Site Water Management Update

Volume 1 of 5

Rosemont Copper Project

This report further develops the key site water management structures planned for the Rosemont Copper Project designed to protect the environment and Project facilities. This update is specific to the base reclamation concept of the Rosemont Ridge Landform.

April 2010
Site Water Management Update

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April 2010
The following document has been prepared by the staff of Tetra Tech under the direct supervision of the ENGINEER of Record, whose seal and signature appear below.

The INFORMATION presented herein, were prepared in accordance with generally accepted professional engineering principles and practices.

David R. Krizek, P.E.
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<th>A.A.C.</th>
<th>Arizona Administrative Code</th>
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<tr>
<td>ADEQ</td>
<td>Arizona Department of Environmental Quality</td>
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<td>ADWR</td>
<td>Arizona Department of Water Resources</td>
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<tr>
<td>AEC</td>
<td>Applied Environmental Consultants</td>
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<tr>
<td>AgL</td>
<td>Agricultural Livestock Watering</td>
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<td>AMA</td>
<td>Active Management Area</td>
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<td>AMEC</td>
<td>AMEC Earth &amp; Environmental, Inc.</td>
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<td>APP</td>
<td>Aquifer Protection Permit</td>
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<tr>
<td>ASMI</td>
<td>Arizona State Mine Inspector</td>
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<tr>
<td>A.R.S.</td>
<td>Arizona Revised Statutes</td>
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<td>AWQS</td>
<td>Aquifer Water Quality Standards</td>
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<tr>
<td>A&amp;W</td>
<td>Aquatic and Wildlife</td>
</tr>
<tr>
<td>A&amp;We</td>
<td>Aquatic and Wildlife (ephemeral)</td>
</tr>
<tr>
<td>A&amp;Ww</td>
<td>Aquatic and Wildlife (warm water)</td>
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<tr>
<td>BADCT</td>
<td>Best Available Demonstrated Control Technology</td>
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<tr>
<td>BLM</td>
<td>Bureau of Land Management</td>
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<td>BMPs</td>
<td>Best Management Practices</td>
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<td>CNF</td>
<td>Coronado National Forest</td>
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<tr>
<td>CNI</td>
<td>Call &amp; Nicholas, Inc.</td>
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<tr>
<td>DIA</td>
<td>Discharge Impact Area</td>
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<tr>
<td>EIS</td>
<td>Environmental Impact Statement</td>
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<td>ET</td>
<td>Evapotranspiration</td>
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<td>FBC</td>
<td>Full Body Contact</td>
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<td>FC</td>
<td>Fish Consumption</td>
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<tr>
<td>GCL</td>
<td>Geosynthetic Clay Liner</td>
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<td>HDPE</td>
<td>High-Density, Polyethylene</td>
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<tr>
<td>H:V</td>
<td>Slope Horizontal to Vertical ratio</td>
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<td>Landform</td>
<td>Rosemont Ridge Landform</td>
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<tr>
<td>LCRS</td>
<td>Leak Collection and Removal System</td>
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<tr>
<td>LLDPE</td>
<td>Linear Low-Density, Polyethylene</td>
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<tr>
<td>MLRP</td>
<td>Mined Land Reclamation Plan</td>
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<tr>
<td>MPO</td>
<td>Mine Plan of Operations</td>
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<tr>
<td>M&amp;A</td>
<td>Montgomery &amp; Associates</td>
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<tr>
<td>NAG</td>
<td>Net Acid Generating</td>
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<tr>
<td>NE</td>
<td>Northeast</td>
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<tr>
<td>NEPA</td>
<td>National Environmental Policy Act</td>
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<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<td>NRCS</td>
<td>National Resource Conservation Service</td>
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<td>OAW</td>
<td>Outstanding Arizona Water</td>
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<td>PCA</td>
<td>Perimeter Containment Area</td>
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<td>PLS</td>
<td>Pregnant Leach Solution</td>
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<td>PMA</td>
<td>Pollutant Management Area</td>
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<td>PMP</td>
<td>Probable Maximum Precipitation</td>
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<td>Project</td>
<td>Rosemont Copper Project</td>
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<td>Property</td>
<td>Rosemont Property</td>
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<tr>
<td>PSIAC</td>
<td>Pacific Southwest Inter-Agency Committee</td>
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PW  Process Water
PWTS  Process Water Temporary Storage
ROM  Run-of-Mine
Rosemont  Rosemont Copper Company
RRE  Regional Regression Equation
Sage  Sage Landscape Architecture & Environmental, Inc.
SE  Southeast
SEAPA  Southeast Arizona Planning Area
SPLP  Synthetic Precipitation Leaching Procedure
SWMP  Site Water Management Plan
SWPPP  Storm Water Pollution Prevention Plan
SWQS  Surface Water Quality Standard
TS  Temporary Storage
USDA  United States Department of Agriculture
USGS  United States Geological Survey
WestLand  WestLand Resources, Inc.
WRCC  Western Regional Climate Center

ABBREVIATIONS

ac-ft  acre-feet
amsl  above mean sea level
cfs  cubic feet per second
gpm  gallons per minute
°F  Fahrenheit
mg/L  milligrams per liter
oz  ounce
sq-mi  square miles
EXECUTIVE SUMMARY

Rosemont Copper Company (Rosemont) is planning the development of an open pit mining and mineral processing operation known as the Rosemont Copper Project (Project) on the east side of the Santa Rita Mountains approximately, 30 miles southeast of Tucson, Arizona in Pima County. At the end of 20 to 25 years of operations, final reclamation of the site will occur, including demolition and closure of the Plant Site facilities and final regrading and revegetation of the Rosemont Ridge Landform. The Rosemont Ridge Landform is the consolidated and contoured earthen structure consisting of waste rock from the Open Pit, a closed Heap Leach Facility encapsulated with waste rock, and a Dry Stack Tailings Facility, also encapsulated with waste rock.

In the Reclamation Concept Update report by Tetra Tech (Tetra Tech, 2010), the Rosemont Ridge Landform (Landform) was described as a diverse habitat mosaic reclamation approach where the final features of the Landform incorporate a variety of end uses and considerations such as controlling stormwater and erosion, allowing access to all areas, addressing the post-mining land use (ranching and wildlife habitat), and incorporating landscaping or aesthetic considerations. Depending on the location, shaping was varied to allow for landscape diversity and to adhere to design and/or physical constraints (Tetra Tech, 2010). Stormwater controls were developed for the Project based on the overall goal of achieving this post-mining Landform and to protect facilities and the environment during the operational period. Many of the controls are designed to handle large storm events such as the 500-year, 24-hour or the Probable Maximum Precipitation events.

Stormwater controls planned for the reclaimed surface of the Rosemont Ridge Landform and the post-operating Project area include:

- Diversion channels/detention basins;
- Detention pools;
- Drainage benches;
- Stilling pools and drop structures;
- Flow-through drains; and
- Diversion channels.

The downstream monitoring point for assessing the effectiveness of the stormwater controls associated with the Project will be the Compliance Point Dam. The Compliance Point Dam is a porous, rockfill structure located down-gradient (east) of the Rosemont Ridge Landform in Lower Barrel Canyon where stormwater samples will be taken.

In addition to the Rosemont Ridge Landform, graded Plant Site, and access roads, the Open Pit will remain as an excavation subject to natural processes of wind and water erosion, including geochemical weathering processes. A terminal pit lake is anticipated to develop in the Open Pit as determined by regional groundwater modeling performed by Montgomery & Associates (M&A) as documented in Groundwater Flow Modeling Conducted for Simulation of Proposed Rosemont Pit Dewatering and Post-Closure Rosemont Project Pima County, Arizona (M&A, 2009). Based on pit recharge information provided by M&A, and geochemical testing performed by Tetra Tech, Tetra Tech prepared a Geochemical Pit Lake Predictive Model (Tetra Tech, 2010). Following 200 years of model simulation, the results of the pit lake model suggest that water in the pit lake will closely resemble the quality of the local groundwater.

The Open Pit and select stormwater control features are shown on Illustration E1.0.
As shown on Illustration E1.0, the flow-through drains are an integral part of the overall site water management strategy for the Project site. Flow-through drains are large rock structures that provide:

- A hydraulic connection between the up-gradient side of the Rosemont Ridge Landform and the down-gradient side;
- Protection of the Project facilities during operational periods; and
- A separation between the wash areas and the dry stack tailings with waste rock.

The network of flow-through drains located in Barrel and McCleary Canyons exit on the east side of the Rosemont Ridge Landform up-gradient of the Compliance Point Dam. These rock drains will be covered with geotextile prior to the placement of waste rock or tailings over these structures to prevent sediments from filtering into the drains.

The watershed upstream of the proposed Compliance Point Dam is approximately 8.2 square miles (sq-mi) while the entire Barrel Canyon drainage is approximately 14.1 sq-mi [United States Geological Survey (USGS) Gauging Station number 09484580]. Barrel Canyon drains into the upper reaches of the Davidson Canyon watershed. The entire Davidson Canyon watershed is approximately 50.5 sq-mi (USGS Gauging Station number 09484590). Davidson Canyon eventually drains into the Cienega Creek basin which is approximately 605 sq-mi.
Therefore, the watershed associated with the Project comprises:

- Approximately 58% of the entire Barrel Canyon drainage;
- Approximately 16% of the Davidson Canyon watershed; or
- Approximately 1.4% of the Cienega Creek basin.

When comparing baseline (pre-operating) and post-operating regulatory (100-year) hydrology and average-annual runoff (average rainfall of 18-inches per year), the following changes are expected to occur at the Compliance Point Dam due to Project activities:

- Baseline regulatory flood-peak at 5,360 cubic feet per second (cfs) versus 2,842 cfs for post-operating conditions; and
- Baseline average-annual runoff at 957 acre-feet (ac-ft) versus 231 ac-ft for post-operating conditions.

Infiltration of rainfall in the Project area will also be affected by the facilities planned within the watershed. For baseline conditions, it was estimated that the 8.2 sq-mi area up-gradient of the Compliance Point Dam results in about 127 ac-ft of recharge to the underlying aquifer. Based on the average-annual runoff reporting to the flow-through drains during post-operating conditions, it was estimated that about 100 ac-ft of infiltration would occur and would likely recharge to the underlying aquifer.

In addition to stormwater management features associated with the reclaimed surface of the Rosemont Ridge Landform, site water management strategies for the Heap Leach and Dry Stack Tailings Facilities have also been developed, including closure strategies for the spent heap leach pile and associated ponds. Construction of these facilities meets or exceeds applicable Best Available Demonstrated Control Technology (BADCT) guidance developed by the Arizona Department of Environmental Quality (ADEQ, 2004). For instance, the dry stack tailings disposal method will be used. This method minimizes seepage from the facility to the maximum extent practicable compared to conventional tailings disposal methods.

Infiltration, seepage, and fate and transport modeling were performed on the Dry Stack Tailings Facility as well as on the Waste Rock Storage Area and the spent heap leach pile as detailed in the report titled *Infiltration, Seepage, Fate and Transport Modeling Report* (Tetra Tech, 2010). The results of this modeling effort indicated that any potential seepage from these facilities will have little or no impact on the quality or quantity of water within the regional groundwater system. Regardless, the hydraulic sink created by the terminal pit lake is expected to provide tertiary containment for any constituents of concern potentially generated from these facilities.

Stormwater generated from the Project site is also not expected to degrade downstream surface water quality standards (SWQS). Applicable SWQS for the Project were determined based on designated use standards, with consideration of the recent designation of Davidson Canyon as an outstanding Arizona water (OAW). These SWQS were compared with baseline stormwater sampling data collected at the Project site and to Synthetic Precipitation Leaching Procedure (SPLP) data taken from samples of the dry stack tailings and waste rock materials.

The Project is currently going through the Environmental Impact Statement (EIS) development process under the National Environmental Policy Act (NEPA). Analyses performed as part of the EIS process may result in modifications to the final Project layout as presented in Illustration E.1.0. Based upon the final preferred arrangement selected during the EIS process, site water management will be further developed and will include stormwater control throughout the Project life based on phased facility plans. This site water management update illustrates water management structures planned for the Project site and includes supporting design documentation.
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1.0 INTRODUCTION

1.1 General

In 2007, Tetra Tech, Inc. (Tetra Tech) prepared a Site Water Management Plan (SWMP) (Tetra Tech, 2007e) for the proposed Rosemont Copper Project (Project) located in Pima County, Arizona. This 2007 SWMP was associated with feasibility level designs and the preparation of the Rosemont Project Mine Plan of Operations (MPO) prepared by WestLand Resources, Inc. (WestLand, 2007). This report presents an update to that plan.

In addition to the 2007 SWMP, other supporting documentation related to site water management and stormwater routing and control has been submitted to regulatory agencies, including the following:

- MPO (WestLand, 2007)
- Dry Stack Facility Design (Tetra Tech, 2007a) submitted as part of the MPO
- Leaching Facilities Design (Tetra Tech, 2007c) submitted as part of the MPO
- Reclamation and Closure Plan (Tetra Tech, 2007d) submitted as part of the MPO
- Mined Land Reclamation Plan (MLRP) submitted to the Arizona State Mine Inspector (ASMI) (Tetra Tech, 2008)
- Rosemont Copper Company Dry Stack Tailings Storage Facility Final Design Report by AMEC Earth & Environmental, Inc. (AMEC) (AMEC, 2009)
- Process Water Pond, Temporary Storage Pond, and Settling Basin Design Report by M3 Engineering & Technology Corporation (M3) (M3, 2009)
- Aquifer Protection Permit (APP) Application to the Arizona Department of Environmental Quality (ADEQ) (Tetra Tech, 2009a)
- Rosemont Heap Leach Facility Permit Design Report (Tetra Tech, 2009c)
- Geochemical Pit Lake Predictive Model (Tetra Tech, 2010b)
- Infiltration, Seepage, Fate and Transport Modeling Report (Tetra Tech, 2010e)

A final Heap Leach Facility design report is being prepared that includes updated site water management and stormwater control features associated with the heap and related ponds. These site water management and stormwater control features are summarized herein. A stormwater management report associated with the 2009 Dry Stack Tailings Facility design was also prepared by AMEC titled Dry Stack Tailings Storage Facility Stormwater Management Design Report (AMEC, 2010). This report is included in Appendix A of this document.

The APP application was submitted in February 2009 and is currently in the technical review phase with ADEQ. Additionally, the Project is going through the Environmental Impact Statement (EIS) development process under the National Environmental Policy Act (NEPA). Analyses performed as part of the EIS process will also guide the final facility design process.

This site water management update, and any other future updates, is intended to supplement and refine information presented in previous submittals. Therefore, the information presented herein is for informational purposes only and is not intended to be a final design package.

Based upon the final preferred alternative or set of alternatives selected during the EIS process, the SWMP will be further developed and will include stormwater control throughout the Project life based on phased facility plans.
1.2 Plan Development Objectives and Report Layout

The goal of this Site Water Management Update is to provide the following:

- A presentation of critical site water management features associated with the base concept of the Rosemont Ridge Landform as presented in the *Reclamation Concept Update* (Tetra Tech, 2010); and
- A summary of the design criteria used to size the site water management features, including pertinent design documentation. The selected design criteria are protective of the both the environment and the Project facilities.

The remainder of this document includes the following sections:

- Section 2.0 – Property Location and Facility Descriptions;
- Section 3.0 – General Project Site Information;
- Section 4.0 – Design Criteria Summary;
- Section 5.0 – General Site Water Management;
- Section 6.0 – Flow-Through Drains;
- Section 7.0 – Dry Stack Tailings Facility Area;
- Section 8.0 – Heap Leach Facility Area;
- Section 9.0 – Hydrology Method Comparison;
- Section 10.0 – Baseline and Post-Mining Hydrology and Average-Annual Runoff;
- Section 11.0 – Baseline and Post-Mining Infiltration;
- Section 12.0 – Sediment Control;
- Section 13.0 – Surface Water Quality Assessment; and
- References.
2.0 PROPERTY LOCATION AND FACILITY DESCRIPTIONS

2.1 Property Location, Ownership, and Land Use

The Rosemont Property (Property) is located approximately 30 miles southeast of Tucson, west of State Route 83 (SR 83), as shown on Figure 01. In geographical terms, the Property is located at the approximate latitude and longitude coordinates of 31º 50'N and 110º 45'W.

Access to the Property is from Interstate 10 south to SR 83, then west on a proposed Primary Access Road shown on Figure 02 that will be constructed at the start of the Project. Figure 02 also shows the main disturbance area located within the following drainages:

- Barrel Canyon;
- Wasp Canyon; and
- McCleary Canyon.

Based on the planned facility layouts, all drainages within the footprint of the main disturbance area report to a proposed Compliance Point Dam (Compliance Point), which is anticipated to be a six (6) foot high, porous rock structure where additional sediment controls will be applied as necessary to manage stormwater quality and where stormwater samples will be taken. This Compliance Point is located within the Lower Barrel Canyon drainage as shown on Figure 02.

The Property consists of a group of patented mining claims, unpatented mining claims, and fee land that cover most of the Rosemont and Helvetia Mining Districts as shown on Figure 03. The core of the Property consists of 132 patented lode claims that total an area of 1,969 acres. A contiguous group of 947 unpatented lode-mining claims, that total an area of about 14,000 acres, surrounds the patented load claims. Additionally, there are a total 911 acres of fee land on the East side of the Santa Rita mountains near the Project site. Most of the unpatented claims were staked on Federal Lands that are now administered by the United States Department of Agriculture (USDA), Forest Service, and the Coronado National Forest (CNF). A limited number of claims in the northwest portion of the Property are on Federal Land administered by the Bureau of Land Management (BLM). The area covered by the patented claims, unpatented claims, and fee lands total about 17,000 acres. All private land and unpatented mining claims described above are owned and/or controlled by Rosemont Copper Company (Rosemont), a subsidiary of Augusta Resource Corporation.

