	0.00	Q	|	|	|	|
1+50	0.0008	0.06	Q	|	|	|	|
2+ 0	0.0062	0.39	Q	|	|	|	|
2+10	0.0280	1.59	Q	|	|	|	|
2+20	0.1001	5.23	Q	|	|	|	|
2+30	0.2944	14.11	Q	|	|	|	|
2+40	0.7188	30.81	Q	|	|	|	|
2+50	1.4836	55.52	Q	|	|	|	|
3+ 0	2.6588	85.32	Q	|	|	|	|
3+10	4.2486	115.42	Q	|	|	|	|
3+20	6.2149	142.76	Q	|	|	|	|
3+30	8.5433	169.04	Q	|	|	|	|
3+40	11.2879	199.26	Q	|	|	|	|
3+50	14.5377	235.94	VQ	|	|	|	|
4+ 0	18.3382	275.91	VQ	|	|	|	|
4+10	22.7029	316.88	VQ	|	|	|	|
4+20	27.6501	359.16	VQ	|	|	|	|
4+30	33.1899	402.19	VQ	|	|	|	|
4+40	39.3255	445.44	V Q	|	|	|	|
4+50	46.0767	490.14	V Q	|	|	|	|
5+ 0	53.4493	535.26	V Q	|	|	|	|

5+10	61.4433	580.36	
5+20	70.0838	627.30	
5+30	79.3902	675.64	
5+40	89.4060	727.15	
5+50	100.2166	784.85	
6+ 0	111.8468	844.35	
6+10	124.2633	901.44	
6+20	137.4651	958.45	
6+30	151.4727	1016.95	
6+40	166.3777	1082.11	
6+50	182.3592	1160.26	
7+ 0	199.4991	1244.36	
7+10	217.8433	1331.79	
7+20	237.5408	1430.04	
7+30	258.7227	1537.81	
7+40	281.6812	1666.79	
7+50	306.9741	1836.26	
8+ 0	335.0085	2035.30	
8+10	366.4637	2283.64	
8+20	402.5227	2617.89	
8+30	443.8988	3003.90	
8+40	491.3451	3444.60	
8+50	546.2865	3988.74	
9+ 0	609.3854	4580.98	
9+10	680.7358	5180.03	
9+20	761.0144	5828.23	
9+30	850.2013	6474.97	
9+40	947.0703	7032.69	
9+50	1050.5552	7513.00	
10+ 0	1159.5167	7910.61	
10+10	1271.4566	8126.84	
10+20	1383.3580	8124.04	
10+30	1493.0286	7962.09	
10+40	1597.4353	7579.92	
10+50	1692.5675	6906.60	
11+ 0	1776.9554	6126.56	
11+10	1851.8425	5436.81	
11+20	1918.2454	4820.85	
11+30	1976.9066	4258.81	
11+40	2029.2848	3802.66	
11+50	2076.4833	3426.61	
12+ 0	2119.3044	3108.81	
12+10	2158.5758	2851.10	
12+20	2194.9093	2637.82	
12+30	2228.8372	2463.16	
12+40	2260.8953	2327.42	
12+50	2291.4737	2219.99	
13+ 0	2320.8635	2133.70	
13+10	2349.3783	2070.17	
13+20	2377.1615	2017.06	
13+30	2404.2677	1967.91	
13+40	2430.7230	1920.66	
13+50	2456.4487	1867.69	
14+ 0	2481.4348	1813.99	
14+10	2505.7905	1768.22	
14+20	2529.6020	1728.72	
14+30	2552.9810	1697.32	
14+40	2576.1814	1684.34	
14+50	2599.4285	1687.74	
15+ 0	2622.6364	1684.89	
15+10	2645.1485	1634.38	
15+20	2666.1163	1522.26	
15+30	2685.4404	1402.93	

15+40	2704.0207	1348.93	Q		V	
15+50	2722.9589	1374.91	Q		V	
16+ 0	2742.6324	1428.30	Q		V	
16+10	2762.8060	1464.60	Q		V	
16+20	2783.1115	1474.18	Q		V	
16+30	2803.3975	1472.77	Q		V	
16+40	2823.5698	1464.51	Q		V	
16+50	2843.5558	1450.98	Q		V	
17+ 0	2863.3602	1437.80	Q		V	
17+10	2883.1073	1433.64	Q		V	
17+20	2902.9297	1439.10	Q		V	
17+30	2922.8051	1442.96	Q		V	
17+40	2942.4854	1428.79	Q		V	
17+50	2961.6199	1389.16	Q		V	
18+ 0	2980.1193	1343.06	Q		V	
18+10	2998.1870	1311.72	Q		V	
18+20	3016.0648	1297.92	Q		V	
18+30	3033.7927	1287.05	Q		V	
18+40	3051.1549	1260.50	Q		V	
18+50	3067.8234	1210.13	Q		V	
19+ 0	3083.7166	1153.85	Q		V	
19+10	3099.0089	1110.22	Q		V	
19+20	3113.8828	1079.84	Q		V	
19+30	3128.4107	1054.73	Q		V	
19+40	3142.5964	1029.88	Q		V	
19+50	3156.4006	1002.19	Q		V	
20+ 0	3169.8618	977.28	Q		V	
20+10	3183.1575	965.27	Q		V	
20+20	3196.4931	968.17	Q		V	
20+30	3209.9720	978.56	Q		V	
20+40	3223.6460	992.73	Q		V	
20+50	3237.5728	1011.09	Q		V	
21+ 0	3251.7460	1028.97	Q		V	
21+10	3266.0233	1036.53	Q		V	
21+20	3280.2221	1030.84	Q		V	
21+30	3294.2525	1018.60	Q		V	
21+40	3308.0654	1002.82	Q		V	
21+50	3321.5992	982.56	Q		V	
22+ 0	3334.8411	961.36	Q		V	
22+10	3347.8640	945.47	Q		V	
22+20	3360.7377	934.63	Q		V	
22+30	3373.4951	926.19	Q		V	
22+40	3386.1613	919.56	Q		V	
22+50	3398.7544	914.26	Q		V	
23+ 0	3411.2903	910.11	Q		V	
23+10	3423.7837	907.02	Q		V	
23+20	3436.2571	905.56	Q		V	
23+30	3448.7469	906.76	Q		V	
23+40	3461.3370	914.04	Q		V	
23+50	3474.1270	928.55	Q		V	
24+ 0	3487.1221	943.45	Q		V	
24+10	3500.1539	946.11	Q		V	
24+20	3512.9488	928.91	Q		V	
24+30	3525.2124	890.33	Q		V	
24+40	3536.2765	803.25	Q		V	
24+50	3545.2438	651.03	Q		V	
25+ 0	3551.8809	481.85	Q		V	
25+10	3556.7313	352.14	Q		V	
25+20	3560.3753	264.56	Q		V	
25+30	3563.0984	197.70	Q		V	
25+40	3565.1326	147.68	Q		V	
25+50	3566.6322	108.87	Q		V	
26+ 0	3567.7129	78.45	Q		V	

26+10	3568.4633	54.48	Q	|	|	|	V|
26+20	3568.9583	35.94	Q	|	|	|	V|
26+30	3569.2656	22.31	Q	|	|	|	V|
26+40	3569.4382	12.53	Q	|	|	|	V|
26+50	3569.5190	5.87	Q	|	|	|	V|
27+ 0	3569.5394	1.48	Q	|	|	|	V|
27+10	3569.5403	0.07	Q	|	|	|	V|

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: north100yr6hr.out

++

Program License Serial Number 4055

Tule Wind Project
Unnamed Northern Wash
Existing 100 Year 6 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
1542.00	3.00

Rainfall Distribution pattern used in study:
Type B for SCS (small dam) or San Diego 6 hour storms

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
1542.00	1.000	82.7	82.7	0.050	B

Area-averaged catchment SCS Curve Number AMC(2) = 82.730
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   1542.00(Ac.)
Catchment Lag time =   0.490 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 17.0068
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 82.730

Rainfall depth area reduction factors:
Using a total area of   1542.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 1.000
Rainfall entered for study =   3.000(In)
Adjusted rainfall =   3.000(In)

++

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

++

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

(K = 18658.20 (CFS))

0.17	0.083	0.016	52.675	0.003
0.34	0.167	0.059	198.756	0.013
0.51	0.250	0.151	507.441	0.041
0.68	0.333	0.408	1365.747	0.114
0.85	0.417	0.818	2742.251	0.261
1.02	0.500	1.000	3350.925	0.440
1.19	0.583	0.827	2770.295	0.589
1.36	0.667	0.554	1856.539	0.688
1.53	0.750	0.424	1420.176	0.765
1.70	0.833	0.319	1068.004	0.822
1.87	0.917	0.247	826.450	0.866
2.04	1.000	0.195	653.065	0.901
2.21	1.083	0.154	515.905	0.929
2.38	1.167	0.122	409.102	0.951
2.55	1.250	0.093	310.128	0.967
2.72	1.333	0.070	233.636	0.980
2.89	1.417	0.050	167.340	0.989
3.06	1.500	0.036	120.679	0.995
3.23	1.583	0.021	69.730	0.999
3.40	1.667	0.006	19.310	1.000
3.57	1.750	0.000	0.046	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In) P	Total SCS Runoff (In) Q	Rainfall Amount (In) dP	Runoff Amount (In) dQ	Infiltration (In) dP-dQ	Revised Runoff Min Loss Rate
0.08	0.0175	0.0000	0.0175	0.0000	0.0175	--------

0.17	0.0350	0.0000	0.0175	0.0000	0.0175	--------
0.25	0.0525	0.0000	0.0175	0.0000	0.0175	--------
0.33	0.0700	0.0000	0.0175	0.0000	0.0175	--------
0.42	0.0875	0.0000	0.0175	0.0000	0.0175	--------
0.50	0.1050	0.0000	0.0175	0.0000	0.0175	--------
0.58	0.1285	0.0000	0.0235	0.0000	0.0235	--------
0.67	0.1520	0.0000	0.0235	0.0000	0.0235	--------
0.75	0.1755	0.0000	0.0235	0.0000	0.0235	--------
0.83	0.1990	0.0000	0.0235	0.0000	0.0235	--------
0.92	0.2225	0.0000	0.0235	0.0000	0.0235	--------
1.00	0.2460	0.0000	0.0235	0.0000	0.0235	--------
1.08	0.2750	0.0000	0.0290	0.0000	0.0290	--------
1.17	0.3040	0.0000	0.0290	0.0000	0.0290	--------
1.25	0.3330	0.0000	0.0290	0.0000	0.0290	--------
1.33	0.3620	0.0000	0.0290	0.0000	0.0290	--------
1.42	0.3910	0.0000	0.0290	0.0000	0.0290	--------
1.50	0.4200	0.0000	0.0290	0.0000	0.0290	--------
1.58	0.4650	0.0011	0.0450	0.0011	0.0439	--------
1.67	0.5100	0.0039	0.0450	0.0029	0.0421	--------
1.75	0.5550	0.0085	0.0450	0.0046	0.0404	--------
1.83	0.6000	0.0147	0.0450	0.0062	0.0388	--------
1.92	0.6450	0.0224	0.0450	0.0077	0.0373	--------
2.00	0.6900	0.0315	0.0450	0.0091	0.0359	--------
2.08	0.8750	0.0822	0.1850	0.0508	0.1342	--------
2.17	1.0600	0.1512	0.1850	0.0690	0.1160	--------
2.25	1.2450	0.2349	0.1850	0.0837	0.1013	--------
2.33	1.4300	0.3307	0.1850	0.0958	0.0892	--------
2.42	1.6150	0.4365	0.1850	0.1058	0.0792	--------
2.50	1.8000	0.5508	0.1850	0.1143	0.0707	--------
2.58	1.8500	0.5830	0.0500	0.0322	0.0178	--------
2.67	1.9000	0.6156	0.0500	0.0327	0.0173	--------
2.75	1.9500	0.6488	0.0500	0.0331	0.0169	--------
2.83	2.0000	0.6824	0.0500	0.0336	0.0164	--------
2.92	2.0500	0.7164	0.0500	0.0340	0.0160	--------
3.00	2.1000	0.7509	0.0500	0.0345	0.0155	--------
3.08	2.1405	0.7791	0.0405	0.0282	0.0123	--------
3.17	2.1810	0.8076	0.0405	0.0285	0.0120	--------
3.25	2.2215	0.8363	0.0405	0.0287	0.0118	--------
3.33	2.2620	0.8652	0.0405	0.0290	0.0115	--------
3.42	2.3025	0.8945	0.0405	0.0292	0.0113	--------
3.50	2.3430	0.9239	0.0405	0.0294	0.0111	--------
3.58	2.3700	0.9436	0.0270	0.0197	0.0073	--------
3.67	2.3970	0.9635	0.0270	0.0198	0.0072	--------
3.75	2.4240	0.9834	0.0270	0.0199	0.0071	--------
3.83	2.4510	1.0034	0.0270	0.0200	0.0070	--------
3.92	2.4780	1.0235	0.0270	0.0201	0.0069	--------
4.00	2.5050	1.0437	0.0270	0.0202	0.0068	--------
4.08	2.5275	1.0606	0.0225	0.0169	0.0056	--------
4.17	2.5500	1.0776	0.0225	0.0170	0.0055	--------
4.25	2.5725	1.0946	0.0225	0.0170	0.0055	--------
4.33	2.5950	1.1117	0.0225	0.0171	0.0054	--------
4.42	2.6175	1.1289	0.0225	0.0171	0.0054	--------
4.50	2.6400	1.1461	0.0225	0.0172	0.0053	--------
4.58	2.6615	1.1625	0.0215	0.0165	0.0050	--------
4.67	2.6830	1.1791	0.0215	0.0165	0.0050	--------
4.75	2.7045	1.1956	0.0215	0.0166	0.0049	--------
4.83	2.7260	1.2123	0.0215	0.0166	0.0049	--------
4.92	2.7475	1.2289	0.0215	0.0167	0.0048	--------
5.00	2.7690	1.2457	0.0215	0.0167	0.0048	--------
5.08	2.7875	1.2601	0.0185	0.0144	0.0041	--------
5.17	2.8060	1.2746	0.0185	0.0145	0.0040	--------
5.25	2.8245	1.2890	0.0185	0.0145	0.0040	--------
5.33	2.8430	1.3036	0.0185	0.0145	0.0040	--------

5.42	2.8615	1.3181	0.0185	0.0146	0.0039
5.50	2.8800	1.3327	0.0185	0.0146	0.0039
5.58	2.9000	1.3485	0.0200	0.0158	0.0042
5.67	2.9200	1.3644	0.0200	0.0158	0.0042
5.75	2.9400	1.3803	0.0200	0.0159	0.0041
5.83	2.9600	1.3962	0.0200	0.0159	0.0041
5.92	2.9800	1.4121	0.0200	0.0160	0.0040
6.00	3.0000	1.4281	0.0200	0.0160	0.0040

Total soil rain loss = 1.57(In)
Total effective runoff = 1.43(In)

Peak flow rate this hydrograph = 1328.54(CFS)
Total runoff volume this hydrograph = 7993792.1(Ft3)

6 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	350.0	700.0	1050.0	1400.0
0+ 5	0.0000	0.00	Q	|	|	|	|
0+10	0.0000	0.00	Q	|	|	|	|
0+15	0.0000	0.00	Q	|	|	|	|
0+20	0.0000	0.00	Q	|	|	|	|
0+25	0.0000	0.00	Q	|	|	|	|
0+30	0.0000	0.00	Q	|	|	|	|
0+35	0.0000	0.00	Q	|	|	|	|
0+40	0.0000	0.00	Q	|	|	|	|
0+45	0.0000	0.00	Q	|	|	|	|
0+50	0.0000	0.00	Q	|	|	|	|
0+55	0.0000	0.00	Q	|	|	|	|
1+ 0	0.0000	0.00	Q	|	|	|	|
1+ 5	0.0000	0.00	Q	|	|	|	|
1+10	0.0000	0.00	Q	|	|	|	|
1+15	0.0000	0.00	Q	|	|	|	|
1+20	0.0000	0.00	Q	|	|	|	|
1+25	0.0000	0.00	Q	|	|	|	|
1+30	0.0000	0.00	Q	|	|	|	|
1+35	0.0004	0.06	Q	|	|	|	|
1+40	0.0029	0.36	Q	|	|	|	|
1+45	0.0122	1.35	Q	|	|	|	|
1+50	0.0407	4.14	Q	|	|	|	|
1+55	0.1148	10.77	Q	|	|	|	|
2+ 0	0.2718	22.79	Q	|	|	|	|
2+ 5	0.5603	41.89	VQ	|	|	|	|
2+10	1.0493	71.00	V Q	|	|	|	|
2+15	1.8590	117.58	V Q	|	|	|	|
2+20	3.2884	207.55	V Q	|	|	|	|
2+25	5.8657	374.22	|V Q	|	|	|	|
2+30	10.0355	605.46	| V | Q	|	|	|	|
2+35	15.8953	850.84	| V | Q	|	|	|	|
2+40	23.2662	1070.25	| V | Q	|	|	|	|
2+45	31.8600	1247.82	| V | Q	|	|	|	|
2+50	41.0097	1328.54	| V | Q	|	|	|	|
2+55	49.6959	1261.24	| V | Q	|	|	|	|
3+ 0	57.3289	1108.31	| V | Q	|	|	|	|
3+ 5	64.0426	974.83	| V | Q	|	|	|	|
3+10	70.2161	896.40	| V | Q	|	|	|	|

3+15	75.9762	836.36	
3+20	81.4003	787.58	
3+25	86.4937	739.56	
3+30	91.2709	693.65	
3+35	95.7829	655.13	
3+40	100.0772	623.53	
3+45	104.1770	595.30	
3+50	108.0626	564.18	
3+55	111.6737	524.33	
4+ 0	114.9915	481.75	
4+ 5	118.0816	448.68	
4+10	121.0319	428.39	
4+15	123.8780	413.25	
4+20	126.6254	398.92	
4+25	129.2596	382.49	
4+30	131.7789	365.80	
4+35	134.2066	352.50	
4+40	136.5716	343.40	
4+45	138.8893	336.52	
4+50	141.1677	330.83	
4+55	143.4093	325.48	
5+ 0	145.6175	320.63	
5+ 5	147.8008	317.01	
5+10	149.9671	314.55	
5+15	152.1172	312.20	
5+20	154.2407	308.33	
5+25	156.3178	301.60	
5+30	158.3404	293.68	
5+35	160.3198	287.41	
5+40	162.2734	283.66	
5+45	164.2114	281.40	
5+50	166.1468	281.02	
5+55	168.0950	282.88	
6+ 0	170.0639	285.89	
6+ 5	172.0456	287.74	
6+10	174.0183	286.44	
6+15	175.9462	279.92	
6+20	177.7326	259.39	
6+25	179.2245	216.62	
6+30	180.3534	163.91	
6+35	181.1822	120.34	
6+40	181.8110	91.30	
6+45	182.2870	69.12	
6+50	182.6481	52.44	
6+55	182.9202	39.51	
7+ 0	183.1219	29.28	
7+ 5	183.2676	21.16	
7+10	183.3687	14.68	
7+15	183.4358	9.74	
7+20	183.4772	6.02	
7+25	183.5003	3.35	
7+30	183.5101	1.42	
7+35	183.5122	0.31	
7+40	183.5122	0.00	

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: north100yr24hr.out

++

Program License Serial Number 4055

Tule Wind Project
Unnamed Northern Wash
Existing 100 Year 24 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
1542.00	6.31

Rainfall Distribution pattern used in study:
Type B for San Diego area of California

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
1542.00	1.000	82.7	82.7	0.050	B

Area-averaged catchment SCS Curve Number AMC(2) = 82.730
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   1542.00(Ac.)
Catchment Lag time =   0.490 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 17.0068
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 82.730

Rainfall depth area reduction factors:
Using a total area of   1542.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 1.000
Rainfall entered for study =   6.310(In)
Adjusted rainfall =   6.310(In)

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

(K = 18658.20 (CFS))

0.17	0.083	0.016	52.675	0.003
0.34	0.167	0.059	198.756	0.013
0.51	0.250	0.151	507.441	0.041
0.68	0.333	0.408	1365.747	0.114
0.85	0.417	0.818	2742.251	0.261
1.02	0.500	1.000	3350.925	0.440
1.19	0.583	0.827	2770.295	0.589
1.36	0.667	0.554	1856.539	0.688
1.53	0.750	0.424	1420.176	0.765
1.70	0.833	0.319	1068.004	0.822
1.87	0.917	0.247	826.450	0.866
2.04	1.000	0.195	653.065	0.901
2.21	1.083	0.154	515.905	0.929
2.38	1.167	0.122	409.102	0.951
2.55	1.250	0.093	310.128	0.967
2.72	1.333	0.070	233.636	0.980
2.89	1.417	0.050	167.340	0.989
3.06	1.500	0.036	120.679	0.995
3.23	1.583	0.021	69.730	0.999
3.40	1.667	0.006	19.310	1.000
3.57	1.750	0.000	0.046	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In) P	Total SCS Runoff (In) Q	Rainfall Amount (In) dP	Runoff Amount (In) dQ	Infiltration (In) dP-dQ	Revised Runoff Min Loss Rate
0.08	0.0095	0.0000	0.0095	0.0000	0.0095	--------

0.17	0.0189	0.0000	0.0095	0.0000	0.0095	--------
0.25	0.0284	0.0000	0.0095	0.0000	0.0095	--------
0.33	0.0379	0.0000	0.0095	0.0000	0.0095	--------
0.42	0.0473	0.0000	0.0095	0.0000	0.0095	--------
0.50	0.0568	0.0000	0.0095	0.0000	0.0095	--------
0.58	0.0642	0.0000	0.0074	0.0000	0.0074	--------
0.67	0.0715	0.0000	0.0074	0.0000	0.0074	--------
0.75	0.0789	0.0000	0.0074	0.0000	0.0074	--------
0.83	0.0862	0.0000	0.0074	0.0000	0.0074	--------
0.92	0.0936	0.0000	0.0074	0.0000	0.0074	--------
1.00	0.1010	0.0000	0.0074	0.0000	0.0074	--------
1.08	0.1104	0.0000	0.0095	0.0000	0.0095	--------
1.17	0.1199	0.0000	0.0095	0.0000	0.0095	--------
1.25	0.1294	0.0000	0.0095	0.0000	0.0095	--------
1.33	0.1388	0.0000	0.0095	0.0000	0.0095	--------
1.42	0.1483	0.0000	0.0095	0.0000	0.0095	--------
1.50	0.1577	0.0000	0.0095	0.0000	0.0095	--------
1.58	0.1672	0.0000	0.0095	0.0000	0.0095	--------
1.67	0.1767	0.0000	0.0095	0.0000	0.0095	--------
1.75	0.1861	0.0000	0.0095	0.0000	0.0095	--------
1.83	0.1956	0.0000	0.0095	0.0000	0.0095	--------
1.92	0.2051	0.0000	0.0095	0.0000	0.0095	--------
2.00	0.2145	0.0000	0.0095	0.0000	0.0095	--------
2.08	0.2261	0.0000	0.0116	0.0000	0.0116	--------
2.17	0.2377	0.0000	0.0116	0.0000	0.0116	--------
2.25	0.2492	0.0000	0.0116	0.0000	0.0116	--------
2.33	0.2608	0.0000	0.0116	0.0000	0.0116	--------
2.42	0.2724	0.0000	0.0116	0.0000	0.0116	--------
2.50	0.2839	0.0000	0.0116	0.0000	0.0116	--------
2.58	0.2934	0.0000	0.0095	0.0000	0.0095	--------
2.67	0.3029	0.0000	0.0095	0.0000	0.0095	--------
2.75	0.3123	0.0000	0.0095	0.0000	0.0095	--------
2.83	0.3218	0.0000	0.0095	0.0000	0.0095	--------
2.92	0.3313	0.0000	0.0095	0.0000	0.0095	--------
3.00	0.3407	0.0000	0.0095	0.0000	0.0095	--------
3.08	0.3523	0.0000	0.0116	0.0000	0.0116	--------
3.17	0.3639	0.0000	0.0116	0.0000	0.0116	--------
3.25	0.3754	0.0000	0.0116	0.0000	0.0116	--------
3.33	0.3870	0.0000	0.0116	0.0000	0.0116	--------
3.42	0.3986	0.0000	0.0116	0.0000	0.0116	--------
3.50	0.4101	0.0000	0.0116	0.0000	0.0116	--------
3.58	0.4228	0.0000	0.0126	0.0000	0.0126	--------
3.67	0.4354	0.0002	0.0126	0.0001	0.0125	--------
3.75	0.4480	0.0004	0.0126	0.0003	0.0123	--------
3.83	0.4606	0.0009	0.0126	0.0004	0.0122	--------
3.92	0.4732	0.0015	0.0126	0.0006	0.0120	--------
4.00	0.4859	0.0022	0.0126	0.0007	0.0119	--------
4.08	0.4995	0.0031	0.0137	0.0009	0.0127	--------
4.17	0.5132	0.0042	0.0137	0.0011	0.0126	--------
4.25	0.5269	0.0054	0.0137	0.0013	0.0124	--------
4.33	0.5406	0.0068	0.0137	0.0014	0.0123	--------
4.42	0.5542	0.0084	0.0137	0.0016	0.0121	--------
4.50	0.5679	0.0101	0.0137	0.0017	0.0120	--------
4.58	0.5826	0.0121	0.0147	0.0020	0.0127	--------
4.67	0.5973	0.0143	0.0147	0.0022	0.0126	--------
4.75	0.6121	0.0166	0.0147	0.0023	0.0124	--------
4.83	0.6268	0.0191	0.0147	0.0025	0.0122	--------
4.92	0.6415	0.0217	0.0147	0.0026	0.0121	--------
5.00	0.6562	0.0245	0.0147	0.0028	0.0119	--------
5.08	0.6731	0.0279	0.0168	0.0034	0.0135	--------
5.17	0.6899	0.0314	0.0168	0.0036	0.0133	--------
5.25	0.7067	0.0352	0.0168	0.0038	0.0131	--------
5.33	0.7235	0.0391	0.0168	0.0039	0.0129	--------

5.42	0.7404	0.0432	0.0168	0.0041	0.0127	--------
5.50	0.7572	0.0475	0.0168	0.0043	0.0125	--------
5.58	0.7751	0.0523	0.0179	0.0048	0.0131	--------
5.67	0.7930	0.0572	0.0179	0.0049	0.0129	--------
5.75	0.8108	0.0624	0.0179	0.0051	0.0128	--------
5.83	0.8287	0.0677	0.0179	0.0053	0.0126	--------
5.92	0.8466	0.0732	0.0179	0.0055	0.0124	--------
6.00	0.8645	0.0788	0.0179	0.0057	0.0122	--------
6.08	0.8855	0.0857	0.0210	0.0069	0.0142	--------
6.17	0.9065	0.0928	0.0210	0.0071	0.0139	--------
6.25	0.9276	0.1002	0.0210	0.0073	0.0137	--------
6.33	0.9486	0.1077	0.0210	0.0076	0.0135	--------
6.42	0.9696	0.1155	0.0210	0.0078	0.0133	--------
6.50	0.9907	0.1235	0.0210	0.0080	0.0131	--------
6.58	1.0149	0.1329	0.0242	0.0094	0.0148	--------
6.67	1.0390	0.1426	0.0242	0.0097	0.0145	--------
6.75	1.0632	0.1526	0.0242	0.0100	0.0142	--------
6.83	1.0874	0.1628	0.0242	0.0102	0.0140	--------
6.92	1.1116	0.1732	0.0242	0.0104	0.0137	--------
7.00	1.1358	0.1839	0.0242	0.0107	0.0135	--------
7.08	1.1673	0.1982	0.0315	0.0143	0.0173	--------
7.17	1.1989	0.2128	0.0316	0.0147	0.0169	--------
7.25	1.2304	0.2279	0.0315	0.0150	0.0165	--------
7.33	1.2620	0.2432	0.0315	0.0154	0.0162	--------
7.42	1.2935	0.2590	0.0316	0.0157	0.0158	--------
7.50	1.3251	0.2750	0.0315	0.0161	0.0155	--------
7.58	1.3724	0.2997	0.0473	0.0247	0.0226	--------
7.67	1.4197	0.3251	0.0473	0.0254	0.0219	--------
7.75	1.4671	0.3512	0.0473	0.0260	0.0213	--------
7.83	1.5144	0.3778	0.0473	0.0267	0.0206	--------
7.92	1.5617	0.4051	0.0473	0.0273	0.0200	--------
8.00	1.6090	0.4330	0.0473	0.0279	0.0195	--------
8.08	1.6795	0.4755	0.0705	0.0425	0.0280	--------
8.17	1.7500	0.5191	0.0705	0.0437	0.0268	--------
8.25	1.8204	0.5639	0.0705	0.0447	0.0257	--------
8.33	1.8909	0.6096	0.0705	0.0458	0.0247	--------
8.42	1.9614	0.6564	0.0705	0.0467	0.0237	--------
8.50	2.0318	0.7040	0.0705	0.0476	0.0228	--------
8.58	2.1244	0.7678	0.0925	0.0638	0.0287	--------
8.67	2.2169	0.8330	0.0925	0.0652	0.0273	--------
8.75	2.3095	0.8995	0.0925	0.0665	0.0261	--------
8.83	2.4020	0.9672	0.0925	0.0677	0.0249	--------
8.92	2.4946	1.0359	0.0925	0.0688	0.0238	--------
9.00	2.5871	1.1057	0.0925	0.0698	0.0227	--------
9.08	2.6881	1.1830	0.1010	0.0772	0.0237	--------
9.17	2.7890	1.2613	0.1010	0.0783	0.0226	--------
9.25	2.8900	1.3406	0.1010	0.0793	0.0216	--------
9.33	2.9909	1.4209	0.1010	0.0803	0.0207	--------
9.42	3.0919	1.5020	0.1010	0.0811	0.0198	--------
9.50	3.1929	1.5840	0.1010	0.0820	0.0190	--------
9.58	3.2791	1.6546	0.0862	0.0706	0.0156	--------
9.67	3.3653	1.7257	0.0862	0.0712	0.0151	--------
9.75	3.4516	1.7974	0.0862	0.0717	0.0146	--------
9.83	3.5378	1.8696	0.0862	0.0721	0.0141	--------
9.92	3.6240	1.9422	0.0862	0.0726	0.0136	--------
10.00	3.7103	2.0152	0.0862	0.0730	0.0132	--------
10.08	3.7534	2.0519	0.0431	0.0367	0.0064	--------
10.17	3.7965	2.0887	0.0431	0.0368	0.0063	--------
10.25	3.8396	2.1255	0.0431	0.0369	0.0062	--------
10.33	3.8828	2.1625	0.0431	0.0370	0.0061	--------
10.42	3.9259	2.1996	0.0431	0.0371	0.0060	--------
10.50	3.9690	2.2368	0.0431	0.0372	0.0060	--------
10.58	3.9974	2.2613	0.0284	0.0245	0.0039	--------

10.67	4.0258	2.2858	0.0284	0.0246	0.0038	--------
10.75	4.0542	2.3104	0.0284	0.0246	0.0038	--------
10.83	4.0826	2.3351	0.0284	0.0246	0.0038	--------
10.92	4.1110	2.3598	0.0284	0.0247	0.0037	--------
11.00	4.1394	2.3845	0.0284	0.0247	0.0037	--------
11.08	4.1635	2.4055	0.0242	0.0211	0.0031	--------
11.17	4.1877	2.4266	0.0242	0.0211	0.0031	--------
11.25	4.2119	2.4478	0.0242	0.0211	0.0031	--------
11.33	4.2361	2.4689	0.0242	0.0212	0.0030	--------
11.42	4.2603	2.4901	0.0242	0.0212	0.0030	--------
11.50	4.2845	2.5113	0.0242	0.0212	0.0030	--------
11.58	4.3066	2.5307	0.0221	0.0194	0.0027	--------
11.67	4.3287	2.5501	0.0221	0.0194	0.0027	--------
11.75	4.3507	2.5695	0.0221	0.0194	0.0027	--------
11.83	4.3728	2.5890	0.0221	0.0194	0.0026	--------
11.92	4.3949	2.6084	0.0221	0.0195	0.0026	--------
12.00	4.4170	2.6279	0.0221	0.0195	0.0026	--------
12.08	4.4380	2.6465	0.0210	0.0186	0.0025	--------
12.17	4.4591	2.6650	0.0210	0.0186	0.0024	--------
12.25	4.4801	2.6836	0.0210	0.0186	0.0024	--------
12.33	4.5011	2.7023	0.0210	0.0186	0.0024	--------
12.42	4.5222	2.7209	0.0210	0.0186	0.0024	--------
12.50	4.5432	2.7395	0.0210	0.0187	0.0024	--------
12.58	4.5632	2.7573	0.0200	0.0177	0.0022	--------
12.67	4.5832	2.7750	0.0200	0.0177	0.0022	--------
12.75	4.6031	2.7928	0.0200	0.0178	0.0022	--------
12.83	4.6231	2.8106	0.0200	0.0178	0.0022	--------
12.92	4.6431	2.8284	0.0200	0.0178	0.0022	--------
13.00	4.6631	2.8462	0.0200	0.0178	0.0022	--------
13.08	4.6810	2.8621	0.0179	0.0159	0.0019	--------
13.17	4.6988	2.8781	0.0179	0.0160	0.0019	--------
13.25	4.7167	2.8940	0.0179	0.0160	0.0019	--------
13.33	4.7346	2.9100	0.0179	0.0160	0.0019	--------
13.42	4.7525	2.9260	0.0179	0.0160	0.0019	--------
13.50	4.7704	2.9420	0.0179	0.0160	0.0019	--------
13.58	4.7872	2.9570	0.0168	0.0151	0.0018	--------
13.67	4.8040	2.9721	0.0168	0.0151	0.0018	--------
13.75	4.8208	2.9872	0.0168	0.0151	0.0017	--------
13.83	4.8377	3.0023	0.0168	0.0151	0.0017	--------
13.92	4.8545	3.0174	0.0168	0.0151	0.0017	--------
14.00	4.8713	3.0325	0.0168	0.0151	0.0017	--------
14.08	4.8902	3.0495	0.0189	0.0170	0.0019	--------
14.17	4.9092	3.0665	0.0189	0.0170	0.0019	--------
14.25	4.9281	3.0835	0.0189	0.0170	0.0019	--------
14.33	4.9470	3.1006	0.0189	0.0170	0.0019	--------
14.42	4.9660	3.1176	0.0189	0.0171	0.0019	--------
14.50	4.9849	3.1347	0.0189	0.0171	0.0019	--------
14.58	4.9954	3.1442	0.0105	0.0095	0.0010	--------
14.67	5.0059	3.1537	0.0105	0.0095	0.0010	--------
14.75	5.0164	3.1632	0.0105	0.0095	0.0010	--------
14.83	5.0270	3.1726	0.0105	0.0095	0.0010	--------
14.92	5.0375	3.1821	0.0105	0.0095	0.0010	--------
15.00	5.0480	3.1916	0.0105	0.0095	0.0010	--------
15.08	5.0648	3.2069	0.0168	0.0152	0.0016	--------
15.17	5.0817	3.2221	0.0168	0.0152	0.0016	--------
15.25	5.0985	3.2373	0.0168	0.0152	0.0016	--------
15.33	5.1153	3.2525	0.0168	0.0152	0.0016	--------
15.42	5.1321	3.2678	0.0168	0.0152	0.0016	--------
15.50	5.1490	3.2830	0.0168	0.0152	0.0016	--------
15.58	5.1647	3.2973	0.0158	0.0143	0.0015	--------
15.67	5.1805	3.3116	0.0158	0.0143	0.0015	--------
15.75	5.1963	3.3259	0.0158	0.0143	0.0015	--------
15.83	5.2121	3.3402	0.0158	0.0143	0.0015	--------

15.92	5.2278	3.3546	0.0158	0.0143	0.0014	--------
16.00	5.2436	3.3689	0.0158	0.0143	0.0014	--------
16.08	5.2583	3.3823	0.0147	0.0134	0.0013	--------
16.17	5.2731	3.3957	0.0147	0.0134	0.0013	--------
16.25	5.2878	3.4091	0.0147	0.0134	0.0013	--------
16.33	5.3025	3.4225	0.0147	0.0134	0.0013	--------
16.42	5.3172	3.4359	0.0147	0.0134	0.0013	--------
16.50	5.3319	3.4493	0.0147	0.0134	0.0013	--------
16.58	5.3477	3.4637	0.0158	0.0144	0.0014	--------
16.67	5.3635	3.4780	0.0158	0.0144	0.0014	--------
16.75	5.3793	3.4924	0.0158	0.0144	0.0014	--------
16.83	5.3950	3.5068	0.0158	0.0144	0.0014	--------
16.92	5.4108	3.5212	0.0158	0.0144	0.0014	--------
17.00	5.4266	3.5356	0.0158	0.0144	0.0014	--------
17.08	5.4392	3.5472	0.0126	0.0115	0.0011	--------
17.17	5.4518	3.5587	0.0126	0.0115	0.0011	--------
17.25	5.4645	3.5702	0.0126	0.0115	0.0011	--------
17.33	5.4771	3.5818	0.0126	0.0115	0.0011	--------
17.42	5.4897	3.5933	0.0126	0.0115	0.0011	--------
17.50	5.5023	3.6049	0.0126	0.0115	0.0011	--------
17.58	5.5160	3.6174	0.0137	0.0125	0.0012	--------
17.67	5.5297	3.6299	0.0137	0.0125	0.0012	--------
17.75	5.5433	3.6424	0.0137	0.0125	0.0011	--------
17.83	5.5570	3.6550	0.0137	0.0125	0.0011	--------
17.92	5.5707	3.6675	0.0137	0.0125	0.0011	--------
18.00	5.5843	3.6800	0.0137	0.0125	0.0011	--------
18.08	5.5949	3.6897	0.0105	0.0096	0.0009	--------
18.17	5.6054	3.6993	0.0105	0.0096	0.0009	--------
18.25	5.6159	3.7090	0.0105	0.0097	0.0009	--------
18.33	5.6264	3.7186	0.0105	0.0097	0.0009	--------
18.42	5.6369	3.7283	0.0105	0.0097	0.0009	--------
18.50	5.6474	3.7380	0.0105	0.0097	0.0009	--------
18.58	5.6580	3.7476	0.0105	0.0097	0.0009	--------
18.67	5.6685	3.7573	0.0105	0.0097	0.0009	--------
18.75	5.6790	3.7669	0.0105	0.0097	0.0008	--------
18.83	5.6895	3.7766	0.0105	0.0097	0.0008	--------
18.92	5.7000	3.7863	0.0105	0.0097	0.0008	--------
19.00	5.7105	3.7960	0.0105	0.0097	0.0008	--------
19.08	5.7200	3.8047	0.0095	0.0087	0.0008	--------
19.17	5.7295	3.8134	0.0095	0.0087	0.0008	--------
19.25	5.7389	3.8221	0.0095	0.0087	0.0008	--------
19.33	5.7484	3.8308	0.0095	0.0087	0.0008	--------
19.42	5.7579	3.8395	0.0095	0.0087	0.0007	--------
19.50	5.7673	3.8482	0.0095	0.0087	0.0007	--------
19.58	5.7779	3.8579	0.0105	0.0097	0.0008	--------
19.67	5.7884	3.8676	0.0105	0.0097	0.0008	--------
19.75	5.7989	3.8773	0.0105	0.0097	0.0008	--------
19.83	5.8094	3.8870	0.0105	0.0097	0.0008	--------
19.92	5.8199	3.8967	0.0105	0.0097	0.0008	--------
20.00	5.8304	3.9064	0.0105	0.0097	0.0008	--------
20.08	5.8420	3.9171	0.0116	0.0107	0.0009	--------
20.17	5.8536	3.9278	0.0116	0.0107	0.0009	--------
20.25	5.8651	3.9384	0.0116	0.0107	0.0009	--------
20.33	5.8767	3.9491	0.0116	0.0107	0.0009	--------
20.42	5.8883	3.9598	0.0116	0.0107	0.0009	--------
20.50	5.8998	3.9705	0.0116	0.0107	0.0009	--------
20.58	5.9104	3.9802	0.0105	0.0097	0.0008	--------
20.67	5.9209	3.9899	0.0105	0.0097	0.0008	--------
20.75	5.9314	3.9997	0.0105	0.0097	0.0008	--------
20.83	5.9419	4.0094	0.0105	0.0097	0.0008	--------
20.92	5.9524	4.0191	0.0105	0.0097	0.0008	--------
21.00	5.9629	4.0288	0.0105	0.0097	0.0008	--------
21.08	5.9724	4.0376	0.0095	0.0088	0.0007	--------

21.17	5.9819	4.0464	0.0095	0.0088	0.0007	--------
21.25	5.9913	4.0551	0.0095	0.0088	0.0007	--------
21.33	6.0008	4.0639	0.0095	0.0088	0.0007	--------
21.42	6.0103	4.0726	0.0095	0.0088	0.0007	--------
21.50	6.0197	4.0814	0.0095	0.0088	0.0007	--------
21.58	6.0292	4.0902	0.0095	0.0088	0.0007	--------
21.67	6.0387	4.0990	0.0095	0.0088	0.0007	--------
21.75	6.0481	4.1077	0.0095	0.0088	0.0007	--------
21.83	6.0576	4.1165	0.0095	0.0088	0.0007	--------
21.92	6.0671	4.1253	0.0095	0.0088	0.0007	--------
22.00	6.0765	4.1341	0.0095	0.0088	0.0007	--------
22.08	6.0860	4.1428	0.0095	0.0088	0.0007	--------
22.17	6.0955	4.1516	0.0095	0.0088	0.0007	--------
22.25	6.1049	4.1604	0.0095	0.0088	0.0007	--------
22.33	6.1144	4.1692	0.0095	0.0088	0.0007	--------
22.42	6.1239	4.1780	0.0095	0.0088	0.0007	--------
22.50	6.1333	4.1867	0.0095	0.0088	0.0007	--------
22.58	6.1428	4.1955	0.0095	0.0088	0.0007	--------
22.67	6.1522	4.2043	0.0095	0.0088	0.0007	--------
22.75	6.1617	4.2131	0.0095	0.0088	0.0007	--------
22.83	6.1712	4.2219	0.0095	0.0088	0.0007	--------
22.92	6.1806	4.2307	0.0095	0.0088	0.0007	--------
23.00	6.1901	4.2395	0.0095	0.0088	0.0007	--------
23.08	6.2006	4.2493	0.0105	0.0098	0.0007	--------
23.17	6.2111	4.2591	0.0105	0.0098	0.0007	--------
23.25	6.2217	4.2688	0.0105	0.0098	0.0007	--------
23.33	6.2322	4.2786	0.0105	0.0098	0.0007	--------
23.42	6.2427	4.2884	0.0105	0.0098	0.0007	--------
23.50	6.2532	4.2982	0.0105	0.0098	0.0007	--------
23.58	6.2627	4.3070	0.0095	0.0088	0.0007	--------
23.67	6.2721	4.3158	0.0095	0.0088	0.0007	--------
23.75	6.2816	4.3246	0.0095	0.0088	0.0007	--------
23.83	6.2911	4.3334	0.0095	0.0088	0.0007	--------
23.92	6.3005	4.3422	0.0095	0.0088	0.0007	--------
24.00	6.3100	4.3511	0.0095	0.0088	0.0006	--------

Total soil rain loss = 1.96(In)
Total effective runoff = 4.35(In)

Peak flow rate this hydrograph = 1428.08(CFS)
Total runoff volume this hydrograph = 24354896.9(Ft3)

++

24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	375.0	750.0	1125.0	1500.0
0+ 5	0.0000	0.00	Q	|	|	|	|
0+10	0.0000	0.00	Q	|	|	|	|
0+15	0.0000	0.00	Q	|	|	|	|
0+20	0.0000	0.00	Q	|	|	|	|
0+25	0.0000	0.00	Q	|	|	|	|
0+30	0.0000	0.00	Q	|	|	|	|
0+35	0.0000	0.00	Q	|	|	|	|
0+40	0.0000	0.00	Q	|	|	|	|
0+45	0.0000	0.00	Q	|	|	|	|
0+50	0.0000	0.00	Q	|	|	|	|
0+55	0.0000	0.00	Q	|	|	|	|

1+ 0	0.0000	0.00	Q	|	|	|	|
1+ 5	0.0000	0.00	Q	|	|	|	|
1+10	0.0000	0.00	Q	|	|	|	|
1+15	0.0000	0.00	Q	|	|	|	|
1+20	0.0000	0.00	Q	|	|	|	|
1+25	0.0000	0.00	Q	|	|	|	|
1+30	0.0000	0.00	Q	|	|	|	|
1+35	0.0000	0.00	Q	|	|	|	|
1+40	0.0000	0.00	Q	|	|	|	|
1+45	0.0000	0.00	Q	|	|	|	|
1+50	0.0000	0.00	Q	|	|	|	|
1+55	0.0000	0.00	Q	|	|	|	|
2+ 0	0.0000	0.00	Q	|	|	|	|
2+ 5	0.0000	0.00	Q	|	|	|	|
2+10	0.0000	0.00	Q	|	|	|	|
2+15	0.0000	0.00	Q	|	|	|	|
2+20	0.0000	0.00	Q	|	|	|	|
2+25	0.0000	0.00	Q	|	|	|	|
2+30	0.0000	0.00	Q	|	|	|	|
2+35	0.0000	0.00	Q	|	|	|	|
2+40	0.0000	0.00	Q	|	|	|	|
2+45	0.0000	0.00	Q	|	|	|	|
2+50	0.0000	0.00	Q	|	|	|	|
2+55	0.0000	0.00	Q	|	|	|	|
3+ 0	0.0000	0.00	Q	|	|	|	|
3+ 5	0.0000	0.00	Q	|	|	|	|
3+10	0.0000	0.00	Q	|	|	|	|
3+15	0.0000	0.00	Q	|	|	|	|
3+20	0.0000	0.00	Q	|	|	|	|
3+25	0.0000	0.00	Q	|	|	|	|
3+30	0.0000	0.00	Q	|	|	|	|
3+35	0.0000	0.00	Q	|	|	|	|
3+40	0.0001	0.01	Q	|	|	|	|
3+45	0.0004	0.05	Q	|	|	|	|
3+50	0.0016	0.17	Q	|	|	|	|
3+55	0.0049	0.49	Q	|	|	|	|
4+ 0	0.0131	1.19	Q	|	|	|	|
4+ 5	0.0294	2.37	Q	|	|	|	|
4+10	0.0567	3.96	Q	|	|	|	|
4+15	0.0969	5.85	Q	|	|	|	|
4+20	0.1520	8.00	Q	|	|	|	|
4+25	0.2239	10.43	Q	|	|	|	|
4+30	0.3138	13.05	Q	|	|	|	|
4+35	0.4225	15.78	Q	|	|	|	|
4+40	0.5503	18.56	Q	|	|	|	|
4+45	0.6978	21.41	Q	|	|	|	|
4+50	0.8659	24.41	Q	|	|	|	|
4+55	1.0563	27.64	Q	|	|	|	|
5+ 0	1.2698	31.00	Q	|	|	|	|
5+ 5	1.5063	34.34	Q	|	|	|	|
5+10	1.7655	37.64	VQ	|	|	|	|
5+15	2.0480	41.01	VQ	|	|	|	|
5+20	2.3558	44.70	VQ	|	|	|	|
5+25	2.6932	48.98	VQ	|	|	|	|
5+30	3.0622	53.58	VQ	|	|	|	|
5+35	3.4618	58.03	VQ	|	|	|	|
5+40	3.8900	62.18	VQ	|	|	|	|
5+45	4.3462	66.24	VQ	|	|	|	|
5+50	4.8311	70.40	VQ	|	|	|	|
5+55	5.3466	74.85	VQ	|	|	|	|
6+ 0	5.8936	79.43	V Q	|	|	|	|
6+ 5	6.4712	83.86	V Q	|	|	|	|
6+10	7.0783	88.15	V Q	|	|	|	|

6+15	7.7161	92.60	V Q
6+20	8.3897	97.81	V Q
6+25	9.1089	104.42	V Q
6+30	9.8783	111.72	V Q
6+35	10.6949	118.57	V Q
6+40	11.5538	124.71	V Q
6+45	12.4545	130.78	V Q
6+50	13.4020	137.58	V Q
6+55	14.4067	145.89	|V Q
7+ 0	15.4735	154.89	|V Q
7+ 5	16.5985	163.35	|V Q
7+10	17.7772	171.15	|V Q
7+15	19.0127	179.40	|V Q
7+20	20.3219	190.10	|V Q
7+25	21.7354	205.23	|V Q
7+30	23.2678	222.52	|V Q
7+35	24.9103	238.49	|V Q
7+40	26.6509	252.73	|V Q
7+45	28.4976	268.15	| V Q
7+50	30.4925	289.66	| V Q
7+55	32.7117	322.22	| V Q
8+ 0	35.1920	360.14	| V Q|
8+ 5	37.9093	394.56	| V Q
8+10	40.8283	423.84	| V |Q
8+15	43.9549	453.98	| V | Q
8+20	47.3538	493.51	| V | Q
8+25	51.1488	551.04	| V | Q
8+30	55.3985	617.06	| V | Q
8+35	60.0549	676.11	| V | Q
8+40	65.0457	724.66	| V | Q|
8+45	70.3589	771.47	| V | Q
8+50	76.0493	826.25	| V | | Q
8+55	82.2394	898.80	| V | | Q
9+ 0	88.9816	978.98	| V | | Q
9+ 5	96.2092	1049.45	| V | | Q
9+10	103.8234	1105.58	| V | | Q|
9+15	111.7814	1155.50	| V | | Q
9+20	120.0752	1204.25	| V | | Q
9+25	128.7319	1256.96	| V| | Q
9+30	137.7542	1310.04	| V| | Q
9+35	147.0906	1355.63	| V | Q
9+40	156.6685	1390.72	| V | Q
9+45	166.4258	1416.75	| V | Q
9+50	176.2610	1428.08	| V | Q
9+55	186.0344	1419.10	| V | Q
10+ 0	195.6736	1399.60	| V | Q
10+ 5	205.1926	1382.16	| V | Q
10+10	214.6121	1367.72	| V | Q
10+15	223.8767	1345.23	| V | Q
10+20	232.7882	1293.94	| V | Q
10+25	241.0071	1193.39	| V | Q
10+30	248.3820	1070.83	| V | Q
10+35	255.0541	968.80	| V | Q
10+40	261.2406	898.27	| V | Q
10+45	267.0261	840.06	| V| Q
10+50	272.4264	784.12	| VQ
10+55	277.3835	719.77	| Q|
11+ 0	281.8882	654.09	| Q V
11+ 5	286.0259	600.79	| Q V
11+10	289.9017	562.77	| Q V
11+15	293.5709	532.77	| Q |V
11+20	297.0607	506.72	| Q |V
11+25	300.3732	480.96	| Q |V

11+30	303.5189	456.76	| Q |V | |
11+35	306.5361	438.10	|Q |V | |
11+40	309.4676	425.64	|Q | V | |
11+45	312.3335	416.13	|Q | V | |
11+50	315.1384	407.27	Q | V | |
11+55	317.8763	397.55	Q | V | |
12+ 0	320.5479	387.91	Q | V | |
12+ 5	323.1678	380.41	Q | V | |
12+10	325.7537	375.47	Q | V | |
12+15	328.3132	371.64	Q| | V | |
12+20	330.8472	367.94	Q| | V | |
12+25	333.3515	363.62	Q| | V | |
12+30	335.8255	359.23	Q| | V | |
12+35	338.2755	355.74	Q| | V | |
12+40	340.7090	353.35	Q| | V | |
12+45	343.1285	351.31	Q| | V | |
12+50	345.5316	348.93	Q| | V | |
12+55	347.9118	345.61	Q| | V | |
13+ 0	350.2669	341.95	Q| | V | |
13+ 5	352.6013	338.95	Q| | V | |
13+10	354.9202	336.71	Q | | V | |
13+15	357.2234	334.43	Q | | V | |
13+20	359.5025	330.92	Q | | V | |
13+25	361.7416	325.11	Q | | V | |
13+30	363.9341	318.35	Q | | V | |
13+35	366.0884	312.80	Q | | V | |
13+40	368.2162	308.96	Q | | V | |
13+45	370.3219	305.75	Q | | V | |
13+50	372.4048	302.45	Q | | V | |
13+55	374.4597	298.37	Q | | V | |
14+ 0	376.4850	294.07	Q | | V | |
14+ 5	378.4872	290.72	Q | | V | |
14+10	380.4759	288.75	Q | | V | |
14+15	382.4591	287.97	Q | | V | |
14+20	384.4515	289.29	Q | | V | |
14+25	386.4732	293.56	Q | | V | |
14+30	388.5340	299.23	Q | | V | |
14+35	390.6252	303.64	Q | | V | |
14+40	392.7285	305.41	Q | | V | |
14+45	394.8231	304.14	Q | | V | |
14+50	396.8600	295.76	Q | | V | |
14+55	398.7646	276.53	Q | | V | |
15+ 0	400.5027	252.38	Q | | V | |
15+ 5	402.1054	232.71	Q | | V | |
15+10	403.6248	220.62	Q | | V | |
15+15	405.0947	213.43	Q | | V | |
15+20	406.5661	213.65	Q | | V| |
15+25	408.1049	223.43	Q | | V| |
15+30	409.7434	237.91	Q | | V| |
15+35	411.4651	249.99	Q | | V| |
15+40	413.2381	257.44	Q | | V| |
15+45	415.0482	262.83	Q | | V| |
15+50	416.8800	265.98	Q | | V| |
15+55	418.7184	266.94	Q | | V| |
16+ 0	420.5551	266.68	Q | | V |
16+ 5	422.3908	266.54	Q | | V |
16+10	424.2288	266.89	Q | | V |
16+15	426.0673	266.95	Q | | V |
16+20	427.8998	266.08	Q | | V |
16+25	429.7163	263.75	Q | | V |
16+30	431.5119	260.73	Q | | V |
16+35	433.2899	258.16	Q | | V |
16+40	435.0558	256.41	Q | | |V |

```
16+45     436.8144    255.35  |      Q    |           |           |V          |
16+50     438.5742    255.53  |      Q    |           |           |V          |
16+55     440.3463    257.31  |      Q    |           |           |V          |
17+ 0     442.1362    259.90  |      Q    |           |           |V          |
17+ 5     443.9403    261.95  |      Q    |           |           |V          |
17+10     445.7507    262.86  |       Q   |           |           |V          |
17+15     447.5590    262.58  |       Q   |           |           | V         |
17+20     449.3466    259.55  |      Q    |           |           | V         |
17+25     451.0848    252.38  |      Q    |           |           | V         |
17+30     452.7606    243.34  |      Q    |           |           | V         |
17+35     454.3854    235.92  |      Q    |           |           | V         |
17+40     455.9779    231.22  |      Q    |           |           | V         |
17+45     457.5481    228.00  |      Q    |           |           | V         |
17+50     459.1083    226.54  |      Q    |           |           | V         |
17+55     460.6719    227.04  |      Q    |           |           | V         |
18+ 0     462.2462    228.58  |      Q    |           |           |  V        |
18+ 5     463.8285    229.75  |      Q    |           |           |  V        |
18+10     465.4117    229.88  |      Q    |           |           |  V        |
18+15     466.9886    228.97  |      Q    |           |           |  V        |
18+20     468.5412    225.45  |      Q    |           |           |  V        |
18+25     470.0419    217.90  |     Q     |           |           |  V        |
18+30     471.4782    208.55  |     Q     |           |           |  V        |
18+35     472.8618    200.89  |     Q     |           |           |  V        |
18+40     474.2111    195.92  |     Q     |           |           |  V        |
18+45     475.5345    192.16  |     Q     |           |           |   V       |
18+50     476.8385    189.35  |     Q     |           |           |   V       |
18+55     478.1276    187.17  |    Q      |           |           |   V       |
19+ 0     479.4047    185.44  |    Q      |           |           |   V       |
19+ 5     480.6721    184.02  |    Q      |           |           |   V       |
19+10     481.9304    182.71  |    Q      |           |           |   V       |
19+15     483.1794    181.37  |    Q      |           |           |   V       |
19+20     484.4151    179.41  |    Q      |           |           |   V       |
19+25     485.6294    176.32  |    Q      |           |           |   V       |
19+30     486.8193    172.77  |    Q      |           |           |   V       |
19+35     487.9900    169.98  |    Q      |           |           |   V       |
19+40     489.1495    168.36  |    Q      |           |           |   V       |
19+45     490.3032    167.52  |    Q      |           |           |    V      |
19+50     491.4591    167.85  |    Q      |           |           |    V      |
19+55     492.6281    169.74  |    Q      |           |           |    V      |
20+ 0     493.8154    172.40  |    Q      |           |           |    V      |
20+ 5     495.0184    174.67  |    Q      |           |           |    V      |
20+10     496.2327    176.31  |    Q      |           |           |    V      |
20+15     497.4580    177.92  |    Q      |           |           |    V      |
20+20     498.6983    180.09  |    Q      |           |           |    V      |
20+25     499.9616    183.44  |    Q      |           |           |    V      |
20+30     501.2512    187.25  |    Q      |           |           |    V      |
20+35     502.5623    190.36  |     Q     |           |           |    V      |
20+40     503.8873    192.40  |     Q     |           |           |     V     |
20+45     505.2209    193.63  |     Q     |           |           |     V     |
20+50     506.5543    193.62  |     Q     |           |           |     V     |
20+55     507.8764    191.96  |     Q     |           |           |     V     |
21+ 0     509.1815    189.50  |     Q     |           |           |     V     |
21+ 5     510.4720    187.37  |    Q      |           |           |     V     |
21+10     511.7518    185.84  |    Q      |           |           |     V     |
21+15     513.0211    184.31  |    Q      |           |           |     V     |
21+20     514.2760    182.21  |    Q      |           |           |     V     |
21+25     515.5084    178.94  |    Q      |           |           |     V     |
21+30     516.7150    175.20  |    Q      |           |           |     V     |
21+35     517.9003    172.11  |    Q      |           |           |      V    |
21+40     519.0708    169.96  |    Q      |           |           |      V    |
21+45     520.2300    168.31  |    Q      |           |           |      V    |
21+50     521.3807    167.08  |    Q      |           |           |      V    |
21+55     522.5250    166.15  |    Q      |           |           |      V    |
```

```
   22+ 0     523.6643    165.43  |    Q      |           |           |       V   |
   22+ 5     524.7999    164.89  |    Q      |           |           |       V   |
   22+10     525.9328    164.51  |    Q      |           |           |       V   |
   22+15     527.0640    164.24  |    Q      |           |           |       V   |
   22+20     528.1937    164.04  |    Q      |           |           |       V   |
   22+25     529.3226    163.91  |    Q      |           |           |       V   |
   22+30     530.4508    163.82  |    Q      |           |           |       V   |
   22+35     531.5789    163.79  |    Q      |           |           |        V  |
   22+40     532.7070    163.80  |    Q      |           |           |        V  |
   22+45     533.8353    163.83  |    Q      |           |           |        V  |
   22+50     534.9638    163.86  |    Q      |           |           |        V  |
   22+55     536.0925    163.89  |    Q      |           |           |        V  |
   23+ 0     537.2215    163.92  |    Q      |           |           |        V  |
   23+ 5     538.3510    164.01  |    Q      |           |           |        V  |
   23+10     539.4821    164.23  |    Q      |           |           |        V  |
   23+15     540.6168    164.76  |    Q      |           |           |        V  |
   23+20     541.7609    166.12  |    Q      |           |           |        V  |
   23+25     542.9237    168.84  |    Q      |           |           |        V  |
   23+30     544.1093    172.14  |    Q      |           |           |        V  |
   23+35     545.3134    174.83  |    Q      |           |           |         V |
   23+40     546.5288    176.49  |    Q      |           |           |         V |
   23+45     547.7507    177.42  |    Q      |           |           |         V |
   23+50     548.9708    177.16  |    Q      |           |           |         V |
   23+55     550.1782    175.32  |    Q      |           |           |         V |
   24+ 0     551.3677    172.71  |    Q      |           |           |         V |
   24+ 5     552.5389    170.07  |    Q      |           |           |         V |
   24+10     553.6886    166.93  |    Q      |           |           |         V |
   24+15     554.8002    161.40  |    Q      |           |           |         V |
   24+20     555.8234    148.57  |   Q       |           |           |         V |
   24+25     556.6758    123.77  |   Q       |           |           |         V |
   24+30     557.3212     93.72  |  Q        |           |           |         V |
   24+35     557.7955     68.87  |Q          |           |           |         V |
   24+40     558.1546     52.13  |Q          |           |           |         V |
   24+45     558.4253     39.31  |Q          |           |           |         V |
   24+50     558.6297     29.68  Q           |           |           |         V |
   24+55     558.7828     22.23  Q           |           |           |         V |
   25+ 0     558.8954     16.36  Q           |           |           |         V |
   25+ 5     558.9763     11.74  Q           |           |           |         V |
   25+10     559.0322      8.12  Q           |           |           |         V |
   25+15     559.0693      5.38  Q           |           |           |         V |
   25+20     559.0922      3.32  Q           |           |           |         V |
   25+25     559.1049      1.85  Q           |           |           |         V |
   25+30     559.1103      0.79  Q           |           |           |         V |
   25+35     559.1115      0.17  Q           |           |           |         V |
   25+40     559.1115      0.00  Q           |           |           |         V |
-------------------------------------------------------------------------------
```

