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Retention pond with the overflow device

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Abstract: In this example, an analysis of runoff hydrograph generation, a determination of infiltration loses for a single pond, and routing of the runoff hydrograph through the retention pond for peak stage and discharge determination, as well as generation of a routed hydrograph are demonstrated. With the MODRET 6.1 we will generate a single watershed runoff hydrograph hydrographs. Wet ponds are constructed basins that have a permanent pool of water throughout the wet season, potentially extending throughout the year. The primary removal mechanism is settling while stormwater runoff resides in the pool. Where algae are present, algal uptake also aids stormwater treatment. Nutrient uptake also occurs through biological activity in the sediment and water. Wet ponds differ from constructed wetlands in that they are typically deeper, ranging from 4 to 6 feet, and have less vegetative cover. Wet ponds are among the most cost-effective and widely used stormwater treatment practices.

Keywords: Watershed area weight average curve number, storm duration, rainfall distribution.

1. INTRODUCTION

The typical configuration of a wet pond includes forebay storage, permanent storage, and lives storage areas. The forebay is a small inlet pool that allows settling of coarse and medium grained sediment. Permanent storage refers to the permanent pool of water remaining in the wet pond between storm events and during dry weather. If intended as wildlife habitat or permanent water feature, supplemental water and the installation of an impermeable liner may be required to maintain the permanent pool during the dry season. Live storage refers to the remaining storage capacity in the wet pond that will vary based on stormwater influx. The stormwater in the live storage area will generally drain from the pond 24 to 48 hours after the end of a storm event.

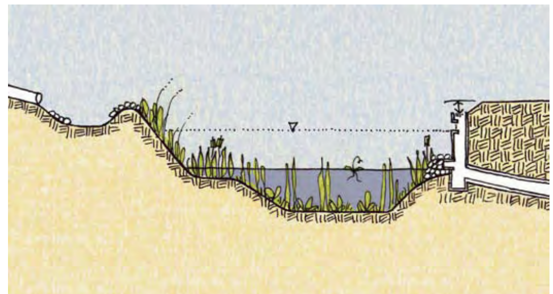

Fig. 1 Dry retention pond

2. RETENTION POND

Through the use of geo-plastics is allows to build steeper embankment verges, which require a less usable space, and require to another less Dyke material. This saves dyke construction materials and in closely limited space allows the renovation and the construction of dykes .The space thus obtained can return to the river are thus to be the growing amount of high water.

In this example, an analysis of runoff hydrograph generation, a determination of infiltration loses for a single pond, and routing of the runoff hydrograph through the retention pond for peak stage and discharge determination, as well as generation of a routed hydrograph are demonstrated. With the MODRET 6.1 we will generate a single watershed runoff hydrograph hydrographs.

The retention pond design data to receive stormwater runoff from a single watershed with the following parameters of surface characteristics:

- Watershed area – 4.1 Acres
- Weight average curve number – 80 (pre-development) and 89 (post-developement)
- Time of concentration 20 min (pre-developement) and 17 (post-developement)
- Design rainfall depth – 5.2 inches
- Storm duration 24 h
- Rainfall distribution – SCS Type II
- Shape factor – 323

A site plan and location of soil borings are presented in fig. 3

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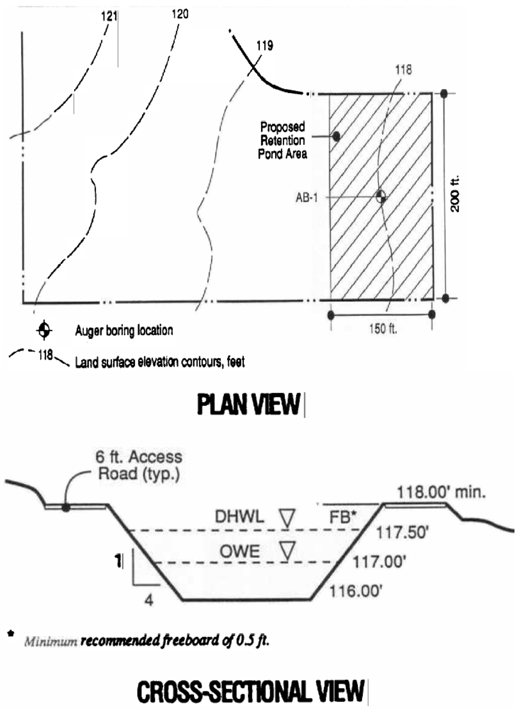


