

Chapter – 2

Physical Features

2.1 Geographical disposition

2.1.1 Chambal basin

The Chambal basin lies between North latitudes $22^{\circ} 27'$ and $27^{\circ} 20'$ and East longitudes of $73^{\circ} 20'$ to $79^{\circ} 15'$. The basin has a geographical area of 1,32,508 sqkm covering its catchment area in Madhya Pradesh, Rajasthan and Uttar Pradesh. The districts lying in the Chambal basin are Indore, Dhar, Dewas, Ujjain, Ratlam, Shajapur, Rajgarh, Mandsaur, Morena, Sehore, Guna and Bhind of Madhya Pradesh; Jhalawar, Udaipur, Chittorgarh, Kota, Bhilwara, Bundi, Sawai Madhopur, Tonk, Ajmer, Jaipur, Dholpur of Rajasthan and Etawa of Uttar Pradesh.

The river Chambal rises from the Vindhyan ranges near Mhow town in the Indore district of Madhya Pradesh. It is the largest tributary of the Yamuna. It joins the Yamuna near village Sahore of the Etawa district after a total travel of 960 kms. The river flows in the northerly direction in its initial reach upto the border of Madhya Pradesh and Rajasthan and north- easterly direction in its subsequent reach upto the village Pinhat in Rajasthan from where it turns south to its confluence with the Yamuna. The important tributaries of the river Chambal are Cham, Siwana, Ratan, Gambhir, Sipra, Kalisindh, Kural, Parbati and Banas.

2.1.2 Parbati sub-basin upto Patanpur

Parbati is a principal tributary of the Chambal River. It originates in the Vindhyan ranges at an elevation of 609 m near Astha town in the Sehore district of Madhya Pradesh and after traversing a distance of 436 km it joins the river Chambal in the Kota district of Rajasthan. It lies between the North latitudes of $22^{\circ} 46'$ to $25^{\circ} 52'$ and East longitudes of $76^{\circ} 19'$ to

$77^{\circ} 25'$ and has fern leaf shape. The catchment area of the Parbati sub-basin is 15,861 sqkm which is 11.96% of the total catchment area of the Chambal basin. The catchment area of sub-basin upto Patanpur is 5312 sqkm. The districts falling in the Parbati sub-basin are Sehore, Bhopal, Vidisha, Shajapur, Rajgarh, Guna, Shivpuri and Morena in Madhya Pradesh and Kota and Jhalawar in Rajasthan. The river Parbati flows through a length of 222 km in Madhya Pradesh passing through Sehore, Bhopal, Vidisha, Shajapur, Rajgarh, Guna, Shivpuri and Morena districts and thereafter it follows along the common boundary of Madhya Pradesh and Rajasthan for a length of about 50 km and the remaining 164 km length of the river lies in Kota district of Rajasthan. The river is joined by a number of tributaries, the more important of which are Papnaus Ajnal, Sewan Paru, Utawali, Paraparwa, Mawal, Tem, Bhader, Gochi, Gaumukh, Sunk, Negri, Chopan, Uproni, Duhral, Andheri, Beram, Kosam, Ahelil and Sukni. The Patanpur dam site is located in Biaora tehsil of Rajgarh district in Madhya Pradesh.

2.1.3 Newaj Sub-basin upto Mohanpura

The Newaj is left bank tributary of the river Parwan which is a right bank principal tributary of the Kalisindh. The catchment lies between North latitudes of 22°51'06" and 24°24'44" and East longitudes 76°27'11" & 77°05'53". The Newaj River rises at an elevation of 634 m in the Astha tehsil of the Sehore district in Madhya Pradesh and traverses a total length of 220 km, out of which 205 km is in Madhya Pradesh and the remaining in Rajasthan. The average bed slope of Newaj River is 0.15%. The catchment area of Newaj upto its confluence with Parwan is 4372 sqkm and the area upto Mohanpura dam site is 3594 sqkm. The districts covered by the sub-basin are Sehore, Dewas, Shajapur and Rajgarh in Madhya Pradesh and Jhalawar in Rajasthan. The Dudhi River is the main tributary of river Newaj.

The Mohanpura dam site is located in Mohanpura Village of Biaora tehsil of Rajgarh district in Madhya Pradesh. The districts covered by the sub-basin upto dam site are Dewas, Sehore, Shajapur and Rajgarh of Madhya Pradesh.