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: east100yr6hr.out

++

Program License Serial Number 4055

Tule Wind Project
Unnamed Eastern Wash
Existing 100 Year 6 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
734.00	3.00

Rainfall Distribution pattern used in study:
Type B for SCS (small dam) or San Diego 6 hour storms

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
734.00	1.000	85.1	85.1	0.050	C

Area-averaged catchment SCS Curve Number AMC(2) = 85.130
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   734.00(Ac.)
Catchment Lag time =   0.380 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 21.9298
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 85.130

Rainfall depth area reduction factors:
Using a total area of   734.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 1.000
Rainfall entered for study =   3.000(In)
Adjusted rainfall =   3.000(In)

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

(K = 8881.40 (CFS))

0.22	0.083	0.017	34.408	0.004
0.44	0.167	0.085	169.808	0.023
0.66	0.250	0.290	580.041	0.088
0.88	0.333	0.784	1566.642	0.265
1.10	0.417	1.000	1997.798	0.490
1.32	0.500	0.716	1430.728	0.651
1.54	0.583	0.467	933.347	0.756
1.75	0.667	0.329	656.341	0.830
1.97	0.750	0.237	473.266	0.883
2.19	0.833	0.175	348.921	0.922
2.41	0.917	0.129	256.962	0.951
2.63	1.000	0.091	181.388	0.972
2.85	1.083	0.062	124.326	0.986
3.07	1.167	0.040	80.165	0.995
3.29	1.250	0.020	40.797	0.999
3.51	1.333	0.003	6.463	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In) P	Total SCS Runoff (In) Q	Rainfall Amount (In) dP	Runoff Amount (In) dQ	Infiltr-ation (In) dP-dQ	Revised Runoff Min Loss Rate
0.08	0.0175	0.0000	0.0175	0.0000	0.0175	--------
0.17	0.0350	0.0000	0.0175	0.0000	0.0175	--------
0.25	0.0525	0.0000	0.0175	0.0000	0.0175	--------
0.33	0.0700	0.0000	0.0175	0.0000	0.0175	--------
0.42	0.0875	0.0000	0.0175	0.0000	0.0175	--------
0.50	0.1050	0.0000	0.0175	0.0000	0.0175	--------

0.58	0.1285	0.0000	0.0235	0.0000	0.0235	--------
0.67	0.1520	0.0000	0.0235	0.0000	0.0235	--------
0.75	0.1755	0.0000	0.0235	0.0000	0.0235	--------
0.83	0.1990	0.0000	0.0235	0.0000	0.0235	--------
0.92	0.2225	0.0000	0.0235	0.0000	0.0235	--------
1.00	0.2460	0.0000	0.0235	0.0000	0.0235	--------
1.08	0.2750	0.0000	0.0290	0.0000	0.0290	--------
1.17	0.3040	0.0000	0.0290	0.0000	0.0290	--------
1.25	0.3330	0.0000	0.0290	0.0000	0.0290	--------
1.33	0.3620	0.0001	0.0290	0.0001	0.0289	--------
1.42	0.3910	0.0010	0.0290	0.0009	0.0281	--------
1.50	0.4200	0.0027	0.0290	0.0018	0.0272	--------
1.58	0.4650	0.0072	0.0450	0.0044	0.0406	--------
1.67	0.5100	0.0135	0.0450	0.0063	0.0387	--------
1.75	0.5550	0.0217	0.0450	0.0081	0.0369	--------
1.83	0.6000	0.0315	0.0450	0.0098	0.0352	--------
1.92	0.6450	0.0428	0.0450	0.0113	0.0337	--------
2.00	0.6900	0.0556	0.0450	0.0128	0.0322	--------
2.08	0.8750	0.1216	0.1850	0.0660	0.1190	--------
2.17	1.0600	0.2055	0.1850	0.0839	0.1011	--------
2.25	1.2450	0.3036	0.1850	0.0981	0.0869	--------
2.33	1.4300	0.4130	0.1850	0.1094	0.0756	--------
2.42	1.6150	0.5318	0.1850	0.1187	0.0663	--------
2.50	1.8000	0.6582	0.1850	0.1264	0.0586	--------
2.58	1.8500	0.6935	0.0500	0.0353	0.0147	--------
2.67	1.9000	0.7292	0.0500	0.0358	0.0142	--------
2.75	1.9500	0.7654	0.0500	0.0362	0.0138	--------
2.83	2.0000	0.8020	0.0500	0.0366	0.0134	--------
2.92	2.0500	0.8390	0.0500	0.0370	0.0130	--------
3.00	2.1000	0.8763	0.0500	0.0373	0.0127	--------
3.08	2.1405	0.9068	0.0405	0.0305	0.0100	--------
3.17	2.1810	0.9376	0.0405	0.0307	0.0098	--------
3.25	2.2215	0.9685	0.0405	0.0310	0.0095	--------
3.33	2.2620	0.9997	0.0405	0.0312	0.0093	--------
3.42	2.3025	1.0311	0.0405	0.0314	0.0091	--------
3.50	2.3430	1.0626	0.0405	0.0316	0.0089	--------
3.58	2.3700	1.0838	0.0270	0.0212	0.0058	--------
3.67	2.3970	1.1050	0.0270	0.0212	0.0058	--------
3.75	2.4240	1.1263	0.0270	0.0213	0.0057	--------
3.83	2.4510	1.1477	0.0270	0.0214	0.0056	--------
3.92	2.4780	1.1692	0.0270	0.0215	0.0055	--------
4.00	2.5050	1.1908	0.0270	0.0216	0.0054	--------
4.08	2.5275	1.2088	0.0225	0.0180	0.0045	--------
4.17	2.5500	1.2269	0.0225	0.0181	0.0044	--------
4.25	2.5725	1.2450	0.0225	0.0181	0.0044	--------
4.33	2.5950	1.2631	0.0225	0.0182	0.0043	--------
4.42	2.6175	1.2814	0.0225	0.0182	0.0043	--------
4.50	2.6400	1.2996	0.0225	0.0183	0.0042	--------
4.58	2.6615	1.3171	0.0215	0.0175	0.0040	--------
4.67	2.6830	1.3347	0.0215	0.0175	0.0040	--------
4.75	2.7045	1.3522	0.0215	0.0176	0.0039	--------
4.83	2.7260	1.3699	0.0215	0.0176	0.0039	--------
4.92	2.7475	1.3875	0.0215	0.0177	0.0038	--------
5.00	2.7690	1.4052	0.0215	0.0177	0.0038	--------
5.08	2.7875	1.4205	0.0185	0.0153	0.0032	--------
5.17	2.8060	1.4358	0.0185	0.0153	0.0032	--------
5.25	2.8245	1.4511	0.0185	0.0153	0.0032	--------
5.33	2.8430	1.4664	0.0185	0.0153	0.0032	--------
5.42	2.8615	1.4818	0.0185	0.0154	0.0031	--------
5.50	2.8800	1.4972	0.0185	0.0154	0.0031	--------
5.58	2.9000	1.5139	0.0200	0.0167	0.0033	--------
5.67	2.9200	1.5306	0.0200	0.0167	0.0033	--------
5.75	2.9400	1.5474	0.0200	0.0167	0.0033	--------

5.83	2.9600	1.5641	0.0200	0.0168	0.0032 --------
5.92	2.9800	1.5809	0.0200	0.0168	0.0032 --------
6.00	3.0000	1.5978	0.0200	0.0168	0.0032 --------

Total soil rain loss = 1.40(In)
Total effective runoff = 1.60(In)

Peak flow rate this hydrograph = 808.32(CFS)
Total runoff volume this hydrograph = 4257090.5(Ft3)

++

6 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0 225.0 450.0 675.0 900.0
0+ 5	0.0000	0.00	Q
0+10	0.0000	0.00	Q
0+15	0.0000	0.00	Q
0+20	0.0000	0.00	Q
0+25	0.0000	0.00	Q
0+30	0.0000	0.00	Q
0+35	0.0000	0.00	Q
0+40	0.0000	0.00	Q
0+45	0.0000	0.00	Q
0+50	0.0000	0.00	Q
0+55	0.0000	0.00	Q
1+ 0	0.0000	0.00	Q
1+ 5	0.0000	0.00	Q
1+10	0.0000	0.00	Q
1+15	0.0000	0.00	Q
1+20	0.0000	0.00	Q
1+25	0.0003	0.05	Q
1+30	0.0021	0.26	Q
1+35	0.0098	1.11	Q
1+40	0.0343	3.56	Q
1+45	0.0935	8.60	Q
1+50	0.2123	17.24	Q
1+55	0.4120	29.00	VQ
2+ 0	0.7019	42.09	VQ
2+ 5	1.0975	57.45	V Q
2+10	1.6519	80.49	V Q
2+15	2.5289	127.34	V Q
2+20	4.1401	233.94	V Q
2+25	6.7974	385.85	V Q
2+30	10.4704	533.31	V Q
2+35	15.0279	661.76	V Q
2+40	20.2786	762.39	V Q
2+45	25.8455	808.32	V Q
2+50	30.9599	742.61	V Q
2+55	35.2026	616.05	V Q
3+ 0	38.8239	525.81	V Q
3+ 5	42.0612	470.06	V Q
3+10	45.0275	430.70	VQ
3+15	47.7741	398.81	Q V
3+20	50.2944	365.94	Q V
3+25	52.6021	335.08	Q V
3+30	54.7581	313.05	Q V
3+35	56.8108	298.06	Q V

```
    3+40      58.7860    286.80  |          | Q        |   V      |          |
    3+45      60.6844    275.64  |          | Q        |   V      |          |
    3+50      62.4600    257.82  |          |Q         |    V     |          |
    3+55      64.0881    236.41  |         Q|          |     V    |          |
    4+ 0      65.6120    221.27  |        Q |          |     V    |          |
    4+ 5      67.0686    211.49  |        Q |          |      V   |          |
    4+10      68.4758    204.33  |        Q |          |       V  |          |
    4+15      69.8381    197.81  |       Q  |          |       V  |          |
    4+20      71.1412    189.20  |       Q  |          |        V |          |
    4+25      72.3806    179.97  |      Q   |          |        V |          |
    4+30      73.5756    173.51  |      Q   |          |         V|          |
    4+35      74.7419    169.35  |      Q   |          |         V|          |
    4+40      75.8887    166.51  |      Q   |          |          |V         |
    4+45      77.0207    164.37  |      Q   |          |          |V         |
    4+50      78.1380    162.22  |      Q   |          |          |V         |
    4+55      79.2406    160.10  |      Q   |          |          | V        |
    5+ 0      80.3335    158.69  |      Q   |          |          | V        |
    5+ 5      81.4203    157.79  |      Q   |          |          |  V       |
    5+10      82.5010    156.93  |     Q    |          |          |  V       |
    5+15      83.5708    155.33  |     Q    |          |          |   V      |
    5+20      84.6142    151.50  |     Q    |          |          |   V      |
    5+25      85.6243    146.67  |     Q    |          |          |    V     |
    5+30      86.6111    143.29  |     Q    |          |          |    V     |
    5+35      87.5836    141.20  |     Q    |          |          |    V     |
    5+40      88.5478    140.00  |     Q    |          |          |     V    |
    5+45      89.5105    139.78  |     Q    |          |          |     V    |
    5+50      90.4825    141.13  |     Q    |          |          |      V   |
    5+55      91.4691    143.26  |     Q    |          |          |      V   |
    6+ 0      92.4667    144.86  |     Q    |          |          |      V   |
    6+ 5      93.4681    145.40  |     Q    |          |          |       V  |
    6+10      94.4559    143.42  |     Q    |          |          |       V  |
    6+15      95.3814    134.39  |    Q     |          |          |        V|
    6+20      96.1296    108.64  |   Q      |          |          |        V|
    6+25      96.6494     75.47  |  Q       |          |          |        V|
    6+30      97.0055     51.71  | Q        |          |          |        V|
    6+35      97.2549     36.22  |Q         |          |          |        V|
    6+40      97.4292     25.32  |Q         |          |          |        V|
    6+45      97.5493     17.43  Q          |          |          |        V|
    6+50      97.6291     11.59  Q          |          |          |        V|
    6+55      97.6792      7.28  Q          |          |          |        V|
    7+ 0      97.7084      4.23  Q          |          |          |        V|
    7+ 5      97.7231      2.14  Q          |          |          |        V|
    7+10      97.7286      0.80  Q          |          |          |        V|
    7+15      97.7294      0.11  Q          |          |          |        V|
-------------------------------------------------------------------------
```

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: east100yr24hr.out

++

Program License Serial Number 4055

Tule Wind Project
Unnamed Eastern Wash
Existing 100 Year 24 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
734.00	5.40

Rainfall Distribution pattern used in study:
Type B for San Diego area of California

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
734.00	1.000	85.1	85.1	0.050	C

Area-averaged catchment SCS Curve Number AMC(2) = 85.130
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   734.00(Ac.)
Catchment Lag time =   0.380 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 21.9298
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 85.130

Rainfall depth area reduction factors:
Using a total area of   734.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 1.000
Rainfall entered for study =   5.400(In)
Adjusted rainfall =   5.400(In)

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

(K = 8881.40 (CFS))

0.22	0.083	0.017	34.408	0.004
0.44	0.167	0.085	169.808	0.023
0.66	0.250	0.290	580.041	0.088
0.88	0.333	0.784	1566.642	0.265
1.10	0.417	1.000	1997.798	0.490
1.32	0.500	0.716	1430.728	0.651
1.54	0.583	0.467	933.347	0.756
1.75	0.667	0.329	656.341	0.830
1.97	0.750	0.237	473.266	0.883
2.19	0.833	0.175	348.921	0.922
2.41	0.917	0.129	256.962	0.951
2.63	1.000	0.091	181.388	0.972
2.85	1.083	0.062	124.326	0.986
3.07	1.167	0.040	80.165	0.995
3.29	1.250	0.020	40.797	0.999
3.51	1.333	0.003	6.463	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In) P	Total SCS Runoff (In) Q	Rainfall Amount (In) dP	Runoff Amount (In) dQ	Infiltr-ation (In) dP-dQ	Revised Runoff Min Loss Rate
0.08	0.0081	0.0000	0.0081	0.0000	0.0081	--------
0.17	0.0162	0.0000	0.0081	0.0000	0.0081	--------
0.25	0.0243	0.0000	0.0081	0.0000	0.0081	--------
0.33	0.0324	0.0000	0.0081	0.0000	0.0081	--------
0.42	0.0405	0.0000	0.0081	0.0000	0.0081	--------
0.50	0.0486	0.0000	0.0081	0.0000	0.0081	--------

0.58	0.0549	0.0000	0.0063	0.0000	0.0063	--------
0.67	0.0612	0.0000	0.0063	0.0000	0.0063	--------
0.75	0.0675	0.0000	0.0063	0.0000	0.0063	--------
0.83	0.0738	0.0000	0.0063	0.0000	0.0063	--------
0.92	0.0801	0.0000	0.0063	0.0000	0.0063	--------
1.00	0.0864	0.0000	0.0063	0.0000	0.0063	--------
1.08	0.0945	0.0000	0.0081	0.0000	0.0081	--------
1.17	0.1026	0.0000	0.0081	0.0000	0.0081	--------
1.25	0.1107	0.0000	0.0081	0.0000	0.0081	--------
1.33	0.1188	0.0000	0.0081	0.0000	0.0081	--------
1.42	0.1269	0.0000	0.0081	0.0000	0.0081	--------
1.50	0.1350	0.0000	0.0081	0.0000	0.0081	--------
1.58	0.1431	0.0000	0.0081	0.0000	0.0081	--------
1.67	0.1512	0.0000	0.0081	0.0000	0.0081	--------
1.75	0.1593	0.0000	0.0081	0.0000	0.0081	--------
1.83	0.1674	0.0000	0.0081	0.0000	0.0081	--------
1.92	0.1755	0.0000	0.0081	0.0000	0.0081	--------
2.00	0.1836	0.0000	0.0081	0.0000	0.0081	--------
2.08	0.1935	0.0000	0.0099	0.0000	0.0099	--------
2.17	0.2034	0.0000	0.0099	0.0000	0.0099	--------
2.25	0.2133	0.0000	0.0099	0.0000	0.0099	--------
2.33	0.2232	0.0000	0.0099	0.0000	0.0099	--------
2.42	0.2331	0.0000	0.0099	0.0000	0.0099	--------
2.50	0.2430	0.0000	0.0099	0.0000	0.0099	--------
2.58	0.2511	0.0000	0.0081	0.0000	0.0081	--------
2.67	0.2592	0.0000	0.0081	0.0000	0.0081	--------
2.75	0.2673	0.0000	0.0081	0.0000	0.0081	--------
2.83	0.2754	0.0000	0.0081	0.0000	0.0081	--------
2.92	0.2835	0.0000	0.0081	0.0000	0.0081	--------
3.00	0.2916	0.0000	0.0081	0.0000	0.0081	--------
3.08	0.3015	0.0000	0.0099	0.0000	0.0099	--------
3.17	0.3114	0.0000	0.0099	0.0000	0.0099	--------
3.25	0.3213	0.0000	0.0099	0.0000	0.0099	--------
3.33	0.3312	0.0000	0.0099	0.0000	0.0099	--------
3.42	0.3411	0.0000	0.0099	0.0000	0.0099	--------
3.50	0.3510	0.0000	0.0099	0.0000	0.0099	--------
3.58	0.3618	0.0001	0.0108	0.0001	0.0107	--------
3.67	0.3726	0.0003	0.0108	0.0002	0.0106	--------
3.75	0.3834	0.0007	0.0108	0.0003	0.0105	--------
3.83	0.3942	0.0011	0.0108	0.0005	0.0103	--------
3.92	0.4050	0.0017	0.0108	0.0006	0.0102	--------
4.00	0.4158	0.0024	0.0108	0.0007	0.0101	--------
4.08	0.4275	0.0033	0.0117	0.0009	0.0108	--------
4.17	0.4392	0.0044	0.0117	0.0010	0.0107	--------
4.25	0.4509	0.0056	0.0117	0.0012	0.0105	--------
4.33	0.4626	0.0069	0.0117	0.0013	0.0104	--------
4.42	0.4743	0.0083	0.0117	0.0014	0.0103	--------
4.50	0.4860	0.0099	0.0117	0.0016	0.0101	--------
4.58	0.4986	0.0117	0.0126	0.0018	0.0108	--------
4.67	0.5112	0.0137	0.0126	0.0020	0.0106	--------
4.75	0.5238	0.0158	0.0126	0.0021	0.0105	--------
4.83	0.5364	0.0181	0.0126	0.0023	0.0103	--------
4.92	0.5490	0.0205	0.0126	0.0024	0.0102	--------
5.00	0.5616	0.0230	0.0126	0.0025	0.0101	--------
5.08	0.5760	0.0260	0.0144	0.0030	0.0114	--------
5.17	0.5904	0.0292	0.0144	0.0032	0.0112	--------
5.25	0.6048	0.0326	0.0144	0.0034	0.0110	--------
5.33	0.6192	0.0361	0.0144	0.0035	0.0109	--------
5.42	0.6336	0.0398	0.0144	0.0037	0.0107	--------
5.50	0.6480	0.0436	0.0144	0.0038	0.0106	--------
5.58	0.6633	0.0478	0.0153	0.0042	0.0111	--------
5.67	0.6786	0.0522	0.0153	0.0044	0.0109	--------
5.75	0.6939	0.0568	0.0153	0.0045	0.0108	--------

5.83	0.7092	0.0615	0.0153	0.0047	0.0106	--------
5.92	0.7245	0.0663	0.0153	0.0049	0.0104	--------
6.00	0.7398	0.0713	0.0153	0.0050	0.0103	--------
6.08	0.7578	0.0774	0.0180	0.0061	0.0119	--------
6.17	0.7758	0.0837	0.0180	0.0063	0.0117	--------
6.25	0.7938	0.0902	0.0180	0.0065	0.0115	--------
6.33	0.8118	0.0968	0.0180	0.0067	0.0113	--------
6.42	0.8298	0.1036	0.0180	0.0068	0.0112	--------
6.50	0.8478	0.1107	0.0180	0.0070	0.0110	--------
6.58	0.8685	0.1189	0.0207	0.0083	0.0124	--------
6.67	0.8892	0.1275	0.0207	0.0085	0.0122	--------
6.75	0.9099	0.1362	0.0207	0.0087	0.0120	--------
6.83	0.9306	0.1451	0.0207	0.0089	0.0118	--------
6.92	0.9513	0.1543	0.0207	0.0091	0.0116	--------
7.00	0.9720	0.1636	0.0207	0.0094	0.0113	--------
7.08	0.9990	0.1761	0.0270	0.0125	0.0145	--------
7.17	1.0260	0.1889	0.0270	0.0128	0.0142	--------
7.25	1.0530	0.2021	0.0270	0.0131	0.0139	--------
7.33	1.0800	0.2155	0.0270	0.0134	0.0136	--------
7.42	1.1070	0.2292	0.0270	0.0137	0.0133	--------
7.50	1.1340	0.2432	0.0270	0.0140	0.0130	--------
7.58	1.1745	0.2647	0.0405	0.0215	0.0190	--------
7.67	1.2150	0.2868	0.0405	0.0221	0.0184	--------
7.75	1.2555	0.3095	0.0405	0.0227	0.0178	--------
7.83	1.2960	0.3327	0.0405	0.0232	0.0173	--------
7.92	1.3365	0.3564	0.0405	0.0237	0.0168	--------
8.00	1.3770	0.3806	0.0405	0.0242	0.0163	--------
8.08	1.4373	0.4176	0.0603	0.0369	0.0234	--------
8.17	1.4976	0.4554	0.0603	0.0379	0.0224	--------
8.25	1.5579	0.4942	0.0603	0.0388	0.0215	--------
8.33	1.6182	0.5339	0.0603	0.0397	0.0206	--------
8.42	1.6785	0.5744	0.0603	0.0405	0.0198	--------
8.50	1.7388	0.6156	0.0603	0.0412	0.0191	--------
8.58	1.8180	0.6708	0.0792	0.0552	0.0240	--------
8.67	1.8972	0.7272	0.0792	0.0564	0.0228	--------
8.75	1.9764	0.7847	0.0792	0.0575	0.0217	--------
8.83	2.0556	0.8431	0.0792	0.0585	0.0207	--------
8.92	2.1348	0.9025	0.0792	0.0594	0.0198	--------
9.00	2.2140	0.9628	0.0792	0.0603	0.0189	--------
9.08	2.3004	1.0294	0.0864	0.0667	0.0197	--------
9.17	2.3868	1.0970	0.0864	0.0676	0.0188	--------
9.25	2.4732	1.1654	0.0864	0.0684	0.0180	--------
9.33	2.5596	1.2346	0.0864	0.0692	0.0172	--------
9.42	2.6460	1.3045	0.0864	0.0699	0.0165	--------
9.50	2.7324	1.3751	0.0864	0.0706	0.0158	--------
9.58	2.8062	1.4359	0.0738	0.0608	0.0130	--------
9.67	2.8800	1.4972	0.0738	0.0613	0.0125	--------
9.75	2.9538	1.5589	0.0738	0.0617	0.0121	--------
9.83	3.0276	1.6210	0.0738	0.0621	0.0117	--------
9.92	3.1014	1.6835	0.0738	0.0625	0.0113	--------
10.00	3.1752	1.7464	0.0738	0.0629	0.0109	--------
10.08	3.2121	1.7779	0.0369	0.0316	0.0053	--------
10.17	3.2490	1.8096	0.0369	0.0316	0.0053	--------
10.25	3.2859	1.8413	0.0369	0.0317	0.0052	--------
10.33	3.3228	1.8731	0.0369	0.0318	0.0051	--------
10.42	3.3597	1.9050	0.0369	0.0319	0.0050	--------
10.50	3.3966	1.9370	0.0369	0.0320	0.0049	--------
10.58	3.4209	1.9580	0.0243	0.0211	0.0032	--------
10.67	3.4452	1.9792	0.0243	0.0211	0.0032	--------
10.75	3.4695	2.0003	0.0243	0.0212	0.0031	--------
10.83	3.4938	2.0215	0.0243	0.0212	0.0031	--------
10.92	3.5181	2.0427	0.0243	0.0212	0.0031	--------
11.00	3.5424	2.0640	0.0243	0.0212	0.0031	--------

11.08	3.5631	2.0821	0.0207	0.0181	0.0026	--------
11.17	3.5838	2.1002	0.0207	0.0181	0.0026	--------
11.25	3.6045	2.1184	0.0207	0.0182	0.0025	--------
11.33	3.6252	2.1366	0.0207	0.0182	0.0025	--------
11.42	3.6459	2.1548	0.0207	0.0182	0.0025	--------
11.50	3.6666	2.1730	0.0207	0.0182	0.0025	--------
11.58	3.6855	2.1897	0.0189	0.0167	0.0022	--------
11.67	3.7044	2.2064	0.0189	0.0167	0.0022	--------
11.75	3.7233	2.2230	0.0189	0.0167	0.0022	--------
11.83	3.7422	2.2398	0.0189	0.0167	0.0022	--------
11.92	3.7611	2.2565	0.0189	0.0167	0.0022	--------
12.00	3.7800	2.2732	0.0189	0.0167	0.0022	--------
12.08	3.7980	2.2892	0.0180	0.0160	0.0020	--------
12.17	3.8160	2.3052	0.0180	0.0160	0.0020	--------
12.25	3.8340	2.3211	0.0180	0.0160	0.0020	--------
12.33	3.8520	2.3371	0.0180	0.0160	0.0020	--------
12.42	3.8700	2.3532	0.0180	0.0160	0.0020	--------
12.50	3.8880	2.3692	0.0180	0.0160	0.0020	--------
12.58	3.9051	2.3844	0.0171	0.0152	0.0019	--------
12.67	3.9222	2.3997	0.0171	0.0153	0.0018	--------
12.75	3.9393	2.4149	0.0171	0.0153	0.0018	--------
12.83	3.9564	2.4302	0.0171	0.0153	0.0018	--------
12.92	3.9735	2.4455	0.0171	0.0153	0.0018	--------
13.00	3.9906	2.4608	0.0171	0.0153	0.0018	--------
13.08	4.0059	2.4745	0.0153	0.0137	0.0016	--------
13.17	4.0212	2.4882	0.0153	0.0137	0.0016	--------
13.25	4.0365	2.5019	0.0153	0.0137	0.0016	--------
13.33	4.0518	2.5156	0.0153	0.0137	0.0016	--------
13.42	4.0671	2.5294	0.0153	0.0137	0.0016	--------
13.50	4.0824	2.5431	0.0153	0.0137	0.0016	--------
13.58	4.0968	2.5560	0.0144	0.0129	0.0015	--------
13.67	4.1112	2.5690	0.0144	0.0129	0.0015	--------
13.75	4.1256	2.5819	0.0144	0.0130	0.0014	--------
13.83	4.1400	2.5949	0.0144	0.0130	0.0014	--------
13.92	4.1544	2.6079	0.0144	0.0130	0.0014	--------
14.00	4.1688	2.6209	0.0144	0.0130	0.0014	--------
14.08	4.1850	2.6355	0.0162	0.0146	0.0016	--------
14.17	4.2012	2.6501	0.0162	0.0146	0.0016	--------
14.25	4.2174	2.6647	0.0162	0.0146	0.0016	--------
14.33	4.2336	2.6794	0.0162	0.0146	0.0016	--------
14.42	4.2498	2.6940	0.0162	0.0146	0.0016	--------
14.50	4.2660	2.7087	0.0162	0.0147	0.0015	--------
14.58	4.2750	2.7168	0.0090	0.0081	0.0009	--------
14.67	4.2840	2.7249	0.0090	0.0081	0.0009	--------
14.75	4.2930	2.7331	0.0090	0.0082	0.0008	--------
14.83	4.3020	2.7412	0.0090	0.0082	0.0008	--------
14.92	4.3110	2.7494	0.0090	0.0082	0.0008	--------
15.00	4.3200	2.7576	0.0090	0.0082	0.0008	--------
15.08	4.3344	2.7706	0.0144	0.0131	0.0013	--------
15.17	4.3488	2.7837	0.0144	0.0131	0.0013	--------
15.25	4.3632	2.7968	0.0144	0.0131	0.0013	--------
15.33	4.3776	2.8098	0.0144	0.0131	0.0013	--------
15.42	4.3920	2.8229	0.0144	0.0131	0.0013	--------
15.50	4.4064	2.8360	0.0144	0.0131	0.0013	--------
15.58	4.4199	2.8483	0.0135	0.0123	0.0012	--------
15.67	4.4334	2.8606	0.0135	0.0123	0.0012	--------
15.75	4.4469	2.8729	0.0135	0.0123	0.0012	--------
15.83	4.4604	2.8852	0.0135	0.0123	0.0012	--------
15.92	4.4739	2.8975	0.0135	0.0123	0.0012	--------
16.00	4.4874	2.9098	0.0135	0.0123	0.0012	--------
16.08	4.5000	2.9213	0.0126	0.0115	0.0011	--------
16.17	4.5126	2.9328	0.0126	0.0115	0.0011	--------
16.25	4.5252	2.9443	0.0126	0.0115	0.0011	--------

16.33	4.5378	2.9558	0.0126	0.0115	0.0011	--------
16.42	4.5504	2.9673	0.0126	0.0115	0.0011	--------
16.50	4.5630	2.9788	0.0126	0.0115	0.0011	--------
16.58	4.5765	2.9912	0.0135	0.0123	0.0012	--------
16.67	4.5900	3.0035	0.0135	0.0123	0.0012	--------
16.75	4.6035	3.0159	0.0135	0.0124	0.0011	--------
16.83	4.6170	3.0282	0.0135	0.0124	0.0011	--------
16.92	4.6305	3.0406	0.0135	0.0124	0.0011	--------
17.00	4.6440	3.0529	0.0135	0.0124	0.0011	--------
17.08	4.6548	3.0628	0.0108	0.0099	0.0009	--------
17.17	4.6656	3.0727	0.0108	0.0099	0.0009	--------
17.25	4.6764	3.0827	0.0108	0.0099	0.0009	--------
17.33	4.6872	3.0926	0.0108	0.0099	0.0009	--------
17.42	4.6980	3.1025	0.0108	0.0099	0.0009	--------
17.50	4.7088	3.1124	0.0108	0.0099	0.0009	--------
17.58	4.7205	3.1231	0.0117	0.0107	0.0010	--------
17.67	4.7322	3.1339	0.0117	0.0107	0.0010	--------
17.75	4.7439	3.1446	0.0117	0.0108	0.0009	--------
17.83	4.7556	3.1554	0.0117	0.0108	0.0009	--------
17.92	4.7673	3.1661	0.0117	0.0108	0.0009	--------
18.00	4.7790	3.1769	0.0117	0.0108	0.0009	--------
18.08	4.7880	3.1852	0.0090	0.0083	0.0007	--------
18.17	4.7970	3.1935	0.0090	0.0083	0.0007	--------
18.25	4.8060	3.2018	0.0090	0.0083	0.0007	--------
18.33	4.8150	3.2100	0.0090	0.0083	0.0007	--------
18.42	4.8240	3.2183	0.0090	0.0083	0.0007	--------
18.50	4.8330	3.2266	0.0090	0.0083	0.0007	--------
18.58	4.8420	3.2349	0.0090	0.0083	0.0007	--------
18.67	4.8510	3.2432	0.0090	0.0083	0.0007	--------
18.75	4.8600	3.2515	0.0090	0.0083	0.0007	--------
18.83	4.8690	3.2598	0.0090	0.0083	0.0007	--------
18.92	4.8780	3.2681	0.0090	0.0083	0.0007	--------
19.00	4.8870	3.2764	0.0090	0.0083	0.0007	--------
19.08	4.8951	3.2839	0.0081	0.0075	0.0006	--------
19.17	4.9032	3.2914	0.0081	0.0075	0.0006	--------
19.25	4.9113	3.2988	0.0081	0.0075	0.0006	--------
19.33	4.9194	3.3063	0.0081	0.0075	0.0006	--------
19.42	4.9275	3.3138	0.0081	0.0075	0.0006	--------
19.50	4.9356	3.3213	0.0081	0.0075	0.0006	--------
19.58	4.9446	3.3296	0.0090	0.0083	0.0007	--------
19.67	4.9536	3.3379	0.0090	0.0083	0.0007	--------
19.75	4.9626	3.3462	0.0090	0.0083	0.0007	--------
19.83	4.9716	3.3546	0.0090	0.0083	0.0007	--------
19.92	4.9806	3.3629	0.0090	0.0083	0.0007	--------
20.00	4.9896	3.3712	0.0090	0.0083	0.0007	--------
20.08	4.9995	3.3804	0.0099	0.0092	0.0007	--------
20.17	5.0094	3.3895	0.0099	0.0092	0.0007	--------
20.25	5.0193	3.3987	0.0099	0.0092	0.0007	--------
20.33	5.0292	3.4079	0.0099	0.0092	0.0007	--------
20.42	5.0391	3.4170	0.0099	0.0092	0.0007	--------
20.50	5.0490	3.4262	0.0099	0.0092	0.0007	--------
20.58	5.0580	3.4346	0.0090	0.0083	0.0007	--------
20.67	5.0670	3.4429	0.0090	0.0083	0.0007	--------
20.75	5.0760	3.4512	0.0090	0.0083	0.0007	--------
20.83	5.0850	3.4596	0.0090	0.0083	0.0007	--------
20.92	5.0940	3.4679	0.0090	0.0083	0.0007	--------
21.00	5.1030	3.4763	0.0090	0.0083	0.0007	--------
21.08	5.1111	3.4838	0.0081	0.0075	0.0006	--------
21.17	5.1192	3.4913	0.0081	0.0075	0.0006	--------
21.25	5.1273	3.4988	0.0081	0.0075	0.0006	--------
21.33	5.1354	3.5064	0.0081	0.0075	0.0006	--------
21.42	5.1435	3.5139	0.0081	0.0075	0.0006	--------
21.50	5.1516	3.5214	0.0081	0.0075	0.0006	--------

21.58	5.1597	3.5289	0.0081	0.0075	0.0006	--------
21.67	5.1678	3.5365	0.0081	0.0075	0.0006	--------
21.75	5.1759	3.5440	0.0081	0.0075	0.0006	--------
21.83	5.1840	3.5515	0.0081	0.0075	0.0006	--------
21.92	5.1921	3.5590	0.0081	0.0075	0.0006	--------
22.00	5.2002	3.5666	0.0081	0.0075	0.0006	--------
22.08	5.2083	3.5741	0.0081	0.0075	0.0006	--------
22.17	5.2164	3.5816	0.0081	0.0075	0.0006	--------
22.25	5.2245	3.5892	0.0081	0.0075	0.0006	--------
22.33	5.2326	3.5967	0.0081	0.0075	0.0006	--------
22.42	5.2407	3.6042	0.0081	0.0075	0.0006	--------
22.50	5.2488	3.6118	0.0081	0.0075	0.0006	--------
22.58	5.2569	3.6193	0.0081	0.0075	0.0006	--------
22.67	5.2650	3.6269	0.0081	0.0075	0.0006	--------
22.75	5.2731	3.6344	0.0081	0.0075	0.0006	--------
22.83	5.2812	3.6420	0.0081	0.0075	0.0006	--------
22.92	5.2893	3.6495	0.0081	0.0075	0.0006	--------
23.00	5.2974	3.6571	0.0081	0.0075	0.0006	--------
23.08	5.3064	3.6654	0.0090	0.0084	0.0006	--------
23.17	5.3154	3.6738	0.0090	0.0084	0.0006	--------
23.25	5.3244	3.6822	0.0090	0.0084	0.0006	--------
23.33	5.3334	3.6906	0.0090	0.0084	0.0006	--------
23.42	5.3424	3.6990	0.0090	0.0084	0.0006	--------
23.50	5.3514	3.7074	0.0090	0.0084	0.0006	--------
23.58	5.3595	3.7150	0.0081	0.0076	0.0005	--------
23.67	5.3676	3.7225	0.0081	0.0076	0.0005	--------
23.75	5.3757	3.7301	0.0081	0.0076	0.0005	--------
23.83	5.3838	3.7376	0.0081	0.0076	0.0005	--------
23.92	5.3919	3.7452	0.0081	0.0076	0.0005	--------
24.00	5.4000	3.7528	0.0081	0.0076	0.0005	--------

Total soil rain loss = 1.65(In)
Total effective runoff = 3.75(In)

Peak flow rate this hydrograph = 597.93(CFS)
Total runoff volume this hydrograph = 9998969.3(Ft3)

++

24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	150.0	300.0	450.0	600.0
0+ 5	0.0000	0.00	Q				
0+10	0.0000	0.00	Q				
0+15	0.0000	0.00	Q				
0+20	0.0000	0.00	Q				
0+25	0.0000	0.00	Q				
0+30	0.0000	0.00	Q				
0+35	0.0000	0.00	Q				
0+40	0.0000	0.00	Q				
0+45	0.0000	0.00	Q				
0+50	0.0000	0.00	Q				
0+55	0.0000	0.00	Q				
1+ 0	0.0000	0.00	Q				
1+ 5	0.0000	0.00	Q				
1+10	0.0000	0.00	Q				
1+15	0.0000	0.00	Q				
1+20	0.0000	0.00	Q				

1+25	0.0000	0.00	Q				
1+30	0.0000	0.00	Q				
1+35	0.0000	0.00	Q				
1+40	0.0000	0.00	Q				
1+45	0.0000	0.00	Q				
1+50	0.0000	0.00	Q				
1+55	0.0000	0.00	Q				
2+ 0	0.0000	0.00	Q				
2+ 5	0.0000	0.00	Q				
2+10	0.0000	0.00	Q				
2+15	0.0000	0.00	Q				
2+20	0.0000	0.00	Q				
2+25	0.0000	0.00	Q				
2+30	0.0000	0.00	Q				
2+35	0.0000	0.00	Q				
2+40	0.0000	0.00	Q				
2+45	0.0000	0.00	Q				
2+50	0.0000	0.00	Q				
2+55	0.0000	0.00	Q				
3+ 0	0.0000	0.00	Q				
3+ 5	0.0000	0.00	Q				
3+10	0.0000	0.00	Q				
3+15	0.0000	0.00	Q				
3+20	0.0000	0.00	Q				
3+25	0.0000	0.00	Q				
3+30	0.0000	0.00	Q				
3+35	0.0000	0.00	Q				
3+40	0.0002	0.02	Q				
3+45	0.0009	0.10	Q				
3+50	0.0032	0.34	Q				
3+55	0.0088	0.82	Q				
4+ 0	0.0192	1.50	Q				
4+ 5	0.0352	2.32	Q				
4+10	0.0575	3.24	Q				
4+15	0.0867	4.24	Q				
4+20	0.1236	5.37	Q				
4+25	0.1689	6.58	Q				
4+30	0.2226	7.79	Q				
4+35	0.2846	9.00	Q				
4+40	0.3550	10.22	Q				
4+45	0.4341	11.49	Q				
4+50	0.5228	12.88	Q				
4+55	0.6215	14.33	Q				
5+ 0	0.7299	15.73	VQ				
5+ 5	0.8475	17.08	VQ				
5+10	0.9745	18.44	VQ				
5+15	1.1117	19.93	VQ				
5+20	1.2617	21.79	VQ				
5+25	1.4260	23.84	VQ				
5+30	1.6031	25.73	VQ				
5+35	1.7922	27.45	VQ				
5+40	1.9927	29.11	VQ				
5+45	2.2048	30.79	V Q				
5+50	2.4298	32.68	V Q				
5+55	2.6684	34.65	V Q				
6+ 0	2.9195	36.46	V Q				
6+ 5	3.1823	38.16	V Q				
6+10	3.4571	39.90	V Q				
6+15	3.7459	41.94	V Q				
6+20	4.0549	44.87	V Q				
6+25	4.3871	48.23	V Q				
6+30	4.7392	51.12	V Q				
6+35	5.1085	53.63	V Q				

6+40	5.4944	56.04	V Q
6+45	5.8988	58.72	V Q
6+50	6.3284	62.38	V Q
6+55	6.7863	66.48	V Q
7+ 0	7.2683	69.98	V Q
7+ 5	7.7712	73.03	V Q
7+10	8.2957	76.15	V Q
7+15	8.8483	80.25	V Q
7+20	9.4485	87.14	V Q
7+25	10.1053	95.38	V Q
7+30	10.8083	102.07	V Q
7+35	11.5495	107.62	V Q
7+40	12.3303	113.36	V Q
7+45	13.1674	121.55	V Q
7+50	14.1085	136.65	V Q
7+55	15.1763	155.05	V Q
8+ 0	16.3449	169.68	V Q
8+ 5	17.5936	181.30	V Q
8+10	18.9201	192.61	V Q
8+15	20.3500	207.62	V Q
8+20	21.9613	233.97	V Q
8+25	23.7907	265.62	V Q
8+30	25.7925	290.67	V Q
8+35	27.9284	310.14	V Q
8+40	30.1866	327.88	V Q
8+45	32.5874	348.61	V Q
8+50	35.2102	380.82	V Q
8+55	38.0897	418.10	V Q
9+ 0	41.1719	447.54	V Q
9+ 5	44.4096	470.11	V Q
9+10	47.7786	489.18	V Q
9+15	51.2735	507.45	V Q
9+20	54.9164	528.96	V Q
9+25	58.7142	551.43	V Q
9+30	62.6372	569.62	V Q
9+35	66.6571	583.69	V Q
9+40	70.7474	593.90	V Q
9+45	74.8653	597.93	V Q
9+50	78.9291	590.06	V Q
9+55	82.8994	576.49	V Q
10+ 0	86.8098	567.78	V Q
10+ 5	90.6827	562.34	V Q
10+10	94.5040	554.86	V Q
10+15	98.1935	535.72	V Q
10+20	101.5409	486.04	V Q
10+25	104.4543	423.02	V Q
10+30	107.0580	378.06	V Q
10+35	109.4587	348.58	V Q
10+40	111.7074	326.51	V Q
10+45	113.8144	305.92	V Q
10+50	115.7333	278.63	V Q
10+55	117.4511	249.42	V Q
11+ 0	119.0257	228.63	V Q
11+ 5	120.5055	214.87	V Q
11+10	121.9175	205.02	V Q
11+15	123.2748	197.08	V Q
11+20	124.5725	188.43	V Q
11+25	125.8094	179.60	V Q
11+30	127.0033	173.35	V Q
11+35	128.1687	169.22	V Q
11+40	129.3134	166.21	V Q
11+45	130.4398	163.55	V Q
11+50	131.5424	160.09	V Q

11+55	132.6187	156.28	Q V
12+ 0	133.6766	153.61	Q V
12+ 5	134.7226	151.87	Q V
12+10	135.7597	150.59	Q V
12+15	136.7887	149.40	Q| V
12+20	137.8060	147.72	Q| V
12+25	138.8106	145.86	Q| V
12+30	139.8062	144.56	Q| V
12+35	140.7960	143.73	Q| V
12+40	141.7813	143.07	Q| V
12+45	142.7612	142.28	Q| V
12+50	143.7313	140.86	Q| V
12+55	144.6898	139.17	Q| V
13+ 0	145.6402	137.99	Q| V
13+ 5	146.5851	137.20	Q| V
13+10	147.5247	136.44	Q| V
13+15	148.4559	135.20	Q| V
13+20	149.3684	132.49	Q | V
13+25	150.2580	129.17	Q | V
13+30	151.1313	126.81	Q | V
13+35	151.9940	125.26	Q | V
13+40	152.8486	124.09	Q | V
13+45	153.6950	122.91	Q | V
13+50	154.5294	121.15	Q | V
13+55	155.3503	119.20	Q | V
14+ 0	156.1618	117.82	Q | V
14+ 5	156.9675	116.99	Q | V
14+10	157.7711	116.68	Q | V
14+15	158.5785	117.24	Q | V
14+20	159.4020	119.56	Q | V
14+25	160.2468	122.67	Q | V
14+30	161.1071	124.92	Q | V
14+35	161.9761	126.18	Q | V
14+40	162.8450	126.16	Q | V
14+45	163.6934	123.19	Q | V
14+50	164.4758	113.61	Q | V
14+55	165.1719	101.07	Q | V
15+ 0	165.8061	92.09	Q | V
15+ 5	166.4013	86.42	Q | V
15+10	166.9739	83.14	Q | V|
15+15	167.5455	83.00	Q | V|
15+20	168.1545	88.44	Q | V|
15+25	168.8197	96.59	Q | V|
15+30	169.5254	102.46	Q | V|
15+35	170.2570	106.24	Q | V|
15+40	171.0066	108.84	Q | V|
15+45	171.7674	110.47	Q | V|
15+50	172.5313	110.91	Q | V
15+55	173.2929	110.59	Q | V
16+ 0	174.0529	110.35	Q | V
16+ 5	174.8120	110.22	Q | V
16+10	175.5695	109.99	Q | V
16+15	176.3228	109.38	Q | V
16+20	177.0658	107.88	Q | V
16+25	177.7964	106.08	Q | V
16+30	178.5182	104.80	Q | |V
16+35	179.2345	104.01	Q | |V
16+40	179.9479	103.59	Q | |V
16+45	180.6620	103.69	Q | |V
16+50	181.3833	104.73	Q | |V
16+55	182.1147	106.20	Q | |V
17+ 0	182.8535	107.27	Q | |V
17+ 5	183.5966	107.90	Q | |V

```
17+10     184.3404    108.00  |       Q  |          |          | V        |
17+15     185.0771    106.96  |       Q  |          |          | V        |
17+20     185.7893    103.41  |      Q   |          |          | V        |
17+25     186.4692     98.72  |      Q   |          |          | V        |
17+30     187.1259     95.36  |      Q   |          |          | V        |
17+35     187.7679     93.22  |      Q   |          |          | V        |
17+40     188.4004     91.83  |      Q   |          |          | V        |
17+45     189.0285     91.20  |      Q   |          |          | V        |
17+50     189.6598     91.67  |      Q   |          |          |  V       |
17+55     190.2984     92.72  |      Q   |          |          |  V       |
18+ 0     190.9422     93.48  |      Q   |          |          |  V       |
18+ 5     191.5888     93.89  |      Q   |          |          |  V       |
18+10     192.2352     93.85  |      Q   |          |          |  V       |
18+15     192.8738     92.72  |      Q   |          |          |  V       |
18+20     193.4876     89.13  |     Q    |          |          |  V       |
18+25     194.0690     84.41  |     Q    |          |          |  V       |
18+30     194.6271     81.03  |     Q    |          |          |  V       |
18+35     195.1700     78.84  |     Q    |          |          |   V      |
18+40     195.7023     77.29  |     Q    |          |          |   V      |
18+45     196.2270     76.17  |     Q    |          |          |   V      |
18+50     196.7458     75.33  |     Q    |          |          |   V      |
18+55     197.2603     74.71  |    Q     |          |          |   V      |
19+ 0     197.7719     74.28  |    Q     |          |          |   V      |
19+ 5     198.2813     73.96  |    Q     |          |          |   V      |
19+10     198.7884     73.64  |    Q     |          |          |   V      |
19+15     199.2917     73.07  |    Q     |          |          |   V      |
19+20     199.7860     71.77  |    Q     |          |          |   V      |
19+25     200.2690     70.13  |    Q     |          |          |   V      |
19+30     200.7439     68.96  |    Q     |          |          |   V      |
19+35     201.2138     68.23  |    Q     |          |          |    V     |
19+40     201.6810     67.84  |    Q     |          |          |    V     |
19+45     202.1489     67.94  |    Q     |          |          |    V     |
19+50     202.6239     68.97  |    Q     |          |          |    V     |
19+55     203.1090     70.43  |    Q     |          |          |    V     |
20+ 0     203.6014     71.49  |    Q     |          |          |    V     |
20+ 5     204.0987     72.21  |    Q     |          |          |    V     |
20+10     204.6004     72.84  |    Q     |          |          |    V     |
20+15     205.1080     73.70  |    Q     |          |          |    V     |
20+20     205.6266     75.31  |     Q    |          |          |    V     |
20+25     206.1583     77.21  |     Q    |          |          |    V     |
20+30     206.6994     78.57  |     Q    |          |          |     V    |
20+35     207.2465     79.44  |     Q    |          |          |     V    |
20+40     207.7970     79.93  |     Q    |          |          |     V    |
20+45     208.3472     79.89  |     Q    |          |          |     V    |
20+50     208.8906     78.90  |     Q    |          |          |     V    |
20+55     209.4241     77.47  |     Q    |          |          |     V    |
21+ 0     209.9506     76.44  |     Q    |          |          |     V    |
21+ 5     210.4723     75.76  |     Q    |          |          |     V    |
21+10     210.9899     75.15  |     Q    |          |          |     V    |
21+15     211.5018     74.32  |    Q     |          |          |     V    |
21+20     212.0028     72.74  |    Q     |          |          |     V    |
21+25     212.4909     70.88  |    Q     |          |          |      V   |
21+30     212.9699     69.55  |    Q     |          |          |      V   |
21+35     213.4429     68.68  |    Q     |          |          |      V   |
21+40     213.9117     68.08  |    Q     |          |          |      V   |
21+45     214.3777     67.66  |    Q     |          |          |      V   |
21+50     214.8417     67.38  |    Q     |          |          |      V   |
21+55     215.3043     67.17  |    Q     |          |          |      V   |
22+ 0     215.7660     67.04  |    Q     |          |          |      V   |
22+ 5     216.2271     66.94  |    Q     |          |          |      V   |
22+10     216.6877     66.89  |    Q     |          |          |      V   |
22+15     217.1483     66.87  |    Q     |          |          |      V   |
22+20     217.6088     66.88  |    Q     |          |          |      V   |
```

22+25	218.0695	66.89	|	Q	|	|	V |
22+30	218.5303	66.90	|	Q	|	|	V |
22+35	218.9911	66.91	|	Q	|	|	V |
22+40	219.4520	66.93	|	Q	|	|	V |
22+45	219.9130	66.94	|	Q	|	|	V |
22+50	220.3741	66.95	|	Q	|	|	V |
22+55	220.8353	66.96	|	Q	|	|	V |
23+ 0	221.2965	66.97	|	Q	|	|	V |
23+ 5	221.7580	67.01	|	Q	|	|	V |
23+10	222.2206	67.17	|	Q	|	|	V |
23+15	222.6867	67.67	|	Q	|	|	V |
23+20	223.1618	68.99	|	Q	|	|	V |
23+25	223.6486	70.68	|	Q	|	|	V |
23+30	224.1438	71.90	|	Q	|	|	V|
23+35	224.6442	72.66	|	Q	|	|	V|
23+40	225.1476	73.09	|	Q	|	|	V|
23+45	225.6504	73.01	|	Q	|	|	V|
23+50	226.1463	72.00	|	Q	|	|	V|
23+55	226.6322	70.55	|	Q	|	|	V|
24+ 0	227.1109	69.51	|	Q	|	|	V|
24+ 5	227.5833	68.59	|	Q	|	|	V|
24+10	228.0436	66.83	|	Q	|	|	V|
24+15	228.4712	62.09	|	Q	|	|	V|
24+20	228.8153	49.96	|	Q	|	|	V|
24+25	229.0538	34.64	|	Q	|	|	V|
24+30	229.2168	23.67	|Q	|	|	|	V|
24+35	229.3305	16.51	|Q	|	|	|	V|
24+40	229.4095	11.48	Q	|	|	|	V|
24+45	229.4637	7.86	Q	|	|	|	V|
24+50	229.4996	5.22	Q	|	|	|	V|
24+55	229.5222	3.28	Q	|	|	|	V|
25+ 0	229.5353	1.90	Q	|	|	|	V|
25+ 5	229.5420	0.96	Q	|	|	|	V|
25+10	229.5444	0.36	Q	|	|	|	V|
25+15	229.5447	0.05	Q	|	|	|	V|

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: west100yr6hr.out

++

Program License Serial Number 4055

Tule Wind Project
Unnamed Western Wash
Existing 100 Year 6 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
1440.00	3.92

Rainfall Distribution pattern used in study:
Type B for SCS (small dam) or San Diego 6 hour storms

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
1440.00	1.000	79.8	79.8	0.050	B

Area-averaged catchment SCS Curve Number AMC(2) = 79.840
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   1440.00(Ac.)
Catchment Lag time =   0.310 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 26.8817
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 79.840

Rainfall depth area reduction factors:
Using a total area of   1440.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 1.000
Rainfall entered for study =   3.920(In)
Adjusted rainfall =   3.920(In)

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

(K = 17424.00 (CFS))

0.27	0.083	0.020	94.729	0.005
0.54	0.167	0.119	555.238	0.037
0.81	0.250	0.521	2427.683	0.177
1.08	0.333	1.000	4660.364	0.444
1.34	0.417	0.777	3622.249	0.652
1.61	0.500	0.462	2154.448	0.776
1.88	0.583	0.302	1407.416	0.856
2.15	0.667	0.205	954.220	0.911
2.42	0.750	0.142	660.405	0.949
2.69	0.833	0.093	433.118	0.974
2.96	0.917	0.058	268.780	0.989
3.23	1.000	0.032	149.085	0.998
3.49	1.083	0.008	36.266	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In) P	Total SCS Runoff (In) Q	Rainfall Amount (In) dP	Runoff Amount (In) dQ	Infiltr-ation (In) dP-dQ	Revised Runoff Min Loss Rate
0.08	0.0229	0.0000	0.0229	0.0000	0.0229	--------
0.17	0.0457	0.0000	0.0229	0.0000	0.0229	--------
0.25	0.0686	0.0000	0.0229	0.0000	0.0229	--------
0.33	0.0915	0.0000	0.0229	0.0000	0.0229	--------
0.42	0.1143	0.0000	0.0229	0.0000	0.0229	--------
0.50	0.1372	0.0000	0.0229	0.0000	0.0229	--------
0.58	0.1679	0.0000	0.0307	0.0000	0.0307	--------
0.67	0.1986	0.0000	0.0307	0.0000	0.0307	--------
0.75	0.2293	0.0000	0.0307	0.0000	0.0307	--------

0.83	0.2600	0.0000	0.0307	0.0000	0.0307	--------
0.92	0.2907	0.0000	0.0307	0.0000	0.0307	--------
1.00	0.3214	0.0000	0.0307	0.0000	0.0307	--------
1.08	0.3593	0.0000	0.0379	0.0000	0.0379	--------
1.17	0.3972	0.0000	0.0379	0.0000	0.0379	--------
1.25	0.4351	0.0000	0.0379	0.0000	0.0379	--------
1.33	0.4730	0.0000	0.0379	0.0000	0.0379	--------
1.42	0.5109	0.0000	0.0379	0.0000	0.0379	--------
1.50	0.5488	0.0007	0.0379	0.0007	0.0372	--------
1.58	0.6076	0.0040	0.0588	0.0033	0.0555	--------
1.67	0.6664	0.0097	0.0588	0.0057	0.0531	--------
1.75	0.7252	0.0177	0.0588	0.0080	0.0508	--------
1.83	0.7840	0.0278	0.0588	0.0101	0.0487	--------
1.92	0.8428	0.0399	0.0588	0.0121	0.0467	--------
2.00	0.9016	0.0538	0.0588	0.0140	0.0448	--------
2.08	1.1433	0.1288	0.2417	0.0750	0.1668	--------
2.17	1.3851	0.2275	0.2417	0.0986	0.1431	--------
2.25	1.6268	0.3451	0.2417	0.1176	0.1241	--------
2.33	1.8685	0.4781	0.2417	0.1330	0.1087	--------
2.42	2.1103	0.6239	0.2417	0.1458	0.0960	--------
2.50	2.3520	0.7803	0.2417	0.1564	0.0854	--------
2.58	2.4173	0.8241	0.0653	0.0439	0.0215	--------
2.67	2.4827	0.8686	0.0653	0.0445	0.0208	--------
2.75	2.5480	0.9137	0.0653	0.0451	0.0203	--------
2.83	2.6133	0.9594	0.0653	0.0457	0.0197	--------
2.92	2.6787	1.0055	0.0653	0.0462	0.0191	--------
3.00	2.7440	1.0523	0.0653	0.0467	0.0186	--------
3.08	2.7969	1.0905	0.0529	0.0382	0.0147	--------
3.17	2.8498	1.1290	0.0529	0.0385	0.0144	--------
3.25	2.9028	1.1679	0.0529	0.0388	0.0141	--------
3.33	2.9557	1.2070	0.0529	0.0391	0.0138	--------
3.42	3.0086	1.2465	0.0529	0.0394	0.0135	--------
3.50	3.0615	1.2862	0.0529	0.0397	0.0132	--------
3.58	3.0968	1.3128	0.0353	0.0266	0.0087	--------
3.67	3.1321	1.3395	0.0353	0.0267	0.0085	--------
3.75	3.1674	1.3664	0.0353	0.0269	0.0084	--------
3.83	3.2026	1.3934	0.0353	0.0270	0.0083	--------
3.92	3.2379	1.4205	0.0353	0.0271	0.0082	--------
4.00	3.2732	1.4477	0.0353	0.0272	0.0081	--------
4.08	3.3026	1.4704	0.0294	0.0227	0.0067	--------
4.17	3.3320	1.4932	0.0294	0.0228	0.0066	--------
4.25	3.3614	1.5161	0.0294	0.0229	0.0065	--------
4.33	3.3908	1.5391	0.0294	0.0230	0.0064	--------
4.42	3.4202	1.5621	0.0294	0.0230	0.0064	--------
4.50	3.4496	1.5852	0.0294	0.0231	0.0063	--------
4.58	3.4777	1.6074	0.0281	0.0221	0.0060	--------
4.67	3.5058	1.6296	0.0281	0.0222	0.0059	--------
4.75	3.5339	1.6518	0.0281	0.0223	0.0058	--------
4.83	3.5620	1.6741	0.0281	0.0223	0.0058	--------
4.92	3.5901	1.6965	0.0281	0.0224	0.0057	--------
5.00	3.6182	1.7189	0.0281	0.0224	0.0057	--------
5.08	3.6423	1.7383	0.0242	0.0193	0.0048	--------
5.17	3.6665	1.7577	0.0242	0.0194	0.0048	--------
5.25	3.6907	1.7771	0.0242	0.0194	0.0047	--------
5.33	3.7149	1.7966	0.0242	0.0195	0.0047	--------
5.42	3.7390	1.8161	0.0242	0.0195	0.0047	--------
5.50	3.7632	1.8356	0.0242	0.0195	0.0046	--------
5.58	3.7893	1.8568	0.0261	0.0212	0.0050	--------
5.67	3.8155	1.8780	0.0261	0.0212	0.0049	--------
5.75	3.8416	1.8993	0.0261	0.0213	0.0049	--------
5.83	3.8677	1.9206	0.0261	0.0213	0.0048	--------
5.92	3.8939	1.9419	0.0261	0.0213	0.0048	--------
6.00	3.9200	1.9633	0.0261	0.0214	0.0047	--------