Fig. 3Site plan and location of soil borings

The stormwater retention pond for this example will be assumed to be located within a designated area of 200 feet by 150 feet. The site soil conditions it was presented in fig. 4

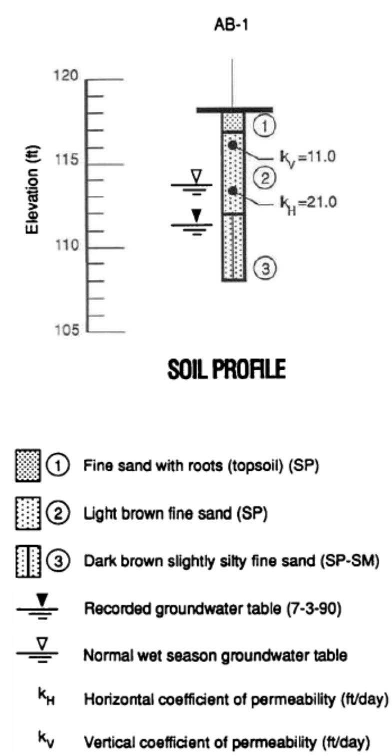


Fig. 4 Soil profile

Design a dry retention pond to retain ½ inch of runoff from the watershed area (pollution abatement volume), which must dissipate within a period of 24 hours. The runoff of the ½ inch pollution abatement volume (PAV) is not related to the 24 hour storm event to be used for pre/post development retention/detention modeling.

Design the pond and the overflow device to retain the difference between the predevelopment and the post-development runoff volumes. One-half (50%) of the total pond volume between starting water level and overflow level must dissipate within a period of 36 hours after the storm event.

Calculate the time of dissipation of the remaining 50% of the pond volume. The design high water level (DHWL) of the pond should not exceed 117.5 feet, to provide a safety factor of 0.5 feet for freeboard.

Initially, pollution abatement volume (PAV) will be calculated and the runoff hydrographs will be generated for evaluation and selection of initial pond geometry.

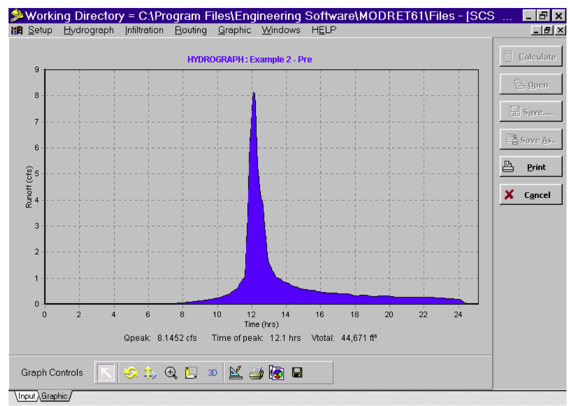


Fig. 5 Hydrograph pre-developement

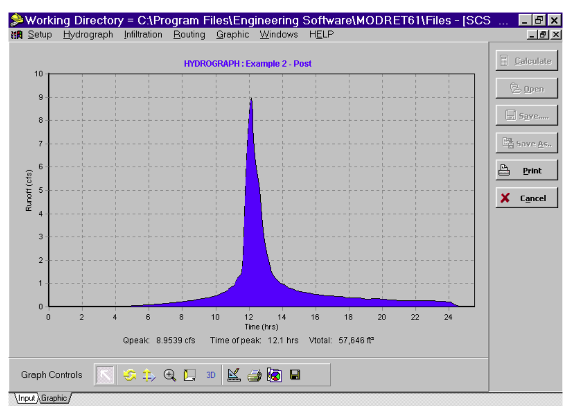


Fig. 6 Hydrograph post-developement

The results indicate a total runoff volume of 44,671 ft^3 for pre-development and 57,646 ft^3 for post-development, resulting in a difference of 12,975 ft^3. The corresponding peak runoff rates are 8.14 cfs and 8.95 cfs, respectively.