2.1.4 Kalisindh sub-basin upto Kundaliya

The river Kalisindh is a principal tributary of the Chambal. It originates near Bagli village in the Dewas district and joins the river Chambal in the Kota district of Rajasthan. The Kalisindh sub-basin lies between North latitude 22°34' and 25°32' and East longitude 75°30' and 77°07'. The catchment area of the Kalisindh sub-basin is 24,663 sqkm, which is 18.61% of the total catchment area of the Chambal basin. The catchment area of Kalisindh sub-basin upto Kundaliya dam site is 5953 sq.km. The districts falling in the Kalisindh sub-basin are Dewas, Ujjain, Shajapur, Rajgarh, Sehore, Guna and Mandsaur in Madhya Pradesh and Jhalawar, Kota and Chittorgarh in Rajasthan. The Kalisindh river rises at an elevation of about 610 m of the Barziri hill near Bagli village in Dewas district and traverses in northerly course for its total length of 351 km till it joins the river Chambal. The river Kalisindh flows through a length of 180 km in Madhya Pradesh through Dewas and Shajapur districts and the remaining 171 km through Jhalawar and Kota districts of Rajasthan. The river is joined by a number of tributaries, the more important of which are Lakhundar, Ahu and Parwan.

The Kundaliya dam across river Kalisindh is proposed to be located near village Kundaliya in Zeerapur tehsil of Rajgarh district of Madhya Pradesh. The districts covered by the sub-basin upto the dam site are Dewas, Ujjain, Shajapur, Rajgarh and Sehore of Madhya Pradesh.

2.2 Topography & Geology

2.2.1 Topography of Parbati sub-basin upto Patanpur dam site

The river Parbati rises from Vindhyan ranges at an elevation of about 609 m. The sub-basin lies in physiographic region of Malwa Plateau. The river originates in the Bhopal Plateau, a sub-section of Malwa Plateau. The Parbati sub-basin comprises of upland, eastern ranges, western ranges and valley portion. The upland areas are either plain rolling land or gently rolling series of mounds and valleys and cover parts of Sehore, Bhopal, Shajapur and Vidisha districts in Madhya Pradesh. The eastern

ranges are well defined and continuous and separate the high table land of Sindh sub-basin and the western ranges of the Kalisindh sub-basin. At many places in the sub-basin, there are isolated hills upto elevation 600 m. The river channel is deep at the dam site and also on the upstream side having a significant storage space in river channel. The area above the bank level on both the sides of the river are generally plain having gentle slope. The drainage density of the sub-basin is moderate.

2.2.2 Topography of Patanpur dam site

The river reach at Patanpur is straight and deep. The left bank has a steep slope. The natural ground level rises from 403 m to 418 m in a distance of 200 m on the left bank and then ground is almost flat and attains the level of 420 m after a distance of 1.5 m. The right bank has a moderate slope. The level on the right bank rises from 402 m to 418 m in a distance of 550 m and then rises to 421 m in a distance of 800 m. The river channel for approximately 150 m width is flat. In the upstream side of the dam axis, the tributary Tem joins river Parbati on the right bank.

2.2.3 Topography of Patanpur reservoir

The reservoir area is mainly flat on both the sides of river with isolated hills on both the banks and also at few places away from the banks. The elevation of these hills rises 400 - 500 m and their presence, even on the banks, is not advantageous for reservoir as these are not continuous. The area around Patanpur dam site has moderate rolling undulation on both the flanks of Parbati valley. The area has alluvium deposits in patches and is suitable for cultivation. The isolated hill tops have mostly exposed rocks with poor vegetation. The reservoir area is mainly confined to the main river channel of Parbati and its tributaries. The slope of river on the upstream side of dam is very gentle with very deep depressions in the river channel. These deep trenches in the river remains filled with water even during non-monsoon period when the river is practically dry. The water stored in these depressions is used by farmers for irrigation by lifting the water by their private pumps.