Total soil rain loss = 1.96(In)
Total effective runoff = 1.96(In)

Peak flow rate this hydrograph = 2051.85(CFS)
Total runoff volume this hydrograph = 10262628.5(Ft3)

6 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	525.0	1050.0	1575.0	2100.0
0+ 5	0.0000	0.00	Q				
0+10	0.0000	0.00	Q				
0+15	0.0000	0.00	Q				
0+20	0.0000	0.00	Q				
0+25	0.0000	0.00	Q				
0+30	0.0000	0.00	Q				
0+35	0.0000	0.00	Q				
0+40	0.0000	0.00	Q				
0+45	0.0000	0.00	Q				
0+50	0.0000	0.00	Q				
0+55	0.0000	0.00	Q				
1+ 0	0.0000	0.00	Q				
1+ 5	0.0000	0.00	Q				
1+10	0.0000	0.00	Q				
1+15	0.0000	0.00	Q				
1+20	0.0000	0.00	Q				
1+25	0.0000	0.00	Q				
1+30	0.0005	0.08	Q				
1+35	0.0057	0.75	Q				
1+40	0.0346	4.19	Q				
1+45	0.1399	15.29	Q				
1+50	0.3951	37.06	Q				
1+55	0.8498	66.01	VQ				
2+ 0	1.5271	98.35	VQ				
2+ 5	2.4754	137.70	V Q				
2+10	3.8985	206.63	V Q				
2+15	6.6378	397.75	V Q				
2+20	11.9454	770.66	V Q				
2+25	20.0033	1170.00	V Q				
2+30	30.5344	1529.11	V Q				
2+35	43.1915	1837.81	V Q				
2+40	57.3227	2051.85	V Q				
2+45	71.0912	1999.19	V Q				
2+50	82.2847	1625.30	V Q				
2+55	91.3582	1317.47	V Q				
3+ 0	99.2290	1142.83	V Q				
3+ 5	106.3054	1027.50	VQ				
3+10	112.8057	943.84	Q V				
3+15	118.7781	867.19	Q V				
3+20	124.2185	789.95	Q V				
3+25	129.2907	736.48	Q V				
3+30	134.1621	707.34	Q V				
3+35	138.9518	695.47	Q V				
3+40	143.6707	685.18	Q V				
3+45	148.1617	652.09	Q V				
3+50	152.2291	590.59	Q V				

3+55	155.9725	543.55	Q V
4+ 0	159.5298	516.51	Q V
4+ 5	162.9707	499.62	Q V
4+10	166.3228	486.73	Q V
4+15	169.5530	469.02	Q V
4+20	172.6104	443.94	Q V
4+25	175.5412	425.55	Q V
4+30	178.4010	415.25	Q V
4+35	181.2223	409.65	Q V
4+40	184.0188	406.05	Q V
4+45	186.7860	401.80	Q V
4+50	189.5149	396.23	Q V
4+55	192.2175	392.42	Q V
5+ 0	194.9078	390.62	Q V
5+ 5	197.5922	389.78	Q V
5+10	200.2650	388.09	Q V
5+15	202.8876	380.80	Q V
5+20	205.4129	366.67	Q V
5+25	207.8639	355.89	Q V
5+30	210.2729	349.78	Q V
5+35	212.6575	346.24	Q V
5+40	215.0326	344.87	Q V
5+45	217.4250	347.37	Q V
5+50	219.8639	354.13	Q V
5+55	222.3417	359.77	Q V
6+ 0	224.8449	363.47	Q V
6+ 5	227.3539	364.30	Q V
6+10	229.7964	354.66	Q V
6+15	231.8927	304.39	Q V
6+20	233.3101	205.80	Q V
6+25	234.1985	129.00	Q V
6+30	234.7724	83.32	Q V
6+35	235.1400	53.38	Q V
6+40	235.3676	33.04	Q V
6+45	235.4981	18.95	Q V
6+50	235.5649	9.70	Q V
6+55	235.5922	3.96	Q V
7+ 0	235.5975	0.78	Q V

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: west100yr24hr.out

++

Program License Serial Number 4055

Tule Wind Project
Unnamed Western Wash
Existing 100 Year 24 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
1440.00	5.01

Rainfall Distribution pattern used in study:
Type B for San Diego area of California

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
1440.00	1.000	79.8	79.8	0.050	B

Area-averaged catchment SCS Curve Number AMC(2) = 79.840
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   1440.00(Ac.)
Catchment Lag time =   0.310 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 26.8817
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 79.840

Rainfall depth area reduction factors:
Using a total area of   1440.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 1.000
Rainfall entered for study =   5.010(In)
Adjusted rainfall =   5.010(In)

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

0.27	0.083	0.020	94.729	0.005
0.54	0.167	0.119	555.238	0.037
0.81	0.250	0.521	2427.683	0.177
1.08	0.333	1.000	4660.364	0.444
1.34	0.417	0.777	3622.249	0.652
1.61	0.500	0.462	2154.448	0.776
1.88	0.583	0.302	1407.416	0.856
2.15	0.667	0.205	954.220	0.911
2.42	0.750	0.142	660.405	0.949
2.69	0.833	0.093	433.118	0.974
2.96	0.917	0.058	268.780	0.989
3.23	1.000	0.032	149.085	0.998
3.49	1.083	0.008	36.266	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In) P	Total SCS Runoff (In) Q	Rainfall Amount (In) dP	Runoff Amount (In) dQ	Infiltr-ation (In) dP-dQ	Revised Runoff Min Loss Rate
0.08	0.0075	0.0000	0.0075	0.0000	0.0075	--------
0.17	0.0150	0.0000	0.0075	0.0000	0.0075	--------
0.25	0.0225	0.0000	0.0075	0.0000	0.0075	--------
0.33	0.0301	0.0000	0.0075	0.0000	0.0075	--------
0.42	0.0376	0.0000	0.0075	0.0000	0.0075	--------
0.50	0.0451	0.0000	0.0075	0.0000	0.0075	--------
0.58	0.0509	0.0000	0.0058	0.0000	0.0058	--------
0.67	0.0568	0.0000	0.0058	0.0000	0.0058	--------
0.75	0.0626	0.0000	0.0058	0.0000	0.0058	--------

0.83	0.0685	0.0000	0.0058	0.0000	0.0058	--------
0.92	0.0743	0.0000	0.0058	0.0000	0.0058	--------
1.00	0.0802	0.0000	0.0058	0.0000	0.0058	--------
1.08	0.0877	0.0000	0.0075	0.0000	0.0075	--------
1.17	0.0952	0.0000	0.0075	0.0000	0.0075	--------
1.25	0.1027	0.0000	0.0075	0.0000	0.0075	--------
1.33	0.1102	0.0000	0.0075	0.0000	0.0075	--------
1.42	0.1177	0.0000	0.0075	0.0000	0.0075	--------
1.50	0.1253	0.0000	0.0075	0.0000	0.0075	--------
1.58	0.1328	0.0000	0.0075	0.0000	0.0075	--------
1.67	0.1403	0.0000	0.0075	0.0000	0.0075	--------
1.75	0.1478	0.0000	0.0075	0.0000	0.0075	--------
1.83	0.1553	0.0000	0.0075	0.0000	0.0075	--------
1.92	0.1628	0.0000	0.0075	0.0000	0.0075	--------
2.00	0.1703	0.0000	0.0075	0.0000	0.0075	--------
2.08	0.1795	0.0000	0.0092	0.0000	0.0092	--------
2.17	0.1887	0.0000	0.0092	0.0000	0.0092	--------
2.25	0.1979	0.0000	0.0092	0.0000	0.0092	--------
2.33	0.2071	0.0000	0.0092	0.0000	0.0092	--------
2.42	0.2163	0.0000	0.0092	0.0000	0.0092	--------
2.50	0.2254	0.0000	0.0092	0.0000	0.0092	--------
2.58	0.2330	0.0000	0.0075	0.0000	0.0075	--------
2.67	0.2405	0.0000	0.0075	0.0000	0.0075	--------
2.75	0.2480	0.0000	0.0075	0.0000	0.0075	--------
2.83	0.2555	0.0000	0.0075	0.0000	0.0075	--------
2.92	0.2630	0.0000	0.0075	0.0000	0.0075	--------
3.00	0.2705	0.0000	0.0075	0.0000	0.0075	--------
3.08	0.2797	0.0000	0.0092	0.0000	0.0092	--------
3.17	0.2889	0.0000	0.0092	0.0000	0.0092	--------
3.25	0.2981	0.0000	0.0092	0.0000	0.0092	--------
3.33	0.3073	0.0000	0.0092	0.0000	0.0092	--------
3.42	0.3165	0.0000	0.0092	0.0000	0.0092	--------
3.50	0.3257	0.0000	0.0092	0.0000	0.0092	--------
3.58	0.3357	0.0000	0.0100	0.0000	0.0100	--------
3.67	0.3457	0.0000	0.0100	0.0000	0.0100	--------
3.75	0.3557	0.0000	0.0100	0.0000	0.0100	--------
3.83	0.3657	0.0000	0.0100	0.0000	0.0100	--------
3.92	0.3757	0.0000	0.0100	0.0000	0.0100	--------
4.00	0.3858	0.0000	0.0100	0.0000	0.0100	--------
4.08	0.3966	0.0000	0.0109	0.0000	0.0109	--------
4.17	0.4075	0.0000	0.0109	0.0000	0.0109	--------
4.25	0.4183	0.0000	0.0109	0.0000	0.0109	--------
4.33	0.4292	0.0000	0.0109	0.0000	0.0109	--------
4.42	0.4400	0.0000	0.0109	0.0000	0.0109	--------
4.50	0.4509	0.0000	0.0109	0.0000	0.0109	--------
4.58	0.4626	0.0000	0.0117	0.0000	0.0117	--------
4.67	0.4743	0.0000	0.0117	0.0000	0.0117	--------
4.75	0.4860	0.0000	0.0117	0.0000	0.0117	--------
4.83	0.4977	0.0000	0.0117	0.0000	0.0117	--------
4.92	0.5093	0.0000	0.0117	0.0000	0.0117	--------
5.00	0.5210	0.0001	0.0117	0.0001	0.0116	--------
5.08	0.5344	0.0003	0.0134	0.0002	0.0131	--------
5.17	0.5478	0.0007	0.0134	0.0004	0.0130	--------
5.25	0.5611	0.0012	0.0134	0.0005	0.0129	--------
5.33	0.5745	0.0019	0.0134	0.0006	0.0127	--------
5.42	0.5878	0.0026	0.0134	0.0008	0.0126	--------
5.50	0.6012	0.0035	0.0134	0.0009	0.0125	--------
5.58	0.6154	0.0046	0.0142	0.0011	0.0131	--------
5.67	0.6296	0.0059	0.0142	0.0012	0.0130	--------
5.75	0.6438	0.0072	0.0142	0.0014	0.0128	--------
5.83	0.6580	0.0087	0.0142	0.0015	0.0127	--------
5.92	0.6722	0.0104	0.0142	0.0016	0.0126	--------
6.00	0.6864	0.0122	0.0142	0.0018	0.0124	--------

6.08	0.7031	0.0144	0.0167	0.0023	0.0144	--------
6.17	0.7198	0.0168	0.0167	0.0024	0.0143	--------
6.25	0.7365	0.0194	0.0167	0.0026	0.0141	--------
6.33	0.7532	0.0222	0.0167	0.0028	0.0139	--------
6.42	0.7699	0.0251	0.0167	0.0029	0.0138	--------
6.50	0.7866	0.0282	0.0167	0.0031	0.0136	--------
6.58	0.8058	0.0320	0.0192	0.0038	0.0154	--------
6.67	0.8250	0.0360	0.0192	0.0040	0.0152	--------
6.75	0.8442	0.0402	0.0192	0.0042	0.0150	--------
6.83	0.8634	0.0445	0.0192	0.0044	0.0148	--------
6.92	0.8826	0.0491	0.0192	0.0046	0.0146	--------
7.00	0.9018	0.0539	0.0192	0.0048	0.0144	--------
7.08	0.9268	0.0604	0.0251	0.0065	0.0185	--------
7.17	0.9519	0.0672	0.0251	0.0068	0.0182	--------
7.25	0.9769	0.0743	0.0251	0.0071	0.0179	--------
7.33	1.0020	0.0817	0.0250	0.0074	0.0176	--------
7.42	1.0270	0.0894	0.0251	0.0077	0.0173	--------
7.50	1.0521	0.0974	0.0251	0.0080	0.0171	--------
7.58	1.0897	0.1099	0.0376	0.0125	0.0251	--------
7.67	1.1273	0.1230	0.0376	0.0131	0.0245	--------
7.75	1.1648	0.1367	0.0376	0.0137	0.0239	--------
7.83	1.2024	0.1509	0.0376	0.0142	0.0233	--------
7.92	1.2400	0.1657	0.0376	0.0148	0.0228	--------
8.00	1.2776	0.1810	0.0376	0.0153	0.0223	--------
8.08	1.3335	0.2047	0.0559	0.0237	0.0323	--------
8.17	1.3894	0.2294	0.0559	0.0247	0.0312	--------
8.25	1.4454	0.2552	0.0559	0.0258	0.0302	--------
8.33	1.5013	0.2819	0.0559	0.0267	0.0292	--------
8.42	1.5573	0.3095	0.0559	0.0276	0.0283	--------
8.50	1.6132	0.3380	0.0559	0.0285	0.0274	--------
8.58	1.6867	0.3767	0.0735	0.0387	0.0348	--------
8.67	1.7602	0.4168	0.0735	0.0400	0.0334	--------
8.75	1.8337	0.4581	0.0735	0.0413	0.0322	--------
8.83	1.9071	0.5006	0.0735	0.0425	0.0310	--------
8.92	1.9806	0.5443	0.0735	0.0437	0.0298	--------
9.00	2.0541	0.5890	0.0735	0.0447	0.0287	--------
9.08	2.1343	0.6390	0.0802	0.0500	0.0302	--------
9.17	2.2144	0.6901	0.0802	0.0511	0.0291	--------
9.25	2.2946	0.7423	0.0802	0.0522	0.0280	--------
9.33	2.3747	0.7955	0.0802	0.0532	0.0270	--------
9.42	2.4549	0.8496	0.0802	0.0542	0.0260	--------
9.50	2.5351	0.9047	0.0802	0.0551	0.0251	--------
9.58	2.6035	0.9525	0.0685	0.0477	0.0207	--------
9.67	2.6720	1.0008	0.0685	0.0483	0.0201	--------
9.75	2.7405	1.0497	0.0685	0.0489	0.0195	--------
9.83	2.8089	1.0992	0.0685	0.0495	0.0190	--------
9.92	2.8774	1.1492	0.0685	0.0500	0.0185	--------
10.00	2.9459	1.1997	0.0685	0.0505	0.0180	--------
10.08	2.9801	1.2252	0.0342	0.0254	0.0088	--------
10.17	3.0143	1.2508	0.0342	0.0256	0.0087	--------
10.25	3.0486	1.2764	0.0342	0.0257	0.0086	--------
10.33	3.0828	1.3022	0.0342	0.0258	0.0084	--------
10.42	3.1171	1.3281	0.0342	0.0259	0.0083	--------
10.50	3.1513	1.3542	0.0342	0.0260	0.0082	--------
10.58	3.1738	1.3714	0.0225	0.0172	0.0054	--------
10.67	3.1964	1.3886	0.0225	0.0172	0.0053	--------
10.75	3.2189	1.4059	0.0225	0.0173	0.0053	--------
10.83	3.2415	1.4232	0.0225	0.0173	0.0052	--------
10.92	3.2640	1.4406	0.0225	0.0174	0.0052	--------
11.00	3.2866	1.4580	0.0225	0.0174	0.0051	--------
11.08	3.3058	1.4729	0.0192	0.0149	0.0043	--------
11.17	3.3250	1.4878	0.0192	0.0149	0.0043	--------
11.25	3.3442	1.5027	0.0192	0.0149	0.0043	--------

11.33	3.3634	1.5177	0.0192	0.0150	0.0042	--------
11.42	3.3826	1.5327	0.0192	0.0150	0.0042	--------
11.50	3.4018	1.5477	0.0192	0.0150	0.0042	--------
11.58	3.4193	1.5614	0.0175	0.0137	0.0038	--------
11.67	3.4369	1.5752	0.0175	0.0138	0.0038	--------
11.75	3.4544	1.5890	0.0175	0.0138	0.0037	--------
11.83	3.4719	1.6028	0.0175	0.0138	0.0037	--------
11.92	3.4895	1.6167	0.0175	0.0138	0.0037	--------
12.00	3.5070	1.6305	0.0175	0.0139	0.0037	--------
12.08	3.5237	1.6437	0.0167	0.0132	0.0035	--------
12.17	3.5404	1.6570	0.0167	0.0132	0.0035	--------
12.25	3.5571	1.6703	0.0167	0.0133	0.0034	--------
12.33	3.5738	1.6835	0.0167	0.0133	0.0034	--------
12.42	3.5905	1.6969	0.0167	0.0133	0.0034	--------
12.50	3.6072	1.7102	0.0167	0.0133	0.0034	--------
12.58	3.6231	1.7229	0.0159	0.0127	0.0032	--------
12.67	3.6389	1.7356	0.0159	0.0127	0.0032	--------
12.75	3.6548	1.7483	0.0159	0.0127	0.0031	--------
12.83	3.6707	1.7610	0.0159	0.0127	0.0031	--------
12.92	3.6865	1.7738	0.0159	0.0128	0.0031	--------
13.00	3.7024	1.7865	0.0159	0.0128	0.0031	--------
13.08	3.7166	1.7980	0.0142	0.0114	0.0028	--------
13.17	3.7308	1.8094	0.0142	0.0115	0.0027	--------
13.25	3.7450	1.8209	0.0142	0.0115	0.0027	--------
13.33	3.7592	1.8324	0.0142	0.0115	0.0027	--------
13.42	3.7734	1.8438	0.0142	0.0115	0.0027	--------
13.50	3.7876	1.8554	0.0142	0.0115	0.0027	--------
13.58	3.8009	1.8662	0.0134	0.0108	0.0025	--------
13.67	3.8143	1.8770	0.0134	0.0109	0.0025	--------
13.75	3.8276	1.8879	0.0134	0.0109	0.0025	--------
13.83	3.8410	1.8988	0.0134	0.0109	0.0025	--------
13.92	3.8544	1.9097	0.0134	0.0109	0.0025	--------
14.00	3.8677	1.9206	0.0134	0.0109	0.0025	--------
14.08	3.8828	1.9328	0.0150	0.0123	0.0028	--------
14.17	3.8978	1.9451	0.0150	0.0123	0.0027	--------
14.25	3.9128	1.9574	0.0150	0.0123	0.0027	--------
14.33	3.9278	1.9697	0.0150	0.0123	0.0027	--------
14.42	3.9429	1.9821	0.0150	0.0123	0.0027	--------
14.50	3.9579	1.9944	0.0150	0.0123	0.0027	--------
14.58	3.9663	2.0013	0.0084	0.0069	0.0015	--------
14.67	3.9746	2.0081	0.0083	0.0069	0.0015	--------
14.75	3.9830	2.0150	0.0084	0.0069	0.0015	--------
14.83	3.9913	2.0219	0.0084	0.0069	0.0015	--------
14.92	3.9996	2.0288	0.0083	0.0069	0.0015	--------
15.00	4.0080	2.0356	0.0084	0.0069	0.0015	--------
15.08	4.0214	2.0467	0.0134	0.0110	0.0023	--------
15.17	4.0347	2.0577	0.0134	0.0110	0.0023	--------
15.25	4.0481	2.0687	0.0134	0.0110	0.0023	--------
15.33	4.0614	2.0798	0.0134	0.0111	0.0023	--------
15.42	4.0748	2.0909	0.0134	0.0111	0.0023	--------
15.50	4.0882	2.1019	0.0134	0.0111	0.0023	--------
15.58	4.1007	2.1123	0.0125	0.0104	0.0021	--------
15.67	4.1132	2.1227	0.0125	0.0104	0.0021	--------
15.75	4.1257	2.1331	0.0125	0.0104	0.0021	--------
15.83	4.1383	2.1435	0.0125	0.0104	0.0021	--------
15.92	4.1508	2.1540	0.0125	0.0104	0.0021	--------
16.00	4.1633	2.1644	0.0125	0.0104	0.0021	--------
16.08	4.1750	2.1741	0.0117	0.0097	0.0019	--------
16.17	4.1867	2.1839	0.0117	0.0098	0.0019	--------
16.25	4.1984	2.1936	0.0117	0.0098	0.0019	--------
16.33	4.2101	2.2034	0.0117	0.0098	0.0019	--------
16.42	4.2218	2.2132	0.0117	0.0098	0.0019	--------
16.50	4.2334	2.2230	0.0117	0.0098	0.0019	--------

16.58	4.2460	2.2334	0.0125	0.0105	0.0020	--------
16.67	4.2585	2.2439	0.0125	0.0105	0.0020	--------
16.75	4.2710	2.2544	0.0125	0.0105	0.0020	--------
16.83	4.2836	2.2650	0.0125	0.0105	0.0020	--------
16.92	4.2961	2.2755	0.0125	0.0105	0.0020	--------
17.00	4.3086	2.2860	0.0125	0.0105	0.0020	--------
17.08	4.3186	2.2944	0.0100	0.0084	0.0016	--------
17.17	4.3286	2.3029	0.0100	0.0084	0.0016	--------
17.25	4.3387	2.3113	0.0100	0.0084	0.0016	--------
17.33	4.3487	2.3197	0.0100	0.0084	0.0016	--------
17.42	4.3587	2.3282	0.0100	0.0084	0.0016	--------
17.50	4.3687	2.3366	0.0100	0.0085	0.0016	--------
17.58	4.3796	2.3458	0.0109	0.0092	0.0017	--------
17.67	4.3904	2.3550	0.0109	0.0092	0.0017	--------
17.75	4.4013	2.3641	0.0109	0.0092	0.0017	--------
17.83	4.4121	2.3733	0.0109	0.0092	0.0017	--------
17.92	4.4230	2.3825	0.0109	0.0092	0.0017	--------
18.00	4.4338	2.3917	0.0109	0.0092	0.0017	--------
18.08	4.4422	2.3988	0.0084	0.0071	0.0013	--------
18.17	4.4505	2.4059	0.0084	0.0071	0.0013	--------
18.25	4.4589	2.4129	0.0084	0.0071	0.0013	--------
18.33	4.4672	2.4200	0.0084	0.0071	0.0013	--------
18.42	4.4756	2.4271	0.0084	0.0071	0.0013	--------
18.50	4.4840	2.4342	0.0084	0.0071	0.0013	--------
18.58	4.4923	2.4413	0.0084	0.0071	0.0013	--------
18.67	4.5006	2.4484	0.0083	0.0071	0.0013	--------
18.75	4.5090	2.4555	0.0084	0.0071	0.0013	--------
18.83	4.5174	2.4626	0.0084	0.0071	0.0012	--------
18.92	4.5257	2.4697	0.0083	0.0071	0.0012	--------
19.00	4.5340	2.4768	0.0084	0.0071	0.0012	--------
19.08	4.5416	2.4832	0.0075	0.0064	0.0011	--------
19.17	4.5491	2.4896	0.0075	0.0064	0.0011	--------
19.25	4.5566	2.4960	0.0075	0.0064	0.0011	--------
19.33	4.5641	2.5024	0.0075	0.0064	0.0011	--------
19.42	4.5716	2.5088	0.0075	0.0064	0.0011	--------
19.50	4.5791	2.5152	0.0075	0.0064	0.0011	--------
19.58	4.5875	2.5224	0.0084	0.0071	0.0012	--------
19.67	4.5958	2.5295	0.0084	0.0071	0.0012	--------
19.75	4.6042	2.5366	0.0084	0.0071	0.0012	--------
19.83	4.6125	2.5438	0.0084	0.0071	0.0012	--------
19.92	4.6209	2.5509	0.0084	0.0071	0.0012	--------
20.00	4.6292	2.5581	0.0084	0.0071	0.0012	--------
20.08	4.6384	2.5659	0.0092	0.0079	0.0013	--------
20.17	4.6476	2.5738	0.0092	0.0079	0.0013	--------
20.25	4.6568	2.5817	0.0092	0.0079	0.0013	--------
20.33	4.6660	2.5895	0.0092	0.0079	0.0013	--------
20.42	4.6752	2.5974	0.0092	0.0079	0.0013	--------
20.50	4.6844	2.6053	0.0092	0.0079	0.0013	--------
20.58	4.6927	2.6125	0.0084	0.0072	0.0012	--------
20.67	4.7010	2.6196	0.0083	0.0072	0.0012	--------
20.75	4.7094	2.6268	0.0084	0.0072	0.0012	--------
20.83	4.7177	2.6340	0.0084	0.0072	0.0012	--------
20.92	4.7261	2.6412	0.0084	0.0072	0.0012	--------
21.00	4.7344	2.6483	0.0084	0.0072	0.0012	--------
21.08	4.7420	2.6548	0.0075	0.0065	0.0010	--------
21.17	4.7495	2.6613	0.0075	0.0065	0.0010	--------
21.25	4.7570	2.6677	0.0075	0.0065	0.0010	--------
21.33	4.7645	2.6742	0.0075	0.0065	0.0010	--------
21.42	4.7720	2.6807	0.0075	0.0065	0.0010	--------
21.50	4.7795	2.6872	0.0075	0.0065	0.0010	--------
21.58	4.7871	2.6936	0.0075	0.0065	0.0010	--------
21.67	4.7946	2.7001	0.0075	0.0065	0.0010	--------
21.75	4.8021	2.7066	0.0075	0.0065	0.0010	--------

21.83	4.8096	2.7131	0.0075	0.0065	0.0010	--------
21.92	4.8171	2.7196	0.0075	0.0065	0.0010	--------
22.00	4.8246	2.7261	0.0075	0.0065	0.0010	--------
22.08	4.8321	2.7326	0.0075	0.0065	0.0010	--------
22.17	4.8397	2.7391	0.0075	0.0065	0.0010	--------
22.25	4.8472	2.7456	0.0075	0.0065	0.0010	--------
22.33	4.8547	2.7521	0.0075	0.0065	0.0010	--------
22.42	4.8622	2.7586	0.0075	0.0065	0.0010	--------
22.50	4.8697	2.7651	0.0075	0.0065	0.0010	--------
22.58	4.8772	2.7716	0.0075	0.0065	0.0010	--------
22.67	4.8847	2.7781	0.0075	0.0065	0.0010	--------
22.75	4.8923	2.7846	0.0075	0.0065	0.0010	--------
22.83	4.8998	2.7911	0.0075	0.0065	0.0010	--------
22.92	4.9073	2.7976	0.0075	0.0065	0.0010	--------
23.00	4.9148	2.8041	0.0075	0.0065	0.0010	--------
23.08	4.9232	2.8114	0.0084	0.0072	0.0011	--------
23.17	4.9315	2.8186	0.0083	0.0072	0.0011	--------
23.25	4.9399	2.8259	0.0084	0.0072	0.0011	--------
23.33	4.9482	2.8331	0.0084	0.0073	0.0011	--------
23.42	4.9566	2.8404	0.0084	0.0073	0.0011	--------
23.50	4.9649	2.8477	0.0084	0.0073	0.0011	--------
23.58	4.9724	2.8542	0.0075	0.0065	0.0010	--------
23.67	4.9799	2.8607	0.0075	0.0065	0.0010	--------
23.75	4.9875	2.8673	0.0075	0.0065	0.0010	--------
23.83	4.9950	2.8738	0.0075	0.0065	0.0010	--------
23.92	5.0025	2.8803	0.0075	0.0065	0.0010	--------
24.00	5.0100	2.8869	0.0075	0.0065	0.0010	--------

Total soil rain loss = 2.12(In)
Total effective runoff = 2.89(In)

Peak flow rate this hydrograph = 909.54(CFS)
Total runoff volume this hydrograph = 15090338.2(Ft3)

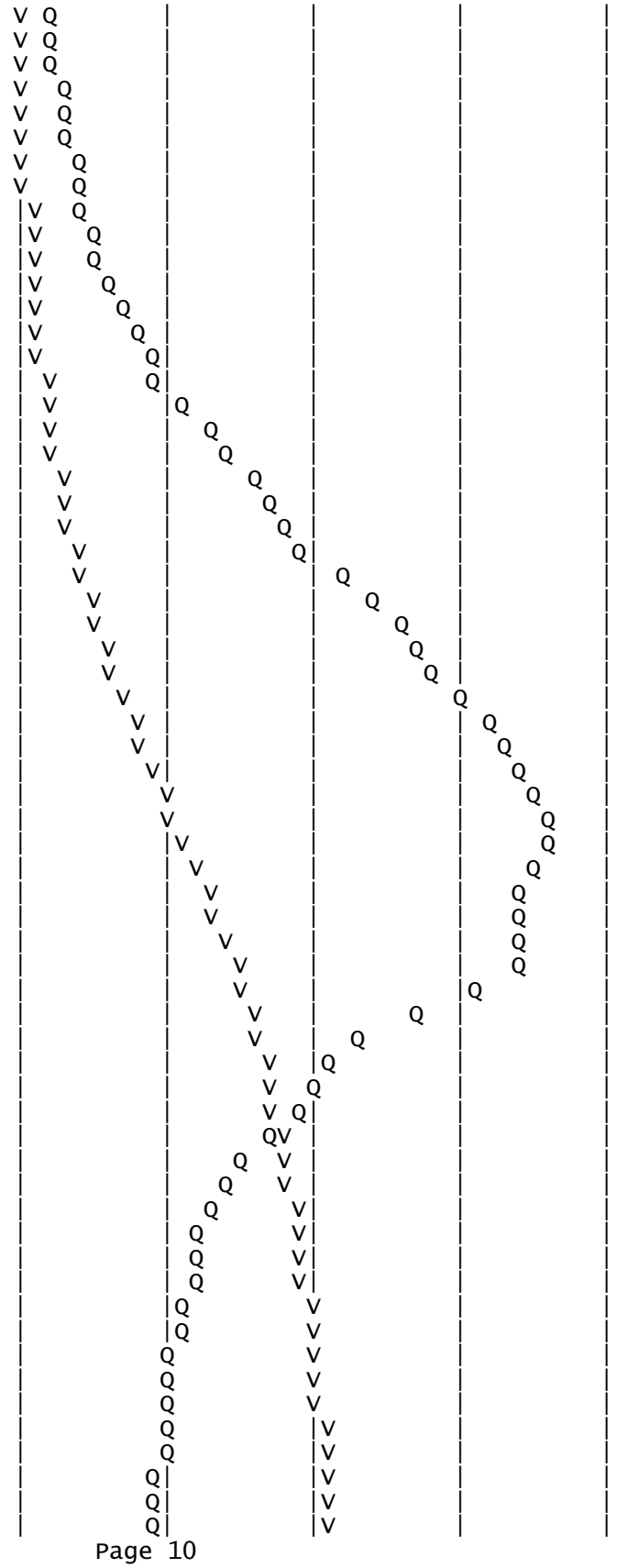
++

24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	250.0	500.0	750.0	1000.0
0+ 5	0.0000	0.00	Q				
0+10	0.0000	0.00	Q				
0+15	0.0000	0.00	Q				
0+20	0.0000	0.00	Q				
0+25	0.0000	0.00	Q				
0+30	0.0000	0.00	Q				
0+35	0.0000	0.00	Q				
0+40	0.0000	0.00	Q				
0+45	0.0000	0.00	Q				
0+50	0.0000	0.00	Q				
0+55	0.0000	0.00	Q				
1+ 0	0.0000	0.00	Q				
1+ 5	0.0000	0.00	Q				
1+10	0.0000	0.00	Q				
1+15	0.0000	0.00	Q				
1+20	0.0000	0.00	Q				
1+25	0.0000	0.00	Q				
1+30	0.0000	0.00	Q				
1+35	0.0000	0.00	Q				

1+40	0.0000	0.00	Q	|	|	|	|
1+45	0.0000	0.00	Q	|	|	|	|
1+50	0.0000	0.00	Q	|	|	|	|
1+55	0.0000	0.00	Q	|	|	|	|
2+ 0	0.0000	0.00	Q	|	|	|	|
2+ 5	0.0000	0.00	Q	|	|	|	|
2+10	0.0000	0.00	Q	|	|	|	|
2+15	0.0000	0.00	Q	|	|	|	|
2+20	0.0000	0.00	Q	|	|	|	|
2+25	0.0000	0.00	Q	|	|	|	|
2+30	0.0000	0.00	Q	|	|	|	|
2+35	0.0000	0.00	Q	|	|	|	|
2+40	0.0000	0.00	Q	|	|	|	|
2+45	0.0000	0.00	Q	|	|	|	|
2+50	0.0000	0.00	Q	|	|	|	|
2+55	0.0000	0.00	Q	|	|	|	|
3+ 0	0.0000	0.00	Q	|	|	|	|
3+ 5	0.0000	0.00	Q	|	|	|	|
3+10	0.0000	0.00	Q	|	|	|	|
3+15	0.0000	0.00	Q	|	|	|	|
3+20	0.0000	0.00	Q	|	|	|	|
3+25	0.0000	0.00	Q	|	|	|	|
3+30	0.0000	0.00	Q	|	|	|	|
3+35	0.0000	0.00	Q	|	|	|	|
3+40	0.0000	0.00	Q	|	|	|	|
3+45	0.0000	0.00	Q	|	|	|	|
3+50	0.0000	0.00	Q	|	|	|	|
3+55	0.0000	0.00	Q	|	|	|	|
4+ 0	0.0000	0.00	Q	|	|	|	|
4+ 5	0.0000	0.00	Q	|	|	|	|
4+10	0.0000	0.00	Q	|	|	|	|
4+15	0.0000	0.00	Q	|	|	|	|
4+20	0.0000	0.00	Q	|	|	|	|
4+25	0.0000	0.00	Q	|	|	|	|
4+30	0.0000	0.00	Q	|	|	|	|
4+35	0.0000	0.00	Q	|	|	|	|
4+40	0.0000	0.00	Q	|	|	|	|
4+45	0.0000	0.00	Q	|	|	|	|
4+50	0.0000	0.00	Q	|	|	|	|
4+55	0.0000	0.00	Q	|	|	|	|
5+ 0	0.0001	0.01	Q	|	|	|	|
5+ 5	0.0007	0.09	Q	|	|	|	|
5+10	0.0037	0.43	Q	|	|	|	|
5+15	0.0126	1.29	Q	|	|	|	|
5+20	0.0313	2.71	Q	|	|	|	|
5+25	0.0621	4.47	Q	|	|	|	|
5+30	0.1064	6.44	Q	|	|	|	|
5+35	0.1652	8.53	Q	|	|	|	|
5+40	0.2391	10.73	Q	|	|	|	|
5+45	0.3293	13.10	Q	|	|	|	|
5+50	0.4373	15.68	Q	|	|	|	|
5+55	0.5629	18.24	Q	|	|	|	|
6+ 0	0.7058	20.74	Q	|	|	|	|
6+ 5	0.8657	23.23	Q	|	|	|	|
6+10	1.0436	25.83	VQ	|	|	|	|
6+15	1.2438	29.07	VQ	|	|	|	|
6+20	1.4722	33.16	VQ	|	|	|	|
6+25	1.7275	37.08	VQ	|	|	|	|
6+30	2.0071	40.61	VQ	|	|	|	|
6+35	2.3100	43.97	VQ	|	|	|	|
6+40	2.6367	47.44	VQ	|	|	|	|
6+45	2.9932	51.76	V Q	|	|	|	|
6+50	3.3874	57.23	V Q	|	|	|	|

6+55	3.8166	62.33	
7+ 0	4.2765	66.78	
7+ 5	4.7656	71.01	
7+10	5.2872	75.74	
7+15	5.8606	83.26	
7+20	6.5107	94.39	
7+25	7.2296	104.38	
7+30	8.0038	112.41	
7+35	8.8290	119.82	
7+40	9.7143	128.55	
7+45	10.7124	144.94	
7+50	11.8914	171.18	
7+55	13.2289	194.21	
8+ 0	14.6879	211.84	
8+ 5	16.2536	227.34	
8+10	17.9391	244.73	
8+15	19.8399	276.00	
8+20	22.0797	325.22	
8+25	24.6139	367.96	
8+30	27.3702	400.21	
8+35	30.3151	427.61	
8+40	33.4539	455.75	
8+45	36.8924	499.26	
8+50	40.7689	562.88	
8+55	45.0219	617.53	
9+ 0	49.5585	658.71	
9+ 5	54.3286	692.63	
9+10	59.3128	723.70	
9+15	64.5434	759.47	
9+20	70.0687	802.27	
9+25	75.8483	839.21	
9+30	81.8304	868.60	
9+35	87.9768	892.46	
9+40	94.2409	909.54	
9+45	100.5020	909.12	
9+50	106.6185	888.11	
9+55	112.6323	873.21	
10+ 0	118.6132	868.44	
10+ 5	124.5766	865.88	
10+10	130.4600	854.27	
10+15	135.9446	796.36	
10+20	140.6403	681.83	
10+25	144.7252	593.13	
10+30	148.4537	541.37	
10+35	151.9513	507.85	
10+40	155.2673	481.48	
10+45	158.3351	445.44	
10+50	161.0542	394.82	
10+55	163.5143	357.20	
11+ 0	165.8243	335.41	
11+ 5	168.0469	322.72	
11+10	170.2074	313.71	
11+15	172.2899	302.39	
11+20	174.2682	287.24	
11+25	176.1700	276.15	
11+30	178.0286	269.87	
11+35	179.8631	266.37	
11+40	181.6794	263.73	
11+45	183.4658	259.38	
11+50	185.2060	252.67	
11+55	186.9120	247.71	
12+ 0	188.5990	244.96	
12+ 5	190.2754	243.40	

12+10	191.9435	242.21	| Q|	| V	|	|
12+15	193.5975	240.16	| Q|	| V	|	|
12+20	195.2292	236.92	| Q|	| V	|	|
12+25	196.8446	234.56	| Q|	| V	|	|
12+30	198.4515	233.32	| Q|	| V	|	|
12+35	200.0537	232.65	| Q|	| V	|	|
12+40	201.6516	232.01	| Q|	| V	|	|
12+45	203.2377	230.31	| Q|	| V	|	|
12+50	204.8028	227.25	| Q|	| V	|	|
12+55	206.3523	224.99	| Q |	| V	|	|
13+ 0	207.8935	223.78	| Q |	| V	|	|
13+ 5	209.4293	223.00	| Q |	| V	|	|
13+10	210.9578	221.93	| Q |	| V	|	|
13+15	212.4628	218.53	| Q |	| V	|	|
13+20	213.9246	212.25	| Q |	| V	|	|
13+25	215.3535	207.47	| Q |	| V	|	|
13+30	216.7634	204.73	| Q |	| V	|	|
13+35	218.1615	203.00	| Q |	| V	|	|
13+40	219.5497	201.58	| Q |	| V	|	|
13+45	220.9222	199.28	| Q |	| V	|	|
13+50	222.2704	195.77	| Q |	| V	|	|
13+55	223.6008	193.17	| Q |	| V	|	|
14+ 0	224.9211	191.72	| Q |	| V	|	|
14+ 5	226.2369	191.05	| Q |	| V	|	|
14+10	227.5548	191.36	| Q |	| V	|	|
14+15	228.8939	194.43	| Q |	| V	|	|
14+20	230.2761	200.70	| Q |	| V	|	|
14+25	231.6926	205.68	| Q |	| V	|	|
14+30	233.1302	208.74	| Q |	| V	|	|
14+35	234.5789	210.35	| Q |	| V	|	|
14+40	236.0171	208.83	| Q |	| V	|	|
14+45	237.3713	196.63	| Q |	| V	|	|
14+50	238.5547	171.83	| Q |	| V	|	|
14+55	239.6047	152.46	| Q |	| V	|	|
15+ 0	240.5755	140.96	| Q |	| V	|	|
15+ 5	241.4968	133.78	| Q |	| V	|	|
15+10	242.3985	130.93	| Q |	| V	|	|
15+15	243.3450	137.43	| Q |	| V	|	|
15+20	244.4084	154.41	| Q |	| V	|	|
15+25	245.5656	168.03	| Q |	| V	|	|
15+30	246.7796	176.26	| Q |	| V	|	|
15+35	248.0328	181.97	| Q |	| V	|	|
15+40	249.3117	185.69	| Q |	| V	|	|
15+45	250.5990	186.91	| Q |	| V	|	|
15+50	251.8774	185.63	| Q |	| V|	|	|
15+55	253.1474	184.40	| Q |	| V|	|	|
16+ 0	254.4124	183.68	| Q |	| V|	|	|
16+ 5	255.6724	182.94	| Q |	| V|	|	|
16+10	256.9261	182.05	| Q |	| V|	|	|
16+15	258.1662	180.05	| Q |	| V|	|	|
16+20	259.3828	176.65	| Q |	| V|	|	|
16+25	260.5817	174.09	| Q |	| V	|	|
16+30	261.7706	172.62	| Q |	| V	|	|
16+35	262.9538	171.81	| Q |	| V	|	|
16+40	264.1361	171.66	| Q |	| V	|	|
16+45	265.3277	173.03	| Q |	| V	|	|
16+50	266.5407	176.12	| Q |	| V	|	|
16+55	267.7707	178.60	| Q |	| V	|	|
17+ 0	269.0113	180.13	| Q |	| | V	|
17+ 5	270.2580	181.03	| Q |	| | V	|
17+10	271.5023	180.66	| Q |	| | V	|
17+15	272.7154	176.15	| Q |	| | V	|
17+20	273.8638	166.76	| Q |	| | V	|

17+25	274.9618	159.42	Q			V
17+30	276.0299	155.09	Q			V
17+35	277.0790	152.32	Q			V
17+40	278.1175	150.79	Q			V
17+45	279.1588	151.20	Q			V
17+50	280.2171	153.67	Q			V
17+55	281.2897	155.75	Q			V
18+ 0	282.3713	157.05	Q			V
18+ 5	283.4585	157.86	Q			V
18+10	284.5429	157.45	Q			V
18+15	285.5956	152.86	Q			V
18+20	286.5829	143.36	Q			V
18+25	287.5191	135.94	Q			V
18+30	288.4251	131.54	Q			V
18+35	289.3111	128.65	Q			V
18+40	290.1836	126.68	Q			V
18+45	291.0468	125.34	Q			V
18+50	291.9041	124.48	Q			V
18+55	292.7579	123.97	Q			V
19+ 0	293.6099	123.71	Q			V
19+ 5	294.4613	123.62	Q			V
19+10	295.3103	123.28	Q			V
19+15	296.1479	121.61	Q			V
19+20	296.9629	118.35	Q			V
19+25	297.7606	115.82	Q			V
19+30	298.5481	114.34	Q			V
19+35	299.3294	113.45	Q			V
19+40	300.1091	113.21	Q			V
19+45	300.8978	114.52	Q			V
19+50	301.7076	117.58	Q			V
19+55	302.5342	120.02	Q			V
20+ 0	303.3710	121.50	Q			V
20+ 5	304.2153	122.60	Q			V
20+10	305.0674	123.73	Q			V
20+15	305.9351	125.99	Q			V
20+20	306.8282	129.68	Q			V
20+25	307.7409	132.52	Q			V
20+30	308.6653	134.23	Q			V
20+35	309.5968	135.25	Q			V
20+40	310.5307	135.60	Q			V
20+45	311.4562	134.39	Q			V
20+50	312.3613	131.42	Q			V
20+55	313.2502	129.07	Q			V
21+ 0	314.1296	127.69	Q			V
21+ 5	315.0021	126.69	Q			V
21+10	315.8676	125.66	Q			V
21+15	316.7181	123.49	Q			V
21+20	317.5437	119.88	Q			V
21+25	318.3504	117.13	Q			V
21+30	319.1460	115.52	Q			V
21+35	319.9348	114.53	Q			V
21+40	320.7191	113.88	Q			V
21+45	321.5005	113.45	Q			V
21+50	322.2799	113.18	Q			V
21+55	323.0584	113.03	Q			V
22+ 0	323.8363	112.96	Q			V
22+ 5	324.6144	112.97	Q			V
22+10	325.3927	113.01	Q			V
22+15	326.1713	113.05	Q			V
22+20	326.9502	113.09	Q			V
22+25	327.7293	113.13	Q			V
22+30	328.5088	113.17	Q			V
22+35	329.2884	113.21	Q			V

```
   22+40     330.0684    113.25  |    Q     |          |          |        V |
   22+45     330.8486    113.29  |    Q     |          |          |        V |
   22+50     331.6291    113.33  |    Q     |          |          |        V |
   22+55     332.4098    113.36  |    Q     |          |          |        V |
   23+ 0     333.1908    113.40  |    Q     |          |          |        V |
   23+ 5     333.9726    113.51  |    Q     |          |          |        V |
   23+10     334.7573    113.95  |    Q     |          |          |        V |
   23+15     335.5545    115.75  |    Q     |          |          |        V |
   23+20     336.3752    119.16  |    Q     |          |          |        V |
   23+25     337.2142    121.83  |    Q     |          |          |        V |
   23+30     338.0643    123.43  |    Q     |          |          |         V|
   23+35     338.9212    124.43  |    Q     |          |          |         V|
   23+40     339.7805    124.76  |    Q     |          |          |         V|
   23+45     340.6312    123.52  |    Q     |          |          |         V|
   23+50     341.4610    120.49  |    Q     |          |          |         V|
   23+55     342.2744    118.10  |    Q     |          |          |         V|
   24+ 0     343.0780    116.68  |    Q     |          |          |         V|
   24+ 5     343.8707    115.11  |    Q     |          |          |         V|
   24+10     344.6339    110.82  |    Q     |          |          |         V|
   24+15     345.2846     94.48  |   Q      |          |          |         V|
   24+20     345.7232     63.69  |  Q       |          |          |         V|
   24+25     345.9973     39.80  |Q         |          |          |         V|
   24+30     346.1736     25.60  |Q         |          |          |         V|
   24+35     346.2863     16.37  Q          |          |          |         V|
   24+40     346.3561     10.13  Q          |          |          |         V|
   24+45     346.3960      5.81  Q          |          |          |         V|
   24+50     346.4165      2.97  Q          |          |          |         V|
   24+55     346.4249      1.21  Q          |          |          |         V|
   25+ 0     346.4265      0.24  Q          |          |          |         V|
-------------------------------------------------------------------------------
```

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: simmons100yr6hr.out

++

Program License Serial Number 4055

Tule Wind Project
Simmons Canyon
Existing 100 Year 6 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
878.00	4.12

Rainfall Distribution pattern used in study:
Type B for SCS (small dam) or San Diego 6 hour storms

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
878.00	1.000	88.8	88.8	0.050	B

Area-averaged catchment SCS Curve Number AMC(2) = 88.780
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   878.00(Ac.)
Catchment Lag time =   0.340 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 24.5098
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 88.780

Rainfall depth area reduction factors:
Using a total area of   878.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 1.000
Rainfall entered for study =   4.120(In)
Adjusted rainfall =   4.120(In)

++

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

++

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

(K = 10623.80 (CFS))

0.25	0.083	0.020	49.323	0.005
0.49	0.167	0.110	269.643	0.030
0.74	0.250	0.429	1050.076	0.129
0.98	0.333	1.000	2450.464	0.360
1.23	0.417	0.973	2384.552	0.584
1.47	0.500	0.601	1473.325	0.723
1.72	0.583	0.397	973.956	0.814
1.96	0.667	0.273	669.261	0.877
2.21	0.750	0.195	476.759	0.922
2.45	0.833	0.138	337.031	0.954
2.70	0.917	0.093	228.604	0.975
2.94	1.000	0.060	146.385	0.989
3.19	1.083	0.035	86.922	0.997
3.43	1.167	0.011	27.498	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In) P	Total SCS Runoff (In) Q	Rainfall Amount (In) dP	Runoff Amount (In) dQ	Infiltr-ation (In) dP-dQ	Revised Runoff Min Loss Rate
0.08	0.0240	0.0000	0.0240	0.0000	0.0240	--------
0.17	0.0481	0.0000	0.0240	0.0000	0.0240	--------
0.25	0.0721	0.0000	0.0240	0.0000	0.0240	--------
0.33	0.0961	0.0000	0.0240	0.0000	0.0240	--------
0.42	0.1202	0.0000	0.0240	0.0000	0.0240	--------
0.50	0.1442	0.0000	0.0240	0.0000	0.0240	--------
0.58	0.1765	0.0000	0.0323	0.0000	0.0323	--------
0.67	0.2087	0.0000	0.0323	0.0000	0.0323	--------

0.75	0.2410	0.0000	0.0323	0.0000	0.0323	--------
0.83	0.2733	0.0003	0.0323	0.0003	0.0319	--------
0.92	0.3056	0.0021	0.0323	0.0018	0.0305	--------
1.00	0.3378	0.0054	0.0323	0.0032	0.0290	--------
1.08	0.3777	0.0112	0.0398	0.0059	0.0340	--------
1.17	0.4175	0.0190	0.0398	0.0078	0.0321	--------
1.25	0.4573	0.0285	0.0398	0.0095	0.0303	--------
1.33	0.4971	0.0396	0.0398	0.0111	0.0287	--------
1.42	0.5370	0.0522	0.0398	0.0126	0.0272	--------
1.50	0.5768	0.0661	0.0398	0.0139	0.0259	--------
1.58	0.6386	0.0902	0.0618	0.0241	0.0377	--------
1.67	0.7004	0.1171	0.0618	0.0268	0.0350	--------
1.75	0.7622	0.1464	0.0618	0.0293	0.0325	--------
1.83	0.8240	0.1778	0.0618	0.0315	0.0303	--------
1.92	0.8858	0.2113	0.0618	0.0334	0.0284	--------
2.00	0.9476	0.2465	0.0618	0.0352	0.0266	--------
2.08	1.2017	0.4069	0.2541	0.1604	0.0936	--------
2.17	1.4557	0.5867	0.2541	0.1797	0.0743	--------
2.25	1.7098	0.7803	0.2541	0.1936	0.0605	--------
2.33	1.9639	0.9842	0.2541	0.2039	0.0501	--------
2.42	2.2179	1.1960	0.2541	0.2118	0.0422	--------
2.50	2.4720	1.4140	0.2541	0.2180	0.0361	--------
2.58	2.5407	1.4738	0.0687	0.0598	0.0089	--------
2.67	2.6093	1.5339	0.0687	0.0601	0.0085	--------
2.75	2.6780	1.5944	0.0687	0.0605	0.0082	--------
2.83	2.7467	1.6552	0.0687	0.0608	0.0079	--------
2.92	2.8153	1.7162	0.0687	0.0610	0.0076	--------
3.00	2.8840	1.7775	0.0687	0.0613	0.0074	--------
3.08	2.9396	1.8273	0.0556	0.0498	0.0058	--------
3.17	2.9952	1.8774	0.0556	0.0500	0.0056	--------
3.25	3.0509	1.9275	0.0556	0.0502	0.0055	--------
3.33	3.1065	1.9778	0.0556	0.0503	0.0053	--------
3.42	3.1621	2.0283	0.0556	0.0505	0.0052	--------
3.50	3.2177	2.0789	0.0556	0.0506	0.0050	--------
3.58	3.2548	2.1127	0.0371	0.0338	0.0033	--------
3.67	3.2919	2.1465	0.0371	0.0339	0.0032	--------
3.75	3.3290	2.1804	0.0371	0.0339	0.0032	--------
3.83	3.3660	2.2144	0.0371	0.0340	0.0031	--------
3.92	3.4031	2.2484	0.0371	0.0340	0.0031	--------
4.00	3.4402	2.2825	0.0371	0.0341	0.0030	--------
4.08	3.4711	2.3109	0.0309	0.0284	0.0025	--------
4.17	3.5020	2.3393	0.0309	0.0285	0.0024	--------
4.25	3.5329	2.3678	0.0309	0.0285	0.0024	--------
4.33	3.5638	2.3964	0.0309	0.0285	0.0024	--------
4.42	3.5947	2.4249	0.0309	0.0286	0.0023	--------
4.50	3.6256	2.4535	0.0309	0.0286	0.0023	--------
4.58	3.6551	2.4809	0.0295	0.0273	0.0022	--------
4.67	3.6847	2.5082	0.0295	0.0274	0.0022	--------
4.75	3.7142	2.5356	0.0295	0.0274	0.0021	--------
4.83	3.7437	2.5631	0.0295	0.0274	0.0021	--------
4.92	3.7732	2.5905	0.0295	0.0275	0.0021	--------
5.00	3.8028	2.6180	0.0295	0.0275	0.0020	--------
5.08	3.8282	2.6417	0.0254	0.0237	0.0017	--------
5.17	3.8536	2.6653	0.0254	0.0237	0.0017	--------
5.25	3.8790	2.6890	0.0254	0.0237	0.0017	--------
5.33	3.9044	2.7128	0.0254	0.0237	0.0017	--------
5.42	3.9298	2.7365	0.0254	0.0237	0.0017	--------
5.50	3.9552	2.7603	0.0254	0.0238	0.0017	--------
5.58	3.9827	2.7859	0.0275	0.0257	0.0018	--------
5.67	4.0101	2.8117	0.0275	0.0257	0.0017	--------
5.75	4.0376	2.8374	0.0275	0.0257	0.0017	--------
5.83	4.0651	2.8632	0.0275	0.0258	0.0017	--------
5.92	4.0925	2.8889	0.0275	0.0258	0.0017	--------

6.00 4.1200 2.9147 0.0275 0.0258 0.0017 --------

Total soil rain loss = 1.21(In)
Total effective runoff = 2.91(In)

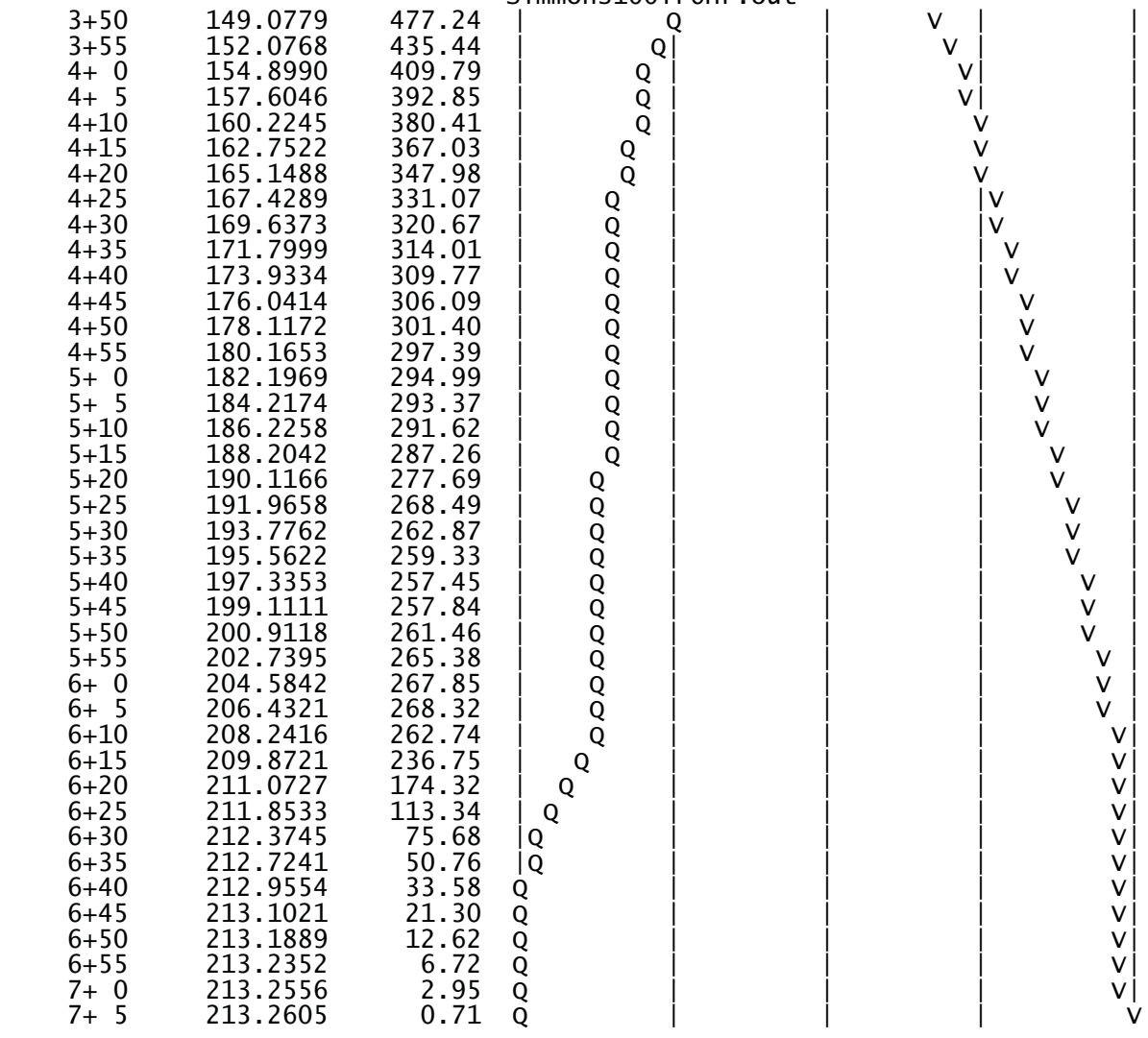
Peak flow rate this hydrograph = 1863.55(CFS)
Total runoff volume this hydrograph = 9289625.3(Ft3)

++

6 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	475.0	950.0	1425.0	1900.0
0+ 5	0.0000	0.00	Q				
0+10	0.0000	0.00	Q				
0+15	0.0000	0.00	Q				
0+20	0.0000	0.00	Q				
0+25	0.0000	0.00	Q				
0+30	0.0000	0.00	Q				
0+35	0.0000	0.00	Q				
0+40	0.0000	0.00	Q				
0+45	0.0000	0.00	Q				
0+50	0.0001	0.02	Q				
0+55	0.0013	0.18	Q				
1+ 0	0.0081	0.99	Q				
1+ 5	0.0346	3.85	Q				
1+10	0.1073	10.54	Q				
1+15	0.2549	21.44	Q				
1+20	0.5052	36.34	Q				
1+25	0.8726	53.35	VQ				
1+30	1.3595	70.69	VQ				
1+35	1.9677	88.31	VQ				
1+40	2.7080	107.49	V Q				
1+45	3.6263	133.34	V Q				
1+50	4.8137	172.40	V Q				
1+55	6.2841	213.51	|V Q				
2+ 0	7.9957	248.53	|V Q				
2+ 5	9.9617	285.46	|V Q				
2+10	12.3527	347.17	| V Q				
2+15	15.8453	507.13	| V Q				
2+20	21.7325	854.83	| V | Q				
2+25	30.1981	1229.20	| V | Q				
2+30	40.6262	1514.16	| V | Q				
2+35	52.5396	1729.83	| V| Q				
2+40	65.3739	1863.55	| V Q				
2+45	78.0080	1834.46	| V Q				
2+50	88.6506	1545.31	| V Q				
2+55	97.1580	1235.27	| V | Q				
3+ 0	104.3758	1048.03	| V| Q				
3+ 5	110.7399	924.06	| QV				
3+10	116.4748	832.71	| Q |V				
3+15	121.6728	754.75	| Q | V				
3+20	126.3501	679.14	| Q | V				
3+25	130.6149	619.26	| Q | V				
3+30	134.6212	581.71	| Q | V				
3+35	138.4629	557.82	|Q | V				
3+40	142.2017	542.87	|Q | V				
3+45	145.7911	521.18	| Q | V				



3+50	149.0779	477.24	
3+55	152.0768	435.44	
4+ 0	154.8990	409.79	
4+ 5	157.6046	392.85	
4+10	160.2245	380.41	
4+15	162.7522	367.03	
4+20	165.1488	347.98	
4+25	167.4289	331.07	
4+30	169.6373	320.67	
4+35	171.7999	314.01	
4+40	173.9334	309.77	
4+45	176.0414	306.09	
4+50	178.1172	301.40	
4+55	180.1653	297.39	
5+ 0	182.1969	294.99	
5+ 5	184.2174	293.37	
5+10	186.2258	291.62	
5+15	188.2042	287.26	
5+20	190.1166	277.69	
5+25	191.9658	268.49	
5+30	193.7762	262.87	
5+35	195.5622	259.33	
5+40	197.3353	257.45	
5+45	199.1111	257.84	
5+50	200.9118	261.46	
5+55	202.7395	265.38	
6+ 0	204.5842	267.85	
6+ 5	206.4321	268.32	
6+10	208.2416	262.74	
6+15	209.8721	236.75	
6+20	211.0727	174.32	
6+25	211.8533	113.34	
6+30	212.3745	75.68	
6+35	212.7241	50.76	
6+40	212.9554	33.58	
6+45	213.1021	21.30	
6+50	213.1889	12.62	
6+55	213.2352	6.72	
7+ 0	213.2556	2.95	
7+ 5	213.2605	0.71	

U N I T H Y D R O G R A P H A N A L Y S I S

Copyright (c) CIVILCADD/CIVILDESIGN, 1990 - 2004, Version 7.0

Study date 08/30/10 File: simmons100yr24hr.out

++

Program License Serial Number 4055

Tule Wind Project
Simmons Canyon
Existing 100 Year 24 Hour
Aug 25, 2010

++

Storm Event Year = 100

Antecedent Moisture Condition = 2

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

Area averaged rainfall isohyetal data:

Sub-Area(Ac.)	Rainfall (In)
878.00	8.00

Rainfall Distribution pattern used in study:
Type B for San Diego area of California

++

********* Area-Averaged SCS Curve Number and Fm *********

Area (Ac.)	Area fract	SCS CN (AMC2)	SCS CN (AMC2)	Fm (In/Hr)	Soil Group
878.00	1.000	88.8	88.8	0.050	B

Area-averaged catchment SCS Curve Number AMC(2) = 88.780
Area-averaged Fm value using values listed = 0.050(In/Hr)

++
Direct entry of lag time by user
Watershed area =   878.00(Ac.)
Catchment Lag time =   0.340 hours
Unit interval =   5.000 minutes
Unit interval percentage of lag time = 24.5098
Hydrograph baseflow =   0.00(CFS)
Minimum watershed loss rate(Fm) = 0.000(In/Hr)
Average adjusted SCS Curve Number = 88.780

Rainfall depth area reduction factors:
Using a total area of   878.00(Ac.) (Ref: SCS Sup A, Sec.4)

Pacific Coastal Climate ratio used
Areal factor ratio (rainfall reduction) = 1.000
Rainfall entered for study =   8.000(In)
Adjusted rainfall =   8.000(In)

The following unit hydrograph was developed using an S-Graph interpolated by time percentage of lag time vs. percentage of peak flow. The S-Graphs for Valley, Foothill, and Mountain were developed by the U.S. Army Corps of Engineers for use in the respective type of basins located in Southern California. (Hydrology San Gabrial River ... U.S. Engineer Office, Dec 1944, revised Jul 1946) The Desert S-Graph is from Report ... on ... Tahquitz Creek, California, same U.S. offfice, Corps of Engineers, June 1963. The Valley Developed S-Graph is used by Orange and San Bernardino counties in California to represent the characteristics of valley areas with a large amount of development. Because of the wide variety in topography in Southern California, these synthetic unit hydrographs were included for use as options in any geographic location.