3. SELECTION OF POND GEOMETRY AND CHARACTERISTICS:

To design the most efficient geometry of the pond (hydraulically), the following general guidelines can be followed:

- Design the pond as long and as narrow as possible.
- Design the pond bottom elevation as high above the groundwater table as possible.
- Provide for maximum separation distance from other ponds that may affect negatively the performance of the pond.
- Design the pond with the minimum water depth possible.

For the purposes of initial design, the criteria of minimum pond size based on the requirements of 100% retention of the pollution abatement volume (7,260 ft3 between pond bottom and weir overflow level) will be used. First, the pond will be modeled for pollution abatement volume recovery and then, the pre/post development runoff will be modeled. From soil boring data, the surface elevation at the pond area is estimated at about 118.0 feet. Initially the starting water level and the overflow water elevations will be selected at 116.0 and 117.0 feet, which can be adjusted later, if necessary.

The pond side slopes will be assumed at 4H:1V (typically, side slopes steeper than 4H:1V require protective measures, such as appropriate fencing around the pond). The minimum average area between starting water level and overflow water elevation (OWE) can be estimated as follows:

The appropriate input data was entered and the model was executed. For additional details of PAV retention and recovery modeling refer to Example 1. The input data and the results of this simulation follow.

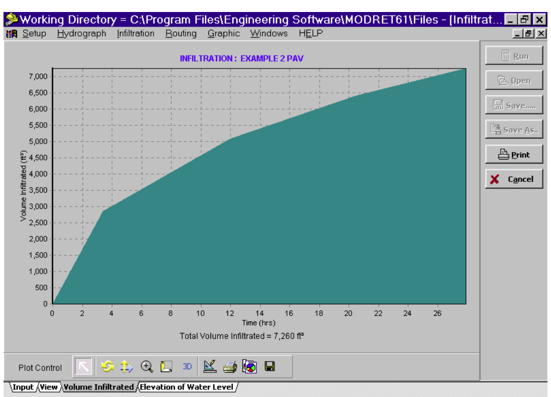


Fig. 7 Volume infiltrated

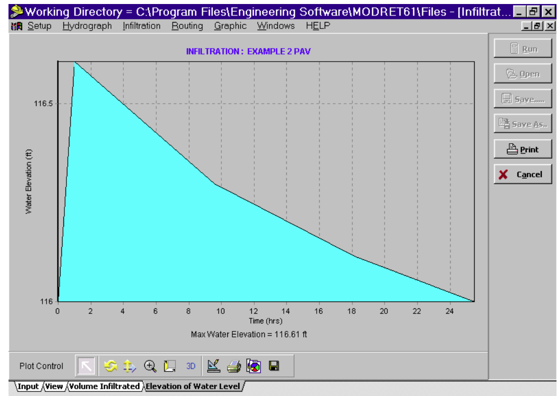


Fig. 8 Elevation of water level

The second model execution was for the pre/post development retention and recovery analysis. The input data and the results of this simulation, both tabular and graphical, follow:

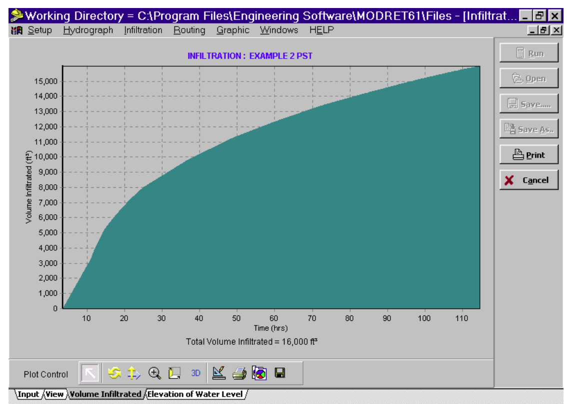


Fig. 9 Volume infiltrated

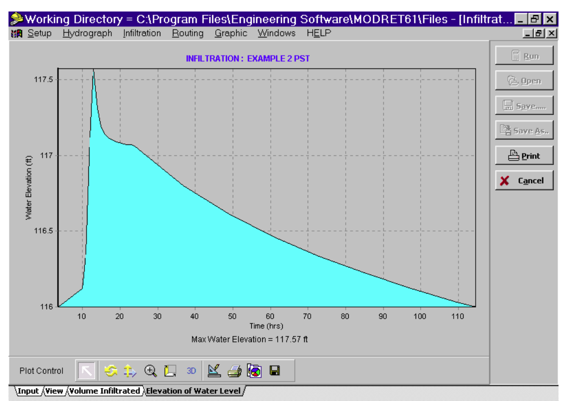
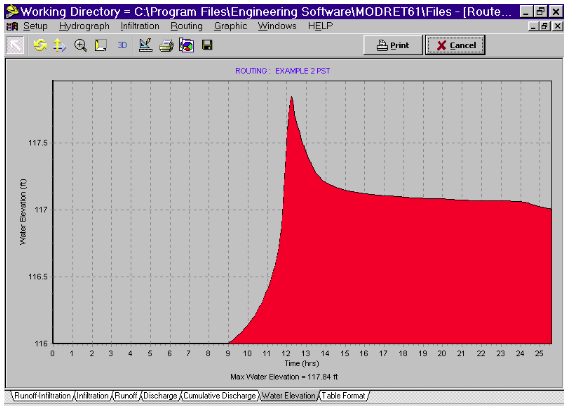


Fig. 10 Elevation of water level



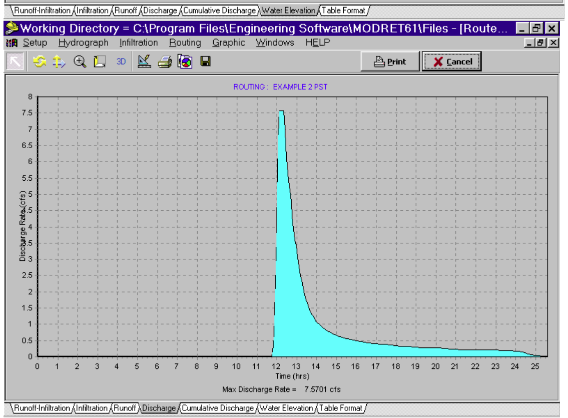


Fig. 11 Water elevation Fig.12 Discharge

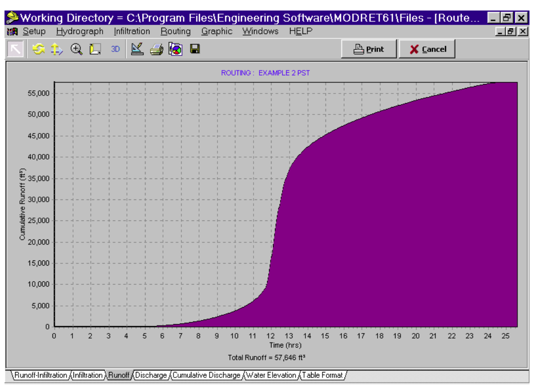


Fig.13 Runoff

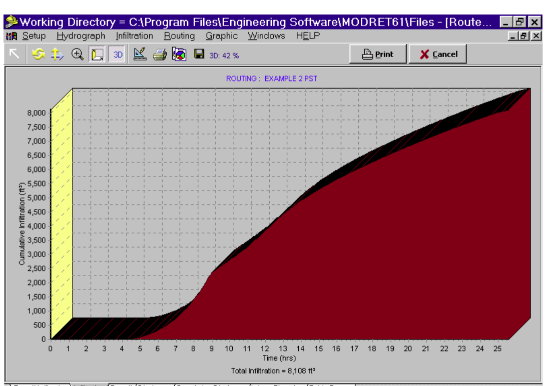


Fig. 14 Infiltration

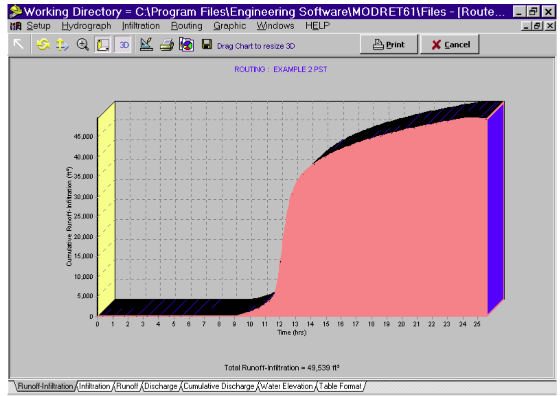


Fig. 15 Runoff infiltration

Pollution Abatement:

Review of the pollution abatement modeling results indicates that the water level in the pond recedes below pond bottom within the 72 hour period as required by the project design criteria. The estimated time for the water level to reach pond bottom is 27.9 hours, as presented at the bottom of tabular summary of results. Therefore, the design criteria of 72 hours is satisfied.