Current land use reflects a mixture of mining activities, ranching, wildlife habitat, and recreational use. A portion of the Arizona Trail is along the southern boundary of the Project site. In addition to the on-going exploration activities, the area is used by off-roaders, hikers and other outdoor enthusiasts.

2.2 General Facility Areas

The Rosemont Copper Project can be divided into several key development and/or operational areas:

- Open Pit Area;
- Plant Site Area;
- Dry Stack Tailings Facility Area;
- Heap Leach Facility Area;
- Waste Rock Storage Area;
- Access Roads; and
- Utility Corridors.

Except for utility corridors, Figure 04 shows a plan view of these key facility areas. This plan view shows the ultimate Open Pit limits, operational Plant Site, and the Rosemont Ridge Landform. The Rosemont Ridge Landform (Landform) is the consolidated and contoured earthen structure that will remain at closure. This structure consists of waste rock from the Open Pit, the closed Heap Leach Facility encapsulated with waste rock, and the Dry Stack Tailings Facility, also encapsulated with waste rock. The base reclamation concept of the Rosemont Ridge Landform is shown on Figure 04 with an operational Plant Site for illustrative purposes. Figure 05 shows the Landform with a graded, post-operating Plant Site area.

In addition to the Rosemont Ridge Landform, graded Plant Site, and access roads, the Open Pit will remain as an excavation subject to natural processes of wind and water erosion, including geochemical weathering processes. A pit lake is anticipated to develop in the Open Pit as determined by regional groundwater modeling performed by Montgomery & Associates (M&A) as documented in *Groundwater Flow Modeling Conducted for Simulation of Proposed Rosemont Pit Dewatering and Post-Closure Rosemont Project Pima County, Arizona* (M&A, 2009). Based on pit recharge information provided by M&A, and geochemical testing performed by Tetra Tech, Tetra Tech prepared a *Geochemical Pit Lake Predictive Model* (Tetra Tech, 2010b). Following 200 years of model simulation, the results of the pit lake model suggest that water in the pit lake will closely resemble the quality of the local groundwater.

As indicated in Section 1.0, the site water management features and stormwater controls presented herein are both protective of the environment and the Project facilities. Additionally, development of the facilities is specific to achieving the base reclamation concept of the Rosemont Ridge Landform as presented in the report titled *Reclamation Concept Update* (Tetra Tech, 2010j). The following provides a description of the Rosemont Ridge Landform:

“The Rosemont Ridge Landform (Landform) can be described as a diverse habitat mosaic reclamation approach where the final features of the Landform incorporate a variety of end uses and considerations such as controlling stormwater and erosion, allowing access to all areas, addressing the post-mining land use (ranching and wildlife habitat), and incorporating landscaping or aesthetic considerations. Depending on the location, shaping was varied to allow for landscape diversity and to adhere to design and/or physical constraints.” (Tetra Tech, 2010j).

Design of the outer shell of the Rosemont Ridge Landform followed the stormwater control features described in Section 5.0 and the overall design criteria described in Section 4.0. A general summary of the stormwater management approach associated with the base reclamation concept of the Rosemont Ridge Landform follows:

Over the mine life, the dry stack tailings and heap leach facilities will be encapsulated within a thick waste rock shell. Waste rock will also be placed around the western perimeter of the Rosemont Ridge Landform footprint early in the mine life to allow concurrent reclamation of the outer slopes. This will allow modification and enhancement of the reclamation approach during the life of the mine – should conditions warrant.

Relief was provided to the Waste Rock Storage Area by shaping the slopes with a modified Ridge and Valley Method using short slope lengths. Slopes were pushed in and out by adding wide benches ranging in width from 100 to 300 feet. These benches also provide access to all areas of the Rosemont Ridge Landform. Water management features, such as shallow pools, are planned on these wide benches. These locations provide stormwater control, locations for enhanced vegetative growth, and wildlife habitat. Several small hill features (hillocks) also
comprise the top surface of the area. The slopes between the benches are generally about 300 to 325 feet long on a 3H:1V (horizontal:vertical) angle. This corresponds to a vertical rise of about 100 feet between benches.

The outer slopes of the Dry Stack Tailings Facility consist of thick waste rock buttresses encapsulating the dry stack tailings. Drainage benches in the Dry Stack Tailings Facility area were placed on an approximate vertical spacing of 100 feet to provide stormwater runoff control and access to all areas of the outer slopes. Drainage from these benches were directed to the Waste Rock Storage Area, to natural ground, or to stilling pools which transition storm flows from the benches to drop structures. These large stilling pool areas are also anticipated to function as sediment traps and are also potential locations for enhanced vegetative growth and wildlife habitat.

The drainage benches are generally 50 feet wide and accommodate an access road, a safety berm, and a stormwater channel. The stilling pool areas range from 100 feet to 200 feet wide. A contoured ridge is also planned for the top surface of the central portion of the Rosemont Ridge Landform, which is above the South Dry Stack Tailings Facility. This ridge is constructed of waste rock and provides a transition from the hillocks constructed in the Waste Rock Storage Area to the top of the North Dry Stack Tailings Facility, or the north end of the Landform.

Contouring was also incorporated into the east facing slope of the Landform associated with the North Dry Stack Tailings Facility. The contouring applied also generally followed a modified Ridge and Valley approach with short slope lengths. Except for the lower section of the east face, the areas between the benches are generally about 300 to 325 feet long on 3H:1V slopes. The lower part of the slope, however, has a slope length of over 600 feet. Placing a rock cover over this lower section is envisioned, along with adding rock to the contoured valleys of the upper slope areas.

Large, shallow depressions are incorporated into the top surface of the North Dry Stack Tailings Facility for stormwater control. Post-operating activities such as wildlife use and ranching are envisioned for this area. These large, shallow depressions are anticipated to enhance vegetative growth and therefore wildlife habitat.

The Open Pit, graded Plant Site, and the Rosemont Ridge Landform were placed on an unreferenced aerial photo taken of the Project site (Figures 06 and 07). An inset of the original photo showing existing conditions is also provided. Both immature and mature vegetation were applied to the Rosemont Ridge Landform and to the graded Plant Site area as shown on Figure 06. Figure 07 shows the Landform with some seasonal variation added to the mature vegetation.

Mature vegetation is defined as:

“… what the site might look like twenty years after planting with native Prosopis velutina, Velvet Mesquites, local Juniperus deppeana pachyphlaea, Alligator Juniper trees, and seed mix understory. It depicts possible results if treated to achieve 100% revegetation. A typical Velvet Mesquite, under natural growing conditions, should achieve maturity after approximately 20 years, reaching a typical size of 30’ H x 30’ W. Alligator Juniper grows slowly up to 20-40’ H x 15-30’ W. Maturity may not be achieved until after 20 years. Results may be slower than anticipated, or with smaller resulting trees due to soil conditions and no irrigation,” [Sage Landscape Architecture & Environmental, Inc. (Sage), 2010]

Mature vegetation with seasonal variation is defined as:
“... what the site might look like after approximately 50 years of growth. Established native grasses and a combination of fully mature, declining and establishing tree and shrub species are shown growing on the slopes. In this view, approximately 25-30% of the vegetation is experiencing either seasonal variation or dieback,” (Sage, 2010)

Immature vegetation is defined as:

“... the same site if the 100% revegetation efforts have 25-30% plant survival after 20 years, or if 25-30% revegetation is initially implemented and achieves complete success. Vegetation remains Velvet Mesquites, Alligator Juniper, and seed mix,” (Sage, 2010).

Besides the application a seed mix and tree plantings, additional mitigation strategies applied to the rendering of the Rosemont Ridge Landform included planting on the benches and on the slopes, and the placement of scree piles. Scree piles may be placed for visual purposes, for erosion protection, or for wildlife habitat. The design of the Rosemont Ridge Landform also includes many water management features which will enhance vegetation growth and wildlife habitat. Reclamation of the Rosemont Ridge Landform was described in the report titled Reclamation Concept Update (Tetra Tech, 2010j).
3.0 GENERAL PROJECT SITE INFORMATION

3.1 Site Specific Climate

Weather patterns at the Project site have been and continue to be studied in order to develop an understanding of the local climate. Data compiled from 1894 through 2008, including precipitation and pan evaporation rates, have been used for calculations associated with sizing ponds, developing seepage and infiltration models, performing water balance calculations, and estimating storm events used to design stormwater runoff controls. The climate information provided below was based on a Technical Memorandum titled *Rosemont Copper Project Design Storm and Precipitation Data/Design Criteria* (Tech Tech, 2009b) provided in Appendix B.

Additional analysis concerning storm event design criteria is detailed in the Technical Memorandum titled *Rosemont Hydrology Method Justification* (Tetra Tech, 2010q) provided in Appendix C. This Technical Memorandum compared peak flows generated by various design storm events using the National Resource Conservation Service (NRCS) curve number method and the Pima County method. Further discussion on this Technical Memorandum is provided in Section 9.0. Section 9.0 also discusses the Local and General Probable Maximum Precipitation (PMP) events. Many of the site water management structures associated with the Rosemont Project are currently designed to manage PMP events. Design criteria used for the various portions of the Project are summarized in Section 4.0.

3.1.1 Weather Stations

Rosemont Copper installed an onsite monitoring station that began recording meteorological data in April 2006. This station is monitored by Applied Environmental Consultants (AEC). The monitoring program includes data processing and instrument audits, calibrations, and maintenance. The station records site specific weather data including temperature, precipitation, wind speed, and wind direction. Pan evaporation was added to this station in mid-2008. The station is located at the center of the proposed Open Pit at an elevation of 5,350 feet above mean sea level (amsl). Other weather stations located within a 30 mile radius of the Project site are indicated in Table 3.1.

<table>
<thead>
<tr>
<th>Name</th>
<th>ID No.</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Elevation (feet amsl)</th>
<th>Distance from Site</th>
<th>Period of Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canelo 1 NW</td>
<td>021231</td>
<td>31° 33’</td>
<td>110° 32’</td>
<td>5,010</td>
<td>25 miles SE</td>
<td>1910 – 2007</td>
</tr>
<tr>
<td>Helvetia</td>
<td>023981</td>
<td>31° 52’</td>
<td>110° 47’</td>
<td>4,300</td>
<td>5 miles W</td>
<td>1916 – 1950</td>
</tr>
<tr>
<td>Santa Rita</td>
<td>027593</td>
<td>31° 46’</td>
<td>110° 51’</td>
<td>4,300</td>
<td>8 miles SW</td>
<td>1950 – 2005</td>
</tr>
</tbody>
</table>

Note: The onsite Rosemont weather station is at 5,350 feet amsl.

The Santa Rita station had inconsistent readings from 2006-2007; therefore, these (3) years were not used in any analysis.

3.1.2 Precipitation

The annual average precipitation for the Rosemont area, estimated by Sellers (University of Arizona, 1977) for the period 1931 through 1970, was approximately 16 inches. Precipitation
data from the weather stations, based on records available from the Western Regional Climate Center (WRCC), are summarized in Table 3.2 (WRCC, 2009).

### Table 3.2  Average Monthly Total Precipitation Summary (inches)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1.22</td>
<td>1.58</td>
<td>1.63</td>
<td>0.88</td>
<td>1.10</td>
<td>0.59</td>
</tr>
<tr>
<td>February</td>
<td>1.17</td>
<td>1.72</td>
<td>1.46</td>
<td>0.83</td>
<td>0.85</td>
<td>0.79</td>
</tr>
<tr>
<td>March</td>
<td>0.93</td>
<td>1.14</td>
<td>1.48</td>
<td>0.76</td>
<td>0.90</td>
<td>0.45</td>
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<tr>
<td>April</td>
<td>0.45</td>
<td>0.52</td>
<td>0.69</td>
<td>0.39</td>
<td>0.39</td>
<td>0.45</td>
</tr>
<tr>
<td>May</td>
<td>0.20</td>
<td>0.28</td>
<td>0.24</td>
<td>0.18</td>
<td>0.22</td>
<td>0.51</td>
</tr>
<tr>
<td>June</td>
<td>0.72</td>
<td>0.67</td>
<td>0.62</td>
<td>0.26</td>
<td>0.47</td>
<td>0.98</td>
</tr>
<tr>
<td>July</td>
<td>4.41</td>
<td>4.05</td>
<td>4.87</td>
<td>2.06</td>
<td>4.34</td>
<td>5.51</td>
</tr>
<tr>
<td>August</td>
<td>4.04</td>
<td>4.15</td>
<td>4.32</td>
<td>2.15</td>
<td>4.13</td>
<td>3.74</td>
</tr>
<tr>
<td>September</td>
<td>1.70</td>
<td>2.19</td>
<td>2.15</td>
<td>1.15</td>
<td>1.55</td>
<td>1.62</td>
</tr>
<tr>
<td>October</td>
<td>1.03</td>
<td>0.68</td>
<td>1.62</td>
<td>0.74</td>
<td>1.33</td>
<td>0.24</td>
</tr>
<tr>
<td>November</td>
<td>0.84</td>
<td>1.22</td>
<td>1.15</td>
<td>0.77</td>
<td>0.66</td>
<td>1.11</td>
</tr>
<tr>
<td>December</td>
<td>1.39</td>
<td>1.52</td>
<td>1.96</td>
<td>0.96</td>
<td>1.43</td>
<td>1.16</td>
</tr>
<tr>
<td>TOTAL</td>
<td><strong>18.10</strong></td>
<td><strong>19.72</strong></td>
<td><strong>22.18</strong></td>
<td><strong>11.13</strong></td>
<td><strong>17.37</strong></td>
<td><strong>17.12</strong></td>
</tr>
</tbody>
</table>

Note: Values reported are average over the recorded history.

Illustration 3.1 provides a combined graph of the average monthly precipitation for the six (6) weather stations showing the correlation between the records.

![Average Monthly Precipitation Graph](image)

**Illustration 3.1  Average Monthly Precipitation**

**3.1.3  Temperature**

From 1914 to 1931, the average monthly minimum temperatures at the Project site usually occurred in January and were approximately 36°F; maximum monthly
temperatures usually occurred in June and were above 90°F (University of Arizona, 1977). Since installation of the onsite weather station in April 2006, the temperatures measured at Rosemont recorded an average hourly maximum temperature of 94.6°F in July 2007 and an average hourly minimum temperature of 19.0°F in November 2006 (Tetra Tech, 2009a).

From 1916 through 1950, the average monthly minimum temperature recorded at the Helvetia station occurred in January and was 35.9°F; the average maximum monthly temperature occurred in June and was 92.1°F (WRCC, 2009).

From 1950 through 2005, the average monthly minimum temperature for the Santa Rita Experimental Range station occurred in January and was 37.7°F; the average maximum monthly temperature occurred in June and was 92.9°F (WRCC, 2009).

From 1910 through 2007, the average monthly minimum temperature for the Canelo 1 NW station occurred in January and was 26.1°F; and the average maximum monthly temperature occurred in June and was 90.4°F (WRCC, 2009).

From 1894 through 2007, the average monthly minimum temperature for the Tucson U of A station occurred in January and was 37.6°F; the average maximum monthly temperature occurred in July and was 100.1°F (WRCC, 2009).

From 1952 through 2007, the average monthly minimum temperature for the Nogales 6 N station occurred in January and was 27.3°F; the average maximum monthly temperature occurred in June and was 95.3°F (WRCC, 2009).

### 3.1.4 Pan Evaporation

Only two (2) of the weather stations, Tucson U of A and Nogales 6 N, had recorded pan evaporation data over an extended period of time. Measurements of pan evaporation at the Rosemont weather station were added in June 2008; however, there were problems with the instrumentation and resultant data recovery. Table 3.3 presents the available average monthly pan evaporation for the three (3) stations. Illustration 3.2 provides a graph of the average monthly pan evaporation for the three (3) stations.

#### Table 3.3 Average Monthly Pan Evaporation Summary (inches)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>3.25</td>
<td>3.59</td>
<td>-</td>
</tr>
<tr>
<td>February</td>
<td>4.57</td>
<td>4.46</td>
<td>-</td>
</tr>
<tr>
<td>March</td>
<td>6.95</td>
<td>7.01</td>
<td>-</td>
</tr>
<tr>
<td>April</td>
<td>9.88</td>
<td>9.35</td>
<td>-</td>
</tr>
<tr>
<td>May</td>
<td>12.87</td>
<td>11.91</td>
<td>-</td>
</tr>
<tr>
<td>June</td>
<td>14.91</td>
<td>13.31</td>
<td>-</td>
</tr>
<tr>
<td>July</td>
<td>13.17</td>
<td>10.00</td>
<td>4.77</td>
</tr>
<tr>
<td>August</td>
<td>11.65</td>
<td>8.28</td>
<td>2.92</td>
</tr>
<tr>
<td>September</td>
<td>10.35</td>
<td>8.06</td>
<td>4.11</td>
</tr>
<tr>
<td>October</td>
<td>7.81</td>
<td>7.17</td>
<td>2.32</td>
</tr>
<tr>
<td>November</td>
<td>4.73</td>
<td>4.49</td>
<td>2.20</td>
</tr>
<tr>
<td>December</td>
<td>3.37</td>
<td>3.57</td>
<td>2.22</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>103.51</strong></td>
<td><strong>91.20</strong></td>
<td><strong>-</strong></td>
</tr>
</tbody>
</table>
Illustration 3.2  Average Monthly Pan Evaporation

3.1.5  Design Storm Events

Rainfall totals for various rainfall events were taken from the online National Oceanic and Atmospheric Administration (NOAA) site. The methods used to determine the temporal distribution of the various rainfall events are discussed in Appendix A1 of NOAA Atlas 14 (NOAA, 2004). As shown in Illustration 3.3, Arizona lies in the convective precipitation area, and 50% of the convective storms have the majority of rainfall occurring in the first six (6) hours (first quartile) of the rainfall event.
Table 3.4 presents the flood frequency storm precipitation summary derived from the NOAA Atlas (NOAA, 2004). The flood frequency design precipitation hyetographs for runoff modeling are summarized in Table 3.5.