The SCS(Soil Conservation Service Dimensionless S-Graph, SCS handbook, of 1972, applies to a broad cross section of geographic locations and hydrologic regions.

The User Defined hydrograph converts the user Q/Qp vs. T/Tp values into an S-Graph based on lag = Tp/0.9. Then, for the lag time used, the S-Graph in interpolated in time % of lag.

The following S-Graph or S-Graph combination is used in this study:

SAN DIEGO CO. HYDROGRAPH

San Deigo Co. Unit Hydrograph Data (III-A-2):
using a constant T/Tp step interval = 0.200

t/tp	q/qp	Sum q/qp
0.000	0.000	0.000
0.200	0.030	0.000
0.400	0.090	0.030
0.600	0.230	0.120
0.800	0.700	0.350
1.000	1.000	1.050
1.200	0.850	2.050
1.400	0.530	2.900
1.600	0.410	3.430
1.800	0.300	3.840
2.000	0.230	4.140
2.200	0.180	4.370
2.400	0.140	4.550
2.600	0.110	4.690
2.800	0.080	4.800
3.000	0.060	4.880
3.200	0.040	4.940
3.400	0.030	4.980
3.600	0.010	5.010
3.800	0.000	5.020

U N I T H Y D R O G R A P H

Time Ratio (t/Lag)	Time (hrs)	Discharge Ratios (Q/Qp)	Q (CFS)	Mass Curve Ratios (Qa/Q)

(K = 10623.80 (CFS))

0.25	0.083	0.020	49.323	0.005
0.49	0.167	0.110	269.643	0.030
0.74	0.250	0.429	1050.076	0.129
0.98	0.333	1.000	2450.464	0.360
1.23	0.417	0.973	2384.552	0.584
1.47	0.500	0.601	1473.325	0.723
1.72	0.583	0.397	973.956	0.814
1.96	0.667	0.273	669.261	0.877
2.21	0.750	0.195	476.759	0.922
2.45	0.833	0.138	337.031	0.954
2.70	0.917	0.093	228.604	0.975
2.94	1.000	0.060	146.385	0.989
3.19	1.083	0.035	86.922	0.997
3.43	1.167	0.011	27.498	1.000

For each time interval of the 6 or 24 hour storm, the total rainfall up to that storm time is calculated. Then the Soil Conservation Service SCS (report 1972, 1975) area averaged Curve Number (CN) is used to determine the amount of direct runoff in (In) using the following equations:

$$Q = \frac{(P - Ia)^2}{P - Ia + S}$$

Where:
Q = direct runoff, P = depth of precipitation, Ia = Initial Abstraction and S is the watershed storage in inches. S and Ia are given by the following equations:

$$S = \frac{1000}{CN} - 10 \quad \text{and} \quad Ia = 0.2\ S$$

Note: If Metric (SI) Units are used, rainfall data is converted by the program internally into inches for these calculations.

Note: In the following printout, the revised runoff column is only used when the minimum soil loss rate, fm, exceeds the normal loss rate of delta P(dP) - delta Q(dQ) then the dP-dQ column equals fm = 0.000(In) (for time interval = 0.000(In)) and the revised runoff is shown in the last column.

Time Period (hours)	Total Rainfall (In) P	Total SCS Runoff (In) Q	Rainfall Amount (In) dP	Runoff Amount (In) dQ	Infiltr-ation (In) dP-dQ	Revised Runoff Min Loss Rate
0.08	0.0120	0.0000	0.0120	0.0000	0.0120	--------
0.17	0.0240	0.0000	0.0120	0.0000	0.0120	--------
0.25	0.0360	0.0000	0.0120	0.0000	0.0120	--------
0.33	0.0480	0.0000	0.0120	0.0000	0.0120	--------
0.42	0.0600	0.0000	0.0120	0.0000	0.0120	--------
0.50	0.0720	0.0000	0.0120	0.0000	0.0120	--------
0.58	0.0813	0.0000	0.0093	0.0000	0.0093	--------
0.67	0.0907	0.0000	0.0093	0.0000	0.0093	--------

0.75	0.1000	0.0000	0.0093	0.0000	0.0093	--------
0.83	0.1093	0.0000	0.0093	0.0000	0.0093	--------
0.92	0.1187	0.0000	0.0093	0.0000	0.0093	--------
1.00	0.1280	0.0000	0.0093	0.0000	0.0093	--------
1.08	0.1400	0.0000	0.0120	0.0000	0.0120	--------
1.17	0.1520	0.0000	0.0120	0.0000	0.0120	--------
1.25	0.1640	0.0000	0.0120	0.0000	0.0120	--------
1.33	0.1760	0.0000	0.0120	0.0000	0.0120	--------
1.42	0.1880	0.0000	0.0120	0.0000	0.0120	--------
1.50	0.2000	0.0000	0.0120	0.0000	0.0120	--------
1.58	0.2120	0.0000	0.0120	0.0000	0.0120	--------
1.67	0.2240	0.0000	0.0120	0.0000	0.0120	--------
1.75	0.2360	0.0000	0.0120	0.0000	0.0120	--------
1.83	0.2480	0.0000	0.0120	0.0000	0.0120	--------
1.92	0.2600	0.0000	0.0120	0.0000	0.0120	--------
2.00	0.2720	0.0003	0.0120	0.0002	0.0118	--------
2.08	0.2867	0.0009	0.0147	0.0006	0.0141	--------
2.17	0.3013	0.0018	0.0147	0.0009	0.0138	--------
2.25	0.3160	0.0030	0.0147	0.0012	0.0135	--------
2.33	0.3307	0.0045	0.0147	0.0015	0.0132	--------
2.42	0.3453	0.0063	0.0147	0.0018	0.0129	--------
2.50	0.3600	0.0084	0.0147	0.0021	0.0126	--------
2.58	0.3720	0.0103	0.0120	0.0019	0.0101	--------
2.67	0.3840	0.0123	0.0120	0.0021	0.0099	--------
2.75	0.3960	0.0146	0.0120	0.0022	0.0098	--------
2.83	0.4080	0.0170	0.0120	0.0024	0.0096	--------
2.92	0.4200	0.0195	0.0120	0.0026	0.0094	--------
3.00	0.4320	0.0223	0.0120	0.0027	0.0093	--------
3.08	0.4467	0.0258	0.0147	0.0035	0.0111	--------
3.17	0.4613	0.0295	0.0147	0.0038	0.0109	--------
3.25	0.4760	0.0335	0.0147	0.0040	0.0107	--------
3.33	0.4907	0.0377	0.0147	0.0042	0.0105	--------
3.42	0.5053	0.0421	0.0147	0.0044	0.0103	--------
3.50	0.5200	0.0466	0.0147	0.0046	0.0101	--------
3.58	0.5360	0.0519	0.0160	0.0052	0.0108	--------
3.67	0.5520	0.0573	0.0160	0.0054	0.0106	--------
3.75	0.5680	0.0629	0.0160	0.0056	0.0104	--------
3.83	0.5840	0.0688	0.0160	0.0059	0.0101	--------
3.92	0.6000	0.0748	0.0160	0.0061	0.0099	--------
4.00	0.6160	0.0811	0.0160	0.0063	0.0097	--------
4.08	0.6333	0.0881	0.0173	0.0070	0.0103	--------
4.17	0.6507	0.0953	0.0173	0.0072	0.0101	--------
4.25	0.6680	0.1027	0.0173	0.0074	0.0099	--------
4.33	0.6853	0.1103	0.0173	0.0076	0.0097	--------
4.42	0.7027	0.1181	0.0173	0.0078	0.0095	--------
4.50	0.7200	0.1261	0.0173	0.0080	0.0093	--------
4.58	0.7387	0.1349	0.0187	0.0088	0.0098	--------
4.67	0.7573	0.1440	0.0187	0.0090	0.0096	--------
4.75	0.7760	0.1532	0.0187	0.0092	0.0094	--------
4.83	0.7947	0.1626	0.0187	0.0094	0.0092	--------
4.92	0.8133	0.1722	0.0187	0.0096	0.0091	--------
5.00	0.8320	0.1820	0.0187	0.0098	0.0089	--------
5.08	0.8533	0.1935	0.0213	0.0114	0.0099	--------
5.17	0.8747	0.2051	0.0213	0.0116	0.0097	--------
5.25	0.8960	0.2170	0.0213	0.0119	0.0095	--------
5.33	0.9173	0.2290	0.0213	0.0121	0.0093	--------
5.42	0.9387	0.2413	0.0213	0.0123	0.0091	--------
5.50	0.9600	0.2538	0.0213	0.0125	0.0089	--------
5.58	0.9827	0.2672	0.0227	0.0135	0.0092	--------
5.67	1.0053	0.2809	0.0227	0.0137	0.0090	--------
5.75	1.0280	0.2947	0.0227	0.0139	0.0088	--------
5.83	1.0507	0.3088	0.0227	0.0141	0.0086	--------
5.92	1.0733	0.3230	0.0227	0.0142	0.0084	--------

6.00	1.0960	0.3375	0.0227	0.0144	0.0082	--------
6.08	1.1227	0.3547	0.0267	0.0172	0.0095	--------
6.17	1.1493	0.3721	0.0267	0.0174	0.0092	--------
6.25	1.1760	0.3897	0.0267	0.0177	0.0090	--------
6.33	1.2027	0.4076	0.0267	0.0179	0.0088	--------
6.42	1.2293	0.4257	0.0267	0.0181	0.0086	--------
6.50	1.2560	0.4440	0.0267	0.0183	0.0084	--------
6.58	1.2867	0.4652	0.0307	0.0213	0.0094	--------
6.67	1.3173	0.4867	0.0307	0.0215	0.0092	--------
6.75	1.3480	0.5085	0.0307	0.0217	0.0089	--------
6.83	1.3787	0.5305	0.0307	0.0220	0.0087	--------
6.92	1.4093	0.5527	0.0307	0.0222	0.0085	--------
7.00	1.4400	0.5751	0.0307	0.0224	0.0083	--------
7.08	1.4800	0.6046	0.0400	0.0295	0.0105	--------
7.17	1.5200	0.6345	0.0400	0.0299	0.0101	--------
7.25	1.5600	0.6647	0.0400	0.0302	0.0098	--------
7.33	1.6000	0.6951	0.0400	0.0305	0.0095	--------
7.42	1.6400	0.7259	0.0400	0.0308	0.0092	--------
7.50	1.6800	0.7570	0.0400	0.0310	0.0090	--------
7.58	1.7400	0.8040	0.0600	0.0471	0.0129	--------
7.67	1.8000	0.8516	0.0600	0.0476	0.0124	--------
7.75	1.8600	0.8998	0.0600	0.0481	0.0119	--------
7.83	1.9200	0.9484	0.0600	0.0486	0.0114	--------
7.92	1.9800	0.9974	0.0600	0.0491	0.0109	--------
8.00	2.0400	1.0469	0.0600	0.0495	0.0105	--------
8.08	2.1293	1.1214	0.0893	0.0744	0.0149	--------
8.17	2.2187	1.1966	0.0893	0.0753	0.0141	--------
8.25	2.3080	1.2727	0.0893	0.0760	0.0133	--------
8.33	2.3973	1.3494	0.0893	0.0767	0.0126	--------
8.42	2.4867	1.4267	0.0893	0.0774	0.0120	--------
8.50	2.5760	1.5047	0.0893	0.0780	0.0114	--------
8.58	2.6933	1.6079	0.1173	0.1032	0.0141	--------
8.67	2.8107	1.7120	0.1173	0.1041	0.0132	--------
8.75	2.9280	1.8169	0.1173	0.1049	0.0124	--------
8.83	3.0453	1.9225	0.1173	0.1056	0.0117	--------
8.92	3.1627	2.0288	0.1173	0.1063	0.0111	--------
9.00	3.2800	2.1357	0.1173	0.1069	0.0105	--------
9.08	3.4080	2.2529	0.1280	0.1172	0.0108	--------
9.17	3.5360	2.3707	0.1280	0.1178	0.0102	--------
9.25	3.6640	2.4891	0.1280	0.1184	0.0096	--------
9.33	3.7920	2.6080	0.1280	0.1189	0.0091	--------
9.42	3.9200	2.7273	0.1280	0.1194	0.0086	--------
9.50	4.0480	2.8472	0.1280	0.1198	0.0082	--------
9.58	4.1573	2.9498	0.1093	0.1027	0.0067	--------
9.67	4.2667	3.0527	0.1093	0.1029	0.0064	--------
9.75	4.3760	3.1559	0.1093	0.1032	0.0061	--------
9.83	4.4853	3.2594	0.1093	0.1034	0.0059	--------
9.92	4.5947	3.3630	0.1093	0.1037	0.0057	--------
10.00	4.7040	3.4669	0.1093	0.1039	0.0055	--------
10.08	4.7587	3.5189	0.0547	0.0520	0.0026	--------
10.17	4.8133	3.5710	0.0547	0.0521	0.0026	--------
10.25	4.8680	3.6231	0.0547	0.0521	0.0025	--------
10.33	4.9227	3.6753	0.0547	0.0522	0.0025	--------
10.42	4.9773	3.7275	0.0547	0.0522	0.0025	--------
10.50	5.0320	3.7797	0.0547	0.0523	0.0024	--------
10.58	5.0680	3.8142	0.0360	0.0344	0.0016	--------
10.67	5.1040	3.8486	0.0360	0.0345	0.0015	--------
10.75	5.1400	3.8831	0.0360	0.0345	0.0015	--------
10.83	5.1760	3.9176	0.0360	0.0345	0.0015	--------
10.92	5.2120	3.9521	0.0360	0.0345	0.0015	--------
11.00	5.2480	3.9866	0.0360	0.0345	0.0015	--------
11.08	5.2787	4.0160	0.0307	0.0294	0.0012	--------
11.17	5.3093	4.0455	0.0307	0.0294	0.0012	--------

11.25	5.3400	4.0749	0.0307	0.0294	0.0012	--------
11.33	5.3707	4.1044	0.0307	0.0295	0.0012	--------
11.42	5.4013	4.1339	0.0307	0.0295	0.0012	--------
11.50	5.4320	4.1633	0.0307	0.0295	0.0012	--------
11.58	5.4600	4.1903	0.0280	0.0269	0.0011	--------
11.67	5.4880	4.2172	0.0280	0.0269	0.0011	--------
11.75	5.5160	4.2441	0.0280	0.0269	0.0011	--------
11.83	5.5440	4.2711	0.0280	0.0270	0.0010	--------
11.92	5.5720	4.2981	0.0280	0.0270	0.0010	--------
12.00	5.6000	4.3250	0.0280	0.0270	0.0010	--------
12.08	5.6267	4.3507	0.0267	0.0257	0.0010	--------
12.17	5.6533	4.3764	0.0267	0.0257	0.0010	--------
12.25	5.6800	4.4021	0.0267	0.0257	0.0010	--------
12.33	5.7067	4.4279	0.0267	0.0257	0.0009	--------
12.42	5.7333	4.4536	0.0267	0.0257	0.0009	--------
12.50	5.7600	4.4793	0.0267	0.0257	0.0009	--------
12.58	5.7853	4.5038	0.0253	0.0245	0.0009	--------
12.67	5.8107	4.5282	0.0253	0.0245	0.0009	--------
12.75	5.8360	4.5527	0.0253	0.0245	0.0009	--------
12.83	5.8613	4.5772	0.0253	0.0245	0.0009	--------
12.92	5.8867	4.6017	0.0253	0.0245	0.0009	--------
13.00	5.9120	4.6261	0.0253	0.0245	0.0008	--------
13.08	5.9347	4.6481	0.0227	0.0219	0.0008	--------
13.17	5.9573	4.6700	0.0227	0.0219	0.0007	--------
13.25	5.9800	4.6919	0.0227	0.0219	0.0007	--------
13.33	6.0027	4.7138	0.0227	0.0219	0.0007	--------
13.42	6.0253	4.7358	0.0227	0.0219	0.0007	--------
13.50	6.0480	4.7577	0.0227	0.0219	0.0007	--------
13.58	6.0693	4.7784	0.0213	0.0207	0.0007	--------
13.67	6.0907	4.7990	0.0213	0.0207	0.0007	--------
13.75	6.1120	4.8197	0.0213	0.0207	0.0007	--------
13.83	6.1333	4.8403	0.0213	0.0207	0.0007	--------
13.92	6.1547	4.8610	0.0213	0.0207	0.0007	--------
14.00	6.1760	4.8817	0.0213	0.0207	0.0007	--------
14.08	6.2000	4.9049	0.0240	0.0233	0.0007	--------
14.17	6.2240	4.9282	0.0240	0.0233	0.0007	--------
14.25	6.2480	4.9515	0.0240	0.0233	0.0007	--------
14.33	6.2720	4.9747	0.0240	0.0233	0.0007	--------
14.42	6.2960	4.9980	0.0240	0.0233	0.0007	--------
14.50	6.3200	5.0213	0.0240	0.0233	0.0007	--------
14.58	6.3333	5.0342	0.0133	0.0129	0.0004	--------
14.67	6.3467	5.0472	0.0133	0.0129	0.0004	--------
14.75	6.3600	5.0601	0.0133	0.0129	0.0004	--------
14.83	6.3733	5.0731	0.0133	0.0129	0.0004	--------
14.92	6.3867	5.0860	0.0133	0.0129	0.0004	--------
15.00	6.4000	5.0990	0.0133	0.0129	0.0004	--------
15.08	6.4213	5.1197	0.0213	0.0207	0.0006	--------
15.17	6.4427	5.1404	0.0213	0.0207	0.0006	--------
15.25	6.4640	5.1611	0.0213	0.0207	0.0006	--------
15.33	6.4853	5.1818	0.0213	0.0207	0.0006	--------
15.42	6.5067	5.2026	0.0213	0.0207	0.0006	--------
15.50	6.5280	5.2233	0.0213	0.0207	0.0006	--------
15.58	6.5480	5.2427	0.0200	0.0194	0.0006	--------
15.67	6.5680	5.2622	0.0200	0.0194	0.0006	--------
15.75	6.5880	5.2816	0.0200	0.0194	0.0006	--------
15.83	6.6080	5.3011	0.0200	0.0194	0.0006	--------
15.92	6.6280	5.3205	0.0200	0.0195	0.0005	--------
16.00	6.6480	5.3400	0.0200	0.0195	0.0005	--------
16.08	6.6667	5.3581	0.0187	0.0182	0.0005	--------
16.17	6.6853	5.3763	0.0187	0.0182	0.0005	--------
16.25	6.7040	5.3945	0.0187	0.0182	0.0005	--------
16.33	6.7227	5.4126	0.0187	0.0182	0.0005	--------
16.42	6.7413	5.4308	0.0187	0.0182	0.0005	--------

16.50	6.7600	5.4490	0.0187	0.0182	0.0005	--------
16.58	6.7800	5.4684	0.0200	0.0195	0.0005	--------
16.67	6.8000	5.4879	0.0200	0.0195	0.0005	--------
16.75	6.8200	5.5074	0.0200	0.0195	0.0005	--------
16.83	6.8400	5.5269	0.0200	0.0195	0.0005	--------
16.92	6.8600	5.5464	0.0200	0.0195	0.0005	--------
17.00	6.8800	5.5658	0.0200	0.0195	0.0005	--------
17.08	6.8960	5.5814	0.0160	0.0156	0.0004	--------
17.17	6.9120	5.5970	0.0160	0.0156	0.0004	--------
17.25	6.9280	5.6126	0.0160	0.0156	0.0004	--------
17.33	6.9440	5.6282	0.0160	0.0156	0.0004	--------
17.42	6.9600	5.6438	0.0160	0.0156	0.0004	--------
17.50	6.9760	5.6594	0.0160	0.0156	0.0004	--------
17.58	6.9933	5.6763	0.0173	0.0169	0.0004	--------
17.67	7.0107	5.6932	0.0173	0.0169	0.0004	--------
17.75	7.0280	5.7101	0.0173	0.0169	0.0004	--------
17.83	7.0453	5.7270	0.0173	0.0169	0.0004	--------
17.92	7.0627	5.7439	0.0173	0.0169	0.0004	--------
18.00	7.0800	5.7608	0.0173	0.0169	0.0004	--------
18.08	7.0933	5.7739	0.0133	0.0130	0.0003	--------
18.17	7.1067	5.7869	0.0133	0.0130	0.0003	--------
18.25	7.1200	5.7999	0.0133	0.0130	0.0003	--------
18.33	7.1333	5.8129	0.0133	0.0130	0.0003	--------
18.42	7.1467	5.8259	0.0133	0.0130	0.0003	--------
18.50	7.1600	5.8389	0.0133	0.0130	0.0003	--------
18.58	7.1733	5.8519	0.0133	0.0130	0.0003	--------
18.67	7.1867	5.8649	0.0133	0.0130	0.0003	--------
18.75	7.2000	5.8780	0.0133	0.0130	0.0003	--------
18.83	7.2133	5.8910	0.0133	0.0130	0.0003	--------
18.92	7.2267	5.9040	0.0133	0.0130	0.0003	--------
19.00	7.2400	5.9170	0.0133	0.0130	0.0003	--------
19.08	7.2520	5.9287	0.0120	0.0117	0.0003	--------
19.17	7.2640	5.9405	0.0120	0.0117	0.0003	--------
19.25	7.2760	5.9522	0.0120	0.0117	0.0003	--------
19.33	7.2880	5.9639	0.0120	0.0117	0.0003	--------
19.42	7.3000	5.9756	0.0120	0.0117	0.0003	--------
19.50	7.3120	5.9873	0.0120	0.0117	0.0003	--------
19.58	7.3253	6.0004	0.0133	0.0130	0.0003	--------
19.67	7.3387	6.0134	0.0133	0.0130	0.0003	--------
19.75	7.3520	6.0264	0.0133	0.0130	0.0003	--------
19.83	7.3653	6.0395	0.0133	0.0130	0.0003	--------
19.92	7.3787	6.0525	0.0133	0.0130	0.0003	--------
20.00	7.3920	6.0655	0.0133	0.0130	0.0003	--------
20.08	7.4067	6.0799	0.0147	0.0143	0.0003	--------
20.17	7.4213	6.0942	0.0147	0.0143	0.0003	--------
20.25	7.4360	6.1085	0.0147	0.0143	0.0003	--------
20.33	7.4507	6.1229	0.0147	0.0143	0.0003	--------
20.42	7.4653	6.1372	0.0147	0.0143	0.0003	--------
20.50	7.4800	6.1515	0.0147	0.0143	0.0003	--------
20.58	7.4933	6.1646	0.0133	0.0130	0.0003	--------
20.67	7.5067	6.1776	0.0133	0.0130	0.0003	--------
20.75	7.5200	6.1907	0.0133	0.0130	0.0003	--------
20.83	7.5333	6.2037	0.0133	0.0130	0.0003	--------
20.92	7.5467	6.2167	0.0133	0.0130	0.0003	--------
21.00	7.5600	6.2298	0.0133	0.0130	0.0003	--------
21.08	7.5720	6.2415	0.0120	0.0117	0.0003	--------
21.17	7.5840	6.2533	0.0120	0.0117	0.0003	--------
21.25	7.5960	6.2650	0.0120	0.0117	0.0003	--------
21.33	7.6080	6.2768	0.0120	0.0117	0.0003	--------
21.42	7.6200	6.2885	0.0120	0.0117	0.0003	--------
21.50	7.6320	6.3002	0.0120	0.0117	0.0003	--------
21.58	7.6440	6.3120	0.0120	0.0117	0.0003	--------
21.67	7.6560	6.3237	0.0120	0.0117	0.0003	--------

21.75	7.6680	6.3355	0.0120	0.0117	0.0003	--------
21.83	7.6800	6.3472	0.0120	0.0117	0.0003	--------
21.92	7.6920	6.3590	0.0120	0.0117	0.0003	--------
22.00	7.7040	6.3707	0.0120	0.0117	0.0003	--------
22.08	7.7160	6.3825	0.0120	0.0117	0.0003	--------
22.17	7.7280	6.3942	0.0120	0.0117	0.0003	--------
22.25	7.7400	6.4060	0.0120	0.0117	0.0003	--------
22.33	7.7520	6.4177	0.0120	0.0118	0.0002	--------
22.42	7.7640	6.4295	0.0120	0.0118	0.0002	--------
22.50	7.7760	6.4412	0.0120	0.0118	0.0002	--------
22.58	7.7880	6.4530	0.0120	0.0118	0.0002	--------
22.67	7.8000	6.4647	0.0120	0.0118	0.0002	--------
22.75	7.8120	6.4765	0.0120	0.0118	0.0002	--------
22.83	7.8240	6.4882	0.0120	0.0118	0.0002	--------
22.92	7.8360	6.5000	0.0120	0.0118	0.0002	--------
23.00	7.8480	6.5117	0.0120	0.0118	0.0002	--------
23.08	7.8613	6.5248	0.0133	0.0131	0.0003	--------
23.17	7.8747	6.5379	0.0133	0.0131	0.0003	--------
23.25	7.8880	6.5509	0.0133	0.0131	0.0003	--------
23.33	7.9013	6.5640	0.0133	0.0131	0.0003	--------
23.42	7.9147	6.5771	0.0133	0.0131	0.0003	--------
23.50	7.9280	6.5901	0.0133	0.0131	0.0003	--------
23.58	7.9400	6.6019	0.0120	0.0118	0.0002	--------
23.67	7.9520	6.6136	0.0120	0.0118	0.0002	--------
23.75	7.9640	6.6254	0.0120	0.0118	0.0002	--------
23.83	7.9760	6.6372	0.0120	0.0118	0.0002	--------
23.92	7.9880	6.6489	0.0120	0.0118	0.0002	--------
24.00	8.0000	6.6607	0.0120	0.0118	0.0002	--------

Total soil rain loss = 1.34(In)
Total effective runoff = 6.66(In)

Peak flow rate this hydrograph = 1240.35(CFS)
Total runoff volume this hydrograph = 21228551.1(Ft3)

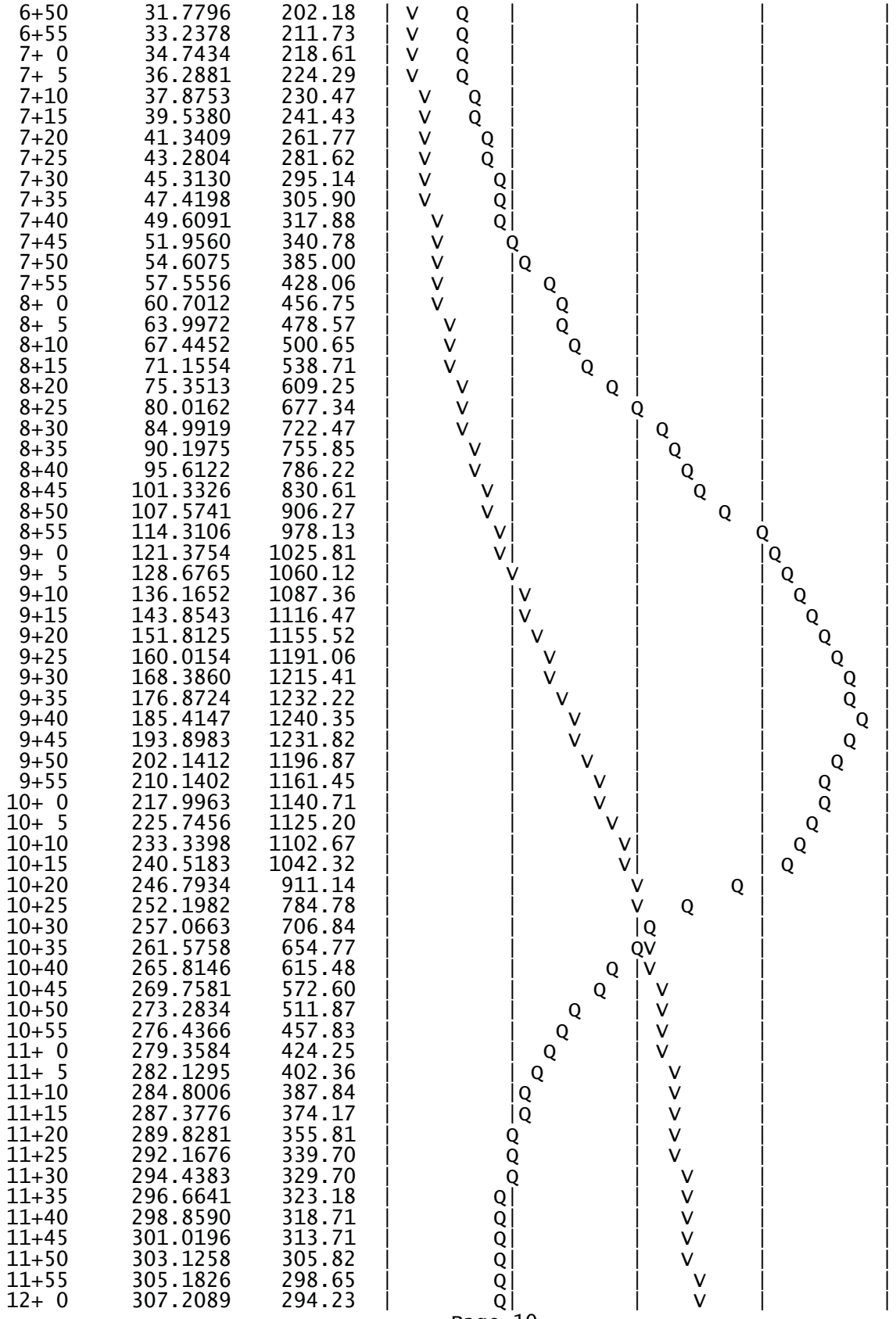
++

24 - H O U R S T O R M
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume Ac.Ft	Q(CFS)	0	325.0	650.0	975.0	1300.0
0+ 5	0.0000	0.00	Q				
0+10	0.0000	0.00	Q				
0+15	0.0000	0.00	Q				
0+20	0.0000	0.00	Q				
0+25	0.0000	0.00	Q				
0+30	0.0000	0.00	Q				
0+35	0.0000	0.00	Q				
0+40	0.0000	0.00	Q				
0+45	0.0000	0.00	Q				
0+50	0.0000	0.00	Q				
0+55	0.0000	0.00	Q				
1+ 0	0.0000	0.00	Q				
1+ 5	0.0000	0.00	Q				
1+10	0.0000	0.00	Q				
1+15	0.0000	0.00	Q				
1+20	0.0000	0.00	Q				
1+25	0.0000	0.00	Q				
1+30	0.0000	0.00	Q				

1+35	0.0000	0.00	Q	|	|	|	|
1+40	0.0000	0.00	Q	|	|	|	|
1+45	0.0000	0.00	Q	|	|	|	|
1+50	0.0000	0.00	Q	|	|	|	|
1+55	0.0000	0.00	Q	|	|	|	|
2+ 0	0.0002	0.02	Q	|	|	|	|
2+ 5	0.0011	0.14	Q	|	|	|	|
2+10	0.0050	0.57	Q	|	|	|	|
2+15	0.0163	1.64	Q	|	|	|	|
2+20	0.0402	3.47	Q	|	|	|	|
2+25	0.0804	5.84	Q	|	|	|	|
2+30	0.1388	8.47	Q	|	|	|	|
2+35	0.2163	11.25	Q	|	|	|	|
2+40	0.3126	13.99	Q	|	|	|	|
2+45	0.4256	16.40	Q	|	|	|	|
2+50	0.5502	18.09	Q	|	|	|	|
2+55	0.6850	19.57	Q	|	|	|	|
3+ 0	0.8310	21.20	Q	|	|	|	|
3+ 5	0.9888	22.92	Q	|	|	|	|
3+10	1.1595	24.78	Q	|	|	|	|
3+15	1.3464	27.14	Q	|	|	|	|
3+20	1.5564	30.48	Q	|	|	|	|
3+25	1.7900	33.92	VQ	|	|	|	|
3+30	2.0441	36.90	VQ	|	|	|	|
3+35	2.3171	39.64	VQ	|	|	|	|
3+40	2.6084	42.30	VQ	|	|	|	|
3+45	2.9197	45.19	VQ	|	|	|	|
3+50	3.2545	48.62	VQ	|	|	|	|
3+55	3.6126	51.99	VQ	|	|	|	|
4+ 0	3.9910	54.95	VQ	|	|	|	|
4+ 5	4.3882	57.67	VQ	|	|	|	|
4+10	4.8036	60.31	VQ	|	|	|	|
4+15	5.2391	63.24	VQ	|	|	|	|
4+20	5.6997	66.87	V Q	|	|	|	|
4+25	6.1847	70.43	V Q	|	|	|	|
4+30	6.6907	73.48	V Q	|	|	|	|
4+35	7.2158	76.24	V Q	|	|	|	|
4+40	7.7594	78.93	V Q	|	|	|	|
4+45	8.3239	81.96	V Q	|	|	|	|
4+50	8.9147	85.79	V Q	|	|	|	|
4+55	9.5313	89.53	V Q	|	|	|	|
5+ 0	10.1694	92.66	V Q	|	|	|	|
5+ 5	10.8271	95.49	V Q	|	|	|	|
5+10	11.5046	98.38	V Q	|	|	|	|
5+15	12.2087	102.23	|V Q	|	|	|	|
5+20	12.9525	108.01	|V Q	|	|	|	|
5+25	13.7356	113.70	|V Q	|	|	|	|
5+30	14.5489	118.09	|V Q	|	|	|	|
5+35	15.3875	121.77	|V Q	|	|	|	|
5+40	16.2493	125.14	|V Q	|	|	|	|
5+45	17.1364	128.80	|V Q	|	|	|	|
5+50	18.0548	133.36	|V Q	|	|	|	|
5+55	19.0033	137.72	|V Q	|	|	|	|
6+ 0	19.9759	141.23	|V Q	|	|	|	|
6+ 5	20.9701	144.36	|V Q	|	|	|	|
6+10	21.9873	147.69	|V Q	|	|	|	|
6+15	23.0397	152.82	|V Q	|	|	|	|
6+20	24.1519	161.48	|V Q	|	|	|	|
6+25	25.3226	169.99	| V Q	|	|	|	|
6+30	26.5357	176.15	| V Q	|	|	|	|
6+35	27.7832	181.12	| V Q	|	|	|	|
6+40	29.0632	185.87	| V Q	|	|	|	|
6+45	30.3872	192.24	| V Q	|	|	|	|



6+50	31.7796	202.18	
6+55	33.2378	211.73	
7+ 0	34.7434	218.61	
7+ 5	36.2881	224.29	
7+10	37.8753	230.47	
7+15	39.5380	241.43	
7+20	41.3409	261.77	
7+25	43.2804	281.62	
7+30	45.3130	295.14	
7+35	47.4198	305.90	
7+40	49.6091	317.88	
7+45	51.9560	340.78	
7+50	54.6075	385.00	
7+55	57.5556	428.06	
8+ 0	60.7012	456.75	
8+ 5	63.9972	478.57	
8+10	67.4452	500.65	
8+15	71.1554	538.71	
8+20	75.3513	609.25	
8+25	80.0162	677.34	
8+30	84.9919	722.47	
8+35	90.1975	755.85	
8+40	95.6122	786.22	
8+45	101.3326	830.61	
8+50	107.5741	906.27	
8+55	114.3106	978.13	
9+ 0	121.3754	1025.81	
9+ 5	128.6765	1060.12	
9+10	136.1652	1087.36	
9+15	143.8543	1116.47	
9+20	151.8125	1155.52	
9+25	160.0154	1191.06	
9+30	168.3860	1215.41	
9+35	176.8724	1232.22	
9+40	185.4147	1240.35	
9+45	193.8983	1231.82	
9+50	202.1412	1196.87	
9+55	210.1402	1161.45	
10+ 0	217.9963	1140.71	
10+ 5	225.7456	1125.20	
10+10	233.3398	1102.67	
10+15	240.5183	1042.32	
10+20	246.7934	911.14	
10+25	252.1982	784.78	
10+30	257.0663	706.84	
10+35	261.5758	654.77	
10+40	265.8146	615.48	
10+45	269.7581	572.60	
10+50	273.2834	511.87	
10+55	276.4366	457.83	
11+ 0	279.3584	424.25	
11+ 5	282.1295	402.36	
11+10	284.8006	387.84	
11+15	287.3776	374.17	
11+20	289.8281	355.81	
11+25	292.1676	339.70	
11+30	294.4383	329.70	
11+35	296.6641	323.18	
11+40	298.8590	318.71	
11+45	301.0196	313.71	
11+50	303.1258	305.82	
11+55	305.1826	298.65	
12+ 0	307.2089	294.23	

12+ 5	309.2153	291.33	Q | | V |
12+10	311.2072	289.22	Q | | V |
12+15	313.1821	286.75	Q | | V |
12+20	315.1300	282.83	Q | | V |
12+25	317.0533	279.27	Q | | V |
12+30	318.9617	277.09	Q | | V |
12+35	320.8600	275.64	Q | | V |
12+40	322.7501	274.44	Q | | V |
12+45	324.6272	272.56	Q | | V |
12+50	326.4802	269.05	Q | | V |
12+55	328.3105	265.76	Q | | V |
13+ 0	330.1270	263.75	Q | | V |
13+ 5	331.9337	262.33	Q | | V |
13+10	333.7299	260.81	Q | | V |
13+15	335.5037	257.56	Q | | V |
13+20	337.2314	250.87	Q | | V |
13+25	338.9152	244.49	Q | | V |
13+30	340.5720	240.56	Q | | V |
13+35	342.2106	237.93	Q | | V |
13+40	343.8350	235.87	Q | | V |
13+45	345.4421	233.34	Q | | V |
13+50	347.0217	229.36	Q | | V |
13+55	348.5764	225.74	Q | | V |
14+ 0	350.1157	223.51	Q | | V |
14+ 5	351.6460	222.20	Q | | V |
14+10	353.1749	222.00	Q | | V |
14+15	354.7186	224.15	Q | | V|
14+20	356.3033	230.09	Q | | V|
14+25	357.9286	236.00	Q | | V|
14+30	359.5793	239.67	Q | | V|
14+35	361.2433	241.61	Q | | V|
14+40	362.9001	240.57	Q | | V|
14+45	364.4908	230.98	Q | | V|
14+50	365.9132	206.53	Q | | V
14+55	367.1699	182.47	Q | | V
15+ 0	368.3244	167.63	Q | | V
15+ 5	369.4138	158.18	Q | | V
15+10	370.4706	153.44	Q | | V
15+15	371.5497	156.68	Q | | V
15+20	372.7360	172.25	Q | | V
15+25	374.0338	188.44	Q | | V
15+30	375.4001	198.39	Q | | V
15+35	376.8122	205.03	Q | | V
15+40	378.2559	209.63	Q | | |V
15+45	379.7159	212.00	Q | | |V
15+50	381.1724	211.48	Q | | |V
15+55	382.6200	210.20	Q | | |V
16+ 0	384.0626	209.46	Q | | |V
16+ 5	385.5009	208.84	Q | | |V
16+10	386.9325	207.87	Q | | |V
16+15	388.3507	205.92	Q | | |V
16+20	389.7442	202.33	Q | | |V
16+25	391.1145	198.97	Q | | | V
16+30	392.4706	196.90	Q | | | V
16+35	393.8178	195.62	Q | | | V
16+40	395.1614	195.09	Q | | | V
16+45	396.5103	195.86	Q | | | V
16+50	397.8782	198.63	Q | | | V
16+55	399.2657	201.46	Q | | | V
17+ 0	400.6652	203.21	Q | | | V
17+ 5	402.0715	204.19	Q | | | V
17+10	403.4765	204.00	Q | | | V
17+15	404.8577	200.56	Q | | | V

17+20	406.1764	191.47		Q			V
17+25	407.4332	182.50		Q			V
17+30	408.6520	176.96		Q			V
17+35	409.8460	173.37		Q			V
17+40	411.0248	171.16		Q			V
17+45	412.2003	170.69		Q			V
17+50	413.3888	172.58		Q			V
17+55	414.5927	174.81		Q			V
18+ 0	415.8060	176.17		Q			V
18+ 5	417.0245	176.92		Q			V
18+10	418.2411	176.65		Q			V
18+15	419.4339	173.19		Q			V
18+20	420.5640	164.09		Q			V
18+25	421.6321	155.09		Q			V
18+30	422.6621	149.55		Q			V
18+35	423.6667	145.87		Q			V
18+40	424.6537	143.31		Q			V
18+45	425.6280	141.46		Q			V
18+50	426.5933	140.16		Q			V
18+55	427.5525	139.28		Q			V
19+ 0	428.5078	138.72		Q			V
19+ 5	429.4605	138.33		Q			V
19+10	430.4101	137.88		Q			V
19+15	431.3503	136.52		Q			V
19+20	432.2686	133.34		Q			V
19+25	433.1656	130.25		Q			V
19+30	434.0495	128.34		Q			V
19+35	434.9251	127.14		Q			V
19+40	435.7973	126.63		Q			V
19+45	436.6746	127.39		Q			V
19+50	437.5709	130.15		Q			V
19+55	438.4867	132.97		Q			V
20+ 0	439.4144	134.71		Q			V
20+ 5	440.3506	135.94		Q			V
20+10	441.2950	137.13		Q			V
20+15	442.2533	139.13		Q			V
20+20	443.2366	142.78		Q			V
20+25	444.2434	146.19		Q			V
20+30	445.2648	148.31		Q			V
20+35	446.2954	149.64		Q			V
20+40	447.3300	150.21		Q			V
20+45	448.3594	149.48		Q			V
20+50	449.3700	146.73		Q			V
20+55	450.3612	143.93		Q			V
21+ 0	451.3407	142.21		Q			V
21+ 5	452.3117	141.00		Q			V
21+10	453.2747	139.82		Q			V
21+15	454.2240	137.84		Q			V
21+20	455.1484	134.22		Q			V
21+25	456.0493	130.82		Q			V
21+30	456.9358	128.71		Q			V
21+35	457.8127	127.34		Q			V
21+40	458.6835	126.44		Q			V
21+45	459.5500	125.82		Q			V
21+50	460.4136	125.39		Q			V
21+55	461.2752	125.10		Q			V
22+ 0	462.1355	124.92		Q			V
22+ 5	462.9950	124.81		Q			V
22+10	463.8544	124.78		Q			V
22+15	464.7138	124.79		Q			V
22+20	465.5733	124.80		Q			V
22+25	466.4328	124.80		Q			V
22+30	467.2924	124.81		Q			V

```
   22+35     468.1520    124.82  |   Q       |           |           |        V |
   22+40     469.0117    124.83  |   Q       |           |           |        V |
   22+45     469.8715    124.83  |   Q       |           |           |        V |
   22+50     470.7312    124.84  |   Q       |           |           |        V |
   22+55     471.5911    124.85  |   Q       |           |           |        V |
   23+ 0     472.4509    124.85  |   Q       |           |           |        V |
   23+ 5     473.3113    124.93  |   Q       |           |           |        V |
   23+10     474.1742    125.29  |   Q       |           |           |        V |
   23+15     475.0465    126.66  |   Q       |           |           |        V |
   23+20     475.9410    129.87  |   Q       |           |           |         V|
   23+25     476.8569    133.00  |    Q      |           |           |         V|
   23+30     477.7862    134.93  |    Q      |           |           |         V|
   23+35     478.7238    136.14  |    Q      |           |           |         V|
   23+40     479.6651    136.67  |    Q      |           |           |         V|
   23+45     480.6012    135.93  |    Q      |           |           |         V|
   23+50     481.5184    133.18  |    Q      |           |           |         V|
   23+55     482.4163    130.37  |    Q      |           |           |         V|
   24+ 0     483.3023    128.64  |   Q       |           |           |         V|
   24+ 5     484.1763    126.91  |   Q       |           |           |         V|
   24+10     485.0228    122.91  |   Q       |           |           |         V|
   24+15     485.7799    109.94  |   Q       |           |           |         V|
   24+20     486.3355     80.67  |  Q        |           |           |         V|
   24+25     486.6959     52.33  |Q          |           |           |         V|
   24+30     486.9356     34.81  |Q          |           |           |         V|
   24+35     487.0957     23.24  Q           |           |           |         V|
   24+40     487.2012     15.33  Q           |           |           |         V|
   24+45     487.2682      9.72  Q           |           |           |         V|
   24+50     487.3078      5.76  Q           |           |           |         V|
   24+55     487.3290      3.07  Q           |           |           |         V|
   25+ 0     487.3382      1.35  Q           |           |           |         V|
   25+ 5     487.3405      0.32  Q           |           |           |         V|
-------------------------------------------------------------------------------
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2004 Version 7.4

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
        Rational Hydrology Study   Date: 09/01/10

2
SYSTEM 100
100-YEAR EVENT

 *********   Hydrology Study Control Information **********

Program License Serial Number 4055

Rational hydrology study storm event year is   100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.530
24 hour precipitation(inches) = 7.840
P6/P24 =   45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station   100.100 to Point/Station   100.200
**** INITIAL AREA EVALUATION ****
_____
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL   ]
(1.0 DU/A or Less   )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance =   76.200(Ft.)
Highest elevation = 5664.000(Ft.)
Lowest elevation = 5644.000(Ft.)
Elevation difference =   20.000(Ft.) Slope = 26.247 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 26.25 %, in a development type of
 1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =   4.48 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(26.247^(1/3)]=   4.48
Calculated TC of   4.482 minutes is less than 5 minutes,
 resetting TC to 5.0 minutes for rainfall intensity calculations
Rainfall intensity (I) =   9.301(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff =   0.301(CFS)
Total initial stream area =   0.090(Ac.)

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      100.200 to Point/Station      100.300
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5644.000(Ft.)
Downstream point elevation =  5557.000(Ft.)
Channel length thru subarea  =   456.000(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =      6.025(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =      6.025(CFS)
Depth of flow =   0.137(Ft.), Average velocity =   4.164(Ft/s)
Channel flow top width =   11.097(Ft.)
Flow Velocity =    4.16(Ft/s)
Travel time  =    1.83 min.
Time of concentration =    6.31 min.
Critical depth =      0.219(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      8.007(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      1.458
Subarea runoff =     11.372(CFS) for      3.960(Ac.)
Total runoff =     11.674(CFS)  Total area =       4.050(Ac.)
Depth of flow =   0.203(Ft.), Average velocity =   5.323(Ft/s)
Critical depth =      0.332(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      100.300 to Point/Station      100.400
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5557.000(Ft.)
Downstream point elevation =  5380.000(Ft.)
Channel length thru subarea  =  2269.600(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =     45.708(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =     45.708(CFS)
Depth of flow =   0.580(Ft.), Average velocity =   6.392(Ft/s)
Channel flow top width =   14.643(Ft.)
Flow Velocity =    6.39(Ft/s)
Travel time  =    5.92 min.
Time of concentration =   12.22 min.
Critical depth =      0.773(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
```

```
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      5.225(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =     15.246
Subarea runoff =     67.984(CFS) for     38.300(Ac.)
Total runoff =     79.658(CFS)  Total area =      42.350(Ac.)
Depth of flow =   0.792(Ft.), Average velocity =   7.633(Ft/s)
Critical depth =      1.078(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      100.400 to Point/Station      100.500
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =  5380.000(Ft.)
Downstream point elevation =  4272.000(Ft.)
Channel length thru subarea  =  2897.500(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =    109.283(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =    109.283(CFS)
Depth of flow =   0.606(Ft.), Average velocity =  14.512(Ft/s)
Channel flow top width =   14.849(Ft.)
Flow Velocity =   14.51(Ft/s)
Travel time  =    3.33 min.
Time of concentration =   15.55 min.
Critical depth =      1.297(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      4.473(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =     31.039
Subarea runoff =     59.192(CFS) for     43.870(Ac.)
Total runoff =    138.850(CFS)  Total area =      86.220(Ac.)
Depth of flow =   0.693(Ft.), Average velocity =  15.674(Ft/s)
Critical depth =      1.484(Ft.)
End of computations, total study area =          86.220 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2004 Version 7.4

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 09/01/10

TULE WIND PROJECT
SYSTEM 200
100 YEAR EVENT

********* Hydrology Study Control Information **********

Program License Serial Number 4055

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.750
24 hour precipitation(inches) = 8.600
P6/P24 = 43.6%
Adjusted 6 hour precipitation (inches) = 3.870
Adjusted P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 200.100 to Point/Station 200.200
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 68.100(Ft.)
Highest elevation = 5677.000(Ft.)
Lowest elevation = 5665.400(Ft.)
Elevation difference = 11.600(Ft.) Slope = 17.034 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 17.03 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 5.18 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(17.034^(1/3)]= 5.18
Rainfall intensity (I) = 9.970(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff = 0.359(CFS)
Total initial stream area = 0.100(Ac.)

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      200.200 to Point/Station      200.300
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5665.400(Ft.)
Downstream point elevation =  5460.000(Ft.)
Channel length thru subarea  =   639.000(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =      7.638(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =      7.638(CFS)
Depth of flow =   0.135(Ft.), Average velocity =   5.357(Ft/s)
Channel flow top width =   11.082(Ft.)
Flow Velocity =    5.36(Ft/s)
Travel time  =    1.99 min.
Time of concentration =    7.16 min.
Critical depth =      0.254(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      8.085(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      1.836
Subarea runoff =     14.485(CFS) for      5.000(Ac.)
Total runoff =     14.844(CFS)  Total area =       5.100(Ac.)
Depth of flow =   0.200(Ft.), Average velocity =   6.857(Ft/s)
Critical depth =      0.387(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      200.300 to Point/Station      200.400
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5460.000(Ft.)
Downstream point elevation =  4797.300(Ft.)
Channel length thru subarea  =  2637.200(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =     78.651(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =     78.651(CFS)
Depth of flow =   0.567(Ft.), Average velocity =  11.316(Ft/s)
Channel flow top width =   14.533(Ft.)
Flow Velocity =   11.32(Ft/s)
Travel time  =    3.88 min.
Time of concentration =   11.05 min.
Critical depth =      1.070(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
```

```
Decimal fraction soil group C = 0.890
Decimal fraction soil group D = 0.110
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.365
Rainfall intensity =      6.114(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.365  CA =     23.287
Subarea runoff =    127.540(CFS) for     58.690(Ac.)
Total runoff =    142.383(CFS)  Total area =      63.790(Ac.)
Depth of flow =   0.791(Ft.), Average velocity =  13.684(Ft/s)
Critical depth =      1.500(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      200.400 to Point/Station      200.500
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------
Upstream point elevation =  4797.300(Ft.)
Downstream point elevation =  3885.000(Ft.)
Channel length thru subarea  =  3957.300(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =    439.354(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =    439.354(CFS)
Depth of flow =   1.484(Ft.), Average velocity =  18.583(Ft/s)
Channel flow top width =   21.870(Ft.)
Flow Velocity =   18.58(Ft/s)
Travel time  =    3.55 min.
Time of concentration =   14.60 min.
Critical depth =      2.750(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.030
Decimal fraction soil group B = 0.040
Decimal fraction soil group C = 0.290
Decimal fraction soil group D = 0.640
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.388
Rainfall intensity =      5.109(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.384  CA =    144.118
Subarea runoff =    593.871(CFS) for    311.660(Ac.)
Total runoff =    736.254(CFS)  Total area =     375.450(Ac.)
Depth of flow =   1.933(Ft.), Average velocity =  21.479(Ft/s)
Critical depth =      3.563(Ft.)
End of computations, total study area =         375.450 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2004 Version 7.4

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 09/01/10

TULE WIND PROJECT
SYSTEM 300
100 YEAR EVENT

********* Hydrology Study Control Information **********

Program License Serial Number 4055

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.820
24 hour precipitation(inches) = 8.820
P6/P24 = 43.3%
Adjusted 6 hour precipitation (inches) = 3.969
Adjusted P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 300.100 to Point/Station 300.200
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 44.600(Ft.)
Highest elevation = 5636.000(Ft.)
Lowest elevation = 5623.500(Ft.)
Elevation difference = 12.500(Ft.) Slope = 28.027 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 28.03 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 4.39 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(28.027^(1/3)]= 4.39
Calculated TC of 4.385 minutes is less than 5 minutes,
resetting TC to 5.0 minutes for rainfall intensity calculations
Rainfall intensity (I) = 10.457(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360

Subarea runoff = 0.151(CFS)
Total initial stream area = 0.040(Ac.)

++
Process from Point/Station 300.200 to Point/Station 300.300
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 5623.500(Ft.)
Downstream point elevation = 5460.000(Ft.)
Channel length thru subarea = 772.300(Ft.)
Channel base width = 10.000(Ft.)
Slope or 'Z' of left channel bank = 4.000
Slope or 'Z' of right channel bank = 4.000
Estimated mean flow rate at midpoint of channel = 5.547(CFS)
Manning's 'N' = 0.040
Maximum depth of channel = 5.000(Ft.)
Flow(q) thru subarea = 5.547(CFS)
Depth of flow = 0.127(Ft.), Average velocity = 4.169(Ft/s)
Channel flow top width = 11.013(Ft.)
Flow Velocity = 4.17(Ft/s)
Travel time = 3.09 min.
Time of concentration = 7.47 min.
Critical depth = 0.207(Ft.)
Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity = 8.070(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360 CA = 1.346
Subarea runoff = 10.715(CFS) for 3.700(Ac.)
Total runoff = 10.865(CFS) Total area = 3.740(Ac.)
Depth of flow = 0.189(Ft.), Average velocity = 5.358(Ft/s)
Critical depth = 0.316(Ft.)

++
Process from Point/Station 300.300 to Point/Station 300.400
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 5460.000(Ft.)
Downstream point elevation = 5347.300(Ft.)
Channel length thru subarea = 2622.100(Ft.)
Channel base width = 10.000(Ft.)
Slope or 'Z' of left channel bank = 4.000
Slope or 'Z' of right channel bank = 4.000
Estimated mean flow rate at midpoint of channel = 75.260(CFS)
Manning's 'N' = 0.040
Maximum depth of channel = 5.000(Ft.)
Flow(q) thru subarea = 75.260(CFS)
Depth of flow = 0.905(Ft.), Average velocity = 6.106(Ft/s)
Channel flow top width = 17.240(Ft.)
Flow Velocity = 6.11(Ft/s)
Travel time = 7.16 min.
Time of concentration = 14.63 min.
Critical depth = 1.047(Ft.)
Adding area flow to channel

```
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      5.232(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =     26.676
Subarea runoff =    128.705(CFS) for     70.360(Ac.)
Total runoff =    139.571(CFS)  Total area =      74.100(Ac.)
Depth of flow =   1.263(Ft.), Average velocity =   7.344(Ft/s)
Critical depth =      1.484(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      300.400 to Point/Station      300.500
**** IMPROVED CHANNEL TRAVEL TIME ****
________________________________________________________________________
Upstream point elevation =  5347.300(Ft.)
Downstream point elevation =  4840.000(Ft.)
Channel length thru subarea  =  3682.200(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =    259.344(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =    259.344(CFS)
Depth of flow =   1.288(Ft.), Average velocity =  13.291(Ft/s)
Channel flow top width =   20.303(Ft.)
Flow Velocity =   13.29(Ft/s)
Travel time  =    4.62 min.
Time of concentration =   19.25 min.
Critical depth =      2.094(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.110
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.750
Decimal fraction soil group D = 0.140
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.357
Rainfall intensity =      4.384(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.358  CA =     86.462
Subarea runoff =    239.447(CFS) for    167.420(Ac.)
Total runoff =    379.018(CFS)  Total area =     241.520(Ac.)
Depth of flow =   1.571(Ft.), Average velocity =  14.820(Ft/s)
Critical depth =      2.547(Ft.)
End of computations, total study area =         241.520 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2004 Version 7.4

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 09/01/10

TULE WIND PROJECT
SYSTEM 400
100 YEAR EVENT

********* Hydrology Study Control Information **********

Program License Serial Number 4055

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.980
24 hour precipitation(inches) = 9.310
P6/P24 = 42.7%
Adjusted 6 hour precipitation (inches) = 4.190
Adjusted P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 400.100 to Point/Station 400.200
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 75.200(Ft.)
Highest elevation = 5513.500(Ft.)
Lowest elevation = 5501.000(Ft.)
Elevation difference = 12.500(Ft.) Slope = 16.622 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 16.62 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 5.22 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(16.622^(1/3)]= 5.22
Rainfall intensity (I) = 10.737(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff = 0.155(CFS)
Total initial stream area = 0.040(Ac.)