2.2.4 Geology of Patanpur dam site and reservoir

The river bed at Patanpur dam alignment has fresh to slightly weathered exposed basalt. Flanks are made up of basaltic rock with thin veneer of soil. The dam alignment area, in general, has soil/alluvial cover consisting of black clayey soil, sandy silty loam and regolith. The rock mass exposed in the Parbati River along the axis of the Patanpur dam is basalt of flow unit dark grey to deep green with fine to medium grained. Both the banks of the Parbati are occupied by alluvial deposits or in-situ soil varying in thickness from 1 m to 6 m. Below soil, the bed rock are weathered to a depth of 2 m to 3 m necessitating the need of partial/positive cut off for earth dam on either flank. In view of the shallow bed rock profile in the river span, low porosity and high compressive strength of the rock mass are met with at the proposed site. The site is geotechnically suitable for masonry/concrete structures.

2.2.5 Topography of Newaj sub-basin upto Mohanpura dam site

The upper catchment of Newaj sub-basin falls under the Makidesh physiographic region while lower catchment falls under Umatwara plateau, which covers parts of Rajgarh and Shajapur districts of Madhya Pradesh. The parts of Jhalawar plateau in the northern part of Rajgarh district and southern part of Jhalawar district also form part of catchment in the lower reaches. The slope of land is from south to north and gentle. The catchment is bounded in the south by the great Vindhyan ranges.

2.2.6 Topography of Mohanpura dam site

The left bank of the river at the Mohanpura dam site is gradually rising for a distance of about 1 km from 385 m to 400 m and there after it becomes flat and joins almost the level ground. The strata on the left bank seems to be pervious with layers of boulders, gravels, pebbles, sand and silt. The river bed is almost flat for about 100 m in the centre. The spillway is proposed to be located centrally where the river has exposed rock surface. The right bank of river is almost vertical at the dam site from a level 378 m to 387 m. After attaining a level of 387 m at right bank, the ground again has a gentle slope for about 600 m and beyond this the ground in almost level. The strata on the left bank appears to be impervious with mainly clay and very fine silt which is suitable for cultivation. The strata on the right flank appears to be impervious with mainly yellow soil and morum mixed with boulders/gravels. The river has gentle slope on the upstream side and steeper slope on the downstream side of dam site.

2.2.7 Topography of Mohanpura reservoir

The reservoir area lies in Rajgarh, Biaora and Narsinghgarh tehsils of Rajgarh district of Madhya Pradesh. Reservoir surveys have been carried. Based on field survey, the reservoir plan has been prepared to a scale of 1:5000 with contour interval 1 m. Both sides of the reservoir are formed by elevated land with elevation more than 405 m. The reservoir area is mainly confined within 500 m on either side of the river and has mostly gentle slope. The slope of the river on the upstream side of the dam is very gentle and no depression has been seen in the river channel.

2.2.8 Geology of Mohanpura dam site and reservoir

The Mohanpura dam site on river Newaj sub-basin is in Malwa Plateau of western Madhya Pradesh which is characterised by a typical trappean topography comprising extensive plains. The region is occupied by rocks of two chronologically different geological domains. The upper most sequence comprises thick cover of basaltic lava flows and associated inter trappeans of the Deccan trap complex covering the sedimentary sequence of Vindhyan super group. Alluvium corresponding to quaternary to recent period is mainly confined along the bank of major rivers. The area comprises soil profile ranging in thickness from 0.5 m to 6 m.

Regional geological formations are the basaltic lava flows occurring in the neighborhood of Newaj River and belong to the Kalisindh formation (100 m thick) of the Malwa Group. The axis of Mohanpura dam passes through flow unit No.F4 exposed in Newaj river section. The basalt in this flow unit is dark gray to deep

green, fine to medium grained, hard, compact, massive and rarely prophyritic, possibly representing the middle part of a flow unit.

2.2.9 Topography of Kalisindh sub-basin

The catchment is dominantly plain and cascades towards north interspersed by two hill ranges viz. Mukandwara and Ratibar. The area is bounded on south by the great Vindhyan ranges where most of the southern tributaries of Yamuna originate. The altitude in the catchment ranges from 600 m in the upper reaches which falls in the Malkidesh physiographic section to 300 m in the lower reaches which falls in the Mukandwara and Ratibar ranges. The lower part of catchment covers the northern parts of Shajapur, Rajgarh, Guna and Southern parts of Jhalawar districts which forms parts of Jhalawar plateau having an average elevation of 300 to 450 m. The catchment area is bounded by the Narmada sub-basin in the east and upper Chambal basin in the west. The land slopes are gentle from south to north and have the characteristics of Malwa Plateau.