**Table 3.4 Flood Frequency Storm Precipitation Summary (inches)**

<table>
<thead>
<tr>
<th>Event</th>
<th>1-Hour</th>
<th>3-Hour</th>
<th>6-Hour</th>
<th>24-Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Year</td>
<td>1.42</td>
<td>1.60</td>
<td>1.83</td>
<td>2.21</td>
</tr>
<tr>
<td>5-Year</td>
<td>1.85</td>
<td>2.03</td>
<td>2.30</td>
<td>2.75</td>
</tr>
<tr>
<td>10-Year</td>
<td>2.16</td>
<td>2.38</td>
<td>2.68</td>
<td>3.18</td>
</tr>
<tr>
<td>25-Year</td>
<td>2.57</td>
<td>2.86</td>
<td>3.22</td>
<td>3.77</td>
</tr>
<tr>
<td>50-Year</td>
<td>2.87</td>
<td>3.24</td>
<td>3.66</td>
<td>4.23</td>
</tr>
<tr>
<td>100-Year</td>
<td>3.17</td>
<td>3.63</td>
<td>4.12</td>
<td>4.75</td>
</tr>
<tr>
<td>500-Year</td>
<td>3.84</td>
<td>4.59</td>
<td>5.24</td>
<td>6.00</td>
</tr>
<tr>
<td>1000-Year</td>
<td>4.14</td>
<td>5.03</td>
<td>5.76</td>
<td>6.57</td>
</tr>
</tbody>
</table>
Table 3.5  Flood Frequency Design Precipitation Hyetographs

<table>
<thead>
<tr>
<th>% of Duration</th>
<th>% of Rainfall</th>
<th>Time (hour)</th>
<th>Storm Depth (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2-Year</td>
<td>5-Year</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>8.3</td>
<td>31.9</td>
<td>0.70</td>
<td>0.88</td>
</tr>
<tr>
<td>17.8</td>
<td>56.9</td>
<td>1.26</td>
<td>1.56</td>
</tr>
<tr>
<td>25.0</td>
<td>73.3</td>
<td>1.62</td>
<td>2.02</td>
</tr>
<tr>
<td>33.3</td>
<td>83.2</td>
<td>1.84</td>
<td>2.29</td>
</tr>
<tr>
<td>41.7</td>
<td>89.0</td>
<td>1.97</td>
<td>2.45</td>
</tr>
<tr>
<td>50.0</td>
<td>92.6</td>
<td>2.05</td>
<td>2.55</td>
</tr>
<tr>
<td>58.3</td>
<td>95.1</td>
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<td>66.7</td>
<td>97.1</td>
<td>2.15</td>
<td>2.67</td>
</tr>
<tr>
<td>75.0</td>
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<td>2.18</td>
<td>2.71</td>
</tr>
<tr>
<td>83.3</td>
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<tr>
<td>100.0</td>
<td>100.0</td>
<td>2.21</td>
<td>2.75</td>
</tr>
</tbody>
</table>

3.2 Natural Environment

The Project area is an arid region typical of the desert southwest. In general, the terrain is
mountainous and rugged with elevations ranging from 4,500 to 6,300 feet amsl. There are three
(3) main contributing basins in the Project area: Barrel, Wasp, and McCleary Canyons
(Figure 02). A network of small arroyos from Wasp and McCleary Canyons feed the main Barrel
Canyon drainage, which drains to Davidson Canyon. The basins primarily drain to the north and
east.

Vegetation on the site generally consists of Madrean evergreen woodlands and semi-desert
grassland. The evergreen woodlands cover the higher elevation portions of the site and are
characterized as trees interspersed with grasses and forbs. The semi-desert grasslands are
primarily located in the lower elevations and are characterized as open grasslands with widely
scattered shrubs and cactuses.

3.3 Geology

3.3.1 Site Soils

The following information on site soils was derived from the Aquifer Protection Permit
Application (Tetra Tech, 2009a).

The natural surficial deposits were derived through slope wash, natural landscape degradation,
and other erosional processes. Four (4) independent units were identified and include older
alluvium, colluvium and talus, younger alluvium, and disturbed areas.

The older alluvium is characterized by terraces comprised of medium to thick-bedded, sandy,
weakly consolidated gravel with scattered cobbles and boulders derived from upslope bedrock
units.

The colluvium and talus are Holocene to late Pleistocene in age and are characterized by
angular to subangular pebbles, cobbles, and boulders derived through slope wash and natural
landscape degradation of the steep terrain, which is pervasive throughout the western portion of
the Project area. These units typically define the toe of the steeper western terrain.
The younger alluvium is confined to active stream channels and washes and generally includes floodplain terraces incised less than ten (10) feet.

The disturbed areas primarily define locations that have undergone reworking of the native soil and rock materials through human activities. The disturbed areas at the Project site include mine dumps, road cuts and fills, and a slag pile. Additional information concerning the site soils is provided in the Aquifer Protection Permit Application (Tetra Tech, 2009a).

### 3.3.2 Physiographic Setting and General Geology

The following description of the physiographic setting and general geology of the Project site were taken from the Aquifer Protection Permit Application (Tetra Tech, 2009a).

The Project site lies within the southern portion of the Basin and Range physiographic province, an extensional terrain characterized by discontinuous northwest to northeast-trending mountain ranges separated by broad, thick, fault controlled alluvial basins. This region can be sub-divided into the Sonoran Desert sub-province and Mexican Highland sub-province. Located in the Mexican Highland sub-province, the Project is situated in the northern portion of the Santa Rita Range, near the boundary separating the two (2) sub-provinces.

The Project area is underlain by a north striking, steep, easterly tilted section of marine sediments (quartzite, limestone, and dolomite). Recent evaluation of core derived from previous exploration programs at the Project site suggests that the Bisbee Group structurally overlies the upper plate of an east dipping, low angle fault zone. At this locality, the Bisbee Group includes the Glance Conglomerate, the Willow Canyon Formation, and the Apache Canyon Formation. The Glance Conglomerate is composed of a limestone-pebble conglomerate. It is stratigraphically overlain by a thick, arkosic sandstone and conglomerate of the Willow Canyon Formation. Arkosic clastics of the Willow Canyon Formation grade upward into the Apache Canyon Formation, a shale and silty mudstone dominated sequence containing subordinate amounts of interbedded dark-gray, thin-bedded, limestone, and sandstone.

The northeastern portion of the Rosemont Project area lies within the Mount Fagan Caldera, a complexly faulted, dominantly rhyolitic volcanic center, which was subsequently tilted 30 to 50 degrees to the southeast by late Tertiary Basin and Range extensional tectonism. A dissected alluvial fan, exposed along the eastern flank of the Santa Rita Range, is characterized by a gently southeast tilted sequence of sands and gravels of the Gila Conglomerate. The Gila Conglomerate unconformably overlies the Bisbee Group and Mount Fagan Caldera in the southeastern portion of the Project area.

Placement of quartz latite porphyry stocks resulted in the development of large zones of copper-bearing skarn, which host the mineral resource at the Project as well as several other smaller occurrences within the Rosemont-Helvetia mining district. Tectonic history of this region includes at least two (2) periods of extensional deformation and one (1) period of compressional deformation, which have resulted in the district’s complex structural setting.

Additional information concerning the site geology is provided in the Aquifer Protection Permit Application (Tetra Tech, 2009a).

### 3.4 Drainage Basins

The watershed upstream of the proposed Compliance Point is approximately 8.2 square miles (sq-mi) while the entire Barrel Canyon drainage is approximately 14.1 sq-mi [United States Geological Survey (USGS) Gauging Station number 09484580]. Barrel Canyon drains into the upper reaches of the Davidson Canyon watershed. The entire Davidson Canyon watershed is
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approximately 50.5 sq-mi (USGS Gauging Station number 09484590). Davidson Canyon eventually drains into the Cienega Creek basin which is approximately 605 sq-mi.

Therefore, the watershed associated with the Project (Figure 08) comprises:

- Approximately 58% of the entire Barrel Canyon drainage;
- Approximately 16% of the Davidson Canyon watershed; or
- Approximately 1.4% of the Cienega Creek basin (Tetra Tech, 2009a).

The location of Davidson Canyon and Cienega Creek are shown on Figure 01.

The Cienega Creek basin is located in the Basin and Range physiographic province. The basin consists of a narrow northeast trending alluvial valley surrounded by fault-block mountains. The basin's central valley, Empire Valley, narrows to the north and southwest where surface water drainages exit the basin. The basin is bounded by the Santa Rita and Empire Mountains to the west, the Rincon Mountains to the north, the Whetstone and Mustang Mountains to the east, and the Canelo Hills and Patagonia Mountains to the south. Cienega and Sonoita Creek are the main surface water drainages in the basin. Cienega Creek is primarily an ephemeral stream that drains towards the north into the Tucson Active Management Area (AMA) and can be divided into two (2) sections: an upper section that drains the central valley and a lower section that flows through a narrow valley and empties into Pantano Wash.

The central valley narrows near the northern end and impermeable bedrock forms what locals call "the Narrows", separating Cienega Creek into the upper and lower sections. Impermeable bedrock at the Narrows, and in several other places downstream, forces groundwater into Cienega Creek's streambed creating small perennial gaining reaches. Other than the perennial stretches in the lower reaches, most flow in Cienega Creek is runoff from local storm events.

The 8.2 sq-mi drainage located upstream of the Compliance Point Dam, as shown on Figure 08, is comprised of the following:

- The Mc Cleary Canyon drainage basin forms the northern portion of the site and is approximately 1,561 acres (2.44 sq-mi). It reports to the lower Barrel Canyon drainage via the Compliance Point Dam and comprises approximately 17% of the Barrel Canyon watershed.
- The Wasp Canyon drainage basin forms the western portion of the site and is approximately 1,383 acres (2.16 sq-mi). It reports to the lower Barrel Canyon drainage via the Compliance Point Dam and comprises approximately 15% of the Barrel Canyon watershed.
- The Barrel Canyon drainage forms the southern and eastern portions of the site and is divided into upper and lower sections.
  - The Upper Barrel Canyon drainage forms the southern portion of the site and is approximately 1,731 acres (2.70 sq-mi). It reports to the Compliance Point Dam via the lower Barrel Canyon drainage and comprises approximately 19% of the Barrel Canyon watershed.
  - The Lower Barrel Canyon drainage forms the eastern portion of the site and is approximately 577 acres (0.90 sq-mi). It reports to the Compliance Point Dam and comprises approximately 6.4% of the Barrel Canyon watershed.

In addition to showing the Compliance Point Dam, Figure 08 also shows the main disturbance area associated with the Project. This disturbance area is associated with the base reclamation
concept of the Rosemont Ridge Landform. The location of the main disturbance area in relation to the main drainages is also shown on an oblique aerial of the Project area (Figure 09).

The outer drainage boundary shown on Figure 08 is also coincident with the Pollutant Management Area (PMA) shown on Figures 04 and 05. As described in Arizona Revised Statutes (A.R.S.) §49-244.1, the PMA is the limit projected in the horizontal plane of the area on which pollutants are or will be placed. The PMA for the APP application consisted of a line circumscribing the APP Regulated Facilities and extended to the Compliance Point Dam, a facility anticipated to be part of the SWMP and used for stormwater sampling and for sediment control. The PMA was developed by first delineating the drainage divide around the Project site as shown on Figure 08. This boundary may change as facility designs and layouts are finalized during the EIS process and upon ADEQ review of the APP application.
4.0 DESIGN CRITERIA SUMMARY

Criteria used to design the various site water management/stormwater control structures at the Rosemont Project site are highlighted throughout the text and are summarized below. This summary is provided to highlight the level of control provided to protect the Project facilities and the environment during operations and at closure. Some of the criteria listed below were also taken from attached design documentation but not summarized in the main report text.

The NRCS method was generally used to size facilities. For storms other than the PMP event, the mean (50%) rainfall precipitation values were used in the hydrology analysis.

**General and Local PMP Event (runoff and storage):**
- Pit Diversion Channel
- Permanent Diversion Channel No. 1
- Permanent Diversion Channel No. 2
- Detention Basin No. 1 (modifications made during operational period)
- Detention Basin No. 2A/2B
- Detention Basin No. 3
- Waste Rock Storage Area (overall containment of the General PMP event with detention pools and perimeter containment areas)

**1,000-Year, 24-Hour Event (storage):**
- Top reclaimed surface of the Dry Stack Tailings Facility (with management of storms over the General PMP event behind a perimeter containment berm)

**500-Year, 24-Hour Event (runoff):**
- Drainage Benches on reclaimed surface of Dry Stack Tailings Facility area
- Drainage Benches on west side of Waste Rock Storage Area
- Drop Structures in Dry Stack Tailings Facility Area
- PLS and Stormwater Ponds Diversion Channel
- Pond Access Road Diversion Channel

**500-Year, 24-Hour Event (storage):**
- Detention pools in the Waste Rock Storage Area (overall management of stormwater in Waste Rock Storage Area for General PMP event)

**100-Year, 1 Hour Event (runoff):**
- Heap Leach Pad Perimeter Road V-Ditch (Rational method)

**100-Year, 24-Hour Event (storage):**
- Raffinate/PLS Pond/Stormwater Ponds (process criteria plus 100-year, 24-hour storm runoff)
- PWTS Pond (process criteria plus 100-year, 24-hour storm runoff)
- Settling Basin (process criteria plus 100-year, 24-hour storm runoff)
- Evaporation Ponds (top of operational dry stack tailings surface)

The PWTS Pond, Settling Basin, and general plant site stormwater ponds were also designed to contain runoff from a General PMP event.

**25-Year, 24-Hour Event (runoff):**

- Temporary Perimeter Ditches (runon and runoff control for operational dry stack tailings)
5.0 GENERAL SITE WATER MANAGEMENT

Figure 10 provides an overall plan view of the stormwater controls planned for the Rosemont Ridge Landform with a graded Plant Site area. As previously indicated, staged stormwater controls will be developed throughout the life of the Project once a preferred alternative or set of alternatives are selected during the EIS process.

The stormwater controls illustrated herein were designed/sized to accommodate the maximum conditions encountered for a particular structure by considering both operational and closure scenarios. Additionally, the design and planning associated with the stormwater control structures kept the ultimate closure configuration in mind, as well as overall Project goals related to site water management. These goals are stated below in Section 5.1. Design criteria applied to the site water management structures are also highlighted in the various report sections and were also summarized in Section 4.0.

5.1 Site Water Management Goals

The following general site water management goals were applied to the design of the general Project facilities as well as the Rosemont Ridge Landform. Select operational controls are also listed that reduce the potential for long-term closure issues to occur.

5.1.1 Placement of Major Facilities Within a Single Drainage Basin

Monitoring the APP regulated facilities, such as the Dry Stack Tailings Facility, Heap Leach Facility, and the Waste Rock Storage Area is simplified by having a single, topographically down-gradient point. Limiting the footprint of the Project was also part of this goal.

5.1.2 Passive Containment Provided by the Open Pit

Based on the regional groundwater model developed by M&A (M&A, 2009), a terminal pit lake is expected to form in the Open Pit. Due to the high evaporation rate of the Project area, the Open Pit will be a hydraulic sink.

As part of the APP application process, the discharge impact area (DIA) will be determined that defines the passive capture zone associated with the terminal pit lake. As described in A.R.S. §49-201, the DIA is the potential areal extent of pollutant migration, as projected on the land surface, resulting from a discharge from a facility. The boundary of the DIA is the point at which the pollutant, because of dilution, dispersion, adsorption, or degradation, reaches a level that is indistinguishable from ambient concentrations by standard test methods.

As indicated in Section 2.2, the Rosemont Ridge Landform will remain at closure along with the Open Pit. Along with the Waste Rock Storage Area, the Rosemont Ridge Landform also encompassed the Dry Stack Tailings Facility and the closed Heap Leach Facility. Infiltration, seepage, and fate and transport modeling were performed on the facilities as detailed in the report titled Infiltration, Seepage, Fate and Transport Modeling Report (Tetra Tech, 2010e). The results of this modeling effort indicated that any potential seepage from these facilities would have little or no impact on the quality or quantity of water within the regional groundwater system.

Regardless, the hydraulic sink created by the terminal pit lake is expected to provide tertiary containment for any constituents of concern potentially generated from APP regulated facilities. To the maximum extent practicable, the goal is to place these facilities within the passive containment zone of the Open Pit.
5.1.3 Placement of Non-Acid Generating Waste Rock on the Outer Slopes of the Rosemont Ridge Landform

A waste rock geochemical characterization program based on Appendix B of the Arizona Mining Best Available Demonstrated Control Technology (BADCT) Guidance Manual (ADEQ, 2004) will be developed and implemented during operations to prevent placement of net acid generating (NAG) materials on the outer slopes.

Geochemical testing of waste rock materials has been performed as summarized in Geochemical Characterization Addendum 1 (Tetra Tech, 2007b). Additionally, infiltration, seepage, fate, and transport modeling was performed for the Waste Rock Storage Area as documented in the Infiltration, Seepage, Fate and Transport Modeling Report (Tetra Tech, 2010e). Fate and transport modeling showed the potential for seepage to reach the base of the Waste Rock Storage Area under large or prolonged precipitation conditions, and that the seepage may have constituents above the Arizona Aquifer Water Quality Standards (AWQS). In these cases, however, the constituent concentrations are not higher than natural background levels that exist in this mineralized area. Chemical modeling results showed a potential arsenic concentration in the seepage of 0.012 milligrams per liter (mg/L). This level of arsenic is slightly above the proposed AWQS of 0.010 mg/L but it is below the current standard of 0.05 mg/L. This concentration is very similar to groundwater conditions at the site. Groundwater monitoring has indicated that naturally occurring arsenic concentrations in the area are above the proposed AWQS (0.011 to 0.027 mg/L).

A review of applicable surface water quality standards (SWQS) was also performed. Stormwater samples, as well as Synthetic Precipitation Leaching Procedure (SPLP) data on waste rock and tailings samples, were compared to SWQSs associated with Barrel Canyon and Davidson Canyon. Results of the analysis are summarized in Section 13.0. Based on rainfall contact with waste rock or tailings, and the potential for stormwater runoff, it was concluded that degradation of the surface water quality at the Project site is not anticipated.