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      400.200 to Point/Station      400.300
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5501.000(Ft.)
Downstream point elevation =  5346.800(Ft.)
Channel length thru subarea  =   739.500(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =     13.250(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =     13.250(CFS)
Depth of flow =   0.213(Ft.), Average velocity =   5.735(Ft/s)
Channel flow top width =   11.703(Ft.)
Flow Velocity =    5.73(Ft/s)
Travel time  =    2.15 min.
Time of concentration =    7.37 min.
Critical depth =      0.359(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      8.596(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      3.056
Subarea runoff =     26.117(CFS) for      8.450(Ac.)
Total runoff =     26.272(CFS)  Total area =       8.490(Ac.)
Depth of flow =   0.318(Ft.), Average velocity =   7.329(Ft/s)
Critical depth =      0.555(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      400.300 to Point/Station      400.400
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5346.800(Ft.)
Downstream point elevation =  4800.000(Ft.)
Channel length thru subarea  =  1933.800(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =    110.924(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =    110.924(CFS)
Depth of flow =   0.665(Ft.), Average velocity =  13.165(Ft/s)
Channel flow top width =   15.324(Ft.)
Flow Velocity =   13.16(Ft/s)
Travel time  =    2.45 min.
Time of concentration =    9.82 min.
Critical depth =      1.297(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.110
Decimal fraction soil group B = 0.000
```

```
Decimal fraction soil group C = 0.410
Decimal fraction soil group D = 0.480
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.374
Rainfall intensity =      7.144(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.372  CA =     27.365
Subarea runoff =    169.217(CFS) for     64.980(Ac.)
Total runoff =    195.488(CFS)  Total area =      73.470(Ac.)
Depth of flow =   0.911(Ft.), Average velocity =  15.721(Ft/s)
Critical depth =      1.781(Ft.)
End of computations, total study area =          73.470 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2004 Version 7.4

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 09/01/10

TULE WIND PROJECT
SYSTEM 500
100 YEAR EVENT

********* Hydrology Study Control Information **********

Program License Serial Number 4055

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 4.060
24 hour precipitation(inches) = 9.440
P6/P24 = 43.0%
Adjusted 6 hour precipitation (inches) = 4.248
Adjusted P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 500.100 to Point/Station 500.200
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 71.900(Ft.)
Highest elevation = 5535.000(Ft.)
Lowest elevation = 5529.500(Ft.)
Elevation difference = 5.500(Ft.) Slope = 7.650 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 7.65 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 6.76 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(7.650^(1/3)]= 6.76
Rainfall intensity (I) = 9.214(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff = 0.232(CFS)
Total initial stream area = 0.070(Ac.)

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      500.200 to Point/Station      500.300
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5529.500(Ft.)
Downstream point elevation =  5491.500(Ft.)
Channel length thru subarea  =  1056.700(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =     20.166(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =     20.166(CFS)
Depth of flow =   0.454(Ft.), Average velocity =   3.761(Ft/s)
Channel flow top width =   13.630(Ft.)
Flow Velocity =    3.76(Ft/s)
Travel time  =    4.68 min.
Time of concentration =   11.44 min.
Critical depth =      0.469(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.240
Decimal fraction soil group C = 0.760
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.350
Rainfall intensity =      6.562(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.350  CA =      6.101
Subarea runoff =     39.802(CFS) for     17.340(Ac.)
Total runoff =     40.034(CFS)  Total area =      17.410(Ac.)
Depth of flow =   0.670(Ft.), Average velocity =   4.713(Ft/s)
Critical depth =      0.719(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      500.300 to Point/Station      500.400
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5491.500(Ft.)
Downstream point elevation =  5361.500(Ft.)
Channel length thru subarea  =  2216.700(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =     91.075(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =     91.075(CFS)
Depth of flow =   0.923(Ft.), Average velocity =   7.210(Ft/s)
Channel flow top width =   17.382(Ft.)
Flow Velocity =    7.21(Ft/s)
Travel time  =    5.12 min.
Time of concentration =   16.57 min.
Critical depth =      1.164(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.030
```

```
Decimal fraction soil group C = 0.970
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.359
Rainfall intensity =      5.168(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.357  CA =     27.478
Subarea runoff =    101.984(CFS) for     59.580(Ac.)
Total runoff =    142.018(CFS)  Total area =      76.990(Ac.)
Depth of flow =   1.173(Ft.), Average velocity =   8.238(Ft/s)
Critical depth =      1.500(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      500.400 to Point/Station      500.500
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------
Upstream point elevation =  5361.500(Ft.)
Downstream point elevation =  4800.000(Ft.)
Channel length thru subarea  =  2975.100(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =    231.210(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =    231.210(CFS)
Depth of flow =   1.114(Ft.), Average velocity =  14.360(Ft/s)
Channel flow top width =   18.911(Ft.)
Flow Velocity =   14.36(Ft/s)
Travel time  =    3.45 min.
Time of concentration =   20.02 min.
Critical depth =      1.969(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.090
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 0.530
Decimal fraction soil group D = 0.380
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.371
Rainfall intensity =      4.574(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.365  CA =     70.028
Subarea runoff =    178.306(CFS) for    114.720(Ac.)
Total runoff =    320.324(CFS)  Total area =     191.710(Ac.)
Depth of flow =   1.325(Ft.), Average velocity =  15.801(Ft/s)
Critical depth =      2.328(Ft.)
End of computations, total study area =         191.710 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2004 Version 7.4

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 09/01/10

TULE WIND PROJECT
SYSTEM 600
100 YEAR EVENT

********* Hydrology Study Control Information **********

Program License Serial Number 4055

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 4.240
24 hour precipitation(inches) = 10.000
P6/P24 = 42.4%
Adjusted 6 hour precipitation (inches) = 4.500
Adjusted P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 600.100 to Point/Station 600.200
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 69.400(Ft.)
Highest elevation = 5666.700(Ft.)
Lowest elevation = 5656.000(Ft.)
Elevation difference = 10.700(Ft.) Slope = 15.418 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 15.42 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 5.35 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(15.418^(1/3)]= 5.35
Rainfall intensity (I) = 11.348(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff = 0.245(CFS)
Total initial stream area = 0.060(Ac.)

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      600.200 to Point/Station      600.300
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5656.000(Ft.)
Downstream point elevation =  5480.500(Ft.)
Channel length thru subarea  =   749.700(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =     12.181(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =     12.181(CFS)
Depth of flow =   0.196(Ft.), Average velocity =   5.768(Ft/s)
Channel flow top width =   11.567(Ft.)
Flow Velocity =    5.77(Ft/s)
Travel time  =    2.17 min.
Time of concentration =    7.52 min.
Critical depth =      0.344(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      9.114(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      2.639
Subarea runoff =     23.805(CFS) for      7.270(Ac.)
Total runoff =     24.050(CFS)  Total area =       7.330(Ac.)
Depth of flow =   0.292(Ft.), Average velocity =   7.375(Ft/s)
Critical depth =      0.523(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      600.300 to Point/Station      600.400
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5480.500(Ft.)
Downstream point elevation =  4740.000(Ft.)
Channel length thru subarea  =  2981.000(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =    218.250(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =    218.250(CFS)
Depth of flow =   1.002(Ft.), Average velocity =  15.540(Ft/s)
Channel flow top width =   18.020(Ft.)
Flow Velocity =   15.54(Ft/s)
Travel time  =    3.20 min.
Time of concentration =   10.72 min.
Critical depth =      1.906(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.480
```

```
Decimal fraction soil group C = 0.440
Decimal fraction soil group D = 0.080
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.345
Rainfall intensity =      7.252(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.345  CA =     56.869
Subarea runoff =    388.346(CFS) for    157.280(Ac.)
Total runoff =    412.396(CFS)  Total area =     164.610(Ac.)
Depth of flow =   1.408(Ft.), Average velocity =  18.741(Ft/s)
Critical depth =      2.656(Ft.)
End of computations, total study area =         164.610 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2004 Version 7.4

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 09/01/10

TULE WIND PROJECT
SYSTEM 700
100 YEAR EVENT

********* Hydrology Study Control Information **********

Program License Serial Number 4055

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 4.270
24 hour precipitation(inches) = 9.950
P6/P24 = 42.9%
Adjusted 6 hour precipitation (inches) = 4.478
Adjusted P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 700.100 to Point/Station 700.200
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 85.600(Ft.)
Highest elevation = 5566.000(Ft.)
Lowest elevation = 5558.000(Ft.)
Elevation difference = 8.000(Ft.) Slope = 9.346 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 9.35 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 6.32 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(9.346^(1/3)]= 6.32
Rainfall intensity (I) = 10.139(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff = 0.146(CFS)
Total initial stream area = 0.040(Ac.)

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      700.200 to Point/Station      700.300
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5558.000(Ft.)
Downstream point elevation =  5292.300(Ft.)
Channel length thru subarea  =   671.700(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =      7.208(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =      7.208(CFS)
Depth of flow =   0.123(Ft.), Average velocity =   5.591(Ft/s)
Channel flow top width =   10.983(Ft.)
Flow Velocity =    5.59(Ft/s)
Travel time  =    2.00 min.
Time of concentration =    8.33 min.
Critical depth =      0.244(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      8.490(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      1.674
Subarea runoff =     14.067(CFS) for      4.610(Ac.)
Total runoff =     14.213(CFS)  Total area =       4.650(Ac.)
Depth of flow =   0.184(Ft.), Average velocity =   7.206(Ft/s)
Critical depth =      0.375(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      700.300 to Point/Station      700.400
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5292.300(Ft.)
Downstream point elevation =  4740.500(Ft.)
Channel length thru subarea  =  2270.000(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =    154.857(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =    154.857(CFS)
Depth of flow =   0.836(Ft.), Average velocity =  13.887(Ft/s)
Channel flow top width =   16.686(Ft.)
Flow Velocity =   13.89(Ft/s)
Travel time  =    2.72 min.
Time of concentration =   11.05 min.
Critical depth =      1.578(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.460
```

```
Decimal fraction soil group C = 0.540
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.342
Rainfall intensity =      7.073(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.342  CA =     41.768
Subarea runoff =    281.229(CFS) for    117.370(Ac.)
Total runoff =    295.442(CFS)  Total area =     122.020(Ac.)
Depth of flow =   1.187(Ft.), Average velocity =  16.879(Ft/s)
Critical depth =      2.234(Ft.)
End of computations, total study area =         122.020 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2004 Version 7.4

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 09/01/10

TULE WIND PROJECT
SYSTEM 800
100 YEAR EVENT

********* Hydrology Study Control Information **********

Program License Serial Number 4055

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 4.190
24 hour precipitation(inches) = 9.560
P6/P24 = 43.8%
Adjusted 6 hour precipitation (inches) = 4.302
Adjusted P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 800.100 to Point/Station 800.200
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 71.700(Ft.)
Highest elevation = 5675.000(Ft.)
Lowest elevation = 5658.500(Ft.)
Elevation difference = 16.500(Ft.) Slope = 23.013 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 23.01 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 4.68 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(23.013^(1/3)]= 4.68
Calculated TC of 4.683 minutes is less than 5 minutes,
resetting TC to 5.0 minutes for rainfall intensity calculations
Rainfall intensity (I) = 11.335(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360

Subarea runoff = 0.367(CFS)
Total initial stream area = 0.090(Ac.)

++
Process from Point/Station 800.200 to Point/Station 800.300
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 5658.500(Ft.)
Downstream point elevation = 5519.300(Ft.)
Channel length thru subarea = 759.000(Ft.)
Channel base width = 10.000(Ft.)
Slope or 'Z' of left channel bank = 4.000
Slope or 'Z' of right channel bank = 4.000
Estimated mean flow rate at midpoint of channel = 5.648(CFS)
Manning's 'N' = 0.040
Maximum depth of channel = 5.000(Ft.)
Flow(q) thru subarea = 5.648(CFS)
Depth of flow = 0.134(Ft.), Average velocity = 4.014(Ft/s)
Channel flow top width = 11.069(Ft.)
Flow Velocity = 4.01(Ft/s)
Travel time = 3.15 min.
Time of concentration = 7.83 min.
Critical depth = 0.209(Ft.)
Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity = 8.484(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360 CA = 1.278
Subarea runoff = 10.476(CFS) for 3.460(Ac.)
Total runoff = 10.843(CFS) Total area = 3.550(Ac.)
Depth of flow = 0.196(Ft.), Average velocity = 5.116(Ft/s)
Critical depth = 0.316(Ft.)

++
Process from Point/Station 800.300 to Point/Station 800.400
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 5519.300(Ft.)
Downstream point elevation = 5451.800(Ft.)
Channel length thru subarea = 2005.000(Ft.)
Channel base width = 10.000(Ft.)
Slope or 'Z' of left channel bank = 4.000
Slope or 'Z' of right channel bank = 4.000
Estimated mean flow rate at midpoint of channel = 44.702(CFS)
Manning's 'N' = 0.040
Maximum depth of channel = 5.000(Ft.)
Flow(q) thru subarea = 44.702(CFS)
Depth of flow = 0.726(Ft.), Average velocity = 4.773(Ft/s)
Channel flow top width = 15.807(Ft.)
Flow Velocity = 4.77(Ft/s)
Travel time = 7.00 min.
Time of concentration = 14.84 min.
Critical depth = 0.766(Ft.)
Adding area flow to channel

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity = 5.620(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360 CA = 13.964
Subarea runoff = 67.639(CFS) for 35.240(Ac.)
Total runoff = 78.482(CFS) Total area = 38.790(Ac.)
Depth of flow = 0.990(Ft.), Average velocity = 5.680(Ft/s)
Critical depth = 1.063(Ft.)

++
Process from Point/Station 800.400 to Point/Station 800.500
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 5451.800(Ft.)
Downstream point elevation = 5341.800(Ft.)
Channel length thru subarea = 2536.500(Ft.)
Channel base width = 10.000(Ft.)
Slope or 'Z' of left channel bank = 4.000
Slope or 'Z' of right channel bank = 4.000
Estimated mean flow rate at midpoint of channel = 312.633(CFS)
Manning's 'N' = 0.040
Maximum depth of channel = 5.000(Ft.)
Flow(q) thru subarea = 312.633(CFS)
Depth of flow = 1.913(Ft.), Average velocity = 9.262(Ft/s)
Channel flow top width = 25.300(Ft.)
Flow Velocity = 9.26(Ft/s)
Travel time = 4.56 min.
Time of concentration = 19.40 min.
Critical depth = 2.313(Ft.)
Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.130
Decimal fraction soil group C = 0.870
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.355
Rainfall intensity = 4.727(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.355 CA = 115.650
Subarea runoff = 468.223(CFS) for 286.600(Ac.)
Total runoff = 546.706(CFS) Total area = 325.390(Ac.)
Depth of flow = 2.523(Ft.), Average velocity = 10.784(Ft/s)
Critical depth = 3.063(Ft.)

++
Process from Point/Station 800.500 to Point/Station 800.600
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 5341.800(Ft.)
Downstream point elevation = 4670.000(Ft.)
Channel length thru subarea = 3795.300(Ft.)
Channel base width = 10.000(Ft.)

```
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =    628.770(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =    628.770(CFS)
Depth of flow =   1.908(Ft.), Average velocity =  18.688(Ft/s)
Channel flow top width =   25.265(Ft.)
Flow Velocity =   18.69(Ft/s)
Travel time  =    3.38 min.
Time of concentration =   22.79 min.
Critical depth =      3.313(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.470
Decimal fraction soil group C = 0.530
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                      ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.341
Rainfall intensity =      4.261(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.351  CA =    166.782
Subarea runoff =    164.031(CFS) for    149.860(Ac.)
Total runoff =    710.737(CFS)  Total area =     475.250(Ac.)
Depth of flow =   2.029(Ft.), Average velocity =  19.330(Ft/s)
Critical depth =      3.500(Ft.)
End of computations, total study area =         475.250 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2004 Version 7.4

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 09/01/10

TULE WIND PROJECT
SYSTEM 900
100 YEAR EVENT

********* Hydrology Study Control Information **********

Program License Serial Number 4055

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 4.250
24 hour precipitation(inches) = 9.550
P6/P24 = 44.5%
Adjusted 6 hour precipitation (inches) = 4.298
Adjusted P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 900.100 to Point/Station 900.200
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 76.500(Ft.)
Highest elevation = 5646.500(Ft.)
Lowest elevation = 5634.800(Ft.)
Elevation difference = 11.700(Ft.) Slope = 15.294 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 15.29 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 5.37 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(15.294^(1/3)]= 5.37
Rainfall intensity (I) = 10.818(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff = 0.234(CFS)
Total initial stream area = 0.060(Ac.)

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      900.200 to Point/Station      900.300
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5634.800(Ft.)
Downstream point elevation =  5455.700(Ft.)
Channel length thru subarea  =   788.800(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =     10.974(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =     10.974(CFS)
Depth of flow =   0.186(Ft.), Average velocity =   5.498(Ft/s)
Channel flow top width =   11.486(Ft.)
Flow Velocity =    5.50(Ft/s)
Travel time  =    2.39 min.
Time of concentration =    7.76 min.
Critical depth =      0.320(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      8.530(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      2.538
Subarea runoff =     21.414(CFS) for      6.990(Ac.)
Total runoff =     21.648(CFS)  Total area =       7.050(Ac.)
Depth of flow =   0.277(Ft.), Average velocity =   7.035(Ft/s)
Critical depth =      0.492(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      900.300 to Point/Station      900.400
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5455.700(Ft.)
Downstream point elevation =  5217.500(Ft.)
Channel length thru subarea  =  2298.300(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =    105.102(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =    105.102(CFS)
Depth of flow =   0.854(Ft.), Average velocity =   9.177(Ft/s)
Channel flow top width =   16.830(Ft.)
Flow Velocity =    9.18(Ft/s)
Travel time  =    4.17 min.
Time of concentration =   11.93 min.
Critical depth =      1.266(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.100
```

```
Decimal fraction soil group C = 0.900
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.356
Rainfall intensity =      6.461(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.356  CA =     29.174
Subarea runoff =    166.854(CFS) for     74.820(Ac.)
Total runoff =    188.502(CFS)  Total area =      81.870(Ac.)
Depth of flow =   1.172(Ft.), Average velocity =  10.946(Ft/s)
Critical depth =      1.750(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station      900.400 to Point/Station      900.500
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------
Upstream point elevation =  5217.500(Ft.)
Downstream point elevation =  4931.700(Ft.)
Channel length thru subarea  =  3731.400(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =    262.539(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =    262.539(CFS)
Depth of flow =   1.512(Ft.), Average velocity =  10.822(Ft/s)
Channel flow top width =   22.095(Ft.)
Flow Velocity =   10.82(Ft/s)
Travel time  =    5.75 min.
Time of concentration =   17.68 min.
Critical depth =      2.094(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.140
Decimal fraction soil group C = 0.860
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.354
Rainfall intensity =      5.014(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.355  CA =     67.112
Subarea runoff =    148.004(CFS) for    107.050(Ac.)
Total runoff =    336.506(CFS)  Total area =     188.920(Ac.)
Depth of flow =   1.718(Ft.), Average velocity =  11.607(Ft/s)
Critical depth =      2.391(Ft.)
End of computations, total study area =         188.920 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2004 Version 7.4

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 09/01/10

TULE WIND PROJECT
SYSTEM 1000
100 YEAR EVENT

********* Hydrology Study Control Information **********

Program License Serial Number 4055

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 4.320
24 hour precipitation(inches) = 9.760
P6/P24 = 44.3%
Adjusted 6 hour precipitation (inches) = 4.392
Adjusted P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 1000.100 to Point/Station 1000.200
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 74.900(Ft.)
Highest elevation = 5684.000(Ft.)
Lowest elevation = 5674.500(Ft.)
Elevation difference = 9.500(Ft.) Slope = 12.684 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 12.68 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 5.71 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(12.684^(1/3)]= 5.71
Rainfall intensity (I) = 10.620(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff = 0.153(CFS)
Total initial stream area = 0.040(Ac.)

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1000.200 to Point/Station     1000.300
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5674.500(Ft.)
Downstream point elevation =  5350.000(Ft.)
Channel length thru subarea  =  1283.000(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =     15.217(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =     15.217(CFS)
Depth of flow =   0.218(Ft.), Average velocity =   6.413(Ft/s)
Channel flow top width =   11.746(Ft.)
Flow Velocity =    6.41(Ft/s)
Travel time  =    3.33 min.
Time of concentration =    9.05 min.
Critical depth =      0.395(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      7.894(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =      3.827
Subarea runoff =     30.057(CFS) for     10.590(Ac.)
Total runoff =     30.210(CFS)  Total area =      10.630(Ac.)
Depth of flow =   0.326(Ft.), Average velocity =   8.195(Ft/s)
Critical depth =      0.602(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1000.300 to Point/Station     1000.400
**** IMPROVED CHANNEL TRAVEL TIME ****
______________________________________________________________________________
Upstream point elevation =  5350.000(Ft.)
Downstream point elevation =  4927.500(Ft.)
Channel length thru subarea  =  3982.200(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =    115.259(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =    115.259(CFS)
Depth of flow =   0.892(Ft.), Average velocity =   9.518(Ft/s)
Channel flow top width =   17.139(Ft.)
Flow Velocity =    9.52(Ft/s)
Travel time  =    6.97 min.
Time of concentration =   16.02 min.
Critical depth =      1.328(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
```

```
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                     ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =      5.461(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =     36.666
Subarea runoff =    170.010(CFS) for     91.220(Ac.)
Total runoff =    200.220(CFS)  Total area =     101.850(Ac.)
Depth of flow =   1.203(Ft.), Average velocity =  11.235(Ft/s)
Critical depth =      1.813(Ft.)
End of computations, total study area =         101.850 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2004 Version 7.4

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 09/01/10

TULE WIND PROJECT
SYSTEM 1100
100 YEAR EVENT

********* Hydrology Study Control Information **********

Program License Serial Number 4055

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.760
24 hour precipitation(inches) = 7.380
P6/P24 = 50.9%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 1100.100 to Point/Station 1100.200
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 1.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.320
Initial subarea total flow distance = 76.500(Ft.)
Highest elevation = 4580.000(Ft.)
Lowest elevation = 4570.800(Ft.)
Elevation difference = 9.200(Ft.) Slope = 12.026 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 12.03 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 6.13 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3200)*(100.000^.5)/(12.026^(1/3)]= 6.13
Rainfall intensity (I) = 8.688(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.320
Subarea runoff = 0.417(CFS)
Total initial stream area = 0.150(Ac.)

++
Process from Point/Station 1100.200 to Point/Station 1100.300
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 4570.800(Ft.)
Downstream point elevation = 4441.000(Ft.)
Channel length thru subarea = 1661.700(Ft.)
Channel base width = 10.000(Ft.)
Slope or 'Z' of left channel bank = 4.000
Slope or 'Z' of right channel bank = 4.000
Estimated mean flow rate at midpoint of channel = 25.351(CFS)
Manning's 'N' = 0.040
Maximum depth of channel = 5.000(Ft.)
Flow(q) thru subarea = 25.351(CFS)
Depth of flow = 0.414(Ft.), Average velocity = 5.252(Ft/s)
Channel flow top width = 13.313(Ft.)
Flow Velocity = 5.25(Ft/s)
Travel time = 5.27 min.
Time of concentration = 11.40 min.
Critical depth = 0.539(Ft.)
Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 1.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.320
Rainfall intensity = 5.821(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.320 CA = 8.621
Subarea runoff = 49.769(CFS) for 26.790(Ac.)
Total runoff = 50.186(CFS) Total area = 26.940(Ac.)
Depth of flow = 0.612(Ft.), Average velocity = 6.593(Ft/s)
Critical depth = 0.820(Ft.)

++
Process from Point/Station 1100.300 to Point/Station 1100.400
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 4441.000(Ft.)
Downstream point elevation = 4230.300(Ft.)
Channel length thru subarea = 2733.000(Ft.)
Channel base width = 10.000(Ft.)
Slope or 'Z' of left channel bank = 4.000
Slope or 'Z' of right channel bank = 4.000
Estimated mean flow rate at midpoint of channel = 253.519(CFS)
Manning's 'N' = 0.040
Maximum depth of channel = 5.000(Ft.)
Flow(q) thru subarea = 253.519(CFS)
Depth of flow = 1.482(Ft.), Average velocity = 10.739(Ft/s)
Channel flow top width = 21.856(Ft.)
Flow Velocity = 10.74(Ft/s)
Travel time = 4.24 min.
Time of concentration = 15.64 min.
Critical depth = 2.063(Ft.)
Adding area flow to channel
Decimal fraction soil group A = 0.120
Decimal fraction soil group B = 0.870
Decimal fraction soil group C = 0.010
Decimal fraction soil group D = 0.000

```
[LOW DENSITY RESIDENTIAL                        ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.314
Rainfall intensity =      4.747(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.315  CA =     96.219
Subarea runoff =    406.583(CFS) for    278.620(Ac.)
Total runoff =    456.769(CFS)  Total area =     305.560(Ac.)
Depth of flow =   2.003(Ft.), Average velocity =  12.664(Ft/s)
Critical depth =      2.813(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1100.400 to Point/Station     1100.500
**** IMPROVED CHANNEL TRAVEL TIME ****
------------------------------------------------------------------------------
Upstream point elevation =  4230.300(Ft.)
Downstream point elevation =  4140.000(Ft.)
Channel length thru subarea  =  3542.300(Ft.)
Channel base width      =   10.000(Ft.)
Slope or 'Z' of left channel bank =   4.000
Slope or 'Z' of right channel bank =   4.000
Estimated mean flow rate at midpoint of channel =    608.056(CFS)
Manning's 'N'    = 0.040
Maximum depth of channel  =    5.000(Ft.)
Flow(q) thru subarea =    608.056(CFS)
Depth of flow =   3.018(Ft.), Average velocity =   9.129(Ft/s)
Channel flow top width =   34.143(Ft.)
Flow Velocity =    9.13(Ft/s)
Travel time  =    6.47 min.
Time of concentration =   22.11 min.
Critical depth =      3.250(Ft.)
 Adding area flow to channel
Decimal fraction soil group A = 0.150
Decimal fraction soil group B = 0.830
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.020
[LOW DENSITY RESIDENTIAL                        ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.314
Rainfall intensity =      3.798(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.315  CA =    199.938
Subarea runoff =    302.510(CFS) for    330.000(Ac.)
Total runoff =    759.278(CFS)  Total area =     635.560(Ac.)
Depth of flow =   3.352(Ft.), Average velocity =   9.678(Ft/s)
Critical depth =      3.625(Ft.)
End of computations, total study area =         635.560 (Ac.)
```

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2004 Version 7.4

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 09/01/10

Tule Wind Project
System 1200
Existing 100 Year
June 4, 2010

********* Hydrology Study Control Information **********

Program License Serial Number 4055

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.000
24 hour precipitation(inches) = 5.050
P6/P24 = 59.4%
San Diego hydrology manual 'C' values used

++

Process from Point/Station 1200.100 to Point/Station 1200.200
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 1.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.320
Initial subarea total flow distance = 307.190(Ft.)
Highest elevation = 4047.500(Ft.)
Lowest elevation = 4025.000(Ft.)
Elevation difference = 22.500(Ft.) Slope = 7.324 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 7.32 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 7.23 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3200)*(100.000^.5)/(7.324^(1/3)]= 7.23
Rainfall intensity (I) = 6.231(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.320
Subarea runoff = 1.256(CFS)
Total initial stream area = 0.630(Ac.)

++

Process from Point/Station 1200.200 to Point/Station 1200.500
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 4025.000(Ft.)
Downstream point elevation = 3200.000(Ft.)
Channel length thru subarea = 7965.330(Ft.)
Channel base width = 10.000(Ft.)
Slope or 'Z' of left channel bank = 4.000
Slope or 'Z' of right channel bank = 4.000
Estimated mean flow rate at midpoint of channel = 130.799(CFS)
Manning's 'N' = 0.040
Maximum depth of channel = 5.000(Ft.)
Flow(q) thru subarea = 130.799(CFS)
Depth of flow = 0.963(Ft.), Average velocity = 9.810(Ft/s)
Channel flow top width = 17.701(Ft.)
Flow Velocity = 9.81(Ft/s)
Travel time = 13.53 min.
Time of concentration = 20.76 min.
Critical depth = 1.438(Ft.)
Adding area flow to channel
Decimal fraction soil group A = 0.070
Decimal fraction soil group B = 0.130
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.800
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.389
Rainfall intensity = 3.155(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.388 CA = 82.482
Subarea runoff = 259.009(CFS) for 211.790(Ac.)
Total runoff = 260.265(CFS) Total area = 212.420(Ac.)
Depth of flow = 1.391(Ft.), Average velocity = 12.022(Ft/s)
Critical depth = 2.094(Ft.)

++
Process from Point/Station 1200.200 to Point/Station 1200.500
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 1
Stream flow area = 212.420(Ac.)
Runoff from this stream = 260.265(CFS)
Time of concentration = 20.76 min.
Rainfall intensity = 3.155(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	260.265	20.76	3.155

Qmax(1) =
1.000 * 1.000 * 260.265) + = 260.265

Total of 1 streams to confluence:
Flow rates before confluence point:
260.265
Maximum flow rates at confluence using above data:
260.265
Area of streams before confluence:
212.420

Results of confluence:
Total flow rate = 260.265(CFS)
Time of concentration = 20.762 min.
Effective stream area after confluence = 212.420(Ac.)

++
Process from Point/Station 1200.300 to Point/Station 1200.400
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 1.000
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.320
Initial subarea total flow distance = 203.190(Ft.)
Highest elevation = 3965.000(Ft.)
Lowest elevation = 3935.000(Ft.)
Elevation difference = 30.000(Ft.) Slope = 14.765 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 14.77 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 5.72 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3200)*(100.000^.5)/(14.765^(1/3)]= 5.72
Rainfall intensity (I) = 7.245(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.320
Subarea runoff = 1.391(CFS)
Total initial stream area = 0.600(Ac.)

++
Process from Point/Station 1200.400 to Point/Station 1200.500
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 3935.000(Ft.)
Downstream point elevation = 3200.000(Ft.)
Channel length thru subarea = 6390.380(Ft.)
Channel base width = 10.000(Ft.)
Slope or 'Z' of left channel bank = 4.000
Slope or 'Z' of right channel bank = 4.000
Estimated mean flow rate at midpoint of channel = 211.854(CFS)
Manning's 'N' = 0.040
Maximum depth of channel = 5.000(Ft.)
Flow(q) thru subarea = 211.854(CFS)
Depth of flow = 1.214(Ft.), Average velocity = 11.753(Ft/s)
Channel flow top width = 19.708(Ft.)
Flow Velocity = 11.75(Ft/s)
Travel time = 9.06 min.
Time of concentration = 14.79 min.
Critical depth = 1.875(Ft.)
Adding area flow to channel
Decimal fraction soil group A = 0.040
Decimal fraction soil group B = 0.120
Decimal fraction soil group C = 0.000
Decimal fraction soil group D = 0.840
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)

```
Impervious value, Ai = 0.100
Sub-Area C Value = 0.394
Rainfall intensity =      3.928(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.393  CA =    107.495
Subarea runoff =    420.837(CFS) for    272.620(Ac.)
Total runoff =    422.228(CFS)  Total area =     273.220(Ac.)
Depth of flow =   1.739(Ft.), Average velocity =  14.318(Ft/s)
Critical depth =      2.688(Ft.)


++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station     1200.400 to Point/Station     1200.500
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =    273.220(Ac.)
Runoff from this stream =    422.228(CFS)
Time of concentration =   14.79 min.
Rainfall intensity =     3.928(In/Hr)
Summary of stream data:

Stream   Flow rate      TC            Rainfall Intensity
 No.       (CFS)       (min)                 (In/Hr)


1      422.228     14.79                  3.928
Qmax(1) =
           1.000 *    1.000 *   422.228) + =     422.228