Pre/Post Model:

The "View" table of the pre/post model output presents a summary of time vs water level, instantaneous infiltration, average infiltration and cumulative overflow. At the bottom of the table the maximum water level in feet and the associated time in hours is presented; in this case 117.57 feet and 12.9 hours, respectively.

However, once the runoff is **ROUTED** the maximum stage in the pond rises slightly to an elevation of **117.84** feet. This value should be used for design, as it is derived

using the small time increment of the hydrograph and the actual stage-storage data of the pond.

The average infiltration rate

Is calculated by MODRET, using the net volumetric water losses between each time increment modeled. Based on the volume of recharge to the pond, the volume of discharge from the pond (through the overflow device(s)), and the change in storage volume in the pond, the MODRET model calculates the net volume infiltrated during a specific time increment. This net volume infiltrated is then divided by the corresponding time increment and converted to cfs to represent the average infiltration rate.

For this example problem, the total Discharge Volume of 42,370 ft^3 can be obtained from the routed discharge graph above. Using the results of the runoff hydrograph graphical output, it was previously calculated that the required retention of pre/post development volume was 12,975 ft^3, from which can be deduced that the total discharge volume from the pond can't exceed the total volume of the pre-development hydrograph of 44,671 ft^3. Therefore, at this point the total Discharge Volume can simply be compared with the total volume of pre-development hydrograph.

Benefits

- Reduces stormwater volume and attenuates peak flow.
- Removes many stormwater pollutants via sedimentation and biological transformation.
- Can be an attractive and recreational public park amenity.
- Creates wildlife and wetland habitat.
- Suitable for sites with poor infiltration rates.
- Suitable for large drainage areas.

Limitation

- Requires relatively large land area and large drainage area (at least 5 acres), thus making it a good choice for master-planned and multi-parcel developments.
- Supplemental water required to maintain permanent pool may outweigh volume reduction benefits.
- If seasonally dry, may appear dusty or unsightly.

Siting

Drainage area and slope: Though they only occupy 2 to 3% of their contributing drainage area, wet ponds require sufficient drainage to maintain a permanent pool, typically around 25 acres or more. Wet ponds can be used at sites with drainage areas as small as 5 acres provided that the permanent pool is maintained during the rainy season, either through use of a liner or addition of supplemental non-potable water if necessary.

Wet ponds must be sited on a relatively flat area with less than 2% slope. While there is no minimum slope requirement, there must be enough elevation drop from the pond inlet to the pond outlet to ensure that water can flow through the system by gravity. The slope downstream of wet ponds should not exceed 15%.

Soils and infiltration rate: Because they are not designed to reduce runoff by infiltration, wet ponds can be used in almost all soil types. In Mediterranean climates like San Francisco, wet ponds may either be allowed to evaporate in the dry season, or may be supplemented

with an alternative source of influent water. Dry-weather water sources could be street and irrigation runoff, recycled water, groundwater, or other urban water applications.

Groundwater protection: Wet ponds may intersect the groundwater table, though this should be avoided in areas where either the stormwater or the groundwater could be contaminated.

4. DESIGN CONSIDERATIONS

Vegetation

Though most of the pond is deeper than wetland plant rooting depth, wet ponds should incorporate an aquatic bench around their perimeter. The aquatic bench is a shallow shelf up to 18 inches deep that supports wetland vegetation. In addition to facilitating stormwater treatment via biofiltration, this feature also helps to stabilize the soil at the edge of the pond and enhances habitat and aesthetic value. Native species that can tolerate drought and inundation should be used wherever possible.

Pretreatment

A pretreatment forebay should be used to settle out coarse sediment before it reaches the main pool. Forebays are separate small ponds located between the inlet and the main pool that typically about 10% of the live storage volume of the pond. They can provide up to 6 inches of storage temporarily, and are located near the pond inlet. This can greatly reduce regular maintenance costs.