5.1.4 Implementation of the Dry Stack Tailings Disposal Method

The Dry Stack Tailings Facility is designed to meet or exceed applicable BADCT guidance (ADEQ, 2004). The dry stack tailings disposal method will be used at the Project site. This method minimizes seepage from the facility to the maximum extent practicable compared to conventional tailings disposal methods.

As indicated in the Infiltration, Seepage, and Fate and Transport Modeling Report (Tetra Tech, 2010e), limited seepage is anticipated to occur from the facility due to a reduction of retained moisture from within the tailings material. Chemical modeling indicated that none of the measured constituents in this source of seepage exceeded AWQS. Seepage from the tailings facility is not expected to occur based on meteoric precipitation (rainfall).

The dry stack tailings will be placed behind large waste rock buttresses, preventing any stormwater contact with the dry stack tailings on the outer slopes of the Rosemont Ridge Landform. Stormwater control for the areas internal to the facility, and within the top perimeter containment berm, are illustrated in the report titled Dry Stack Tailings Storage Facility Stormwater Management Design (AMEC, 2010). This report is provided in Appendix A and summarized in Section 7.0.

AMEC’s stormwater management report illustrates control features designed to prevent stormwater runon to the Dry Stack Tailings Facility, including runoff control from the surface of the dry stack tailings. As indicated Section 5.1.3, should rainfall contact the tailings and runoff to
down-gradient stormwater receptors, it was concluded that degradation of the surface water quality at the Project site would not be anticipated (see Section 13.0).

5.1.5 **BADCT for the Heap Leach Facility**

The Heap Leach Facility is also designed to meet or exceed applicable BADCT guidance (ADEQ, 2004). The Heap Leach Pad and ponds will be lined facilities and are designed to minimize the potential to impact groundwater and surface water resources. Early decommissioning of the Heap Leach Facility will allow for monitoring of heap drain-down during active sulfide mining and milling operations. Discussions on site water management strategies for the Heap Leach Facility during operations and potential treatment of the drain-down solutions from the spent ore pile are provided in Section 8.0.

5.1.6 **Facility Operations Behind Perimeter Berms/Buttresses**

Early in the development of the Rosemont Project, perimeter berms and buttresses will be constructed along the footprint of the Rosemont Ridge Landform. Construction of these perimeter berms and buttress areas will allow for concurrent reclamation of the outer slopes of the Landform during operations. Additionally, once the starter buttress is constructed in the Lower Barrel Canyon drainage as part of the South Dry Stack Tailings Facility; the down-gradient water course will be separated from the up-gradient Project area. This will provide sediment control for all up-gradient Project activities in Barrel and Wasp Canyons. Basin wide sediment control will also be provided in McCleary Canyon once the starter buttress associated with the North Dry Stack Tailings Facility is constructed in approximate Operations Year 10. General sediment control and potential loading to downstream watercourses are discussed in Section 12.0. The downstream monitoring point for assessing the effectiveness of the stormwater controls associated with the Project will be the Compliance Point Dam. This location will also provide an opportunity to incorporate additional quality control elements such as sediment control to maintain surface water quality.

Placement of the starter buttresses will include the construction of flow-through drains through the buttresses. Flow-through drains are large rock structures that provide:

- A hydraulic connection between the up-gradient side of the Rosemont Ridge Landform and the down-gradient side;
- Protection of the Project facilities during operational periods; and
- A separation between the wash areas and the dry stack tailings with waste rock.

The network of flow-through drains located in Barrel and McCleary Canyons exit the Landform through their respective starter buttresses. These rock drains will be covered with geotextile prior to the placement of waste rock or tailings over these structures and will prevent sediments from filtering into the drains. Waste rock will also be placed in minor washes (finger drains) in the dry stack tailings area. Finger drains will not be covered with geotextile and do not function to provide a hydraulic connection or to protect facilities. Both the flow-through drains and the finger drains provide separation between the wash areas and the dry stack tailings. Details on the flow-through drains and finger drains are provided in Section 6.0.

5.2 **Stormwater Control Areas**

As shown on Figure 10, flow arrows indicate the overall stormwater routing and control associated with the post-operating Rosemont Ridge Landform. Figure 11 illustrates the watershed basins created by the Rosemont Ridge Landform under closure conditions. These basins consist of the following:
Areas that are self contained;
Areas that report directly to the Compliance Point Dam;
Areas that are partially self-contained;
Areas that report to flow-through drains; and
Areas reporting to or are contained within the Open Pit.

Basins that are self-contained are able to hold up to the 500-year, 24-hour event with overflow to containment areas able to hold the General PMP event.

Areas that report directly to the Compliance Point Dam include natural, unimpacted areas and a portion of the reclaimed surface of the Dry Stack Tailings Facility. Stormwater control on the reclaimed outer surface of the Dry Stack Tailings Facility is described in Section 5.5.2.

Areas that are partially self contained hold up to the 1,000-year, 24-hour event with overflow to the basins reporting directly to a flow-through drain or to basins reporting directly to the Compliance Point Dam.

Areas that report directly to flow-through drain inlets located on the west and north sides of the Landform.

A diversion channel is planned up-gradient of the Open Pit as shown on Figure 04 and Figure 05. Stormwater not diverted by this channel reports to the Open Pit. The Open Pit itself is considered non-discharging with regard to stormwater. The Pit Diversion Channel is further explained in Section 5.3.1.

Section 10.0 provides an estimate of the regulatory 100-year flood-peak and the average-annual runoff generated from baseline (pre-operating) conditions as well as post-operating conditions based on the general assumptions listed above and on Figure 11. The baseline and post-operating regulatory flood-peak and the average-annual runoff estimates presented in Section 10.0 assumed no downstream stormwater contribution from the flow-through drains under average-annual conditions or from the 100-year regulatory event. Section 11.0 further discusses the flow-through drains in terms of their response to different storm events, including estimates of post-operating stormwater infiltration at the Project site.

The following sections provide general descriptions of the post-operating stormwater control assuming development of the Rosemont Ridge Landform. The design of stormwater control structures was also based on operational considerations if those conditions required a higher level of control.

Stormwater control in the following areas is discussed in the remainder of this section. Figure 12 provides an index of the figures associated with each of these stormwater control areas.

- Open Pit Area – Pit Diversion Channel (Section 5.3.1) (Figures 13 through 18);
- Open Pit and Southern Plant Site Areas – Pit and Crusher Stormwater Ponds (Section 5.3.2) (Figures 19 and 20);
- Main Plant Site Area – Permanent Diversion Channels, Detention Basins, Process Water Temporary Storage (PWTS) Pond, and Settling Basin (Section 5.4) (Figures 21 through 24);
- Reclaimed surface of the Rosemont Ridge Landform (Section 5.5);
  - Waste Rock Storage Area (Section 5.5.1) (Figures 25 through 27); and
  - Dry Stack Tailings Facility (Section 5.5.2.) (Figures 28 through 36).
Section 6.0 and Figure 37 through Figure 47 provide details on the flow-through drains. These drains are an integral part of the overall stormwater management for all areas during operations and at closure.

Additional details are also provided on stormwater controls for the following areas during operations:

- Dry Stack Tailings Facility (Section 7.0); and
- Heap Leach Facility (Section 8.0).

The remaining figures, Figure 48 through Figure 51, along with Section 12.0, illustrate the overall general sediment control strategy for the site.

5.3 Open Pit and Southern Plant Site Area

Stormwater control associated with the Open Pit and Southern Plant Site area consist mainly of three (3) components:

- Pit Diversion Channel;
- Pit Stormwater Pond; and
- Crusher Stormwater Pond.

The Pit Diversion Channel is designed to direct stormwater runoff away from the Open Pit area while the Pit Stormwater Pond is designed to manage stormwater runoff from within the general pit area but outside the ultimate pit limits. The Crusher Stormwater Pond receives runoff from the Open Pit area as well as from the southern Plant Site area.

5.3.1 Pit Diversion Channel

The Pit Diversion Channel will be constructed early in the Project life to divert unimpacted stormwater around the west and south sides of the Open Pit as shown on Figure 04 and Figure 05. The channel will also be coincident with a Pit Loop Electrical Road. Once expansion of the Open Pit reaches the elevation at the upper end of the Pit Diversion Channel, the Pit Electrical Loop Road will be extended across the Open Pit benches, connecting the electrical loop to the north side of the pit.

Discharge from the Pit Diversion Channel will be directed to a perimeter containment area (PCA) located along the west side of the Waste Rock Storage Area as shown on Figure 04 and Figure 05. This PCA is positioned between the toe of the Waste Rock Storage Area and a natural ridge. An overflow channel leads out of this PCA into another downstream PCA. As described in Section 5.5.1 below, these PCAs, along with detention pools located on wide benches in the Waste Rock Storage Area, generally function to contain runoff from a General PMP event. The Pit Diversion Channel is sized to handle the Local PMP event. Section 4.0 provided general design criteria on this channel and the other hydraulic structures associated with the Project.

Details of the Pit Diversion Channel are shown on Figure 13 through Figure 18.

- Figure 13: Pit Diversion Channel – Plan View w/ Index;
- Figure 14: Pit Diversion Channel – Lower Section – Plan & Profile;
- Figure 15: Pit Diversion Channel – Upper Section – Plan & Profile;
- Figure 16: Pit Diversion Channel – Multi-Plate Culvert – Plan & Sections;
- Figure 17: Pit Diversion Channel – Sections; and
Design features associated with the Pit Diversion Channel include:
- Typical sections of the channel and pit loop electrical road;
- Typical sections of the drop structure;
- Plan and sections of the large fill area along the lower reach of the channel; and
- Plan and sections of the large multi-plate culvert at end of the channel.

Except for a large fill area along the lower reach, the majority of the channel shown on Figure 13 through Figure 18 was designed in cut. There is also a large drop structure associated with the design. Articulated concrete blocks are anticipated for use as erosion control along the drop structure and within the outlet apron.

For approximately half of the channel length, a planned Pit Electrical Loop Road will be coincident with the bottom of the channel. The Pit Electrical Loop Road will transition into the channel bottom at the upper end of the drop structure. From this point to its intersection with a haul road located on the south side of the Open Pit, the Pit Electrical Loop Road will run parallel to the channel along the outside crest.

As indicated above, the channel discharges unimpacted stormwater to a PCA located at the toe of the Waste Rock Storage Area. Prior to discharging to this area, storm flows will pass through a large multi-plate culvert. An access road passes across this area, linking mine operational areas with a Perimeter Access Road (see Figure 16).

Preliminary design calculations for the Pit Diversion Channel are provided in Appendix D. Final design of the Pit Diversion Channel may include such items as sequenced installation of the channel or replacing the multi-plate culvert with a channel cut and light vehicle bridge.

5.3.2 **Pit and Crusher Stormwater Ponds**

As mining progresses, the area down-gradient of the Pit Diversion Channel not contained within the pit limits will decrease over time. Prior to Operations Year 1, stormwater control berms may be required on the east side of the pit to contain stormwater runoff from the pit walls. Localized sumps would be required during this time to collect stormwater. Stormwater would be allowed to evaporate or would be pumped for use in construction or to the process circuit. At the end of the pre-production period (Operations Year 1), stormwater reporting to the pit should be fully contained within the pit limits.

Stormwater runoff not contained within the limits of the Open Pit reports either to one (1) of two (2) locations:
- A ponding area north of the Primary Crusher (Crusher Stormwater Pond); and
- A ponding area south of the Primary Crusher against a major haul road intersection (Pit Stormwater Pond).

These areas are shown on Figure 19 with various operational scenarios.

The watershed contributing runoff to the Crusher Stormwater Pond is part of the southern Plant Site area. Expansion of the Open Pit removes a significant portion of the watershed contributing to this ponding area. Likewise, the watershed contributing storm flows to the Pit Stormwater Pond is large during the early years of the operation, becoming non-existent at closure due to expansion of the Open Pit.
The Pit Stormwater Pond is located up-gradient of a major haul road intersection. Culverts would be extended through the intersection to a down-gradient flow-through drain to pass storms over the 100-year, 24-hour event (Figure 20). Nine (9) 60-inch diameter culverts would be needed to prevent the General PMP event from overtopping the haul road at maximum watershed conditions. During early development, peak flow from a Local PMP event would likely overcome the flow capacity of the culverts and overtop the haul road.

Figure 20 also provides a section through the road embankment creating the Crusher Stormwater Pond. Two (2) 60-inch diameter culverts would be required to pass the General and Local PMP events. The culverts would be structured to retain the 100-year, 24-hour event while passing larger events to a down-gradient flow-through drain.

Culverts shown may be reduced to allow larger events to pass over the haul road during the early development years. Regardless, mine drainage would be captured and retained within the pit development area. Only those areas without direct impact from mining would be allowed to discharge or pass through to the down-gradient flow-through drains.

5.4 Main Plant Site Area

In addition to the Crusher Stormwater Pond described in Section 5.3.2, the following additional site water management structures will be constructed in the Plant Site Area early in the Project life. These structures include:

- Permanent Diversion Channel No. 1 (Section 5.4.1); and
- PWTS Pond and Settling Basin (Section 5.4.2).

These features are shown on Figure 21 with other general stormwater control basins located throughout the Plant Site area.

At approximate Operations Year 10, additional stormwater control structures will be constructed, including the following:

- Detention Basin No. 1;
- Permanent Diversion Channel No. 2;
- Detention Basin No. 2A; and
- Detention Basin No. 2B.

These structures are shown on Figure 22 through Figure 24 and are discussed in Section 5.4.3. In addition to protecting Plant Site facilities, these structures are also designed to control stormwater runon to the North Dry Stack Tailings Facility. These structures are planned in addition to flow-through drains in McCleary Canyon.

5.4.1 Permanent Diversion Channel No. 1

Permanent Diversion Channel No. 1 shown on Figure 21 will be constructed at the beginning of the Project on the northeast side of the Open Pit. This diversion channel diverts unimpacted storm runoff from an up-gradient watershed around the Plant Site area into McCleary Canyon drainage. This channel was designed by AMEC to convey the Local PMP event as detailed in the design report titled *Dry Stack Tailings Storage Facility Stormwater Management Design Report* (AMEC, 2010) provided in Appendix A.

Storm flows from Permanent Diversion Channel No. 1 will be discharged to a natural channel in upper McCleary Canyon drainage and will pass through culverts underneath the Primary Access Road and into the lower portion of McCleary Canyon. This configuration will remain until
approximate Operations Year 10 when construction of the North Dry Stack Tailings Facility begins. Details of the Dry Stack Tailings Facility can be found in the report titled *Dry Stack Tailings Storage Facility Final Design Report* prepared by AMEC (AMEC, 2009).

The road culvert [two (2) 8’ x 4’ box culverts] shown on Figure 21 is sized to pass storms up to the 100-year, 24-hour event underneath the Primary Access Road, while passing larger storms, such as the PMP event, over the road. Additional road culverts are located along the Primary and West Access Roads as needed to pass storm events. Unless otherwise indicated, these culverts are sized to pass peak flows from the 100-year, 24-hour event.

In addition to showing Permanent Diversion Channel No. 1, Figure 21 also shows the operational Plant Site area with general stormwater control ponds/basins, the PWTS Pond, and the Settling Basin. The PWTS Pond and Settling Basin are lined facilities and are described in Section 5.4.2 below.

### 5.4.2 Plant Site Area – PWTS Pond, Settling Basin, and Miscellaneous Stormwater Ponds

The PWTS Pond and Settling Basin are planned for construction early in the Project life. The embankment of the PWTS Pond will initially be free standing but will be incorporated into the waste rock buttress associated with the South Dry Stack Tailings Facility in about Operations Year 3. Additionally, the starter buttress for the South Dry Stack Tailings Facility is located downstream of the PWTS Pond. This starter buttress follows construction of the PWTS Pond by less than one (1) year, providing watershed separation to the down-gradient watercourse. This watershed separation is further discussed in Section 12.0.

The design of the PWTS Pond is detailed in a design report titled *Process Water Pond, Temporary Storage Pond, and Settling Basin Design Report* (M3, 2009) provided in Appendix E. The Settling Basin is also highlighted in this report. The PWTS Pond is a combination of two (2) ponds: the Process Water (PW) Pond and the Temporary Storage (TS) Pond.

A spillway connects the Settling Basin to the PW Pond portion of the PWTS Pond. A spillway also connects the PW Pond to the TS Pond. Early sequencing of facilities’ construction may necessitate the installation of a stormwater pond at the Settling Basin location early in the life of the Project. Construction of the actual Settling Basin will occur after installation of the PWTS Pond. If a stormwater pond is constructed, it will be unlined and managed to control stormwater flow into the PW Pond.

Based on the design report prepared by M3, the PW Pond, the TS Pond, and the Settling Basin were designed to contain the following during operations:

**PW Pond**

- Recovered water from Tailings Thickeners;
- Recovered water from the Tailings Filter Plant;
- Overflow from the Settling Basin;
- Fresh water make-up;
- Accumulated groundwater and stormwater from the Open Pit; and
- Stormwater runoff from the Plant Site area.

**TS Pond**

- Stormwater Runoff;
Overflow from the PW Pond; and

**Settling Basin**

- Short-term storage of non-filtered tailings.

Other miscellaneous ponds will be placed throughout the Plant Site area as needed to control stormwater runoff. Unlike the PWTS Pond and the Settling Basin, these ponds will be unlined.

Closure of the PWTS Pond and Settling Basin will follow the procedures outlined in a Technical Memorandum titled *Prescriptive BADCT Closure for Lined Facilities at the Rosemont Project* (Tetra Tech, 2010h) provided in Appendix F. Following facility demolition and liner removal, the Plant Site area will be graded to match post-operations land use objectives.