Total of 1 streams to confluence:
Flow rates before confluence point:
     422.228
Maximum flow rates at confluence using above data:
      422.228
Area of streams before confluence:
      273.220
Results of confluence:
Total flow rate =    422.228(CFS)
Time of concentration =    14.785 min.
Effective stream area after confluence =    273.220(Ac.)
End of computations, total study area =         485.640 (Ac.)
```

APPENDIX D – Proposed Conditions Hydrology Summary

Project: Tule Wind
Subject: Drainage Report
Task: 21
Job#: 115965
No: Rev 1

Proposed Conditions, Unit Hydrograph

Watershed Loss

Watershed	A (mi^2)	A (ac)	CN (AMC II)	PZN	PZN (>35yr)	CN (>35yr)	Soil Type
Tule Creek	28.52	18250	74	3.42	2.58	82	2.1
Bow Willow Creek North	4.29	2747	84	3.37	2.63	90	3.3
Bow Willow Creek South	8.12	5197	81	3.40	2.60	88	3.0
Northern Unnamed Wash	2.41	1542	77	3.51	2.49	83	2.1
Eastern Unnamed Wash	1.15	734	80	3.55	2.45	85	2.7
Western Unnamed Wash	2.25	1440	69	3.30	2.70	80	2.0
Simmons Canyon	1.37	878	80	3.23	2.77	89	2.5

Watershed Lag

Watershed	Elev US (ft)	Elev DS (ft)	L (mi)	Lca (mi)	Slope (ft/mi)	Basin n	m	lag (hr)
Tule Creek	5802.5	3473	12.13	5.14	192	0.040	0.38	1.70
Bow Willow Creek North	5620	3930	4.91	2.33	344	0.040	0.38	0.80
Bow Willow Creek South	5642	3410	6.55	2.65	341	0.040	0.38	0.94
Northern Unnamed Wash	4156	3765	2.51	0.83	156	0.040	0.38	0.49
Eastern Unnamed Wash	4125	3620	1.91	0.74	265	0.040	0.38	0.38
Western Unnamed Wash	4795	4140	2.06	0.43	318	0.040	0.38	0.31
Simmons Canyon	5652	4120	2.19	0.79	701	0.040	0.38	0.34

Subwatershed Rainfall, Inches (SDC Hydrology Manual)

Watershed	100Yr 6Hr	100Yr 24Hr
Tule Creek	3.36	6.41
Bow Willow Creek North	3.26	6.43
Bow Willow Creek South	3.37	9.70
Northern Unnamed Wash	3.00	6.31
Eastern Unnamed Wash	3.00	5.40
Western Unnamed Wash	3.92	5.01
Simmons Canyon	4.12	8.00

$$lag = 24n\left(\frac{L \bullet L_{ca}}{S^{0.5}}\right)^{m}$$

Proposed Permanent Impact Summary

Watershed	Basin Area (acres)	Perm Impacted Area	% Impacted	Turbines	O&M	Substation	Total Impervious Area (sq ft)	Total Impervious Area (acres)	% Impervious
Tule Creek	18250.10	239.18	1.31%	49	4	2	45599	1.046805213	0.006%
Bow Willow Creek North	2746.89	30.91	1.13%	9.5			3412	0.078329179	0.003%
Bow Willow Creek South	5197.41	82.14	1.58%	22			7902	0.181393889	0.003%
Northern Unnamed Wash	1541.63	61.56	3.99%	13	1	1	13669	0.313798868	0.020%
Eastern Unnamed Wash	734.43	20.52	2.79%	5			1796	0.041225884	0.006%
Western Unnamed Wash	1439.89	9.70	0.67%	0			0	0	0.000%
Simmons Canyon	877.79	22.15	2.52%	5.5			1975	0.045348472	0.005%
100	86.22	6.34	7.36%	2			718	0.016490354	0.019%
200	375.45	10.86	2.89%	3.5			1257	0.028858119	0.008%
300	241.52	16.91	7.00%	5.5			1975	0.045348472	0.019%
400	73.46	1.04	1.42%	0.5			180	0.004122588	0.006%
500	191.71	12.57	6.56%	3.5			1257	0.028858119	0.015%
600	164.61	3.71	2.26%	1			359	0.008245177	0.005%
700	122.03	4.35	3.57%	1.5			539	0.012367765	0.010%
800	475.25	22.81	4.80%	6			2155	0.049471061	0.010%
900	188.92	14.73	7.80%	1			359	0.008245177	0.004%
1000	101.85	1.81	1.77%	3.5			1257	0.028858119	0.028%
1100	635.56	5.17	0.81%	0			0	0	0.000%
1200	485.64	6.12	1.26%	2			718	0.016490354	0.003%
Totals	33930.35604	572.59		134			85127	1.954256809	0.01%

EXHIBITS

Exhibit A – Existing Conditions Hydrology Map

Exhibit B – Proposed Conditions Hydrology Map

Exhibit C – Western Proposed Conditions Hydrology Map

Exhibit D – Eastern Proposed Conditions Hydrology Map

SYSTEM 100
86.2 Acres
Q100 = 138.5 CFS

SYSTEM 200
375.5 Acres
Q100 = 736.3 CFS

SYSTEM 300
241.5 Acres
Q100 = 239.5 CFS

SYSTEM 400
73.5 Acres
Q100 = 195.5 CFS

SYSTEM 500
191.7 Acres
Q100 = 320.3 CFS

SYSTEM 600
154.6 Acres
Q100 = 412.4 CFS

SYSTEM 700
122.0 Acres
Q100 = 295.4 CFS

SYSTEM 800
475.3 Acres
Q100 = 710.7 CFS

SYSTEM 1000
101.9 Acres
Q100 = 200.2 CFS

SYSTEM 900
188.9 Acres
Q100 = 336.5 CFS

BOW WILLOW CREEK NORTH
2747 Acres
Q100 = 3058.3 CFS

BOW WILLOW CREEK SOUTH
5197 Acres
Q100 = 8126.8 CFS

UNNAMED NORTHERN WASH
1542 Acres
Q100 = 1428.1 CFS

UNNAMED EASTERN WASH
734 Acres
Q100 = 808.3 CFS

SIMMONS CANYON
878 Acres
Q100 = 1683.6 CFS

Bow Willow Creek South

Unnamed Northern Wash

Unnamed Eastern Wash

Simmons Canyon

Legend

- Nodes
- Flowpaths
- Basin Boundary
- 100' Contours
- Flow Arrows

N W E S

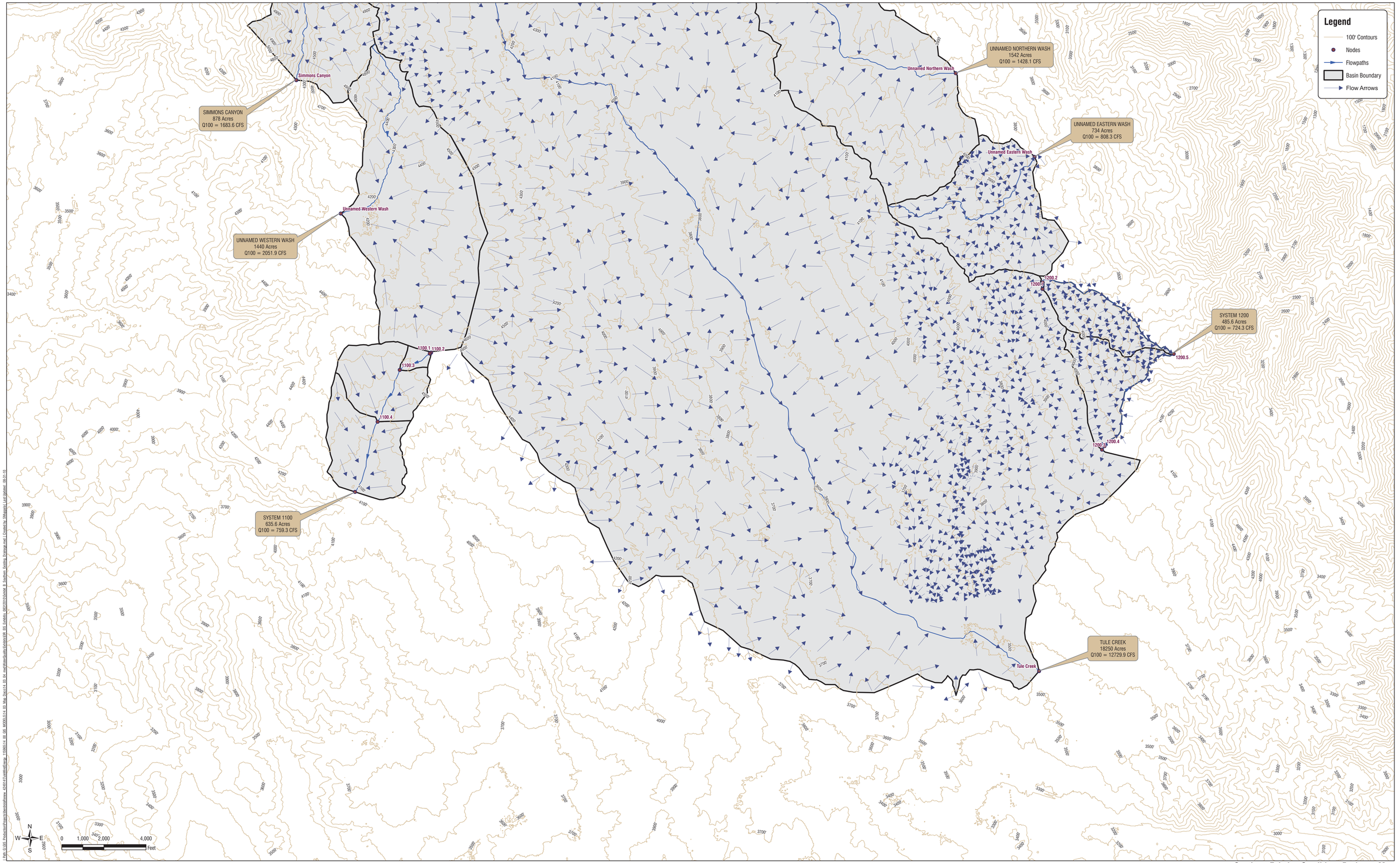
0 1,000 2,000 4,000 Feet

I:\Jobs - 01-09\5 Products\Drainage\Drawings\Exhibits\New_v1\SHEET\Drainage_115965.14 dgn 08:31:19 May, Dec v14 (R) 64 - northernExistingExhibit.EIR.EIS Exhibits 08/31/2019 Exhibit A Northern Existing Drainage.mxd | Created by: SMcquaid | Last Updated: 08-31-19

HDR
ONE COMPANY | *Many Solutions*™

Northern Existing Conditions Drainage Map

EXHIBIT A



I:\hdr_GIS\Projects\Renewables\new_434141\MXD\Fig_1105651.14_05_MXD$5.14_03_May_Doc114_03_04_ewf\ArtworkQuality\October\EIR_EIS_Exhibit_05312013\Exhibit B_Southern_Existing_Drainage.mxd Created by: ttdesjardin Last Updated: 05-31-13

HDR
ONE COMPANY | *Many Solutions*

Southern Existing Conditions Drainage Map

EXHIBIT B

Tule Wind Project | Preliminary EIR EIS Drainage Report

SYSTEM 100
86.2 Acres
Q100 = 138.5 CFS

SYSTEM 200
375.5 Acres
Q100 = 736.3 CFS

SYSTEM 300
241.5 Acres
Q100 = 239.5 CFS

SYSTEM 400
73.5 Acres
Q100 = 195.5 CFS

SYSTEM 500
191.7 Acres
Q100 = 320.3 CFS

SYSTEM 600
164.6 Acres
Q100 = 412.4 CFS

SYSTEM 700
122.0 Acres
Q100 = 295.4 CFS

SYSTEM 800
475.3 Acres
Q100 = 710.7 CFS

SYSTEM 1000
101.9 Acres
Q100 = 200.2 CFS

SYSTEM 900
188.9 Acres
Q100 = 336.5 CFS

BOW WILLOW CREEK NORTH
2747 Acres
Q100 = 3058.3 CFS

BOW WILLOW CREEK SOUTH
5197 Acres
Q100 = 8126.8 CFS

Bow Willow Creek South

UNNAMED NORTHERN WASH
1542 Acres
Q100 = 1428.1 CFS

Unnamed Northern Wash

UNNAMED EASTERN WASH
734 Acres
Q100 = 808.3 CFS

Unnamed Eastern Wash

SIMMONS CANYON
876 Acres
Q100 = 1683.6 CFS

Simmons Canyon

Legend

- Flow Arrows
- 100' Contours
- Nodes
- Flowpaths
- Basin Boundary
- Permanent Impact Area

N W E S

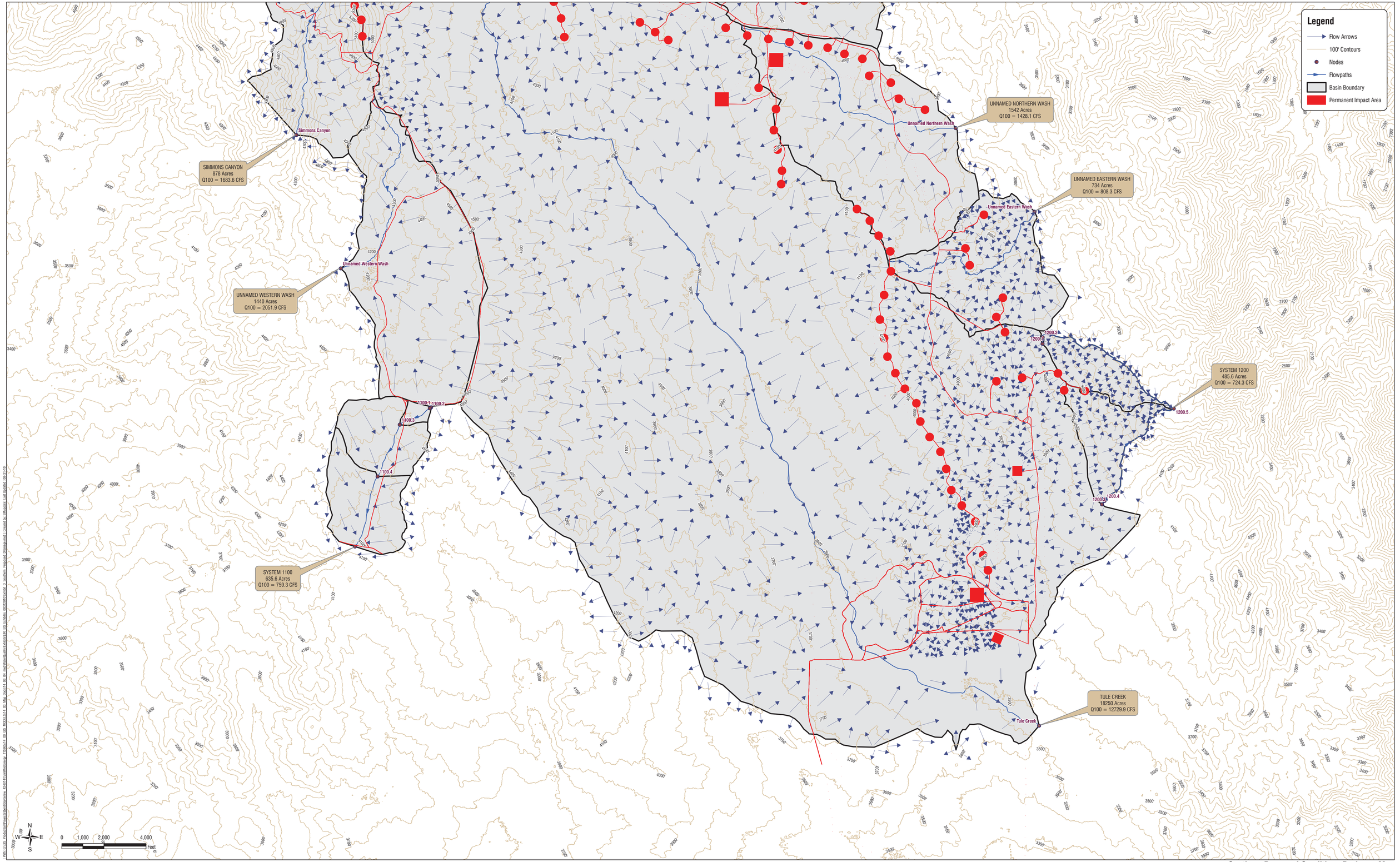
0 1,000 2,000 4,000 Feet

Path: G:\GIS_Projects\Projects\Bertoldi\Maps_mxds\Hydrology_11\09\09-14_00_00_MXDS\09-14_03_Map_Book\14_03_04_northernQuality\Exhibits\ER_EIS_Exhibits_05\31\05\Exhibit C_Northern_Proposed_Drainage.mxd | Created by: DBurgess | Last Updated: 08-31-16

HDR ONE COMPANY | *Many Solutions*

Northern Proposed Conditions Drainage Map

EXHIBIT C



I:\ln_GIS\05_Products\Projects\Services\Rhome_4245147\Layout\Comp_115955.11.05_MXD\15.11.03_Map_Doc.v.11.03_04_mxd\Standard\Layout\EXH_05_Exhibits_05312019.indd D_Southern_Proposed_Drainage.mxd Created by: SMcgaha | Last Updated: 05-31-19

HDR
ONE COMPANY | *Many Solutions*™

Southern Proposed Conditions Drainage Map

EXHIBIT D

Client Name and Number | Project Name and Number | Report Type

TULE WIND PROJECT

STORM WATER MANAGEMENT PLAN

DRAFT

Prepared for:

Iberdrola Renewables, Inc.
1125 NW Couch Street, Suite 700
Portland, Oregon

Prepared by:

HDR Engineering, Inc.
8690 Balboa Avenue, Suite 200
San Diego, California 92123
858-712-8400

September 2010

Table of Contents

1.0 PROJECT DESCRIPTION 1

1.1 Project Requirements 5

2.0 Pollutants of Concern 6

2.1 Receiving Waters 7
2.1.1 303 (d) List of Water Bodies and Pollutants of Concern 9

3.0 Conditions of concern 10

3.1 Existing Drainage Patterns 10
3.2 Proposed Drainage Patterns 11
3.3 Hydromodification 11

4.0 Site Design BMPs 13

4.1 Low Impact Development Features 14

5.0 Source Control BMPs 17

6.0 Individual Priority Project BMPs 19

6.1 Private Roads 19
6.2 Surface Parking Areas 19
6.3 Steep Hillside Landscaping 20

7.0 Treatment Control BMPs 21

7.1 Structural Treatment Control BMP Discussion 21

8.0 Storm Water BMP Maintenance 23

9.0 Conclusion 24

Tables

Table 1: Standard Storm Water BMP Selection Matrix 6
Table 2: Anticipated and Potential Pollutants Generated by Land Use Type. 7
Table 3: Project Drainages and Hydrologic Unit Summary. 9
Table 4: Drainage Basin Summary 10
Table 5: Groups of Pollutants and Relative Effectiveness of Treatment Facilities 22
Table 6: Treatment Control BMP Capital Cost Responsible Party 22
Table 7: BMP Maintenance Responsibility 23

Figures

Figure 1: Vicinity Map 2
Figure 2: Configuration Alternatives on BLM Land 4

Appendices

Appendix A – Preliminary Project Details
Appendix B – County of San Diego Stormwater Intake Form for Development Projects
Appendix C – Project Exhibits
Appendix D – Additional BMP Information

Executive Summary

The purpose of this Storm Water Management Plan (SWMP) is to identify potential impacts to water quality from development of the Tule Wind Project (Project) and to investigate Best Management Practices (BMPs). This report is intended to accompany and support the Environmental Impact Statement (EIS)/Environmental Impact Report (EIR) in accordance with the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). The following regulations and guidelines apply to the water quality for the Project:

- Clean Water Act of 1977 Section 311 and 402, United States Code Title 33 Section 1342, Code of Federal Regulations Title 40 Parts 123-136;
- California Porter-Cologne Water Quality Control Act 1998, California Water Code Section 13000-14957, Division 7;
- California State Water Resources Control Board National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated With Construction and Land Disturbance Activities, Order No. 2009-0009-DWQ (General Construction Permit);
- San Diego County Standard Urban Storm Water Mitigation Plan (SUSMP), March 2008,
- County of San Diego Watershed Protection, Storm Water Management and Discharge Control Ordinance (County Ordinance 9589),
- County of San Diego Stormwater Standards Manual,
- California Regional Water Quality Control Board San Diego Region Order No. R9-2007-0001, NPDES No. CAS0108758.
- Colorado River Basin Region 7 Water Quality Control Plan, California Regional Water Quality Control Board.
- California Stormwater Quality Association Stormwater Best Management Practice Handbooks.

All portions of the Project are within the County of San Diego with portions outside of existing Phase I and Phase II Region 9 State Water Resources Control Board NPDES permits. No Phase I or Phase II project areas are within County of San Diego jurisdiction, rather they are on Federal or Indian Reservation land. This being the case, the Project is required to address the California State Water Resources Control Board NPDES General Construction Permit post-construction BMP guidelines. However, since the Project is located within San Diego County, the County of San Diego SUSMP guidelines and the General Construction Permit post-construction BMPs are considered for all project areas. Based on these governing documents the following items are included in the SWMP:

- Project description and vicinity map,

- Site map defining drainage patterns, existing storm drain systems, proposed drainage crossings, soil types, existing land types, and existing and proposed slopes,
- Identification of Pollutants of Concern,
- Identification of Conditions of Concern,
- Identification of Site Design BMP recommendations,
- Preliminary hydromodification discussion,
- Identification of Source Control BMPs,
- BMPs for Individual Priority Project Categories,
- Identification of Treatment Control BMP recommendations, and
- Storm Water BMP maintenance discussion.

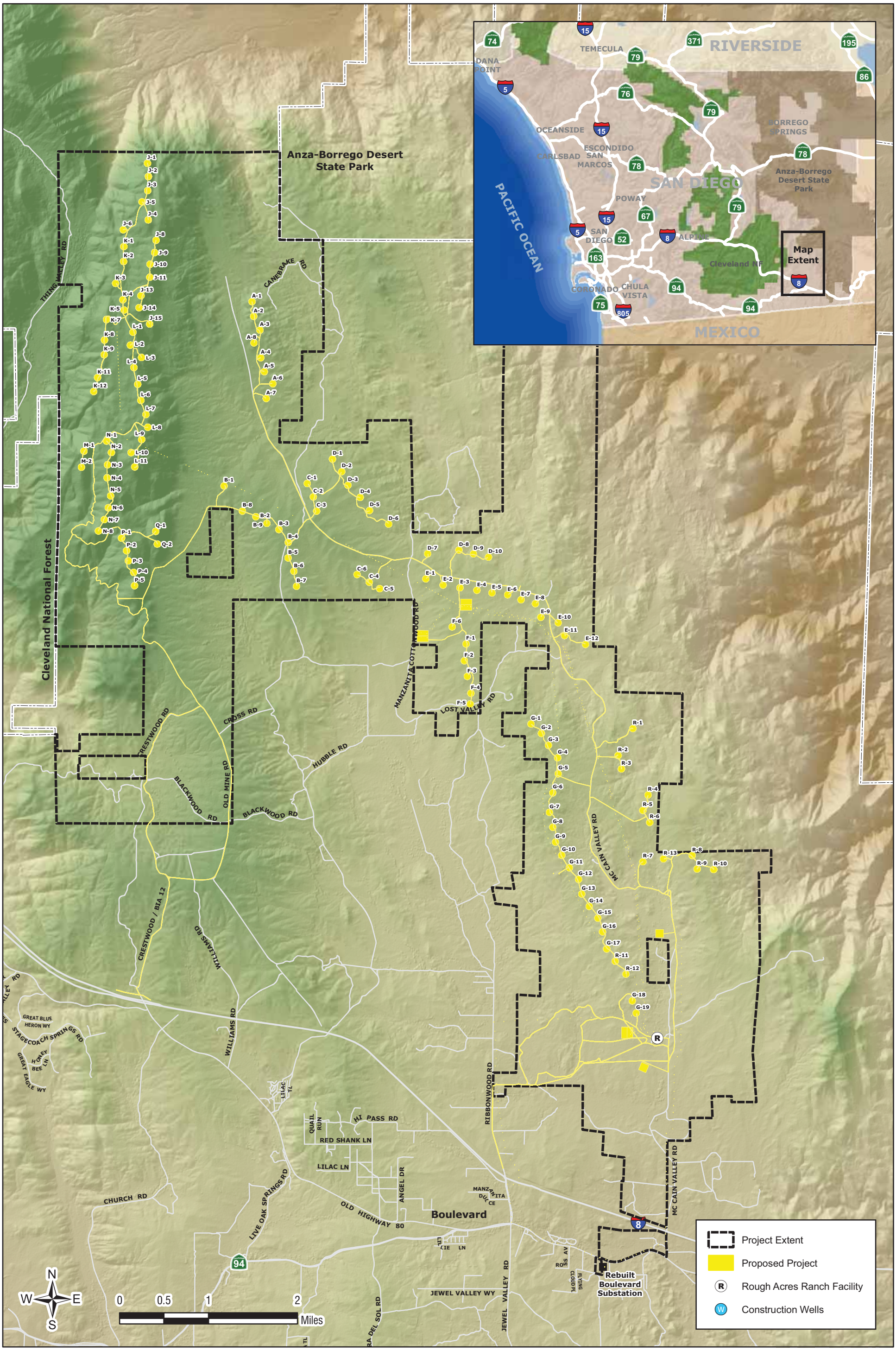
1.0 PROJECT DESCRIPTION

The Tule Wind Project proposes to develop a wind turbine "farm" for power generation, in the County of San Diego in the State of California. The project area is located in the eastern portion of San Diego County, approximately 50 miles east of City of San Diego, 90 miles west of Arizona, and north of the community of Boulevard (see Figure 1). The area is accessible via Interstate 8 (I-8), State Route 94 (SR-94) and Ribbonwood Road junction, and McCain Valley Road off of Old Highway 80. The majority of the project area lies in the In-Ko-Pah Mountains adjacent to the Tecate Divide, south of the Cleveland National Forest. The topography of the area is gently-to-steep sloping with an elevation ranging between about 3,600 and 5,600 feet above mean sea level. The project area contains lands administered by the BLM, the Ewiiaapaayp Reservation, the Campo and Manzanita Reservations (access only), the California State Lands Commission (CSLC), and privately-owned parcels under the jurisdiction of the County of San Diego. Permanent Project impact areas investigated for water quality are approximately 575-acres, which conservatively assumes development of all siting alternatives.

Under existing conditions the Project site is mainly undeveloped naturally vegetated rocky hills. A number of existing access roads traverse the area, providing service routes to existing utility facilities, commercial facilities, rural houses, agricultural facilities, and a landing strip. Existing topography is fairly steep with some flatter drainage courses at the base of the some of the hills and gullies. Naturally occurring native vegetation is predominant throughout the site, with periodic scattered unvegetated rock outcroppings.

Development will consist of up to 134 wind turbines, 34.5 kilovolt (kV) overhead and underground collector lines, 138 kV overhead transmission line, 5-acre collector substation site, 5-acre operation and maintenance building site, access road between turbines, improvements to existing roads to provide site access, 5-acre temporary batch plant, 10-acre temporary parking lot, 19 2-acre lay down areas, two meteorological towers, and a sonic detection and ranging system (SODAR) unit. A number of site configuration alternatives have been prepared for the EIR, which differ by the location of the operation and maintenance facility, substation, and transmission line. Water quality analysis evaluated all siting alternatives as occurring concurrently when looking at impacts in order to conservatively account for all potential improvements. Figure 2 illustrates site configuration alternatives with operation and maintenance and substation facilities located on Bureau of Land Management (BLM) property or on private County of San Diego land.

Proposed wind turbines range in size between 328 feet in height to 492 feet in height, to produce 200 megawatts total power. Turbines are constructed with a 48-foot diameter concrete foundation. Concrete foundations slope away from the centrally located turbine and will be buried greater than half a foot, so that exposed concrete foundations are approximately 6-inches to 8-inches thick and 18-feet to 20-feet in diameter. Turbines also include five-foot by nine-foot concrete pads for transformer foundations. Graded dirt pads around the turbines will be approximately 200-feet radius.



HDR
ONE COMPANY | *Many Solutions*℠

Vicinity Map

FIGURE 1

Iberdrola | Tule Wind Project

Access roads between turbines will be 36-feet wide to accommodate self propelled cranes and supply trucks, while access roads to the turbine strings will only need to be 24-feet wide, as the crane and other assembly equipment can be brought onsite in pieces. Thirty-six foot access roads between turbines are intended to be temporary for construction activities and will be allowed to revegetate to a 20-foot width, pending construction completion. Roads under San Diego County jurisdiction will revegetate to a 24-foot width to comply with County standards. Proposed access road alignments will follow existing access roads to the maximum extent practicable to limit the amount of additional disturbed areas. New access roads will follow existing contours to maximum extent practicable to limit the amount of disturbed areas resulting from grading cuts.

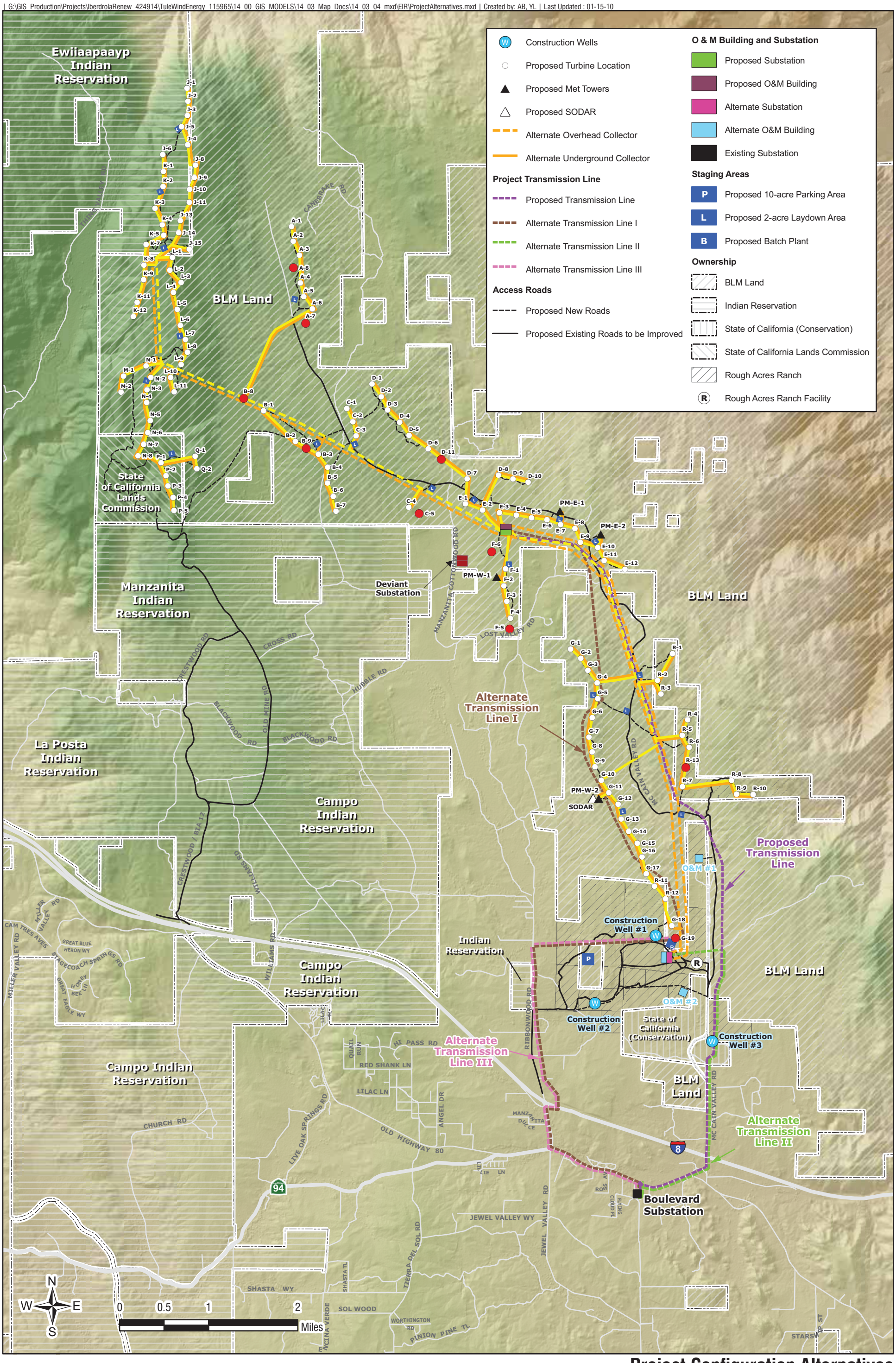
Operation and maintenance facility pads and substation pads will be graded to allow for construction of the required facilities and the accompanying access and operation spaces. Impervious areas associated with these facilities will be minimal, limited to the structures themselves. All access and parking areas will be constructed of permeable materials. Additionally, there is the potential for detention basins attached to these graded pads, in order to adequately address water quality concerns.

Electrical collector lines for the Project will be a combination of overhead and buried, with a majority being buried. Overhead collector lines will be supported by single steel or wood poles; typically 60-feet to 80-feet in height. Foundation footprints for collector line poles will be similar to the diameter of the pole itself. Collector line temporary disturbed widths are assumed to be 24-feet to allow construction vehicle access and trenching or pole erection. Transmission lines will be carried by approximately 75-foot tall poles spaced 600-feet to 700-feet. Temporary transmission line disturbed areas are assumed to be 24-feet to allow construction vehicle access and pole erection. After construction natural vegetation will be established over collector line and transmission line access roads. All buried collector lines will be completely re-vegetated.

Temporary parking lot, batch plant, and lay down areas will be re-vegetated to existing conditions and are not deemed a permanent impact. In addition, all naturally occurring vegetation around proposed grading and facilities will be returned to a naturally vegetated state upon completion of construction activities.

Project development will increase impervious areas by a very small amount. Each turbine pad represents approximately 360 square feet of impermeable area in addition to the impervious building footprints at the operation and maintenance pads and substation pads. Overall Project development proposes to increase impervious area by approximately 79,097 square feet or 0.3% for the overall 573 acre site.

| G:\GIS_Production\Projects\IberdrolaRenew_424914\TuleWindEnergy_115965\14_00_GIS_MODELS\14_03_Map_Docs\14_03_04_mxd\EIR\ProjectAlternatives.mxd | Created by: AB, YL | Last Updated : 01-15-10



Project Configuration Alternatives

FIGURE 2

Iberdrola | Tule Wind Project

HDR
ONE COMPANY | *Many Solutions*℠

1.1 PROJECT REQUIREMENTS

Using the County of San Diego SWMP approach as a guideline in conjunction with General Construction Permit requirements, Project water quality mitigation criteria were established. Based on the County of San Diego SUSMP, a Stormwater Intake Form for Development Projects was completed for the Project and is included in Appendix B. Based on the checklist, the Tule Wind Project is considered a priority project and is required to adhere to Major SWMP requirements. A completed Major SWMP form is included in the SWMP for private County of San Diego Project areas, published by HDR under a separate cover. Priority project criteria are outlined in the SUSMP Standard Storm Water BMP Selection Matrix as shown in Table 1. General Construction Permit post-construction BMPs are required for all projects outside of Phase I and Phase II projects, and include site design considerations, source control considerations and treatment alternatives. Based on this, Project development will require site design, source control, priority project BMPs, and treatment control BMPs, to be discussed in Sections 4, 5, 6, and 7, respectively.

Table 1: Standard Storm Water BMP Selection Matrix

Priority Project Category	Site Design BMPs[1]	Source Control BMPs[2]	Requirements Applicable to Individual Priority Project Categories[3]										
			a. Private Roads	b. Residential Driveways & Guest Parking	c. Dock Areas	d. Maintenance Bays	e. Vehicle Wash Areas	f. Outdoor Processing Areas	g. Equipment Wash Areas	h. Outdoor Processing Areas	i. Surface Parking Areas	j. Fueling Areas	k. Hillside Landscaping
Detached Residential Development	R	R	R	R									R
Attached Residential Development	R	R	R	R									R
Commercial Development >1 Acre	R	R			R	R	R	R					
Heavy industry/industrial development	**R**	**R**	**R**		**R**	**R**	**R**	**R**	**R**			**R**	
Automotive Repair Shop	R	R			R	R	R		R	R		R	
Restaurants	R	R			R				R				
Hillside Development >5,000 ft^2	**R**	**R**	**R**										**R**
Parking Lots	R	R								R[4]			
Retail Gasoline Outlets	R	R				R	R					R	
Streets, Highways & Freeways	R	R									R		

R=Required; select one or more applicable and appropriate BMPs from the applicable steps in section 4.1 &4.2, or equivalent as identified in section 4.6.1-4.6.3.
(1) Refer to Section 4.1.
(2) Refer to Section 4.2.
(3) Priority project categories must apply specific stormwater BMP requirements, where applicable. Projects are subject to the requirements of all priority project categories that apply.
(4) Applies to the paved area totals >5,000 square feet or with >15 parking spaces and is potentially exposed to urban runoff.

2.0 POLLUTANTS OF CONCERN

Under existing conditions pollutants generated by the Project site include sediments, nutrients, trash & debris, oil & grease, bacteria & viruses, and pesticides. Based on the County of San Diego SUSMP anticipated pollutants for hillside developments and industrial developments are sediment, nutrients, heavy metals, organic compounds, oil & grease, trash and debris, oxygen demanding substances, and pesticides. Table 2 outlines the pollutants of concern as shown in the County of San Diego SUSMP. However, based on the minimal amount of development that is proposed, anticipated pollutants are more likely to be sediment from dirt roads and turbine pads, and oil and grease from the vehicles using roads.

Table 2: Anticipated and Potential Pollutants Generated by Land Use Type.

	General Pollutant Categories								
Priority Project Categories	Sediments	Nutrients	Heavy Metals	Organic Compounds	Trash & Debris	Oxygen Demanding Substances	Oil & Grease	Bacteria & Viruses	Pesticides
Detached Residential Development	X	X			X	X	X	X	X
Attached Residential Development	X	X			X	P(1)	P(2)	P(1)	X
Commercial Development >1 Acre	P(1)	P(1)		P(2)	X	P(5)	X	P(3)	P(5)
Heavy industry/industrial development	**X**		**X**	**X**	**X**	**X**	**X**		
Automotive Repair Shop			X	X(4)(5)	X		X		
Restaurants					X	X	X	X	
Hillside Development >5,000 ft²	**X**	**X**			**X**	**X**	**X**		**X**
Parking Lots	P(1)	P(1)	X		X	P(1)	X		P(1)
Retail Gasoline Outlets			X	X	X	X	X		
Streets, Highways & Freeways	X	P(1)	X	X(4)	X	P(5)	X		

X = anticipated
P = potential
(1) A potential pollutant if landscaping exists on-site.
(2) A potential pollutant if the project includes uncovered parking areas.
(3) A potential pollutant if land use involves food or animal waste products.
(4) Including petroleum hydrocarbons.
(5) Including solvents.

2.1 RECEIVING WATERS

A number of existing streams will convey flows generated by the Project. A majority of the Project drains to the east ultimately discharging into the Salton Sea. Approximately one sixth of the Project drains runoff to the west, ultimately discharging into the Pacific Ocean at the Tijuana Estuary.

A northeastern ridgeline crosses the easterly draining portions of the Project, dividing Salton Sea bound flows southwest into Tule Creek and northeast into Carrizo Wash, Bow Willow Creek, and Canebrake Wash. Approximately one third of the Project drains to Tule Creek via McCain Valley and Lark Canyon. Tule Creek flows are conveyed southeast into Tule Lake, which discharges into Tule Canyon, then converges with Carrizo Wash in Carrizo Gorge. Tule Creek and Bow Willow Creek are natural unconfined streams. A small portion of the Project along the southeast, in close

proximity to Interstate 8 (I-8), is conveyed into Walker Creek on the south side of I-8. Walker Creek conveys flows into Carrizo Wash. After picking up Walker Creek and Tule Creek, Carrizo wash flows northeasterly where it picks up discharges from Bow Willow Creek and Vallecito Creek. Vallecito Creek is a natural stream. Vallecito Creek conveys flows from Canebrake Wash into Carrizo Wash. All flows in Carrizo Wash are then conveyed into San Felipe Creek and the Salton Sea. The Salton Sea is a minimum of approximately 45 miles downstream of the Project.

Westerly draining flows (Simmons Canyon, Unnamed Western Wash, and Basin No. 300 - 1000) are conveyed into La Posta Creek, which conveys flows into Cottonwood Creek, discharging into Lake Morena. The dam at Lake Morena discharges back into Cottonwood Creek, which then discharges into Barrett Lake. Barrett Lake dam releases flows back into Cottonwood Creek, which discharges into the Tijuana River and into the Pacific Ocean. Cottonwood creek is a natural unconfined stream. Lake Morena is a minimum of approximately 14 miles downstream of the Project. Table 3 contains a summary of drainages receiving runoff directly from Project areas and drainages indirectly receiving runoff from Project areas.

Southerly draining flow (Basin No. 1100) is conveyed into Miller Creek, which conveys flows into Campo Creek, which then conveys into Tijuana River and into the Pacific Ocean. The hydrologic unit is 911.83. Both the Miller Creek and Campo Creek are natural streams.

Based on the Project location and the existing conditions, there are no dry weather flows for drainages associated with this Project. There are minimal existing rural developments within the Project drainage basins that would generate flows during dry weather. Frequent site visits during the dry season confirmed that no flows were present in drainages associated with the Project.

Easterly draining Project areas are located in three hydrologic sub-areas, McCain, Carrizo, and Canebrake; hydrologic units 722.71, 722.61, and 722.63, respectively. These easterly draining sub-areas are conveyed through Ocotillo Lower Felipe hydrologic sub area; hydrologic unit 722.20. Westerly draining Project areas are located in the Cameron (Basin No. 100, 200) hydrologic sub-area; hydrologic unit 911.70. Cameron sub-area drains through the Cottonwood, Morena, Barrett Lake, Barrett, Marron, Water Tanks, and San Ysidro hydrologic sub-areas before reaching the Pacific Ocean; hydrologic units 911.60, 911.50, 911.30, 911.23, 911.21, 911.12, 911.11, respectively.

Table 3: Project Drainages and Hydrologic Unit Summary.

Drainage Name	Ultimate Discharge	Watershed	Hydrologic Area	Hydrologic Sub-Area	Hydrologic Unit
Direct Project Drainages					
Tule Creek	Carrizo Creek	Anza Borrego	Jacumba	McCain	722.71
Walker Creek	Carrizo Creek	Anza Borrego	Jacumba	McCain	722.71
Canebrake Wash	Carrizo Creek	Anza Borrego	Agua Caliente	Canebrake	722.63
Bow Willow Creek	Carrizo Creek	Anza Borrego	Agua Caliente	Carrizo	722.61
Carrizo Creek	San Felipe Creek	Anza Borrego	Agua Caliente	Carrizo	722.61
La Posta Creek	Cottonwood Creek	Tijuana	Cameron	Cameron	911.70
Miller Creek	Campo Creek	Tijuana	Campo	Clover Flat	911.83
Indirect Downstream Project Drainages					
San Felipe Creek	Salton Sea	Anza Borrego	Ocotillo Lower Felipe	Ocotillo Lower Felipe	722.20
Cottonwood Creek	Tijuana River	Tijuana	Cottonwood, Morena, Barrett Lake, Potrero	Cottonwood, Morena, Barrett Lake, Barrett	911.60, 911.50, 911.30, 911.23
Tijuana River	Pacific Ocean	Tijuana	Potrero, Tijuana Valley	Marron, Water Tanks, San Ysidro	911.21, 911.12, 911.11

2.1.1 303 (d) List of Water Bodies and Pollutants of Concern

Based on the 303(d) list approved by the United States Environmental Protection Agency (USEPA) in 2006, the Salton Sea is listed for nutrients, salinity, and selenium. Salton Sea pollutant sources are identified as agricultural, major industrial, point source, or out of state. Morena Reservoir and Barrett Lake are listed for color, manganese, and pH; with pollutant sources unknown. The Tijuana River is listed for eutrophic, indicator bacteria, low dissolved oxygen, pesticides, solids, synthetic organics, trace elements, and trash. Tijuana River pollutant sources are listed as nonpoint and point source. The Tijuana Estuary is listed for eutrophic, indicator bacteria, lead, low dissolved oxygen, nickel, pesticides, thallium, trash, and turbidity. Tijuana Estuary pollutant sources are listed as nonpoint, point source, urban runoff, wastewater, and unknown sources. Based on the distance of impaired water bodies from the Project Site and the opportunity for natural pollutant removal in conveyance features, only Morena Reservoir could be impacted by Project development.

Currently there are no Region 9 State Water Resources Control Board (SWRCB) special requirements for any water bodies that will be impacted by this Project. Based on the available information there are no High Risk Areas within the Project limits.

Comparison of the anticipated pollutants and the receiving water bodies' impairments indicates there are no primary pollutants of concern. Secondary pollutants of concern are sediment and oil and grease.

3.0 CONDITIONS OF CONCERN

A Preliminary EIS/EIR Drainage Report dated September 2010 was completed by HDR under a separate cover and discusses the existing and proposed drainage patterns for the Project. A review of this drainage summary is presented below.

3.1 EXISTING DRAINAGE PATTERNS

Project areas are drained by 19 drainage basins. Overall runoff patterns are either westerly to the Pacific Ocean or easterly to the Salton Sea. Westerly draining basins include Simmons Canyon, Western Unnamed Wash, and Basins 300-1100. Easterly draining basins include Tule Creek, Bow Willow Creek North, Bow Willow Creek South, Northern Unnamed Wash, Eastern Unnamed Wash, and Basins 100-200. Table 4 presents a summary of the drainage basins and areas.

Table 4: Drainage Basin Summary

Watershed	Basin Area (acres)
Tule Creek	18,250
Bow Willow Creek North	2,747
Bow Willow Creek South	5,197
Northern Unnamed Wash	1,542
Eastern Unnamed Wash	734
Western Unnamed Wash	1,440
Simmons Canyon	878
100	86
200	375
300	242
400	73
500	192
600	165
700	122
800	475
900	189
1000	102
1100	636
1200	474
Total	33,919

All basins have similar drainage patterns. Runoff sheet flows across the ground surface until it encounters rivulets which then discharge into larger streams which ultimately discharge easterly or westerly. Precipitation that falls on typical existing access roads sheet flows off the side of the roads where it is either collected in swales running parallel to the road or continues to sheet flow across the natural terrain. Swales carry runoff to streams crossing the access road, where they are then conveyed to major drainage features.

There are no major improvements to the drainage features within the basins. However, a number of culverts have been installed on portions of several of the basins to facilitate access roads across the smaller drainage features. An unnamed tributary to Tule Creek along the northeastern edge of the

Project crosses a number of public and private roads via culverts just east of the landing strip. A number access roads scattered throughout the drainage basins utilize a depressed on grade type crossing, where flows are conveyed across the top of the road, rather than constructing culverts to carry flows under the road (Arizona crossing). Ribbonwood road crosses a number of drainage features along the southwestern portion of the Project utilizing both culverts and Arizona type low flow crossings. Tule Creek crosses a number of existing access roads via culverts or Arizona type low flow crossings. Exhibit A presents the existing drainage patterns. Detailed drainage patterns can also be found in the HDR Preliminary Drainage Report (published under a separate cover).

3.2 PROPOSED DRAINAGE PATTERNS

Proposed Project improvements will mimic existing drainage patterns and will minimize redirection of any flows. Improvements include graded pads, access roads, and utility lines, and constructed crossings at each drainage feature.

All proposed project crossings of existing drainage features will utilize a stabilized Arizona type crossing. Arizona crossings will be constructed similar to San Diego County Design Standard DS-14 without low flow culverts. Road surfaces will be stabilized with articulated concrete block (ACB) systems or reinforced concrete, or equivalent, depending on crossing flow rates. Riprap protection, or equivalent, will be provided in the channel immediately upstream and downstream of the crossing to protect against soil erosion and increased sediment loads.

Precipitation falling on graded pads will sheet flow off the proposed features and finished surfaces to swales/brow ditches that will collect runoff. Runoff from the exposed portions of the turbine pads will flow through a layer of placed gravel. Runoff will then be directed to the existing natural surface drainage features, with flow patterns intended to mimic existing conditions.

Proposed electrical collector lines will be located throughout the Project. Minor effects on drainage patterns from collector lines or transmission lines may occur during construction. Once the collector and transmission lines are either hung or buried the surrounding vegetation and grades will be restored to existing conditions to the greatest extent practicable.

Nearly all access roads will be constructed of gravel and/or locally available soil, and as such will be permeable. Any runoff from the roads themselves will be conveyed into swales/brow ditches parallel to the road. Swale flows will be conveyed to surrounding existing drainage features, where they will return to the existing drainage patterns. Access roads over 10% will be required to be paved based on the County of San Diego Fire Department requirements. Any short distances of paved roads will be drained similarly to the gravel roads.

A complete discussion of the Project drainage is completed in the report Preliminary EIS/EIR Drainage Report, dated September 2010.

3.3 HYDROMODIFICATION

Based on the County of San Diego Major Storm Water Management Plan form this Project is required to complete a Hydromodification Plan (HMP). However, after discussions with the County of San Diego it was determined that the Project would not be subject to the County hydromodification requirements given the location of Project County of San Diego jurisdiction lands outside of Phase I and Phase II NPDES permits. Therefore, the General Construction Permit post

construction BMP criteria will apply. Alterations to the natural watershed and stream processes (hydromodification) from Project development are the main concern in the General Construction Permit. In order to apply and quantify post construction BMP requirements aimed at addressing hydromodification, a Post-Construction Water Balance Calculator is being created by the SWRCB. Final implementation of these requirements will commence in September of 2012, with further refinements to the Post-Construction Water Balance Calculator anticipated prior to implementation.

Given the current planning stage of the Project and the preliminary Post-Construction Water Balance Calculator, specific sizing and application of the General Construction Permit post construction BMPs is limited to recommendations in this report. All future design work will consider the General Construction Permit sizing requirements for included features intended to address hydromodification.

4.0 SITE DESIGN BMPS

Site design requirements for the Project are taken from the County of San Diego Storm Water Management Plan Form and are discussed are presented below. There are no specific site design BMPs identified in the General Construction Permit other than those shown on the Water Balance Calculator. This being the case, site design BMPs listed below are all those listed on the County of San Diego Storm Water Management Plan Form, however some may not apply given the limited amount of development proposed. Since the Project is in the preliminary stages of planning, site design BMPs could change as planning progresses.

Principle 1: Maintain Pre-Development Rainfall Runoff Characteristics

1. Locate the Project and road improvement alignments to avoid or minimize impacts to receiving waters or to increase the preservation of critical (or problematic) areas such as floodplains, steep slopes, wetlands, and areas with erosive or unstable soil conditions.
2. Minimize the Project impervious footprint.
3. Conserve natural areas.
4. Where landscape is proposed drain rooftops, impervious sidewalks, walkways, trails and patios into adjacent landscaping.
5. Design and locate roadway structures and bridges to reduce the amount of work in live streams and minimize the construction impacts.
6. Implement the following methods to minimize erosion from slopes:
    - Disturb existing slopes only when necessary;
    - Minimize cut and fill areas to reduce slope lengths;
    - Incorporate retaining walls to reduce steepness of slopes or to shorten slopes;
    - Provide benches or terraces on high cut and fill slopes to reduce concentration of flows;
    - Round and shape slopes to reduce concentrated flow;
    - Collect concentrated flows in stabilized drains and channels.

Project development will incorporate nearly all of the Principle 1 criteria. Access road development and improvements are sited to follow existing roads to the maximum extent practicable and typically follow ridgelines to limit the amount of grading and the amount of disturbed vegetated areas. Overall areas disturbed by the Project are kept to the minimum required for construction and operation of the facilities, and limit the amount of grading, crossings of drainages, and removal of vegetation. All improvements will drain to vegetated brow ditches/swales rather than a hardened storm drain system. All cut and fill slopes will include terraces as required by the San Diego County Grading Ordinances. Concentrated flows from slopes will be collected in swales/brow ditches for conveyance to existing drainage facilities.

Principle 2: Protect Slopes and Channels

1. Minimize disturbances to natural drainages.
2. Convey runoff safely from the tops of slopes
3. Vegetate slopes with native or drought tolerant vegetation.
4. Stabilize permanent channel crossings.
5. Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable

specifications to minimize erosion. Energy dissipaters shall be installed in such a way as to minimize impacts to receiving waters.

6. Other design principles which are comparable and equally effective.

Preliminary planning for the Project has not identified specific slope and channel protection measures, but Principle 2 criteria will be implemented. Project planning will limit the number of unnecessary drainage crossings, but will include engineered crossings at locations where crossings are required. All drainage crossing will be completed such that San Diego County Drainage Design Manual criteria are met, including outfall energy dissipation design guidelines. Any slope grading will be completed such that direction and impacts of runoff are carefully controlled with brow ditches, grading methods, or other similar alternatives. Additional CASQA site design BMP information is included in Appendix D.

4.1 LOW IMPACT DEVELOPMENT FEATURES

LID features requirements are identified in the Major SWMP form and are discussed in further detail in the County LID Handbook. LID feature requirements reviewed for the Project are as follows:

- Conserve natural areas, soils, and vegetation
- Preserve well draining soils (Type A or B)
- Preserve Significant Trees
- Minimize disturbance to natural drainages
- Set-back development envelope from drainages
- Restrict heavy construction equipment access to planned green/open space areas
- Minimize and disconnect impervious surfaces
- Preserve well draining soils (Type A or B)
- Preserver Significant Trees
- Minimize soil compaction
- Restrict heavy construction equipment access to planned green/open space areas
- Re-till soils compacted by construction vehicles/equipment
- Collect and reuse upper soil layers of development site containing organic materials
- Drain runoff from impervious surfaces to pervious areas
- Curb-cuts to landscaping

- Rural swales
- Concave median
- Cul-de-sac landscaping design
- LID parking lot design
- Permeable pavements
- Curb-cuts to landscaping
- LID driveway, sidewalk, bike-path design
- Permeable pavements
- Pitch pavements toward landscaping
- LID Building Design
- Cisterns and rain barrels
- Downspout to swale
- Vegetated roofs
- LID landscaping design
- Soil amendments
- Reuse of native soils
- Smart irrigation systems
- Street trees

Project development proposes to utilize applicable LID features. Nearly all runoff generated by the Project site will discharge to surrounding naturally landscaped areas, which represents a majority of the previously listed features. Surrounding landscaping includes brow ditches or vegetated swales. Potential additional LID features considered are bioretention facilities and buffer strips. Disturbances to existing natural features will be limited during Project development by concentrating development on areas that have already been disturbed, typically existing roads. Soil compaction will be minimized by having well planned out access paths between the turbine sites, which will limit the disturbed areas impacted by the larger cranes required for turbine construction. Impervious areas will all drain to surrounding naturally vegetated areas. No significant impermeable parking lots, sidewalks, roads, or other impermeable access features are planned for the Project, as nearly all surface improvements will be gravel or compacted dirt. All landscaping will be completed to match

the existing surrounding conditions and will be composed of similar slopes and drought tolerant native species of plants.

5.0 SOURCE CONTROL BMPS

Source control requirements are discussed below. Similar to site design the County of San Diego guidelines were used for BMP discussion, as General Construction Permit criteria are not very descriptive. Given the preliminary stage of Project development the following source control BMPs are recommended and will be updated during planning to better reflect utilized source control BMPs. Future site planning will be subject to standards in effect at the time of development.

Principle 3: Provide Storm Drain System Stenciling and Signage

1. All storm drain inlets and catch basins within the Project area shall have a stencil or tile placed with prohibitive language (such as: "NO DUMPING – I LIVE IN <<name receiving water>>") and/or graphical icons to discourage illegal dumping.
2. Signs and prohibitive language and/or graphical icons, which prohibit illegal dumping, must be posted at public access points along channels and creeks within the Project area.

Project development will not likely contain any storm drain inlets, however any inlets constructed will contain the standard stenciling and signage packages. All access roads to the turbines are intended to be private and as such will not provide public access points to the natural drainage systems.

Principle 4: Design Outdoors Material Storage Areas to Reduce Pollution Introduction

1. Hazardous materials with the potential to contaminate urban runoff shall either be: (1) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with runoff or spillage to the stormwater conveyance system; or (2) protected by secondary containment structures such as berms, dikes, or curbs.
2. The storage area shall be paved and sufficiently impervious to contain leaks and spills
3. The storage area shall have a roof or awning to minimize direct precipitation within the secondary containment area.

Maintenance and operation facilities are intended to safely house any materials that could potentially pollute storm water in a dedicated indoor facility. All operation and maintenance materials will be located in these structures.

Principle 5: Design Trash Storage Areas to Reduce Pollution Introduction

1. Paved with an impervious surface, designed not to allow run-on from adjoining areas, screened or walled to prevent off-site transport of trash; and,
2. Provide attached lids on all trash containers that exclude rain, or roof or awning to minimize direct precipitation.

Similar to material storage, trash storage areas will utilize indoor trash storage or trash containers with covers to limit direct precipitation and runoff.

Principle 6: Use Efficient Irrigation Systems and Landscape Design

1. Employ rain shutoff devices to prevent irrigation after precipitation.
2. Design irrigation systems to each landscape area's specific water requirements.
3. Use flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.

4. Employ other comparable, equally effective, methods to reduce irrigation water runoff.

Landscaping to be incorporated in Project design is likely to be similar to exiting vegetation and as such will not require any irrigation. However, any irrigation that would be required, either short term (for vegetation establishment) or permanent would be constructed with rain shutoff devices, flow reducers, and specific design for water requirements. Additional CASQA source control BMP information is included in Appendix D.

6.0 INDIVIDUAL PRIORITY PROJECT BMPS

The County of San Diego SUSMP requires specific BMPs for private roads, residential driveways & guest parking, dock areas, maintenance bays, vehicle wash areas, equipment wash areas, outdoor processing areas, surface parking areas, fueling areas, or steep hillside landscaping. Preliminary site planning includes private roads, surface parking areas, and steep hillside landscaping. Applicable individual priority project BMP requirements are presented below with discussion of the utilized BMPs. These BMPs are similar to CASQA BMP handbook guidelines.

6.1 PRIVATE ROADS

The design of private roadway drainage requires at least one of the following;

- Rural swale system: street sheet flows to vegetated swale or gravel shoulder, curbs at street corners, culverts under driveways and street crossings;
- Urban curb/swale system: street slopes to curb, periodic swale inlets drain to vegetated swale/biofilter
- Dual drainage system: first flush captured in street catch basins and discharged to adjacent vegetated swale or gravel shoulder, high flows connect directly to stormwater conveyance system.
- Other methods which are comparable and equally effective within the Project.

Current Project planning uses gravel or compacted dirt permeable roads with parallel swale/brow ditch drainage facilities. Precipitation will sheet flow off the private roads where it will be collected in the swale/brow ditch system. There are no hardened storm drains facilities planned for the proposed private roads at this time.

6.2 SURFACE PARKING AREAS

To minimize the offsite transport of pollutants from parking areas, the following design concepts shall be considered, and incorporated and implemented where determined applicable and feasible by the County;

- Where landscaping is proposed in surface parking areas, incorporate landscape areas into the drainage design; or
- Overflow parking (parking stalls provided in excess of the County's minimum parking requirements) may be constructed with permeable paving.
- Other design concepts which are comparable and equally effective.

Surface parking areas proposed for Project development are all small areas intended for accommodating only several vehicles at a time. Parking areas will be constructed of gravel or compacted dirt and will sheet flow to surrounding landscaping. There is no hardened storm drain features proposed for the Project at this time.

6.3 STEEP HILLSIDE LANDSCAPING

Hillside areas, as defined in the County of San Diego SUSMP, that are disturbed by Project development shall be landscaped with deep-rooted, drought tolerant plant species selected for erosion control, satisfactory to the County.

Hillside areas disturbed during Project development will be revegetated with drought tolerant native species to stabilize the new slopes. Vegetation will be selected based on its ability to provide erosion resistance to the slopes as well as survive the arid local climate.

7.0 TREATMENT CONTROL BMPS

7.1 STRUCTURAL TREATMENT CONTROL BMP DISCUSSION

Discussions with the County of San Diego identified that Project development would not specifically require treatment BMPs based on the County guidelines. However, based on the Project location, General Construction Permit post-construction BMPs will be required. General Construction Permit post-construction BMP objectives are to reduce the impacts from project development on existing natural drainages. These impacts are typically increased channel erosion or deposition resulting from changes in runoff patterns from the Project site, also known as hydromodification. It has been found that the flows that actually cause the most impact to existing drainages are associated with the high frequency lower volume storms, which is the focus of the General Construction Permit. Project impacts are quantified in the General Construction Permit by a Water Balance Calculator, which identifies the changes in Project runoff and allows for mitigation of these impacts through numerous LID and local detention features. Water Balance Calculator analysis gives mitigation credit to the following Project features:

- Porous pavement,
- Tree planting,
- Downspout disconnection,
- Impervious area disconnection,
- Green roof
- Vegetated swales,
- Rain barrels/cisterns, and
- Soil quality.

Project development proposes to use vegetated swales, downspout disconnection, and potentially several detention basins for the operation and maintenance area and/or substation areas. Additionally, all impervious areas will be disconnected and will be drained via natural features. A comparison of these features with the County of San Diego SUSMP requirements was completed in order to better identify mitigation benefits. Table 5 contains Table 2-3: Treatment Control Selection Matrix, from the County of San Diego SUSMP.

Table 5: Groups of Pollutants and Relative Effectiveness of Treatment Facilities

Pollutant of Concern	Bioretention Facilities (LID)	Settling Basins (Dry Ponds)	Wet Ponds and Wetlands	Infiltration Facilities or Practices (LID)	Media Filters	High-rate biofilters	High-rate media filters	Trash Rack & Hydro-dynamic Devices
Course Sediment and Trash	**High**	**High**	**High**	**High**	**High**	**High**	**High**	**High**
Pollutants that tend to associate with fine particles during treatment	**High**	**High**	**High**	**High**	**High**	**Medium**	**Medium**	**Low**
Pollutants that tend to be dissolved following treatment	Medium	Low	Medium	High	Low	Low	Low	Low

There are no primary pollutants of concern for the Project, and the Project will not contribute pollutants to a 303 (d) list water body, with the possible exception of Morena Reservoir. With no primary pollutants of concern, the County of San Diego SUSMP requires the Project to focus on the secondary pollutants of concern. Secondary pollutants of concern are trash and oil and grease; which represent course sediment and trash as well as pollutants that tend to associate with fine particles during treatment. Table 5 identifies settling basins and LID bioretention facilities as having high removal efficiencies for all pollutants of concern. Based on this, the selection of swales/brow ditches and detention basins for General Construction Permit post-construction BMP requirements, also meets the intent of the County of San Diego SUSMP.