2.2.10 Topography of Kundaliya dam site

The cross section of river Kalisindh is with gorge portion and relatively flat. The right bank is almost vertical rising to a level 376 m from bed level of 337.45 m in a distance of 50 m. The river bed is flat for about 75 m and rises steeply to a level of 350 m. Beyond this, the ground has a gentle slope for a length about 2.00 km and finally rises steeply upto level of 382 m. The right bank has steep sloping hill with exposed rocks. The entire river bed is covered with boulder. The sloping left flank has mainly soil strata.

2.2.11 Topography of Kundaliya reservoir

The area around the Kundaliya dam site is almost flat with rolling undulation on both the flanks of the Kalisindh River. The Channel of Kalisindh River and its tributary Lakhunder River also form part of reservoir/storage. On the upstream side of the dam axis, there are few low lying areas especially on right bank of the river. The low lying areas have high hills bordering them and makes the site suitable for construction of a storage dam. Overall the area is characterised by a typical trappean topography comprising extensive plains, low lying flat topped hills and isolated hills forming mesa, butte and various other land forms. The reservoir area is mostly flat on both sides of the river. The river mostly flows from south to north with dendritic to sub-dendritic pattern. The drainage density in the area is low to moderate. Vegetation is poor especially on the right bank side due to presence of pebbles and sloppy ground rendering the soil unfit for cultivation.

2.2.12 Geology of the Kundaliya dam site and reservoir area

The proposed Kundaliya dam alignment, except river section has soil cover consisting of Yellowish, concretionary soil, Sandy-silty loamy soil, black cotton soil, in addition to unconsolidated to semi-consolidated recent sediments of sands, Kankars, boulders etc. Near the dam axis, the right river flank has two flow units of mixed character with a thickness of 8 to 10 m. In the river bed, along the dam alignment,

the older flow unit is exposed. The basalt flow unit is dark grey, fine to medium grained, hard, compact, massive and rarely prophyritic.

Structurally the area around the proposed Kundaliya dam site is free from major structures such as fault, lineament or shear. The location and alignment of storage dam is ideal and geologically favourable. Seismically also, the area has not experienced any major geological event in the recent past. Being located in a flat/peneplained country, the risk of other natural hazards is minimal. The presence of sound and fresh mass (dark gray, hard, dense, massive, sparsely prophyritic basalt with low porosity and high compressive strength) at the site make it geotechnically suitable for masonry concrete structures.

2.3 Hydrogeology of Parbati-Kalisindh-Chambal link

The Parbati-Kalisindh-Chambal link is confined to the Chambal basin only. The upper parts of the catchment of Parbati, Newaj and Kalisindh sub-basins contribute to the water availability for transfer. The enroute command also lies in the upper parts of Parbati, Newaj, Kalisindh and upper Chambal sub-basins.

The hydrogeological formations of the area includes Purana formation of both Vindhyan and Cuddapah age comprising of orthoquartzites, lime stone and shale sequences. The districts of Bhopal, Guna and Rajgarh are covered by these formations. The orthoquartzites and shale behave similar to the older metamorphics with ground water occurring only in the weathered mantle and fractured zone underneath. The lime stone sequence is however different in its behavior, as it is generally typically karstic with well developed grikes, clints and varieties of sink holes. The well located in the lime stone formation of the purana sequence are easily capable of yielding 100-500 m³/day for a draw down of 3 m.

The Deccan trap cover large part of the Shajapur, Bhopal, Guna and Indore of Madhya Pradesh and Chittorgarh and Jhalawar district of Rajasthan. They are generally simple and AA type of flow, where each flow is separable into vesicular and massive units. These flows are generally 10 m to 20 m in thickness, of which 25 to 40 percent is generally vesicular. The characteristic red bole beds generally form the marker horizons between the successive flows. The Deccan traps with vesicular units in them are generally moderately reproductive with well capable of yielding 250-750m³/day from a draw down of 3 m to 6 m. The specific capacity ranges from 50 to 150 lpm/m of draw down. Hydraulic conductivity ranges from 5 m to 15 m/day.