Post-closure grading of the Plant Site area will likely include the construction of stock ponds/sediment basins at the same locations as the former PWTS Pond and Settling Basin and other former ponding areas (Figure 23). Upon removal of the pond liner, stormwater reaching the former PWTS Pond area will pass into a flow-through drain (South 1 Drain) leading out of Wasp Canyon drainage and into the main Barrel Canyon flow-through drain (South Main Drain). South Main Drain exists on the east side of the Rosemont Ridge Landform in the Lower Barrel Canyon drainage, up-gradient of the Compliance Point Dam. Section 6.0, along with Figure 37 through Figure 47, provides details on the design of the flow-through drains.

Water detention/retention structures planned for construction at the Project site, such as the PWTS Pond, will be submitted to the Arizona Department of Water Resources (ADWR) in a separate Technical Memorandum for evaluation as potential jurisdictional structures. As much as practicable, Project facilities were designed to reduce or eliminate their potential for being categorized as jurisdictional dams.

### 5.4.3 Permanent Diversion Channel No. 2 and Detention Basins

About Operations Year 10, construction of the North Dry Stack Tailings Facility will begin in McCleary Canyon. Buttress construction will block the McCleary Canyon drainage immediately north of the Settling Basin as shown on Figure 22. Figure 22 shows the operational Plant Site area with the post-closure Rosemont Ridge Landform blocking the McCleary Canyon drainage. A flow-through drain (North 1 Drain) extends through the waste rock buttress at this location to protect the Settling Basin and pass storm flows from the up-gradient side of the Rosemont Ridge Landform to the down-gradient side. In conjunction with placement of flow-through drains in the McCleary Canyon drainage, detention basins and other diversion channel segments will be constructed as shown on Figure 22. These detention basins and channel segments include:

- Detention Basin No. 1;
- Permanent Diversion Channel No. 2;
- Detention Basin No. 2A;
- Detention Basin No. 2B; and
- Detention Basin No. 3.

The embankments for Detention Basins No. 1, No. 2B, and No 3 are rock-filled structures designed to manage the General and Local PMP events (AMEC, 2010). Detention Basin No. 1 is a free standing structure while Detention Basins No. 2B and No. 3 are eventually incorporated into the waste rock buttress associated with the North Dry Stack Tailings Facility. The embankment for Detention Basin 2A is the Primary Access Road. As shown on Figure 22 and Figure 23, the Primary Access Road passes between Detention Basins No. 2A and 2B. Culverts
are planned connecting Detention Basin 2A with 2B. These road culverts are intended to pass \( \frac{1}{2} \) of the Local PMP event. Larger events would pass over the road.

Flow-through drains (North 2 Drain and North 3 Drain, respectively) connect Detention Basins No. 2B and No. 3 to a main flow-through drain (North Main Drain) constructed along the McCleary Canyon drainage. North Main Drain exists the Landform immediately up-gradient of the confluence of McCleary Canyon drainage with Lower Barrel. Section 6.0, along with Figure 37 through Figure 47, provides details on the design of the flow-through drains.

Based on the configuration of the ponding area associated with North 1 Drain (Figure 22), and the layout of the Settling Basin, attenuation of the storm flows are required between Operations Year 10 and closure to protect the Settling Basin from inundation during PMP events. Modifications to Detention Basin No. 1 include the addition of a high-density, polyethylene (HDPE) liner on the upstream side of the embankment and a 24-inch culvert placed along the invert of the drainage. The 24-inch culvert size was selected to maintain a water surface elevation (WSE) below the Settling Basin embankment elevation.

At closure, the liner placed on the upstream side of the Detention Basin No. 1 embankment will be removed and the Settling Basin will be closed. Figure 23 shows stormwater routing through the post-closure Plant Site area. Storm events may inundate the North 1 Drain inlet area and overflow into the former Settling Basin and PWTS Pond areas. At this time, however, both the Settling Basin and the PWTS Pond will have been closed per the procedures outlined in the Technical Memorandum titled *Prescriptive BADCT Closure for Lined Facilities at the Rosemont Project* (Tetra Tech, 2010h) provided in Appendix F. Figure 24 shows Detention Basin No. 1 with and without the HDPE liner.

### 5.5 Rosemont Ridge Landform Stormwater Control

Stormwater controls applied to the reclaimed surface of the Rosemont Ridge Landform are described below for the following two (2) areas:

- Waste Rock Storage Area; and
- Dry Stack Tailings Facility.

#### 5.5.1 Waste Rock Storage Area – Reclaimed Surface

Shaping of the Waste Rock Storage Area was based on application of the stormwater control features as illustrated on Figure 25 and as described below.

Stormwater detention pools are planned on the wide benches in the Waste Rock Storage Area to hold up to the 500-year, 24-hour storm event. Stormwater generated from flows over the 500-year, 24-hour storm event would be routed to PCAs located between the toe of the Waste Rock Storage Area and adjacent natural ridge areas. In conjunction with the detention pools, the PCAs are sized to hold the General PMP event. Stormwater routing to the PCAs from the benches would be via rocked slopes. Benches in the Waste Rock Storage Area are generally spaced 100 feet vertically with intervening 3:H:1V slopes. This results in slope lengths of about 315 feet between benches. As shown on Figure 11, the majority of the Waste Rock Storage Area is considered self-contained according to the criteria described in Section 5.2 and shown on Figure 25.

Cross sections were prepared for the Waste Rock Storage Area showing typical stormwater detention pools and a PCA (see Figure 26 and Figure 27).
- Figure 26: Cross Section S-S’ – Typical section showing the wide benches in the Waste Rock Storage Area and location of the stormwater detention pools. These pools are typically four (4) feet to eight (8) feet deep;

- Figure 26: Cross Section T-T’ shows the flow channel between the stormwater detention pools. These connecting channels are approximately two (2) feet deep;

- Figure 27: Cross Section U-U’ – Section through a typical PCA between the toe of the Waste Rock Storage Area and an adjacent natural ridge. The Pit Diversion Channel shown on Figure 13 discharges to this PCA. The Pit Diversion Channel diverts unimpacted stormwater runoff from an area up-gradient of the Open Pit; and

- Figure 27: Cross Section U-U’ provides an additional section through this PCA.

The outline of the closed Heap Leach Facility is shown on Figure 25. No stormwater ponding is allowed above this closed and encapsulated facility. A minimum waste rock cover of 20 feet will be placed over the spent ore pile and ponds. Section 8.0 provides details related to modeling work associated with selecting a minimum cover thickness to prevent meteoric precipitation (rainfall or snowmelt) from infiltrating into the spent ore material and causing seepage.

A limited area on the west face of the Rosemont Ridge Landform, adjacent to the closed Heap Leach Facility, will have slopes steeper than 3H:1V due to conflicts with extending the toe of the Rosemont Ridge Landform in this area. As indicated on Figure 11 and on Figure 25, this area is not self-contained but reports to a flow-through drain (South 2 Drain) located on the west side of the Rosemont Ridge Landform. These slopes will have rock facing to control erosion over the entire steepened face. Additionally, drainage channels will be constructed in this area to control stormwater runoff. These drainage channels will be similar to those planned for the Dry Stack Tailings Facility. These channels are shown on Figures 27 and 28 and explained in Section 5.5.2 below.

Design calculations for the stormwater control structures associated with the reclaimed surface Waste Rock Storage Area are detailed in the Technical Memorandum titled *Rosemont Waste Rock Storage Area Stormwater Management* (Tetra Tech, 2010u) provided in Appendix G. Section 6.0, along with Figure 37 through Figure 47, provides details on the design of the flow-through drains.

### 5.5.2 Dry Stack Tailings Facility – Reclaimed Surface

Shaping of the Dry Stack Tailings Facility was based on application of the following stormwater control features as illustrated on Figure 30 and as described below.

- The configuration of the slopes are typically 3H:1V with drainage control benches spaced about 100 feet vertically. This results in slope lengths of approximately 315 feet. Drainage control benches are generally 50 feet wide and accommodate a drainage channel, access road, and a safety berm. This configuration assumes that the waste rock material placed on the outer slopes is fairly coarse. Thick waste rock buttresses will encapsulate the dry stack tailings material;

- The drainage channels route storm flows to the Waste Rock Storage Area, natural ground, or to stilling pools/drop structures. At a minimum, the channels are sized to accommodate a 500-year, 24-hour event even with a 30% loss in channel volume due to sedimentation as detailed in the Technical Memorandum titled *Rosemont Dry Stack Tailings Facility Drainage Bench Analysis* (Tetra Tech, 2010l) provided in Appendix H. Typical drainage bench and channel configurations are shown on
Figures 28 and 29. These figures show both V-channel and trapezoidal channel designs. Channel flow depths are shown assuming various storm events, both with and without a 30% loss of channel capacity due to sedimentation. The V-channel configuration is anticipated for the Project:

- For reference, peak flows generated by a 500-year, 24-hour storm event using the NRCS curve number approach were deemed equivalent to the Pima County method using PC-Hydro, which uses a 100-year storm event. This comparison is available in the Technical Memorandum titled *Rosemont Hydrology Method Justification* (Tetra Tech, 2010q) provided in Appendix C;
- The drop structures, and associated stilling basins, transfer stormwater off the reclaimed slopes of the Dry Stack Tailings Facility. At a minimum, these drop structures are designed to accommodate peak flows generated by a 500-year, 24-hour event;
- Stormwater will pond on the top surface of the North Dry Stack Tailings Facility in large depressed areas. These areas are designed to hold runoff from up to the 1,000-year, 24-hour event before storm flows are discharged through decant structures to stilling pools/drop structures located on the face of the Dry Stack Tailings Facility. A containment berm located around the top perimeter of the North Dry Stack Tailings Facility, however, is designed to control storm volumes larger than the General PMP event; and
- Waste rock will be mounded over a majority of the top surface of the South Dry Stack Tailings Facility. Storm events up to the 10-year, 24-hour event will be contained in large depressed areas located around the top reclaimed surface of the South Dry Stack Tailings Facility. Runoff from storms over the 10-year, 24 hour event, but under the 1,000-year, 24-hour event, will be controlled on the top surface behind a rock weir located on the west side of the Rosemont Ridge Landform. Storms over this event will discharge through or over the rock weir to a rocked slope leading to a flow-through drain (South 1 Drain). Except for the outlet on the west side, a large containment berm is also located around the perimeter of the North Dry Stack Tailings Facility.

Figure 31 through Figure 35 show the development of typical stilling pool and drop channel design elements. Other stilling pool/drop channel locations are anticipated on the west side of the Rosemont Ridge Landform as shown on Figure 30.

- Figure 31: Plan view of the Southeast (SE) stilling pools/drop structures;
- Figure 32: Detailed plan view of a SE stilling pool;
- Figure 33: Plan view of the Northeast (NE) stilling pools/drop structures;
- Figure 34: Typical sections associated with the SE stilling pools/drop structures; and
- Figure 35: Typical sections associated with the NE stilling pools/drop structures.

Figure 36 shows a typical plan and section view for the decant structures located on top of the North Dry Stack Tailings Facility. Design calculations related to the stormwater control structures associated with the reclaimed surface of the Dry Stack Tailings Facility are detailed in the Technical Memorandum titled *Rosemont Dry Stack Tailings Facility Stormwater Management* (Tetra Tech, 2010m) provided in Appendix I.
6.0 FLOW-THROUGH DRAINS

As described in the sections above, flow-through drains are an integral part of the overall site water management strategy for the Rosemont Project. Flow-through drains were described in Section 5.1.6 as large rock structures that provide the following functions:

- A hydraulic connection between the up-gradient side of the Rosemont Ridge Landform and the down-gradient side;
- Protection of the Project facilities during operational periods; and
- A separation between the wash areas and the dry stack tailings with waste rock.

Design of the flow-through drains are detailed in a Technical Memorandum titled *Rosemont Flow-Through Drain Design* (Tetra Tech, 2010n) provided in Appendix J. Preliminary design of the flow-through drains was provided by AMEC in the report titled *Dry Stack Tailings Storage Facility Final Design Report* (AMEC, 2009). Drain design was reassessed based on the need for additional flow-through drains required for protection of the Heap Leach Facility, and additional design considerations such as drain lengths and changes in the hydraulic head gradient throughout the drains.

Tetra Tech’s analysis of the flow-through drains led to the use of a new sizing equation. Flow passing through the drains will vary both spatially and temporally. Consequently, a routing model developed by Samani, J. M. V. and and Heydari, M. at the Tarbiat Modares University was used to estimate outflow from the drains. Samani, J. M. V. and Heydari, M. (2007) proposed a method for reservoir routing through rockfill dam structures that was applied to the outflow calculations for the flow-through drains. This method is applicable to these structures since it incorporates length as one of the equation variables. This equation was deemed more appropriate for this analysis than the previous Leps equation since Leps assumes a constant velocity at all times as flow passes through the structure.

The primary source of the flow-through drain material will be from select run-of-mine (ROM) rock types (Escrabosa and Glance) mined from the proposed Rosemont Open Pit. Based on AMEC’s original design specifications, the flow-through drain material was anticipated to have a $d_{50}$ of 12 inches with rock particles less than 24 inches in size. AMEC’s specifications are provided as an attachment to the Technical Memorandum titled *Rosemont Flow-Through Drain Design* (Tetra Tech, 2010n) in Appendix J.

An analysis of available particle size distribution data for the Rosemont deposit [Call & Nicholas, Inc. (CNI), 2008] was used to reassess the anticipated particle size distribution of the flow-through drain material. From the analyses, a final distribution of $d_{50} = 14''$, with a standard deviation of $\sigma = 5''$, was selected. The $d_{50}$ is the particle size diameter where 50% (by weight) of the total particles are smaller.

A sensitivity analysis was also performed to evaluate the effect of different rockfill particle distributions with Samani’s equation. The analysis results indicated a direct correlation between flow and the rock size distribution. A well sorted rock distribution will result in better controlled flow at the downstream side of the drain than a rock size distribution with a standard deviation greater than two (2) times the largest rock size.

The analysis and sizing of the flow-through drains assumed ponding would occur at the upstream end of the drains (inlets). This allowed modeling of the system as a detention reservoir routing system with the ponding area acting as the reservoir, the basin hydrograph controlling inflow to the reservoir, and the drain acting as the outlet.
An inflow hydrograph for each of the reservoir/ponding locations was developed using the largest possible contributing basin determined from preliminary waste rock placement/sequencing plans associated with the base concept of the Rosemont Ridge Landform.

Elevation-Area storage functions (stage-storage curves) were determined for each of the inlet ponding areas. Drains were sized to accommodate the worst case scenarios that would be encountered during operating and post-operating conditions associated with managing the Local and/or General PMP events. Optimizing drain sizes required maximizing upstream ponding volumes and attenuating peak flows.

The calculated drain dimensions were typically widened to accommodate anticipated construction equipment. Additionally, the height of the drains was increased to account for an upper compaction zone caused by the construction or mining equipment during placement. For drain segments anticipated to be constructed using large mine equipment, a ten (10) foot compaction zone was used. For drain segments anticipated to be constructed using smaller construction equipment, a five (5) foot compaction zone was used.

Sizing details are provided in Appendix K in the Technical Memorandum titled Rosemont Flow-Through Drain Sizing (Tetra Tech, 2010o). Additional discussion on the flow-through drains associated with the Heap Leach Facility is presented in the Technical Memoranda titled Heap Leach Facility Flood Surface Analysis and Stormwater Controls (Tetra Tech, 2010c) provided in Appendix L.

Details associated with the flow-through drains are provided on Figures 37 through 47.

- Figure 37: Flow-Through Drains – Plan View w/Index;
- Figure 38: Flow-Through Drains – Plan View;
- Figure 39: Flow-Through Drains – Stormwater Diversion Cut – Plan View;
- Figure 40: Leach Haul Road Culvert – Plan View & Sections;
- Figure 41: Flow-Through Drains – Sections;
- Figure 42: Flow-Through Drains – Section Details;
- Figure 43: Flow-Through Drains – Typical Drain Inlet – Plan & Sections;
- Figure 44: Flow-Through Drains – Typical Detention Basin Inlet;
- Figure 45: Flow-Through Drains – Typical Drain Outlet – Plan & Sections;
- Figure 46: Flow-Through Drains – Stormwater Diversion Cut – Sections; and
- Figure 47: Flow-Through Drains – Sections.

The flow-through drains will be covered with a non-woven, 10 ounce (oz) geotextile prior to the placement of waste rock or tailings over these structures and will prevent sediments from filtering into the drains. Waste rock will also be placed in minor washes (finger drains) in the dry stack tailings area. Finger drains will not be covered with geotextile and do not function to provide a hydraulic connection or to protect facilities. Both the flow-through drains and the finger drains provide separation between the wash areas and the dry stack tailings.

The flow-through drain and finger drain design concept arose after examining the operating Dry Stack tailings facility at Pogo near Fairbanks, Alaska. The Pogo design specifically considered the 2009 U.S. Supreme Court case regarding the Coeur Alaska mine project (Coeur Alaska, Inc. v. Southeast Alaska Conservation Council, et al.) which proposed discharge of slurry tailings to a 20-acre lake. Ultimately the Supreme Court found in favor of Coeur Alaska by determining
discharge of tailings to waters of the U.S. is regulated by the Clean Water Act Section 404 permit program and not the Section 401 program. Regardless of the decision, there still has been much discussion regarding the law; therefore, Rosemont has elected to construct the Dry Stack Tailings Facility such that the loss of potential waters of the U.S. will result from construction of the drain system and not from direct fill by dry stack tailings.

As shown on the Figure 38, two (2) main flow-through drain segments are associated with the Project and include:

- South Main Drain located in the Barrel and Wasp Canyon drainages; and
- North Main Drain located in the McCleary Canyon drainage.

Typical drain sections are shown on Figure 41. Both the South Main Drain and the North Main Drain exit the Rosemont Ridge Landform immediately up-gradient of the confluence of Lower Barrel and McCleary Canyons and up-gradient of the Compliance Point Dam. A typical outlet is shown on Figure 45.