Further design of these post-construction BMPs will be required during final Project engineering. As the planning process progresses more detail will be available as to the opportunities and locations for these features. Exhibit C includes a BMP Map which defines potential locations for treatment BMPs as well as typical site design and source control BMPs. The BMP Map is only intended to be representative of potential or typical BMP locations and is not intended to exclude additional locations of features. Additional CASQA BMP information is located in Appendix D.

Responsible parties for the capital costs associated with construction of the treatment control BMPs are presented in Table 6.

Table 6: Treatment Control BMP Capital Cost Responsible Party

Treatment Control BMP	Responsible Party
Detention Basins	Iberdrola
Swales/Brow Ditches	Iberdrola

8.0 STORM WATER BMP MAINTENANCE

In accordance with Section 5 of the County of San Diego SUSMP the Project BMPs will be classified as First Category. BMPs will largely "maintain themselves" via the natural process of vegetation growth cycles. Vegetated swales/natural drainages and open spaces for impervious area disconnection will be seeded with local naturally occurring plant types, which will be allowed to grow naturally in these facilities. Permeable paving surfaces will be maintained by Iberdrola to provide uniform access roads. Any erosion issues associated with the unvegetated drive surface will be immediately addressed to limit any sediment discharge from the site. Table 7 defines the anticipated BMP responsible parties.

Table 7: BMP Maintenance Responsibility

Treatment Control BMP	Responsible Party
Detention Basins	Iberdrola
Swales/Brow Ditches	Iberdrola

All operation and maintenance required by these BMPs will be the responsibility of Iberdrola. More specific operation and maintenance of the BMPs will be established during final Project design.

9.0 CONCLUSION

Based on the currently applicable water quality requirements, an analysis of the potential impacts was completed for the Tule Wind Project. This analysis determined that the Project would have a low potential to result in water quality impacts to the surrounding water bodies. Minimal impervious area increases are proposed with Project disturbance placement intended to limit the impacts to surrounding water bodies. Based on the minimal level of impervious surfaces proposed as part of the project and implementation of applicable site design BMPs, source control BMPs, individual priority project BMPs, treatment control BMPs, and storm water BMP maintenance, the project will not substantially degrade water quality. Mitigation measures are implemented to the maximum extent practicable to address these limited numbers of potential impacts. Operation and maintenance of the BMPs should be minimal, due to their natural operation conditions, with responsibility for these features performance over the life of the Project being the developers.

APPENDIX A – Preliminary Project Details

Typical Turbine Schematic

Typical Turbine Site

Typical Access Road Sections

Typical Substation Facility

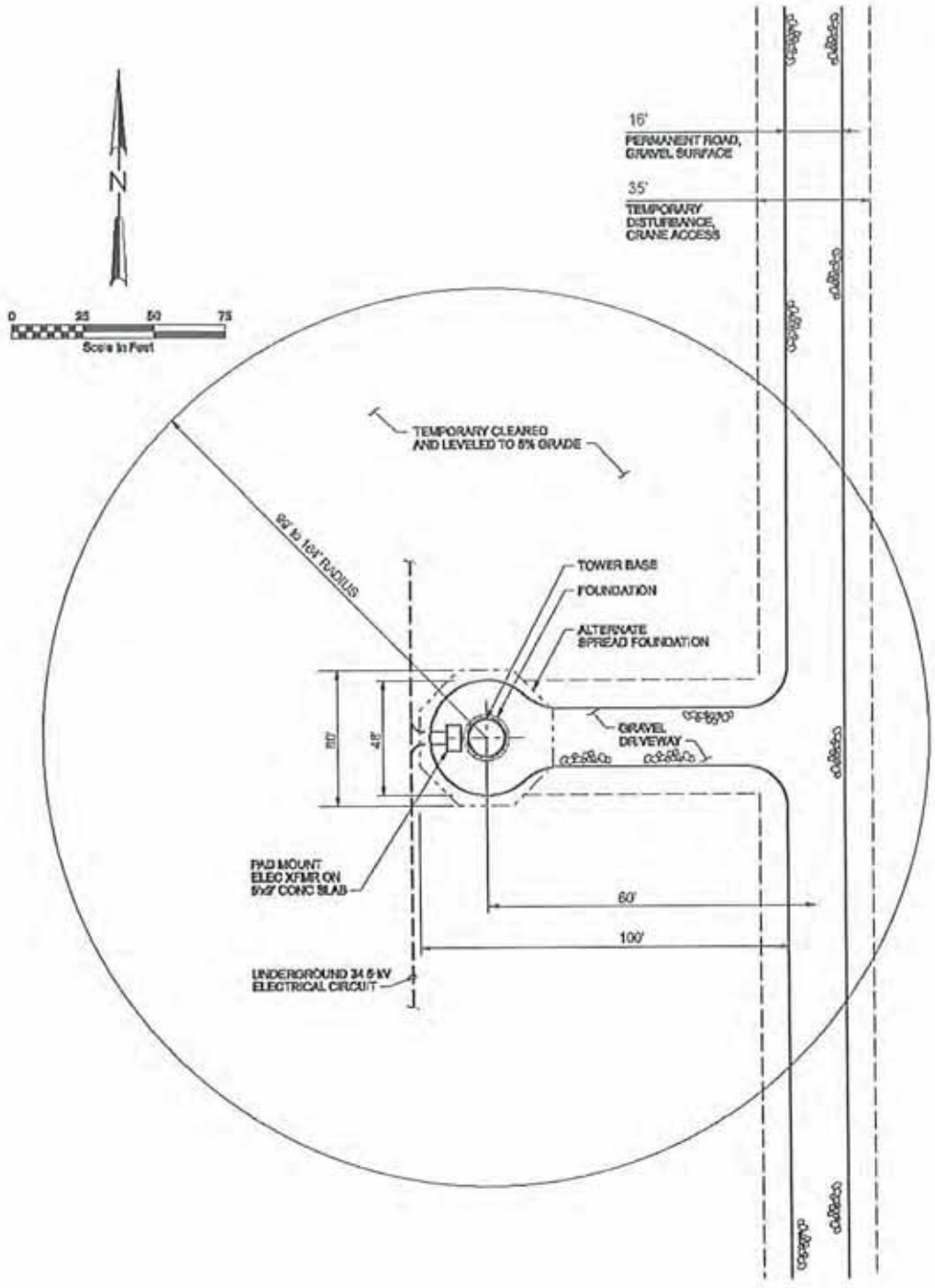
Typical Operation and Maintenance Facility Site

Typical Operation and Maintenance Facility Elevations

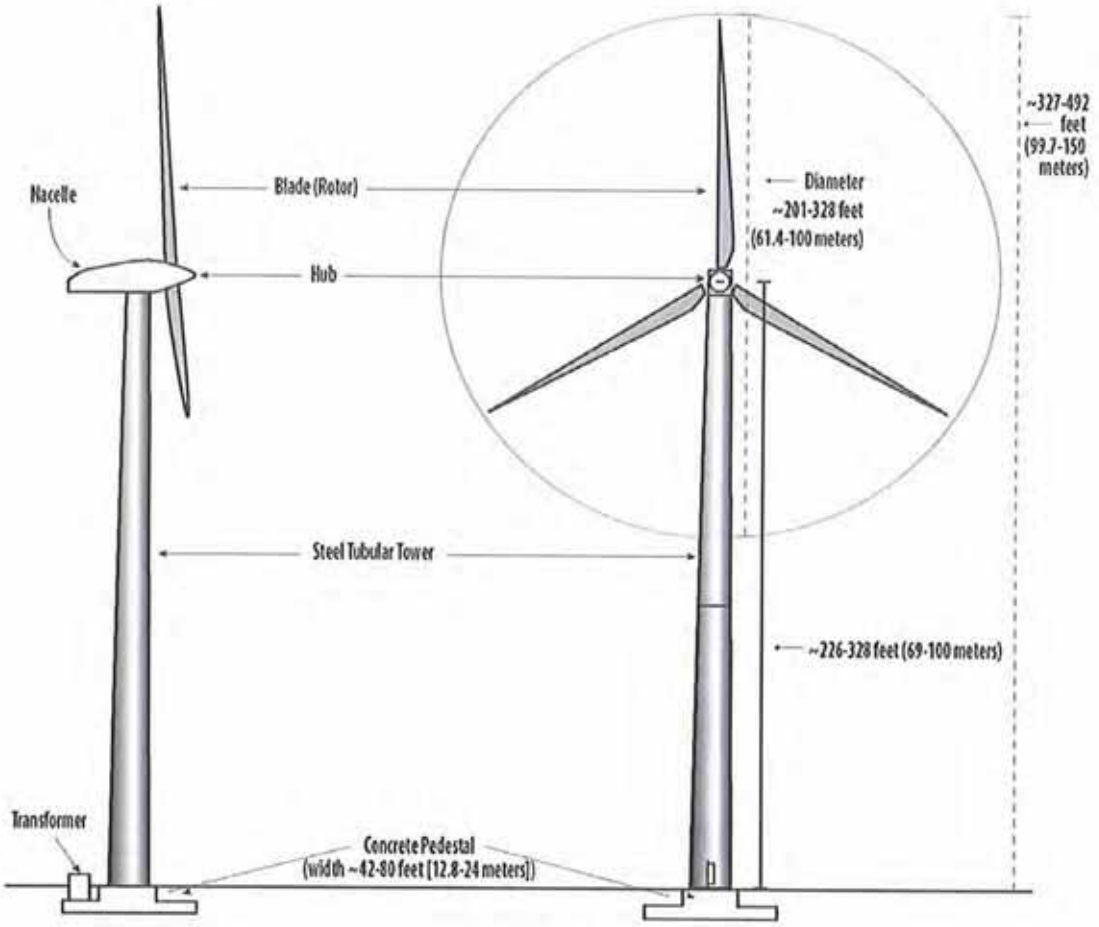
Typical Transmission Power Pole

Typical Collector Line Power Pole

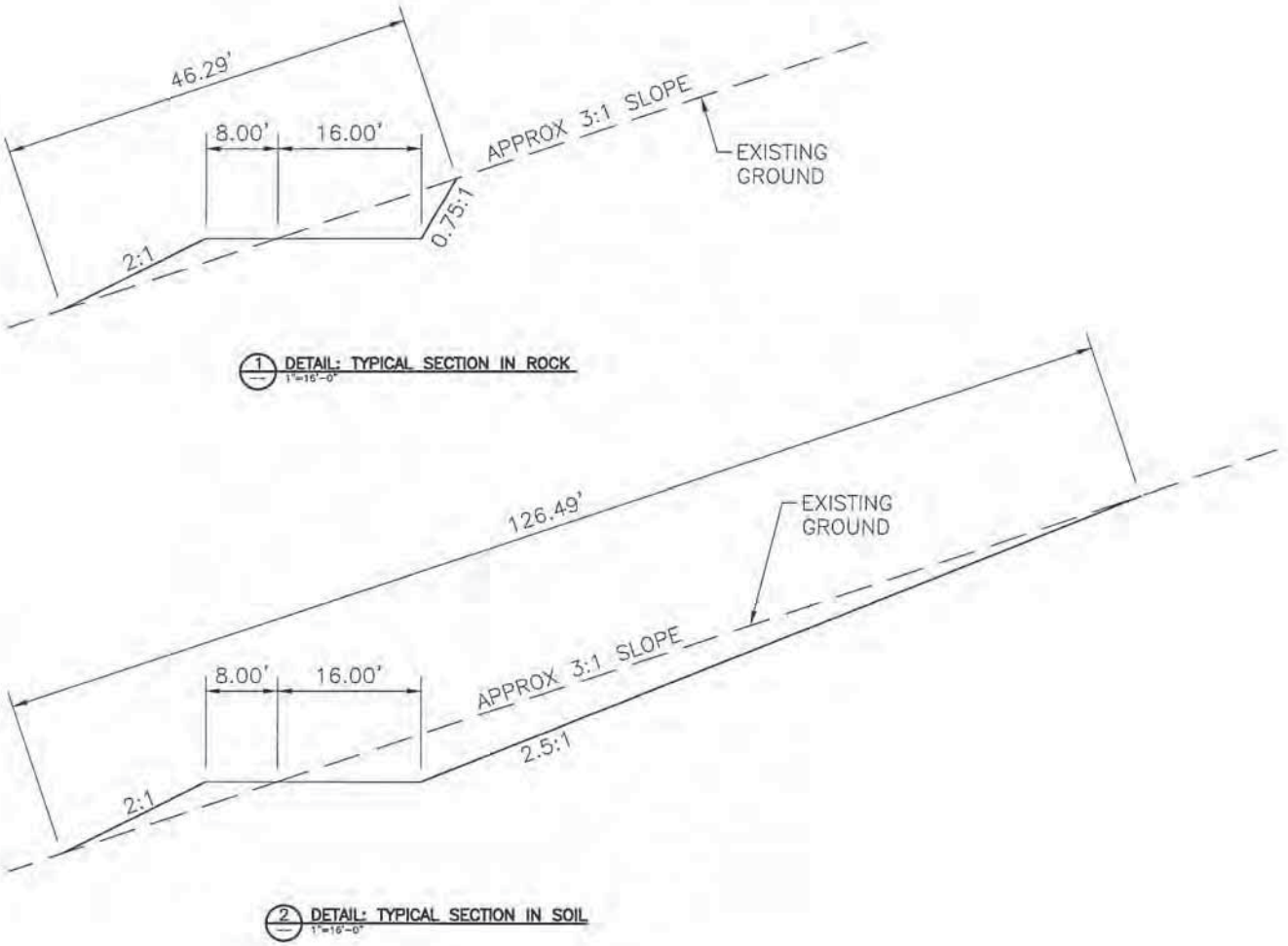
Typical Buried Collector Line



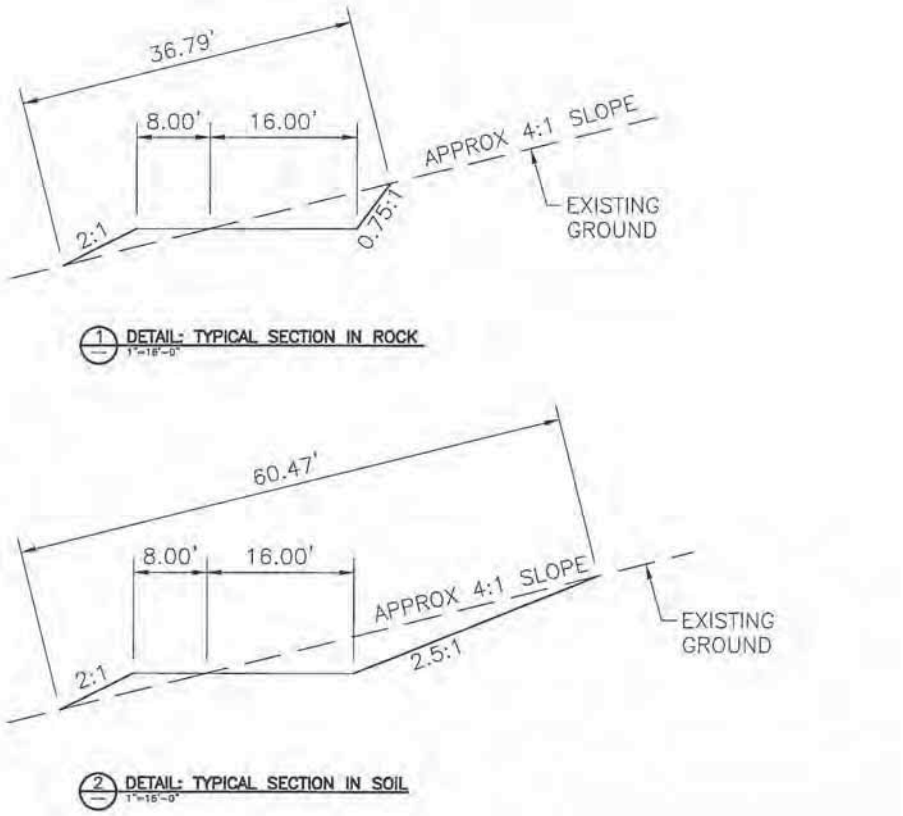
Turbine Site



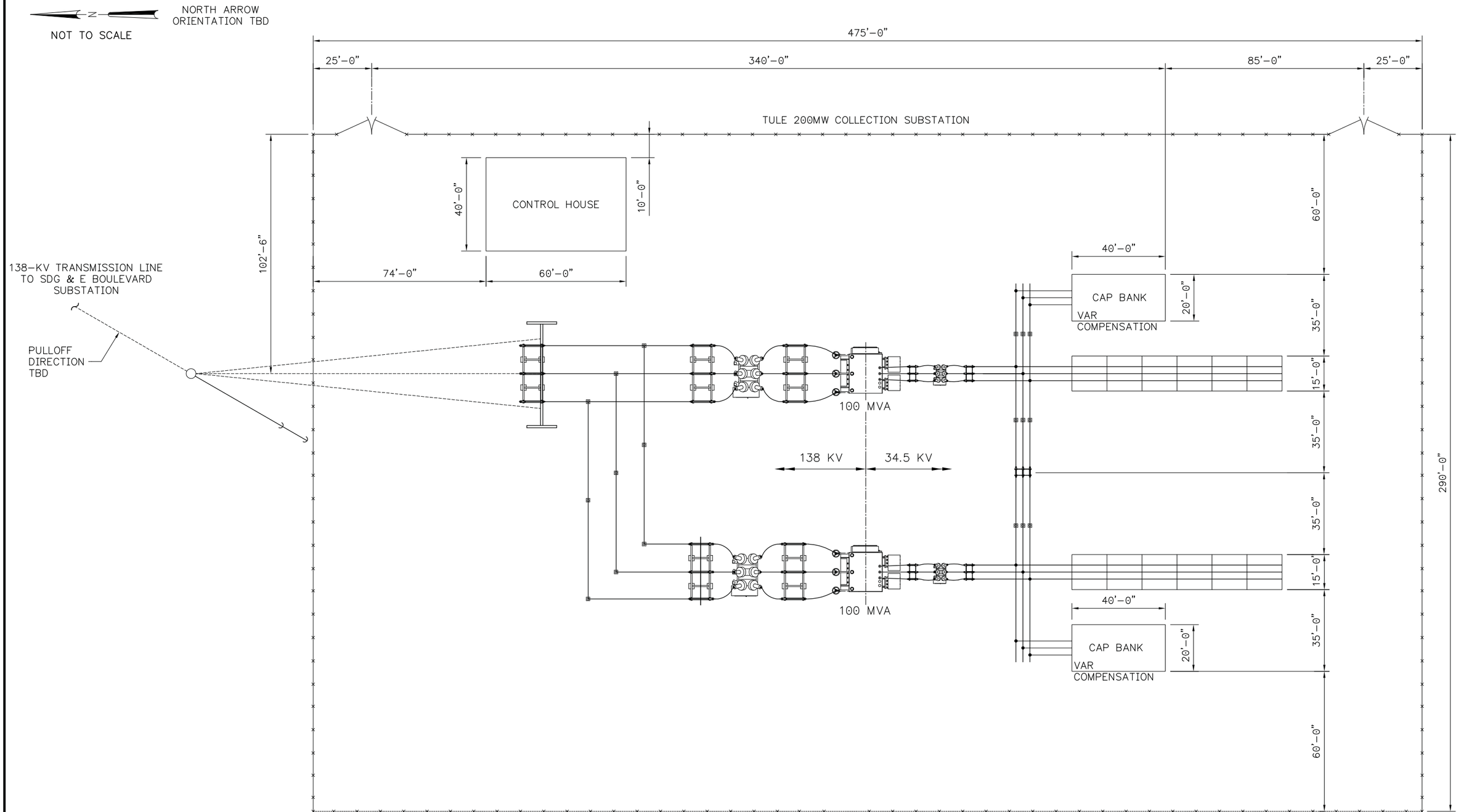
Turbine Schematic



Typical Access Road Cross Sections



Typical Access Road Cross Sections



TriAxis Engineering, Inc.

DSGN	J KING					
DR	FIGURE4.DWG T WEBSTER					
CHK	G ORMSBY					
APVD	G ORMSBY	NO.	DATE	REVISION	BY	APVD

REUSE OF DOCUMENTS

THIS DOCUMENT, AND THE IDEAS AND DESIGNS INCORPORATED HEREIN, AS AN INSTRUMENT OF PROFESSIONAL SERVICE, IS THE PROPERTY OF TRIAXIS ENGINEERING, INC. AND IS NOT TO BE USED, IN WHOLE OR IN PART, FOR ANY OTHER PROJECT WITHOUT THE WRITTEN AUTHORIZATION OF TRIAXIS ENGINEERING, INC.

VERIFY SCALES

BAR IS ONE HALF INCH ON ORIGINAL DRAWING

0 1/2"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

TULE SUBSTATION
IBERDROLA RENEWABLES

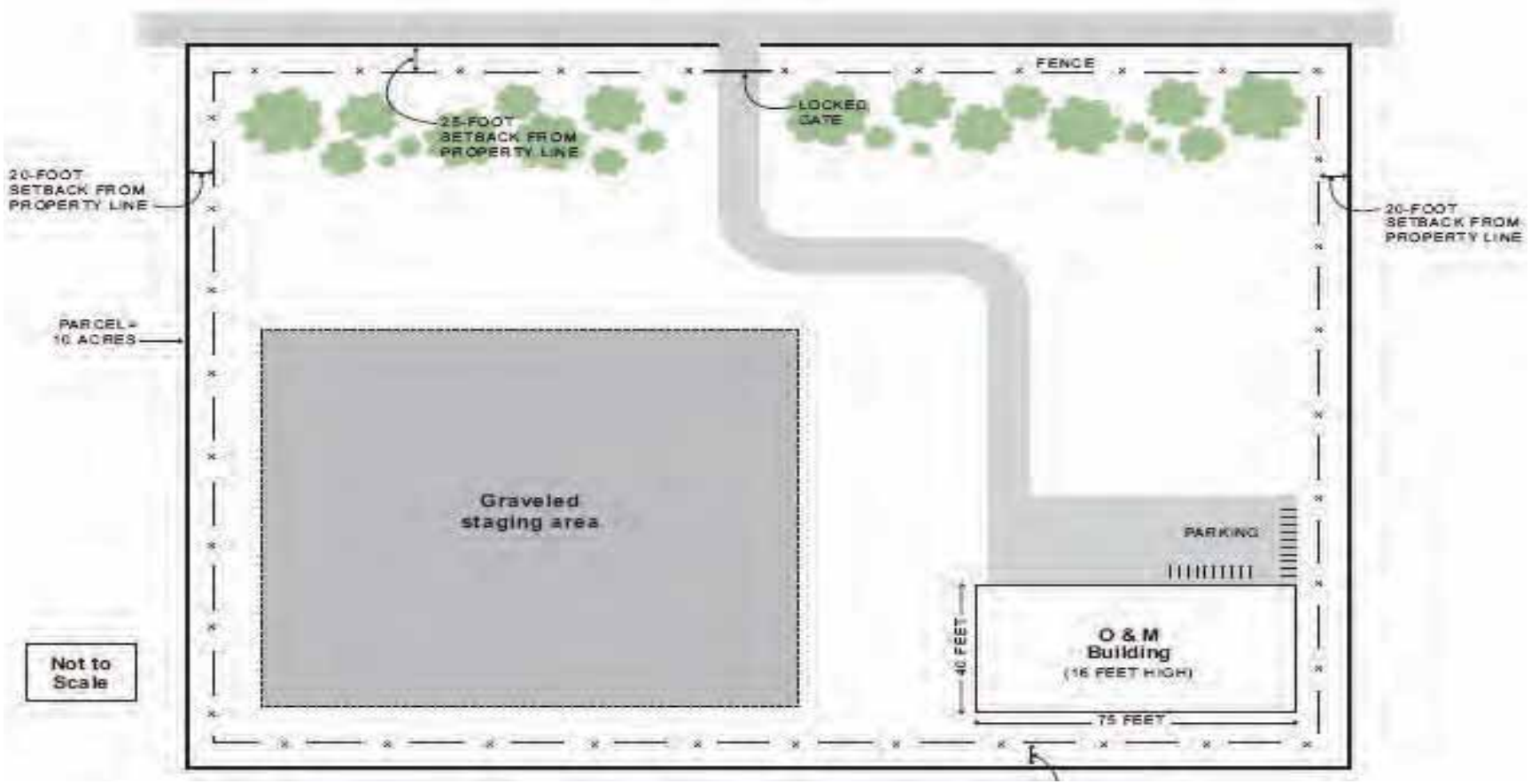
TULE WIND PROJECT

FIGURE 4
200MW COLLECTION SUBSTATION
PLAN VIEW

SHEET	
DWG NO.	FIGURE4
DATE	DEC 2009
PROJ NO.	Y8773

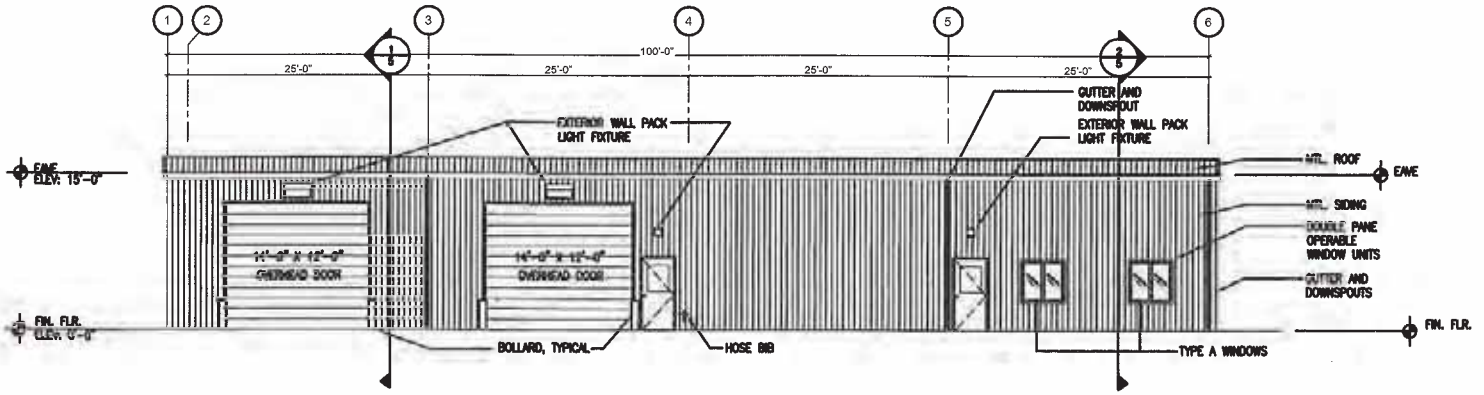
PRELIMINARY

Source: Iberdrola, 2009 | G:/Projects\IberdrolaRenew_424914\TuleWindEnergy_115965\14_00_GIS_MODELS\14_02_Graphics\14_02_01_docs\Ltr_Landscp_master.ai| Last Updated : 12-24-2009

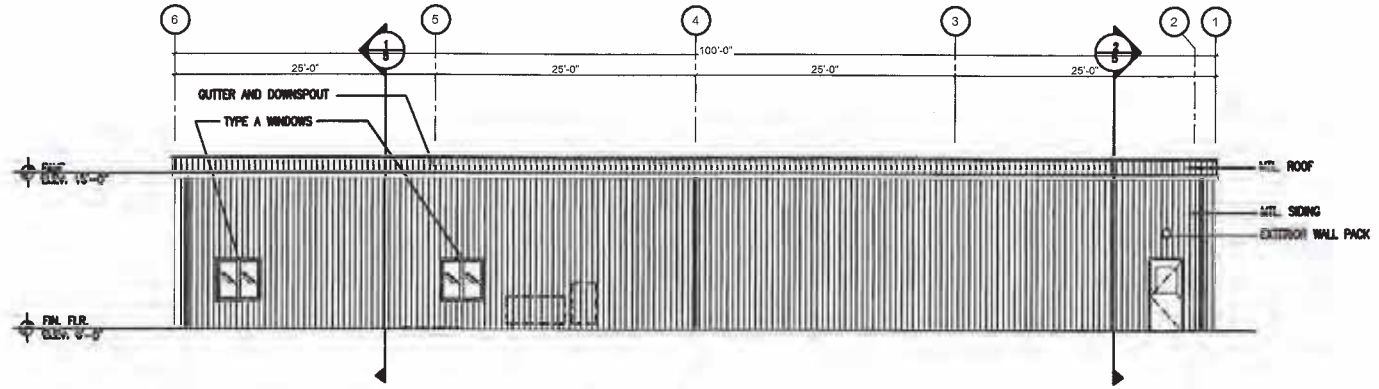


Typical Operations and Maintenance Facility Site

FIGURE 2.0-9a



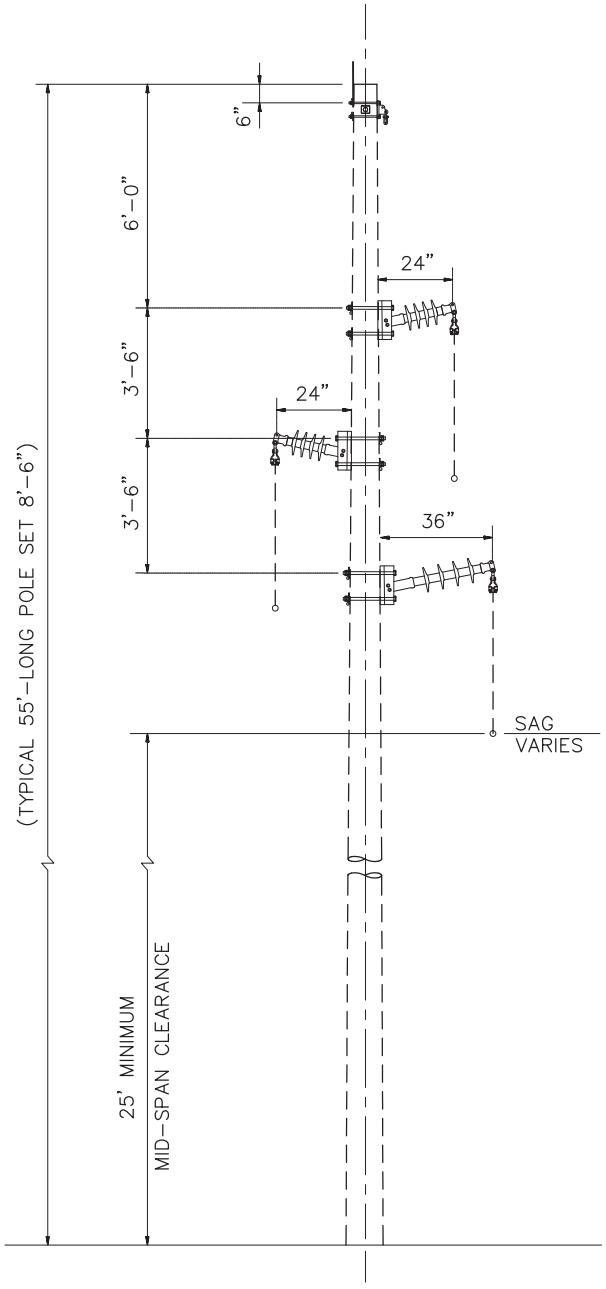
1 SOUTH ELEVATION



2 NORTH ELEVATION

Typical Operations and Maintenance Facility Elevations

FIGURE 2.0-9b



DESIGN ASSUMPTIONS:

- 1590 KCMIL "COREOPSIS" AAC
- 280' MAX SPAN

NOTES:

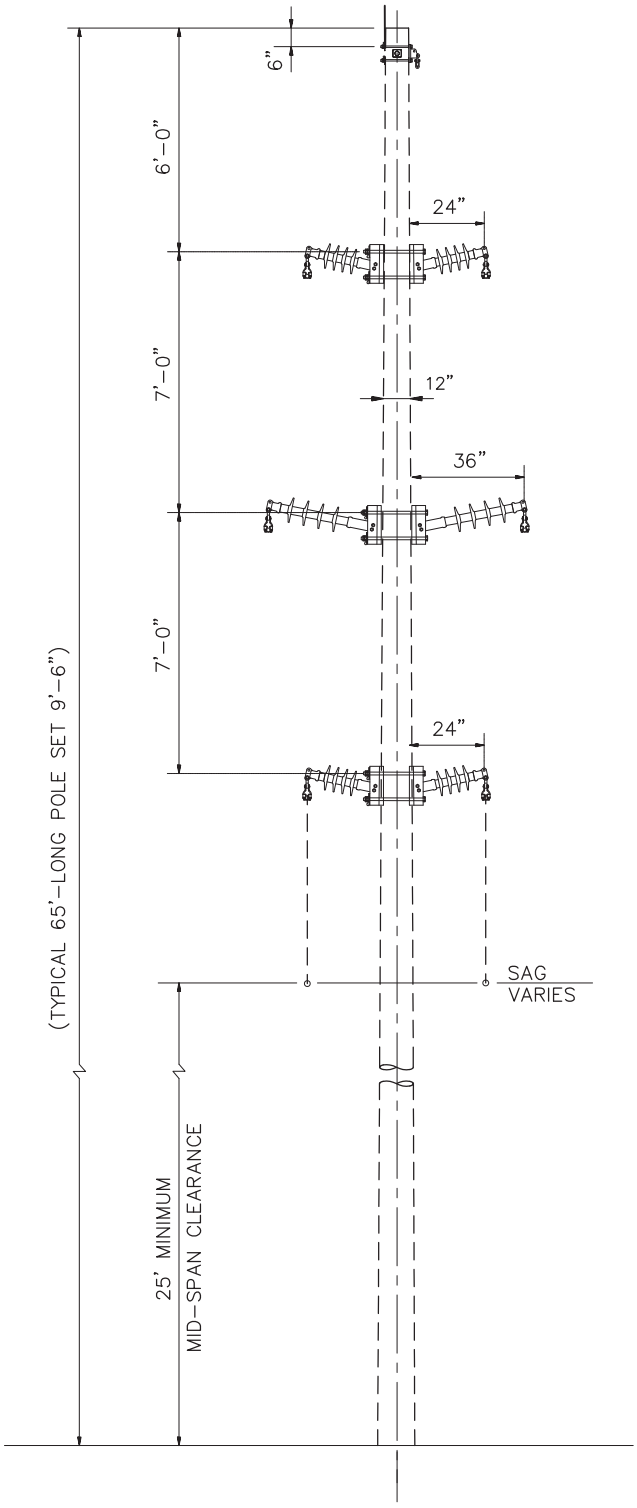
1. STRUCTURE DIMENSIONS ARE APPROXIMATE. ACTUAL DIMENSIONS MAY VARY.
2. DIMENSIONS ARE TO ATTACHMENT HOLES.
3. DRAWING IS NOT TO EXACT SCALE

IBERDROLA
TULE WIND
PROJECT

TriAxis Engineering, Inc.

TYPICAL
34.5–KV HORIZONTAL LINE POST
TANGENT SINGLE–CIRCUIT CONFIGURATION

DSGN MCF	DR JHR	DATE FEB 2010	FIG 1



DESIGN ASSUMPTIONS:

- 1590 KCMIL "COREOPSIS" AAC
- 280' MAX SPAN

NOTES:

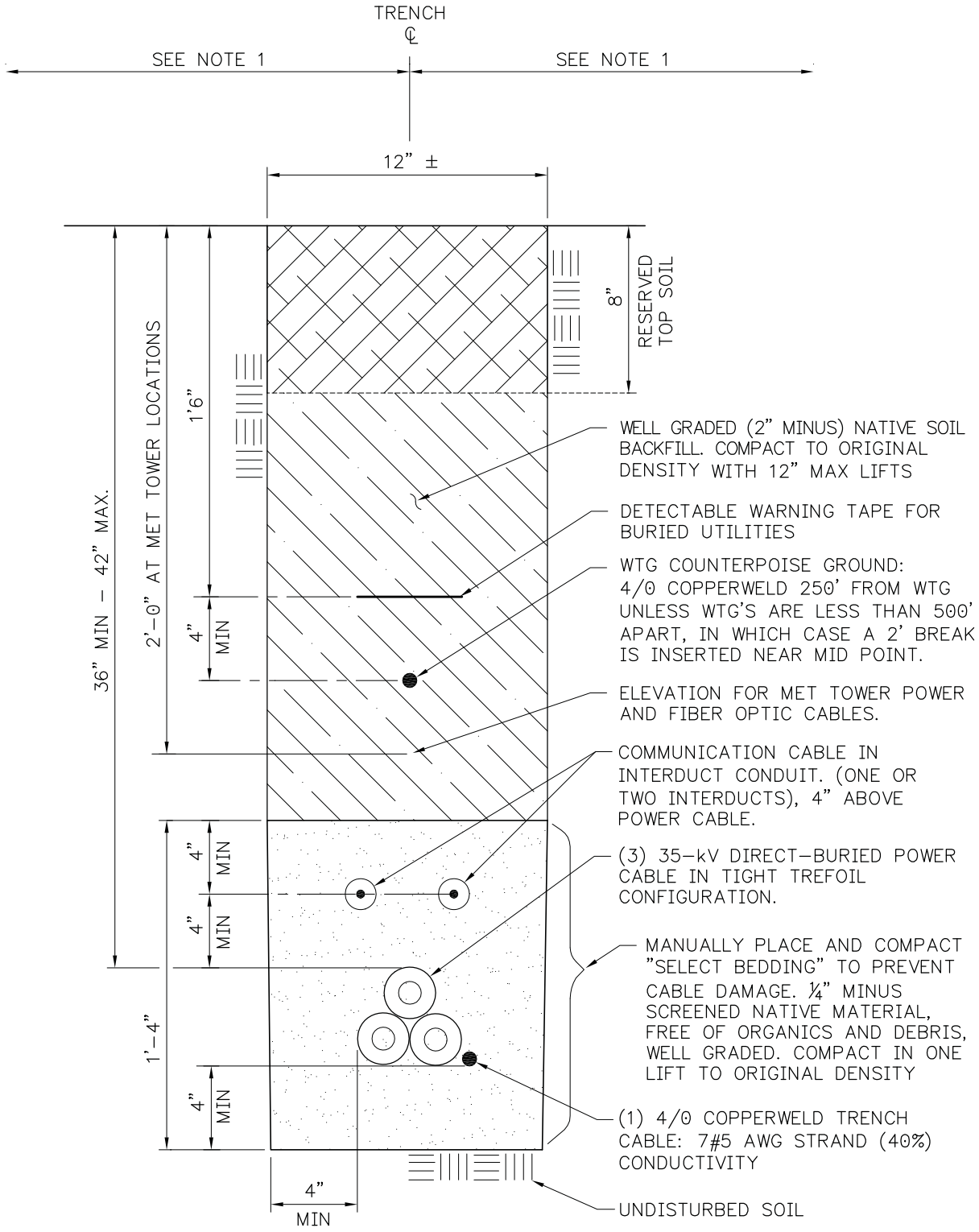
1. STRUCTURE DIMENSIONS ARE APPROXIMATE. ACTUAL DIMENSIONS MAY VARY.
2. DIMENSIONS ARE TO ATTACHMENT HOLES.
3. DRAWING IS NOT TO EXACT SCALE

IBERDROLA TULE WIND PROJECT

TriAxis Engineering, Inc.

TYPICAL 34.5-KV HORIZONTAL LINE POST TANGENT DOUBLE-CIRCUIT CONFIGURATION

DSGN MCF	DR JHR	DATE FEB 2010	FIG 2



NOTES:
1. EACH 3-PHASE CABLE TRENCH SHALL BE SEPARATED FROM ALL OTHER CABLE TRENCHES BY 10'-6" MINIMUM, CENTERLINE-TO-CENTERLINE UNLESS OTHERWISE NOTED ON DRAWINGS.
2. ROCKS SHALL NOT COME IN CONTACT WITH CABLES.

IBERDROLA RENEWABLES TULE WIND PROJECT	FIGURE 2 DIRECT BURIED 34.5-KV UNDERGROUND CABLE TRENCH DETAIL	TriAxis Engineering, Inc.

APPENDIX B – County of San Diego StormWater Intake Form for Development Projects

County of San Diego Stormwater Intake Form for Development Projects

County of San Diego

STORMWATER INTAKE FORM FOR DEVELOPMENT PROJECTS

This form must be completed in its entirety and accompany applications for any of the discretionary or ministerial permits and approvals referenced in Sections 67.803(c)(1) and 67.803(c)(2) of the County of San Diego Watershed Protection, Stormwater Management and Discharge Control Ordinance (WPO).

STEP 1: IDENTIFY RELEVANT PROJECT INFORMATION

Applicant Name: Andrew Linehan		Contact Information: Jeffrey Durocher
Project Address: Multiple Properties	APN(s): See APN list	Permit Application #:

STEP 2: DETERMINE PRIORITY DEVELOPMENT PROJECT STATUS

WPO Section 67.802(w) defines the criteria for determining whether your project is considered a Priority Development Project (PDP). If you answer "Yes" to any of the questions below, your project is a PDP subject to review and approval of a Major Stormwater Management Plan (SWMP). If you answer "No" to all of the questions below, your project is subject to review and approval of a Minor SWMP.

1. *Residential subdivision of 10 or more dwelling units (Single-family, Multi-family, Condo, or Apartment Complex) ..... Yes (No)*
2. *Commercial development that includes development of land area greater than one (1) acre ..... Yes (No)*
3. *Industrial development greater than one (1) acre ..... Yes (No)*
4. *Automotive repair shop ..... Yes (No)*
5. *Restaurant or restaurant facilities with an area of development of 5,000 square feet or greater ..... Yes (No)*
6. *On a steep hillside (>25% natural slope) AND proposes 5,000 square feet of impervious surface or more, or includes grading of any natural slope >25%[1] .....(Yes) No*
7. *Located within 200 feet of an Environmentally Sensitive Area AND creates 2,500 square feet or more of impervious surface or increases the area of imperviousness of a site to more than 10% of its naturally occurring condition[1][2] ..... Yes (No)*
8. *A parking lot that is 5,000 square feet or greater OR proposes at least 15 new parking stalls ..... Yes (No)*
9. *Streets or roads that create a new paved surface that is 5,000 square feet or greater ..... Yes (No)*
10. *Retail gasoline outlet ..... Yes (No)*

[1] In lieu of a Major SWMP, Ministerial Permit Applications for residential dwellings/additions on an existing legal lot answering "Yes" may be able to utilize the Minor Stormwater Management Plan upon approval of a county official. Please note that upon further analysis, staff may determine that a Major SWMP will be required.
[2] A County technician will assist you in determining whether your project is located within 200 feet of an Environmentally Sensitive Area.

If you answered "Yes" to any of the questions, please complete a Major SWMP for your project.
Instructions and an example of the form can be downloaded from http://www.co.san-diego.ca.us/dpw/watersheds/land_dev/susmp.html

If you answered "NO" to all of the questions above, please complete a Minor SWMP for your project.
Instructions and an example of the form can be downloaded from http://www.sdcounty.ca.gov/dplu/docs/LUEG-SW.pdf

STEP 3: SIGN AND DATE THE CERTIFICATION

APPLICANT CERTIFICATION: I have read and understand that the County of San Diego has adopted minimum requirements for managing urban runoff, including stormwater, from construction and land development activities. I certify that this intake form has been completed to the best of my ability and accurately reflects the project being proposed. I also understand that non-compliance with the County's WPO and Grading Ordinance may result in enforcement by the County, including fines, cease and desist orders, or other actions.

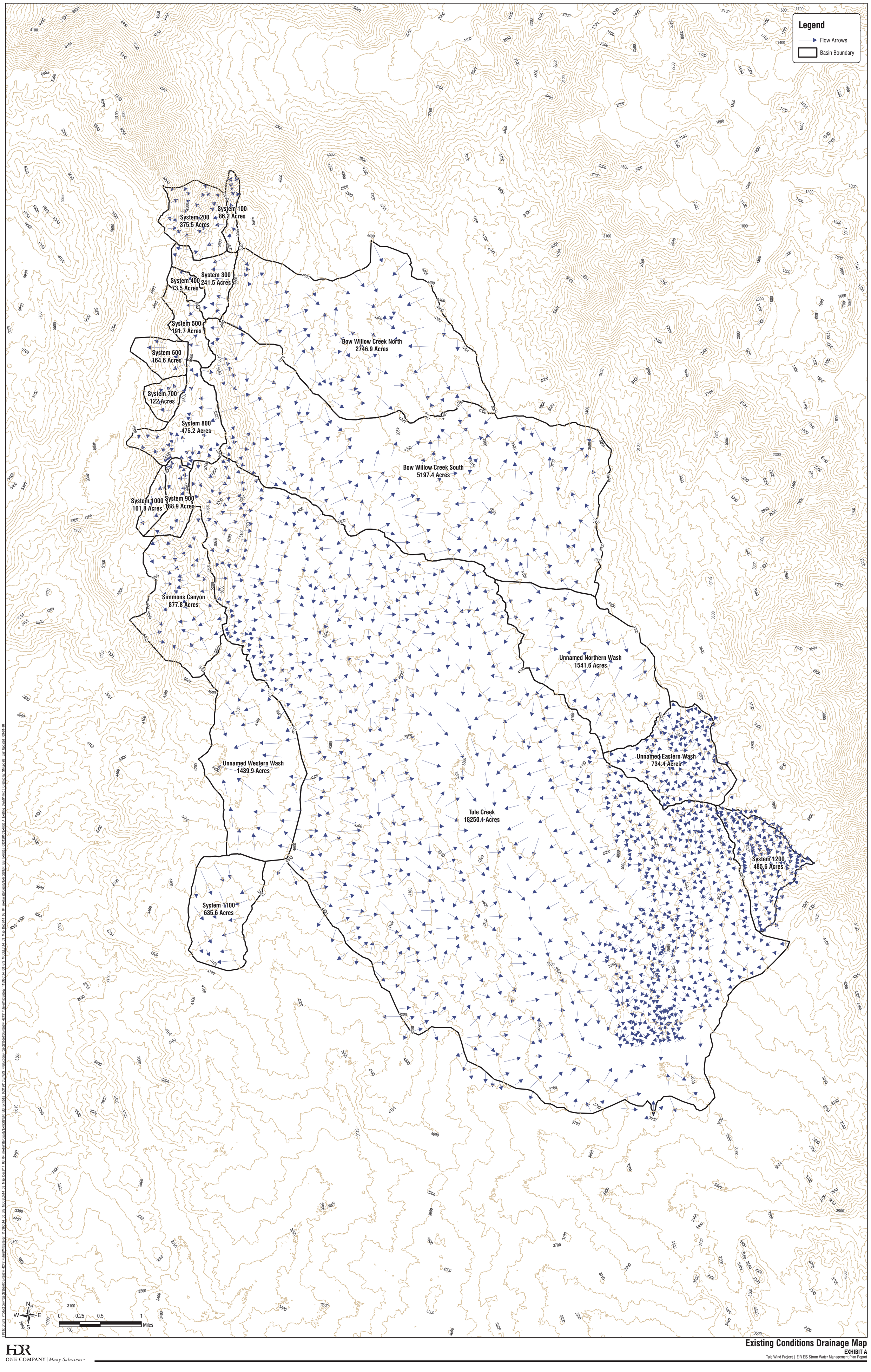
Applicant : *Date:*

APPENDIX C – PROJECT EXIBITS

Exhibit A – Existing Conditions Drainage Map

Exhibit B – Proposed Conditions Drainage Map

Exhibit C – BMP Map



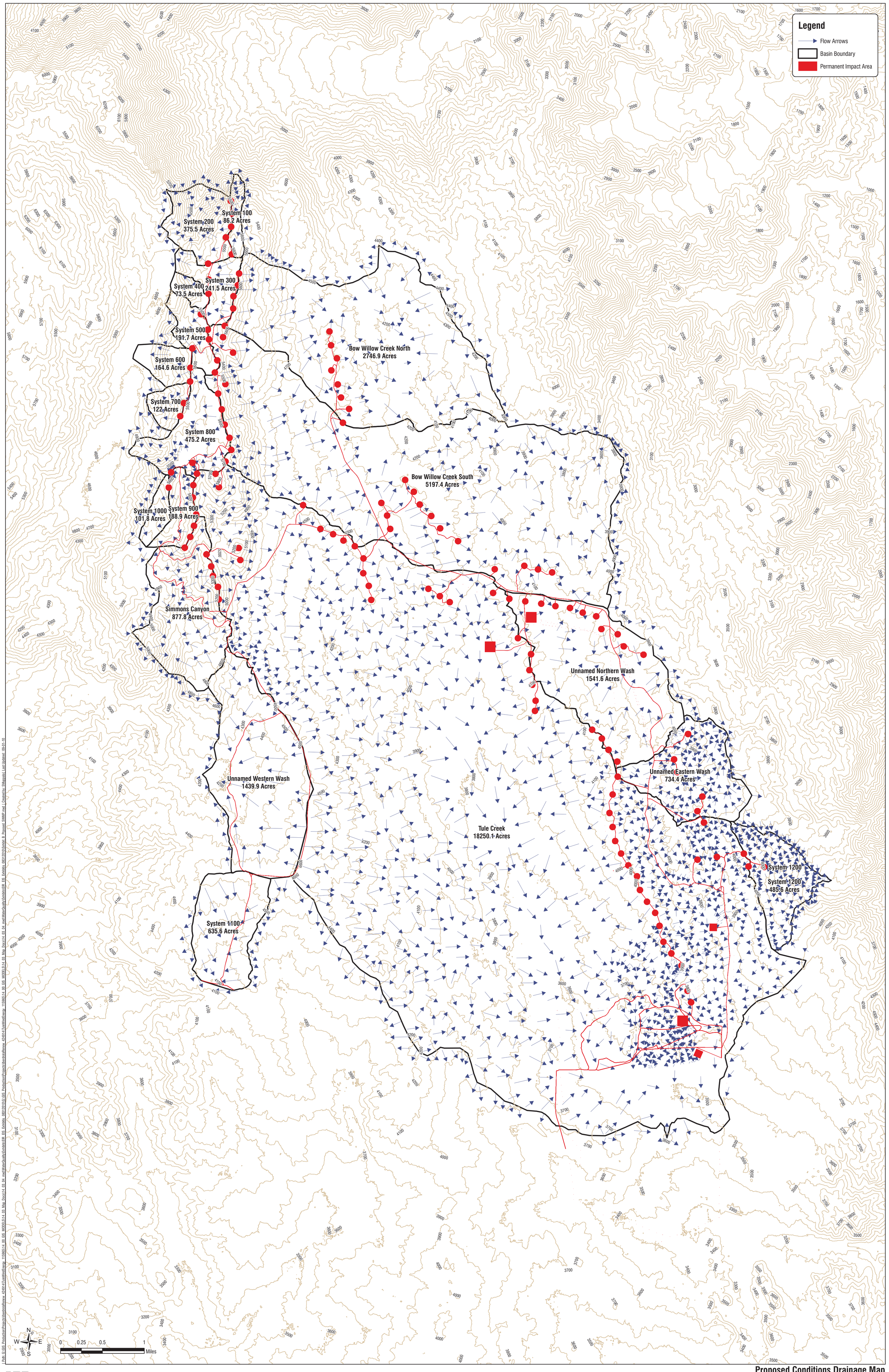
| Path: G:\GIS Production\Projects\Iberdrola\Renew 4249141\TuleWindEnergy 115965\14 00 GIS MODELS\14 03 Map Docs\14 03 04 mxd\WaterQuality\Exhibits\EIR EIS Exhibits 08312010\Exhibit A Existing SWMP.mxd | Created by: SMuppala | Last Updated: 09-01-10

HDR
ONE COMPANY | *Many Solutions*™

Existing Conditions Drainage Map

EXHIBIT A

Tule Wind Project | EIR EIS Strom Water Management Plan Report



Path: G:\GIS Production\Projects\IberdrolaRenew 424914\TuleWindEnergy 1159651\14 00 GIS MODELS\14 03 Map Docs\14 03 04 mxd\WaterQuality\Exhibits\EIR EIS Exhibits 08312010\Exhibit B Proposed SWMP.mxd | Created by: SMappala | Last Updated: 09-01-10

HDR
ONE COMPANY | *Many Solutions*™

Proposed Conditions Drainage Map

EXHIBIT B

Tule Wind Project | EIR EIS Storm Water Management Plan Report

Legend

- Flowpaths
- Basin Boundary
- Permanent Impact Area

System 100
86.2 Acres

System 200
375.5 Acres

System 300
241.5 Acres

System 400
73.5 Acres

System 500
191.7 Acres

System 600
164.6 Acres

System 700
122 Acres

System 800
475.2 Acres

System 900
188.9 Acres

System 1000
101.8 Acres

System 1100
635.6 Acres

System 1200
485.6 Acres

Bow Willow Creek North
2746.9 Acres

Bow Willow Creek South
5197.4 Acres

Simmons Canyon
877.8 Acres

Unnamed Western Wash
1439.9 Acres

Unnamed Northern Wash
1541.6 Acres

Unnamed Eastern Wash
734.4 Acres

Tule Creek
18250.1 Acres

Minimized cut and fill slopes on turbine pads and roads to limit disturbed areas (Typ.)

Conservation of natural areas (Typ.)

Minimzed project footprint by minimal impervious areas, as well as minimized grading (Typ.)

Vegetated swale/brow ditch parallel to access road (Typ.)

Vegetation of slopes to minimize erosion (Typ.)

Use of naturally occuring vegetation or drought tolerant plants for seeding of cut/fill slopes (Typ.)

Disconnected impervious areas (Typ.)

Access road located to minimize number of channel crossings and impacts to existing drainages (Typ.)

Potential detention basin for operation and maintenance facility or substation (Typ.)

Stabilized drainage crossing (Typ.)

N
W E
S

0 0.25 0.5 1 Miles

Path: G:\GIS Production\Projects\IberdrolaRenew 424914\TuleWindEnergy 115965\14 00 GIS MODELS\14 03 Map Docs\14 03 04 mxd\WaterQuality\Exhibits\EIR EIS Exhibits 08312010\Exhibit C BMP Map.mxd | Created by: SMuegala | Last Updated: 09-01-10

HDR
ONE COMPANY | *Many Solutions*™

BMP Map

EXHIBIT C

Tule Wind Project | EIR EIS Storm Water Management Plan Report

APPENDIX D – ADDITIONAL BMP INFORMATION

CASQA Site Design and Facility Design

CASQA Site Design and Landscape Planning

CASQA Vegetated Swale

CASQA Extended Detention Basin

Section 3
Site and Facility Design for Water Quality Protection

3.1 Introduction

Site and facility design for stormwater quality protection employs a multi-level strategy. The strategy consists of: 1) reducing or eliminating post-project runoff; 2) controlling sources of pollutants; and 3), if still needed after deploying 1) and 2), treating contaminated stormwater runoff before discharging it to the storm drain system or to receiving waters.

This section describes how elements 1), 2), and 3) of the strategy can be incorporated into the site and facility planning and design process, and by doing so, eliminating or reducing the amount of stormwater runoff that may require treatment at the point where stormwater runoff ultimately leaves the site. Elements 1) and 2) may be referred to as "source controls" because they emphasize reducing or eliminating pollutants in stormwater runoff at their source through runoff reduction and by keeping pollutants and stormwater segregated. Section 4 provides detailed descriptions of the BMPs related to elements 1) and 2) of the strategy. Element 3) of the strategy is referred to as "treatment control" because it utilizes treatment mechanisms to remove pollutants that have entered stormwater runoff. Section 5 provides detailed descriptions of BMPs related to element 3) of the strategy. Treatment controls integrated into and throughout the site usually provide enhanced benefits over the same or similar controls deployed only at the "end of the pipe" where runoff leaves the project site.

3.2 Integration of BMPs into Common Site Features

Many common site features can achieve stormwater management goals by incorporating one or more basic elements, either alone or in combination, depending on site and other conditions. The basic elements include infiltration, retention/detention, biofilters, and structural controls. This section first describes these basic elements, and then describes how these elements can be incorporated into common site features.

Infiltration

Infiltration is the process where water enters the ground and moves downward through the unsaturated soil zone. Infiltration is ideal for management and conservation of runoff because it filters pollutants through the soil and restores natural flows to groundwater and downstream water bodies. See Figure 3-1.

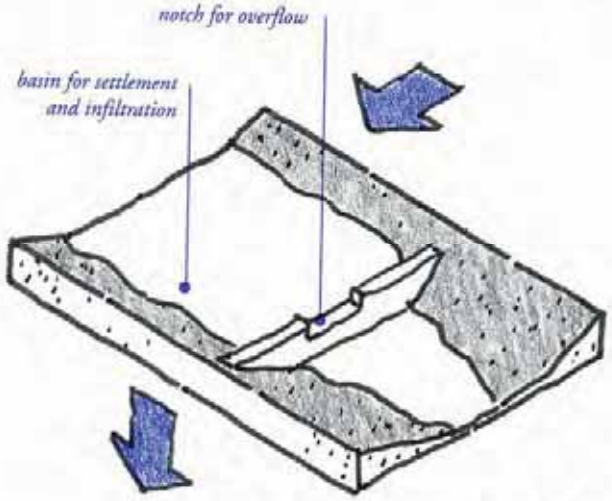


Figure 3-1
Infiltration Basin

The infiltration approach to stormwater management seeks to "preserve and restore the hydrologic cycle." An infiltration stormwater system seeks to infiltrate runoff into the soil by allowing it to flow slowly over permeable surfaces. The slow flow of runoff allows pollutants to settle into the soil where they are naturally mitigated. The reduced volume of runoff that remains takes a long time to reach the outfall, and when it empties into a natural water body or storm sewer, its pollutant load is greatly reduced.

Infiltration basins can be either open or closed. Open infiltration basins, include ponds, swales and other landscape features, are usually vegetated to maintain the porosity of the soil structure and to reduce erosion. Closed infiltration basins can be constructed under the land surface with open graded crushed stone, leaving the surface to be used for parking or other uses. Subsurface closed basins are generally more difficult to maintain and more expensive than open filtration systems, and are used primarily where high land costs demand that the land surface be reclaimed for economic use.

Infiltration systems are often designed to capture the "first flush" storm event and used in combination with a detention basin to control peak hydraulic flows. They effectively remove suspended solids, particulates, bacteria, organics and soluble metals and nutrients through the vehicle of filtration, absorption and microbial decomposition. Groundwater contamination should be considered as a potential adverse effect and should be considered where shallow groundwater is a source of drinking water. In cases where groundwater sources are deep, there is a very low chance of contamination from normal concentrations of typical urban runoff.

Retention and Detention

Retention and detention systems differ from infiltration systems primarily in intent. Detention systems are designed to capture and retain runoff temporarily and release it to receiving waters at predevelopment flow rates. Permanent pools of water are not held between storm events. Pollutants settle out and are removed from the water column through physical processes. See Figure 3-2.

Retention systems capture runoff and retain it between storms as shown in Figure 3-3. Water held in the system is displaced by the next significant rainfall event. Pollutants settle out and are thereby removed from the water column. Because the water remains in the system for a period of time, retention systems benefit from biological and biochemical removal mechanisms provided by aquatic plants and microorganisms. See Figure 3-3.

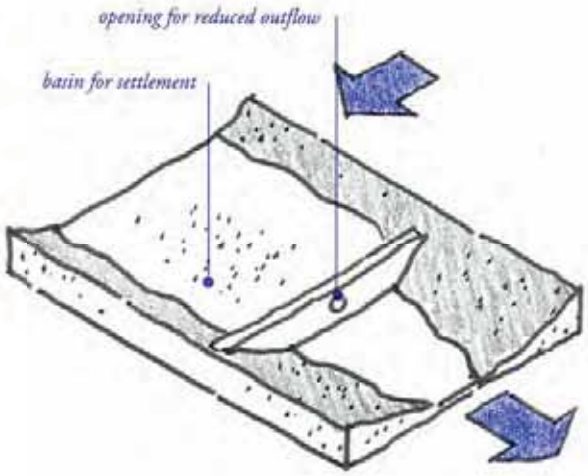


Figure 3-2
Simple Detention System

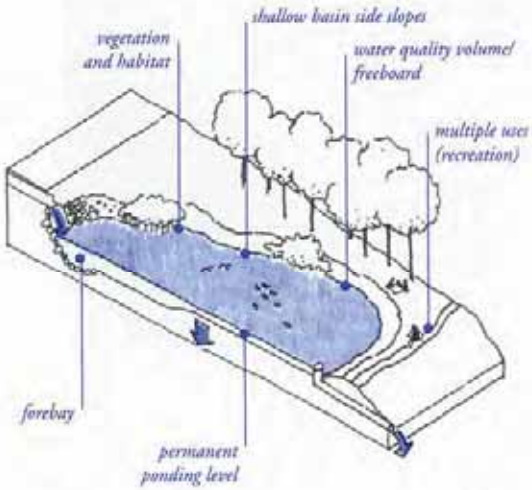


Figure 3-3
Retention System

Retention/detention systems may release runoff slowly enough to reduce downstream peak flows to their pre-development levels, allow fine sediments to settle, and uptake dissolved nutrients in the runoff where wetland vegetation is included.

Bioretention facilities have the added benefit of aesthetic appeal. These systems can be placed in parking lot islands, landscaped areas surrounding buildings, perimeter parking lots, and other open space sections. Placing bioretention facilities on land that city regulations require developers to devote to open space efficiently uses the land. An experienced landscape architect can choose plant species and planting materials that are easy to maintain, aesthetically pleasing, and capable of effectively reducing pollutants in runoff from the site.

Constructed wetland systems retain and release stormwater in a manner that is similar to retention or detention basins. The design mimics natural ecological functions and uses wetland vegetation to filter pollutants. The system needs a permanent water source to function properly and must be engineered to remove coarse sediment, especially construction related sediments, from entering the pond. Stormwater has the potential to negatively affect natural wetland functions and constructed wetlands can be used to buffer sensitive resources.

Biofilters

Biofilters, also known as vegetated swales and filter strips, are vegetated slopes and channels designed and maintained to transport shallow depths of runoff slowly over vegetation. Biofilters are effective if flows are slow and depths are shallow (3% slope max.). The slow movement of runoff through the vegetation provides an opportunity for sediments and particulates to be filtered and degraded through biological activity. In most soils, the biofilter also provides an opportunity for stormwater infiltration, which further removes pollutants and reduces runoff volumes. See Figure 3-4.

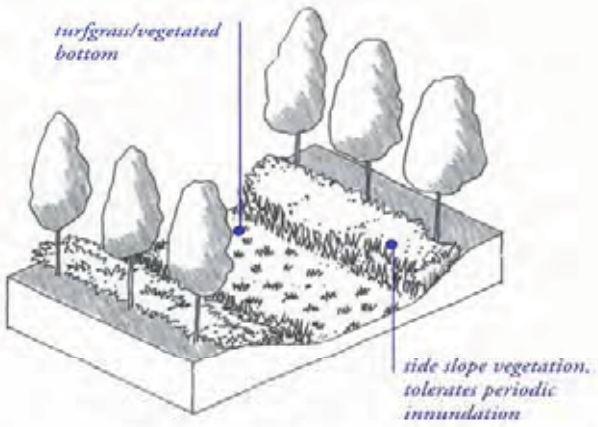


Figure 3-4
Vegetated Swale

Swales intercept both sheet and concentrated flows and convey these flows in a concentrated, vegetation-lined channel. Grass filter strips intercept sheet runoff from the impervious network of streets, parking lots, and rooftops and divert stormwater to a uniformly graded meadow, buffer zone, or small forest. Typically, the vegetated swale and grass strip-planting palette can

comprise a wide range of possibilities from dense vegetation to turf grass. Grass strips and vegetated swales can function as pretreatment systems for water entering bioretention systems or other BMPs. If biofilters are to succeed in filtering pollutants from the water column, the planting design must consider the hydrology, soils, and maintenance requirements of the site.

Appropriate plantings not only improve water quality, they provide habitat and aesthetic benefits. Selected plant materials must be able to adapt to variable moisture regimes. Turf grass is acceptable if it can be watered in the dry season, and if it is not inundated for long periods. Species such as willows, dogwoods, sedge, rush, lilies, and bulrush tolerate varying degrees of soil moisture and can provide an attractive plant palette year round.

Structural Controls

Structural controls in the context of this section include a range of measures that prevent pollutants from coming into contact with stormwater. In this context, these measures may be referred to as "structural source controls" meaning that they utilize structural features to prevent pollutant sources and stormwater from coming into contact with one another, thus reducing the opportunity for stormwater to become contaminated. Examples of structural source controls include covers, impermeable surfaces, secondary containment facilities, runoff diversion berms, and diversions to wastewater treatment plants.

3.2.1 Streets

More than any other single element, street design has a powerful impact on stormwater quality. Street and other transportation-related structures typically can comprise between 60 and 70% of the total impervious coverage in urban areas and, unlike rooftops, streets are almost always directly connected to an underground stormwater system.

Recognizing that street design can be the greatest factor in development's impact on stormwater quality, it is important that designers, municipalities and developers employ street standards that reduce impervious land coverage. Directing runoff to biofilters or swales rather than underground storm drains produces a street system that conveys stormwater efficiently while providing both water quality and aesthetic benefits.

On streets where a more urban character is desired, or where a rigid pavement edge is required, curb and gutter systems can be designed to empty into drainage swales. These swales can run parallel to the street, in the parkway between the curb and the sidewalk, or can intersect the street at cross-angles, and run between residences, depending on topography or site planning. Runoff travels along the gutter, but instead of being emptied into a catch basin and underground pipe, multiple openings in the curb direct runoff into surface swales or infiltration/detention basins.

In recent years, new street standards have been gaining acceptance that meets the access requirements of local residential streets while reducing impervious land coverage. These standards create a new class of street that is narrower and more interconnected than the current local street standard, called an "access" street. An access street is at the lowest end of the street hierarchy and is intended only to provide access to a limited number of residences.

Street design is usually mandated by local municipal standards. Officials must consider the scale of the land use as they select stormwater and water quality design solutions. Traffic volume and speeds, bicycle lane design criteria, and residential and business densities influence the willingness of decision makers to permit the narrow streets that include curbless design alternatives.

Emergency service providers often raise objections to reduced street widths. Street designs illustrated here meet national Fire Code standards for emergency access. An interconnected grid system of narrow streets also allows emergency service providers with multiple access routes to compensate for the unlikely possibility that a street may be blocked.

Many municipal street standards mandate 80 to 100% impervious land coverage in the public right-of-way, and are a principal contributor to the environmental degradation caused by development.

A street standard that allows an interconnected system of narrow access streets for residential neighborhoods has the potential to achieve several complimentary environmental and social benefits. A hierarchy of streets sized according to average daily traffic volumes yields a wide variety of benefits: improved safety from lower speeds and volumes, improved aesthetics from street trees and green parkways, reduced impervious land coverage, less heat island effect, and lower development costs. If the reduction in street width is accompanied by a drainage system that allows for infiltration of runoff, the impact of streets on stormwater quality can be greatly mitigated.

There are many examples of narrow streets, from both newly constructed and older communities, which demonstrate the impact of street design on neighborhood character and environmental quality. See Table 3-1.

Table 3-1 Adopted Narrow Street Standards (Typ. Cross-Sections, two-way traffic)	
City of Santa Rosa	30 ft wide with parking permitted both sides, <1000 Average Daily Traffic (ADT) 26 – 28 ft with parking permitted one side 20 ft - no parking permitted 20 ft neck downs at intersections
City of Palmdale	28 ft wide with parking permitted both sides
City of San Jose	30 ft wide with parking permitted both sides, <21 Dwelling Units (DU) 34 ft wide with parking permitted both sides, <121 DU
City of Novato	24 ft wide with parking permitted both sides, 2-4 DU 28 ft with parking permitted both sides, 5-15 DU
County of San Mateo	19 ft wide rural pavement cross-section with parking permitted on adjacent gravel shoulders

A comparison of street cross-sections is shown in Figure 3-5.

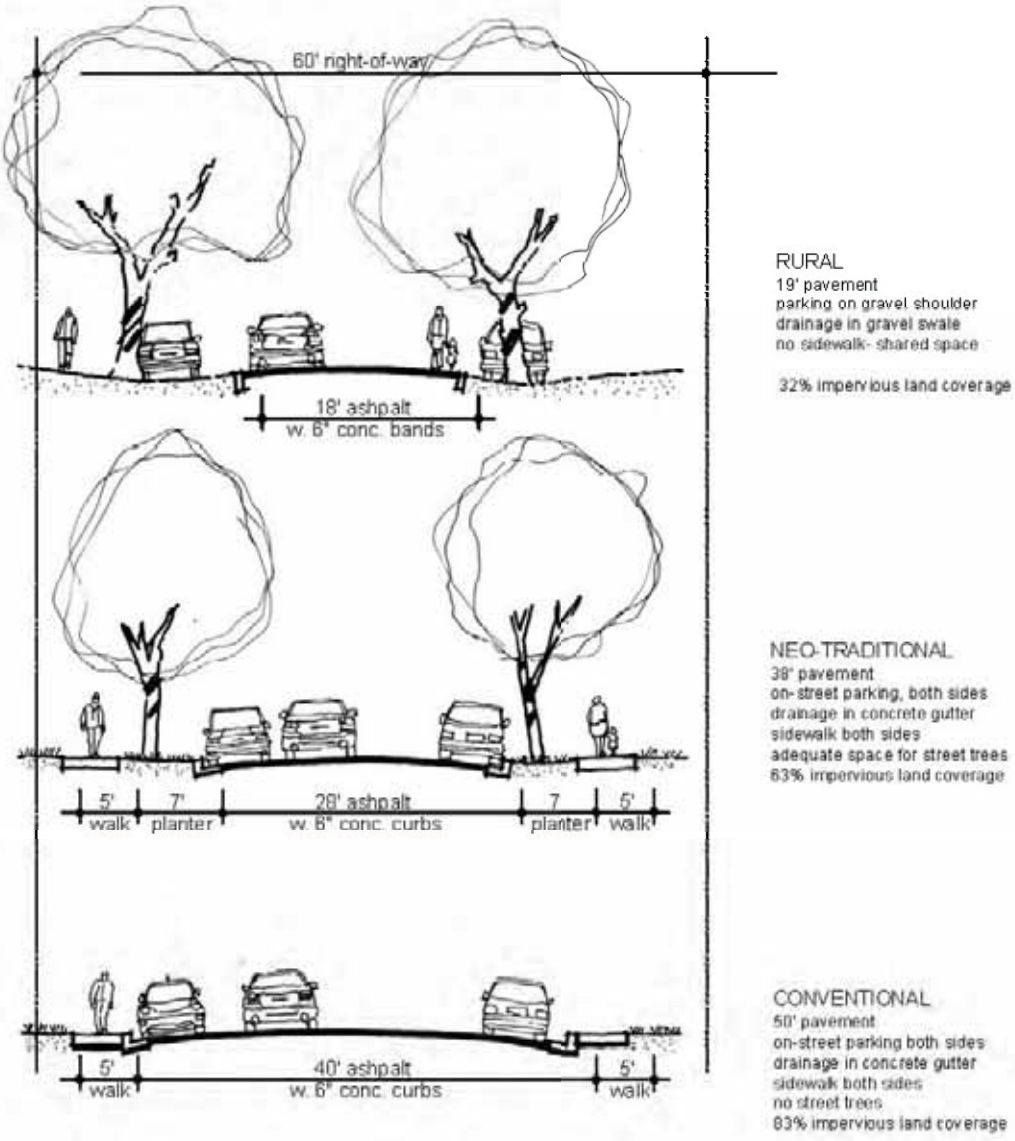


Figure 3-5
Comparison of Street Cross-Sections (two-way traffic, residential access streets)

3.2.2 Parking Lots

In any development, storage space for stationary vehicles can consume many acres of land area, often greater than the area covered by streets or rooftops. In a neighborhood of single-family homes, this parking area is generally located on private driveways or along the street. In higher density residential developments, parking is often consolidated in parking lots.

The space for storage of the automobile, the standard parking stall, occupies only 160 ft², but when combined with aisles, driveways, curbs, overhang space, and median islands, a parking lot can require up to 400 ft² per vehicle, or nearly one acre per 100 cars. Since parking is usually accommodated on an asphalt or concrete surface with conventional underground storm drain systems, parking lots typically generate a great deal of DCIA.

There are many ways to both reduce the impervious land coverage of parking areas and to filter runoff before it reaches the storm drain system.

Hybrid Parking Lot

Hybrid lots work on the principle that pavement use differs between aisles and stalls. Aisles must be designed for speeds between 10 and 20 mph, and durable enough to support the concentrated traffic of all vehicles using the lot. The stalls, on the other hand, need only be designed for the 2 or 3 mph speed of vehicles maneuvering into place. Most of the time the stalls are in use, vehicles are stationary. Hybrid lots reduce impervious surface coverage in parking areas by differentiating the paving between aisles and stalls, and combining impervious aisles with permeable stalls, as shown in Figure 3-6.

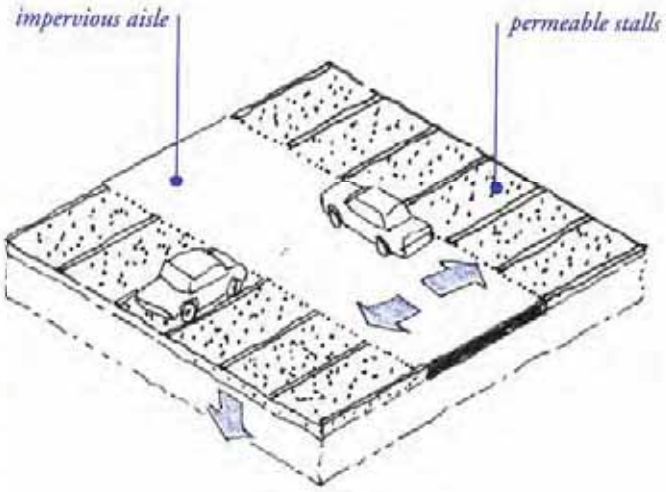


Figure 3-6
Hybrid Parking Lot

If aisles are constructed of a more conventional, impermeable material suitable for heavier vehicle use, such as asphalt, stalls can be constructed of permeable pavement. This can reduce the overall impervious surface coverage of a typical double loaded parking lot by 60% and avoid the need for an underground drainage system.

Permeable stalls can be constructed of a number of materials including pervious concrete, unit pavers such as brick or stone spaced to expose a permeable joint and set on a permeable base, crushed aggregate, porous asphalt, turf block, and cobbles in low traffic areas. Turf blocks and permeable joints are shown in Figures 3-7 and 3-8.

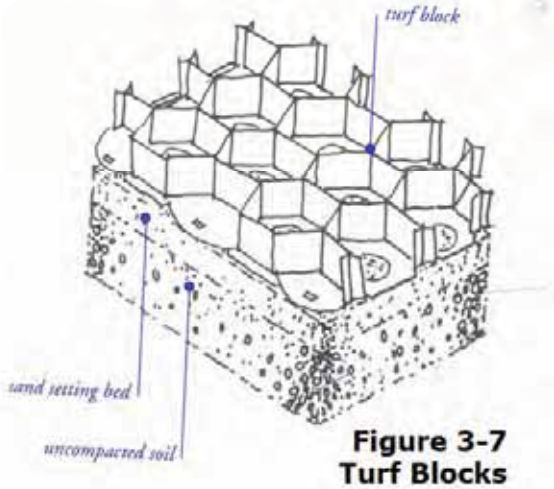


Figure 3-7
Turf Blocks

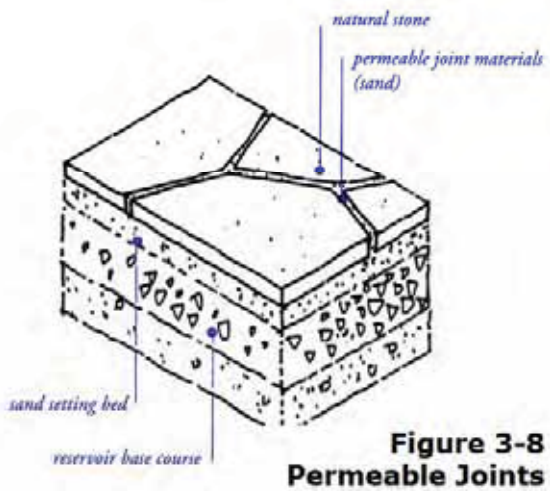


Figure 3-8
Permeable Joints

Parking Grove

A variation on the permeable stall design, a grid of trees and bollards can be used to delineate parking stalls and create a "parking grove." If the bollard and tree grids are spaced approximately 19 ft apart, two vehicles can park between each row of the grid. This 9.5 ft stall spacing is slightly more generous than the standard 8.5 to 9 ft stall, and allows for the added width of the tree trucks and bollards. A benefit of this design is that the parking grove not only shades parked cars, but also presents an attractive open space when cars are absent. Examples of parking groves are shown in Figures 3-9 and 3-10.

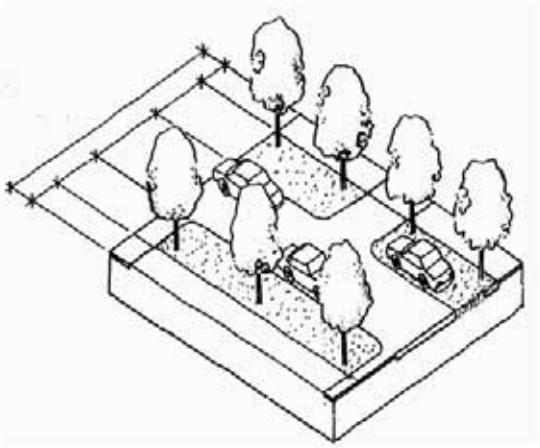


Figure 3-9
Parking Grove

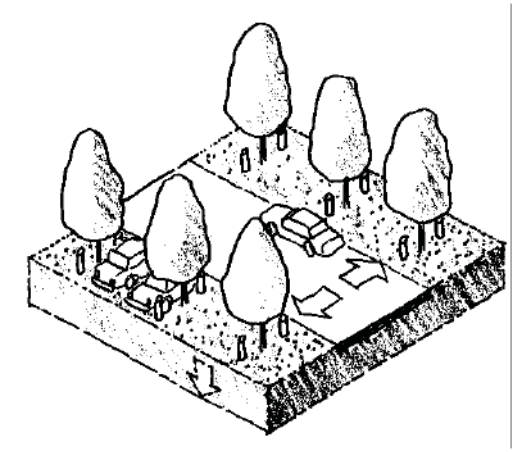


Figure 3-10
Parking Grove

Overflow Parking

Parking lot design is often required to accommodatepeak demand, generating a high proportion of impervious land coverage of very limited usefulness. An alternative is to differentiate between regular and peak parking demands, and to construct the peak parking stalls of a different, more permeable, material. This "overflow parking" area can be made of a turf block, which appears as a green lawn when not occupied by vehicles, or crushed stone or other materials. See Figure 3-11. The same concept can be applied to areas with temporary parking needs, such as emergency access routes, or in residential applications, RV, or trailer parking.

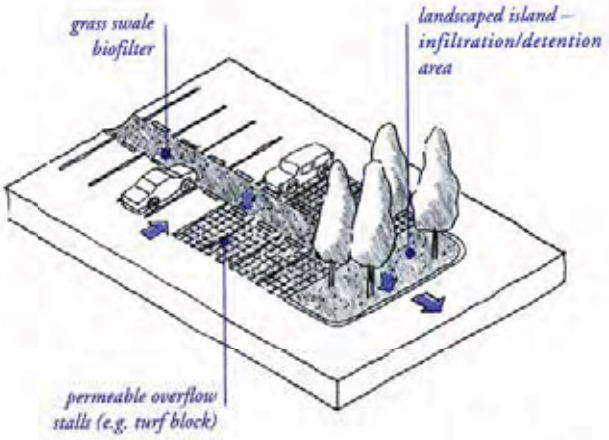


Figure 3-11
Overflows Parking

Porous Pavement Recharge Bed

In some cases, parking lots can be designed to perform more complex stormwater management functions. Constructing a stone-filled reservoir below the pavement surface and directing runoff underground by means of perforated distribution pipes can achieve subsurface stormwater storage and infiltration as shown in Figure 3-12. Subsurface infiltration basins eliminate the possibilities of mud, mosquitoes and safety hazards sometimes perceived to be associated with ephemeral surface drainage. They also can provide for storage of large volumes of runoff, and can be incorporated with roof runoff collection systems.

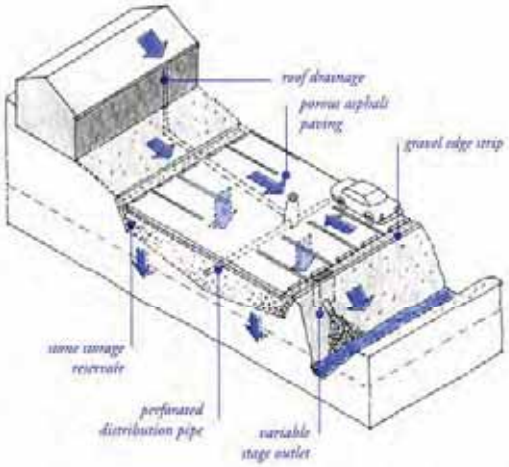


Figure 3-12
Porous Pavement Recharge Bed

3.2.3 Driveways

Driveways can comprise up to 40% of the total transportation network in a conventional development, with streets, turn-arounds, and sidewalks comprising the remaining 60%.

Driveway length is generally determined by garage setback requirements, and width is usually mandated by municipal codes and ordinances. If garages are setback from the street, long driveways are required, unless a rear alley system is included to provide garage access. If parking for two vehicles side by side is required, a 20 ft minimum width is required. Thus, if a 20 ft setback and a two-car-wide driveway are required, a minimum of 400 ft² of driveway will result, or 4% of a typical 10,000 ft² residential lot. If the house itself is compact, and the driveway is long, wide, and paved with an impervious material such as asphalt or concrete, it can become the largest component of impervious land coverage on the lot.

Municipalities can reduce the area dedicated to driveways by allowing for tandem parking (one vehicle in front of another on a narrow driveway). In addition, if shared driveways are permitted, then two or more garages can be accessed by a single driveway, further reducing required land area. Rear alley access to the garage can reduce driveway length, but overall impervious surface coverage may not be reduced if the alleys are paved with impervious materials and the access streets remain designed to conventional municipal standards.

Alternative solutions that work to reduce the impact of water quality problems associated with impervious land coverage on city streets also work on driveways. Sloping the driveway so that it drains onto an adjacent turf or groundcover area prevents driveways from draining directly to storm drain systems. This concept is shown in Figures 3-13 and 3-14. Use of turf-block or unit pavers on sand creates attractive, low maintenance, permeable driveways that filter stormwater. See Figure 3-15. Crushed aggregate can serve as a relatively smooth pavement with minimal maintenance as shown in Figure 3-16. Paving only under wheels (Figure 3-17) is a viable, inexpensive design if the driveway is straight between the garage and the street, and repaving temporary parking areas with permeable unit pavers such as brick or stone can significantly reduce the percentage of impervious area devoted to the driveway.

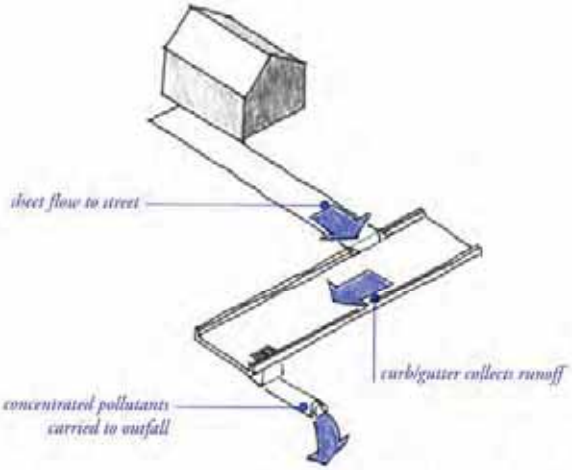


Figure 3-13
Traditional Design
Drains Flow Directly to Storm Drain

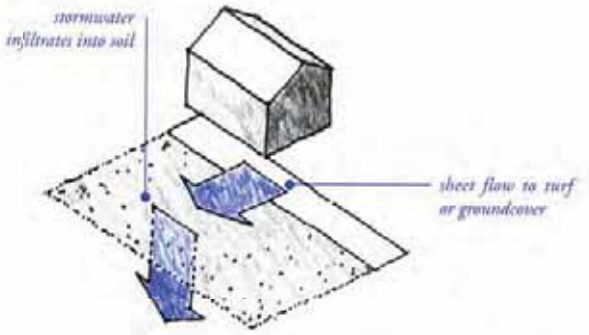


Figure 3-14
Alternative Solution
Slopes Flow to Groundcover

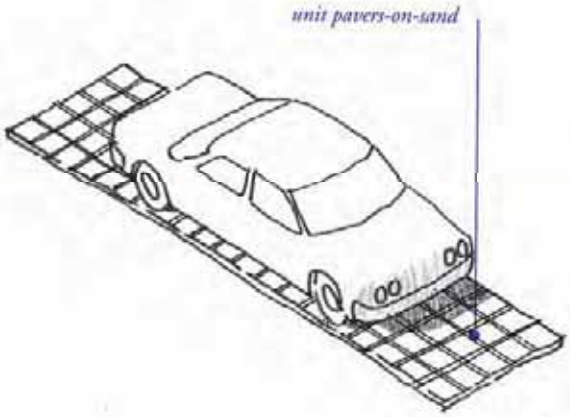


Figure 3-15
Unit Pavers

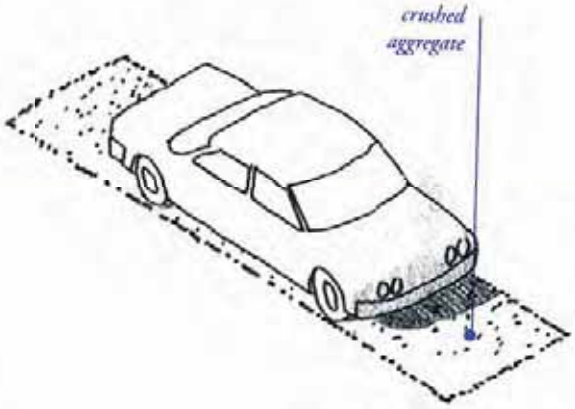


Figure 3-16
Crushed Aggregate

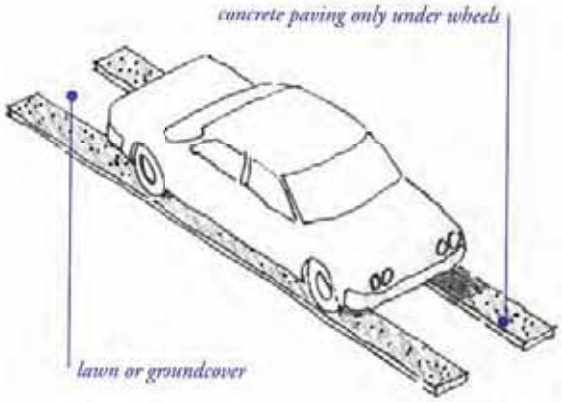


Figure 3-17
Paving Only Under Wheels

3.2.4 Landscape and Open Space

In the natural landscape, most soils infiltrate a high percentage of rainwater through a complex web of organic and biological activities that build soil porosity and permeability. Roots reach into the soil and separate particles of clay, insects excavate voids in the soil mass, roots decay leaving networks of macro pores, leaves fall and form a mulch over the soil surface, and earthworms burrow and ingest organic detritus to create richer, more porous soil. These are just a few examples of the natural processes that occur within the soil.

Maintenance of a healthy soil structure through the practice of retaining or restoring native soils where possible and using soil amendments where appropriate can improve the land's ability to filter and slowly release stormwater into drainage networks. Construction practices such as decreasing soil compaction, storing topsoil on-site for use after construction, and chipping wood for mulch as it is cleared for the land can improve soil quality and help maintain healthy watersheds. Practices that reduce erosion and help retain water on-site include incorporating organic amendments into disturbed soils after construction, retaining native vegetation, and covering soil during revegetation.

Subtle changes in grading can also improve infiltration. Landscape surfaces are conventionally graded to have a slight convex slope. This causes water to run off a central high point into a surrounding drainage system, creating increased runoff. If a landscape surface is graded to have a slightly concave slope, it will hold water. The infiltration value of concave vegetated surfaces is greater in permeable soils. Soils of heavy clay or underlain with hardpan provide less infiltration value. In these cases, concave vegetated surfaces must be designed as retention/detention basins, with proper outlets or under drains to an interconnected system.

Multiple Small Basins

Biofilters, infiltration, retention/detention basins are the basic elements of a landscape designed for stormwater management. The challenge for designers is to integrate these elements creatively and attractively in the landscape – either within a conventional landscape aesthetic or by presenting a different landscape image that emphasizes the role of water and drainage.

Multiple small basins can provide a great deal of water storage and infiltration capacity. These small basins can fit into the parkway planting strip or shoulders of street rights-of-way. If connected by culverts under walks and driveways, they can create a continuous linear infiltration system. Infiltration and retention/detention basins can be placed under wood decks, in parking lot planter islands, and at roof downspouts. Outdoor patios or seating areas can be sunken a few steps, paved with a permeable pavement such as flagstone or gravel, and designed to hold a few inches of water collected from surrounding rooftops or paved areas for a few hours after a rain.

All of these are examples of small basins that can store water for a brief period, allowing it to infiltrate into the soil, slowing its release into the drainage network, and filtering pollutants. An ordinary lawn can be designed to hold a few inches of water for a few hours after a storm, attracting birds and creating a landscape of diversity. Grass/vegetated swales can be integrated with landscaping, providing an attractive, low maintenance, linear biofilter. Extended detention (dry ponds) store water during storms, holding runoff to predevelopment levels. Pollutants

settle and are removed from the water column before discharging to streams. Wet ponds serve a similar purpose and can increase property values by providing a significant aesthetic, and passive recreation opportunity.

Plant species selection is critical for proper functioning of infiltration areas. Proper selection of plant materials can improve the infiltration potential of landscape areas. Deep-rooted plants help to build soil porosity. Plant leaf-surface area helps to collect rainwater before it lands on the soil, especially in light rains, increasing the overall water-holding potential of the landscape.

A large number of plant species will survive moist soils or periodic inundation. These plants provide a wide range of choices for planted infiltration/detention basins and drainage swales. Most inundated plants have a higher survival potential on well-drained alluvial soils than on fine textured shallow soils or clays.

Maintenance Needs for Stormwater Systems

All landscape treatments require maintenance. Landscapes designed to perform stormwater management functions are not necessarily more maintenance intensive than highly manicured conventional landscapes. A concave lawn requires the same mowing, fertilizing, and weeding as a convex one and often less irrigation because more rain is filtered into the underlying soil. Sometimes infiltration basins may require a different kind of maintenance than conventionally practiced.

Typical maintenance activities include periodic inspection of surface drainage systems to ensure clear flow lines, repair of eroded surfaces, adjustment or repair of drainage structures, soil cultivation or aeration, care of plant materials, replacement of dead plants, replenishment of mulch cover, irrigation, fertilizing, pruning and mowing. In addition, dead or stressed vegetation may indicate chemical dumping. Careful observation should be made of these areas to determine if such a problem exists.

Landscape maintenance can have a significant impact on soil permeability and its ability to support plant growth. Most plants concentrate the majority of their small absorbing roots in the upper 6 in. of the soil surface if a mulch or forest litter protects the surface. If the soil is exposed or bare, it can become so hot that surface roots will not grow in the upper 8 to 10 in. The common practice of removing all leaf litter and detritus with leaf blowers creates a hard-crusted soil surface of low permeability and high heat conduction. Proper mulching of the soil surface improves water retention and infiltration, while protecting the surface root zone from temperature extremes.

In addition to impacting permeability, landscape maintenance practices can have adverse effects on water quality. Because commonly used fertilizers and herbicides are a source of organic compounds, it is important to keep these practices to a minimum, and prevent overwatering.

When well maintained and designed, landscaped concave surfaces, infiltration basins, swales and bioretention areas can add aesthetic value while providing the framework for environmentally sound, comprehensive stormwater management systems.

Street Trees

Trees improve water quality by intercepting and storing rainfall on leaves and branch surfaces, thereby reducing runoff volumes and delaying the onset of peak flows. A single street tree can have a total leaf surface area of several hundred to several thousand ft^2, depending on species and size. This aboveground surface area created by trees and other plants greatly contributes to the water holding capacity of the land. They attenuate conveyance by increasing the soil's capacity to filter rainwater and reduce overland flow rates. By diminishing the impact of raindrops on un-vegetated soil, trees reduce soil erosion. Street trees also have the ability to reduce ambient temperature of stormwater runoff and absorb surface water pollutants.

When using street trees to achieve stormwater management goals, it is important to use tree species with wide canopies. Street tree design criteria should specify species expected to attain 20 to 30 ft canopies at maturity. Planter strips with adequate width and depth of soil volume are necessary to ensure tree vitality and reduce future maintenance. Structural soils also provide rooting space for large trees and can be specified along narrow planter strips and underneath sidewalks to enable continuous belowground soil and root connections.

3.2.5 Outdoor Work Areas

The site design and landscape details listed in previous sections are appropriate for uses where low concentrations of pollutants can be mitigated through infiltration, retention, and detention. Often in commercial and industrial sites, there are outdoor work areas in which a higher concentration of pollutants exists, and thus a higher potential of pollutants infiltrating the soil. These work areas often involve automobiles, equipment machinery, or other commercial and industrial uses, and require special consideration.

Outdoor work areas are usually isolated elements in a larger development. Infiltration and detention strategies are still appropriate for and can be applied to other areas of the site, such as parking lots, landscape areas, employee use areas, and bicycle path. It is only the outdoor work area within the development – such as the loading dock, fueling area, or equipment wash area – that requires a different drainage approach. This drainage approach is often precisely the opposite from the infiltration/detention strategy – in other words, collect and convey.

In these outdoor work areas, infiltration is discouraged and runoff is often routed directly to the sanitary sewer, not the storm drain. Because this runoff is being added to the loads normally received by the water treatment plants (publicly owned treatment works – POTWs), it raises several concerns that must be addressed in the planning and design stage. These include:

- Higher flows that could exceed the sewer system capacity
- Catastrophic spills that may cause harm to POTW operation
- A potential increase in pollutants

These concerns can be addressed at policy, management, and site planning levels.

Policy

Piping runoff and process water from outdoor work areas directly to the sanitary sewer for treatment by a downstream POTW displaces the problem of reducing stormwater pollution. Municipal stormwater programs and/or private developers can work with the local POTW to develop solutions that minimize effects on the treatment facility. It should be noted that many POTWs have traditionally prohibited the discharge of stormwater to their systems. However, these prohibitions are being reviewed in light of the benefits possible from such diversions.

Management

Commercial and industrial sites that host special activities need to implement a pollution prevention program minimizing hazardous material use and waste. For example, if restaurant grease traps are directly connected to the sanitary sewer, proper management programs can mitigate the amount of grease that escapes from the trap, clogging sewer systems and causing overflows or damage to downstream systems.

Site Planning

Outdoor work areas can be designed in particular ways to reduce their impacts on both stormwater quality and sewage treatment plants.

- Create an impermeable surface such as concrete or asphalt, or a prefabricated metal drip pan, depending on the use.
- Cover the area with a roof. This prevents rain from falling on the work area and becoming polluted runoff.
- Berm or mound around the perimeter of the area to prevent water from adjacent areas to flow on to the surface of the work area.
- Directly connect runoff. Unlike other areas, runoff from these work areas is directly connected to the sanitary sewer or other specialized containment systems. This allows the more highly concentrated pollutants from these areas to receive special treatment that removes particular constituents. Approval for this connection must be obtained from the appropriate sanitary sewer agency.
- Locate the work area away from storm drains or catch basins. If the work area is adjacent to, or directly upstream from a storm drain or landscape drainage feature (e.g., bioswales), debris or liquids from the work area can migrate into the stormwater system.
- Plan the work area to prevent run-on. This can be accomplished by raising the work area or by diverting run-on around the work area.

These design elements are general considerations for work areas. In designing any outdoor work area, evaluate local ordinances affecting the type of work area, as many local jurisdictions have specific requirements.

Some activities are common to many commercial and industrial sites. These include garbage and recycling, maintenance and storage, and loading. These activities can have a significant

negative impact on stormwater quality, and require special attention to the siting and design of the activity area.

3.2.6 Maintenance and Storage Areas

To reduce the possibility of contact with stormwater runoff, maintenance and storage areas can be sited away from drainage paths and waterways, and covered. Implementing a regular maintenance plan for sweeping, litter control, and spill cleanup also helps prevent stormwater pollution.

Specifying impermeable surfaces for vehicle and equipment maintenance areas will reduce the chance of pollutant infiltration. A concrete surface will usually last much longer than an asphalt one, as vehicle fluids can either dissolve asphalt or be absorbed by the asphalt and released later. See Figure 3-18.

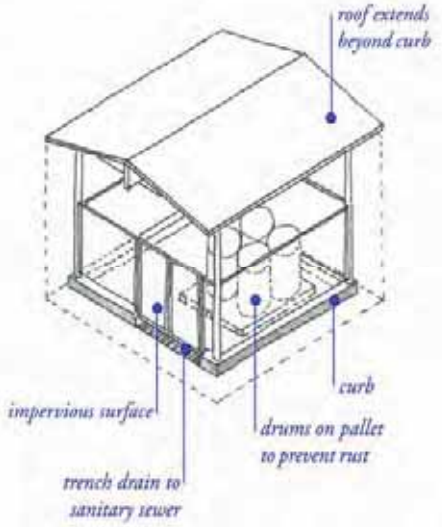


Figure 3-18
Material Storage

3.2.7 Vehicle and Equipment Washing Areas

It is generally advisable to cover areas used for regular washing of vehicles, trucks, or equipment, surround them with a perimeter berm, and clearly mark them as a designated washing area. Sumps or drain lines can be installed to collect wash water, which may be treated for reuse or recycling, or for discharge to the sanitary sewer. The POTW may require some form of pretreatment, such as a trap, for these areas.

Fueling and maintenance activities must be isolated from the vehicle washing facilities. These activities have specific requirements, described later in this section.

Storage of bulk materials, fuels, oils, solvents, other chemicals, and process equipment should be accommodated on an impervious surface covered with a roof. To reduce the chances of corrosion, materials should not be stored directly on the ground, but supported by a wire mesh or other flooring above the impervious pavement. In uncovered areas, drums or other containers can be stored at a slight angle to prevent ponding of rainwater from rusting the lids. Liquid containers should be stored in a designated impervious area that is roofed, fenced within a berm, to prevent spills from flowing into the storm drain.

If hazardous materials are being used or stored, additional specific local, state, or federal requirements may apply.

3.2.8 Loading Area

Loading areas and docks can be designed with a roof or overhang, and a surrounding curb or berm. See Figure 3-19. The area should be graded to direct flow toward an inlet with a shutoff valve or dead-end sump. The sump must be designed with enough capacity to hold a spill while the valve is closed. If the sump has a valve, it must be kept in the closed position and require an

action to open it. All sumps must have a sealed bottom so they cannot infiltrate water. Contaminated accumulated waste and liquid must not be discharged to a storm drain and may be discharged to the sanitary sewer only with the POTW's permission. If the waste is not approved for discharge to the sanitary sewer, it must be conveyed to a hazardous waste (or other offsite disposal) facility, and may require pretreatment. Some specific uses have unique requirements.

3.2.9 Trash Storage Areas

Areas designated for trash storage can be covered to protect containers from rainfall. Where covering the trash storage area is not feasible, the area can be protected from run on using grading and berms, and connected to the sanitary sewer to prevent leaks from leaving the designated trash storage area enclosure.

3.2.10 Wash Areas

Areas designated for washing of floor mats, containers, exhaust filters, and similar items can be covered and enclosed to protect the area from rainfall and from overspray leaving the area. These areas can also be connected to the sanitary sewer to prevent wash waters from leaving the designated enclosures. A benefit of covering and enclosing these areas is that vectors may be reduced and aesthetics of the area improved.

3.2.11 Fueling Areas

In all vehicle and equipment fueling areas, plans must be developed for cleaning near fuel dispensers, emergency spill cleanup, and routine inspections to prevent leaks and ensure properly functioning equipment.

If the fueling activities are minor, fueling can be performed in a designated, covered, and bermed area that will not allow run-on of stormwater or runoff of spills.

Retail gasoline outlets and vehicle fueling areas have specific design guidelines. These are described in a Best Management Practice Guide for retail gasoline outlets developed by the California Stormwater Quality Task Force, in cooperation with major gasoline corporations. The practice guide addresses standards for existing, new, or substantially remodeled facilities. In addition, some municipal stormwater permits require RGOs to provide appropriate runoff treatment.