Accumulated sediment should be removed from the forebay when its depth exceeds 6 inches or 50% of the forebay storage capacity, typically every 3 to 5 years.

A vegetated buffer should be created around the pond to protect the banks from erosion, and to provide some pollutant removal before runoff enters the pond by overland flow. This landscaping also provides aesthetic and habitat amenities for the community.

Treatment

Wet ponds, along with constructed wetlands, are among the most effective BMPs in removing pollutants from stormwater. While the degree of treatment varies with

the volume and retention time of the permanent pool, wet ponds have been shown to remove on average 80% of suspended solids, 30 to 50% of nitrogen and phosphorus, 70% of bacteria and 30% of metals.

Drainage

Stormwater should be conveyed to and from wet ponds safely and in a manner that minimizes downstream erosion potential. The wet pond outfall should always be stabilized to prevent scour. An emergency spillway should be provided to safely convey large flood events into the collection system or a receiving water body.

If discharging to streams, lakes, or the bay or ocean, designers should provide shade around the outflow channel to prevent warming that could adversely affect aquatic species.

Overflow

Wet ponds should be designed with a non-clogging outlet such as a weir outlet with a trash rack or a reverse slope pipe that is at least 3 inches in diameter. Because reverse slope pipes draw water from below the surface of the permanent pool, they are less likely to be clogged by floating debris. If the wet pond is online, meaning it receives continuous flow that cannot be diverted, principle and emergency spillways should provide at least 1 foot of freeboard.

Access

For ease of maintenance, wet ponds should incorporate direct access to both the forebay and the main pool of ponds. In addition, ponds should generally have a drain to draw down the pond or forebay to facilitate periodic sediment removal.

Sizing

Wet ponds are sized using the volume based calculations described an electronic sizing tool.

Typical Inspection Activities for Wet Ponds

Activity	*Schedule*
· Inspect for erosion damage, animal burrows, and structural integrity, especially of pond outlet. · Inspect for signs of hydrocarbon build-up and deal with appropriately. · Monitor for sediment accumulation in the forebay and main pond. · Examine to ensure that inlet and outlet devices are operational and free of debris.	Semi-annually (beginning and end of rainy season)

Typical Maintenance Activities for Wet Ponds

Activity	*Schedule*
· Remove debris from and clean inlet and outlet structures. · Remove accumulated trash and debris from forebay and edges of main pond. · Mow or trim side slopes if vegetated. · Repair undercut or eroded areas. · Stock permanent pool with mosquitofish *(Gambusia spp.)*.	Semi-annually (beginning and end of rainy season)
· Remove sediment from forebay when depth exceeds 6 inches or 50% of storage capacity. · Replant vegetation as necessary.	As needed (expected frequency every 3 to 5 years)
· Remove sediment when the pond volume has been reduced by 25% or if the pond becomes eutrophic. This can be measured with a barrel thief or on a sediment gauge installed near the basin outlet.	As needed (expected frequency every 25 to 50 years)

Cost

Typical wet pond costs range from $0.50 to $1.00 per cubic foot ($17.50-$35.00 per cubic meter) of storage area, but vary by size and site location. New wet ponds in undeveloped areas are easier and cheaper to construct than retrofit ponds in developed areas.

Operations and maintenance costs should be low, typically between 3 and 5% of construction costs, and wet ponds can last well over 20 years. Caltrans estimates annual maintenance costs for a wet pond treating 4.2 acres to be $17,000 per year; in contrast, King County estimates annual wet pond maintenance costs to be $3,000 per pond.

On-site disposal can reduce sediment removal costs by up to 50%.

4. CONCLUSIONS:

At this point, the pond is optimized, since it is already dimensioned for the minimum size required by the project criteria. Although, it retains more than the required pre/post runoff volume (by about 5%), it can not be downsized because the project criteria specifies a minimum required volume of pond of 7,260 ft3 between starting water level and overflow water elevation.

As presented by the routed graphical data, the peak stage (maximum water level) rises to 117.84 feet, therefore, for final pond design the DHWL should be set at **117.84 feet**. At this point, the pond design has been optimized using MODRET and available site soil and groundwater conditions, which are the major limiting factors in infiltration analysis.

The selected model parameters, presented on the input and output tables and graphs can be used for final dimensioning, design and construction of the pond.

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