As shown on Figure 38, the flowing drains feed into South Main Drain:

- South 1 Drain;
- South 2 Drain; and
- South 3 Drain.

South 1 Drain will have one (1) inlet point during operations and two (2) during closure. The South 1 Drain segment extending into the PWTS Pond will become functional once the PWTS Pond liner is removed at closure (see Figure 21). Additionally, stormwater overflow from the Pit Stormwater and Crusher Stormwater Ponds shown on Figures 19 and 20 will extend into South 1 Drain. At closure, only the Crusher Stormwater Pond will remain as shown on Figure 21. The Pit Stormwater Pond becomes fully enveloped by the ultimate pit limits. Besides stormwater contributions from the former PWTS Pond area, the inlet to South 1 Drain receives stormwater from the west slopes of the South Dry Stack Tailings Facility as well as from the reclaimed top surface of the facility at closure.

A typical flow-through drain inlet is shown on Figure 43. The drains will be extended approximately 30 feet beyond the toe of the Rosemont Ridge Landform. Non-woven, ten (10) oz geotextile will be placed at the inlet area and covered with about a ten (10) foot thick layer of rock to prevent sediments filtering into the drain. This configuration will allow cleaning of the drain inlets as needed and replacement of the geotexile fabric. Over time, the watershed surfaces reporting to the drain inlets should stabilize with a corresponding reduction in sediment loading. Because the drains have been resized and the drain inlets redesigned, the installation of pipes in the first few hundred feet of the drain inlets is no longer envisioned as previously illustrated in the report titled Dry Stack Tailings Storage Facility Final Design Report (AMEC, 2009).

Both South 2 Drain and South 3 Drain function to protect the Heap Leach Facility during operations. The inlet area to South 3 Drain will eventually be covered with waste rock and will have no outlet during closure. This drain is required to pass storm flows through the Dry Stack Haul Road and Heap Stormwater Control Berm during operations for protection of the Stormwater Pond embankment located at the toe of the Heap Leach Pad (Figure 39). Construction of the Dry Stack Haul Road will prevent storm flows from passing unimpeded down Barrel Canyon.

The Heap Stormwater Control Berm will be placed up-gradient of the Stormwater Pond to attenuate peak flows passing through the South 3 Drain and into the ponding area adjacent to
Stormwater Pond embankment. Another haul road, the Leach Haul Road, will eventually be constructed across Barrel Canyon, up-gradient of the Heap Stormwater Control Berm. This haul road will further attenuate storm flows reaching the Stormwater Pond embankment area. A 36-inch diameter culvert will be placed through the Leach Haul Road to pass storm flows as shown on Figure 40.

Figures 46 and 47 show typical sections associated with Drain 2 South and Drain 3 South. These sections show the flow-through drains in relation to a stormwater diversion cut located north of the Heap Leach Pad, and in relation to the Heap Stormwater Control Berm and the Dry Stack Haul Road. In addition to receiving stormwater from the west side of the Waste Rock Storage Area, South 2 Drain, along with the stormwater diversion cut, is required to divert storm flows away from the Pregnant Leach Solution (PLS) and Stormwater Ponds. These ponds are currently located within a natural drainage path.

In addition to South 1 Drain, South 2 Drain, and South 3 Drain, Finger Drains also branch out from the South Main Drain. These structures, however, are not designed to pass stormwater as discussed above, but only provide separation between wash areas and the dry stack tailings. Geotextile fabric will not be placed over the Finger Drains. However, fabric will be placed at the intersection of the finger drains and the flow-through drains to prevent sediments from filtering into the flow-through drains.

In addition to showing South Main Drain, Figure 38 also shows the following drains feeding into North Main Drain located within the McCleary Canyon drainage:

- North 1 Drain;
- North 2 Drain; and
- North 3 Drain.

North 1 Collector Drain also feeds into North 1 Drain and North 2 Collector Drain feeds into North 2 Drain. A Finger Drain also branches out from North Main Drain.

The inlet to North 1 Drain receives stormwater during operations and at closure. As described in Section 5.4.3 and shown on Figure 22, storm flows reaching this drain inlet during operations require modification of Detention Basin No. 1 to prevent inundation of the Settling Basin embankment during PMP events. Modification entails the installation of a 24-inch diameter culvert through the embankment of Detention Basin No. 1 and the installation of an HDPE liner on the inside face. At closure, the liner will be removed. During closure conditions, storm flows inundating the inlet to North 1 Drain may overtop into the former Settling Basin and PWTS Pond areas and into South 1 Drain. Calculations for the North 1 Drain inlet area assumed that the small watershed areas reporting to North 1 Collector Drain and North 2 Collector Drain inlets reported directly to North 1 Drain.

North 2 Drain receives stormwater passing through the Detention Basin No. 2A embankment. A typical connection is shown on Figure 44. Two (2) North 3 Drain segments connect to Detention Basin No. 3 as shown on Figure 38. The detention basin embankments are assumed constructed of the same material used in the flow-through drains.

Placement of the flow-through drains will be immediately followed by the placement of geotextile fabric along the toe of the structure as show on Figure 42. Prior to placing tailings or waste rock over the drains, fabric will be placed over the top and sides, overlapping the previous fabric placed along the toe. Progression of the drains in the Barrel and McCleary Canyon drainages is discussed in Section 12.0 as part of an overall sediment control strategy.
7.0 DRY STACK TAILINGS FACILITY

As a supplement to the design report titled Dry Stack Tailings Storage Facility Final Design Report (AMEC, 2009), AMEC developed a stormwater management plan associated with the dry stack tailings. This report, titled Dry Stack Tailings Storage Facility Stormwater Management Design Report, is provided in Appendix A and includes details on the following:

- Permanent Diversion Channel No. 1;
- Permanent Diversion Channel No. 2;
- Detention Basin No. 1;
- Detention Basin No. 2A/2B; and
- Detention Basin No. 3.

These site water management structures were previously described in Sections 5.4.1 and 5.4.3 in terms of stormwater control associated with the Plant Site area. Modifications were proposed for Detention Basin No. 1 to protect the Settling Basin during the operational period. These diversion channels and detention basins also route stormwater flows around the North Dry Stack Tailings Facility or to flow-through drain inlets along the toe of the Rosemont Ridge Landform. The design and sizing of the flow-through drains are described in Section 6.0.

As noted in Section 5.0, the diversion channels and detention basins were designed to handle the higher of the Local or General PMP events. Section 4.0 provided a summary of the design criteria applicable to these structures and to other stormwater management structures associated with the Dry Stack Tailings Facility and to the Project in general.

Drawings prepared by AMEC for the dry stack tailings stormwater management plan are also provided in Appendix A. These drawings illustrate the sequencing of the South Dry Stack Tailings facility as well as the North Dry Stack Tailings facility, from construction of the starter buttresses through operations and closure.

AMEC’s stormwater management plans, and associated dry stack tailings facility designs, were not developed from the base concept of the Rosemont Ridge Landform. Therefore, the footprint and overall shape of the Rosemont Ridge Landform shown on the figures associated with this site water management update report differ from the stacking plans shown by AMEC. As indicated in Section 1.0, updated stacking plans and phased stormwater controls will be developed once the final preferred alternative or set of alternatives is selected during the EIS process.

In addition to the shape of the Rosemont Ridge Landform, the flow-through drains highlighted in Section 6.0 were also modified from those presented by AMEC. An updated closure concept for the Dry Stack Tailings Facility has also been prepared in the report titled Reclamation Concept Update (Tetra Tech, 2010j). Stormwater control on the reclaimed surface of the Dry Stack Tailings Facility associated with the base concept of the Rosemont Ridge Landform was presented in Section 5.5.2 of this site water management update report and as shown on Figure 30.

In addition to the diversion channels and detention basins designed to protect the Plant Site area and to provide stormwater runon control to the North Dry Stack Tailings Facility, surface water management structures and protocols are presented in AMEC’s stormwater report designed to control storm runon to and runoff from the dry stack tailings surface during operations. The structures highlighted in AMEC’s report include:
- Temporary Perimeter Ditches; and
- Evaporation Ponds.

Stormwater from the tailings top surface will be controlled using perimeter ditches and by grading the tailings surface and routing runoff to evaporation ponds. These evaporation ponds will be sized to handle a 100-year, 24-hour storm event.

Temporary perimeter stormwater runon control ditches will also be constructed as needed to minimize the accumulation of stormwater on the tailings surface from up-gradient areas. Stormwater collected on the tailings surface will be allowed to evaporate or will be pumped to the process circuit.

The temporary perimeter ditches will be sized to handle the 25-year storm event. Ditches installed on the tailings surface will have sedimentation traps and siltation fencing as required for erosion control.

Once the waste rock buttresses are built-up along all sides of the dry stack facility, and the flow-through drains are covered with tailings, a minimum 10- to 12-foot high containment berm will encircle the tailings surface, preventing stormwater runon to and runoff from the tailings surface from storms over the General PMP event. Until this time, the possibility exists for stormwater leaving the interior of the dry stack tailings facility via the flow-through drains. As indicated in Section 5.1.4, should rainfall contact the tailings and reach down-gradient stormwater receptors, degradation of the surface water quality at the Project site is not anticipated. Section 13.0 provides further detail on a comparison made between SWQSs and SPLP results performed on tailings samples.
8.0 HEAP LEACH FACILITY AREA

Stormwater control associated with the final design effort for Heap Leach Facility is detailed in the Technical Memorandum titled *Heap Leach Flood Surface Analysis and Stormwater Controls* (Tetra Tech, 2010c) provided in Appendix L.

Stormwater controls associated with the Heap Leach Facility include the following:

- Construction of flow-through drains to protect the PLS and Stormwater Ponds (discussed in Section 6.0 and sized to handle the Local and General PMP events);
- PLS and Stormwater Ponds Diversion Channel to route stormwater runoff from up-gradient areas around the ponds (500-year, 24-hour event);
- Pond Access Road Stormwater Channel to control stormwater runoff generated along the Pond Access Road and from the Leach Pad Loading Haul Road (500-year, 24-hour event);
- Heap Leach Pad Perimeter Road V-Ditch to control stormwater runoff along the Heap Perimeter Access Road (Rational Method, 100-year return period); and
- Miscellaneous V-Ditches around the PLS, Stormwater, and Raffinate Ponds (incidental rainfall).

A 100-year flood surface was also analyzed as part of the design process for locating the PLS and Stormwater Ponds. These ponds were placed outside the 100-year flood surface adjacent to Barrel Canyon wash.

The Raffinate Pond is located in the Plant Site area, up-gradient of the PW Pond as shown on Figures 21 and 22 and is not located near a floodplain. Stormwater from limited up-gradient watershed areas is controlled by a V-Ditch around the pond.

The location of the PLS and Stormwater Ponds is shown on Figure 39 associated with the flow-through drains and in relation to the Heap Leach Pad. Figure 48 shows the remaining stormwater control features listed above.

In addition to the stormwater management features listed above, an underdrain will be constructed beneath the PLS and Stormwater Pond liners. As indicated in Section 6.0, the PLS and Stormwater Ponds will be constructed in a natural drainage channel. South 2 Drain, along with a stormwater diversion cut and construction of the Dry Stack Haul Road, will direct storm flows away from the ponds to a point downstream in Barrel Canyon. This underdrain is designed to maintain the integrity of the liner system by preventing seepage buildup. The Rosemont Spring is also located up-gradient of the ponds and may contribute seepage to the underdrain. Figure 48 shows the proposed alignment of the underdrain.

Both the PLS Pond and the Raffinate Pond will be double-lined facilities with a prescriptive leak collection and removal system (LCRS) having the following components:

- An 80-mil smooth HDPE liner (top liner);
- A geonet that is part of the LCRS and located between the top and bottom liners;
- A 60-mil smooth linear low-density, polyethylene (LLDPE) liner (bottom liner);
- A geosynthetic clay liner (GCL) below the 60-mil smooth LLDPE bottom liner; and
- Liner bedding beneath the GCL.
The Stormwater Pond will be a single-lined pond with the following components:

- An 80-mil smooth HDPE liner;
- A GCL below the 80-mil smooth HDPE liner; and
- Liner bedding beneath the GCL.

The lining system for the Heap Leach Pad will be comprised of the following:

- A minimum three (3) foot thick layer of overliner material with imbedded perforated drainage piping;
- A 60-mil double-textured LLDPE liner;
- A GCL below the 60-mil double-textured LLDPE liner; and
- Liner bedding beneath the GCL.

By about Operations Year 6 of the 20 to 25 year mine life, the delivery of oxide ore to the lined Heap Leach Pad is expected to cease. Following the suspension of leaching, drain-down of the spent ore pile will begin. Modeling has indicated that between (two) to three (3) years after the cessation of leaching, the drain-down seepage rate would be less than ten (10) gallons per minute (gpm). Covering the spent ore pile and the ponds located at the base of the heap with waste rock is envisioned no later than three (3) years after the cessation of leaching. If residual seepage continues, the PLS and Stormwater Ponds may be converted to passive treatment basins as described in the Technical Memorandum titled *Heap Leach Facility Infiltration, Seepage, and Fate and Transport Modeling/Treatment Options* (Tetra Tech, 2010d) provided in Appendix M.

Prior to conversion, closure of the Heap Leach Facility ponds would follow BADCT guidance (ADEQ, 2004). This closure concept is provided in Appendix N in the Technical Memorandum titled *Prescriptive BADCT Closure for the Heap Leach Facility Ponds* (Tetra Tech, 2010i) and would be evaluated by ADEQ prior to implementation.

Covering the spent ore pile with waste rock is envisioned to prevent flows, other than drain-down, that might result from meteoric precipitation (i.e., rainfall and/or snowmelt). Seepage, Fate and Transport modeling of the spent ore pile indicated that a minimum waste rock cover of 20 feet was needed to prevent infiltration from meteoric precipitation as detailed in the Technical Memorandum titled *Minimum Thickness Analysis for Waste Rock Placed Over Spent Leach Ore Material* (Tetra Tech, 2010f). This Technical Memorandum is provided in Appendix O.

Two (2) different passive treatment systems were considered for residual drain-down as presented in Appendix M. The first is an engineered biological type system. This type of system would be constructed using a variety of carbon sources to reduce sulfates and limestone to maintain proper alkalinity. Seepage would be routed to the former PLS Pond (Treatment Basin 1) from the spent ore pile and allowed to percolate through the treatment materials (crushed limestone, manure, straw, wood chips, etc.). Attenuated solutions would then flow into the closed Stormwater Pond (Treatment Basin 2). Treatment Basin 2 would be filled with crushed limestone. The second system considered would only use crushed limestone in both basins.

The modeling results presented in Appendix M indicated that both treatment options would increase the pH of the seepage water due to the alkalinity sources within the treatment systems. In addition to an increase in pH, the biological system would also reduce the quantity of sulfate in the seepage water. Both treatment systems would also tend to remove metals through precipitation onto the limestone surface. The precipitation of metals, however, can cause a crushed limestone system to lose its effectiveness over time by blocking access to the alkalinity.
In addition to other APP regulated facilities, monitoring of potential seepage from the Heap Leach Facility will take place during operations and at closure and will follow the conditions to be set in the APP and administered by ADEQ.

As indicated in Section 1.0, final design plans associated with the Heap Leach Facility are being prepared and will be submitted to ADEQ as part of the APP application. Additionally, a summary of the ponds associated with the Heap Leach Facility will be included in a Technical Memorandum being prepared that summarizes possible jurisdictional water detention/retention structures planned at the Project site.

Based on the configuration of the Raffinate, PLS, and Stormwater Ponds, the Stormwater Pond potentially falls within the jurisdiction of the ADWR. If under ADWR jurisdiction, the Stormwater Pond would likely be considered a small, very low hazard dam. In this case, the pond would be required to handle a 100-year, 24-hour event with three (3) feet of freeboard. Under prescriptive BADCT guidance, engineering equivalents to specific elements are deemed acceptable as long as supporting evidence is provided to ADEQ. In terms of stormwater control, the minimum criteria applicable in the absence of other regulatory guidance is the 100-year, 24-hour event for pond sizing and storm water diversions. For ponds, two (2) feet of freeboard is also recommended along with accounting for operational flows.

The following criteria were used to size the PLS and Stormwater Ponds:

- **PLS Pond:** Lined storage of eight (8) hours of operational flows, including 24 hours of drain-down flows from the Heap Leach Pad.
- **Stormwater Pond:** Passive storage of the 100-year, 24-hour storm event.
- **Total PLS Pond design capacity of 30.3 ac-ft.**
- **Total Stormwater Pond design capacity of 38.3 ac-ft.**
- Three (3) feet of freeboard over the design volume(s) provides a total combined pond capacity of 86.9 ac-ft.

As indicated, the combined PLS and Stormwater Ponds were designed to meet the criteria for both ADEQ and ADWR. Therefore, these ponds have the capacity to handle the required storm event plus operational flows with an additional three (3) feet of freeboard. Although not considered jurisdictional, the Raffinate Pond was also designed with three (3) feet of freeboard as documented in the Design Report titled *Rosemont Heap Leach Facility Permit Design Report* (Tetra Tech, 2009c).

The current sizing of the PLS/Stormwater Ponds was evaluated against runoff volumes generated using the upper 90% rainfall confidence level associated with a 100-year, 24-hour storm event and a 500-year, 24-hour event. The runoff volume was obtained by simply multiplying the plan area of the contributing watershed by the rainfall amount. For comparison, runoff from the 100-year and 500-year events were also performed using the 50% confidence level. The current design assumes use of the 50% rainfall confidence level.