Fuel dispensing areas are defined as extending 6.5 ft from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus 1 ft, whichever is less. These areas must be paved with smooth impervious surfaces, such as Portland cement concrete, with a 2-4% slope to prevent ponding, and must be covered. The cover must not drain onto the work area. The rest of the site must separate the fuel dispensing area by a grade break that prevents run-on of stormwater.

Within the gas station, the outdoor trash receptacle area (garbage and recycling), and the air/water supply area must be paved and graded to prevent stormwater run-on. Trash receptacles should be covered.

Site Design & Landscape Planning SD-10

Design Objectives

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- ☑ Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

Description

Each project site possesses unique topographic, hydrologic, and vegetative features, some of which are more suitable for development than others. Integrating and incorporating appropriate landscape planning methodologies into the project design is the most effective action that can be done to minimize surface and groundwater contamination from stormwater.

Approach

Landscape planning should couple consideration of land suitability for urban uses with consideration of community goals and projected growth. Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

Design Considerations

Design requirements for site design and landscapes planning should conform to applicable standards and specifications of agencies with jurisdiction and be consistent with applicable General Plan and Local Area Plan policies.

Designing New Installations

Begin the development of a plan for the landscape unit with attention to the following general principles:

- Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.
- Map and assess land suitability for urban uses. Include the following landscape features in the assessment: wooded land, open unwooded land, steep slopes, erosion-prone soils, foundation suitability, soil suitability for waste disposal, aquifers, aquifer recharge areas, wetlands, floodplains, surface waters, agricultural lands, and various categories of urban land use. When appropriate, the assessment can highlight outstanding local or regional resources that the community determines should be protected (e.g., a scenic area, recreational area, threatened species habitat, farmland, fish run). Mapping and assessment should recognize not only these resources but also additional areas needed for their sustenance.

Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

Conserve Natural Areas during Landscape Planning

If applicable, the following items are required and must be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.
- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.
- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.
- Promote natural vegetation by using parking lot islands and other landscaped areas.
- Preserve riparian areas and wetlands.

Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.
- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and

regulations to discourage the clearing, filling, and channelization of these features. Utilize them in drainage networks in preference to pipes, culverts, and engineered ditches.

- Evaluating infiltration opportunities by referring to the stormwater management manual for the jurisdiction and pay particular attention to the selection criteria for avoiding groundwater contamination, poor soils, and hydrogeological conditions that cause these facilities to fail. If necessary, locate developments with large amounts of impervious surfaces or a potential to produce relatively contaminated runoff away from groundwater recharge areas.

Protection of Slopes and Channels during Landscape Design

- Convey runoff safely from the tops of slopes.
- Avoid disturbing steep or unstable slopes.
- Avoid disturbing natural channels.
- Stabilize disturbed slopes as quickly as possible.
- Vegetate slopes with native or drought tolerant vegetation.
- Control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems.
- Stabilize temporary and permanent channel crossings as quickly as possible, and ensure that increases in run-off velocity and frequency caused by the project do not erode the channel.
- Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion. Energy dissipaters shall be installed in such a way as to minimize impacts to receiving waters.
- Line on-site conveyance channels where appropriate, to reduce erosion caused by increased flow velocity due to increases in tributary impervious area. The first choice for linings should be grass or some other vegetative surface, since these materials not only reduce runoff velocities, but also provide water quality benefits from filtration and infiltration. If velocities in the channel are high enough to erode grass or other vegetative linings, riprap, concrete, soil cement, or geo-grid stabilization are other alternatives.
- Consider other design principles that are comparable and equally effective.

Redeveloping Existing Installations

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Redevelopment may present significant opportunity to add features which had not previously been implemented. Examples include incorporation of depressions, areas of permeable soils, and swales in newly redeveloped areas. While some site constraints may exist due to the status of already existing infrastructure, opportunities should not be missed to maximize infiltration, slow runoff, reduce impervious areas, disconnect directly connected impervious areas.

Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Stormwater Management Manual for Western Washington, Washington State Department of Ecology, August 2001.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

Vegetated Swale TC-30

Design Considerations

- Tributary Area
- Area Required
- Slope
- Water Availability

Description

Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curbs, gutters and storm sewer systems.

Targeted Constituents

☑	Sediment	▲
☑	Nutrients	●
☑	Trash	●
☑	Metals	▲
☑	Bacteria	●
☑	Oil and Grease	▲
☑	Organics	▲

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

California Experience

Caltrans constructed and monitored six vegetated swales in southern California. These swales were generally effective in reducing the volume and mass of pollutants in runoff. Even in the areas where the annual rainfall was only about 10 inches/yr, the vegetation did not require additional irrigation. One factor that strongly affected performance was the presence of large numbers of gophers at most of the sites. The gophers created earthen mounds, destroyed vegetation, and generally reduced the effectiveness of the controls for TSS reduction.

Advantages

- If properly designed, vegetated, and operated, swales can serve as an aesthetic, potentially inexpensive urban development or roadway drainage conveyance measure with significant collateral water quality benefits.

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

- Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible.

Limitations

- Can be difficult to avoid channelization.
- May not be appropriate for industrial sites or locations where spills may occur
- Grassed swales cannot treat a very large drainage area. Large areas may be divided and treated using multiple swales.
- A thick vegetative cover is needed for these practices to function properly.
- They are impractical in areas with steep topography.
- They are not effective and may even erode when flow velocities are high, if the grass cover is not properly maintained.
- In some places, their use is restricted by law: many local municipalities require curb and gutter systems in residential areas.
- Swales are mores susceptible to failure if not properly maintained than other treatment BMPs.

Design and Sizing Guidelines

- Flow rate based design determined by local requirements or sized so that 85% of the annual runoff volume is discharged at less than the design rainfall intensity.
- Swale should be designed so that the water level does not exceed 2/3rds the height of the grass or 4 inches, which ever is less, at the design treatment rate.
- Longitudinal slopes should not exceed 2.5%
- Trapezoidal channels are normally recommended but other configurations, such as parabolic, can also provide substantial water quality improvement and may be easier to mow than designs with sharp breaks in slope.
- Swales constructed in cut are preferred, or in fill areas that are far enough from an adjacent slope to minimize the potential for gopher damage. Do not use side slopes constructed of fill, which are prone to structural damage by gophers and other burrowing animals.
- A diverse selection of low growing, plants that thrive under the specific site, climatic, and watering conditions should be specified. Vegetation whose growing season corresponds to the wet season are preferred. Drought tolerant vegetation should be considered especially for swales that are not part of a regularly irrigated landscaped area.
- The width of the swale should be determined using Manning's Equation using a value of 0.25 for Manning's n.

Construction/Inspection Considerations

- Include directions in the specifications for use of appropriate fertilizer and soil amendments based on soil properties determined through testing and compared to the needs of the vegetation requirements.
- Install swales at the time of the year when there is a reasonable chance of successful establishment without irrigation; however, it is recognized that rainfall in a given year may not be sufficient and temporary irrigation may be used.
- If sod tiles must be used, they should be placed so that there are no gaps between the tiles; stagger the ends of the tiles to prevent the formation of channels along the swale or strip.
- Use a roller on the sod to ensure that no air pockets form between the sod and the soil.
- Where seeds are used, erosion controls will be necessary to protect seeds for at least 75 days after the first rainfall of the season.

Performance

The literature suggests that vegetated swales represent a practical and potentially effective technique for controlling urban runoff quality. While limited quantitative performance data exists for vegetated swales, it is known that check dams, slight slopes, permeable soils, dense grass cover, increased contact time, and small storm events all contribute to successful pollutant removal by the swale system. Factors decreasing the effectiveness of swales include compacted soils, short runoff contact time, large storm events, frozen ground, short grass heights, steep slopes, and high runoff velocities and discharge rates.

Conventional vegetated swale designs have achieved mixed results in removing particulate pollutants. A study performed by the Nationwide Urban Runoff Program (NURP) monitored three grass swales in the Washington, D.C., area and found no significant improvement in urban runoff quality for the pollutants analyzed. However, the weak performance of these swales was attributed to the high flow velocities in the swales, soil compaction, steep slopes, and short grass height.

Another project in Durham, NC, monitored the performance of a carefully designed artificial swale that received runoff from a commercial parking lot. The project tracked 11 storms and concluded that particulate concentrations of heavy metals (Cu, Pb, Zn, and Cd) were reduced by approximately 50 percent. However, the swale proved largely ineffective for removing soluble nutrients.

The effectiveness of vegetated swales can be enhanced by adding check dams at approximately 17 meter (50 foot) increments along their length (See Figure 1). These dams maximize the retention time within the swale, decrease flow velocities, and promote particulate settling. Finally, the incorporation of vegetated filter strips parallel to the top of the channel banks can help to treat sheet flows entering the swale.

Only 9 studies have been conducted on all grassed channels designed for water quality (Table 1). The data suggest relatively high removal rates for some pollutants, but negative removals for some bacteria, and fair performance for phosphorus.

Table 1 Grassed swale pollutant removal efficiency data

	Removal Efficiencies (% Removal)						
Study	TSS	TP	TN	NO_3	Metals	Bacteria	Type
Caltrans 2002	77	8	67	66	83-90	-33	dry swales
Goldberg 1993	67.8	4.5	-	31.4	42–62	-100	grassed channel
Seattle Metro and Washington Department of Ecology 1992	60	45	-	-25	2–16	-25	grassed channel
Seattle Metro and Washington Department of Ecology, 1992	83	29	-	-25	46–73	-25	grassed channel
Wang et al., 1981	80	-	-	-	70–80	-	dry swale
Dorman et al., 1989	98	18	-	45	37–81	-	dry swale
Harper, 1988	87	83	84	80	88–90	-	dry swale
Kercher et al., 1983	99	99	99	99	99	-	dry swale
Harper, 1988.	81	17	40	52	37–69	-	wet swale
Koon, 1995	67	39	-	9	-35 to 6	-	wet swale

While it is difficult to distinguish between different designs based on the small amount of available data, grassed channels generally have poorer removal rates than wet and dry swales, although some swales appear to export soluble phosphorus (Harper, 1988; Koon, 1995). It is not clear why swales export bacteria. One explanation is that bacteria thrive in the warm swale soils.

Siting Criteria

The suitability of a swale at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the swale system (Schueler et al., 1992). In general, swales can be used to serve areas of less than 10 acres, with slopes no greater than 5 %. Use of natural topographic lows is encouraged and natural drainage courses should be regarded as significant local resources to be kept in use (Young et al., 1996).

Selection Criteria (NCTCOG, 1993)

- Comparable performance to wet basins
- Limited to treating a few acres
- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

The topography of the site should permit the design of a channel with appropriate slope and cross-sectional area. Site topography may also dictate a need for additional structural controls. Recommendations for longitudinal slopes range between 2 and 6 percent. Flatter slopes can be used, if sufficient to provide adequate conveyance. Steep slopes increase flow velocity, decrease detention time, and may require energy dissipating and grade check. Steep slopes also can be managed using a series of check dams to terrace the swale and reduce the slope to within acceptable limits. The use of check dams with swales also promotes infiltration.

Additional Design Guidelines

Most of the design guidelines adopted for swale design specify a minimum hydraulic residence time of 9 minutes. This criterion is based on the results of a single study conducted in Seattle, Washington (Seattle Metro and Washington Department of Ecology, 1992), and is not well supported. Analysis of the data collected in that study indicates that pollutant removal at a residence time of 5 minutes was not significantly different, although there is more variability in that data. Therefore, additional research in the design criteria for swales is needed. Substantial pollutant removal has also been observed for vegetated controls designed solely for conveyance (Barrett et al, 1998); consequently, some flexibility in the design is warranted.

Many design guidelines recommend that grass be frequently mowed to maintain dense coverage near the ground surface. Recent research (Colwell et al., 2000) has shown mowing frequency or grass height has little or no effect on pollutant removal.

Summary of Design Recommendations

1) The swale should have a length that provides a minimum hydraulic residence time of at least 10 minutes. The maximum bottom width should not exceed 10 feet unless a dividing berm is provided. The depth of flow should not exceed 2/3rds the height of the grass at the peak of the water quality design storm intensity. The channel slope should not exceed 2.5%.

2) A design grass height of 6 inches is recommended.

3) Regardless of the recommended detention time, the swale should be not less than 100 feet in length.

4) The width of the swale should be determined using Manning's Equation, at the peak of the design storm, using a Manning's n of 0.25.

5) The swale can be sized as both a treatment facility for the design storm and as a conveyance system to pass the peak hydraulic flows of the 100-year storm if it is located "on-line." The side slopes should be no steeper than 3:1 (H:V).

6) Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible. If flow is to be introduced through curb cuts, place pavement slightly above the elevation of the vegetated areas. Curb cuts should be at least 12 inches wide to prevent clogging.

7) Swales must be vegetated in order to provide adequate treatment of runoff. It is important to maximize water contact with vegetation and the soil surface. For general purposes, select fine, close-growing, water-resistant grasses. If possible, divert runoff (other than necessary irrigation) during the period of vegetation

establishment. Where runoff diversion is not possible, cover graded and seeded areas with suitable erosion control materials.

Maintenance

The useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely. The maintenance objectives for vegetated swale systems include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover.

Maintenance activities should include periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages. Cuttings should be removed from the channel and disposed in a local composting facility. Accumulated sediment should also be removed manually to avoid concentrated flows in the swale. The application of fertilizers and pesticides should be minimal.

Another aspect of a good maintenance plan is repairing damaged areas within a channel. For example, if the channel develops ruts or holes, it should be repaired utilizing a suitable soil that is properly tamped and seeded. The grass cover should be thick; if it is not, reseed as necessary. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals (e.g., silt, grass cuttings) must be disposed in accordance with local or State requirements. Maintenance of grassed swales mostly involves maintenance of the grass or wetland plant cover. Typical maintenance activities are summarized below:

- Inspect swales at least twice annually for erosion, damage to vegetation, and sediment and debris accumulation preferably at the end of the wet season to schedule summer maintenance and before major fall runoff to be sure the swale is ready for winter. However, additional inspection after periods of heavy runoff is desirable. The swale should be checked for debris and litter, and areas of sediment accumulation.
- Grass height and mowing frequency may not have a large impact on pollutant removal. Consequently, mowing may only be necessary once or twice a year for safety or aesthetics or to suppress weeds and woody vegetation.
- Trash tends to accumulate in swale areas, particularly along highways. The need for litter removal is determined through periodic inspection, but litter should always be removed prior to mowing.
- Sediment accumulating near culverts and in channels should be removed when it builds up to 75 mm (3 in.) at any spot, or covers vegetation.
- Regularly inspect swales for pools of standing water. Swales can become a nuisance due to mosquito breeding in standing water if obstructions develop (e.g. debris accumulation, invasive vegetation) and/or if proper drainage slopes are not implemented and maintained.

Cost

Construction Cost

Little data is available to estimate the difference in cost between various swale designs. One study (SWRPC, 1991) estimated the construction cost of grassed channels at approximately $0.25 per ft². This price does not include design costs or contingencies. Brown and Schueler (1997) estimate these costs at approximately 32 percent of construction costs for most stormwater management practices. For swales, however, these costs would probably be significantly higher since the construction costs are so low compared with other practices. A more realistic estimate would be a total cost of approximately $0.50 per ft², which compares favorably with other stormwater management practices.

Table 2 Swale Cost Estimate (SEWRPC, 1991)

Component	Unit	Extent	Unit Cost			Total Cost		
			Low	Moderate	High	Low	Moderate	High
Mobilization / Demobilization-Light	Swale	1	$107	$274	$441	$107	$274	$441
Site Preparation								
Clearing[b]	Acre	0.5	$2,200	$3,800	$5,400	$1,100	$1,900	$2,700
Grubbing[c]	Acre	0.25	$3,800	$5,200	$6,600	$950	$1,300	$1,650
General Excavation[d]	Yd^3	372	$2.10	$3.70	$5.30	$781	$1,376	$1,972
Level and Till[e]	Yd^2	1,210	$0.20	$0.35	$0.50	$242	$424	$605
Sites Development								
Salvaged Topsoil Seed, and Mulch[f]	Yd^2	1,210	$0.40	$1.00	$1.60	$484	$1,210	$1,936
Sod[g]	Yd^2	1,210	$1.20	$2.40	$3.60	$1,452	$2,904	$4,356
Subtotal	--	--	--	--	--	$5,116	$9,388	$13,660
Contingencies	Swale	1	25%	25%	25%	$1,279	$2,347	$3,415
Total	--	--	--	--	--	$6,395	$11,735	$17,075

Source: (SEWRPC, 1991)

Note: Mobilization/demobilization refers to the organization and planning involved in establishing a vegetative swale.

[a] Swale has a bottom width of 1.0 foot, a top width of 10 feet with 1:3 side slopes, and a 1,000-foot length.

[b] Area cleared = (top width + 10 feet) x swale length.

[c] Area grubbed = (top width x swale length).

[d] Volume excavated = (0.67 x top width x swale depth) x swale length (parabolic cross-section).

[e] Area tilled = $\left(\text{top width} + \frac{8(\text{swale depth}^2)}{3(\text{top width})}\right) \times$ swale length (parabolic cross-section).

[f] Area seeded = area cleared x 0.5.

[g] Area sodded = area cleared x 0.5.

Table 3 Estimated Maintenance Costs (SEWRPC. 1991)

Component	Unit Cost	Swale Size (Depth and Top Width)		Comment
		1.5 Foot Depth, One-Foot Bottom Width, 10-Foot Top Width	3-Foot Depth, 3-Foot Bottom Width, 21-Foot Top Width	
Lawn Mowing	$0.85 / 1,000 ft²/ mowing	$0.14 / linear foot	$0.21 / linear foot	Lawn maintenance area=(top width + 10 feet) x length. Mow eight times per year
General Lawn Care	$9.00 / 1,000 ft²/ year	$0.18 / linear foot	$0.28 / linear foot	Lawn maintenance area = (top width + 10 feet) x length
Swale Debris and Litter Removal	$0.10 / linear foot / year	$0.10 / linear foot	$0.10 / linear foot	--
Grass Reseeding with Mulch and Fertilizer	$0.30 / yd²	$0.01 / linear foot	$0.01 / linear foot	Area revegetated equals 1% of lawn maintenance area per year
Program Administration and Swale Inspection	$0.15 / linear foot / year, plus $25 / inspection	$0.15 / linear foot	$0.15 / linear foot	Inspect four times per year
Total	--	**$0.58 / linear foot**	**$ 0.75 / linear foot**	--

Maintenance Cost

Caltrans (2002) estimated the expected annual maintenance cost for a swale with a tributary area of approximately 2 ha at approximately $2,700. Since almost all maintenance consists of mowing, the cost is fundamentally a function of the mowing frequency. Unit costs developed by SEWRPC are shown in Table 3. In many cases vegetated channels would be used to convey runoff and would require periodic mowing as well, so there may be little additional cost for the water quality component. Since essentially all the activities are related to vegetation management, no special training is required for maintenance personnel.

References and Sources of Additional Information

Barrett, Michael E., Walsh, Patrick M., Malina, Joseph F., Jr., Charbeneau, Randall J, 1998, "Performance of vegetative controls for treating highway runoff," *ASCE Journal of Environmental Engineering*, Vol. 124, No. 11, pp. 1121-1128.

Brown, W., and T. Schueler. 1997. *The Economics of Stormwater BMPs in the Mid-Atlantic Region*. Prepared for the Chesapeake Research Consortium, Edgewater, MD, by the Center for Watershed Protection, Ellicott City, MD.

Center for Watershed Protection (CWP). 1996. *Design of Stormwater Filtering Systems*. Prepared for the Chesapeake Research Consortium, Solomons, MD, and USEPA Region V, Chicago, IL, by the Center for Watershed Protection, Ellicott City, MD.

Colwell, Shanti R., Horner, Richard R., and Booth, Derek B., 2000. *Characterization of Performance Predictors and Evaluation of Mowing Practices in Biofiltration Swales*. Report to King County Land And Water Resources Division and others by Center for Urban Water Resources Management, Department of Civil and Environmental Engineering, University of Washington, Seattle, WA

Dorman, M.E., J. Hartigan, R.F. Steg, and T. Quasebarth. 1989. *Retention, Detention and Overland Flow for Pollutant Removal From Highway Stormwater Runoff. Vol. 1*. FHWA/RD 89/202. Federal Highway Administration, Washington, DC.

Goldberg. 1993. *Dayton Avenue Swale Biofiltration Study*. Seattle Engineering Department, Seattle, WA.

Harper, H. 1988. *Effects of Stormwater Management Systems on Groundwater Quality*. Prepared for Florida Department of Environmental Regulation, Tallahassee, FL, by Environmental Research and Design, Inc., Orlando, FL.

Kercher, W.C., J.C. Landon, and R. Massarelli. 1983. Grassy swales prove cost-effective for water pollution control. *Public Works*, 16: 53–55.

Koon, J. 1995. *Evaluation of Water Quality Ponds and Swales in the Issaquah/East Lake Sammamish Basins*. King County Surface Water Management, Seattle, WA, and Washington Department of Ecology, Olympia, WA.

Metzger, M. E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. 2002. The Dark Side Of Stormwater Runoff Management: Disease Vectors Associated With Structural BMPs. Stormwater 3(2): 24-39.Oakland, P.H. 1983. An evaluation of stormwater pollutant removal

through grassed swale treatment. In *Proceedings of the International Symposium of Urban Hydrology, Hydraulics and Sediment Control, Lexington, KY*. pp. 173–182.

Occoquan Watershed Monitoring Laboratory. 1983. Final Report: *Metropolitan Washington Urban Runoff Project*. Prepared for the Metropolitan Washington Council of Governments, Washington, DC, by the Occoquan Watershed Monitoring Laboratory, Manassas, VA.

Pitt, R., and J. McLean. 1986. *Toronto Area Watershed Management Strategy Study: Humber River Pilot Watershed Project*. Ontario Ministry of Environment, Toronto, ON.

Schueler, T. 1997. Comparative Pollutant Removal Capability of Urban BMPs: A reanalysis. *Watershed Protection Techniques* 2(2):379–383.

Seattle Metro and Washington Department of Ecology. 1992. *Biofiltration Swale Performance: Recommendations and Design Considerations*. Publication No. 657. Water Pollution Control Department, Seattle, WA.

Southeastern Wisconsin Regional Planning Commission (SWRPC). 1991. *Costs of Urban Nonpoint Source Water Pollution Control Measures*. Technical report no. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI.

U.S. EPA, 1999, Stormwater Fact Sheet: Vegetated Swales, Report # 832-F-99-006 http://www.epa.gov/owm/mtb/vegswale.pdf, Office of Water, Washington DC.

Wang, T., D. Spyridakis, B. Mar, and R. Horner. 1981. *Transport, Deposition and Control of Heavy Metals in Highway Runoff*. FHWA-WA-RD-39-10. University of Washington, Department of Civil Engineering, Seattle, WA.

Washington State Department of Transportation, 1995, *Highway Runoff Manual*, Washington State Department of Transportation, Olympia, Washington.

Welborn, C., and J. Veenhuis. 1987. *Effects of Runoff Controls on the Quantity and Quality of Urban Runoff in Two Locations in Austin, TX*. USGS Water Resources Investigations Report No. 87-4004. U.S. Geological Survey, Reston, VA.

Yousef, Y., M. Wanielista, H. Harper, D. Pearce, and R. Tolbert. 1985. *Best Management Practices: Removal of Highway Contaminants By Roadside Swales*. University of Central Florida and Florida Department of Transportation, Orlando, FL.

Yu, S., S. Barnes, and V. Gerde. 1993. *Testing of Best Management Practices for Controlling Highway Runoff*. FHWA/VA-93-R16. Virginia Transportation Research Council, Charlottesville, VA.

Information Resources

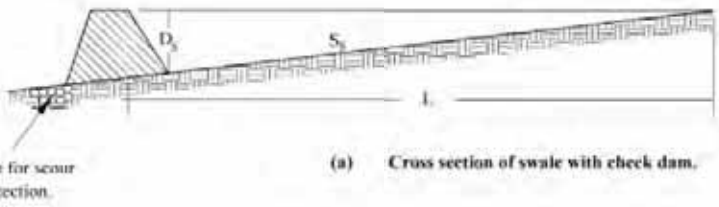
Maryland Department of the Environment (MDE). 2000. *Maryland Stormwater Design Manual*. www.mde.state.md.us/environment/wma/stormwatermanual. Accessed May 22, 2001.

Reeves, E. 1994. Performance and Condition of Biofilters in the Pacific Northwest. *Watershed Protection Techniques* 1(3):117–119.

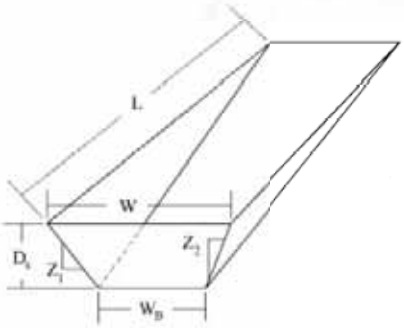
Seattle Metro and Washington Department of Ecology. 1992. *Biofiltration Swale Performance.* Recommendations and Design Considerations. Publication No. 657. Seattle Metro and Washington Department of Ecology, Olympia, WA.

USEPA 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters.* EPA-840-B-92-002. U.S. Environmental Protection Agency, Office of Water. Washington, DC.

Watershed Management Institute (WMI). 1997. *Operation, Maintenance, and Management of Stormwater Management Systems.* Prepared for U.S. Environmental Protection Agency, Office of Water. Washington, DC, by the Watershed Management Institute, Ingleside, MD.



(a) Cross section of swale with check dam.



(b) Dimensional view of swale impoundment area.

Notation:
L = Length of swale impoundment area per check dam (ft)
D_S = Depth of check dam (ft)
S_B = Bottom slpe of swale (ft/ft)
W = Top width of check dam (ft)
W_B = Bottom width of check dam (ft)
$Z_{1&2}$ = Ratio of horizontal to vertical change in swale side slope (ft/ft)

Extended Detention Basin TC-22

Design Considerations

- Tributary Area
- Area Required
- Hydraulic Head

Description

Dry extended detention ponds (a.k.a. dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain the stormwater runoff from a water quality design storm for some minimum time (e.g., 48 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. They can also be used to provide flood control by including additional flood detention storage.

Targeted Constituents

☑	Sediment	▲
☑	Nutrients	●
☑	Trash	■
☑	Metals	▲
☑	Bacteria	▲
☑	Oil and Grease	▲
☑	Organics	▲

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

California Experience

Caltrans constructed and monitored 5 extended detention basins in southern California with design drain times of 72 hours. Four of the basins were earthen, less costly and had substantially better load reduction because of infiltration that occurred, than the concrete basin. The Caltrans study reaffirmed the flexibility and performance of this conventional technology. The small headloss and few siting constraints suggest that these devices are one of the most applicable technologies for stormwater treatment.

Advantages

- Due to the simplicity of design, extended detention basins are relatively easy and inexpensive to construct and operate.
- Extended detention basins can provide substantial capture of sediment and the toxics fraction associated with particulates.
- Widespread application with sufficient capture volume can provide significant control of channel erosion and enlargement caused by changes to flow frequency

relationships resulting from the increase of impervious cover in a watershed.

Limitations

- Limitation of the diameter of the orifice may not allow use of extended detention in watersheds of less than 5 acres (would require an orifice with a diameter of less than 0.5 inches that would be prone to clogging).
- Dry extended detention ponds have only moderate pollutant removal when compared to some other structural stormwater practices, and they are relatively ineffective at removing soluble pollutants.
- Although wet ponds can increase property values, dry ponds can actually detract from the value of a home due to the adverse aesthetics of dry, bare areas and inlet and outlet structures.

Design and Sizing Guidelines

- Capture volume determined by local requirements or sized to treat 85% of the annual runoff volume.
- Outlet designed to discharge the capture volume over a period of hours.
- Length to width ratio of at least 1.5:1 where feasible.
- Basin depths optimally range from 2 to 5 feet.
- Include energy dissipation in the inlet design to reduce resuspension of accumulated sediment.
- A maintenance ramp and perimeter access should be included in the design to facilitate access to the basin for maintenance activities and for vector surveillance and control.
- Use a draw down time of 48 hours in most areas of California. Draw down times in excess of 48 hours may result in vector breeding, and should be used only after coordination with local vector control authorities. Draw down times of less than 48 hours should be limited to BMP drainage areas with coarse soils that readily settle and to watersheds where warming may be determined to downstream fisheries.

Construction/Inspection Considerations

- Inspect facility after first large to storm to determine whether the desired residence time has been achieved.
- When constructed with small tributary area, orifice sizing is critical and inspection should verify that flow through additional openings such as bolt holes does not occur.

Performance

One objective of stormwater management practices can be to reduce the flood hazard associated with large storm events by reducing the peak flow associated with these storms. Dry extended detention basins can easily be designed for flood control, and this is actually the primary purpose of most detention ponds.

Dry extended detention basins provide moderate pollutant removal, provided that the recommended design features are incorporated. Although they can be effective at removing some pollutants through settling, they are less effective at removing soluble pollutants because of the absence of a permanent pool. Several studies are available on the effectiveness of dry extended detention ponds including one recently concluded by Caltrans (2002).

The load reduction is greater than the concentration reduction because of the substantial infiltration that occurs. Although the infiltration of stormwater is clearly beneficial to surface receiving waters, there is the potential for groundwater contamination. Previous research on the effects of incidental infiltration on groundwater quality indicated that the risk of contamination is minimal.

There were substantial differences in the amount of infiltration that were observed in the earthen basins during the Caltrans study. On average, approximately 40 percent of the runoff entering the unlined basins infiltrated and was not discharged. The percentage ranged from a high of about 60 percent to a low of only about 8 percent for the different facilities. Climatic conditions and local water table elevation are likely the principal causes of this difference. The least infiltration occurred at a site located on the coast where humidity is higher and the basin invert is within a few meters of sea level. Conversely, the most infiltration occurred at a facility located well inland in Los Angeles County where the climate is much warmer and the humidity is less, resulting in lower soil moisture content in the basin floor at the beginning of storms.

Vegetated detention basins appear to have greater pollutant removal than concrete basins. In the Caltrans study, the concrete basin exported sediment and associated pollutants during a number of storms. Export was not as common in the earthen basins, where the vegetation appeared to help stabilize the retained sediment.

Siting Criteria

Dry extended detention ponds are among the most widely applicable stormwater management practices and are especially useful in retrofit situations where their low hydraulic head requirements allow them to be sited within the constraints of the existing storm drain system. In addition, many communities have detention basins designed for flood control. It is possible to modify these facilities to incorporate features that provide water quality treatment and/or channel protection. Although dry extended detention ponds can be applied rather broadly, designers need to ensure that they are feasible at the site in question. This section provides basic guidelines for siting dry extended detention ponds.

In general, dry extended detention ponds should be used on sites with a minimum area of 5 acres. With this size catchment area, the orifice size can be on the order of 0.5 inches. On smaller sites, it can be challenging to provide channel or water quality control because the orifice diameter at the outlet needed to control relatively small storms becomes very small and thus prone to clogging. In addition, it is generally more cost-effective to control larger drainage areas due to the economies of scale.

Extended detention basins can be used with almost all soils and geology, with minor design adjustments for regions of rapidly percolating soils such as sand. In these areas, extended detention ponds may need an impermeable liner to prevent ground water contamination.

The base of the extended detention facility should not intersect the water table. A permanently wet bottom may become a mosquito breeding ground. Research in Southwest Florida (Santana et al., 1994) demonstrated that intermittently flooded systems, such as dry extended detention ponds, produce more mosquitoes than other pond systems, particularly when the facilities remained wet for more than 3 days following heavy rainfall.

A study in Prince George's County, Maryland, found that stormwater management practices can increase stream temperatures (Galli, 1990). Overall, dry extended detention ponds increased temperature by about 5°F. In cold water streams, dry ponds should be designed to detain stormwater for a relatively short time (i.e., 24 hours) to minimize the amount of warming that occurs in the basin.

Additional Design Guidelines

In order to enhance the effectiveness of extended detention basins, the dimensions of the basin must be sized appropriately. Merely providing the required storage volume will not ensure maximum constituent removal. By effectively configuring the basin, the designer will create a long flow path, promote the establishment of low velocities, and avoid having stagnant areas of the basin. To promote settling and to attain an appealing environment, the design of the basin should consider the length to width ratio, cross-sectional areas, basin slopes and pond configuration, and aesthetics (Young et al., 1996).

Energy dissipation structures should be included for the basin inlet to prevent resuspension of accumulated sediment. The use of stilling basins for this purpose should be avoided because the standing water provides a breeding area for mosquitoes.

Extended detention facilities should be sized to completely capture the water quality volume. A micropool is often recommended for inclusion in the design and one is shown in the schematic diagram. These small permanent pools greatly increase the potential for mosquito breeding and complicate maintenance activities; consequently, they are not recommended for use in California.

A large aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W) where feasible. Basin depths optimally range from 2 to 5 feet.

The facility's drawdown time should be regulated by an orifice or weir. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes. The outlet design implemented by Caltrans in the facilities constructed in San Diego County used an outlet riser with orifices

Figure 1
Example of Extended Detention Outlet Structure

sized to discharge the water quality volume, and the riser overflow height was set to the design storm elevation. A stainless steel screen was placed around the outlet riser to ensure that the orifices would not become clogged with debris. Sites either used a separate riser or broad crested weir for overflow of runoff for the 25 and greater year storms. A picture of a typical outlet is presented in Figure 1.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure can be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed.

Summary of Design Recommendations

(1) Facility Sizing - The required water quality volume is determined by local regulations or the basin should be sized to capture and treat 85% of the annual runoff volume. See Section 5.5.1 of the handbook for a discussion of volume-based design.

Basin Configuration – A high aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W). The flowpath length is defined as the distance from the inlet to the outlet as measured at the surface. The width is defined as the mean width of the basin. Basin depths optimally range from 2 to 5 feet. The basin may include a sediment forebay to provide the opportunity for larger particles to settle out.

A micropool should not be incorporated in the design because of vector concerns. For online facilities, the principal and emergency spillways must be sized to provide 1.0 foot of freeboard during the 25-year event and to safely pass the flow from 100-year storm.

(2) Pond Side Slopes - Side slopes of the pond should be 3:1 (H:V) or flatter for grass stabilized slopes. Slopes steeper than 3:1 (H:V) must be stabilized with an appropriate slope stabilization practice.

(3) Basin Lining – Basins must be constructed to prevent possible contamination of groundwater below the facility.

(4) Basin Inlet – Energy dissipation is required at the basin inlet to reduce resuspension of accumulated sediment and to reduce the tendency for short-circuiting.

(5) Outflow Structure - The facility's drawdown time should be regulated by a gate valve or orifice plate. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure should be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed. This same valve also can be used to regulate the rate of discharge from the basin.

The discharge through a control orifice is calculated from:

$$Q = CA(2g(H-H_o))^{0.5}$$

where: Q = discharge (ft^3/s)
C = orifice coefficient
A = area of the orifice (ft^2)
g = gravitational constant (32.2)
H = water surface elevation (ft)
H_o= orifice elevation (ft)

Recommended values for C are 0.66 for thin materials and 0.80 when the material is thicker than the orifice diameter. This equation can be implemented in spreadsheet form with the pond stage/volume relationship to calculate drain time. To do this, use the initial height of the water above the orifice for the water quality volume. Calculate the discharge and assume that it remains constant for approximately 10 minutes. Based on that discharge, estimate the total discharge during that interval and the new elevation based on the stage volume relationship. Continue to iterate until H is approximately equal to H_o. When using multiple orifices the discharge from each is summed.

(6) Splitter Box - When the pond is designed as an offline facility, a splitter structure is used to isolate the water quality volume. The splitter box, or other flow diverting approach, should be designed to convey the 25-year storm event while providing at least 1.0 foot of freeboard along pond side slopes.

(7) Erosion Protection at the Outfall - For online facilities, special consideration should be given to the facility's outfall location. Flared pipe end sections that discharge at or near the stream invert are preferred. The channel immediately below the pond outfall should be modified to conform to natural dimensions, and lined with large stone riprap placed over filter cloth. Energy dissipation may be required to reduce flow velocities from the primary spillway to non-erosive velocities.

(8) Safety Considerations - Safety is provided either by fencing of the facility or by managing the contours of the pond to eliminate dropoffs and other hazards. Earthen side slopes should not exceed 3:1 (H:V) and should terminate on a flat safety bench area. Landscaping can be used to impede access to the facility. The primary spillway opening must not permit access by small children. Outfall pipes above 48 inches in diameter should be fenced.

Maintenance

Routine maintenance activity is often thought to consist mostly of sediment and trash and debris removal; however, these activities often constitute only a small fraction of the maintenance hours. During a recent study by Caltrans, 72 hours of maintenance was performed annually, but only a little over 7 hours was spent on sediment and trash removal. The largest recurring activity was vegetation management, routine mowing. The largest absolute number of hours was associated with vector control because of mosquito breeding that occurred in the stilling basins (example of standing water to be avoided) installed as energy dissipaters. In most cases, basic housekeeping practices such as removal of debris accumulations and vegetation

management to ensure that the basin dewaters completely in 48-72 hours is sufficient to prevent creating mosquito and other vector habitats.

Consequently, maintenance costs should be estimated based primarily on the mowing frequency and the time required. Mowing should be done at least annually to avoid establishment of woody vegetation, but may need to be performed much more frequently if aesthetics are an important consideration.

Typical activities and frequencies include:

- Schedule semiannual inspection for the beginning and end of the wet season for standing water, slope stability, sediment accumulation, trash and debris, and presence of burrows.
- Remove accumulated trash and debris in the basin and around the riser pipe during the semiannual inspections. The frequency of this activity may be altered to meet specific site conditions.
- Trim vegetation at the beginning and end of the wet season and inspect monthly to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and re-grade about every 10 years or when the accumulated sediment volume exceeds 10 percent of the basin volume. Inspect the basin each year for accumulated sediment volume.

Cost

Construction Cost

The construction costs associated with extended detention basins vary considerably. One recent study evaluated the cost of all pond systems (Brown and Schueler, 1997). Adjusting for inflation, the cost of dry extended detention ponds can be estimated with the equation:

$$C = 12.4V^{0.760}$$

where: C = Construction, design, and permitting cost, and
V = Volume (ft^3).

Using this equation, typical construction costs are:

$ 41,600 for a 1 acre-foot pond

$ 239,000 for a 10 acre-foot pond

$ 1,380,000 for a 100 acre-foot pond

Interestingly, these costs are generally slightly higher than the predicted cost of wet ponds (according to Brown and Schueler, 1997) on a cost per total volume basis, which highlights the difficulty of developing reasonably accurate construction estimates. In addition, a typical facility constructed by Caltrans cost about $160,000 with a capture volume of only 0.3 ac-ft.

An economic concern associated with dry ponds is that they might detract slightly from the value of adjacent properties. One study found that dry ponds can actually detract from the

perceived value of homes adjacent to a dry pond by between 3 and 10 percent (Emmerling-Dinovo, 1995).

Maintenance Cost

For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost (EPA website). Alternatively, a community can estimate the cost of the maintenance activities outlined in the maintenance section. Table 1 presents the maintenance costs estimated by Caltrans based on their experience with five basins located in southern California. Again, it should be emphasized that the vast majority of hours are related to vegetation management (mowing).

Table 1 Estimated Average Annual Maintenance Effort

Activity	Labor Hours	Equipment & Material ($)	Cost
Inspections	4	7	183
Maintenance	49	126	2282
Vector Control	0	0	0
Administration	3	0	132
Materials	-	535	535
Total	**56**	**$668**	**$3,132**

References and Sources of Additional Information

Brown, W., and T. Schueler. 1997. *The Economics of Stormwater BMPs in the Mid-Atlantic Region*. Prepared for Chesapeake Research Consortium. Edgewater, MD. Center for Watershed Protection. Ellicott City, MD.

Denver Urban Drainage and Flood Control District. 1992. *Urban Storm Drainage Criteria Manual—Volume 3: Best Management Practices*. Denver, CO.

Emmerling-Dinovo, C. 1995. Stormwater Detention Basins and Residential Locational Decisions. *Water Resources Bulletin 31(3)*: 515–521

Galli, J. 1990. *Thermal Impacts Associated with Urbanization and Stormwater Management Best Management Practices*. Metropolitan Washington Council of Governments. Prepared for Maryland Department of the Environment, Baltimore, MD.

GKY, 1989, *Outlet Hydraulics of Extended Detention Facilities* for the Northern Virginia Planning District Commission.

MacRae, C. 1996. Experience from Morphological Research on Canadian Streams: Is Control of the Two-Year Frequency Runoff Event the Best Basis for Stream Channel Protection? In *Effects of Watershed Development and Management on Aquatic Ecosystems*. American Society of Civil Engineers. Edited by L. Roesner. Snowbird, UT. pp. 144–162.

Maryland Dept of the Environment, 2000, Maryland Stormwater Design Manual: Volumes 1 & 2, prepared by MDE and Center for Watershed Protection.
http://www.mde.state.md.us/environment/wma/stormwatermanual/index.html

Metzger, M. E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. 2002. The Dark Side Of Stormwater Runoff Management: Disease Vectors Associated With Structural BMPs. Stormwater 3(2): 24-39.

Santana, F., J. Wood, R. Parsons, and S. Chamberlain. 1994. Control of Mosquito Breeding in Permitted Stormwater Systems. Prepared for Southwest Florida Water Management District, Brooksville, FL.

Schueler, T. 1997. Influence of Ground Water on Performance of Stormwater Ponds in Florida. *Watershed Protection Techniques* 2(4):525–528.

Watershed Management Institute (WMI). 1997. *Operation, Maintenance, and Management of Stormwater Management Systems*. Prepared for U.S. Environmental Protection Agency, Office of Water. Washington, DC.

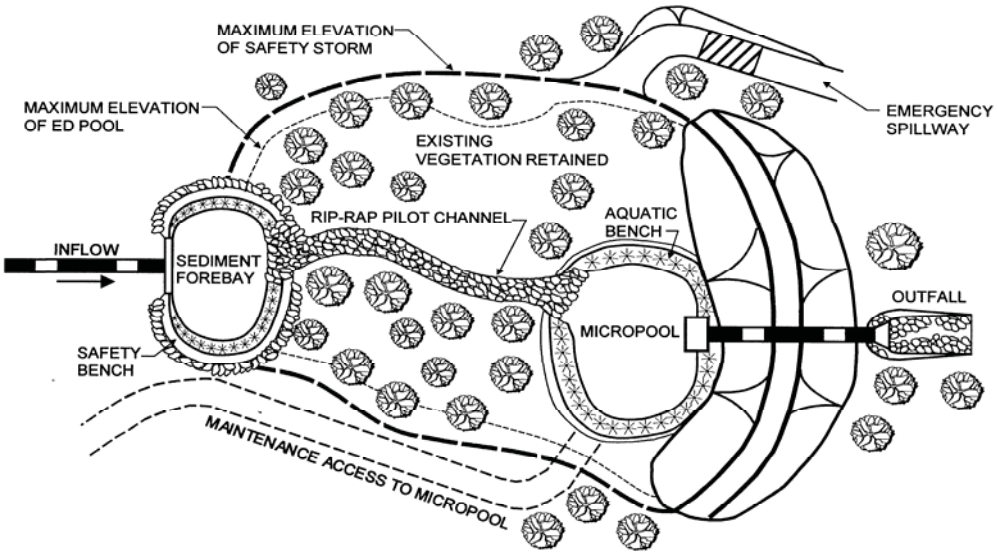
Young, G.K., et al., 1996, *Evaluation and Management of Highway Runoff Water Quality*, Publication No. FHWA-PD-96-032, U.S. Department of Transportation, Federal Highway Administration, Office of Environment and Planning.

Information Resources

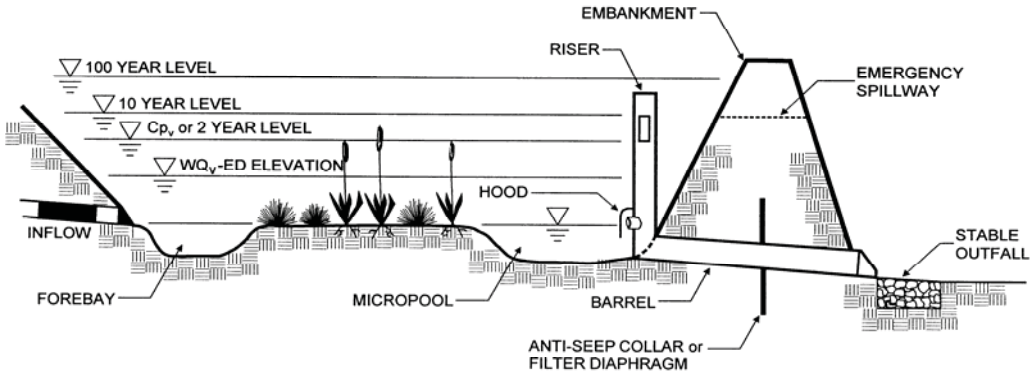
Center for Watershed Protection (CWP), Environmental Quality Resources, and Loiederman Associates. 1997. *Maryland Stormwater Design Manual*. Draft. Prepared for Maryland Department of the Environment, Baltimore, MD.

Center for Watershed Protection (CWP). 1997. *Stormwater BMP Design Supplement for Cold Climates*. Prepared for U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds. Washington, DC.

U.S. Environmental Protection Agency (USEPA). 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA-840-B-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.



PLAN VIEW



PROFILE

Schematic of an Extended Detention Basin (MDE, 2000)