Based on the current design of the Heap Leach Facility, the PLS and Stormwater Ponds located at the base of the planned Heap Leach Pad can accommodate stormwater runoff generated from a 100-year, 24-hour event in addition to operational flows while maintaining three (3) feet of freeboard. Containment of runoff volumes generated by a 500-year, 24-hour event at the 50% rainfall confidence level can also be accommodated in the current design while maintaining three (3) feet of freeboard. As indicated, these volume checks were determined by simply multiplying the plan area by the rainfall depth.
The existing design of the solution transfer system between the Heap Leach Pad and the PLS Pond is able to accommodate 150% of the planned operational flows in addition to storm runoff from a 100-year, 24-hour event. This design assumed use of the 50% rainfall confidence level and that placement of Overliner Drain Fill had been initiated along with placement of the initial ore lifts. Three (3) 18 inch diameter Header Pipes are designed to pass solution from the Heap Leach Pad to the Transfer Channel through a Solution Containment Berm. A spillway is also incorporated into the design of the Solution Containment Berm that can pass about 75% of the combined flow capacity of the pipes. Additional capacity is also provided by lined berms on either side of the Transfer Channel and Solution Containment Berm spillway.

Prior to placing Overliner Drain Fill and drain piping on the lined heap Leach Pad surface, the Transfer Channel between the Heap Leach Pad and the PLS Pond is assumed open, i.e., the Solution Containment Berm is not installed. Assuming a fully lined heap pad, peak flows generated by 100-year and 500-year, 24-hour events can be accommodated by the existing design for both the 50% and 90% rainfall confidence levels. Peak flows were generated using the Rational Method, which is fundamentally comparable to the approach approved by Pima County for a given natural watershed.

Once the Solution Containment Berm is installed, the Solution Containment Berm will have a 30-foot wide, 0.5-foot deep spillway along with the three (3) 18-inch diameter solution transfer pipes (Header Pipes) to pass PLS and storm flows to the PLS Pond.

Additional information concerning stormwater management for the Heap Leach Facility is detailed in the Technical Memorandum titled *Rosemont Heap Leach Facility Stormwater Management Analysis* (Tetra Tech, 2010p) provided in Appendix P.
9.0 HYDROLOGY METHOD COMPARISON

For the design of hydraulic structures, an analysis was made between different design methodologies and design storms in order to confirm Rosemont’s selection of the most practical and protective hydrologic methodology and design storm criteria for use at the Project site. A Technical Memorandum titled *Rosemont Hydrology Method Justification* (Tetra Tech, 2010q) provides details on this comparative analysis. This Technical Memorandum is provided in Appendix C and is summarized below:

In addition to comparing various storm events, two (2) different hydrologic methodologies were analyzed in the comparative analysis:

- NRCS method; and
- Pima County method.

The NRCS method described herein is based on two (2) components, the NRCS curve number approach (to determine initial losses and excess precipitation) and the unit hydrograph method (to derive the hydrograph resulting from excess rainfall). The analysis using the NRCS method was performed using HEC-HMS. HEC-HMS is a hydrologic modeling software package developed by the U.S. Army Corps of Engineer’s for general applications. Additionally, HEC-HMS allows for the analysis of more complex/integrated systems, i.e., multiple sub-basins, reservoir and channel routing, etc.

Variations in storm distributions and durations for the NRCS method were analyzed to determine the most appropriate criteria for the Rosemont site. Storms analyzed using the NRCS method were the 24-hour NRCS Type II Distribution, the 1-hour NRCS Type II Distribution, the 1-hour Symmetrically-Centered Thunderstorm, the 1-hour Compressed Distribution from a 6-hr NOAA Atlas 14 Distribution, and the 6-hour Local and 72-hour General PMP storm events. For the NRCS method, the following return periods were analyzed: 100-year, 500-year, 1000-year, and the Local and General PMP.

The Pima County method was performed using PC-Hydro, a modeling software package specifically developed for Pima County. PC-Hydro is intended to be used to analyze the peak flow from a watershed at a single point of concentration without consideration for variations in the time distribution of precipitation and discharge. Since hydrology calculations performed for Pima County are primarily concerned with 100-year return period and lesser events, only the 100-year, 1-hour event was analyzed using this method.

In order to compare flow rates and volumes generated using the various methods and storm distributions, three (3) watershed basins, varying in size and geometry, were investigated as part of the analysis.

9.1 Comparative Peak Flow Results

The 6-hour Local PMP event produced the highest peak flow of any of the storms analyzed. In general, the peak flow generated by the Local PMP event was followed in size by (in decreasing order): the 1,000-year, 24-hour event; the 500-year, 24-hour event; the 100-year, one-hour NRCS Type II event; the 100-year, one-hour thunderstorm; the 100-year, one-hour compressed 6-hour event; the 100-year, 24-hour NRCS Type II event, and finally the General PMP. With the exclusion of the PMP events, the order listed above assumed the use of mean (50%) precipitation values from the NOAA Atlas 14 precipitation data.
Peak flows generated by employing the Pima County method (using the upper 90% precipitation value) fell between the 100-year, 24-hour and the 100-year, one-hour NRCS Type II storm events, which used the mean precipitation values.

As expected, when comparing the same event using the mean and upper 90% precipitation values, the upper value produced greater peak flows.

### 9.2 Comparative Runoff Volume Results

The General PMP event produced the highest amount of runoff of all the storms analyzed. This volume was followed by (in decreasing order): the Local PMP event; the 1,000-year, 24-hour event; the 500-year, 24-hour event; the 100-year, 24-hour event; and the 100-year, one-hour events. With the exclusion of the PMP events, the order listed above assumed the use of mean precipitation values from the NOAA Atlas 14 precipitation data.

The volumes generated by employing the Pima County method (using the upper 90% precipitation value) fell between 100-year, one-hour and the 100-year, 24-hour events, which used the mean precipitation values.

Also as expected, when comparing the same event using the mean and upper 90% precipitation values, the upper value produced greater runoff volumes.

### 9.3 Comparative Analysis Conclusions

The NRCS method was developed for general hydrologic analysis and allows for various storm distributions and durations to be analyzed and is applicable to the analysis of large complex watershed systems, such as mining sites, where landscape conditions may change over time. The Pima County method, on the other hand, is generally used for simple watersheds having a single point of concentration without consideration for variations in the time distribution of precipitation and discharge.

For permanent conveyance structures, the minimum event used to calculate peak flows will generally be the 500-year, 24-hour storm. For comparison, the 500-year, 24-hour event produced higher peak flows than the 100-year storm calculated using the Pima County method (PC-Hydro) for the watersheds analyzed. Other event types may be used for sizing conveyance structures, depending on the length of service of a structure (i.e., temporary) or the location of the structure within the facilities (i.e., upstream of large containment structures or barriers, such as the Rosemont Ridge Landform). Many of the permanent structures at the Rosemont have also been designed to pass the Local PMP event.

For permanent and semi-permanent containment structures, runoff volumes were generally calculated using, at a minimum, the 100-year, 24-hour event. Less frequent, larger events, such as the 500-year, 24-hour event or the General PMP event, are used when failure would cause interference outside of the operational areas or to structures that are integral to the Project operation. For temporary or sediment-control structures, lesser storm events would be used. The runoff volumes calculated using PC-Hydro were less than the volumes generated using the 100-year, 24-hour event for the scenarios modeled in the analysis.

The NRCS method is applicable for watersheds over five (5) acres in size. As outlined in the Technical Memorandum titled *Rosemont Copper Project Design Storm and Precipitation Data/Design Criteria* (Tetra Tech, 2009b) provided in Appendix B, use of the Rational method to calculate runoff values from watersheds less than five (5) acres in size is advised using a 100-year return period.
10.0 BASELINE AND POST-OPERATING HYDROLOGY AND AVERAGE-ANNUAL RUNOFF

A baseline and post-operating (mining) hydrology (100-year regulatory event) and average-annual runoff analysis was performed for the Project site and is summarized in this section. Details of this analysis are provided in the following Technical Memoranda:

- *Baseline Regulatory (100-Yr) Hydrology and Average-Annual Runoff, Rosemont Copper Project* (Tetra Tech, 2010a) provided in Appendix Q; and
- *Post-Mining Regulatory (100-Yr) Hydrology and Average-Annual Runoff, Rosemont Copper Project* (Tetra Tech, 2010g) provided in Appendix R.

Watersheds analyzed for both the baseline and post-operating conditions were located up-gradient of the Compliance Point Dam. Post-operating conditions assumed the development of the base concept of the Rosemont Ridge Landform as shown on Figure 05. The potential for stormwater runoff to reach the Compliance Point Dam during post-operating conditions followed the watershed delineations shown on Figure 11.

For post-operating conditions, the following were assumed for the 100-year regulatory event:

- The Waste Rock Storage Area fully contained a 100-year event with no runoff;
- The top of the Dry Stack Tailings Facility fully contained a 100-year event with no runoff; and
- Storm runoff contributions to the flow-through drains from a 100-year event were assumed not to reach the Compliance Point Dam or were attenuated to the point as not to affect the 100-year peak flow.

For the post-operating conditions, the following were assumed for average-annual runoff:

- No runoff from the Waste Rock Storage Area;
- No runoff from the top of the Dry Stack Tailings Facility; and
- No runoff from average-annual storm contributions reporting to the flow-through drain inlets passed through the drains.

Therefore, only the basins reporting directly to the Compliance Point Dam, as shown on Figure 11, affected the post-operating hydrology and average-annual runoff estimates.

10.1 Surface Water Hydrology

Baseline regulatory hydrology for the Project site was determined using Computer Program HEC-HMS, Version 3.4 (August 2009). In order to ascertain the reasonableness of results using HEC-HMS, the computed regulatory (100-year) peak-discharge values were compared to the regulatory peaks using results from application of the USGS Regional Regression Equation (RRE) to the region which encompasses the Project site (i.e., Region 13).

In order to validate use of the USGS Region 13 RRE to calibrate regulatory peaks for watersheds at the Project site, regulatory peaks for two (2) nearby USGS stream gauges (Barrel Canyon and Davidson Canyon) were computed using results obtained from Bulletin 17B statistical analysis, and then compared to results using the USGS Region 13 RRE at these same two (2) stream gauge locations. A comparison of the results using Bulletin 17B statistical analysis to the results using the USGS Region 13 RRE indicated that the use of the USGS
Region 13 RRE was appropriate for the calibration of regulatory peak discharges emanating from watersheds at the Project site.

Based upon calibration using USGS Region 13 RRE regulatory peak values, it was determined that, rather than a 3-hour thunderstorm distribution, a NRCS Type II 24-hour temporal storm distribution could be used in the HEC-HMS model, in combination with a NOAA Atlas 14 24-hour mean-precipitation value and an appropriate HYDRO-40 areal-reduction factor. Consequently, an areally reduced NOAA Atlas 14 mean-precipitation value of 4.28 inches was selected for use in the HEC-HMS model. Details of the analysis are provided in Appendix Q.

10.1.1 Baseline Regulatory (100-year) Hydrology

Appendix Q provides the results of the baseline hydrology analysis performed for the Project site. In summary, the baseline regulatory 100-year peak event at the Compliance Point Dam was estimated to be 5,360 cubic feet per second (cfs).

10.1.2 Post-Operating Regulatory (100-year) Hydrology

Similarly, the post-operating regulatory hydrology for the Project site was determined using the Computer Program HEC-HMS. The results of a drainage bench analysis detailed in the Technical Memorandum titled Rosemont Dry Stack Tailings Facility Drainage Bench Analysis (Tetra Tech, 2010) were also used in this analysis. This Technical Memorandum is provided in Appendix H.

Appendix R provides the results of the post-operating hydrology analysis performed for the Project site. In summary, the post-operating regulatory 100-year peak event at the Compliance Point Dam was estimated to be 2,842 cfs.

10.2 Average-Annual Runoff

An extensive precipitation/runoff data-collection effort was conducted prior to computing baseline average-annual runoff values for the Project site. Six (6) primary sources were relied upon to obtain precipitation/runoff data. These sources were: (1) the USGS; (2) the ADWR; (3) the USDA; (4) the USDA NRCS; (5) the NOAA WRCC; and (6) the NOAA Hydrometeorological Design Studies Center.

Based on detailed map of average-annual precipitation in Arizona obtained from the NRCS titled Arizona Annual Precipitation (1961-1990), baseline average-annual precipitation was determined to be ±24 inches. However, average-annual precipitation data collected at the Project site indicates that average-annual precipitation is closer to 18 inches. Accordingly, results were presented in Appendix Q for average-annual precipitation depths ranging from 18 to 24 inches and then compared to other study results of average-annual runoff.

According to the Arizona Water Atlas (ADWR), the Project site lies adjacent to the Tucson AMA, within the Southeast Arizona Planning Area (SEAPA). The Arizona Water Atlas states that:

- For the Tucson AMA: “Average annual runoff is highest, two inches per year or 106.7 ac-ft per sq-mi, in the eastern portion of the AMA...”; and
- For the SEAPA: “Average annual runoff is two inches per year, or 106.6 ac-ft per sq-mi in the northwestern portion of the basin and decreases...”

At the proposed Compliance Point Dam, the high-end “average” runoff value (1,698 ac-ft for 24 inches of average-annual precipitation) is considerably higher per square mile (2.0 times
higher) than the highest values (106.6 and 106.7 ac-ft/sq mi) quoted in the Arizona Water Atlas for regions encompassing the Project site. On the other hand, the low-end “average” runoff value (912 ac-ft for 18 inches of average-annual precipitation) is about equivalent (1.043 times higher) on a per-square-mile basis to the highest values (106.6 and 106.7 ac-ft/sq mi) quoted in the Arizona Water Atlas. Therefore, an average-annual precipitation of 18 inches was selected to provide the best estimate of average-annual runoff emanating from the Project site and reporting to the Compliance Point Dam.

10.2.1 Baseline Average-Annual Runoff

Appendix Q provides the results of the baseline average-annual runoff analysis for watersheds within the Project site. In summary, the baseline average-annual runoff at the Compliance Point Dam using 18 inches of average-annual precipitation was estimated to be 957 ac-ft.

10.2.2 Post-Operating Average-Annual Runoff

Appendix R provides the results of the post-operating average-annual runoff analysis for watersheds within the Project site. In summary, the post-operating average-annual runoff at the Compliance Point Dam using 18 inches of average-annual precipitation was estimated to be 231 ac-ft.

10.2.3 Yearly Runoff Variation

The Arizona Water Atlas (ADWR) contains a table which lists minimum and maximum annual runoff amounts for specific years of record for watersheds located within the Tucson AMA, which is adjacent to the Project site. Using only those watersheds listed which are less than 100 square miles in size, average ratios of yearly runoff variation were calculated to be 0.2 (minimum to mean) and 2.5 (maximum to mean), suggesting that the estimated average-annual runoff values can be multiplied by 0.2 and 2.5, respectively. Assuming a long period of time, reasonable estimates can be determined of the minimum and the maximum runoff volumes, in ac-ft, expected to emanate from the Project site.
11.0 BASELINE AND POST-OPERATING INFILTRATION ANALYSIS

In addition to the baseline and post-operating regulatory (100-year) hydrology and average-annual runoff results presented in Section 10.0, modeling was performed to determine the overall effect of the post-operating Project site on infiltration of storm runoff and possible recharge to the groundwater system. As a result of this infiltration analysis, the contribution to down-gradient stormwater flows via the flow-through drains was also determined. For clarity of calculation, the analysis presented in Section 10.0 did not show the flow-through drains contributing to down-gradient flows; however, that assumption was reviewed and updated as appropriate herein and in the Technical Memorandum titled *Rosemont Infiltration Analysis* (Tetra Tech, 2010) provided in Appendix S.

11.1 Baseline Conditions

11.1.1 Baseline Regulatory Hydrology

Baseline regulatory hydrology for the Project site was determined using the Computer Program HEC-HMS, Version 3.4 (August 2009). The hydrologic inputs to the model were based on previous baseline hydrologic analysis as detailed in the Technical Memorandum titled *Baseline Regulatory (100-Yr) Hydrology and Average-Annual Runoff, Rosemont Copper Project* (Tetra Tech, 2010a) provided in Appendix Q. As indicated in Section 10.0, the baseline regulatory (100-year) peak-discharge value at the Compliance Point Dam was estimated to be 5,360 cfs. For the 100-year, 24-hour storm event using 4.75 inches of precipitation and a 50% rainfall confidence interval, the runoff volume was calculated to be about 1,000 ac-ft.

11.1.2 Baseline Average-Annual Runoff

Average-annual runoff was calculated based upon a multi-variable relationship as described in Section 10.0. The estimated baseline average-annual runoff value at the Compliance Point Dam, assuming 18 inches of average-annual precipitation, was 957 ac-ft.

11.1.3 Baseline Regulatory Infiltration

The NRCS method was used to estimate excess runoff from storm events emanating from the Project site. The total excess runoff for the 8.2 sq-mi basin up-gradient of the Compliance Point was estimated to be 3.23 inches for a 100-year, 24-hour storm event of 4.75 inches (assuming a 50% rainfall confidence interval). Providing for factors such as evapotranspiration (ET) (Scott, R. L. et al, 2008), a total of 0.88 inches of infiltration was estimated, resulting in about 385 ac-ft of infiltration for the 100-year, 24-hour storm event.

11.1.4 Baseline Average-Annual Infiltration

An extensive precipitation/runoff data-collection effort was conducted prior to estimating baseline average-annual runoff values for the Project site. Average-annual runoff was calculated based upon a multi-variable relationship. For average-annual runoff, the regression analysis was based on the following:

- USGS-supplied contributing watershed area;
- Average-annual precipitation; and
- Mean watershed elevation.
The relationship for an assumed average-annual precipitation of 18 inches is:

\[ Q_{AA} = 8.44885 \times 10^{-6} P^{2.1198} A^{0.9821} E^{1.2101} \]

Where:

- \( Q_{AA} \) = Average-annual runoff, in acre-feet (ac-ft);
- \( A \) = Watershed area, in square miles;
- \( E \) = Mean watershed elevation, in feet; and
- \( P \) = Average-annual precipitation, in inches.

Utilizing this equation for the 8.2 sq-mi basin up-gradient of the Compliance Point, an average-annual base unit of one (1) acre was calculated for runoff. Using an average annual precipitation value of 18 inches and the same hydrologic conditions assumed for estimating the baseline average-annual runoff, a runoff of 0.213 ac-ft per unit acre was calculated.

Assuming an average-annual runoff of 0.213 ac-ft from each acre throughout the entire contributing watershed above the Compliance Point, and assuming no losses in the system, the total average-annual runoff would be 1,116 ac-ft.

The difference between the baseline average-annual runoff value of 957 ac-ft, estimated in Section 10.0, and the total of 1,116 ac-ft (159 ac-ft) represents losses as runoff travels through the system until reaching the Compliance Point. The loss of 159 ac-ft would include evaporation, transpiration, and infiltration. Based on studies performed in the southwest arid regions of the United States, up to 20% of the runoff volume can be lost in the drainage channel areas due to ET. Assuming ET losses are 20% of the total loss, the approximate infiltration value would be approximately 127 ac-ft annually from the 8.2 sq-mi watershed up-gradient of the Compliance Point Dam.

### 11.1.5 Summary of Baseline Regulatory and Average-Annual Results

Table 10.1 summarizes the results of the baseline hydrology and infiltration analysis associated with the 8.2 sq-mi watershed up-gradient of the Compliance Point and based on the regulatory, 100-year event. Table 10.2 summarizes the results under average-annual conditions.

<table>
<thead>
<tr>
<th>Basin ID</th>
<th>Baseline Regulatory Peak Flow (cfs)</th>
<th>Baseline Regulatory Runoff (ac-ft)</th>
<th>Baseline Regulatory Infiltration (in)</th>
<th>Baseline Regulatory Infiltration (ac-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance Point</td>
<td>5,360</td>
<td>1003</td>
<td>0.88</td>
<td>385</td>
</tr>
</tbody>
</table>

Note: Baseline regulatory 100-year event = 4.75 inches
### Table 10.2 Baseline Average-Annual Runoff and Infiltration

<table>
<thead>
<tr>
<th>Basin ID</th>
<th>Baseline Average-Annual Runoff (ac-ft)</th>
<th>Baseline Average-Annual Infiltration (ac-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance Point</td>
<td>957</td>
<td>127</td>
</tr>
</tbody>
</table>

Note: Baseline average-annual conditions based on 18 inches of average annual precipitation.

### 11.2 Post-Operating Conditions

From the previous analysis presented in Section 10.0, the post-operating regulatory 100-year peak event at the Compliance Point Dam was estimated to be 2,842 cfs. The post-operating average annual runoff using 18 inches of average-annual precipitation was estimated to be 231 ac-ft. These values assumed no stormwater contribution from the flow-through drains.

In the analysis presented in Appendix S, storm runoff reporting to the flow-through drains for both the regulatory 100-year event and average-annual runoff conditions was analyzed for its contribution to down-gradient flows and to infiltration and possible recharge to the underlying aquifer.

In addition to storm runoff reporting to the flow-through drain inlets, average-annual infiltration associated with the perimeter containment area receiving discharge from the Pit Diversion Channel was also analyzed. Infiltration calculated for the regulatory 100-year event was found to be negligible.

#### 11.2.1 Regulatory Peak Discharge/Volume and Average-Annual Runoff at Inlets

Post-operating hydrology (peak discharge and flow volume) and average-annual runoff at each flow-through drain inlet was calculated using the same methods for calculating the baseline hydrology. The characteristic hydrologic inputs to the model were created based upon previous baseline and post-operating hydrologic analysis as detailed in the Technical Memoranda titled *Baseline Regulatory (100-Yr) Hydrology and Average-Annual Runoff, Rosemont Copper Project* (Tetra Tech, 2010a); *Post-Mining Regulatory (100-Yr) Hydrology and Average-Annual Runoff, Rosemont Copper Project* (Tetra Tech, 2010g); and *Rosemont Dry Stack Tailings Facility Drainage Bench Analysis* (Tetra Tech, 2010l). These three (3) Technical Memoranda are provided in Appendices Q, R, and H, respectively. Flood hydrographs were also generated by HEC-HMS at each flow-through drain inlet.

#### 11.2.2 Regulatory Peak Discharge/Volume and Average-Annual Runoff at Outlets

Post-mining hydrology (flow volume and infiltration) and average-annual runoff at each flow-through drain outlet was determined by using the Samani J. equation for flow velocity through rockfill (Samani and Heydari, 2007) and the 1959 Ayers equation for infiltration presented in the Handbook on the Principles of Hydrology (Gray, 1970).

Because of the infiltration capacity of the underlying soils, not all flows will make it to the outlet of each flow-through drain, particularly smaller flows which occur on a frequent basis. Consequently, a threshold analysis was conducted to determine which flow events would be of sufficient size to flow to the outlet of each flow-through drain.
11.2.3 **Average-Annual Infiltration: Perimeter Containment Area**

Average-annual infiltration was determined at the PCA located on the southwest side of the Waste Rock Storage Area at the outlet location for the Pit Diversion Channel. A water balance assessing infiltration, evaporation, and runoff was performed to determine the average-annual infiltration. The analysis was performed under the following assumptions:

- The rate of infiltration occurs at the same pace of the hydraulic conductivity of the soil;
- Given the conditions for this ponding area, no vegetation uptake was considered; and
- The analysis was done for the unsaturated zone where infiltration may become recharge when reaching the water table.

11.2.4 **Summary of Post-Operating Regulatory Hydrology and Average-Annual Results**

Table 10.3 summarizes the results of the post-operating hydrology and infiltration analysis associated with the 8.2 sq-mi watershed up-gradient of the Compliance Point Dam and based on the regulatory, 100-year event. Table 10.4 summarizes the results under average-annual conditions.

**Table 10.3 Post-Operating Regulatory (100-Year) Peak Flow, Runoff, and Infiltration**

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance Point</td>
<td>2,842</td>
<td>272</td>
<td>24</td>
<td>57</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Note: Baseline regulatory 100-year event = 4.75 inches

**Table 10.4 Post-Operating Average-Annual Runoff and Infiltration**

<table>
<thead>
<tr>
<th>Basin ID</th>
<th>Post-Operating Average-Annual Direct Runoff (ac-ft)</th>
<th>Post-Operating Average-Annual Runoff Through Drains (ac-ft)</th>
<th>Post-Operating Average-Annual Infiltration from Drains (ac-ft)</th>
<th>Post-Operating Average-Annual Infiltration from Pond PCA (ac-ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compliance Point</td>
<td>231</td>
<td>1.27</td>
<td>100</td>
<td>56</td>
</tr>
</tbody>
</table>

Note: Baseline average-annual conditions based on 18 inches of average annual precipitation.

11.3 **Summary**

From the analysis of baseline and post-operating conditions associated with the base reclamation concept of the Rosemont Ridge Landform, the anticipated post-operating average-annual runoff reporting to the Compliance Point Dam is expected to be about 232 ac-ft versus 957 ac-ft for baseline or pre-operating conditions. This results in about a 75% reduction in
average-annual runoff from the Project site as determined at the Compliance Point. Runoff volumes from the regulatory, 100-year event are also similarly reduced.

Infiltration of storm runoff, however, is anticipated to be equal or greater than pre-operating conditions due to the configuration of the facilities. Baseline or pre-mining infiltration was estimated to be 127 ac-ft per year. For post-operating, average-annual conditions, infiltration was estimated to be about 100 ac-ft associated with the flow-through drains and about 56 ac-ft for the perimeter containment area associated with the Pit Diversion Channel. Infiltration from these areas may or may not result in recharge to the underlying aquifer.

The post-operating estimates assumed no runoff from the detention pools in the Waste Rock Storage Area and in the Dry Stack Tailings Facility area based on the available retention capacity in relation to the regulatory 100-year event and average-annual runoff.

The post-operating infiltration estimates also assumed that precipitation retained in these areas would not result in seepage under average-annual conditions based on infiltration modeling performed and summarized in the report titled *Infiltration, Seepage, and Fate and Transport Modeling Report* (Tetra Tech, 2010e). Infiltration into the dry stack tailings is also not expected to develop from meteoric precipitation associated with the 100-year regulatory event based on the analysis performed.

For the Waste Rock Storage Area, infiltration may occur into the waste rock at the ponding locations under the influence of the 100-year regulatory event. However, seepage from the facility should not occur in most cases. Therefore, no seepage was assumed from the Waste Rock Storage Area associated with the regulatory 100-year event.

Additionally, the release of pore water (retained moisture) from the dry stack tailings was not included in these estimates. The dry stack tailings are expected to release about 8.4 gpm from the entire Dry Stack Tailings Facility as highlighted in the report titled *Rosemont Copper Company Dry Stack Tailings Storage Facility Final Design Report* (AMEC, 2009) and also summarized in the report titled *Infiltration, Seepage, and Fate and Transport Modeling Report* (Tetra Tech, 2010e). The estimate of 8.4 gpm equates to about 13.5 ac-ft per year. This peak rate occurs close to the ultimate operational year and decreases over time. Modeling indicates that this seepage rate reaches zero about 500 years past the cessation of operations. Based on fate and transport modeling results (Tetra Tech, 2010e), none of the measured constituents in this source of seepage exceeded baseline water quality. Should this seepage reach the underlying aquifer, it is expected to have little or no impact on the quality or quantity of water within the regional groundwater system.
12.0 SEDIMENT DELIVERY AND CONTROL

Except for access roads, development of the Rosemont Project will be up-gradient of the Compliance Point Dam and within the watersheds comprised of Barrel, Wasp, and McCleary Canyons as shown on Figure 03. During early development of the Project, Best Management Practices (BMPs) will be employed to control sediment loading as needed to down-gradient receptors. Localized sediment control BMPs may also include the following:

- Temporary diversion channels and sediment traps;
- Containment berms;
- Riprap slope protection and culvert protection;
- Flow-through rock weirs; and
- Silt fencing, straw bales, and wattles.

Early revegetation of disturbed or reclaimed areas, or concurrent reclamation, is a significant part of the plan for this Project and will be employed as practicable. The construction stormwater pollution prevention plan (SWPPP) will be updated prior to the start of construction activities. An appropriate Stormwater Permit application will be submitted to ADEQ and the SWPPP will be updated for the operational period.

Project facilities such as haul roads and stormwater ponding areas will also provide localized sediment control once constructed. Once the starter embankments for the South Dry Stack Tailings Facility and for the North Dry Stack Tailings Facility are constructed, they will provide sediment control for the entire area up-gradient of the structures. Stormwater runoff will filter through the flow-through drains and exit in Lower Barrel or McCleary Canyons, up-gradient of the Compliance Point Dam.

Figures 49 through 52 show simplified progressions of flow-through drain construction, including construction of the starter embankments. The figures also show the start of the area-wide soil salvage operation. This clearing operation can begin in Barrel Canyon Drainage once the starter embankment for the South Dry Stack Tailings Facility is constructed. Until this point, construction activities will generally be limited to the Plant Site area and to the Heap Leach Pad area. The main flow-through drain alignment along Barrel Canyon drainage (South Main Drain) will likely be used to access the other flow-through and finger drain segments in the Barrel Canyon drainage. Once the starter embankment is constructed, the ground will be cleared and grubbed in an up-gradient or westerly direction, generally followed by placement of the finger drains and other flow-through drains.

Similarly, the main flow-through drain in McCleary Canyon (North Main Drain) will generally progress in a down-gradient manner. Once the starter embankment is constructed, clearing and grubbing will proceed up-gradient. The finger drains and flow-through drain extensions will be constructed once stripping operations pass that point. In this manner, stripping operations will not be impeded by the drains, etc.

Flow-through and finger drain construction also provide the opportunity for localized sediment and/or stormwater control within the watershed basin up-gradient of the starter embankments. Stormwater would be routed out of the system via the flow-through drains while sediments would be filtered out by the protective geotextile. Details on the flow-through and finger drains are provided in Section 6.0 and on Figures 37 through 47.

As part of the analysis prepared for the flow-through drain sizing, the maximum WSE was estimated up-gradient of the starter embankments assuming open watersheds and with the
main flow-through drain installed. No overtopping of the starter embankments was encountered for the General and Local PMP events. The results are summarized below:

- The maximum WSE encountered in the area up-gradient of the starter embankment for the South Dry Stack Tailings Facility was 4,708 feet amsl. The initial starter embankment elevation is at an elevation of 4,750 feet amsl.

- The maximum WSE encountered in the area up-gradient of the starter embankment for the North Dry Stack Tailings Facility was 4,715 feet amsl. The initial starter embankment elevation is at an elevation of 4,750 feet amsl.

Once these starter embankments are constructed, the outer surface will be reclaimed and revegetated as soon as practicable. Additionally, a rock facing is also planned for the lower east slope of the North Dry Stack Tailings Facility. As indicated, Project activities will generally be occurring behind the waste rock berms in the case of the Waste Rock Storage Area and Heap Leach Facility, or behind waste rock buttresses, in the case of the Dry Stack Tailings Facility. The final design of the Rosemont Ridge Landform results in a reclaimed Landform that minimizes direct runoff from the Landform to down-gradient receptors. Until the reclaimed surfaces stabilize, sediment basins may be installed between the toe of the Landform and the Compliance Point Dam for local sediment control. The Compliance Point Dam also functions as a sediment control structure. As indicated previously, the Compliance Point Dam is anticipated to be a six (6) foot high, porous rock structure where additional sediment controls will be applied as necessary to manage stormwater quality and where stormwater samples will be taken.

In addition to the baseline and post-mining hydrology and average-annual runoff conditions at the Project site presented in Section 10.0, a general sediment delivery (sediment yield) analysis was made. This assessment was made based on the 1968 Pacific Southwest Inter-Agency Committee (PSIAC) method which computes the average-annual sediment yield from a watershed. The analysis is highlighted in a Technical Memorandum included in Appendix T titled Rosemont Baseline and Post-Mining Conditions – Sediment Delivery (Tetra Tech, 2010k). For the analysis, the post-operating conditions followed Figure 11, which only included those watersheds reporting directly to the Compliance Point Dam.

For baseline conditions, the sediment delivery at the Compliance Point Dam was estimated to be 9.43 ac-ft (ac-ft) per year for the 8.2 sq-mi up-gradient watershed. For post-operating conditions, the average-annual sediment delivery was estimated to be 2.22 ac-ft based on a 1.93 sq-mi watershed up-gradient of the Compliance Point. These values were developed based on an average-annual sediment yield of 1.15 ac-ft/sq-mi/year computed using the PSIAC method rating factors.
13.0  SURFACE WATER QUALITY ASSESSMENT

SWQS are defined in Arizona Administrative Code (A.A.C.) Title 18, Chapter 11 and are applicable at the Project site based on designated use standards, taking into consideration the recent designation of Davidson Canyon as an outstanding Arizona Water (OAW). Applicable SWQS were calculated based on the hardness of the water using the methods outlined in A.A.C. R18-11 Appendix B.  

Applicable SWQS associated with the wash in Barrel Canyon include:
- Aquatic and Wildlife (ephemeral) (A&We); and
- Agricultural Livestock Watering (AgL).

Applicable SWQS associated with the reaches near or downstream of the OAW section of Davidson Canyon include:
- Aquatic and Wildlife (A&W) Acute exposure;
- A&We;
- AgL;
- Fish Consumption (FC);
- Full Body Contact (FBC); and
- Aquatic and Wildlife (warm water) (A&Ww).

These SWQS were compared with baseline stormwater sampling data collected by Rosemont from the Project site and to SPLP data from samples of the dry stack tailings and waste rock materials. The A&Ww Acute exposure standard was used in the comparison since chronic exposure typically requires constant, or prolonged, contact with a substance and acute exposure mimics stormwater flow which is intermittent.

The comparison of the samples collected at the site with the A&Ww and AgL indicated that current runoff from the Project site exceeds SWQS for dissolved copper, total copper, total arsenic, total cadmium, and total lead. At the time these stormwater samples were taken, only general site maintenance activities were taking place.

SPLP data from available waste rock and tailings samples were also compared against the SWQS. Laboratory detection limits are requested at the time of sampling; however, because the SWQS are calculated using a hardness value, the potential exists for a limit to be chosen that is higher than the calculated SWQS. Therefore, issues with detection limits resulted in a possible exceedance of SWQS for Selenium in the waste rock samples compared to the Barrel Canyon A&W Acute SWQS. For the tailings samples, detection limit issues also resulted in possible exceedances for Selenium and Silver compared to the Barrel Canyon A&W Acute SWQS.

Based on these results, and that the designation of Davidson Canyon as an OAW occurs approximately ten (10) miles downstream of the Project site, any stormwater runoff from the waste rock or dry stack tailings would be significantly diluted prior to reaching Davidson Canyon and would not cause further degradation of surface water quality.

Further details of this surface water analysis are provided in the Technical Memorandum titled Rosemont Surface Water Quality Baseline Analysis (Tetra Tech, 2010) provided in Appendix U.
REFERENCES


ROSEMONT COPPER PROJECT
SITE WATER MANAGEMENT UPDATE

PROJECT LOCATION MAP

STATE OF ARIZONA
N.T.S.

PROJECT LOCATION MAP

TITLE SHEET AND GENERAL LOCATION MAP

TETRA TECH

ROSEMONT COPPER PROJECT
PIMA COUNTY, ARIZONA

Issued by:

ROSEMONT COPPER PROJECT

Figure no. 01

PAGE 1

REVISION

Project

Figure no. 01

PROJECT LOCATION MAP

TITTLE SHEET AND GENERAL LOCATION MAP

TETRA TECH
Legend

- Roads
- Mile marker

Note:
The Main Disturbance Area is based on the updated base concept of the Rosemont Ridge Landform.
**F14 DIVERSION LOWER CHANNEL - TYPICAL SECTION**

**F14 DIVERSION UPPER CHANNEL - TYPICAL SECTION**

**F14 DIVERSION FILL AREA - SECTION**

**F14 DIVERSION FILL AREA - SECTION**

**F14 DIVERSION FILL AREA - SECTION**

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**SITE WATER MANAGEMENT UPDATE**

**F14 DIVERSION CHANNEL SECTIONS**